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C. Scott Hardaway Jr.

Donna A. Milligan

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Table of Contents

Introduction

Hole in the Wall (HITW) is located in Mathews County, Virginia (Figure 1). It is a natural channel between fetch-limited barrier islands that provides access from Chesapeake Bay to Milford Haven and Gwynn Island. Milford Haven is a unique tidal creek watershed occurring between Chesapeake Bay and the Piankatank River and consists of numerous lateral tidal creeks entering from Gwynn Island to the north and others entering from the south including Lanes Creek, Stutts Creek, Billups Creek, Stoakes Creek and Whites Creek (Figure 2). Presently, the barrier between Milford Haven and Chesapeake Bay includes the northern barrier and Rigby Island. Another tidal inlet ebbs and flows between Milford and Hills Bay. This inlet on the western side of Milford Haven is recognized as a federal navigation channel.

Reach Geomorphological Change

In 1853, sea level was about 1.5 ft lower than present. The bay barriers bordering Chesapeake Bay were more extensive and more continuous at this time having two tidal inlets entering Milford Haven from the east (Figure 3). The tidal flow through Milford Haven occurred through those two inlets/channels and the channel into Hills Bay. The proposed HITW channel has occupied its approximate present position since at least 1853. The 1877 map shows that the channel is likely a persistent feature as indicated by the shallow ebb shoal mapped at the mouth of HITW in Chesapeake Bay (Figure 4). The Milford Haven federal channel and the more southern barrier channel that exited just north of where Stoakes and Whites Creek joined had channel throat depths of 20 and 16 ft, respectively. These two channels controlled most of the tidal volume at that time because the present day HITW channel was shoaled in at 2 ft. The topographic map from 1916 shows the more southern channel has closed as the two southern barrier islands became one large barrier called Rigby Island (Figure 5). The southern tip of Rigby was only barely attached to the mainland such that a new, small inlet developed at the very southern distal end of Whites Creek. The Milford Haven federal channel was still about the same, but the HITW channel was wider and had become the main inlet between Milford and Chesapeake Bay.

Ongoing erosion continued to fragment the bay barrier system. In 1937, the HITW channel was still present along with another small inlet that had developed just north of HITW (Figure 6). The Milford federal channel remained the same while the small Whites Creek inlet has filled in. Aerial imagery in 1953 shows the inlet between the two barriers where HITW channel occured had broadened with shoaling in the middle (Figure 7). The channel was still the primary eastward tidal connection between Milford Haven and Chesapeake Bay. By 1978, the opening on the HITW channel was very wide as the bay/barrier system continued to fragment but the present-day channel appeared roughly entrenched (Figure 8). A breach between Gywnn Island and the adjacent northern barrier can be seen into Hills Creek, further exacerbating open water breaches along the reach. The small intermittent inlet at the south end of Whites Creek appeared closed at this time.

By 1994, both the northern barrier island and Rigby Island had been significantly reduced in size and separated from mainland (Figure 9). Sediment transport processes on this Bay coast favor a net alongshore southerly flow as evidenced by a large shallow shoal east of Sandy Point. Thissand shoal impacted the existing channel where the southerly-moving sand is filling in some areas of the natural channel.

In 2002, the inlet between Gwynn Island and the northern barrier was still open, and HITW channel had roughly the same orientation (Figure 10). A more southern inlet opened, but it was not in the same location as the historical inlet that flowed out of Milford Haven in 1877 just north of the confluence of Stoakes and Whites Creeks. The historical channel was located about 1,600 ft south of the 2002 inlet. This southern channel was shallow, only about -4 to -5 ft mean lower low water (MLLW). The Whites Creek inlet was fully open as Rigby Island continued to be reduced in size. In 2017, the HITW channel is shown just south of the offshore shoals, and the northern inlet had begun to fill in with sand (Figure 11). The tidal current regime along the bay/barrier system was relatively diffuse because the barrier system consisted of only fragments of islands whereas the Milford federal channel tidal inlet remained the same with strong currents and deep water.

Hole in the Wall Today

Today, Milford Haven is known for having significant working waterfront facilities and infrastructure, including the US Coast Guard Station. Though it is possible to access the Chesapeake Bay through the Milford federal channel, it is the long way around. The HITW channel is the only viable location to exit directly to Chesapeake Bay. It is not a federally-authorized channel, but it is marked with aids to navigation (ATONs). Mathews County temporarily assumed maintenance of the federal ATONs in October 2017 in an attempt to cover the public responsibility for maritime transit at HITW. The County has continued to maintain the ATONs until the channel is dredged to a depth that will allow the US Coast Guard to resume its maintenance responsibilities. This temporary solution provided by the County has ensured safe maritime travel over the short-term, but dredging the channel and returning ATON maintenance responsibilities to the US Coast Guard will provide the most sustainable long-term solution for HITW.

Hole in the Wall once provided easy access to the Chesapeake Bay for commercial fishing as well as for recreation. In addition, the US Coast Guard Station at Milford Haven uses this open channel to reach calls or conduct maintenance south of Gwynn Island more easily and quickly. Currently, the US Coast Guard boats may have to travel around Gwynn Island to the west to reach calls to the south of Gwynn Island. This could ultimately increase time to reach calls and conduct maintenance. What is a 4-mile trip through Hole in the Wall becomes 8 miles when traveling around Gwynn Island. In addition, Milford Haven is a Harbor of Refuge which is a port, inlet, or other body of water normally sheltered from heavy seas by land and in which a vessel can navigate and safely moor. Having to travel farther in adverse conditions to access the harbor of refuge poses problems for mariners.

Today, narrowing of the channel in some sections makes it difficult for ingress and egress of vessels to Milford Haven through HITW. Public and private boating facilities are currently being utilized as Milford Haven provides seasonally critical access for landing, docking, and mooring in close proximity to public and private oyster grounds and fishing in Chesapeake Bay as well as year-round recreation. Dredging of HITW is necessary to establish a channel with navigable depths to provide safe navigation for vessels. The data collected for this project was used to develop the dredging and disposal strategies for the channel.

Channel Condition Survey & Sediment Sampling

Channel Condition Survey and Base Mapping

The channel condition surveys were performed by licensed surveyors at Waterway Surveys & Engineering, Ltd to determine the depths at Milford Haven. Though this site has ATONs, it is not a federally-designated channel and has never been dredged. The survey covers enough area to define the proposed channel both inside and outside of Milford Haven, on either side of the proposed channel, and far enough seaward to reach the channel design depth in the natural system. Soundings were taken using a single beam sonar system operating at 208 kilohertz, and a differential global positioning system (DGPS) was used to obtain horizontal positions.

Coordinates were taken in US survey feet and referred to the Virginia State Plane coordinate system south zone based on NAD83 (Figure 12). Sounding were taken on July 7-21, 2020 about 10 ft apart in lines spaced approximately 100 ft apart. The points were referred to mean lower low water (MLLW). MLLW, National Tidal Epoch of 1983-2001, was determined by the National Ocean Service (NOS) at HITW Creek. Mean tide range is 1.2 ft based on NOS observations.

Survey points were imported to Esri ArcMap, and a vector-based triangular irregular networks (TIN) surface was created. A TIN is a representation of a continuous surface consisting entirely of triangular facets. The vertices of these triangles are created from field recorded spot elevations from the bathymetric survey. From the TIN, a digital elevation model (DEM) was created. The DEM is a 3D computer graphics model of elevation data to represent terrain. In this case, the raster DEM grid size was 5 ft and uses colors to represent the bathymetry in feet relative MLLW (Figure 13). The DEM can be used to calculate the amount of material that will be removed during dredging by assigning the channel grids to the desired dredge depth and determining the difference between the existing bathymetry and channel DEMs.

Sediment Sampling – Physical and Chemical

A geotechnical analysis provides a sediment profile through direct sampling and testing studies of the in-situ benthic material. Ten, 10-foot cores were taken by Athena Technologies, Inc. in the channel (Figure 14). In addition, three 5-foot cores were taken by Waterway Surveys & Engineering, Ltd. The cores were photographed (Appendix A), logged (Appendix B), and sampled by VIMS to provide the types, configuration, and geotechnical character of the subbottom soils present. Grain size analysis by the VIMS Analytical Services Center included percent gravel, sand, silt, and clay (Appendix C) as well as a detailed representation of the sand portion using the Rapid Sediment Analyzer (RSA) settling tube. Percent moisture also was determined. Select samples taken from cores 5, 6, 8, and 9 were sent to Schnabel Engineering, LLC for analysis because these cores contain the material to be dredged. A moisture content (ASTM D2216) and sieve analysis (ASTM D 422) were performed.

The Evaluation of Dredged Material Proposed for Discharge in the Waters of the U.S. – Testing Manual was developed as a joint effort by the Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (EPA&USACE, 1998) and is referred to as the "Inland Testing Manual (ITM)." The purpose of the manual was to "establish procedures applicable to the evaluation of potential contaminant-related environmental impacts associated with the discharge of dredged materials in inland waters, near coastal waters and surrounding environs." The ITM was primarily developed to establish testing protocols associated with the disposal of dredged material discharges associated with navigation dredging.

The ITM utilizes a tiered approach to determining test requirements for dredged material disposal. There are four tiers: Tier I is an evaluation based on existing information; Tier II includes a chemical evaluation of identified contaminants of concern; Tier III is associated with general toxicity and bioaccumulation tests; and Tier IV provides for project specific toxicity and bioaccumulation tests.

The development of testing requirements always starts with a Tier I evaluation which is an analysis based on existing information. The evaluation can be based on previously collected physical, chemical or biological data; physical sediment characteristics (i.e. is the material comprised of sand, gravel or inert materials); or if the dredged material is associated with known sources of contamination. If there is no available chemical data at the dredging site, but the material is a sandy or inert material or there are no known sources of contamination or contaminant pathways to the dredging site, then there is "no reason to believe" that the disposal of the dredged material would have an adverse impact at the disposal site. Once it has been determined that there is "no reason to believe," then the dredged material passes the Tier I and no additional evaluation is required. If, however, there is "reason to believe" that there is the potential for contaminants to exist at the dredging site, then a Tier II evaluation would be initiated. The "contaminants of concern" must be identified and a then a sampling plan should be designed to address the concentration of those specific contaminants in the site sediment and water. The results of the Tier II evaluation determine the need for evaluation at higher tiers. If the dredging site passes a Tier I evaluation, the only other time that chemical testing may be required is for disposal of dredged material into a regulated area such as a landfill.

Even though HITW passes the Tier I test, it was sampled for chemical contamination because the material will be placed on Haven Beach, a public site in Mathews County. Two samples were collected from HITW on 4 Feb 2021 for chemical testing – one at a landward location and one at a bayward channel location (Figure 14). A grab sampler was used for data collection. The grab sampler was thoroughly cleaned before samples were extracted by rinsing in water, with any excess debris scrubbed off with a brush. Once retrieved with sediment inside, the grab sampler was set on the side of the boat to allow any excess water to drain. The closed grab sampler was then positioned on the side of the boat with the mouth of the sampler hanging over the edge, to prevent the sediment from coming in contact with the surface of the boat and potentially contaminating the sample. Sediment was scooped into sterile glass containers of various sizes provided by *Enthalpy Analytical* using a stainless-steel spoon. Samples were then placed in coolers and kept below 43ºF. Table 1 shows a variety of different chemicals, toxins, and metals that each sample was analyzed for, as well as potential sources. The results are shown in Appendix D, but neither sample locations had any of the contaminants in quantities larger than the limits of the tests used.

Table 1. A list of chemicals and metals tested in samples taken from Hole in the Wall as well as their possible source.

Analysis:	Source:
MTBEX*	fuel component for gasoline engines
TCLP Silver	Industrial use
TCLP Mercury	Industrial use
TCLP Arsenic	Industrial use
TCLP Lead	Industrial use
TCLP Barium	Industrial use
TCLP Selenium	Industrial use
TCLP Cadmium	Industrial use
TCLP Chromium	Industrial use
PCB**	Commercial electrical equipment
TCLP Predetermination SVOC***	Occurs naturally/Industrial use
TCLP Pest	Industrial use
TCLP Herb	Industrial use
Semi-Volatile Hydrocarbons as TPH Diesel Range Organics****	Compounds in diesel fuel
Organochlorine Pesticides and PCB's as Aroclor	Pesticides in agriculture
TCLP Organochlorine Herbicides	Pesticides in agriculture/plant removal
	Pesticides in agriculture

Note: TCLP stands for "Toxicity Characteristic Leaching Procedure"
*MTBEX refers to methyl tert-butyl ether (MtBE) which is the analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX)
**PCB refers to polychlorinated biphenyls, a harmful and highly toxic industrial compound
***SVOC refers to Semi Volatile Organic Compounds
****TPH refers to Total Petroleum Hydrocarbons

Benthic and Fisheries Assessment

HITW and Milford Haven are located in the polyhaline salinity zone of the lower Chesapeake Bay. Salinity ranges from about 18 to 30 ppt. Benthic sediment ranges from fine material in the creeks and lower energy areas to sand in the higher energy areas particularly along Chesapeake Bay and Hills Bay. The benthic communities around the Bay have been assessed using the Index of Biological Integrity. This index ranks the relative value of bottom communities around Chesapeake Bay by comparing values of key benthic community attributes ("metrics") to reference values expected under non-degraded conditions in similar habitat types. It is therefore a measure of deviation from reference conditions. Overall, the lower Bay had average ecosystem health (C) in 2019 (EcoHealth, 2019). After being the highest scoring region for six years, this region declined to the fourth highest score. All indicator scores decreased between 2018 and 2019 except for total phosphorus which remained the same. In 2019, the lower Bay was classified as average, 40% to <60%, on the benthic IBI scale (EcoHealth, 2019). Like all of Chesapeake Bay, Milford Haven was classified as very good for bay anchovy and striped bass.

Habitat is an important factor in bivalve community structure and distribution in lower Chesapeake Bay. Glaspie & Seitz (2017) found that the greatest densities of deposit-feeding bivalves were in detrital mud habitats; the greatest densities of thin-shelled and surface-dwelling bivalves were in submerged aquatic vegetation (SAV) habitats; and the greatest densities of armored bivalves were in oyster shell habitats. In addition, they reported that SAV increased bivalve diversity by 68, 76, 87, and 94% when compared to oyster shell, detrital mud, coarse sand, and shell hash habitats, respectively. Overall, bivalve diversity was associated with habitat type, habitat volume, and predator densities, and all habitats, and particularly SAV, play a role in maximizing bivalve functional diversity in Chesapeake Bay (Glaspie & Seitz, 2017). In particular, densities of thin-shelled commercial clams were associated with habitats with a high degree of complexity (seagrass and shell) as compared to some less complex habitats (mud, sand, and gravel) (Glaspie et al, 2018). Deposit feeding bivalves densities were lower in areas with higher blue crab densities. Blue crab is the dominant epibenthic predator. Some of the lateral creeks that feed into Milford Haven are restricted for shellfish harvesting due to water quality, but Milford Haven itself has no such restrictions. SAV habitat is shown on Figure 14.

In 2018, the VMRC approved 700 oyster cages covering about 5.5 acres of subaqueous bottom in Milford Haven. This will most likely result in increased efforts to establish oyster aquaculture in Milford Haven. The designed channel location occurs within public grounds (Figure 15) established by § 28.2-644 which declares the area "to be public oyster rocks, beds, and shoals and unassignable to any person for private use". It is important to note that the HITW public grounds were established separately and at a later date from the majority of public grounds established by the Baylor Surveys. Being that this section of Code sets restrictions for private uses only and the proposed use would be for public benefit and not occur within or over any public oyster rock or beds, it is recommended that the County apply for the proposed channel dredging at HITW as a public need maritime transit project. In addition to the public grounds, there is one private oyster lease occurring near but not within the HITW designed channel location (Figure 15). As part of the Joint Permit Application process, it will be necessary to contact this particular lease holder to discuss the proposed activities. It is recommended that it be communicated to the lease holder that every attempt will be made to ensure that the dredging activities will not occur within the leased area and that best management practices will be applied to limit turbidity in the water column during the dredging process.

Cores taken for this project included the top benthic horizon. Through ongoing visual assessment, no macroscopic benthic species were noted. This might include various species of polychaetae worms and small clams. This does not mean the benthic community is void but just not sampled by the cores. Despite their relatively small size, macro and meiobenthos are important components of the estuarine ecosystem, serving as critical links between the variety of organic matter sources in estuaries (e.g., phytoplankton, benthic micro- and macroalgae, detritus) and the economically, ecological, and recreationally important finfish and crustaceans that live there (Cicchetti, 1998). Baird & Ulanowicz (1989) estimated that approximately 50% of the fish production in Chesapeake Bay is directly linked to a benthic food web.

The abundance and distribution of juvenile fish is monitored as indicators of ecologically important finfish stocks. Recent recreational catches in Virginia are dominated by Atlantic Croaker (*Micropogonias undulatus*), Summer Flounder (*Paralichthys dentatus*), Spot (*Leiostomus xanthurus*), Striped Bass (*Morone saxatilis*), Black Sea Bass (*Centropristis striata*), Bluefish (Pomatomus saltatrix), Pigfish (*Orthopristis chrysoptera*), Weakfish (*Cynoscion regalis*), and Kingfishes (*Menticirrhus spp*.). These species depend on the lower Bay and its tributaries as nursery areas (Tuckey & Fabrizio, 2019). Additional species of recreational interest, such as Scup (*Stenotomus chrysops*), White Perch (*Morone americana*), Silver Perch (*Bairdiella chrysoura*), White Catfish (*Ameiurus catus*), Channel Catfish (*Ictalurus punctatus*) and Blue Catfish (*I. furcatus*), are also found in the lower Bay.

Schloesser & Fabrizio (2019) found that a particular area or habitat type may disproportionately support juveniles of one species due to the influence of spatially varying environmental factors which ultimately reveals spatial patterns. The estimation of habitat suitability for each forage species includes consideration of environmental and physical conditions (e.g., distance to shore, percent fine sediment). Suitable seasonal habitat extents for forage species exhibited strong seasonal and annual signals indicating that for juvenile forage species, suitable habitat conditions resulted from a complex interplay between water quality and the physical properties of the habitat. (Fabrizio et al., 2020). In general, the greatest extent of suitable habitat occurred in summer, and no suitable habitat occurred in fall and winter.

Dredging impacts to fisheries is a concern that has been evaluated and researched by the Corps over the years. Motile forms of biota should be able to avoid the dredging operation; as such, most fish will not be impacted. The main potential impact is by entrainment of the species in the hydraulic dredging operation itself. The proposed project would result in the temporary destruction of marine habitat and the associated benthos in the channel. For oysters, larval stage impacts have been reported. However, after dredging, repopulation of benthic organisms within the dredging will begin quickly (Newell et al., 1998). In estuaries, communities are well adapted to rapid recolonization of deposits because they are typically subject to frequent natural disturbances. Rates of recovery vary from 6-8 months in estuarine muds, possibly 2-3 years in sand and gravel habitats.

Sometimes permitting agencies will invoke a time of year (TOY) restriction on dredging when these species are migrating and/or overwintering. In addition, deeper dredging projects at a site will limit the frequency and duration of impacts over time because additional cycles of dredging may not be needed. In general, this project will not cause long-term adverse effects on the surrounding ecosystem. Any effects on the environment should be minimal and be offset by the project benefits of maintaining safe navigation and commerce.

Channel Design and Disposal Strategy

Channel Design

Several designs were considered at HITW. The final dredge channel design took into consideration the existing historic channel and ATONs. The resulting proposed channel is 150 ft wide and 18,000 ft long with a controlling depth of 6 ft below MLLW. It follows existing ATONs from inside Milford Haven to where it exits to Chesapeake Bay.

Presently, to create a -6 ft MLLW channel and 1 ft of over-dredge (Total dredge depth -7 ft MLLW), approximately **40,000** cy of material will be hydraulically dredged and disposed of (Figure 16). Generally, only the area in the middle of the channel needs to be dredged. The calculated DEM depicts the amount of material to be removed using color. Sections of the channel that require more dredging are shown in red. Sections of the channel where less material needs to be removed are shown in green. Areas deeper than -7 ft MLLW are shown in white because no material needs to be dredged in that section of channel. A draft joint permit application for this scenario is included as Appendix E.

The nature of channel dredging and maintenance can be seen in the core logs and depositional patterns. Typical channel cross-sections depict the change from existing bottom that will occur due to dredging (Figure 17). At profile A, only a little material will need to be dredged. Profile B shows that there is a natural channel at the site. The dredging will expand its width, but it is already 7 ft deep. Though profile C does not need much dredging at this time, the existing conditions show the large, shallow sand shoal on the right side of the profile. At profile D, the sand shoal is migrating south into the channel, and this area will need the most dredging.

Sediment analysis of cores taken in the channel show that the material is sandy enough to be placed along the shoreline (Figure 18). The percent of fines in cores 5, 6, 8, and 9 in samples taken above -7 ft MLLW varies from 1% to 6%. The D_{50} for the section of the cores that will be dredged was 0.25 mm (core 5), 0.33 mm (core 6), 0.2 mm (core 8), and 0.2 (core 9). Beach nourishment minimum grain size requirements typically require that the D_{50} be about 0.25 mm. This material should average out to at least that.

Also modeled were two other dredge depth options. A -5 ft MLLW channel with a 1 ft overdepth would require about **12,000** cy of material to be removed. However, a channel needs to be at least 6 ft deep so that a buoy-tender can access the site to set and/or maintain the ATONs. Also calculated was a -7 ft MLLW channel with a 1 ft overdepth. The amount of material that would need to be removed increases to **83,000** cy. Increasing the depth by this one foot doubles the amount of material that needs to be dredged because a larger area of the channel would need to be dredged. In cores 11, 12, and 6, the deeper material is clay. Dredging deeper increases the amount of clay material that would have to be disposed of. The amount of fines in the sample would grow, increasing the D_{50} such that the material may not be suitable for placement on the shoreline.

Advanced maintenance is another option for this channel. Advance maintenance is dredging to a specified depth and/or width beyond the authorized channel dimensions in critical and fast shoaling areas to avoid frequent re-dredging and ensure the reliability and least overall cost of operating and maintaining the project authorized dimensions (Tavolar, 2007). At HITW, advanced maintenance would be useful only on the outbound portion of the channel where the sand shoal impacts it. The proposed advanced maintenance would widen the channel another 150 ft on the north side, extend about 4,300 ft but is only 6 ft deep. If this is dredged, it would result in an additional 55,000 cy of sand, more than doubling the proposed channel dredging. This has significant implications for cost, disposal, and permitting issues that need to be considered. Cores 7 and 10, which were taken on the sand shoal north of the channel (Figure 14), indicate that the material down to -6 ft MLLW is sand that can be placed along the shoreline at Haven Beach.

Disposal Strategy

The sediment analyses show the dredge material to be sand suitable for shoreline beneficial use as beach nourishment. The present plan is to pump the material about 2-2.5 miles south of HITW to Haven Beach which is a Mathews County-owned property that is regularly used for recreational access (Figure 19). Two breakwaters presently occur at the site. In the Mathews County Shoreline Management Plan, Hardaway et al. (2010) created a conceptual plan for additional breakwaters at Haven Beach because outside of those two structures, downdrift shorelines continue to erode. A series of breakwaters with beach fill was suggested along this reach, and because a great deal of sand will be needed for beach fill, dredging from Mathews' shallow draft channels was suggested as a possible source. Data collected by VIMS, Shoreline Studies Program in 2010 found that sediment in the nearshore at Haven Beach had a D_{50} of 0.22 mm and at midbeach the D_{50} was 0.28 (Milligan, 2020). This makes a good match for the dredge material.

Haven Beach Geomorphic Change

Haven Beach is part of a low barrier beach/dune feature that is migrating (receding) westward. The shoreline at Haven was eroding at a high rate (-5 to -10 ft/yr, 1937-2017 end point rate). In 1953, the present location of the beach was well inland, and Rigby Island was still attached to the mainland although the location of attachment was very narrow (Figure 20). By 1994, Rigby Island had detached and was rapidly deteriorating (Figure 21).

Haven Beach historically has been used by residents and visitors for recreation and Bay access. In 1985, State Route 643 ended at the shore where a small sandy parking area existed behind a timber bulkhead, and a fairly continuous beach along the Haven Beach shore had several concrete well curb groins. In an attempt to alleviate erosion at this site, five experimental breakwaters were installed in 1985, but these ultimately failed. Today, none of these original shore protection structures exist. In 2005, the county installed one large breakwater and one small breakwater with beach fill along the shoreline to stop erosion and protect the marsh habitat in the backshore (Figure 22). South of the breakwaters, an old peat surface intersects the beach at about mean tide level. The peat forms a wide terrace in some areas south of the breakwater that has supported the regrowth of smooth cordgrass. Above the peat, wash-over sand occurs which is sparsely populated with upper marsh and dune grasses. The north half of Haven Beach is a sandy beach/dune complex vegetated by dune grasses and fronting the marsh. Though the large breakwater is functioning well as shore protection, the smaller breakwater lost most of the sand behind it during a storm in 2015.

In 2017, Rigby Island had broken into two sections, and, as a result, Whites Creek experienced a much greater level of exposure to the Chesapeake Bay (Figure 23). The small, southern, Rigby Island remnant, just barely above water level in 2017, is completely eroded by July 2020. At Haven Beach, no sand occurs behind the small breakwater. Drone imagery taken 30 July 2020 and rectified in GIS was used to provide a baseline of existing conditions for the plan. It shows the habitats along the shoreline (Figure 24), and the peat outcrops that occur along the shoreline south of the breakwaters. Along the shoreline, sandy beaches front washover dunes and vegetated and non-vegetated wetlands. The tombolo behind the large breakwater is heavily vegetated.

The physical assessment of the shore zone at Haven Beach included shoreline type, stability, width, and the location of natural resources, such as SAV. Using Real-Time Kinematic GPS and Robotic Total Station technology, the beach, marsh, and nearshore were surveyed for elevation and areal extent of habitat on October 14 and October 28, 2020. The survey was tied into horizontal and vertical survey control systems (NAD 83 horizontal datum/NAVD 88 vertical datum) and adjusted to mean low water (MLW). The conversion from NAVD88 to MLW at the site is 1.1 ft. Cross-shore profiles were exported at locations shown on Figure 25. Tide range is 1.3 ft. No SAV occurs in the nearshore of Haven Beach. A private oyster ground lease occurs right at the boundary with Haven Beach (Figure 26). Every attempt will be made to ensure that project will not interfere or impede the leased area. The dredge material can be placed to the south so it can be bulldozed northward. Where possible, the dredge pipes will be placed around the lease to minimize impacts. Turbidity curtains will be used at the site to contain finer material. Due to the southward longshore transport of sand along this section of Chesapeake Bay, placed dredge material is unlikely to have long-term impacts to the nearhore region north of the project. An application exists for a private ground just offshore of Haven, but the Virginia Marine Resources Commission stated that it would be on hold pending an application for a living shoreline/dredge disposal project.

Haven Beach Living Shoreline Design

Haven Beach is an ideal spot for disposal of sandy material from HITW channel dredging. This beneficial reuse of material will provide protection to the Haven Beach shoreline. In addition to also providing enhanced recreational access for the citizens of Mathews County, the sand will protect the eroding marsh habitat behind the beach and provide broader protection and coastal resilience to areas in the County vulnerable to coastal flooding and storm surge. The dredged sand will be placed starting at the +8 ft MLW contour (Figure 27). North of the large breakwater, the fill will extend out 60 ft before it slopes on a 10:1 slope to +4 ft MLW. A 10 ft terrace will be constructed, and the material will then extend into the nearshore on a 10:1 slope. South of the large breakwater, the upper terrace will only be 50 ft wide. The sand will be pumped to Haven Beach and spread along the shoreline into the design configuration by bulldozer. This design will accommodate about 40,000 cy of material within the area shown in yellow and between the northern boundary and BW 5 (Figure 28). The outer boundary of yellow approximates the new position of MLW after dredge material placement. If additional sand is dredged through advanced maintenance, some of it could be accommodated at Haven Beach but not all 55,000 cy. It could either be placed south of Haven Beach, along the barrier islands, or at Gwynn Island. However, these sites would require owner's permission and permitting.

Without additional structures, it is likely that the placed sand will be eroded from Haven Beach and moved south via longshore transport. Sand north of the existing breakwaters would be eroded from the shoreline and transported south bypassing the structures. Overall, the beach width would gradually diminish over time along the reach. BW 2 would continue to function, but BW 3 would still be too short to effectively hold sand behind it.

Additional breakwaters can be constructed to hold the material in place and enhance long-term shore protection and coastal resiliency at Haven Beach. The conceptual plan consists of three, 200-ft breakwaters (BW 1, 5, and 6), an extension off the small existing breakwater (BW 3 extension), and 100-foot breakwater (BW 4). BW 5 is placed at the peat outcropping on the southern end of the site to hold that headland. BWs 1 and 6 are placed near the boundary of the site to hold as much material onsite as possible. BW 4 is a small, bumper breakwater to maintain the beach within the larger embayment created between BWs 3 and 5. The limit of fill shown in black on Figure 28 shows the minimum amount of material needed for construction of the breakwaters. Without dredge material placement, machinery needs to be able to access the site. For that, sand will have to be brought in. In addition, the final plan should include sand fencing and beach/dune plantings.

The final breakwater design should be similar in size and construction to the existing BW 2. The structures are conceptualized and costed as engineered structures that layer large granite armor stone (2,000 lbs to 4,000 lbs) over 3" to 15" core bedding stone. A rock toe is designed on the bayward side of the structure to reduce scour in front. The existing structure was designed to have a +6 ft MLW crest elevation and crest width of 8 ft. Side slopes of the structure are at 1:1.5.

These breakwaters can be built in phases. The first phase should include, at a minimum BW 3 extension and BW 5. Extending BW 3 is most important because it presently does not function as intended. All the sand placed behind it has been lost, and the shoreline is continuing to erode. Eventually, it may impact the effectiveness of BW 2 which is functioning exactly as intended. Constructing BW 5 is very important to hold the existing marsh headland. Without it, the entire site will continue to erode at a high rate of erosion. Between 1937 and 2017, the end point rate of change has been about -7 to -8 ft/yr (Hardaway et al., 2020). Haven Beach is impacted by waves from both the northeast and southwest (Hardaway et al., 2010). BW 6 is oriented toward the southwest to protect the site from the waves coming through the mouth of Chesapeake Bay. It also protects the site's southern boundary and is an important structure to reduce downdrift impacts. If this structure is built, the beach fill template may need to be adjusted as there may not be enough dredge material from the HITW channel to place along this southern section of the shoreline. The overall width of the beach fill cross-section could be adjusted during final design process to compensate. BW 4 creates a wider beach in the center of the large embayment between BWs 3 and 5. Without it, the predicted embayed shoreline between the 2 structures would likely be landward of the present 2020 shoreline once the dredge material has reached equilibrium. BW 1 occurs on the northern boundary and will hold the material on site.

Other living shoreline solutions designed to withstand the high energy environments at Haven Beach may be a suitable and cheaper alternative to the engineered rock structures proposed in this report. Such designs and costs were not available at the time this report was prepared, but technologies may exist to fabricate concrete-molded, interlocking structures of adequate size and dexterity for use at Haven Beach. These structures also may be cast in a manner where the interior is hollow and could be used to store dredge material. However, Virginia code § 10.1-704 (1988) states that "the beaches of the Commonwealth shall be given priority consideration as sites for the disposal of that portion of dredged material determined to be suitable for beach nourishment". Whether the sandy material must be placed on the beach or in a containment unit may need consideration.

Should these structures be proven to provide the same resilience and shoreline protection as engineered rock structures in this high energy environment as well as prove cost effective, then it could be incorporated into the project design. Should VMRC not be willing to approve a permit for these structures, it could be proposed that the extension needed at BW 3 be constructed to test the effectiveness of the structures. If the VMRC approves this approach, then it would provide an excellent test location in that the structures could be tested in a side-by-side fashion with the existing granite breakwater at BW 3.

Threatened Northeastern Beach Tiger Beetle

The northeastern beach tiger beetle (*C. dorsalis dorsalis*) was listed as threatened in 1990. This once abundant insect has seen their populations greatly decline in Chesapeake Bay because their sandy habitats are impacted by human activities. The northeastern beach tiger beetle is a tiny (13-15 mm), sand-colored beetle that lives on sandy beaches throughout the middle and lower Chesapeake Bay. It feeds near the water's edge on flies, fleas and amphipods, and will also eat dead crabs and fish that wash up on the beach. Beetles mate in late June through August, and females lay their eggs in the sand just above the high tide mark. Eggs hatch in late July through August, and larvae live in vertical burrows in the sand (Chesapeake Bay Program, 2020). Beach width has been identified as the most important habitat variable accounting for presence and abundance of adults and larvae. Because most larvae are at and above the high tide line, narrow beaches do not provide sufficient back beach area for them to survive the effects of storms, tidal fluctuations, and erosional events during their two-year developmental period (Knisley & Gwiazdowski, 2020).

The significant decline and loss of populations of *C. dorsalis dorsalis* along the western shoreline of the Chesapeake Bay in Maryland and Virginia was documented by Knisley, Drummond, & McCann (2016). The Chesapeake Bay beaches occupied by *C. dorsalis dorsalis* are subject to progressive changes from erosion and accretion. The most recent surveys document a significant decline to <40,000 adults at about 70 sites throughout the Bay, with most of the decline along the more heavily populated and developed western shoreline (Knisley et al. 2016). In Mathews County, the beetle was found south of Haven Beach at three sites, two of which had declining populations. At Bethel Beach North and Bethel Beach, the population was declining, but at Winter Harbor, the population was increasing. In 2008, Winter Harbor had 412 tiger beetles, but in 2012, there were 2,301. In 2009, sand dredged from Winter Harbor federal navigation channel maintenance was placed along the shore. The primary cause of this decline was attributed to shoreline recession from rising tidal levels and the associated dramatic increase in shoreline armoring along the western shoreline (revetments, bulkheads, groins) in the past 20–30 years (Knisley & Gwiazdowski, 2020).

However, beach restoration has been identified as a method to increase the tiger beetle population in the Bay. Fenster et al. (2006) studied the impact of dredge material placement on the endangered tiger beetle within Chesapeake Bay. His study site was just north of Winter Harbor, and the material placed during the course of his study was the dredge spoil from the 2002 Winter Harbor dredging. The results of the study showed that sand nourishment resulted in an increase in adults and larvae of tiger beetle in the nourished region of Winter Harbor. In fact, large numbers of adults and larvae were found in the deposition area at Winter Harbor most likely because of the additional habitat (beach width) provided by the nearshore deposition (Fenster et al., 2006).

This finding further documents the importance of beach width as a significant habitat requisite for the threatened tiger beetle. Favorable habitats develop and subsist when sufficient (natural or artificial) space (beach width) exists and when the sediment characteristics of the dredge disposal material and natural beach habitat closely match (Fenster et al., 2006). At Winter Harbor Beach, nearshore deposition caused a 150 ft increase on average in beach width. Within weeks of deposition, adult northeastern beach tiger beetles rapidly moved onto the nourished sections of both beaches and produced large numbers of larvae. Winter Harbor Beach experienced the greatest increase in beetle numbers, most likely because of the additional habitat created by nearshore deposition (Fenster, Knisley & Reed, 2006). These beach parameters provided habitat for adult foraging, ovipositing and larval survival. Creating a stable beach habitat at Haven Beach is a restoration opportunity for the tiger beetle. In addition to creating habitat, species placement on site have been shown to increase populations. If a population of tiger beetles exists on Haven Beach, dredge disposal could be timed to avoid their peak reproduction times which occur during the summer months.

Longer-Term Sediment Management

Due to the sandy nature of the material in the long-shore transport system on Mathews County's Chesapeake Bay coast, longer-term regional sediment management should be considered. These coarser sands from the proposed HITW dredge channel as well as those at

Winter Harbor and Horn Harbor farther south can be used to create long-term resiliency for coastal areas of Mathews County. Presently, the approved site for disposal of dredge material at Winter Harbor is updrift of the channel. Though it increases the tiger beetle population as discussed above, it reduces the useful life of the channel as transported sand shoals in the mouth fairly quickly. These sands could potentially be used for projects that have the benefit of reducing coastal flooding and storm impacts along vulnerable coastal properties and infrastructure and protecting coastal habitats from erosion. Through regional sediment management, long-term projects could be identified so that when material becomes available, these projects are ready to be implemented.

In the Mathews County Shoreline Management Plan, Hardaway et al. (2010) created a conceptual plan for rebuilding Rigby Island using breakwater and beach fill. For many years, Rigby Island has provided wave, storm, and coastal flooding protection to the extensive shorelines of Milford Haven and associated creeks. As the Island has disintegrated, this energy has traveled farther into Milford Haven affecting coastal properties. This process will only worsen as Rigby Island continues to disappear especially in the face of sea-level rise. The potential for island reconstruction using dredge material from HITW and the shallow draft federally-approved channels in Mathews exists for future dredging cycles. In addition, the fine sands dredged regularly from the York Spit Channel could potentially be used in this process creating a beneficial use for the material.

Another potential project could be the construction of breakwaters and placement of fill at New Point Comfort Lighthouse. In the past, the lighthouse was attached to land (Hardaway et al., 2010), but due to high erosion rates along this section of coast, it now resides about 0.55 miles offshore. Presently the lighthouse is protected by a large revetment. However, the site is popular with kayakers, and creating a beach could not only improve recreation but also would provide a wide, beneficial buffer around the lighthouse that will enhance protection for this historic building.

Sand and finer sediment is an important natural resource that is critical to the environmental health and economic vitality of the coastal zone. By developing a planning approach that addresses coastal sediment processes and issues on a broader geographic scale, more solutions can be realized. Conserving and restoring the sediment resources along the coastline provides the opportunity to reduce shoreline erosion and coastal storm damages, protect sensitive environmental resources, preserve and enhance beaches, improve water quality along the shoreline, and manage coastal projects for the regional benefit.

Costs

Estimated costs were provided by Waterway Surveys & Engineering and Shoreline Studies Program, VIMS. Dredge material from Hole in the Wall will be placed on Haven Beach in Mathews County. The cost shown in Table 2 includes pumping 40,000 cy material to the site and spreading it along the beach. The estimated cost shown does not include the cost for advanced maintenance dredging. Should that alternative be considered, it would likely add an additional $660,000 ($12/cy) to the dredging costs (assuming mobilization/demobilization costs are shared with the channel dredging project). The use of vegetation and sand fencing on the landward portions of beach nourishment projects can reinforce the stability of the material placed at the site. For this project, about 67,000 plants can be planted on the upper terrace and one row of dune fencing placed (Table 3). Breakwaters can be used to hold dredged sand in place at Haven Beach (Figure 28). A conceptual design has been created by VIMS Shoreline Studies Program. Four additional breakwaters and an extension to an existing structure can be built (Table 3). Also shown on the graphic is the extent of approximately 40,000 cy of dredged sand (in yellow) placed starting at the +8 ft MLW contour and extending bayward. If the structures are built before the dredge material is placed, additional sand (shown in black) will be needed for construction equipment to access the site. That cost could be as much as an additional $800,000.

Dredging Mobilization includes all costs for operations accomplished prior to commencement of actual dredging operations. This includes as a minimum the following:

- Transfer of dredge and attendant plant, booster pumps, bulldozers and other like equipment and machinery for site work;
- All initial installation of pipe, if required; and
- All costs for any other associated work that is necessary in advance of the actual dredging operations.

Dredging Demobilization includes general preparation for transfer of plant to its home base, removal of pipelines, cleanup of site of work areas, and transfer of plant to its home base.

Table 2. Estimated cost for dredging 40,000 cy of sand at Hole in the Wall and placing it on Haven Beach. Estimates provided by Waterway Surveys & Engineering.

Creek	***Dredge Scenario***	***Volume (cy)***	***Mob/Demob***	***Dredging***	***Cost***
Hole in the Wall	-6 ft MLLW with 1 ft overdepth	40,000	$650,000	$480,000	$1,130,000

Table 3. Estimated cost to construct rock breakwaters at Haven Beach utilizing dredge material from Hole in the Wall.

Structure	**Structure Length (ft)**	**Total Cost**		**Num. of Plants**	**Cost/plant installed**	**Total Cost**
BW 1	230	$303,160		67,000	$2	$134,000
BW 3 extension	55	$102,960				
				Sand Fencing Lenth (ft)	**Cost/ft Installed**	**Total Cost**
BW 4	115	$150,150				
BW5	230	$303,160		2,600	$5	$13,000
BW6	230	$303,160				
Total Rock Structures		**$1,162,590**				
					Subtotal	$147,000
15% mob, demob, site work		$174,389		15% mob, demob, site work		$22,050
	Total	**$1,336,979**			**Total**	**$169,050**
			Project Total	**$1,506,029**		

Useful Life Estimates

Estimating the useful life of the dredge project is difficult for HITW. Because the channel has not previously been dredged, no data exists channel infilling due to dredging. However, an unpublished sediment budget created for Stamper et al. (2013) indicated that a great deal of material is being transported through the littoral system along Mathews Bay coast (Figure 29). Some material is lost offshore to Milford Haven Spit (as indicated by Bay Coast 1) and into Milford Haven itself (Bay Coast 2), but it was estimated that about 26,000 cy of material is being transported along this system (Bay Coast 3)

The proposed HITW channel is 150 ft wide. In the future, the channel will likely infill first at the mouth of the inlet where the sand shoals are moving south and impacting the channel. This area will need dredging before other areas of the channel. Using Virginia Geographic Information Network (VGIN) orthorectified aerial imagery, the movement of the sand shoal can be documented just north of the proposed HITW channel. North of the outbound portion of the channel, the sand shoal appears to be migrating south at about between 70-90 ft/year. However, computer modeling by the VIMS researchers (Xiong, Qin, &Shen, 2020, Appendix F) found that by dredging the channel shear stress along the bottom will increase in some areas and decrease in others (Figure 30). The decrease in bottom shear stress is expected because dredging will deepen the system thereby reducing the stress that the water will have on bottom sediments. However, creating a channel concentrates flow and in some cases will increase shear stress along the bottom. This will help maintain the dredge channel by reducing sedimentation. Based on the transport rate and modeling, the useful life of this project is estimated to be between 5 and 10 years. Most of the channel will not need to be dredged. It will only be at the mouth of the inlet where the sand shoals will impact it that is a concern.

To increase the useful life of the dredge channel, advance maintenance dredging could be considered. At HITW, advanced maintenance would be useful only on the outbound portion of the channel where the sand shoal would impact it. The proposed advanced maintenance would widen the channel another 150 ft but is only 6 ft deep. This scenario was modeled and the results show an increase in shear stress along the bottom in some sections of the channel that will help maintain the dredge channel (Figure 31). This could increase the useful life of the project to 10-20 years.

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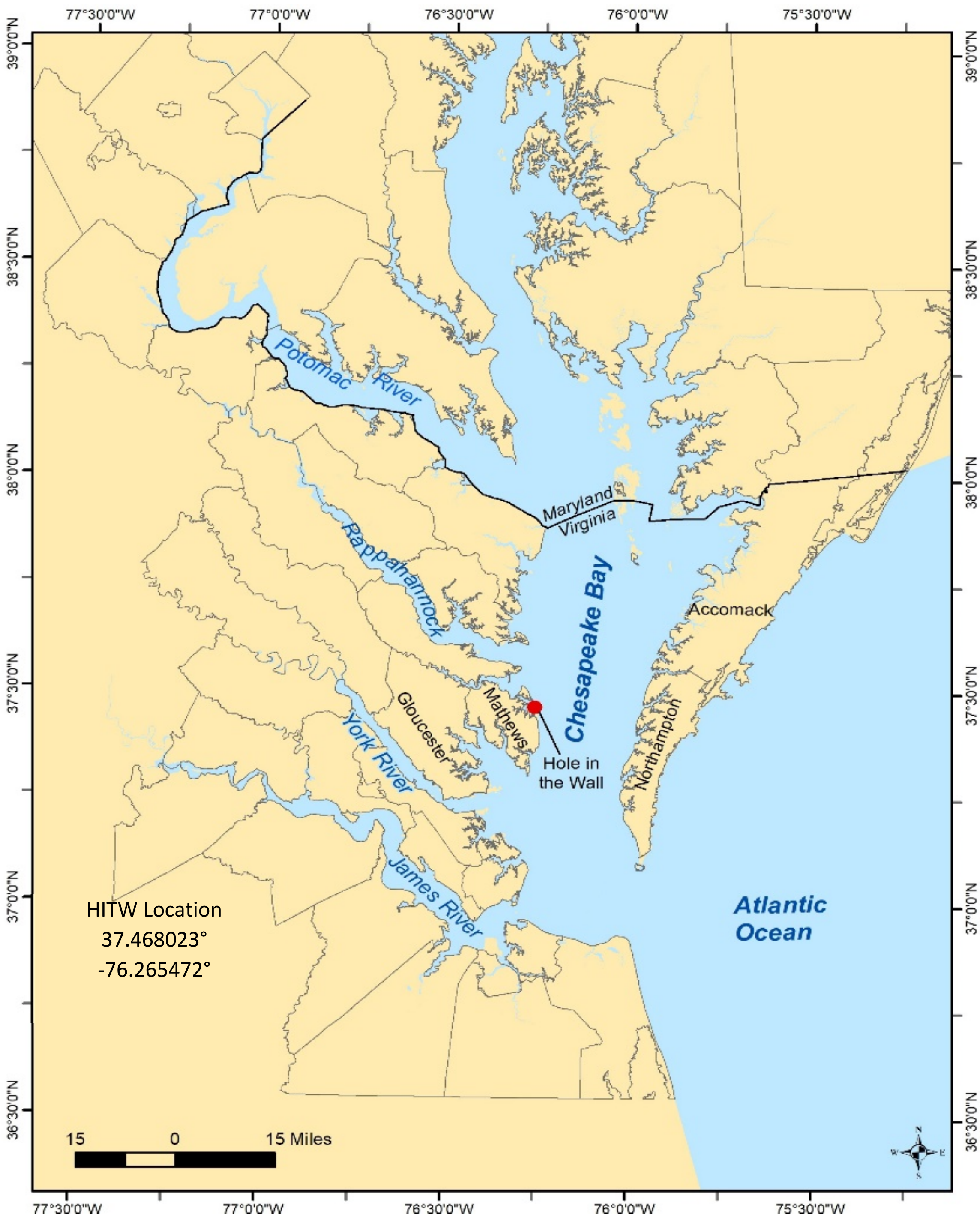


Figure 1. Location of Hole in the Wall channel.

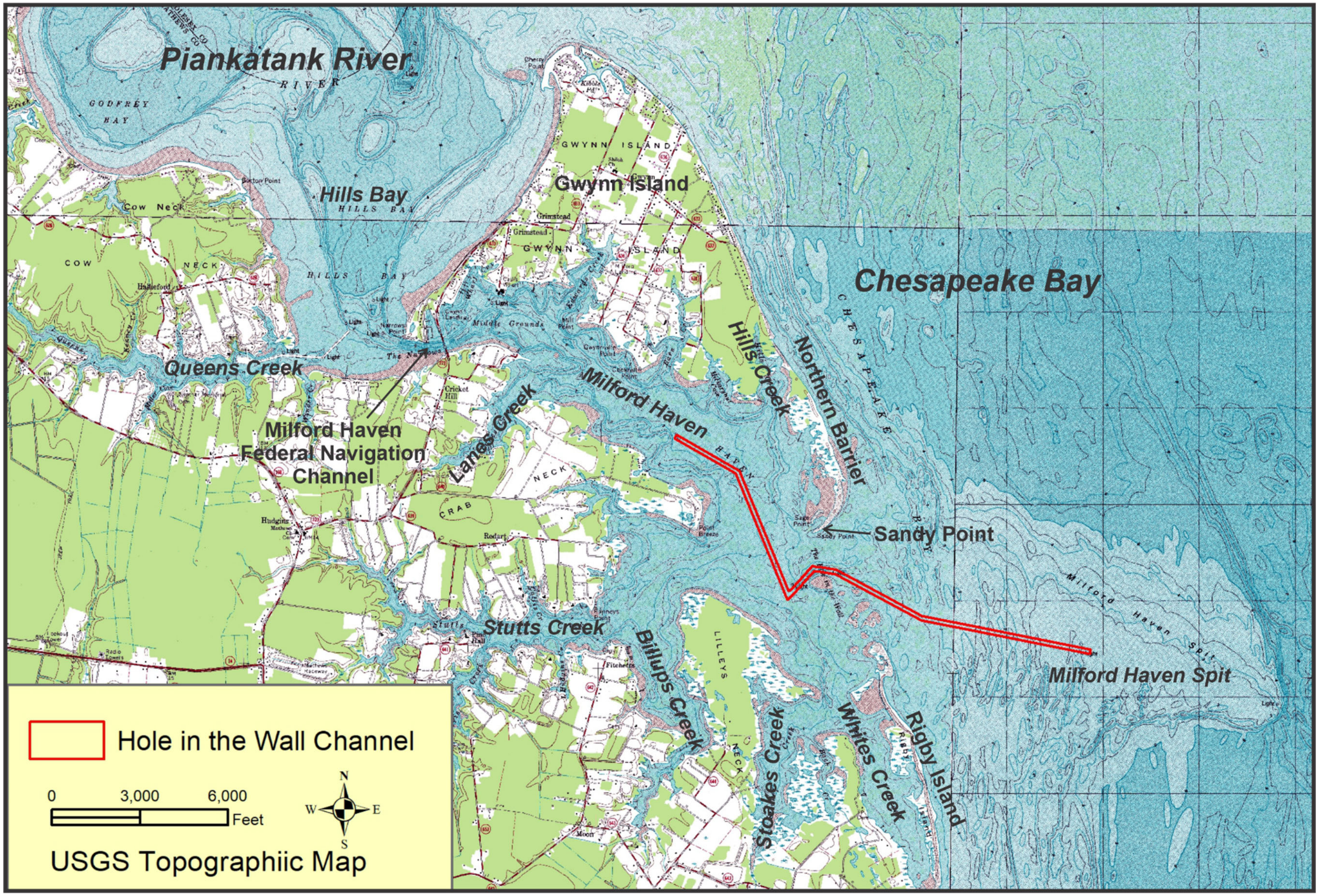


Figure 2. Topographic map showing physical features of Milford Haven and surrounding shorelines.

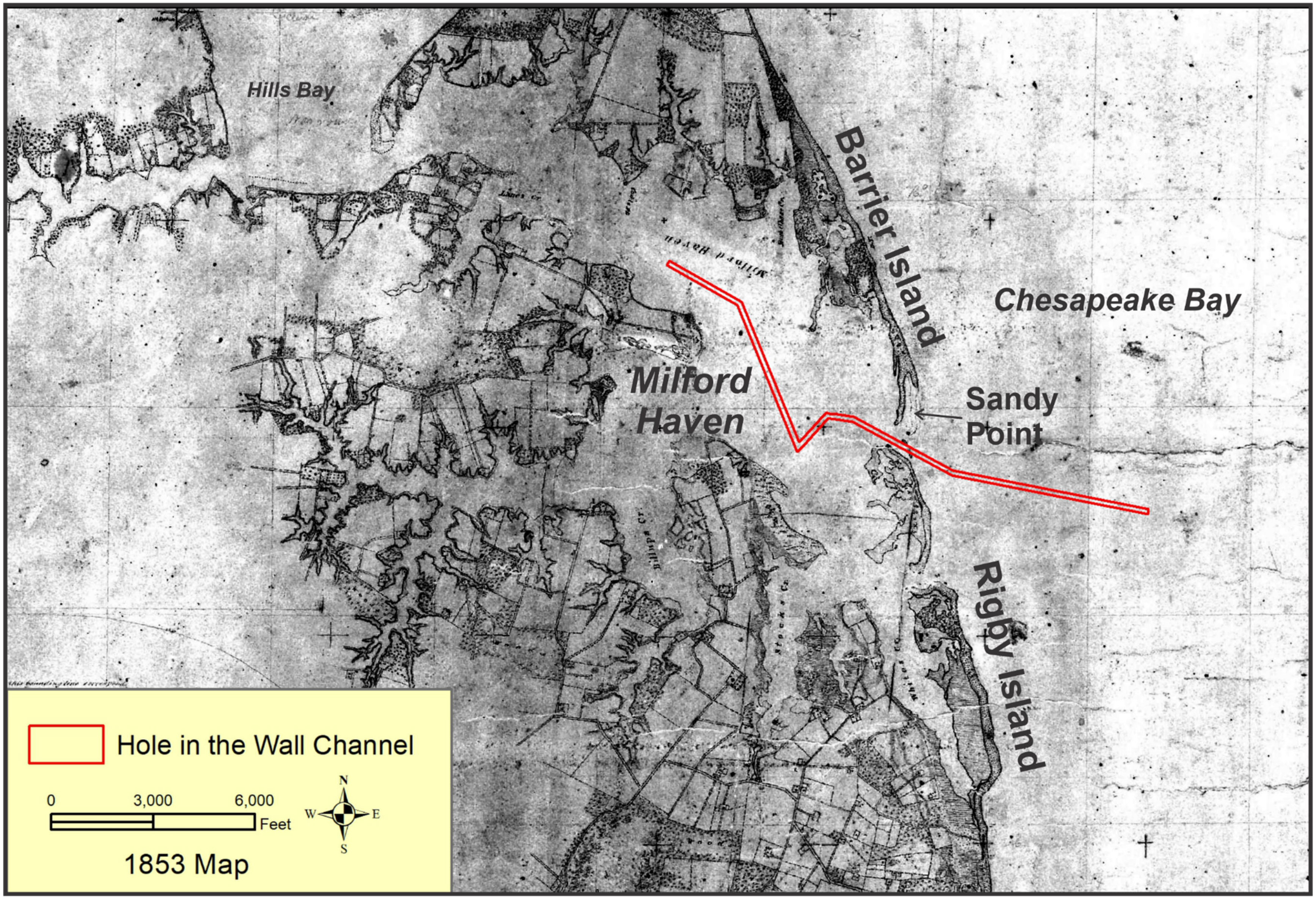


Figure 3. An 1853 map showing Hole in the Wall and the barrier islands fronting Milford Haven.

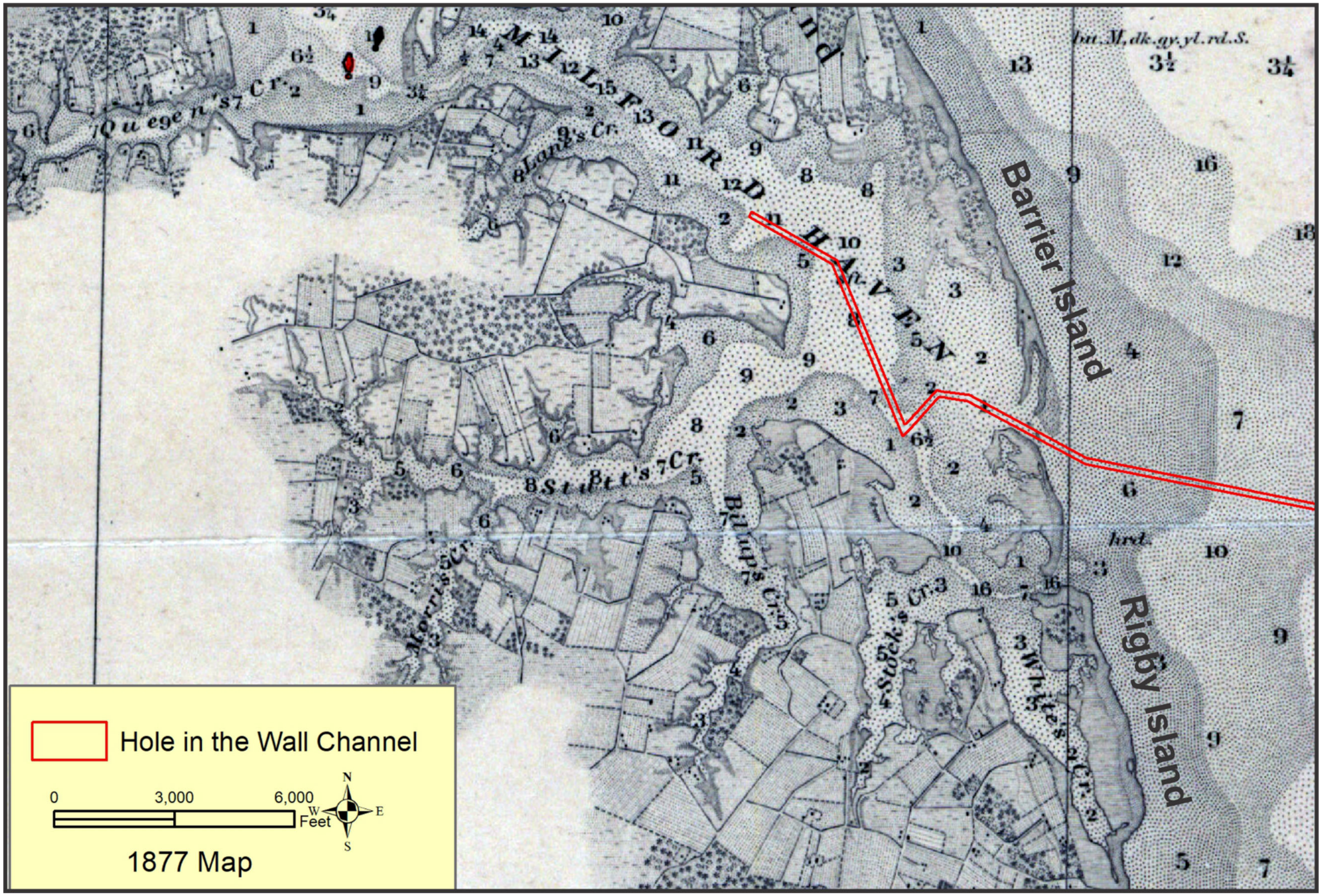


Figure 4. An 1877 map showing Hole in the Wall and the barrier islands fronting Milford Haven. Note depths are shown in both feet and fathoms. Fathoms are the depths shown with fractions.

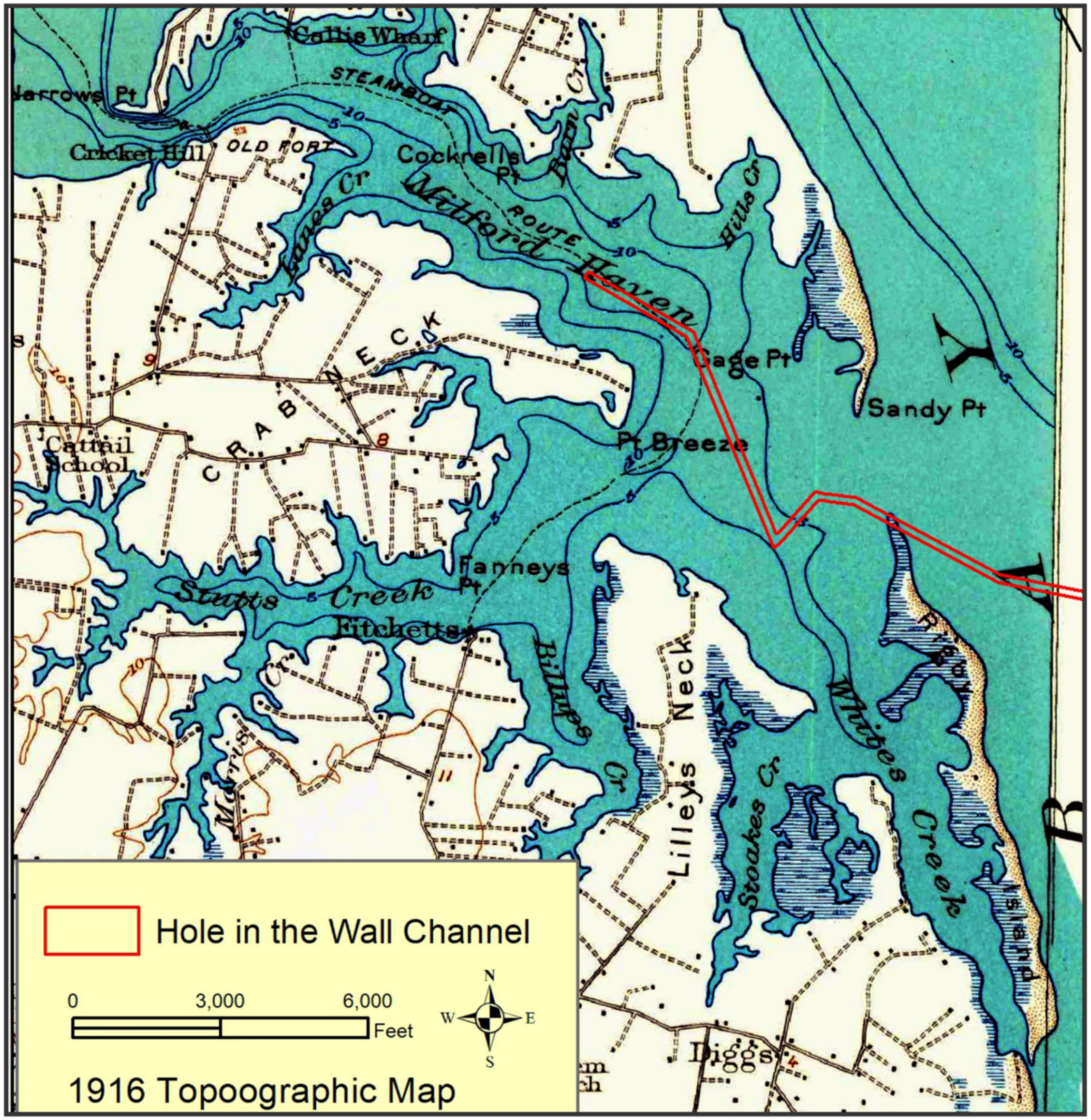


Figure 5. A 1916 map showing Hole in the Wall and the barrier islands fronting Milford Haven.

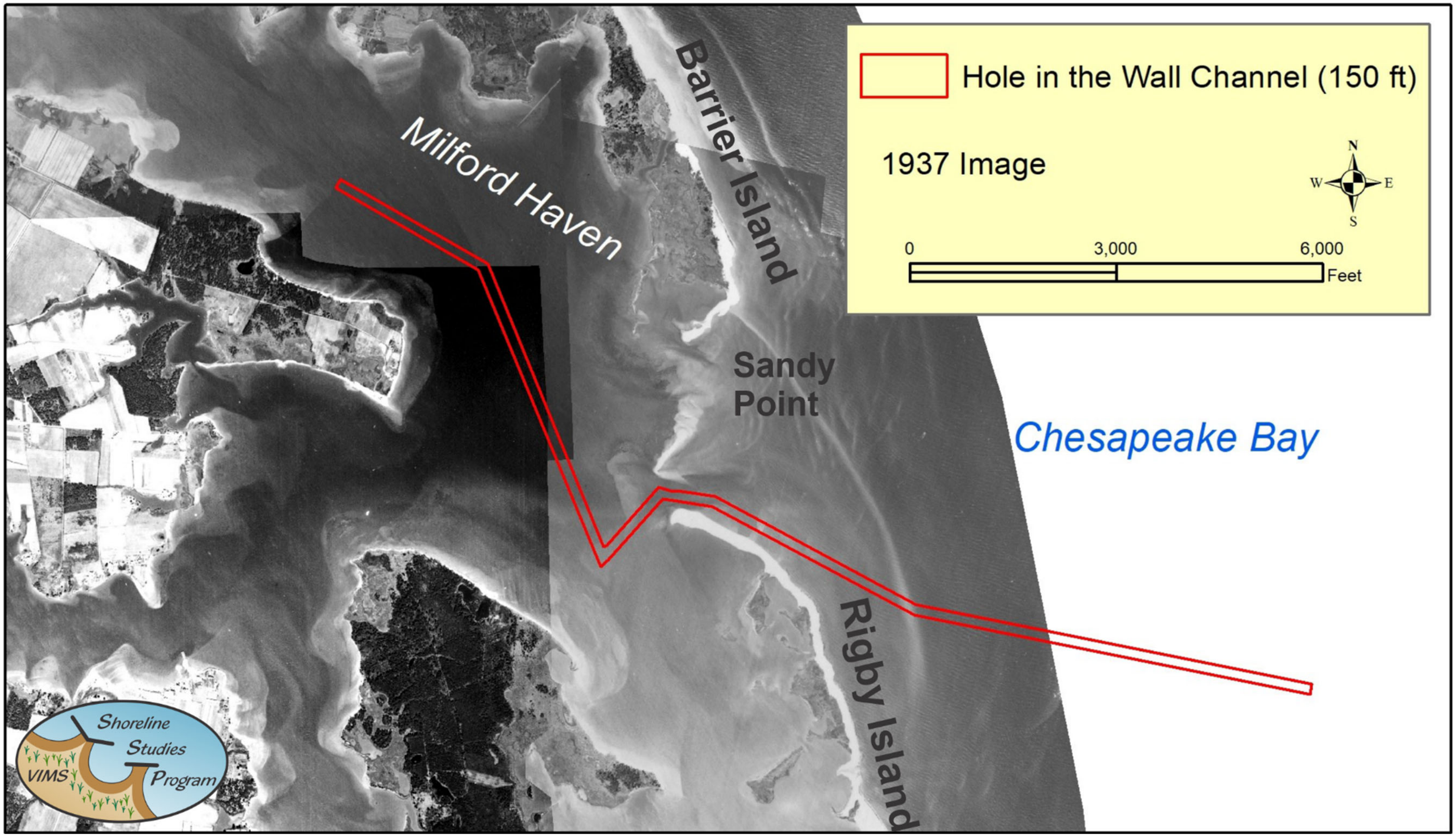


Figure 6. An orthorectified photo taken in 1937 showing Hole in the Wall and the barrier islands fronting Milford Haven.

