Appendix I

Executive Summaries
Of
Technical Reports

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James Island Reports

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FINAL

JAMES ISLAND HABITAT RESTORATION EXISTING ENVIRONMENTAL CONDITIONS:

CONSOLIDATED REPORT

Prepared for

Maryland Port Administration
2310 Broening Highway
Baltimore, MD 21224

Prepared Under Contract to

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, MD 21401

MES Contract # 03-07-21
MPA Contract # 504804
MPA Pin # 52270020

February 2005
Prepared by

John E. Harms, Jr. & Assoc., Inc.
90 Ritchie Highway
Pasadena, Maryland 21122

EXECUTIVE SUMMARY

James Island and the adjacent waters of the mid Chesapeake Bay were investigated during Fall 2001, Summer and Fall 2002 and Winter, Spring and Summer 2003 with one supplemental survey in Winter 2004. The purpose of the investigations was to document the existing environmental conditions on and adjacent to the Island remnants as part of the joint feasibility study, between the U.S. Army Corps of Engineers and the Maryland Port Administration (MPA), for the potential of James Island to be used as an island restoration project through the managed use of dredged material placement. This report contains the consolidated results from the four quarters of sampling. Both aquatic and terrestrial sampling were conducted, and included water quality and nutrient analyses, fishery and plankton sampling, benthic sampling and sediment testing, vegetation identification and mapping (both aquatic and terrestrial), submerged aquatic vegetation surveys, avian and other wildlife observations (both aquatic and terrestrial), horseshoe crab spawning surveys, diamondback terrapin nesting surveys, crab pot surveys and investigations of other resources (Table ES-1).

EA Engineering, Science and Technology, Inc. (EA) and Andrews, Miller and Associates with their subcontractor, Chesapeake Environmental Management, Inc. conducted the studies in Fall 2001 and Summer and Fall 2002. John E. Harms, Jr. & Assoc., Inc. (Harms) with sub-consultants Barry A. Vittor, & Assoc., Inc. (BVA) and Straughan Environmental Services conducted the studies in Winter, Spring and Summer of 2003 and the supplemental study in Winter 2004. All studies were conducted under contract to Maryland Environmental Service (MES) for the MPA.

TABLE ES-1. COMPONENTS OF SITE RECONNAISSANCE AND SAMPLING EFFORTS AT JAMES ISLAND

Type of Study Conducted
• Fisheries Studies • Commercial Utilization • Benthic Macroinvertebrate Studies • Plankton Studies • Nutrient Analysis • Sediment Quality • *In-Situ* Water Quality • Submerged Aquatic Vegetation (SAV) Surveys • Vegetation Identification and Mapping • Wildlife and Avian Observations • Horseshoe Crab Spawning Surveys • Diamondback Terrapin Nesting Survey

James Island currently consists of three eroding island remnants, referred to as the Northern, Middle and Southern remnants. Mixed forest stands of loblolly pine dominate the interior of the islands. Small remnants of high marsh can be found on all three remnants and the southern remnant has a fairly extensive marsh complex in the center. Historically, James Island was connected to the mainland at Taylor’s Island. Over 800 acres of the island have eroded since

1847, leaving the island one mile offshore and in three remnants, totaling less than 100 acres (MES et. al., 2002). As late as November, 2002, the northern two remnants (Northern and Middle) were connected by a sand spit. By March, 2003, this sand spit was no longer visible during high tide. The northern and western shorelines of each remnant show the heaviest erosion and there are many downed trees in the water in these areas. The tidal marshes on the Middle remnant have almost disappeared, and those on the Northern and Southern remnants are diminishing quickly. The marshes have either eroded completely away or been covered by new sandy beaches. There was evidence of fire that killed many trees, impacted some of the marsh areas on the northern and southern remnants and left scorch marks on the trunks of the pine trees of all three remnants. The actual cause of the fire is unknown, but speculation at a public meeting on February 20, 2003 at the court house in Cambridge, Maryland, suggested either campfires or lightning storms (Boraczek, 2004).

Benthic community characterization indicated that there is low benthic diversity. All but one of the ten stations did not meet the Chesapeake Restoration Goal Index of 3.0. Benthic sampling determined that the area is stressed with low total abundance, diversity, low abundance of stress-sensitive taxa and low ratios of carnivores to omnivores.

The temperature, salinity, and pH levels recorded during the *in-situ* water quality surveys were all within the range expected for this region of the Chesapeake Bay during all seasons of sampling. Dissolved oxygen levels exceeded the criteria set by the EPA and adopted by the Chesapeake Bay Program; including those for migratory fish spawning and nursery use (instantaneous minimum of 5 mg/L from February through May) and shallow open-water fish and shellfish use (instantaneous minimum of 3.2 mg/L year-round) (EPA, 2003). Secchi depth readings exceeded EPA criteria depths for application to shallow-water bay grass habitat (EPA, 2003). Nutrient analyses of whole water and filtered water samples produced concentrations typical for this area, with the exception of Chlorophyll-a.

Fisheries investigations of the shorelines indicated that the remnants support a fairly diverse fish community, including juveniles of commercially important species such as red drum, bluefish and summer flounder. The presence of these three species indicated that the waters in the vicinity of James Island may provide essential fish habitat (EFH) for them as well as for seven other species which are all managed under the Magnasun Stevens Fisheries Conservation Act. A variety of forage species, which are important food sources for the managed species, was also present around the remnants. All species were typical of the region. Fisheries communities present around James Island vary greatly between seasons but were shown to be more abundant during the spring months.

Crab pots were surveyed from April through September and were present west and south of the remnants during the late spring and summer months. July through September exhibited the greatest number of pots to the west of the island remnants.

Clam surveys revealed a general lack of an appreciable number of clams and a lack of productive clam bar, per Maryland Department of Natural Resources (MDNR) definition, in the vicinity. The MDNR defines a productive natural clam bar as having an existing or potential harvesting rate of either 500 hard clams (*Mercenaria mercenaria*) per hour, 0.5 bushel soft-shell clams (*Mya arenaria*) per hour, or 1.5 bushels of razor clams (*Tagelus plebius*) per hour (COMAR, 2004). Razor clams were the most prevalent. A few individual soft shell clams were found but no hard shell clams were present.

According to a MDNR survey commercial fishermen are currently fishing 3 of the 9 licensed net locations within the project area. The 3 nets are fished from March to November and are not set within any of the proposed alignments. Pound net fishing is more opportunistic, rather then targeted for certain commercially important species, but all nets catch menhaden, striped bass and croaker in the fall.

SAV mapping from previous seasons (2001-2002) (EA, 2003) as well as the presence of SAV beds in the area directly south of this area, suggests that SAV beds were present along a considerable portion of the suitable habitat located east of the Northern remnant. In addition to the relatively dense beds located east of the Middle remnant, smaller less-dense beds were located east of the Southern remnant in Spring 2003 than were observed in Summer 2002. Although no SAV beds were observed during the Supplemental Survey conducted in August 2003. SAV mapping from previous years (1971-2002) suggests that SAV beds were never present along the western shores of the James Island complex during that time period (http://www.vims.edu/bio/sav/).

Of the 155 chemical constituents tested in the sediment, 57 were detected in the James Island sediments. The majority of these detected constituents were found in low concentrations and were representative of background concentrations. Semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), and organophosphorus pesticides were not detected in any of the sediment samples. One polynuclear aromatic hydrocarbon (PAH), acenaphthylene, exceeded the threshold effects level (TEL) value at one sampling station (JAM-002) by a factor of approximately 2.6 but did not exceed probable effects level (PEL) values. None of the other detected chemical constituents exceeded TEL values.

Wildlife surveys at the island indicated some utilization of the remnants by terrestrial mammals. River otter (*Lutra canadensis*) was observed and signs of raccoon (*Procyon lotor*), white-tailed deer (Odocoileus virginianus), sika deer (Cervus nippon) and muskrat (*Ondatra zibethicus*) were present. Avian utilization, however, was higher during spring surveys, due to migration and arrival of breeding summer residents. Winter waterfowl such as surf scoters (*Melanitta perspicillata*), bufflehead (*Bucephala albeola*) and long-tailed ducks (*Clangula hyemalis*), present in March and April, were gone by May, by which time the shorebirds had arrived, utilizing the marsh edges and beaches. Ospreys and bald eagles were breeding successfully and a barred owl was observed on the Northern Remnant.

Aquatic wildlife utilizing the shores included mollusks, bivalves, and crustaceans. Evidence of use was higher during late spring, summer and early fall surveys. Silversides were numerous at nighttime near the beaches. Cow-nosed rays swam frequently into the shallow coves to feed. A pod of bottlenose dolphins was spotted in the waters south of the Southern remnant during the Spring 2003 survey.

