US Army Corps of Engineers
Baltimore District

Baltimore Harbor and Channels (MD and VA) Dredged Material Management Plan and Final Tiered Environmental Impact Statement

Volume I – Text

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LIST OF ACRONYMS

AE&D	advance engineering and design
AIC	Artificial Island Creation
AIRFA	American Indian Religious Freedom Act
APE	area of potential effect
ASMFC	Atlantic States Marine Fisheries Commission
bcy	billion cubic yards
BEWG	Bay Enhancement Working Group
B-IBI	Benthic Index of Biotic Integrity
BMP	best management practice
bp	before present
bu	bushels
C&D	Chesapeake and Delaware
CAA	Clean Air Act
CAC	Citizens' Advisory Committee
CAD	confined aquatic disposal
CDF	confined disposal facility
CBP	Chesapeake Bay Program
CBBMP	Chesapeake Bay Benthic Monitoring Program
CBBT	Chesapeake Bay Bridge-Tunnel
CBSAC	Chesapeake Bay Stock Assessment Committee
CE	cost effectiveness
CENAB	U.S. Army Corps of Engineers, Baltimore District
CENAO	U.S. Army Corps of Engineers, Norfolk District
CENAP	U.S. Army Corps of Engineers, Philadelphia District
CENWW	U.S. Army Corps of Engineers, Walla Walla District
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CHKOH	Chickahominy River
CO	carbon monoxide
CEQ	Council on Environmental Quality
CRRMH	Corrotoman River
CWA	Clean Water Act
cy	cubic yard
dB	decibel
dBA	weighted-A decibel scale
DMA	Dredged Material Area

LIST OF ACRONYMS
(Continued)

DMCF	Dredged Material Containment Facility
DMMP	Dredged Material Management Program
DN	disseminated neoplasia
DO	dissolved oxygen
E	endangered
E&S	erosion and sedimentation
EFH	essential fish habitat
EIS	Environmental Impact Statement
EPCRA	Emergency Planning and Community Right to Know Act
EPW	Evaluation for Planned Wetlands
ER	Engineering Regulation
ESA	Endangered Species Act
ESC	Erosion and Soil Control
ETM	Estuarine Turbidity Maximum
FE	federally endangered
FEMA	Federal Emergency Management Agency
FPP	Farmland Protection Policy
FMP	Fishery Management Plan
FT	federally threatened
ft/s	feet/second
FWCA	Fish and Wildlife Coordination Act
GIS	Geographic Information System
gpm	gallons per minute
GRR	General Re-evaluation Report
HAPC	Habitat Areas of Potential Concern
HEP	Habitat Evaluation Procedure
HMI	Hart-Miller Island
HTRS	hazardous, toxic, and radioactive substance
HTRW	hazardous, toxic, and radioactive waste
HUD	Department of Housing and Urban Development
ICA	incremental cost analysis
ITM	Inland Testing Manual
ITR	Independent Technical Review
lf	linear feet
LID	low-impact development

LIST OF ACRONYMS
(Continued)

LIR	Large Island Restoration
LWCFA	Land and Water Conservation Fund Act
ma	million years ago
MAFMC	Mid-Atlantic Fishery Management Council
MACEJ	Maryland Advisory Council on Environmental Justice
MBWSR	Minnesota Board of Water and Soil Resources
mcy	millions in cubic yards
MD DNR	Maryland Department of Natural Resources
MDE	Maryland Department of the Environment
mg/L	milligrams per liter
MGS	Maryland Geological Survey
MHT	Maryland Historic Trust
MinRAM	Minnesota Routine Assessment Method for Evaluating Wetland Functions
MLLW	mean lower low water
MNRP	Maryland Natural Resources Police
MPA	Maryland Port Administration
MPRSA	Marine Protection, Research, and Sanctuaries Act
msl	mean sea level
NAAQS	national ambient air quality standard
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	Naval Air Station
NCDC	National Climatic Data Center
NCDEHNR	North Carolina Department of Environment, Health, and Natural Resources
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
nm	nautical miles
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOB	natural oyster bar
Norfolk DMA	Norfolk Ocean Dredged Material Area
NOx	nitrogen oxides
NPL	National Priorities List
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places

LIST OF ACRONYMS (Continued)

NWR	National Wildlife Refuge
O&M	operation and maintenance
MNR	Ministry of Natural Resources
PA	Preliminary Assessment
PADEP	Pennsylvania Department of Environmental Protection
PAHs	polycyclic aromatic hydrocarbons
PELs	probable effects levels
PGL	Planning Guidance Letter
PIERP	Poplar Island Environmental Restoration Project
PM	particulate matter
PMP	Project Management Plan
PPA	Pollution Prevention Act
psu	practical salinity unit
QA/QC	quality assurance/quality control
RCRIS	Resource Conservation and Recovery Information System
ROD	Record of Decision
RPPMH	Lower Rappahannock River
RPPTF	Upper Rappahannock River
RTE	rare, threatened, and endangered
SAFMC	South Atlantic Fisheries Management Council
SAV	submerged aquatic vegetation
SC	special concern
sf	square feet
SHPO	State Historic Preservation Office
SIR	Small Island Restoration
SOx	sulfur oxides
SNS	shortnose sturgeon
SRBC	Susquehanna River Basin Commission
SSPRA	Sensitive Species Project Review Areas
SWH	shallow water habitat
T	threatened
TCE	trichloroethene
TELs	threshold effects levels
TMDL	total maximum daily load
TOC	total organic carbon

LIST OF ACRONYMS
(Continued)

TPH	total petroleum hydrocarbons
TRI	Toxic Release Inventory
TSS	total suspended solids
U.S. EPA	U.S. Environmental Protection Agency
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
VADEQ	Virginia Department of Environmental Quality
VDCR	Virginia Department of Conservation and Recreation
VESCL&R	Virginia Erosion and Sediment Control Law, Regulations, and Certification Regulations
VIMS	Virginia Institute of Marine Science
VMRC	Virginia Marine Resources Commission
VNRHP	Virginia Natural Resources Heritage Program
VOC	volatile organic compound
WCSC	Waterborne Commerce Statistical Center
WET	wetland evaluation technique
WQI	Wetland Quality Index
WRAP	Wetland Rapid Assessment Procedure
WRDA	Water Resources Development Act
WWTP	wastewater treatment plant

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EXECUTIVE SUMMARY

Introduction

The U.S. Army Corps of Engineers (USACE) Baltimore District (CENAB) is responsible for the maintenance of a network of federal navigation channels leading to and from the Port of Baltimore. Under the auspices of the currently authorized Baltimore Harbor and Channels project, CENAB maintains a series of main channels, approach channels, and connecting channels that provide passage from the Virginia Capes into Baltimore Harbor and northward in the Chesapeake Bay to a point south of Pooles Island. The project was authorized by the River and Harbor Act of August 8, 1917 and was modified by the River and Harbor Acts of January 1927, July 1930, October 1940, March 1945, July 1958, and December 1970 and Section 101a(22) of the Water Resources and Development Act (WRDA) 1999. The project consists of the following three components: 1) the 42-Ft Project; 2) the 50-Ft Project; and 3) the Baltimore Harbor Anchorages and Channels Project.

The Baltimore Harbor and Channels 42-Ft Project includes the southern approach and connecting channels, 35 ft deep and 600 ft wide, leading to the Inland Waterway – Delaware River to Chesapeake Bay, Delaware and Maryland, Chesapeake and Delaware (C&D) Canal project. It also includes branch channels 18, 22, 35, and 42 ft deep and 200 to 600 ft wide in the Curtis Creek and Ferry Bar reaches of the Harbor.

The Baltimore Harbor and Channels 50-Ft Project includes a uniform main channel 50 ft deep, and generally 800 (in Maryland) or 1,000 ft wide (in Virginia) through the Chesapeake Bay from the Virginia Capes to Fort McHenry in the Port of Baltimore. Depths of 50, 49, and 40 ft are authorized in the 600-ft-wide channels of Curtis Bay, Northwest Branch East Channel, and Northwest Branch West Channel, respectively.

The Baltimore Harbor Anchorages and Channels Project provides for improvements and maintenance of two anchorages, a turning basin, and branch channels to the Dundalk, Seagirt, and South Locust Point Marine Terminals within Baltimore Harbor.

The Inland Waterway – Delaware River to Chesapeake Bay, Delaware and Maryland, C&D Canal project is maintained by the USACE Philadelphia District and provides for, in part, channels 35 ft deep and 450 ft wide from the Delaware River to just south of Pooles Island in the Chesapeake Bay.

Purpose and Need

The USACE Engineering Regulation (ER) 1105-2-100 mandates that the USACE Districts develop a Dredged Material Management Plan (DMMP) for all federally maintained navigation harbor projects where there is an indication of insufficient placement capacity to accommodate maintenance dredging for the next 20 years. The DMMP is a planning document that ensures maintenance dredging activities are performed in an environmentally acceptable manner, use sound engineering techniques, and are economically justified. A DMMP addresses a full range of placement alternatives, leading to the selection of a final plan that ensures that sufficient placement capacity is available for at least the next 20 years.

In July 2001, a Preliminary Assessment (PA) for the Baltimore Harbor and Channels DMMP was completed by CENAB. The purposes of the PA were to document the continued viability of the Baltimore Harbor and Channels project and to determine whether there is dredged material placement capacity sufficient to cover at least 20 years of maintenance and new work dredging. The PA recommended that a DMMP be prepared, concluded that continued maintenance dredging of the authorized federal channels is justified, and determined there is a shortfall of over 50 million cubic yards (mcy) of dredged material placement capacity for the next 20 years. The Philadelphia District's Dredged Material Management Plan Preliminary Assessment for the Inland Waterway from the Delaware River to Chesapeake Bay, Delaware and Maryland, September 1995, concluded that there is a shortage in dredged material capacity for the channel reach from the Sassafras River to Pooles Island and recommended a dredged material management study to identify suitable placement sites. Thus, preparation of a programmatic DMMP was recommended.

The specific objectives of the Baltimore Harbor and Channels DMMP are to:

- Develop a plan to maintain, in an economically and environmentally sound manner, channels necessary for navigation to the Port of Baltimore.
- Conduct dredged material placement in an environmentally sound manner.
- Maximize the use of dredged material as a beneficial resource.

- Ensure that there is a minimum of 20 years of dredged material capacity for the project.

Study Area

The study area includes a major portion of the Chesapeake Bay watershed, which is an area of more than 64,000 square miles of land that drains into the Chesapeake Bay and its tributaries. Although the watershed stretches across six states—New York, Pennsylvania, Maryland, Delaware, Virginia, and West Virginia—and the District of Columbia, the area evaluated in this study is limited to the Bay and potential dredged material placement sites in Pennsylvania, Maryland, and Virginia required for maintaining the federal channels serving the Port of Baltimore. The Port of Baltimore is located on the Patapsco River Basin on the west side of the upper Chesapeake Bay and has 45 miles of waterfront, 25 miles of which are industrially developed.

In order to effectively evaluate the entire navigation system, the federal channels for the Port of Baltimore were divided into four geographic subareas. The four geographical subareas are C&D Canal Approach Channels, which extend from the mouth of the Sassafras River south to the Tolchester Channel, south of Pooles Island; Harbor Channels, which include the channels in the Patapsco River, inside the North Point-Rock Point Line; Chesapeake Bay Approach Channels (MD), which extend from the North Point-Rock Point Line south and east to include the Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, Brewerton Channel Eastern Extension, Tolchester Channel, and Swan Pt. Channel; and the Chesapeake Bay Approach Channels (VA), which extend from the Maryland-Virginia state line south to the Atlantic Ocean and include the Rappahannock Shoal, York Spit, and Cape Henry Channels.

Dredging Need

Over the 21-year period (2005-2025) to be covered in the DMMP, there is an estimated total need of approximately 119.7 mcy of dredged material capacity, including maintenance of existing channels and new work dredging. Approximately 16 mcy of maintenance dredging is projected from the Chesapeake Bay Approach Channels (VA), where there is sufficient capacity at the existing open-water sites. Therefore, the total projected net need is 103.7 mcy.

The existing dredged material placement sites of the Cox Creek Confined Disposal Facility (CDF), Pooles Island Open Water Site, Hart-Miller Island (HMI), and Poplar Island Environmental Restoration Project (PIERP) have a total remaining placement capacity of 47.7 mcy. Therefore, over the 21-year period of the DMMP, after subtracting the existing capacity in Maryland of 47.7 mcy and in Virginia open water placement sites of 16 mcy, there is a total shortfall of 56 mcy of capacity.

Local Sponsor

Successful dredged material management planning is a collaborative process. The planning for this DMMP has been conducted by a partnership that includes the federal government; the local sponsor, the State of Maryland through the Maryland Port Administration (MPA); state and local governments; public interest groups; the scientific community; and private citizens.

The State of Maryland, through the MPA, is conducting its own DMMP for the Port of Baltimore. The program will develop a long-term dredging and dredged material placement plan for the Port, including the identification of potential new placement sites. The USACE DMMP differs from the state's DMMP in that it is more inclusive geographically, including all of the Baltimore Harbor & Channels project channels in Virginia waters in addition to those in Maryland waters; it includes an economic evaluation to determine the federal interest in continued maintenance of the channels; it addresses a wide range of dredged material placement alternatives, including some that may be prohibited by state law in order to determine the appropriate federal authorities for constructing and cost sharing dredged material placement sites; and it includes a programmatic Environmental Impact Statement (EIS) that addresses the placement alternatives and updates the National Environmental Policy Act (NEPA) documentation for dredging all of the Baltimore Harbor & Channels project channels.

CENAB is an integral player in the state's program and has representatives on the state's Executive, Management, and ad hoc working committees. CENAB also provides periodic briefings to the state's Citizens' Advisory Committee. CENAB will continue to work closely with the state to integrate the two processes, use the state's committees, share information, and prevent duplication of effort. This close coordination is essential in developing a comprehensive program for the Port of Baltimore that will provide cost-effective dredging and placement operations and protect, conserve, and restore coastal resources.

DMMP Study Process

The process that the CENAB DMMP team has followed in the preparation of this plan is shown in Figure ES-1.

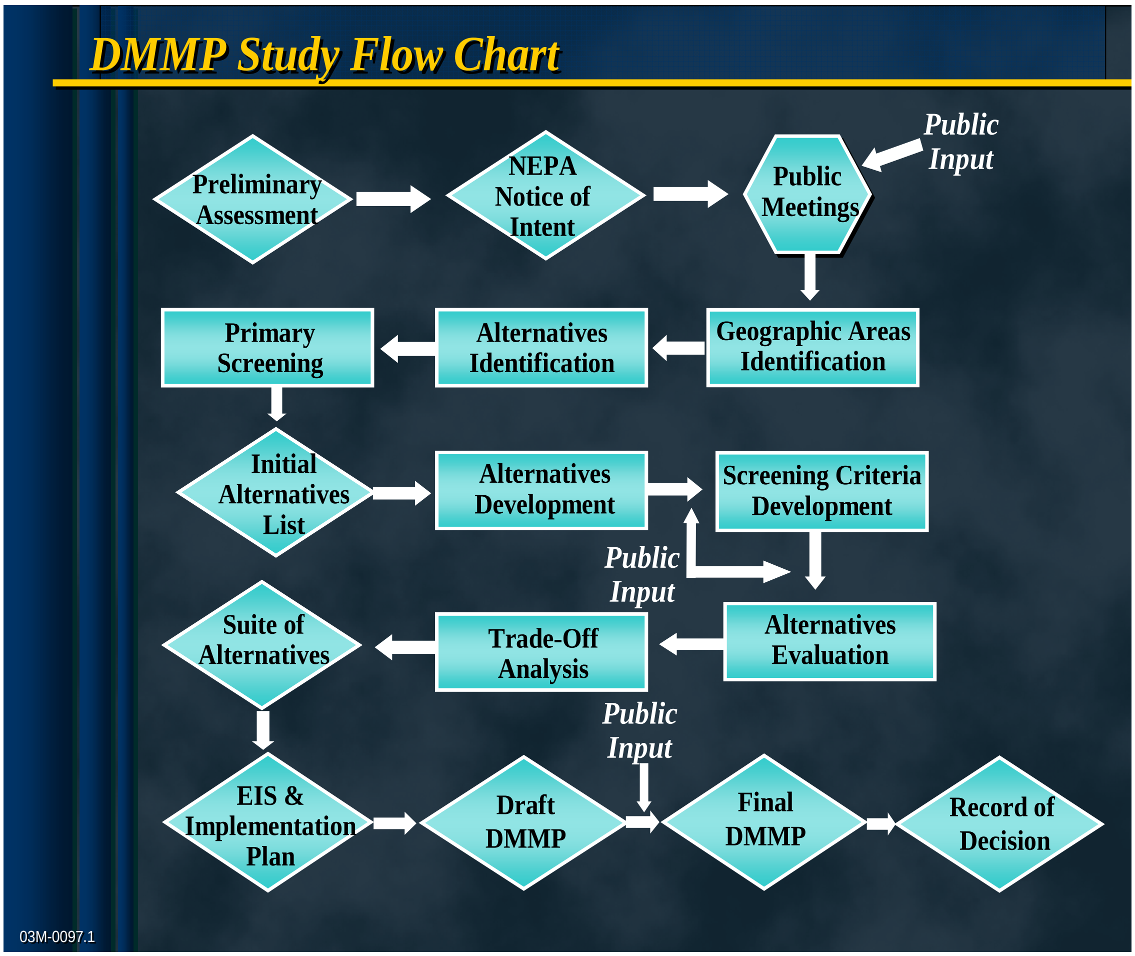

Figure ES-1 DMMP Process

The first step in the DMMP process was the PA, which CENAB finalized in July 2001. Following the PA, it was determined that an EIS would be required to satisfy the requirements of the NEPA. A NEPA Notice of Intent (NOI) to prepare a Draft EIS was published in the Federal Register in May 2002 and public meetings were held in Stevensville, MD; Baltimore, MD; and Arnold, MD, in June 2002. A Project Management Plan (PMP) was developed in October 2002 and scoping ensued for the DMMP Study. Scoping culminated in July 2003 with the award of a contract to Weston Solutions, Inc., for the preparation of the DMMP Study and EIS.

The first step of the DMMP study was the Geographic Areas Identification within the study area. Following the identification of the geographical areas, the team performed an Alternatives Identification for dredged material placement. All alternatives that were being considered at the time through the State of Maryland Dredged Material Management Program were included along with alternatives the state was not considering because the alternative was 1) contrary to state law or 2) applicable outside Maryland. The CENAB DMMP is a federal study and is therefore not constrained by state or local laws or regulations. Where feasible, the team will give due consideration to state and local laws, but will not be constrained by them in cases where state and local laws are not based on scientific criteria, applicable federal criteria are met, and consideration of such laws would add significant costs.

Once a full host of alternatives was identified, the team performed a primary screening to remove any alternative that was either not feasible or involved locations outside the Chesapeake Bay Watershed Area. An example of an alternative that is not feasible is beach nourishment in the northern Bay. Because of the silty nature of the dredged material in the Upper Bay, it would not be appropriate for use as beach nourishment. The team made two exceptions to the Bay watershed area criteria—mines and ocean placement. There are mines outside the watershed area, such as Bark Camp Mine in Pennsylvania, which have tremendous capacity and are currently being used by other USACE districts as a dredged material placement site. Ocean placement was considered, despite being outside the watershed area, because of the vast capacity available for placement and interest amongst the public and environmental groups to consider this option.

The result of the primary screening is the Initial Alternatives List. The team performed further Alternatives Development on the list by compiling additional information for each placement alternative. The information included a general location for each new placement alternative; the relative capacity of the placement alternative; relative cost to construct, operate, and maintain the placement alternative; accessibility, constructability, and operability issues for the placement alternative; and environmental, recreational, commercial, residential, and regulatory impacts from the placement alternative.

The next step in the DMMP process was the Screening Criteria Development. In order to compare the alternatives to each other, the team developed four main criteria: capacity of the placement alternative; cost to dredge, construct, operate, and maintain each placement alternative; the environmental impact (positive or negative) caused by each placement alternative; and the risk, both technical/logistical and acceptability associated with the alternative. The Alternatives Evaluation followed by comparing each alternative for capacity (mcy), cost ($), and environmental impact.

A Trade-off Analysis was then performed by comparing the cost per cubic yard of capacity provided by each alternative and the cost per habitat value generated from each alternative. Alternatives were assembled into suites for each of the four geographic subareas to meet the net dredged material placement quantity requirements for the subarea. Once the Suite of Alternatives for each of the four geographic subareas were developed and compared, a recommended plan was selected and the EIS was prepared. Following the preparation and distribution of the Draft Programmatic DMMP and Tiered EIS and holding public meetings to solicit public comment on the document, a Final Programmatic DMMP and Tiered EIS will be published for public distribution. Not less than 30 days after the publication of the EPA's Notice of Availability of the Final Programmatic DMMP and Tiered EIS, USACE may issue a Record of Decision (ROD) documenting its decision regarding the proposed action. Signing the ROD will complete the federal requirements for finalizing the EIS process and Phase II of the overall DMMP process. The decision that is documented in the ROD will determine the necessary project-specific feasibility studies to be undertaken in Phase III of the DMMP process, during which project-specific NEPA documents will be prepared.

Alternatives

The CENAB DMMP evaluated numerous alternatives for achieving sufficient dredged material placement capacity over the next 21 years to include "no action," the federal standard, use of existing sites, expansion of existing sites, creation of new sites, and innovative uses.

The "no action" alternative consists of the continuation of current maintenance dredging at the constructed channel dimensions and placing the dredged material at existing placement sites without modification. The existing placement sites include Pooles Island Open Water Site, HMI Dredged Material Containment Facility (DMCF), Cox Creek CDF, PIERP Site, Rappahannock Shoal Deep Alternate Open Water Site (VA), Wolf Trap Alternate Open Water Site (VA), Norfolk Ocean Open Water Site (VA), and Dam Neck Ocean Open Water Site (VA). Although the open water placement sites in Virginia have adequate capacity for the next 21 years, the other existing sites will exhaust capacity within the next 10 years.

The federal standard is the least costly dredged material placement alternative consistent with sound engineering practices and compliant with federal environmental laws. The federal standard limits federal investment to a justified level of costs, serves as a basis for cost-sharing, and establishes baseline costs for economic analyses. The federal standard for the Port of Baltimore is open water placement at Pooles Island for C&D Canal Approach Channel (Lower Approach) material, placement at HMI DMCF for Harbor Channel material, open water placement in the Deep Trough for Chesapeake Bay Approach Channel (MD) material, and open water placement at existing sites in the Chesapeake Bay and Atlantic Ocean for Chesapeake Bay Approach Channel (VA) material. Maryland state law mandates closure of Pooles Island Open Water Site in 2010, mandates closure of HMI DMCF in 2009, and prohibits open water placement in Maryland waters of the Chesapeake Bay, including at the Deep Trough. Open water placement sites in Virginia waters are the only portions of the federal standard that are implementable under state law after 2009 and 2010.

Within the CENAB DMMP, 36 different types of placement sites were considered to include existing sites, expanded existing sites, new sites, and innovative uses. When evaluated over the four geographic subareas, a total of 77 alternatives were developed and compared. They are included in Table ES-1. The block symbol next to each alternative type indicates the geographic subareas where the alternative is applicable.

For each alternative that was not associated with existing sites, a representative geographic location was defined for the alternative. This was done by utilizing extensive geographic information system (GIS) data to identify suitable locations that exhibited desired characteristics. or trends (i.e., shoreline that has eroded over time, providing opportunity for restoration) and avoid environmental resources (e.g., oyster beds, submerged aquatic vegetation).

Table ES-1 USACE Baltimore Harbor & Channels DMMP Alternatives

Dredged Material Management Placement Options	Harbor Channels	C&D Approach Channels	Ches Bay Approach (MD)	Ches Bay Approach (VA)
Agricultural Placement -- Maryland	■	■	■	
Agricultural Placement -- Virginia				■
Artificial Island Creation -- Lower Bay				■
Artificial Island Creation -- Upper Bay	■	■	■	
Beach Nourishment -- Virginia				■
Building Products	■	■	■	■
C&D Canal Upland Sites Expansion	■	■	■	
Capping -- Brownfields	■	■	■	■
Capping -- Landfill	■	■	■	■
Capping -- Elizabeth River, VA				■
Capping -- Patapsco River, MD		■	■	
Confined Aquatic Disposal Area -- Patapsco River, MD	■			
Confined Disposal Facility -- Lower Bay				■
Confined Disposal Facility -- Patapsco River, MD	■			
Cox Creek Expansion	■			
Hart-Miller Island Expansion	■	■	■	
Large Island Restoration -- Lower Bay				■
Large Island Restoration -- Mid Bay		■	■	
Mine Placement -- Cecil County, MD	■	■	■	
Mine Placement -- Western Maryland	■	■	■	
Norfolk Ocean Open Water Placement		■	■	■
Pooles Island Open Water Site Expansion		■	■	
PIERP Expansion		■	■	
Rappahannock Shoal Deep Alternate Open Water Site Expansion		■	■	■
Shoreline Restoration -- Lower Bay				■
Shoreline Restoration -- Mid Bay	■	■	■	
Shoreline Restoration -- Upper Bay	■	■	■	
Small Island Restoration -- Lower Bay				■
Small Island Restoration -- Mid Bay	■	■	■	
Wetlands Restoration -- Dorchester County, MD		■	■	
Dam Neck Ocean Open Water Placement (Existing)				BASE
Hart-Miller Island (Existing)	BASE	■	■	
New Open Water Placement -- Mid Bay (Deep Trough)		■	BASE	
Pooles Island Open Water Site (Existing)		BASE		
Rappahannock Shoal Deep Alternate Open Water Site (Existing)				BASE
Wolf Trap Alternate Open Water Placement (Existing)		■	■	BASE

Concept-level design assumptions were developed for all alternatives except those at existing sites. The design parameters include information such as dike configuration, dimensions, and length; facility infrastructure size and construction materials; equipment that would dredge, transport, and off-load material, etc. Developing a concept-level design for each new or modified alternative and utilizing the current parameters at existing sites allowed development of environmental impacts and calculations of cost and capacity during the plan formulation phase of the DMMP.

Plan Formulation

Within the DMMP Plan Formulation phase, the 77 alternatives were compared to determine the most feasible means to manage 21 years of dredged material using three quantitative (environmental impact, capacity, cost) and two qualitative (technical/logistical risk and acceptability risk) criteria.

Environmental impact for each of the alternatives was measured using a relative habitat index that reflects the net amount and quality of habitat that will be created by an alternative. The State of Maryland DMMP Bay Enhancement Working Group's (BEWG) Environmental Ranking of Dredged Material Management Plan Options was used as the basis for this DMMP's environmental impact analysis. The BEWG scored each of the federal DMMP alternatives using a scale of +1 (potential positive impact), 0 (neutral impact), and -1 (potential negative impact). The alternatives were scored using 52 different criteria, each with a unique weight, in 10 categories (water quality, shallow water habitat, wetlands, aquatic biology, rare/threatened/endangered species, waterbirds, terrestrial, physical parameters, human use attributes, beneficial attributes). The resulting BEWG score was normalized, then multiplied by the acreage of habitat created by the alternative to generate a habitat benefit index. The methodology used to normalize and adjust the BEWG scores is presented in detail in Appendix B. This ranking scheme created an in-depth method of evaluating each alternative for its impact on the environment and a means to compare the relative effects of each alternative against the others to identify those most desirable alternatives.

Capacity for each of the alternatives was developed using the concept-level design assumptions created for each of the alternatives. Since the site's remaining capacity will increase as the dredged material dries and consolidates, a conversion factor was applied to the site volume to determine the total capacity for the life of the project. The conversion factor ranges from 0.7 to 0.9 depending on the site and application.

The total cost for each alternative was derived by using the concept-level design assumptions and computing the individual costs associated with dredging, material transportation, material off-loading, material pre-treatment (if necessary), site construction, material placement, site management, site restoration, site maintenance, and site monitoring. By dividing the total cost by capacity, a cost per cubic yard ($/cy) was calculated.

In addition to quantitative criteria, the study considered two types of qualitative criteria that reflect the likelihood of an alternative being "implementable." Technical and Logistical Risk is defined as the likelihood that an alternative will not perform as expected, in terms of placement capacity and/or environmental benefits within the planning period. Acceptability Risk is defined as the likelihood that legal and political challenges will prevent or significantly delay the implementation and performance of an alternative within the planning period. Each alternative was scored for both technical/logistical and acceptability risk using a scale of 1 to 5 (low risk to high risk of potential impact to implementation).

A summary of the quantitative and qualitative criteria is shown in Table ES-2 for each alternative.

When the quantitative and qualitative criteria were developed for each alternative, the alternatives were grouped into "suites" of alternatives that together met the placement needs of one or more geographic subareas. A systematic process was employed to reduce the many thousands of possible suites to the several hundred that became the focus of a trade-off analysis. The trade-off analysis consisted of both cost-effectiveness (CE) analysis and incremental cost analysis (ICA) to develop a recommended plan that was fiscally responsible, environmentally beneficial, likely to achieve authorization, and able to provide dredged material placement capacity in both the current and out-years.

Table ES-2

Quantitative & Qualitative Criteria Summary Table

Shading indicates alternatives not included in any suite due to high risk ranking. See footnotes for additional detail.

Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Habitat Benefit Index	Technical/ Logistical Risk[a]	Acceptability Risk[b]
Agricultural Placement - Maryland	$51	$51	$50		500,000	0	4	2
Agricultural Placement - Virginia				$43	500,000	0	4	2
Artificial Island Creation - Lower Bay				$18	34,600,000	601	2	3
Artificial Island Creation - Upper Bay	$12	$11	$12		48,400,000	962	2	3
Beach Nourishment - Virginia				$12	5,600,000	0	1	1
Building Products	$117	$120	$118	$124	500,000	0	4	2
C&D Canal Pierce Creek Upland Sites Expansion	$20	$16	$19		4,400,000	0	1	2
Capping - Landfill	$37	$39	$38	$36	500,000	0	2	2
Capping - Brownfields	$68	$70	$69	$68	500,000	0	2	2
Capping - Elizabeth River, VA				$28	97,000	56	2	2
Capping - Patapsco River, MD		$12	$11		810,000	701	2	2
Confined Aquatic Disposal Pit - Patapsco R	$5				3,700,000	0	2	3
Confined Disposal Facility - Lower Bay				$11	10,000,000	0	1	5
Confined Disposal Shoreline Facility - Patapsco R	$16				3,600,000	0	1	2
Cox Creek Expansion	$19				1,900,000	0	1	3
HMI Expansion	$12	$11	$12		25,000,000	0	1	5
Large Island Restoration - Lower Bay				$16	4,600,000	406	2	2
Large Island Restoration - Mid Bay		$20	$18		34,600,000	2,387	2	2
Mine Placement - Cecil County, MD	$52	$49	$52		10,700,000	0	3	3
Mine Placement - Western Maryland	$65	$72	$66		2,000,000	1,073	4	3
Norfolk Ocean Open Water Placement		$28	$27	$11	sufficient	0	1,2	2
Pooles Island Open Water Site Expansion		$5	$6		5,000,000	0	1	5
PIERP Expansion		$19	$18		24,000,000	727	2	2
Rappahannock Shoal Deep Alternate Open Water Site Expansion		$20	$19	$8	5,000,000	0	1	2
Shoreline Restoration - Lower Bay				$41	790,000	155	2	2
Shoreline Restoration - Mid Bay	$41	$41	$39		1,260,000	267	2	2
Shoreline Restoration - Upper Bay	$42	$40	$40		790,000	202	2	2
Small Island Restoration - Lower Bay				$26	2,300,000	170	2	2

Table ES-2
Quantitative & Qualitative Criteria Summary Table
(Continued)

Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Habitat Benefit Index	Technical/ Logistical Risk[a]	Acceptability Risk[b]
Small Island Restoration - Mid Bay	$28	$26	$25		2,300,000	169	2	2
Wetland Restoration - Dorchester County, MD		$38	$35		3,200,000	3,719	3	1
Dam Neck Ocean Open Water Placement				$9	sufficient	0	1	1
HMI (Existing)	$9	$8	$9		10,000,000	0	1	1
New Open Water (Deep Trough)		$6	$5		sufficient	0	1	5
Pooles Island Open Water Site (Existing)		$5			4,700,000	0	1	2
Rappahannock Shoal Deep Alternate Open Water Site (Existing)				$7	sufficient	0	1	1
Wolf Trap Alternate Open Water Placement		$22	$20	$8	sufficient	0	1	1

[a]Alternatives with a Technical/Logistical Risk score of 4 or 5 were considered too risky to be implementable within the planning horizon being used for this DMMP and were removed from consideration prior to suite formulation.

[b]Alternatives with an Acceptability Risk score of 3, 4, or 5 (those that were illegal due to state or local legislation, or faced significant public opposition) were not included in suites of alternatives being considered to meet the 20-year placement needs of the Port of Baltimore. These alternatives remained under consideration during suite formulation, but suites containing these alternatives were removed prior to selection of the recommended plan.

The recommended plan to achieve this goal is:

- Continued maintenance dredging of the Virginia Channels and use of Open Water Placement in Virginia (Dam Neck Open Water Placement; Rappahannock Shoal Deep Alternate Open Water Placement; Wolf Trap Alternate Open Water Placement).
- Continued maintenance dredging of the Maryland Channels and optimized use of existing dredged material management sites including Pooles Island Open Water Site, HMI DMCF, Cox Creek CDF (+36 ft dike height), and PIERP.
- Multiple CDFs for Baltimore Harbor material.
- PIERP Expansion.
- Large Island Restoration – Mid Bay.
- Wetland Restoration – Dorchester County.
- Continue to pursue opportunities to innovatively use dredged material.

Recommended Plan

The overall goal of the DMMP is to develop a plan to maintain, in an economically and environmentally sound manner, channels necessary for navigation to and from the Port of Baltimore, conduct dredged material placement in the most environmentally sound manner, and maximize the use of dredged material as a beneficial resource.

The location of the recommended plan alternatives throughout the Bay is shown in Figure ES-2:

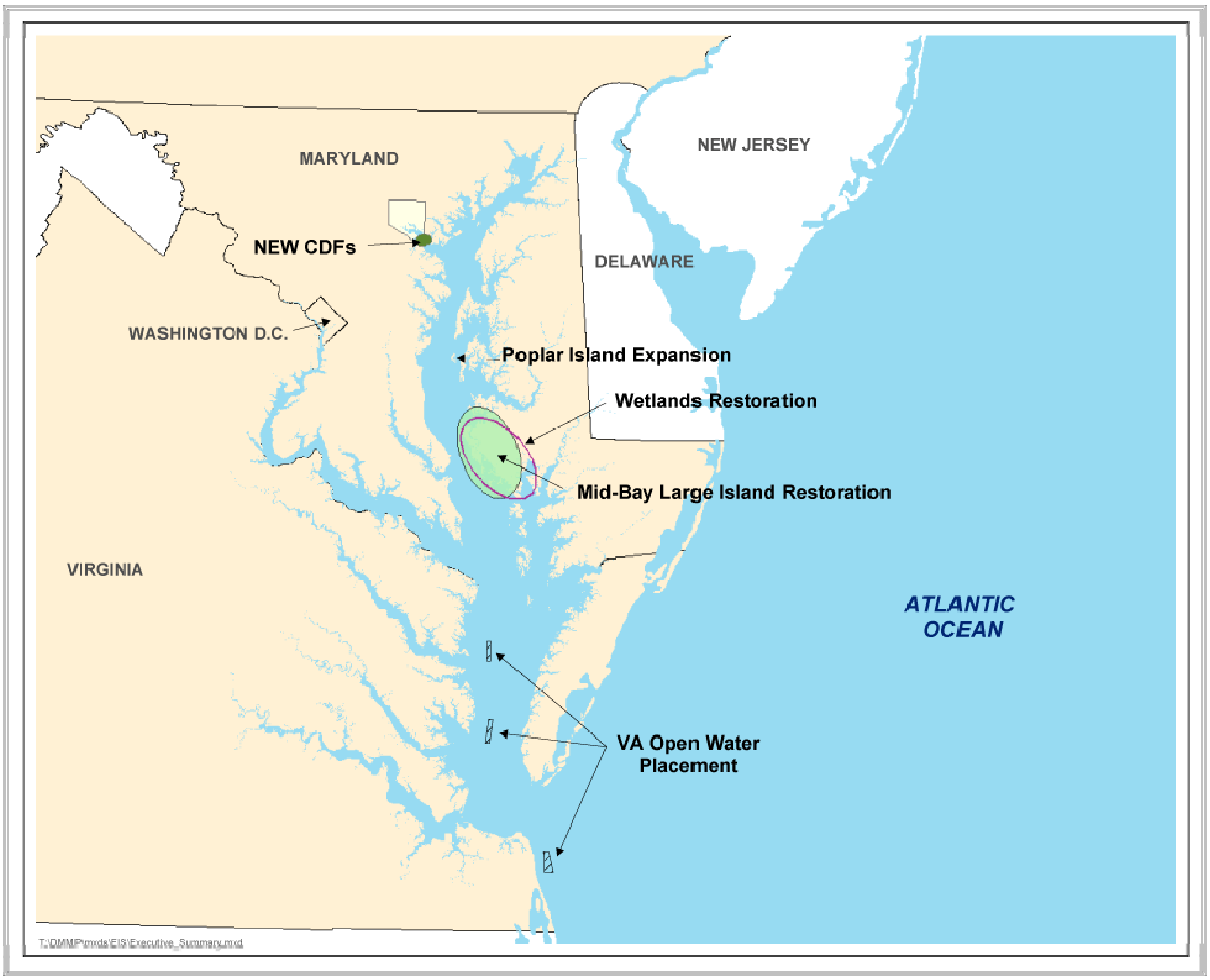

Figure ES-2 Recommended Plan

The recommended plan was chosen because it 1) achieves capacity in a cost-effective manner while gaining appreciable habitat benefit; 2) the combination of alternatives provides a reasonable amount of remaining capacity beyond the required 20-year period, thus reducing risk in out-years; 3) combining routine and innovative alternatives reduces the risk of capacity shortfalls should funding, study, development, and/or implementation of the innovative alternatives be delayed; and 4) including the expansion of an existing USACE project (PIERP) has a higher chance of success given the existing authority.

Within the Plan Formulation Phase, environmental impact analysis was performed for each alternative using the State of Maryland BEWG process. Once the recommended plan was identified, a more in-depth analysis was performed to evaluate impacts individually from each of the six alternatives as well as cumulatively from the recommended plan as a whole. A summary of the environmental consequences follows.

Environmental Consequences of the Recommended Plan

Implementation of the recommended plan will result in substantial beneficial impacts to important natural and socioeconomic resources at the project sites and throughout the region. Although the construction of the new alternatives and subsequent placement of dredged material will result in a permanent change in land use and loss of shallow water habitat, the overall benefit of restoring and/or creating valuable wetlands and island habitat outweigh any short-term or permanent adverse impacts. Providing sufficient long-term dredged material placement capacity will allow continued maintenance dredging of the federal channels, thereby contributing to the economic vitality of the Port, the region, and the nation. The following sections provide brief summaries of the anticipated environmental effects of the recommended plan alternatives considered in the DMMP/EIS. Table ES-3 presents a summary of those effects by environmental resource.

Continued Maintenance Dredging

The dredging activity associated with the channels and the other components of the recommended plan would have minor and short-term effects on aquatic resources by removing sediments and benthic organisms (macroinvertebrate species). Re-colonization of macroinvertebrates would occur relatively rapidly in the area that was dredged. Dredging of the Virginia channels may have the potential to adversely affect sensitive species, such as sea turtles and short-nosed sturgeon. Although many sensitive species can avoid direct impacts from dredging, hopper dredges can and do entrain sea turtles. The dredging of the Virginia channels has been and will continue to be coordinated with the National Marine Fisheries Service and Biological Opinions and incidental take statements have been issued. The Biological Opinion requirements, which include dredging windows, draghead deflectors, inflow screens, and observers (inflow screens and observers are required only when dredging outside of the dredging window) on the dredge, will continue to be implemented during dredging to reduce or avoid any adverse impacts to sensitive species.

Continued Use of Open Water Placement in Virginia (Dam Neck Open Water Placement; Rappahannock Shoal Deep Alternate Open Water Placement; Wolf Trap Alternate Open Water Placement)

The placement of dredged material at the existing, designated open water placement sites in Virginia is a component of the no-action alternative (status quo) and would have the same temporary impacts associated with placing suitable dredged material at these sites.

Continued Use of Existing Sites in Maryland

The placement of dredged material at the existing, designated placement sites in Maryland (HMI DMCF, Cox Creek CDF (+36 ft dike height), PIERP, and Pooles Island Open Water Placement Site) is a component of the no-action alternative (status quo) and would have the same temporary impacts associated with placing suitable dredged material at these sites.

Multiple CDFs for Harbor Material—Patapsco River

The benefits resulting from implementation of this alternative include reef habitat from the armored dikes and providing long-term dredged material confinement that allows removal of potentially contaminated sediment from the Baltimore Harbor. Construction of the nearshore, proposed CDFs would have a permanent adverse effect on aquatic resources through the filling of shallow water habitat. The water quality of the surrounding area would be temporarily impacted during dike construction. Resuspension of sediments would occur, increasing turbidity and potentially releasing contaminants into the water column. Although the sites for the CDFs would likely be in industrial areas, any existing wildlife would be temporarily displaced during construction. However, potentially contaminated sediments may not be suitable for wildlife habitats. No adverse impacts to cultural resources are expected and only minor, short-term impacts to recreation, navigation, and air quality are anticipated during construction.

Table ES-3
Environmental Consequences of the Recommended Plan *
(Maintenance Dredging and New Alternatives)

Discipline	Maintenance Dredging	Poplar Island Expansion	Large Island Restoration - Mid Bay	Wetland Restoration - Dorchester County	Confined Disposal Facilities-Patapsco River
Aquatic Resources	Minor direct and indirect impacts. No long-term effects. Permanent loss of benthic invertebrates, oysters, soft-shell clams, blue crabs, and bottom feeder finfish. Detrimental to commercial blue crab fishery. Valuable finfish rearing habitat may be lost.	Minor direct and indirect impacts. Permanent loss of up to 600 acres of benthic habitats. All soft-shell clams and razor clams within footprint will be lost. Direct and indirect impacts to oysters and commercial oyster harvesting are expected to be minimal. Commercial blue crab harvesting industry not to suffer significant losses. The created marsh creeks expected to provide valuable habitat for all stages of the crab's life cycle. Short-term detrimental effects on the early life stages of some fish species. Direct impact on finfish habitat, offset somewhat by the creation of reef and tidal marsh habitat. Restoration will protect SAV beds by reducing the effects of wave action.	Direct impact on benthic invertebrates, permanent loss. Addition of tidal marsh habitat will provide new benthic and shallow water habitat. No impact to oyster industry. Minimal impacts to the soft-shell clam industry. Permanent displacement of commercial crabbing within the footprint, but no significant losses. After construction completion, the newly created marsh creeks will provide habitat for all stages of the crabs' life cycle. No severe impact on finfish. SWH and SAV within the footprint will be permanently lost. After construction there will be improved conditions for SAV growth.	Direct insignificant impacts to benthic invertebrates, bivalves, blue crabs, and finfish. Existing shallow water habitat will be lost. Proposed restoration is expected to benefit aquatic resources, improving habitat for benthic invertebrates, bivalves, blue crab, finfish, and SAV.	Direct insignificant impacts to benthic invertebrates, which will be permanently buried. No impact to oyster populations or commercial harvesting. Direct insignificant impact on soft-shell clams, blue crab population and commercial harvesting, and to finfish populations. Possible permanent loss of SAV beds.
Wetlands	No direct impacts on existing wetlands.	No long-term negative impacts, only short-term impacts due to construction. Additional benefits from wetland creation supporting recreation, education, and research on Poplar Island.	Short-term impacts, but long-term positive effects by stabilizing erosion, and creating additional wetland habitats.	Temporary, short-term impacts during construction, but long-term positive effects. Enhance and restore wetland functions and values.	Potential direct impacts to wetlands during construction if located where dikes connect with existing shorelines.
Terrestrial Resources	Minor indirect and short-term effects on terrestrial wildlife and habitats. No substantial impacts from maintenance dredging activities.	Short-term impacts during construction. Temporary displacement due to noise during construction. Beneficial increase of upland and wetland habitat for birds and herptile species.	Short-term impacts during construction. However, construction activities associated with a proposed project should follow the schedule implemented for the Poplar Island Habitat Restoration Project. Benefit of stabilizing shoreline habitats and increased upland and wetland habitat.	Short-term impacts during construction. Temporary displacement. No severe impacts; instead restored vegetated areas will provide habitat for a wide variety of terrestrial species and protect surrounding wetlands.	Short-term impacts during construction. Temporary displacement. Potentially contaminated sediments may not be suitable for wildlife.
Water Quality	Minor direct effects on water quality. Short-term effects due to turbidity.	Short-term effects. Overall, should improve water quality by protecting shorelines from erosion, and reducing amount of suspended solids in water column.	Short-term impacts on water quality and sediments. Minimal impact to groundwater. Tidal wetlands to improve water quality, reduce erosion.	Short-term impacts expected. Restoration efforts should reduce wetland losses, and improve overall long-term water quality.	Potential impacts from facility construction due to increased turbidity and contaminant release.
Recreation	Minor, short-term impacts to recreational boat traffic near the proposed dredging locations.	Intermittent barge traffic to temporarily restrict or inconvenience recreational boat traffic and other activities in the area. Long-term increase of recreational fishery in the area. Newly created habitat will benefit recreational activities.	Short-term, indirect impacts. All recreational activities temporarily displaced during restoration. Long-term increase of recreational fishery in the area. Newly created habitat will benefit recreational activities.	No significant impacts on recreation; however, some activities may be detoured or temporarily suspended during restoration.	No significant impact on recreation; however, depending on location, some resources may be impacted.
Cultural Resources	No impact on cultural resources.	No significant impact.	Only those cultural resources close to the shoreline may be affected by dredging activities.	Possibility of impact due to the presence of cultural resources in the area; further investigations would be necessary.	No adverse effects expected.
Socioeconomics	Long-term benefits.	Job creation during construction and O&M.	Job creation during construction and O&M.	Job creation during construction and O&M.	Job creation during construction and O&M.
Transportation	Maintain existing transportation systems. No impacts on highways or railroads.	Minor and temporary impacts to navigation. Temporary increase in rail and vehicle traffic due to material transport, worker commute, etc.	Minor and temporary impacts to navigation. Temporary increase in rail and vehicle traffic due to material transport, worker commute, etc.	Temporary increase of traffic due to workers commuting and materials, equipment being delivered. Temporary impacts to boat traffic.	Minor and temporary impacts to navigation. Temporary increase in rail traffic due to material transport, worker commute, etc.
Geology and Soils	No impact on geology; however, accumulated sediment will be removed.	Will impact soil by permanently covering soils and sediments in the project footprint. Long-term benefits to island remnants due to more protection from erosive wave actions.	Will impact soil by permanently covering soils and sediments in the project footprint. Long-term benefits to island remnants due to more protection from erosive wave actions.	Will impact soil by permanently covering soils and sediments in the project footprint. Benefit includes wetland habitat creation, which will provide long-term changes in the elevation and soils in the area.	Minor, short-term effects to the soils and topography from earthmoving and other activities. Will impact soil by permanently covering soils and sediments in the project footprint.