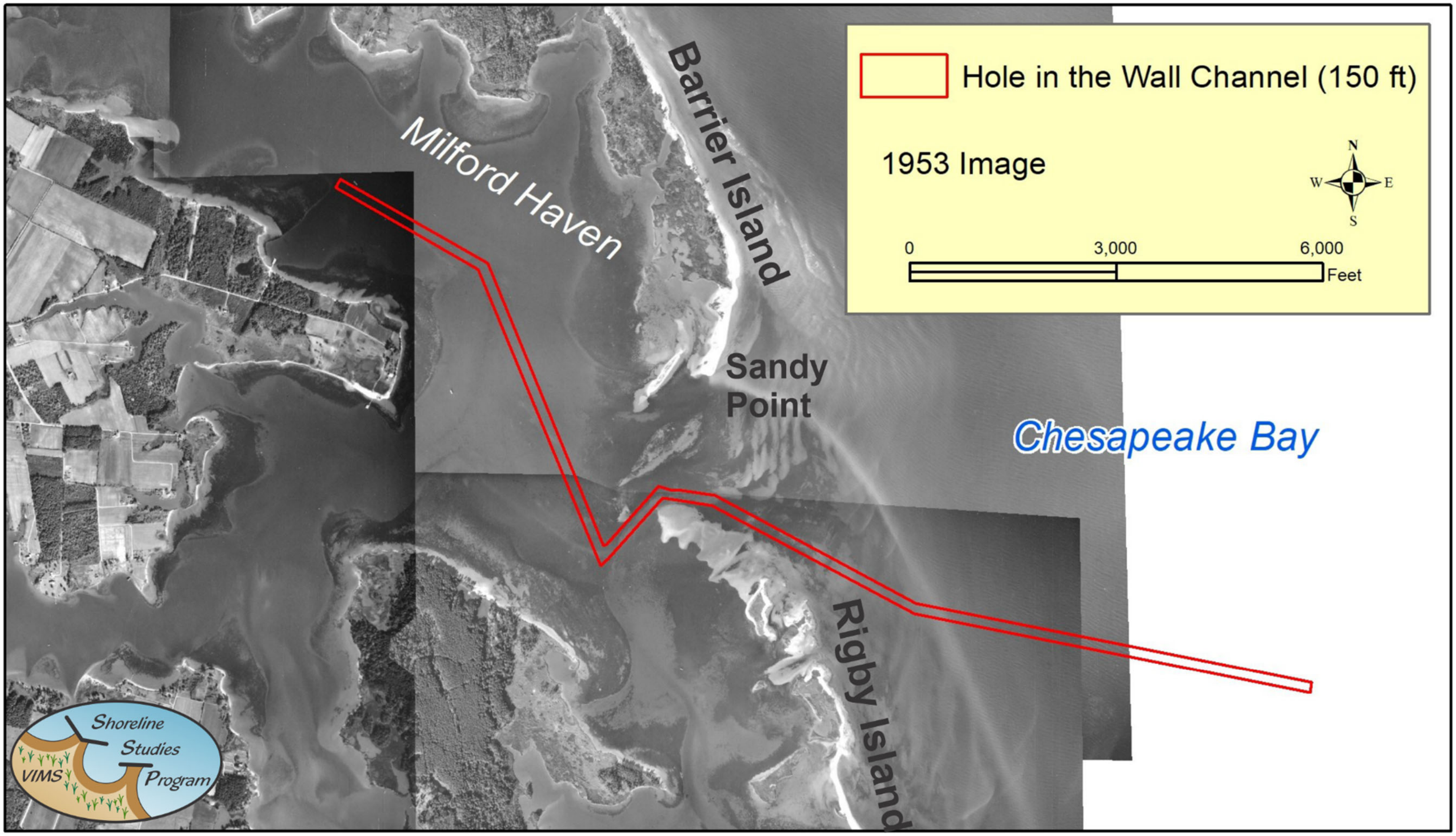


Figure 7. An orthorectified photo taken in 1953 showing Hole in the Wall and the barrier islands fronting Milford Haven.

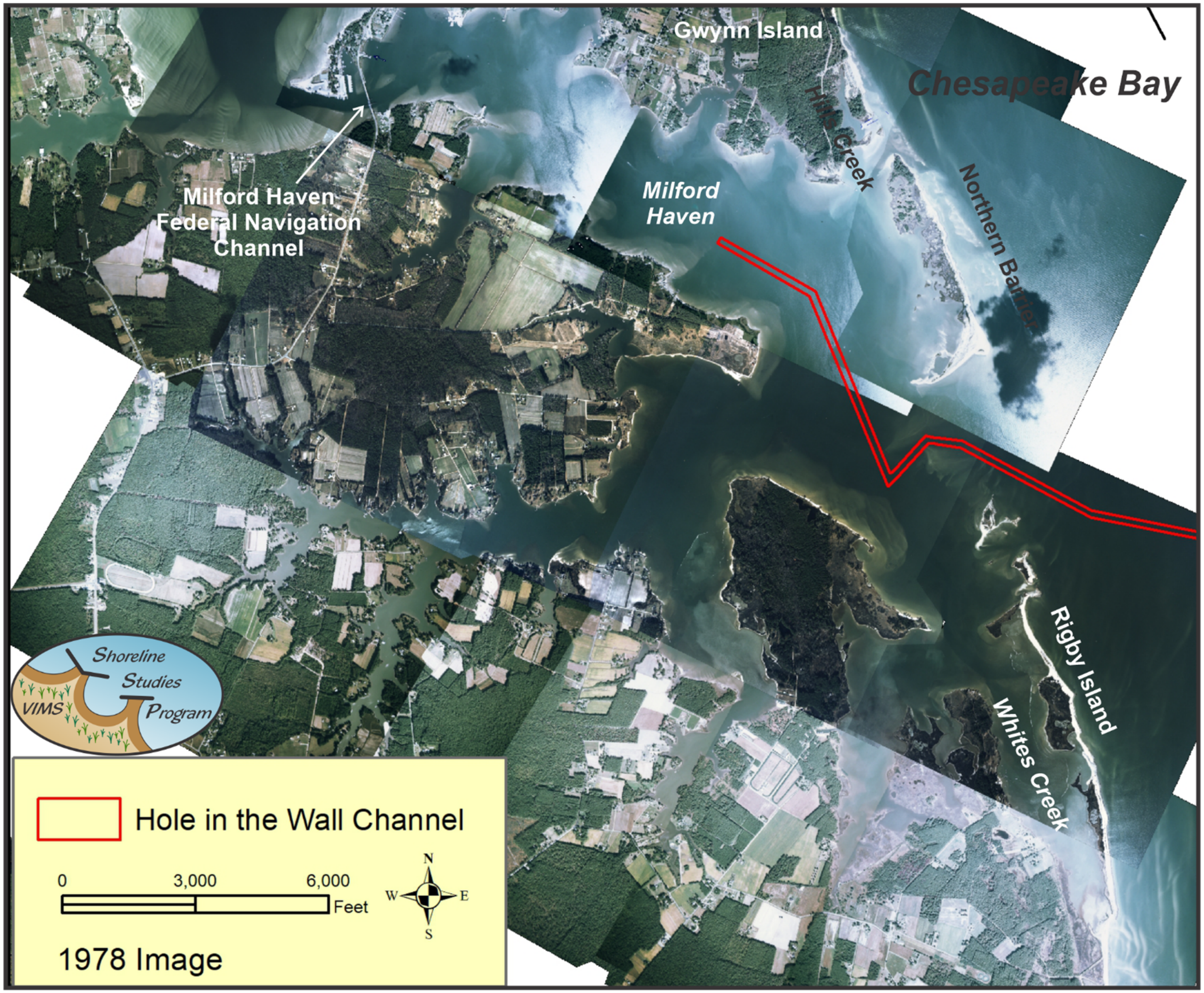


Figure 8. An orthorectified photo taken in 1978 showing Hole in the Wall and the barrier islands fronting Milford Haven.

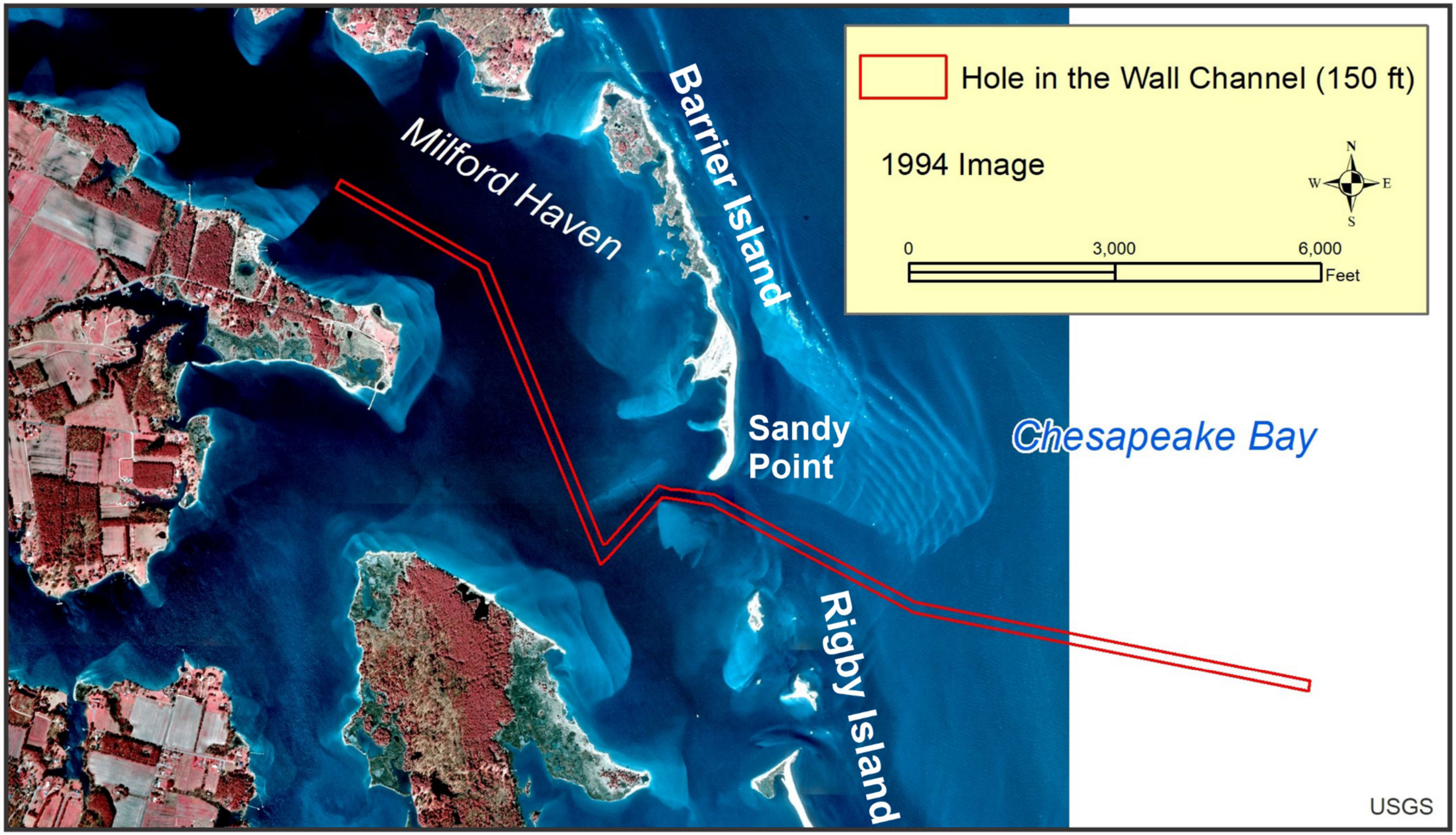


Figure 9. An orthorectified USGS photo taken in 1994 showing Hole in the Wall and the barrier islands fronting Milford Haven.

Figure 10. VGIN photo taken in 2002 showing Hole in the Wall and the barrier islands fronting Milford Haven.

Figure 11. VGIN photo taken in 2017 showing Hole in the Wall and the barrier islands fronting Milford Haven. Also shown is the 1877 digitized shoreline.

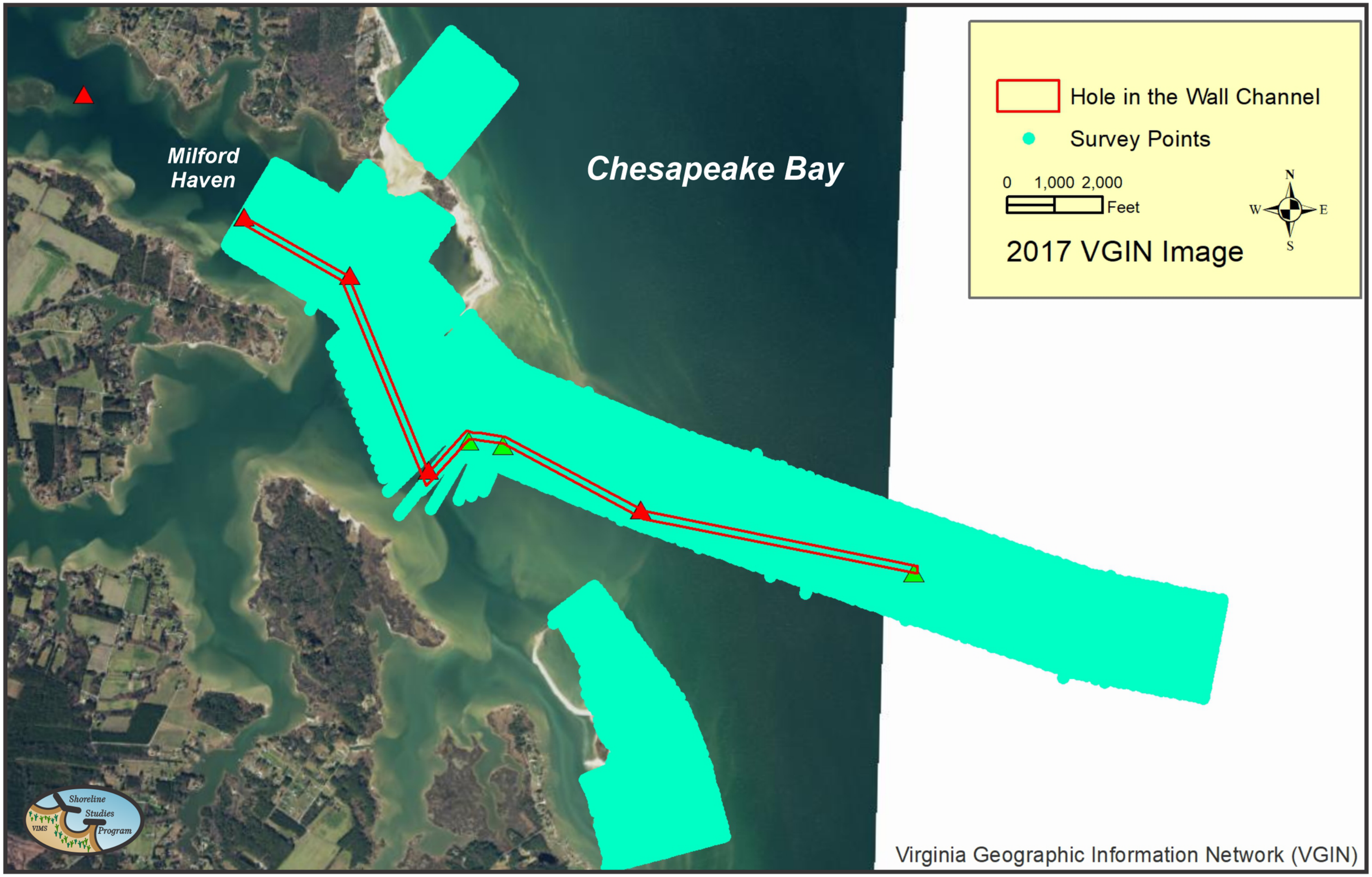


Figure 12. Survey points taken to determine existing bottom elevations

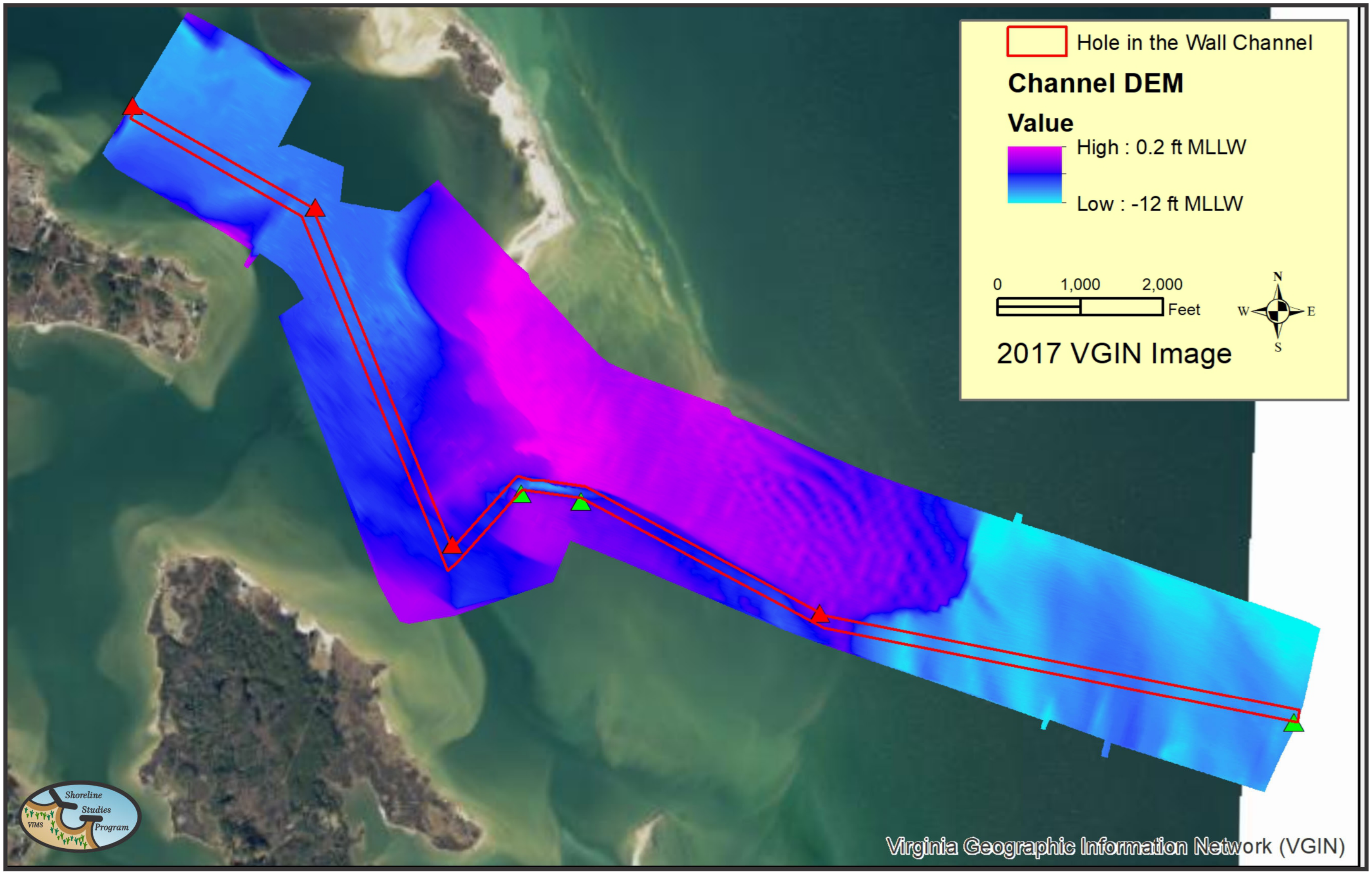


Figure 13. Digital elevation model derived from survey points showing existing conditions.

Figure 14. Location of cores taken for the project. Also shown is the compilation outline of submerged aquatic vegetation mapped between 2014 and 2018 from the VIMS SAV program.

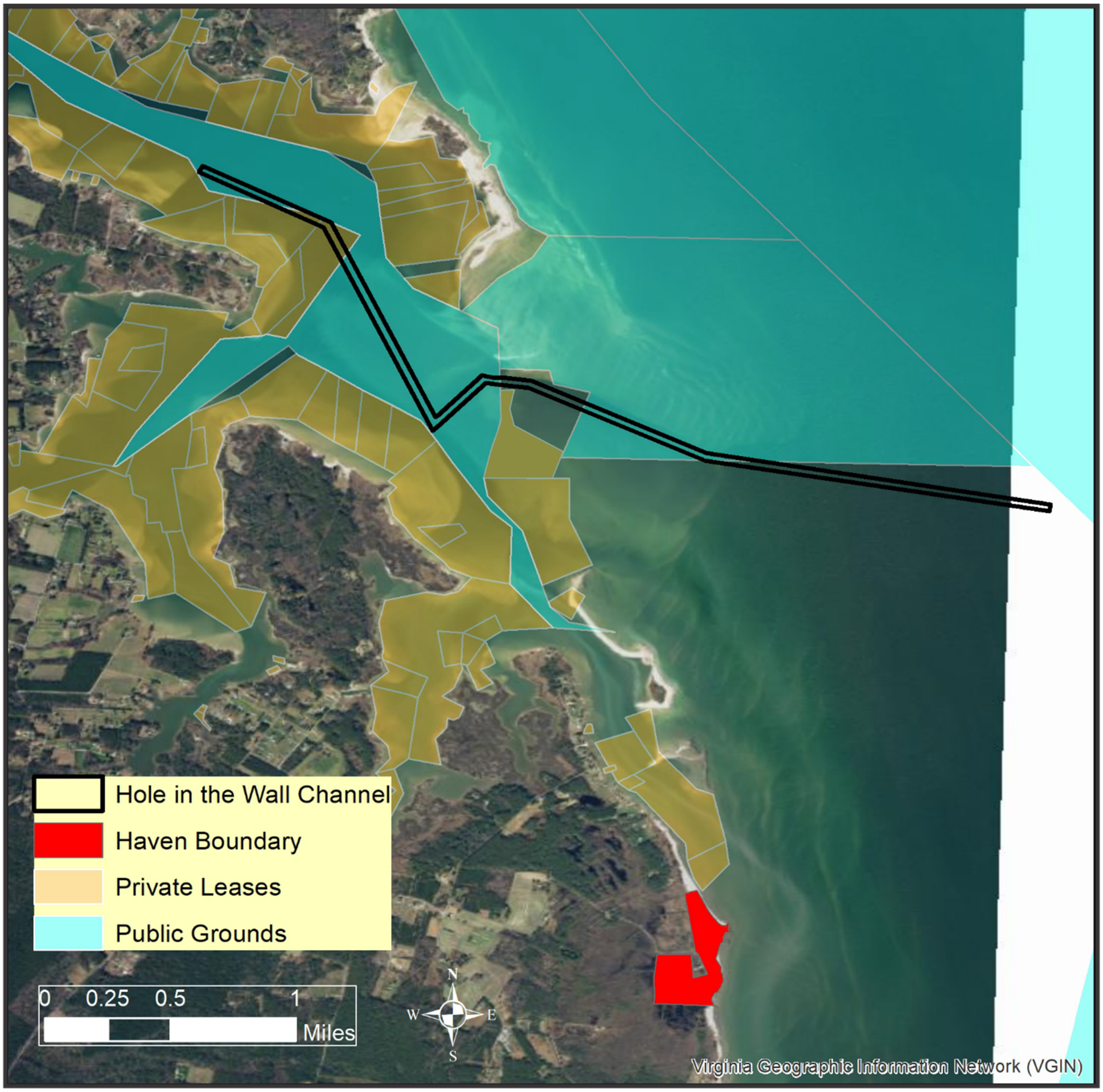


Figure 15. Private oyster ground leases and public bottom. webapps.mrc.virginia.gov/public/maps/chesapeakebay_map.php

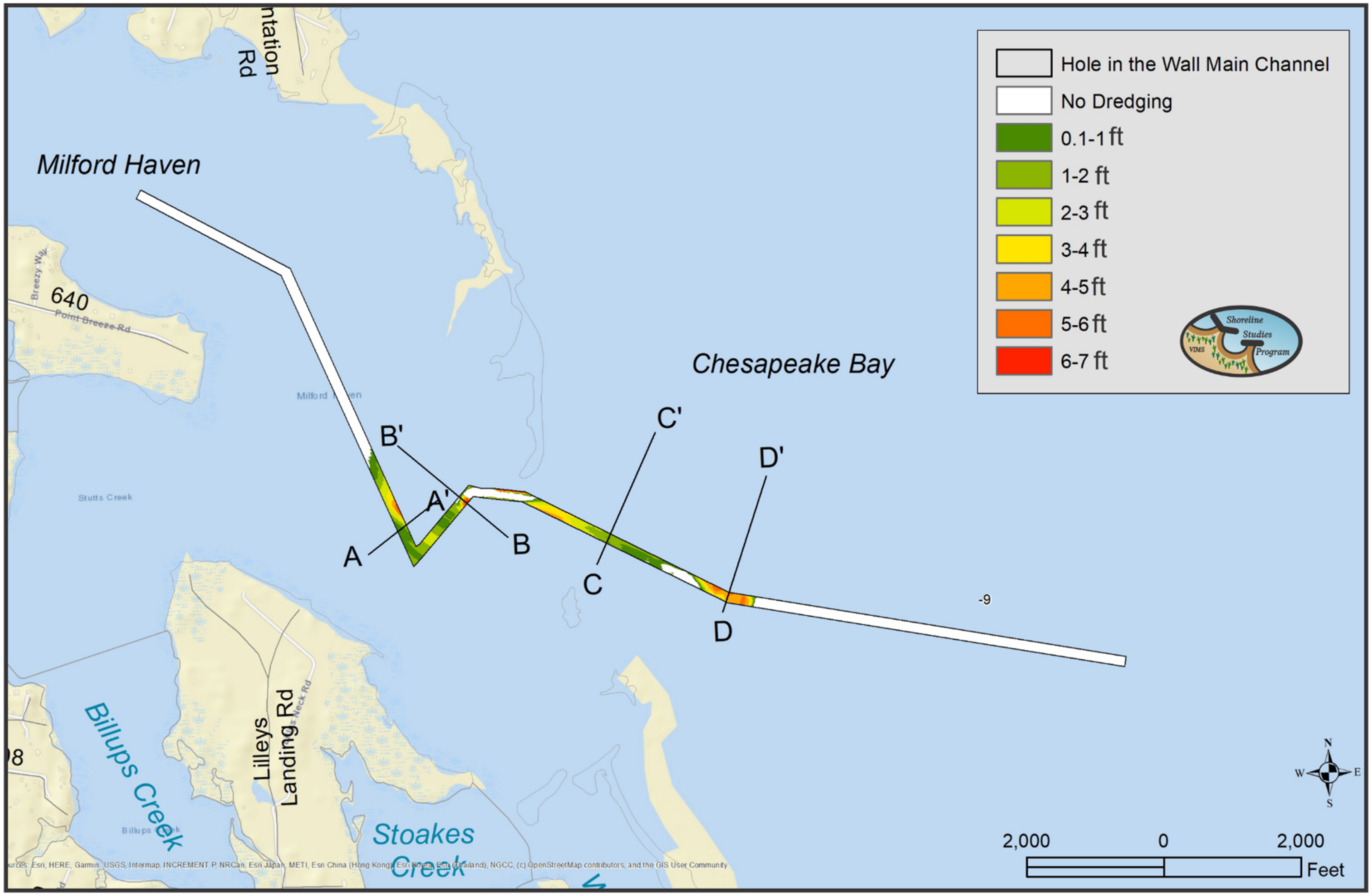


Figure 16. Digital elevation model (DEM) showing the locations in the channel that are shallower than -7 ft MLLW. Areas that need more material removed are shown in red. Areas that need less material removed are shown in green. Areas deeper than -7 ft MLLW are shown in white because no dredging need occur. Also shown are the locations of typical cross-sections of the channel.

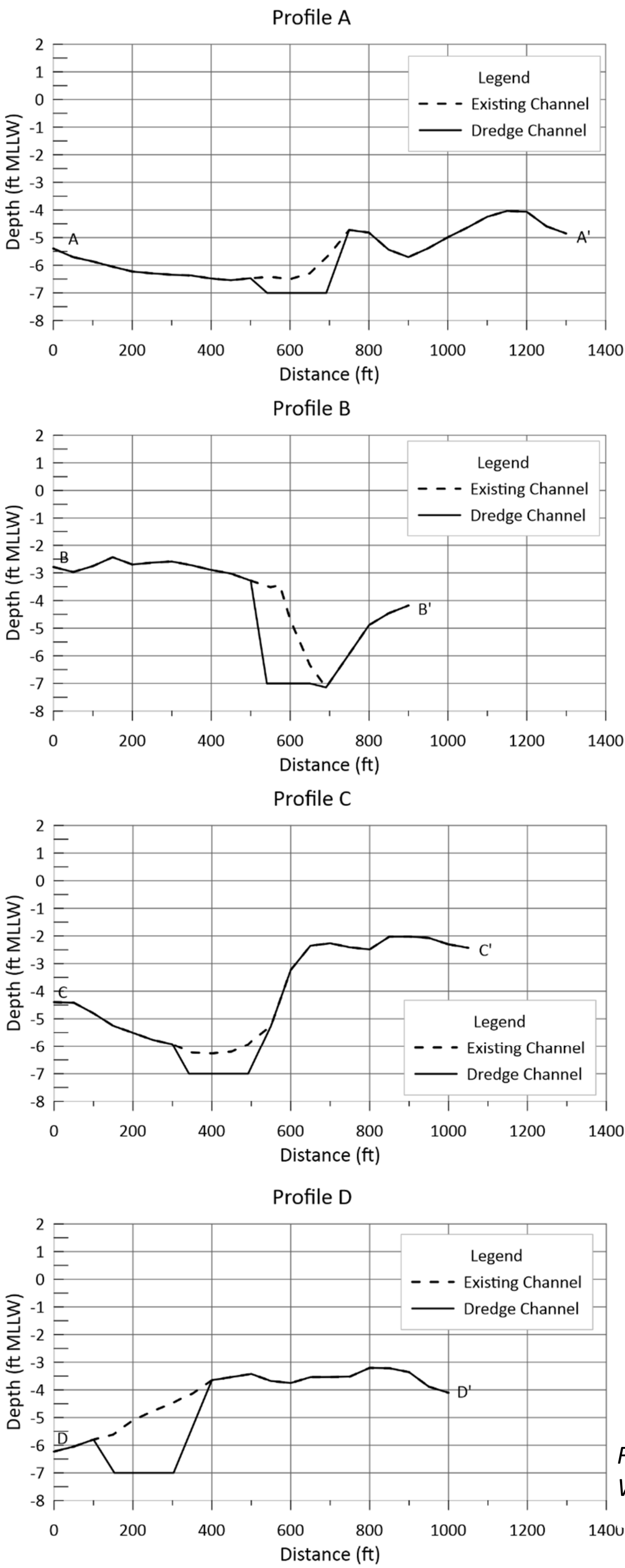


Figure 17. Typical channel cross-sections at Hole in the Wall. Their location is shown on Figure 16.

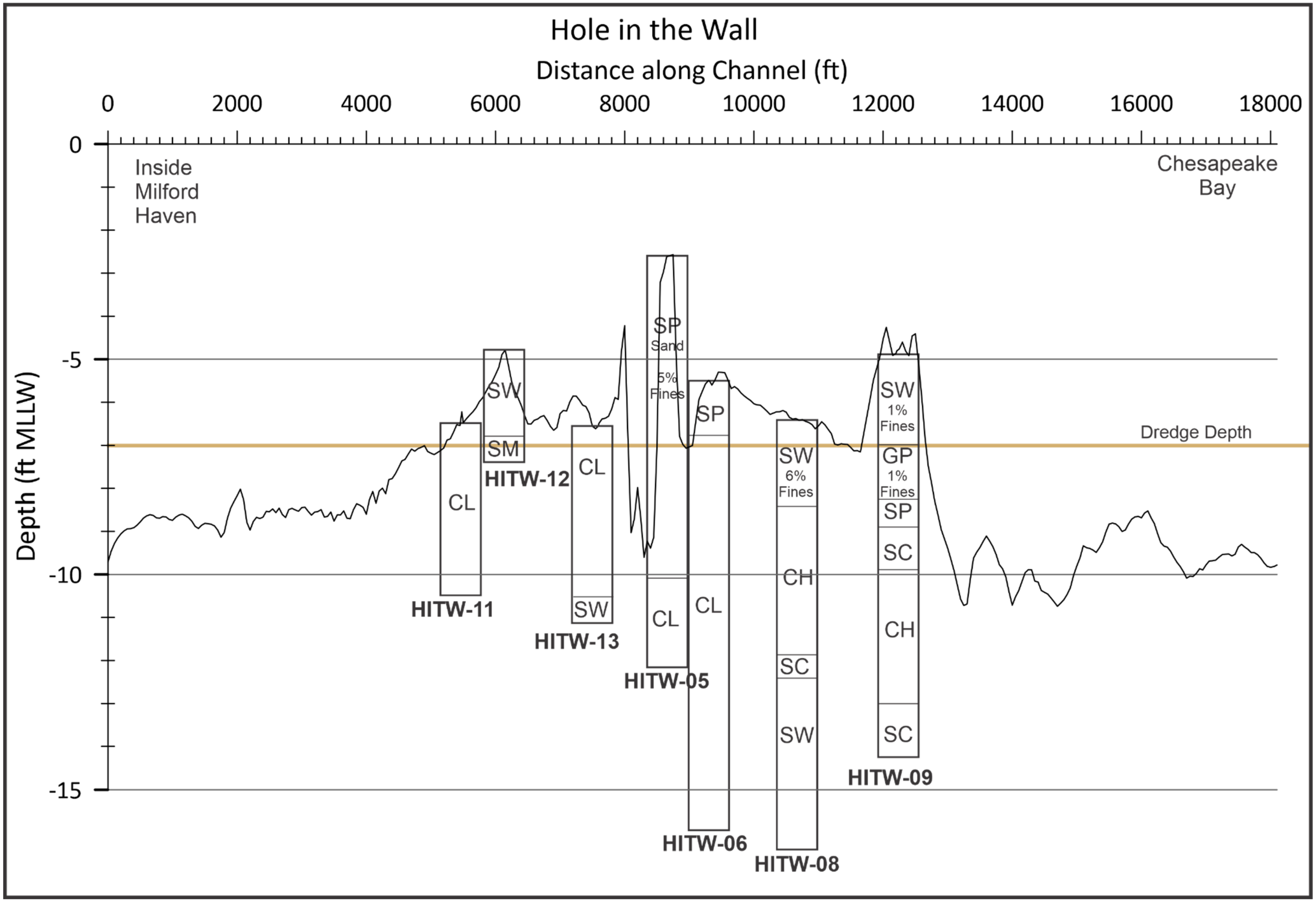


Figure 18. Along-channel cross-section showing the position of the cores and the type of material in the core. The dredge depth is -7 ft MLLW.

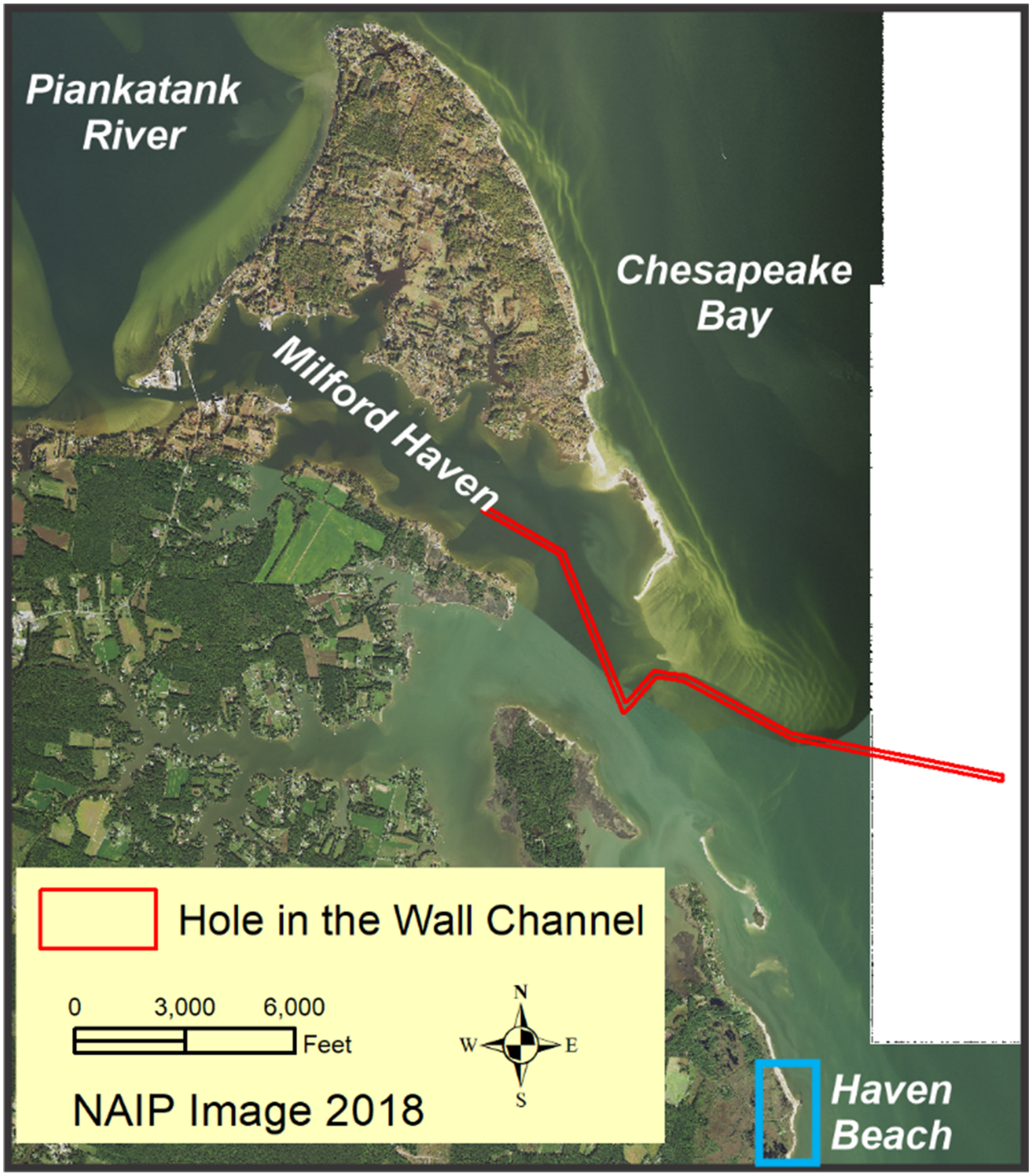


Figure 19. Location of Haven Beach in proximity to the proposed dredge channel at Hole in the Wall.

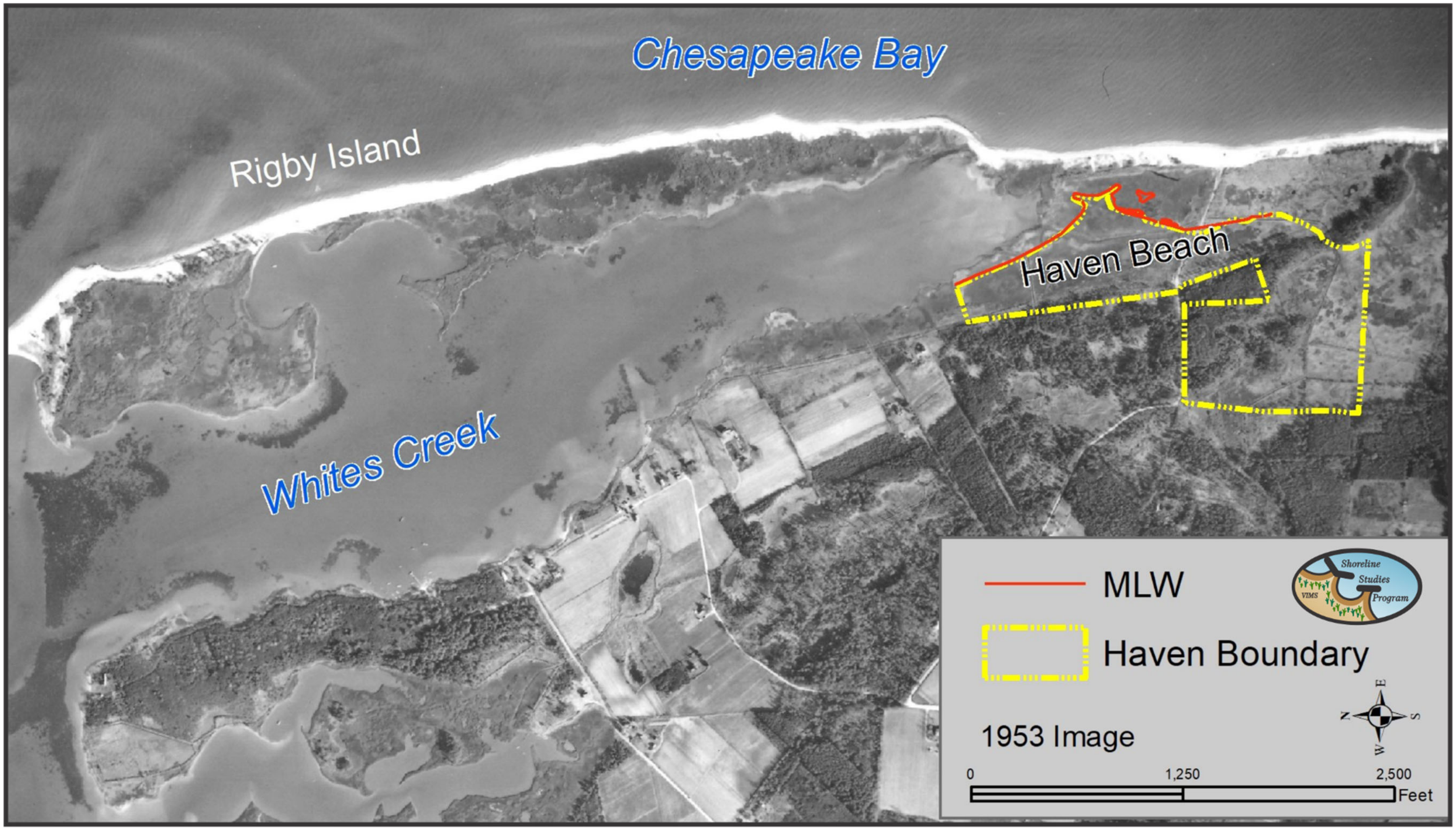


Figure 20. Haven Beach location shown on a 1953 image. Rigby Island was still attached to the mainland at this time.

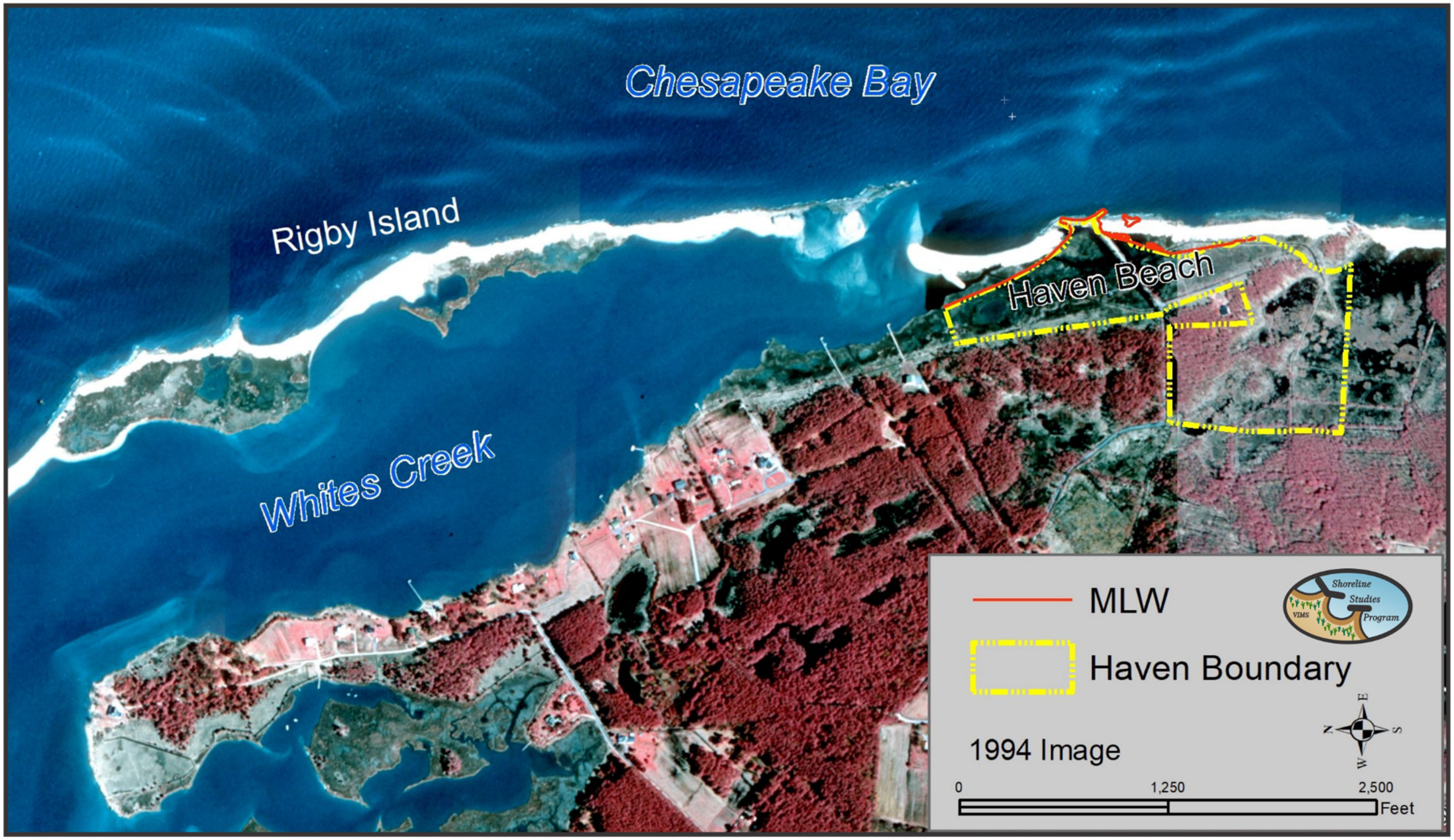


Figure 21. Location of Haven Beach in 1994.

Figure 22. Aerial photo (top) and ground photo (bottom) taken at Haven Beach after breakwater and beach fill installation.

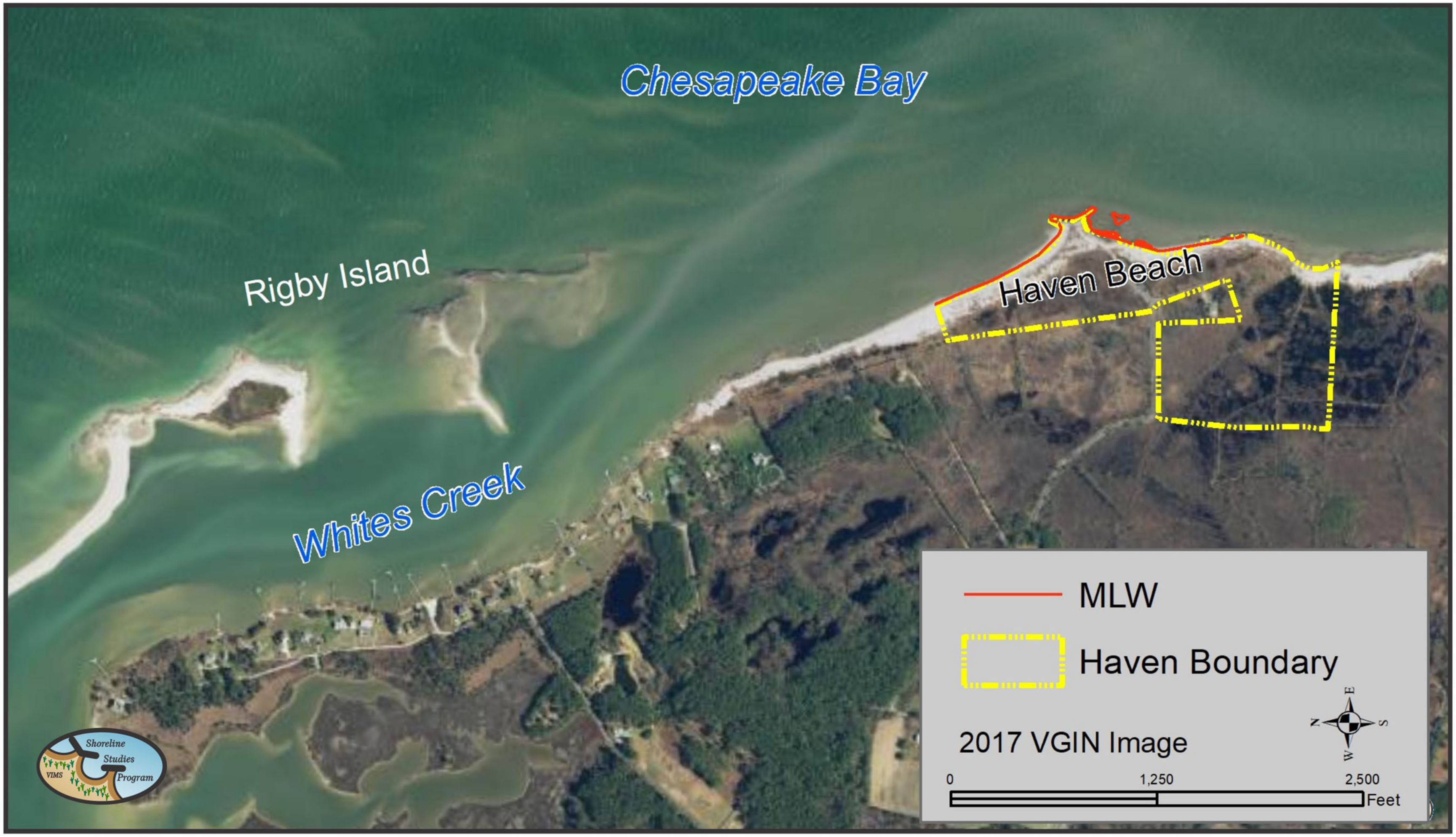


Figure 23. Location of Haven Beach in 2017.

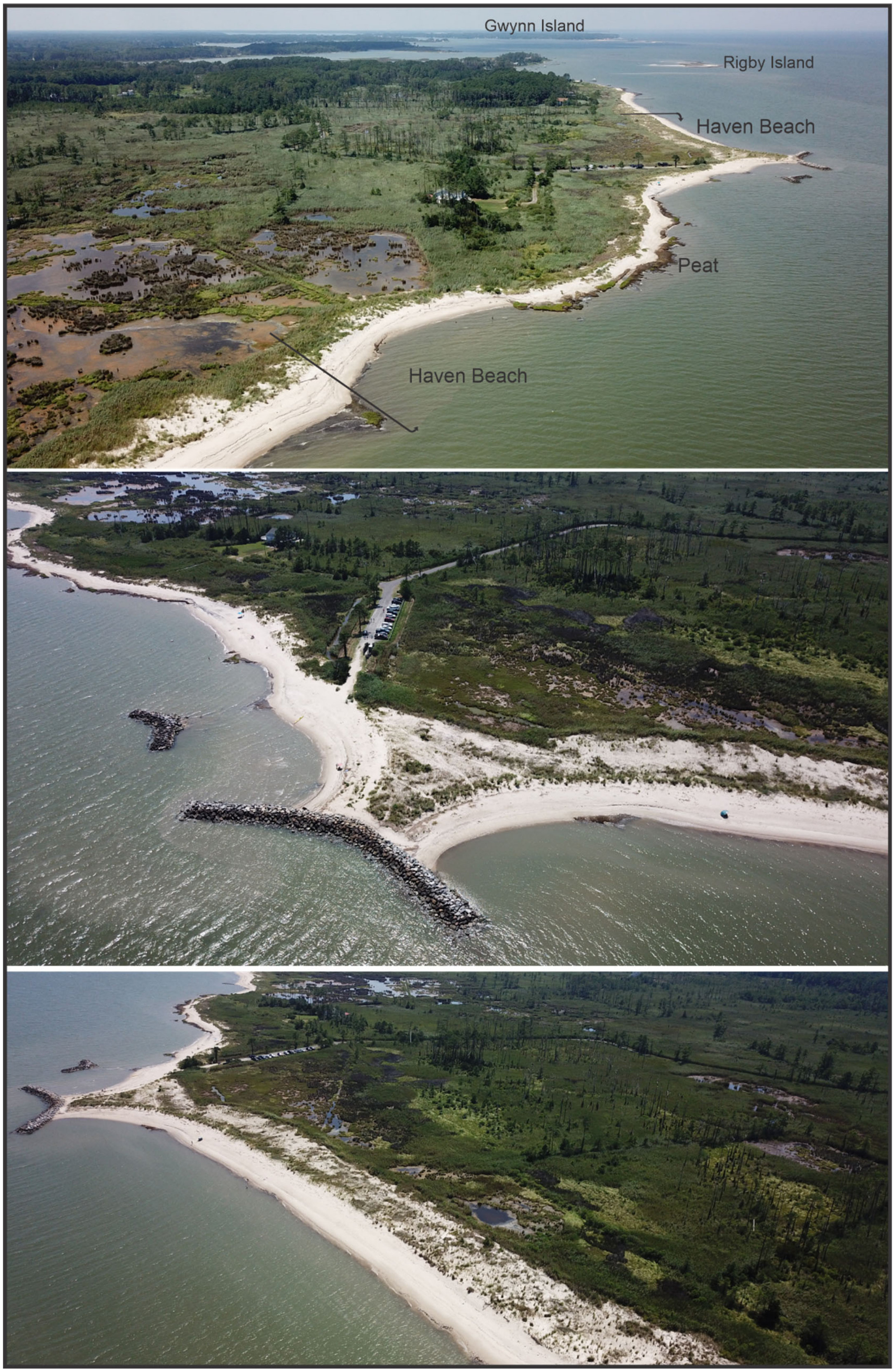


Figure 24. Drone imagery taken July 30, 2020 at Haven Beach.

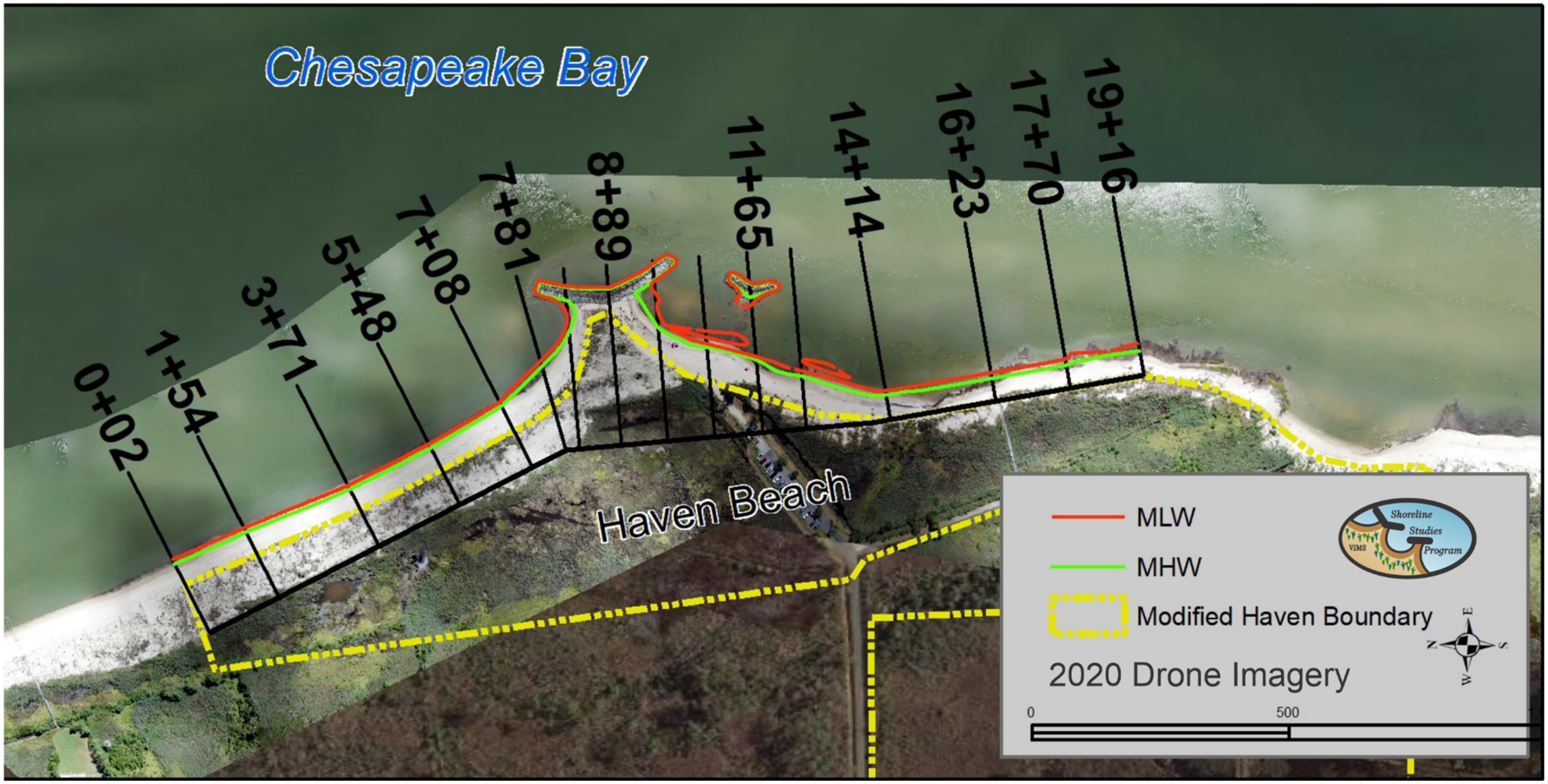


Figure 25. Haven Beach in 2020 showing the profile locations for cross-sections.

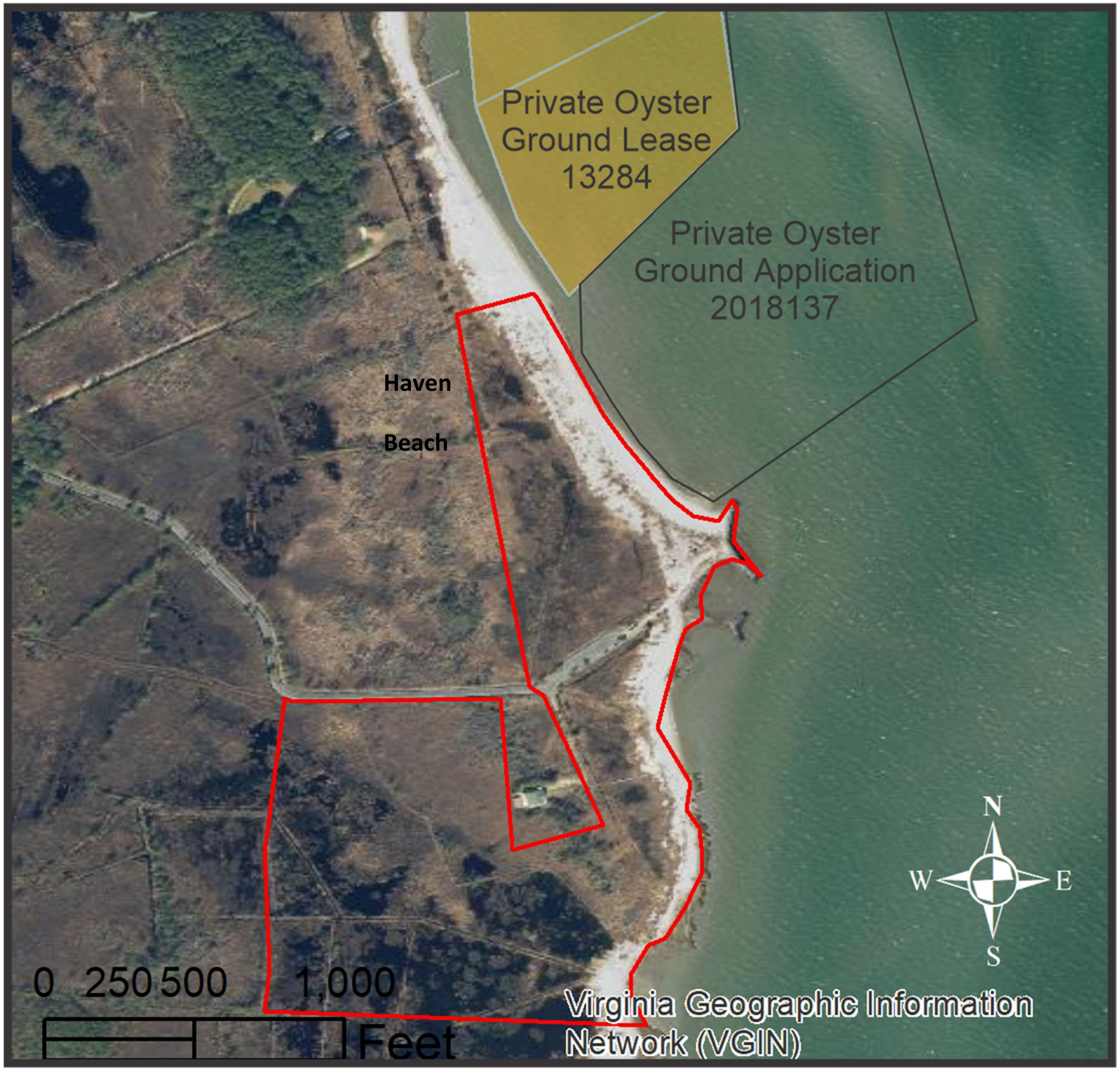


Figure 26. Private oyster ground leases.
webapps.mrc.virginia.gov/public/maps/chesapeakebay_map.php

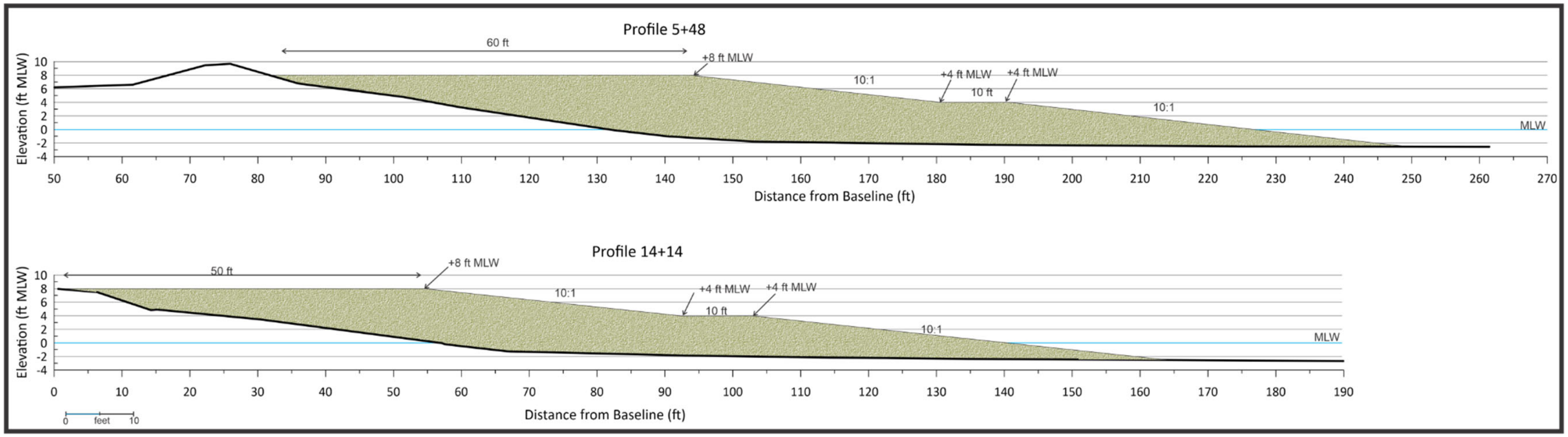


Figure 27. Dredge disposal design for Haven Beach.

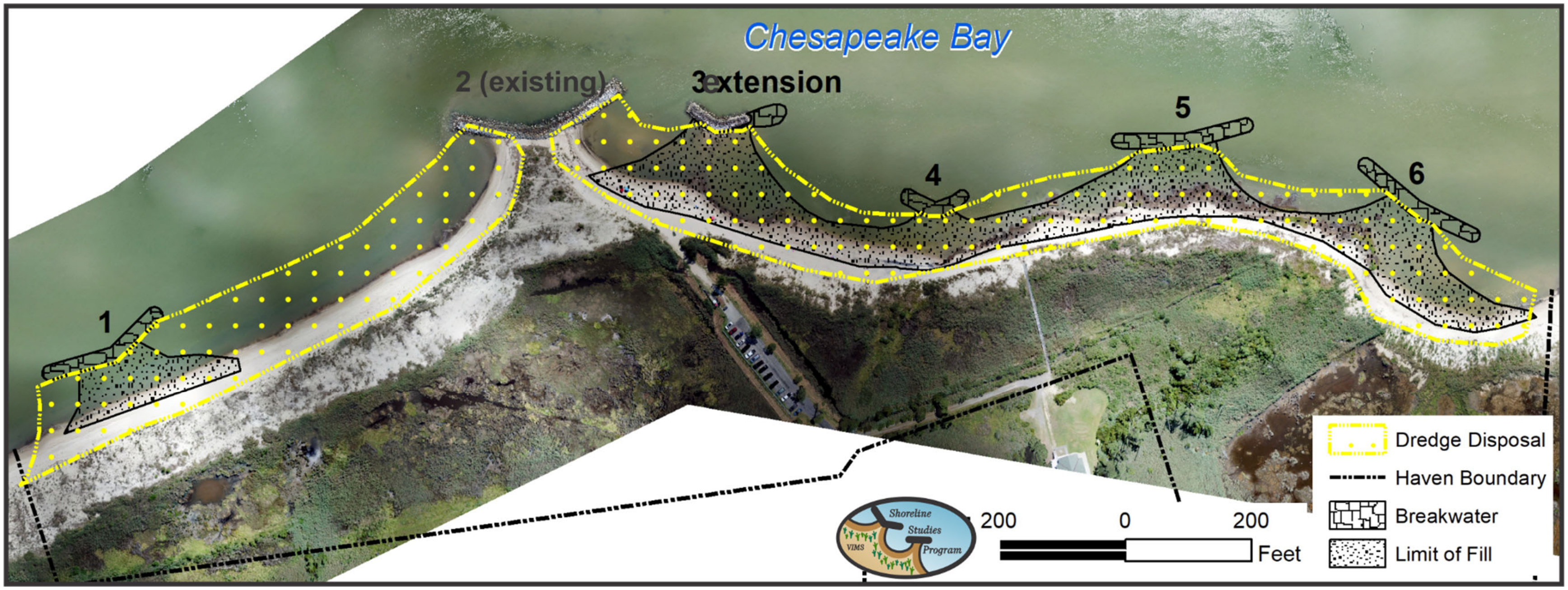


Figure 28. Proposed extent of dredge material along Haven Beach in yellow. Additional breakwaters can be constructed to better hold the fill material.