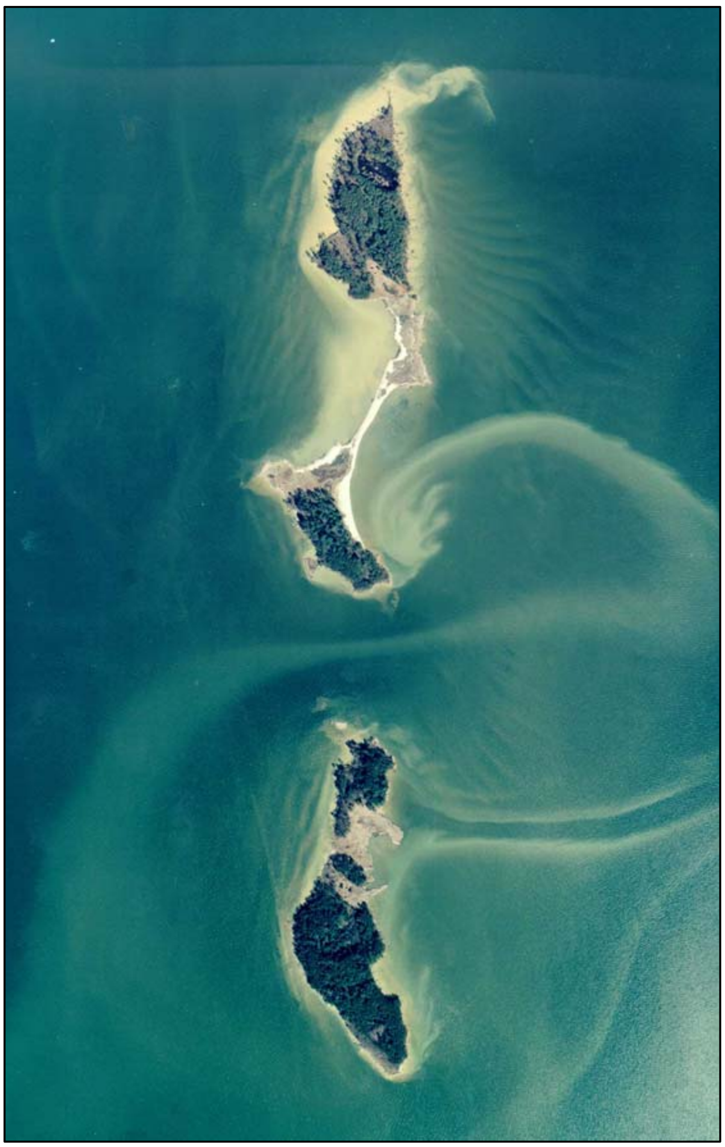
Horseshoe crabs and diamondback terrapins utilized the east beach of the Middle remnant for spawning and nesting, respectively, during the late spring.

Vegetation on the remnants remained consistent during all seasons of survey, with the exception of the northwest marsh on the Middle remnant. Strong storms washed significant sand onto the shore, covering the marshes with beach, filling in one of the marsh ponds, and eroding marsh vegetation during the Spring of 2003.

Archaeological and historical resources noted included some pottery shards along the eastern beach of the Middle remnant. There are also three to four foot tall and four to five foot wide berms reaching across both the Southern and Northern remnants. A long-time local resident waterman states that the berms were historically made to prevent water from reaching sika deer (*Cervus nippon*) forage fields, and to form ponds for duck hunting (Willey, 2003).

Final James Island
Beneficial Use of Dredged Material

Consolidated Reconnaissance Report



Prepared for

Maryland Port Administration
2310 Broening Highway
Baltimore, MD 21224

Under Contract to

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, MD 21401

Prepared by

EA Engineering, Science & Technology, Inc.
15 Loveton Circle
Sparks, MD 21030

MES Contract # 02-07-10
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MPA Pin # 600105-P
April 2003

EXECUTIVE SUMMARY

James Island is an eroding island that has been identified by the Maryland Port Administration's (MPA) Dredged Material Management Program (DMMP) process as a potential option for island habitat restoration through the beneficial use of dredged material. In addition, the Dorchester County Resource Preservation and Development Corporation (DCRPDC), a non-profit organization, had originally recommended and presently supports James Island as a possible habitat restoration project using dredged material. The DCRPDC is interested in stabilizing and protecting the Dorchester County shoreline, but does not have any ownership interest in James Island (MES 2002). In addition to support from DCRPDC, DMMP, and MPA, the private landowners of James Island indicate their support of the proposed habitat restoration project as well. Following the recommendation of James Island as a restoration project, reconnaissance level studies for evaluating the island as a potential beneficial use site were initiated in Spring 2001. The designation of James Island as a preferred option for habitat restoration using dredged material was the result of conceptual studies and evaluation by technical management and citizens in the DMMP process. Reconnaissance studies were then initiated on the option.

James Island currently consists of three eroding island remnants. The island remnants are located in Dorchester County, Maryland east of the mouth of the Little Choptank River. The existing remnant islands were formed as a result of natural processes of shoreline erosion that affect the Chesapeake Bay region. Historic and current mapping of the island has indicated that over 800 acres of the island have eroded away since 1847. James Island was estimated at 976 acres in 1847 and recent estimates from 1994 measure the island at 92 acres.

EA Engineering, Science, and Technology, Inc. (EA) was contracted by Maryland Environmental Service (MES) to complete a reconnaissance study and consolidated report that includes all current studies of James Island as a prospective habitat restoration area using dredged material from the outer approach channels to the Baltimore Harbor (east of North Point/Rock Point Line in the Patapsco River). These studies were conducted to support the MPA DMMP process. This consolidated report combines the findings of several separate investigations and includes the following studies: subsurface geotechnical investigations, coastal engineering investigations, hydrodynamic and sedimentation modeling, dredging and site engineering (including design and cost specifications), and the existing environmental conditions at James Island. This report includes investigations and modeling studies that have either been updated or completed since the Conceptual James Island Beneficial Use of Dredged Material Report was prepared by MES. A total of 5 alignments with two dike elevations and a 50 percent upland to 50 percent wetland ratio are currently being considered.

Site visits to James Island were conducted by MES in June 2001 and by EA in the Fall of 2001 and Summer of 2002, during the seasonal sampling surveys. Initial site visits and reconnaissance survey demonstrated that James Island is primarily forested. The shoreline consists of fringe marshes and eroding wooded banks lined with submerged snags in the adjacent waters. The shoreline elevations range from 5 to 10 feet (ft) in height on the northwestern shores and gradually decrease to the south. The surrounding waters are relatively shallow and range from 3-12 ft. Natural oyster bars (NOBs) are located in the general vicinity. The island is currently used for recreation such as hunting and fishing. Natural habitats include forested uplands, wet meadows, submerged aquatic vegetation (SAV), tidal marshes, coves, and some sandy beach areas.

A Geotechnical Reconnaissance Study was conducted by Engineering, Construction, Consulting, and Remediation, Inc. (E2CR) to evaluate subsurface conditions along the five proposed dike alignments for construction at James Island. This geotechnical investigation focused on the suitability of foundation soils for supporting dike construction, the availability of suitable borrow to construct a dike system, and the development of a preliminary dike section. The foundation soils in most areas consisted of silty sand, which is suitable for supporting a dike. However, some soils were soft silty clays at the mud line that would require undercutting and backfilling with sand. The site contained a sufficient quantity of suitable borrow for constructing the perimeter dike to an elevation of 20+ ft. The net quantity of sand available was approximately 12+ million cubic yards (mcy). For this reconnaissance phase, it was assumed that the dike would be constructed by hydraulic dredging, and the slopes achievable would be 3H:1V above and below the water table.

A Coastal Engineering Reconnaissance Study was conducted by Moffatt and Nichol Engineers (MNE) to evaluate the five alignment options for beneficial use of dredged material at James Island. This investigation included an evaluation of existing physical site conditions, relevant bathymetry, wind, water level and geotechnical data for evaluation of wave height and dike construction requirements, and designs of proposed dike alignments and typical cross-sections. Waves were hindcast for eight directional windspeeds using methods recommended by the U.S. Army Corps of Engineers (USACE). The highest waves for the site approach from both the north and south. From these wave forecasts, seven preliminary cross-sections were developed for the containment dikes. The dike designs are based upon a 35-year return period. Dike heights are based on allowable overtopping for an unarmored crest and an allowance for settlement. The dike design also incorporates 3:1 side slopes, above grade toe protection, a core constructed of sand, and a crushed stone roadway on the structure crest. Overall, seven dike cross-sections were designed for the five proposed alignments. Each alignment would require four to five different dike cross-sections for construction. Should this study move forward to feasibility, recent bathymetric surveys conducted within the vicinity of James Island are recommended to be used.