Table ES-3
Environmental Consequences of the Recommended Plan *
(Maintenance Dredging and New Alternatives)

Discipline	Maintenance Dredging	Poplar Island Expansion	Large Island Restoration - Mid Bay	Wetland Restoration - Dorchester County	Confined Disposal Facilities-Patapsco River
Rare, Threatened, and Endangered Species	Possibility of direct impact to federally-listed shortnose sturgeon (E) and sea turtles (E). Can be reduced or avoided by imposing work restrictions during spawning and migration periods, using observers, and draghead deflectors. Also impacted are the federally-listed bald eagle (T) and piping plover (T), and state-listed peregrine falcon (MD E, VA T), black skimmer (T), and least tern (T) due to turbidity plumes impacting their food sources.	Minimal impacts to federally-listed shortnose sturgeon (E) and sea turtles (E). Temporary displacement of federally-listed bald eagles (T), and state-listed least tern (T). Expansion will benefit certain RTE species by providing additional habitat.	Little impact on RTE species in the area is expected . The additional upland and wetland habitat will benefit certain RTE species.	Temporary impacts to federally-listed bald eagle (T), state-listed peregrine falcon (MD E, VA T), and least tern (T) due to construction and placement activities. 1,000 acres of former wetlands will be restored, to provide vital nesting, foraging, and protective habitat for certain RTE species.	State-listed peregrine falcons (MD E, VA T) can potentially be exposed to contaminants released from dredging-related operations, but not likely to bioaccumulate.
Hazardous, Toxic, and Radioactive Waste (HTRW)	No effects are anticipated. May be short-term impacts due to contamination releases into the water column during dredging operations in Baltimore Harbor. Potential for unexploded ordnance might be present, which can be disposed of in a safe manner.	No impact.	No impact.	No impact.	No direct impact, due to containment and regular leachate monitoring.
Air Quality	Direct, minor, short-term effects to local air quality due to dredging operations.	Direct, minor, short-term effects during construction and placement operations. Minimal effects from dust due to wind erosion.	Direct, minor, short-term effects during construction and placement operations. Minimal effects from dust due to wind erosion.	Direct, minor, short-term effects during construction and placement operations. Minimal effects from dust due to wind erosion.	Direct, minor, short-term effects during construction and placement operations. Minimal effects from dust due to wind erosion. Possibility of greater impact in some areas due to residences, schools, hospitals nearby.
Noise	Localized, minor, short-term effects due to dredging equipment operations.	Localized, short-term impacts due to construction and operations.	Localized, short-term impacts due to construction and operations.	Localized, short-term impacts due to construction and operations.	Localized short-term impacts due to construction and operations. Possibility of greater impact in some areas due to residences, schools, hospitals nearby. Operations should be limited to daytime work for noise-sensitive areas.
Short-Term Uses versus Long-Term Productivity	Minor short-term impacts.	Minor short-term impacts outweighed by long-term benefits of habitat creation, island restoration, restoring degrading wetlands.	Minor short-term impacts outweighed by long-term benefits of habitat creation, island restoration, restoring degrading wetlands.	Minor short-term impacts outweighed by long-term benefits of habitat creation, and restoring degrading wetlands.	Minor short-term impacts outweighed by long-term benefits of providing confined dredged material capacity for harbor material.
Irreversible or Irretrievable Commitments of Resources	Energy to operate dredges, move barges and equipment, and transport workers will cause an irretrievable consumption of fuel and lubricants.	Permanent loss of energy resources. Land use changes due to zoning and permitting processes. Irreversible and irretrievable loss of shallow water habitat.	Permanent loss of energy resources. Land use changes due to zoning and permitting processes. Irreversible and irretrievable loss of shallow water habitat.	Permanent loss of energy resources. Land use changes due to zoning and permitting processes. Irreversible and irretrievable loss of shallow water habitat.	Permanent loss of energy resources. Land use changes due to zoning and permitting processes. Irreversible and irretrievable loss of shallow water habitat.
Cumulative Effects and Mitigation	Minimal cumulative physical impacts. Total aquatic area impacted is significant; however, the negative impacts are short-term and the long-term impacts are insignificant or beneficial. Minimal impact on wetlands, terrestrial resources, endangered species, recreation, socioeconomics, cultural resources, transportation, water and air quality. No adverse HTRW or noise impacts or impacts to geology, groundwater, or soils. Mitigation measures should be implemented to avoid and minimize negative environmental impacts and to maximize environmental benefits or compensate for impacts if necessary.	Minimal cumulative physical impacts. Total aquatic area impacted is significant; however, the negative impacts are outweighed by the long-term benefits of habitat creation. Minimal impact on existing wetlands, terrestrial resources, endangered species, recreation, socioeconomics, cultural resources, transportation, water and air quality. No adverse HTRW or noise impacts or impacts to geology, groundwater, or soils. Mitigation measures should be implemented to avoid and minimize negative environmental impacts and to maximize environmental benefits or compensate for impacts if necessary.	Minimal cumulative physical impacts. Total aquatic area impacted is significant; however, the negative impacts are outweighed by the long-term benefits of habitat creation. Minimal impact on existing wetlands, terrestrial resources, endangered species, recreation, socioeconomics, cultural resources, transportation, water and air quality. No adverse HTRW or noise impacts or impacts to geology, groundwater, or soils. Mitigation measures should be implemented to avoid and minimize negative environmental impacts and to maximize environmental benefits or compensate for impacts if necessary.	Minimal cumulative physical impacts. Total aquatic and wetland area impacted is significant; however, the negative impacts are outweighed by the long-term benefits of wetland restoration. Minimal impact on existing terrestrial resources, endangered species, recreation, socioeconomics, cultural resources, transportation, water and air quality. No adverse HTRW or noise impacts or impacts to geology, groundwater, or soils. Mitigation measures should be implemented to avoid and minimize negative environmental impacts and to maximize environmental benefits or compensate for impacts if necessary.	Minimal cumulative physical impacts. Total aquatic area impacted could be significant; however, the negative impacts are outweighed by the long-term benefits of confined dredged material capacity. Minimal impact on existing wetlands, terrestrial resources, endangered species, recreation, socioeconomics, cultural resources, transportation, water and air quality. Most long-term impacts will be beneficial. No adverse HTRW or noise impacts or impacts to geology, groundwater, or soils. Mitigation measures should be implemented to avoid and minimize negative environmental impacts and to maximize environmental benefits or compensate for impacts if necessary.

*****The impacts resulting from the continued placement of dredged material at the existing, permitted placement sites are considered a component of the no-action alternative and are not included in this table.

PIERP Expansion

Expanding Poplar Island would restore vital island habitat that is being lost throughout the Bay area. Additional uplands will benefit terrestrial resources, including nesting habitat for birds. The creation of additional wetlands would provide long-term valuable habitat for blue crab, finfish, and other aquatic resources. Wetland function and value would be enhanced and long-term water quality would be improved. Expansion of the PIERP would have a permanent adverse effect on aquatic resources through the filling of shallow water habitat. The water quality of the surrounding area would be temporarily impacted during dike construction, although armoring of the dikes with rock would have a long-term benefit by creating reef habitat. As dike material is placed, temporary resuspension of sediments would occur, increasing turbidity in the area of construction. No adverse impacts to cultural resources are expected and only minor, short-term impacts to recreation, navigation, and air quality are anticipated during construction.

Large Island Restoration – Mid Bay

Restoring a large island in the middle region of the Bay would restore vital island habitat that is being lost throughout the Bay area. Additional uplands will benefit terrestrial resources, including nesting habitat for birds. The creation of additional wetlands would provide long-term valuable habitat for blue crab, finfish, and other aquatic resources. Wetland function and value would be enhanced and long-term water quality would be improved by reducing coastal erosion and the suspended solids in the water column. Restoring a large island would result in the permanent loss of shallow water habitat within the proposed footprint at the site. The water quality of the surrounding area would be temporarily impacted during dike construction, although armoring of the dikes with rock would have a long-term benefit by creating reef habitat. As dike material is placed, resuspension of sediments would occur, resulting in increased turbidity in the water column. No adverse impacts to cultural resources are expected and only minor, short-term impacts to recreation, navigation, and air quality are anticipated during construction.

Wetland Restoration – Dorchester County

The coastal wetlands of Dorchester County and adjacent areas are nationally and internationally recognized to be of ecological significance because of their importance as a staging and wintering ground for waterbirds and waterfowl. Their ecological significance extends beyond birds to include estuarine foodweb support, water quality maintenance, and other functions. Dorchester County marshes, particularly in the Blackwater National Wildlife Refuge (NWR) area, have been lost at an accelerated rate as a consequence of human activities exacerbating natural wetlands loss processes. Detrimental impacts to water quality and existing wetlands would occur during construction from dredged material transport and placement operations for a several-year to decade period of time. These impacts would be minimized through careful coordination with resource agencies and adoption of an array of best management practices. Although many engineering and real estate challenges would need to be surmounted, landscape-scale tidal marsh restoration that USACE could undertake would provide significant international and national environmental benefits to wildlife, aquatic life, and Chesapeake Bay water quality. This proposed action is strongly supported by the interagency Bay Enhancement Working Group and U.S. Fish and Wildlife Service.

Irreversible or Irretrievable Commitments of Resources

Although implementing the recommended plan would result in an irretrievable commitment of resources, the overall benefits from using dredged material to create and/or restore habitats far outweigh the loss of natural and socioeconomic resources. Specifically, the alternatives that have a habitat restoration component would have a permanent, though beneficial, change in wetlands habitat value and function. Maintenance dredging and implementation of the recommended plan would consume both natural and socioeconomic resources. Construction and dredged material placement at each of the new alternative sites would result in a change of land use by permanently filling in areas of shallow water habitat. Construction activities would require fuel, dedicated labor resources, and substantial amounts of sand, roadway stone, armor stone, geotextiles, and other construction materials.

Cumulative Effects and Mitigation

NEPA and the Council on Environmental Quality's regulations require federal agencies to consider the cumulative impacts of their actions on the natural and human environment. A "cumulative impact" is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Other past, present, and reasonably foreseeable projects or actions that could, when added to the recommended plan alternatives, result in cumulative impacts include:

- Construction of the HMI DMCF.
- Vertical expansion of the Cox Creek CDF to the permitted dike elevation of +36 ft.
- Land uses in the study area.
- Closure of the Pooles Island Open Water Disposal Site.
- Closure of the HMI DMCF.
- Past and present dredging and disposal activities undertaken by USACE at other authorized navigation projects throughout the Bay, as well as dredging undertaken by the state and the private sector throughout the study area.
- Construction of the PIERP and the PIERP Expansion Feasibility Study.
- The Mid-Bay Island Restoration Feasibility Study.
- Sediment and nutrient reduction programs implemented in the 64,000 square-mile-Chesapeake Bay watershed.
- Proposed water quality standards for the Chesapeake Bay.

The recommended plan alternatives considered in combination with past and present dredging and dredged material placement activities, and other reasonably foreseeable plans and projects, are not anticipated to cumulatively adversely affect the resources evaluated in the DMMP/EIS. Implementation of the recommended plan will enhance and restore habitats while providing sufficient placement capacity for any planned and reasonably foreseeable dredging projects within the 21-year planning period.

Implementation

In developing the schedule for implementation of the recommended plan, consideration has been given to the authorization process, planning and design, construction, dredging needs by channel reach, and both the projected annual and total dredged material capacity at each site.

The existing open-water placement sites, Rappahannock Shoal Deep Alternate, Wolf Trap Alternate, and the Dam Neck Ocean, have sufficient capacity for the required 20-year period to remain as the federal standard for the Virginia channels. As such, dredged material from the Rappahannock Shoal, York Spit, and Cape Henry channels will be placed at their respective designated placement sites under the existing authority of the Baltimore Harbor and Channels 50-ft Project. Continued maintenance of these channels at their constructed dimensions will be federally funded and non-federally funded. The federal government is responsible for 100% of the maintenance costs associated with maintaining the channels to a 45-ft depth. The additional costs of maintaining the channels to the 50-ft depth are shared 50/50 with the non-federal sponsor. No additional studies are anticipated unless the current constructed channel dimensions have to be increased and/or a new federal action necessitates the preparation of a NEPA document.

The existing HMI DMCF, Cox Creek CDF, PIERP, and Pooles Island Open Water Placement Site have an estimated remaining capacity of 47.7 million cubic yards. The capacity of these sites should continue to be used and optimized until their capacity is exhausted or they are required to be closed by state law.

In order to meet the annual placement needs of the Harbor material, two (100 acres each) of the proposed CDFs, or equivalent, must be available to accept dredged material in fiscal year 2010. The remaining two (100 acres) sites must be available in fiscal year 2014 to avoid excessively overloading the Cox Creek CDF. Additional studies, including feasibility, design, and a NEPA document, will be required to determine the specific sites and evaluate any potential environmental impacts. Any incremental study costs beyond that required for the federal standard will be a non-federal cost unless other authorities (e.g., beneficial use of dredged material) are used.

Construction of the new confined disposal facilities would be cost shared with the non-federal sponsor, in accordance with the provisions of Section 201 of WRDA 1996, only if the CDFs are considered GNF facilities (i.e., facilities that meet the federal standard as the least-cost, environmentally acceptable placement option). Since the new CDFs would not be GNF facilities, the federal cost share for these facilities would be limited to the increment of costs associated with continued use of HMI. In addition, the funding of capacity requirements related to non-federal dredged material is a non-federal responsibility.

Although specific congressional authorization is not required for placement facilities needed for the operation and maintenance of authorized federal navigation projects that meet the federal standard (USACE Planning Guidance Letter (PGL) Number 47), additional authority may be required if the CDFs would include any feature that involves the beneficial use of dredged material (e.g., wetlands). Consequently, each CDF will have its own feasibility study and potential authorization, which may allow a provision for cost sharing based on the underlying project purpose and authority.

Because of the state-mandated closure of the Pooles Island Open-Water Site in 2010, the expansion of the PIERP is necessary to meet the projected capacity needs of the material to be dredged from the C&D Canal Approach Channels (Lower Approach) and the Chesapeake Bay Approach Channels (MD). The expanded sections of Poplar Island must be available to accept material in 2011 to avoid excessively overloading the existing cells at the PIERP.

USACE and the State of Maryland are currently partnering on the PIERP under the existing project authority (Section 537 of WRDA 96). Modifying the PIERP by raising the dikes and expanding the footprint, as included in the recommended plan, is currently being investigated through a General Re-evaluation Report (GRR) under the existing PIERP authorization. Raising the dikes and expanding the footprint of PIERP will exceed the cost and/or project limitations and will likely require congressional authorization.

It is projected that the existing cells at the PIERP will have reached their maximum capacity in 2015 or early 2016. The proposed 600-acre northern expansion, if approved and authorized, will provide only part of the annual and total dredged material capacity required for the 20-year period. Restoring a large island in the Middle Bay region is the preferred method to meet the remaining capacity needs. The large island needs to be operational before 2015 to avoid overloading the expanded area of the PIERP, or earlier if the expansion of the PIERP is not approved and authorized.

USACE and the State of Maryland are currently partnering on a feasibility study for large island restoration for Middle Bay Large Island Restoration under the Eastern Shore of Maryland General Investigation authority. However, the implementation of the project will require congressional authorization. The project would likely be authorized under Section 204 of WRDA 92, as amended by Section 207 of WRDA 96. (These sections provide authority to USACE to implement projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with construction, operation, or maintenance dredging of an authorized federal navigation project.)

Restoring wetlands at the Blackwater NWR in Dorchester County, Maryland, and the surrounding area would provide substantial environmental benefit and additional dredged material capacity for the 20-year period and beyond. Additional studies will be required to determine the specific locations for dredged material placement and evaluate any potential environmental impacts. Preparation of a feasibility study would be required under an appropriate congressional authorization (either current or future authority). Any incremental study costs beyond that required for the federal standard would be cost-shared based on the authority, but would most likely be 50/50 between the non-federal sponsor and the USACE.

The incremental cost, or cost beyond the federal standard, associated with the restoration of wetlands at Blackwater NWR, Dorchester County, Maryland, and the surrounding area could be non-federally financed, or could be cost shared with USACE under separate authorities, such as Section 204 of WRDA 1992, and later amended by Section 207 of WRDA 1996. If the cost beyond the federal standard is justified by the environmental outputs of the plan using CE and ICA rationale, the federal government may share the additional costs of those features based on other authorities for ecosystem restoration. However, if the additional costs are not justified based on these environmental outputs but are required based on non-federal restrictions, non-federal financing may be required for costs beyond the federal standard.

The DMMP will be reviewed and updated approximately every 5 years, or as necessary to reflect significant changes in statutory, regulatory, scientific, or environmental conditions.

Recommendation

Within the next 20 years, there will be a critical shortage of dredged material placement capacity for maintenance dredging of the Baltimore Harbor and Channels. Through a rigorous and systematic process within this study, 77 feasible options for dredged material placement alternatives have been compared for capacity, cost, environmental benefit and/or impact, and implementation risk, resulting in the selection of a recommended plan. The recommended plan consists of continued maintenance dredging and seven alternatives that together provide sufficient dredged material placement capacity through the next 20 years, with capacity remaining for out-year use. These seven alternatives are continued use of the open water placement sites in Virginia; continued use of existing sites in Maryland; construction of multiple CDFs along the Patapsco River, Maryland; expansion of the currently authorized PIERP; large island restoration in the Middle Bay; wetland restoration in Dorchester County, Maryland; and continue to pursue opportunities to innovatively use dredged material. These alternatives will have little adverse impact on the quality of the environment and have the potential to provide environmental benefit by restoring habitat and protecting the environment from further degradation.

It is recommended that the alternatives included in the recommended plan continue into the feasibility study phase to further refine the alternatives, complete the assessment of environmental impacts, optimize capacity and environmental benefit, and mitigate any adverse impacts. As well, it is recommended that innovative dredged material placement alternatives that were eliminated prior to development of the recommended plan because of their high cost, high technical uncertainty, and high implementation risk be pursued in partnership with the State of Maryland. At such time as these alternatives can be refined for full-scale use, they should be considered for inclusion in the recommended plan.

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1. INTRODUCTION

A key mission of the U.S. Army Corps of Engineers (USACE) is to provide safe, reliable, and efficient waterborne transportation systems (channels, harbors, and waterways) for movement of commerce, national security needs, and recreation. Accomplishing this successfully requires dredging of channels and placement and/or management of dredged material, an increasingly challenging task.

Since 1824, the USACE Baltimore District (CENAB) has been actively involved in constructing and maintaining a system of channels to allow large, deep-draft commercial shipping vessels to call on the Port of Baltimore. In addition to the shipping channels, a number of anchorage areas were established within the Port of Baltimore for vessels requiring layover. The existing project for the Baltimore Harbor and Channels was authorized by the River and Harbor Act of August 8, 1917 and was modified by the River and Harbor Acts of January 1927, July 1930, October 1940, March 1945, July 1958, and December 1970.

The USACE Engineering Regulation (ER) 1105-2-100 mandates that the USACE Districts develop a Dredged Material Management Plan (DMMP) for all federally maintained navigation harbor projects where there is an indication of insufficient placement capacity to accommodate maintenance dredging for the next 20 years. The DMMP is a planning document that ensures maintenance-dredging activities are performed in an environmentally acceptable manner, use sound engineering techniques, and are economically justified. A DMMP addresses a full range of placement alternatives, leading to the selection of a final plan that ensures that sufficient placement capacity is available for at least the next 20 years.

The DMMP for the Baltimore Harbor and Channels project has been developed using a consistent and logical procedure by which dredged material management alternatives have been identified, evaluated, screened, and recommended so that dredged material placement operations are conducted in a timely, environmentally sensitive, and cost-effective manner. The overall framework for the DMMP development is shown in Figure 1-1.

Phase I of the DMMP process is the preparation of the Preliminary Assessment (PA) (Appendix G), which was completed by CENAB in July 2001. CENAB initiated Phase II of the process in

October 2002 by preparing a detailed scope for the management plan study. Scoping culminated in July 2003 with the initiation of this detailed study. This programmatic DMMP document represents Phase II of the DMMP process. Subsequent phases of the DMMP process will be initiated following a Record of Decision (ROD). These phases include project-specific feasibility studies, implementation, and periodic review and update.

1.1 PURPOSE AND NEED

In July 2001, a PA for the Baltimore Harbor and Channels DMMP was completed by CENAB. The purposes of the PA were to document the continued viability of the Baltimore Harbor and Channels project and to determine whether there is dredged material placement capacity sufficient to cover at least 20 years of maintenance and new work dredging. The PA recommended that a DMMP be prepared, concluded that continued maintenance dredging of the authorized federal channels is justified, and concluded there is a shortfall of over 50 mcy of dredged material placement capacity for the next 20 years. The Philadelphia District's Dredged Material Management Plan Preliminary Assessment for the Inland Waterway from the Delaware River to Chesapeake Bay, Delaware and Maryland, September 1995, concluded that there is a shortage in dredged material capacity for the channel reach from the Sassafras River to Pooles Island and recommended a dredged material management study to identify suitable placement sites. Thus, preparation of a programmatic DMMP was recommended.

The specific objectives of the Baltimore Harbor and Channels DMMP are to:

- Develop a plan to maintain, in an economically and environmentally sound manner, channels necessary for navigation to the Port of Baltimore.
- Conduct dredged material placement in an environmentally sound manner.
- Maximize the use of dredged material as a beneficial resource.
- Ensure that there is a minimum of 20 years of dredged material capacity for the project.

The following study goals have been developed in coordination with local, regional, and state agencies, the public involvement process, review of prior studies and reports, and review of existing projects. The specific goals for this study are:

- Consider all dredging and dredged material management alternatives, or combinations of alternatives. No option will be ruled out prior to the initial plan formulation process.
- Consider the use of innovative techniques, partnering policies, and nontraditional placement options to maximize the use of dredged material that may include but is not limited to: wetland restoration, shoreline restoration, island restoration, landfill cover, building products, agricultural application, and abandoned mine land reclamation.
- Utilize and incorporate appropriate data and information from other relevant USACE studies and projects, as well as, information and results from the State of Maryland's Dredged Material Management Program.
- Include an economic analysis of the viability of maintaining the existing channels.
- Include a Web site dedicated to the study that will be available to the public. All current documentation available on the DMMP will be posted on the Web site, including meeting minutes, plans, maps, discussion of options, etc. The Web site will be linked to other related Web sites, including the sites established for existing dredged material placement sites.
- Include an extensive public and agency campaign for participation in the study plan formulation process. The team will widely publicize the study through at least two newsletters, notice of availability of the draft and final environmental impact statements, newspaper and public announcements, and letters to resource agencies, as well as notices to the various interested groups in the Chesapeake Bay community.

1.2 STUDY AUTHORITY

This DMMP is being conducted pursuant to existing authorities for individual project operation and maintenance, as provided in the public laws that authorized the specific Baltimore Harbor and Channels projects.

General authorities relating primarily to beneficial uses of dredged material supplement these specific project authorities. Beneficial uses, which are not part of the federal standard (the plan that accomplishes dredged material placement in the least costly manner, consistent with sound engineering practice and meets all federal environmental standards) for the navigation purpose, will be considered separable elements of the management plan and will be pursued under relevant authorities and separate funding sources. However, although it is funded from different sources and under separate authorities, the proposed beneficial use planning efforts must be pursued in conjunction with the overall management plan effort to ensure acceptability and implementability of a recommended plan to meet maintenance dredging needs for at least the next 20 years. Where management plan studies disclose the need to consider expanding or enlarging existing projects, such studies may only be pursued under specific study authority or under Section 216 of the Flood Control Act of l970.

Management plan studies shall address the requirements of all applicable environmental statutes for all placement options considered including the requirements of the National Environmental Policy Act (NEPA), Section 404 of the Clean Water Act, Section 103 of the Marine Protection, Research and Sanctuaries Act, and the Coastal Zone Management Act.

The costs of management plan studies for continued maintenance of existing federal navigation projects are operation and maintenance costs and shall be federally funded. For harbor projects, such costs shall be reimbursable from the Harbor Maintenance Trust Fund. Costs for beneficial uses that are consistent with and part of the federal standard are federal operation and maintenance costs. However, study costs for beneficial uses that are not part of the federal standard, beyond those reconnaissance-level studies needed to identify these potential uses as part of management plan studies, are either a non-federal responsibility or are a shared federal and non-federal responsibility depending on the type of beneficial use, as follows:

(1) *Ecosystem Restoration.* The incremental costs above the federal standard for the use of dredged material to restore and protect environmental resources, pursuant to Section 204 of the WRDA 92, must be shared on a 75% federal and 25% non-federal basis with a qualified non-federal sponsor. Incremental costs for planning, design, and implementation for ecosystem restoration are not navigation operation and maintenance costs and the federal portion of such costs are not recoverable from the Harbor Maintenance Trust Fund. If a potential restoration beneficial use project exceeds the cost limitations of Section 204, it may be pursued as a cost shared feasibility study leading to specific project authorization.

(2) *Placement of Material on Beaches.* USACE may participate in the additional costs of placing clean sand or other suitable material, dredged by USACE during construction or maintenance of federal navigation projects, onto adjacent beaches or nearshore waters, if the added cost of placement is justified primarily by the benefits associated with hurricane and storm damage protection provided by such beach or beaches and the beach involved is open to the public with public access. Under the authority of Section 145, WRDA 76 as amended by Section 933 of WRDA 86, Section 207 of WRDA 92, and Section 217 of WRDA 99, the cost sharing for the placement of the sand is 65% federal and 35% non-federal.

(3) *Other Beneficial Uses*. Other potential beneficial uses include placement of dredged material for land creation or land enhancement for development purposes, placement of dredged material on beaches not meeting the criteria for USACE participation, and environmental enhancement projects not meeting the criteria for USACE participation. In these cases all incremental study costs and implementation costs above the cost required for the federal standard must be paid by non-federal interests.

1.3 STUDY LIMITATIONS

The Programmatic DMMP and Tiered Environmental Impact Statement (EIS) have been developed using a programmatic approach to evaluate potential alternatives for placement of dredged material throughout the study area (see Figure 1-2). This study has not been prepared as a feasibility study for specific sites, but as a broader planning document to recommend follow-on, site-specific analysis of the recommended suite of alternatives. The following is a brief summary of the issues considered outside the scope of this study:

Impacts of New Work Dredging. This analysis evaluates the potential impacts of continued maintenance dredging to the constructed depths and dimensions of the existing federal channels. However, potential impacts associated with new work dredging (enlarging the channel or anchorage up to or beyond current authorization, none of which is currently planned) have not been evaluated.

Impacts at Existing Placement Sites. This analysis does not evaluate the impacts resulting from the placement of dredged material at the existing, permitted placement sites. The continued placement of dredged material at the existing sites is considered a component of the No Action alternative, or status quo. As such, these sites will be used until their placement capacity is exhausted. Impacts have already been evaluated during their respective permitting processes.

Site-Specific Analyses. Although potential impacts from expanding existing, permitted sites will be evaluated, evaluation of site-specific impacts from implementing new placement alternatives is outside the scope of this study. For the purposes of preparing the cost estimate a representative location has been selected for each new placement alternative. These locations are representative because the final designated site may not be at that location. The impact analysis in this study corresponds with a broader level of planning, evaluating potential impacts for a particular type of alternative in a general area. Designation of any new placement site will normally require a reconnaissance report and/or site-specific feasibility study that includes the appropriate environmental review required by the National Environmental Policy Act, the Clean Water Act, and other applicable environmental laws.

1.4 AUTHORIZED FEDERAL PROJECTS

The existing project for the Baltimore Harbor and Channels includes a main channel, 50 ft deep, between Cape Henry, Virginia, and Fort McHenry at Baltimore and a series of branch channels that provide access to various public and private terminals serving the Port of Baltimore. The authorized project provides for improvements to federal and state anchorages and channels and maintenance of the same. In addition, the Chesapeake and Delaware (C&D) Canal project authorizes maintenance of the Approach Channels to the C&D Canal.

The individual project authorizations for the current project are:

1. River and Harbor Acts of 1927, 1930, 1940, and 1945.
2. The Baltimore Harbor and Channels 42-ft Project (authorized in Section 101 of the River and Harbor Act of 1958).
3. The Baltimore Harbor and Channels 50-ft Project (authorized in Section 101 of the River and Harbor Act of 1970).
4. The Baltimore Harbor Anchorages and Channels Project (authorized in Section 101a(22) of Water Resources Development Act (WRDA) 1999).
5. The Chesapeake and Delaware (C&D) Canal Project is under the jurisdiction of the Philadelphia District and was adopted as House Document 63-196 in 1919 and modified by Section 3 of the River and Harbor Act of 1927, by River and Harbor Committee Document 71-41 and Senate Document 71-151 in 1930, by House Document 72-201, House Document 73-18, and House Document 73-24 in 1935, and by Senate Document 83-123 in 1954.

1.5 DESCRIPTION OF THE STUDY AREA

The study area includes a major portion of the Chesapeake Bay watershed, which is an area of more than 64,000 square miles of land that drains into the Chesapeake Bay and its tributaries (Figure 1-2). Although the watershed stretches across six states—New York, Pennsylvania, Maryland, Delaware, Virginia, and West Virginia—and the District of Columbia, the area evaluated in this study is limited to the Bay and potential dredged material placement sites in Pennsylvania, Maryland, and Virginia required for maintaining the federal channels serving the Port of Baltimore.

The Port of Baltimore is located on the Patapsco River Basin on the west side of the upper Chesapeake Bay and has 45 miles of waterfront, 25 miles of which are industrially developed.

In order to effectively evaluate the entire navigation system, the federal channels for the Port of Baltimore were divided into four geographic subareas. The four geographic subareas are C&D

Canal Approach Channels (Figure 1-3), which extends from the mouth of the Sassafras River south to near Tolchester Beach in Kent County, Harbor Channels (Figure 1-4), which includes the channels in the Patapsco River, inside the North Point-Rock Point Line; Chesapeake Bay Approach Channels (MD) (Figure 1-5), which extends from the North Point-Rock Point Line south and east to include the Craighill Channels, Tolchester Channels, and Swan Pt. Channel; and the Chesapeake Bay Approach Channels (VA) (Figure 1-6), which extends from the Maryland-Virginia state line south to the Atlantic Ocean and includes the Rappahannock Shoal, York Spit, and Cape Henry Channels. The federal channels for the Port of Baltimore were divided into four geographic subareas for three reasons 1) the environment, and thus the environmental impacts will vary throughout the bay; 2) the federal standard will differ for the four different areas; and 3) the suite of likely alternatives will differ for the four different areas.

1.5.1 Chesapeake and Delaware (C&D) Canal Approach Channels

The C&D Canal Approach Channels extend approximately 30 miles from Town Point near the western end of the C&D Canal southwest to the vicinity of Pooles Island. The project provides a channel 35 ft deep and 450 ft wide from the Delaware River through Elk River and the Chesapeake Bay, to water of natural 35-ft depth in the Chesapeake Bay (CENAP, 1996). Only the Lower Approach reaches (south of the Sassafras River) of the C&D Canal Approach Channels are included in the scope of this study.

1.5.1.1 Location and Description

The Lower Approach reaches of the C&D Canal Approach Channels extend approximately 15 nautical miles (nm) from the mouth of the Sassafras River southwest to the natural 35-ft deep contour of the Chesapeake Bay. Location of the reaches can be found in Figure 1-3 and Table 1-1 provides dimensions and past maintenance dredging quantities.

1.5.1.2 Maintenance Dredging

Periodic maintenance dredging of the Lower Approach Channel must be performed every year because of the heavy commercial usage of the C&D Canal Approach Channels and rapid shoaling rates. This dredging operation is mainly performed mechanically by a clamshell bucket dredge with bottom dump scows. All of the material dredged from this channel goes directly to the Pooles Island Open Water Site (see Figure 3-5).

1.5.1.3 Sediment Characterization

Physical Characteristics

The sediments historically dredged from the C&D Canal Lower Approach Channel have the physical characteristics of soft and plastic material with clayey silts, shell fragments, sand, gravel, and wood pieces.

Chemical Characteristics

The Susquehanna River is the major contributing factor for the sediments in the upper bay and these sediments have been found to contain a higher total organic carbon (TOC) concentration (13.4%) when compared to sediments in the remainder of the Bay (CENAB, 2001a).

1.5.2 Harbor Channels

The harbor comprises various branch channels that provide access to the public and private terminals serving the Port of Baltimore (see Figure 1-4). The harbor channels are defined as those west of the Rock Point and North Point line (Maryland Port Administration (MPA), 1990).

1.5.2.1 Location and Description

This section contains the descriptions and locations of the federal and non-federal channels (with authorization for federal maintenance) within the Baltimore Harbor area. Table 1-2 presents a summarized version of these data.

- **Curtis Bay Channel** – This channel is approximately 2.2 nautical miles (nm) long, north of Marley Neck, extending from the Fort McHenry Channel to Curtis Bay with an approximate width of 400 ft and a dredged depth of 50 ft mean lower low water (MLLW).
- **Curtis Creek Channel –** Curtis Creek lies in the more industrialized section of the Baltimore Harbor and flows north into Curtis Bay. The entire Curtis Creek Channel is approximately 2.2 nm long and comprises an upper, middle, and lower reach. The approximate channel depths are 22, 22, and 35 ft MLLW, respectively. The average respective channel widths are 150, 290, and 200 ft.

- **Middle Branch Channel Ferry Bar East Section –** This channel is 42 ft deep and 600 ft wide, from the main channel at Fort McHenry to Ferry Bar, a distance of 1.4 nm.

- **Northwest Branch - East and West Channels –** The East Channel, which connects to the Fort McHenry Channel, is approximately 1.3 nm long, 600 ft wide, and 49 ft deep MLLW. The West Channel branches from the East Channel into the Northwest Harbor and is approximately 1.3 nm long, 40 ft deep MLLW, and 600 ft wide. Both channels have turning basins to allow large cargo ships to change course within the channels.

- **East and West Dundalk Marine Channels –** These branch channels work together to serve the Seagirt and Dundalk Marine Terminals. The Dundalk Marine Terminal, a 570-acre cargo terminal, is the largest and most versatile general cargo facility at the Port of Baltimore. This terminal handles containers, automobiles, farm and construction equipment, wood pulp, steel, break and liquid bulk, and project cargo on a daily basis (GS, 2004). The East Dundalk Channel is 400 ft wide by 1.1 nm long and the West Dundalk Channel is 500 ft wide by .67 nm long. Both channels have a dredged depth of 42 ft MLLW.

- **Dundalk/Seagirt Connecting Channel –** This channel provides access to both the Dundalk and Seagirt Marine Terminals. The Seagirt Marine Terminal is a state-of-the-art, 275-acre container terminal, capable of handling 150,000 containers a year as well as automobiles, farm and construction equipment, wood pulp, steel, break and liquid bulk, and project cargo. The channel is 500 ft wide by .42 nm long and is dredged to a depth of 42 ft MLLW.

- **South Locust Point Marine Channel –** This channel is 400 ft wide by .83 nm long and dredged to a depth of 36 ft MLLW and provides access to the 80-acre South Locust Marine Terminal, which began operation in 1979. The facility is designed to handle medium-sized sea vessels and conveniently borders Interstate 95 to the south, making it ideal for cargo that requires timely delivery.

- **Brewerton Channel –** From the Cutoff Angle, the Brewerton Channel runs into the Patapsco River and connects to the Fort McHenry Channel via the Brewerton Angle. This channel is approximately 3 nm long, 50 ft deep MLLW, and 700 ft wide.

- **Brewerton Angle –** This channel is the connecting point between the Brewerton Channel and the Fort McHenry Channel. It is approximately 0.8 nm long and 50 ft deep MLLW with an average width of 1,075 ft.

- **Fort McHenry Channel –** The Fort McHenry Channel is the main channel within the Patapsco River. It runs from the Brewerton Angle to the East Dundalk Marine Channel and is approximately 3.8 nm long, 50 ft deep MLLW, and 700 ft wide.

1.5.2.2 Maintenance Dredging

Baltimore's harbor channels require periodic maintenance dredging approximately every 2 to 5 years because of sedimentation and to allow for the passage of deep-draft ships that call on the harbor for trade purposes (see Table 1-2). Dredging is normally done mechanically by clamshell dredge and placed at the Hart-Miller Island Dredged Material Containment Facility (DMCF) (see Figure 1-5).

1.5.2.3 Sediment Characterization

Physical Characteristics

The primary source of sediment in the Inner Harbor originates from runoff and shoreline erosion because the harbor is sheltered from large wave action. These sediments are mainly composed of clay, silt, sand, and gravel. Some areas within the harbor have historically been found to contain some industrial and municipal contamination, not unusual in heavily industrialized areas (EA, 2003a).

Chemical Characteristics

In 1998, EA Engineering sampled sediments from Curtis Bay and Curtis Creek. Several metals (e.g., arsenic, cadmium, chromium, copper, lead, and zinc), and pesticides (DDT, DDD, and DDE) exceeded the Threshold Effects Levels (TELs) and Probable Effects Levels (PELs) for a number of resident species. This study also indicated that TOC, total phosphorus, biological and chemical oxygen demand, and total nitrogen were elevated in many of the sediments tested, which was not typical for Chesapeake Bay Approach Channel sediments (EA, 2003a).

1.5.2.4 Anchorages

Baltimore Harbor Anchorages are used mainly by smaller bulk cargo vessels waiting for a berth to clear, cargo to arrive, or safe weather conditions (CENAB, 1997).

There are currently three anchorages authorized under the existing Baltimore Harbor and Channels project, which are maintained by the federal government and are regulated by the U.S. Coast Guard (CENAB, 2001). The location and description of these anchorages are described in the following section.

1.5.2.4.1 Location and Description

The Baltimore Harbor Anchorages are within the Harbor area as shown in Figure 1-4 and Table 1-3 provides a summary of each. Note that there is no Anchorage #2 cited here because it is no longer used.

- **Fort McHenry Anchorage (Anchorage #1)—**The Fort McHenry Anchorage (Anchorage #1) has been deauthorized.
- **Riverview Anchorage #1 (Anchorage #3)—**Located in the Patapsco River, along the northeast side of the Fort McHenry Channel, southwest of Seagirt Marine Terminal. Anchorage #3 has two sections. The dimensions of #3A are authorized at 2,200 ft wide by 2,200 ft long and #3B at 1,800 ft wide by 1,800 ft long. Both sections are 42 ft deep.
- **Riverview Anchorage #2 (Anchorage #4)—**This anchorage is located in the Patapsco River, along the northeast side of the Fort McHenry Channel, 3,000 ft southwest of the Dundalk Marine Terminal. It is approximately 0.4 nm long, 35 ft deep, and 1,200 ft wide.

1.5.2.4.1.1 Maintenance Dredging

The shoaling rate for the federally maintained anchorages is minimal, and they are usually maintained on a 10-year dredging cycle. The average maintenance dredging from 1996 to 2004 is provided in Table 1-3.

1.5.2.4.1.2 Sediment Characterization

Physical Characteristics

The majority of the sediments that lie in the anchorage areas within Baltimore Harbor come from runoff and shoreline erosion. They are generally characterized as soft, highly plastic, and organic silty clay. The upper layer of sediment, approximately 0.5 to 3.0 ft thick, predominantly exists in a semi-liquid state (CENAB, 1997). Sediments around Anchorage #3 are entirely composed of a very soft, highly plastic, silty clay, with traces of sand and gravel. Shell fragments, slag pieces, and cobbles are also found occasionally in these sediments. Anchorage #4 sediments are characteristically very soft, highly plastic, and silty clay with traces of sand, shell fragments, wood pieces, and gravel (CENAB, 1997).

Chemical Characteristics

Historical sediment quality tests have shown that areas around Anchorage #3 have some of the highest levels of barium, elevated levels of heavy metals (mercury, chromium, and zinc), and high levels of both total nitrogen and TOC when compared to the rest of the harbor anchorages. Also compared with the rest of the harbor anchorages, Anchorage #4 was found to contain the highest levels of arsenic, copper, lead, fluoranthene, naphthalene, benzo{a}pyrene, and pyrene (CENAB, 1997).

1.5.3 Chesapeake Bay Approach Channels (MD)

The Chesapeake Bay Approach Channels (MD) are located north of the Bay Bridge at Kent Island, just south of Hart Miller Island DMCF, and lead into the Patapsco River (see Figure 1-5).

1.5.3.1 Location and Description

The following channels are considered the approach channels in Maryland that service the Port of Baltimore. Refer to Table 1-4 for a summary of these data and Figure 1-5 to see the location of these approach channels.

- **Craighill Entrance –** The Craighill Entrance Channel begins north of the William P. Lane Jr. Memorial Bridge, which connects Sandy Point to Kent Island. This channel is 3.1 nm long, 50 ft deep MLLW, and 700 ft wide.

- **Craighill Channel –** This channel lies between the Sillery Bay and the Belvidere Shoal connecting Craighill Entrance with Craighill Angle. It is approximately 2.8 nm long, 50 ft deep MLLW, and 700 ft wide.

- **Craighill Angle –** The Craighill Angle is approximately 1.6 nm long and 50 ft deep MLLW, with an average width of 1,258 ft.

- **Craighill Upper Range –** This channel connects the Craighill Angle with the Cutoff Angle and is approximately 2.1 nm long, 50 ft deep MLLW, and 700 ft wide.

- **Cutoff Angle –** This channel connects the Craighill Channel Upper Range with the Brewerton Channel. It is approximately 0.9 nm long, and 50 ft deep MLLW with an average width of 1,220 ft.

- **Brewerton Eastern Extension –** This channel extension connects the Tolchester Channel to the Brewerton Channel and is approximately 5.0 nm long, 600 ft wide, and 35 ft deep MLLW.

- **Swan Point Channel –** Swan Point Channel is located west of Eastern Neck and is approximately 1.7 nm long, 600 ft wide, and 35 ft deep MLLW.
- **Tolchester Channel –** This channel is west of Tolchester Beach and connects to the Brewerton Channel Eastern Extension. It is approximately 6.5 nm long, 600 ft wide, and 35 ft deep MLLW.

1.5.3.2 Maintenance Dredging

Maintenance dredging is normally done mechanically by clamshell dredges approximately every 2 years and placed at the Poplar Island Restoration Site (see Figure 3-2). Dredging is generally not performed on a yearly basis on some of the approach channels. Shoaling is usually allowed to accumulate in a channel until there is sufficient quantity to warrant the award of a dredging contract (MPA, 1990). Refer to Table 1-4 for maintenance dredged quantities from 1996 to 2004.

1.5.3.3 Sediment Characterization

Physical Characteristics

The sediment characteristics in the Chesapeake Bay Approach Channels (MD) have historically been found to be clayey silt and a sand-silt-clay combination. The majority of new sediments come into the Bay from the Susquehanna River. Other sediments are caused by strong wave action and ship energy, which causes shoreline erosion and resuspension of bottom sediment material (CENAB, 2001a).

Chemical Characteristics

Sediments from the Tolchester Channel have been tested for contamination following the U.S. Environmental Protection Agency (U.S. EPA)/USACE Inland Testing Manual (ITM), 1998, and Quality Assurance/Quality Control (QA/QC) Guidance for Dredged Material Evaluations, 1995. It was found that the majority of detected contaminants were at low concentrations and below the U.S. EPA/USACE (1995) recommended target detection limits. Results of water column and sediment toxicity tests indicate that the sediments are not toxic to estuarine water column and benthic organisms (CENAB, 2001a).

In December 2000, EA Engineering prepared a report for CENAB, which evaluated dredged material from the Baltimore Harbor Approach Channels. Maintenance dredging samples were taken from the Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, and Brewerton Channel Eastern Extension. USACE and U.S. EPA's Inland Testing Manual (ITM) was used for this study, which outlines a standard process of characterizing sediment quality (EA, 2000).

The test results found that the dredged material in the federal navigation channels is of similar quality to existing sediments in the Chesapeake Bay as a whole. A review of the characteristics of each chemical found that the majority of the chemicals present in the samples were at insignificant concentrations. Only 12 of the 202 chemical constituents tested in the full-strength elutriates were detected in concentrations that exceeded applicable water quality criteria. Therefore, discharges from a dredged material placement site would require management and monitoring, although monitoring would likely be minor considering the low frequency of detection and low concentrations.

1.5.4 Chesapeake Bay Approach Channels (VA)

The three main Chesapeake Bay Approach Channels (VA): Cape Henry, York Spit, and Rappahannock Shoal, are maintained by the U.S. Army Corps of Engineers, Norfolk District (CENAO). However, the budget for maintenance dredging of these channels located in the Commonwealth of Virginia is the responsibility of CENAB (MPA, 1990).