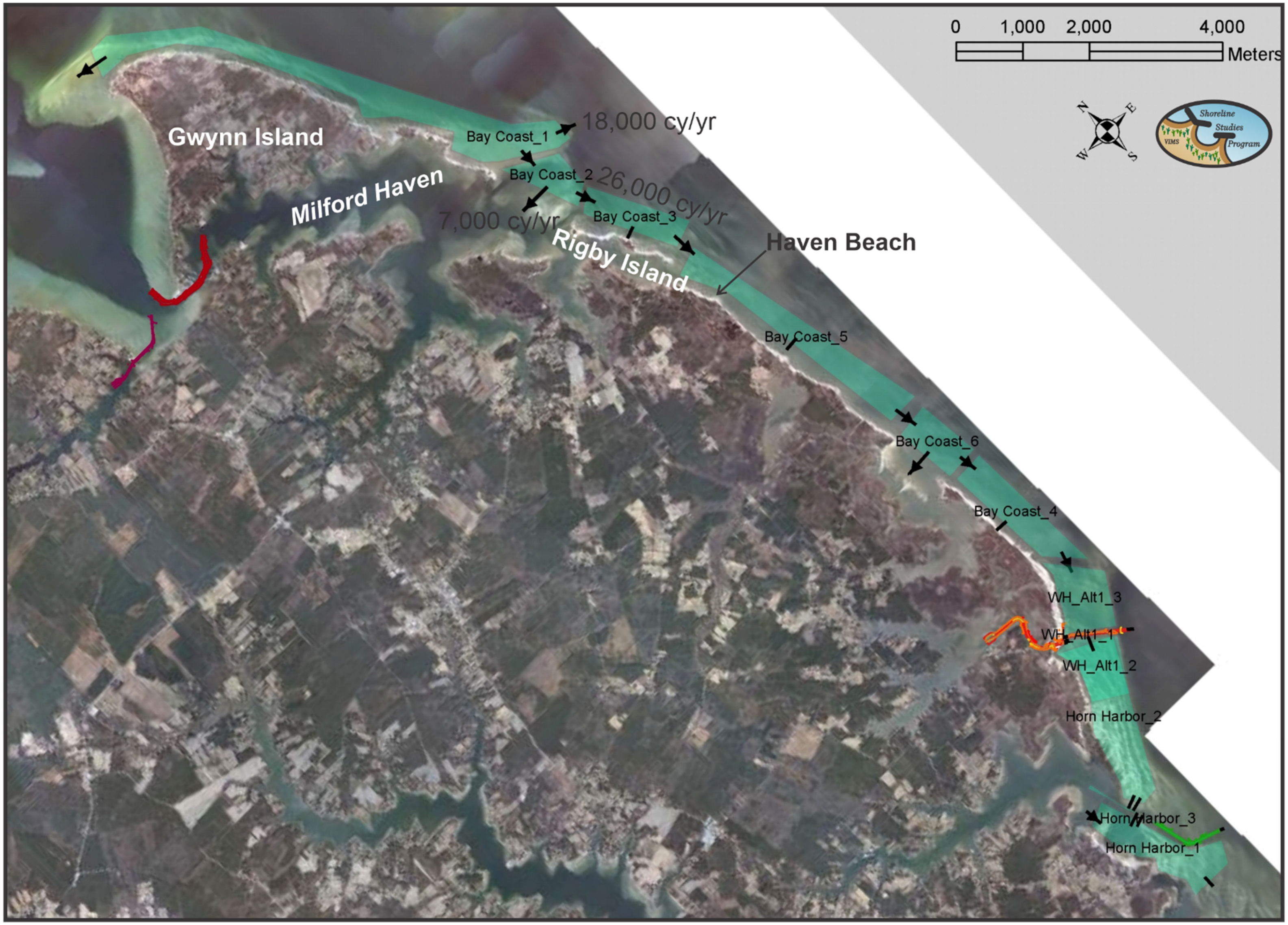


Figure 29. Unpublished sediment budget for the Mathews County Bay coast. VIMS, Shoreline Studies Program.

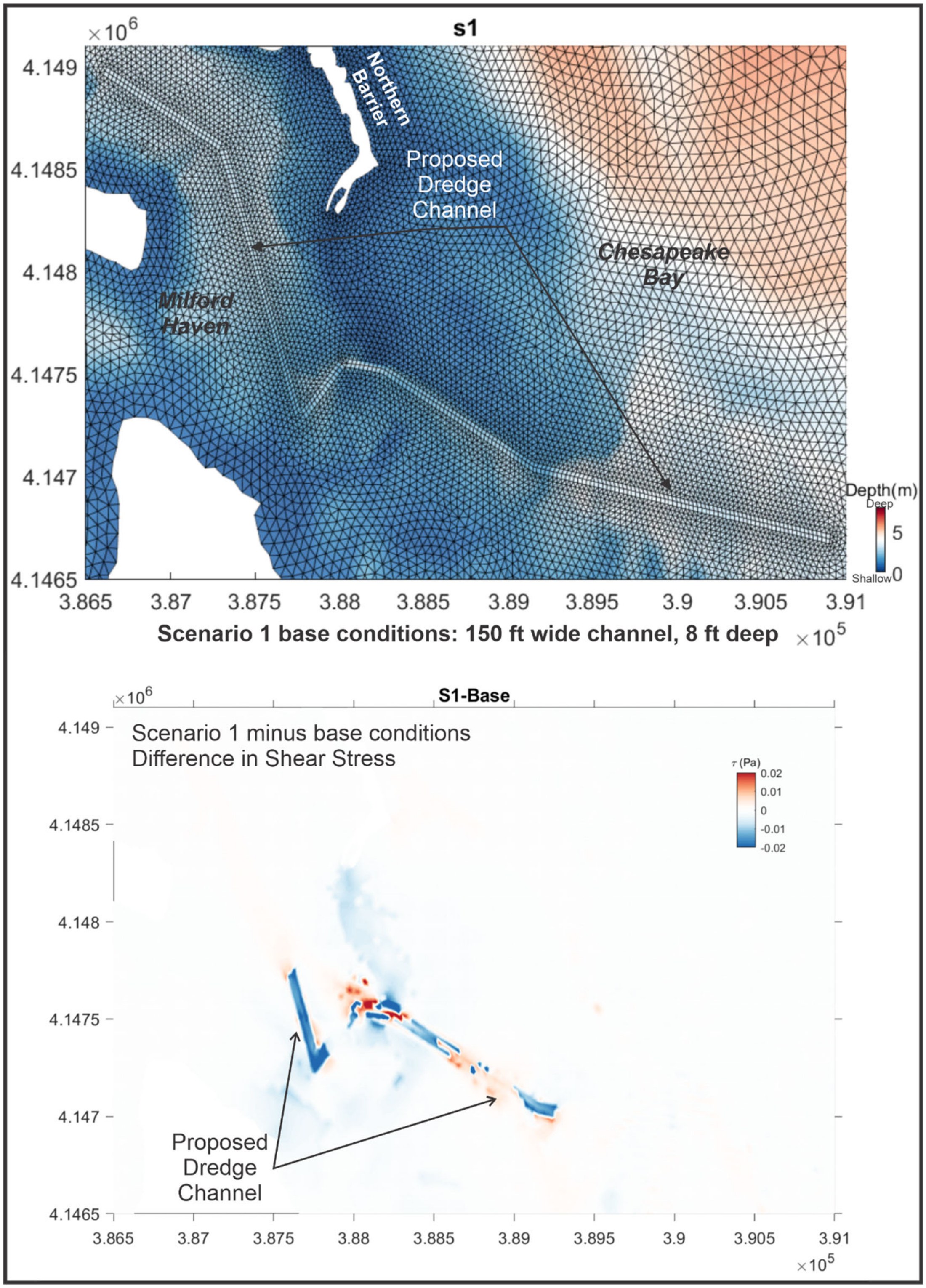


Figure 30. Computer modeling results of proposed channel dredging at HITW. The top show the bathymetry and grid of Scenario 1 which includes dredging the channel 150 ft wide and 8 ft deep. The bottom shows the change in bottom shear stress as a result of the dredging. Inside Milford, the shear stress is reduced (blue) as a result of deepening of the bottom. On the outside of the channel, some areas of bottom shear stress increase (red) due to channelization of the currents.

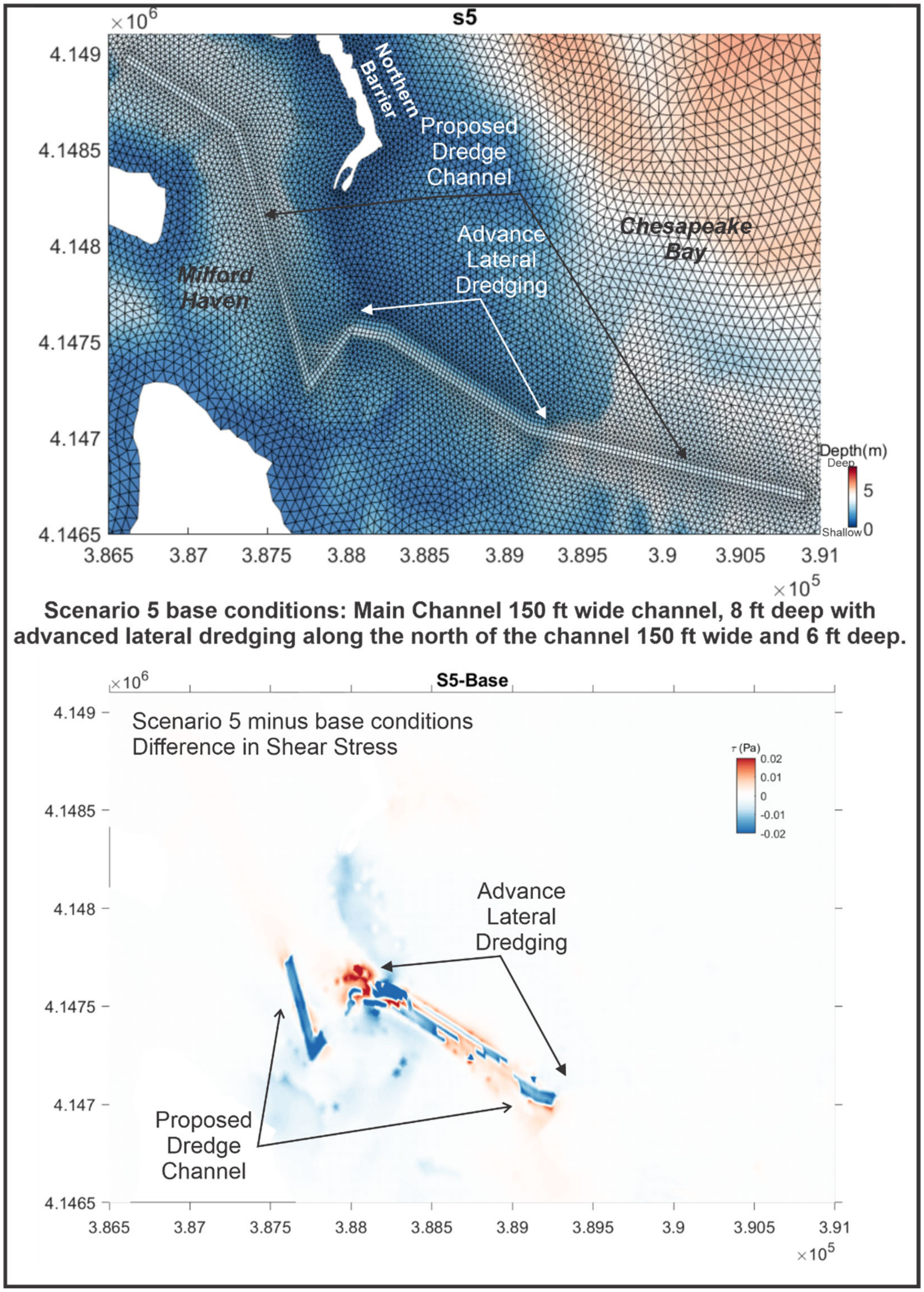
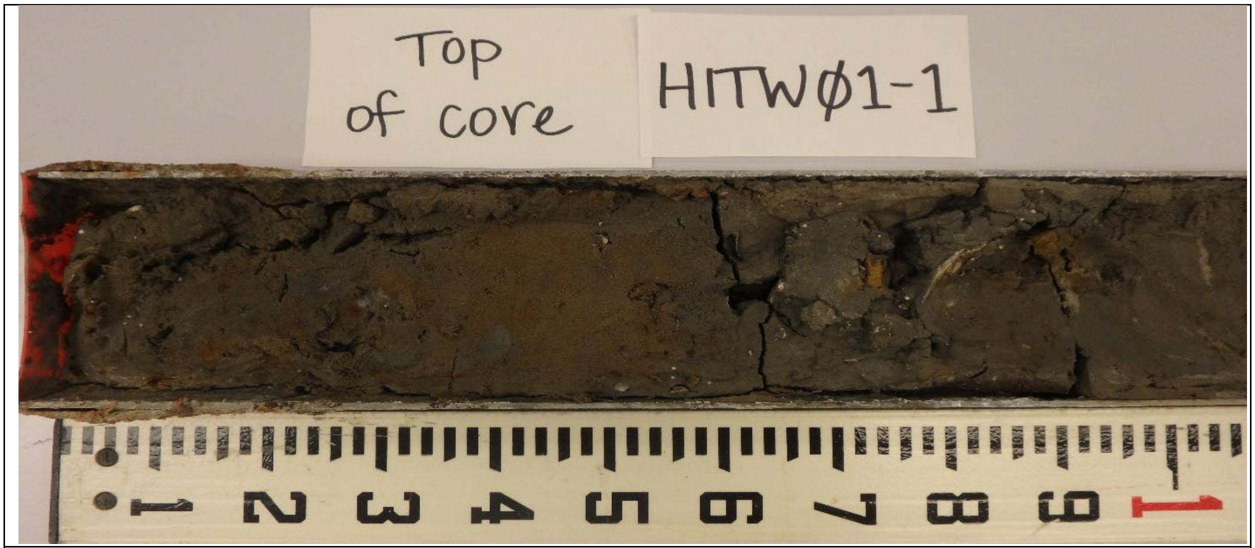


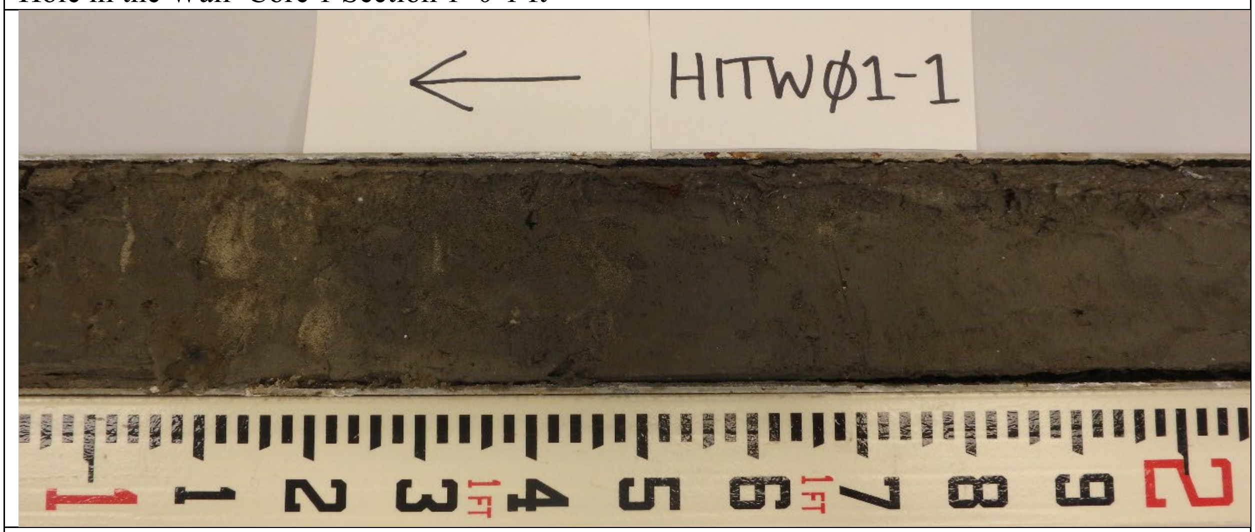
Figure 31. Computer modeling results of proposed channel dredging at HITW with advanced lateral maintenance. The top show the bathymetry and grid of Scenario 5 which includes dredging the channel 150 ft wide and 8 ft deep and the area of ALM which is an additional 150 ft wide and 6 ft deep. The bottom shows the change in bottom shear stress as a result of the dredging. Inside Milford, the shear stress is reduced (blue) as a result of deepening of the bottom. On the outside of the channel, some areas of bottom shear stress increase (red) due to channelization of the currents.

Appendix A

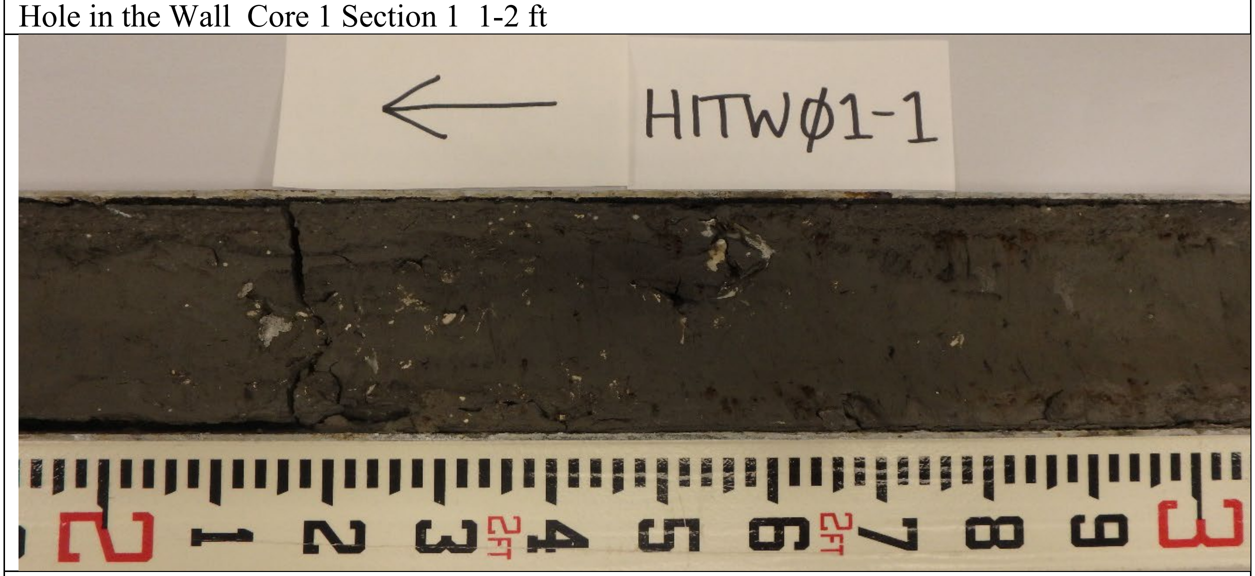
Core Photographs



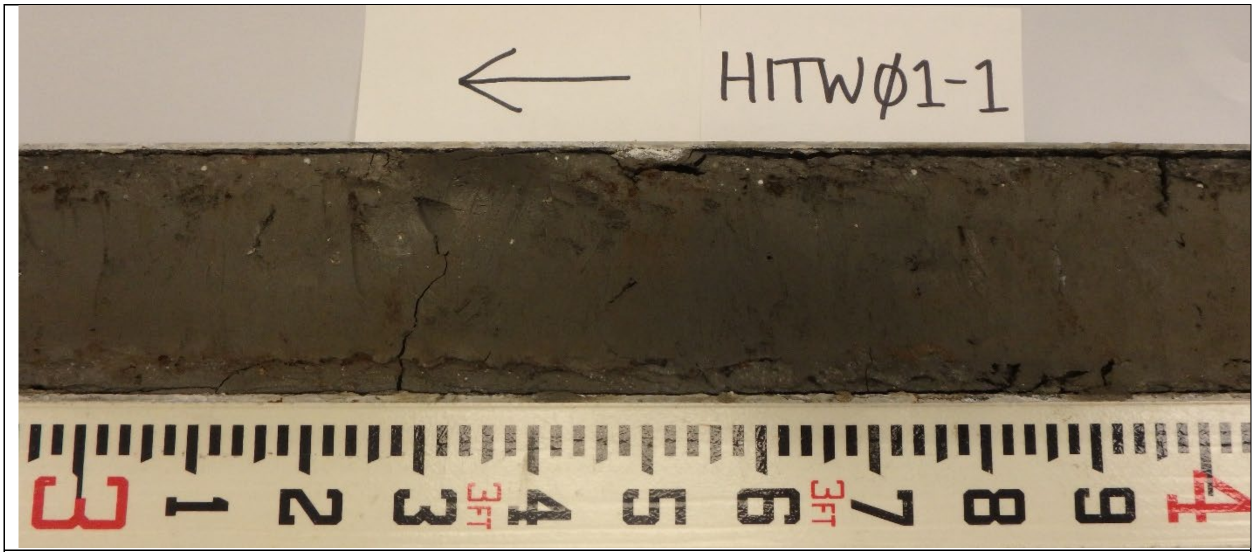
Hole in the Wall Core 1 Section 1 0-1 ft



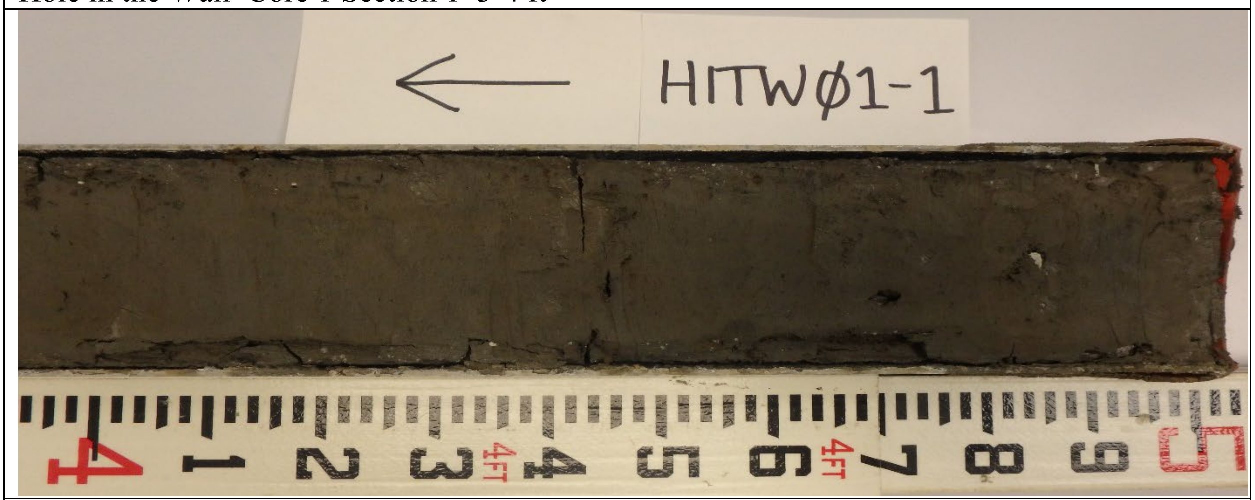
Hole in the Wall Core 1 Section 1 1-2 ft



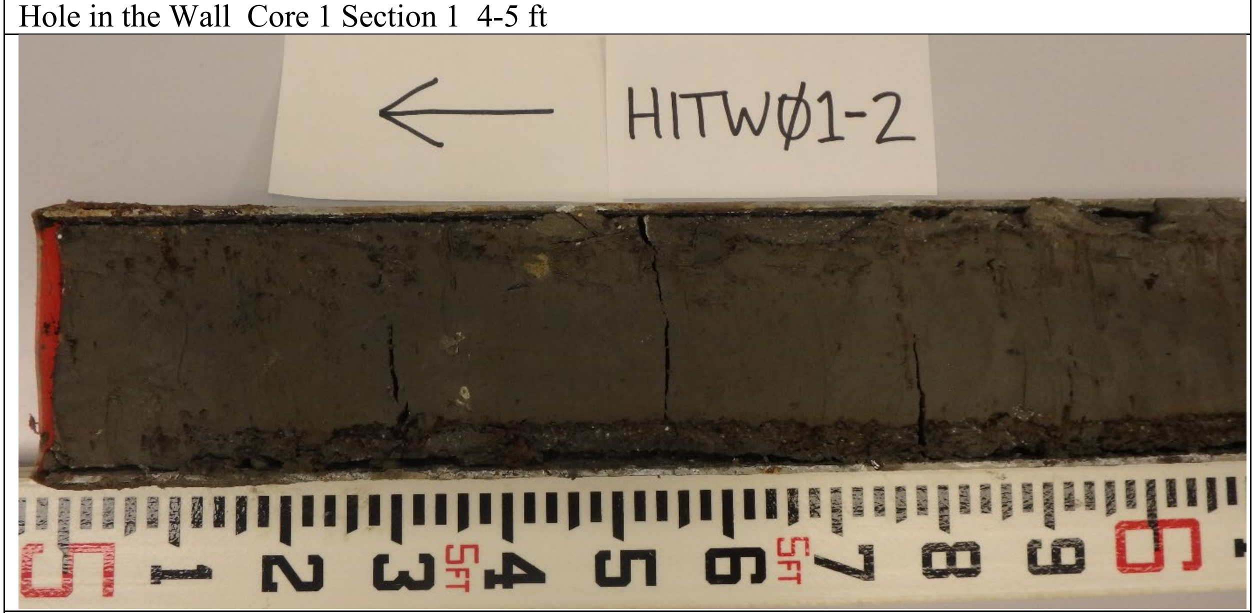
Hole in the Wall Core 1 Section 1 2-3 ft



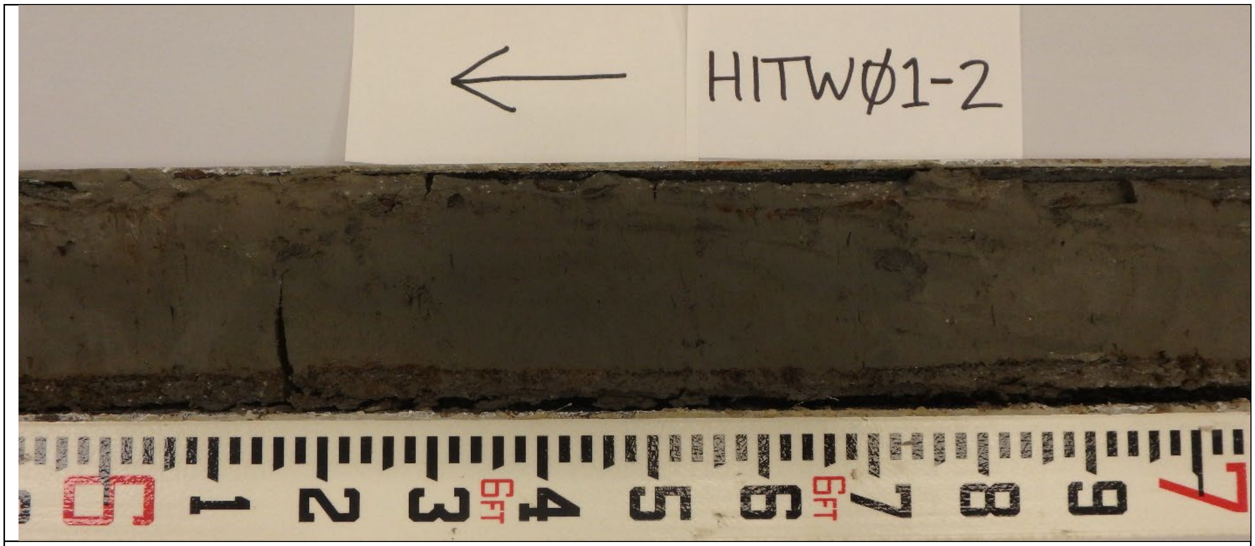
Hole in the Wall Core 1 Section 1 3-4 ft



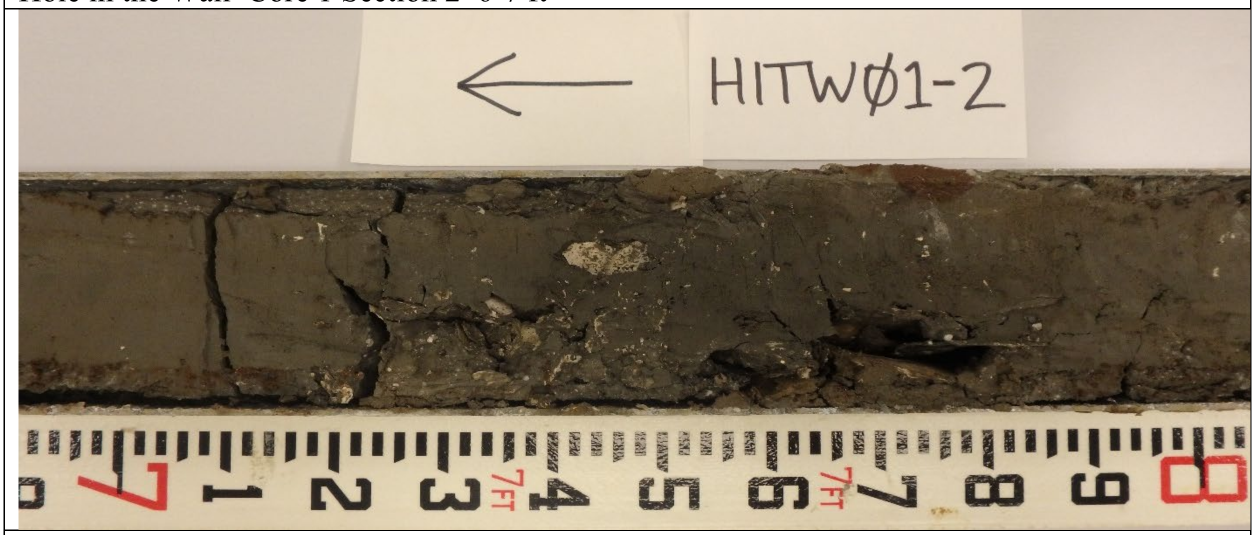
Hole in the Wall Core 1 Section 1 4-5 ft



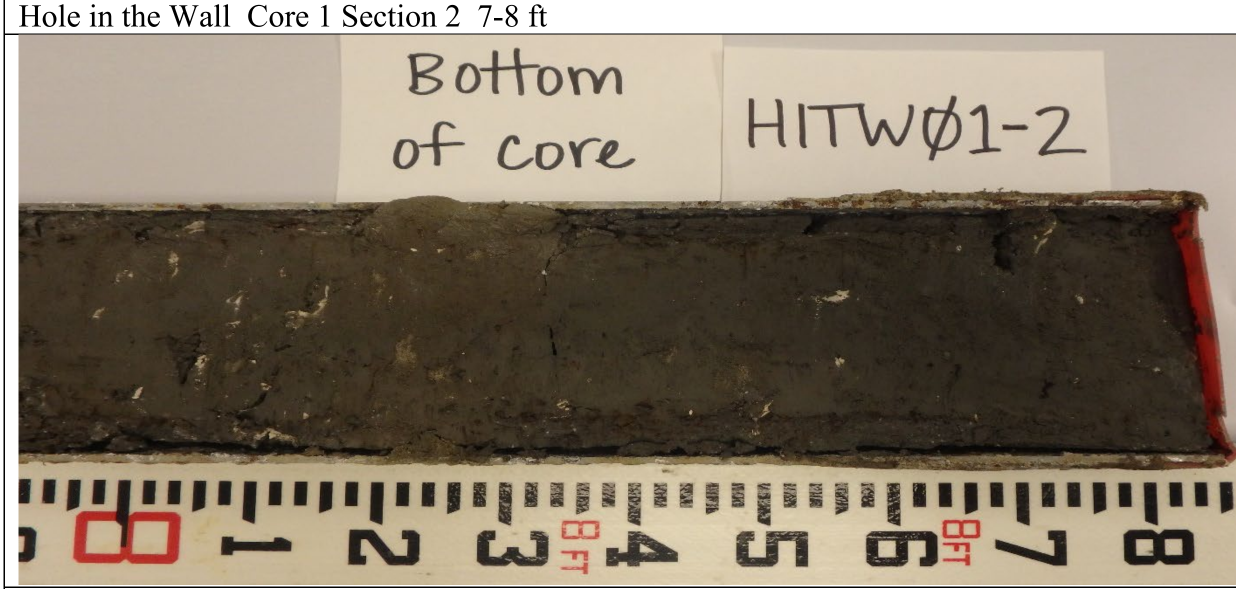
Hole in the Wall Core 1 Section 2 5-6 ft



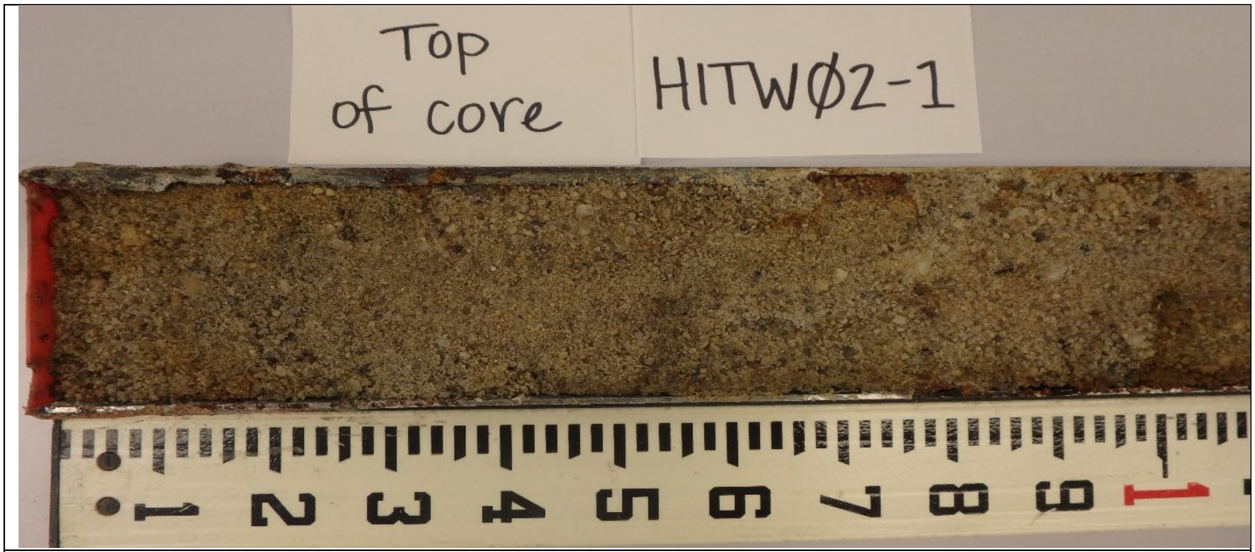
Hole in the Wall Core 1 Section 2 6-7 ft



Hole in the Wall Core 1 Section 2 7-8 ft



Hole in the Wall Core 1 Section 2 8-8.8 ft

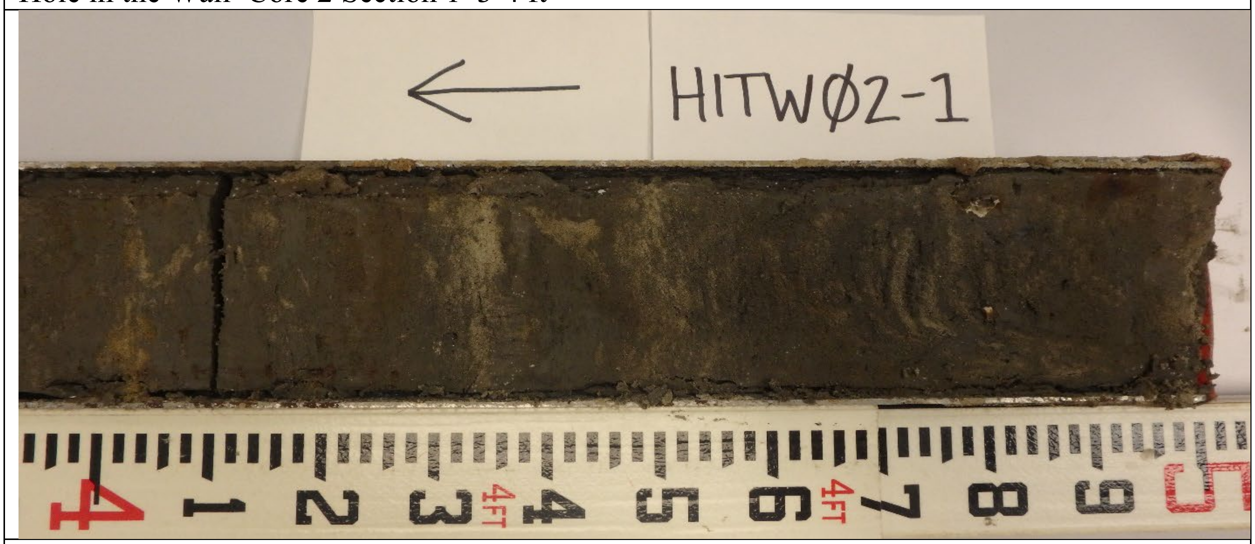


Hole in the Wall Core 2 Section 1 0-1 ft

Hole in the Wall Core 2 Section 1 1-2 ft

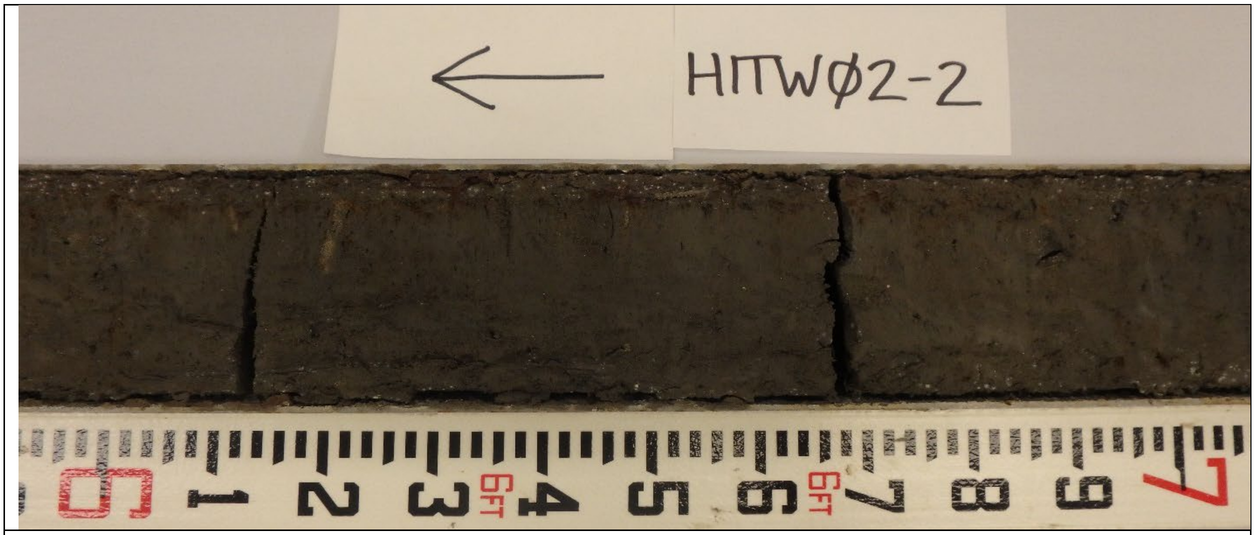
Hole in the Wall Core 2 Section 1 2-3 ft

Hole in the Wall Core 2 Section 1 3-4 ft

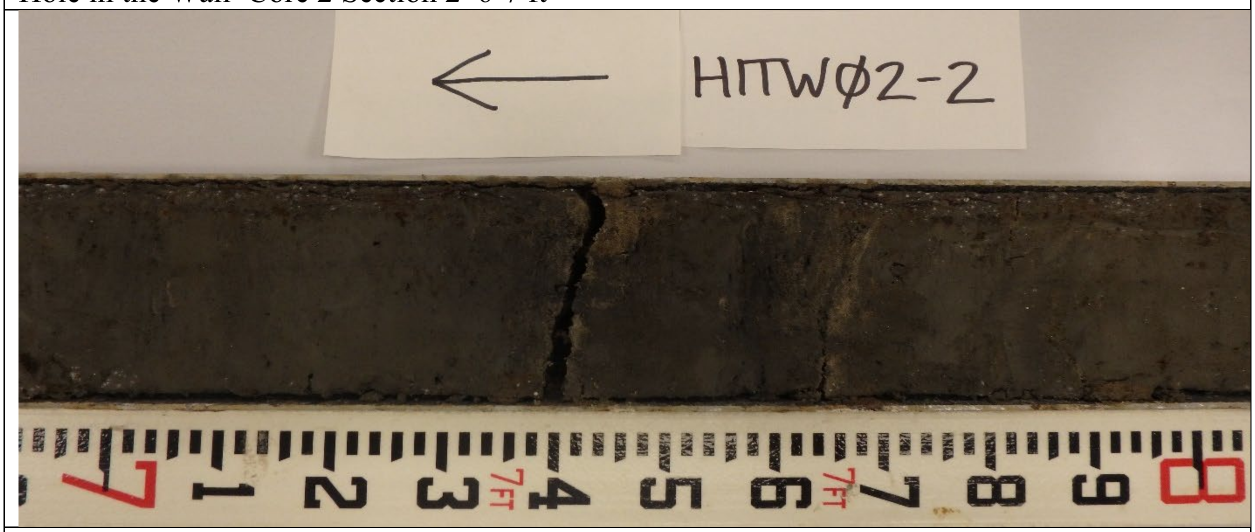


Hole in the Wall Core 2 Section 1 4-5 ft

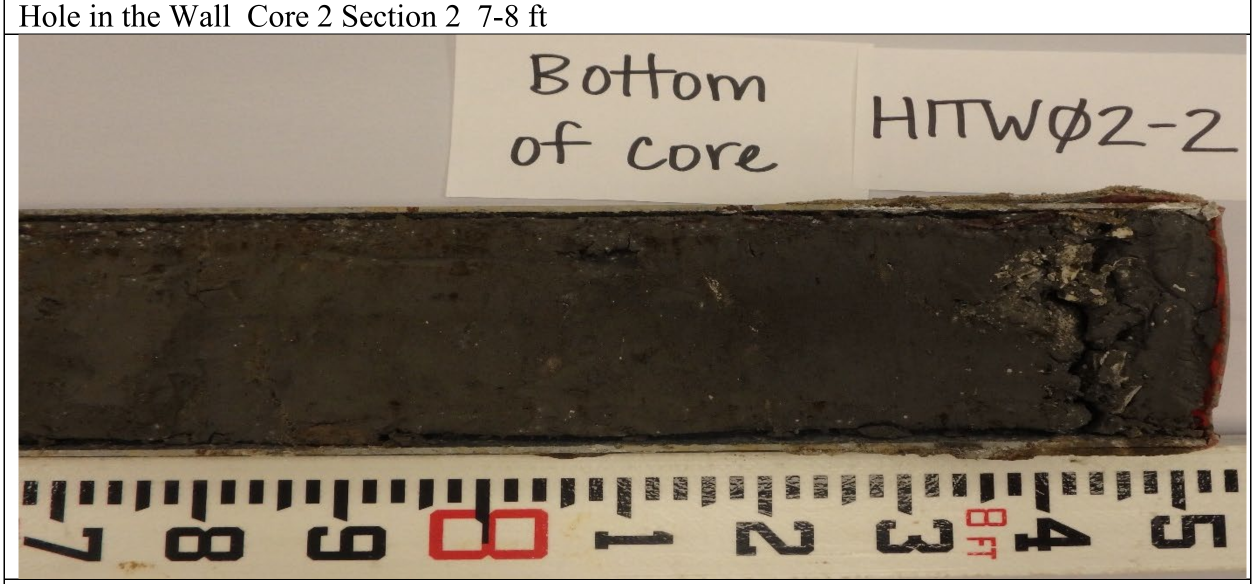
Hole in the Wall Core 2 Section 2 5-6 ft



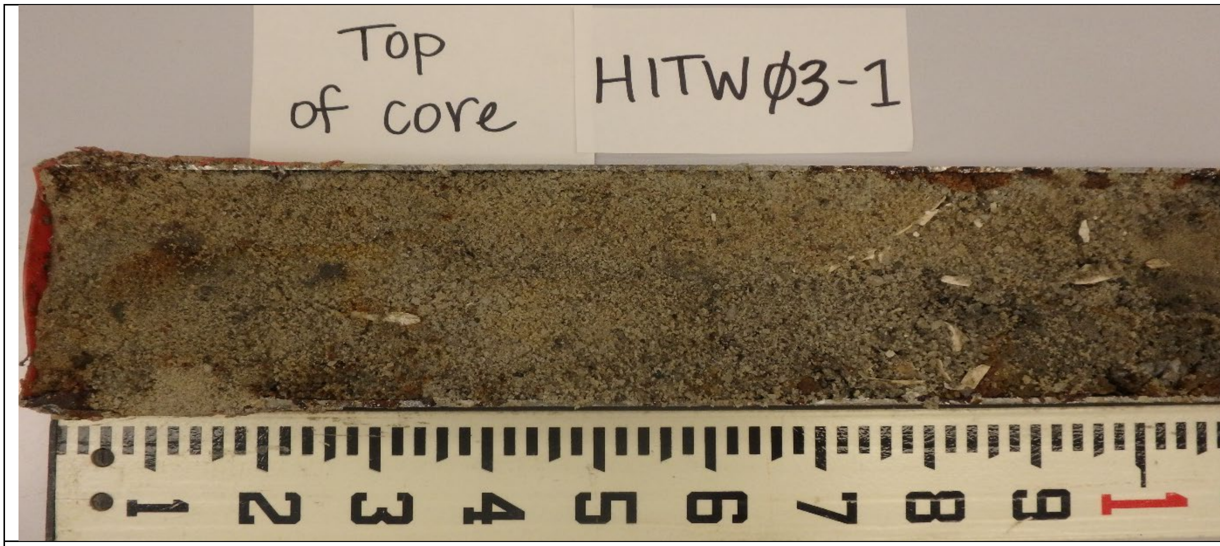
Hole in the Wall Core 2 Section 2 6-7 ft



Hole in the Wall Core 2 Section 2 7-8 ft

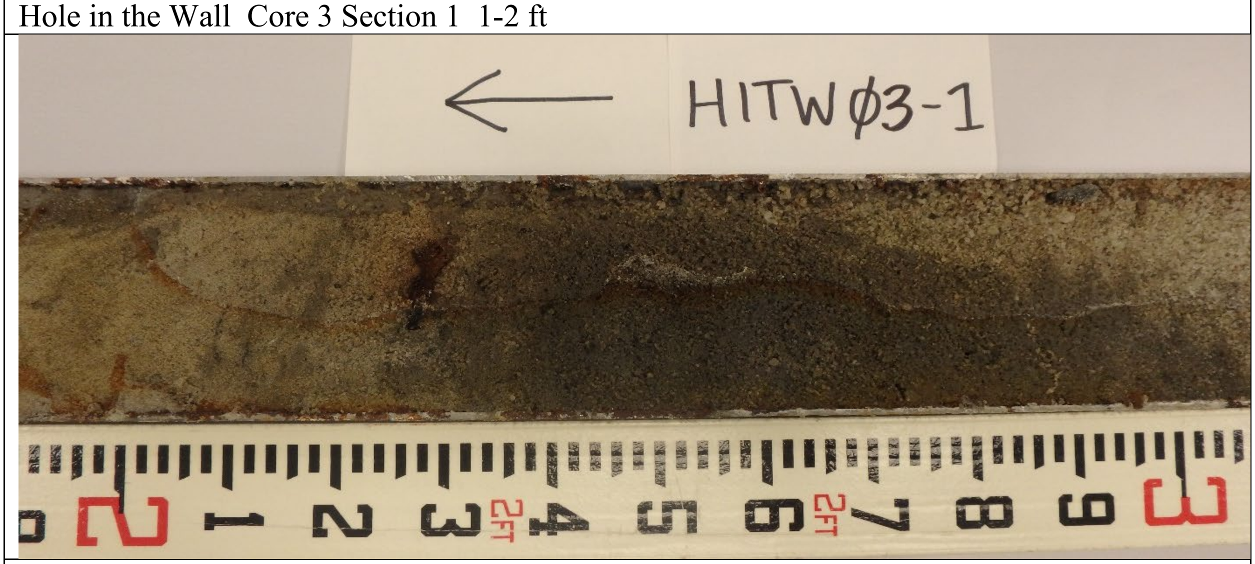


Hole in the Wall Core 2 Section 2 7.7-8.5 ft

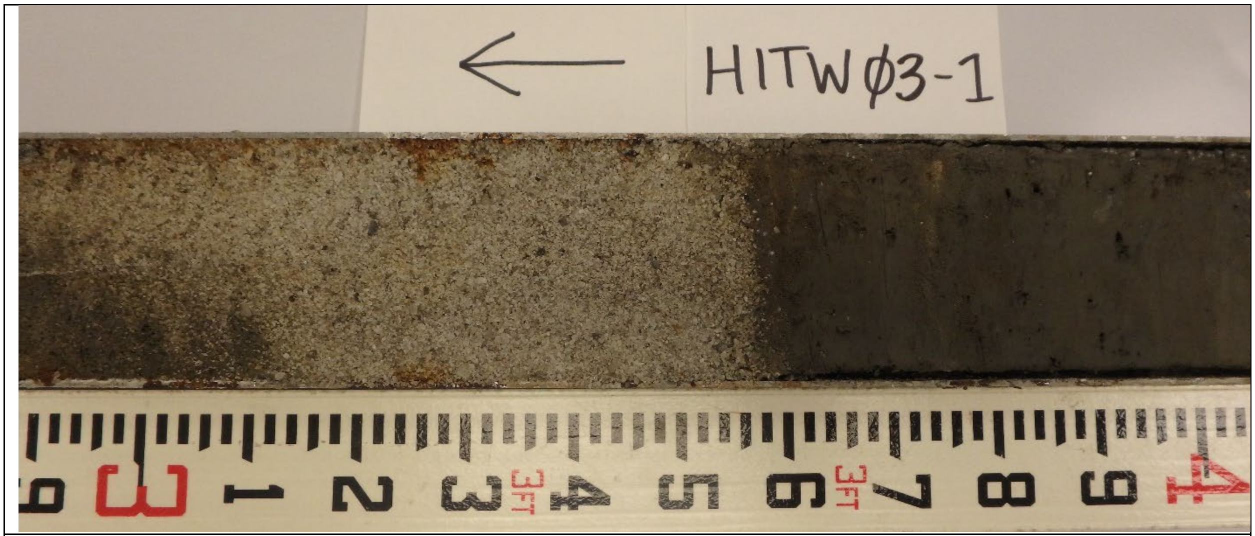


Hole in the Wall Core 3 Section 1 0-1 ft

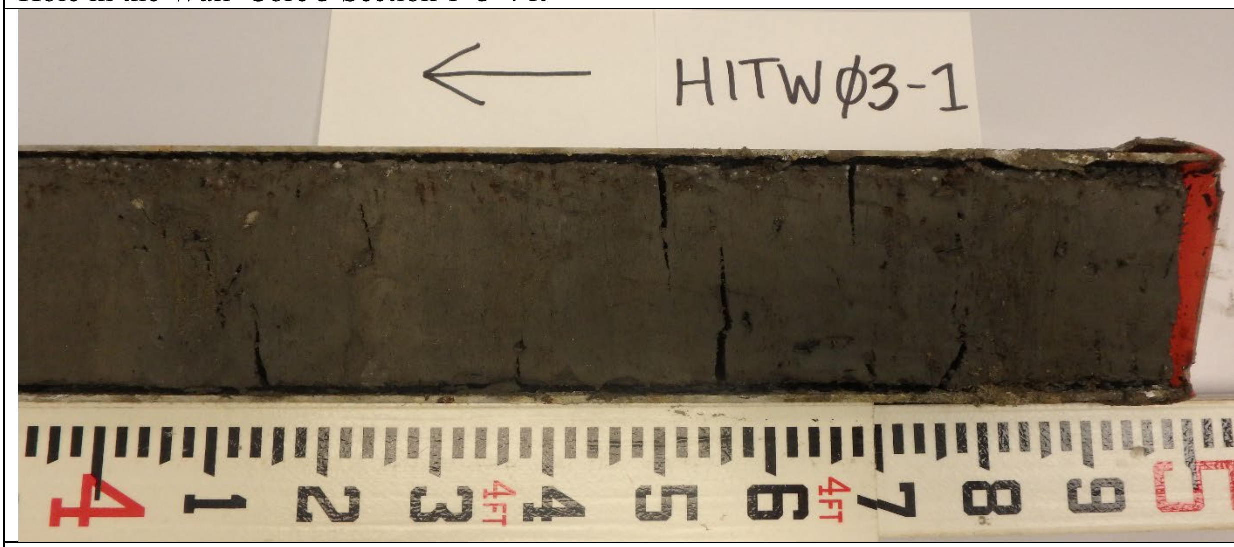
Hole in the Wall Core 3 Section 1 1-2 ft



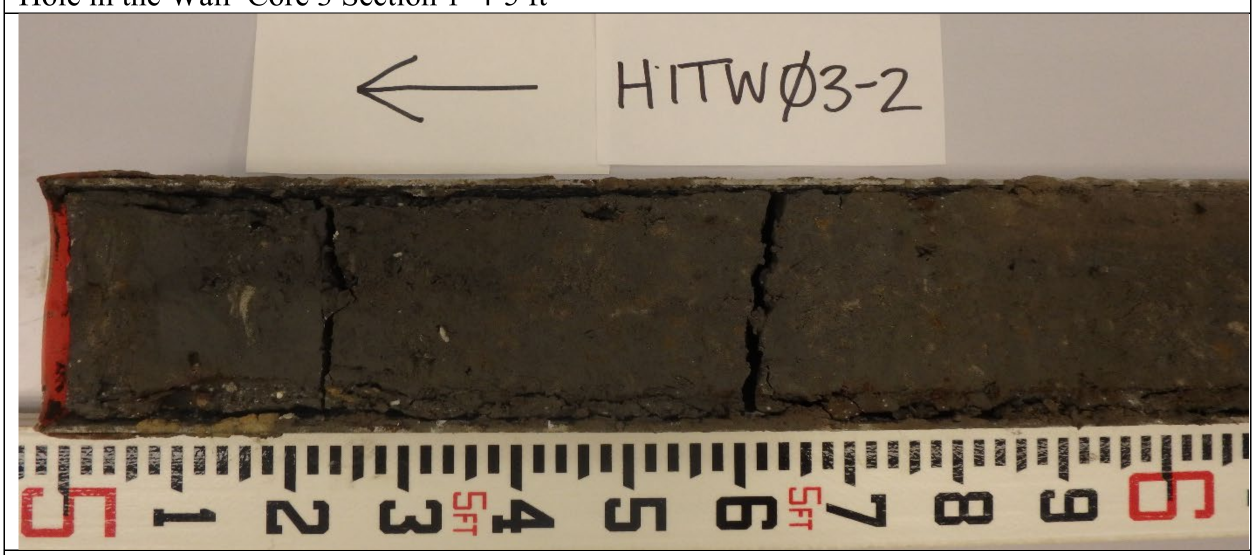
Hole in the Wall Core 3 Section 1 2-3 ft



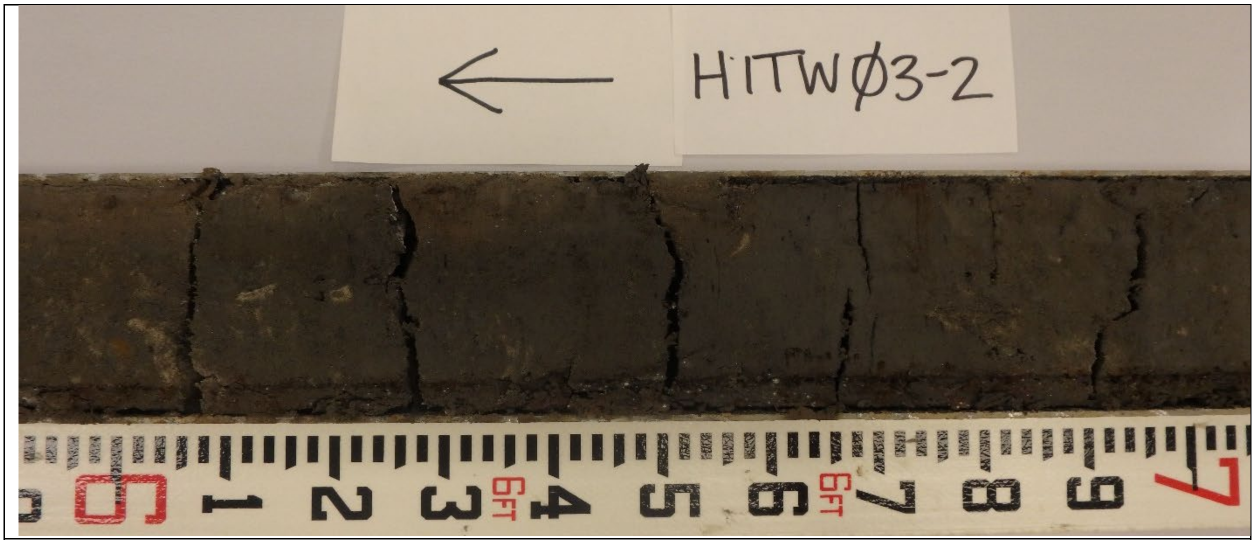
Hole in the Wall Core 3 Section 1 3-4 ft



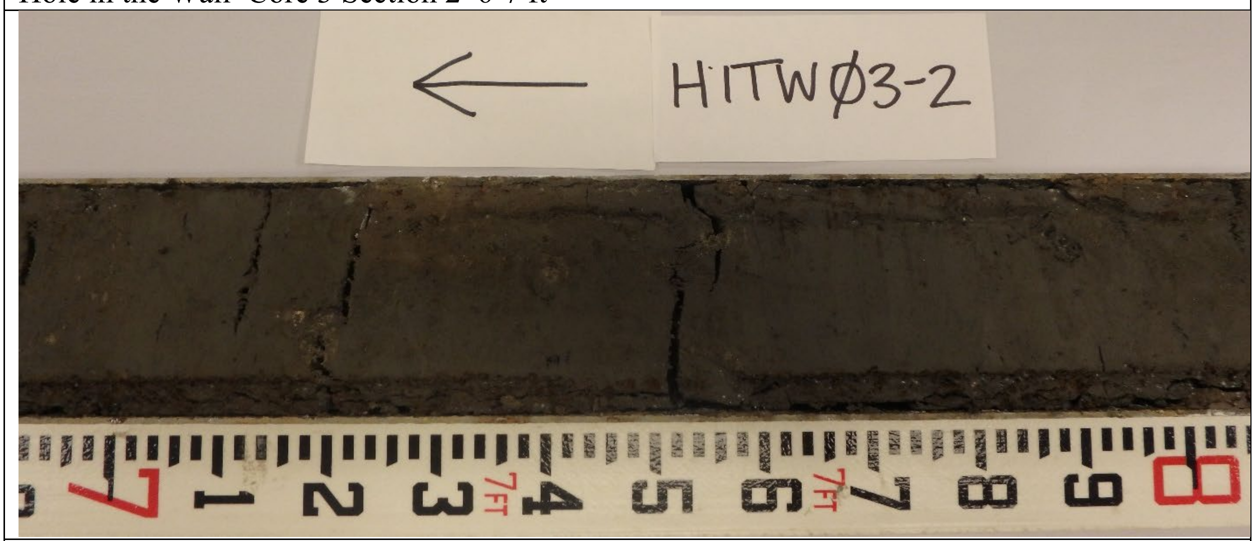
Hole in the Wall Core 3 Section 1 4-5 ft



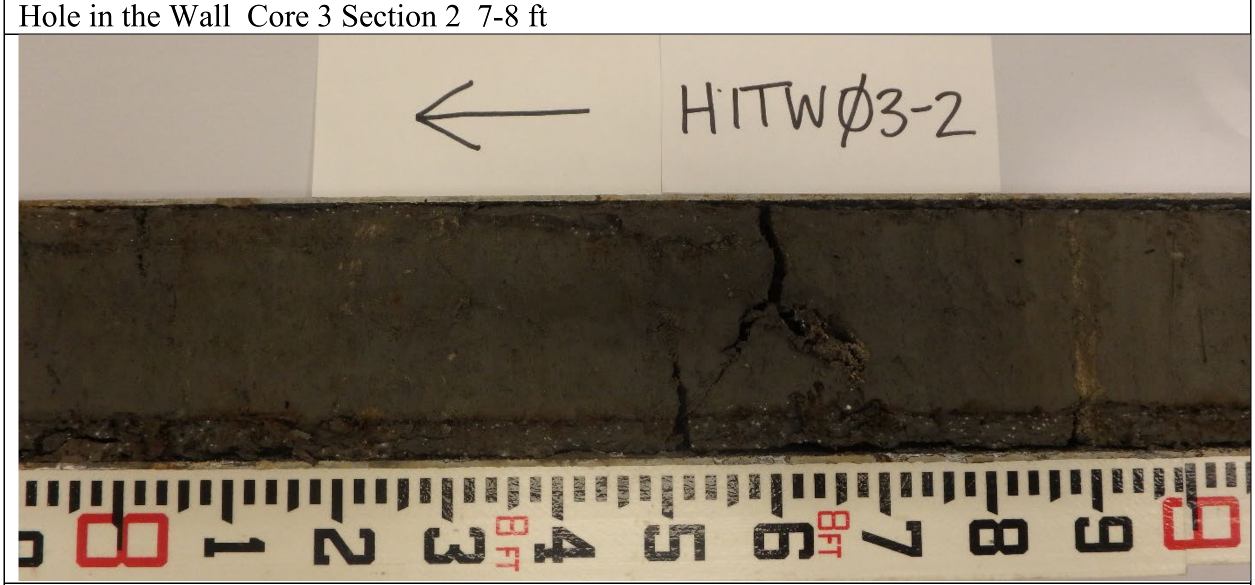
Hole in the Wall Core 3 Section 2 5-6 ft



Hole in the Wall Core 3 Section 2 6-7 ft

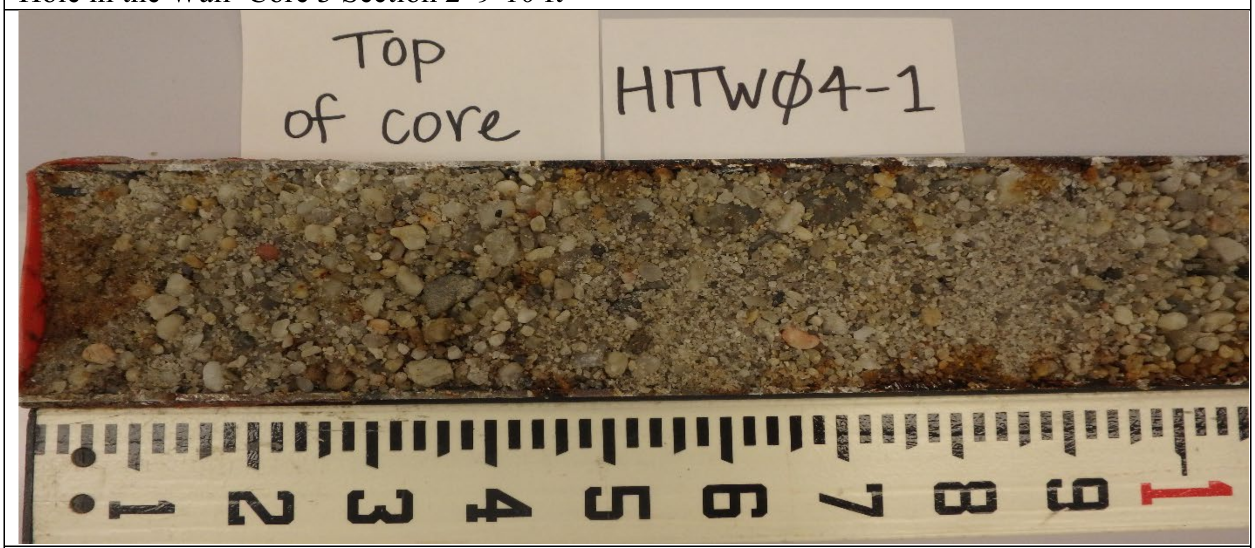


Hole in the Wall Core 3 Section 2 7-8 ft

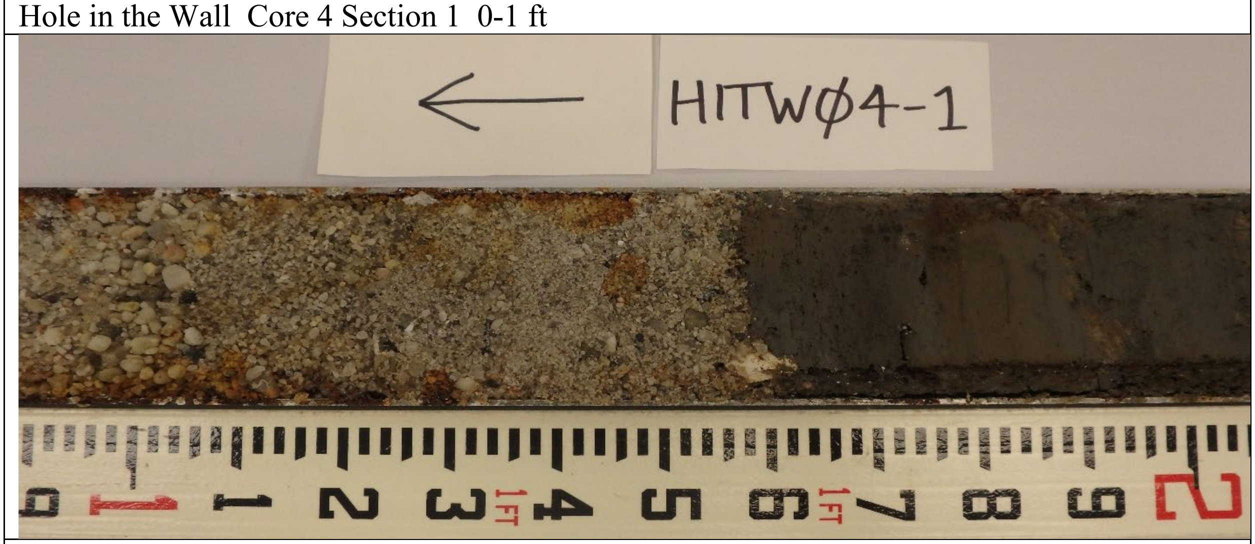


Hole in the Wall Core 3 Section 2 8-9 ft

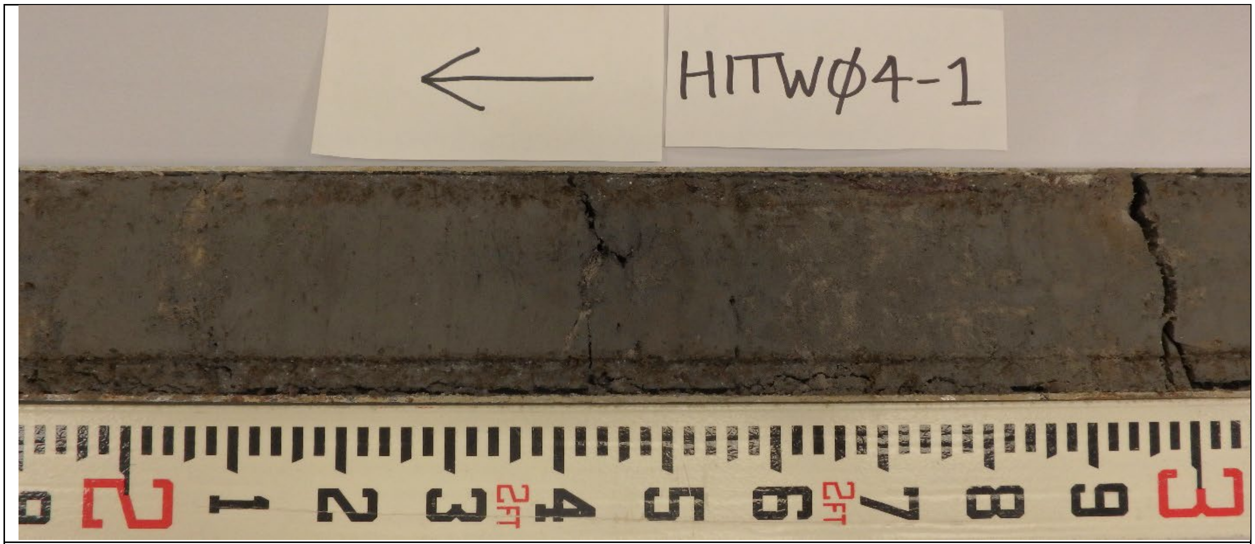
Hole in the Wall Core 3 Section 2 9-10 ft