A Hydrodynamics and Sedimentation Modeling Reconnaissance Study was conducted by MNE to evaluate the projected hydrodynamic changes at James Island if construction of the various alignments takes place. The MNE Upper Chesapeake Bay – Finite Element Model was used to predict existing conditions as well as with- and without-project hydrodynamics and sedimentation for each of the five proposed alignments (MNE 2000). The modeling results for the James Island habitat restoration project show minimal impacts on local tidal elevations, which are essentially unchanged. Current velocities are impacted following island construction, with a maximum increase or decrease in current velocity of about 0.4 ft/second (sec). The project construction at James Island would have beneficial effects on sedimentation rates and patterns, with less erosion of the James Island shoreline and the shallow areas surrounding the remnants. Some protection would also be afforded to the shoreline of Taylors Island from wind and waves coming from the N, NNW, and NW directions. This reduction in erosion would likely reduce suspended sediment and improve water quality in the surrounding area.

A Dredging and Site Engineering Reconnaissance Study was conducted by Gahagan and Bryant Associates, Inc. (GBA) to summarize the dredging and site engineering aspects of restoring and developing habitat at James Island using dredged material. The study presented five proposed alignments and their associated costs to assist decision-makers in selecting the site layout to be carried to the final design. Each of the five alignments included a wetland and upland cell designation, with a 50 percent upland to 50 percent wetland ratio. In addition, two different upland dike heights were examined for the five alignments and included a 10-ft and 20-ft dike height alternative for each alignment. For the 10-ft upland dike elevation alternative, the site capacity for the five alignments ranged from 23 to 52 million cubic yards (mcy). For the 20-ft upland dike elevation alternative, the site capacity for the five alignments ranged from 35 to 79 mcy. The total site areas for the alignments range from 979 to 2,202 acres. Alignment 1 is the smallest layout and would have a footprint of 979 acres, Alignment 2 would have a footprint of 2,127 and Alignment 3 would have a footprint of 1,586. Alignment 4 is the largest of the five site designs and is a variation of Alignment 2 that would have a footprint of 2,202 acres. Finally, Alignment 5 is a variation of Alignment 4 and would have a footprint of 2,072 acres. The site operational life of all five alignments is estimated between 13 and 15 years with respect to the 10-ft dike elevation, and between 20 and 23 years with respect to the 20-ft dike elevation.

The 10-ft mean lower low water (MLLW) dike elevation total estimated costs for the project range from $406 million to $759 million. The schedule for construction is 2.3 to 3.2 years and is dependent upon the borrow method used. The easiest, quickest, and least costly borrow source is onsite borrow. The total costs per cubic yard (cy) of site capacity range from $14/cy to $18/cy. The 20-ft MLLW dike elevation total estimated costs for the project range from $591 million to $1.106 billion. The time required for construction is 3.0 to 3.7 years and is dependent upon the borrow method used. The total costs per cubic yard (cy) of site capacity range from $14/cy to $17/cy.

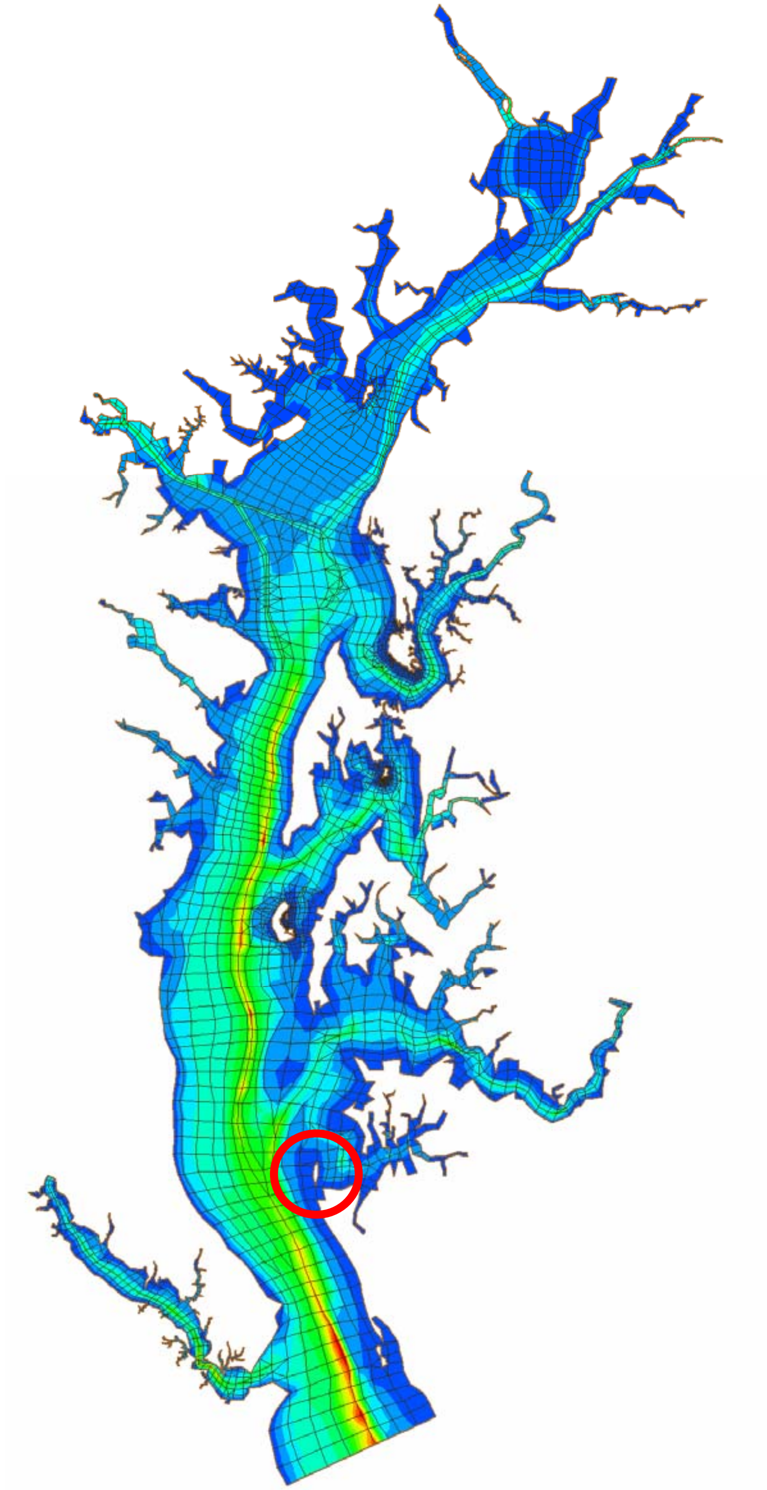
The Existing Environmental Conditions Study investigated the current conditions and the potential impacts of the proposed project. This reconnaissance level study includes information obtained from conceptual studies, literature reviews, and observations from previous field investigations. Several site visits to James Island have been conducted to assess the environmental conditions of the island remnants and to document the terrestrial and aquatic resources present in and around the project area. This report includes observations from a site visit conducted by MES in June 2001 and two site visits conducted by EA in the Fall of 2001 and the Summer of 2002, as part of seasonal sampling for feasibility evaluations. Components of these investigations included vegetation identification and mapping, avian and wildlife utilization surveys, fisheries and plankton sampling, benthic invertebrate studies, sediment and water quality investigations, historic and recreational resource evaluations, and submerged aquatic vegetation (SAV) mapping.

The current condition of James Island includes significant and severe erosion along the northern and western shorelines of the island remnants. The island remnants currently support SAV growth along the eastern shorelines and are composed of monotypic beds of widgeon grass (*Ruppia maritima*). The fisheries investigations of the island's shorelines indicated that the remnants supported a fairly diverse fish community, including juveniles of commercially important species. All collected fish species were typical of the region. In addition, avian utilization of the island was typical for this area of the Bay as well, including the federal and Maryland state-listed threatened species, the bald eagle. Bald eagles were observed utilizing the area in and around James Island. Also, an active eagle nest with a fledgling was observed on the middle remnant of James Island. Several other avian species identified at James Island during the Fall 2001 and Summer 2002 surveys have conservation status determinations associated with their breeding status. However, avian utilization of the open water areas of the proposed alignments was minor compared to that of the wetland and forested areas of the island. Three NOBs are located in the vicinity of the island remnants but not within the concept areas. Ichthyoplantkton densities were relatively high and were dominated by the bay anchovy (*Anchoa mitchilli*). Zooplankton collected were typical of the region. In general, the benthic community was typical of this area of the Bay but was dominated by a single species at most stations, the gem clam (*Gemma gemma*). The majority of the benthic species found were stress-tolerant, resulting in low Benthic Index of Biotic Integrity (B-IBI) scores at most locations. B-IBI scores of 3.0 or greater are considered as meeting the Chesapeake Bay Restoration Goal. Total B-IBI scores were low (1.0 – 1.8) for 9 of 10 stations sampled at James Island in October 2001. One station had a total B-IBI score of 3.0, and was the only station sampled in the footprint area to meet the Chesapeake Bay Restoration Goal.