1.5.4.1 Location and Description

The location of the Cape Henry, York Spit, and Rappahannock Shoal Channels are shown in Figure 1-6. A summary of each channel is provided in Table 1-5.

- **Cape Henry Channel –** The Cape Henry Channel is located north of Cape Henry and approximately 4.7 nm long, 1,000 ft wide, and 50 ft deep MLLW.
- **York Spit Channel –** This channel is located near the center of the Bay, east of the York River Entrance Channel and north of the Chesapeake Bay Bridge Tunnel. The York Spit Channel is approximately 18.4 nm long, maintained to 800 ft wide, and 50 ft deep MLLW.
- **Rappahannock Shoal –** The Rappahannock Shoal Channel is located in the center of the bay, east of the Rappahannock River. The channel is approximately 10.3 nm long, maintained to a width of 800 ft, and 50 ft deep MLLW.

1.5.4.2 Maintenance Dredging

The Virginia channels undergo periodic maintenance dredging to aid in vessel navigation throughout the Chesapeake Bay (refer to Table 1-5). Dredged material from these channels has traditionally been placed at open water sites within the Virginia boundaries of the Chesapeake Bay as well as ocean placement sites and it is not anticipated that there will be a shortfall of placement capacity in the near future (MPA, 1990). There are four main open water placement sites for Virginia dredged material: Dam Neck Ocean, Norfolk Ocean, Wolf Trap Alternate, and Rappahannock Shoal Deep Alternate (see Figure 3-3 for placement site locations), although the current biological opinion lists only Dam Neck and Wolf Trap Alternate as available for placement of dredged material.

Historically, dredged material from the Cape Henry Channel has been found to be adequately clean for ocean placement and thus suitable for open water placement at the Norfolk Ocean Dredged Material Area (Norfolk DMA), which is permitted to receive clean dredged material from the Bay waters of Virginia (CENAB, 1981). The Norfolk DMA has an unlimited useful life and serves as an alternative site to the Dam Neck Ocean Dredged Material Area (Dam Neck DMA) for lower Bay channels, as well as a site that can accommodate dredged material suitable for ocean placement from the Inner Harbor channels within the Port of Hampton Roads (CENAO, 1994). The Norfolk DMA lies in the Atlantic Ocean and is approximately 50 square miles in dimension and located 17 miles east of Cape Henry, Virginia.

The Dam Neck DMA has been designated by U.S. EPA as the primary placement site for material from three federal channels: Thimble Shoal, Cape Henry, and Atlantic Ocean channels. It is approximately 10 square miles in size and located 3 miles east of Virginia Beach (CENAO, 1994).

New work and maintenance dredged material from the York Spit and Rappahannock Shoal Channels have historically been placed in the Wolf Trap Alternate and Rappahannock Shoal Deep Alternate placement areas, respectively. The Wolf Trap Alternate placement area is located northeast of Mobjack Bay and the Rappahannock Shoal Deep Alternate placement area is located northeast of the Rappahannock River.

1.5.4.3 Sediment Characterization

Physical Characteristics

Subsurface studies have shown the Virginia channel sediments to be a greenish-grey in color and consisting of silt, sand, and clay mixtures, with traces of shells. The mean sediment grain size found in the Cape Henry, York Spit, and Rappahannock Shoal Channel are 0.23, 0.17, and 0.02 mm, respectively.

Chemical Characteristics

Historical data from previous studies pertaining to chemical analysis of Virginia Channel sediments, such as those performed by the Virginia Institute of Marine Sciences (VIMS), has shown the sediments to be clean and thus meet overboard criteria for placement in the Chesapeake Bay and Atlantic Ocean. The sediments have been found to contain low levels of all testing parameters when compared with the guidelines set forth by the State of VA Spoil Disposal Criteria Committee, which have been deemed reasonable by EPA Region III. Elutriate analyses performed for the dredging and placement areas showed little effect on the ambient water quality (CENAB, 1981).

1.6 LOCAL SPONSORS

Successful dredged material management planning is a collaborative process. The planning should be conducted by a partnership that includes the federal government, the Port authorities, state and local governments, public interest groups, the scientific community, and private citizens.

It is especially important to establish a successful partnership with a project sponsor as described in USACE Engineering Regulation (ER) 1105-2-100.

The local sponsor for the Baltimore Harbor & Channels Project is the State of Maryland through the MPA. The MPA works to promote and increase waterborne commerce in Maryland, particularly at the Port of Baltimore. The MPA maintains and improves facilities and strengthens the workings of the private operator. Through the Administration’s efforts, the Port of Baltimore has been transformed into one of the world’s leading commercial ports. The Port is considered a significant economic engine for the entire region, generating $1.4 billion in revenue annually and providing approximately 32,956 jobs (direct, induced, and indirect).

1.6.1 State of Maryland's DMMP Process

The state, through the MPA, is conducting its own DMMP for the Port of Baltimore. The program will develop a long-term dredging and dredged material placement plan for the Port, including the identification of potential new placement sites. The state's plan is focused on the federal, state, and private channels serving the Port in the Upper Chesapeake Bay (C&D Canal Approach and Chesapeake Bay Approach (MD) Channels) and Patapsco River and placement alternatives in the Upper and Middle reaches of the Bay. The state's DMMP incorporates input from various stakeholders and the process is organized around an Executive Committee, a Management Committee, a Citizens' Advisory Committee, and numerous ad hoc working groups. Representatives from federal agencies (CENAB, U.S. Army Corps of Engineers Philadelphia District (CENAP), U.S. Environmental Protection Agency (U.S. EPA), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), etc.), state and local agencies (MPA), Maryland Geological Survey (MGS), Maryland Department of Natural Resources (MD DNR), Maryland Department of the Environment (MDE), were formed into an advisory group, the Bay Enhancement Working Group (BEWG). A citizen's group was formed into a second advisory committee, the Citizens' Advisory Committee (CAC). The working groups will continuously identify, study, review, and prioritize potential sites.

The State of Maryland's program and this DMMP process both have similar goals of identifying suitable placement sites to contain dredged material from the federal, state, and local non-federal channels over at least the next 20 years. USACE's plan is conducted from a federal perspective and is intended to ensure that the Port's federal navigation projects continue to be completed and maintained in an environmentally acceptable and cost-effective manner, thereby justifying an ongoing investment of federal funds.

This DMMP differs from the state's DMMP in that it is more inclusive geographically, including all of the Baltimore Harbor & Channels project channels in Virginia waters in addition to those in Maryland waters; it includes an economic evaluation to determine the federal interest in continued maintenance of the channels; it addresses a wide range of dredged material placement alternatives, including some that may be prohibited by state law in order to determine the appropriate federal authorities for constructing and cost sharing dredged material placement sites; and it includes a programmatic EIS that addresses the placement alternatives and updates the NEPA documentation for dredging all of the Baltimore Harbor & Channels project channels.

CENAB is an integral player in the state's program and has representatives on the state's Executive, Management, and ad hoc working committees. CENAB also provides periodic briefings to the state's Citizens' Advisory Committee. Dredging and dredged material management should be a cooperative process that benefits from the involvement of key government and nongovernment stakeholders. CENAB will continue to work closely with the state to integrate the two processes, share information, and prevent duplication of effort. This close coordination is essential in developing a comprehensive program for the Port of Baltimore that will provide cost-effective dredging and placement operations and protect, conserve, and restore coastal resources.

1.7 DMMP STUDY PROCESS

The process that the CENAB DMMP team is following in preparation of this plan is shown in Figure 1-7.

Preliminary Assessment, NEPA Notice of Intent and Public Meetings

The DMMP process began with the Preliminary Assessment (PA), which CENAB finalized in July 2001. A NEPA Notice of Intent was submitted in May 2002 and public meetings were held in Stevensville, MD; Baltimore, MD; and Arnold, MD, in June 2002. A Project Management Plan (PMP) was developed in October 2002 and scoping ensued for the DMMP Study. Scoping culminated in July 2003 with the award of a contract to Weston Solutions, Inc. (WESTON®) for the preparation of the Programmatic DMMP Study and Tiered Environmental Impact Statement (EIS).

Geographic Areas Identification and Alternatives Identification

The first step of the DMMP study was the Geographic Areas Identification within the study area, including the C&D Canal Approach Channels, Harbor Channels, Chesapeake Bay Approach Channels (MD), and Chesapeake Bay Approach Channels (VA). Following the identification of the geographic areas, the project delivery team performed an Alternatives Identification for dredged material placement. The State of Maryland is preparing a state dredged material management program concurrently with the federal DMMP (see Section 1.6.1). Within the state process, the BEWG worked for 2 years to compile alternatives for dredged material placement. To develop a host of placement alternatives for the federal DMMP, the team used the BEWG's list of alternatives as a starting point. The BEWG list was augmented with additional alternatives that the BEWG did not consider because the alternative was either 1) contrary to state law or 2) only applicable outside Maryland. Because the CENAB DMMP is a federal study, it is not constrained by state or local laws or regulations. Where feasible, the team will give due consideration to state and local laws, but will not be constrained by them in cases where state and local laws are not based on scientific criteria, applicable federal criteria are met, and consideration of such laws would add significant costs.

Preliminary Screening and Initial Alternatives List

The project delivery team next performed a Primary Screening to remove any alternative that was either not feasible or involved locations outside the Chesapeake Bay Watershed Area. An example of an alternative that is not feasible is beach nourishment in the northern bay. Because of the silty nature of the dredged material in the Upper Bay, it would not be appropriate for use as beach nourishment. The team made two exceptions to the Bay watershed area criteria, for mines and ocean placement. There are mines outside the watershed area, such as Bark Camp Mine in Pennsylvania, which have tremendous capacity and are currently being used by other USACE districts as a dredged material placement site. Ocean placement was considered, despite being outside the watershed area, because of the vast capacity available for placement and interest amongst the public and environmental groups to consider this option.

The result of the preliminary screening was the Initial Alternatives List, which includes a total of 36 new and existing placement sites. The 36 alternatives were then considered for each of the four geographic subareas. Those deemed applicable for each area were carried forward to be formulated and optimized, for a total of 77 placement alternatives (see Section 3.3).

Alternatives Development

The project delivery team performed further alternatives development by compiling additional information for each placement alternative. The information included a programmatic geographic location for each new placement alternative; the relative capacity of the placement alternative; relative cost to construct, operate, and maintain the placement alternative; accessibility, constructability, and operability issues for the placement alternative; and environmental, recreational, commercial, residential, and regulatory impacts from the placement alternative. The developed dredged material placement alternatives were presented to the BEWG on 6 January 2004 and the CAC on 11 February 2004.

Screening Criteria Development

The next step in the DMMP process was Screening Criteria Development. To compare the 77 alternatives against each other, the project delivery team considered three main quantitative criteria—capacity of the placement alternative; cost to dredge, construct, operate, and maintain each placement alternative; and the environmental benefit or impact caused by each placement alternative. The team also considered two main qualitative criteria: technical and logistical risk; and acceptability risk.

Alternatives Evaluation

Once the screening criteria were accepted by the BEWG and by the public through the CAC, the Alternatives Evaluation was initiated and both qualitative and quantitative assessments were developed for each alternative.

As a measure of the environmental benefit and/or impact of a placement alternative, the project delivery team again used a product of the BEWG efforts. The BEWG established an alternatives scoring matrix, which includes 52 criteria grouped under the following subsets: water quality, shallow water habitat, wetlands, aquatic biology, rare/threatened/endangered species, waterbirds, terrestrial, physical parameters, human use attributes, and beneficial attributes. The BEWG assigned a score, which varies between –1 and +1, for each alternative for each criterion. When the score for each alternative was multiplied by the weight for each criterion, a total score was calculated and then normalized against the full list of alternatives. Using this system, each CENAB DMMP alternative was scored for environmental benefit and/or impact by the BEWG in March and April 2004. The screening criteria were presented to the CAC on 14 April 2004. To allow comparison of alternatives against one another, a Habitat Benefit Index was derived by multiplying the Benefit Unit Score, a product of the BEWG scoring, by the area of habitat created by the alternative. A full description of the environmental evaluation is included in Section 3.3.2.

Concurrent with environmental scoring activities, the project delivery team prepared concept-level design assumptions for each of the alternatives and calculated capacity in mcy and cost, in dollars ($). For all alternatives that did not include the use or expansion of an existing facility, the project delivery team chose an available and acceptable representative location for the alternative by using Geographic Information System (GIS) maps to identify suitable locations. The capacities were then calculated for a full site life for each alternative. Life-cycle cost estimates were prepared for each alternative considering five elements: 1) Initial Study, Permitting, and Design; 2) Site Development and Closeout; 3) Dredging, Transport, and Placement; 4) Habitat Development; and 5) Operation and Maintenance. The screening criteria were presented to the Management Committee on 20 May 2004, the BEWG on 8 June 2004, and the CAC on 9 June 2004. A full description of the capacity and cost evaluations are included in Sections 3.3.3 and 3.3.4, respectively.

To perform a qualitative analysis of the alternatives, the DMMP team convened a management roundtable meeting on 16 June 2004. Representatives from CENAB and MPA considered each alternative and assigned scores from 1 (low risk) to 5 (high risk) in the area of technical and logistical risk and acceptability risk. The groups considered the likelihood that the alternatives would not achieve the expected capacity and benefit within the 21-year planning window of the DMMP. A full description of the risk evaluations is included in Sections 3.3.5 and 3.3.6.

Trade-off Analysis and Suite of Alternatives

Once qualitative and quantitative measures were completed for each alternative, a Trade-off Analysis was performed. The management roundtable determined the level of technical/logistical risk that it considered acceptable for proceeding with an alternative. In setting a threshold risk level, the group eliminated those alternatives that had unacceptably high risk. Three alternatives were deemed to have an unacceptable level of technical/logistical risk and were thus eliminated. The remaining viable alternatives were assembled into Suites of Alternatives that meet the required 20-year net dredged material capacity need for each of the four geographic subareas. Once the suites were developed, they were evaluated for cost effectiveness of habitat created and reasonableness of acceptability risk. The management roundtable was reconvened on 29 June 2004 to consider additional qualitative criteria.

EIS & Implementation Plan and Record of Decision

As a result of both quantitative and qualitative evaluation, six alternatives were selected as part of the recommended plan to meet the required 20-year dredged material capacity needs of the Port of Baltimore. These alternatives will be covered within this document in a Tiered Environmental Impact Statement and Implementation Plan. The Programmatic DMMP and Tiered EIS will be prepared in Draft and Final form, will be available for review by the public, and will result in a ROD scheduled for July 2005.

CHAPTER 1

TABLES

Table 1-1

C&D Approach Channels
Federally Authorized Maintenance Dredging

Channel Section	Length* (nautical miles)	Constructed Width* (feet)	Maintenance Dredging Average Annual Quantity Placed* (cubic yards)
C&D Canal Approach Channel (Lower Approach)	15	450	1,200,000

* Information provided by U.S. Army Corps of Engineers Philadelphia District (CENAP)

Table 1-2

Harbor Channels
Federally Authorized Maintenance Dredging

Channel Section	Length* (nautical miles)	Constructed Width* (feet)	Authorized Depth (feet)	Maintenance Dredging Average Annual Pay Quantity (1996-2004)* (cubic yards)
Curtis Bay Channel	2.2	400	50	96,431
Curtis Creek Channel	2.2	150 (Upper) 290 (Middle) 200 (Lower)		12,132
East Dundalk Branch	1.0	400	42	0
West Dundalk Branch	1.2	500	42	484
Dundalk/Seagirt Connecting	1.0	500	42	2,814
South Locust Point Branch	0.7	400	36	0
Middle Branch Channel – Ferry Bar East	1.4	600	42	11,727
Northwest Branch - East	1.3	600	49	0
Northwest Branch - West	1.3	600	40	10,187
Brewerton Channel	3.0	700	50	111,364
Brewerton Angle	0.8	1,075	50	107,648
Fort McHenry Channel	**3.8**	**700**	**50**	101,392
			Total	454,179

* Information provided by U.S. Army Corps of Engineers Baltimore District (CENAB). Dredging quantities prior to 1996 are not included. "Pay quantity" is defined as the required volume to be dredged in accordance with a unit-cost contract. Because of the inaccuracies of dredging, the amount that is actually dredged is often more than the "pay quantity."

Table 1-3

Baltimore Harbor Anchorages
Federally Authorized Maintenance Dredging

Channel Section	Length* (nautical miles)	Constructed Width* (feet)	Authorized Depth (Feet)*	Maintenance Dredging Average Annual Pay Quantity (1996-2004)* (cubic yards)
Fort McHenry	0.3	Deauthorized	Deauthorized	0
Riverview #1 (3A)	0.4	2,200	42	16,667 (3A & 3B)
Riverview #1 (3B)	0.3	1,800	42	0
Riverview #2	**0.4**	**1,800**	**35**	4,441
			Total	21,108

* Information provided by U.S. Army Corps of Engineers Baltimore District (CENAB). Dredging quantities prior to 1996 are not included. "Pay quantity" is defined as the required volume to be dredged in accordance with a unit-cost contract. Because of the inaccuracies of dredging, the amount that is actually dredged is often more than the "pay quantity."

Table 1-4

Chesapeake Bay Approach Channel (MD)
Federally Authorized Maintenance Dredging

Channel Section	Length* (nautical miles)	Constructed Width* (feet)	Authorized Depth (Feet)*	Maintenance Dredging Average Annual Pay Quantity (1996-2004)* (cubic yards)
Craighill Entrance	3.1	700	50	193,983
Craighill	2.8	700	50	100,668
Craighill Angle	1.6	1,258	50	396,742
Craighill Upper Range	2.1	700	50	56,889
Cutoff Angle	0.9	1,220	50	188,855
Brewerton Eastern Extension	5.0	600	35	439,906
Swan Point	1.7	600	35	103,465
Tolchester	**6.5**	**600**	**35**	208,787
			Total	1,689,295

* Information provided by U.S. Army Corps of Engineers Baltimore District (CENAB). Dredging quantities prior to 1996 are not included. "Pay quantity" is defined as the required volume to be dredged in accordance with a unit-cost contract. Because of the inaccuracies of dredging, the amount that is actually dredged is often more than the "pay quantity."

Table 1-5

Virginia Channels
Federally Authorized Maintenance Dredging

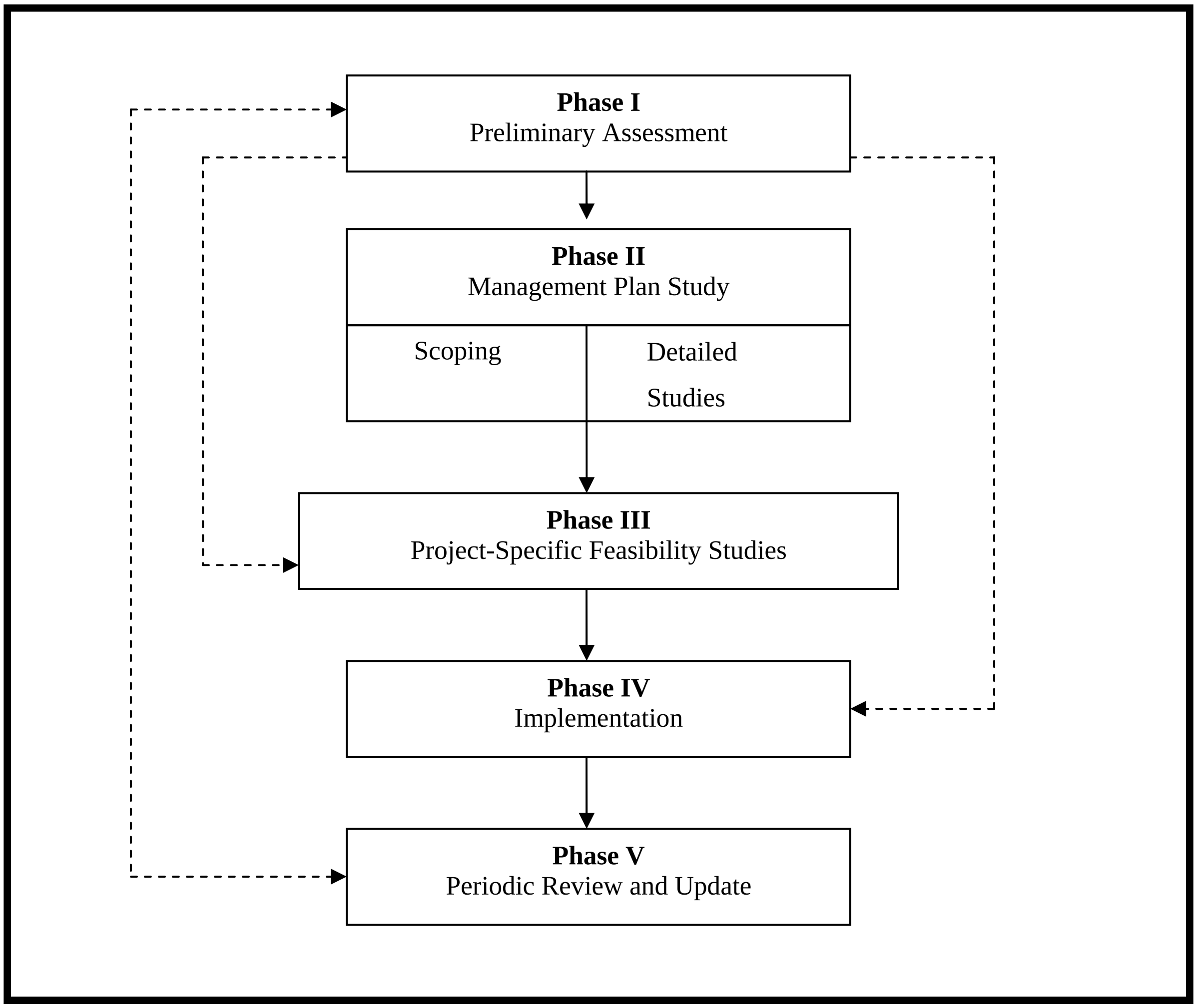
Channel Section	Length* (nautical miles)	Constructed Width* (feet)	Authorized Depth (Feet)*	Maintenance Dredging Average Annual Pay Quantity (1996-2004)* (cubic yards)
Cape Henry	4.7	1,000	50	443,381
York Spit	18.4	800	50	187,211
Rappahannock Shoal	**10.3**	**800**	**50**	0
			Total	630,592

* Information provided by U.S. Army Corps of Engineers Baltimore District (CENAB). Dredging quantities prior to 1996 are not included. "Pay quantity" is defined as the required volume to be dredged in accordance with a unit-cost contract. Because of the inaccuracies of dredging, the amount that is actually dredged is often more than the "pay quantity."

CHAPTER 1

FIGURES

Figure 1-1 DMMP Framework



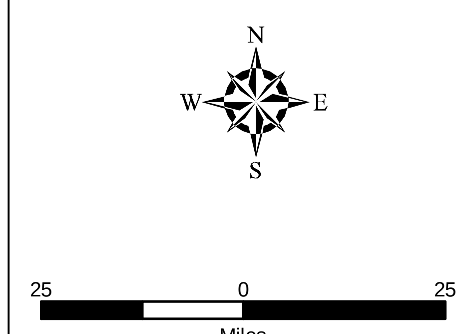


Figure 1-2
Chesapeake Bay Area

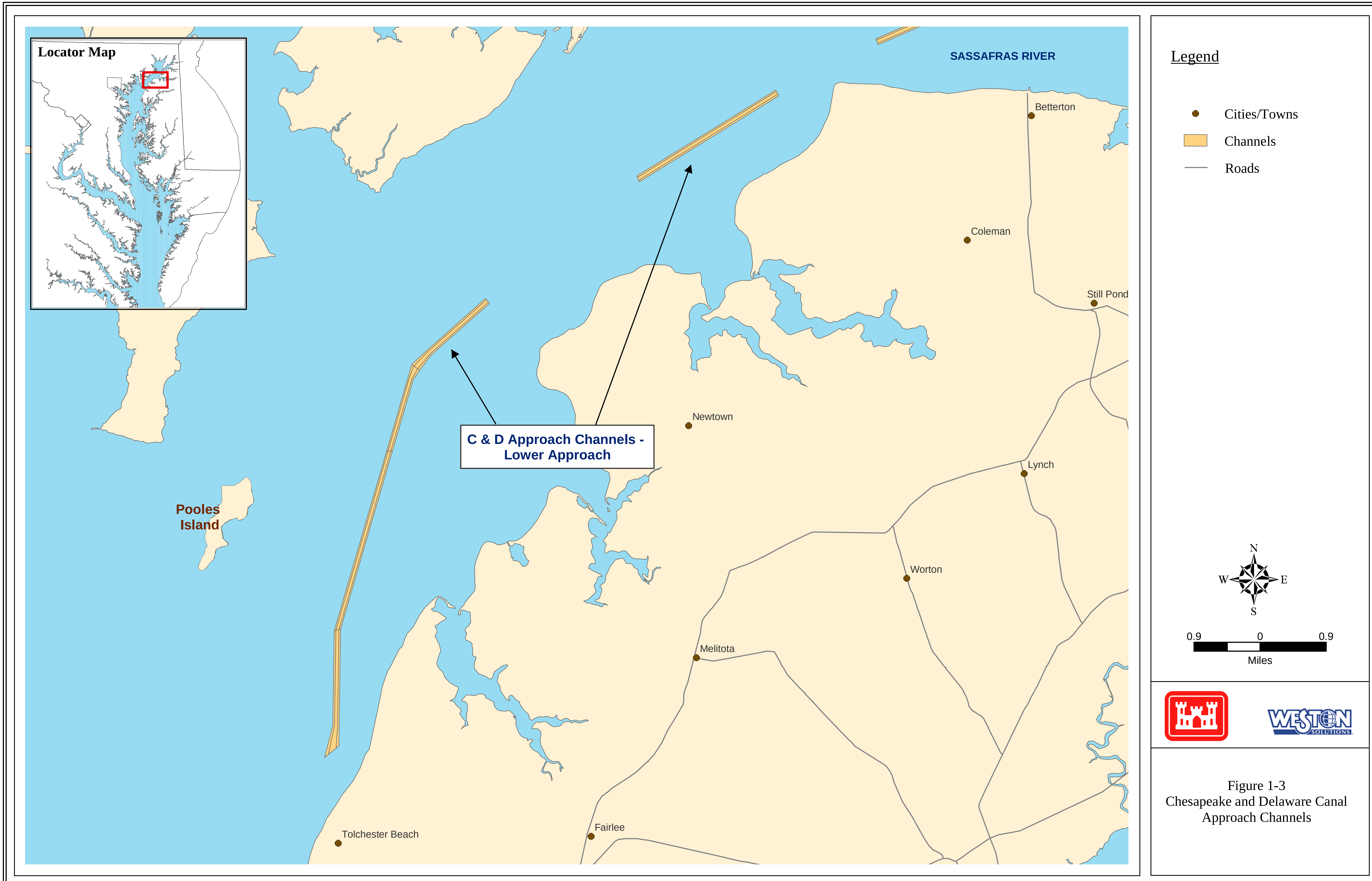


Figure 1-3
Chesapeake and Delaware Canal
Approach Channels

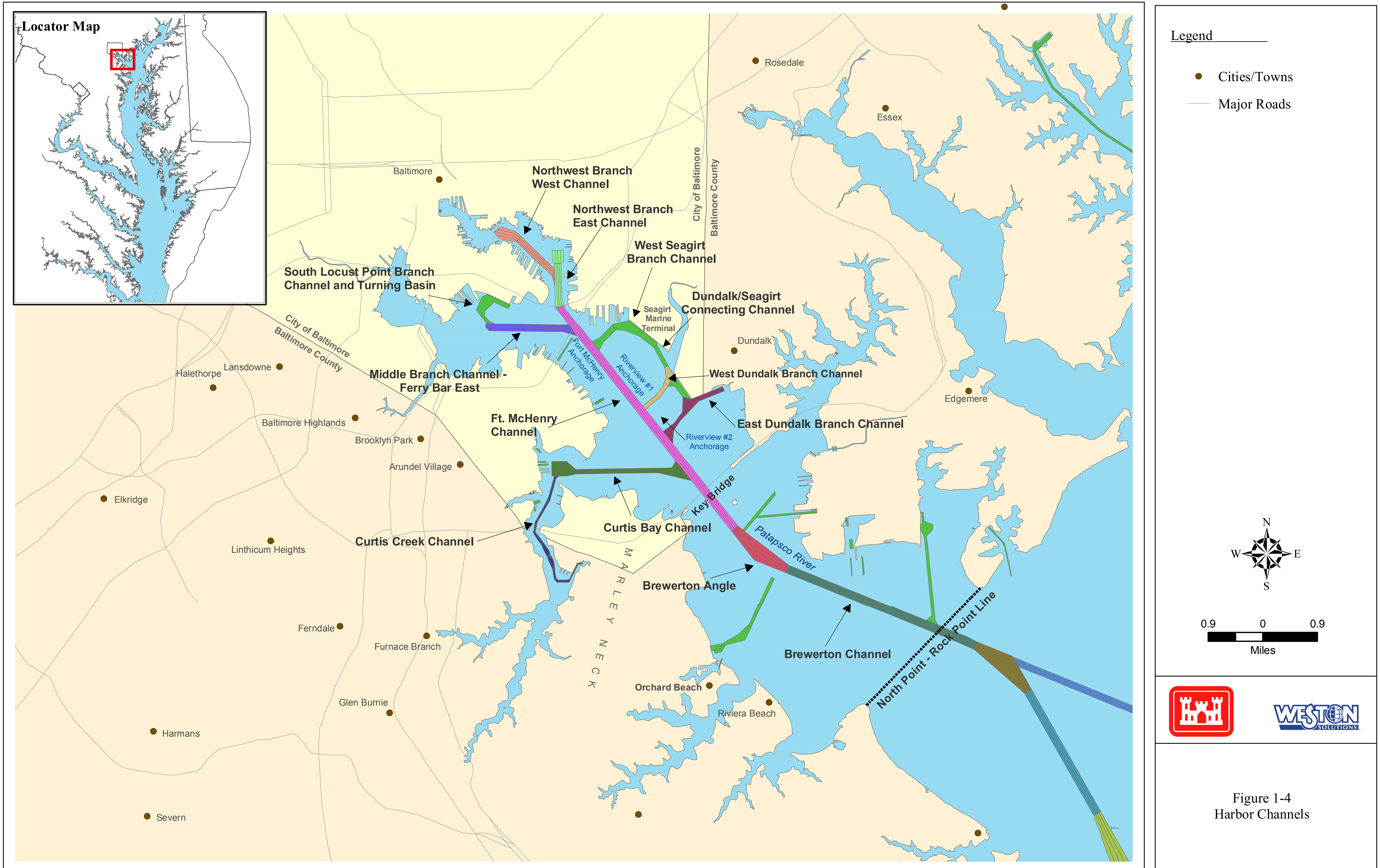


Figure 1-4
Harbor Channels

Figure 1-5
Chesapeake Bay
Approach Channels (MD)

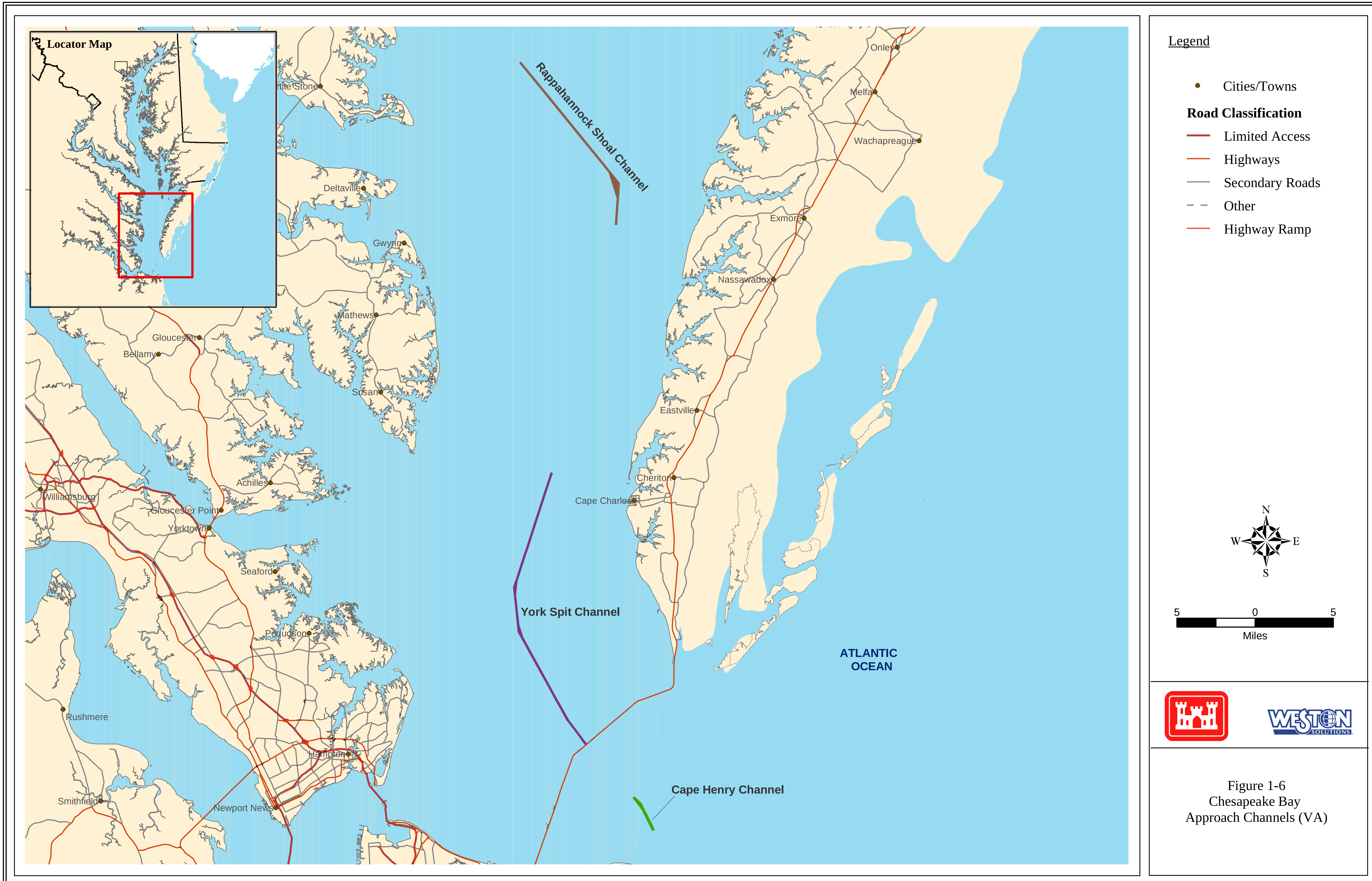
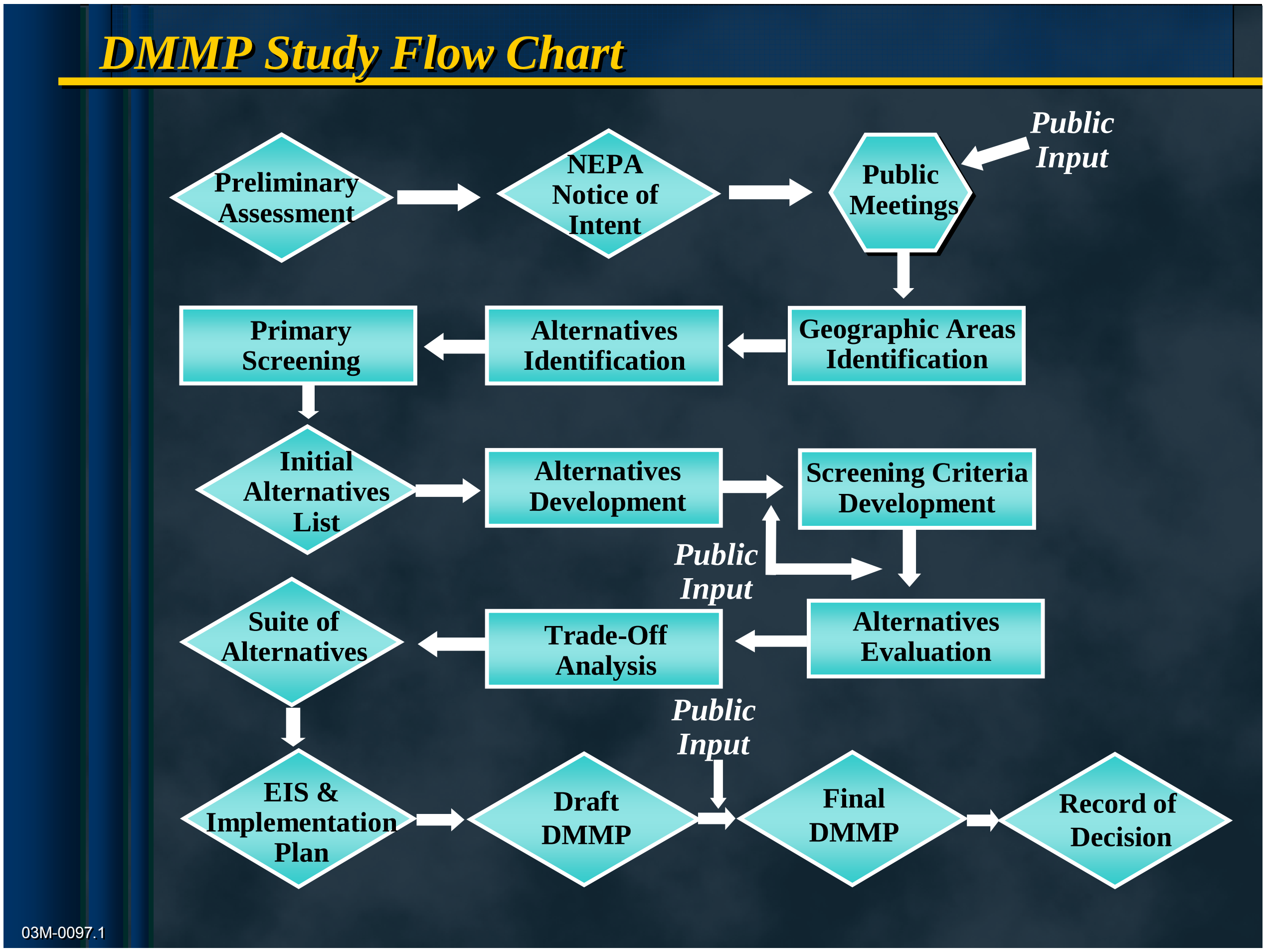


Figure 1-6
Chesapeake Bay
Approach Channels (VA)

Figure 1-7 DMMP Process



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2. AFFECTED ENVIRONMENT

The Chesapeake Bay is the nation's largest estuary, encompassing approximately 2,500 square miles of water. The watershed discharging into the Bay is approximately 64,000 square miles and includes parts of six states (Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia) and the District of Columbia.

The Bay is approximately 200 miles long from Havre de Grace, MD, to Norfolk, VA (Figure 1-2 in Chapter 1). The width of the Bay ranges from 3.4 miles near Aberdeen, MD, to 35 miles near the mouth of the Potomac River (CBP Web site). The average water depth of the Bay is approximately 21 ft with some deep troughs, which traverse much of the Bay's length, at depths of up to 175 ft.

The Chesapeake Bay watershed is an incredibly complex ecosystem, with more than 3,600 species of flora and fauna and a human population exceeding 16 million. The Bay is a major resting ground along the Atlantic Migratory Bird Flyway. The diversity of habitats supports economic, recreational, and educational resources. Important commercial and recreational species include blue crab, oyster, striped bass, and numerous species of waterfowl (CBP, 2003d).

The protection and restoration of the Bay's resources is considered vital to its future, and the impacts from dredging and the placement of dredged material is of concern. This chapter presents general descriptions of the Bay environments that could be impacted from these activities. For the purpose of discussing the environment, the Bay is divided into four regions as follows:

- Upper Bay—The region of the Bay and its tributaries above the Chesapeake Bay Bridge.
- Baltimore Harbor—The Patapsco River and its tributaries west of the North Point - Rock Point Line.
- Middle Bay—The region of the Bay and its tributaries from the Chesapeake Bay Bridge south to the Virginia state line.
- Lower Bay—The region of the Bay and its tributaries south of the Virginia state line.

For each region, the information presented focuses on the portions of the Bay most likely to be impacted from placement. As a result, the focus is on the water resources of the Bay and the wetland and upland areas along the margin of the Bay where most, if not all, dredging and dredged material placement will occur under the Baltimore Harbor and Channels project.

Where practical, information for an environmental resource category is summarized separately for each of the four regions. In some instances it is not practical to make these distinctions either because the information does not lend itself to those separations (e.g., geology and aquifers) or because the source information did not use those geographic separations.

Note that the DMMP is programmatic in nature. Dredged material management alternatives presented within the DMMP are non-site specific, except for those that include existing sites such as PIERP, Cox Creek, etc. Therefore the affected environment information is also programmatic in nature.

As part of the DMMP recommended plan development process, the State of Maryland Dredged Material Management Program (DMMP), Bay Enhancement Working Group (BEWG) evaluated all alternatives for environmental impact, considering 52 different environmental criteria. The criteria considered by the BEWG along with discussions of the impacted Bay environment are included in Appendix B and provide the reader with information, in addition to that presented here in Chapter 2, about the affected environment.

It is recognized that some of the dredged material placement alternatives considered could involve transport to areas outside of this region (e.g., agricultural placement and mine placement). However, it is not practical to present this information given the uncertainty of where dredged material placement under these alternatives might be feasible. In addition, the alternatives that would be located outside of the Chesapeake Bay area were eliminated from further consideration during the screening process (Section 3.3).

2.1 PHYSICAL CONDITIONS OF THE CHESAPEAKE BAY

Approximately one-half of the water in the Chesapeake Bay comes from the 150 major rivers and streams in the Chesapeake drainage basin and the other half of the water enters the Bay at Cape Henry from the Atlantic Ocean (CBP, 2004f). The general climate of the Chesapeake Bay region is characterized as moderate with an average precipitation of 44 inches per year, 13 inches of which is snowfall. The Bay is oriented in a north-south direction and its tidal shoreline is approximately 8,100 miles in length (Leatherman et al., 1995). Because the Bay covers a wide latitudinal area, the physical conditions of the Bay vary according to geographical region. The physical conditions of particular concern include bathymetry, water levels, wind conditions, wave conditions, and tidal currents. The following sections discuss these physical conditions in detail.

2.1.1 Upper Bay

The Chesapeake Bay Approach Channels (MD) that service the Port of Baltimore include the Tolchester Channel, Swan Point Channel, Brewerton Eastern Extension, Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, and the Brewerton Channel (Figures 1-4 and 1-5).

2.1.1.1 *Bathymetry*

These federal channels are heavily used by the larger cargo vessels for navigation to and from the Chesapeake Bay. Where water depths would naturally be shallower than the authorized navigation channel depth, the authorized depth is maintained by periodic dredging. The physical conditions of the Upper Bay area are listed in the following sections.

Hydrographic data for the Upper Bay region was obtained from the National Oceanic and Atmospheric Administration (NOAA) Chart No. 12273. Approximate water depths for the Swan Point, Tolchester, and Brewerton Eastern Extension channels are each 35 ft mean lower low water (MLLW).

The remaining bathymetry in the Upper Bay is generally shallow with gradual depth transitions except near natural or dredged channels, where some steeper gradients exist. Depths in the undeveloped margins of the bay are shallow with gradual slopes ending in wetlands, or submerged aquatic vegetation (SAV). Commercial berths are typically dredged to adjacent federal channel depths and have bulkheads, low-level relieving platforms, or other berthing structures. This results in abrupt changes in bathymetry from the berthing areas to adjacent port facility. Recreational marina facilities also dredge berthing areas and have bulkhead structures that result in abrupt transitions in bathymetry adjacent to marina property, but to a lesser extent than commercial berthing facilities.

2.1.1.2 *Water Levels*

Normal water level variations in the upper Chesapeake Bay region are generally dominated by astronomical tides, although wind and freshwater discharge into the Bay have impacts as well (M&N 2001). Strong winds have the ability to force water in and out of the Upper Bay, which can temporarily alter the water level in this region. However, extreme changes in water levels are mainly due to storm surge caused by northeasters and hurricanes, which have caused serious flooding resulting in extensive property damage, and have been a reoccurring phenomenon throughout the Upper Bay region (CENAB, 1981).

2.1.1.3 *Wind Conditions*

Wind direction within the Chesapeake Bay varies throughout the day and strong, prolonged winds from the northern Upper Bay region have a tendency to move water out of the Bay, creating unusually low tides (CENAB, May, 2001). Mean wind speed data is available from the NOAA, National Climatic Data Center (NCDC). For the Upper Bay area, the Aberdeen Proving Ground wind monitoring station recorded a mean wind speed of 2.1 knots for 2003.

2.1.1.4 *Wave Conditions*

Strong wind conditions, primarily from the north and south, have an impact on the wave heights in the upper Chesapeake Bay area. Except during storm surges, the wave conditions throughout the Upper Bay are generally less than 3 ft in height (CENAB, 1981). However, significant offshore wave heights range from a minimum of 4.8 ft for a 5-year storm to a maximum of 9.7 ft for a 100-year storm (M&N, October 2002).

2.1.1.5 *Tides and Currents*

Astronomical tides above MLLW in the upper Chesapeake Bay are semidiurnal with a mean tidal level between 0.7 and 0.9 ft. The mean tidal range is between 1.0 and 2.0 ft and the spring tidal range is between 1.5 and 1.8 ft (M&N, 2001).

Tidal currents caused by vertical water movement from the rise and fall of the tide are classified as moderate to weak, and the Upper Bay area has an average velocity of approximately 2 feet/second (ft/s) (USACE, 1999). The currents are also driven by wind and freshwater discharge, mainly from the Susquehanna River. During storm events, surges and runoff will frequently exceed the average velocity range in the Upper Bay. Currents measured around Eastern Neck Island are considered weak compared to the rest of the Upper Bay, approximately 0.6 to 0.8 ft/s (EA, 2003b). South of this area, near Kent Island, studies have shown this area to experience diurnal tide currents with a net southerly movement of surface water velocity and a northerly net movement of bottom water velocity.