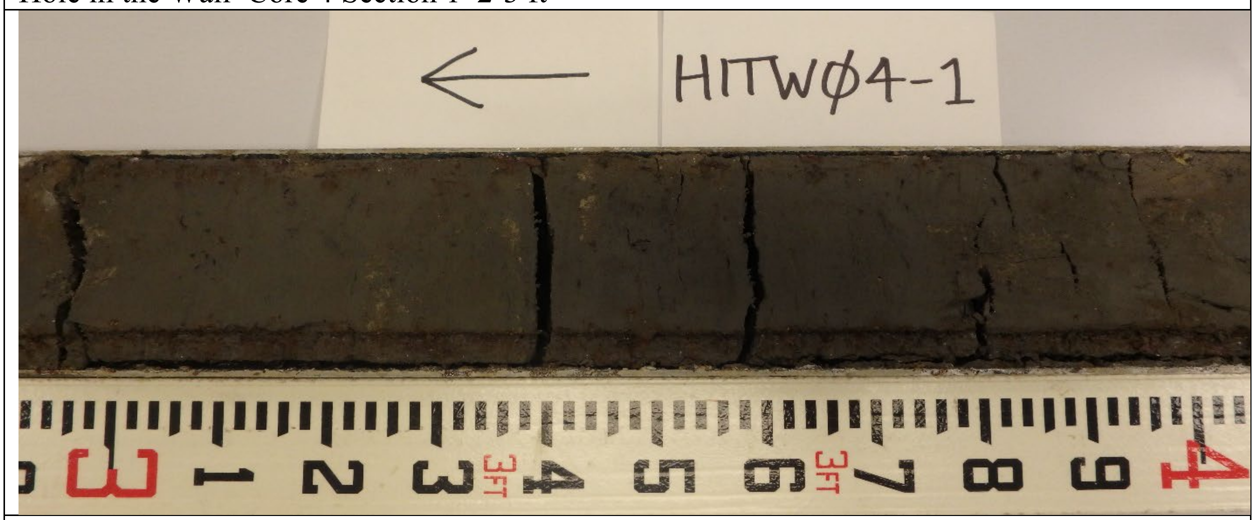
Hole in the Wall Core 4 Section 1 0-1 ft



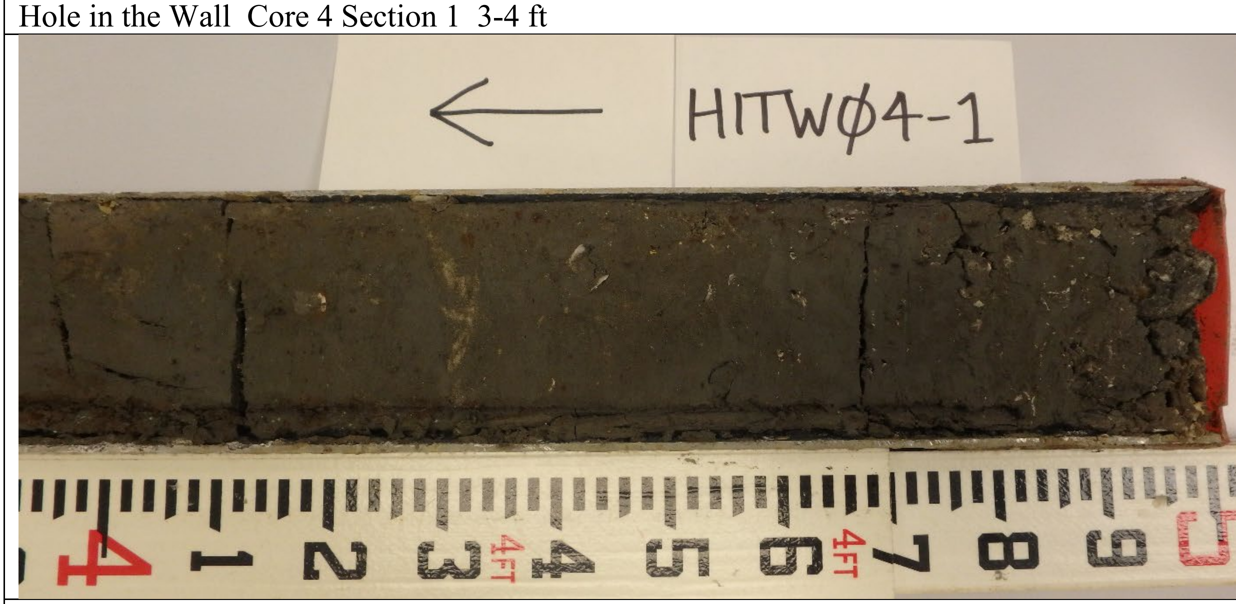
Hole in the Wall Core 4 Section 1 1-2 ft



Hole in the Wall Core 4 Section 1 2-3 ft

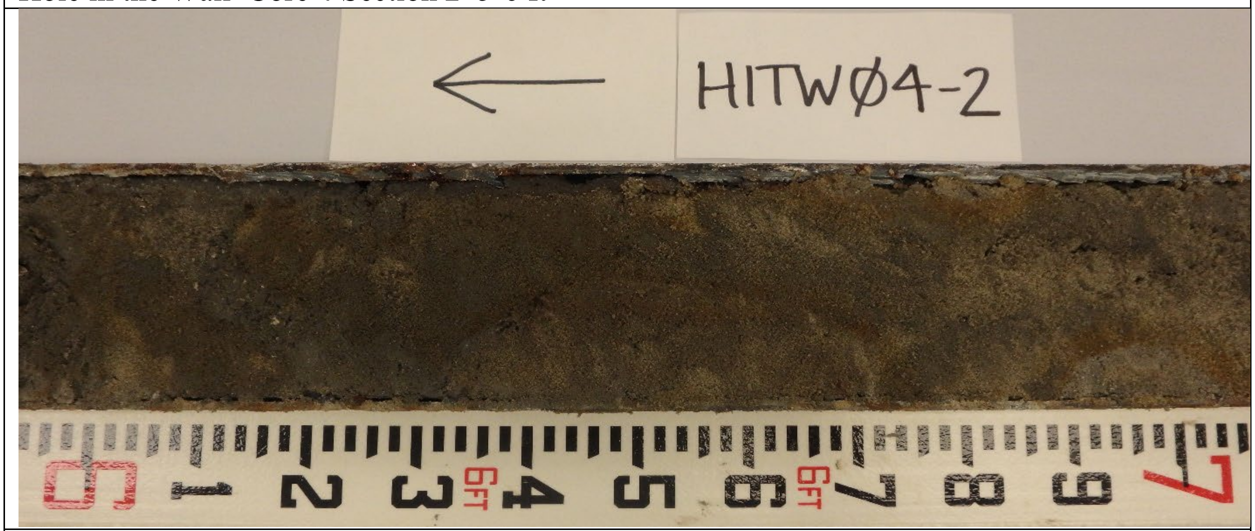


Hole in the Wall Core 4 Section 1 3-4 ft

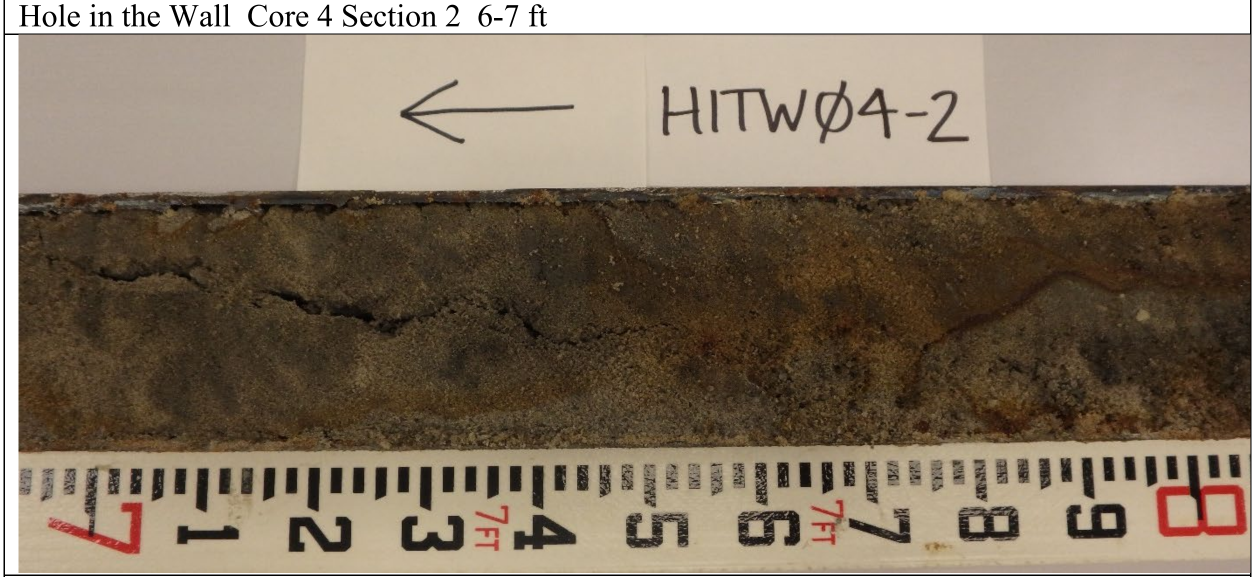


Hole in the Wall Core 4 Section 1 4-5 ft

Hole in the Wall Core 4 Section 2 5-6 ft

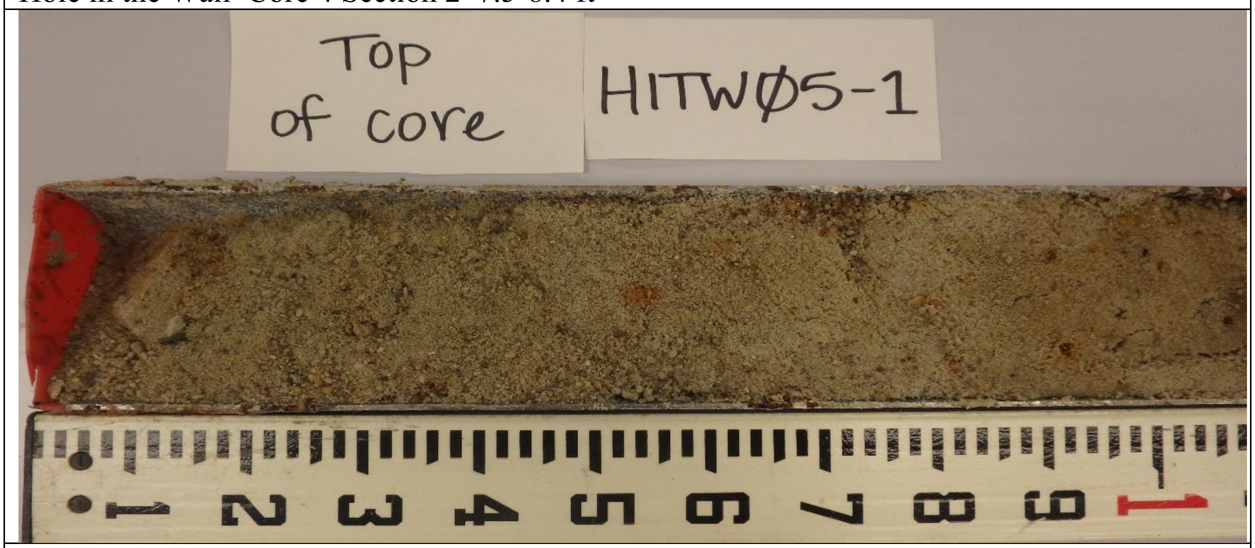


Hole in the Wall Core 4 Section 2 6-7 ft

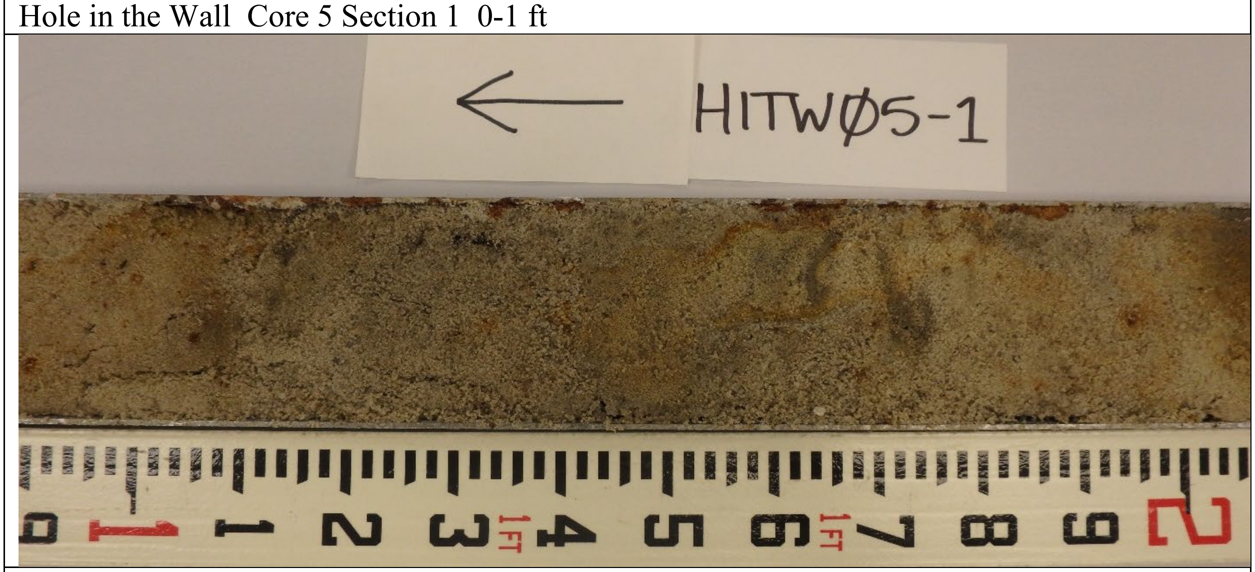


Hole in the Wall Core 4 Section 2 7-8 ft

Hole in the Wall Core 4 Section 2 7.5-8.4 ft



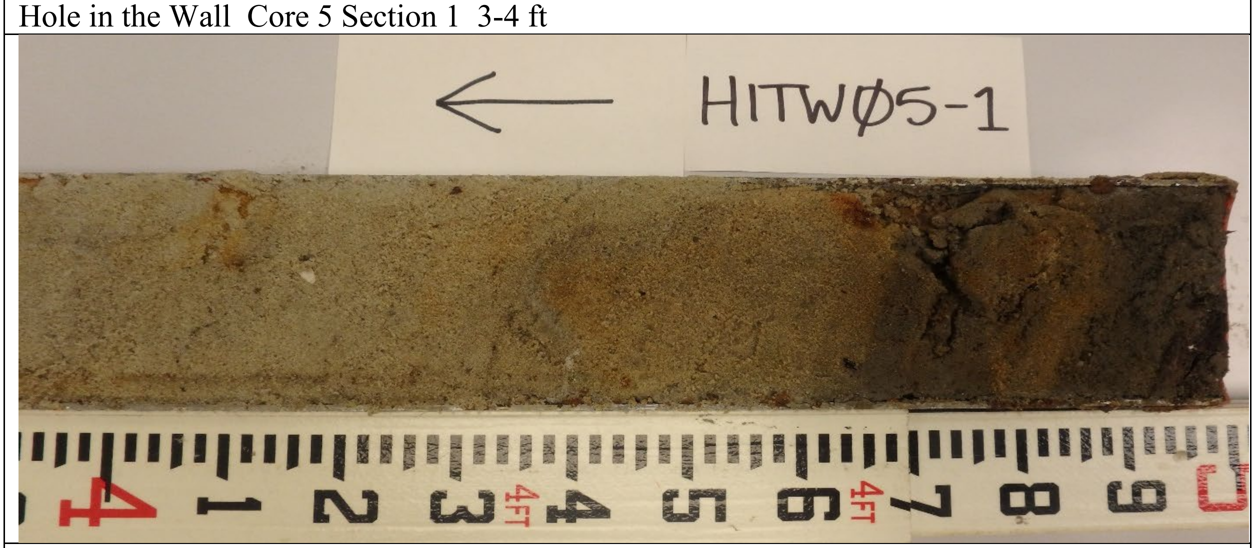
Hole in the Wall Core 5 Section 1 0-1 ft



Hole in the Wall Core 5 Section 1 1-2 ft

Hole in the Wall Core 5 Section 1 2-3 ft

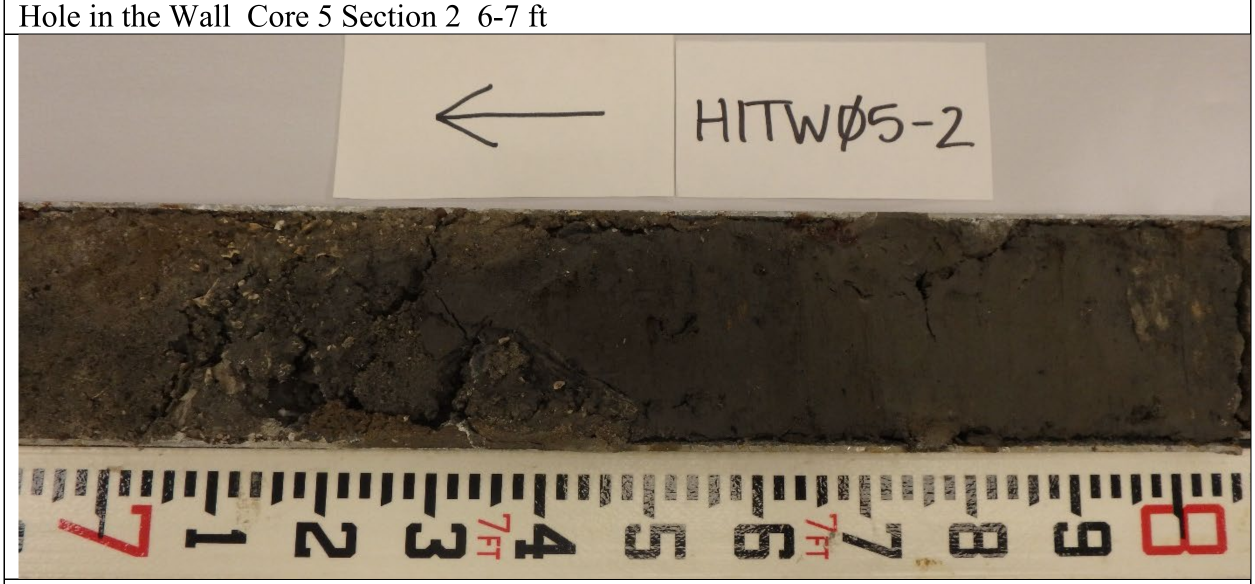
Hole in the Wall Core 5 Section 1 3-4 ft



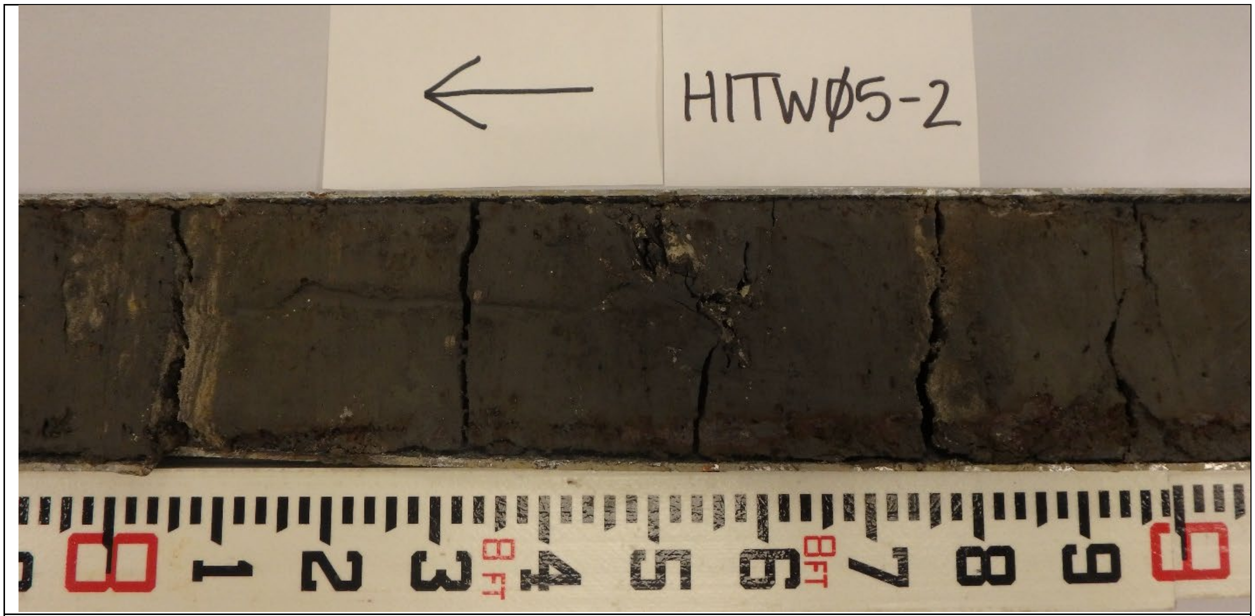
Hole in the Wall Core 5 Section 1 4-5 ft

Hole in the Wall Core 5 Section 2 5-6 ft

Hole in the Wall Core 5 Section 2 6-7 ft

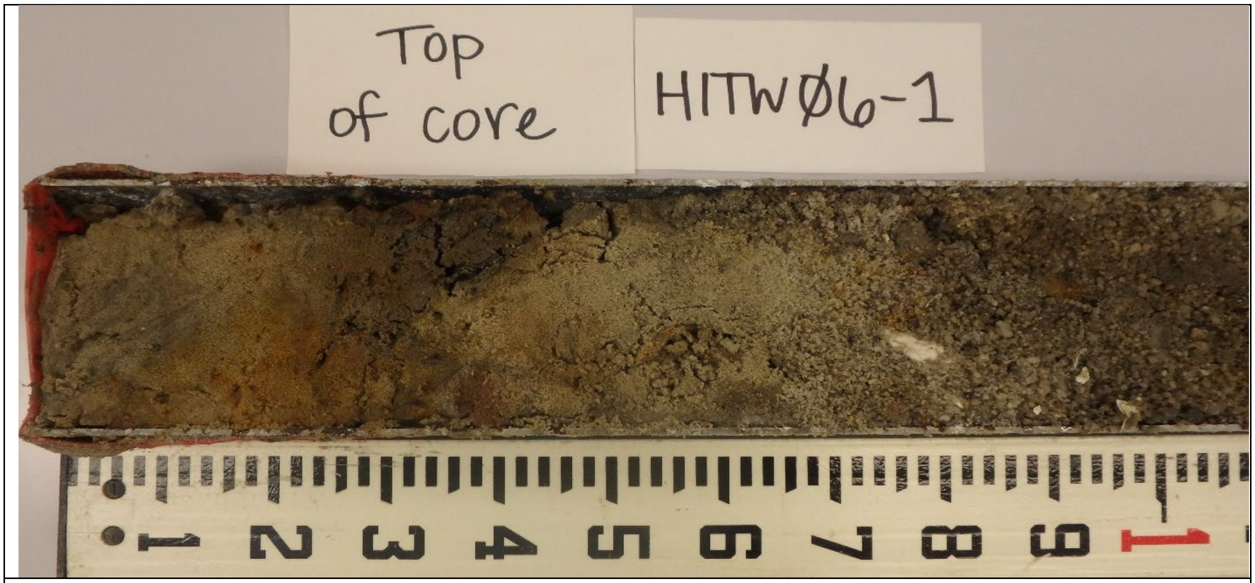


Hole in the Wall Core 5 Section 2 7-8 ft

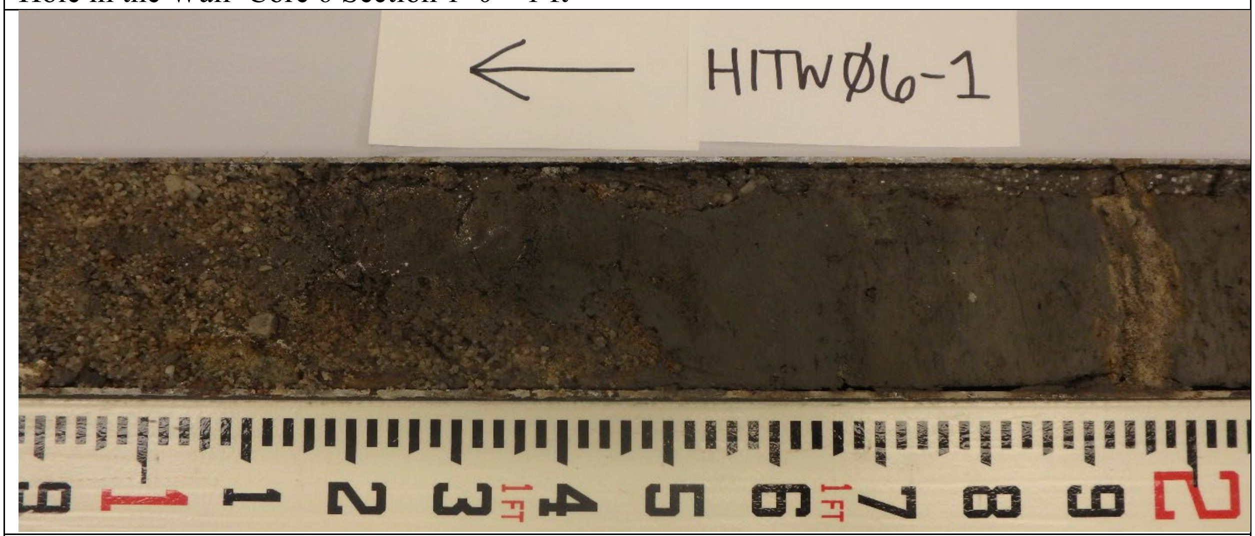


Hole in the Wall Core 5 Section 2 8-9 ft

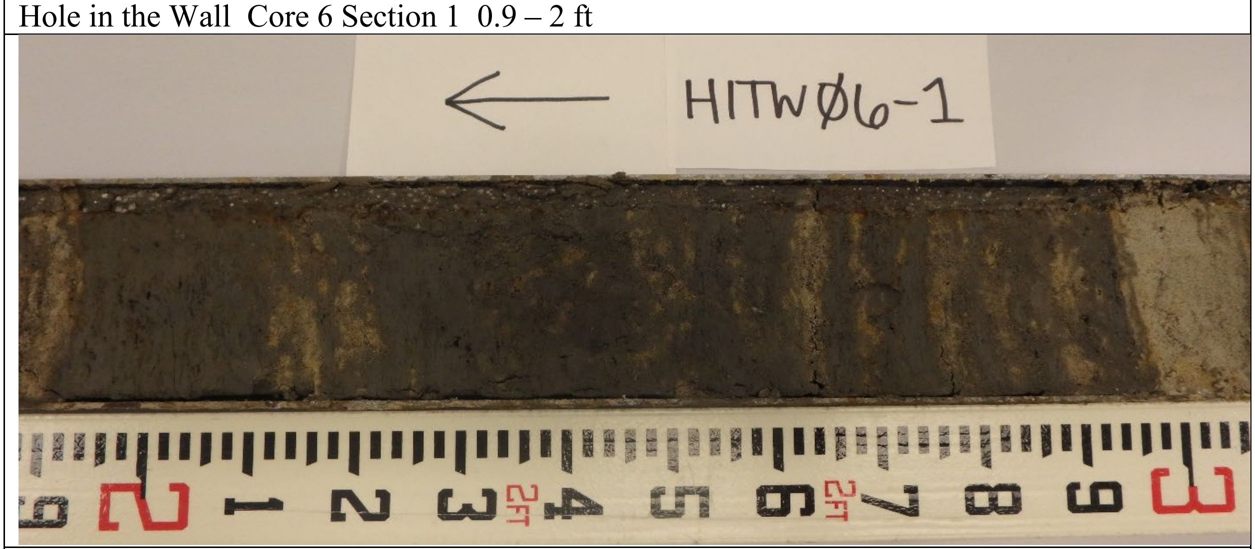
Hole in the Wall Core 5 Section 2 8.6-9.3 ft



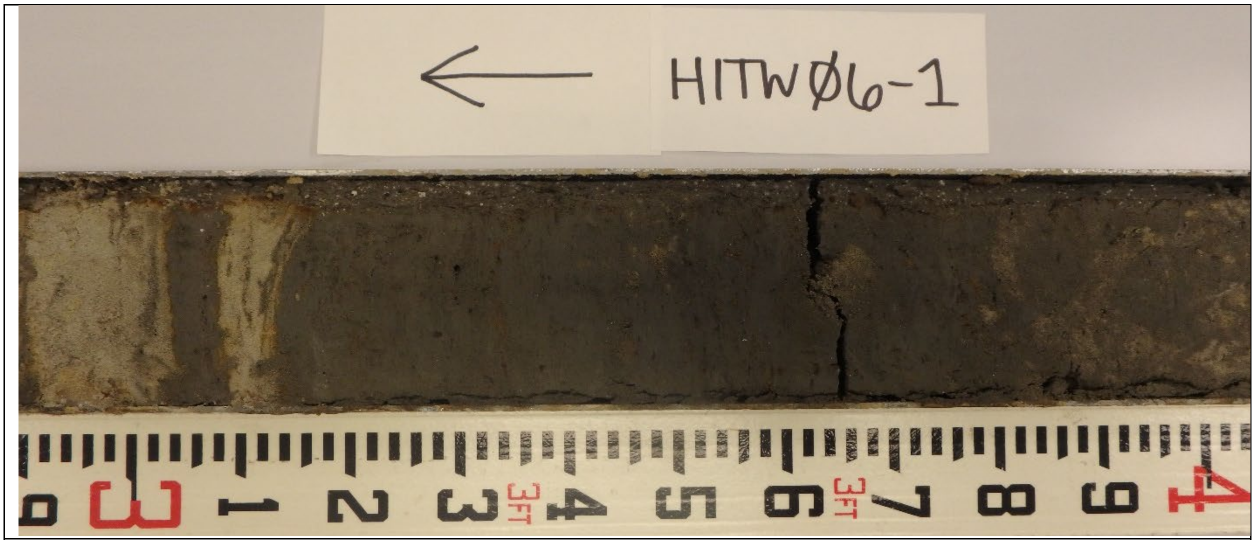
Hole in the Wall Core 6 Section 1 0 – 1 ft



Hole in the Wall Core 6 Section 1 0.9 – 2 ft

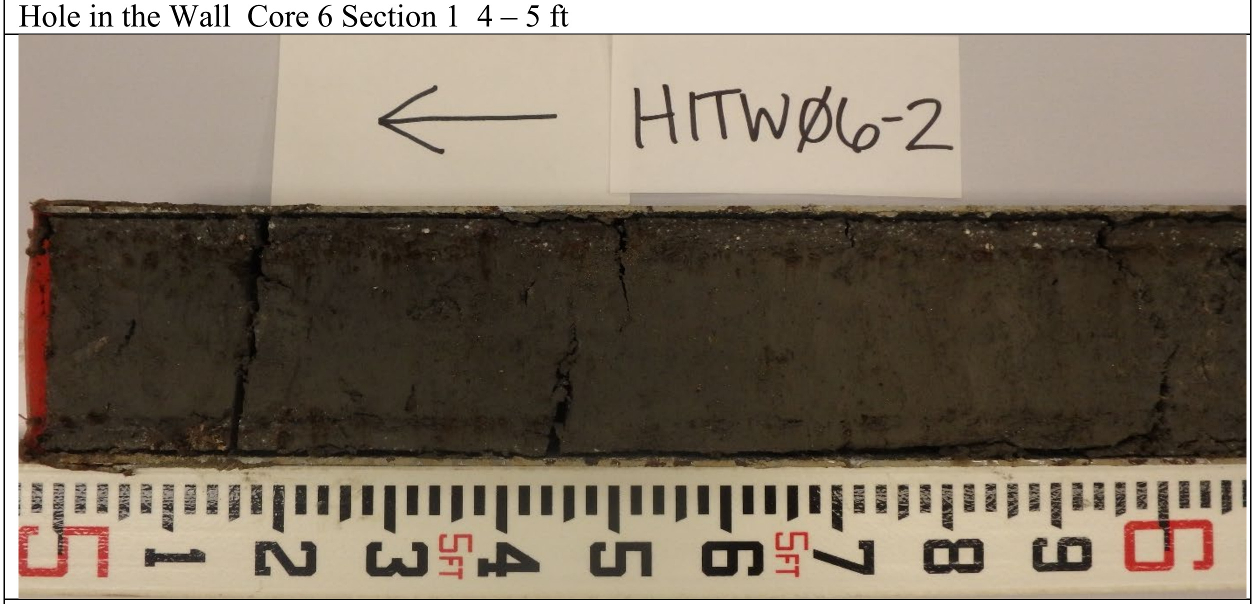


Hole in the Wall Core 6 Section 1 1.9 – 3 ft

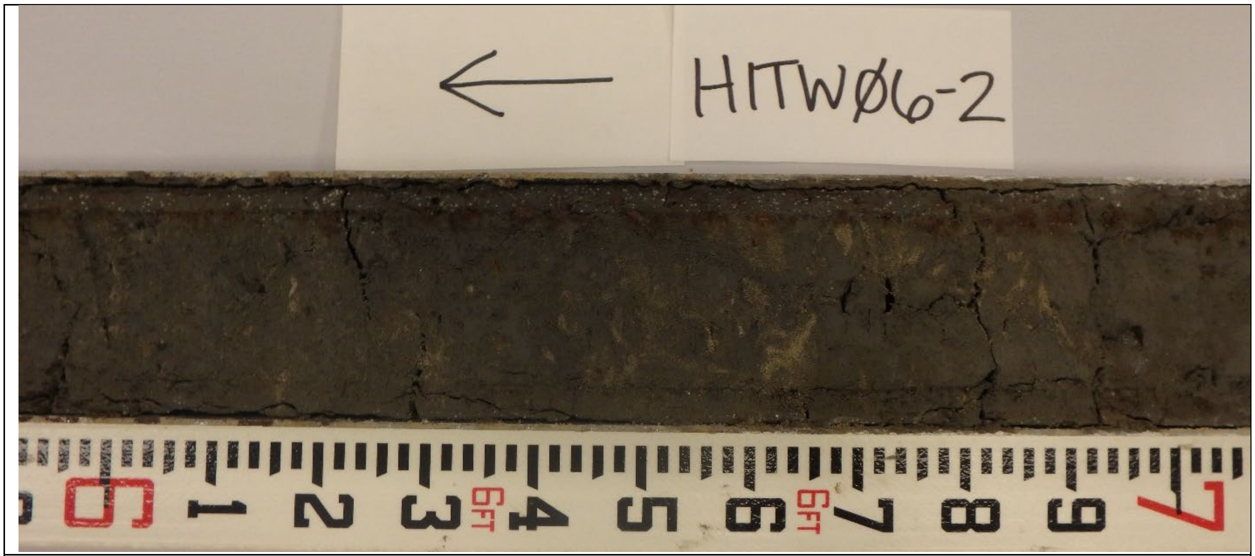


Hole in the Wall Core 6 Section 1 3 – 4 ft

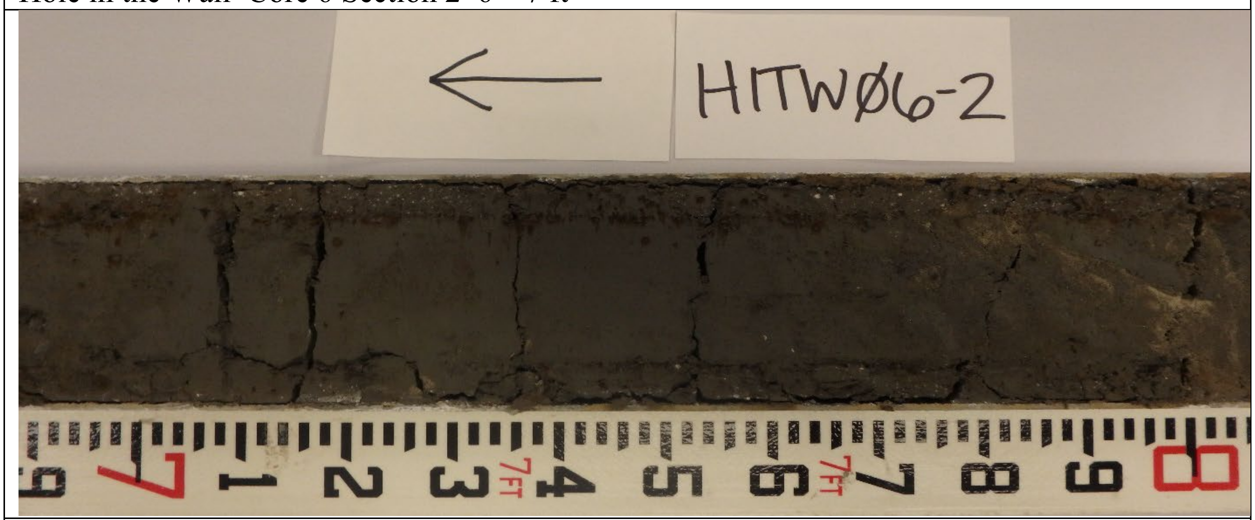
Hole in the Wall Core 6 Section 1 4 – 5 ft



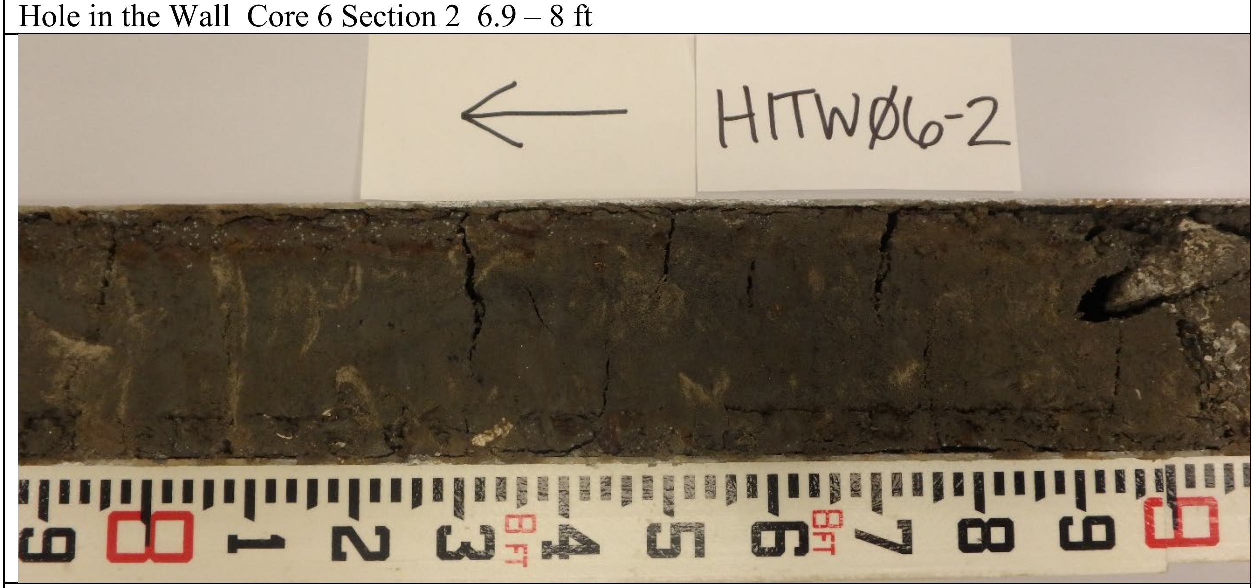
Hole in the Wall Core 6 Section 2 5 – 6 ft



Hole in the Wall Core 6 Section 2 6 – 7 ft



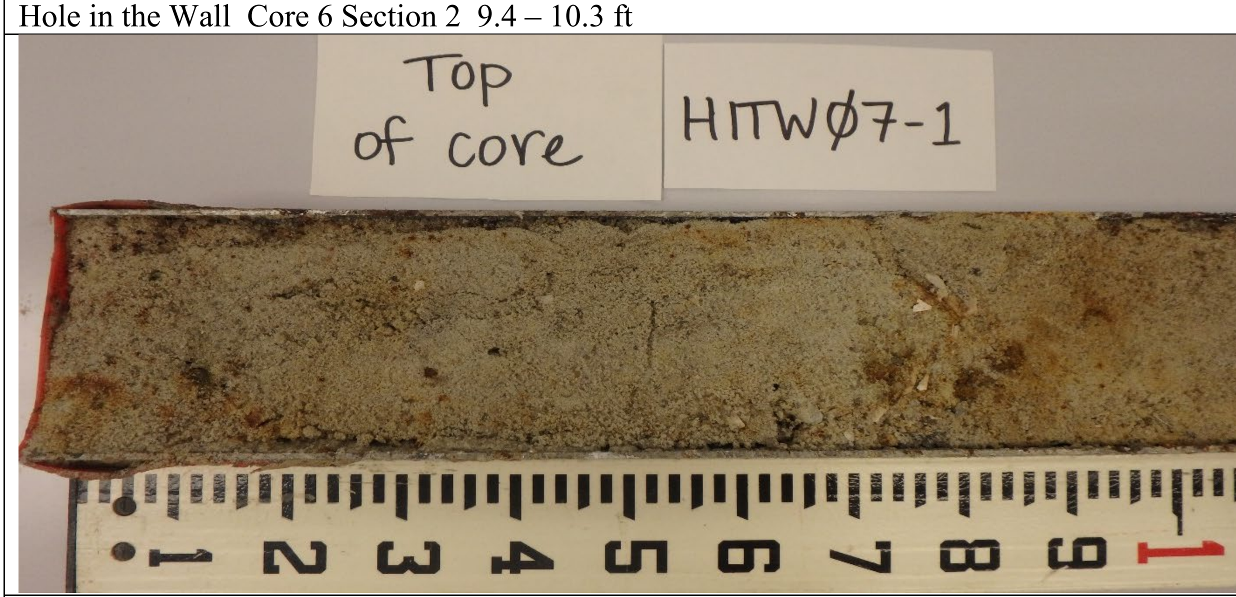
Hole in the Wall Core 6 Section 2 6.9 – 8 ft



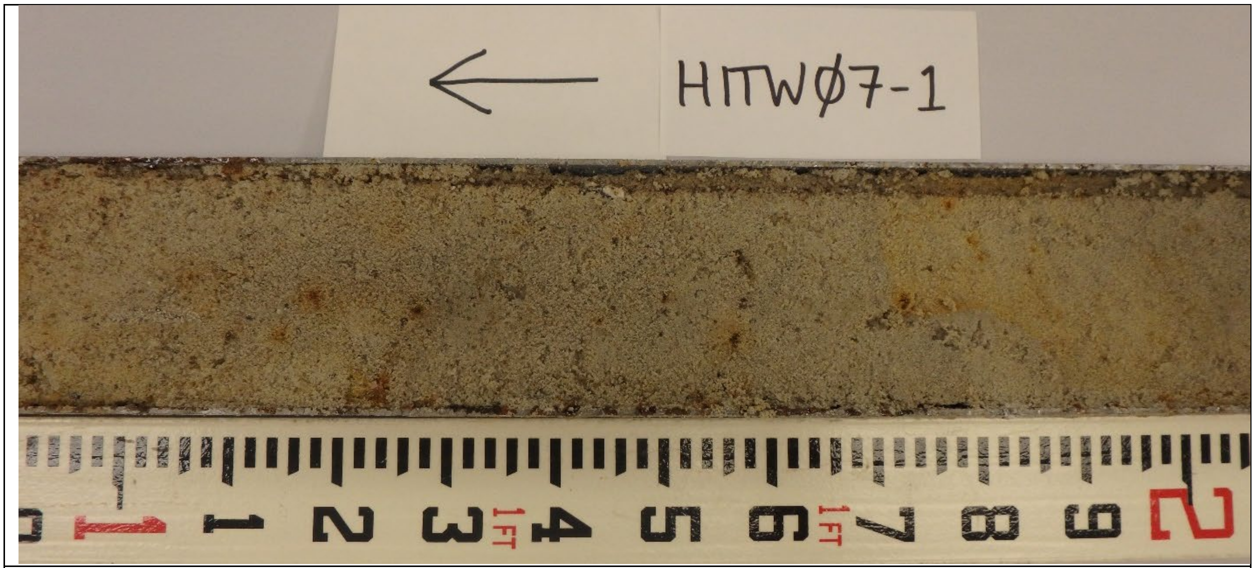
Hole in the Wall Core 6 Section 2 7.9 – 9 ft

Hole in the Wall Core 6 Section 2 8.9 – 10 ft

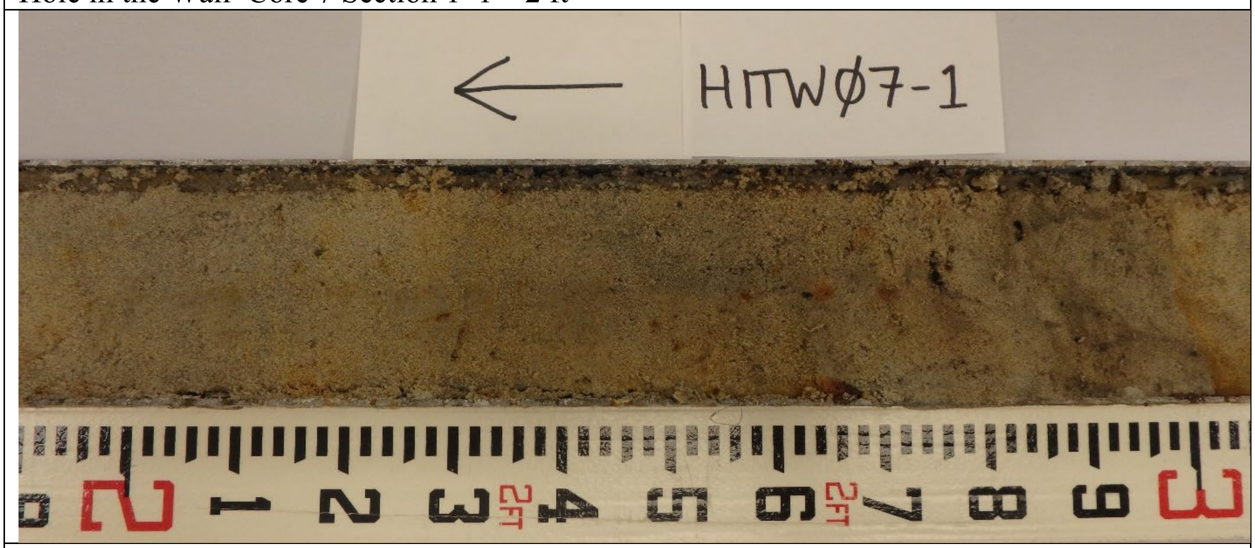
Hole in the Wall Core 6 Section 2 9.4 – 10.3 ft



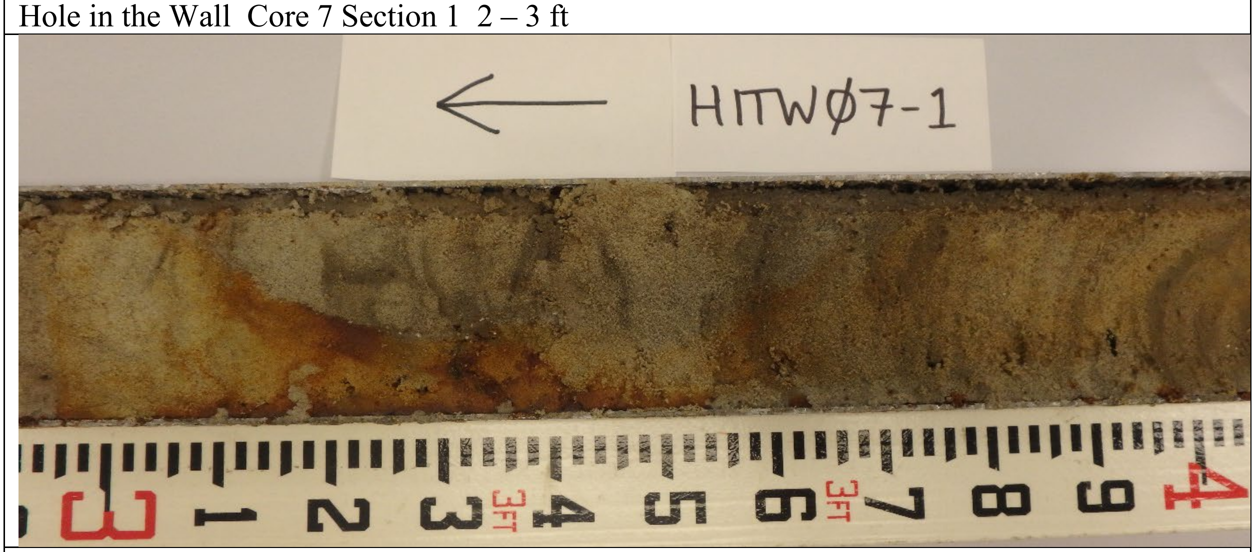
Hole in the Wall Core 7 Section 1 0 – 1 ft



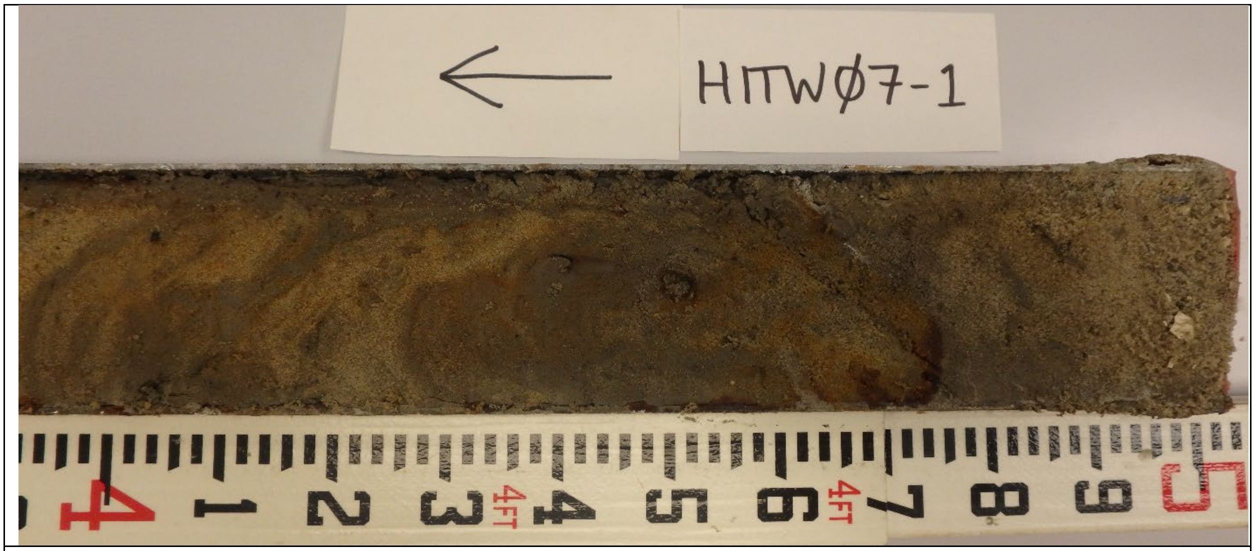
Hole in the Wall Core 7 Section 1 1 – 2 ft



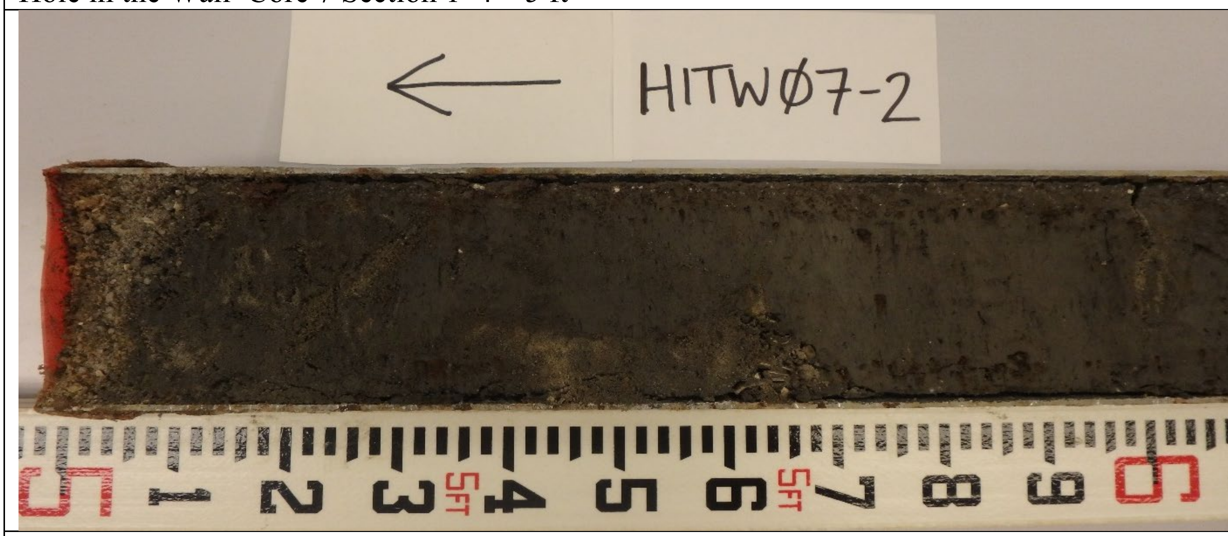
Hole in the Wall Core 7 Section 1 2 – 3 ft



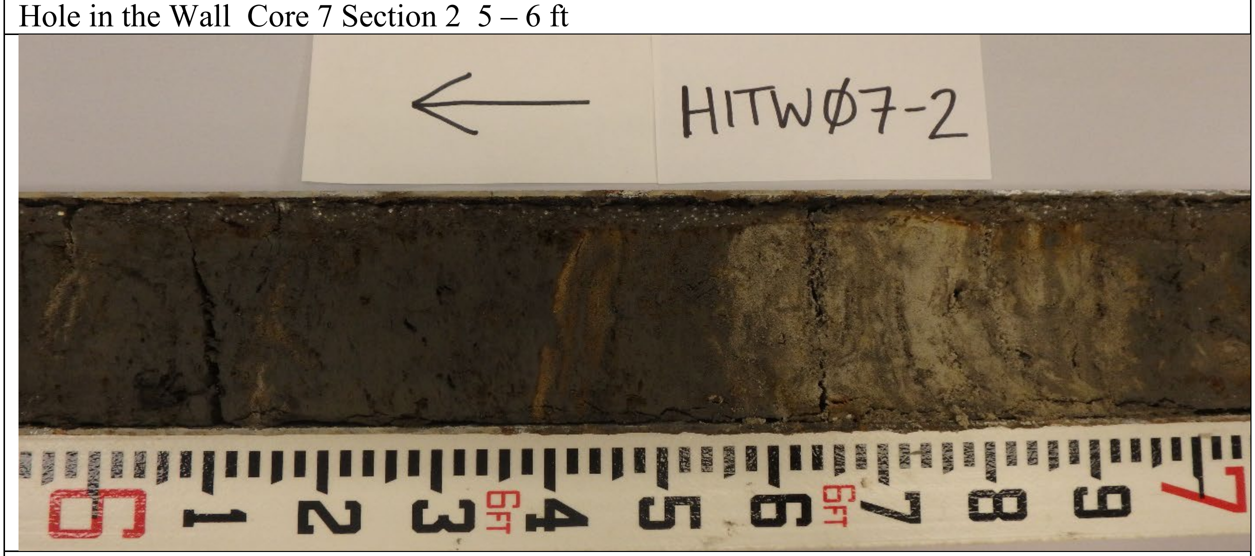
Hole in the Wall Core 7 Section 1 3 – 4 ft



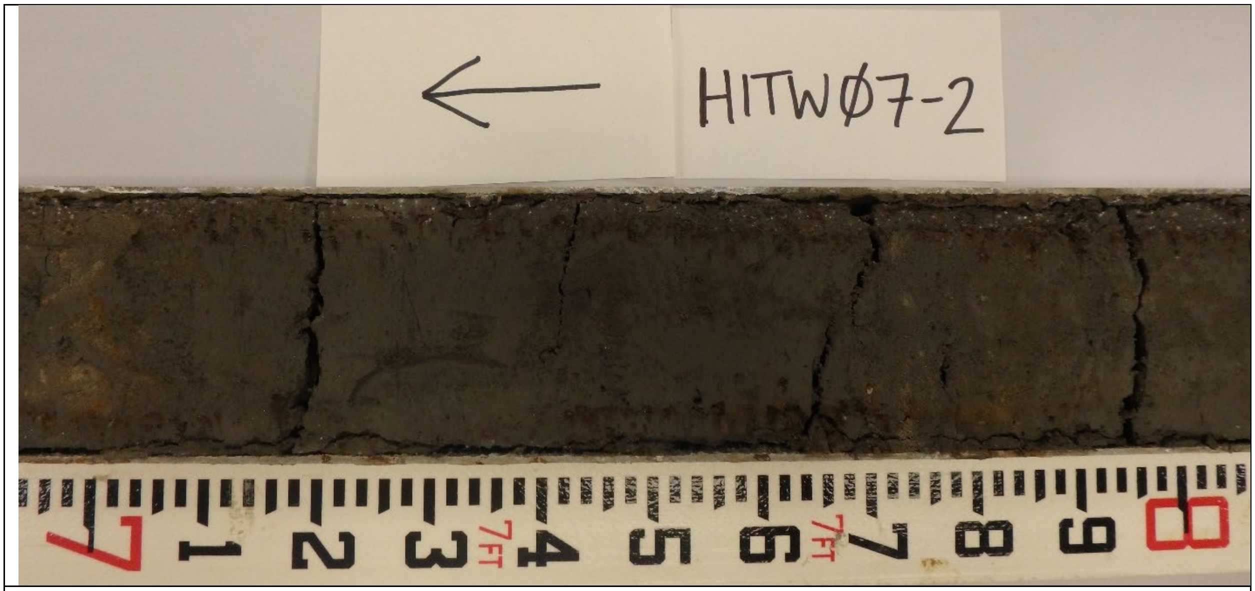
Hole in the Wall Core 7 Section 1 4 – 5 ft



Hole in the Wall Core 7 Section 2 5 – 6 ft

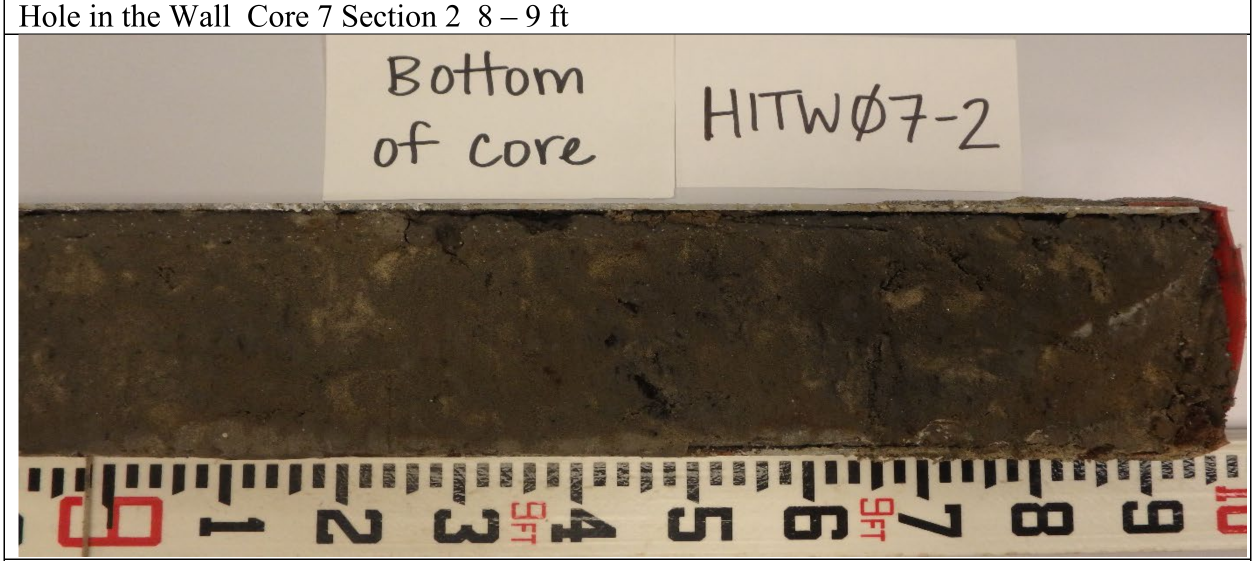


Hole in the Wall Core 7 Section 2 6 – 7 ft

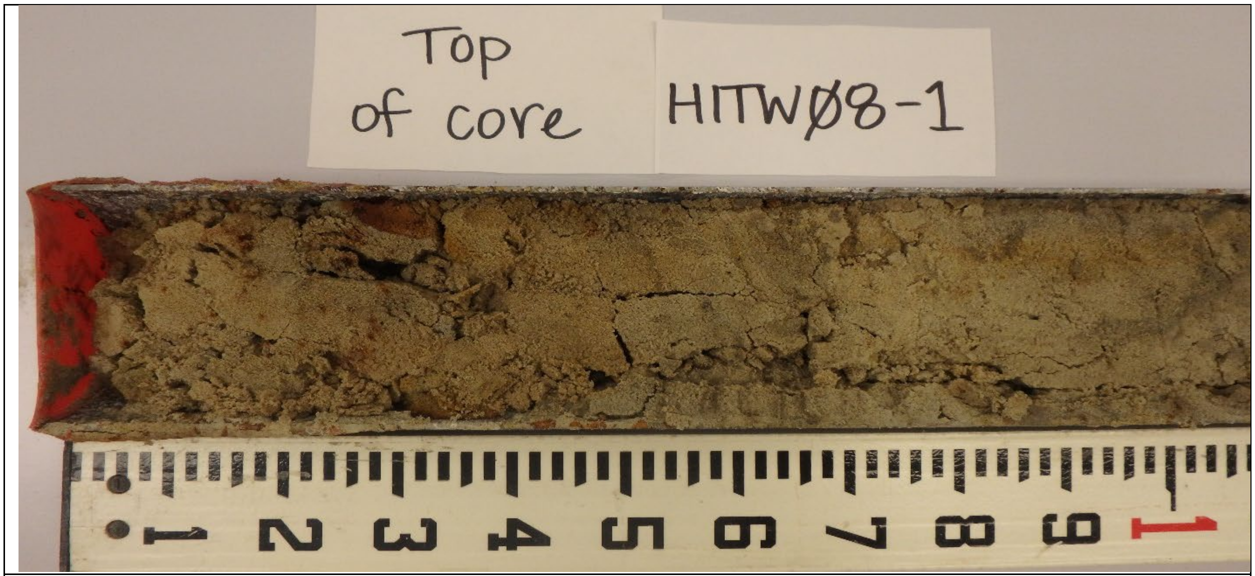


Hole in the Wall Core 7 Section 2 7 – 8 ft

Hole in the Wall Core 7 Section 2 8 – 9 ft



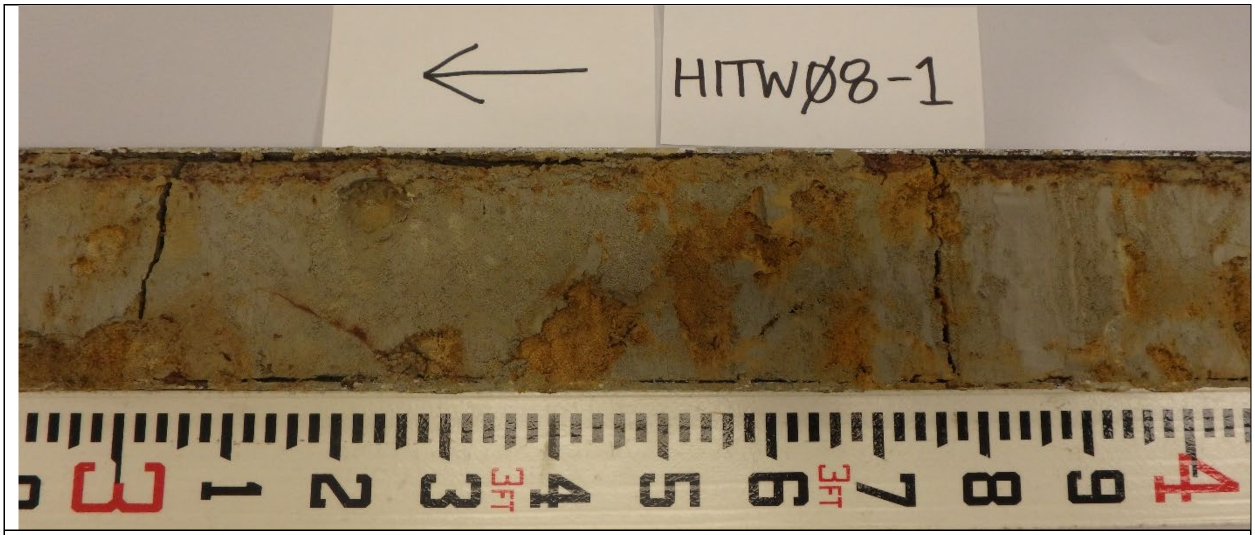
Hole in the Wall Core 7 Section 2 9 – 10 ft