Additionally, archeological sites including an oyster shell midden and historic foundations are present on the island, but are not located in the concept areas. Potential impacts that may be a concern to the aquatic and terrestrial wildlife include short-term water and sediment quality effects, and the temporary displacement of wildlife. There is also a potential to displace some commercial crabbing within the proposed habitat restoration area.

This study and the analyses of its results were conducted at a reconnaissance level. Therefore, the following report, results, and conclusions should be considered preliminary. The completed construction of the facility should improve water quality in the area by reducing erosion and the resulting suspended solids, which may help sustain or improve the oyster and clam fisheries in the area. In addition, construction of a beneficial use of dredged material project at this site would be expected to provide additional natural habitat, including both wetland and upland areas.

JAMES ISLAND RECONNAISSANCE STUDY



HYDRODYNAMICS AND SEDIMENTATION MODELING

FINAL REPORT
NOVEMBER 15, 2002

Maryland Port Administration
MPA Contract Number: 500912
MPA Pin Number: 600105-P

Maryland Environmental Services
MES Contract Number: 02-07-49

Prepared by

Moffatt & Nichol Engineers
2700 Lighthouse Point East
Suite 501
Baltimore, MD 21224

Executive Summary

The purpose of this Hydrodynamics and Sedimentation Modeling Reconnaissance Study is to evaluate the projected impacts due to construction of a Beneficial Use Habitat Restoration Site at James Island. Moffatt & Nichol Engineers' (MNE) Upper Chesapeake Bay – Finite Element Model (UCB-FEM) (MNE, 2000) was used to predict existing conditions and with- and without-project hydrodynamics and sedimentation. This report summarizes the calibration and implementation of the UCB-FEM two-dimensional numerical model of the Chesapeake Bay and evaluation of hydrodynamic and sedimentation output including time-varying flow velocity, water surface elevations, and patterns of erosion and accretion.

A summary of site conditions that are relevant to the project is provided below:

- **Bathymetry and Topography.** Water depths in the area where the dikes would be located range from –2 to –12 ft Mean Lower Low Water (MLLW), with an average depth along the exterior dikes ranging from –3 to –12 MLLW. Water depths in the deeper main stem portions of the Bay west of James Island are as great as –93 ft MLLW.

- **Freshwater Inflow.** The drainage area of the Chesapeake Bay is approximately 64,000 square miles and includes portions of Maryland, Virginia, West Virginia, Pennsylvania, New York and the District of Columbia. Freshwater enters the Chesapeake Bay via approximately 150 major rivers and streams at approximately 80,000 cubic ft per second (Schubel and Pritchard, 1987).

- **Tides.** Water levels in the Chesapeake Bay are dominated by a semidiurnal lunar tide. Tides enter the Bay via the Chesapeake Bay entrance and the Chesapeake and Delaware (C&D) Canal. The mean range of tides throughout the entire Chesapeake Bay is generally 1 to 3 ft (NOS, 1988). In the project vicinity, the mean tide level is 0.9 ft above MLLW; the mean tidal range is 1.3 ft and the spring tidal range is 1.8 ft (NOS 1997).

- **Currents.** In the project vicinity, approximately 2.5 miles west of James Island, peak flood currents are about 1.0 ft/sec, and peak ebb currents are about 0.8 ft/sec (NOS, 1996). Currents are not considered important for shore protection design at this project site.

- **Wind and Wave Conditions.** Design winds for the site were developed on the basis of data collected at Baltimore-Washington International (BWI) airport. These winds, which can exceed 90 miles per hour during a 100-year storm event, were used to develop design wave conditions. James Island is exposed to wind-generated waves approaching from all directions.

- **Site Soil Characteristics.** Results of the separate geotechnical preliminary study indicate that the underlying soil consists of silty sand, suitable for supporting the dike. Areas with soft silty clays at the mud line, however, would need to be undercut and backfilled with sand.

The numerical modeling system used in this study consists of the US Army Corps of Engineers finite element hydrodynamics (RMA-2) and sedimentation (SED-2D) models – collectively known as TABS-2 (Thomas, McAnally and Ademac, 1985). The numerical modeling system uses a bathymetric mesh of water depths, represented by nodes located in the horizontal plane that are interconnected to create elements.

Correlation of the hydrodynamic model calibration results to NOAA predicted data for tidal elevations and current velocities is generally better than 90%. Predicted percent error is typically less than 10% for tidal elevations and less than 15% for current velocity.
The non-cohesive sediment model was run using 0.1mm (.004 inch) sediment under no-wind conditions. Analysis of results shows negligible sand transport due to tidal currents. Modeled non-cohesive sediment transport for existing conditions is negligible for 4- and 13-mph winds for all directions. Sixteen-mph winds, when taken cumulatively with lower wind speeds, account for nearly 90% of the yearly wind occurrences and cause significant sediment transport for winds from the NNW and SSE directions with less sediment transport for winds from other directions.

The cohesive sediment model was run for a 6-month simulation period at which point the model achieved a dynamic equilibrium (average values and rates remain steady over time). The cohesive sediment model was then run for each of 16 wind directions for wind speeds of 4- and 13-mph.

Hydrodynamics and sedimentation numerical modeling for the James Island Reconnaissance Study show minimal impacts on local tidal elevations, which are essentially unchanged. Current velocities are impacted following island construction, with maximum increase or decrease in current velocity of about 0.4 ft/sec. Construction at James Island also would have beneficial effects on sedimentation rates and patterns, with less erosion of the James Island shoreline and the shallow areas surrounding the remnant James Islands. Some protection would also be afforded to the shoreline of Taylors Island from wind and waves coming from the N, NNW, and NW directions. This reduction in erosion would likely cause reduced suspended sediment and improved water quality.

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Barren Island Reports

Feasibility-Level Environmental Conditions Studies for a Potential Island Restoration Project at Barren Island, Dorchester County, MD

Final Consolidated Report

Prepared for:
Maryland Port Administration
2310 Broening Highway
Baltimore, MD 21224

Under Contract to:
Maryland Environmental Service
259 Najoles Road
Millersville, MD 21108

MES Contract # 03-07-22
MPA Contract # 504804
MPA PIN # 52270020

February 2005

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BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

Executive Summary

Barren Island is located in the Chesapeake Bay in Dorchester County, Maryland, immediately west of Hoopers Island at Fishing Creek and across the Bay from the mouth of the Patuxent River (Figure 1-1). Historical and current maps of Barren Island indicate that the island has lost about 78% of its acreage since 1848 (Figure 1-2) (Weston, 2002a). Currently, Barren Island consists of three island remnants that total approximately 180 acres (Figure 1-3) (Weston, 2002a). Two additional island remnants, Opossum Island and an unnamed island, are located due east and south of Barren Island, respectively. Barren Island is currently federally owned and managed by the U.S. Fish and Wildlife Service (USFWS) as a satellite refuge area to Blackwater National Wildlife Refuge (BNWR).

Environmental conditions studies prepared for the Maryland Port Administration (MPA) under contract to Maryland Environmental Service (MES) were conducted by Blasland, Bouck and Lee, Inc. (BBL), EA Engineering, Science & Technology, Inc. (EA), Chesapeake Environmental Management Inc. (CEM), and Weston Solutions Inc. (Weston) to support a planned feasibility study to evaluate Barren Island as a potential island restoration project. The proposed restoration project would beneficially utilize dredged material from the Port of Baltimore Chesapeake Bay shipping channels to construct, stabilize, and restore wetland and upland habitats in the vicinity of Barren Island. Two potential dike alignments were originally considered for the potential island restoration project (Figure 1-4). As part of the joint feasibility study between the U.S. Army Corps of Engineers (USACE) and the MPA, these alignments were refined. Four potential dike alignments lying to the north, west and south of Barren Island were advanced for consideration (Figure 1-5), as part of the joint feasibility study process between the USACE and the MPA. During this process, a fifth alternative for Barren, in conjunction with dredged material placement at James Island, was also considered (Figure 1-6).