This region of the Bay includes an area of "turbidity maximum" between Pooles Island and Turkey Point, where an interaction between freshwater from the Susquehanna River and the Bay's saltwater generates a relative maximum concentration of suspended sediment. Since this area of the Bay is generally the northern extent of salinity intrusion, high levels of turbidity can occur resulting from this mixing.

2.1.2 Baltimore Harbor

2.1.2.1 *Bathymetry*

The Harbor Channels include the Curtis Bay Channel, Curtis Creek, East and West Dundalk Marine, Dundalk/Seagirt Connecting, South Locust Point Marine, Middle Branch, Northwest Branch, Fort McHenry, Brewerton Angle, and Brewerton Channels (Figure 1-4). Where water depths would naturally be shallower than the authorized navigation channel depth, the authorized depth is maintained by periodic dredging. The physical conditions of these main inner harbor channels are listed in the following sections.

Hydrographic data for the Harbor Channels Region was obtained from the NOAA chart 12281. Approximate water depths for the harbor channels vary from -22 to -50 MLLW. The bathymetry outside of the main channels varies extensively throughout the harbor area of the Bay. Because of heavy industrialization, the majority of the harbor coastline is dominated by wharves for commercial and recreational purposes. These areas experience routine maintenance dredging and thus have greater depths when compared to the shallow points along the shoreline of Curtis Bay, Sollers Point, and shoreline surrounding the harbor area that is fed by the Patapsco River. This shoreline is characterized by sparse vegetation, riprapping along the length, and some sand accretion.

2.1.2.2 *Water Levels*

Normal water level variations in the Harbor Channels are generally dominated by astronomical tides and freshwater discharge; however, fluctuations in the water levels caused by tidal movement are considered insignificant when compared to water level change due to weather conditions.

2.1.2.3 *Wind Conditions*

Wind direction within the Bay varies throughout the day and strong, prolonged winds from either north or south have an impact on water levels within the Harbor Channels region. However, the bay waters in the harbor are protected by wind due to the heavy industrialization along the reach. Mean wind speed data from the NOAA National Climatic Data Center (NCDC), for the Baltimore-Washington International Airport for 2003 was recorded at 6.0 knots with a maximum sustained wind speed of 13.1 knots.

2.1.2.4 *Wave Conditions*

Wave conditions throughout the Harbor Channels are relatively calm in relation to the rest of the Chesapeake Bay. The main reach of the harbor is protected from wind in a north and south direction, minimizing large wave heights more commonly experienced in the general bay vicinity.

2.1.2.5 *Tides and Currents*

Normal water levels in the Chesapeake Bay are driven by astronomical tide patterns. The mean tide level in the harbor is 0.8 ft above MLLW, the mean tidal range is 1.1 ft, and the mean spring tide increases the tide level to 1.7 ft. Tidal current velocities in the Harbor Channels are typically weak and variable, with a maximum velocity of less than 1 ft/s (EA, 2003a).

Overall current velocities in the Harbor Channels are low because it is sheltered from the rest of the Bay, and thus wave and wind stress is minimal (M&N, 2002a). The significant wave heights range from 2.5 to 5.3 ft for the 35-year and 100-year storm profiles, respectively (MES, 2003).

2.1.3 Middle Bay

2.1.3.1 *Bathymetry*

The Deep Trough defines the deepest water in the Middle Bay and runs through the middle of the bay, meandering slightly. Several access channels branch from the federal channels and are generally shallower than the federal channel but deeper than natural depths surrounding them. The remaining bathymetry in the Middle Bay is generally shallow with gradual depth transitions except near natural or dredged channels, where some steeper gradients exist. Depths in the undeveloped margins of the bay are shallow with gradual slopes ending in wetlands, or SAV. There are several commercial berths in the Middle Bay. These berths are typically dredged to adjacent federal channel depths and have bulkheads, low-level relieving platforms, or other berthing structures. This results in abrupt changes in bathymetry from the berthing area to the adjacent port facility. Recreational marina facilities also dredge berthing areas and have bulkhead structures that result in abrupt transitions in bathymetry adjacent to marina property, but to a lesser extent than commercial berthing facilities.

2.1.3.2 *Water Levels*

The Middle Bay water levels are influenced by tidal changes, weather conditions, and freshwater stream flow from the Susquehanna River basin, which typically contributes more than 50% of the flow to the Bay. Above-normal rain- and snowfall is critical during the spring season to replenish low freshwater stream flow and groundwater levels. However, water levels due to heavy rainfall and rapid snowmelt only temporarily increase the water level in the Bay.

2.1.3.3 *Wind Conditions*

Prevailing winds in the Middle Bay region are predominantly from the northwest and can intensify over the Chesapeake Bay (CENAB, May 2001). Mean wind speed data is available from the NOAA NCDC and for the Middle Bay region; the Patuxent River Naval Air Station (NAS) wind monitoring system recorded a mean wind speed of 7.1 knots and an average maximum sustained wind speed of 13.7 knots for 2003.

2.1.3.4 *Wave Conditions*

The Middle Bay region is impacted primarily by wind-generated waves in the Chesapeake Bay. Historical wind data from Baltimore-Washington International Airport was used to calculate wave height in the Sharp's Island area. The highest wave heights were estimated to approach from the south where the 100-year return wave height was computed to be 12.4 ft, with a peak period of 7.1 seconds. For the same southerly exposure, the 35-year return wave height is estimated to be 10.0 ft with a peak period of 6.4 seconds. These wave-height design parameters have incorporated the effects of storm surge levels as reported by the Virginia Institute of Marine Science (AMA, 2002).

2.1.3.5 *Tides and Currents*

The Middle Bay region experiences mean tidal levels of approximately 0.8 to 0.9 ft above MLLW, with a mean tidal range of 1.1 to 1.4 ft (MES, 2003).

Average maximum tidal currents in the Chesapeake Bay range from 0.5 knots to over 2.0 knots. The ranges for the velocity of the flood and ebb currents are 0.6 to 1.0 knots and 0.7 to 1.5 knots, respectively, with higher velocities occurring near the mouth of the Bay near Cape Henry (CENAB, 1981).

2.1.4 Lower Bay

2.1.4.1 *Bathymetry*

The Chesapeake Bay Approach Channels (VA) in the Lower Bay include the Cape Henry Channel, York Spit, and Rappahannock Shoal Channel. The physical conditions for these Lower Bay channels are listed in the following sections.

Hydrographic data for the Lower Bay region was obtained from the NOAA chart 12221. Approximate water depths for the Cape Henry, York Spit, and Rappahannock Shoal Channels are 50 ft MLLW. The remaining bathymetry in the Lower Bay is generally shallow with deeper waters toward the mouth of the Bay. Similar to the rest of the bay, there are gradual transitions between depths except near natural or dredged channels, where some steeper gradients exist. Depths in the undeveloped margins of the Bay are shallow with gradual slopes ending in wetlands, or SAV. Sandy beaches are more frequent in the Lower Bay and larger relative sediment size causes slightly steeper slopes adjacent to the shoreline compared to grassier shorelines. Commercial berths in the Lower Bay, generally concentrated around the Norfolk area, are typically dredged to adjacent federal channel depths and have bulkheads, low-level relieving platforms, or other berthing structures. This results in abrupt changes in bathymetry from the berthing area to adjacent port facility. Recreational marina facilities dredge berthing areas and have bulkhead structures that result in abrupt transitions in bathymetry adjacent to marina property, but to a lesser extent than commercial berthing facilities.

2.1.4.2 *Water Levels*

Water levels are generally lower in winter because of north and northwest winds that increase the egress from the lower Chesapeake Bay region. The water levels tend to be higher in the spring and summer, when southerly winds reverse this process.

2.1.4.3 *Wind Conditions*

Wind direction within the lower Chesapeake Bay varies throughout the day and strong, prevailing winds from the south tend to force water into the Bay (CENAB, May 2001). Mean wind speed data are available from NOAA, NCDC. For the Lower Bay area, the Norfolk International Airport wind monitoring station recorded a mean wind speed of 8.1 knots and an average maximum sustained wind speed of 14.4 knots for 2003.

2.1.4.4 *Wave Conditions*

The southern portion of the Chesapeake Bay, in Virginia waters, has generally higher wave conditions than the upper portions of the Bay. A southeasterly exposure to the Atlantic Ocean allows larger ocean swells to propagate into the Lower Bay. Waves as high as 20 ft (significant wave height) have been recorded at the NOAA wave buoy Station CHLV2 – Chesapeake Light, VA, located approximately 25 miles southeast of Smith Island. (These larger waves from the southeasterly direction will enter the Chesapeake Bay but gradually lose size and strength due to refraction and diffraction as they propagate into the mouth of the bay.) Although swells from the Atlantic can be large in the deeper channel waters near the mouth of the Bay, they dissipate significantly before reaching the eastern shore of Virginia (NOAA, 2004d).

Locally strong winds and long stretches of open water or fetches are responsible for significantly large waves in the Lower Bay. Based on 12 years of wind data recorded at the NOAA wave buoy (Station CHLV2), the 1-hour maximum sustained winds are 60 mph. Although no wave data for the Bay were available, wave heights can be estimated using shallow water wave formation theory using the fetch length, depth of water, and sustained wind speed. Fetches of up to 50 miles in the Lower Bay coupled with these winds would generate waves of 6 to 8 ft in the deeper waters of the Middle Bay and 4 to 6 ft at the leeward margins of the Bay (USACE, 1984). Banks of the Bay that have mild slopes (adjacent to shallow waters) will experience smaller waves than banks immediately adjacent to deeper water (NOAA, 2004d).

2.1.4.5 *Tides and Currents*

The mean range of tide is 2.8 ft at the Cape Henry Channel.

The velocities of the flood and ebb currents vary in strength throughout the Lower Bay and have a respective, approximate rate of 1.7 and 2.5 ft/s at the Bay entrance (CENAB, 1981).

In the Hampton Roads area, the normal high tide varies from 1.7 ft to 3.5 ft above mean low water. Normal low tide in this area varies from 0.4 ft below mean low water to 0.7 ft above mean low water.

2.2 GEOLOGY AND SOILS

2.2.1 Geology

The Chesapeake Bay formed as the last glaciers melted and sea level rose at the beginning of the Holocene Epoch. The following sections discuss the geomorphology, geologic history, stratigraphy, and hydrostratigraphy of the Chesapeake Bay from the present to the beginning of the Miocene Epoch, approximately 23.8 million years before present (bp) (see Table 2-32). Many of the predominant aquifers in the Bay are Miocene in age, including portions of the Yorktown and Cohansey Formations. In addition, the Miocene is exposed within the Bay watershed on the western shore (e.g., Calvert Cliffs).

2.2.1.1 *Geomorphology*

The Chesapeake Bay lies within the Atlantic Coastal Plain Physiographic Province. The land surface of this province is characterized by low-rolling terrain with a maximum elevation of approximately 300 ft above mean sea level (msl). The geology consists of crystalline rock overlain by southeast-dipping, wedge-shaped layers of unconsolidated sediment. The Atlantic Coastal Plain is separated from the adjacent Piedmont Physiographic Province to the west by the Fall Zone (Fall Line), a "line of falls" in the streams that feed into the Bay. This Fall Zone represents the upstream extent of tidal effects from the Bay and the contact between crystalline basement rock and the unconsolidated sediments of the Coastal Plain.

The Bay is approximately 180 miles long with a mean width of 15 miles and a mean depth of 25 to 30 ft. The Chesapeake watershed drains an area of approximately 64,000 square miles (Wolman, 1968). Bay width ranges from 3.4 miles near Aberdeen, MD, to 35 miles near the mouth of the Potomac River. The width/depth ratio is approximately 3,000/1; the Chesapeake Bay, therefore, is a shallow pan creased by a narrow channel, the ancestral Susquehanna River. A second channel, the James River, is present at the mouth of the Bay.

The Bay is still growing, with sea level rise occurring at an average rate of approximately 1 ft per century (USGS, 1998b). The rate of sea level rise in the Chesapeake Bay, and the entire Mid-Atlantic area, is twice the worldwide average, likely due to isostatic adjustment from the last glacial retreat and land subsidence (USGS, 1998b). Sea level is rising at a rate of 0.16 inches/year (1.3 ft/century) near the mouth of the Bay; this rate decreases northward. At Solomons, MD, the rate is 0.12 inches/year (1 ft/century) (USGS, 1998b). As a consequence of erosion and land-inundation, the Bay grows by several hundred acres per year. Land losses occur Bay wide but are concentrated in the low-lying lower Eastern Shore (USACE, 1990).

There are over 50 tributaries delivering freshwater into the Chesapeake Bay. Eighty-five to 90% of the freshwater input is derived from the north and west and the remaining 10% to 15% is from the Eastern Shore. The Susquehanna River to the north supplies 50% of the freshwater delivery (annual average of 38,775 ft^3/second); the Susquehanna, Potomac, Rappahannock, York, and James Rivers together provide 90% of the freshwater.

A nearly equal volume of saltwater enters from the ocean at the mouth of the Bay (George Mason University, 1995). Thus, the salinity of Bay water varies from 3.5% (seawater) at the mouth of the Bay to freshwater north of Baltimore, MD.

The Susquehanna River carries an annual average of 2.5 million tons of sediment. Of this approximately 1.2 million tons (slightly lower in recent years) reaches the Bay with the remainder being trapped in the river (see Section 2.2.2). Sediment is also delivered to the Bay by slope failures along the shoreline, especially the western shoreline. The baywide average for shoreline erosion is 1 to 2 ft/year, with the highest rates of nearly 10 ft/year along the western shoreline where the cliffs are undercut during storm events. A final, but substantial, source for sediment in the Bay is the Continental Shelf, which contributes up to 40% of the sediment in the Lower Bay, as far north as Tangier Island at the Maryland/Virginia border (Hobbs et al., 1990). Currently, the rate of sediment infilling of the Bay (0.08 inches per year on the flat floor and 0.04 to 0.19 inches/year in the deep channels) is less than the rate of sea level rise (0.16 inches/year); thus, the Bay is remaining relatively stable (Nichols and Biggs, 1985; Coleman et al., 1992).

The Bay floor is generally flat with broad terraces cut into pre-Holocene sediments, especially along the eastern margin (Nichols and Biggs, 1985). There are local large-scale sand wave fields, but the shallow terraces are generally surfaced with thin, coarse lag deposits. Extensive salt marsh deposits are abundant where the surface is relatively flat and where sedimentation has exceeded the local rate of sea level rise. Most of the bay floor is covered with silts and clays with rare shell or sand layers and laminations (Nichols and Biggs, 1985). Islands occur in the Bay where erosion and inundation from rising sea level have isolated what were formerly areas connected to the mainland. These processes cause gradual loss of existing islands as well as continued formation of new islands. Existing islands are currently being lost at a more rapid rate than new islands are being created (Wray et al., 1995).

The Chesapeake Bay is microtidal (spring tide < 6.5 ft), with a tidal range of 0.66 to 2.95 ft. The tides are greater at the mouth of the Bay (2.95 ft) and decrease northward to ~1 ft near the Fall Zone at the head of the Bay. The mean tidal range is ~2.6 ft. The tide takes 12 hours to migrate from the mouth to the head; therefore, the Bay has two high tides along its length at the same time. Currents speeds within the Bay waters are generally slow, mostly < 1.6 ft/second (Nichols and Biggs, 1985).

The geologic structure of the Chesapeake Bay is dominated by the Chesapeake-Delaware (Salisbury Embayment) basin (Walker and Coleman, 1987). This structural basin is relatively broad and slowly subsiding, and it controls the shape of the Bay, causing the northeastward curvature along the basin rim at Baltimore and the southwestward deflection of the Susquehanna and Potomac Rivers. The lateral movement of these two rivers began with the downwarping in the Late Cretaceous (144 to 665 ma) or Early Tertiary (65 to 1.5 ma) and continued through the Quaternary (1.8 ma to present) (Walker and Coleman, 1987). The rivers contributing to the Bay are generally parallel to the dip direction of the underlying units, trending northwest to southeast.

2.2.1.2 *Geologic History*

The geologic history of the Chesapeake Bay is dominated primarily by the changes in sea level that occurred throughout the Pleistocene epoch from 1.65 million to 10,000 years bp. Sea level rose as glaciers retreated and fell while they advanced during this time period. Based on oxygen isotope data, there were at least nine glacial advances during the Pleistocene (Messina, 1999).

The Chesapeake Bay evolved as river valleys became entrenched during the last Pleistocene low stand of sea level and were drowned as the Holocene transgression progressed. During the last (Wisconsin) glaciation, sea level was ~300 ft below present sea level and the shoreline was ~80 miles east of Ocean City, MD (Wolman, 1968). This resulted in downcutting of the rivers and increased erosion of the Piedmont uplands, with subsequent deposition near the edge of the Continental Shelf. The end of the Wisconsin glaciation about 10,000 years bp resulted in sea level rise, causing an increased base level for streams in the Chesapeake region and subsequent aggradation in the stream valleys. As sea level continued to rise, the stream valleys were drowned, forming the Bay. Thus, the deep portions of the Bay are the incised channels that flooded during the period of rapid sea level rise and the shallower margins are areas that have been eroded or flooded since then.

2.2.1.3 *Stratigraphy*

The shallow stratigraphy (Miocene Epoch to Recent, beginning approximately 23.8 million years ago (ma)) of the Chesapeake Bay is a result of the geomorphic processes that have acted upon the area during the glacial periods. Coastal plain sediments of the Chesapeake Bay were deposited in marine, estuarine, and fluvial environments during alternately high and low stands of the sea. The coastal plain sediments range in thickness, from 0 at the fall line to 8,000 ft on Maryland's Atlantic Coast. The sections above discuss these processes; this section describes the shallow stratigraphy of the Bay area.

Table 2-31 shows the stratigraphic unit correlation for Virginia, Maryland, and both the eastern and western shores of the Chesapeake Bay from the early Miocene to the present. The following paragraphs provide a brief description of these units. The stratigraphic units are discussed from youngest to oldest.

The **Talbot Formation** comprises two lithofacies and is Pleistocene in age. The upper sediments comprise massive, clayey-silt facies, while the lower sediments comprise a thick-bedded, gravelly sand facies. When composed of coarse-grained sediments, this formation can serve as an unconfined aquifer.

The **Parsonsburg Sand** is located at the surface on the Eastern Shore of the Bay and was deposited during the Quaternary Period (1.8 ma to the present). It is a light-colored, medium-grained, poor to well-sorted sand deposited in an estuarine/bay environment.

The **Tabb Formation** is a sequence of sediment representative of a transgressive sequence. It consists of three members: The Poquoson Member, the Lynnhaven Member, and the Sedgefield Member. The Poquoson Member is preserved in low-lying areas less than 3.5 m above mean sea level (msl). It was deposited in an arcuate to linear ridge and swale topography behind modern barrier islands and on the inside of tidal channel meander bends. The Lynnhaven Member is found at an elevation of 3 to 5.5 m msl and consists of upward fining sediments deposited in the ancestral Chesapeake Bay. The Sedgefield Member has a flat or arcuate ridge and swale topography and contains plant fossils in the lower portions of the unit. The unit consists of an organic-rich silty clay of a brackish to nearshore marine environment.

The **Kent Island**, **Wachapreague**, and **Sinepuxent Formations** were deposited penecontemporaneously during the Late Pleistocene Epoch. The Kent Island Formation is a relatively thin layer consisting of coarse to very coarse gray sand and sandy gravel grading upward to poorly to well sorted fine to medium sand with some clayey or silty portions. This unit was deposited in a fluvial/estuarine environment. The Wachapreague Formation, which was deposited in a marginal marine environment, is a coarsening upward sequence consisting of clayey, silty, fine to very fine gray sand interbedded with clay/silt and medium to coarse gravelly sand. The Sinepuxent Formation is a micaceous silty sand overlain by peat and gravelly sand.

The Middle Pleistocene **Nassawadox Formation** consists of three members, all deposited in marginal marine environments: Occohannock, Butlers Bluff, and Stumptown. The Occohannock Member is a fine to medium quartz sand, light yellowish gray, massive to horizontally bedded. Locally, there is minor clay. The Butlers Bluff Member consists of fine to coarse quartz sand, gravelly in part, commonly strongly crossbedded. The Stumptown Member consists of layers of gravel, peat, and clay-silt.

The **Omar Formation** (Accomack Member) is an Early Pleistocene deposit of interbedded sand, gravel, and clay/silt representing marginal marine environment, probably a transgressive barrier complex (tidal delta, lagoon, and marsh (Mixon, 1985)).

The **Beaverdam Formation and Brandywine Sand** were deposited in the Pliocene. The Beaverdam Formation is primarily made up of river channel deposits and consists of interbedded sand/silty sand and gravelly sand/clayey silt. This unit outcrops in deep river channels and pits. The Brandywine Sand is an orange-brown gravel and sand with minor silt and clay. Thickness of this unit ranges from 0 to 50 ft.

The **Yorktown-Cohansey Formation** is Miocene-Pliocene in age and is a greenish gray, fine to coarse glauconitic quartz sand, with interbeds of gray clay and silt. The depositional environment was transgressive marine sequence deposited in the shallow nearshore and overlain by prodelta, then delta, deposits. This unit does not outcrop at the surface.

The **Eastover Formation** is an upper Miocene greenish gray shelly sand and silt that contains mollusk fossils. The sand fraction is typically fine to very fine. This formation contains two units: The Cobham Bay Member and the older Claremont Manor Member. The upward-coarsening Eastover was deposited in a shallow marine environment.

The **St. Mary's Formation** is upper Miocene in age and contains multiple marine transgressions and regressions. The unit thickness ranges from 0 to 80 ft, and consists of yellowish gray sandy clay and fine-grained argillaceous sand with abundant oyster shell hash.

The **Choptank Formation** was deposited in the middle to upper Miocene. The lower portions of the unit represent a shallow marine depositional environment, while the upper portions show a regressional marine sequence. The unit consists of interbedded brown to yellow, very fine to fine sand and gray argillaceous silt with prominent shell beds. Thickness ranges from 0 to 50 ft.

The **Calvert Formation**, which ranges from 0 to 150 ft thick, has two members: the Plum Point Marl and the Fairhaven Member. The Plum Point Marl is an interbedded dark gray, fine-grained argillaceous sand and sandy clay with prominent shell beds. The Fairhaven Member consists of greenish blue diatomaceous clay and fine-grained argillaceous sand and sandy clay. The Calvert Formation, which is exposed on the Western Shore of the Bay in Calvert County, Maryland, is known for fossil sharks' teeth and other marine fossils, which indicates that this unit was deposited as an inland arm of the Atlantic Ocean.

2.2.1.4 *Hydrostratigraphy*

Hydrostratigraphy is a geologic framework consisting of a body of rock having considerable lateral extent and composing a reasonably distinct hydrologic system.

Hydrostratigraphic units are delineated on the basis of their water-bearing properties and do not necessarily correlate with stratigraphic contacts. Table 2-32 presents the stratigraphic and hydrostratigraphic units from the Miocene Epoch (23.8 ma) to the present (Holocene) for the Virginia and Maryland Coastal Plain surrounding the Chesapeake Bay. Each hydrostratigraphic unit is discussed, from oldest (Miocene) to youngest (Holocene) in the following paragraphs.

Potomac Formation Aquifers

The Potomac Formation consists of three aquifers that are separated by confining units. The most commonly used aquifers are the Patapsco and Patuxent Aquifers. These units generally consist of fine to very coarse-grained quartz sand that is moderately well sorted and contains minor granule to cobble beds. This unit is up to 800 ft thick.

Magothy Aquifer

The Magothy Aquifer is a fine to very coarse, distinctively white, massive, quartz sand with thin beds of clay and silt. This unit, which is up to 60 ft thick, unconformably overlies the Potomac Formation.

Monmouth Aquifer

The Monmouth Aquifer is a dark gray to reddish brown sand that is up to 100 ft thick.

Aquia Confining Unit

The Aquia Confining Unit is a fine- to medium-grained sand with a silt/clay matrix.

Aquia Aquifer

The Aquia Aquifer consists of medium-grained quartz sand with little silt or clay. The combined Aquia Aquifer/Confining Unit is up to 100 ft thick.

Calvert Confining Unit

The Calvert Confining Unit consists of the clayey deposits of the Calvert Formation. This unit crops out in major stream valleys in the western portion of the Coastal Plain. The unit thickness ranges from 0 in the western portion of the Coastal Plain to 350 ft along the eastern edge of the Eastern Shore. The lithology includes interbedded sandy and silty clays and diatomite. At the base of the unit are coarse quartz sand and pebbles, phosphate pebbles and phosphatic sharks teeth, shells, and bone fragments.

St. Marys-Choptank Aquifer

The St. Marys-Choptank Aquifer consists of the sandy facies of the St. Marys and Choptank Formations. The lithology includes medium-grained sand interlayered with clays and silts. The thickness of the unit ranges from 0 in the western portions of the Coastal Plain to 160 ft in the east.

The St. Marys-Choptank Aquifer yields from 10 to 400 gallons per minute (gpm), but there are no known users of this water because the water quality has been found to be unsuitable for most uses (Meng and Harsh, 1988).

St. Marys Confining Unit

The St. Marys Confining Unit consists primarily of interbedded sandy and silty clays from the St. Marys Formation, but in some areas includes the lower clayey facies of the Eastover Formation (Meng and Harsh, 1988). The only known outcrop of this unit is along the Rappahannock River in Virginia. The unit thickness ranges from 0 in the western portion of the Coastal Plain to 318 ft on the eastern edge of the Eastern Shore.

Yorktown-Eastover Aquifer

The Yorktown-Eastover Aquifer consists of sandy deposits of the Yorktown Formation, the upper portions of the Eastover Formation, and lower, sandy portions of the Bacon Castle Formation. The lithology includes interlayered, thick shelly sand beds separated by thinner clay beds that represent marine transgressions.

This aquifer is exposed or has been eroded in major stream valleys of the Coastal Plain on the western shore of the Bay, and is overlain by the Yorktown Confining Unit on the Eastern Shore. The thickness of the unit generally ranges from 100 to 200 ft, although thicknesses of 296 ft have been measured along the eastern extent of the Eastern Shore.

This aquifer is used for light industrial and domestic water supply and can yield 10 to 400 gpm of water.

Yorktown Confining Unit

The Yorktown Confining Unit consists of clays and silts that comprise the upper portion of the Yorktown Formation. These Pliocene-aged deposits crop out along major stream valleys just east of the outcrop of the Yorktown-Eastover Aquifer. This unit, like other Coastal Plain sediments, dips southeastward and thickens in the dip direction. The maximum known thickness, measured on the eastern side of the Eastern Shore, is 109 ft.

Columbia Aquifer

The Columbia Aquifer is the surficial aquifer present east of the Chesapeake Bay. This aquifer includes several formations, such as Kent Island, Wachapreague, Sinepuxent, Ironshire, Nassawadox, and Omar, and consists of primarily sandy sediments with interbedded and/or lenticular silt and clay. These deposits are the result of marine transgressions and regressions during the Pleistocene and early Holocene. The unit consists of sequences of fining-upward deposition, with very coarse gravelly log deposits at the base that grade up through sands to fine silts and clays (Meng and Harsh, 1988). Thicknesses of the unit across the Eastern Shore vary due to surface erosion.

This aquifer is used primarily for domestic water supply and can yield 50 to 500 gpm of water.

2.2.2 Sediment

Delivery of excess sediments to the Bay is of concern. Eroded sediments from upland and riverine sources enter the Bay in quantities considerably greater than natural levels as a consequence of human activities and landscape alterations. Accumulating sediments shoal navigation channels. Nutrients adsorbed to fine-grained sediments derived from eroded topsoil contribute to eutrophication. Contaminants harmful or toxic to aquatic life bind to fine-grained sediments in urban and industrial areas. Fine-grained sediments can remain suspended in Bay waters for extended periods of time. This reduces water clarity, limiting growth of submerged aquatic vegetation (SAV). Wave resuspension of bottom sediments and shoreline erosion are a major source of suspended sediments in shallow water areas. Generally, wave energies can move bottom sediments down to about 6-ft depth. Historically, large populations of oysters filtered suspended sediments out of Bay waters, and greater expanses of SAV may have reduced wave resuspension of bottom materials.

Sediment Sources and Transport Processes

Understanding the origin, transport, and fate of sediment material in the Chesapeake Bay helps to determine current sediment loads entering the Bay from primary sources, key sediment transport paths within the Bay, and significant deposition locations. In addition to understanding natural sediment processes, anthropogenic land disturbances that can affect and alter these processes must be considered. From this information, strategic sediment load allocations can be developed for each primary source to reduce the amount of sediment being transported to, and deposited in, the Bay. Implementation of management strategies to achieve these sediment load allocations is part of the effort to reduce total sediment loads and also to decrease sediment concentration in the water column, thus improving water quality.

There are four primary sources of sediments entering the Bay with the relative importance of each varying throughout the watershed:

- Input from main rivers, smaller tributaries, and streams in the watershed (watershed sources).
- Erosion from shorelines and coastal marshes (shoreline erosion).
- Ocean input at the mouth of the Bay.
- Internal biogenic production of skeletal and organic material (minor source).

The two most important watershed sources of sediment are: (1) erosion from upland land surfaces and (2) erosion of stream corridors (banks and channels) (USGS, 2003a). Sediment erosion is a natural process influenced by geology, soil characteristics, land cover, topography, and climate. Natural sediment transport processes can be affected by anthropogenic land disturbances. Agriculture and timber production can cause increased upland erosion and delivery of sediments to streams. Urbanization promotes increased runoff, which causes stream bank and channel erosion to increase. Sediments eroded from the land surface are transported downstream or are stored in the watershed for an undetermined time before making their way to the Bay.

Sediment inputs to the rivers of the Bay watershed from agriculture and forestry sources peaked in the late 1800s/early 1900s and have since declined substantially as a consequence of natural forest recovery and implementation of soil conservation management practices (Curtin et al., 2001). Monitoring data from major rivers entering tidal waters of Chesapeake Bay show that sediment loads have not changed over the period of the 1980s through 2001 (CBP, 2004n).

Shoreline erosion of the banks and coastal marshes of the Chesapeake Bay is also a large source of fine-grained sediment, particularly in the Middle Bay. However, the amount of sediment material is difficult to quantify because sediment loads vary greatly depending on the region and location. It is likely that shoreline erosion will become an increasing source of sediment given that sea level is currently rising and is expected to continue to rise (USGS, 2003a).

Although eroding shorelines do contribute sediment to the Bay, it is important to note that shorelines with erosional conditions are natural to much of the Bay. Sediment from eroding shorelines is critical to maintenance and creation of shallow water and shoreline habitats. Stabilization of eroding shorelines often leads to accelerated downdrift erosion, increased water depth alongshore, and loss of beach. In addition, eroding shoreline sediment typically contains only limited quantities of biologically available nutrients in contrast to eroding topsoil and nutrients delivered from artificial fertilizers, animal waste, and human waste.

Shoreline protection measures may be an important component in future management actions, although it may be difficult to measurably reduce the input of material because of the dispersed nature of the source (USGS, 2003a).

It should be noted that sediment transport from the Atlantic Ocean is also a major source of sediment to the lower bay, along with shoreline erosion.

Figure 2-5 shows the major pathways of sediment transport in the Chesapeake Bay, which are important to understand when developing sediment reduction goals and implementing sediment reduction programs.

Sediment Sinks in the Bay

Sediments are stored within the watershed in three primary places: upland surface areas, in reservoirs behind dams, and in floodplain riparian regions. The large numbers of dams and impoundments that have been built in the Bay watershed have a significant effect on river sediment loads and many reservoirs trap at least half the sediment annually flowing into them until reaching sediment storage capacity (USGS, 2003a). For example, on the lower Susquehanna River, a reservoir system formed by four consecutive hydroelectric dams trap much of the suspended sediment transported by the river to the Upper Chesapeake Bay. The most downstream reservoir, the Conowingo Reservoir, is the only one of the four that has not reached capacity and is currently trapping about 50% to 70% of suspended sediment that would otherwise be discharged to the Chesapeake Bay (CBP, 2000 and USGS, 1998a, 2003a). Approximately 42 million tons of sediment storage capacity remains (USGS, 2003a). When capacity is reached, increased sediment loading to the Bay is expected; however, there is not an estimated time period in which the reservoirs will fill because sediment transport rates are variable. The Susquehanna River Basin Commission (SRBC) has taken an active role in assessing implications associated with reaching sediment trapping capacity by recommending implementation of best management practices (BMPs).

In addition to sediment storage behind dams, riparian zones effectively trap sediment from immediate transport downstream. Research has shown that extensive riparian wetlands within the Coastal Plain regions of the Bay trapped as much as 77 tons/year of sediment along a 1.2-mile reach (USGS, 2003a). Overall, the relative contribution of upland sediment and the sediment stored in stream corridors has not been quantified in the Bay watershed, but monitoring stations at several larger tributaries have been set up to measure suspended sediment to advance research efforts. Such information is important to formulate effective sediment reduction strategies (USGS, 2003a).

Sediment Reduction Goals

The Chesapeake Bay Program (CBP), as part of the effort to protect and restore the Bay, committed to sediment reduction goals in April 2003 to reduce annual sediment loads washing into the Bay from its major tributaries. Currently, more than 5 million tons of sediment enter the Bay from land-based sources in New York, Pennsylvania, Maryland, Delaware, Virginia, and West Virginia (CBP, 2003a).

One of the key sediment reduction goals is to develop sediment allocations for major basins within the Chesapeake Bay watershed to reduce the sediment load entering the Bay from 5 million tons to 4.15 million tons by 2010 (CBP, 2003a). This reduction of sediment by approximately 20% could slow the accumulation of sediment material in areas frequently requiring dredging activities, and, therefore, potentially reduce the frequency with which these areas need to be dredged. The proposed sediment allocation plan for the nine major tributary basins of the Chesapeake Bay watershed is presented in Table 2-33.

In order to meet these sediment allocation goals, the Chesapeake Bay Program partners, which include Maryland, Virginia, Pennsylvania, West Virginia, Delaware, New York, and the District of Columbia, are developing tributary strategies for each of 36 subbasins that make up the Chesapeake Bay watershed (CBP, 2003b). A tributary strategy is a river-specific cleanup strategy that details actions needed to reduce the amount of nutrients and sediment flowing into the Bay (CBP, 2003b). Tributary strategies provide a framework that will evolve over time in an effort to plan for the most efficient and effective course of action. As they mature, the strategies will detail the funding initiatives needed, the policies that must be implemented and the technologies needed to expedite sediment reduction, and, ultimately, Bay restoration.

Each state is responsible for developing, with extensive public and government involvement, a tributary strategy for every subbasin or portion of a subbasin located within their boundaries. Each tributary-specific strategy is designed to address the unique land use characteristics of that watershed. All 36 strategies are to be added together to ensure that the required sediment reductions are accounted for in each river basin to meet sediment allocation goals. The project schedule states that tributary strategies from each state were submitted by April 2004 and subsequently reviewed and compiled such that the combined effort yields a comprehensive sediment reduction plan for the Bay watershed. The initial effectiveness of sediment reduction programs will be evaluated in 2005-6, and in 2010, an assessment to determine whether set standards have been met will be conducted. At this point, any waters in the Chesapeake Bay Watershed that remain listed as impaired due to high sediment concentrations will undergo development of Total Maximum Daily Load (TMDL) reports as per applicable regulations (CBP, 2003a).

Table 2-34 gives a summary of sediment loads from each state's land-based sources as well as reductions in sediment from 2002-2004. The percentage of each state's total sediment contribution from agricultural lands, urban/suburban areas, or forests is also outlined.

Possible effective management strategies outlined in the states' tributary strategies may include cooperative efforts to: conduct further research involving long-term sediment transport studies; develop, calibrate, and apply a model; develop a Baywide sediment budget; and implement innovative BMPs. BMPs include planting riparian forest buffers, enhancing stormwater management policies, practicing Low Impact Development (LID) strategies, applying erosion and sediment control practices, and implementing other innovative processes. Descriptions of some possible BMPs are listed below (CBP, 2004c):

- <u>Forest or riparian buffers</u>: Wooded areas along rivers, streams, and shorelines that help filter nutrients, sediments, and other pollutants from runoff.
- <u>Riparian grass buffers</u>: Linear strips of grass or other nonwoody vegetation maintained between the edge of agricultural fields and streams, rivers, or tidal waters that help filter nutrients, sediment, and other pollutants from runoff.
- <u>Farm conservation plans</u>: A combination of agronomic, management, and engineered practices that protect and improve soil productivity and water quality. The deterioration of natural resources is prevented.

- Effective stormwater management and LID practices: Effective stormwater management can be achieved by implementing a series of BMPs designed to work together. These practices, which include rain gardens, rain barrels, roof gardens, and downspout disconnects, improve water quality by filtering pollutants into natural areas and minimizing erosion and stormwater flow.

- Stream restoration in urban areas: Restoring natural hydrology and landscape of urban streams. Objectives of stream restoration in urban areas include reducing stream channel erosion, promoting physical channel stability, and reducing the transport of sediments and other pollutants downstream.

- Erosion and sediment control practices: By retaining soil on-site, sediment and attached nutrients are prevented from leaving disturbed areas and polluting streams.

- Stream protection with fencing and off-stream watering: Alternative watering sites are used in conjunction with the installation of fencing along streams to exclude livestock, which protects stream banks from erosion caused by livestock.

- Wetland Restoration: Reestablish the natural hydraulic condition in an area that had been modified by the installation of subsurface drainage.

An additional concern regarding ongoing sediment loading to the Bay is the potential contribution to the sediment contamination noted in Chapter 1. Sediment contamination in the Bay's tidal tributaries has been evaluated (CBP, 1999). Although much of the contamination entering the rivers is expected to be trapped within the river, with a small amount entering the mainstem Bay (CBP, 1999), it would be likely that sediment reduction efforts would also help to reduce these impacts to the Bay.

2.2.2.1 *Upper Bay*

In the Upper Bay, the Susquehanna River is the dominant source of sediment influx, supplying over 80% of the total sediment load in the area north of Annapolis (SRBC Sediment Symposium, 2001). This northern area of the Bay, known as the Estuarine Turbidity Maximum Zone (ETM zone), is a region where most of the fine-grained particulate matter from the Susquehanna is trapped and deposited. The ETM zone is characterized by high turbidity and is an important site of sediment deposition because it acts as a barrier for southward sediment transport of material introduced into the Bay from the Susquehanna (USGS, 2003a). Asymmetrical tidal resuspension and transport are primarily responsible for the maintenance of the ETM zone at approximately the limit of saltwater intrusion. Generally, fine-grained river-borne sediment in the ETM zone escapes only during extreme hydrologic events (USGS, 2003a).

New York, Pennsylvania, and Maryland are involved in the development of tributary strategies for the subbasins contributing to the Upper Bay. On 29 April 2004, an update documenting each state's progress in developing their tributary strategies was produced (Tributary Strategy Highlights, 2004). According to this update, New York has not yet committed to a date of completion for their tributary strategy, Pennsylvania has completed a draft version of its tributary strategy, and Maryland has released an Executive Summary of a statewide tributary strategy and implementation plans are to follow. Each state's tributary strategies are highlighted below (Tributary Strategy Highlights, 2004):

New York contributes approximately 3% of sediment pollution reaching the Bay, with 56% of the sediment originating from agricultural land, 27% from forests, and 17% from urban/suburban areas. New York's tributary strategy will focus on actions that reduce nutrients and sediment loads from agricultural lands, urban lands, and point sources. Thus far, based on progress made from 1985 to 2002, New York is 67% of the way to achieving its sediment goal.

Pennsylvania contributes approximately 22% of the sediment pollution reaching the Bay, with a large majority (71%) of the load originating from agricultural land. Pennsylvania's tributary strategy will focus efforts on reducing sediment derived from agricultural land. The Pennsylvania Department of Environmental Protection (PADEP) organized watershed teams to develop a list of BMPs that should achieve sediment allocation goals when implemented. In addition, PADEP plans to use trading and other innovative market-based systems as tools to encourage reductions in sediment and nutrient pollution. Thus far, based on progress made from 1985 to 2002, Pennsylvania is 53% of the way to achieving its sediment goal.

See Section 2.2.2.3 for Maryland's tributary strategy highlights.

2.2.2.2 *Baltimore Harbor*

The Harbor Channels are a zone of sediment deposition; the primary sources are the Chesapeake Bay and other local erosion-prone sites. The bottom sediments in the Harbor are generally characterized as soft, highly plastic, organic silty clay (Baker et al., 1997). Because of heavy urban and industrial development, sediments in the Harbor/Patapsco River/Back River system are characterized as some of the most highly contaminated in Chesapeake Bay. Tributary strategies developed for this region focus primarily on nutrient reduction from point and nonpoint sources. Sediment loading levels are also a concern and are addressed, but in less detail.

Sediment load and the quality of sediment entering the Harbor from the Patapsco River/Back River Basin is largely affected by the basin's land uses. Approximately 55% of the basin is urbanized, approximately 24% is designated as forest or wetlands, and approximately 21% is devoted to agricultural use (Basin Team, 2004). Dominant sources of sediment into this river system in 2002 were urban areas, contributing approximately 53%, and agricultural areas, contributing approximately 32% (Basin Team, 2004). Figure 2-6 shows a comparison of sediment loads entering the Patapsco/Back River in 1985 and 2002 and the percentage of sediments originating from each source (Basin Team, 2004). There were 55,000 tons of sediment entering the river in 1985, and by 2002, the amount of sediment was reduced to 48,000 tons. A reduction of approximately 13% was achieved, potentially attributed, in part, to the implementation of BMPs.

To date, BMPs have been implemented in primarily agricultural areas to reduce nonpoint source sediment pollution entering the river system. Shore and soil erosion control methods, such as planting riparian forest buffers and practicing effective stormwater management techniques, have been implemented as part of the effort to reduce sediment loads into the Harbor (Basin Team, 2004). Other conservation efforts are planned, but have not yet been implemented. These efforts, as related to sediment reduction, include stream protection, forest conservation, tree planting, grass buffer development, and runoff control.

2.2.2.3 *Middle Bay*

In the Middle Bay, the majority of sediment influx comes from shoreline erosion or is produced internally by biological processes. The Maryland Shore Erosion Task Force states that approximately 31% of Maryland's shoreline is eroding (MD DNR, 2000).

Maryland, the District of Columbia, West Virginia, and Delaware are involved in the development of tributary strategies for the subbasins contributing to the Middle Bay. On 29 April 2004, an update documenting each state's progress in developing their tributary strategies was produced (Tributary Strategy Highlights, 2004). According to this update, Maryland has released an Executive Summary of a statewide tributary strategy and implementation plans are to follow;

the District of Columbia has not yet provided a date for the completion of its tributary strategy, which will focus on nutrient reduction because no sediment reduction goal was set; West Virginia has completed a draft version of its tributary strategy; and Delaware plans to develop TMDLs and strategies for five of its water bodies draining into the Bay. Each state's tributary strategies are highlighted below (Tributary Strategy Highlights, 2004):

Maryland contributes approximately 20% of sediment pollution reaching the Bay, with 70% of the sediment originating from agricultural land, 21% from urban/suburban areas, and 9% from forests. The Maryland tributary strategy focuses on a variety of actions that reduce pollution from agricultural and urban areas, depending on the land usage in a particular watershed. The focus in rural areas will be to reduce sediment pollution from agricultural land by implementing BMPs, such as planting cover crops on over 60% of cropland. In urban areas, Maryland plans to retrofit up to 40% of developed land that is not currently treated for urban stormwater runoff. Thus far, based on progress made from 1985 to 2002, Maryland is 45% of the way to achieving its sediment goal.

West Virginia contributes approximately 7% of the sediment pollution reaching the Bay, with 69% of the load originating from agricultural land, 15% originating from urban/suburban areas, and 16% originating from forests. West Virginia's tributary strategies involve actions to reduce sediment loads from agricultural and urban/suburban areas. The strategy for agricultural lands includes implementation of a suite of BMPs. The strategy for urban/suburban areas includes a commitment to reduce pollutant loads by managing stormwater runoff. Thus far, based on progress made from 1985 to 2002, West Virginia is 77% of the way to achieving its sediment goal.

Delaware contributes approximately 1% of the sediment pollution reaching the Bay, with a large majority (85%) of the load originating from agricultural land. Delaware's tributary strategy focuses primarily on nutrient reduction and does not include descriptions of sediment reduction programs.

2.2.2.4 *Lower Bay*

In the Virginia portion of the Bay, shoreline erosion, nonpoint watershed sources, and influx from the ocean are the dominant sediment sources. Large quantities of sediment are produced from coastal erosion of headlands along the Bay margins and from the Atlantic Ocean through the mouth of the Bay due to ocean currents and tidal effects (USGS, 2003a).

Virginia Department of Conservation and Recreation operates a state Erosion and Soil Control (ESC) Program according to the *Virginia Erosion and Sediment Control Law, Regulations, and Certification Regulations* (VESCL&R). The law is codified as Title 10.1, Chapter 5, Article 4 of the Code of Virginia. The ESC Program's goal is to control soil erosion, sedimentation, and nonagricultural runoff from regulated "land-disturbing activities" to prevent degradation of property and natural resources. Although this program is not directly related to protecting resources in the Chesapeake Bay, reduction in sediment throughout the watershed ultimately leads to less sediment in tributaries contributing to the Lower Bay.

West Virginia and Virginia are involved in the development of tributary strategies for the subbasins contributing to the Lower Bay. On 29 April 2004, an update documenting each state's progress in developing their tributary strategies was produced (Tributary Strategy Highlights, 2004). According to this update, both West Virginia and Virginia have completed draft versions of their tributary strategies:

See Section 2.2.2.3 for a description of West Virginia's Tributary Strategy.