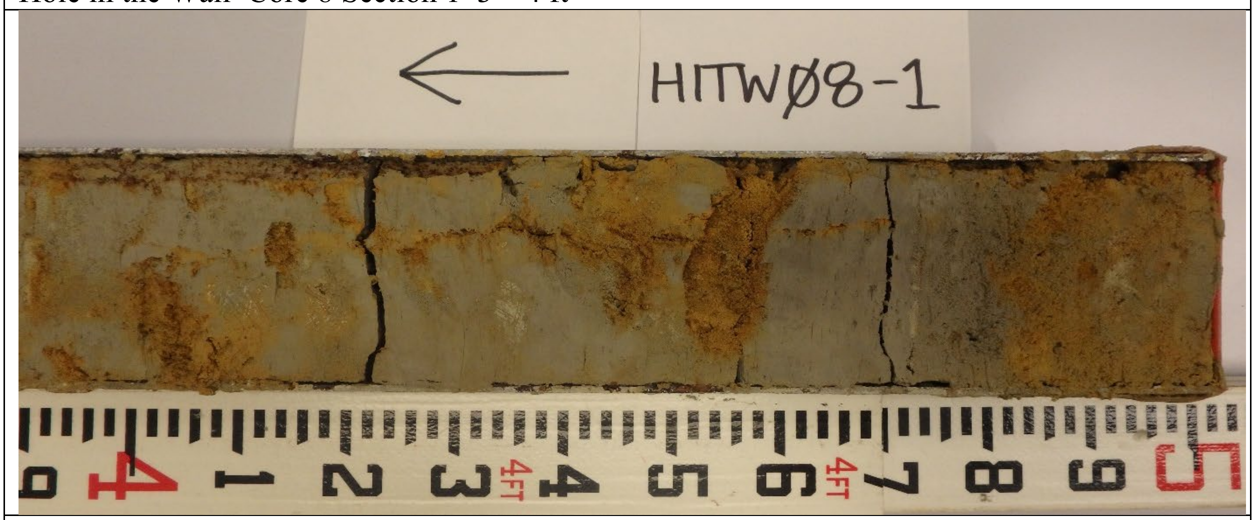
Hole in the Wall Core 8 Section 1 0 – 1 ft

Hole in the Wall Core 8 Section 1 1 – 2 ft

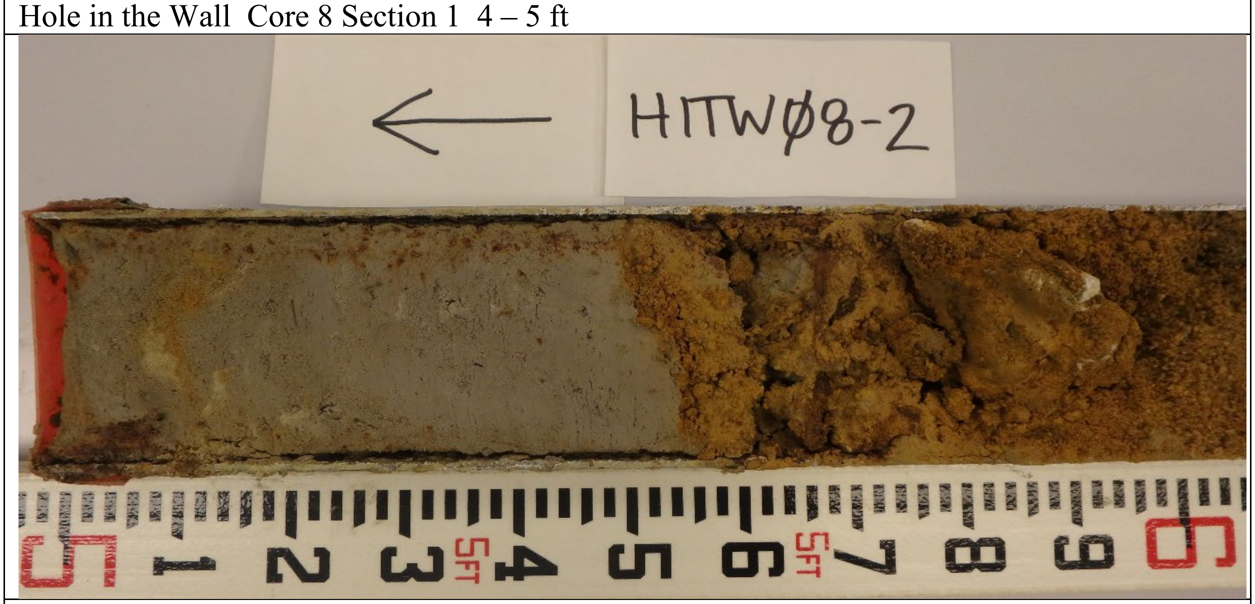
Hole in the Wall Core 8 section 1 2 – 3 ft



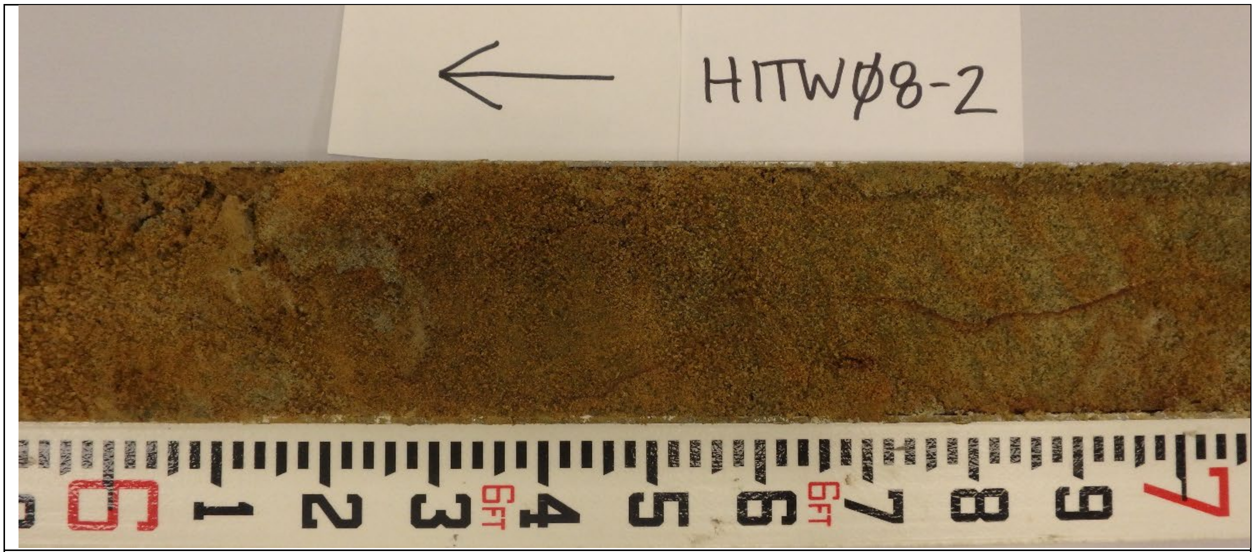
Hole in the Wall Core 8 Section 1 3 – 4 ft



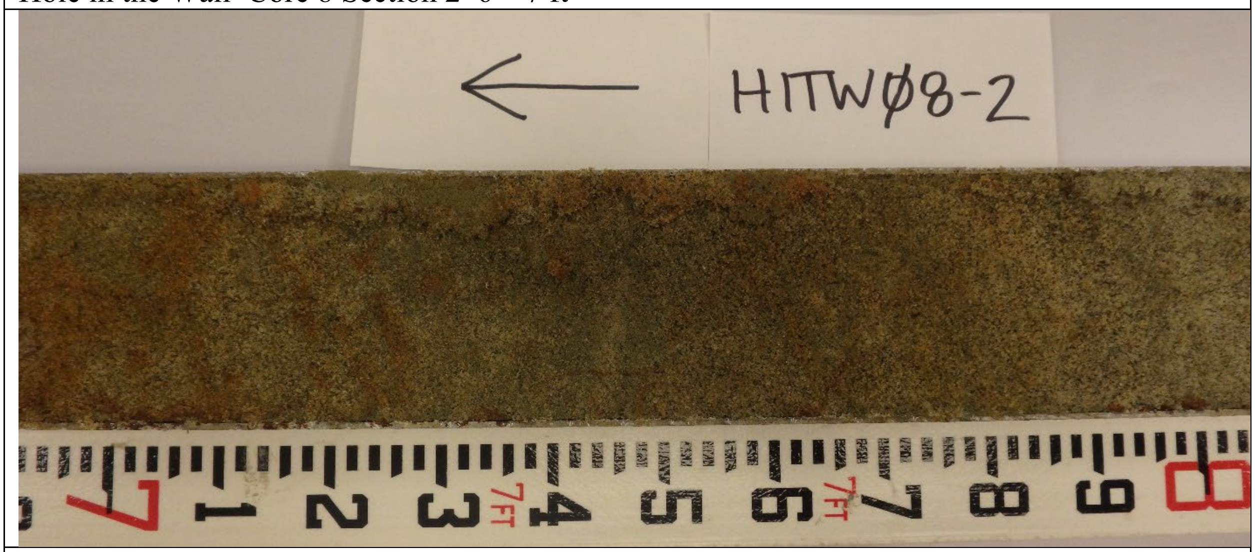
Hole in the Wall Core 8 Section 1 4 – 5 ft



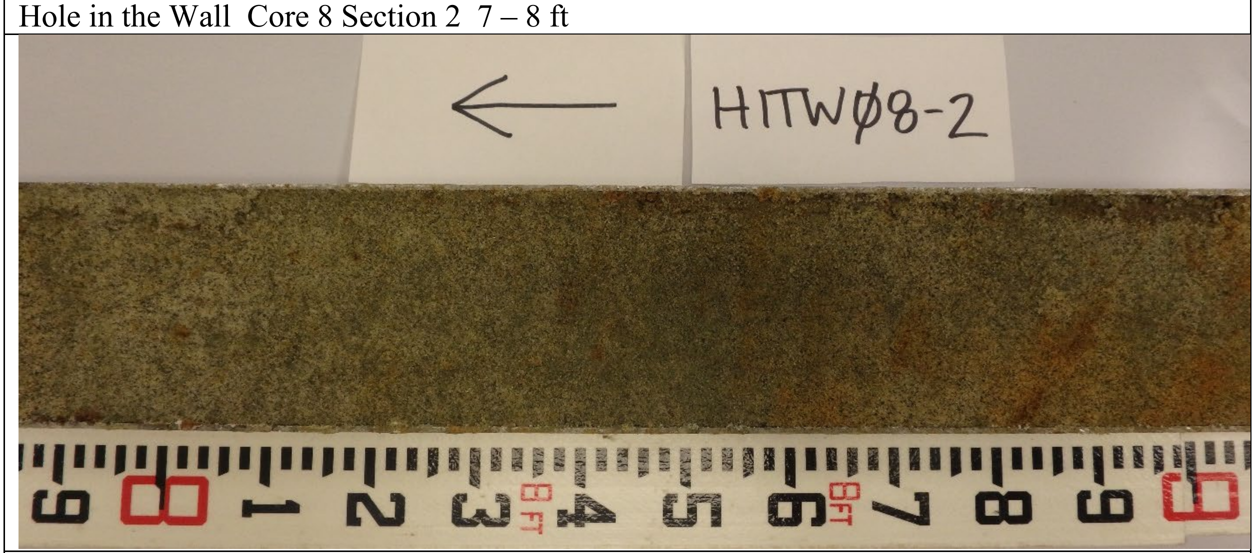
Hole in the Wall Core 8 Section 2 5 – 6 ft



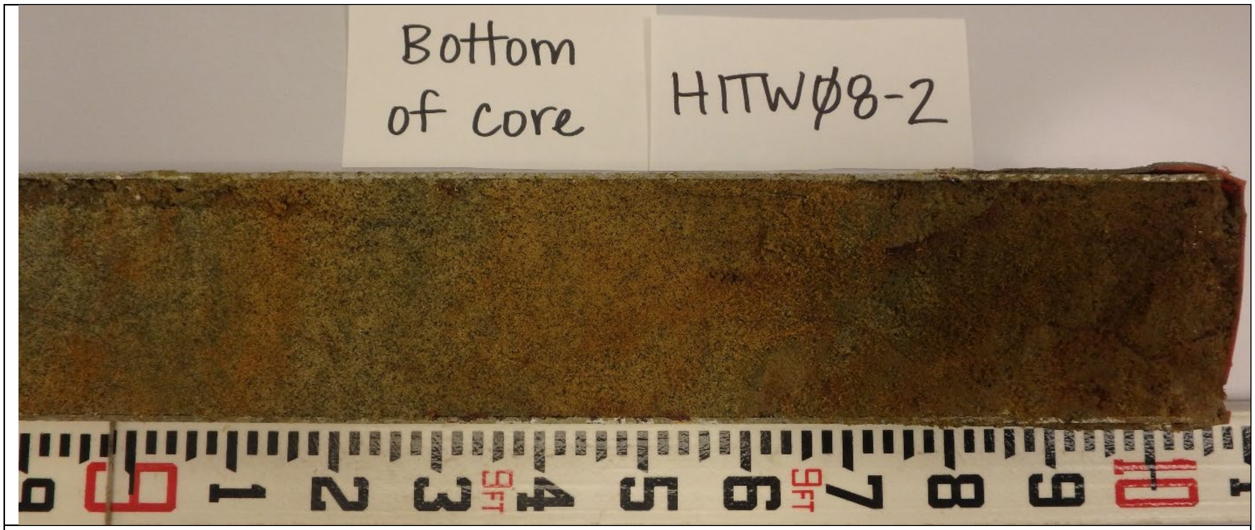
Hole in the Wall Core 8 Section 2 6 – 7 ft



Hole in the Wall Core 8 Section 2 7 – 8 ft

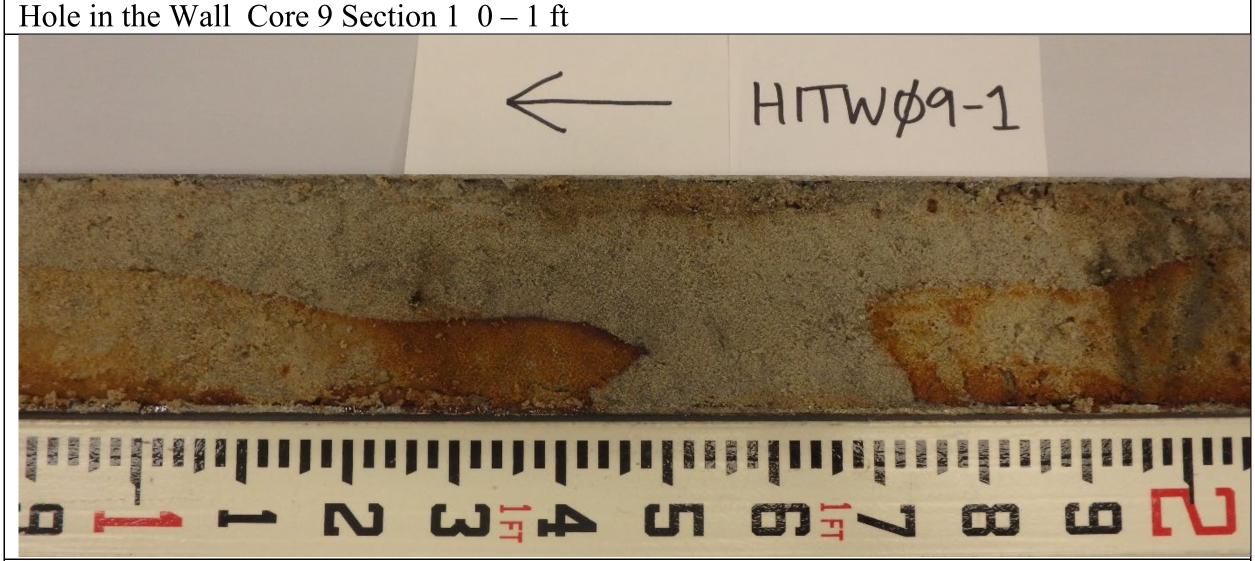


Hole in the Wall Core 8 Section 2 7.9 – 9 ft

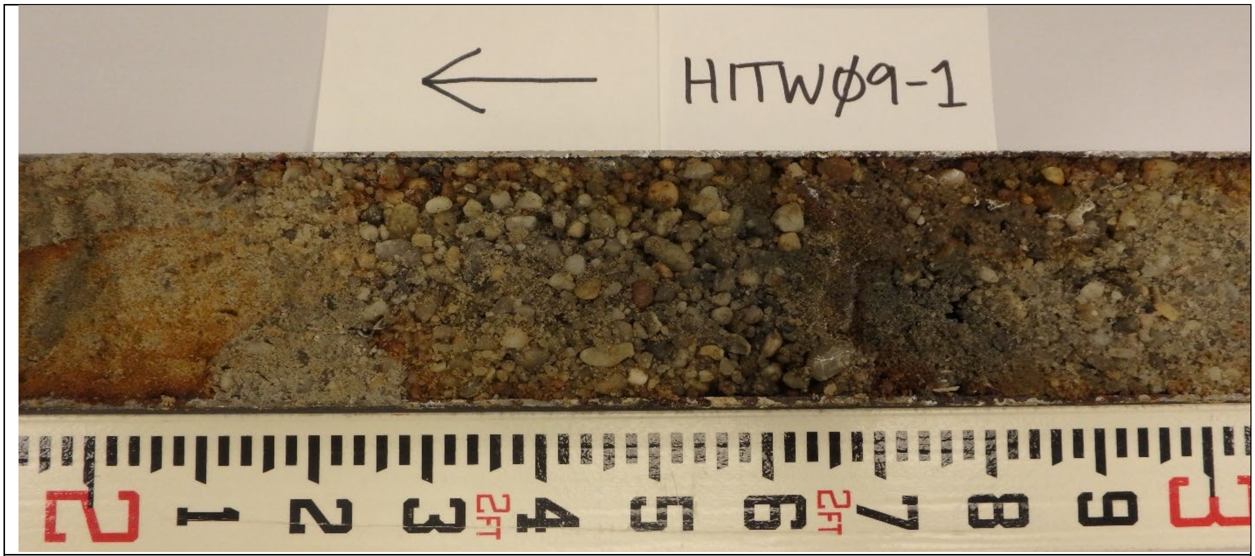


Hole in the Wall Core 8 Section 2 8.9 – 10 ft

Hole in the Wall Core 9 Section 1 0 – 1 ft

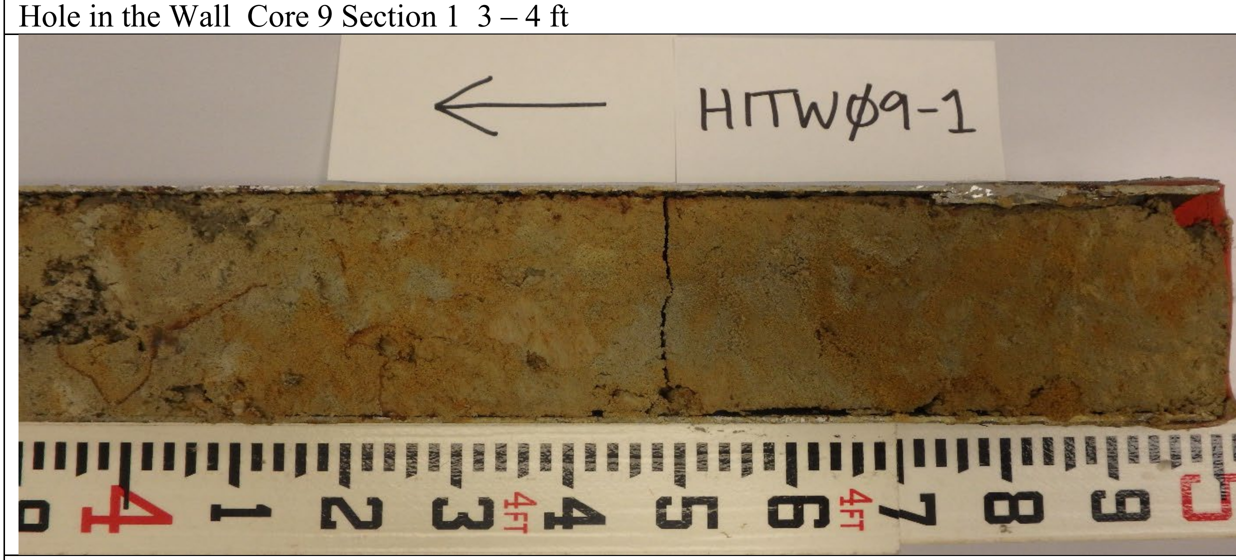


Hole in the Wall Core 9 Section 1 1 – 2 ft

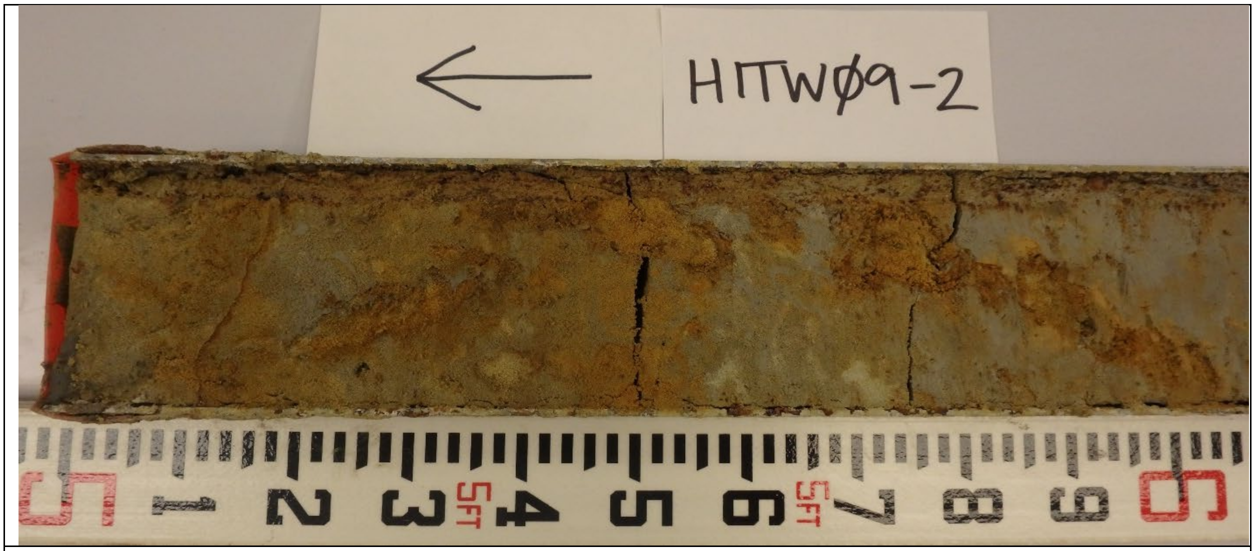


Hole in the Wall Core 9 Section 1 2 – 3 ft

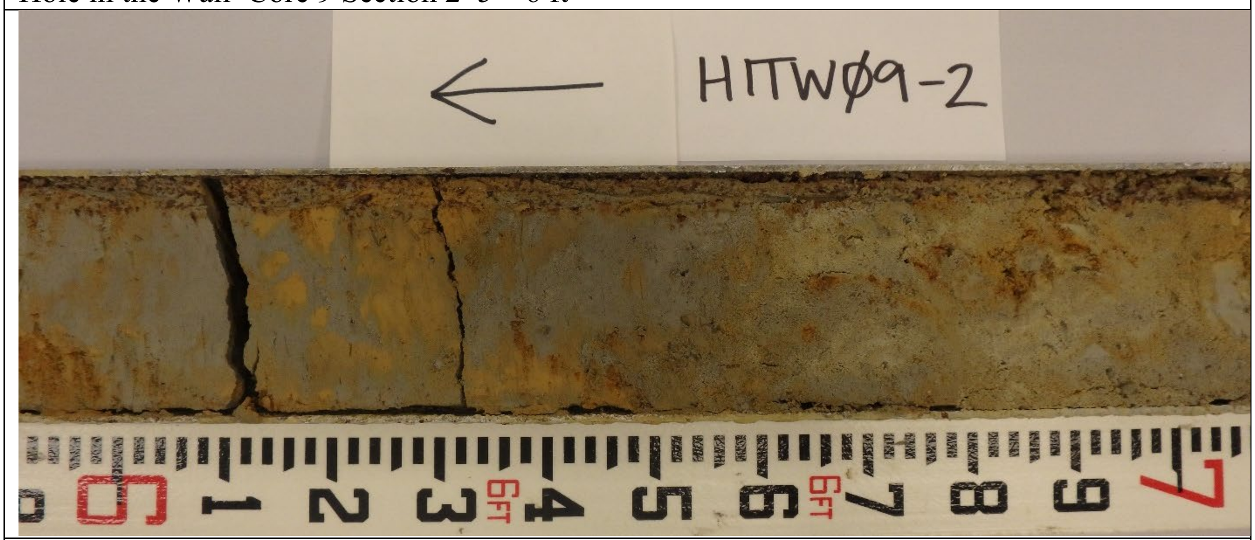
Hole in the Wall Core 9 Section 1 3 – 4 ft



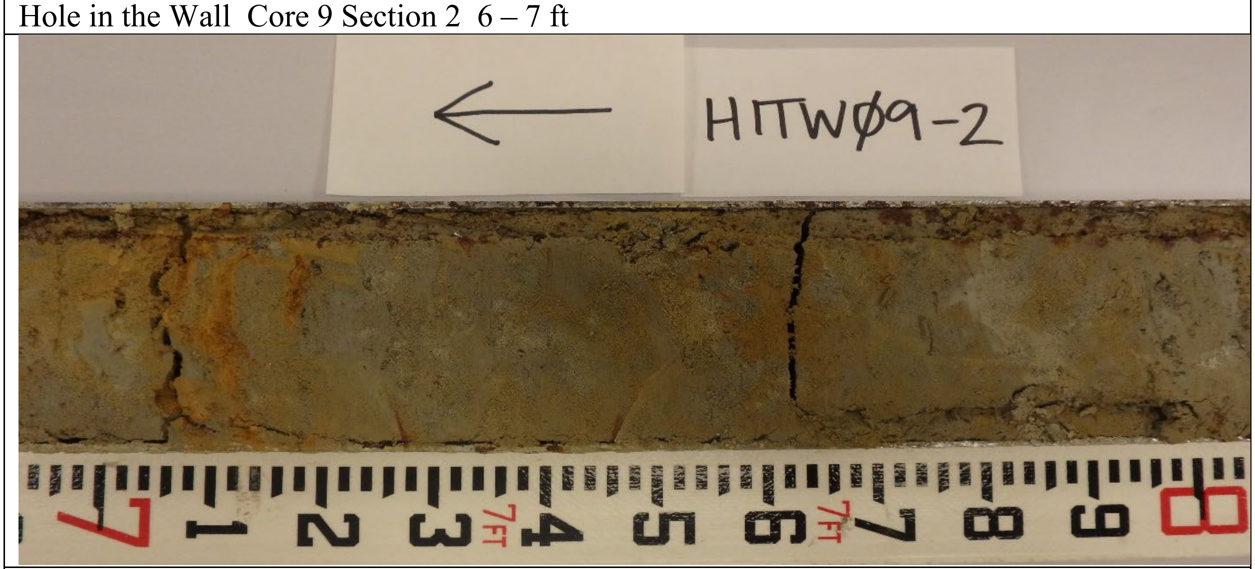
Hole in the Wall Core 9 Section 1 4 – 5 ft



Hole in the Wall Core 9 Section 2 5 – 6 ft



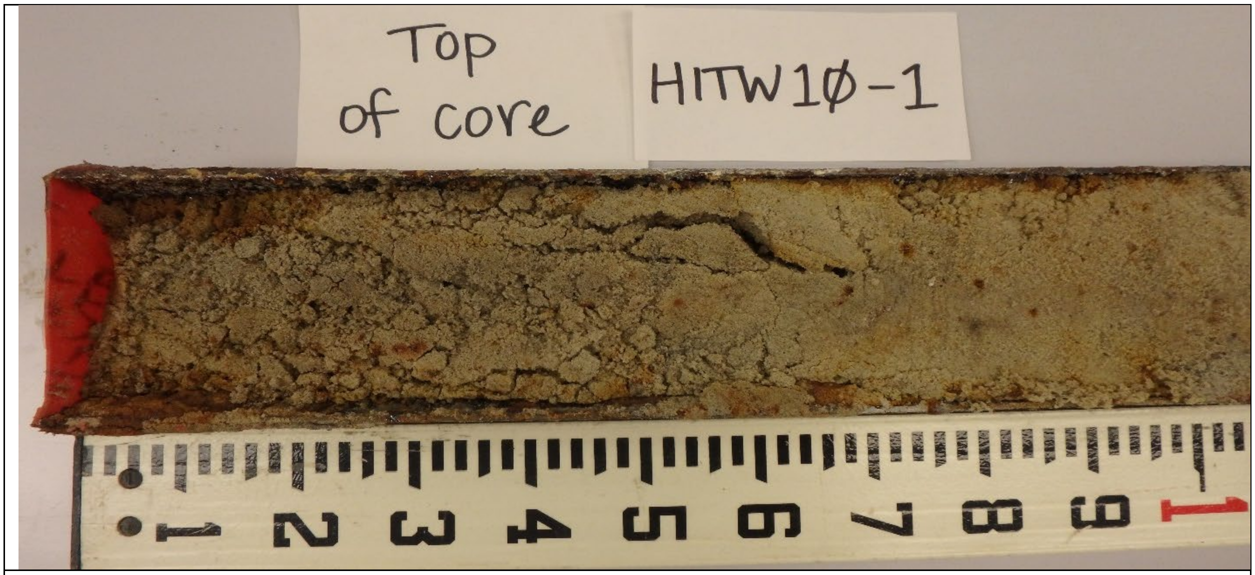
Hole in the Wall Core 9 Section 2 6 – 7 ft



Hole in the Wall Core 9 Section 2 7 – 8 ft

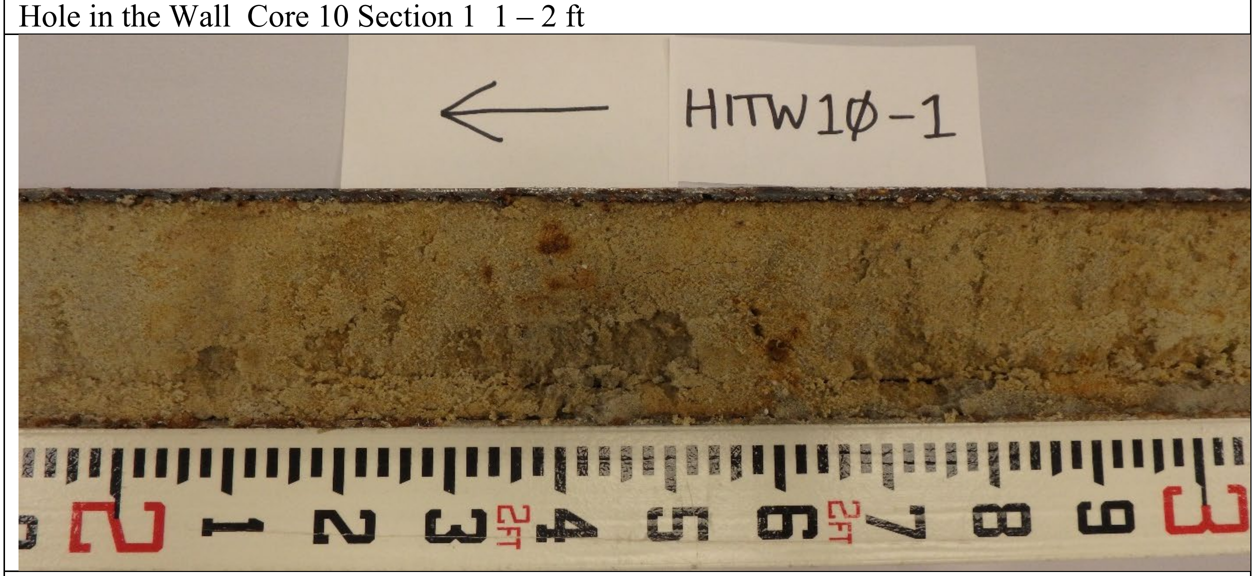
Hole in the Wall Core 9 Section 2 8 – 9 ft

Hole in the Wall Core 9 Section 2 8.5 – 9.3 ft

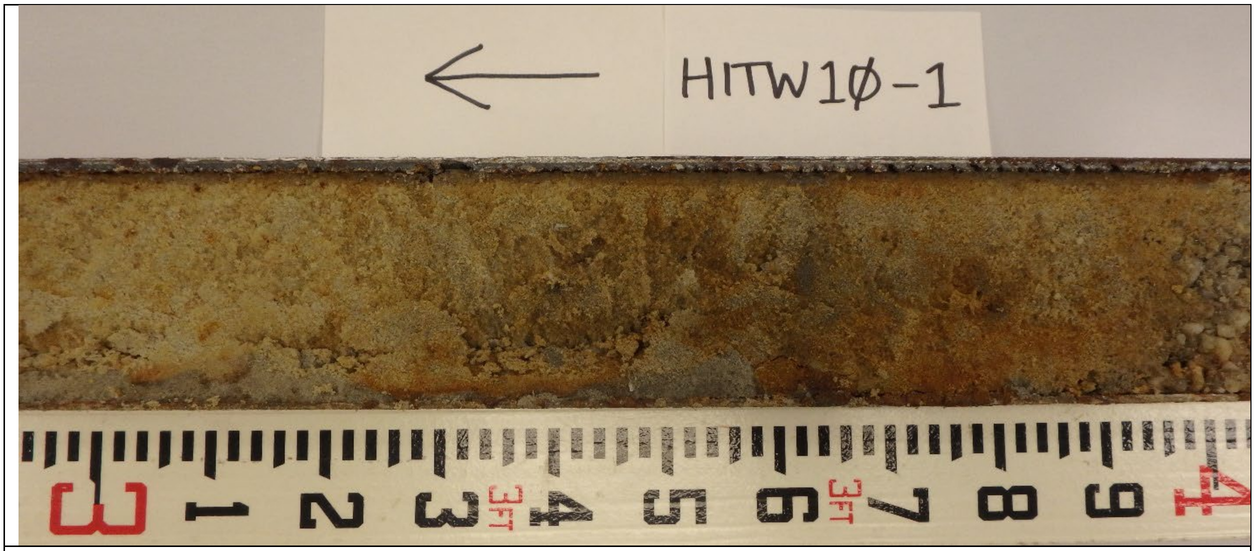


Hole in the Wall Core 10 Section 1 0 – 1 ft

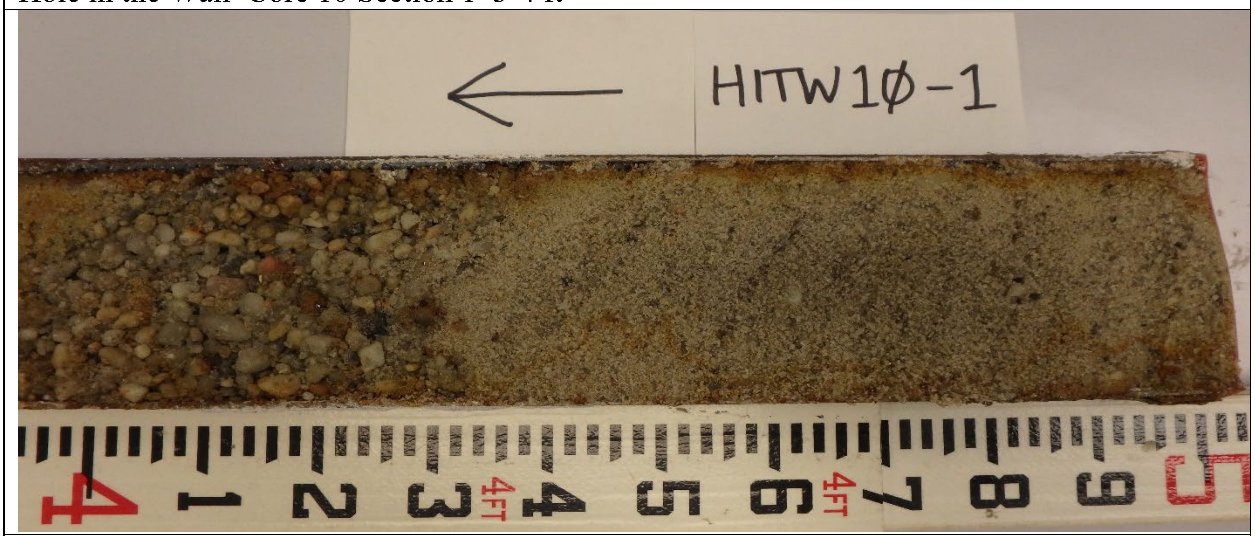
Hole in the Wall Core 10 Section 1 1 – 2 ft



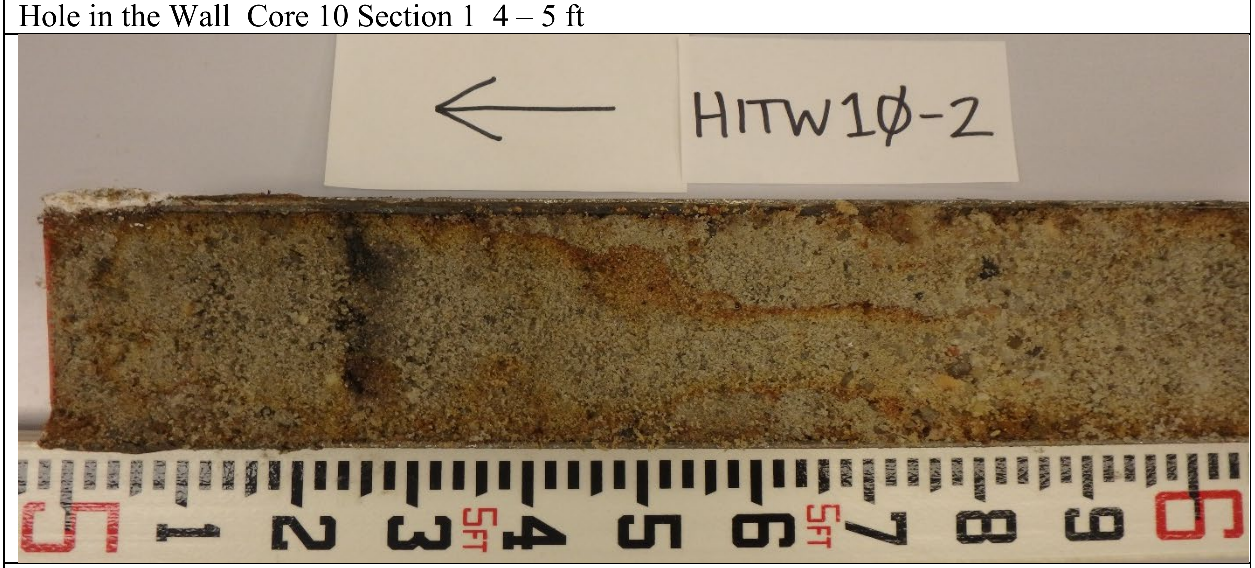
Hole in the Wall Core 10 Section 1 2 – 3 ft



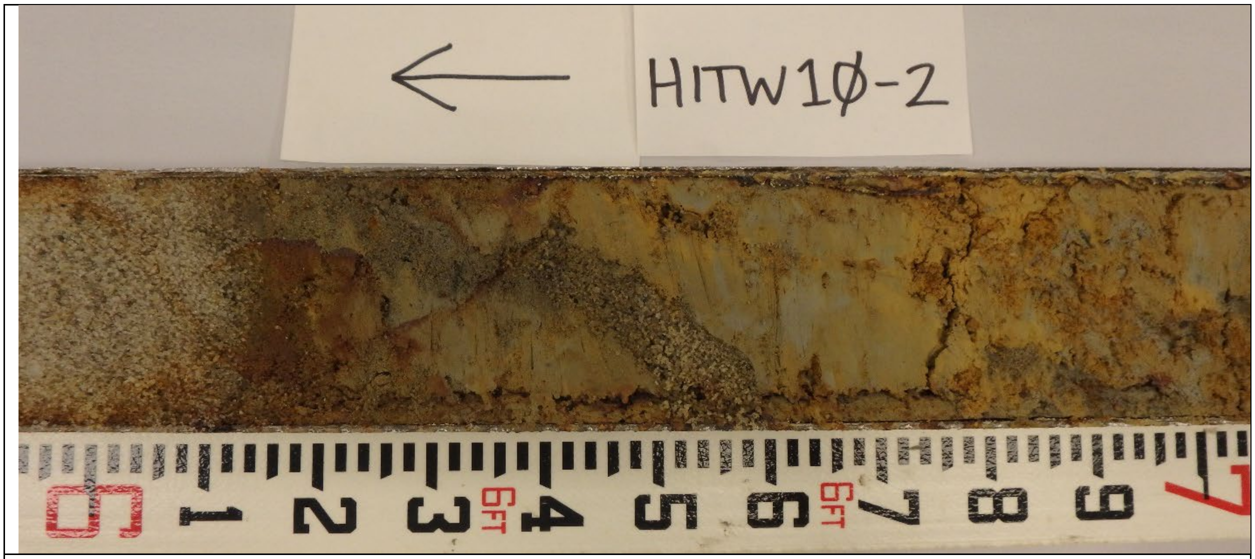
Hole in the Wall Core 10 Section 1 3-4 ft



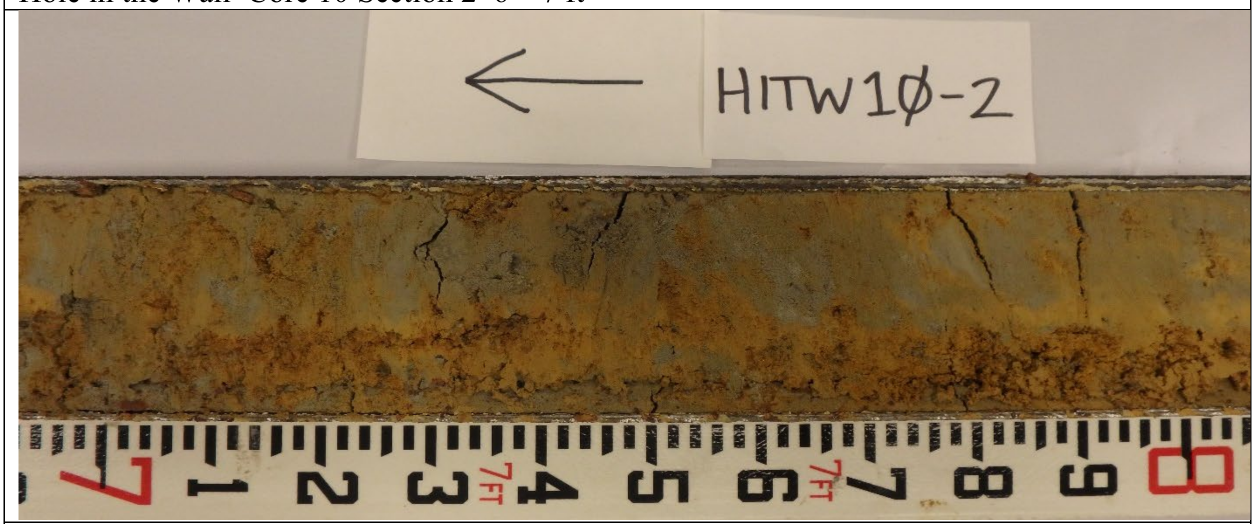
Hole in the Wall Core 10 Section 1 4 – 5 ft



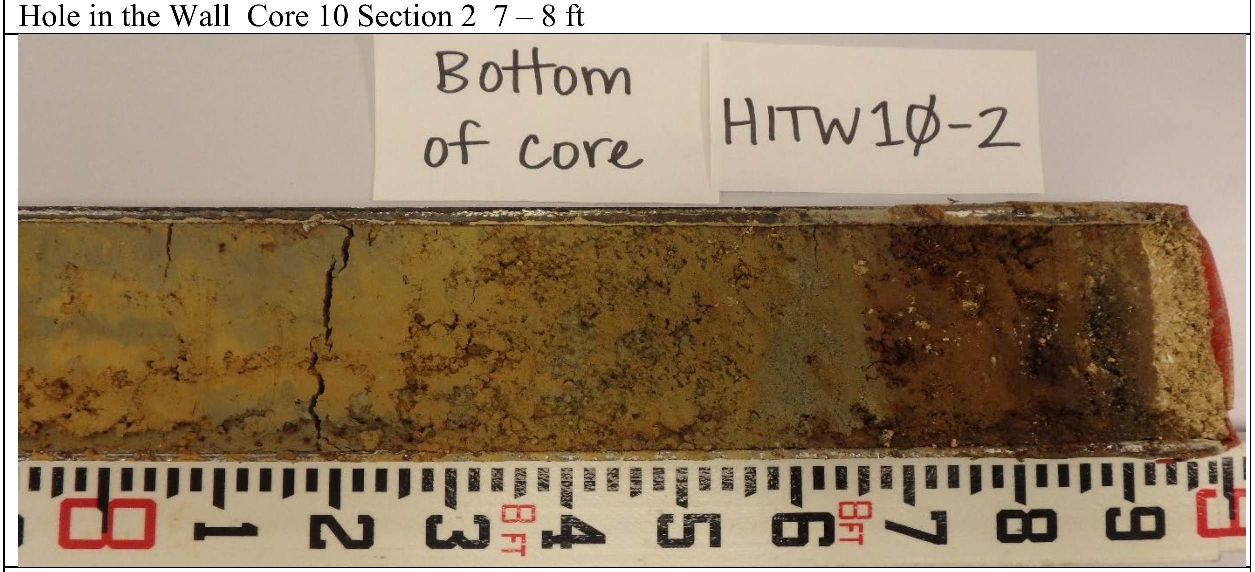
Hole in the Wall Core 10 Section 2 5 – 6 ft



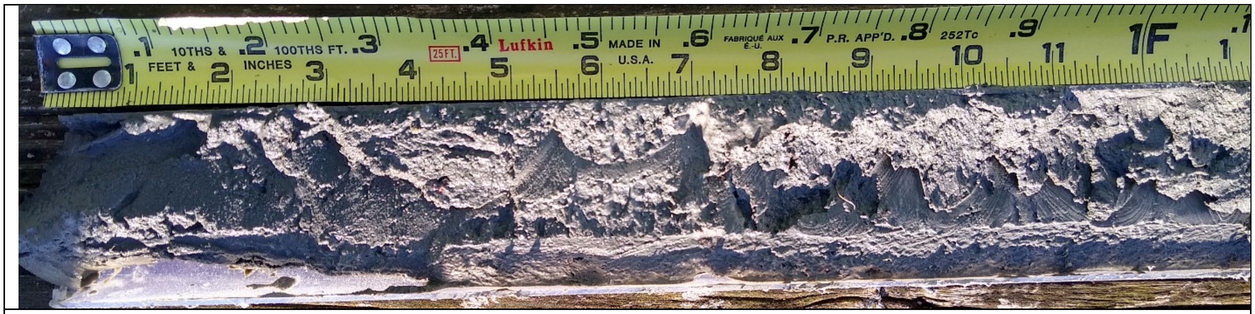
Hole in the Wall Core 10 Section 2 6 – 7 ft



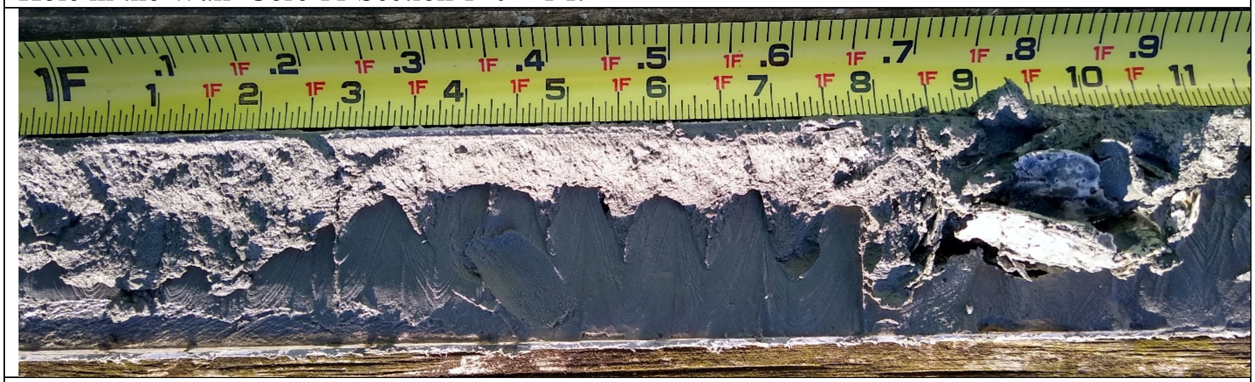
Hole in the Wall Core 10 Section 2 7 – 8 ft



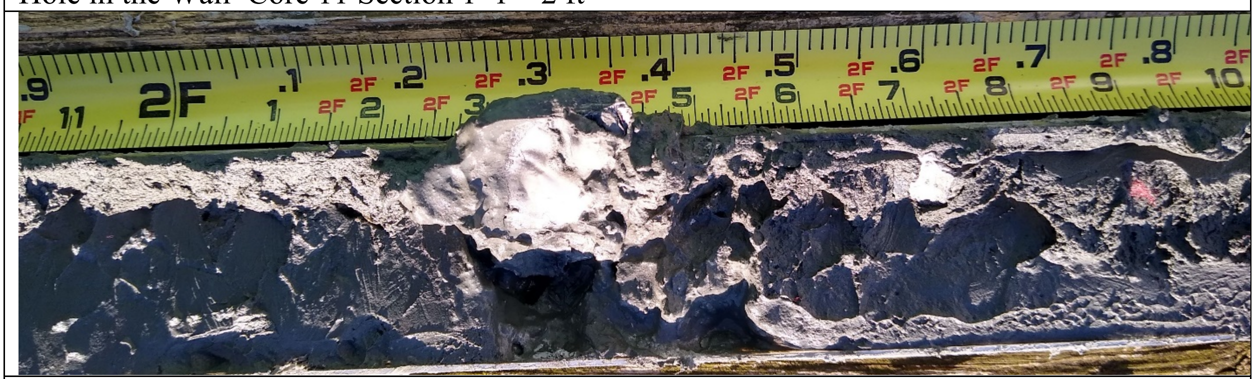
Hole in the Wall Core 10 Section 2 8 – 9 ft



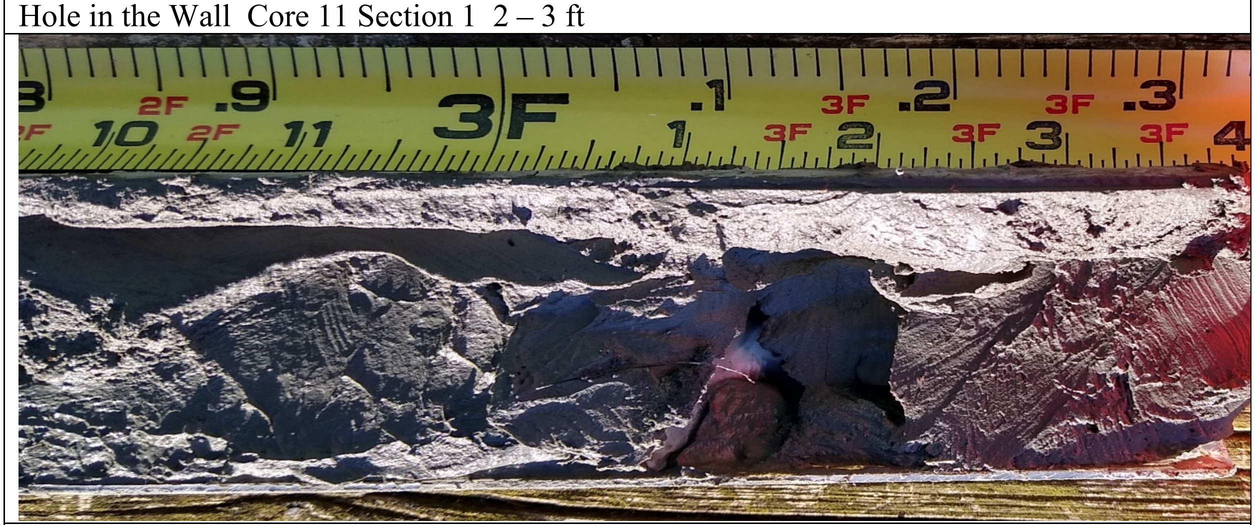
Hole in the Wall Core 11 Section 1 0 – 1 ft



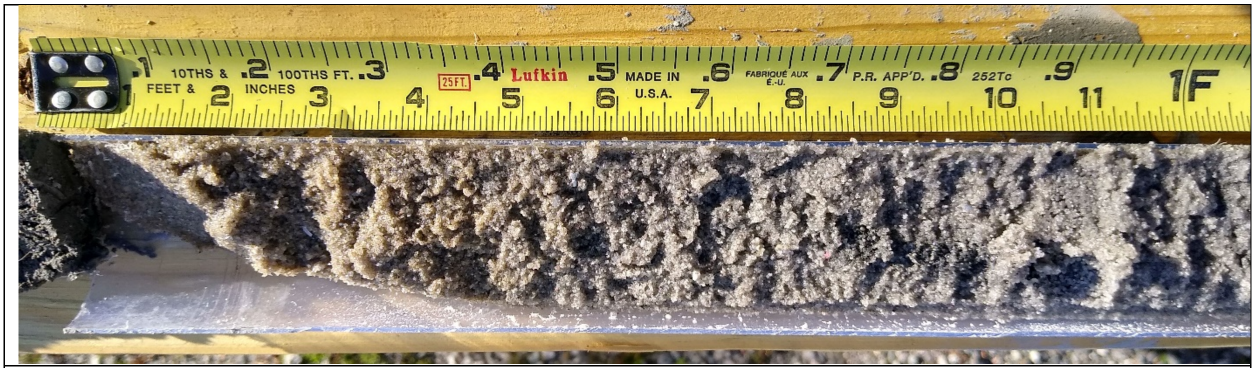
Hole in the Wall Core 11 Section 1 1 – 2 ft



Hole in the Wall Core 11 Section 1 2 – 3 ft



Hole in the Wall Core 11 Section 1 2.8 – 3.3 ft



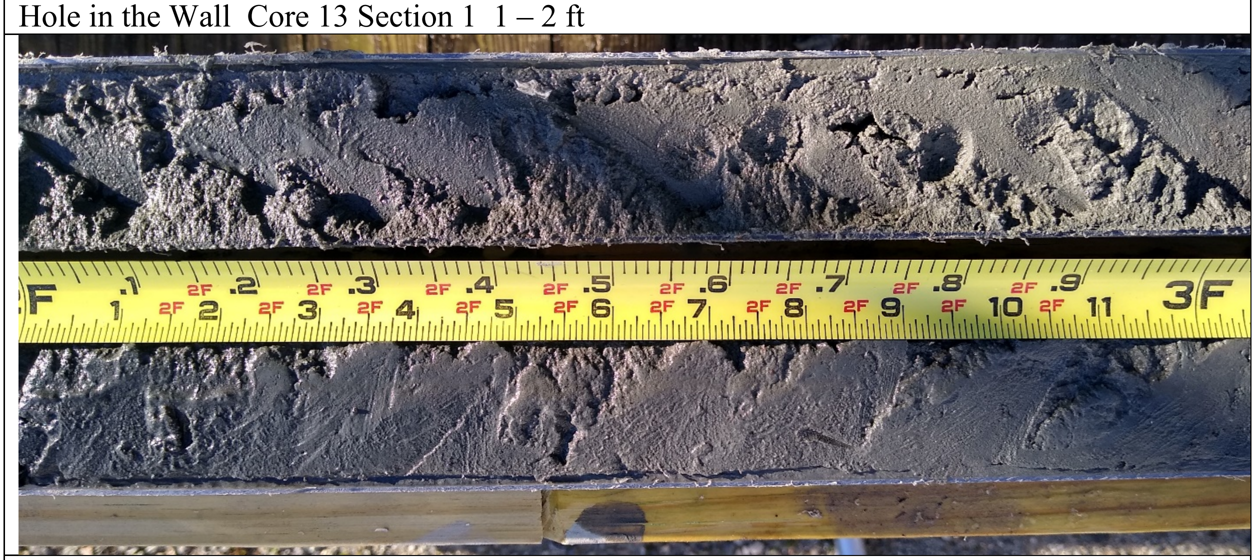
Hole in the Wall Core 12 Section 1 0 – 1 ft

Hole in the Wall Core 12 Section 1 1 – 2 ft

Hole in the Wall Core 12 Section 1 1.9 – 2.7 ft

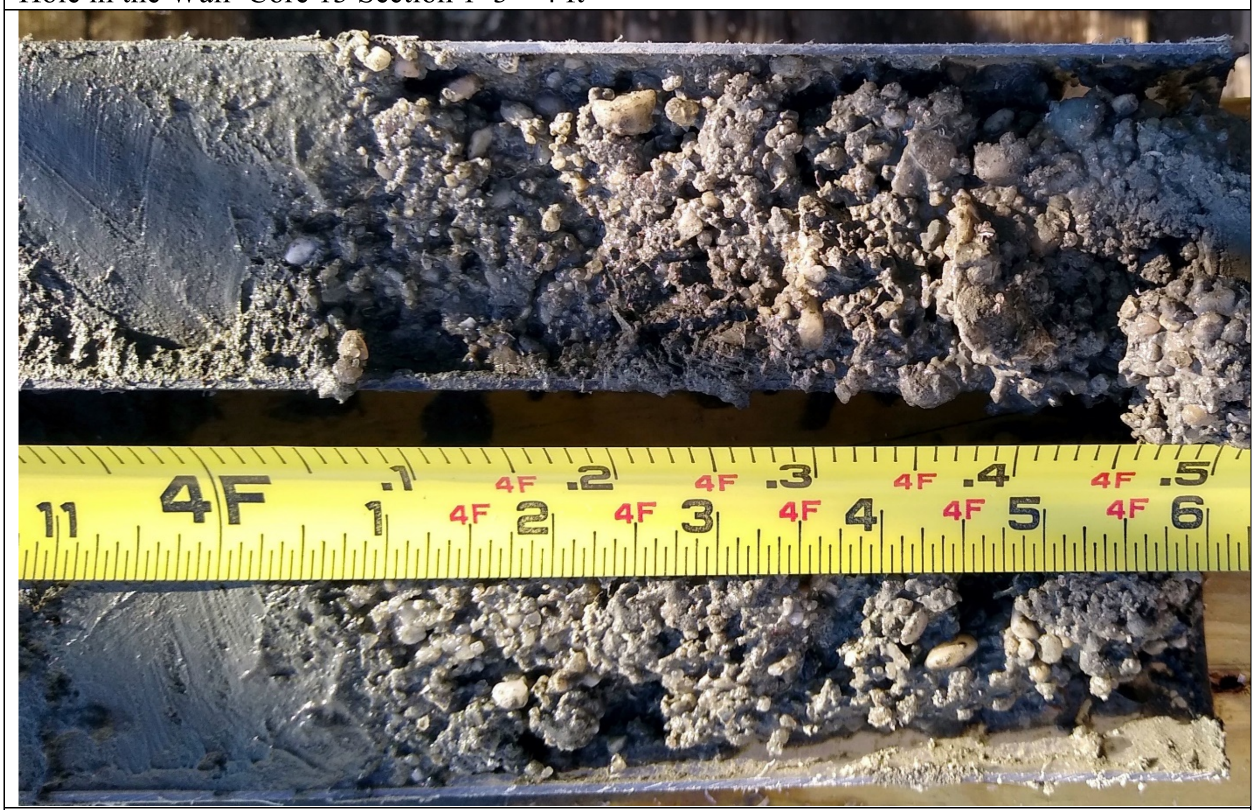
Hole in the Wall Core 13 Section 1 0 – 1 ft

Hole in the Wall Core 13 Section 1 1 – 2 ft



Hole in the Wall Core 13 Section 1 2 – 3 ft

Hole in the Wall Core 13 Section 1 3 – 4 ft



Hole in the Wall Core 13 Section 1 4 – 4.5 ft

Appendix B

Core Logs

Hole in the Wall Core 1 Latitude: 37.4723 Longitude: -76.2699 Date: 08/05/2020

Section	**Depth (ft)**	**Depth Below Sediment Surface MLLW (ft)**	**Graphic**	**USCS Soil Type**	**Description**	**Color**	**Grain Size %G/SD/S/C %Fines %Moisture**	**Comments**
1	0-5	-6.6 to -11.6		**CL**	silty clay with trace very fine sand, micaceous, clay has low plasticity, shell fragments throughout.	olive gray	0/23.0/40.7/36.3 77.0 41.5	
1	5				**End of Section 1**			
2	5-8.8	-11.6 to -15.4		**CL**	silty clay with trace very fine sand, micaceous, clay has low plasticity, shells and shell fragments at 7-8.84 ft.	olive gray	0/26.2/42.9/30.9 73.8 32.0	
2	8.8				**End of Section 2**			
Core	8.8				**End of Core**			

Hole in the Wall Core 2 Latitude: 37.4717 Longitude: -76.2682 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-2.3	-2.9 to -5.2		**SP**	medium to very coarse sand with granules and pebbles (5-10 mm), grains are subangular, sand is loose and very poorly sorted.	light gray	11.1/87.8/0.6/0.5 1.1 0.6	
1	2.3-5	-5.2 to -7.9		**SC**	very fine to fine sand and silty clay, micaceous, abundant shells and shell fragments at 2.5-3.2 ft, sharp contact with unit above.	olive gray	0/71.8/14.5/13.7 28.2 19.8	
1	5				**End of Section 1**			
2	5-8.5	-7.9 to -11.4		**CL**	silty clay with some very fine to fine sand, micaceous, low to medium plasticity.	olive gray	0/48.5/29.4/22.1 51.5 27.2	
2	8.5				**End of Section 2**			
Core	8.5				**End of Core**			

Hole in the Wall Core 3 Latitude: 37.4693 Longitude: -76.2672 Date: 08/05/2020

Section	**Depth (ft)**	**Depth Below Sediment Surface MLLW (ft)**	**Graphic**	**USCS Soil Type**	**Description**	**Color**	**Grain Size %G/SD/S/C %Fines %Moisture**	**Comments**
1	0-3.6	-3.4 to -7		**SP**	fine to very coarse sand and granules and pebbles with trace silt, poorly sorted, sand is subangular, some shell fragments	light gray	3.9/92.5/1.8/1.8 3.6 6.6	
1	3.6-5	-7 to -8.4		**CL**	silty clay with trace fine sand, micaceous, sharp contact with unit above	olive gray	3.9/21.7/44.1/34.2 78.3 35.2	
1	5				**End of Section 1**			
2	5-10	-8.4 to -13.4		**CL**	silty clay with little fine sand, micaceous	olive gray	0/37.1/38.8/24.2 63.0 29.2	
2	10				**End of Section 2**			
Core	10				**End of Core**			

Hole in the Wall Core 4 Latitude: 37.4672 Longitude: -76.2648 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-1.6	-2.5 to -4.1		**GP**	coarse to very coarse sand with granules and pebbles (5-20 mm), grains are subangular, sand is loose and very poorly sorted.	light gray	34.0/64.4/0.8/0.8 1.6 0.1	
1	1.6-5	-4.1 to -7.5		**CL**	silty clay with little very fine to fine sand, micaceous, medium plasticity.	olive gray	0/29.5/37.5/33.0 70.5 31.6	
1	5				**End of Section 1**			
2	5-6.1	-7.5 to -8.6		**SW**	fine to medium sand with trace silty clay, abundant shells and shell fragments at 5-5.9 ft (difficult to sample), few granules throughout.	light gray and olive gray	0/68.7/16.5/14.9 31.4 11.8	
2	6.1-8.4	-8.6 to -10.9		**SW**	fine to medium sand with trace silty clay	light gray and olive gray	4.8/89.2/2.1/3.9 6.0 2.1	
2	8.4				**End of Section 2**			
Core	8.4				**End of Core**			

Hole in the Wall Core 5 Latitude: 37.4681 Longitude: -76.2644 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-5	-2.3 to -7.3		**SP**	very fine to medium sand with trace silty clay, some very coarse sand and granules throughout, poorly sorted, micaceous, heavy mineral laminations at 3.5-4 ft.	light gray	0.25 0/96.5 3.5 9.1	
1	5				**End of Section 1**			
2	5-7.4	-7.3 to -9.7		**SP**	very fine to medium sand with little silty clay, some very coarse sand and granules, poorly sorted, micaceous, some heavy minerals, abundant shell fragments at 7.1-7.4 ft.	light gray, light brown around oxidized, clay-rich areas	0.30 0.4/93.2 6.4 9.4	
2	7.4-9.4	-9.7 to -11.7		**CL**	silty clay with trace very fine sand, micaceous, low-medium plasticity.	olive gray	0/32.1/38.1/29.8 67.9 31.0	
2	9.4				**End of Section 2**			
Core	9.4				**End of Core**			

Hole in the Wall Core 6 Latitude: 37.4674 Longitude: -76.2624 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-1.2	-5.3 to -6.5		**SP**	very fine to very coarse sand and pebbles with little clay, unit is poorly sorted, fining upward sequence, sand is subangular, some shell fragments	yellowish orange/light gray	0.32 0.5/93.8 5.7 11.3	Core sampled for Pb-210 analysis
1	1.2-5	-6.5 to -10.3		**CL**	silty clay with some very fine sand, some laminations of clean sand throughout, micaceous	olive gray	0/46.7/31.3/22.0 53.3 24.4	
1	5				**End of Section 1**			
2	5-10.4	-10.3 to -15.7		**CL**	clay with some very fine to fine sand, medium plasticity, micaceous, shell hash in bottom 1.3 ft of section	olive gray	0/43.7/31.8/24.5 56.3 26.0	
2	10.4				**End of Section 2**			
Core	10.4				**End of Core**			