To conduct a comprehensive assessment of the existing environmental conditions at Barren Island, field sampling events were completed on a seasonal basis in the Summer and Fall of 2002 and the Winter and Spring 2003. Additional aquatic investigations were also completed at various times at Barren Island from May 2003 to March 2004. The objectives of the environmental conditions studies at Barren Island and vicinity were to document the aquatic and terrestrial ecological resources that exist on the remnants of Barren Island, and within and adjacent to the proposed alignments. Aquatic surveys included water quality and nutrient analyses, sediment quality and geotechnical characterizations, benthic invertebrate surveys, ichthyoplankton and zooplankton surveys, fisheries surveys (bottom trawl, gillnet, beach seine, and pop net gear types), submerged aquatic vegetation (SAV) surveys, soft-shell and razor clam surveys, crab pot surveys, and pound net surveys. Terrestrial and wildlife surveys included terrain type and vegetation characterizations and avian and wildlife surveys.

In situ water quality measurements were taken during 2002-2004 aquatic investigations in the vicinity of Barren Island. Water depth, sampling depth, water temperature, salinity, pH, turbidity, Secchi depth, and dissolved oxygen (DO) were recorded at each location. Sampling depths ranged from 0.5 to 14.0 feet. Water temperatures recorded during sampling activities ranged from 1.7 to 25.8 ^{o}C. Salinity ranged from 9.0 to 18.7 ppt. Measurements of pH ranged from 7.5 to 8.8, which is typical of waters of this salinity regime. Secchi depths were measured during the Winter and Spring 2003 surveys and ranged from 0.2 to 2.1 m. DO concentrations measured during various Barren Island aquatic surveys ranged from 6.1 to 15.2 mg/L. All DO measurements taken at Barren Island including the minimum recorded value (6.1 mg/L) in the Winter 2003 exceed anoxic and hypoxic levels and the Chesapeake Bay DO criteria (USEPA, 2003). Water samples were collected for laboratory analyses during the Summer and Fall 2002 and Winter and Spring 2003 seasonal field investigations and analyzed for dissolved inorganic nutrients, dissolved organic nutrients, particulate nutrients, chlorophyll-*a*, phaeophytin, and total suspended solids (TSS). Inorganics, organics and particulates were consistent among locations sampled around Barren Island. Chlorophyll-*a* and its degradation product, phaeophytin were somewhat high during the Spring 2003 survey. This is not unexpected, because algal blooms often occur in the late spring and early summer seasons. Higher TSS values were associated with locations with shallow depths that facilitated sediment suspension due to wave action. Overall, *in situ* water quality and nutrient data collected at Barren Island during the aquatic investigations fall within expected seasonal conditions and are representative for this portion of the Chesapeake Bay.

Sediment geotechnical characteristics were assessed during the Summer 2002 and Spring 2003 field investigations to determine bottom types of the surficial sediments surrounding Barren Island. Sediment geotechnical characteristics varied slightly in grain-size distribution between sampling locations. During both surveys, sediment sampling locations were primarily sand substrate with some silt/clay substrate composition variances between seasonal surveys. The minor differences recorded may be attributed to the normal variances between each sediment grab at a given location. The objective of the sediment quality assessment was to determine the presence and concentrations of chemical constituents in the surficial sediments surrounding Barren Island. Sediment samples were analyzed for a variety of organic compounds and inorganic chemicals during the Spring 2003 survey (BBL, 2004a). Chemicals detected in sediment samples were limited to metals, two individual polychlorinated biphenyl (PCB) congeners, and two polychlorinated dibenzo-*p*-dioxin (PCDD) congeners. The concentrations of these chemicals did not exceed available marine sediment quality guidelines (Buchman, 1999). This suggests that there are no contaminant risks to aquatic organisms in the project area.

Benthic invertebrate surveys were completed during the Summer and Fall 2002 and Spring 2003 field investigations to document existing (infaunal) communities of benthic invertebrates in sediments from the Chesapeake Bay surrounding Barren Island. Benthic invertebrates are used extensively as indicators of estuarine environmental status and trends. In total, 84 benthic invertebrate taxa were identified during the field surveys at Barren Island. The most dominant species identified during the combined 2002–2003 surveys representing 18.4% of the total count of benthic invertebrate taxa was the polychaete *Mediomastus ambiseta*. The benthic invertebrate data were evaluated by the use of the Chesapeake Bay Benthic Index of Biotic Integrity (B-IBI) developed by Weisberg et al. (1997), and other additional metrics to further characterize the benthic community. B-IBI metrics include total abundance, Shannon-Weiner Diversity Index, carnivore/omnivore abundance, percent stress-indicative taxa abundance, and percent stress-sensitive taxa abundance. Based on the calculated B-IBI scores, the majority of sampling locations yielded total B-IBI scores of 3.0 or greater, indicating that they meet the Chesapeake Bay Restoration Goal. Lower B-IBI scores associated with stations that did not meet the

Chesapeake Bay Restoration Goal may be related to environmental stresses such as wave action and sediment disturbance expected near the Chesapeake Bay channel.

Plankton surveys were completed during the Summer 2002 and Winter and Spring 2003 field investigations to characterize the existing seasonal communities of ichthyoplankton and zooplankton in the top and bottom of the water column of the Chesapeake Bay surrounding Barren Island. Bottom plankton tows captured a larger diversity and almost a four-fold greater density of zooplankton than surface tows across all seasonal surveys. Bay anchovy (*Anchoa mitchilli*) were the most abundant ichthyoplankton species identified during both bottom tows and surface tows. Fish eggs were not found in the Summer 2002 surveys, which is typical for late summer since most fish species begin spawning in early spring. The low densities of ichthyoplankton in the water column during the Winter 2003 survey indicate the low spawning activity that occurs in Chesapeake Bay fishes during this part of the year, and the increased densities of ichthyoplankton in the water column during the Spring 2003 supports the fact that the spawning activity occurs in Chesapeake Bay fishes during this part of the year (Murdy et al., 1997; NOAA, 1994). Several zooplankton taxa were identified during all seasonal field surveys (cnidaria, polychaeta, bivalvia, copepoda, mysidacea, cumaciea, isopoda, amphipoda, shrimp larvae), showing the seasonal consistency of these zooplankton taxa in the mid-Chesapeake Bay.

Fisheries surveys were conducted during the Summer and Fall 2002 and Winter and Spring 2003 field investigations to characterize the existing fish and blue crab (*Callinectes sapidus*) communities surrounding Barren Island. Several fisheries gear types were used during the various fisheries surveys: bottom trawls, gillnets, beach seines and pop nets. The beach seine sampling gear type represented 49% of the overall fish catch for the combined 2002–2003 fisheries surveys. In total, 15,689 individual fish were captured, 40 fish species were identified, and one unknown clupeid species was observed. Commercially and recreationally important finfish species that were identified during the fisheries surveys included American eel (*Anguilla rostrata*), Atlantic croaker (*Micropogonias undulate*), Atlantic menhaden (*Brevortia tyrannus*), bluefish, striped bass (*Morone saxatilis*), summer flounder (*Paralichthys dentatus*), white perch (*Morone americana*), and winter flounder (*Pleuronectes americanus*).

During the Summer 2002 fisheries survey, 30 fish species were identified and 13,069 individual fish and 135 blue crabs were captured. During the Fall 2002 fisheries survey, 12 fish species were identified and 154 individual fish and 4 blue crabs were captured. During the Winter 2003 fisheries survey, 8 fish species were identified and 178 individual fish were captured. As was expected due to this species' life cycle, blue crabs were absent from the shallow waters surrounding Barren Island during the Winter 2003 survey. During the Spring 2003 fisheries survey, 20 species were identified, one clupeid species was not identified, and 2,018 individual fish, 208 blue crabs, and 9 horseshoe crabs (*Limulus polyphemus*) were captured. As was expected due to this species' life cycle, horseshoe crabs were only present in the shallow waters surrounding Barren Island during the timeframe for expected spawning activities. During the Summer 2003 pop net fisheries survey, a total of 222 individual fish were captured and seven fish species were identified. In general, sampling areas to the west of Barren Island had the greatest abundances of fish across all seasons and gear types.

The highest combined abundance and species diversity was noted during the Summer 2002 field surveys, and the lowest combined abundance and species diversity was noted during the Winter 2003 survey. The following species were observed across seasonal surveys (gillnet, beach seine, and bottom trawl sampling gear types): Atlantic menhaden, Atlantic silverside (*Menidia menidia*), striped bass, striped killifish (*Fundulus majalis*), and white perch. The Atlantic silverside was the only species observed in all fisheries surveys (gillnet, beach seine, bottom trawl, and pop net sampling gear types). When the 2002–2003 fisheries data are combined, three of 41 observed species represented more than 88% of the 15,689 individuals captured: bay anchovy represented 73.5% of the catch with 11,531 individuals, Atlantic silverside represented 12% of the catch with 1,908 individuals, and striped killifish represented 3% of the catch with 419 individuals.