Virginia contributes approximately 47% of sediment pollution reaching the Bay, with 55% of the sediment originating from agricultural land, 19% from urban/suburban areas, and 26% from forests. The Virginia Tributary Strategies (2000) addresses sediment entering the Chesapeake Bay from three major tributaries on the western shore (James, York, and Rappahannock) and several lesser tributaries. These tributary strategies focus actions that reduce pollution from agricultural and urban areas, including planting riparian forest buffers. Virginia has committed in its tributary strategy to increase the number of riparian forest buffer acres from less than 6,000 acres in 2002 to over 520,000 acres. Thus far, based on progress made from 1985 to 2002, Virginia is 42% of the way to achieving its sediment goal.

2.2.3 Soils

The land surface surrounding the Chesapeake Bay ranges from level, low-lying areas adjacent to the Bay and tributary rivers to inland undulating, rolling hills. Particular soil types characterize each of the geomorphic areas in the vicinity of the Bay. These soils are described in the following paragraphs.

Adjacent to the Bay. The soils in areas adjacent to the Bay consist primarily of two soil types; both types are subject to tidal flooding.

1. Marshland: organic material with sand, silt, and clay. These are deep, poorly drained soils with a mixed sandy, loamy, and clayey substrate.
2. Well drained, nearly level, sandy coastal beaches.

Low Flats and Terraces. Located adjacent to the marshes, these are deep, loamy soils that can be poorly or moderately well drained, depending on the substrate. The land surface in these areas is nearly level.

Broad, Low-Lying Flats. This geomorphic area is nearly level and is found at elevations of less than 20 ft above mean sea level (ft msl). The very poorly to well-drained soils are deep loams and silt loams with loamy to clayey subsoil. The subsoil is underlain by loam or sand.

Broad, Flat Necklands. These poorly to moderately well-drained soils are found on nearly level, narrow bands of land that are situated between bodies of water. The soils range from sand or silt to fine sandy loam, and are formed on Coastal Plain sediments.

Broad Land Areas. This geomorphic area is found on level to moderate slopes, and consists of well and poorly drained clayey and silty soil.

Along Tributary Rivers. The land surface in this geomorphic area is nearly level to steeply sloping. The soils are very poorly to well-drained alluvial soils that formed in loamy sediments.

Broad, Smooth Uplands. These poorly to well-drained, sand, silt, or clay loams are found on nearly level to gently sloping land at elevation from 20 to 50 ft msl. They are deep soils formed on silty or clayey sand or on a mixture of sand, silt, and clay.

Broad Ridges. This geomorphic area is found at elevations from 20 to 50 ft msl with slopes ranging from nearly level to very steep. The soils consist of well-drained sand to loamy sand with loamy subsoil.

Uplands and Terraces. The soils in this geomorphic area consist of poorly to well-drained silt and loam formed on Coastal Plain sediments or on basic rocks. The slopes range from nearly level to steep.

Higher Elevations. The land surface in the geomorphic area is gently sloping to steep, with fairly narrow, rounded, sloping ridgetops and more strongly sloping, irregular upper slopes. The area is moderately to severely eroded and strongly dissected by steep-walled, mostly sandy ravines. Soils are coarse-textured and porous and moderately well drained. There are some loamy fine sands to sandy clay loams with loam subsoil.

The U.S. Department of Agriculture (USDA) has surveyed soils for all counties in the Chesapeake Bay region and watershed. These soil surveys furnish soil maps and interpretations needed to guide decisions about soil selection, use, and management; and in planning research and disseminating the results of the research. They are also used in educational programs about soil use and conservation.

The USDA Natural Resource Conservation Service (NRCS) maintains a web site listing soil surveys that have been published (http://soils.usda.gov/survey). A soil survey published by the USDA that is still in print can be requested from the state or local office of the NRCS. In addition, many libraries keep published soil surveys on file for reference. Also, soil conservation district offices and county agricultural extension offices have copies of local soil surveys that can be used for reference.

The NRCS Web Site for soils (http://soils.usda.gov/survey) contains online soil publications and data and a link to request this information in hard copy. The NRCS Web Site also contains information about soil conservation and farmland soil conservation efforts.

Two categories of classified mapped soils are worth mentioning because of characteristics and location in the landscape. These include 1) Prime Farmland Soils and 2) Hydric (Wetland) Soils.

Prime and Unique Farmland Soils

Prime farmland is land having the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. Prime farmland is designated independently of current land use, but it cannot be areas of water or urban or built-up land as defined for the National Resource Inventories. Map units that are complexes or associations containing components of urban land or miscellaneous areas as part of the map unit name cannot be designated as prime farmland. Soil survey map units that meet the soil requirements for prime farmland are identified, coordinated, and listed, and are available to users of soil survey information.

The Farmland Protection Policy (FPP) Act, PL 97 98, authorizes the USDA to develop criteria for identifying the effects of federal programs on the conversion of farmland to nonagricultural uses. Federal agencies are directed to use the developed criteria; to identify and take into account the adverse effects of federal programs on the preservation of farmland; to consider appropriate alternative actions that could lessen adverse effects; and to ensure that such federal programs, to the extent practicable, are compatible with state, unit of local government, and private programs and policies to protect farmland. NRCS policy and procedures on prime and unique farmlands are published in the Code of Federal Regulations 7CFR657.

Hydric Soils

A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Hydric soils along with hydrophytic vegetation and wetland hydrology are used to define wetlands. The current criteria for generating a list of hydric soils is in the Federal Register, February 24, 1995, volume 60, number 37, page 10349. The reference for field identification of hydric soils is Field Indicators of Hydric Soils of the United States, Version 4.0, 1998. (ftp://ftp-fc.sc.egov.usda.gov/NSSC/Hydric_Soils/field_ind.pdf) States maintain current lists of hydric soil map units in the field office technical guide.

2.3 SURFACE WATER QUALITY

Surface water quality conditions in the Chesapeake Bay are dependent on numerous factors, such as land usage in the watershed, wind and tidal effects, and physical and chemical characteristics of freshwater stream flow. The Chesapeake Bay watershed drains an approximately 64,000-square-mile area that covers portions of six states (New York, Pennsylvania, West Virginia, Delaware, Maryland, and Virginia) and the entire District of Columbia. Approximately 15 million people live in this area.

Current conditions of the Chesapeake Bay, compared with monitoring data collected since 1985, are analyzed by the Chesapeake Bay Program (CBP) Monitoring Team. The team conducts the analysis from provisional data collected by MD DNR and Old Dominion University for surface temperature, bottom dissolved oxygen (no data available for total water column dissolved oxygen), water clarity, and water salinity. The analysis is a graphical analysis that plots monthly current data against averaged monthly historical data at eight key stations in the mainstem of the Chesapeake Bay (CBP, 2004b). The graphical representations of the data can be found at the CBP Web site, http://www.chesapeakebay.net/ status/WQcrntcond.cfm?subjectarea=TIDAL by first selecting the station, and then selecting the parameter. Two monitoring stations are in the Upper Bay; CB1.1 is located at the mouth of the Susquehanna River and CB3.1 is located east of Baltimore, along Maryland's Eastern Shore. Three stations are in the Middle Bay; CB3.3C is located at the Bay Bridge, just east of Annapolis; CB4.2C is located west of the Choptank River; and CB5.2 is located northeast of the mouth of the Potomac River. Three stations are in the Lower Bay; CB6.1 is located east of the mouth of the Rappahannock River, CB6.4 is located east of the mouth of the York River; and CB7.4 is located at the Baltimore Channel of the Bay Bridge Tunnel. A map of the monitoring station locations is provided in Figure 2-7. Additional information was also gathered from various sources as discussed below. Water quality for each section of the Bay is discussed in the sections below.

Salinity is measured as the number of grams of dissolved salt in 1,000 grams of water, and is expressed in practical salinity units (psu). Salinity gradually increases from the fall line of the Bay (low salinity) to the Bay's mouth (high salinity), and has an impact on the habitats of living resources and physical processes in the Bay. Freshwater contains few salts (<0.5 psu) and is less dense than full ocean strength seawater, which averages 30 psu. Salinity increases with depth; therefore, freshwater tends to remain at the surface. Salinity is an important factor to the mixing of oxygen-rich surface water with the oxygen-depleted bottom waters (CBP, 2004b). The mixing zone at the boundary between the upper fresher layer of the water column and the lower saltier layer of the water column is called the pycnocline.

Sufficient dissolved oxygen (DO) throughout the water column is essential to the health and survival of aquatic organisms. DO concentrations below 5 milligrams per liter (mg/L) are stressful to the growth, reproduction, and survival of the Bay's fish, shellfish, and bottom-dwelling organisms. DO concentrations below 2 mg/L are severely stressful and potentially lethal (CBP, 2004b). DO levels in the Bay vary according to season and depth. Bay waters are stratified during warmer months and partial stratification may persist for most of the year. Since DO is more soluble in cold water, the winter months at the Bay produce higher levels when compared to DO levels in the summer. DO levels decrease at greater depths despite the cooler temperatures because of the increased oxygen demand of benthic organisms and decaying organic matter. In warmer weather months, water below the pycnocline usually becomes oxygen deficient (Kemp et al., 1999). In the fall and winter, the surface waters cool and sink, mixing the oxygen content to an almost uniform state (CENAB, 1981). Massive onset of low DO conditions in the Bay occurred following World War II (Karlsen et al., 2000). This change correlates with the onset of massive anthropogenic nutrient delivery to the Bay following World War II, in large part related to the increased availability and use of fertilizers. Recently, Bay DO has been particularly poor in high-precipitation years when delivery of nutrients from anthropogenic sources to the Bay from the watershed is also high (CBP, 2003e).

The clarity of the water column affects the survival of SAV and other photosynthetic organisms in the Bay. Clear water allows more light energy to reach primary producers like SAV and phytoplankton. The health of SAV is important because it provides habitat for numerous organisms and oxygenates the water. The health of phytoplankton is essential because phytoplankton form the base of the food chain for the entire ecosystem and oxygenates the water. Elevated levels of total suspended solids (TSS) result in high turbidity levels, reducing the depth of light penetration in the water. Elevated TSS levels also negatively affect the feeding ability of filtering organisms, such as oysters. A more qualitative measure of water clarity is Secchi depth. The Secchi depth is the depth at which a white and black disc, when lowered into the water, is no longer visible. Clear water adsorbs less light than turbid water; thus the less turbid the water, the greater the Secchi depth. Secchi depths are lowest in the summer months.

Temperature affects the rates of chemical and biochemical reactions in the water. Many biological, physical, and chemical processes are temperature dependent, including the distribution, abundance, and growth of living resources; the solubility of compounds in seawater;

rates of chemical reactions; density; mixing; and current movements. The Bay is shallow, and as a result, water temperature fluctuates considerably on an annual basis. Water temperature patterns in the Chesapeake Bay are mainly driven by seasonal changes.

Nutrients are substances that help plants grow. The most important nutrients are nitrogen and phosphorus. Plant and animal matter (including human waste), fertilizer, and even deposition from car exhaust and power plants all contain nutrients. If not treated, these nutrients will find their way into creeks, rivers, and eventually the Bay. Rates of nutrient pollutant delivery to the Bay from anthropogenic (having a human source, or having origins caused by the actions of people) sources increased explosively following World War II (Boesch, 2002). Nitrogen inputs are currently entering the Bay at about 7 times greater than natural levels (Howarth et al., 1996). Phosphorus inputs from anthropogenic sources are entering the Bay at a rate 16.5 times greater than natural levels (Seagle, et al., 1999). Once the nutrients are in the Bay, they become food for plants. But excess nutrients cause too much plant growth, especially algae (microscopic floating plants). When there is too much algae, the water becomes cloudy and blocks the light needed by underwater plants called bay grasses, also known as SAV. Algae can also coat the leaves of the SAV, further reducing the amount of light received by the plants. SAV are very important to blue crabs because they provide food, shelter, and nursery areas. Research has shown that the density of juvenile crabs is 10 times greater in SAV beds than in unvegetated Bay areas. An excess amount of algae can also cause other problems. When the algae die, they settle to the bottom, where they are naturally decomposed by bacteria. During this normal decompositional process, the bacteria use dissolved oxygen from the Bay's bottom waters. When large amounts of algae are decomposed by bacteria, the removal of dissolved oxygen is substantially increased. This dissolved oxygen is needed by many organisms living on and near the bottom. Blue crabs, hard clams, summer flounder, bay anchovies, and worms are some of the organisms affected by low dissolved oxygen. For example, the resulting low dissolved oxygen concentrations caused by decomposing algae drive blue crabs from their preferred habitat and kill many of the small bottom organisms on which the blue crabs feed. This situation worsens in the summer, when several natural factors act to further lower the amount of dissolved oxygen in the Bay's water. The low dissolved oxygen conditions caused by excess nutrients are the primary reason large bottom sections of the Bay are unsuitable for bottom-dwelling organisms (oysters, crabs, etc.) (MD DNR, 2004e). Nitrogen and phosphorus trends are taken from the Tidal Water Quality

Status and Trends page on the Chesapeake Bay Program Web site. The trends are based on samples collected throughout the entire year and the data are not adjusted to account for variations in river flow. The status of a parameter is a comparison of the last 3 years of monitoring data with previous years. The trend reflects either consistently improved or worsened conditions compared to the earliest complete data set since 1985 through 1998. Figures of nitrogen and phosphorus trends can be viewed there (CBP, 2004a).

The most severe chemical contamination problems in the Bay are generally limited to those areas located near urban centers close to the Bay. The three regions of concern or areas with known chemical contaminant-related issues are the Harbor Channels, the Anacostia River, and the Elizabeth River. Scientists have characterized the status of chemical contaminant effects on living resources in the Bay's tidal rivers based on available chemical contaminant data in the report, *Targeting Toxics: A Characterization Report - A Tool for Directing Management & Monitoring Actions in the Chesapeake Bay's Tidal Rivers (CBP, 1999)*. However, the mainstem of the Bay was not characterized in the report because of historically low levels of chemical contaminants in the Bay itself (CBP, 1999).

2.3.1 Upper Bay

There are two monitoring stations in the Upper Bay, CB1.1, at the mouth of the Susquehanna River, and CB3.1, along the Eastern Shore of Maryland, east of Baltimore. The pycnocline (see Section 2.3) occurs below about 9 to 12 ft in the upper Bay (Kemp et al., 1999).

2.3.1.1 *Salinity*

The surface water at the Susquehanna River Station (CB1.1) is essentially freshwater supplied by the river. This large amount of freshwater coming into the Upper Bay affects the salinity patterns. The historic surface salinity content at this station is 0 psu. The station was not sampled in February 2003 because of adverse weather conditions.

The historic mean for surface salinity at the Gunpowder Neck Station (CB3.1) ranges from a low of approximately 2 psu in April to a high of approximately 6 psu in September. The surface salinity values for 2002 were generally above the historic average while the values for 2003 were generally below the historic average.

Other studies conducted in the Upper Bay, particularly around the Site 104 area, Queen Anne's County, MD, have shown that salinity varies according to water depth, precipitation, season, and seasonal runoff from the Susquehanna River. The middle and bottom layers of the Upper Bay vary significantly, while the surface layer remains fairly consistent (MDE, 1998). Surface salinities in this area have been measured at 8.0 to 9.5 psu, and at the middle and bottom layers, approximately 16.0 to 17.0 psu, respectively (MDE, 1998).

Areas around Tolchester Channel West, Brewerton Angle, Swan Point Channel West, Pooles Island, and the mouth of the Patapsco River have had surface and bottom layer salinity measurements in the range of 0 to 14 psu and 0 to 18 psu, respectively (MES, 2003).

2.3.1.2 *Dissolved Oxygen*

Station CB1.1 set a record low for bottom DO in April of 2002 and then jumped to above average in May and June. For the remainder of 2002, bottom DO levels remained near the mean. For most of 2003, bottom DO levels at this station were above the mean and a record high was set in April. The station was not sampled in February 2003 because of adverse weather. The historic mean for this station varies between approximately 7 mg/L in the summer months and approximately 13 mg/L in the winter months. The bottom DO at this station usually remains above 5 mg/L and therefore does not fall into the stressful range.

The bottom DO historic mean for station CB3.1 ranges from approximately 3 mg/L in the summer months to approximately 10 mg/L in the winter months. This station was following a below-average trend for bottom DO through July 2002. In August and September 2002 the bottom DO was above average and the values remained at the mean for the remainder of 2002. In January and November 2003, record historic lows were set for each month. For the rest of the year, the bottom DO averaged below or only slightly above the historic mean. The bottom DO often drops to stressful levels (below 5 mg/L) and sometimes to severely stressful levels (below 2 mg/L) in the summer months at this station.

Recent studies conducted in areas around the Swan Point West Submerged Island and the Tolchester West/Brewerton Angle Island show the decline of DO during summer months to be as low as 1.0 mg/L (MES, 2003).

2.3.1.3 *Secchi Depth*

The historic mean for Secchi depth, a measure of the clarity or turbidity of the water, at station CB1.1 is approximately 1 m and the actual readings range from less than 0.5 m to almost 3 m. The Secchi depth readings at this station in 2002 stayed within the historic range. For 7 nonconsecutive months in 2003 (March, April, June, August, September, October, and December), Secchi depth did not meet the SAV habitat requirements. The station was not sampled in February 2003 because of adverse weather.

The historic mean for Secchi depth at station CB3.1 is approximately 1 m and the actual readings range from less than 0.5 m to almost 3 m. The 2002 Secchi depth reading at this station stayed close to the historic mean for the entire year. In 2003, the Secchi depth did not meet the habitat requirements for SAV from May through December. Also, the December value was a record historic low for the station.

2.3.1.4 *Temperature*

Temperature measurements in the Upper Bay area have shown to be mostly uniform in the upper, middle, and lower layers during the colder months. During the summer months, temperatures at the surface are similar but vary in the middle and bottom layers (MDE, 1998).

The historic mean surface water temperature at station CB1.1 ranges from approximately 3°C in January up to approximately 27°C in July and August. The 2002 water temperatures were above average for January through April and dropped below average for May and June. They stayed near the historic average until December when the reading was near the historic low for the station. For most of 2003, the surface water temperatures were at or below the historical mean. February measurements were not taken due to adverse weather conditions. July was the only month when the surface water temperature went above the average. Similar trends were also recorded at station CB3.1.

2.3.1.5 *Nutrients*

The status of nitrogen in the entire Upper Bay is poor to fair. However, monitoring locations on the C&D Canal, Elk River, Back River, and Patapsco River all show decreasing (improving) trends of nitrogen.

The status of phosphorus in the Upper Bay is fair to good for most of the area. Only a few tributaries have a poor status. In addition, most tributary monitoring stations (Middle, Patapsco, Magothy, and Chester Rivers) are showing decreasing (improving) trends of phosphorus. Only the station on the Bush River is showing a negative (increasing) trend.

2.3.2 Baltimore Harbor

Historically, the water quality in the Harbor was considered of poor quality. Although discharge management strategies and watershed management practices have decreased nutrient and toxics loading in the Harbor since 1975, nutrient enrichment and eutrophication are still apparent (EA, 2003a). The water quality in the Harbor is impacted by the heavy volume of urban runoff combined with industrial and commercial discharges. Nutrient levels are relatively high and algae blooms are frequent. Waters below the pycnocline frequently become hypoxic (dissolved oxygen less than 2 mg/L) during the summer months (CENAB, 1997).

Some of the data presented in this section are from the Patapsco and Back Rivers - Harbor Channels Monitoring Station (WT5.1), which is located in the Harbor Channels on the Patapsco River. The minimum, maximum, and mean values were available from the MD DNR Web site and the monthly data for years 2002 and 2003 were evaluated from the CBP Web site.

2.3.2.1 *Salinity*

The historic mean for surface salinity at the Patapsco and Back Rivers - Harbor Channels Station (WT5.1) ranges from a low of approximately 4 psu in April to a high of approximately 12 psu in December. The surface salinity values for 2002 were generally above the historic average while the values for 2003 were generally below the historic average. In June and September 2003, new record lows for the station were recorded.

The Harbor Channels contains a three-layer circulation pattern that consists of a fresh top layer and a saline bottom layer, both flowing into the harbor with a mixed middle layer flowing out. The harbor channels are located in the mesohaline (5 to 18 psu salinity) ecological zone near its transition with the oligohaline (0.5 to 5 psu salinity) zone. The longitudinal salinity gradient may undergo significant variations depending on the amount of freshwater inflow from the Susquehanna River. Seasonal changes also contribute to the salinity of the harbor. During the wet season, the salinity may be 3 psu at the mouth of the Patapsco River and 6 psu at the Bay

Bridge. During the dry season the salinity can increase to 8 psu at the Patapsco River's mouth and 13 psu at the Bay Bridge (CENAB, 1981).

Historical data from advance engineering and design (AE&D) studies conducted for the General Design Memorandum, referenced in this document, have shown that the greatest salinity differences occur in the Patapsco River. Differences at shallow water areas within the river have indicated a much reduced salinity sensitivity to channel deepening (CENAB, 1981).

2.3.2.2 *Dissolved Oxygen*

Dissolved oxygen content has been a concern within the confines of the Harbor Channels. The harbor experiences a low DO content, especially during the summer months, which may be caused in part by anthropogenic impacts and contaminants that exceed levels set forth by the Maryland Acute Water Quality Criteria for the harbor (MES, 2003).

The bottom DO historic mean for station WT5.1 varies between less than 1 mg/L in the summer months to approximately 10 mg/L in the winter months. In 2002, the bottom DO stayed at or below the historic mean through July and fell into stressful levels in the summer months. From August through December, the bottom DO was above the historic mean. In 2003, levels of the bottom DO were right around the historical average for all months except January and November. The values for May through September fell into the very stressful zone.

2.3.2.3 *Secchi Depth*

The historic mean for Secchi depth at station WT5.1 varies between approximately 0.6 m and 1.3 m and the actual readings range from approximately 0.2 m to 1.8 m. The Secchi depth readings at this station in 2002 were close to or above the historic mean for every month except January and December. In 2003, the Secchi depth stayed close to or below the historic mean. The water clarity at this station does not usually meet the SAV habitat requirements.

2.3.2.4 *Temperature*

Surface temperatures in the harbor are continually monitored by MD DNR and the average temperature has been recorded as 14.6 °C from 1985 to the present (MD DNR, 2003).

The historic mean surface water temperature at station WT5.1 range from approximately 2°C in February up to approximately 27°C in August. The 2002 water temperatures were above average for most of the year except for July and December. For most of 2003, the surface water temperatures were at or below the historical mean.

2.3.2.5 *Nutrients*

Both the nitrogen status and phosphorus status for the Patapsco River are poor. However, both nitrogen and phosphorus are showing decreasing (improving) trends due to improving discharge and watershed management practices.

2.3.3 Middle Bay

The Chesapeake Bay Approach Channels that service the Port of Baltimore include the Craighill Entrance, Craighill Channel, Craighill Angle, Craighill Upper Range, Cutoff Angle, Brewerton Channel, Brewerton Angle, and the Fort McHenry Channel. These channels are considered to be in the Middle Bay area.

There are three monitoring stations in the Middle Bay; CB3.3C is located at the Bay Bridge, just east of Annapolis, CB4.2C is located west of the Choptank River, and CB5.2 is located northeast of the mouth of the Potomac River. The pycnocline (see Section 2.3) occurs below about 18 to 36 ft in the Middle Bay (Kemp et al., 1999).

2.3.3.1 *Salinity*

Salinity in the Middle Bay is characterized as mesohaline to high mesohaline in the 5.0- to 18.0-psu range (MES, 2003).

The historic mean for surface salinity at the Bay Bridge Station (CB3.3C) ranges from a low of approximately 5 psu in April to a high of approximately 11 psu in September and October. The surface salinity values for 2002 were generally above the historic average while the values for 2003 were generally below the historic average. In September 2003, a new record low for the station was recorded.

The historic mean for surface salinity at the Choptank River Station (CB4.2C) ranges from approximately 10 psu in April to 15 psu in October. The values drop occasionally below the requirements for oyster habitat in the spring months. In 2002, surface salinity was at or above the historic mean every month except June. However, in 2003, surface salinity was at or below the historic mean every month except March.

The historic mean for surface salinity at the Potomac River Station (CB5.2) ranges from approximately 12 psu in May to 17 psu in October. The historic range of values has never dropped below the requirements for oyster habitat. In 2002, surface salinity was at or above the historic mean for the entire year. However, in 2003, surface salinity was at or below the historic mean every month except March and a new record low was set in December.

2.3.3.2 *Dissolved Oxygen*

Dissolved oxygen levels in the Middle Bay region vary seasonally and mainly stay at or above the minimum requirements for SAV and aquatic species. Studies concerning dissolved oxygen levels in the mid portion of the bay, in particular areas near Poplar, Sharps, Ragged, James, and Barren Islands, have been measured to be in the range of 6.9 to 8.5 mg/L (MES, 2003).

The bottom DO historic mean for station CB3.3C varies between less than 1 mg/L in the summer months to approximately 9 mg/L in the winter months. In 2002, the bottom DO followed the historic trends and fell into very stressful levels in the summer months. In 2003, bottom DO set historical lows in January and November at this station. April through September levels of bottom DO were right around the historical average, and in March through September the levels fell into the very stressful zone. Bottom DO levels in October increased, but fell further below the average.

The bottom DO historic mean for station CB4.2C varies between less than 1 mg/L in the summer months to approximately 10 mg/L in the winter months. In 2002, the bottom DO followed the historic trends and fell into very stressful levels in the summer months. In 2003, the bottom DO followed similar trends for the year but fell close to the historic low in November.

The bottom DO historic mean for station CB5.2 varies between less than 1 mg/L in the summer months to approximately 10 mg/L in the winter months. In 2002, the bottom DO followed the historic trends and fell into very stressful levels in the summer months. In 2003, the bottom DO followed similar trends for the year but fell close to the historic low in September.

2.3.3.3 *Secchi Depth*

The historic mean for Secchi depth at station CB3.3C is approximately 1.5 m and the actual readings range from less than 0.5 m to almost 4 m. The Secchi depth readings at this station in 2002 stayed close to the historic mean. In 2003, the Secchi depth also was close to or just below the historic mean in all months except for January and December, when the readings were well below the mean.

The historic mean for Secchi depth at station CB4.2C is approximately 2 m and the actual readings range from less than 1 m to almost 4 m. The Secchi depth readings at this station in 2002 stayed close to the historic mean. In 2003, the Secchi depth readings remained below the historic mean for the entire year. In June, the Secchi depth did not meet SAV habitat requirements and set a new low record.

The historic mean for Secchi depth at station CB5.2 is approximately 2 m and the actual readings range from less than 1 m to almost 5 m. The Secchi depth readings at this station in 2002 stayed close to the historic mean. In 2003, the Secchi depth readings remained at or below the historic mean for the entire year. In June, the Secchi depth did not meet SAV habitat requirements and set a new low record.

2.3.3.4 *Temperature*

The historic mean surface water temperature at station CB3.3C ranges from approximately 3°C in January up to approximately 27°C in July and August. The 2002 water temperatures were above average for January through April and dropped below average in May. They stayed near the historic average until December when the reading was near the historic low for the station. For most of 2003, the surface water temperatures were at or below the historical mean.

The surface water temperatures for stations CB4.2C and CB5.2 are similar to CB3.3C with regard to historic values as well as the trends over the past 2 years.

2.3.3.5 *Nutrients*

The status of nitrogen in the entire Middle Bay is fair to good. However, several tributaries, including the Potomac and Choptank Rivers, have a poor status. Tributary monitoring locations on the Potomac and Patuxent Rivers show decreasing (improving) trends of nitrogen. Only the monitoring station on the Nanticoke River is showing a negative (increasing) trend.

The status of phosphorus in the Middle Bay is good for most of the area. Only the Tangier Sound and a few tributaries have a fair status. In addition, most tributary monitoring stations are showing decreasing (improving) trends of phosphorus. Only the stations on or near the mouth of the Potomac River are showing a negative (increasing) trend.

2.3.4 Lower Bay

There are three monitoring locations in the Lower Bay; CB6.1 is located east of the mouth of the Rappahannock River, CB6.4 is located east of the mouth of the York River, and CB7.4 is located at the Baltimore Channel of the Chesapeake Bay Bridge-Tunnel (CBBT). The pycnocline (see Section 2.3) occurs below about 18 to 36 ft in the Middle Bay, and below about 12 to 30 ft in the Lower Bay.

2.3.4.1 *Salinity*

The historic mean for surface salinity at the Rappahannock River Station (CB6.1) ranges from a low of approximately 15 psu in May to a high of approximately 20 psu in November. The surface salinity values for 2002 were generally above the historic average and the station recorded a new historic high in April. The values for 2003 were generally below the historic average. In October 2003, a new record low for the station was recorded. The station was not sampled in January or September 2003 because of adverse weather conditions.

The historic mean for surface salinity at the York River Station (CB6.4) ranges from approximately 18 psu in May to 23 psu in October. In 2002 surface salinity was at or above the historic mean every month except for November. However, in 2003 surface salinity was below the historic mean for the entire year. In July, October, and December 2003, new record lows for the station were recorded. The station was not sampled in September 2003 because of adverse weather conditions.

The historic mean for surface salinity at the Chesapeake Bay Bridge Tunnel Station (CB7.4) ranges from approximately 24 psu in May to 28 psu in November. In 2002, surface salinity was at or above the historic mean every month except November. The station was not sampled in

April or December 2002. However, in 2003, surface salinity was below the historic mean the entire year and new record lows were set in April, July, October, November, and December. The station was not sampled in September 2003 because of adverse weather conditions.

The Virginia channels are within the polyhaline (18 to 30 psu) ecological zone, with salinity being the highest at the mouth of the Chesapeake Bay where seawater enters the estuary. The longitudinal salinity gradient varies from close to 30 psu at Cape Henry to approximately 19 psu at the upper Rappahannock Shoal Channel. During periods of high freshwater river discharge, the salinities in the water may drop as much as 5 psu (CENAB, 1981).

Historical data from studies conducted for the General Design Memorandum (CENAB, 1981), have shown that there is an increase in salinity at the bottom depths of the Virginia channels associated with deepening. The study also concluded that monitoring stations placed at the mouths of the James and York Rivers have shown that there is fresh, deep water that reduces salinity intrusion at these areas (CENAB, 1981).

2.3.4.2 *Dissolved Oxygen*

The bottom DO historic mean for station CB6.1 varies between less than 2 mg/L in July to approximately 11 mg/L in the winter months. In 2002, the bottom DO followed the historic trends and fell into stressful levels in the summer months. In 2003, the bottom DO set historic highs in October and December at this station. February through June levels of bottom DO were right around the historical average but fell below the average and into the very stressful zone in July and August. The station was not sampled in January and September because of adverse weather conditions.

The bottom DO historic mean for station CB6.4 varies between approximately 4 mg/L in July to approximately 11 mg/L in the winter months. In 2002, the bottom DO stayed near or above the historic mean and barely dipped into the stressful zone in September. In 2003 the bottom DO set a new historic low in February and then remained near the mean for March through May. In June through August, the bottom DO values were in the stressful or very stressful range and remained below average through November. The station was not sampled in September because of adverse weather conditions.

The bottom DO historic mean for station CB7.4 varies between approximately 6 mg/L in the summer months to approximately 10 mg/L in the winter months. The historic range does fall into the stressful zone in the summer months. In 2002, the bottom DO followed the historic mean. In 2003 the bottom DO stayed at or above the historic mean and set a record high for March. The station was not sampled in September because of adverse weather conditions.

2.3.4.3 *Secchi Depth*

The historic mean for Secchi depth at station CB6.1 is approximately 2 m and the actual readings range from approximately 1 m to 4 m. The Secchi depth readings at this station in 2002 stayed at or above the historic mean. In 2003, except for October, the Secchi depth was below the historic mean and set a record low for the station in December. The water clarity did not meet the SAV habitat requirements for July and August.

The historic mean for Secchi depth at station CB6.4 is approximately 2 m and the actual readings range from less than 1 m to approximately 4 m. The Secchi depth readings at this station in 2002 were below the historic mean for May, June, and September but were above average for the rest of the year. In 2003 the Secchi depth readings remained below the historic mean for the entire year, except for February, when it was slightly above average.

The historic mean for Secchi depth at station CB7.4 is approximately 2 m and the actual readings range from less than 1 m to more than 7 m. In 2002, the Secchi depth readings at this station stayed close to the historic mean. In 2003, the Secchi depth readings remained at or below the historic mean for the entire year. In April, the Secchi depth did not meet SAV habitat requirements and set a new low record. June also set a record low for the station.

2.3.4.4 *Temperature*

The temperature in the Lower Bay, especially near the mouth, is relatively stable compared to the upper reaches because of the proximity to the Atlantic Ocean (CENAB, 1981).

The historic mean surface water temperature at station CB6.1 ranges from approximately 3°C in January up to approximately 27°C in July and August. The 2002 water temperatures were above average for January through July and fell below average in August. They stayed below the historic average for the remainder of the year. For most of 2003, the surface water temperatures were at or below the historical mean and set a new record low in February.

The historic mean surface water temperature at station CB6.4 ranges from approximately 4°C in January up to approximately 26°C in July and August. The 2002 water temperatures were above average for January through September but dropped below average in October. They stayed below the historic average for the remainder of the year. For most of 2003, the surface water temperatures were at or below the historical mean, except for October, when a new record high for the station was set.

The surface water temperatures for stations CB7.4 are similar to CB6.4 with respect to historic values as well as the trends over the past 2 years.

2.3.4.5 *Nutrients*

The status of nitrogen in the Lower Bay ranges from good near the Middle Bay region and the mouth of the Bay, to fair on the eastern half of the Lower Bay, to poor on the western half of the Lower Bay. The tributary monitoring stations (Rappahannock, York, James, and Elizabeth Rivers) all have decreasing (improving) trends.

The status of phosphorus in the Lower Bay is mostly fair, with a good status near the adjacent to the Middle Bay region. However, several tributaries (Rappahannock, York, and James Rivers) have major sections with a poor status. The trends in the James and Elizabeth Rivers are decreasing (improving); however, trends in the Rappahannock and York Rivers are increasing.

2.3.5 Floodplains

Floodplains are defined in Executive Order 11988, Floodplain Management, as "the lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year;" i.e., the area that would be inundated by a 100-year flood. In addition, Executive Order 11988 directs federal agencies to "take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains."

Areas subject to flooding (100-year and 500-year floodplains are identified and mapped according to existing Flood Insurance Rate maps (FIRM) issued by Federal Emergency Management Agency (FEMA). Floodplain maps and information for the Chesapeake Bay region are available at the FEMA Flood Hazard Mapping Web site at www.fema.gov/fhm. The 100-year and 500-year floodplain for the study area would vary depending on surrounding topography and hydrologic conditions.

2.3.6 Groundwater

The unconsolidated sediments of the Chesapeake Bay are divided into numerous aquifer systems, aquifers, and confining units. The distribution of aquifer sediments and corresponding groundwater flow patterns vary across the Bay. Sand and gravel deposits comprising surficial aquifers likely discharge directly to the Bay. Deeper confined aquifers, which may be vertically stacked and hydraulically connected, are likely part of the regional flow system and may flow under the Bay or a portion of the bay.

Groundwater recharge is influenced by stream flow, which carries nutrients, sediment, and contaminants into the Bay. The variability of stream flow due to seasonal and yearly changes in rainfall affects salinity, dissolved oxygen, and water clarity in the Bay. All of these factors affect the living resources in the Bay. Major aquifers in the Bay include the Aquia, Severn-Magothy, and the Potomac Aquifers (USGS, 1997).

2.4 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

Toxic chemicals are a major stressor for the Chesapeake Bay. Chemical contaminants harm plants, animals, fish, and humans, affecting reproduction, development, and the survival of organisms. Major contaminants found in sediments include bulk organics (such as oil and grease), halogenated hydrocarbons (chemicals very resistant to decay such as DDT and PCBs), polycyclic aromatic hydrocarbons (such as petroleum), and metals (such as lead, cadmium, and mercury) (EPA, 1999). The nature, extent, and severity of toxic effects varies widely throughout the Chesapeake systems. Some toxic chemicals such as zinc, copper, and other metals occur naturally in soils and sediments.

Chemical contaminants enter the Bay and its tributaries from point sources (industrial and municipal wastewater treatment plants), and nonpoint sources (urban and suburban stormwater runoff and agricultural runoff). Domestic activities such as home and lawn maintenance, driving, and discarding unused household chemicals add airborne and waterborne contaminants to the Bay. Chemicals typically travel through the watershed and deposit in the Bay and its tributaries. Persistent chemicals may reach harmful levels when they continue to accumulate in the sediment at the bottom of the Bay. As population (currently more than 15 million people) continues to grow in the Chesapeake Bay watershed, the nonpoint sources become difficult to track and control.

According to the Chesapeake Bay Basinwide Toxics Reduction Reevaluation Report (1994), the highest estimated toxic metal loading to the Bay basin comes from urban stormwater runoff, followed by point sources and atmospheric deposition. Metal loading is highest in the Potomac, followed by the Susquehanna, West Chesapeake, James, mainstem Bay, Patuxent, Eastern Shore, York, and Rappahannock basins. The highest estimated loadings of toxic organic contaminants (PAHs and PCBs) are from atmospheric deposition, followed by urban stormwater runoff and point sources. The West Chesapeake has the highest organic chemical contaminant load, followed by the mainstem Bay, Susquehanna, Potomac, James, Eastern Shore, Patuxent, York, and Rappahannock basins. Atmospheric deposition is of relatively greater importance in the southern Chesapeake. Some of these airborne materials may originate from the sources far away. Bay sediments have become reservoirs of certain persistent toxic compounds which, though banned by current regulations, have accumulated over many prior years of use.

The Chesapeake Bay Toxics Characterization Report (1999) provides four categories for the 27 tidal rivers in the Bay area according to the toxicity of the region, as illustrated in Figure 2-8.

1. **Regions of Concern:** These river segments have an apparent chemical contamination-related problem, including concentrations above the threshold values, which leads to adverse effects and negative impacts on living resources. These are Elizabeth River, Patapsco River, and Anacostia River.

2. **Areas of Emphasis:** These rivers show signs of elevated chemical concentrations and/or adverse effects on living resources. Areas showing significant potential for contamination are Middle River, Back River, Magothy River, Severn River, Patuxent River, Potomac River, Chester River (MD), and James River (VA).

3. **Areas of Low Probability for Adverse Effects:** Contaminant levels in these areas fall below the thresholds for adverse effects and there are no signs of contaminant-related effects on aquatic plants and animals. Areas that are unlikely to have chemical contaminant-related problems are Sassafras River, Nanticoke River (MD), Rappahannock River, and York River (VA).

4. **Areas of Insufficient or Inconclusive Data:** These are river segments where existing data are too old to reliably reflect current conditions. Twenty areas in the Bay fall under this category. These are: Bush River, Gunpowder River, South/Rhode River, Northeast River, Elk River/Bohemia River, Wye River/Miles River/Eastern Bay, Choptank River, Wicomico River, Manokin River, Big Annemessex River, Pocomoke River (MD), Rappahannock River, Mattaponi River, Pamunkey River, York River, and James River (VA).

Upper Bay and Harbor

The most severe toxic contamination problems in the Chesapeake Bay are mostly in the Upper Bay, where the Patapsco River is located. In the September 1993 Toxics Reduction Strategy Reevaluation Directive, the Chesapeake Executive Council designated the Baltimore Harbor as a Region of Concern that had known chemical contaminant-related problems. Baltimore Harbor and the Patapsco River are among the highest in the United States with concentrations of toxic metals in the sediments, due to decades of intense industrial pollution.

The Maryland Department of the Environment has issued fish consumption advisories throughout the Chesapeake Bay based on exposure levels for certain contaminants. The following species of fish, which may be found in the Upper Bay, have consumption advisories:

- Channel catfish (PCBs and pesticides)
- White perch (PCBs and pesticides)
- Striped bass (PCBs and methylmercury)
- Blue crab (PCBs)
- American eel (PCBs and pesticides)
- Common carp (PCBs and pesticides)
- Small and largemouth bass (PCBs and pesticides)
- Yellow perch (PCBs) (MDE, 2004b)

Middle Bay

Severe toxic contamination problems in the Middle Bay are concentrated in the Anacostia River, which is known for its adverse impacts. In the September 1993 Toxic Reduction Strategy Reevaluation Directive, the Chesapeake Executive Council designated the Anacostia River as a Region of Concern that had known chemical contaminant-release problems.

The Maryland Department of the Environment has issued fish consumption advisories throughout the Chesapeake Bay based on exposure levels for certain contaminants. The following species of fish, which may be found in the Middle Bay, have consumption advisories:

- Channel catfish (PCBs and pesticides)
- White perch (PCBs and pesticides)
- Striped bass (PCBs and methylmercury)
- American eel (PCBs and pesticides)
- Brown bullhead (PCBs and pesticides)
- Spot (PCBs and pesticides)
- Common carp (PCBs and pesticides)
- Small and largemouth bass (PCBs and pesticides) (MDE, 2004b)

Lower Bay

In 1998, Virginia designated the lower tidal James River as threatened due to chemical contamination. In 1983 the CBP identified the Elizabeth River as one of the most highly polluted bodies. Heavy metals and organic compounds have contaminated bottom sediments and thus it was considered a toxic hot spot. Heavy loads of lead, copper, and mercury have been detected in the Elizabeth River, and over 200 different organic compounds have been identified in the sediments. PCBs have also been detected in significant quantity in the Elizabeth River and they have bioaccumulated in crab, fish, and other aquatic organisms. The Elizabeth River is identified as one of three Regions of Concern in the CBP Toxics Characterization Report (CBP, 1999) while the James River is considered an Area of Emphasis (indicating early signs that living resources may be affected by chemical contamination, and a significant potential for chemical contaminant concerns. Data are insufficient or inconclusive for a number of other rivers in the Lower Bay. The Maryland Department of the Environment and the Virginia Department of Health have issued fish consumption advisories throughout the Chesapeake Bay based on exposure levels for certain contaminants. The following species of fish, which may be found in the Lower Bay, have consumption advisories (MDE, 2004b and VDH, 2005):

- Channel catfish (PCBs and pesticides)
- White perch (PCBs and pesticides)
- Striped bass (PCBs and methylmercury)
- American eel (PCBs and pesticides)
- Brown bullhead (PCBs and pesticides)
- Common carp (PCBs and pesticides)
- Small and largemouth bass (PCBs and pesticides)

There are 316 potential hazardous waste sites in the Elizabeth river basin, and two designated Superfund sites along the river, sources of lead, creosote, and pentachlorophenol.

Baywide Toxics Data Sources

The Chesapeake Bay Program (CBP) maintains a toxics database divided into three categories: toxic chemical concentration in Bay organisms (biological), in sediments (sediment), and in the water column (water). The data sources are from the CBP, private industries, the National Bureau of Standards, state agencies, and the EPA STORET database. Information can also be obtained from The Toxic Release Inventory (TRI) program, which is a publicly available EPA database that can be used to find toxic chemical releases and other waste management operations by certain industries and federal facilities in the Bay area. This was established under Emergency Planning and Community Right to Know Act (EPCRA, 1986) and expanded by the Pollution Prevention Act of 1990.

Nevertheless, in a 2002 Chesapeake Bay Program survey of watershed water quality issues, 54% of the residents in the Bay area were concerned about pollution in the Bay. Approximately 49% mentioned that the Bay was more polluted than 10 years ago.

Contaminated Sites

A second issue with respect to toxics in the Bay area is the potential presence of contaminated sites in or near the Bay that may affect dredging or placement options.

USACE regulations typically require documentations and evidence of the CERCLA and NPL sites within boundaries of a proposed project that can impact or be impacted by HTRW contamination. USACE Engineer Regulation 1165-2-132 states that dredged material and sediments beneath navigable waters proposed for dredging qualify for HTRW only if they are within the boundaries of a site designated by EPA or a state for a response action, like removal or remediation under CERCLA. However, dredged sediments that exhibit one or more RCRA hazardous waste characteristics are subject to RCRA Subtitle C Requirements for management and disposal.

Dredged material management regulations prohibit placement of HTRW in the dredged area. It is therefore required that none of the originating locations for the material to be placed in a site are listed as CERCLIS or NPL sites or considered to be potential sources of hazardous, toxic, or radioactive substances. For both the Maryland area and the Virginia area, a link to the hazardous and toxic waste sites or the NPL sites can be found through this link: http://www.epa.gov/enviro/html/em, through EPA's Enviromapper.

In addition to federal Superfund (NPL) sites, other contaminated sites, including those under various state oversight and cleanup programs (i.e., state Superfund, UST or Voluntary Cleanup programs, among others) may, by virtue of their contaminants and their proximity to the Bay, affect dredged material management options. A large number of sites may fall under one of these categories and site-specific studies should identify and evaluate those that might affect a proposed action. Sites listed by the State of Maryland can be identified through the Maryland Internet Mapping Center at: http://www.mde.state.md.us/mappingsite/index.asp. This gives information about Hazardous sites on the NPL, Voluntary Cleanup Program, State Master List, and Federal Facilities. Information on sites addressed under Virginia's Hazardous Waste, Brownfields, and Voluntary Remediation Programs, as well as federal Superfund sites in Virginia, can be accessed at: http://www.deq.state.va.us/waste.

The potential exists for the presence of unexploded ordnance buried in the Harbor sediment. Unexploded ordnance recovered during dredging operations would have to be handled and disposed of in an appropriate manner to prevent safety threats or detrimental impacts to the environment.

2.5 AIR QUALITY

The airshed for the Chesapeake Bay covers approximately 420,000 square miles, approximately six times the size of the watershed (NPS, 2003). It extends south to South Carolina, west into Indiana, and northwest into Ontario and north into Quebec.

Airborne pollution originates from a variety of sources, including automobile and small engine emissions, power-generating facilities, industry, agriculture, and construction. Natural sources (e.g., fire and lightning) also contribute to airborne pollution. The impact of air emissions on water quality is a major concern in the Chesapeake Bay. It is estimated that approximately 32% of the total nitrogen load to the Bay comes from atmospheric deposition. The Chesapeake 2000 agreement commits to significantly decreasing the total load of nitrogen from all sources, including atmospheric (CBP, 2002a).