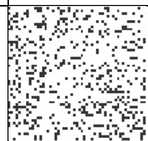
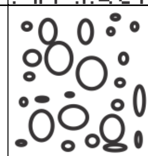
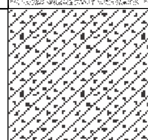
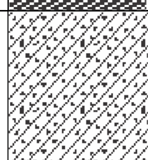
Hole in the Wall Core 7 Latitude: 37.4680 Longitude: -76.2621 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-5	-1.6 to -6.6		**SP**	very fine to fine sand with some very coarse sand and granules and trace clay, poorly sorted, micaceous, some shell and plant/wood fragments	light gray	2.9/92.6/1.7/2.9 4.6 10.9	
1	5				**End of Section 1**			
1	5-8.5	-6.6 to -10.1		**CL**	silty clay with little fine sand, micaceous, layer of clean fine sand with laminations of silty clay at 6.6-6.9 ft	olive gray	0/64.3/20.8/14.9 35.7 26.4	
2	8.5-10	-10.1 to -11.6		**SC**	very fine to fine sand with little silty clay, micaceous	light gray and olive gray	0/71.4/16.5/12.1 28.6 16.7	
2	10				**End of Section 2**			
Core	10				**End of Core**			

Hole in the Wall Core 8 Latitude: 37.4657 Longitude: -76.2579 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-2	-5.9 to -7.9		**SW**	very fine to fine sand with trace clay, some subangular granules and pebbles at 1-1.5 ft, micaceous	light gray and yellowish orange	0.18 1.8/92.0 6.2 9.2	
1	2-5	-7.9 to -10.9		**CH**	clay and very fine to fine sand, clay is stiff (high plasticity), sand content decreases down core, micaceous, diffuse contact with unit above	light gray and yellowish orange	0.4/46.1/24.3/29.2 53.5 20.4	
1					**End of Section 1**			
2	5-5.5	-10.9 to -11.4		**CH**	clay and very fine sand, clay is medium-high plasticity, micaceous	light gray	0.3/45.5/25.1/29.0 54.1 15.6	
2	5.5-10	-11.4 to -15.9		**SC**	layer of extremely stiff clay and sand, hardened clumps of material are heavily oxidized, some loose medium to very coarse sand	yellowish orange	0/90.5/3.1/6.4 9.5 7.5	
2	10				**End of Section 2**			
Core	10				**End of Core**			

Hole in the Wall Core 9 Latitude: 37.4637 Longitude: -76.2536 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-2.1	-5 to -7.1		**SW**	fine sand with trace granules, well sorted, micaceous, heavy minerals		0.20 0/98.8 1.2 12.3	
1	2.1-3.3	-7.1 to -8.3		**GP**	fine to very coarse sand and pebbles with trace clay, very poorly sorted, sub-rounded grains		1.80 27.5/71.7 0.8 2.0	
1	3.3-4	-8.3 to -9		**SP**	very fine to fine sand with some granules and pebbles with trace clay, poorly sorted		0.20 2.0/90.3 7.7 8.1	
1	4-5	-9 to -10		**SC**	very fine to fine sand and clay, few granules and pebbles, micaceous		0.10 0.7/63.7 35.6 15.5	
1	5				**End of Section 1**			
2	5-8.1	-10 to -13.1		**CH**	clay and very fine sand, clay is stiff (high plasticity), micaceous		5.1/55.7/15.5/23.7 39.2 13.8	
2	8.1-9.3	-13.1 to -14.3		**SC**	coarse to very coarse sand with granules and pebbles and clay, clumps of hardened material throughout		8.5/70.2/11.6/9.8 21.4 21.2	
2	9.3				**End of Section 2**			
Core	9.3				**End of Core**			

Hole in the Wall Core 10 Latitude: 37.4645 Longitude: -76.2533 Date: 08/05/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-4	-2.9 to -6.9		**SW**	very fine to fine sand with trace very coarse sand and granules, well sorted, micaceous, heavy minerals	light gray and yellowish orange	2.6/95.1/0.5/1.8 2.3 12.1	
1	4-4.4	-6.9 to -7.3		**GP**	granules and pebbles (5-10 mm) with some very coarse sand, very poorly sorted, sub-rounded grains	light gray	80.4/18.9/0.3/0.4 0.7 0.8	
1	4.4-5	-7.3 to -7.9		**SP**	medium to very coarse sand with little granules and pebbles, poorly sorted, subangular grains	light gray	1.9/96.9/0.5/0.7 1.2 0.4	
1	5				**End of Section 1**			
2	5-6.2	-7.9 to -9.1		**SP**	fine to very coarse sand with some granules and pebbles, poorly sorted, subangular grains	light gray	8.7/90.4/0.5/0.4 0.9 0.5	
2	6.2-8.7	-9.1 to -11.6		**CH**	clay and very fine sand, trace very coarse sand, clay is stiff (high plasticity), micaceous	light gray and yellowish orange	2.4/42.8/23.6/31.2 54.8 18.7	
2	8.7-8.9	-11.6 to -11.8		**PT**	clay and fine sand, soil-like, clumps of extremely stiff material	light brown	20.0/40.1/14.0/26.0 40.0 20.2	
2	9				**End of Section 2**			
Core	9				**End of Core**			

Hole in the Wall Core 11 Latitude: 37.4693 Longitude: -76.2707 Date: 12/28/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-4	-2.2 to -6.2		**CL**	soft clay with trace oyster shell	gray		
1	4				**End of Section 1**			
Core	4				**End of Core**			

Hole in the Wall Core 12 Latitude: 37.4676 Longitude: -76.2698 Date: 12/28/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-1	-4.5 to -5.5		**SW**	loose medium coarse sand	light gray		
1	1-2.6	-5.5 to -7.1		**SM**	loose very fine silty sand	gray		
1	2.6				**End of Section 1**			
Core	2.6				**End of Core**			

Hole in the Wall Core 13 Latitude: 37.4670 Longitude: -76.2675 Date: 12/28/2020

Section	Depth (ft)	Depth Below Sediment Surface MLLW (ft)	Graphic	USCS Soil Type	Description	Color	Grain Size %G/SD/S/C %Fines %Moisture	Comments
1	0-1	-7.5 to -8.5		**SC**	very loose clayey sand	dark gray		
1	1-2	-8.5 to -9.5		**CL**	very soft clay	dark gray		
1	2-3	-9.5 to -10.5		**CL**	very soft clay	dark gray		
1	3-4	-10.5 to -11.5		**CL**	very soft clay	dark gray		
1	4-4.5	-11.5 to -12		**SW**	medium dense coarse sand and gravel with trace clay, trace pebbles	gray		
1	4.5				**End of Section 1**			
Core	4.5				**End of Core**			

Appendix C

Sediment Data

Summary Of Laboratory Tests

Project Number: 20C33097

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Testing Laboratory	Natural Moisture (%)	Percent Gravel	% Passing No. 10 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve
HITW-05-1	0.0 - 5.0	Bag	POORLY GRADED SAND (SP), fine to medium grained sand, light brown	NN	9.1	0.0	99.5	77.5	3.5
HITW-05-2	5.0 - 7.0	Bag	POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, light brown	NN	9.4	0.4	98.4	66.5	6.4
HITW-06-1	0.0 - 1.2	Bag	POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, contains shell fragments, light brown	NN	11.3	0.5	93.1	54.4	5.7
HITW-08-1	0.0 - 2.0	Bag	POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, contains shell fragments, light brown	NN	9.2	1.8	95.5	88.7	6.2
HITW-09-1	0.0 - 2.1	Bag	POORLY GRADED SAND (SP), fine to medium grained sand, contains shell fragments, light brown	NN	12.3	0.0	99.7	95.0	1.2
HITW-09-1	2.1 - 3.3	Bag	POORLY GRADED SAND WITH GRAVEL (SP), fine to coarse grained sand, light brown	NN	2.0	27.5	52.0	11.3	0.8
HITW-09-1	3.3 - 4.0	Bag	POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, light brown	NN	8.1	2.0	93.6	85.6	7.7

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed

Schnabel ENGINEERING

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Summary Of Laboratory Tests

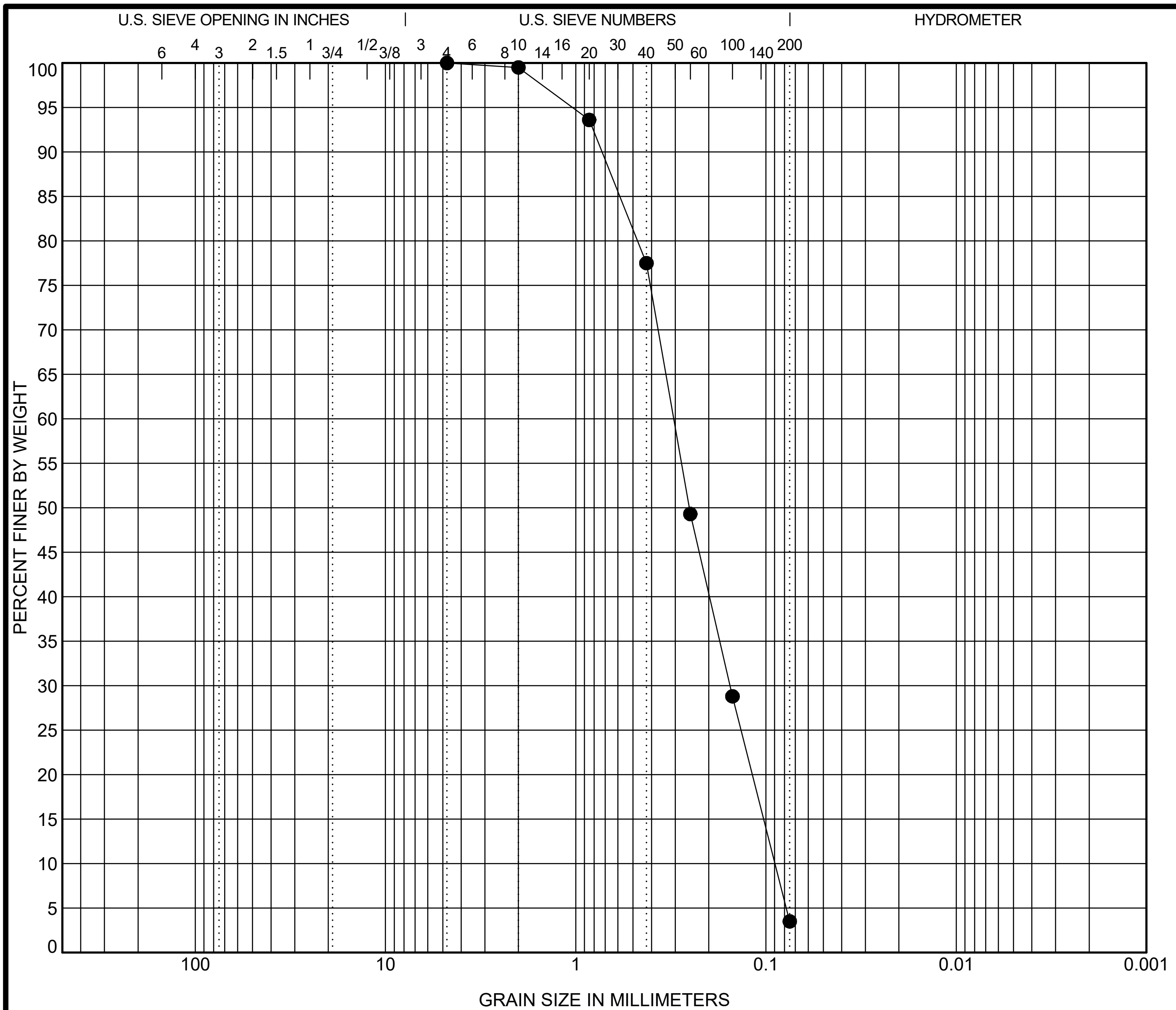
Project Number: 20C33097

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Testing Laboratory	Natural Moisture (%)	Percent Gravel	% Passing No. 10 Sieve	% Passing No. 40 Sieve	% Passing No. 200 Sieve
HITW-09-1	4.0 - 5.0	Bag	SILTY, CLAYEY SAND (SC-SM), fine to medium grained sand, orange-brown (VISUAL)	NN	15.5	0.7	98.5	96.3	35.6

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed

Schnabel ENGINEERING

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen		Sample Description	LL	PL	PI	Cc	Cu
● HITW-05-1	0.0 ft	**POORLY GRADED SAND (SP), fine to medium grained sand, light brown**	--	--	--	**0.87**	**3.41**

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**4.75**	**0.306**	**0.155**	**0.09**	**0.0**	**96.5**	**3.5**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4
% Finer	3.5	28.8	49.3	77.5	93.6	99.5	100.0

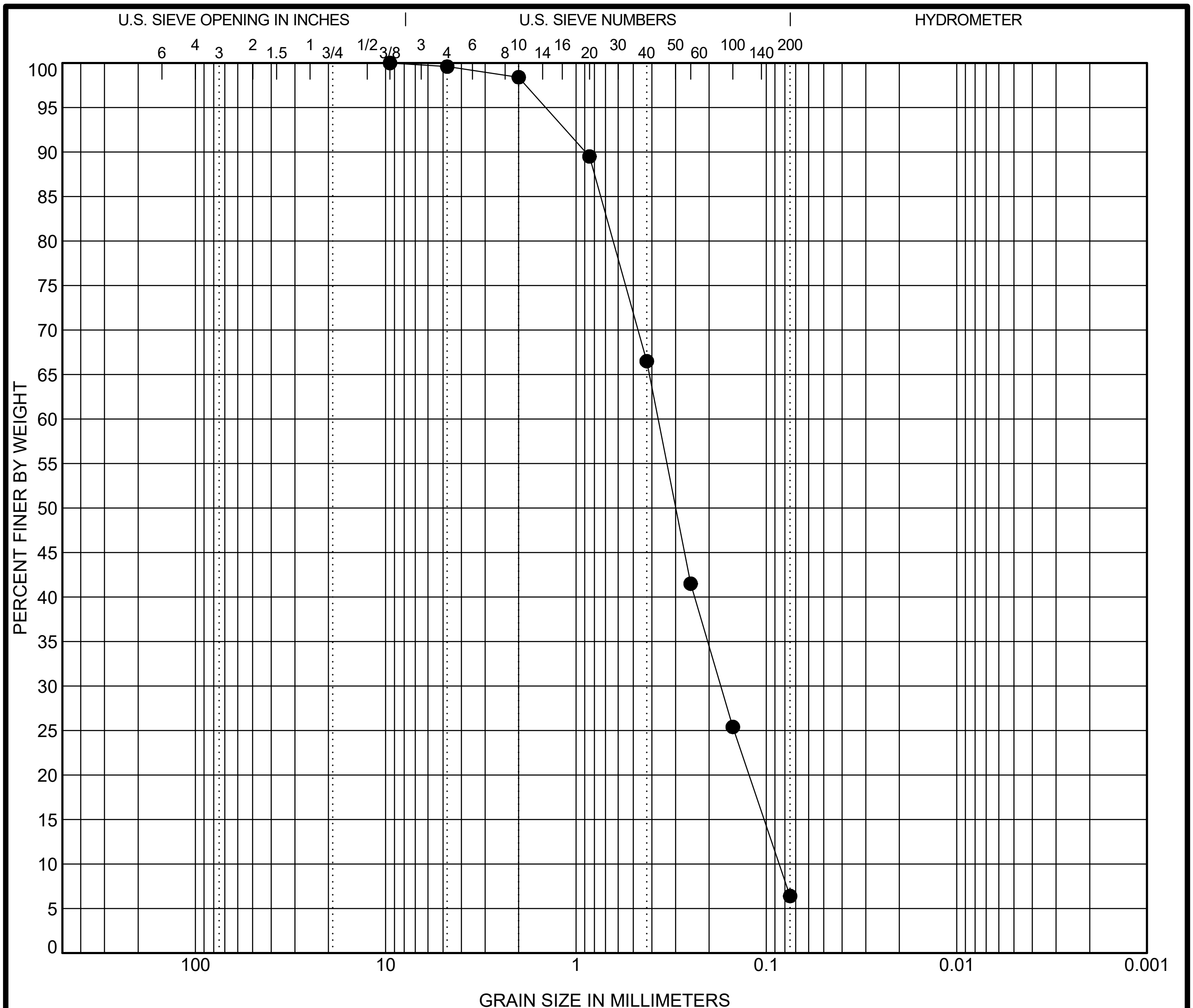
Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI	Cc	Cu
●	HITW-05-2	5.0 ft	**POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, light brown**	--	--	--	**0.95**	**4.33**

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**9.5**	**0.37**	**0.174**	**0.086**	**0.4**	**93.2**	**6.4**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4	3/8
% Finer	6.4	25.4	41.5	66.5	89.5	98.4	99.6	100.0

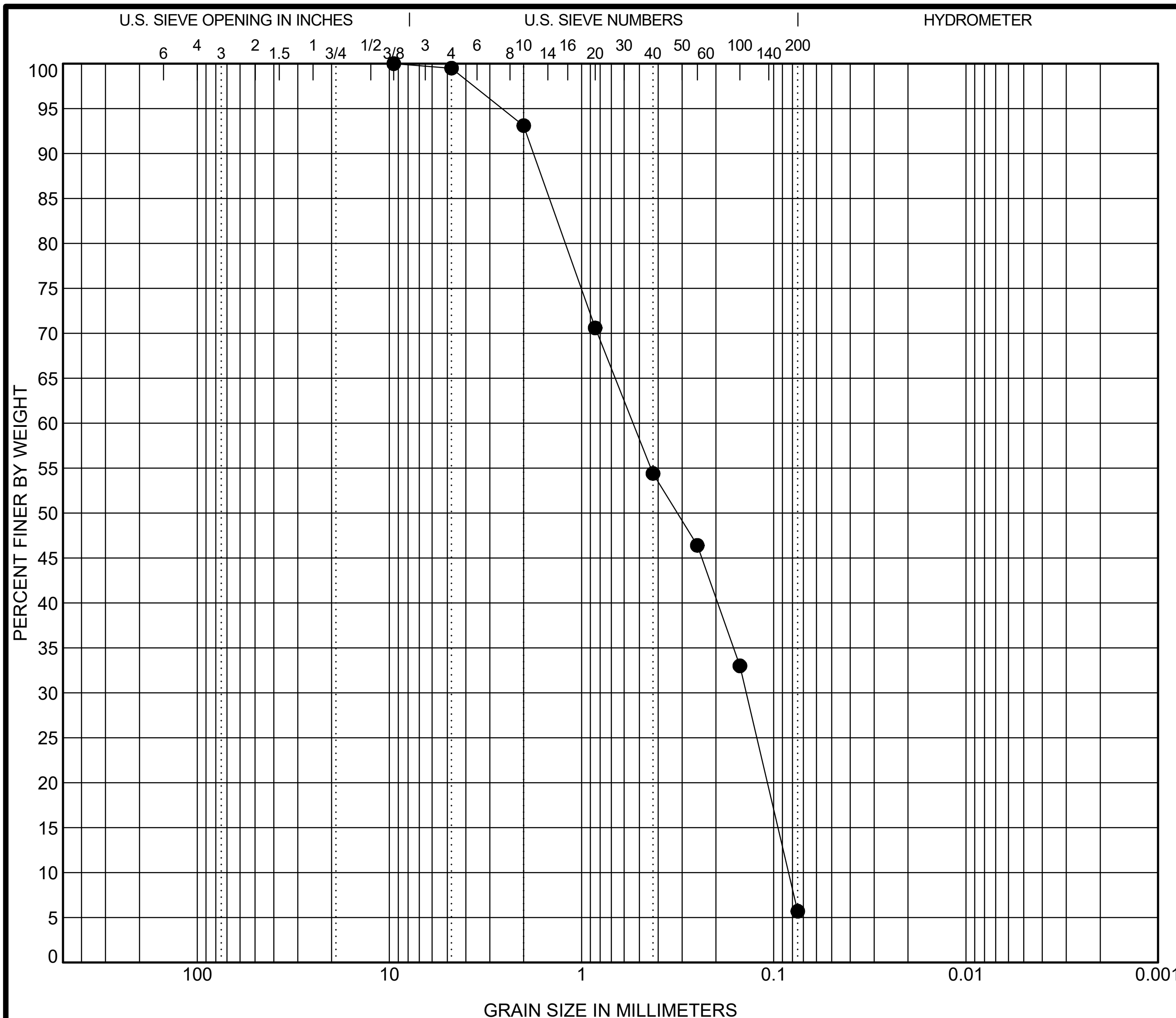
Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI	Cc	Cu
●	HITW-06-1	0.0 ft	**POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, contains shell fragments, light brown**	**--**	**--**	**--**	**0.43**	**6.46**

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**9.5**	**0.54**	**0.139**	**0.084**	**0.5**	**93.8**	**5.7**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4	3/8
% Finer	5.7	33.0	46.4	54.4	70.6	93.1	99.5	100.0

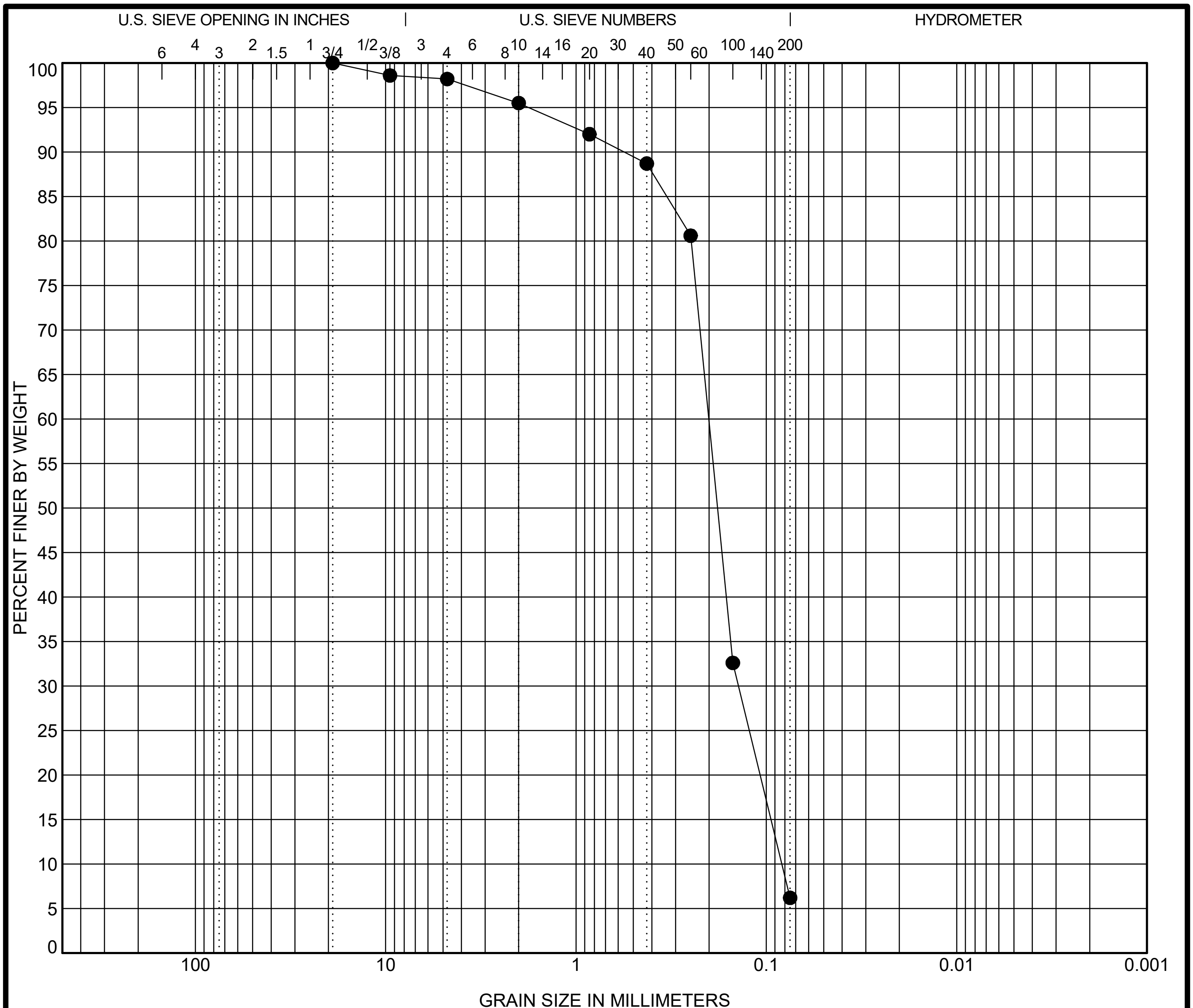
Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI	Cc	Cu
●	HITW-08-1	0.0 ft	**POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, contains shell fragments, light brown**	**--**	**--**	**--**	**1.18**	**2.42**

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**19**	**0.201**	**0.14**	**0.083**	**1.8**	**92.0**	**6.2**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4	3/8	3/4
% Finer	6.2	32.6	80.6	88.7	92.0	95.5	98.2	98.6	100.0

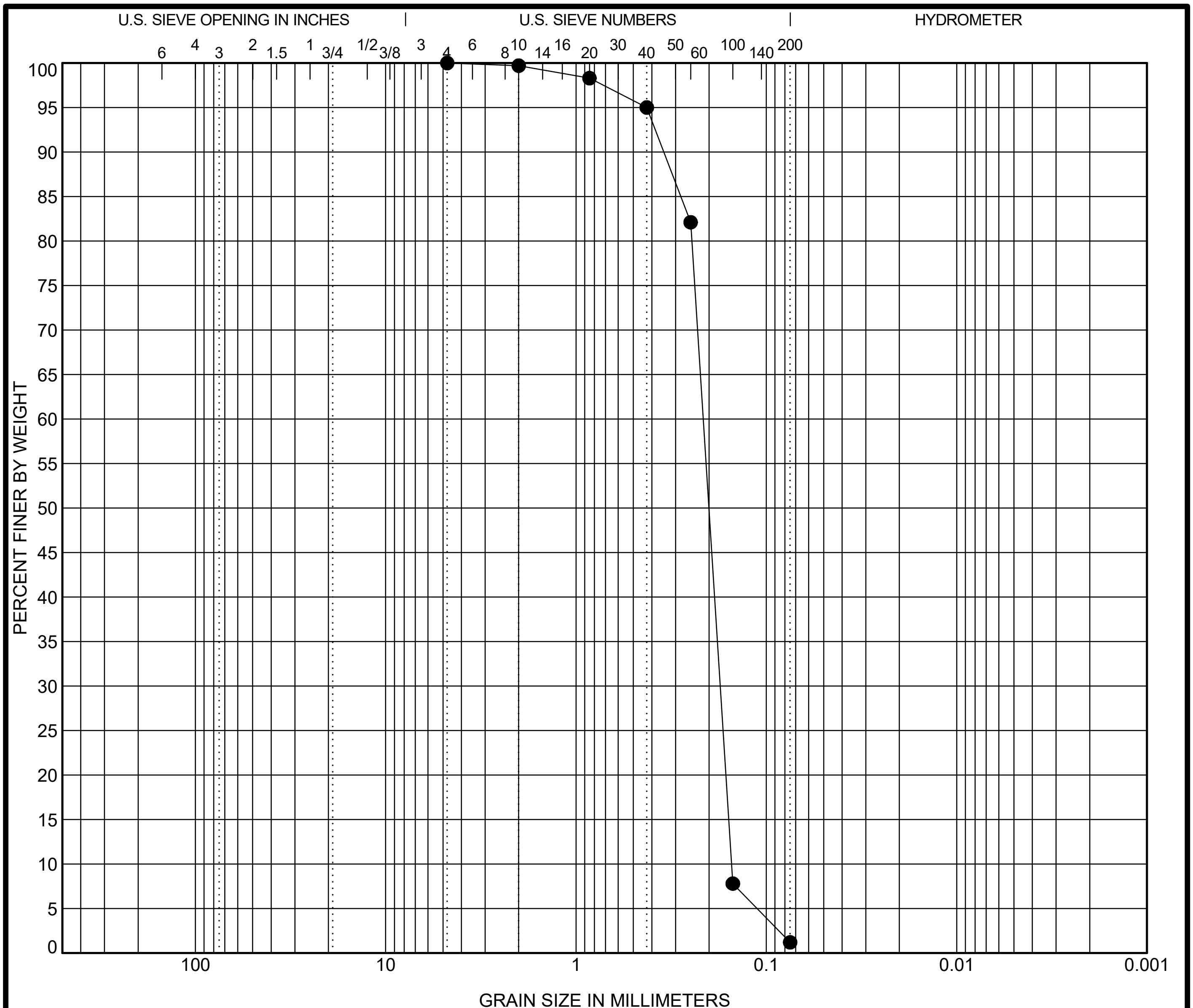
Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI	Cc	Cu
●	HITW-09-1	0.0 ft	**POORLY GRADED SAND (SP), fine to medium grained sand, contains shell fragments, light brown**	--	--	--	**0.93**	**1.41**

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**4.75**	**0.215**	**0.175**	**0.152**	**0.0**	**98.8**	**1.2**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4
% Finer	1.2	7.8	82.1	95.0	98.3	99.7	100.0

Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

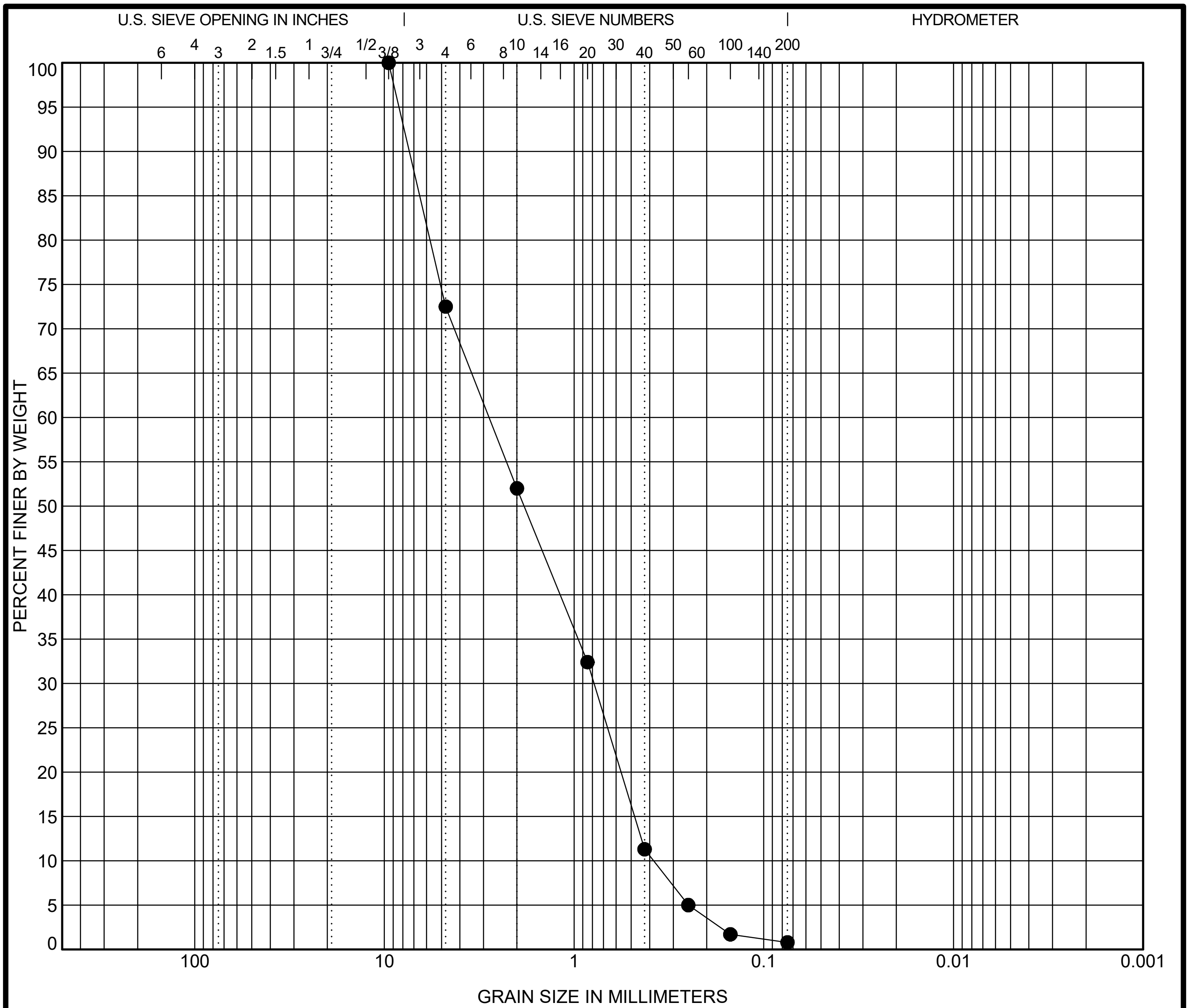
Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN

SIEVE 1/SHEET 20C33097 LAB.GPJ SCHNABEL DATA TEMPLATE 2010 02 25.GDT 11/30/20



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen		Sample Description	LL	PL	PI	Cc	Cu
● HITW-09-1	2.1 ft	**POORLY GRADED SAND WITH GRAVEL (SP), fine to coarse grained sand, light brown**	--	--	--	**0.58**	**7.36**

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**9.5**	**2.803**	**0.786**	**0.381**	**27.5**	**71.7**	**0.8**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4	3/8
% Finer	0.8	1.7	5.0	11.3	32.4	52.0	72.5	100.0

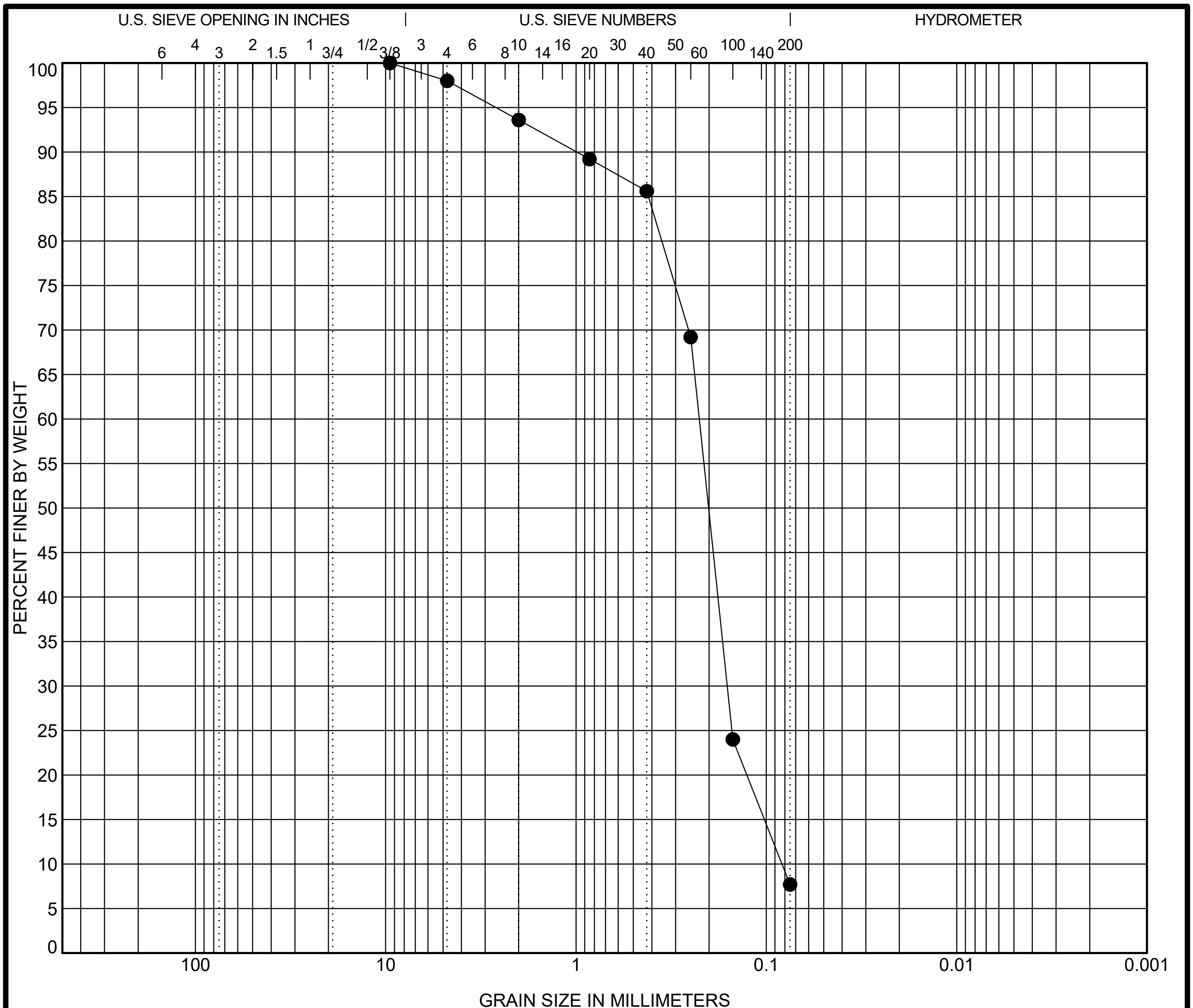
Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen		Sample Description	LL	PL	PI	Cc	Cu
●	HITW-09-1	3.3 ft	**POORLY GRADED SAND WITH SILT (SP-SM), fine to coarse grained sand, light brown**	--	--	--	**1.38**	**2.72**

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**9.5**	**0.225**	**0.161**	**0.083**	**2.0**	**90.3**	**7.7**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4	3/8
% Finer	7.7	24.0	69.2	85.6	89.2	93.6	98.0	100.0

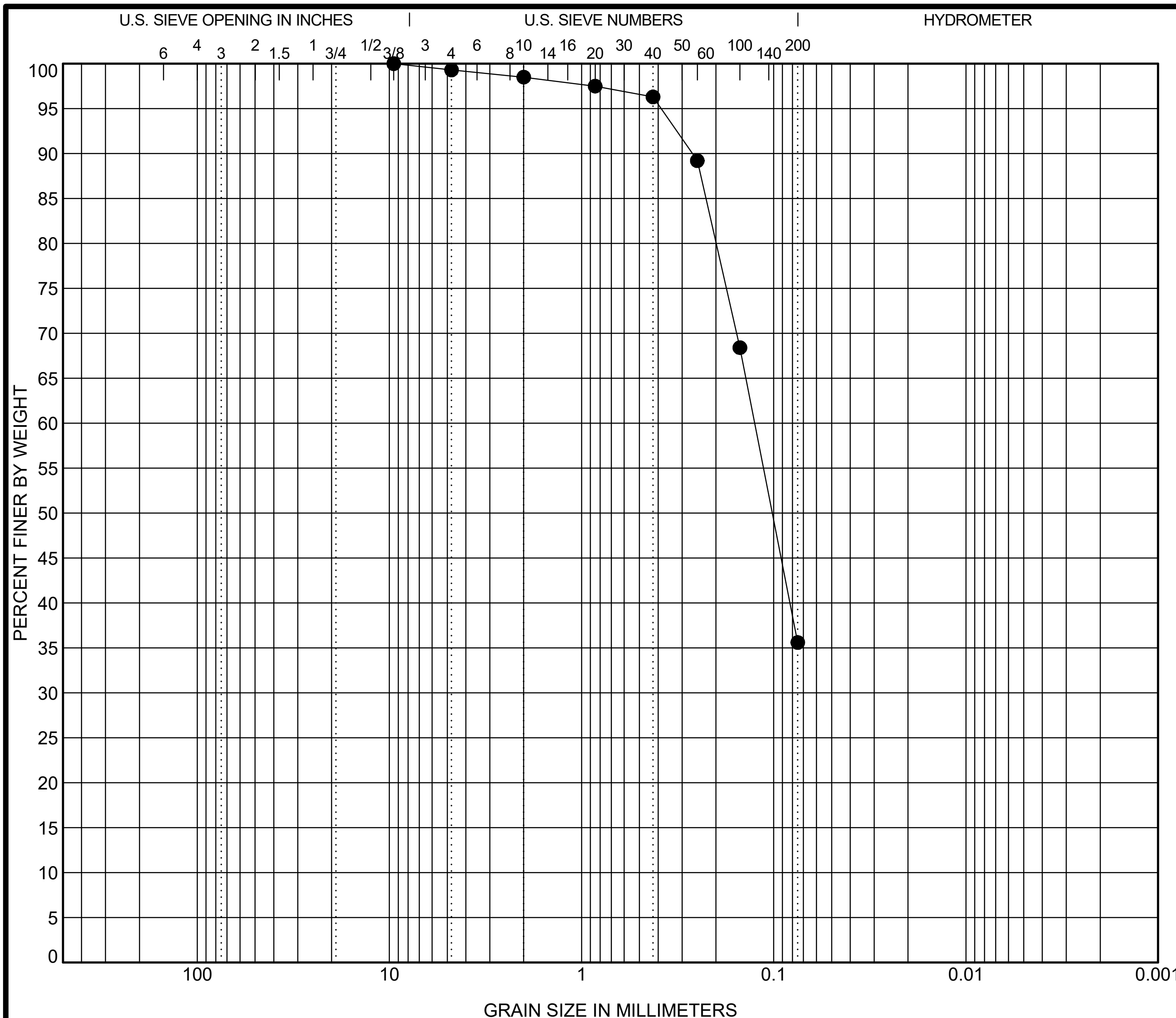
Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen		Sample Description	LL	PL	PI		
● HITW-09-1	4.0 ft	**SILTY, CLAYEY SAND (SC-SM), fine to medium grained sand, orange-brown (VISUAL)**	--	--	--		

Test Method	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
ASTM D422	**9.5**	**0.126**	**--**	**--**	**0.7**	**63.7**	**35.6**	

Percent Finer

Sieve Size	No. 200	No. 100	No. 60	No. 40	No. 20	No. 10	No. 4	3/8
% Finer	35.6	68.4	89.2	96.3	97.5	98.5	99.3	100.0

Tested By	Tested Date	Reviewed By
KR	11/24/20	PD

Schnabel ENGINEERING

GRADATION CURVE

Project: Virginia Institute of Marine Science
Sediment Samples
Gloucester Point, Virginia

Contract: 20C33097 **Testing Lab:** NN

Location	Core-Section	SampleID	% Moisture Units: % MDL: 0.1	% Gravel Units: % MDL: 0.1	% Sand Units: % MDL: 0.1	% Silt Units: % MDL: 0.1	% Clay Units: % MDL: 0.1	% Fines
HITW	1-1	1-1 (0-5 ft)	41.5	0.0	23.0	40.7	36.3	77
HITW	1-2	1-2 (5-8.84 ft)	32.0	0.0	26.2	42.9	30.9	73.8
HITW	2-1	2-1 (0-2.3 ft)	0.6	11.1	87.8	0.6	0.5	1.1
HITW	2-1	2-1 (2.3-5 ft)	19.8	0.0	71.8	14.5	13.7	28.2
HITW	2-2	2-2 (5-8.52 ft)	27.2	0.0	48.5	29.4	22.1	51.5
HITW	3-1	3-1 (0-3.56 ft)	6.6	3.9	92.5	1.8	1.8	3.6
HITW	3-1	3-1 (3.56-5 ft)	35.2	3.9	21.7	44.1	34.2	78.3
HITW	3-2	3-2 (5-10 ft)	29.2	0.0	37.1	38.8	24.2	63
HITW	4-1	4-1 (0-1.58 ft)	0.1	47.7	51.0	0.1	1.3	1.4
HITW	4-1	4-1 (1.58-5 ft)	31.6	0	29.5	37.5	33	70.5
HITW	4-2	4-2 (1.1-3.4ft)	2.1	4.8	89.2	2.1	3.9	6
HITW	4-2	4-2 (0-1.1ft)	11.8	0	68.7	16.5	14.9	31.4
HITW	4-2	4-2 (5-8.38 ft)	7.3	0.0	91.4	3.9	4.8	8.7
HITW	5-1	5-1 (0-5 ft)	12.9	0.3	95.7	1.9	2.1	4
HITW	5-2	5-2 (5-7.4 ft)	8.4	6.5	85.1	4.4	4.1	8.5
HITW	5-2	5-2 (7.4-9.36 ft)	31.0	0.0	32.1	38.1	29.8	67.9
HITW	5-2	5-2 (7-9.3 ft)	27.7	0.0	29.5	42.2	28.3	70.5
HITW	6-1	6-1 (1.2-5 ft)	24.4	0.0	46.7	31.3	22	53.3
HITW	6-2	6-2 (5-10.36 ft)	26.0	0.0	43.7	31.8	24.5	56.3
HITW	7-1	7-1 (0-5 ft)	10.9	2.9	92.6	1.7	2.9	4.6
HITW	7-2	7-2 (5-8.5 ft)	26.4	0.0	64.3	20.8	14.9	35.7
HITW	7-2	7-2 (8.5-9.96 ft)	16.7	0.0	71.4	16.5	12.1	28.6
HITW	8-1	8-1 (2-5 ft)	20.4	0.4	46.1	24.3	29.2	53.5
HITW	8-2	8-2 (5-5.5 ft)	15.6	0.3	45.5	25.1	29	54.1
HITW	8-2	8-2 (5.5-10.06 ft)	7.5	0.0	90.5	3.1	6.4	9.5
HITW	9-2	9-2 (5-8.1 ft)	13.8	5.1	55.7	15.5	23.7	39.2
HITW	9-2	9-2 (8.1-9.3 ft)	21.2	8.5	70.2	11.6	9.8	21.4
HITW	10-1	10-1 (0-4 ft)	12.1	2.6	95.1	0.5	1.8	2.3
HITW	10-1	10-1 (4-4.4 ft)	0.8	80.4	18.9	0.3	0.4	0.7
HITW	10-1	10-1 (4.4-5 ft)	0.4	1.9	96.9	0.5	0.7	1.2
HITW	10-2	10-2 (5-6.16 ft)	0.5	8.7	90.4	0.5	0.4	0.9
HITW	10-2	10-2 (6.16-8.66 ft)	18.7	2.4	42.8	23.6	31.2	54.8
HITW	10-2	10-2 (8.66-8.96 ft)	20.2	20.0	40.1	14	26	40

Appendix D

Chemical Sediment Analysis Results

ENTHALPY ANALYTICAL

formerly Air, Water & Soil Laboratories

1941 Reymet Road ● Richmond, Virginia 23237 ● Tel: (804)-358-8295 Fax: (804)-358-8297

Certificate of Analysis

Final Report

Laboratory Order ID 21B0425

Client Name:	Virginia Institute of Marine Science	Date Received:	February 9, 2021 14:11
	1370 Greate Road	Date Issued:	February 16, 2021 17:39
	Gloucester, VA 23062-1346	Project Number:	Shallow Water Dredging
Submitted To:	Donna Milligan	Purchase Order:	PCO2643144
Client Site I.D.:	Shallow Water Dredging		

Enclosed are the results of analyses for samples received by the laboratory on 02/09/2021 14:11. If you have any questions concerning this report, please feel free to contact the laboratory.

Sincerely,

Ted Soyars
Technical Director

End Notes:

The test results listed in this report relate only to the samples submitted to the laboratory and as received by the Laboratory.

Unless otherwise noted, the test results for solid materials are calculated on a wet weight basis. Analyses for pH, dissolved oxygen, temperature, residual chlorine and sulfite that are performed in the laboratory do not meet NELAC requirements due to extremely short holding times. These analyses should be performed in the field. The results of field analyses performed by the Sampler included in the Certificate of Analysis are done so at the client's request and are not included in the laboratory's fields of certification nor have they been audited for adherence to a reference method or procedure.

The signature on the final report certifies that these results conform to all applicable NELAC standards unless otherwise specified. For a complete list of the Laboratory's NELAC certified parameters please contact customer service.

NELAP ACCREDITED TNI LABORATORY

ENTHALPY ANALYTICAL
formerly Air, Water & Soil Laboratories

1941 Reymet Road ● Richmond, Virginia 23230 ● Tel: (804)-358-8295 Fax: (804)-358-8297

Certificate of Analysis

Final Report

Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued:	February 16, 2021 17:39
		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

ANALYTICAL REPORT FOR SAMPLES

Laboratory Order ID 21B0425

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Davis Up Creek	21B0425-01	Solids	02/04/2021 12:42	02/09/2021 14:11
Davis Down Creek	21B0425-02	Solids	02/04/2021 13:07	02/09/2021 14:11
Winter Up Creek	21B0425-03	Solids	02/08/2021 11:10	02/09/2021 14:11
Winter Down Creek	21B0425-04	Solids	02/08/2021 11:30	02/09/2021 14:11
HITW Landward	21B0425-05	Solids	02/04/2021 10:30	02/09/2021 14:11
HITW Bayward	21B0425-06	Solids	02/04/2021 10:50	02/09/2021 14:11

PCB results have been calculated based on dry weight.

ENTHALPY ANALYTICAL
formerly Air, Water & Soil Laboratories

1941 Reymet Road ● Richmond, Virginia 23230 ● Tel: (804)-358-8295 Fax: (804)-358-8297

Certificate of Analysis

Final Report

Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued: Project Number: Purchase Order:	February 16, 2021 17:39 Shallow Water Dredging PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Laboratory Order ID: 21B0425

Analytical Results

Sample I.D. HITW Landward **Laboratory Sample ID:** 21B0425-05

Grab Date/Time: 02/04/2021 10:30

Field Residual Cl: **Field pH:**

Parameter	Samp ID	Method	Result	Qual	Reporting Limit	D.F.	Sample Prep Date/Time	Analysis Date/Time	Analyst
TCLP Metals by 6000/7000 Series Methods									
TCLP Silver	05	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:43	BG
TCLP Arsenic	05	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:43	BG
TCLP Barium	05	SW6010D	<5.00 mg/L		5.00	1	02/11/21 10:00	02/11/21 16:43	BG
TCLP Cadmium	05	SW6010D	<0.0400 mg/L		0.0400	1	02/11/21 10:00	02/11/21 16:43	BG
TCLP Chromium	05	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:43	BG
TCLP Mercury	05	SW7470A	<0.008 mg/L		0.008	1	02/12/21 08:49	02/12/21 13:03	MWL
TCLP Lead	05	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:43	BG
TCLP Selenium	05	SW6010D	<0.250 mg/L		0.250	1	02/11/21 10:00	02/11/21 16:43	BG
TCLP Extraction Fluid, Metals	05	SW1311	**1 #**		--	1	02/10/21 16:00	02/10/21 16:00	ESW
Volatile Organic Compounds by GC									
Methyl-t-butyl ether (MTBE)	05	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:12	MAK
Benzene	05	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:12	MAK
Toluene	05	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:12	MAK
Ethylbenzene	05	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:12	MAK
m+p-Xylenes	05	SW8021B	<10.0 ug/kg		10.0	1	02/11/21 00:00	02/11/21 16:12	MAK
o-Xylene	05	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:12	MAK
Xylenes, Total	05	SW8021B	<15.0 ug/kg		15.0	1	02/11/21 00:00	02/11/21 16:12	MAK
Surr: 2,5-Dibromotoluene (Surr PID)	*05*	*SW8021B*	*96.7 %*		*80-120*		*02/11/21 00:00*	*02/11/21 16:12*	*MAK*
Semivolatile Hydrocarbons by GC									
TPH-Semi-Volatiles (DRO)	05	SW8015C	<10.0 mg/kg		10.0	1	02/11/21 17:00	02/12/21 19:56	LBH2
Surr: Pentacosane (Surr)	*05*	*SW8015C*	*71.6 %*		*45-160*		*02/11/21 17:00*	*02/12/21 19:56*	*LBH2*
TCLP Semivolatile Organic Compounds									

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Final Report

Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued:	February 16, 2021 17:39
		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Laboratory Order ID: 21B0425

Analytical Results

Sample I.D. HITW Landward **Laboratory Sample ID:** 21B0425-05

Grab Date/Time: 02/04/2021 10:30

Field Residual Cl: **Field pH:**

Parameter	Samp ID	Method	Result	Qual	Reporting Limit	D.F.	Sample Prep Date/Time	Analysis Date/Time	Analyst
TCLP Semivolatile Organic Compounds									
TCLP Extraction Fluid, SV Organics	05	SW1311	**1 #**		--	1	02/10/21 16:00	02/11/21 09:00	SMM
Organochlorine Pesticides and PCBs by GC/ECD									
PCB as Aroclor 1016	05	SW8082A	<0.135 mg/kg dry		0.135	1	02/12/21 10:30	02/15/21 16:00	SKS
PCB as Aroclor 1221	05	SW8082A	<0.135 mg/kg dry		0.135	1	02/12/21 10:30	02/15/21 16:00	SKS
PCB as Aroclor 1232	05	SW8082A	<0.135 mg/kg dry		0.135	1	02/12/21 10:30	02/15/21 16:00	SKS
PCB as Aroclor 1242	05	SW8082A	<0.135 mg/kg dry		0.135	1	02/12/21 10:30	02/15/21 16:00	SKS
PCB as Aroclor 1248	05	SW8082A	<0.135 mg/kg dry		0.135	1	02/12/21 10:30	02/15/21 16:00	SKS
PCB as Aroclor 1254	05	SW8082A	<0.135 mg/kg dry		0.135	1	02/12/21 10:30	02/15/21 16:00	SKS
PCB as Aroclor 1260	05	SW8082A	<0.135 mg/kg dry		0.135	1	02/12/21 10:30	02/15/21 16:00	SKS
Surr: DCB	*05*	*SW8082A*	*70.5 %*		*30-105*		*02/12/21 10:30*	*02/15/21 16:00*	*SKS*
Surr: TCMX	*05*	*SW8082A*	*56.2 %*		*30-105*		*02/12/21 10:30*	*02/15/21 16:00*	*SKS*
TCLP Organochlorine Herbicides by GC/ECD									
TCLP 2,4,5-TP (Silvex)	05	SW8151A	<0.0005 mg/L		0.0005	1	02/11/21 14:55	02/15/21 15:42	SKS
TCLP 2,4-D	05	SW8151A	<0.001 mg/L		0.001	1	02/11/21 14:55	02/15/21 15:42	SKS
Surr: DCAA (Surr)	*05*	*SW8151A*	*66.0 %*		*60-112*		*02/11/21 14:55*	*02/15/21 15:42*	*SKS*
TCLP Organochlorine Pesticides and PCBs by GC/ECD									
TCLP Chlordane	05	SW8081B	<0.030 mg/L		0.030	1	02/12/21 14:00	02/15/21 20:23	SKS
TCLP Endrin	05	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:23	SKS
TCLP gamma-BHC (Lindane)	05	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:23	SKS
TCLP Heptachlor	05	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:23	SKS
TCLP Heptachlor Epoxide	05	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:23	SKS
TCLP Methoxychlor	05	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:23	SKS
TCLP Toxaphene	05	SW8081B	<0.500 mg/L		0.500	1	02/12/21 14:00	02/15/21 20:23	SKS
Surr: TCMX	*05*	*SW8081B*	*58.5 %*		*18-112*		*02/12/21 14:00*	*02/15/21 20:23*	*SKS*

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Final Report

Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued:	February 16, 2021 17:39
		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Laboratory Order ID: 21B0425

Analytical Results

Sample I.D. HITW Landward **Laboratory Sample ID:** 21B0425-05

Grab Date/Time: 02/04/2021 10:30

Field Residual Cl: **Field pH:**

Parameter	Samp ID	Method	Result	Qual	Reporting Limit	D.F.	Sample Prep Date/Time	Analysis Date/Time	Analyst
TCLP Organochlorine Pesticides and PCBs by GC/ECD									
Surr: DCB	*05*	*SW8081B*	*54.7 %*		*27-131*		*02/12/21 14:00*	*02/15/21 20:23*	*SKS*
Wet Chemistry Analysis									
Percent Solids	05	SM22 2540G-2011	**73.2 %**		0.10	1	02/15/21 09:32	02/15/21 09:32	SNL

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Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued:	February 16, 2021 17:39
		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Laboratory Order ID: 21B0425

Analytical Results

Sample I.D. HITW Bayward **Laboratory Sample ID:** 21B0425-06

Grab Date/Time: 02/04/2021 10:50

Field Residual Cl: **Field pH:**

Parameter	Samp ID	Method	Result	Qual	Reporting Limit	D.F.	Sample Prep Date/Time	Analysis Date/Time	Analyst
TCLP Metals by 6000/7000 Series Methods									
TCLP Silver	06	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:54	BG
TCLP Arsenic	06	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:54	BG
TCLP Barium	06	SW6010D	<5.00 mg/L		5.00	1	02/11/21 10:00	02/11/21 16:54	BG
TCLP Cadmium	06	SW6010D	<0.0400 mg/L		0.0400	1	02/11/21 10:00	02/11/21 16:54	BG
TCLP Chromium	06	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:54	BG
TCLP Mercury	06	SW7470A	<0.008 mg/L		0.008	1	02/12/21 08:49	02/12/21 13:05	MWL
TCLP Lead	06	SW6010D	<0.100 mg/L		0.100	1	02/11/21 10:00	02/11/21 16:54	BG
TCLP Selenium	06	SW6010D	<0.250 mg/L		0.250	1	02/11/21 10:00	02/11/21 16:54	BG
TCLP Extraction Fluid, Metals	06	SW1311	**1 #**		--	1	02/10/21 16:00	02/10/21 16:00	ESW
Volatile Organic Compounds by GC									
Methyl-t-butyl ether (MTBE)	06	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:35	MAK
Benzene	06	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:35	MAK
Toluene	06	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:35	MAK
Ethylbenzene	06	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:35	MAK
m+p-Xylenes	06	SW8021B	<10.0 ug/kg		10.0	1	02/11/21 00:00	02/11/21 16:35	MAK
o-Xylene	06	SW8021B	<5.00 ug/kg		5.00	1	02/11/21 00:00	02/11/21 16:35	MAK
Xylenes, Total	06	SW8021B	<15.0 ug/kg		15.0	1	02/11/21 00:00	02/11/21 16:35	MAK
Surr: 2,5-Dibromotoluene (Surr PID)	*06*	*SW8021B*	*103 %*		*80-120*		*02/11/21 00:00*	*02/11/21 16:35*	*MAK*
Semivolatile Hydrocarbons by GC									
TPH-Semi-Volatiles (DRO)	06	SW8015C	<10.0 mg/kg		10.0	1	02/11/21 17:00	02/12/21 20:23	LBH2
Surr: Pentacosane (Surr)	*06*	*SW8015C*	*71.3 %*		*45-160*		*02/11/21 17:00*	*02/12/21 20:23*	*LBH2*
TCLP Semivolatile Organic Compounds									

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Client Name:	Virginia Institute of Marine Science	Date Issued:	February 16, 2021 17:39
	1370 Greate Road	Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
	Gloucester VA, 23062-1346		
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Laboratory Order ID: 21B0425

Analytical Results

Sample I.D. HITW Bayward **Laboratory Sample ID:** 21B0425-06

Grab Date/Time: 02/04/2021 10:50

Field Residual Cl: **Field pH:**

Parameter	Samp ID	Method	Result	Qual	Reporting Limit	D.F.	Sample Prep Date/Time	Analysis Date/Time	Analyst
TCLP Semivolatile Organic Compounds									
TCLP Extraction Fluid, SV Organics	06	SW1311	**1 #**		--	1	02/10/21 16:00	02/11/21 09:00	SMM
Organochlorine Pesticides and PCBs by GC/ECD									
PCB as Aroclor 1016	06	SW8082A	<0.123 mg/kg dry		0.123	1	02/12/21 10:30	02/15/21 16:21	SKS
PCB as Aroclor 1221	06	SW8082A	<0.123 mg/kg dry		0.123	1	02/12/21 10:30	02/15/21 16:21	SKS
PCB as Aroclor 1232	06	SW8082A	<0.123 mg/kg dry		0.123	1	02/12/21 10:30	02/15/21 16:21	SKS
PCB as Aroclor 1242	06	SW8082A	<0.123 mg/kg dry		0.123	1	02/12/21 10:30	02/15/21 16:21	SKS
PCB as Aroclor 1248	06	SW8082A	<0.123 mg/kg dry		0.123	1	02/12/21 10:30	02/15/21 16:21	SKS
PCB as Aroclor 1254	06	SW8082A	<0.123 mg/kg dry		0.123	1	02/12/21 10:30	02/15/21 16:21	SKS
PCB as Aroclor 1260	06	SW8082A	<0.123 mg/kg dry		0.123	1	02/12/21 10:30	02/15/21 16:21	SKS
Surr: DCB	*06*	*SW8082A*	*87.3 %*		*30-105*		*02/12/21 10:30*	*02/15/21 16:21*	*SKS*
Surr: TCMX	*06*	*SW8082A*	*75.4 %*		*30-105*		*02/12/21 10:30*	*02/15/21 16:21*	*SKS*
TCLP Organochlorine Herbicides by GC/ECD									
TCLP 2,4,5-TP (Silvex)	06	SW8151A	<0.0005 mg/L		0.0005	1	02/11/21 14:55	02/15/21 16:07	SKS
TCLP 2,4-D	06	SW8151A	<0.001 mg/L		0.001	1	02/11/21 14:55	02/15/21 16:07	SKS
Surr: DCAA (Surr)	*06*	*SW8151A*	*72.2 %*		*60-112*		*02/11/21 14:55*	*02/15/21 16:07*	*SKS*
TCLP Organochlorine Pesticides and PCBs by GC/ECD									
TCLP Chlordane	06	SW8081B	<0.030 mg/L		0.030	1	02/12/21 14:00	02/15/21 20:42	SKS
TCLP Endrin	06	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:42	SKS
TCLP gamma-BHC (Lindane)	06	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:42	SKS
TCLP Heptachlor	06	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:42	SKS
TCLP Heptachlor Epoxide	06	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:42	SKS
TCLP Methoxychlor	06	SW8081B	<0.005 mg/L		0.005	1	02/12/21 14:00	02/15/21 20:42	SKS
TCLP Toxaphene	06	SW8081B	<0.500 mg/L		0.500	1	02/12/21 14:00	02/15/21 20:42	SKS
Surr: TCMX	*06*	*SW8081B*	*60.0 %*		*18-112*		*02/12/21 14:00*	*02/15/21 20:42*	*SKS*

Page 19 of 37

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Final Report

Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued:	February 16, 2021 17:39
		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Laboratory Order ID: 21B0425

Analytical Results

Sample I.D. HITW Bayward **Laboratory Sample ID:** 21B0425-06

Grab Date/Time: 02/04/2021 10:50

Field Residual Cl: **Field pH:**

Parameter	Samp ID	Method	Result	Qual	Reporting Limit	D.F.	Sample Prep Date/Time	Analysis Date/Time	Analyst
TCLP Organochlorine Pesticides and PCBs by GC/ECD									
Surr: DCB	*06*	*SW8081B*	*60.6 %*		*27-131*		*02/12/21 14:00*	*02/15/21 20:42*	*SKS*
Wet Chemistry Analysis									
Percent Solids	06	SM22 2540G-2011	**81.0 %**		0.10	1	02/15/21 09:32	02/15/21 09:32	SNL

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Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued:	February 16, 2021 17:39
		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Analytical Summary

Preparation Method:

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
Wet Chemistry Analysis		**Preparation Method:**	**No Prep Wet Chem**		
21B0425-01	10.0 g / 10.0 mL	SM22 2540G-2011	BEB0457	SEB0430	
21B0425-02	10.0 g / 10.0 mL	SM22 2540G-2011	BEB0457	SEB0430	
21B0425-03	10.0 g / 10.0 mL	SM22 2540G-2011	BEB0457	SEB0430	
21B0425-04	10.0 g / 10.0 mL	SM22 2540G-2011	BEB0457	SEB0430	
21B0425-05	10.0 g / 10.0 mL	SM22 2540G-2011	BEB0457	SEB0430	
21B0425-06	10.0 g / 10.0 mL	SM22 2540G-2011	BEB0457	SEB0430	

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
TCLP Metals by 6000/7000 Series Methods		**Preparation Method:**	**SW1311 Metals**		
21B0425-01	100 g / 2000 mL	SW1311	BEB0355	SEB0333	
21B0425-02	100 g / 2000 mL	SW1311	BEB0355	SEB0333	
21B0425-03	100 g / 2000 mL	SW1311	BEB0355	SEB0333	
21B0425-04	100 g / 2000 mL	SW1311	BEB0355	SEB0333	
21B0425-05	100 g / 2000 mL	SW1311	BEB0355	SEB0333	
21B0425-06	100 g / 2000 mL	SW1311	BEB0355	SEB0333	

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
TCLP Metals by 6000/7000 Series Methods		**Preparation Method:**	**SW3010A**		
21B0425-01	10.0 mL / 50.0 mL	SW6010D	BEB0359	SEB0388	AB10051
21B0425-02	10.0 mL / 50.0 mL	SW6010D	BEB0359	SEB0388	AB10051
21B0425-03	10.0 mL / 50.0 mL	SW6010D	BEB0359	SEB0388	AB10051
21B0425-04	10.0 mL / 50.0 mL	SW6010D	BEB0359	SEB0388	AB10051
21B0425-05	10.0 mL / 50.0 mL	SW6010D	BEB0359	SEB0388	AB10051
21B0425-06	10.0 mL / 50.0 mL	SW6010D	BEB0359	SEB0388	AB10051

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
TCLP Semivolatile Organic Compounds		**Preparation Method:**	**SW3510C**		

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		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
21B0425-01	100 g / 2000 mL	SW1311	BEB0372	SEB0345	AL00098
21B0425-02	100 g / 2000 mL	SW1311	BEB0372	SEB0345	AL00098
21B0425-03	100 g / 2000 mL	SW1311	BEB0372	SEB0345	AL00098
21B0425-04	100 g / 2000 mL	SW1311	BEB0372	SEB0345	AL00098
21B0425-05	100 g / 2000 mL	SW1311	BEB0372	SEB0345	AL00098
21B0425-06	100 g / 2000 mL	SW1311	BEB0372	SEB0345	AL00098
TCLP Organochlorine Herbicides by GC/ECD		**Preparation Method:**	**SW3510C**		
21B0425-01	100 mL / 5.00 mL	SW8151A	BEB0380	SEB0500	AK00094
21B0425-02	100 mL / 5.00 mL	SW8151A	BEB0380	SEB0500	AK00094
21B0425-03	100 mL / 5.00 mL	SW8151A	BEB0380	SEB0500	AK00094
21B0425-04	100 mL / 5.00 mL	SW8151A	BEB0380	SEB0500	AK00094
21B0425-05	100 mL / 5.00 mL	SW8151A	BEB0380	SEB0500	AK00094
21B0425-06	100 mL / 5.00 mL	SW8151A	BEB0380	SEB0500	AK00094
Semivolatile Hydrocarbons by GC		**Preparation Method:**	**SW3510C**		
21B0425-01	50.6 g / 1.00 mL	SW8015C	BEB0403	SEB0456	AA10005
21B0425-02	50.8 g / 1.00 mL	SW8015C	BEB0403	SEB0456	AA10005
21B0425-03	51.7 g / 1.00 mL	SW8015C	BEB0403	SEB0456	AA10005
21B0425-04	50.2 g / 1.00 mL	SW8015C	BEB0403	SEB0456	AA10005
21B0425-05	52.0 g / 1.00 mL	SW8015C	BEB0403	SEB0456	AA10005
21B0425-06	50.6 g / 1.00 mL	SW8015C	BEB0403	SEB0456	AA10005
TCLP Organochlorine Pesticides and PCBs by GC/ECD		**Preparation Method:**	**SW3510C**		
21B0425-01	100 mL / 1.00 mL	SW8081B	BEB0442	SEB0502	AK00001
21B0425-02	100 mL / 1.00 mL	SW8081B	BEB0442	SEB0502	AK00001
21B0425-03	100 mL / 1.00 mL	SW8081B	BEB0442	SEB0502	AK00001
21B0425-04	100 mL / 1.00 mL	SW8081B	BEB0442	SEB0502	AK00001
21B0425-05	100 mL / 1.00 mL	SW8081B	BEB0442	SEB0502	AK00001
21B0425-06	100 mL / 1.00 mL	SW8081B	BEB0442	SEB0502	AK00001