BBL conducted a monthly survey of crab pots from May through September 2003 to determine the approximate number of crab pots in the vicinity of the proposed alignments. During the May 2003 survey, approximately 850 crab pots were observed to the north, west, and south of Barren Island covering approximately 550.7 acres. During the June 2003 survey, approximately 700 crab pots were observed to the north, west, and south covering approximately 743.7 acres. During the July 2003 survey, approximately 700 crab pots were observed to the north, west, and south covering approximately 493.0 acres. During the August 2003 survey, approximately 1,500 crab pots were observed to the north, west, and south covering approximately 2,987.5 acres. During the September 2003 survey, only 70 crab pots were observed along three crab pot lines to the north of Barren Island. The probable cause of the decrease in crab pots in September was due to commercial watermen removing their crab pots prior to Hurricane Isabel.

A survey for soft-shell clams (*Mya arenaria*) and razor clams (*Tagelus plebius*) was conducted in March 2004 in the vicinity of Barren Island using a hydraulic clam dredge. Sampling was conducted along four transects: two transects located to the west and south of Barren Island within the proposed alignments, one transect located to the east of Barren Island, and a reference transect located to the west of the proposed alignments. At each transect segment, legal and sublegal clams were separated, enumerated, and volumes were measured to provide both actual volume of clams per hour (actual harvesting rate) and the potential volume of clams per hour (potential harvesting rate). In total, 3 legal and 14 sublegal soft-shell clams were identified, and 964 razor clams were identified. The Maryland Code of Regulations defines a productive natural clam bar as having an existing or potential harvesting rate of either 500 hard clams (*Mercenaria*) per hour, 0.5 bushels per hour of soft-shell clams, or 1.5 bushels per hour of razor clams (MDSD, 2004). Based on this definition, there were no observed transect locations with a productive natural clam bar.

Pound net owners licensed by the Maryland Department of Natural Resources (MDNR) were contacted in 2004 by the MDNR to confirm ownership and use of the licensed pound nets in the areas surrounding Barren Island. A telephone questionnaire was used to record this information. A summary of the survey results was provided to MES (and subsequently BBL) by MDNR for inclusion in this report (Section 3.1.9). In total, the 14 pound net license holders have 23 locations in the vicinity of Barren Island, of which 17 are actively being set and fished. Eight of the 14 pound net license holders conduct fishing activities daily from March or May through November or December. All of the fishermen surveyed responded that the following fish species were typically caught: Atlantic croaker, Atlantic menhaden, striped bass, summer flounder, and weakfish (*Cynoscion regalis*).

SAV surveys were conducted during the Summer 2002 and Spring and Summer 2003 field investigations to identify areas of SAV growth, the density of SAV growth, and the types of SAV present in each area. The Summer 2002 and 2003 SAV surveys were conducted in September in order to document the potential presence of widgeon grass (*Ruppia maritina*) and other late season grasses (Bergstrom, 2002). The Spring 2003 survey was conducted in mid June to catch the potential presence of horned pondweed (*Zannichellia palustris*) and eelgrass (*Zostera marina*), as instructed in the *Draft Chesapeake Bay Submerged Aquatic Vegetation (SAV) Ground Survey Directions, revised June 21, 2002* developed by Dr. Peter Bergstrom of the USFWS (Bergstrom, 2002). Aquatic species observed at Barren Island include eelgrass, horned pondweed, and widgeon grass. During the Summer 2002 survey, widgeon grass was the only species identified, but the macroalgae sea lettuce (*Ulva lactuca*) and eelgrass were observed washed up on the beach. Horned pondweed was the only species found in the area surrounding Barren Island during the Spring and Summer 2003 surveys. However, shallow salt ponds that support dense growths of widgeon grass were noted during the Spring 2003 terrestrial surveys on the northern end of the northern remnant and southwestern end of the southern remnant of Barren Island. The absence of SAV along the majority of the Barren Island shoreline during the Summer (i.e., September) 2003 survey may be associated with the scouring effects of Hurricane Isabel. The presence of SAV appears to be dependent on the location around the island. SAV crown densities were highest along the northern and eastern shorelines of Barren Island. SAV was absent within the geotextile tube areas, and was absent or in very low densities along the western shoreline of Barren Island. The likely reasons for the absence of SAV along the western shorelines of Barren Island are the steep slopes of the shoreline, lower water clarity, and a higher exposure to wave action.

Terrain type and vegetation characterizations including wildlife and avian surveys were conducted during the Summer and Fall 2002 and Winter and Spring 2003 field studies. Habitat types present on the Barren Island remnants include tidal flat, sand spit, beach, low and high salt marsh, freshwater marsh, salt panes, swale, upland forest, upland habitats on filled material, and smaller island habitat. A total of 78 plant species (21 tree species, 7 shrub species, 45 herbaceous species and 5 wood vine species) were observed during these habitats during the seasonal surveys. The most common invasive species on Barren Island is common reed (*Phragmites australis*), which is the dominant species and found throughout the island in any disturbed habitat, except the tidal flats and the low salt marshes.

There are several tidal flats associated with the various Barren Island remnants, covering approximately 17.3 acres. Invertebrates (including mud snail *Nassarius obsoletus* and blue crab) and fish are abundant in spring and summer months in this habitat. Beaches cover approximately 9.5 acres at Barren Island. Invertebrate, bird, and wildlife use of beaches is greatest during the warm seasons. Diamondback terrapin (*Malaclemys terrapin*) nesting activities observed along beaches appeared to increase the use of this habitat by predators, such as red fox (*Vulpus fulva*), raccoon (*Procyon lotor*), boat tailed grackle (*Quiscalus major*), and American crow (*Corcus brachyrynochos*). An observation of horseshoe crab spawning activity was followed by large schools of fish feeding on the dislodged eggs in the surf zone. The low salt marshes on Barren

Island remnants cover approximately 43.6 acres. The low salt marshes are dominated by monotypic stands of the tall form of common reed and changes to the short form before transitioning into high marshes.

In 2001, geotextile tubes were placed on the western shoreline of the Barren Island northern remnant, creating approximately 11 acres of low marshes. This area was planted with 100,000 plugs of saltmeadow cordgrass (*Spartina alterniflora*) in June 2001 and 50,000 plugs in May 2002. The created marsh appears to be successful and continued planting of marsh plant species is planned for September 2004 (Friends of BNWR, 2004).

The high salt marshes covering approximately 31.1 acres are more diverse floristically with respect to other terrain types at Barren Island and contain a mosaic of monotypic stands of individual species. Throughout the high marshes are shallow salt ponds that support dense growths of eelgrass. Bird and wildlife use of high marsh habitat is intense during the warm season. Salt pannes cover approximately 4.0 acres along the Barren Island northeastern remnant and behind the geotextile tube areas and are being used by several species for lofting and feeding as with the high marsh habitats. There are several freshwater (wetland) swales covering approximately 3.6 acres on Barren Island remnants as a result of anthropogenic alterations and natural effects. Freshwater marshes cover approximately 9.5 acres and are located in several areas on the northern and southern Barren Island remnants including depressions associated with the dredged material areas. Loblolly pine is the dominant tree species associated with the approximately 74.3 acres of forested terrain on both the northern and southern Barren Island remnants. During the spring and summer months, Opossum Island, located east of the Barren Island southern remnant and the small remnant island south of the southern Barren Island remnant is used as a nesting area by several species of birds.

Timed avian surveys were conducted at Barren Island during the Summer and Fall 2002 and Winter and Spring 2003 at five locations selected to represent the range of habitat types available around the island. In addition to the timed bird observations, qualitative surveys were conducted throughout the island remnants and adjacent aquatic areas. A total of 107 species of birds were observed during the seasonal field surveys. Of these, 45 species and 1,797 individuals were observed during the timed quantitative surveys. Of the 46 identified species, two species represented approximately half of all individuals recorded during all seasonal timed quantitative surveys: mute swan represented 30% of species with 531 individuals, and brown pelican represented 17% of species with 309 individuals. Diversity and abundance are highest in the shallow, sheltered aquatic ecosystems on the eastern shoreline of Barren Island. Location A-5 had the highest diversity across all seasonal field surveys, with 27 recorded species. The high densities of aquatic and upland birds are likely correlated to Barren Island's shelter, foraging, and breeding habitat, including nesting habitat for various rare and colonial nesting species. Three bird species observed at Barren Island are listed as rare, threatened, and endangered (RTE) species in Maryland (MDNR, 2004): the bald eagle (*Haliaeetus leucocephalus*), royal tern (*Sterna maxima*), and sedge wren (*Cistothorus platensis*). Based on these RTE-listed species and other avian resources such as colonial waterbird nesting sites, the Maryland Department of Natural Resources (MDNR) Wildlife and Heritage Service has designated Barren Island as part of the Sensitive Species Project Review Area (SSPRA) data layer (MDNR, 2005a,b).