Air quality within the immediate area of the Chesapeake Bay watershed is considered good. However, significant portions of Maryland are in nonattainment for ozone, including Central Maryland, the Baltimore Metropolitan region, the Washington Metropolitan region, part of southern Maryland, and part of the Eastern Shore (MDE Web site). In Virginia ozone nonattainment areas include Hampton Roads, Richmond, Fredericksburg, and northern Virginia (VADEQ Web site). Air quality is also affected regionally and locally by emissions from a variety of sources (see above).

2.5.1 Upper Bay

The entire area is in nonattainment for ozone. The various counties, however, are located in three different nonattainment areas: Baltimore (Anne Arundel, Baltimore City and County, and Harford), Philadelphia-Wilmington-Trenton/Atlantic City (Cecil), and Kent and Queen Anne's Counties. Under the 1-hour average ozone national ambient air quality standard (NAAQS), both the Baltimore and Philadelphia areas were severe nonattainment areas for ozone, while Kent & Queen Anne's was designated as only marginal nonattainment. However, EPA has proposed to revoke the 1-hour NAAQS in June 2005 because the standard is being replaced with an 8-hour average NAAQS. The same areas have been designated as nonattainment under the new standard, but all three areas are classified as moderate nonattainment (EPA Greenbook Web site). There are ozone monitors in each of the counties, except Queen Anne's, and the monitored values have generally been well above the standard, indicating a long-term air quality problem that is likely to continue. In addition, although attainment designations for the new fine particulate matter, which is less than or equal to 2.5 μm in diameter. (PM-2.5). NAAQS are not expected to be proposed until winter 2004-2005, preliminary monitoring data indicate that the Baltimore area will be nonattainment (EPA Geoselect Web site). A major source of PM-2.5 emissions is diesel engines, including those in dredges, tugboats, and earth-moving equipment. In the past (1992 through 1995), portions of Baltimore City were nonattainment for carbon monoxide (CO), a pollutant largely generated by mobile sources along with other stationary combustion sources, but this area was reclassified as reaching attainment of the CO NAAQS in 1995.

Air quality is also affected regionally and locally by emissions from a variety of sources (see above).

2.5.2 Baltimore Harbor

The entire Harbor area is in nonattainment for ozone. As noted above, the Baltimore area is a severe nonattainment area under the 1-hour ozone NAAQS and a moderate nonattainment area under the 8-hour ozone NAAQS. Moreover, preliminary monitoring data indicate that the Baltimore area will be nonattainment for the new PM-2.5 NAAQS. Portions of Baltimore City were nonattainment for CO, a pollutant largely generated by mobile sources along with other stationary combustion sources, but this area was reclassified as reaching attainment of the CO NAAQS in 1995.

Air quality is also affected regionally and locally by emissions from a variety of sources (see above).

2.5.3 Middle Bay

Some of the area is in nonattainment for ozone. In particular, southern Anne Arundel County is part of the Baltimore nonattainment area noted above, southern Queen Anne's County is part of the Kent & Queen Anne's County nonattainment area noted above, and Calvert County is part of the Washington, DC-MD-VA nonattainment area. As for the Baltimore area, the Washington area is considered severe nonattainment under the 1-hour NAAQS and has been classified as moderate under the 8-hour NAAQS. The Calvert County ozone monitor measured a value about 6% higher than the 8-hour standard. Therefore, substantial progress would have to be made to achieve attainment, but Calvert County is much closer to attainment than the other counties in the Upper and Middle Bays. However, even if attainment was demonstrated for Calvert County, Maryland would have to petition that Calvert County be split off from the remainder of the Washington nonattainment area, which is not expected to attain the 8-hour standard as readily. Portions of the Washington area other than Calvert County were nonattainment for CO in the past (1992-1995), but were reclassified as reaching attainment of the CO NAAQS in 1996.

Air quality is also affected regionally and locally by emissions from a variety of sources (see above).

2.5.4 Lower Bay

Areas of Virginia are in nonattainment for ozone. The Hampton Roads Area (then including following areas bordering Chesapeake Bay: the cities of Hampton, Norfolk, Virginia Beach, and York County) were classified as a marginal nonattainment area for the 1-hour ozone NAAQS in the past (1992-1997), but was reclassified as attainment in 1997. However, under the 8-hour ozone NAAQS, the same area, which now also includes Gloucester County, is classified as marginal nonattainment. There is only one ozone monitor in the counties bordering the Chesapeake Bay, and that monitor in Hampton has exceeded the standard only in some years. (Compliance with the standard is determined based on the average of the fourth highest maximum value in the last 3 years.) Therefore, it may be possible for part or all of the area to demonstrate attainment in the near future. The monitors in the Virginia areas bordering the Chesapeake Bay for other pollutants, including PM-2.5 in Hampton and Norfolk and PM-10 in those two cities plus Northumberland County, have not violated NAAQS in recent years.

Air quality is also affected regionally and locally by emissions from a variety of sources (see above).

2.6 AQUATIC RESOURCES

The Chesapeake Bay provides a wide range of habitats for thousands of different aquatic species, including finfish, shellfish, benthic invertebrates, and SAV. Habitats are the places where plants and animals live, where they feed, find shelter, and reproduce. Bay habitats of critical importance to aquatic organisms include oyster beds, SAV beds, and tidal marsh. The Bay's aquatic resources are part of a complex food web, with phytoplankton and zooplankton at the base of the food chain, and large finfish species, waterbirds, marine mammals, and humans at higher trophic levels. Many aquatic species are commercially important, such as Atlantic menhaden (*Brevoortia tyrannus*), blue crab (*Callinectes sapidus*), and striped bass (*Morone saxatilis*). The Chesapeake Bay is a very productive and ecologically important ecosystem, which produces 500 million pounds of harvested seafood per year (CBP, 2004a).

Aquatic resources in the Bay are protected at the federal level under a number of environmental protection statutes including the Endangered Species Act, Fish and Wildlife Coordination Act, Anadromous Fish Conservation Act, The Magnuson Stevens Fishery Conservation and

Management Act, and Emergency Wetlands Resources Act. The State of Maryland protects species and their habitats through several additional statutes including the Nongame and Endangered Species Conservation Act, Chesapeake Bay Critical Area Law, Nontidal Wetlands Protection Act, and Tidal Wetlands Act. The Commonwealth of Virginia has analogous environmental protection laws including the Chesapeake Bay Preservation Act, Virginia Wetlands Act, Virginia Endangered Species Act, and Endangered Plant and Insect Species Act. For a comprehensive list of Federal Statutes, Executive Orders, Memoranda, and State Statutes, see Chapter 4.

Under these statutes, aquatic resources of the Chesapeake Bay are monitored and protected by a number of federal, state, and public entities. USFWS biologists at the USFWS Chesapeake Bay Field Office work to protect endangered and threatened species, freshwater and anadromous fish, and wildlife habitats in the District of Columbia, Delaware, Maryland, and Virginia. The National Marine Fisheries Service Office for Law Enforcement is dedicated to the enforcement of laws that protect and conserve living marine resources and their natural habitat. CENAB assists federal, state, and local agencies in preparing environmental analyses, complying with environmental requirements, conserving natural resources, and implementing pollution prevention measures within the Bay region. MD DNR and Virginia Department of Environmental Quality (VADEQ) preserve, protect, and restore their respective state's natural resources through law enforcement, monitoring, education, and management.

In addition to these federal and state entities, numerous partnerships and nonprofit agencies assist in the protection and monitoring of the aquatic resources of the Bay. The most notable example is the Chesapeake Bay Program, which is a regional partnership whose mission is to protect the Bay's living resources and their habitats, and restore degraded habitats. The program's Executive Council (governed by the governors of Maryland, Pennsylvania, and Virginia; the Administrator of the U.S. Environmental Protection Agency; the Mayor of the District of Columbia; and the Chair of the Chesapeake Bay Commission) establishes the policy direction for the restoration and protection of the Chesapeake Bay and its living resources.

The Bay's diverse aquatic resources are described in the following sections. A complete inventory of Bay aquatic resources is beyond the scope of this document. Emphasis is placed on key commercially and ecologically important species. Site-specific aquatic resource investigations are required if specific project locations are selected for dredged material placement.

2.6.1 Benthic Invertebrates

Benthic macroinvertebrates, large, generally soft-bodied organisms without a backbone that live in or on the bottom sediment in the Bay, are a diverse assemblage of species from many different taxa. To date, over 340 species of benthic macroinvertebrates have been collected from soft bottom habitats by the Chesapeake Bay Benthic Monitoring Program (CBBMP) since the program was initiated in 1984 (CBBMP, 2004). The majority of Bay benthic macroinvertebrate species (i.e., invertebrates >0.5 mm) collected belong to one of six groups: gastropods, bivalves, polychaete worms, oligochaete worms, amphipods, and chironomids. The monitoring program's Web site provides a complete species list (online: http://www.baybenthos.versar.com/benthos/macro.htm).

Environmental factors dictate the benthic community present at a particular site. Substrate type, temperature, salinity, and dissolved oxygen concentration are the key environmental factors for benthic invertebrates. Bottom salinity is the dominant factor in the Chesapeake Bay. Benthic communities in the Bay are classified according to the salinity ranges in which they occur. These salinity ranges define five benthic invertebrate habitats: Tidal Freshwater (0 to 0.5 psu), Oligohaline (0.5 to 5 psu), Low Mesohaline (5 to 12 psu), High Mesohaline (12 to 18 psu), and Polyhaline (18 to 25 psu). Tidal freshwater habitats are low-lying areas adjacent to the upper reach of an estuary that is periodically inundated by low-salinity water. Oligohaline habitats are primarily graminoid-dominated wetlands of slightly brackish zones along tidal rivers and streams of the coastal plain. Mesohaline and polyhaline habitats are found on lower stretches of tidal rivers and creeks in the inner coastal plane and both shores of the Chesapeake Bay (mostly mesohaline) and on extensive nonriverine flats, were salinity may range from mesohaline to polyhaline. In mesohaline and polyhaline habitats, benthic community composition also differs in muddy and sandy sediments. Soft bottom (i.e., muddy or sandy) habitats comprise 99% of the Bay. Oyster beds and other hard bottoms comprise the remaining 1% of Bay bottom substrate (CBBMP, 2004).

2.6.1.1 *Benthic Indicator Species*

Benthic organisms are excellent indicators of the health in aquatic systems. As such, both the MD DNR and VADEQ have long performed benthic monitoring throughout the Bay. In 1996, these programs, while remaining separate, have adjusted or supplemented their sampling strategies such that the entire Bay is monitored and evaluated annually using benthic organisms and uniform data analysis methods. Trend analyses are performed, and the entire Bay is evaluated to see whether Restoration Goals are being met.

Benthic data are evaluated using the Benthic Index of Biotic Integrity (B-IBI), which is a commonly used measure of biological integrity, general health, and quality of the benthic community. The B-IBI developed for the Chesapeake Bay evaluates the ecological condition of a sample by comparing values of 11 (MD program) or 13 (VA program) key benthic community attributes ("metrics") to reference values expected under nondegraded conditions in similar habitat types. Each metric is assigned a value from 1 to 5, with 5 for pristine sites and 1 for degraded sites. The values are then averaged to calculate an overall B-IBI score. By applying this system, sites throughout the Bay can be compared to one another, as well as data from year to year at a single location. Samples with index values of 3.0 or more are considered to have good benthic condition and are indicative of good habitat quality. The index period for the Chesapeake Bay IBI is 15 July through 30 September.

2.6.1.2 *Chesapeake Bay Monitoring Program*

Since 1994, the Chesapeake Bay Benthic Monitoring Program has consisted of two elements: a fixed-site monitoring sampling effort directed at identifying trends in benthic condition, and a probability-based sampling effort intended to estimate the area of benthic communities meeting and failing to meet the Chesapeake Bay Program's Benthic Community Restoration Goals. MD Benthic Datasets and detailed information about trends in the benthic community are available from the Maryland Chesapeake Bay Long-Term Benthic Monitoring and Assessment Program (CBBMP, 2004). There are 46 fixed-site monitoring stations: 27 in MD and 19 in VA (see Figure 2-1). Regions of the Bay mainstem deeper than 12 m are not included in the sampling strata because these areas are subjected to summer anoxia and have consistently been found to be azoic (monitoring program Bay Web site). Refer to the MD and VADEQ benthic monitoring program Web sites for more details (CBBMP, 2004; VADEQ, 2004a, respectively).

Sites with B-IBI index values of 3 or more are considered to meet the Chesapeake Bay Program's Benthic Community Restoration Goals. The Restoration Goals describe the characteristics of benthic invertebrate assemblages expected in nondegraded habitats of the Bay. Of the 250 probability-based samples collected in the entire Chesapeake Bay in 2002, nearly 50% failed the Restoration Goals. Four regions with the highest average percentages of area failing between 1994 and 2001 include the York River, Potomac River, Maryland Middle Bay Mainstem, and Maryland Tidal Waters. Baywide, the Potomac River and the Maryland Mainstem were in worst condition in 2002, with over 70% of the bottom area failing the Restoration Goals. As in previous years, the Upper Bay mainstem, the Virginia mainstem, and the eastern tributaries of Maryland continued to have the best condition overall (CBBMP, 2004).

2.6.1.2.1 Upper Bay

The Upper Bay is a more variable environment than the Lower Bay because it is subject to greater fluctuations in temperature and salinity. Consequently, the Upper Bay is generally colonized by opportunistic benthic species that are less sensitive to environmental fluctuation. Opportunistic species are commonly relatively short-lived, tolerant species with relatively high reproductive and recruitment potential, and these taxa often dominate disturbed or stressed habitats.

There are four fixed benthic monitoring stations in the Upper Bay area: Stations 024 (Mainstem); 026 (Mainstem); 029 (Elk River); and 068 (Chester River mesohaline) (Figure 2-1). All fixed stations of the Upper Bay area meet or exceed Bay Restoration Goals. Additional details about these sites are provided in Table 2-1.

Over 50% of the Upper Bay probability-based stations that failed Restoration Goals from 1996 to 2002 had insufficient abundance, insufficient biomass, or both. Nearly 30% of the stations that failed during this period had excess abundance and/or excess biomass, which is indicative of effects on benthos resulting from nutrient enrichment in these areas (CBBMP, 2004).

2.6.1.2.2 Baltimore Harbor

There are four fixed benthic monitoring stations in the Harbor area: Stations 022 (Patapsco River, Middle Branch), 023 (Patapsco River), 201 (Patapsco River, Bear Creek), and 202 (Patapsco River, Curtis Bay) (Figure 2-1). All four stations are designated as "degraded" or "severely degraded." Additional details about these sites are provided in Table 2-1.

Nearly 65% of the Maryland western tributaries probability-based stations that failed Restoration Goals from 1996 to 2002 were designated as "severely degraded." During this period, 68% of the stations that failed had insufficient abundance, and/or insufficient biomass. The western tributaries suffer from various types of pollution, including toxic contamination, low dissolved oxygen, excess phytoplankton growth, lack of water clarity, and nutrient runoff, but these factors vary greatly among systems, and the stress to the benthic communities varies accordingly (CBBMP, 2004).

2.6.1.2.3 Middle Bay

There are 18 fixed benthic monitoring sites in the Middle Bay: Stations 001 (Calvert Cliffs); 006 (Calvert Cliffs); 015 (North Beach); 036 (Potomac River at Rosier Bluff); 040 (Potomac River at Maryland Point); 043 (Potomac River Morgantown ‹5m); 044 (Potomac River Morgantown ›11m); 047 (Potomac River Morgantown ‹5m); 051 (Potomac River St. Clements Island ‹5m); 052 (Potomac River St. Clements Island ›9m); 062 (Nanticoke River); 064 (Choptank River mesohaline); 066 (Choptank River oligohaline); 071 (Patuxent River at Broomes Island); 074 (Patuxent River at Chalk Point); 077 (Patuxent River at Holland Cliff); 079 (Patuxent River at Lyons Creek); and 204 (Severn River) (Figure 2-1). More than a quarter of the fixed stations in this region are designated as "degraded" or "severely degraded." Eight of the stations meet or exceed Bay Restoration Goals. Additional details about these sites are provided in Table 2-1.

Fixed monitoring stations 01 and 06, however, are located in shallow, sandy habitats of the Middle Bay mainstem. These stations have shown significant improving trends in the B-IBI and have met Restoration Goals between 1999 and 2001. The Potomac and Patuxent Rivers had the largest percentage of probability-based stations that failed Restoration Goals for insufficient abundance and/or biomass. It is suggested in the MD monitoring program's December 2002 comprehensive report that benthic degradation in the Patuxent River is mainly related to adverse effects from low dissolved oxygen (DO). The intensity of summer hypoxic events varies annually, and this variability is reflected in the B-IBI. Much of the problem in the Potomac River is severe oxygen depletion in the lower deep mainstem (CBBMP, 2004).

2.6.1.2.4 Lower Bay

It is generally accepted that the Lower Bay is a more stable environment than the Upper Bay since it has relatively stable temperature and salinity. The influence of relatively pristine ocean water in this region helps mitigate water quality impacts. Consequently, the Lower Bay has a greater proportion of equilibrium benthic species. Equilibrium species are generally large, relatively long-lived organisms that often dominate community biomass in undisturbed or unstressed habitats.

There are 12 fixed benthic monitoring sites in the Virginia Bay mainstem or tributaries that are close to areas dredged by USACE: Stations CB5.4 (Upper VA deep mainstem); CB6.1 (VA mainstem); CB6.4 (VA mainstem); CB7.3E (VA deep mainstem); CB8.1 (VA mainstem); LE4.3 (York River polyhaline); LE4.3B (York River deep polyhaline); LE5.1 (James River oligohaline); LE5.2 (James River mesohaline); LE5.4 (James River polyhaline); SBE2 (Elizabeth River); SBE5 (Elizabeth River) (Figure 2-1). Several additional VA fixed stations are monitored in the various tributaries, and additional details about these sites are provided in Table 2-1. More than 40% of the stations meet or exceed Bay Restoration Goals. None of the stations are designated as “severely degraded.” Additional details about these sites are provided in Table 2-1.

Probability-based stations in the James and York Rivers had excess abundance, excess biomass, or both in more than 23% of the sites failing Restoration Goals from 1996 to 2002. Goal failure in the York River may be linked to both excess nutrients and physical disturbance of the sediments. In the James River, patterns in benthic community condition among years are partially explained by the clumping of samples in areas with local contamination problems (CBBMP, 2004).

2.6.1.3 *Site-Specific Benthic Investigations*

Although comprehensive benthic investigations have not been conducted throughout each of the four Bay areas specifically for this EIS, site-specific investigations in each of the four areas were conducted as part of previous reconnaissance studies and environmental impact statements for various dredging projects in the Bay. The results of these investigations are briefly summarized here. Note that these discussions are limited to noncommercially important benthic species. Results of oyster and soft-shell clam investigations are presented in Sections 2.6.2 and 2.6.3, respectively.

2.6.1.3.1 Upper Bay

Environmental conditions assessments were conducted in the Upper Bay as part of reconnaissance studies for proposed dredging-related placement/habitat restoration projects: Lower Eastern Neck Island LENI (EA, 2003b); Parsons Island (EA, 2003g); and Site 104 in Queen Anne's County, Maryland (CENAB, 1999c). Observations made during these three environmental assessments are reviewed below to characterize the benthic composition of the Upper Bay.

A variety of organisms typical of mesohaline mud/sand were recorded in the vicinity of Parsons Island and LENI. Tubificid oligochaetes, *Littoridinops tenuipes (*coastal marsh snail*)*, the polychaete *Heteromastus filiformis* (capitellid thread worm), and the amphipod *Leptocheirus plumulosus* were the most commonly observed species. The clam *Gemma gemma* (amethyst gem clam) and the polychaetes *Heteromastus filiformis* and *Streblospio benedicti* (spionid worm) were the most common observed at the remaining two stations. The commercially important soft-shell clam, *Mya arenaria*, was also present, but would not be expected to be abundant in typical benthic grab samples, because they are large and strong enough to evade the sampling gear.

Site 104 lies in the seasonally variable oligohaline to high mesohaline region of the Chesapeake Bay in Maryland. Benthic macroinvertebrate species diversity and distribution are lower in the Site 104 vicinity than in areas farther south due to hypoxia/anoxia and the larger salinity and temperature fluctuations that occur. A high abundance of opportunistic species and a low abundance of equilibrium species were observed at all sampling stations. The equilibrium species found during this sampling event consisted of annelids *Glycera* sp., *Marenzelleria viridis*, and clams *Mya arenaria* and *Rangia cuneata* (brackish water clam). The most abundant opportunistic species found consistently at all stations were from the Phylum Annelida, and included *Streblospio benedicti*, *Capitella* spp., and *Hypereteone heteropoda*.

2.6.1.3.2 Baltimore Harbor

According to the Harbor EIS (CENAB, 1997), pollution in the Harbor is having a negative impact to biological resources, but impacts are not as great as in the past. The current benthic macroinvertebrate community in the Harbor is substantially poorer in biomass and species diversity when compared to other areas in the Chesapeake Bay. Two major conditions suggested to be limiting the success of the benthic community were poor substrate and high frequency of disturbance from harbor traffic. Other stressors include hypoxia/anoxia and contaminated sediments. The benthos observed consisted mainly of ephemeral, surface-dwelling opportunistic species in the region of the anchorages, while longer-lived, deep-dwelling species were absent. Similar observations were presented in a recent Environmental Assessment conducted as part of a Reconnaissance Study for upland placement of Harbor dredged material (EA, 2003c).

2.6.1.3.3 Middle Bay

Site-specific surveys of benthic invertebrates were conducted as part of environmental conditions assessments for dredging-related projects in the vicinity of James Island (EA, 2003d) and PIERP (EA, 2003e).

Benthic sampling was conducted at James Island in 2001 and 2002. In general, the benthic community is typical of this area of the Bay and was dominated by a single species, the gem clam (*Gemma gemma*), at most stations. Annelids were the second most dominant group found at the benthic stations. The dominant annelids were the polychaetes *Glycinde solitaria* (chevron worm), *Streblospio benedicti,* and *Neanthes succina* (common clam worm). The majority of the species collected were stress-tolerant, resulting in low B-IBI scores at most locations (EA, 2003d).

Benthic collections were conducted for 10 locations around PIERP in 2001. Overall, total B-IBI scores were low (ranging from 1.8 to 2.2) for almost all stations. Only two stations were considered as meeting the 3.0 Bay Restoration Goal. Bivalvia and gastropoda were the most dominant groups found at the benthic stations. The dominant bivalve was the clam *Gemma gemma* and the dominant gastropod was the snail *Acteocina canaliculata.* The dominant annelids were the polychaetes *Glycinde solitaria* and *Mediomastus ambiseta.* Both of these polychaetes are pollution sensitive taxa (EA, 2003e).

2.6.1.3.4 Lower Bay

Discussions of benthic invertebrate resources (i.e., noncommercially important species) were not presented in available dredging studies (CENAO, 1985; CENAO, 1994). Location-specific species composition, biomass, and trends of benthic organisms in the Lower Bay are available from the Chesapeake Bay Benthic Monitoring Program at both fixed and probabilistic monitoring stations (CBBMP, 2004).

2.6.2 Oysters

For hundreds of years, eastern oysters (*Crassostrea virginica)*, also called the American or Atlantic oyster, were among the most abundant bivalves and the most commercially important fishery resources in the Bay. Oysters were once plentiful enough in the Chesapeake Bay that seasonal harvests were in the millions of bushels. During the 1950s, approximately 35 million pounds of oysters were harvested annually. Oyster landings in the Chesapeake Bay have experienced a 95% decline since 1980, and are estimated to be at their lowest recorded level. Oyster harvests are now tallied in terms of thousands of bushels (Kennedy, 1991; Jordan et al., 2002).

Over-harvesting, dwindling habitat, pollution, and diseases are all responsible for the dramatic decline in oyster populations. Historic overharvesting removed huge volumes of large oyster shells, and destroyed reef habitats and suitable sites for oyster spat settlement. In fact, current oyster harvests show that much of what was classified as productive oyster bottom at the turn of the century is no longer capable of producing an economically viable harvest (MD DNR, 1997). Pollution, particularly suspended solids and eutrophication, have further limited the quality and quantity of available habitat; however, the biggest challenge to oyster populations in the Chesapeake Bay is the impact of disease. There are at least 14 different diseases and parasites documented for the eastern oyster; however, two oyster protozoan parasites, *Perkinsus marinus* (Dermo) and *Haplosporidium nelsoni* (MSX), are currently the major sources of oyster mortality in the Chesapeake Bay. MSX thrives in higher salinity brought on by dry years. Dermo tolerates lower salinity, and is more damaging to the oyster population.

The American oyster has long been considered one of the Bay's keystone species. Oysters perform valuable ecosystem benefits by consuming algae and other water-borne nutrients by filtering water at a rate of up to 5 liters per hour (CBP, 2004d). Oyster reefs historically provided the only available hard bottom habitat for numerous species, such as worms, snails, sea squirts, sponges, small crabs, and fishes. Today there are essentially no oyster reefs remaining in the Bay. The oyster usually lives in water depths of between 8 and 25 ft. Seasonal deficiencies in dissolved oxygen in Bay waters prevent their establishment in most waters 35 ft deep.

2.6.2.1 *Monitoring and Restoration*

Oyster populations are distributed patchily over more than 400,000 acres in the Chesapeake Bay, so it is difficult to assess their absolute numbers or biomass. Traditionally, landings data have been used as a means of estimating populations trends. It has been predicted that oyster populations have decreased approximately 99% (Newell and Ott, 1999). Historic natural oyster bar information is available (e.g., MD DNR, 1997; Woods et al., 2004). A long-term monitoring program in Maryland has recorded relative numbers and size distributions of oysters annually; 43 fixed sites have been monitored consistently since 1990, with many records from these sites available from earlier years. An extensive monitoring program is also conducted by the Virginia Institute of Marine Sciences (e.g., Southworth et al., 2004).

Intensive oyster restoration efforts are currently underway in the Bay. A Chesapeake Bay Oyster Fishery Management Plan was adopted in 1989 and revised in 1994. The final Chesapeake Bay Program Oyster Management Plan (OMP) was completed in December 2004. The Corps of Engineers expects to have a draft Oyster Program document during the winter of 2005. Most recently, the Chesapeake 2000 Agreement was adopted, which is a renewed and better-coordinated effort to address the commitment of achieving the oyster restoration goal of a minimum of a tenfold increase in native oysters by 2010.

According to the U.S. Army Corps of Engineers Norfolk District Web site, both the Norfolk and the Baltimore Districts are working with the Virginia Institute of Marine Science and the Chesapeake Bay Foundation to address all oyster-related activities in Maryland and Virginia Chesapeake Bay waters with the aim of meeting the Chesapeake 2000 agreement's goals. The plan specifies oyster reef project sites distributed around the Bay and its tributaries.

MD DNR currently has 24 oyster sanctuary areas (i.e., areas protected from harvesting) throughout the Bay. Sanctuary bars range in size from around 5 acres to over 5,800 acres. The entire Severn and Magothy Rivers are examples of two of the larger sanctuaries. In addition, reserves are areas where restoration efforts are done and next the site is closed like a sanctuary for a period of 5 years. Next, the site is opened for a managed harvest, and then when the set amount is harvested from the site, the site will be closed again. There are currently 19 reserves in Maryland (MD DNR, 2004g).

Oyster landings data from 1990 through 2002 have been obtained and tabulated from MD DNR (MD DNR Fisheries Service, 2004k) and the Virginia Marine Resource Commission (VMRC, 2004) for each of the four Bay areas. Landings are grouped and reported yearly as sales from specific subregions. Figure 2-2 shows the approximate locations of oyster bars, public oyster grounds, and oyster restoration sites in the Chesapeake Bay.

2.6.2.2 *Upper Bay*

Oyster landings for two subregions of the Upper Bay are provided in Table 2-2. The Upper Bay supports a substantial oyster fishery worth an average (1990-2002) of over $360,000 annually, although yearly catch size is quite variable and is trending downward. Approximately 115,000 pounds of oysters were collected in the 2002 season (following a catch of only 30,000 pounds in 2001). The northernmost portion of the Upper Bay does not support a substantial oyster population, as shown in Figure 2-2.

Several of the 11 historical oyster bars surrounding LENI are productive in terms of oyster growth; however, these bars must be seeded annually with bed oysters because reproduction rates are low or nonexistent. Harvest data are not recorded for individual bars near LENI, but they are fished and contribute to the harvest figures of the lower Chester River region (EA, 2003b).

Parsons Island is also surrounded by productive oyster bars in waters deeper than 8 ft. MD DNR plants shells in the beds to the south and southwest of the island to encourage the production of seed oysters, which are collected and used to seed other areas in the Oyster Recovery Program (EA, 2003g).

There are six oyster bars known to exist in the vicinity of the Site 104; however, a portion of the area is prohibited to shellfish harvesting because of the presence of the Kent Island Waste Water Treatment Plant outfall. Broad Creek is directly adjacent to the eastern boundary of Site 104 and is actively harvested, although it is not naturally reproducing and requires annual seeding by MD DNR (CENAB, 1999c).

2.6.2.3 *Baltimore Harbor*

No Natural Oyster Bars exist near any of the areas studied and no commercial harvesting of oysters or soft clams occurs within the Harbor Channels (CENAB, 1997).

2.6.2.4 *Middle Bay*

Oyster landings for the Middle Bay are listed in Table 2-2. Although still productive oyster beds, oysters in the Middle Bay are greatly impacted by disease and many beds require seeding. The Middle Bay supports a substantial oyster fishery worth an average (1990-2002) of over $420,000 annually, although yearly catch size is quite variable and is trending downward. Approximately 130,000 pounds of oysters were collected in the 2002 season (following a catch of only 14,500 pounds in 2001). Numerous oyster restoration sites are located within the Middle Bay, as shown in Figure 2-2.

2.6.2.5 *Lower Bay*

Oyster landings for the Lower Bay are listed in Table 2-2. Although still productive oyster beds, oysters in the Lower Bay are greatly impacted by disease, and harvests are much lower than historical levels. The Lower Bay oyster fishery was worth an average (1990-2002) of approximately $80,000 annually, although yearly catch size is quite variable and is trending downward. Approximately 18,500 pounds of oysters were collected in the 2002 season (following a catch of 37,400 pounds in 2001).

The USFWS reports that there is little if any commercial harvest of oysters around Ragged Island in the James River, partially due to disease. Others sections of the James River within the vicinity of Mulberry Island were designated as the most productive oyster fisheries in the Lower Bay (CENAO, 1994).

The Conservation and Replenishment Department of the Virginia Marine Resources Commission is responsible for the management and replenishment of the public oyster grounds in Virginia. The spreading of shell as oyster setting substrate, rejuvenation of old oyster beds using dredges, creation of oyster reefs for optional oyster habitat, and the movement of oysters from seed areas to grow-out areas are some of the restoration activities taking place (VMRC, 2003).

2.6.3 Soft-Shell Clams

The soft-shell clam (*Mya arenaria*) is a commercially important shellfish species in the Bay. The soft-shell clam is usually found in substrate mixtures of sand and mud, in shallow parts of mesohaline portion of the Bay. Optimal areas for soft-shell clams are found on the Eastern Shore of the Pocomoke Sound to Eastern Bay, and on the western side from the Rappahannock River to the Severn River (CENAB, 1999c). See Figure 2-3 for map of areas with high soft-shell clam abundance.

Soft-shell clams feed on small detrital particles, phytoplankton, small zooplankton, and bacteria (CBP, 2004e). Most of the predation on soft clams occurs during the larval and juvenile stages. In addition to being a commercially important species, soft-shell clams have an ecologically important role in the food chain. Clam larvae are an important food source for larger planktonic organisms, including larval fish, jellyfish, and comb jellies. Crabs, eels, finfish, waterfowl, muskrats, and raccoons prey on juveniles and mature clams.

Soft-shell clam abundance has decreased from historical levels. In addition to fishing mortality and predation, populations are affected by several pathological conditions, including disseminated neoplasia (DN) and *Perkinsus* sp. protozoan infections. Clam population and disease status assessments conducted in 2001 found that infection levels of *Perkinsus* sp. in soft-shell clams greatly varied among regions with severe levels found on some sites in Eastern Bay, the Chester River, and in the Patuxent River (Homer, 2003).

2.6.3.1 *Monitoring*

The soft-shell clam has supported an important commercial fishery in the Maryland portion of Chesapeake Bay since the early 1950s, when harvesting by hydraulic escalator dredge began. Landings over the past 9 years show levels less than 1% of peak landings (680,000 bushels [bu]) from the 1960s. See Table 2-3 for landings of soft-shell clams by year for each of the four Bay areas.

Maryland and Virginia commercial landings surveys provide Baywide abundance and distribution data for commercially important fisheries species, including soft-shell clams. The Chesapeake Bay Benthic Monitoring Program also records abundance and distribution information for benthic macroinvertebrates, including soft-shell clams. When a specific project site is designated for dredged material placement, these sources should be consulted for site-specific data of the soft-shell clam.

2.6.3.2 *Upper Bay*

Soft-shell clam landings data for two subregions of the Upper Bay are provided in Table 2-3. Subregion NOAA 025 stretching from Bay Bridge north to Pooles Island supports a substantial soft-shell clam fishery worth an average (1990-2002) of over $950,000 annually, although yearly catch size is quite variable and is trending downwards. Commercial clamming landed 119,292 pounds of clams in the 2002 season. The portion of the Upper Bay north of Pooles Island does not sustain a soft-shell clam fishery.

The Chester River/Rock Hall area represents the uppermost extension of the soft-shell clams on the Eastern Shore. Communication cited in the LENI study confirmed that commercial clamming occurred in this area (EA, 2003b). Clamming is not permitted close to Parsons Island to protect the existing productive oyster beds (EA, 2003g).

Soft clamming activity was documented to occur near the boundaries of Site 104. However, clamming in parts of Site 104 is prohibited because it is near a closure zone around the Kent Island Wastewater Treatment Plant (WWTP) outfall. This study indicated that no soft clams are harvested within the Site 104 boundaries because most of the site is too deep to support the resource (CENAB, 1999c).

2.6.3.3 *Baltimore Harbor*

Baltimore Harbor is a restricted shellfish area. Therefore, no commercial soft clam harvesting occurs within the Harbor Channels (CENAB, 1997). Consequently, landings were not recorded in subregion NOAA 066 between 1990 and 2002.

2.6.3.4 *Middle Bay*

Soft-shell clam landings data for two subregions of the Middle Bay are provided in Table 2-3. The clamming harvest in subregion NOAA 027 of the Middle Bay mainstem closely matches that of the Upper Bay. Annual landings are variable, but have generally decreased since 1993. Commercial clamming landed 86,448 pounds over the 2002 season, worth a market value of $333,515.

No soft-shell clams were collected in the vicinity of Barren Island for the last decade, and the closest clamming activity for soft-shell clams is located south of the Island. Information on the health and productivity of soft-shell clams in the vicinity of Barren Island was not available (WESTON, 2002a).

Two of the 10 Benthic Monitoring Program stations sampled at James Island had soft-shell clams (EA, 2003d). There has also been little to no clamming activity in the Holland Island vicinity in the past, although specific data are not kept for the island (Baker, 2003). Studies in the vicinity of PIERP indicated that soft clamming was among the most important commercial harvests for Talbot County, but that densities may be somewhat depressed in the immediate area of the site (CENAB, 1996).

2.6.3.5 *Lower Bay*

Commercial soft-shell clam harvest is expected to occur in the Lower Bay region; however, landings data were not provided by VMRC (VMRC, 2004).

2.6.4 Blue Crab

It is widely recognized that the blue crab, *Callinectes sapidus*, symbolizes the life and culture of the Chesapeake Bay region. The blue crab is both commercially and ecologically important. The Chesapeake Bay is the largest producer of crabs in the country; it is estimated that more than one-third of the nation's catch of blue crabs comes from Bay waters. Annual commercial landings have averaged approximately 39 million pounds since 2000 (CBP, 2004e).

Blue crabs are classified as general scavengers: bottom carnivores, detritivores, and omnivores. At different stages of development, they serve as both prey and as consumers of plankton, benthic macroinvertebrates, fish, plants, mollusks, crustaceans, and organic debris. As larvae, they are vulnerable to fish, jellyfish, shrimp, and other planktivores. Juvenile crabs are consumed by various fish and birds, as well as other blue crabs. Predators of adult crabs include American eels, predatory fish, sea turtles, herons and egrets, various diving ducks, raccoons, and humans.

Blue crabs are found from the mouth of the Chesapeake Bay to tidal freshwater areas. Crabs utilize nearly every habitat type during some stage of their life cycles. Juvenile and soft-shell adult crabs often hide in SAV beds for protection. Mating occurs from June to October generally in shallow water of the middle and Upper Bay areas. During winter, female crabs will remain in the higher salinity waters of the Lower Bay, whereas males will remain in the upper portions, migrating to deeper waters to spend the colder months.

2.6.4.1 *Monitoring and Restoration*

There are four major sources of information concerning blue crab populations of the Chesapeake Bay: Maryland Trawl and Commercial Landings Surveys; Virginia Trawl and Commercial Landings Surveys; MD DNR Winter Dredge Survey, and the Blue Crab Advisory Report produced by the Chesapeake Bay Stock Assessment Committee (CBSAC). When a specific project site is designated for dredged material placement, one or more of these sources should be consulted for site-specific crabbing data. Interviews with natural resource police and/or commercial fishermen would also provide site-specific information on productive crabbing areas.

Trawl and Commercial Landings Surveys provide Baywide abundance and distribution data for fisheries species including blue crabs. Mandatory reporting of commercial landings replaced voluntary reporting for Maryland in 1981, and for Virginia in 1993. In a cooperative effort with the Virginia Institute of Marine Science (VIMS), the MD DNR conducts the Chesapeake Bay Winter Dredge Survey. Winter surveys produce indices of recruitment and spawning potential in addition to estimates of abundance and commercial exploitation. The Bay is divided into three sampling strata: Lower Bay, Middle Bay, and the Upper Bay/Tributaries. A total of 1,500 randomly selected and 125 fixed sites are sampled each year (MD DNR, 2004d).

The CBSAC Blue Crab Advisory Report is based on data from trawl surveys, Calvert Cliffs peeler pot survey, and the Baywide winter dredge survey. In 2004, the committee reports that the 3-year (2001-2003) average Baywide commercial harvest (50 million pounds) was 32% below the long-term (1968-2003) average of about 73 million pounds. The average abundance of exploitable (Age 1+) crabs during this period was below average for all four surveys. For the seventh consecutive year, low abundance combined with a high exploitation rate indicated a stock condition that warrants concern. According to the report, however, current low harvest levels may also be the result of conservative crabbing restrictions instituted since 2001 (NOAA, 2004a).

2.6.4.2 *Upper Bay*

The upper Chesapeake Bay supports a substantial commercial blue crab industry worth an average (1990-2002) of $3.7 million annually; however, the annual commercial blue crab harvest has generally decreased since the 10-year high (7,449,848 pounds) recorded in 1995. Commercial crabbing landed only 2,557,737 pounds over the 2002 season, bringing in the lowest market value of $2,486,761. The 3-year (2000-2002) average commercial harvest of 2,655,837 pounds was roughly half of the long-term (1990-2002) average and nearly one-third the weight recorded in 1995.

The blue crab supports the dominant commercial fishery in the vicinity of LENI. Male and juvenile blue crabs are known to overwinter in the Maryland Upper Bay (EA, 2003b). No crabbing activity was observed during the site visit to Parsons Island, although moderate densities exist in the Eastern Bay (EA, 2003g). Due to the depth, Site 104 is not highly utilized by commercial crabbers. Blue crabs utilize this site and other similar deeper areas of the Bay to overwinter (CENAB, 1997).

2.6.4.3 *Baltimore Harbor*

The Harbor Channels support a small commercial crabbing industry, producing an average (1990-2002) of 165,810 pounds annually, but amounting to less than 2% of the Baywide average of 9,497,514 pounds. Commercial landings show a 10-year decreasing trend, although annual values are highly variable.

Blue crabs are known to occur in the Harbor Channels and are commercially harvested at this location. MDE has issued a consumption advisory for blue crabs for the entire Patapsco River, including the Baltimore Harbor. This advisory recommends the maximum allowable yearly fish consumption by humans from selected waters. Harbor harvests represent a minimal part of the total Bay harvest of blue crabs. According to this study, the Harbor is not considered a significant blue crab overwintering area and is expected to have even lower densities than other areas of the Bay of similar depth (CENAB, 1997).

2.6.4.4 *Middle Bay*

The Middle Bay area supports the second largest commercial harvest of the four areas; however, the three year (2000-2002) average landing (8,876,749 pounds) is less than 70% of the long-term average. Landings data show a general decreasing trend between 1990 and 2002, although there is high amount variation among years. Commercial landings contributed $9,355,693 to the Middle Bay industry in 2002.

Specific harvest information for the footprint of Barren Island was not available; however, the study indicated that crabbing does occur within the vicinity of the island. The shallow water habitat around Barren Island supports significant SAV beds that are favored as blue crab habitat (WESTON, 2002a). James Island is also surrounded by shallow water with scattered SAV beds. James Island is located within an area known to support high densities of male blue crabs in the summertime. The surrounding waters of the island support both hard and soft crabbing industries. During all site visits to the island, commercial crab pot fields were observed (EA, 2003d).

Crab pots were observed during the 27 September 2001 site visit along the northwest side of Middle and North Holland Island. In general, however, the size of the blue crab harvest from the Holland Island vicinity has been decreasing (Baker, 2003). The size of the blue crab harvest is also generally declining in the vicinity of Sharps Island (AMA, 2002). Commercial crabbing is said to regularly occur in the waters surrounding the PIERP archipelago (EA, 2003g).

2.6.4.5 *Lower Bay*

Landings data indicate that the Lower Bay has the highest average annual (1990-2002) crabbing harvest of all four Bay areas. Like other areas of the Bay, however, landings data show a decreasing trend over the 10-year period. Commercial crabbing landed 16,504,391 pounds over the 2002 season, with a market value of $12,721,293.

2.6.5 Finfish

More than 295 species of fish are known to occur in the Chesapeake Bay region (USFWS, 2004b). Of these fish species, only 32 species are year-round residents of the Bay. The remaining species enter the Bay either from freshwater streams or the Atlantic Ocean to feed, reproduce, and find shelter. Highly abundant species such as the Bay anchovy (*Anchoa mitchilli*) form a critical link in the food web, serving as the dietary basis for other species, including a variety of birds and mammals. Many other species, including striped bass, and the Atlantic menhaden (*Brevoortia tyrannus*), support a multimillion-dollar commercial fishing industry. Commercially important species and current Bay monitoring and regulatory programs for finfish are discussed in more detail below.

Spatial and temporal distributions and relative abundance of common bay fish are provided in a 1994 NOAA publication entitled *Distribution and Abundance of Fishes and Invertebrates in Mid-Atlantic Estuaries*. Table 2-4 lists the temporal distribution and relative abundance of 41 species of finfish for the Chesapeake Bay mainstem (NOAA, 1994). Life history information for common finfish species is readily available from VIMS (VIMS, 2004b).

When a specific project site is designated for dredged material placement, site-specific information regarding finfish should be collected.

2.6.5.1 *Commercially Important Finfish*

The Chesapeake Bay has been ranked as third in the nation in fishery landings. Only the Atlantic and Pacific Oceans exceed the Bay in production. Fish species including striped bass and the Atlantic menhaden support a multimillion-dollar commercial fishing industry. Maryland's commercial fishing industry alone harvested an average (2000-2002) of over 13 million pounds of fish annually, at a dockside value of $7.3 million (Maryland State Archives, 2004).

Most commercial fisheries of the Bay are regulated at the federal level under a number of environmental protection statutes including the Endangered Species Act, Fish and Wildlife Coordination Act, Anadromous Fish Conservation Act, Atlantic Coastal Fisheries Cooperative Management Act, Atlantic Striped Bass Conservation Act, Magnuson Fishery Conservation and Management Act, National Oceanic and Atmospheric Administration Marine Fisheries Program Authorization Act, Interjurisdictional Fisheries Act, and Emergency Wetlands Resources Act.

Under these statutes, finfish of the Chesapeake Bay are monitored and protected by a number of federal, state, and public entities. The Atlantic States Marine Fisheries Commission (ASMFC) and Mid-Atlantic Fishery Management Council (MAFMC) manage and protect fish species inhabiting the Atlantic coastal waters, many of which migrate into the Chesapeake Bay. USFWS biologists at the Chesapeake Bay Field Office work to protect endangered and threatened species, freshwater and anadromous fish, and aquatic habitats. MD DNR and VADEQ preserve, protect, and restore their respective state's natural resources through law enforcement, monitoring, education, and management.

A number of sources are available for information concerning the distribution, abundance, and stability of commercial finfish populations throughout the Bay. The MD DNR and Virginia Marine Resources Commission (VMRC) conduct seine and trawl surveys to monitor the annual recruitment of some juvenile fish species and produce indices of species abundance. Maryland's Striped Bass Stock Assessment Survey uses drift gillnet sampling to assess the status of spawning adult population. The NOAA-National Marine Fisheries Division provides Baywide summaries of recreational and commercial fishery trends, stock assessment information, and commercial and recreational fisheries landings data. When a specific project site is designated for dredged material placement, these sources may be consulted for specific data of the local commercial fishery.

Species-specific fisheries management plans also may serve as an information source for the distribution and life history of commercially important species. There are 13 federally managed species in the mid-Atlantic, as listed in Table 2-5, which are managed by the MAFMC. Habitats of these species are subject to EFH protection under the Magnuson-Stevens Act of 1996 (see Section 2.6.6).

The following sections detail commercial finfish landings for each of the four areas within the Bay. Following these general discussions, information on finfish from specific areas within the four regions summarized from dredging-related environmental studies is briefly reviewed.