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
Organochlorine Pesticides and PCBs by GC/ECD		**Preparation Method:**	**SW3550B**		
21B0425-01	30.4 g / 5.00 mL	SW8082A	BEB0391	SEB0487	AJ00088
21B0425-02	30.6 g / 5.00 mL	SW8082A	BEB0391	SEB0487	AJ00088
21B0425-03	30.3 g / 5.00 mL	SW8082A	BEB0391	SEB0487	AJ00088
21B0425-04	30.1 g / 5.00 mL	SW8082A	BEB0391	SEB0487	AJ00088

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			Project Number:	Shallow Water Dredging
			Purchase Order:	PCO2643144
Submitted To:	Donna Milligan			
Client Site I.D.:	Shallow Water Dredging			

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
21B0425-05	30.4 g / 5.00 mL	SW8082A	BEB0391	SEB0487	AJ00088
21B0425-06	30.1 g / 5.00 mL	SW8082A	BEB0391	SEB0487	AJ00088

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
Volatile Organic Compounds by GC		**Preparation Method:**	**SW5030B**		
21B0425-01	5.37 g / 5.00 mL	SW8021B	BEB0400	SEB0411	AB10048
21B0425-02	5.19 g / 5.00 mL	SW8021B	BEB0400	SEB0411	AB10048
21B0425-03	5.20 g / 5.00 mL	SW8021B	BEB0400	SEB0411	AB10048
21B0425-04	5.09 g / 5.00 mL	SW8021B	BEB0400	SEB0411	AB10048
21B0425-05	5.14 g / 5.00 mL	SW8021B	BEB0400	SEB0411	AB10048
21B0425-06	5.01 g / 5.00 mL	SW8021B	BEB0400	SEB0411	AB10048

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
TCLP Metals by 6000/7000 Series Methods		**Preparation Method:**	**SW7470A**		
21B0425-01	1.00 mL / 20.0 mL	SW7470A	BEB0413	SEB0402	AB10056
21B0425-02	1.00 mL / 20.0 mL	SW7470A	BEB0413	SEB0402	AB10056
21B0425-03	1.00 mL / 20.0 mL	SW7470A	BEB0413	SEB0402	AB10056
21B0425-04	1.00 mL / 20.0 mL	SW7470A	BEB0413	SEB0402	AB10056
21B0425-05	1.00 mL / 20.0 mL	SW7470A	BEB0413	SEB0402	AB10056
21B0425-06	1.00 mL / 20.0 mL	SW7470A	BEB0413	SEB0402	AB10056

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Final Report

Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued: Project Number: Purchase Order:	February 16, 2021 17:39 Shallow Water Dredging PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

TCLP Metals by 6000/7000 Series Methods - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0355 - SW1311 Metals										
Blank (BEB0355-BLK1)				Prepared & Analyzed: 02/10/2021						
Extraction Fluid, Metals	1 #	0	#							
Batch BEB0359 - SW3010A										
Blank (BEB0359-BLK1)				Prepared & Analyzed: 02/11/2021						
Arsenic	<0.100 mg/L	0.100	mg/L							
Barium	<5.00 mg/L	5.00	mg/L							
Cadmium	<0.0400 mg/L	0.0400	mg/L							
Chromium	<0.100 mg/L	0.100	mg/L							
Lead	<0.100 mg/L	0.100	mg/L							
Selenium	<0.250 mg/L	0.250	mg/L							
Silver	<0.100 mg/L	0.100	mg/L							
LCS (BEB0359-BS1)				Prepared & Analyzed: 02/11/2021						
Arsenic	2.51 mg/L	0.100	mg/L	2.50 mg/L		100	80-120			
Barium	<5.00 mg/L	5.00	mg/L	2.50 mg/L		105	80-120			
Cadmium	2.40 mg/L	0.0400	mg/L	2.50 mg/L		96.0	80-120			
Chromium	2.39 mg/L	0.100	mg/L	2.50 mg/L		95.6	80-120			
Lead	2.38 mg/L	0.100	mg/L	2.50 mg/L		95.1	80-120			
Selenium	2.39 mg/L	0.250	mg/L	2.50 mg/L		95.5	80-120			
Silver	0.471 mg/L	0.100	mg/L	0.500 mg/L		94.1	80-120			
LCS Dup (BEB0359-BSD1)				Prepared & Analyzed: 02/11/2021						
Arsenic	2.48 mg/L	0.100	mg/L	2.50 mg/L		99.2	80-120	1.04	20	
Barium	<5.00 mg/L	5.00	mg/L	2.50 mg/L		104	80-120	0.978	20	
Cadmium	2.39 mg/L	0.0400	mg/L	2.50 mg/L		95.5	80-120	0.519	20	
Chromium	2.36 mg/L	0.100	mg/L	2.50 mg/L		94.4	80-120	1.31	20	
Lead	2.38 mg/L	0.100	mg/L	2.50 mg/L		95.2	80-120	0.0673	20	
Selenium	2.38 mg/L	0.250	mg/L	2.50 mg/L		95.0	80-120	0.470	20	
Silver	0.462 mg/L	0.100	mg/L	0.500 mg/L		92.4	80-120	1.88	20	

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Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

TCLP Metals by 6000/7000 Series Methods - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0359 - SW3010A										
Matrix Spike (BEB0359-MS1)		**Source: 21B0425-01**		Prepared & Analyzed: 02/11/2021						
Arsenic	2.57 mg/L	0.100	mg/L	2.50	<0.100 mg/L	103	75-125			
Barium	<5.00 mg/L	5.00	mg/L	2.50	<5.00 mg/L	114	75-125			
Cadmium	2.44 mg/L	0.0400	mg/L	2.50	<0.0400 mg/L	97.8	75-125			
Chromium	2.44 mg/L	0.100	mg/L	2.50	<0.100 mg/L	97.6	75-125			
Lead	2.43 mg/L	0.100	mg/L	2.50	<0.100 mg/L	97.3	75-125			
Selenium	2.45 mg/L	0.250	mg/L	2.50	<0.250 mg/L	98.0	75-125			
Silver	0.470 mg/L	0.100	mg/L	0.500	<0.100 mg/L	94.0	75-125			
Matrix Spike Dup (BEB0359-MSD1)		**Source: 21B0425-01**		Prepared & Analyzed: 02/11/2021						
Arsenic	2.58 mg/L	0.100	mg/L	2.50	<0.100 mg/L	103	75-125	0.398	20	
Barium	<5.00 mg/L	5.00	mg/L	2.50	<5.00 mg/L	114	75-125	0.182	20	
Cadmium	2.45 mg/L	0.0400	mg/L	2.50	<0.0400 mg/L	98.0	75-125	0.189	20	
Chromium	2.46 mg/L	0.100	mg/L	2.50	<0.100 mg/L	98.5	75-125	0.959	20	
Lead	2.46 mg/L	0.100	mg/L	2.50	<0.100 mg/L	98.2	75-125	0.911	20	
Selenium	2.45 mg/L	0.250	mg/L	2.50	<0.250 mg/L	98.1	75-125	0.149	20	
Silver	0.469 mg/L	0.100	mg/L	0.500	<0.100 mg/L	93.8	75-125	0.168	20	
Batch BEB0413 - SW7470A										
Blank (BEB0413-BLK1)				Prepared & Analyzed: 02/12/2021						
Mercury	<0.008 mg/L	0.008	mg/L							
LCS (BEB0413-BS1)				Prepared & Analyzed: 02/12/2021						
Mercury	0.049 mg/L	0.008	mg/L	0.0500	mg/L	98.7	80-120			
LCS Dup (BEB0413-BSD1)				Prepared & Analyzed: 02/12/2021						
Mercury	0.047 mg/L	0.008	mg/L	0.0500	mg/L	94.7	80-120	4.17	20	

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Client Name:	Virginia Institute of Marine Science 1370 Greate Road Gloucester VA, 23062-1346	Date Issued:	February 16, 2021 17:39
		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

TCLP Metals by 6000/7000 Series Methods - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0413 - SW7470A										
Matrix Spike (BEB0413-MS1)		**Source: 21B0425-01**		Prepared & Analyzed: 02/12/2021						
Mercury	0.050 mg/L	0.008	mg/L	0.0500	<0.008 mg/L	99.9	80-120			
Matrix Spike Dup (BEB0413-MSD1)		**Source: 21B0425-01**		Prepared & Analyzed: 02/12/2021						
Mercury	0.051 mg/L	0.008	mg/L	0.0500	<0.008 mg/L	102	80-120	2.33	20	

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		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Volatile Organic Compounds by GC - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0400 - SW5030B										
Blank (BEB0400-BLK1)				Prepared & Analyzed: 02/11/2021						
Methyl-t-butyl ether (MTBE)	<5.00 ug/kg	5.00	ug/kg							
Benzene	<5.00 ug/kg	5.00	ug/kg							
Toluene	<5.00 ug/kg	5.00	ug/kg							
Ethylbenzene	<5.00 ug/kg	5.00	ug/kg							
m+p-Xylenes	<10.0 ug/kg	10.0	ug/kg							
o-Xylene	<5.00 ug/kg	5.00	ug/kg							
Xylenes, Total	<15.0 ug/kg	15.0	ug/kg							
Surr: 2,5-Dibromotoluene (Surr PID)	98.8		ug/L	100		98.8	80-120			
LCS (BEB0400-BS1)				Prepared & Analyzed: 02/11/2021						
Methyl-t-butyl ether (MTBE)	105 ug/kg	5.00	ug/kg	100	ug/kg	105	70-130			
Benzene	115 ug/kg	5.00	ug/kg	100	ug/kg	115	70-130			
Toluene	117 ug/kg	5.00	ug/kg	100	ug/kg	117	70-130			
Ethylbenzene	118 ug/kg	5.00	ug/kg	100	ug/kg	118	70-130			
m+p-Xylenes	234 ug/kg	10.0	ug/kg	200	ug/kg	117	70-130			
o-Xylene	112 ug/kg	5.00	ug/kg	100	ug/kg	112	70-130			
Surr: 2,5-Dibromotoluene (Surr PID)	109		ug/L	100	ug/L	109	80-120			
Matrix Spike (BEB0400-MS1)	**Source: 21B0425-04**			Prepared & Analyzed: 02/11/2021						
Methyl-t-butyl ether (MTBE)	104 ug/kg	5.00	ug/kg	94.5	<5.00 ug/kg	110	70-130			
Benzene	108 ug/kg	5.00	ug/kg	94.5	<5.00 ug/kg	114	70-130			
Toluene	107 ug/kg	5.00	ug/kg	94.5	<5.00 ug/kg	113	70-130			
Ethylbenzene	106 ug/kg	5.00	ug/kg	94.5	<5.00 ug/kg	112	70-130			
m+p-Xylenes	205 ug/kg	10.0	ug/kg	189	<10.0 ug/kg	109	70-130			
o-Xylene	98.5 ug/kg	5.00	ug/kg	94.5	<5.00 ug/kg	104	70-130			
Surr: 2,5-Dibromotoluene (Surr PID)	101		ug/L	100	ug/L	101	80-120			
Matrix Spike Dup (BEB0400-MSD1)	**Source: 21B0425-04**			Prepared & Analyzed: 02/11/2021						
Methyl-t-butyl ether (MTBE)	100 ug/kg	5.00	ug/kg	97.5	<5.00 ug/kg	103	70-130	3.43	20	
Benzene	103 ug/kg	5.00	ug/kg	97.5	<5.00 ug/kg	105	70-130	4.64	20	
Toluene	102 ug/kg	5.00	ug/kg	97.5	<5.00 ug/kg	104	70-130	5.17	20	
Ethylbenzene	99.8 ug/kg	5.00	ug/kg	97.5	<5.00 ug/kg	102	70-130	5.99	20	

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		Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Volatile Organic Compounds by GC - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0400 - SW5030B										
Matrix Spike Dup (BEB0400-MSD1)		**Source: 21B0425-04**		Prepared & Analyzed: 02/11/2021						
m+p-Xylenes	194 ug/kg	10.0	ug/kg	195	<10.0 ug/kg	99.4	70-130	5.83	20	
o-Xylene	92.7 ug/kg	5.00	ug/kg	97.5	<5.00 ug/kg	95.1	70-130	6.05	20	
Surr: 2,5-Dibromotoluene (Surr PID)	106		ug/L	100	ug/L	106	80-120			

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Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Semivolatile Hydrocarbons by GC - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0403 - SW3510C										
Blank (BEB0403-BLK1)				Prepared: 02/11/2021 Analyzed: 02/12/2021						
TPH-Semi-Volatiles (DRO)	<10.0 mg/kg	10.0	mg/kg							
Surr: Pentacosane (Surr)	3.55		mg/kg	4.99		71.2	45-160			
LCS (BEB0403-BS1)				Prepared: 02/11/2021 Analyzed: 02/12/2021						
TPH-Semi-Volatiles (DRO)	76.5 mg/kg	10.0	mg/kg	100	mg/kg	76.5	40-160			
Surr: Pentacosane (Surr)	3.42		mg/kg	5.00	mg/kg	68.5	45-160			
Matrix Spike (BEB0403-MS1)		**Source: 21B0516-06**		Prepared: 02/11/2021 Analyzed: 02/12/2021						
TPH-Semi-Volatiles (DRO)	84.4 mg/kg	10.0	mg/kg	100	<10.0 mg/kg	84.4	40-160			
Surr: Pentacosane (Surr)	3.75		mg/kg	5.00	mg/kg	75.0	45-160			
Matrix Spike Dup (BEB0403-MSD1)		**Source: 21B0516-06**		Prepared: 02/11/2021 Analyzed: 02/12/2021						
TPH-Semi-Volatiles (DRO)	93.8 mg/kg	10.0	mg/kg	98.6	<10.0 mg/kg	95.1	40-160	10.6	20	
Surr: Pentacosane (Surr)	4.03		mg/kg	4.93	mg/kg	81.8	45-160			

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		Purchase Order:	PCO2643144
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Client Site I.D.:	Shallow Water Dredging		

Organochlorine Pesticides and PCBs by GC/ECD - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0391 - SW3550B										
Blank (BEB0391-BLK1)				Prepared: 02/11/2021 Analyzed: 02/12/2021						
PCB as Aroclor 1016	<0.100 mg/kg wet	0.100	mg/kg wet							
PCB as Aroclor 1221	<0.100 mg/kg wet	0.100	mg/kg wet							
PCB as Aroclor 1232	<0.100 mg/kg wet	0.100	mg/kg wet							
PCB as Aroclor 1242	<0.100 mg/kg wet	0.100	mg/kg wet							
PCB as Aroclor 1248	<0.100 mg/kg wet	0.100	mg/kg wet							
PCB as Aroclor 1254	<0.100 mg/kg wet	0.100	mg/kg wet							
PCB as Aroclor 1260	<0.100 mg/kg wet	0.100	mg/kg wet							
Surr: DCB	0.0127		mg/kg wet	0.0167		75.9	30-105			
Surr: TCMX	0.0149		mg/kg wet	0.0167		89.3	30-105			
LCS (BEB0391-BS1)				Prepared: 02/11/2021 Analyzed: 02/12/2021						
PCB as Aroclor 1016	0.156 mg/kg wet	0.100	mg/kg wet	0.167	mg/kg wet	93.4	60-140			
PCB as Aroclor 1260	0.144 mg/kg wet	0.100	mg/kg wet	0.167	mg/kg wet	86.4	60-140			
Surr: DCB	0.0172		mg/kg wet	0.0167	mg/kg wet	103	30-105			
Surr: TCMX	0.0145		mg/kg wet	0.0167	mg/kg wet	87.0	30-105			
Matrix Spike (BEB0391-MS1)		**Source: 21B0518-01**		Prepared: 02/11/2021 Analyzed: 02/12/2021						
PCB as Aroclor 1016	0.254 mg/kg dry	0.110	mg/kg dry	0.183	<0.110 mg/kg	139	60-140			
PCB as Aroclor 1260	0.203 mg/kg dry	0.110	mg/kg dry	0.183	<0.110 mg/kg	111	60-140			
Surr: DCB	0.0152		mg/kg dry	0.0183	mg/kg dry	83.0	30-105			
Surr: TCMX	0.0178		mg/kg dry	0.0183	mg/kg dry	97.1	30-105			
Matrix Spike Dup (BEB0391-MSD1)		**Source: 21B0518-01**		Prepared: 02/11/2021 Analyzed: 02/12/2021						
PCB as Aroclor 1016	0.181 mg/kg dry	0.110	mg/kg dry	0.183	<0.110 mg/kg	98.5	60-140	33.8	20	P
PCB as Aroclor 1260	0.181 mg/kg dry	0.110	mg/kg dry	0.183	<0.110 mg/kg	98.5	60-140	11.8	20	
Surr: DCB	0.0159		mg/kg dry	0.0183	mg/kg dry	86.6	30-105			
Surr: TCMX	0.0158		mg/kg dry	0.0183	mg/kg dry	86.2	30-105			

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Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

TCLP Organochlorine Herbicides by GC/ECD - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0380 - SW3510C										
Blank (BEB0380-BLK1)				Prepared: 02/11/2021 Analyzed: 02/15/2021						
2,4,5-TP (Silvex)	<0.0005 mg/L	0.0005	mg/L							
2,4-D	<0.001 mg/L	0.001	mg/L							
Surr: DCAA (Surr)	0.00918		mg/L	0.0100		91.8	60-112			
LCS (BEB0380-BS1)				Prepared: 02/11/2021 Analyzed: 02/15/2021						
2,4,5-TP (Silvex)	0.004 mg/L	0.0005	mg/L	0.00500 mg/L		81.8	62-132			
2,4-D	0.004 mg/L	0.001	mg/L	0.00500 mg/L		88.4	74-139			
Surr: DCAA (Surr)	0.00907		mg/L	0.0100 mg/L		90.7	60-112			
Matrix Spike (BEB0380-MS1)	**Source: 21B0425-06**			Prepared: 02/11/2021 Analyzed: 02/15/2021						
2,4,5-TP (Silvex)	0.006 mg/L	0.0005	mg/L	0.00500	<0.0005 mg/L	112	52-129			
2,4-D	0.006 mg/L	0.001	mg/L	0.00500	<0.001 mg/L	117	53-126			
Surr: DCAA (Surr)	0.0119		mg/L	0.0100 mg/L		119	60-112			S
Matrix Spike Dup (BEB0380-MSD1)	**Source: 21B0425-06**			Prepared: 02/11/2021 Analyzed: 02/15/2021						
2,4,5-TP (Silvex)	0.006 mg/L	0.0005	mg/L	0.00500	<0.0005 mg/L	113	52-129	0.820	20	
2,4-D	0.006 mg/L	0.001	mg/L	0.00500	<0.001 mg/L	115	53-126	1.77	20	
Surr: DCAA (Surr)	0.0103		mg/L	0.0100 mg/L		103	60-112			

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		Purchase Order:	PCO2643144
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

TCLP Organochlorine Pesticides and PCBs by GC/ECD - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0442 - SW3510C										
Blank (BEB0442-BLK1)				Prepared: 02/12/2021 Analyzed: 02/15/2021						
Chlordane	<0.030 mg/L	0.030	mg/L							
Endrin	<0.005 mg/L	0.005	mg/L							
gamma-BHC (Lindane)	<0.005 mg/L	0.005	mg/L							
Heptachlor	<0.005 mg/L	0.005	mg/L							
Heptachlor Epoxide	<0.005 mg/L	0.005	mg/L							
Methoxychlor	<0.005 mg/L	0.005	mg/L							
Toxaphene	<0.500 mg/L	0.500	mg/L							
Surr: TCMX	0.00139		mg/L	0.00200		69.6	18-112			
Surr: DCB	0.000772		mg/L	0.00200		38.6	27-131			
LCS (BEB0442-BS1)				Prepared: 02/12/2021 Analyzed: 02/15/2021						
Endrin	<0.005 mg/L	0.005	mg/L	0.00100 mg/L		73.0	23-134			
Heptachlor	<0.005 mg/L	0.005	mg/L	0.00100 mg/L		62.5	23-134			
Heptachlor Epoxide	<0.005 mg/L	0.005	mg/L	0.00100 mg/L		70.8	23-134			
Methoxychlor	<0.005 mg/L	0.005	mg/L	0.00100 mg/L		82.5	23-134			
Surr: TCMX	0.00113		mg/L	0.00200 mg/L		56.3	18-112			
Surr: DCB	0.000678		mg/L	0.00200 mg/L		33.9	27-131			
LCS (BEB0442-BS2)				Prepared: 02/12/2021 Analyzed: 02/15/2021						
Toxaphene	<0.500 mg/L	0.500	mg/L	0.0250 mg/L		62.0	23-134			
LCS (BEB0442-BS3)				Prepared: 02/12/2021 Analyzed: 02/15/2021						
Chlordane	<0.030 mg/L	0.030	mg/L	0.0250 mg/L		95.4	23-134			
Matrix Spike (BEB0442-MS1)		**Source: 21B0425-05**		Prepared: 02/12/2021 Analyzed: 02/15/2021						
Endrin	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	51.3	23-134			
Heptachlor	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	54.6	23-134			
Heptachlor Epoxide	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	51.1	23-134			
Methoxychlor	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	54.9	23-134			
Surr: TCMX	0.00117		mg/L	0.00200 mg/L		58.4	18-112			
Surr: DCB	0.00117		mg/L	0.00200 mg/L		58.5	27-131			

Page 32 of 39

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Certificate of Analysis

Final Report

Client Name:	Virginia Institute of Marine Science	Date Issued:	February 16, 2021 17:39
	1370 Greate Road	Project Number:	Shallow Water Dredging
		Purchase Order:	PCO2643144
	Gloucester VA, 23062-1346		
Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

TCLP Organochlorine Pesticides and PCBs by GC/ECD - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0442 - SW3510C										
Matrix Spike Dup (BEB0442-MSD1)		**Source: 21B0425-05**		Prepared: 02/12/2021 Analyzed: 02/15/2021						
Endrin	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	48.8	23-134	5.01	20	
Heptachlor	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	54.3	23-134	0.496	20	
Heptachlor Epoxide	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	48.7	23-134	4.69	20	
Methoxychlor	<0.005 mg/L	0.005	mg/L	0.00100	<0.005 mg/L	53.9	23-134	1.78	20	
Surr: TCMX	0.00111		mg/L	0.00200	mg/L	55.6	18-112			
Surr: DCB	0.00118		mg/L	0.00200	mg/L	58.8	27-131			

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Client Site I.D.:	Shallow Water Dredging		

Wet Chemistry Analysis - Quality Control

Air Water & Soil Laboratories, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BEB0457 - No Prep Wet Chem										
Blank (BEB0457-BLK1)				Prepared & Analyzed: 02/15/2021						
Percent Solids	100 %	0.10	%							
Duplicate (BEB0457-DUP1)		**Source: 21B0425-02**		Prepared & Analyzed: 02/15/2021						
Percent Solids	65.7 %	0.10	%		68.9 %			4.83	20	

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Client Site I.D.:	Shallow Water Dredging		

Certified Analyses included in this Report

Analyte	Certifications
SW1311 in Solids	
Extraction Fluid, Metals	VELAP
Extraction Fluid, SV Organics	VELAP
SW6010D in Non-Potable Water	
Arsenic	VELAP,WVDEP
Barium	VELAP,WVDEP
Cadmium	VELAP,WVDEP
Chromium	VELAP,WVDEP
Lead	VELAP,WVDEP
Selenium	VELAP,WVDEP
Silver	VELAP,WVDEP
SW7470A in Non-Potable Water	
Mercury	VELAP,WVDEP
SW8015C in Solids	
TPH-Semi-Volatiles (DRO)	VELAP,NCDEQ,WVDEP
SW8021B in Solids	
Methyl-t-butyl ether (MTBE)	VELAP,WVDEP
Benzene	VELAP,WVDEP
Toluene	VELAP,WVDEP
Ethylbenzene	VELAP,WVDEP
m+p-Xylenes	VELAP,WVDEP
o-Xylene	VELAP,WVDEP
Xylenes, Total	VELAP,WVDEP
SW8081B in Non-Potable Water	
Chlordane	VELAP,WVDEP
Endrin	VELAP,WVDEP
gamma-BHC (Lindane)	VELAP,WVDEP
Heptachlor	VELAP,WVDEP
Heptachlor Epoxide	VELAP,WVDEP
Methoxychlor	VELAP,WVDEP
Toxaphene	VELAP,WVDEP
SW8082A in Solids	
PCB as Aroclor 1016	VELAP,NCDEQ
PCB as Aroclor 1221	VELAP,NCDEQ
PCB as Aroclor 1232	VELAP,NCDEQ
PCB as Aroclor 1242	VELAP,NCDEQ

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Certified Analyses included in this Report

Analyte	Certifications
PCB as Aroclor 1248	VELAP,NCDEQ
PCB as Aroclor 1254	VELAP,NCDEQ
PCB as Aroclor 1260	VELAP,NCDEQ
SW8151A in Non-Potable Water	
2,4,5-TP (Silvex)	VELAP,WVDEP
2,4-D	VELAP,WVDEP

Code	Description	Laboratory ID	Expires
MdDOE	Maryland DE Drinking Water	341	12/31/2021
NCDEQ	North Carolina DEQ	495	12/31/2021
NCDOH	North Carolina Department of Health	51714	07/31/2021
NJDEP	NELAC-New Jersey DEP	VA015	06/30/2021
NYDOH	New York DOH Drinking Water	12096	04/01/2021
PADEP	NELAC-Pennsylvania Certificate #006	68-03503	10/31/2021
VELAP	NELAC-Virginia Certificate #11064	460021	06/14/2021
WVDEP	West Virginia DEP	350	02/28/2021

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Summary of Data Qualifiers

P	Duplicate analysis does not meet the acceptance criteria for precision
S	Surrogate recovery was outside acceptance criteria
RPD	Relative Percent Difference
Qual	Qualifers
-RE	Denotes sample was re-analyzed
D.F.	Dilution Factor. Please also see the Preparation Factor in the Analysis Summary section.
TIC	Tentatively Identified Compounds are compounds that are identified by comparing the analyte mass spectral pattern with the NIST spectral library. A TIC spectral match is reported when the pattern is at least 75% consistent with the published pattern. Compound concentrations are estimated and are calculated using an internal standard response factor of 1.
PCBs, Total	Total PCBs are defined as the sum of detected Aroclors 1016, 1221, 1232, 1248, 1254, 1260, 1262, and 1268.

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RICHMOND, VIRGINIA 23237
(804) 358-8295 PHONE
(804)358-8297 FAX

Chain of Custody
Form #: F1331
Rev. 2.0
Effective: Jun 28, 2016

CHAIN OF CUSTODY

PAGE ___ OF ___

COMPANY NAME: Virginia Institute of Marine Science	INVOICE TO: Virginia Institute of Marine Science	PROJECT NAME: Shallo Water Dredging
CONTACT: Donna Milligan	INVOICE CONTACT: Donna Milligan	SITE NAME:
ADDRESS: 1370 Greate Road, Gloucester, VA 23062	INVOICE ADDRESS:	PROJECT NUMBER: Shallow Water Dredging
PHONE #: 804-684-7596	INVOICE PHONE #:	P.O. #:
FAX #:	EMAIL: milligan@vims.edu	Pretreatment Program:
Is sample for compliance reporting? YES NO	Is sample from a chlorinated supply? YES NO	PWS I.D. #:
SAMPLER NAME (PRINT):	SAMPLER SIGNATURE:	Turn Around Time: Circle: 10 (5) Days or __ Day(s)

Matrix Codes: WW=Waste Water/Storm Water GW=Ground Water DW=Drinking Water S=Soil/Solids OR=Organic A=Air WP=Wipe OT=Other________

ANALYSIS / (PRESERVATIVE)

CLIENT SAMPLE I.D.	Grab	Composite	Field Filtered (Dissolved Metals)	Composite Start Date	Composite Start Time	Grab Date or Composite Stop Date	Grab Time or Composite Stop Time	Time Preserved	Matrix (See Codes)	Number of Containers	Herb, Pest, Predetermination SVOC TCLP	TPH-DRO SW 8015	MBTEX SW 8021	PCB SW 8082	Percent Solids	TCLP Metals			COMMENTS
1) Davis Up Creek	X					02/04/21	12:42	13:00	S	2	|	|	|	|	|	|			
2) Davis Down Creek	X					02/04/21	13:07	13:00	S	2	|	|	|	|	|	|			
3) Winter Up Creek	X					02/08/21	11:10	14:00	S	2	|	|	|	|	|	|			
4) Winter Down Creek	X					02/08/21	11:30	14:00	S	2	|	|	|	|	|	|			
5) HITW Landward	X					02/04/21	10:30	15:00	S	2	|	|	|	|	|	|			
6) HITW Bayward	X					02/04/21	10:56	15:00	S	2	|	|	|	|	|	|			
7)																			
8)																			
9)																			#277 no seals mlk

COMMENTS:

Preservative Codes: N=Nitric Acid C=Hydrochloric Acid S=Sulfuric Acid H=Sodium Hydroxide A=Ascorbic Acid Z=Zinc Acetate T=Sodium Thiosulfate M=Methanol

PLEASE NOTE PRESERVATIVE(S), INTERFERENCE CHECKS or PUMP RATE (L/min)

RELINQUISHED:	DATE / TIME	RECEIVED:	DATE / TIME
[signature]	02/09/21 / 2:11	[signature]	2-9-21 14:11
RELINQUISHED:	DATE / TIME	RECEIVED:	DATE / TIME
RELINQUISHED:	DATE / TIME	RECEIVED:	DATE / TIME

QC Data Package
Level III ☐
Level IV ☐

LAB USE ONLY
COOLER TEMP 0.7 °C

21B0425
Virginia Institute of 21B0425
Shallow Water Dredging
Recd: 02/09/2021 Due: 02/16/2021
v130325002

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Submitted To:	Donna Milligan		
Client Site I.D.:	Shallow Water Dredging		

Sample Conditions Checklist

Samples Received at:	**0.70°C**
How were samples received?	Walk In
Were Custody Seals used? If so, were they received intact?	No
Are the custody papers filled out completely and correctly?	Yes
Do all bottle labels agree with custody papers?	Yes
Is the temperature blank or representative sample within acceptable limits or received on ice, and recently taken?	Yes
Are all samples within holding time for requested laboratory tests?	Yes
Is a sufficient amount of sample provided to perform the tests included?	Yes
Are all samples in appropriate containers for the analyses requested?	Yes
Were volatile organic containers received?	No
Are all volatile organic and TOX containers free of headspace?	NA
Is a trip blank provided for each VOC sample set? VOC sample sets include EPA8011, EPA504, EPA8260, EPA624, EPA8015 GRO, EPA8021, EPA524, and RSK-175.	NA
Are all samples received appropriately preserved? Note that metals containers do not require field preservation but lab preservation may delay analysis.	Yes

Work Order Comments

Appendix E

Draft Joint Permit Application

FOR AGENCY USE ONLY	
	Notes:
JPA#	

APPLICANTS

PLEASE PRINT OR TYPE ALL ANSWERS. If a question does not apply to your project, please print N/A (not applicable) in the space provided. ***If additional space is needed, attach extra 8 ½ x 11 inch sheets of paper.***

Check all that apply			
☐ Pre-Construction Notification (PCN) ☐ NWP # ________ ☐ RP # 05 (*For NWPs & RP 05 ONLY - No DEQ-VWP permit writer will be assigned*)	☐ SPGP	☐ DEQ Reapplication Existing permit number: ____________________	☐ Receiving federal funds Agency providing funding: ________________________
☐ Regional Permit 17 Checklist (RP-17)			

PREVIOUS ACTIONS RELATED TO THE PROPOSED WORK (Include all federal, state, and local pre application coordination, site visits, previous permits, or applications whether issued, withdrawn, or denied)				
Historical information for past permit submittals can be found online with VMRC - https://webapps.mrc.virginia.gov/public/habitat/ - or VIMS - http://ccrm.vims.edu/perms/newpermits.html				
Agency	Action / Activity	Permit/Project number, including any non-reporting Nationwide permits previously used (e.g., NWP 13)	Date of Action	If denied, give reason for denial

1. APPLICANT, AGENT, PROPERTY OWNER, AND CONTRACTOR INFORMATION **The applicant(s) is/are the legal entity to which the permit may be issued (see How to Apply at beginning of form). The applicant(s) can either be the property owner(s) or the person/people/company(ies) that intend(s) to undertake the activity. The agent is the person or company that is representing the applicant(s). If a company, please also provide the company name that is registered with the State Corporation Commission (SCC), or indicate no registration with the SCC.**	
Legal Name(s) of Applicant(s)	Agent (if applicable)
Mailing address	Mailing address
City / State / ZIP Code	City / State / ZIP Code
Phone number w/area code / Fax	Phone number w/area code / Fax
Mobile / E-mail	Mobile / E-mail
State Corporation Commission Name and ID number (if applicable)	State Corporation Commission Name and ID number (if applicable)
Certain permits or permit authorizations may be provided via electronic mail. If the applicant wishes to receive their permit via electronic mail, please provide an e-mail address here: ____	

1. APPLICANT, AGENT, PROPERTY OWNER, AND CONTRACTOR INFORMATION (Continued)	
Property owner(s) legal name, if different from applicant	Contractor, if known
Mailing address	Mailing address
City / State / ZIP code	City / State / ZIP code
Phone number w/area code / Fax	Phone number w/area code / Fax
Mobile / E-mail	Mobile / E-mail
State Corporation Commission Name and ID number (if applicable)	State Corporation Commission Name ID number (if applicable)

2. PROJECT LOCATION INFORMATION
(Attach a copy of a detailed map, such as a USGS topographic map or street map showing the site location and project boundary, so that it may be located for inspection. Include an arrow indicating the north direction. Include the drainage area if the SPGP box is checked on Page 7.)

Street Address (911 address if available)	City/County/ZIP Code Mathews County
Subdivision	Lot/Block/Parcel #

Name of water body(ies) within project boundaries and drainage area (acres or square miles).
Milford Haven and Chesapeake Bay

Tributary(ies) to: Milford Haven/Chesapeake Bay
Basin: ________________ Sub-basin: ________________
(*Example: Basin: James River Sub-basin: Middle James River*)

Special Standards (based on DEQ Water Quality Standards 9VAC25-260 et seq.): ________________

Project type (check one)
______ Single user (private, non-commercial, residential)
__X__ Multi-user (community, commercial, industrial, government)
______ Surface water withdrawal

Latitude and longitude at center of project site (decimal degrees): 37.46803° / -76.26539°
(Example: 37.33164/-77.68200)

USGS topographic map name: Mathews

8-digit USGS Hydrologic Unit Code (HUC) for your project site (See http://cfpub.epa.gov/surf/locate/index.cfm): 02080102
If known, indicate the 10-digit and 12-digit USGS HUCs (see http://consapps.dcr.virginia.gov/htdocs/maps/HUExplorer.htm) :
________________ 020801020303

Name of your project (*Example: Water Creek driveway crossing*) Hole in the Wall Channel

Is there an access road to the project? ☑Yes ☐No. If yes, check all that apply: ☑public ☐private ☐improved ☐unimproved

Total size of the project area (in acres): 27 acres of dredging at Hole in the Wall, 7.2 acres of beach fill placement at Haven Beach

2. PROJECT LOCATION INFORMATION (Continued)

Provide driving directions to your site, giving distances from the best and nearest visible landmarks or major intersections:

Take Rt 17 North from the Coleman Bridge to Gloucester Courthouse. Bear right onto Main St. Turn right onto Rt. 14. Follow Rt. 14 for 13.6 miles. Turn right onto Rt. 14/Rt. 198. Go 1.7 miles and at the hardee's go straight to stay on Rt. 198. Rt. 198 becomes Rt 642. Bear right onto Rt. 643, haven Beach Rd. Make a left at the T to stay on Rt. 643 then make a right. In 0.8 mile, turn left to stay on Rt. 643, then in 0.3 mile turn right to stay on Rt. 643. The road makes a hard left, then in 0.2 miles turn right to stay on Rt. 643. Go 0.7 mile to the end of the road to get to the Haven Beach placement site.

Does your project site cross boundaries of two or more localities (i.e., cities/counties/towns)? ☐ Yes ☑ No

If so, name those localities:

3. DESCRIPTION OF THE PROJECT, PROJECT PRIMARY AND SECONDARY *PURPOSES*, PROJECT *NEED*, INTENDED USE(S), AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

- The purpose and need must include any new development or expansion of an existing land use and/or proposed future use of residual land.
- Describe the physical alteration of surface waters, including the use of pilings (#, materials), vibratory hammers, explosives, and hydraulic dredging, when applicable, and *whether or not tree clearing will occur* (include the area in square feet and time of year).
- Include a description of alternatives considered and measures taken to avoid or minimize impacts to surface waters, including wetlands, to the maximum extent practicable. Include factors such as, but not limited to, alternative construction technologies, alternative project layout and design, alternative locations, local land use regulations, and existing infrastructure
- For utility crossings, include both alternative routes and alternative construction methodologies considered
- For surface water withdrawals, public surface water supply withdrawals, or projects that will alter in stream flows, include the water supply issues that form the basis of the proposed project.

This project consists of new dredging at Hole in the Wall with dredged material placement as beneficial use at Haven Beach. Dredging of The Hole in the Wall is necessary to allow safe navigation for vessels utilizing Milford Haven, particularly commercial fishing boats, recreational boats, and the US Coast Guard. The channel will be dredged to a maximum depth of -7 ft MLLW including allowable overdepth and non-pay depth. The proposed Hole in the Wall channel is 18,000 ft long and 150 ft wide and follows existing aids to navigation. Approximately 40,000 cy of material will be dredged. Dredged material placement will occur at Haven Beach in Mathews County. This public beach has a high erosion rate (-7 to -8 ft/yr). The beach protects the extensive marsh behind the barrier beach.

Date of proposed commencement of work (MM/DD/YYYY) ____________________	Date of proposed completion of work (MM/DD/YYYY) ____________________
Are you submitting this application at the direction of any state, local, or federal agency? _____Yes _____No	Has any work commenced or has any portion of the project for which you are seeking a permit been completed? _____ Yes __X__ No

If you answered "yes" to either question above, give details stating when the work was completed and/or when it commenced, who performed the work, and which agency (if any) directed you to submit this application. In addition, you will need to clearly differentiate between completed work and proposed work on your project drawings.

Are you aware of any unresolved violations of environmental law or litigation involving the property? _____Yes __X__No
(If yes, please explain)

4. PROJECT COSTS

Approximate cost of the entire project, including materials and labor: $ 1,130,000
Approximate cost of only the portion of the project affecting state waters (channelward of mean low water in tidal areas and below ordinary high water mark in nontidal areas): $ 1,130,000

5. PUBLIC NOTIFICATION (Attach additional sheets if necessary)

Complete information for all property owners adjacent to the project site and across the waterway, if the waterway is less than 500 feet in width. If your project is located within a cove, you will need to provide names and mailing addresses for all property owners within the cove. If you own the adjacent lot, provide the requested information for the first adjacent parcel beyond your property line. Per Army Regulation (AR 25-51) outgoing correspondence must be addressed to a person or business.
Failure to provide this information may result in a delay in the processing of your application by VMRC.

Property owner's name	Mailing address	City	State	ZIP code
Mathews County Land Conservancy	P.O. Box 306	Mathews	VA	23109
Richard Cardwell, IV	7108 Club Vista Lane	Richmond	VA	23229
Charles E. Argenzio Family	#70 Raft Island	Gig Harbor	WA	98335
Jonathan&David Kinney	2311 Wilson Blvd, Suite 500	Arlington	VA	22201
J. & M. Chisenhall	3100 Larkwood Rd.	Quinton	VA	23141
R.E. Bushnell & Sung-Yun Kang	200 N. Rolling R.	Catonsville	MD	21228

Name of newspaper having general circulation in the area of the project: Gloucester-Mathews Gazette-Journal
Address and phone number (including area code) of newspaper________________________________

Have adjacent property owners been notified with forms in Appendix A? _____Yes _____No (attach copies of distributed forms)

6. THREATENED AND ENDANGERED SPECIES INFORMATION

Please provide any information concerning the potential for your project to impact state and/or federally threatened and endangered species (listed or proposed). Attach correspondence from agencies and/or reference materials that address potential impacts, such as database search results or confirmed waters and wetlands delineation/jurisdictional determination. Include information when applicable regarding the location of the project in Endangered Species Act-designated or -critical habitats. Contact information for the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Virginia Dept. of Game and Inland Fisheries, and the Virginia Dept. of Conservation and Recreation-Division of Natural Heritage can be found on page 4 of this package.

7. HISTORIC RESOURCES INFORMATION

Note: Historic properties include but are not limited to archeological sites, battlefields, Civil War earthworks, graveyards, buildings, bridges, canals, etc. Prospective permittees should be aware that section 110k of the NHPA (16 U.S.C. 470h-2(k)) prevents the USACE from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of Section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the USACE, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant.

Are any historic properties located within or adjacent to the project site? ____ Yes __X__ No _____ Uncertain
If Yes, please provide a map showing the location of the historic property within or adjacent to the project site.

Are there any buildings or structures 50 years old or older located on the project site? ____ Yes __X__ No _____ Uncertain
If Yes, please provide a map showing the location of these buildings or structures on the project site.

Is your project located within a historic district? ____ Yes __X__ No ____ Uncertain

If Yes, please indicate which district: ________________________________

7. HISTORIC RESOURCES INFORMATION (Continued)

Has a survey to locate archeological sites and/or historic structures been carried out on the property?
___ Yes _x__ No ___ Uncertain

If Yes, please provide the following information: Date of Survey: ___________________________________

Name of firm: ____

Is there a report on file with the Virginia Department of Historic Resources? ____ Yes _X___ No ___Uncertain

Title of Cultural Resources Management (CRM) report: ____

Was any historic property located? ____ Yes ____ No __ Uncertain

8. WETLANDS, WATERS, AND DUNES/BEACHES IMPACT INFORMATION

Report each impact site in a separate column. If needed, attach additional sheets using a similar table format. Please ensure that the associated project drawings clearly depict the location and footprint of each numbered impact site. For dredging, mining, and excavating projects, use Section 17.

	Impact site number 1	Impact site number 2	Impact site number 3	Impact site number 4	Impact site number 5
Impact description (use all that apply): F=fill EX=excavation S=Structure T=tidal NT=non-tidal TE=temporary PE=permanent PR=perennial IN=intermittent SB=subaqueous bottom DB=dune/beach IS=hydrologically isolated V=vegetated NV=non-vegetated MC=Mechanized Clearing of PFO (*Example: F, NT, PE, V*)	EX, T, PE, SB	F, NT, DB			
Latitude / Longitude (in decimal degrees)	37.46803°, -76.26539°	37.435923°, -76.252769°			
Wetland/waters impact area (square feet / acres)	27				
Dune/beach impact area (square feet)		7.2			
Stream dimensions at impact site (length and average width in linear feet, and area in square feet)					
Volume of fill below Mean High Water or Ordinary High Water (cubic yards)					

8. WETLANDS/WATERS IMPACT INFORMATION (Continued)

Cowardin classification of impacted wetland/water or geomorphological classification of stream *Example wetland: PFO; Example stream: 'C' channel and if tidal, whether vegetated or non-vegetated wetlands per Section 28.2-1300 of the Code of Virginia*	E1UBL				
Average stream flow at site (flow rate under normal rainfall conditions in cubic feet per second) and method of deriving it (gage, estimate, etc.)					
Contributing drainage area in acres or square miles (*VMRC cannot complete review without this information*)	<15 sq miles				
DEQ classification of impacted resource(s): Estuarine Class II Non-tidal waters Class III Mountainous zone waters Class IV Stockable trout waters Class V Natural trout waters Class VI Wetlands Class VII https://law.lis.virginia.gov	Estuarine Class II				

For DEQ permitting purposes, also submit as part of this section a wetland and waters boundary delineation map – see (3) in the Footnotes section in the form instructions.

For DEQ permitting purposes, also submit as part of this section a written disclosure of all wetlands, open water, or streams that are located within the proposed project or compensation areas that are also under a deed restriction, conservation easement, restrictive covenant, or other land-use protective instrument.

9. APPLICANT, AGENT, PROPERTY OWNER, AND CONTRACTOR CERTIFICATIONS

READ ALL OF THE FOLLOWING CAREFULLY BEFORE SIGNING

PRIVACY ACT STATEMENT: The Department of the Army permit program is authorized by Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act, and Section 103 of the Marine Protection Research and Sanctuaries Act of 1972. These laws require that individuals obtain permits that authorize structures and work in or affecting navigable waters of the United States, the discharge of dredged or fill material into waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters prior to undertaking the activity. Information provided in the Joint Permit Application will be used in the permit review process and is a matter of public record once the application is filed. Disclosure of the requested information is voluntary, but it may not be possible to evaluate the permit application or to issue a permit if the information requested is not provided.

CERTIFICATION: I am hereby applying for permits typically issued by the DEQ, VMRC, USACE, and/or Local Wetlands Boards for the activities I have described herein. I agree to allow the duly authorized representatives of any regulatory or advisory agency to enter upon the premises of the project site at reasonable times to inspect and photograph site conditions, both in reviewing a proposal to issue a permit and after permit issuance to determine compliance with the permit.

In addition, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

9. APPLICANT, AGENT, PROPERTY OWNER, AND CONTRACTOR CERTIFICATIONS (Continued)

Is/Are the Applicant(s) and Owner(s) the same? ☐ *Yes* ☐ *No*

Legal name & title of Applicant	Second applicant's legal name & title, if applicable
Applicant's signature	Second applicant's signature
Date	Date
Property owner's legal name, if different from Applicant	Second property owner's legal name, if applicable
Property owner's signature, if different from Applicant	Second property owner's signature
Date	Date

CERTIFICATION OF AUTHORIZATION TO ALLOW AGENT(S) TO ACT ON APPLICANT'S(S') BEHALF (IF APPLICABLE)

I (we), ____________________________________ (and) _________________________________ ,
APPLICANT'S LEGAL NAME(S) – *complete the second blank if more than one Applicant*

hereby certify that I (we) have authorized ______________________________ (and) ________________________________
AGENT'S NAME(S) – *complete the second blank if more than one Agent*
to act on my (our) behalf and take all actions necessary to the processing, issuance, and acceptance of this permit and any and all standard and special conditions attached. I (we) hereby certify that the information submitted in this application is true and accurate to the best of my (our) knowledge.

Applicant's signature	Second applicant's signature, if applicable
Date	Date
Agent's signature and title	Second agent's signature and title, if applicable
Date	Date

CONTRACTOR ACKNOWLEDGEMENT (IF APPLICABLE)

I (we), ____ (and) ____ ,
APPLICANT'S LEGAL NAME(S) – *complete the second blank if more than one Applicant*

have contracted _______________________________________ (and) _______________________________________
CONTRACTOR'S NAME(S) – *complete the second blank if more than one Contractor*

to perform the work described in this Joint Permit Application, signed and dated ___________________________________.

I (we) will read and abide by all conditions as set forth in all federal, state, and local permits as required for this project. I (we) understand that failure to follow the conditions of the permits may constitute a violation of applicable federal, state, and local statutes and that we will be liable for any civil and/or criminal penalties imposed by these statutes.
In addition, I (we) agree to make available a copy of any permit to any regulatory representative visiting the project site to ensure permit compliance. If I (we) fail to provide the applicable permit upon request, I (we) understand that the representative will have the option of stopping our operation until it has been determined that we have a properly signed and executed permit and are in full compliance with all of the terms and conditions.

Contractor's name or name of firm (printed/typed)	Contractor's or firm's mailing address	
Contractor's signature and title	Contractor's license number	Date
Applicant's signature	Second applicant's signature, if applicable	
Date	Date	

15. TIDAL/NONTIDAL SHORELINE STABILIZATION STRUCTURES (INCLUDING BULKHEADS AND ASSOCIATED BACKFILL, RIPRAP REVETMENTS AND ASSOCIATED BACKFILL, MARSH TOE STABILIZATION, GROINS, JETTIES, AND BREAKWATERS, ETC.)

Information on non structural, vegetative alternatives (i.e., Living Shoreline) for shoreline stabilization is available at http://ccrm.vims.edu/coastal_zone/living_shorelines/index.html.

Is any portion of the project maintenance or replacement of an existing and currently serviceable structure? _____Yes _____No
If yes, give length of existing structure: __________ linear feet

If your maintenance project entails replacement of a bulkhead, is it possible to construct the replacement bulkhead within 2 feet channelward of the existing bulkhead? _____Yes _____No If not, please explain below:

Length of proposed structure, including returns: _______________linear feet

*Average c*hannelward encroachment of the structure from Mean high water/ordinary high water mark: ____________ feet Mean low water: _____________feet	*Maximum c*hannelward encroachment of the structure from Mean high water/ordinary high water mark: xx___________ feet Mean low water: _____________feet
Maximum channelward encroachment form the back edge of the Dune ________feet	*Maximum* channelward encroachment from the back edge of the Beach _________feet

Describe the type of construction including all materials to be used (including all fittings). Will filter cloth be used? ____Yes ____No

What is the source of the backfill material? ________________

What is the composition of the backfill material? ____

If rock is to be used, give the average volume of material to be used for every linear foot of construction: ___________cubic yards
What is the volume of material to be placed below the plane of ordinary high water mark/mean high water? ___________cubic yards

For projects involving stone:
Average weight of core material (bottom layers): ___________pounds per stone (Class________)
Average weight of armor material (top layers): _____________pounds per stone (Class________)

Are there similar shoreline stabilization structures in the vicinity of your project site? _____Yes _____No
If so, describe the type(s) and location(s) of the structure(s):

If you are building a groin or jetty, will the channelward end of the structure be marked to show a hazard to navigation? _____Yes _____No	Has your project been reviewed by the Shoreline Erosion Advisory Service (SEAS)? _____Yes x_____No If yes, please attach a copy of their comments.

16. BEACH NOURISHMENT

Source of material and composition (percentage sand, silt, clay): ____	Volume of material: _______________________cubic yards

Area to be covered _________ square feet channelward of mean low water ________square feet channelward of mean high water

_________ square feet landward of mean low water __________square feet channelward of mean high water

Mode of transportation of material to the project site (truck, pipeline, etc.):

16. BEACH NOURISHMENT (Continued)

Describe the type(s) of vegetation proposed for stabilization and the proposed planting plan, including schedule, spacing, monitoring, etc. Attach additional sheets if necessary.

17. DREDGING, MINING, AND EXCAVATING

FILL OUT THE FOLLOWING TABLE FOR DREDGING PROJECTS

	NEW dredging				**MAINTENANCE dredging**			
	Hydraulic		Mechanical (clamshell, dragline, etc.)		Hydraulic		Mechanical (clamshell, dragline, etc.)	
	Cubic yards	Square feet	Cubic yards	Square feet	Cubic yards	Square feet	Cubic yards	Square feet
Vegetated wetlands								
Non-vegetated wetlands								
Subaqueous land	26							
Totals	26							

Is this a one-time dredging event? X Yes _____ No If "no", how many dredging cycles are anticipated: ____________________
(____ initial cycle in cu. yds.) (_____ subsequent cycles in cu. yds.)

Composition of material (percentage sand, silt, clay, rock):
Provide documentation (i.e., laboratory results or analytical reports) that *dredged* material from on-site areas is free of toxics. If not free of toxics, provide documentation of proper disposal (i.e., bill of lading from commercial supplier or disposal site).

94-99% sand with a D50 of 0.2 to 0.3 mm. Hole in the Wall is a small channel through eroding barrier islands in rural Mathews County far removed from the sources of industrial contamination. Dredge material is recently shoaled sediments migrating through the littoral system. Sands do not exhibit affinity to bind with organic contaminants.

Please include a dredged material management plan that includes specifics on how the dredged material will be handled and retained to prevent its entry into surface waters or wetlands. If on-site dewatering is proposed, please include plan view and cross-sectional drawings of the dewatering area and associated outfall.

A turbidity curtain will be used at Haven Beach will material is placed along the shoreline.

Will the dredged material be used for any commercial purpose or beneficial use? x_____Yes _____No
If yes, please explain:

Haven Beach is a local public beach that is highly utilized by the citizens of Mathews County. The shoreline has a high erosion rate. As the shore erodes, so to does the marsh complex behind the beach. Two breakwaters occur on site. The dredge material will create a wide recreational beach that will be resilient to sea level rise and provide protection to State Route 643.

If this is a maintenance dredging project, what was the date that the dredging was last performed? ________________________
Permit number of original permit: _______________________ *(It is important that you attach a copy of the original permit.)*

17. DREDGING, MINING, AND EXCAVATING (Continued)	
For mining projects: On separate sheets of paper, explain the operation plans, including: 1) the frequency (e.g., every six weeks), duration (i.e., April through September), and volume (in cubic yards) to be removed per operation; 2) the temporary storage and handling methods of mined material, including the dimensions of the containment berm used for upland disposal of dredged material and the need (or no need) for a liner or impermeable material to prevent the leaching of any identified contaminants into ground water; 3) how equipment will access the mine site; and 4) verification that dredging: a) will not occur in water body segments that are currently on the effective Section 303(d) Total Maximum Daily Load (TMDL) priority list (available at http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/TMDL/TMDLDevelopment/TMDLProgramPriorities.aspx) or that have an approved TMDL; b) will not exacerbate any impairment; and c) will be consistent with any waste load allocation/limit/conditions imposed by an approved TMDL (see, "What's in my backyard" or subsequent spatial files at http://www.deq.virginia.gov/ConnectWithDEQ/VEGIS.aspx to determine the extent of TMDL watersheds and impairment segments). *Have you applied for a permit from the Virginia Department of Mines, Minerals and Energy?* _____Yes _____No If Yes: Existing permit number:______________________ Date permit issued: ________________	
Contributing drainage area: __________square miles	Average stream flow at site (flow rate under normal rainfall conditions): _______________cfs

18. FILL (not associated with backfilled shoreline structures) AND OTHER STRUCTURES (other than piers and boathouses) IN WETLANDS OR WATERS, OR ON DUNES/BEACHES	
Source and composition of fill material (percentage sand, silt, clay, rock): ____ Provide documentation (i.e., laboratory results or analytical reports) that *fill* material from *off-site* locations is free of toxics. If not free of toxics, provide documentation of proper disposal (i.e., bill of lading from commercial supplier or disposal site). Documentation is not necessary for fill material obtained from on-site areas.	
Explain the purpose of the filling activity and the type of structure to be constructed over the filled area (if any):	
Describe any structure that will be placed in wetlands/waters or on a beach dune and its purpose:	
Will the structure be placed on pilings? ____ Yes ____ No	Total area occupied by any structure. ___________ Square Feet
How far will the structure be placed channelward from the back edge of the dune? ______feet	How far will the structure be placed channelward from the back edge of the beach? ________feet

19. NONTIDAL STREAM CHANNEL MODIFICATIONS FOR RESTORATION OR ENHANCMENT, or TEMPORARY OR PERMANENT RELOCATIONS
If proposed activities are being conducted for the purposes of compensatory mitigation, please attach separate sheets of paper providing all information required by the most recent version of the stream assessment methodology approved by the Norfolk District of the U.S. Army Corps of Engineers and the Virginia Department of Environmental Quality, in lieu of completing the questions below. Required information outlined by the methodology can be found at: http://www.nao.usace.army.mil/Missions/Regulatory/UnifiedStreamMethodology.aspx *or* http://www.deq.virginia.gov/Programs/Water/WetlandsStreams/Mitigation.aspx. *For all projects proposing stream restoration provide a completed Natural Channel Design Review Checklist and Selected Morphological Characteristics form. These forms and the associated manual can be located at:* https://www.fws.gov/chesapeakebay/StreamReports/NCD%20Review%20Checklist/Natural%20Channel%20Design%20Checklist%20Doc%20V2%20Final%2011-4-11.pdf
Has the stream restoration project been designed by a local, state, or federal agency? ____ Yes ____ No. If yes, please include the name of the agency here: ____. Is the agency also providing funding for this project? _____ Yes _____ No
Stream dimensions at impact site (length and average width in linear feet, and area in square feet): L: _________(feet) AW:_________ (feet) Area:___________ (square feet)
Contributing drainage area: __________acres *or* __________square miles

APPENDIX A

Adjacent Property Owner's Acknowledgement Form

I, ____, own land next to/ across the water from/ in the same cove
(print adjacent property owner's name)

as the land of ____.
(print applicant's name)

I have reviewed the applicant's project drawings dated ____ to be submitted for all
(date of drawings)

necessary federal, state, and local permits.

_____ I have no comment regarding the proposal

_____ I do not object to the proposal

_____ I object to the proposal

The applicant has agreed to contact me for additional comments if the proposal changes prior to construction of the project.

(Before signing this form, please be sure that you have checked the appropriate option above)

____
Adjacent property owner's signature

____
Date

NOTE: IF YOU OBJECT TO THE PROPOSAL, THE REASON(S) YOU OPPOSE THE PROJECT MUST BE SUBMITTED TO VMRC IN WRITING. AN OBJECTION WILL NOT NECESSARILY RESULT IN A DENIAL OF A PERMIT FOR THE PROPOSED WORK. HOWEVER, VALID COMPLAINTS WILL BE GIVEN FULL CONSIDERATION DURING THE PERMIT REVIEW PROCESS.

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APPENDIX C

Chesapeake Bay Preservation Act Information

Please answer the following questions to determine if your project is subject to the requirements of the Bay Act Regulations:

1. Is your project located within Tidewater Virginia? _X__Yes ____No (See map on page 31) - If the answer is "no", the Bay Act requirements do not apply; if "yes", then please continue to question #2.

2. Please indicate if the project proposes to impact any of the following Resource Protection Area (RPA) features:

____ Tidal wetlands,

____ Nontidal wetlands connected by surface flow and contiguous to tidal wetlands or water bodies with perennial flow,

____ Tidal shores,

____ Other lands considered by the local government to meet the provisions of subsection A of 9VAC25-830-80 and to be necessary to protect the quality of state waters (contact the local government for specific information),

____ A buffer area not less than 100 feet in width located adjacent to and landward of the components listed above, and along both sides of any water body with perennial flow.

If the answer to question #1 was "yes" and any of the features listed under question #2 will be impacted, compliance with the Chesapeake Bay Preservation Area Designation and Management Regulations is required. **The Chesapeake Bay Preservation Area Designation and Management Regulations** are enforced through locally adopted ordinances based on the Chesapeake Bay Preservation Act (CBPA) program. Compliance with state and local CBPA requirements mandates the submission of a ***Water Quality Impact Assessment (WQIA)*** for the review and approval of the local government. Contact the appropriate local government office to determine if a WQIA is required for the proposed activity(ies).

The individual localities, <u>not</u> the DEQ, USACE, or the Local Wetlands Boards, are responsible for enforcing the CBPA requirements and, therefore, local permits for land disturbance are not issued through this JPA process. **Approval of this wetlands permit does not constitute compliance with the CBPA regulations nor does it guarantee that the local government will grant approval for encroachments into the RPA that may result from this project.**

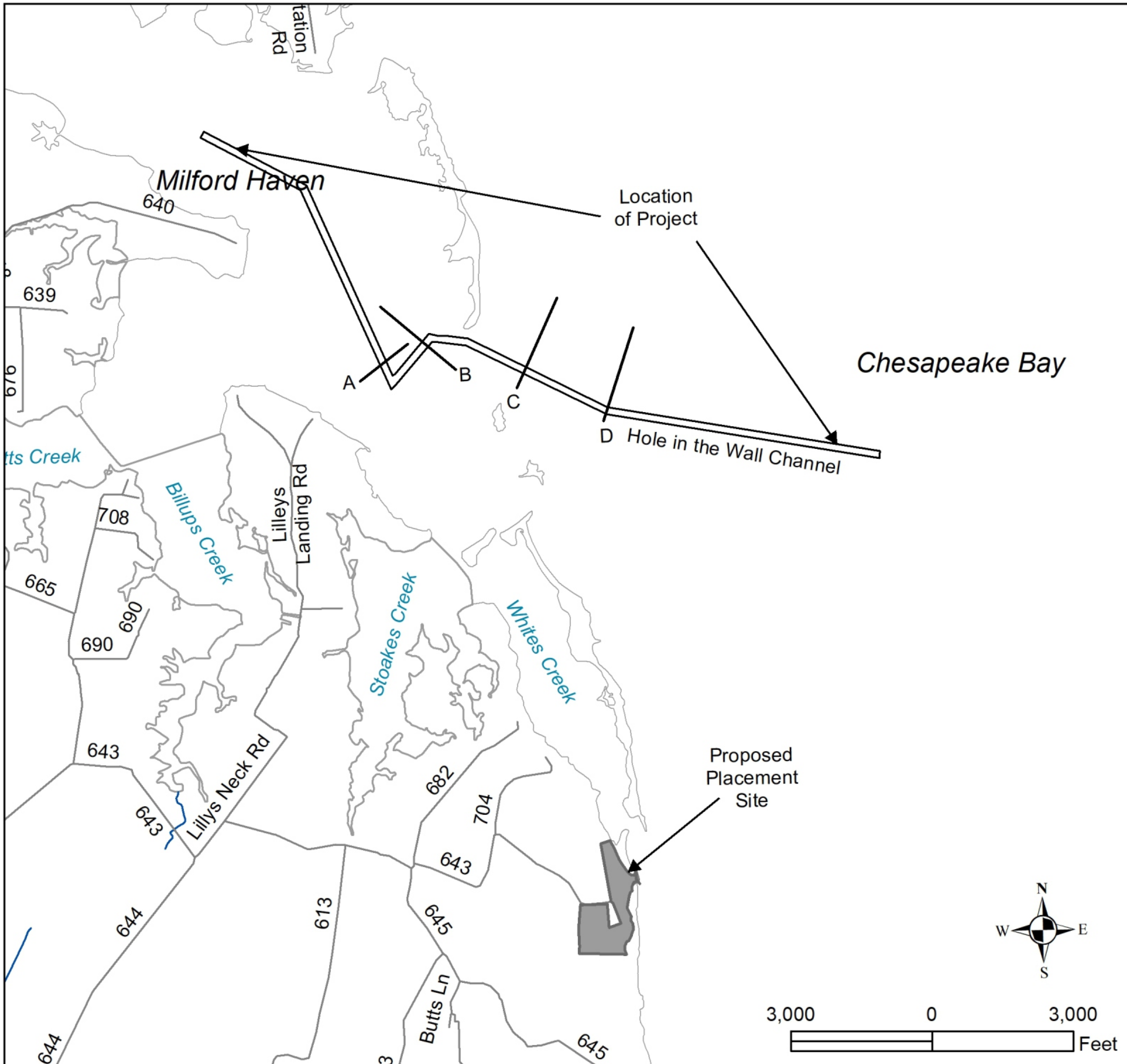
<u>Notes for all projects in RPAs</u>
Development, redevelopment, construction, land disturbance, or placement of fill within the RPA features listed above requires the approval of the locality and may require an exception or variance from the local Bay Act ordinance. Please contact the appropriate local government to determine the types of development or land uses that are permitted within RPAs.

Pursuant to 9VAC25-830-110, *on-site delineation of the RPA is required for all projects in CBPAs*. Because USGS maps are not always indicative of actual "in-field" conditions, they may not be used to determine the site-specific boundaries of the RPA.

<u>Notes for shoreline erosion control projects in RPAs</u>
Re-establishment of woody vegetation in the buffer will be required by the locality to mitigate for the removal or disturbance of buffer vegetation associated with your proposed project. Please contact the local government to determine the mitigation requirements for impacts to the 100-foot RPA buffer.

Pursuant to 9VAC25-830-140 5 a (4) of the Virginia Administrative Code, shoreline erosion projects are a permitted modification to RPAs provided that the project is based on the "best technical advice" and complies with applicable permit conditions. In accordance with 9VAC25-830-140 1 of the Virginia Administrative Code, the locality will use the information provided in this Appendix, in the project drawings, in this permit application, and as required by the locality, to make a determination that:

1. Any proposed shoreline erosion control measure is necessary and consistent with the nature of the erosion occurring on the site, and the measures have employed the "best available technical advice"
2. Indigenous vegetation will be preserved to the maximum extent practicable
3. Proposed land disturbance has been minimized
4. Appropriate mitigation plantings will provide the required water quality functions of the buffer (9VAC25-830-140 3)
5. The project is consistent with the locality's comprehensive plan
6. Access to the project will be provided with the minimum disturbance necessary.