Four mammal species were observed at Barren Island during the Summer and Fall 2002 and Winter and Spring 2003 surveys: muskrat (*Ondatra zibethica*), raccoon, red fox, sika deer (*Cervus nippon*), and whitetail deer (*Odocoileus virginianus*). Seven reptiles and two amphibians were also observed: diamondback terrapin, eastern box turtle (*Terrapene carolina*), eastern mud turtle (*Kinosternon subrubrum*), eastern painted turtle (*Chrysemys picta picata*), Fowler's toad (*Bufo fowleri*), narrow mouthed toad (*Gastrophryne carolinensis*), northern red bellied turtle (*Pseudemys rubriventris*), northern water snake (*Nerodia sipedon*), and spotted turtle (*Clemmys guttata*). Tiger beetle species (*Cicindela sp.*) were observed during the Summer 2002 survey on the sand spit located on the Barren Island northeastern remnant. Several tiger beetle species are listed as endangered species in Maryland (MDNR, 2004). No other mammal, macroinvertebrate, reptile, or amphibian species observed at Barren Island during any field survey activities are listed as rare, threatened, and endangered (RTE) animal species in Maryland (MDNR, 2004).

In addition, horseshoe crab and diamondback terrapin surveys were conducted during the Spring 2003 field investigation. These surveys were conducted for seven consecutive late night and early morning periods to try to capture horseshoe crab spawning activity and terrapin nesting activity along the shorelines of Barren Island at or near high tide. During the horseshoe crab survey, greater than 500 individuals were observed along the shorelines of Barren Island. Generally, beaches with a gradual slope up from the waters edge to the beach had the greatest observed usage as spawning habitat. The greatest horseshoe crab activity occurred along the shores of the southern geotextile tube area beach. During the terrapin survey, 141 individuals and 173 terrapin nests were recorded at Barren Island. The beach area on the northeastern shoreline of the Barren Island northeastern remnant accounted for 23% of all terrapin sightings on land or in the water near the shoreline of Barren Island. The northern beach of the northern remnant to the east of the old hunting lodge building remains and associated docks accounted for 29% of the observed nests. Generally, beaches with a gradual slope up from the waters edge to the beach had the greatest observed usage as a nesting habitat.

FINAL CONSOLIDATED REPORT

RECONNAISSANCE OF THE PROPOSED ENVIRONMENTAL RESTORATION PROJECT NEAR BARREN ISLAND DORCHESTER COUNTY, MARYLAND

Prepared for

MARYLAND ENVIRONMENTAL SERVICE
Annapolis, Maryland
Contract No. 01-07-30

Prepared by

WESTON SOLUTIONS, INC.
1400 Weston Way
West Chester, Pennsylvania 19380

August 2002

EXECUTIVE SUMMARY

Barren Island is an uninhabited island owned by the United States Fish and Wildlife Service (USFWS) that is located in the eastern portion of the middle Chesapeake Bay, to the east of the mouth of the Patuxent River, 1 mile off the eastern shore in Dorchester County, MD. The Island is currently approximately 180 acres, and is a federal wildlife refuge. Barren Island also serves as a satellite refuge for the Blackwater National Wildlife Refuge, located in Dorchester County, Maryland. Barren Island consists of several different types of high quality habitat including low and high salt marsh, tidal flats, and forested upland habitat. Barren Island is used as nesting habitat by several federally listed bird species. According to estimates by the USFWS, Barren Island is eroding along its western shore at a rate of approximately 10 to 14 feet per year, which is equivalent to a loss rate of 2.4 to 3.4 acres per year. The Island has lost approximately 450 acres in the past 325 years as the result of erosion caused by rising sea levels.

Barren Island is under consideration for a habitat restoration and beneficial use of dredged material project under the Maryland Port Administration's Dredged Material Management Program (DMMP), formerly the Dredging Needs and Placement Options Program (DNPOP). Four separate studies were conducted to evaluate the use of dredged materials in this environmentally sensitive area in order to provide shoreline stabilization and restoration for the island as well as provide additional marsh and upland habitat areas around the island.

These four studies include:

1. *Preliminary Assessment of Environmental Conditions on Barren Island* (ECR) - An environmental conditions assessment to document (including site visits, agency consultation, and literature review) environmental resources in the project area and determine the potential impacts of the proposed dredged material placement alternatives.

2. *Geotechnical Reconnaissance Study for Barren Island* (GRS) - A study of the geotechnical conditions (including foundation and borrow source conditions at Barren Island) of the area proposed for dredged material placement.

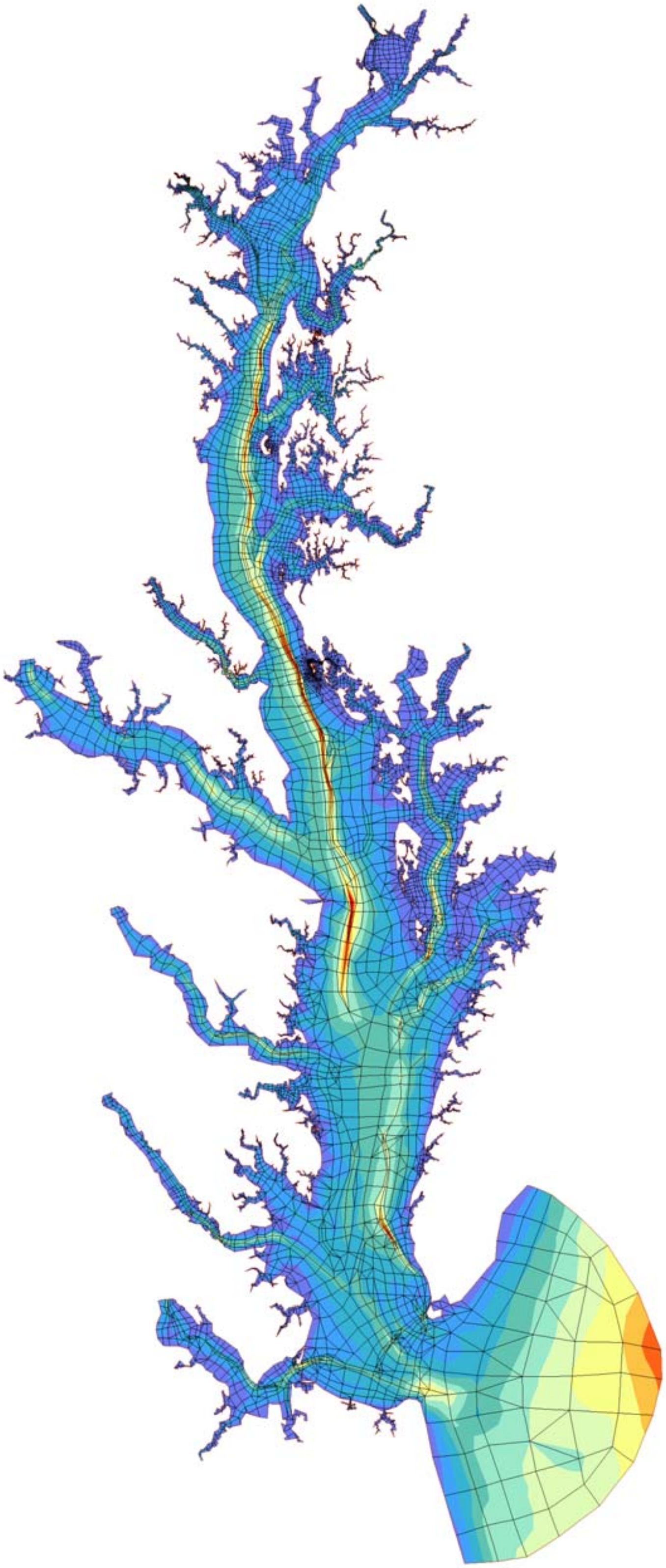
3. *Coastal Engineering Reconnaissance Study for Barren Island, Maryland* (CERS) - A preliminary coastal engineering analysis for use as a planning factor for dredging engineering and dike design.

4. *Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Barren Island* (*DECE)* – A study that provided a dredging engineering and cost analysis for each of the selected alternatives.