2.6.5.2 *Upper Bay*

The upper Chesapeake Bay supports a diverse commercial finfish industry. Table 2-6 provides commercial landings data for 20 finfish species designated as commercially important species by

MD DNR. Six key fish (Atlantic menhaden, American eel, yellow perch, white perch, striped bass, and catfish) make up more than 95% of the average (1990-2002) total annual harvest of over 1.4 million pounds. Landings data were provided by Connie Lewis of MD DNR (MD DNR Fisheries Service, 2004k).

Trawling and gillnetting surveys conducted adjacent to Parsons Island from 1978 to 1980 recorded a finfish population dominated by spot (*Leiostomus xanthurus*), four-spine sticklebacks (*Apeltes quadracus*), silversides (*Menidia* spp), killifish species (*Fundulus* spp.), and winter flounder (*Pseudopleuronectes americanus*). The study concluded that vegetated bottoms near Parsons Island did not support substantially larger numbers of fish relative to the unvegetated area. Qualitative gillnet surveys indicated that bluefish (*Pomatomus saltatrix*), Common carp (*Cyprinus carpio*), Spot, Atlantic menhaden (*Brevoortia tyrannus*), and cow-nosed rays inhabit the area. Of the seven species of concern expected in the area, only bluefish and summer flounder were collected during trawling and gillnetting surveys of the area (EA, 2003g).

2.6.5.3 *Baltimore Harbor*

The Harbor Channels supports a small commercial finfish industry worth an average (1990-2002) of $25,137 annually. Table 2-7 provides commercial landings data for 14 finfish species designated as commercially important species by the MD DNR. Five key species (Atlantic menhaden, American eel, yellow perch, white perch, and striped bass) make up 95% of the average (1990-2002) total annual harvest of over 24,800 pounds. Landings data were provided by Connie Lewis of MD DNR (MD DNR Fisheries Service, 2004k).

Because of reduced water quality and degraded benthic habitat in the Harbor area, the abundance and diversity of finfish in the project area is also expected to be low. Anadromous species, particularly alewife (*Alosa pseudoharengus)* and blueback herring *(Alosa aestivalis*) migrate through the Patapsco subestuary en route to and from spawning areas in the upper nontidal section of the river. Anadramous fish restoration efforts have been made in the Harbor to help reinvigorate the spawning run. Previous studies have concluded that the Harbor provides nursery and adult habitat for a number of fish species (CENAB, 1997).

2.6.5.4 *Middle Bay*

The Middle Bay region also supports a diverse commercial fishing industry. Table 2-8 provides commercial landings data for the 19 commercially important finfish species designated by the MD DNR. Five key fish (Atlantic menhaden, American eel, white perch, striped bass, and catfish) make up more than 90% of the average (1990-2002) total annual harvest of over 701,257 pounds. Landings data were provided by Connie Lewis of MD DNR (MD DNR Fisheries Service, 2004k).

Two sampling techniques, bottom trawl and beach seining, were employed at 10 locations to collect adult and juvenile fish species around James Island in June 2002. There were no differences in the number of fish species collected inside and outside of the SAV beds. The lack of diversity found in the trawl collections can be attributed to the lack of diversity of bottom types in the area. It was suggested that these areas were likely used for foraging, but lack other habitat features that would cause fish to linger. According to this study, consultations with the National Marine Fisheries Service (NMFS) have indicated that bluefish, summer flounder, and red drum are the federally managed species of particular concern in the vicinity of James Island (EA, 2003d).

Several pound nets were observed south and west of Holland Island during the site visit in September 2001. Commercial fishing for finfish does not take place directly adjacent to Holland Island due to extremely shallow water. Common fish species in the Holland Island vicinity include the Atlantic menhaden (*Brevoortia tyrannus*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), spot (*Leiostomus xanthurus*), and weakfish or gray seatrout (*Cynoscion regalis*) (Baker, 2003).

No specific fish data were available from the Sharps Island study. Of the nine managed species of concern in the area, only bluefish, summer flounder, Spanish mackerel, and red drum were expected to occur near the island. According to this study, pound net and drift gill net fishermen catch a broad variety of fish in the area (AMA, 2002).

Surveys by the Maryland Natural Resources Police (MNRP) have identified fishing for weakfish (*Cynoscion regalis*), Atlantic menhaden, Atlantic croaker (*Micropogonias undulates*), summer flounder, and spot (*Leiostomus xanthurus*) in the vicinity of Barren Island. The MNRP indicated that 4-pound nets for commercial fishing are regularly deployed on the west side of Barren Island, in the area locally called "Barren Island Grounds." MNRP estimated that there are eight potential pound nets sites in this stretch, though only four were actively used. MNRP have confirmed that commercial fishing of menhaden, rockfish, and summer flounder is conducted west of Barren Island (WESTON, 2002a).

A seasonal monitoring study was conducted at PIERP using bottom trawl and beach seining techniques in fall 1994 through summer 1995 (EA, 2003e). Results of this study indicated that a total of 25 species were collected, and the bay anchovy, Atlantic silverside, and Atlantic menhaden were most abundant during different sampling seasons. Bluefish and summer flounder were the only managed species of concern collected during fishery surveys of the area in the mid-1990s. However, red drum juveniles were collected in the Poplar Island archipelago in 2001 (NOAA, 2001) and 2004 (EA, 2004b). There are several licensed pound nets in the vicinity of PIERP, and some are still actively fished.

2.6.5.5 *Lower Bay*

The Lower Bay region also supports a diverse commercial fishing industry (VIMS, 2004a). Table 2-9 provides commercial landings data for 34 Lower Bay species, commercially important in terms of harvest quantity and/or value. Although gaps in the available data make it difficult to assess trends in these data, general observations can be made concerning average harvest biomass and market value. Eleven species (striped bass, menhaden, bluefish, dogfish spp., summer flounder, mullet, minnow spp., spotted seatrout, tautog, ribbonfish, Atlantic herring) yielded the highest average (1990-2002) annual market value of the Lower Bay. The menhaden, spot, and Atlantic croaker have the largest average (1990-2002) annual harvest biomass. Landings data were provided by VMRC (VMRC, 2004).

2.6.6 Essential Fish Habitat

In 1976, and later amended in 1986, the Magnuson Fishery Conservation and Management Act (Magnuson Act) established a management system for the marine fishery resources of the United States. The Magnuson Act requires each of the eight Regional Fishery Management Councils (Councils) to evaluate the effects of habitat loss or degradation on their fishery stocks and take actions to mitigate damage. Recognizing the importance of fish habitat to the productivity and sustainability of U.S. marine fisheries, Congress added habitat conservation provisions to the Act in 1996.

The renamed Magnuson-Stevens Act of 1996 calls for direct action to stop or reverse the continued loss of fish habitats, and mandates the identification of Essential Fish Habitat (EFH) for managed species of marine, estuarine, and anadromous finfish, mollusks, and crustaceans. Essential Fish Habitat is broadly defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Act requires the Councils to describe and identify the essential habitat for their managed species, minimize to the extent practicable adverse effects on EFH caused by fishing, and identify other actions to encourage the conservation and enhancement of EFH.

The Act also establishes measures to protect EFH. Federal agencies, such as USACE, must consult with NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. In turn, NMFS must provide recommendations to federal and state agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, or mitigate adverse effects on EFH resulting from the proposed action. The Magnuson-Stevens Act requires cooperation among NOAA's NMFS, Regional Fisheries Management Councils, fishing participants, federal and state agencies, and others to achieve EFH protection, conservation, and enhancement.

EFH has been identified within some parts of the Chesapeake Bay and its tributaries for 16 species (NOAA, 2004b). The tables in Appendix D contain a brief life history description and habitat requirements for each life stage for each species. Fish species with EFH in the Bay are as follows:

- Atlantic butterfish (*Peprilus triacanthus*)
- Atlantic sea herring (*Clupea harengus*)
- Atlantic sharpnose shark (*Rhizopriondon terraenovae)*
- Black sea bass (*Centropristus striata*)
- Bluefish (*Pomatomus saltatrix*)
- Cobia (*Rachycentron canadum*)
- Dusky shark (*Charcharinus obscurus*)
- King mackerel (*Scomberomorus cavalla*)
- Red drum (*Sciaenops occelatus*)
- Red hake (*Urophycis chuss*)
- Sandbar shark (*Charcharinus plumbeus*)

- Sand tiger shark (*Rhizopriondon terraenovae*)
- Scup (*Stenotomus chrysops*)
- Spanish mackerel (*Scomberomorus maculatus*)
- Summer flounder (*Paralicthys dentatus*)
- Windowpane flounder (*Scopthalmus aquosus*)

Fish species with EFH for the mainstem of the Chesapeake Bay in both Maryland and Virginia are listed in Table 2-10. This area encompasses the mainstem of the Bay in the Upper Bay, Middle Bay, and Lower Bay areas defined by the DMMP. Because of the lower salinity content and differing habitat, fish species with EFH for tributaries to the Bay are different from that of the mainstem. The fish species with EFH for tributaries in Maryland are listed in Table 2-11. Similarly, fish species with EFH designations for James River are listed in Table 2-12. Lastly, Table 2-13 lists the fish species with EFH for the southernmost portion of the Lower Bay at the mouth of the Chesapeake Bay. The mouth of the Bay includes several highly migratory shark species not present in other Bay areas.

Information presented in Tables 2-10 through 2-13 was summarized from NOAA's online *Guide to Essential Fish Habitat Designations in the Northeastern United States* (NOAA, 2004c). Note that these EFH summaries are to serve only as a guide for EFH designations. If a specific project site is selected, additional consultation with NMFS is required. NMFS's *Guide to Essential Fish Habitat Descriptions* lists the specific regulatory boundaries for most federally managed species (NMFS, 2001). The species tables from this document are provided in Appendix D and contain distribution and life history information for each species.

NMFS's EFH document referenced above does not contain EFH data on Highly Migratory Species (i.e., sharks). EFH for highly migratory species is detailed in a separate document (NMFS, 2003). Also note that NMFS is currently in the process of updating all EFH designations through an "Omnibus Amendment." EFH descriptions may change or be expanded as a result of this amendment. In addition to these references, NMFS suggests consultation of the texts *Fishes of Chesapeake Bay* (Murdy, 2002) or *The Chesapeake Bay in Maryland, an Atlas of Natural Resources* (Lippson, 1973) for additional life history and species range information.

In addition to EFH, some regions within the Bay have also been designated Habitat Areas of Particular Concern (HAPC). HAPC are those areas of special importance within EFH that may require additional protection from adverse effects. HAPC is defined on the basis of its ecological importance, sensitivity, exposure, and rarity of the habitat (Dobrzynski and Johnson, 2001).

The Mid-Atlantic Fisheries Management Council (MAFMC), the regional council that oversees the Chesapeake Bay, has designated HAPC for one of its managed species: summer flounder (MAFMC, 1998a). Specifically, the MAFMC designated SAV and macroalgae beds in nursery habitats as HAPCs for juvenile and larval-stage summer flounder; however, MAFMC's HAPC definition does not contain maps or geographic coordinates of the designated HAPC (Dobrzynski and Johnson, 2001). NMFS has also designated HAPC in the Chesapeake Bay for nursery and pupping grounds for one highly migratory species, the sandbar shark, but not for any other Atlantic highly migratory species. A map of the approximate HAPC locations for sandbar shark is available (Figure 10.4e; NMFS, 2003).

The South Atlantic Fisheries Management Council (SAFMC) has designated HAPC for red drum. Specifically, the SAFMC designated passes between barrier islands into estuaries as very important for the productivity of any estuary. Any rapid changes to this environment may cause stresses too great for red drum to withstand. The SAV within the Bay are also critical areas for red drum, particularly for 1- and 2-year-old fish (SAFMC, 2004).

2.6.7 Submerged Aquatic Vegetation

SAV is a diverse assembly of rooted macrophytes found in shoal areas of Chesapeake Bay, in geographic locations that span from its mouth to the headwaters of its tributaries (see Figure 2-4). SAV normally occurs in water depths to 10 ft, the depth to which light penetration generally permits the growth of rooted aquatic plants; however, because of increased turbidity, most SAV is currently found in water depths of 3 to 5 ft or less in the Bay, approximately equal to Secchi depth (Section 2.3) (Batiuk et al., 1992). The term "submerged aquatic vegetation" is used for both marine angiosperms (the so-called true seagrasses) and freshwater macrophytes that have colonized Chesapeake Bay and its tributaries. SAV encompasses 19 taxa from 10 vascular macrophyte families and 3 taxa from one freshwater macrophytic algal family, the Characeae, but excludes all other algae (CBP, 2003e).

2.6.7.1 *Ecological Role of SAV*

SAV plays an important ecological role within the aquatic environment of the Chesapeake Bay by providing food and habitat for waterfowl, fish, shellfish, and invertebrates. The grasses serve as a nursery habitat for many species of fish, such as juvenile striped bass or blue crabs, which seek refuge from predators in the grass beds. Additionally, SAV serves other important ecological functions within the Chesapeake Bay by producing oxygen in the water column as part of the photosynthesis process; filtering and trapping sediment that would otherwise increase turbidity and potentially bury benthic organisms, such as oysters; protecting shorelines from erosion by slowing down wave action; and removing excess nutrients, such as nitrogen and phosphorus, that could fuel unwanted growth of algae in the surrounding waters (Stevenson and Confer, 1978). As a result, SAV plays a key energy cycling role within the Chesapeake Bay.

2.6.7.2 *SAV as an Indicator of Ecological Health*

SAV has historically contributed to the high primary and secondary productivity of Chesapeake Bay (Stevenson and Confer, 1978). The strong link between water quality and SAV distribution and abundance (Batiuk et al., 1992) supports the concept that SAV is a good barometer of ecological health for the Chesapeake Bay (Orth and Moore, 1988).

The dramatic Baywide decline of all SAV species in the Chesapeake Bay during the late 1960s and 1970s (Orth and Moore, 1983) correlates with great increase in nutrient inputs from the surrounding watershed following World War II (Boesch, 2002), and with loss of oysters from disease and overharvesting (Newell and Ott, 1999). This situation galvanized diverse groups into formulating a policy and implementation plan that would ensure the future of SAV in Chesapeake Bay.

The 1987 Chesapeake Bay Agreement, signed by the governors of Pennsylvania, Maryland, and Virginia, the mayor of the District of Columbia, the chair of the Chesapeake Bay Commission, and the administrator of the U.S. EPA, set as a major commitment the "need to determine the essential elements of habitat quality and environmental quality necessary to support living resources and to see that these conditions are attained and maintained" (Chesapeake Executive Council, 1987). The *Submerged Aquatic Vegetation Policy for the Chesapeake Bay and Tidal Tributaries* (Chesapeake Executive Council, 1989) and the *Implementation Plan for the*

Submerged Aquatic Vegetation Policy (Chesapeake Executive Council, 1990) were developed to guide managers and scientists in areas of SAV assessment, protection, education, and research. The 1992 amendments to the 1987 Chesapeake Bay Agreement state, "*distribution and abundance of SAV as documented by baywide and other aerial surveys will be used as an initial measure of progress in the restoration of living resources and water quality*" (Chesapeake Executive Council, 1992). In 1993 the Chesapeake Bay Program (CBP) adopted a goal to restore SAV in Chesapeake Bay and its tidal tributaries to 114,000 acres. In 2003, this goal was revised upward, to achieve 185,000 acres by the year 2010. Achieving this goal depends on improving water quality to allow SAV to grow in more areas; protecting existing SAV; and restoring SAV to where it once grew (NOAA, 2003). Specific preservation and restoration initiatives adopted by the CBP to achieve the 2010 goal are available online at www.chesapeakebay.net/info/savrest.cfm.

2.6.7.3 *SAV Species and Distribution*

SAV surveys track the recovery of SAV in Chesapeake Bay, and guide protection and restoration efforts. SAV beds in Chesapeake Bay are mapped and measured annually by the Virginia Institute of Marine Science (VIMS) using aerial photography. The reports from 1994 onward are available through the VIMS Web site at www.vims.edu/bio/sav.

The distribution of SAV species in the shallow waters of the Chesapeake Bay depends greatly on their individual habitat requirements (Orth and Moore, 1984). Salinity is a primary factor affecting SAV distribution; therefore, SAV species often are categorized by salinity tolerance. Tidal fresh species of SAV require a salinity concentration range of 0 to 0.5 psu. Slightly brackish or oligohaline species require a salinity concentration range of 0.5 to 5 psu, moderately brackish or mesohaline species require a salinity concentration range of 5 to 18 psu, and high-salinity or polyhaline species require a salinity concentration range of 18 to 30 psu (CBP, 2003e). The submerged grasses commonly found in areas of higher salinity in the Bay include *Zostera marina* (eelgrass) and *Ruppia maritima* (widgeon grass). Grasses commonly found in areas of lower salinity include *Potamogeton perfoliatus* (redhead grass) and *Potamogeton pectinatus* (sago pondweed) (Orth and Moore, 1984).

Other aquatic habitat conditions influencing SAV distribution include temperature, light penetration, water depth, water currents, wave action, nutrient availability, and sediment deposition (CBP, 2003e). Storm events and the grazing of herbivores also influence SAV habitat conditions. The Chesapeake Bay Program has developed criteria for determining SAV habitat suitability of an area based on water quality. The "Percent Light at Leaf" habitat requirement assesses the amount of available light reaching the leaf surface of SAV after being attenuated in the water column and by epiphytic growth on the leaves themselves. The older "Habitat Requirements" of five water quality parameters of light attenuation (%), total suspended solids (mg/L), plankton chlorophyll-a (µg/L), dissolved inorganic nitrogen (mg/L), and dissolved inorganic phosphorus (mg/L) are also used for diagnostic purposes. Reestablishment of SAV is measured against the "Tier 1 Goal," an effort to restore SAV to any areas known to contain SAV from 1971 to 1990 (CBP, 2003e).

Seventeen species of SAV are commonly found in Chesapeake Bay and its tributaries. *Zostera marina* (eelgrass), the only "true" seagrass species, can tolerate salinities as low as 10 psu, and is dominant in the lower reaches of the Bay. *Myriophyllum spicatum* (Eurasian watermilfoil), *Potamogeton pectinatus* (sago pondweed), *Potamogeton perfoliatus* (redhead grass), *Potamogeton crispus* (curly pondweed), *Potamogeton pusillus* (Slender pondweed), *Zannichellia palustris* (horned pondweed), *Vallisneria americana* (wild celery), *Elodea canadensis* (common elodea), *Ceratophyllum demersum* (coontail), *Hydrilla verticillata* (hydrilla), *Heteranthera dubia* (water stargrass), *Najas guadalupensis* (southern naiad), *Najas minor*, *Najas gracillima*, and *Najas* sp. are freshwater species, some of which have the capacity to tolerate some level of salt, and are found in the middle and upper reaches of the Bay (Stevenson and Confer, 1978; Orth et al., 1979; Orth and Moore, 1981, 1983; Moore et al., 2000). *Ruppia maritima* (widgeon grass) is tolerant of a wide range of salinities and is found from the Bay mouth to the Susquehanna Flats. Approximately nine other species are only occasionally found within the Chesapeake Bay. When present, these less common species occur primarily in the middle and upper reaches of the Bay and the tidal rivers. Of all the species of SAV, the most abundant in the Chesapeake Bay are *Z. marina, R. maritime, V. Americana, H. verticillata, P. perfoliatus, P. pectinatus (Stuckenia pectinata),* and *M. spicatum*. *H. verticillata* (hydrilla), an introduced exotic species, has been shown to dominate SAV beds in the tidal freshwater reaches of the Potomac River (Carter and Rybicki, 1986). Hydrilla has also been reported to occur in the Susquehanna Flats and in the tidal freshwater portions of the Patuxent River, although its growth has not been as widespread as in the Potomac River.

Zostera marina and *R. maritima* are the dominant SAV species found in the Delmarva Peninsula coastal bays.

An online key to Chesapeake Bay SAV is available from the MD DNR Web page at http://www.dnr.state.md.us/bay/sav/key/.

SAV densities are highly variable from year to year. In 2003, 24,966 hectares of SAV were mapped by VIMS in the Chesapeake Bay and its tributaries. This represents an overall decrease of 30% (10,576 ha) from 2002 levels of mapped SAV. However, some portions of the Bay were not fully mapped (Tavern and Swan Creeks; lower Chester River; upper Wicomico River; Prestice, Driving and Ball creeks; Dameron Marsh; and Great Wicomico River) because of adverse weather in the spring and summer and Hurricane Isabel in the fall. All direct comparisons to previous years only include the portions mapped in both years. The area mapped in 2003 represents 35% of the 2010 Restoration goal (set by the Chesapeake Executive Council in Directive 93-3, revised in 2003) adjusted to include only these mapped regions (70,027 ha) (VIMS, 2003a).

2.6.7.3.1 Upper Bay

The Upper Bay Zone comprises 17 Chesapeake Bay Program (CBP) segments extending south from the Susquehanna River to the Chester and Magothy rivers. A map of the CBP segments is available online at : http://www.vims.edu/bio/sav/sav03/quadindex.html. In the Upper Bay Zone, 4,215 hectares (10,416 ac) of SAV were mapped during 2003. Comparing the same mapped regions between 2003 and 2002, SAV declined from 5,264 hectares (13,009 ac) in 2002 to 4,200 hectares (10,378 ac) in 2003. Three segments in the Upper Bay Zone met the 2010 Restoration Goal. One of the 17 CBP segments (or mapped portions) had documented increases of SAV by at least 20% and by at least 5 hectares. Six of the 17 CBP segments (or mapped portions) decreased by at least 20% and by at least 5 hectares. Four of the 17 CBP segments remained unvegetated in 2003. In the Northern Chesapeake Bay segment (CB1TF), SAV decreased by 18% (3,063 ha in 2003 versus 3,734 ha in 2002) (VIMS, 2003a).

The recorded abundance of SAV used to evaluate for habitat requirements throughout the C&D Canal Approach Channels (Upper Bay) is presented in Table 2-14.

2.6.7.3.2 Baltimore Harbor

Two of the 17 Upper Bay Zones comprise the Harbor Channels CBP segments. These zones include the Back River (BACOH) and the Patapsco River (PATMH). The Back River had a 0% change in SAV acreage since it remained unvegetated in 2003. The Patapsco River had an SAV acreage decrease of 17% (2.64 ha in 2003 versus 3.19 ha in 2002) (VIMS, 2003a).

The recorded abundance of SAV used to evaluate for habitat requirements throughout Harbor Channels is presented in Table 2-15.

2.6.7.3.3 Middle Bay

The Middle Bay Zone comprises 34 CBP segments extending south from the Bay Bridge to the Rappahannock River and Pocomoke Sound, and including the Potomac River. In the Middle Bay Zone, 12,333 hectares (30,475 ac) of SAV were mapped during the year 2003. Comparing the same mapped regions between 2003 and 2002, SAV decreased 41% from 20,280 ha in 2002 to 11,869 ha in 2003. Three segments of the Middle Bay Zone met the 2010 restoration goal. Four of the 34 segments (or mapped portions) had documented increases of SAV by at least 20% and by at least 5 hectares. Seventeen of the 34 segments (or mapped portions) had SAV decrease by at least 20% and by at least 5 hectares. Ten of the 34 CBP segments remained unvegetated in 2003 (VIMS, 2003a).

The recorded abundance of SAV information used to evaluate for habitat requirements throughout the Chesapeake Bay Approach Channels (MD; Middle Bay) is presented in Table 2-16.

2.6.7.3.4 Lower Bay

The Lower Bay Zone comprises 27 CBP segments covering the region south from the Rappahannock River and Pocomoke Sound regions to the mouth of the Chesapeake Bay. In the Lower Bay Zone, 8,418 hectares (20,802 ac) were mapped during the year 2003. Comparing the same mapped regions between 2003 and 2002, SAV decreased by 12% (1,100 ha, 2,718 ac) in 2003, comprising 45% of the 2010 restoration goal for the zone. Four segments of the Lower Bay Zone met the 2010 restoration goal. Three of the 27 CBP segments (or mapped portions) had documented increases of SAV by at least 20% and by at least 5 hectares. Five of the 27 CBP segments decreased by at least 20% and by at least 5 hectares. Twelve segments of the Lower Bay Zone were unvegetated in 2003 (VIMS, 2003a).

The recorded abundance of SAV information used to evaluate for habitat requirements throughout the Chesapeake Bay Approach Channels (VA; Lower Bay) is presented in Table 2-17.

2.6.8 Marine Mammals

There are few marine mammals that are known to infrequently visit the Chesapeake Bay. Species have been identified through rare sightings or strandings along the shore. Sightings have been made primarily in the Lower Bay. These marine mammals include humpback, pilot, and mink whales, manatees, dolphins, porpoises, and harbor seals (CBP, 2004l; CBP, 2004m).

2.7 WETLANDS

Wetlands are semiaquatic lands, flooded or saturated by water for varying periods of time. In order for an area to be delineated as wetlands, it must exhibit appropriate hydrology, contain hydric soils, and support hydrophytic vegetation (USFWS, 2004a).

Wetlands are highly valuable because they are vital to the health and productivity of the Chesapeake Bay and its tributaries. Wetlands function to restore and maintain water quality by removing and retaining nutrients contained in stormwater runoff that would otherwise flow directly into the water column. Critical habitat for a diversity of plants and animals, including fish, shellfish, waterfowl, shorebirds, wadingbirds, songbirds, and several mammals is provided by wetlands. Wetlands provide flood control and reduce the effects of storm damage by retaining water, which slowly dissipates to protect and minimize the erosion in coastal areas. Wetlands buffer coastal ponds and shores from highly erosive nearshore wave action. Lastly, wetlands provide many recreational activities (CBP, 2004h; MD DNR, 2004a).

Of the five types of wetlands classified by Cowardin (Cowardin et al., 1979), four types of wetlands have been identified in the Chesapeake Bay area: estuarine, palustrine, lacustrine, and riverine. Estuarine wetlands are deep-water tidal habitats with brackish water, and are found primarily along the shores of the Chesapeake Bay and its tidal rivers. Palustrine wetlands are freshwater nontidal, and are situated on the floodplains bordering rivers and streams, fringing the shorelines of lakes and ponds, filling isolated depressions, and covering broad flat areas at or near sea level. Palustrine wetlands are dominated by trees, shrubs, persistent emergent plants, and emergent mosses and lichens. Lacustrine wetlands are found in depressions or dammed river channels with deep water and few plants, and are generally larger than 20 acres. Riverine wetlands are typically contained within a channel with water flowing periodically or continuously, or that connects two bodies of standing water (MD DNR, 2004a).

Nearly 1.5 million acres of wetlands occur in the watershed of the Chesapeake Bay; 1.3 million acres are nontidal palustrine wetlands and 200,000 acres are tidal estuarine wetlands (CBP, 2004h). The coastal wetlands of Dorchester County and adjacent areas are internationally and nationally recognized to be of ecological significance. The Dorchester County wetlands are contained within a larger region of coastal wetlands on the lower Eastern Shore of Maryland and Virginia identified as "wetlands of international importance" in the Ramsar Convention, primarily because of their importance as a staging and wintering ground for waterbirds and waterfowl. This international treaty identified wetlands recognized to be of great ecological significance throughout the world, and obliged signatories to undertake conservation measures to ensure that these sites would continue to perform the vital ecological functions for which they were recognized. Dorchester County's coastal wetlands are listed as a "priority wetland" by EPA, were identified by USFWS as a "unique ecosystem," and are a "focus area" of the *North American Waterfowl Management Plan Atlantic Coast Joint Venture Report*. Their ecological significance extends beyond birds to include estuarine foodweb support, water quality maintenance, and other functions.

Wetlands are further characterized by their vegetation as follows:

1. **Estuarine emergent wetlands** are the most common types of estuarine wetlands. They are typically dominated by grasses, sedges, and other herbaceous species or nonwoody plants. Salt-tolerant grasses, including smooth cordgrass, salt hay grass, giant cordgrass, and switchgrass, are generally the dominant species within emergent wetlands. Other herbaceous plants including black needlebrush, three-squares, narrow-leaved cattail, and rose mallow may be abundant in brackish water areas (CBP, 2004h).

2. **Scrub-shrub estuarine wetlands** are characterized by woody plants less than 6 m tall. Common shrubs include button bush, hightide bush, and other halophytic shrubs (CBP, 2004h).

3. **Scrub-shrub palustrine wetlands** are characterized by low- to medium-height woody plants, and are among the Chesapeake Bay's most common type of palustrine wetland. Common shrubs include buttonbush, swamp rose, alders, willows, and silky dogwood (CBP, 2004h).

4. **Forested wetlands** are another very common type of palustrine wetland found in the Chesapeake Bay that is dominated by woody tree species. Red maple, silver maple, black gum, willow oak, green ash, pin oak, and sweet gum are among the most common trees in forested wetlands (CBP, 2004h).

Wetlands, both tidal and nontidal, play a critical role in the Chesapeake Bay ecosystem. This role was first recognized by the Chesapeake Bay Program in the *1987 Chesapeake Bay Agreement,* and again in the *1989 Chesapeake Bay Wetlands Policy*. In 1997 the Chesapeake Executive Council adopted a wetlands policy designed to speed the restoration and protection of wetlands in the Chesapeake Bay basin. Recognizing the role wetlands play in the overall health of the Bay and its living resources, this directive reaffirmed commitments made in the *1987 Chesapeake Bay Agreement* and the *1989 Chesapeake Bay Wetlands Policy* to take steps to achieve a net resource gain as a long-term goal for wetland restoration in the Chesapeake Bay basin (CBP, 2004h).

Sufficient data are not available to estimate long-term trends of tidal wetlands acreage in the Bay; however, the Bay has suffered a net loss of tidal wetlands as a consequence of loss to development, agriculture, and rising sea level (CBP Web site). The Bay lost about 9% of its tidal wetlands to dredging, filling, and impoundments between the 1950s and early 1980s (USGS, 2003b). Dorchester County marshes, particularly in the Blackwater National Wildlife Refuge (NWR) area, have been lost at an accelerated rate as a consequence of human activities exacerbating natural processes. Natural causes of marsh loss include sea level rise, subsidence, and erosion. Human causes of loss include marsh and wildlife management practices that favored chronic overgrazing by wildlife, marsh burning at a rate far in excess of natural burn frequencies, introduction of exotic grazers (nutria), road construction that alters marsh hydrology and salinity, and perhaps groundwater withdrawals. In 1988, the Chesapeake Bay Program established a "no net loss" goal for the Bay watershed within the Wetlands Policy Implementation Plan. The plan called for fostering the protection of wetlands through four strategies—the inventory and mapping of wetlands, the protection of existing wetlands, the rehabilitation and restoration of degraded wetlands, and education and research (CBP, 2004h).

Public support for wetland protection and restoration, as well as concern about wetland destruction, has steadily increased in recent years. Consequently, protecting wetlands is one of the goals of the Chesapeake Bay restoration effort. Maryland, Virginia, and Pennsylvania all have tidal and nontidal wetlands programs that help develop policies and regulations toward wetland protection. In addition, these states have taken steps to protect wetlands beyond the regulatory programs (CBP, 2004h).

The maintenance of existing wetlands and restoration of wetland acreage and function are critical to sustaining habitats for breeding, spawning, nesting, and wintering living resources, including those living resources vital to the regional economy.

Tidal and nontidal wetlands are regulated by the federal government, individual state governments, and often locally by municipalities. Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act regulate impacts to wetlands at the federal level, and are overseen by the U.S. Army Corps of Engineers (USACE) and the U.S. EPA. In the State of Maryland, the Tidal Wetlands Act and Program and the Nontidal Wetlands Act and Program are overseen primarily by the Maryland Department of the Environment (MDE), as well as the MD DNR and the Maryland Historical Trust. Many of Maryland's cities and counties also have local wetland regulations (MDE, 2004a). The Virginia Marine Resources Commission and VADEQ oversee the regulatory protection of wetlands under Title 28.2 of the Code of Virginia, Chapter 12 for submerged lands and Chapter 13 for wetlands. Similar to Maryland, many of Virginia's cities and counties have also incorporated local wetland regulations (VADEQ, 2004a). For a comprehensive list of Federal Statutes, Executive Orders, Memoranda, and State Statutes, see Chapter 4.

Note: The following subsections summarize the acreage of wetlands for each major watershed (including the Chesapeake Bay) in the Bay region. These estimates are based on information obtained from the Chesapeake Bay Program.

2.7.1 Upper Bay

The Susquehanna watershed comprises the northern region of the Chesapeake Bay watershed. This watershed contains a total of 5 acres of estuarine wetlands, a total of 704 acres of lacustrine wetlands, 224,701 acres of palustrine wetlands, and 328 acres of riverine wetlands. Of these wetlands, 43,769 are less than 3 acres in size. A total of 15,706 of the wetlands are between 3 and 10 acres in size, and 4,683 of the wetlands are greater than 10 acres in size (CBP, 2004i).

2.7.2 Baltimore Harbor

The Maryland western shore watershed lies in the northcentral region of the Chesapeake Bay watershed. This watershed contains a total of 11,389 acres of estuarine wetlands, 413 acres of lacustrine wetlands, 16,740 acres of palustrine wetlands, and 2 acres of riverine wetlands. Of these wetlands, 3,021 are less than 3 acres in size. A total of 1,126 of the wetlands are between 3 and 10 acres in size, and 512 of the wetlands are greater than 10 acres in size (CBP, 2004i).

2.7.3 Middle Bay

The Patuxent River watershed contains a total of 5,785 acres of estuarine wetlands, 38 acres of lacustrine wetlands, 27,212 acres of palustrine wetlands, and 178 acres of riverine wetlands. Of these wetlands, 1,728 are less than 3 acres in size. A total of 1,141 of the wetlands are between 3 and 10 acres in size, and 697 of the wetlands are greater than 10 acres in size (CBP, 2004i).

The Potomac River watershed contains a total of 11,070 acres of estuarine wetlands, 106 acres of lacustrine wetlands, 120,401 acres of palustrine wetlands, and 435 acres of riverine wetlands. Of these wetlands, 22,840 are less than 3 acres in size. A total of 6,894 of the wetlands are between 3 and 10 acres in size, and 2,563 of the wetlands are greater than 10 acres in size (CBP, 2004i).

The Rappahannock watershed contains a total of 11,248 acres of estuarine wetlands, 12 acres of lacustrine wetlands, 54,710 acres of palustrine wetlands, and 52 acres of riverine wetlands. Of these wetlands, 10,653 are less than 3 acres in size. A total of 3,399 of the wetlands are between 3 and 10 acres in size, and 1,237 of the wetlands are greater than 10 acres in size (CBP, 2004i).

2.7.4 Lower Bay

The York watershed contains a total of 31,425 acres of estuarine wetlands, 108 acres of lacustrine wetlands, and 143,368 acres of palustrine wetlands. Of these wetlands, 20,127 are less than 3 acres in size. A total of 6,504 of the wetlands are between 3 and 10 acres in size, and 3,286 of the wetlands are greater than 10 acres in size (CBP, 2004i). Although there are no riverine wetlands currently mapped in this watershed, the NWI inventory is still incomplete.

The James watershed contains a total of 18,446 acres of estuarine wetlands, 97 acres of lacustrine wetlands, 200,028 acres of palustrine wetlands, and 193 acres of riverine wetlands. Of these wetlands, 26,356 are less than 3 acres in size. A total of 8,307 of the wetlands are between 3 and 10 acres in size, and 4,345 of the wetlands are greater than 10 acres in size (CBP, 2004i).

2.8 TERRESTRIAL RESOURCES

The Chesapeake Bay supports a wide variety of mammals, birds, and herpetiles (reptiles and amphibians). The remarkable species diversity and abundance of the Bay is supported by a unique environmental gradient, from higher elevation freshwater environments near its many tributaries to the saline marshlands and shallow open waters at its mouth.

Six Bay habitats, presented below, provide specific food, light, and shelter requirements for the Bay's diverse terrestrial inhabitants: upland habitat, freshwater wetlands, salt marshes, tidal flats, island beaches, and shallow water habitat (CENAB, 2004a):

- Upland habitat is land that is rarely or never inundated by water. Upland habitats support the growth of grasses, shrubs, and trees and provide habitat for many of the Bay's mammals, tree nesting birds, reptiles, and amphibians.

- Freshwater wetlands are areas saturated or inundated with freshwater for at least part of the growing season. Ducks, geese, and a large number of songbirds feed, nest, and raise their young in these wetlands. Muskrat *(Ondatra zibethicus)* and beaver *(Castor canadensis*) are the most familiar wetland mammals, as well as white-tailed deer *(Odocoilius virginianus),* which use wetlands for food and shelter, especially evergreen forested wetlands.

- Salt marshes are wetlands dominated by salt-tolerant plant species, such as *Spartina* sp. Salt marshes provide critical habitat for waterfowl, shorebirds, wading birds, mammals, juvenile fish, shellfish, and a variety of invertebrates. Salt marshes also serve as nurseries and spawning grounds for many aquatic resources.

- Tidal flats are unvegetated wet areas of mud or sand that do not contain rooted plants, and are subject to tidal inundation. Tidal flats occur along the shoreline of the Bay, and typically border marsh areas. Tidal flats, with their abundant invertebrate communities of worms, crabs, and clams, serve as a primary food source for Bay shorebirds including oystercatchers, terns, gulls, and plovers. Tidal flat habitat is naturally of limited availability in the Chesapeake Bay region because of the narrow tidal range.

- Shallow water habitat is aquatic habitat less than 6 ft deep. The vast, shallow water habitat supports abundant communities of SAV and finfish, which provides a major source of food for both herbivorous ducks and predatory birds including the osprey (*Pandion haliaetus)* and bald eagle (*Haliaeetus leucocephalus*).

- Island beaches comprising shell and sand, although limited in aerial extent in the Bay, provide key nesting habitat for several shorebirds, including the double-crested cormorant (*Phalacrocorax auritus*) and the federally endangered least tern (*Sterna antillarum*).

The six major habitat types described above generally occur throughout the entire Bay area. Water salinity increases and land elevations decrease in a southeasterly direction throughout the Bay. Therefore, water salinity is lowest (0 to 18 psu) and elevations are highest in the Upper Bay area relative to the other three areas (MD DNR, 2004). Island beaches are more common in lower reaches of the Chesapeake Bay.

Terrestrial resources in the Bay are protected at the federal level under a number of environmental protection statutes including the Endangered Species Act, Fish and Wildlife Coordination Act, Migratory Bird Treaty Act, and Emergency Wetlands Resources Act. The State of Maryland protects species and their habitats through several additional statutes including the Nongame and Endangered Species Conservation Act, Chesapeake Bay Critical Area Law, Nontidal Wetlands Protection Act, and Tidal Wetlands Act. The Commonwealth of Virginia has analogous environmental protection laws including the Chesapeake Bay Preservation Act, Virginia Wetlands Act, Virginia Endangered Species Act, and Endangered Plant and Insect Species Act. For a comprehensive list of Federal Statutes, Executive Orders, Memoranda, and State Statutes, see Chapter 4.

Under these statutes, wildlife resources of the Chesapeake Bay are monitored and protected by a number of federal, state, and public entities. USFWS biologists at the Chesapeake Bay Field Office work to protect endangered and threatened species, migratory birds, and wildlife habitats in the District of Columbia, Delaware, Maryland, and Virginia. CENAB assists federal, state, and local agencies in preparing environmental analyses, complying with environmental requirements, conserving natural resources, and implementing pollution prevention measures within the Bay region. MD DNR and VADEQ preserve, protect, and restore their respective state's natural resources through law enforcement, monitoring, education, and management.

In addition to these federal and state entities, there are numerous organizations and educational institutions that support Bay research and protection. For example, the Chesapeake Bay Program is a regional partnership whose mission is to protect the Bay's living resources and their habitats, and restore degraded habitats by improving water quality, managing lands soundly, and engaging individuals and local communities. The program's Executive Council establishes the policy direction for the restoration and protection of the Chesapeake Bay and its living resources. Public involvement in the preservation and restoration of the Bay occurs mainly through a number of nonprofit and educational institutions dedicated to promoting local efforts to improve the region's natural resources.

General information available from the Chesapeake Bay Program and other sources has been compiled below to describe mammal, bird, and herpetile resources in the Chesapeake Bay. Most readily available species information encompasses the entire Bay, rather than one of the four project areas defined by this DMMP. However, more area-specific information is present in the recent environmental conditions assessments and EISs prepared for dredging-related placement/habitat restoration projects proposed for various reaches within the Bay. This general information and the site-specific studies are summarized briefly below to characterize the habitat and terrestrial species composition of the four Bay areas for mammals, birds, and herpetiles. The site-specific studies referenced above include the following:

- Upper Bay—Lower Eastern Neck Island Reconnaissance Study (LENI; EA, 2003b); Parsons Island Reconnaissance Study (EA, 2003g).
- Harbor—Feasibility Study and EIS for the Harbor Channels anchorages and channels (CENAB, 1997); Harbor Channels Reconnaissance Study (EA, 2003a).
- Middle Bay—Barren Island Reconnaissance Study (WESTON, 2002a), Holland Island Reconnaissance Study (Baker, 2003), James Island Reconnaissance Study (EA, 2002b), Sharps Island Reconnaissance Study (AMA, 2002), and PIERP Reconnaissance Study (EA, 2003e).
- Lower Bay—EIS for deepening of Norfolk Harbor and Channels (CENAO, 1985). In Draft Information Report on Lower Bay Uses of Dredged Material (CENAO, 1994).

2.8.1 Mammalian Habitats

The six major habitat types of the Bay described above support a variety of mammal species. Commonly observed mammals species are listed in Table 2-18. Upland grasses, shrubs, and forests provide an abundant source of food and shelter for various species of deer, mice, and squirrels. Habitat diversity is essential for other species, including the river otter (*Lutra* *canadensis*), muskrat, and beaver that utilize both land and aquatic habitats of the region. The Bay also contains suitable habitat for a number of federally threatened or endangered species, including the Delmarva Fox Squirrel (*Sciurus niger cinereus*). Threatened and endangered species inhabiting the Bay are further discussed in Section 2.9.

2.8.1.1 *Upper Bay*

Common mammals species expected to be present in Chesapeake Bay terrestrial habitats, including the Upper Bay, are listed in Table 2-18.

The LENI Reconnaissance study reported that a variety of mammals and marsupials were present on the island, including white-tailed deer, beaver, red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), muskrat, opossum (*Didelphis virginiana*), woodchuck (*Marmota monax*), and the eastern gray squirrel (*Sciurus carolinensis*). USFWS additionally observed white-tailed deer, meadow vole (*Microtus pennsylvannicus*), red fox, gray fox (*Urocyon cinereoargenteus*), and raccoon in restored marsh areas of the island (EA, 2003b).

No mammals were directly observed during the reconnaissance visit of Parsons Island, but several white-tailed deer, raccoon, and red fox tracks were viewed, especially in sandy areas along the shoreline. Deer and fox reportedly swim back and forth from Kent Island because the island cannot sustain the expanding population in all seasons (EA, 2003g).

2.8.1.2 *Baltimore Harbor*

Common mammal species expected to be present in Chesapeake Bay terrestrial habitats, including the Harbor area, are listed in Table 2-18.

Urbanization has drastically impacted food sources and protective habitat, which has altered the wildlife composition of the Harbor Channels area. Tidal marshes that once occupied 3 square miles of the harbor area have been virtually eliminated, leaving mainly patches of common reed (*Phragmites australis)*, which are believed to be less valuable habitat to wildlife than was their historic environment.

Though mammal populations have not been encouraged by the deliberate creation of mammal habitat in the Harbor Channels area, tracks of common raccoon, white-tailed deer, and red fox were observed during the site visits (EA, 2003a). Lists of mammals either observed during site reconnaissance visits in March 2002 or expected at the Harbor were included in Table 2-18.

2.8.1.3 *Middle Bay*

Common mammals species expected to be present in Chesapeake Bay terrestrial habitats, including the Middle Bay, are listed in Table 2-18.

Little additional information on mammals was provided in the site-specific reconnaissance studies for the Middle Bay. No baseline ecological survey has been conducted on Barren Island, and few species were observed during the reconnaissance visit to Barren Island (WESTON, 2002a). No direct mammal observations were made during the Holland Island site visit; however, indirect evidence of mammal populations (groundhog or muskrat shelter) was observed (Baker, 2003). Sika deer (*Cervus nippon*) and raccoon were identified by their tracks as seen in the sand and clay areas of James Island (EA, 2002e). Since Sharps Island became completely submerged in the 1960s, terrestrial habitat has been lost and no mammal species currently reside at this location (AMA, 2002). There were also no mammal observations made during the reconnaissance visit to PIERP (EA, 2003e).

2.8.1.4 *Lower Bay*

Common mammals species expected to be present in Chesapeake Bay terrestrial habitats, including the Lower Bay, are listed in Table 2-18.

Generally speaking, terrestrial habitats throughout the Lower Bay support a similar variety of mammal species as were described for the other three Bay areas. However, mammal observations in this region are less frequent because expansive salt marshes comprise the majority of the habitat in the Lower Bay and provide less ideal habitats for terrestrial mammals.

2.8.2 Avian Habitats

The Chesapeake Bay provides valuable and diverse habitat for avian species. Seasonal surveys conducted in the Bay have identified five major groups of inhabiting birds—colonial waterbirds, shorebirds and marsh birds, waterfowl, predatory and scavenging birds (raptors), and other land birds.

Six species of colonial nesting waterbirds inhabit the Bay region: great blue heron (*Ardea herodias*), the great egret (*Ardea alba*), the snowy egret (*Egretta thula*), the little blue heron (*Egretta caerulea*), the green-backed heron (*Butorides striatus*), and the night heron (*Nycticorax nycticorax*.) Colonial waterbirds hunt in shallow water habitat, feeding mainly on small fish, amphibians, and arthropods. They nest in tall trees in mainland areas, but can nest on shrubs and even dense grassy vegetation on islands isolated from terrestrial predators. Colonial waterbirds concentrate their reproductive energies in colonies at just a few locations. Continuing regional loss of nesting habitat on the mainland to development and disturbance, and interruption of the natural and human processes that form islands increases the relative importance and value of nesting habitat that remains (CBP, 2004e).