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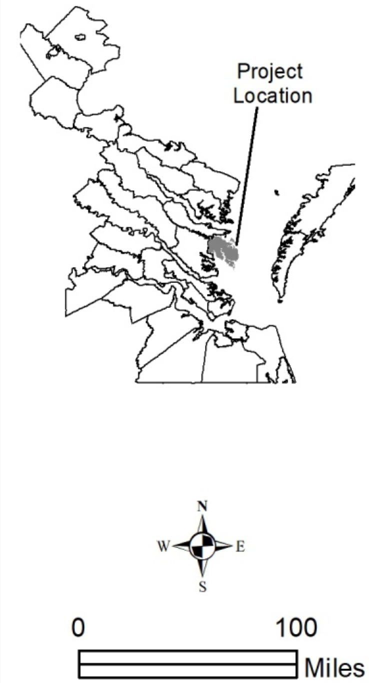
VIRGINIA INSTITUTE OF MARINE SCIENCE
Shoreline Studies Program



Virginia Institute of Marine Science
Gloucester County, Virginia

COVERSHEET

Hole in the Wall Channel
Mathews County
Virginia

SCALE: AS SHOWN ON SHEET
December 2020
Sheet: 1 of 6

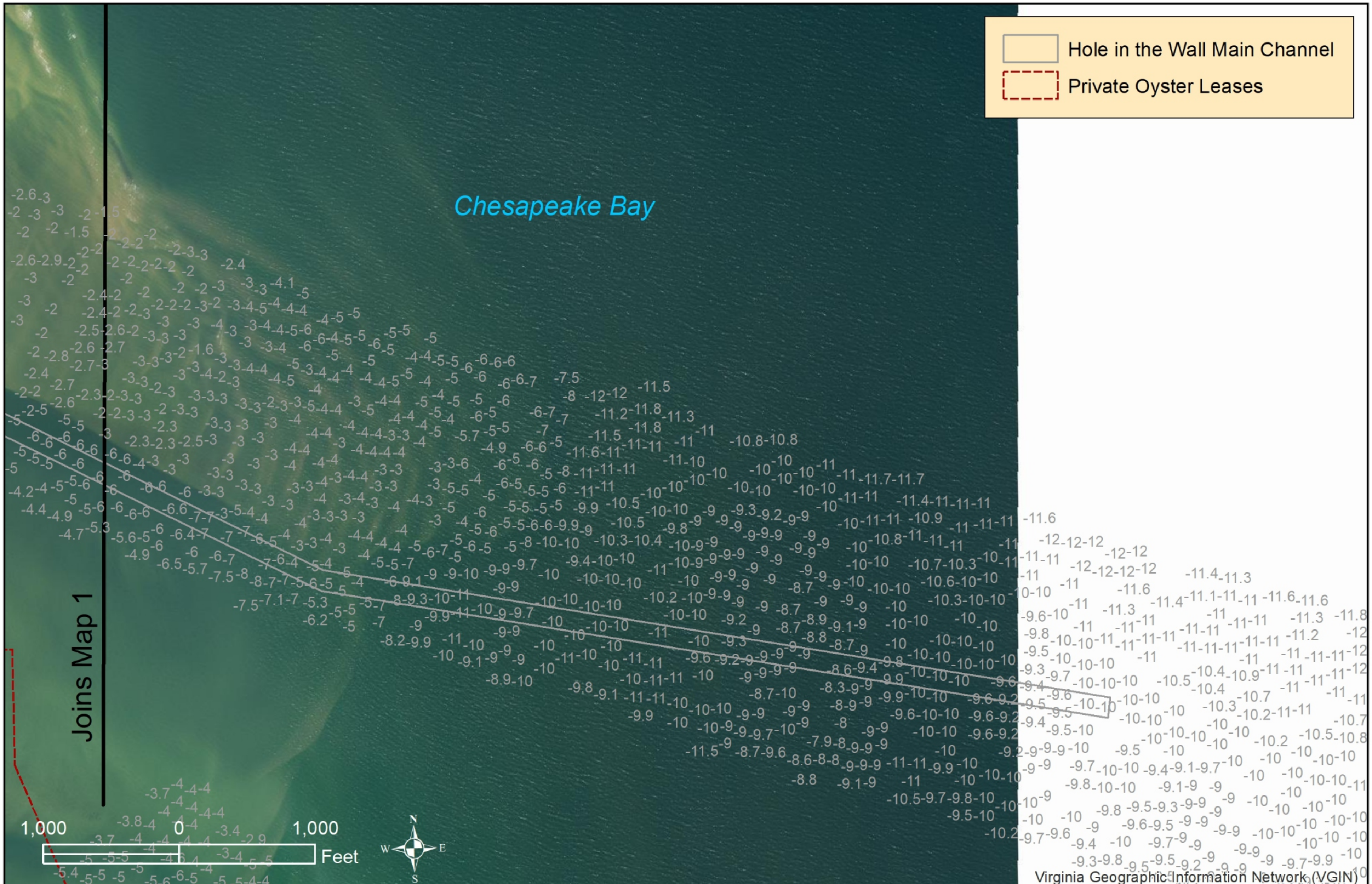
EXISTING CONDITIONS MAP 1

HOLE IN THE WALL
MATHEWS COUNTY, VIRGINIA

SCALE: AS SHOWN

Shoreline Studies Program VIMS

December 2020



EXISTING CONDITIONS MAP 2

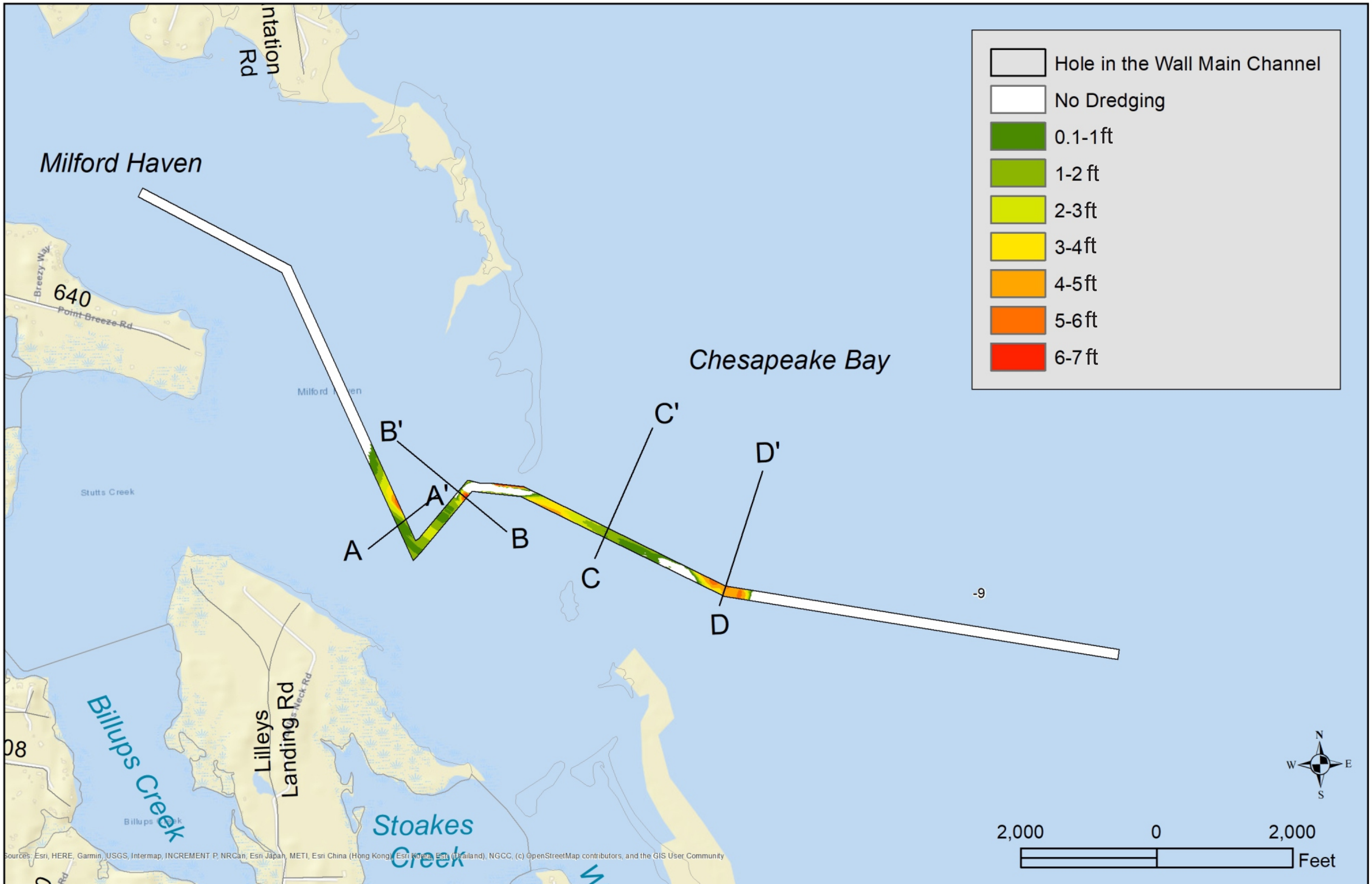
HOLE IN THE WALL
MATHEWS COUNTY, VIRGINIA

SCALE: AS SHOWN

Shoreline Studies Program
VIMS

December 2020

Sheet: 3 of 6



EXISTING CONDITIONS

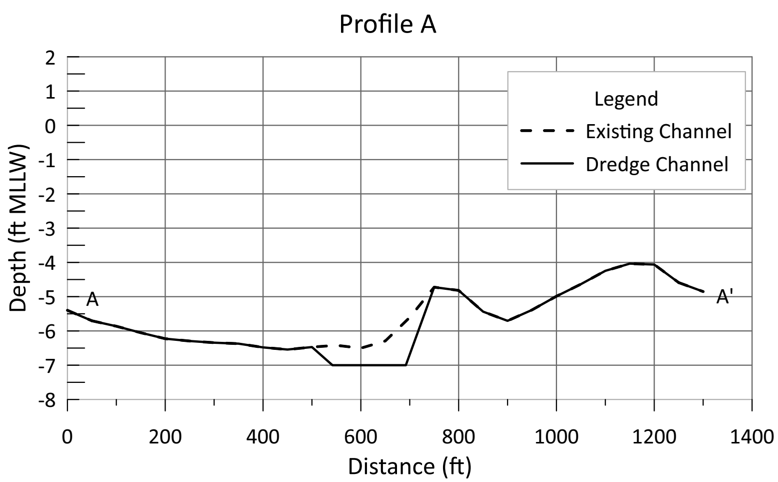
HOLE IN THE WALL
MATHEWS COUNTY, VIRGINIA

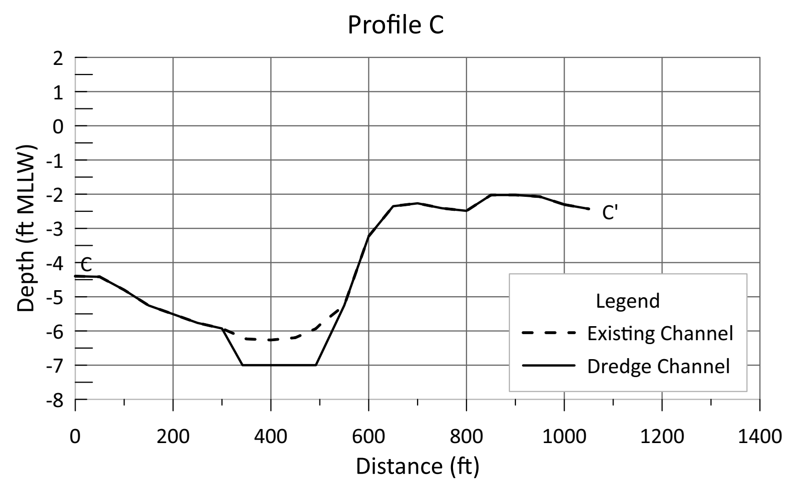
SCALE: AS SHOWN

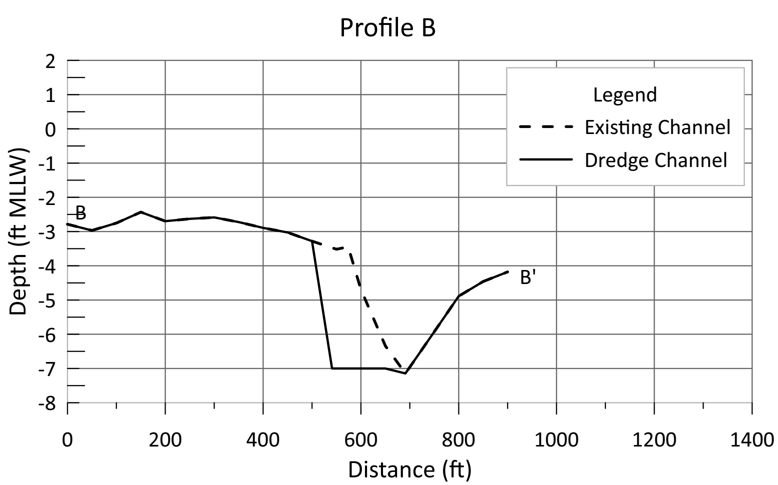
Shoreline Studies Program VIMS

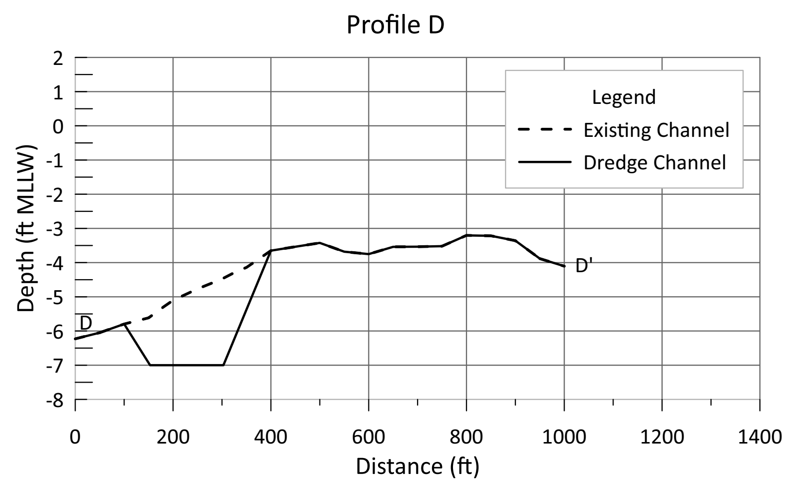
December 2020

Sheet: 4 of 6





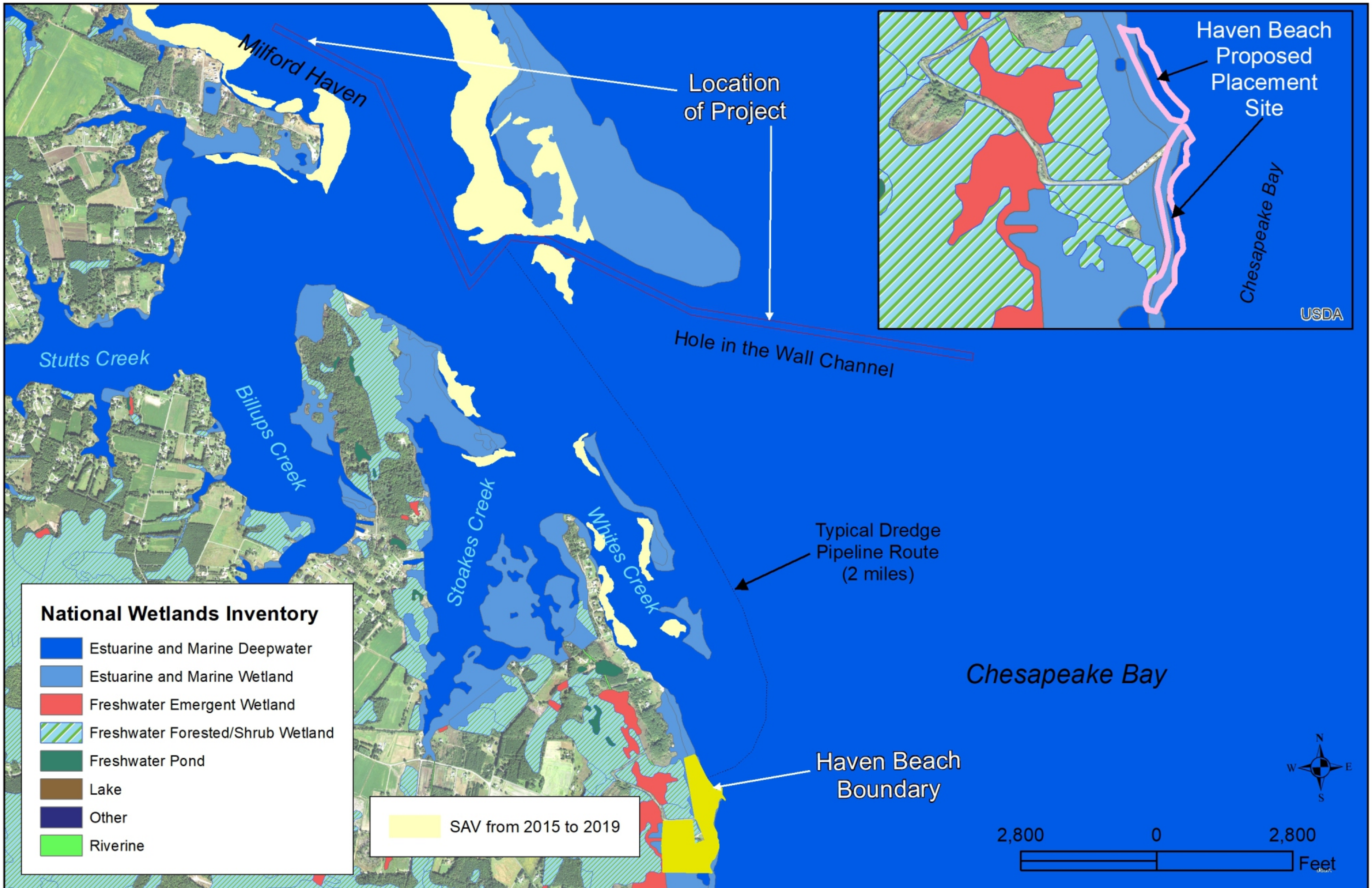




CROSS-SECTIONS
Hole in the Wall Channel
Mathews County, Virginia

Scale: As Shown

December 2020



PROPOSED PLACEMENT SITE

HOLE IN THE WALL
MATHEWS COUNTY, VIRGINIA

SCALE: AS SHOWN Image: NAIP 2018

December 2020 Sheet: 6 of 6

Appendix F

Hydrodynamic Modeling

Methods and Results Report

Hydrodynamic Modeling Study for Milford Haven

Jilian Xiong, Qubin Qin, Jian Shen

Virginia Institute of Marine Science

1. Method

1.1 The SCHISM model setup for base and dredging scenarios

The 3D unstructured-grid (UG) SCHISM (Semi-Implicit Cross-scale Hydroscience Integrated System Model) model (Zhang et al. 2016) is used to simulate the hydrodynamics in the project area. SCHISM is an open-source, community-supported model system, based on the unstructured grids in the horizontal and a very flexible coordinate system in the vertical. The present model domain has 36,093 nodes and 66,732 mixed triangular-quadrangular elements in the horizontal dimension for Scenario 1 (Fig. 1), with resolution varying from ~20 m to 1 km, and finer resolution used in Milford Haven. A flexible LSC^2 (Localized Sigma Coordinates with Shaved Cells) vertical grid (Zhang et al. 2015) is used to cover depths from deep to shallow regions effectively, with a maximum of 12 vertical layers used at the maximum depth of ~17 m and a minimum of 1 layer for the shallow area. The main bathymetry source is from NOAA Booklet Chart (https://charts.noaa.gov/InteractiveCatalog/nrnc.shtml#mapTabs-1) and the surveyed bathymetry data provided by Waterway Surveys & Engineering as referenced in the main section of the report.

The model is forced by the non-point freshwater discharge from the Phase 6 Chesapeake Bay Watershed Model (https://cast.chesapeakebay.net/). At the air-water interface, the model is forced by the wind, atmospheric pressure, and heat fluxes predicted by NARR (https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-regional-reanalysis-narr). At the open boundary, the elevation, salinity, and velocity boundary conditions are interpolated from the larger domain of the EFDC Chesapeake Bay model (Hong and Shen, 2012). Four scenarios are proposed for the dredging project (Table 1), thus, four grids are developed correspondingly (Fig. 2), with the quadrangular grids following the proposed dredging channels. The model scenarios included an 80 ft and 150 ft main channel and with and without advance lateral maintenance dredging along the northern side of the channel. We ran two cases for each scenario: the one with original bathymetry and the one with modified bathymetry, to compare the variations in dynamics before and after dredging. The model grids for scenerios are not exactely the same due to channel configuration for model simulations as shown in Fig. 2. Two location points were selected for showing and comparing the time series of bottom shear stress. Point 1 is in the “Hole in the Wall” on the channel and Point 2 is farther along the channel on the Chesapeake Bay side.

For model calibration, we utilize available observational data from Virginia Estuarine and Coastal Observing System (VECOS, http://vecos.vims.edu/) and EPA’s Chesapeake Bay Program (https://www.chesapeakebay.net/what/downloads/cbp_water_quality_database_1984_present). Fig. 3 shows the names and locations of these stations, where basic hydrodynamic variables (elevation, salinity, and temperature) are measured. The year 2006 was chosen as the simulation period because of the availability of most observational data.

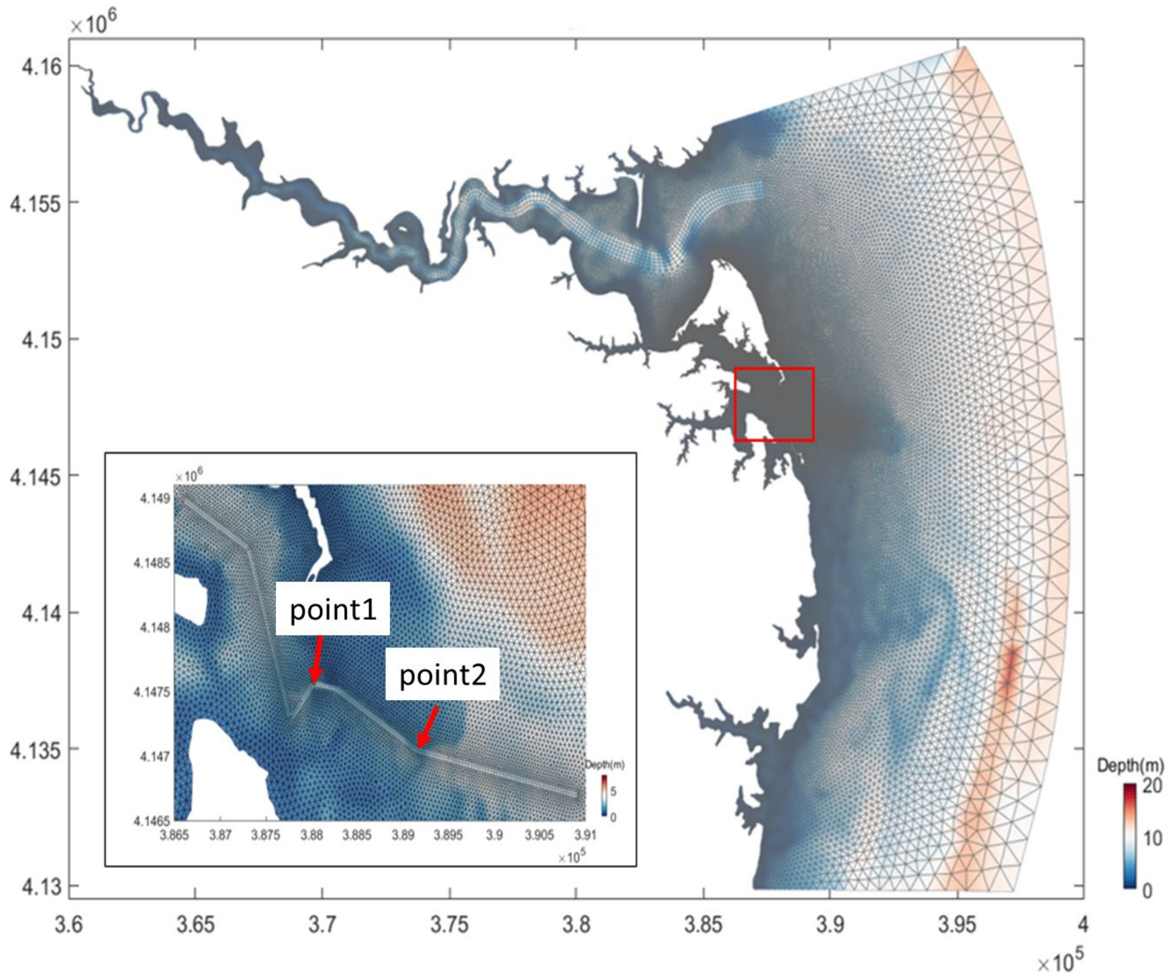


Fig. 1 Domain extent and the computational grid for the base run for Scenario 1, with inserted zoom-in figure near Milford Haven and the two selected location points for comparison.

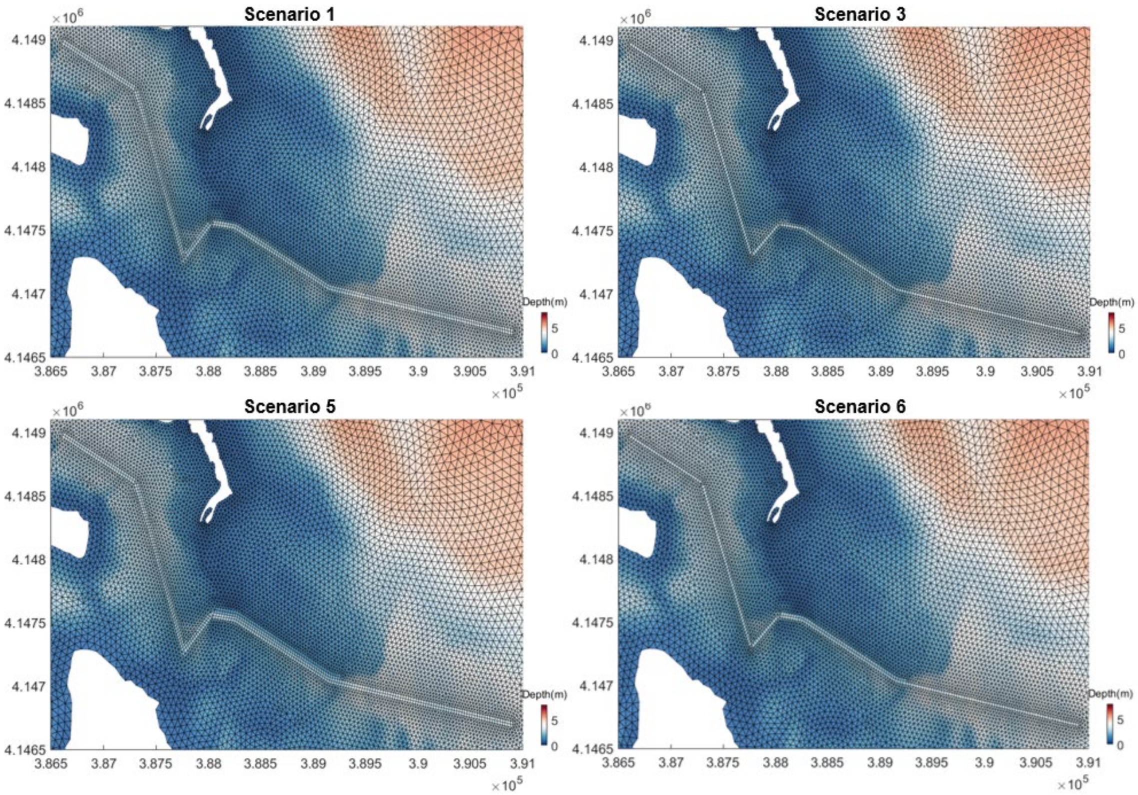


Fig. 2 Grids design for each scenario, with the horizontal quadrangular elements following the proposed dredging channels.

Table 1. Dredging details for each scenario

Dredging Scenario	Width (W) and depth (D) of dredging channels
Scenario 1	W = 150 feet; D = 7.9 feet
Scenario 3	W = 80 feet; D = 7.9 feet
Scenario 5	W1 = 150 feet; D1 = 7.9 feet; W2 = 150 feet; D2 = 5.9 feet
Scenario 6	W1 = 80 feet; D1 = 7.9 feet; W2 = 80 feet; D2 = 5.9 feet

*D1, D2, W1, and W2 refer to depths and widths of two parallel channels, respectively. Scenarios 5 and 6 have the main channel as well as a slightly shallower area dredged as advance maintenance north of the main channel just in the shoaling region.

Fig. 3 Observation stations used in this report. Site LE3.7 includes salinity and temperature data from Chesapeake Bay Program; Site PNK002 includes elevation, salinity, and temperature data from Virginia Estuarine and Coastal Observing System (VECOS).

1.2 Calibrations for the base case of Scenario 1

We used the simulation results from the base run with the grid of Scenrio 1 for model calibration. Base runs for other scenerios are almost identical to scenerio 1 with slight difference in the channel. The comparisons of the time-series of surface elevation, near-surface salinity and temperature between the model results and observational data are presented in Fig. 4. Different metrics have been introduced for evaluating the model skills, including mean absolute errors (MAE = $(\sum|X_{model} - X_{obs}|)/N$), correlation coefficient (R), root-mean-square-error (RMSE=$\sqrt{(\sum|X_{model} - X_{obs}|^2)/N}$) and predictive skill (Skill =1 $- \frac{\sum|X_{model}-X_{obs}|^2}{\sum(|X_{model}-\overline{X_{obs}}|+|X_{obs}-\overline{X_{obs}}|)^2}$). The overall statistics of these variables are summarized in Table 1. Generally, the model captures the temporal and spatial variability well. The MAEs for the surface elevation, near-surface salinity and temperature are less than 3.5 cm, 1.6, and 1.3 °C, respectively. The RMSEs for both salinity and temperature are within 1.6 and 1.1 °C. The predictive skills for the surface elevation and temperature are close to 1.0, while the salinity skill is greater than 0.65. Based on these results, the model is deemed to have a satisfactory skill and can be used to assess the impact of channel dredging.

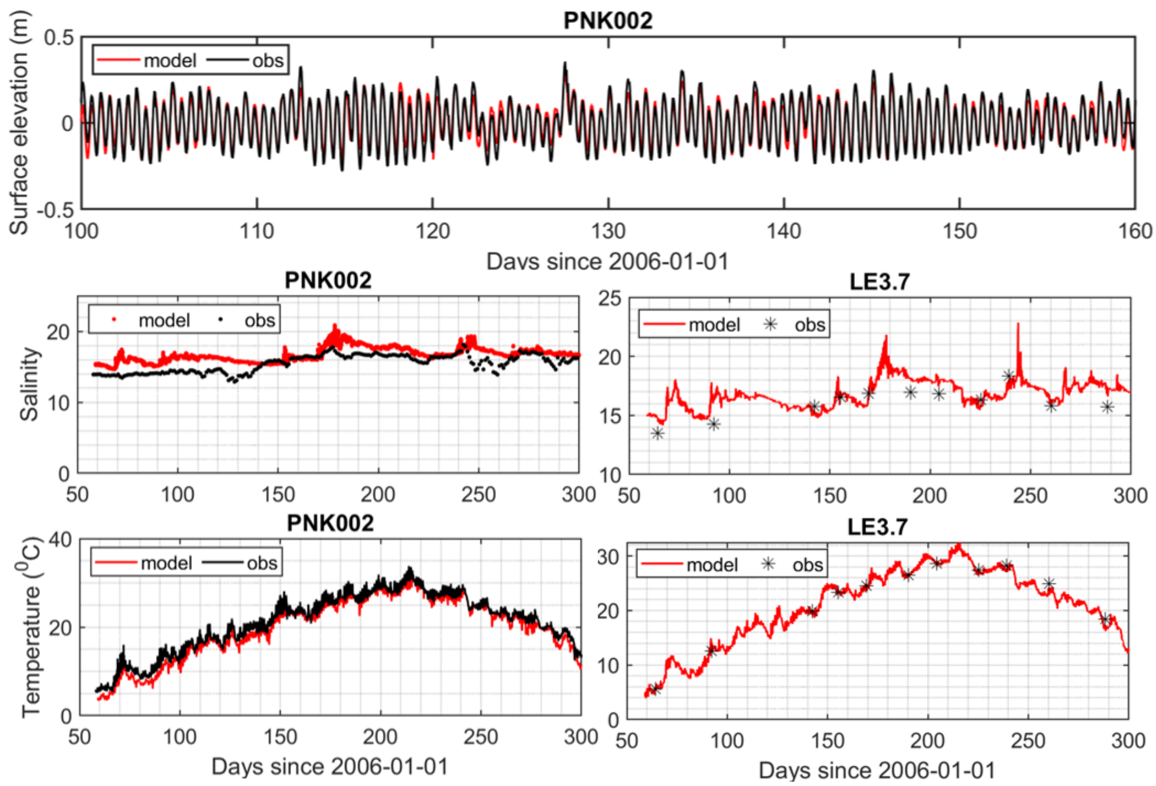


Fig. 4 Comparison of water level, near-surface salinity and temperature between model results and observation data from two sites PNK002 and LE3.7.

Table 2. Summary of statistics for surface elevation, near-surface salinity and temperature at two observation stations.

Station	Surface elevation				Salinity				Temperature			
	MAE (m)	R	RMSE (m)	Skill	MAE	R	RMSE	Skill	MAE (°C)	R	RMSE	Skill (°C)
PNK002	0.034	0.942	0.046	0.965	1.541	0.671	1.526	0.654	1.226	0.993	1.475	0.988
LE3.7	/	/	/	/	0.900	0.649	1.072	0.761	0.836	0.991	1.054	0.994

2. Results

2.1 Current condition (Base Scenario)

The current hydrodynamic conditions in Milford Haven were simulated in Base Scenario (Figs. 5 and 6). For all the four study periods (Spring and neap tides in April and July, respectively), the mean surface velocity was relatively high at the two ends of the Milford Haven, compared with the inside region. Correspondingly, the mean bottom shear stress was also relatively large at the two ends.

Fig. 7 shows the time series of elevation and bottom shear stress at two selected points during the spring tide in July. It can be seen that bottom shear stress can reach as high as 0.08 Pa at Point 1 and 0.09 Pa at Point 2. The mean bottom shear stress is 0.026-0.031 Pa at Point 1 and 0.036-0.037 Pa at Point 2 during this spring tide, varying with the different model grids used for dredging scenarios (Table 3).

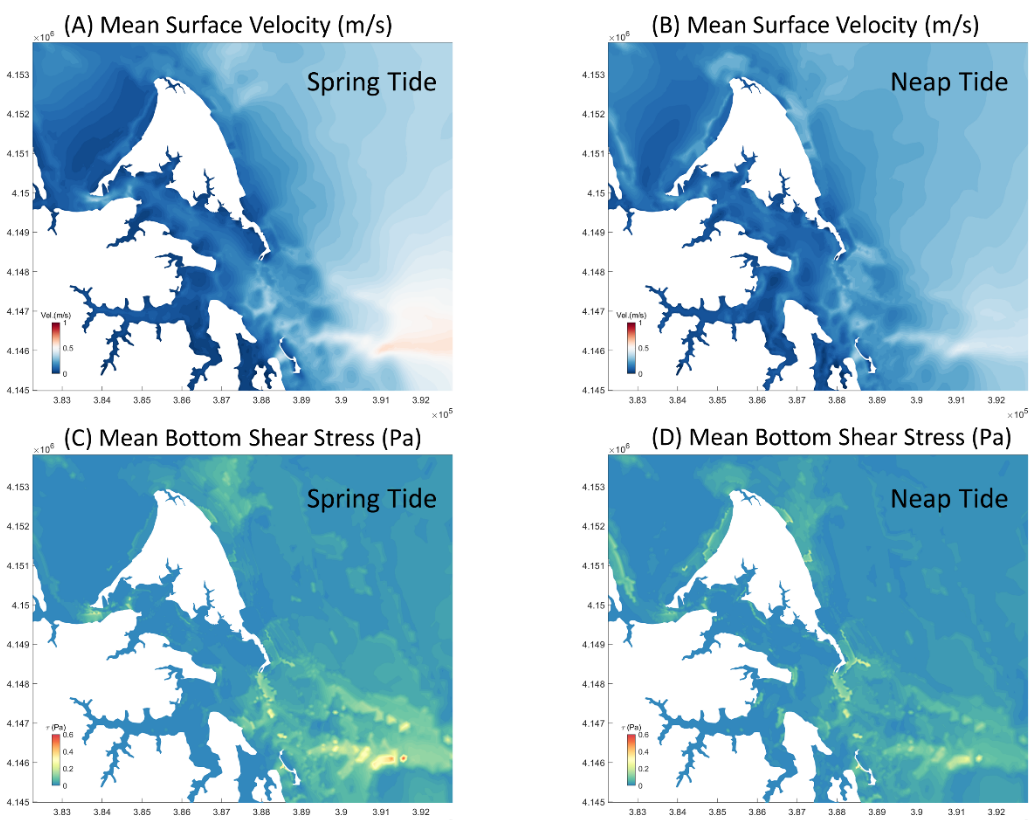


Fig. 5. Mean surface velocity and mean bottom shear stress over a spring tide (A, C) and a neap tide (B, D) in April.

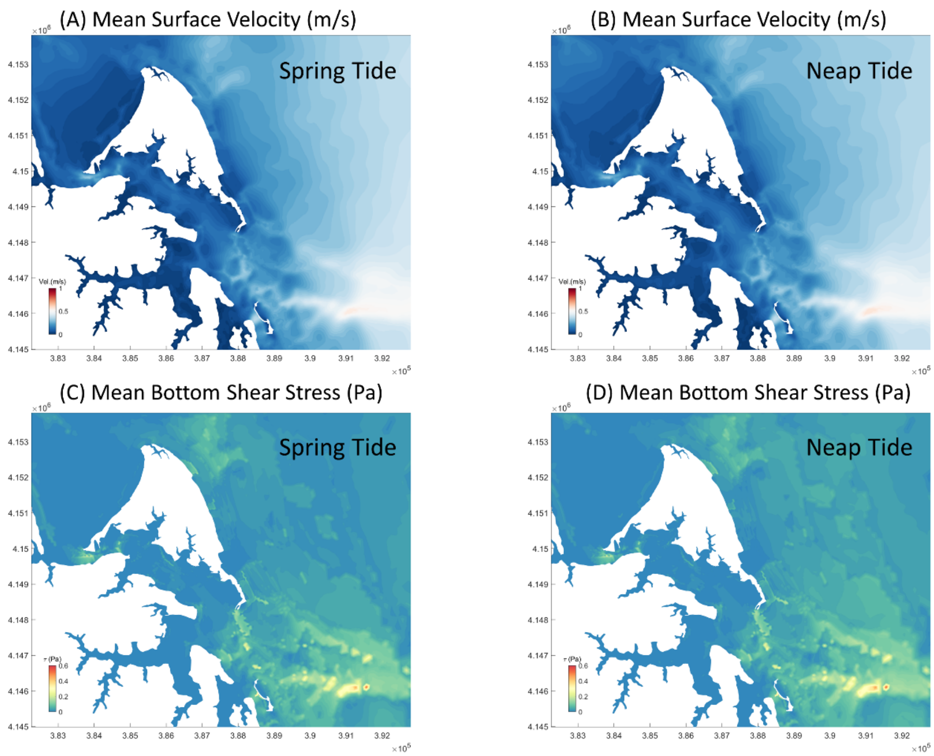


Fig. 6. Mean surface velocity and mean bottom shear stress over a spring tide (A, C) and a neap tide (B, D) in July.

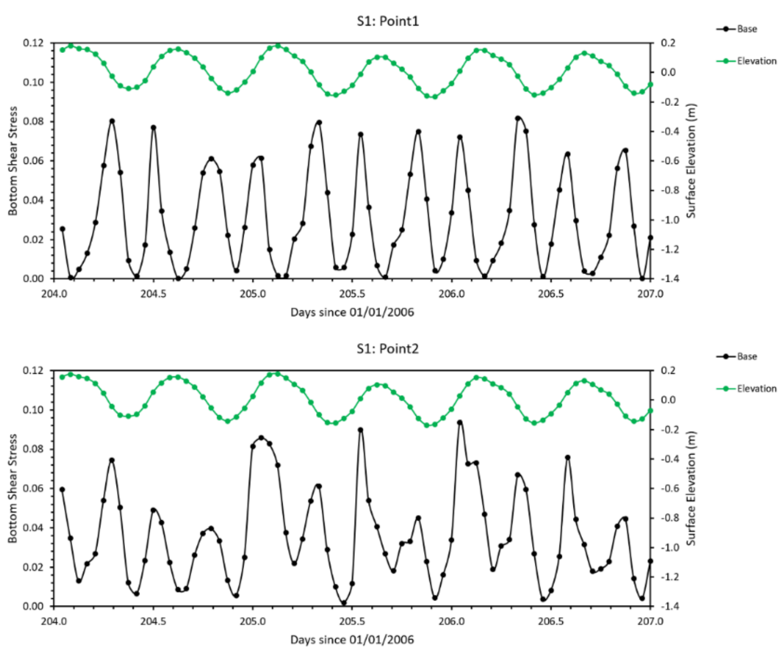


Fig. 7. Time series of elevation (m) and bottom shear stress (Pa) at two selected points during the spring tide in July for Base Scenario using the model grid for Scenario 1.

Table 3. Bottom shear stress in Base Scenario (mean ± standard deviation), varying with the model grid used for each dredging Scenario.

Base Scenario	Point 1 (Pa)	Point 2 (Pa)
Scenario 1	0.031 ± 0.025	0.036 ± 0.023
Scenario 3	0.026 ± 0.021	0.037 ± 0.024
Scenario 5	0.030 ± 0.025	0.036 ± 0.023
Scenario 6	0.026 ± 0.022	0.036 ± 0.023

2.2 Dredging Scenarios

After dredging, the bottom shear stress changes (Fig. 8). In the study area, the bottom shear stress can either increase or decrease depending on the location.

Overall, the bottom shear stress increases at Point 1 but decreases at Point 2 in all dredging Scenarios (Fig. 9). The mean relative increase at Point 1 is about 17.6-32.0% and the mean relative decrease at Point 2 is about 38.5-42.0% (Tables 4 and 5). Among the four dredging scenarios, Scenario 6 has the largest relative increase in the bottom shear stress in Point 1.

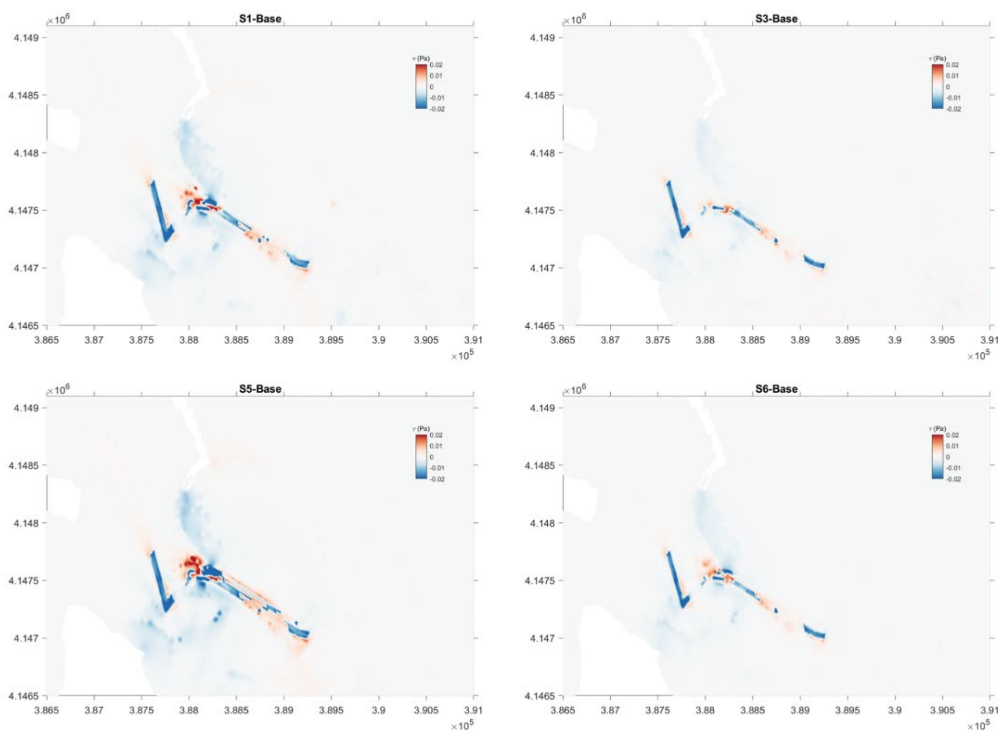


Fig. 8. The difference of bottom shear stress (Pa) between each dredging scenario and Base Scenario.

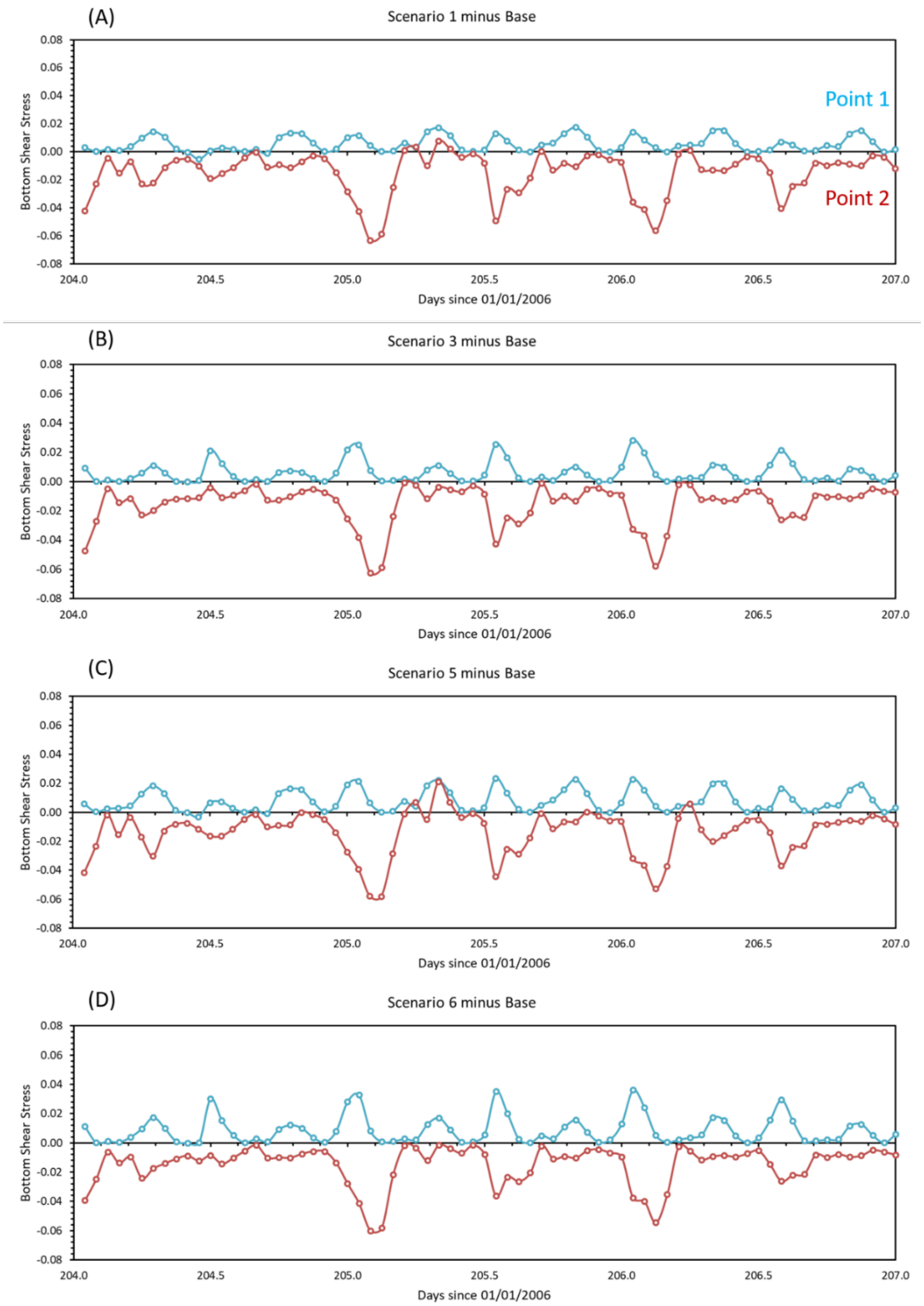


Fig. 9. Time series of the difference in bottom shear stress (Pa) between each dredging Scenario and Base Scenario at two selected points during the spring tide in July. Blue lines: Point 1; Red lines: Point 2.

Table 4. Bottom shear stress in dredging Scenario (mean ± standard deviation) and the relative changes for each dredging scenario (= Dredging Scenario/Base Scenario – 1) at Point 1.

	Dredging Scenario (Pa)	Relative Change
Scenario 1	0.036 ± 0.030	17.6%
Scenario 3	0.032 ± 0.027	22.7%
Scenario 5	0.038 ± 0.032	25.8%
Scenario 6	0.035 ± 0.030	32.0%

Table 5. Bottom shear stress in dredging Scenario (mean ± standard deviation) and the relative changes for each dredging scenario (= Dredging Scenario/Base Scenario – 1) at Point 2.

	Dredging Scenario	Relative change
Scenario 1	0.021 ± 0.015	-41.6%
Scenario 3	0.022 ± 0.016	-42.0%
Scenario 5	0.022 ± 0.017	-38.5%
Scenario 6	0.021 ± 0.016	-41.8%

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Zhang, Y. J., Ateljevich, E., Yu, H. C., Wu, C. H., & Jason, C. S. (2015). A new vertical coordinate system for a 3D unstructured-grid model. *Ocean Modelling*, *85*, 16-31.

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Appendix G

Sediment Dating

Sedimentation Rate Sampling

Sediments contain a background level of ^{210}Pb that is continuously deposited over time as it becomes fixed on sediment particles. With a half-life time of 22.3 years, ^{210}Pb is the sole natural radioactive lead isotope, the presence of which in the environment is directly related to the presence of the parent isotope. ^{210}Pb that was incorporated into the sediments 22.3 years ago will be only one half as radioactive as when initially deposited. This property of radioactive decay can be used to calculate the approximate age of sediments at other depths in the sediment column and/or the rate of sediment accumulation over about the last 100 years.

Sedimentation rates were obtained by analyzing core samples for ^{210}Pb and ^{137}Cs radioisotopes using gamma spectroscopy. Dried and homogenized samples were packed in Petri dishes and sealed with electrical tape and paraffin wax 30 days prior to analysis to allow for equilibration between 226Ra and its daughter isotopes, 214Pb and 214Bi (supported ^{210}Pb). Total ^{210}Pb (46.5 keV photopeak) and ^{137}Cs (662 keV photopeak) activity was measured for all samples along each core using a Canberra GL 2020 Low Energy Germanium detector (Virginia Institute of Marine Science Geochronology Lab). Total ^{210}Pb counts were corrected for detector efficiency and self-attenuation using the point-source method (Cutshall et al., 1983). Concentrations of excess ^{210}Pb used to obtain age models were determined as the difference between total ^{210}Pb and supported ^{210}Pb (Table 1). ^{137}Cs is a bomb-produced radionuclide used to verify accumulation rates determined by ^{210}Pb geochronology. ^{137}Cs is a by-product of nuclear weapons testing. It first occurred in the atmosphere in about 1952 and peaked during 1963-64. It adsorbs strongly to fine-grained sediments and therefore can be used to determine the time of deposition of sediments that have been exposed to atmospheric fallout. Peak ^{137}Cs activity is assumed to be 1963.

The constant flux-constant sedimentation (CFCS) model (Corbett & Walsh, 2015) was used to calculate sedimentation rates over the last ~100 years at all sites, assuming a constant rate of accumulation and flux of excess ^{210}Pb. These rates were calculated using the following formulas:

$$Az = A0\ e\text{-}\lambda t$$

$$t = z / S$$

where Az is the excess (unsupported) ^{210}Pb activity for a sample at depth z, A0 is the excess ^{210}Pb activity at the time of sample collection, λ is the ^{210}Pb decay constant, and t is elapsed time since burial. To calculate a vertical accretion rate (S), the natural log of excess ^{210}Pb activities were plotted against depth to obtain a slope of the best-fit line (m):

$$S = \lambda / m$$

Using Hole in the Wall's core 4, 4-centimeter (cm) samples were taken from the top of the core at 12 cm intervals until a depth of 140 cm was reached. Each sample farther along the core was still 4 cm along the length of the core, but it occurred at 28 cm intervals (Table G-1).

Unfortunately, because there was no defined peak, we were unable to use ^{137}Cs radioisotopes also to determine the approximate age of the sediments at a particular depth by assuming the peak of ^{137}Cs is the year 1963.

Table G-1. Table 1. Summary table of ^{210}Pb and ^{137}Cs sedimentation analysis of Hole in the Wall core 4.

Sample ID	Depth Range (cm)	Mean Depth (cm)	Depth Range ± (cm)	Excess ^{210}Pb DPM/g	^{210}Pb Error (±DPM/g)	Ln(Excess)	Total ^{137}Cs (DPM/g)	^{137}Cs Error (±DPM/g)
HITW-06_8-12cm	8 - 12 cm	10	2	0.653833143	0.104541332	-0.424903093	0.008495534	0.002338814
HITW-06_40-44cm	40 - 44 cm	42	2	0.345437969	0.072657138	-1.062942191	0.016542148	0.003160228
HITW-06_72-76cm	72 - 76 cm	74	2	0	0.089495546	0	0	0
HITW-06_104-108c	104 - 108 cm	106	2	0.003778547	0.09383365	-5.578415695	0.010329782	0.002646895
HITW-06_136-140c	136 - 140 cm	138	2	0.36811679	0.10591385	-0.999355026	0.010641663	0.002639893
HITW-06_168-172c	168 - 172 cm	170	2	0.616139238	0.129577776	-0.484282306	0.016869272	0.003840742
HITW-06_200-204c	200 - 204 cm	202	2	0.297075773	0.106369267	-1.213768046	0	0
HITW-06_232-236c	232 - 236 cm	234	2	0.295056957	0.119675664	-1.220586865	0	0
HITW-06_264-268c	264 - 268 cm	266	2	0	0.089995638	0	0.01631366	0.003303866
HITW-06_296-300c	296 - 300 cm	298	2	0.266839244	0.110418501	-1.321108883	0.004265643	0.001727

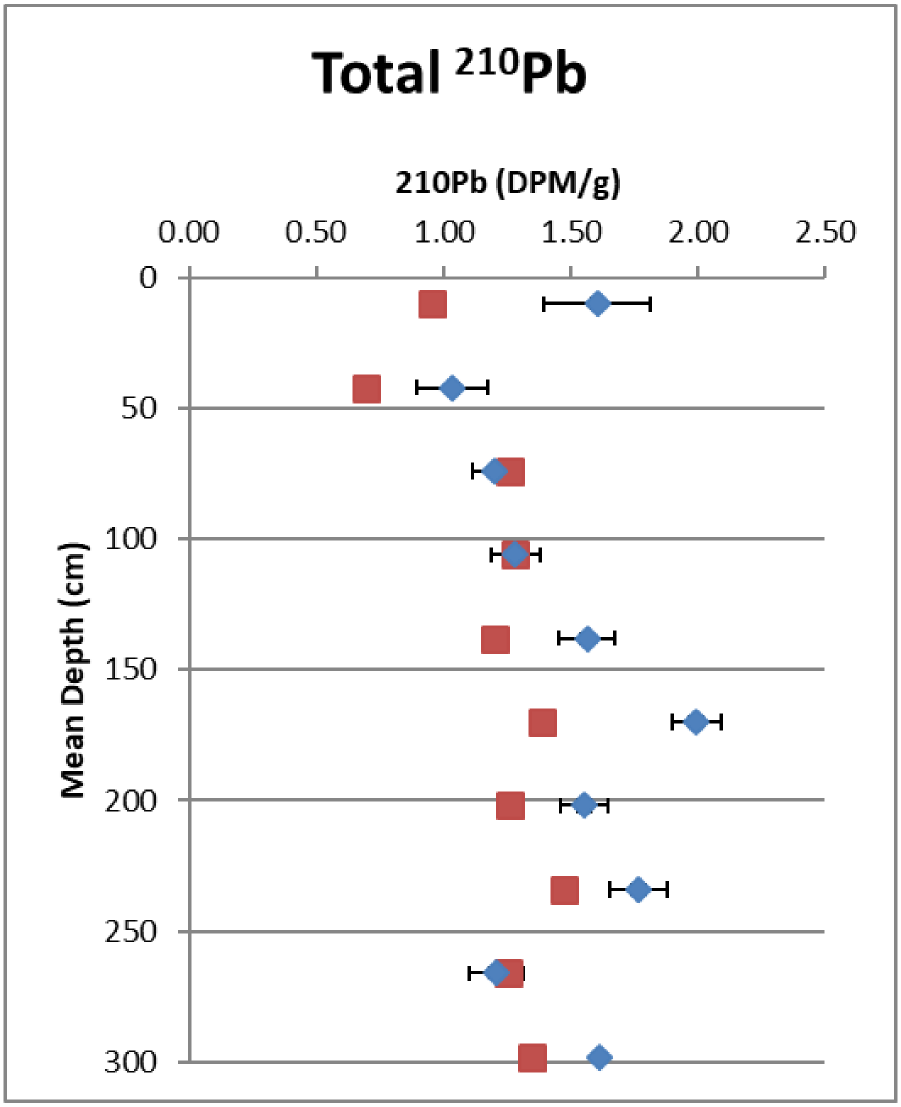

Figure G-1. Total ^{210}Pb from the sample at Hole in the Wall.

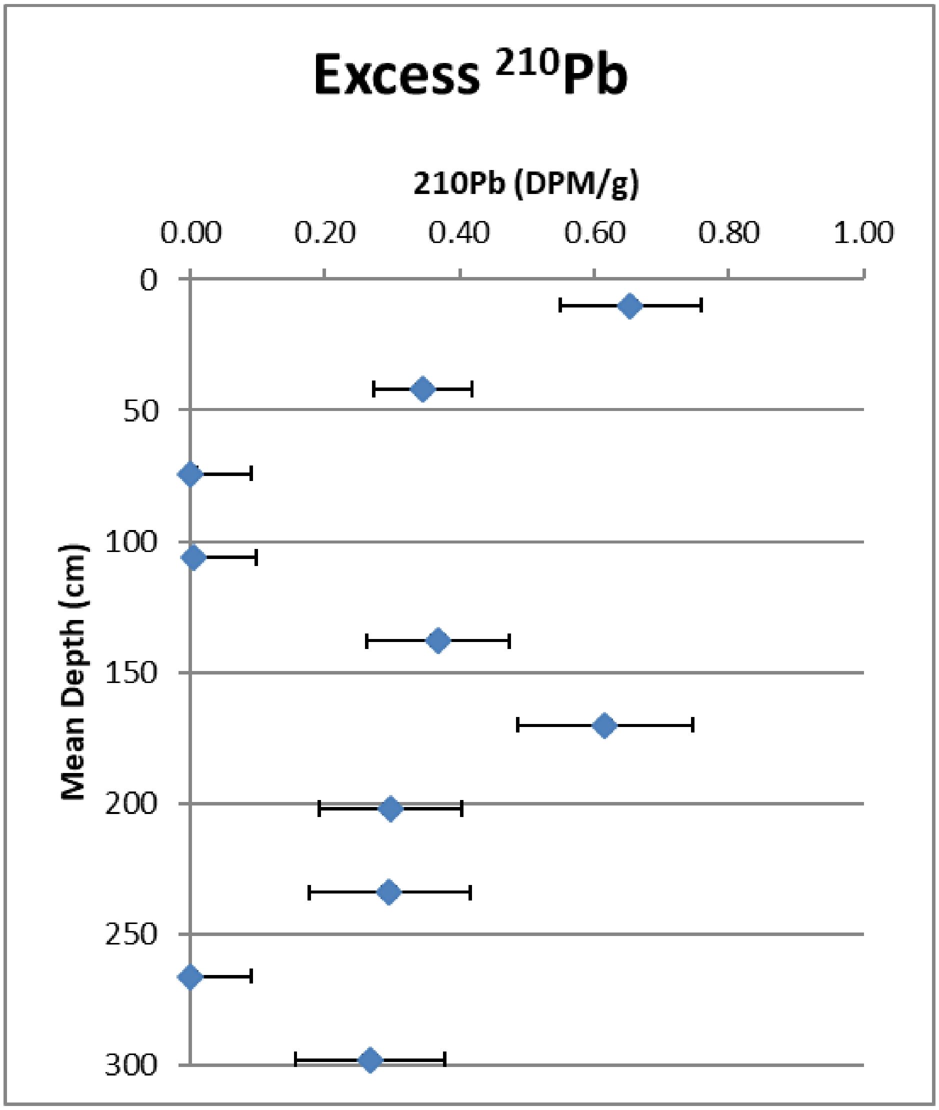

Figure G-2. Excess ^{210}Pb from the sample at Hole in the Wall.

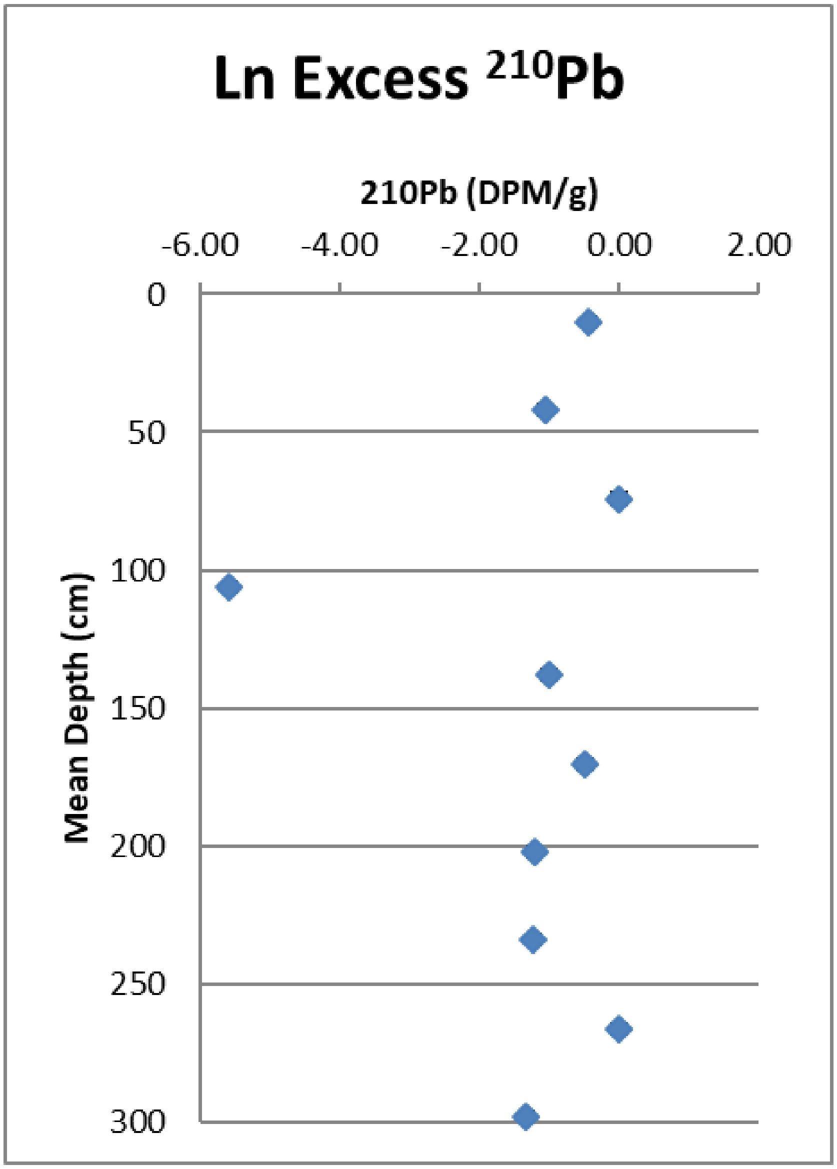

Figure G-3. Natural logarithm of excess ^{210}Pb from the sample at Hole in the Wall.

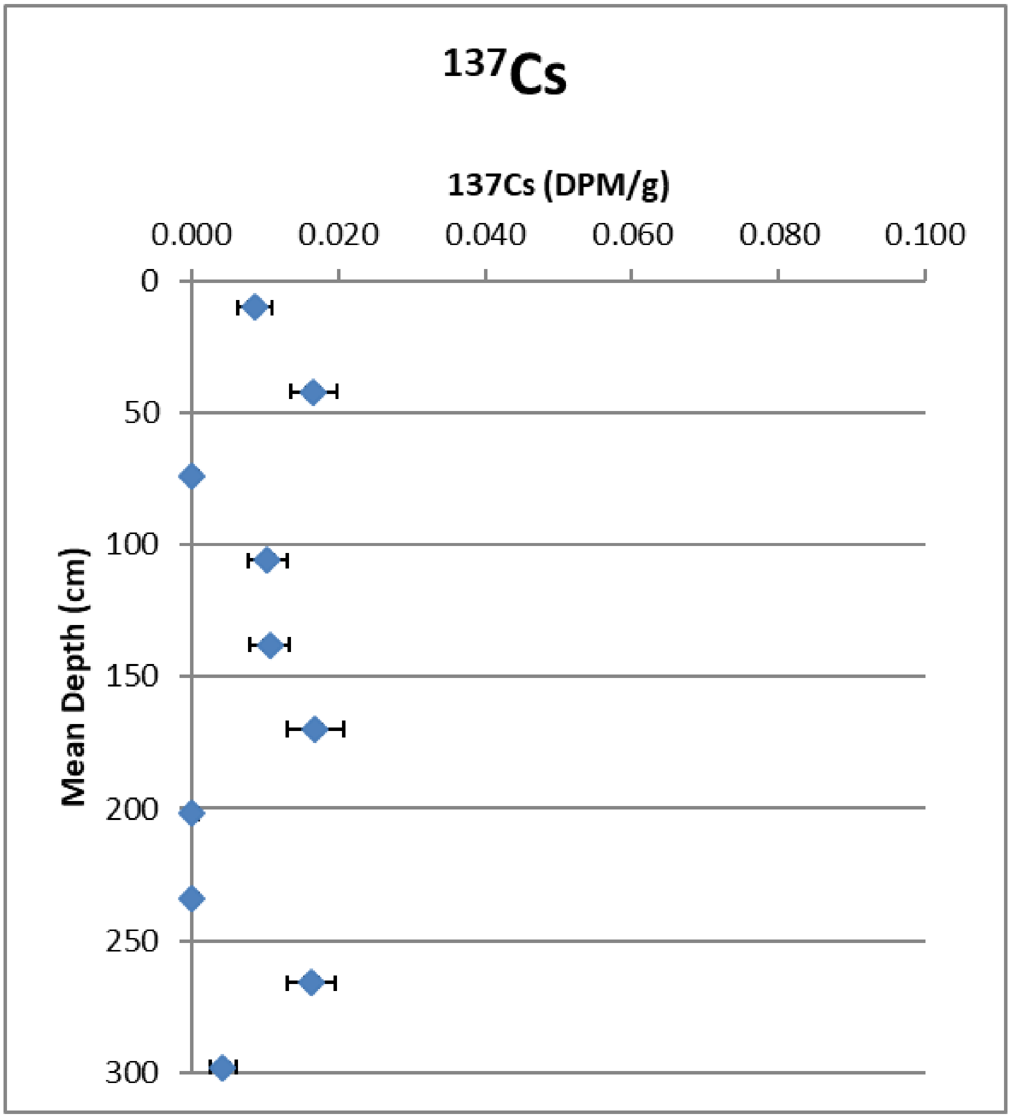

Figure G-4. Total ^{137}Cs from the sample at Hole in the Wall.