The two conceptual configurations assessed are an approximately 1,000-acre environmental restoration area (Alignment #1) and an approximately 2,000-acre environmental restoration area (Alignment #2). Both alignments are located in shallow water to the west and south of Barren Island. Both alignments would be constructed with stone armored sand dikes extending west and south from Barren Island towards the Chesapeake Bay mainstem and would include the generation of new habitat composed of 50% uplands and 50% wetlands. Both alignments would provide a tidal gut area between Barren Island proper and the environmental restoration area. For each alignment, two dike height options (10 and 20 feet) were assessed.

The results of these four reconnaissance studies are summarized in this consolidated report prepared for the Maryland Environmental Service on behalf of the Maryland Port Administration to evaluate the use of the area near Barren Island for habitat restoration and for shoreline stabilization of Barren Island.

BARREN ISLAND RECONNAISSANCE STUDY



HYDRODYNAMICS AND SEDIMENTATION MODELING

FINAL REPORT
SEPTEMBER 10, 2004

Prepared for

U.S. Army Corps of Engineers
Baltimore District

Contact No. DACW31-03-D-0002

Prepared by

Moffatt & Nichol
2700 Lighthouse Point East
Suite 501
Baltimore, MD 21224

EXECUTIVE SUMMARY

The purpose of this Hydrodynamics and Sedimentation Modeling Reconnaissance Study is to evaluate the projected impacts due to proposed construction of a Beneficial Use Habitat Restoration Site at Barren Island. Moffatt & Nichol's (MN) Chesapeake Bay – Finite Element Model (CB-FEM) was used to predict existing (without-project) and with-project conditions hydrodynamics and sedimentation for four alternative project alignments. This report summarizes the calibration and implementation of the CB-FEM two-dimensional numerical model of the Chesapeake Bay and evaluation of hydrodynamic and sedimentation output including time-varying flow velocity, water surface elevations, and patterns of erosion and accretion.

Background

A summary of site conditions that are relevant to the project is provided below:

- **Alignments.** Four project alignments, shown in Figure 2-3, have been proposed for this study. All four proposed alignments are located to the west of Barren Island with one alignment, Alignment E, attached to Barren Island and the remaining three alignments separated from Barren Island by a 500 foot wide channel. Alignment A is approximately 1,325 acres and extends farthest to the south relative to the other alignments. Alignment C is approximately 1,125 acres and extends farthest west but not as far south as Alignment A. Alignment D is approximately 600 acres and is long and narrow with a typical width of 1,500 feet for wetland creation. Alignment E is attached to Barren Island and most closely resembles the historic 1860's shoreline. Alignment E is approximately 690 acres.
- **Bathymetry and Topography.** Water depths in the area where the dikes would be located range from –2 ft to –12 ft Mean Lower Low Water (MLLW), with a maximum depth along the exterior dikes of -10 ft MLLW. Water depths in the deeper main stem portions of the Bay west of Barren Island are as great as –155 ft MLLW. In the project vicinity, three natural oyster bars (NOBs) and a fertile aquatic nursery area have been identified as shown in Figure 2-3.
- **Freshwater Inflow.** The drainage area of the Chesapeake Bay is approximately 64,000 square miles and includes portions of Maryland, Virginia, West Virginia, Pennsylvania, New York and the District of Columbia. Freshwater enters the Chesapeake Bay via approximately 150 major rivers and streams at approximately 80,000 cubic ft per second (Schubel and Pritchard, 1987).
- **Tides.** Water levels in the Chesapeake Bay are dominated by a semidiurnal lunar tide. Tides enter the Bay via the Chesapeake Bay entrance and the Chesapeake and Delaware (C&D) Canal. The mean range of tides throughout the entire Chesapeake Bay is generally 1 to 3 ft (NOS, 1988). In the project vicinity, the mean tide level is 0.9 ft above MLLW; the mean tidal range is 1.3 ft and the spring tidal range is 1.8 ft (NOS 1997).
- **Currents.** In the project vicinity, peak flood currents are on the order of 0.7 ft/sec, and peak ebb currents approach 0.4 ft/sec (NOS, 1996). Currents are not considered the limiting factor for shore protection design at this project site.
- **Wind and Wave Conditions.** Design winds for the site were developed on the basis of data collected at Baltimore-Washington International (BWI) airport. These winds, which

can exceed 90 miles per hour during a 100-year storm event, were used to develop design wave conditions. Barren Island is exposed to wind-generated waves approaching from all directions.

- **Site Soil Characteristics.** Results of the separate geotechnical preliminary study (E2CR, 2002) indicate that the underlying soils consist mostly of loose silty sand, suitable for supporting the dike. Areas with soft silty clays at the mud line, however, would need to be undercut and backfilled with sand.

Numerical Model

The numerical modeling system used in this study consists of the US Army Corps of Engineers finite element hydrodynamics (RMA-2) and sedimentation (SED-2D) models – collectively known as TABS-2 (Thomas, McAnally and Ademac, 1985). The numerical modeling system uses a bathymetric mesh of water depths, represented by nodes located in the horizontal plane that are interconnected to create elements.

Calibration

Correlation of the hydrodynamic model calibration results to NOAA predicted data for tidal elevations and current velocities is better than 90%. Predicted percent error is less than 10% for tidal elevations and less than 20% for current velocity.
The non-cohesive sediment model was run using 0.1mm (.004 inch) sediment under no-wind conditions. Analysis of results shows negligible sand transport due to tidal currents. Non-cohesive sediment was then modeled non-cohesive for existing conditions under 4-, 13-, and 16-mph winds. Results show that sediment transport is negligible for 4- and 13-mph winds for all directions. Sixteen-mph winds, when taken cumulatively with lower wind speeds, account for nearly 90% of the yearly wind occurrences and cause sediment transport for winds from the north-northwest through to the south-southeast (counter-clockwise direction) directions with less sediment transport for winds from other directions. The results of the 16-mph wind modeling are discussed in this report.

The cohesive sediment model was run for a 6-month simulation period at which point the model achieved a dynamic equilibrium (average values and rates remain steady over time). The cohesive sediment model was then run for each of 16 wind directions for wind speeds of 4- and 13-mph. Sediment transport of cohesive sediment occurs for 13-mph winds from the north-northwest through to the south-southeast (counter-clockwise direction) directions with less sediment transport for winds from other directions, and the results of 13-mph winds are presented in this report.

Results

Hydrodynamics and sedimentation numerical modeling for the Barren Island Reconnaissance Study show no impacts on local tidal elevations, which are unchanged from existing to with-project conditions. Local current velocities are impacted following island construction, with typical maximum changes in current velocity on the order of 0.5 ft/sec which when taken with existing tidal currents are not sufficient to cause sediment suspension or shoreline erosion. The proximity of the southern tip of Alignments A and D to Upper Hooper Island cause a constriction which increases current velocities locally and reduces overall flow between Barren Island and Upper Hooper Island. Alignments A, C, and D show areas of increased velocity in the gap between the proposed project and existing Barren Island. Alignment E shows the least changes to current velocity patterns and rates.

Alignments A and D have the longest north-south profiles and provide the most shoreline protection to Upper Hooper Island. Alignment C has a shorter north-south profile and provides less shoreline protection than A and D while Alignment E has the shortest north-south profile and results in the least shoreline protection to Upper Hooper Island.

Alignment C creates the largest sheltered areas and causes reduced erosion and accretion over the NOBs to the northwest and southwest and over the nursery area to the north of Barren Island. Alignment A creates smaller sheltered areas and provides less reduction over the NOBs and nursery area than Alignment C. Alignments D and E create limited sheltered areas and create almost no change in sedimentation rates and patterns over the NOBs northwest and southwest and the nursery area north of Barren Island.

Storm tides are projected to magnify the current velocity and sedimentation results presented in this report. Project construction would provide some sheltering by reducing wind fetches and the resulting waves. The long north-south profile of Alignments A and D would provide added protection to Barren Island, Upper Hooper Island, and Meekins Neck for winds and waves from the southwest through the southeast and existing Barren Island would be protected from winds and waves from the north-northwest through southeast. Alignments C and E provide additional protection to Barren Island, Meekins Neck, and Upper Hooper Island from erosion but the protection is not as extensive as for Alignments A and D due to the shorter north-south profile of Alignments C and E.

Recommendations

Alignment A provides the most increase in shoreline protection while providing beneficial changes to sedimentation by reducing erosion and accretion over the nursery area and the NOBs. Alignment A has a long north-south profile which protects the Upper Hooper Island shoreline. Alignment A also protrudes to the west which provides some sheltering to the nursery and NOBs from waves.

The Alignment which provides the most increase to shoreline protection with the least impacts to hydrodynamic and sedimentation is Alignment D. Due to its long, narrow profile, Alignment D acts more like a breakwater than an island. The narrow profile of Alignment D causes the least changes to current velocities and to sedimentation patterns and rates over the nursery to the north and the NOBs to the northwest and southwest of Barren Island.