Shorebirds, marsh birds, and waterfowl are common residents throughout the Bay. These birds include "aerial gleaners" that consume fish or insects, such as gulls, terns, barn swallows (*Hirundo rustica*), brown pelicans (*Pelecanus occidentalis*), and the cormorants (*Phalacrocorax* sp.). Wading birds include the sandpipers, sanderlings, willet (*Cataoptrophorus semipalmatus*), black-bellied plover (*Pluvialis squatarola*), dowitchers (*Limnodromus* sp.), and glossy ibis (*Plegadis falcinellus*). Dozens of species of waterfowl (i.e., ducks and geese) inhabit or migrate the Bay region, including the commonly sighted mallard (*Anas platyrhynchos*), wood duck (*Aix sponsa*), and red-breasted merganser (*Mergus serrator*) (CBP, 2004e).

Bald eagles (*Haliaeetus leucocephalus*) and ospreys (*Pandion haliaetus*) are the Bay's most familiar raptors. The osprey is tolerant of human activity, and it builds its nests along the Bay shoreline and on navigation markers, utility poles, dead trees, and manmade structures near the water. The bald eagle nests, roost, and perch at the top of tall trees in upland areas, often in loblolly pine stands. The trees must be in areas where human activity is limited because bald eagles have little tolerance for human activity.

Land birds include birds typically present in upland habitats in the mid-Atlantic region, such as American robin (*Turdus migratorius*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), and various species of finches and sparrows.

The diversity of avian fauna in the Bay is largely affected by the number of migratory species. The Chesapeake Bay is strategically positioned on the Atlantic Flyway, a major migration route for neotropical migrants and migrating waterfowl. Waterfowl and other birds migrating along the

Flyway find food and shelter in the Bay's many coves and marshes. The Bay also serves as one of the most heavily used wintering areas for waterfowl. On average, nearly a million waterfowl winter each year on the Bay; more than 35% of all the waterfowl using the Atlantic Flyway (NPS 2003). Waterfowl staging and concentration areas have been identified in Maryland by MD DNR throughout Chesapeake Bay. These areas are typically afforded additional protection from activities that could disrupt waterfowl concentrations. Surveys suggest that unvegetated island habitats are preferentially selected by many migratory bird species because of their relative lack of human disturbance and predators (CENAB, 2004a).

Loss of habitat along waterways poses the biggest threat to many bird species in the Bay watershed. Deforestation, shoreline development, and shoreline erosion disrupt nesting activities, and chemical contaminants in the water damage the food source of many Bay birds. The Bay's vast tidal marshlands are important nesting, nursery, and wintering areas for colonial waterbirds, wading birds, and several federally listed and state-listed endangered species. Rare, threatened, and endangered species found in the Chesapeake Bay are discussed in Section 2.9. In order to assess the status of Bay avian fauna, state biologists and USFWS count at least 20 species or species groups of waterfowl each winter in the Bay watershed. Although waterfowl populations are variable because of their migratory nature and the effects of factors outside the basin, these annual counts provide an estimate of trends in Bay waterfowl. The goal of the Chesapeake Bay Program is to restore avian populations in the Bay to levels measured in the 1970s.

As of September 2004, ten of the 20 monitored waterfowl species have met their goals and are showing improving trends in populations: mallard, gadwall (*Mareca strepera*), American widgeon (*Mareca Americana*), northern shoveler (*Anas clypeata*), northern pintail (*Anas acuta*), green-winged teal (*Anas crecca*), scaup (*Aythya affinis*), ring-necked duck (*Aythya collaris*), bufflehead (*Bucephala albeola*), and ruddy duck (*Oxyura jamaicensis*). Ten of the 20 monitored waterfowl have not met their goals. Four of these 10 species have shown improving trends (but have not met goals): black duck, redhead, scoters, and Canada goose (migratory). The remaining six species have shown declining trends: canvasback (*Aythya valisineria*), common goldeneye (*Bucephala clangula*), long-tailed duck (*Clangula hyemalis*), mergansers sp., brant (*Branta bernicla*), and tundra swan (*Cygnus columbianus*) (CBF, 2004k).

Table 2-20 presents a list of species of birds that use the Chesapeake Bay as habitat. Because of the migratory nature of birds, few specific differences among the four Bay areas were noted. Bird species identified as part of recent reconnaissance studies for each of the four Bay areas are discussed further in the following sections.

Note that the bird species listed in Table 2-18 are not a comprehensive list of birds potentially present in the Chesapeake Bay. The appropriate state agencies should be contacted to determine if waterfowl Sensitive Species Project Review Areas (SSPRA) or colonial waterbird nesting sites are in the proposed dredging area. Site-specific bird counts may be available from the National Audubon Society (e.g., Christmas Bird Count data), universities, or other programs.

2.8.2.1 *Upper Bay*

Numerous bird species utilize the varied habitats of the Upper Bay. Several colonial waterbird nesting sites have been documented throughout the Upper Bay, particularly along the Chester and Eastern rivers. Several waterfowl SSPRA areas are located in the Upper Bay, including in the Elk River near the dredging channel, Pooles Island, and Neds Island. Of the six terrestrial habitats discussed, salt marshes are the most limited in extent in the Upper Bay. Birds likely to be present in the Upper Bay are listed in Table 2-18.

The LENI reconnaissance study (EA, 2003b) reported that avian inhabitants of the island include one threatened species, the bald eagle, and 243 other species of birds. The study also reports that the island is a designated waterfowl concentration area, as well as a waterfowl staging area (EA, 2003b). According to the USFWS, currently four nesting pairs of bald eagles are located on LENI and all were observed during the site visit. Osprey are known to nest in several locations on the island. Lists of birds either observed or expected at the site on LENI are included in the consolidated report (EA, 2003b) and were incorporated in Table 2-18.

Several species of birds were observed on Parsons Island as part of that island's Reconnaissance Study (EA, 2003g), including a bald eagle, killdeer (*Charadrius vociferus*), belted kingfisher (*Ceryle alcyon*), great blue heron, black scoter (*Melanitta nigra*), canvasbacks, and great horned owl (*Bubo virginianus*). A comprehensive avian survey was not performed for this study (EA, 2003g).

2.8.2.2 *Baltimore Harbor*

There are three documented colonial waterbird nesting sites within the Harbor area. Two of the sites are located on the shoreline of the Patapsco River, and the other site is on the shoreline of the Bay mainsteam, approximately 2 miles south of HMI. A large area within the Harbor has been designated as waterfowl SSPRA by MD DNR. The waterfowl SSPRA essentially borders the Patapsco River on both shorelines as well as around HMI.

In the northern portion of the Chesapeake Bay, one of the most limited avian habitats is shallow-water habitat for wintering waterfowl and tidal flat habitat for migrant shorebirds. Shallow water habitat ranges from approximately 3 ft deep to approximately 12 ft, measured at mean low water. Over the years, the HMI complex has proven to be a significant provider of this type of habitat. USFWS reported the existence of two waterbird nesting colonies near the Harbor (CENAB, 1997). An established colony of black-crowned night herons (*Nycticorax nycticorax*), consisting of approximately 350 breeding pairs, reportedly nested at Sollers Point near the northern end of the Francis Scott Key Bridge. Approximately 500 pairs of herring gulls nested at a site on Sparrows Point.

Many resident species such as great blue herons, cormorants, and osprey are also known to utilize the harbor area. A variety of waterfowl species winter in the Harbor, although not all of the areas are considered waterfowl concentration areas. Parts of Dead Ship Anchorage may be a waterfowl staging and concentration area, as well as Thoms Cove, historically utilized by wood duck and black duck (EA, 2003a).

2.8.2.3 *Middle Bay*

Island beaches of the Middle Bay provide key nesting habitat for several shorebirds. Protected from most human disturbance and mammal predation, large nesting colonies of double-crested cormorant and terns thrive in this region. Numerous colonial waterbird nesting sites have been documented throughout the Middle Bay area, particularly on Bay islands and along riverine shorelines. Many Bay islands in this region have also been designated waterfowl SSPRAs by MD DNR.

Tidal influences create extensive networks of salt marshes and tidal flats in the Middle Bay that support diverse communities of bird species. Bird species observed or expected to occur in the

Middle Bay are listed in Table 2-18. Many of these bird species were directly observed as part of one or more reconnaissance studies in this region of the Bay.

Barren Island supports waterfowl habitat, feeding grounds, and nesting areas. Numerous bird species are known to frequent the Island, including the least tern (federally endangered) and black skimmer (MD state endangered). Table 2-18 includes those species observed during various site visits, USFWS field notes, and avian species included in a previous Environmental Assessment of impacts on Barren Island (WESTON, 2002a).

Avian species that have been reported to use Holland Island include great egrets (*Casmerodius albus*), tricolored herons (*Egretta tricolor*), little blue herons (*Egretta caerulea*), black-crowned night-herons, yellow-crowned night-herons (*Nycticorax violaceus*), glossy ibises, and bald eagles (Baker, 2003). Two osprey nests were also observed on the island.

A total of 42 species of birds were identified during visits to the James Island site in November 2001 and June 2002 (EA, 2003d). Wintering waterfowl utilized the waters surrounding the James Island remnants as evidenced by seven species of waterfowl observed in November. In June, only resident Canada geese (*Branta canadensis*) and mute swan (*Cygnus olor*) were observed.

A seasonal monitoring study was conducted in fall 1994 through summer 1995 to assess avifauna either observed or inhabiting the PIERP study area. More recent observations of bird inhabitants for the PIERP archipelago were conducted in June 2001 to provide an update. Twenty-eight species of birds have been identified on PIERP. Bird species observed are consistent with those discussed previously (EA, 2003e).

2.8.2.4 *Lower Bay*

Vast salt marshes and the low numbers of mammal predators provide ideal habitats for a variety of bird species in the Lower Bay. Tidal flats, with their abundant invertebrate communities of worms, crabs, and clams, serve as a primary food source for Bay shorebirds, including oystercatchers, terns, gulls, and plovers. USFWS reports included in the 1994 USACE Draft Report on Lower Bay list bird species either observed or expected within the region. The report states that at least six species of colonial waterbirds nests on islands of the Lower Bay as well as black duck, shorebirds, American oystercatcher, and osprey. Approximately 40 species of birds have been observed in the Lower Bay, half of which breed on local islands (CENAO, 1994).

Bird species are consistent with those discussed previously. Species either known or expected to inhabit the Lower Bay region are listed in Table 2-18.

2.8.3 Herpetile Habitats

The herpetile (reptile and amphibian) population of the Bay includes frogs, toads, turtles, salamanders, newts, and snakes. Most amphibian species utilize freshwater wetlands and upland wet pools of the Bay area for protection, feeding, and reproduction. The diamondback terrapin (*Malaclemys terrapin*) is the only North American turtle that lives exclusively in brackish water. Terrapins feed mostly on mollusks that inhabit the Bay's salt marshes, tidal flats, and shallow water habitats (CBP, 2004l). Few comprehensive studies have been conducted to monitor the distribution or abundance of herpetile species in the Chesapeake Bay; however, herpetiles are frequently observed members of all six Bay habitats.

Note that exclusively aquatic herpetiles (i.e., sea turtles) also utilize the Bay as habitat. Terrestrial requirements for sea turtles are limited to nesting habitat, although there is no evidence that sea turtles use the Chesapeake Bay area to nest (NOAA, 2003b).

2.8.3.1 *Upper Bay*

Herpetiles expected to occur in Chesapeake Bay terrestrial habitats, including the Upper Bay, are listed in Table 2-18.

During a site visit to LENI in October 2000, one amphibian was observed, the southern leopard frog (*Rana uticularia*). In addition, USFWS personnel have recorded observations of snapping turtles (*Chelydra serpentina*), diamondback terrapins (*Malaclemys terrapin*), and northern watersnake *(Natrix sipedon*) in the marsh restoration area of LENI (EA, 2003b). Lists of herpetiles observed or expected at LENI were included in Table 2-18.

No reptiles or amphibians were observed on Parsons Island, but according to caretakers, snapping turtles are common in freshwater wetlands and ponds. Diamondback terrapins are also known to utilize the Island during warmer months and have been observed laying eggs in some areas (EA, 2003g). Lists of mammals expected at Parsons Island were also incorporated into Table 2-18.

2.8.3.2 *Baltimore Harbor*

Herpetiles expected to occur in Chesapeake Bay terrestrial habitats, including the Harbor area, are listed in Table 2-18.

Three observations recorded in the 1997 USACE Impact Statement were of water snakes, black rat snake (*Elaphe obsoleta obsoleta*), and snapping turtle. A dead sea turtle (carapace) was found during the March 2002 visit to Thoms Cove. Lists of herpetiles either observed during site reconnaissance visits in March 2002 or expected in the Harbor are included in Table 2-18.

2.8.3.3 *Middle Bay*

Herpetiles expected to occur in Chesapeake Bay terrestrial habitats, including the Middle Bay, are listed in Table 2-18.

Barren Island is known to support diamondback terrapin, redbelly turtle (*Pseudemys rubriventrus*), and various other reptiles and amphibians, although the island's Refuge Manager indicated that USFWS has not conducted any herpetological surveys on Barren Island to date (WESTON, 2002a). Diamondback terrapins are the only herpetiles listed as species known or expected to occur on Holland Island (Baker, 2003). Several diamondback terrapin, a northern water snake, and garter snake (*Thamnophis sirtalis*) were found along the shoreline during the habitat characterization visit to James Island in 2002 (EA, 2002e). The reptile and amphibian species that are known or expected to occur on these three islands were incorporated in Table 2-18.

Since Sharps Island became completely submerged in the 1960s, terrestrial bird habitat has been lost, and no herpetile species currently reside at this location (AMA, 2002). Diamondback terrapins had successfully nested on PIERP, but juveniles from some nests required human assistance to enable their migration to the Bay. During surveys conducted 4 June 2002, diamondback terrapin nests were found and marked for identification. Follow-up surveys of the same nests indicated that there were as many as 39 terrapin nests with eggs (EA, 2003e).

2.8.3.4 *Lower Bay*

As with the mammals of the Lower Bay, terrestrial habitats throughout the Bay support a similar variety of herpetiles as were outlined for other Bay areas. Common Bay reptiles, including the diamondback terrapin, are known to inhabit these salt marshes, but herpetile observations overall are low in open water areas. Species known or expected to inhabit the Lower Bay are listed in Table 2-18. Unlike other Bay areas, however, sea turtles could utilize sandy habitats in this region for nesting.

2.8.4 Additional Wildlife Concerns

A description of terrestrial resources in the Bay would not be complete without some mention of the nonindigenous species in the Bay that are threatening the existing resident species populations. Approximately 160 Bay species are believed to have nonindigenous origins (SERC, 2004). Impacts of two of the species with the greatest effects, nutria and mute swan, are described below.

The non-native, resident mute swan competes with the migratory tundra swan for food and habitat. Mute swans devour entire plants and beds when they graze, eliminating the potential for the plants to recover. Also, mute swans do not migrate, so the impacts are magnified. Mallards, Canada geese, and mute swans have growing resident populations (introduced or non-native) that may harm the Bay ecosystem by consuming food resources needed by wintering populations, such as SAV; competing for breeding areas and food with native black ducks; increasing conflicts with humans at beaches and ponds; and increasing bacterial levels in swimming areas. Because these resident populations are difficult to differentiate during the winter survey, it is problematic to determine the trends of native waterfowl.

Nutria (*Myocastor coypus*) are semiaquatic rodents native to South America, which now also occupy brackish water marshes in parts of Maryland, Virginia, and Delaware. The rodents were first introduced to the United States to enhance the fur trade, and arrived in Dorchester County, Maryland, in 1943 as part of an experimental fur station. The station did not succeed and the nutria that were inadvertently released to the wild produced the major populations that exist today in the Chesapeake Bay watershed. The beaver-like nutria have large yellow incisors and very large appetites. They forage on the essential root mats of wetland grasses. The destruction of these root mats, also called an “eat-out,” destabilizes soil, which leads to erosion of vital wetland areas.

2.9 RARE, THREATENED, AND ENDANGERED (RTE) SPECIES

Certain species of plants and animals are protected by federal and state regulations under the Endangered Species Act (ESA) of 1973, the Maryland Nongame and Endangered Species Conservation Act of 1975, the Virginia Endangered Species Act (Code of Virginia, Section 29.1-564-568), and the Virginia Endangered Plant and Insect Act (Section 3.1 -1020 through 1030, Code of Virginia). For a comprehensive list of Federal Statutes, Executive Orders, Memoranda, and State Statutes, see Chapter 4.

Under the consistency clause (Section 7[a]) of the ESA, federal agencies are required to consult with the USFWS and NMFS if a prospective action proponent has reason to believe that endangered or threatened species may be present in the area affected by a proposed project. The Maryland Nongame and Endangered Species Conservation Act and Virginia Endangered Species Act have similar consultation requirements regarding potentially affected protected species.

In fulfillment of federal and state requirements, consultation via letter was conducted with the USFWS Ecological Services Office in Annapolis, Maryland; the Habitat and Protected Resources Division of the NMFS in Oxford, MD; MD DNR's Heritage and Wildlife Service in Annapolis, MD; and the Virginia Department of Conservation and Recreation (VDCR), Division of Natural Heritage in Richmond, VA. Information requested from these agencies included federal and state listed rare, threatened, and endangered species; designated proposed critical habitat; and candidate taxa occurring in the project area. Because the DMMP is programmatic, rather than site-specific, the Maryland and Virginia portions of the Chesapeake Bay watershed are considered to be the project area (copies of correspondence are provided in Appendix H). Selection of specific sites for dredged material placement or habitat reconstruction will require additional consultation with these agencies.

Information on RTE species potentially present in the project area identified by federal and state agencies can be found in Tables 2-19, 2-20, 2-21, and 2-22. These species occur in a wide variety of habitats, including habitat types not present inside the DMMP project area, such as portions of the Chesapeake Bay watershed located in Delaware, New York, and Pennsylvania. Federally listed species identified by NPS likely to occur in the Maryland and Virginia portions of the Bay included the bald eagle (*Haliaeetus leucocephalus*), piping plover (*Charadrius melodus*), several species of sea turtles, shortnose sturgeon (*Acipenser brevirostrum*), several tiger beetles, northeastern bulrush (*Scirpus ancistrochaetus*), and small whorled pogonia (*Isotria medeoloides*), among others. The Chesapeake Bay Program has also had sightings and/or strandings of federally listed marine mammals including humpback whale *(Megaptera novaeangiiae)* and West Indian manatee (*Trichechus manatus*) (CBP, 2004L). In addition, NPS identified several hundred state-listed species.

Of the federally listed species identified by NPS, the most likely to be impacted by dredging activities are shortnose sturgeon and several species of sea turtles. CENAB is in the process of preparing a shortnose sturgeon Biological Assessment. According to catch information obtained through the U.S. Fish and Wildlife Service (USFWS) Fisherman's reward program, shortnose sturgeon populations are found throughout the Bay. Approximately 57 shortnose sturgeon have been caught between 1996 and 2004. See Table 2-23 for specific capture locations.

The federally listed sea turtle species that are found in the Bay are the loggerhead (*Caretta caretta*), the leatherback (*Dermochelys coriacea*), kemp's ridley (*Lepidochelys kempi*), green sea turtle (*Chelonia mydas*), and the Hawksbill (*Eretmochelys imbricata*) (NOAA, 2003b).

2.9.1 Upper Bay

MD DNR maintains current lists of species of special concern (i.e., rare, threatened, and endangered species) for each Maryland county on its Web site (http://www.dnr.state.md.us/wildlife/espaa.html; MD DNR, 2004). This information was accessed 21 January 2004, and lists from four counties with both shoreline in the Upper Bay and the potential to be impacted by dredging activities were compiled to determine which species of special concern could potentially be located in this region (MD DNR, 2004). Four Maryland counties were included in the compilation—Anne Arundel County, Baltimore County, Kent County, and Queen Anne's County. The results of this search are presented in Table 2-19.

Six federally endangered and five federally threatened species are potentially present in the Upper Bay (Table 2-19). The federally endangered species are the shortnose sturgeon (*Acipenser brevirostrum*), dwarf wedge mussel (*Alasmidonta heterodon*), Delmarva fox squirrel (*Sciurus niger cinereus*), sandplain gerardia (*Agalinis acuta* [plant]), Canby's dropwort (*Oxypolis canbyi* [plant]), and chaffseed (*Schwalbea americana* [plant]). The five federally threatened species potentially present in the Upper Bay are tiger beetle (*Cicindela patruela*), the Puritan tiger beetle

(*Cicindela puritana*), the bald eagle (*Haliaeetus leucocephalus*), sensitive joint-vetch (*Aeschynomene virginica* [a plant]), and swamp pink (*Helonias bullata* [a plant]).

Approximately 30 state endangered (E) and 80 state threatened (T) species are potentially present in the four Upper Bay counties (Table 2-19). Five bird species were identified, including the peregrine falcon (*Falco peregrinus,* E), least tern (*Sterna antillarum*, T), and bald eagle (*Haliaeetus leucocephalus,* T). Seven invertebrate species were identified, including the Puritan tiger beetle (*Cicindela puritana*, E) and five species of butterflies/moths. One mammal and three herpetiles were listed, including the Delmarva fox squirrel *(Sciurus niger cinereus*, E) and eastern tiger salamander (*Ambystoma tigrinum*, E). Over 100 plant RTE species were included (see Table 2-19).

Although focused on project-specific areas, recent environmental conditions assessments were conducted as part of reconnaissance studies for dredging-related placement/habitat restoration projects proposed for various reaches within the Upper Bay. These reconnaissance studies include Lower Eastern Neck Island (LENI; EA, 2003b) and Parsons Island (EA, 2003g). Three RTE were identified on LENI—the bald eagle (*Haliaeetus leucocephalus*), least tern (*Sterna antillarum*), and Delmarva fox squirrel (*Sciurus niger cinereus*). Bald eagle nest sites have been documented on both LENI and Parsons Island. Also, LENI is one of only seven sites on the Eastern Shore where naturally occurring Delmarva fox squirrel populations can still be found.

In addition to these reconnaissance-level studies, an Environmental Impact Statement was prepared for Site 104 in Queen Anne's County, Maryland (CENAB, 1999c). This document evaluated the potential impacts of using Site 104 as an open water placement site for dredged material. Since the site was entirely aqueous habitat, terrestrial RTE species were not expected. Aquatic RTE in the project area included shortnose sturgeon (*Acipenser brevirostrum, FE)* and wild Atlantic Sturgeon *(Acipenser oxyrhynchus,* Maryland Rare) populations. The EIS detailed the history, status, and biology of shortnose sturgeon populations in the Bay, as well as provided a summary to date of the USFWS's rewards program for sturgeon capture. The majority of shortnose sturgeon captured as part of this program were captured in the far Upper Bay (north of the Sassafras River). Two shortnose sturgeon, however, were captured near HMI (Table 2-23).

2.9.2 Baltimore Harbor

The MD DNR RTE list for Baltimore City (MD DNR, 2004) indicated that no federally threatened or endangered plant or animal species are present in Baltimore City or Harbor; however, recent environmental assessments for dredging-related projects in the Harbor area suggest that the federally threatened bald eagle (*Haliaeetus leucocephalus*) may nest in the vicinity of the Harbor, as discussed in more detail below.

The MD DNR RTE list for Baltitmore City identified several state-listed species, including two threatened species, seven endangered species, and one species under investigation, as shown in Table 2-20. Two species are of particular note—state endangered peregrine falcon (*Falco peregrinus*) and state threatened showy goldenrod (*Solidago speciosa*) although this species' main habitat is dry to moist open woods and fields (NPS, 2004).

CENAB recently prepared a Feasibility Study and Environmental Impact Statement for the Harbor Channels anchorages and channels (CENAB, 1997). This investigation included an RTE species evaluation for the Harbor area. USFWS identified two listed species in the Harbor Channels area: the peregrine falcon (*Falco peregrinus*), and the bald eagle (*Haliaeetus leucocephalus*). Peregrine falcons (Maryland endangered) have been consistently observed nesting in downtown Baltimore at the Inner Harbor, and a pair of falcons nest less successfully on the Francis Scott Key Bridge. Their diet generally consists of pigeons, but they occasionally prey on waterbirds. A bald eagle (FT) nest site is located in the vicinity of Black Marsh near the mouth of Back River, approximately 7 miles from the Harbor (CENAB, 1997).

The results of the 1997 Harbor EIS were supported by a recent Environmental Assessment conducted as part of a Reconnaissance Study for upland placement of Harbor dredged material. Correspondence with USFWS for this project also identified peregrine falcons (*Falco peregrinus*) and bald eagles (*Haliaeetus leucocephalus*) as the only species of concern in the area (EA, 2003a). NMFS indicated that the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) is probably only transient to the Harbor, and that no incidental catches of sturgeon have occurred in the Harbor as part of the USFWS rewards program for sturgeon.

2.9.3 Middle Bay

As for the Upper Bay evaluation above, MD DNR's county-based lists of RTE species (MD DNR, 2004) were accessed to determine which RTE species could potentially occur in the Middle Bay. Lists from the five counties with both shoreline in the Middle Bay and the potential to be impacted by dredging activities were compiled—Calvert County, Dorchester County, Somerset County, St. Mary's County, and Talbot County. The results of this search are presented in Table 2-21.

Five federally endangered and five federally threatened species are potentially present in the Middle Bay (Table 2-21). The federally endangered species are the red-cockaded woodpecker (*Picoides borealis*), American burying beetle (*Nicrophorus americanus*), dwarf wedge mussel (*Alasmidonta heterodon*), Delmarva fox squirrel (*Sciurus niger cinereus*), and Chermock's mulberry wing (*Poanes massasoit chermocki* [a butterfly]). The five federally threatened species potentially present in the Middle Bay are the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), the Puritan tiger beetle (*Cicindela puritana*), the bald eagle (*Haliaeetus leucocephalus*), sensitive joint-vetch (*Aeschynomene virginica* [a plant]), and swamp pink (*Helonias bullata* [a plant]).

Approximately 30 state endangered (E) and 80 state threatened (T) species are potentially present in the five Middle Bay counties (Table 2-21). Six bird species were identified, including the peregrine falcon (*Falco peregrinus,* E), least tern (*Sterna antillarum*, T), and bald eagle (*Haliaeetus leucocephalus,* T). Six invertebrate species were identified, including the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*, E) and Puritan tiger beetle (*Cicindela puritana*, E). One mammal and two herpetiles were listed: Delmarva fox squirrel *(Sciurus niger cinereus*, E), eastern tiger salamander (*Ambystoma tigrinum*, E), and eastern narrow-mouthed toad (*Gastrophryne carolinensis*, E). Over 100 plant species were included (Table 2-21).

Although focused on project-specific areas, recent environmental conditions assessments were conducted as part of reconnaissance studies for dredging-related placement/habitat restoration projects proposed for various reaches within the Middle Bay. These reconnaissance studies include Barren Island (WESTON, 2002a), Holland Island (Baker, 2003), James Island (EA, 2003d), Sharps Island (AMA, 2002), and PIERP (EA, 2003e).

These reconnaissance studies demonstrated that Middle Bay islands provide breeding grounds, foraging grounds, or habitat for several federal or state RTE species. Bald eagles were cited as either residents or potential residents or foragers on all islands investigated (Holland, James, Poplar, Barren, and Sharps Islands). The Maryland State threatened least tern (*Sterna antillarum*) was identified on PIERP during various site visits since 1994, and approximately five nest sites were observed for the least tern in 2001 (EA, 2003e). Least tern and state threatened black skimmers (*Rynchops niger*)) were documented on Barren Island (WESTON, 2002a). Sightings of the Maryland State-ranked Rare northern harrier (*Circus cyaneus*) were noted for James Island (EA, 2002b). Many of the islands have high concentrations of waterfowl and serve as colonial waterbird nesting sites. The reconnaissance studies also indicated the presence of shortnose sturgeon (*Acipenser brevirostrum*, FE) and wild Atlantic sturgeon (*Acipenser oxyrhynchus,* Maryland Rare). Atlantic sturgeon were caught within 1 mile of James Island, as reported by the Maryland Rewards Program for sturgeon (EA, 2002b). Nine shortnose sturgeon have been caught in the Middle Bay as reported by the Maryland Rewards Program for sturgeon (Table 2-23).

2.9.4 Lower Bay

The Virginia Natural Resources Heritage Program (VNRHP) has developed an online searchable database (http://www.dcr.state.va.us/dnh/nhrinfo.htm) for rare, threatened, and endangered species in Virginia (VNRHP, 2004). This database is searchable by county, watershed, subwatershed, physiographic province, or natural community. The database was accessed and searched by subwatershed to determine which species of special concern could potentially be located in the Lower Chesapeake Bay and adjacent land areas. The results of this search are presented in Table 2-22. The specific subwatersheds included in the analysis are also listed in Table 2-22.

One federally endangered and three federally threatened species are potentially present in the Lower Bay: shortnose sturgeon (*Acipenser brevirostrum*, FE), the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), the piping plover (*Charadrius melodus),* and the bald eagle (*Haliaeetus leucocephalus)*. In addition, four federal species of special concern were identified: Brimley's assassin bug (*Pnirontis brimleyi*), creamflower tick-trefoil (*Desmodium ochroleucum;* vascular plant), Harper's fimbristylis (*Fimbristylis perpusilla*; vascular plant), and Virginia least trillium (*Trillium pusillum var. virginian;* vascular plant). No federally endangered species were identified in the proposed project area.

Five state endangered (E), five state threatened (T), and four state species of special concern (SC) are potentially present in the Lower Bay. The identified species are as follows: eastern big-eared bat (*Corynorhinus rafinesquii macrotis,* E); tiger salamander (*Ambystoma tigrinum,* E); canebrake rattlesnake (*Crotalus horridus atricaudatus*, E); chicken turtle (*Deirochelys reticularia*, E); Harper's Fimbristylis (*Fimbristylis perpusilla,* E [vascular plant]), Mabee's salamander (*Ambystoma mabeei,* T); barking treefrog (*Hyla gratiosa,* T); piping plover (*Charadrius melodus,* T); peregrine falcon (*Falco peregrinus,* T); bald eagle (*Haliaeetus leucocephalus,* T); saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus,* SC); Northern harrier (*Circus cyaneus,* SC); yellow-crowned night-heron (*Nyctanassa violacea,* SC); and least tern (*Sterna antillarum,* SC).

The VNRHP also identified numerous state-ranked species, in addition to state-listed species (i.e., "extremely rare," "very rare," or "rare" species). State-ranked species are also presented in Table 2-22. Rare species identified in the proposed project area include three species of nonvascular plants, four species of spiders, seven species of true bugs, five species of birds, and more than 50 species of vascular plants.

In 1994, USACE Norfolk District prepared a *Draft Information Report on Lower Bay Uses of Dredged Material* (CENAO, 1994). This evaluation, focused on the lower reaches of James River, indicated that eight federally listed species may be present—piping plover, bald eagle, shortnose sturgeon, Atlantic loggerhead turtle (*Caretta caretta*), Atlantic green turtle (*Chelonia mydas*), Atlantic hawksbill turtle (*Eretmochelys imbricata*), Atlantic leatherback turtle (*Dermochelys coriacea*), and Atlantic Ridley turtle (*Lepidochelys kempii*). This EIS noted that with the exception of the piping plover, all species are considered to be transient and would not be affected by island creation.

USACE prepared an EIS for a larger area encompassing more of the Lower Bay for the deepening of Norfolk Harbor and Channels (CENAO, 1985). This study indicated that the marine turtles occur on more than an occasional or transient basis in the Lower Bay, and that Chesapeake Bay is an important nursery for immature loggerheads (*Caretta caretta*) and Kemp's ridleys (*Lepidochelys kempii*). Also, the Lower Bay is a summer foraging area for several populations of juvenile sea turtles, and the EIS cites a Virginia Institute of Marine Science study that estimated more than 3,000 loggerheads and more than 250 Kemp's ridleys moving into the Bay each summer to forage.

In 2003, the National Marine Fisheries Service (NOAA Fisheries) prepared a Biological Opinion on the impacts of the U.S. Army Corps of Engineers maintenance dredging in the Virginia channels. According to this opinion, maintenance dredging should not be performed from April 1 to November 30 to minimize the incidental take of sea turtles. If dredging must be performed during this time period, sea turtle deflectors must be added to the hopper dredge and endangered species observers must be used 100% of the time (NOAA, 2003b).

In October 2003, one short-nose sturgeon was caught during pre-dredge exclusion trawling in Thimble Shoals Channel (Boraczek, 2004). This is of interest because shortnose sturgeon are usually found farther north in the Bay.

2.10 RECREATION

The Bay's open waters, tidal rivers, shorelines, parks, wildlife refuges, and a rapidly developing system of land and water trails provide excellent opportunities for public use, enjoyment, education, and scientific study with ecotourism becoming very popular in the Bay Region. The traditional uses of the Bay's waters by area residents have attracted visitors from along the east coast of the United States for recreation. Typical recreational activities in the Chesapeake Bay area include fishing, fly-fishing, oystering, crabbing (blue crabs), boating, bike riding through trails, forest discovery hikes organized by the Chesapeake Bay Program, Bay Lighthouse tours, arboretum and museum tours, picnicking, and bird watching, as well as enjoying the scenic beauty of the Bay, beaches, and the islands. In recent decades, Bay-related recreation has become a socioeconomic force in the region. Included below is a brief review of some of the Chesapeake Bay's recreational resources.

2.10.1 Parks

The Alliance for the Chesapeake Bay, in partnership with federal, state, and local government agencies, as well as other conservation groups, created the Susquehanna River Trail. These water trails are recreational waterways on a lake, river, or ocean between specific points containing access points and day use and/or camping sites for the boating public. Boating, canoeing, and kayaking are predominant recreational activities in this area.

The Chesapeake Bay Area consists of hundreds of local parks and over 500 public access sites, which are catalogued through the Public Access Guide-Chesapeake Bay, Susquehanna River, and Tidal tributaries. The Chesapeake Bay Gateways Network, a partnership system of sites, land trails, and water trails around the Chesapeake Bay watershed, represents a broad cross section of Bay area parks. The Gateways Network includes more than 120 parks, refuges, historic ports, museums, and trails. More specifically, it includes 21 state parks, 8 units of the National Park System, 5 national wildlife refuges, 18 museums, an Indian reservation, 17 water trails, and a number of other sites (Chesapeake Bay Gateways Network, 2002).

Responding to a request from Congress, the National Park Service (NPS) is exploring the potential for a new unit of the National Park Service focused on the Chesapeake Bay. This study and Environmental Impact Statement (EIS) describes a series of conceptual alternatives for how the National Park System might best represent the national significance of the Chesapeake Bay. (*Draft Chesapeake Bay Special Resource Study (SRS) and Environmental Impact Statement* Executive Summary).

At the completion of this study it was found that the most effective alternative for the National Park Service was to enhance the version of the Chesapeake Bay Gateways Network. According to an article on the Chesapeake Bay Gateways Network Web site (www.baygateways.net), the study found that enhancements to the existing programs of the Chesapeake Bay Gateways Network will allow the National Park Service to assist partners in telling the story and preserving the resources of the Chesapeake Bay. The Park Service would not manage or acquire new lands, but would continue to assist designated Gateways with interpretation and education, improving public access and engaging citizens in the stewardship of Chesapeake Bay resources. (Information on this study is located at www.chesapeakestudy.org.)

2.10.2 Sport Fishing

Desirable sport fish species are found throughout the Bay at various times during the year. According to the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation in Maryland, there was an estimated 7.5 million days of sport fishing in the year 2001 for Maryland alone (U.S. Census Bureau, 2001).

In the spring, American and hickory shad, river herring, and white perch are found in the Bay streams, with fishing for river herring closed from June 6 to December 31, 2004 (MD DNR, 2004l). Intensive spring fishing is done in the Susquehanna Flats, the Choptank River, and in Charles County. Sport fishermen also catch bluefish, channel catfish, spotted sea trout, striped bass, weakfish, white catfish, white perch, winter flounder (*Pseudopleuronectes americanus*), and yellow perch near the HMI. At PIERP, striped bass and white perch fishing is very popular in the shallows near both islands. In Tangier Sound, there is fishing for large red drum (*Scianeops occellata*) and black drum (*Pogonius cromis*) that move into the area in the spring. In addition to fishing in the bay proper, there is also a great deal of freshwater fishing of largemouth bass and crappies in Bay tributaries.

Sport fishing for blue crabs is extremely popular along the shoreline throughout the Bay during summer months.

2.10.3 Boating

The Bay region offers a number of seasonal recreational activities such as sea kayaking, power boating, and sail boating. Recreational boats now outnumber work boats in most of the Bay's communities. In 2000, there were more than 445,000 recreational boats registered in Maryland, Virginia, and the District of Columbia (U.S. Coast Guard, 2000). The Department of Chesapeake Bay Affairs mentions that an additional 20,000 out-of-state boats visit Maryland waters each year.

Local marinas have various recreational features, including piers and docking facilities for the public. A comprehensive list of Chesapeake Bay marinas is presented online at http://www.baydreaming.com/marinas.htm. The marinas are full-service yards that offer a wide range of services and facilities for recreational boaters.

Many tourists also choose to board a charter boat for sightseeing and sport fishing. A charter boat captain location service is offered on the Upper Bay Charter Captains Association, Inc., Web site (www.baycaptains.com).

2.10.4 Other Recreation Resources

Chesapeake Bay beaches, many with soft, sandy bottoms, are popular summertime destinations for swimmers. The Baltimore region alone has nearly 2 miles of swimming beaches open to the public.

Upper Chesapeake Bay has numerous museums preserving and interpreting the heritage of the Bay area. There are a significant number of National Historic Landmarks scattered throughout the Bay region.

The Chesapeake Bay Gateways Network provides resources to help visitors experience the Bay's vast diversity. A comprehensive Web site and an annual map guide provide information on all Chesapeake destinations, namely museums, wildlife refuges, historic towns, hundreds of miles of water trails, sailing ships, and other recreational activities, including walking, hiking, paddling, and bird watching.

2.10.5 Wild and Scenic Rivers

The Wild and Scenic Rivers Act, P. L. 90-542, (as amended) (16 U.S.C. 1271-1287) states:

> It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations. The Congress declares that the established national policy of dam and other construction at appropriate sections of the rivers of the United States needs to be complemented by a policy that would preserve other selected rivers or sections thereof in their free-flowing condition to protect the water quality of such rivers and to fulfill other vital national conservation purposes.

The National Park Services National Wild and Scenic Rivers System Web site (www.nps.gov/rivers) lists designated rivers by state. Additional information concerning the rivers entering the Chesapeake Bay is contained on the Chesapeake Bay Foundation's Web site (www.cbf.org). There are no federally designated wild and scenic rivers in the Chesapeake Bay area.

Both Maryland and Virginia have rivers in the Bay region designated as scenic and wild (Maryland) and scenic (Virginia) (American Rivers, undated). Rivers in Maryland designated as scenic and wild include the Anacostia River, Deer Creek, Monocacy River, Patuxent River, Pocomoke River, Potomac River (in Montgomery and Frederick counties), Severn River, Wicomico River in Charles County, and Youghiugheny River. The Virginia Scenic Rivers System includes the Appomattox River, Catoctin Creek, Chickahominy River, Clinch River, Goose Creek, Guest River, James River, Moormans River, North Landing and tributaries, North Meherrin River, Nottoway River, Rappahannock River, Rockfish River, Rivanna River, Shenandoah River, and Staunton River.

2.11 CULTURAL RESOURCES

From 3 April through 10 May 2004, Panamerican Consultants, Inc., a subcontractor to WESTON, conducted a reconnaissance-level cultural resources survey for the CENAB DMMP. The purpose of the survey was to identify known cultural resources within proposed and existing dredge material placement sites. Cultural resources include archaeological sites, buildings, structures, objects, or districts. Based on the prehistory, history, and topography of each DMMP site, a determination of the potential for additional cultural resources within each site was formulated. The reconnaissance-level cultural resource survey identified known cultural resources within the proposed and existing dredge material placement areas within and near the Chesapeake Bay. Further site specific testing and assessment of project effects will need to be addressed on a site-by-site basis. The full report of cultural resources is included in Appendix E of this report.

2.12 SOCIOECONOMICS

The Chesapeake Bay is an integral part of the socioeconomic framework of this region. The socioeconomics of the Chesapeake Bay region are tied to commercial and recreational activities on the Chesapeake Bay and at associated ports. Demographics, employment, industry, environmental justice, and commercial fishing activity are discussed in the following sections.

2.12.1 Population

Demographic information for the Upper Bay, Middle Bay, Lower Bay, and Harbor areas was obtained from the U.S. Census Bureau database (Year 2000 Census data) available online: http://www.census.gov/main/www/cen2000.html (U.S. Census Bureau, 2004). Information in the database was queried by county or independent city, and then compiled for the four geographic areas. The database does not have Chesapeake Bay Watershed-specific delineations available.

General descriptive population characteristics are presented here at the county/independent level. Substantially more-detailed population characteristics, such as education and heritage, are available on the U.S. Census Bureau Web site. This more-detailed information is available at the state, county, and municipality level. In addition, all general and detailed information is also available for much smaller geographic areas (e.g., census block level).

2.12.1.1 *Upper Bay*

Population information was obtained and compiled from the U.S. Census Bureau (U.S. Census Bureau, 2004) for the four Maryland counties with both shoreline in the Upper Bay and the potential to be impacted by dredging activities—Anne Arundel County, Baltimore County, Kent County, and Queen Anne's County. Demographic information for the Upper Bay is presented in Table 2-24.

Baltimore County and Anne Arundel County are densely populated areas, with 1,260 and 1,177 persons per square mile in 2000, respectively. These high-population densities are due to the proximity to metropolitan areas. Baltimore County is located adjacent to Baltimore City. Anne Arundel County is centered between Baltimore City and Washington, DC. In contrast, Kent and Queen Anne's Counties are more rural and less densely populated, with 69 and 109 persons per square mile in 2000, respectively.

Total population in Baltimore County in 2000 was 754,292 persons; 489,656 persons in Anne Arundel County; 19,197 persons in Kent County; and 40,563 persons in Queen Anne's County. Populations in all four counties increased significantly over the past decade (period from 1990 to 2000). The absolute growth rate for population ranged from +7.6% in Kent County to +19.5% in Queen Anne's County. The percentage of populations less than 5 years of age and over 65 years of age are provided in Table 2-24 for each area.

Of the four counties, minority populations comprise the greatest percentage in Baltimore County (26.6%), with smaller populations in Kent County (21.6%), Anne Arundel County (20.2%), and a substantially smaller population in Queen Anne's County (11.6%).

The homeownership rate in 2000 was highest for Queen Anne's County (83.4%), with lower rates in Anne Arundel County (75.5%), Kent County (70.4%), and Baltimore County (67.6%). The percentage of persons below the poverty level was highest in Kent County (13.0%), with lower rates in Baltimore County (6.5%), Queen Anne's County (6.3%), and Anne Arundel County (5.1%). The median value of owner-occupied housing units ranged from a high of $159,300 in Anne Arundel County to a low of $115,500 in Kent County. Additional housing and household information for each of the four counties is provided in Table 2-24, including per capita income and total number of households.

2.12.1.2 *Baltimore Harbor*

Population information was obtained and compiled from the U.S. Census Bureau for Baltimore City (U.S. Census Bureau, 2004). Demographic information for Baltimore City is presented in Table 2-25.

Baltimore City is a metropolitan center with a high population density (8,058 persons per square mile). In 2000, the total population numbered 651,154 persons. The population in Baltimore City has decreased significantly over the past decade (period from 1990 to 2000). The absolute growth rate for Baltimore City for this period was -11.5%. Approximately 6.4% of the existing population is less than 5 years of age, while approximately 13.2% of the population is over 65 years of age. Minority populations comprise approximately 69% of Baltimore City residents.

The homeownership rate in 2000 was 50.3% for Baltimore City residents, with the median value of owner-occupied housing units averaging $69,100. Per capita income (average value) for Baltimore City was $16,978. Poverty is a pervasive problem in Baltimore City, with 22.9% of persons living below the poverty level in 1999. The poverty threshold for this year was $13,410 (U.S. Census Bureau, 2004).

2.12.1.3 *Middle Bay*

Population information was obtained and compiled from the U.S. Census Bureau (U.S. Census Bureau, 2004) for the six Maryland counties with both shoreline in the Middle Bay and the potential to be impacted by dredging activities: Anne Arundel County, Calvert County, Dorchester County, Somerset County, St. Mary's County, and Talbot County. Demographic information for Anne Arundel County is presented in Table 2-24. Demographic information for the remaining counties bordering the Middle Bay is presented in Table 2-26.

The population density in Middle Bay counties ranges from 55 persons per square mile in Dorchester County to 1,177 persons per square mile in Anne Arundel County.

Total population in Anne Arundel County in 2000 was 489,656 persons; 74,563 persons in Calvert County; 30,674 persons in Dorchester County; 24,747 persons in Somerset County; 86,211 persons in St. Mary's County; and 33,812 persons in Talbot County. Populations in all six counties increased over the past decade (1990 to 2000), although the rate of growth varied considerably. Dorchester County had the population with the most modest absolute growth rate (1.4%). Calvert County grew by an astounding 45.1% over this period. The percentage of populations less than 5 years of age and over 65 years of age are provided in Table 2-26 for each area.

Of the six counties, minority populations comprise the greatest percentage in Somerset County (44.2%), with smaller populations in Dorchester County (31.2%), Anne Arundel County (20.2%), St. Mary's County (19.6%), Talbot County (18.8%), and Calvert County (17.0%).

The homeownership rate in 2000 was highest for Calvert County (85.2%), with lower rates in Anne Arundel County (75.5%), Talbot County (71.6%), St. Mary's County (71.8%), Dorchester County (70.1%), and Somerset County (69.6%). The percentage of persons below the poverty level was highest in Somerset County (20.1%), with lower rates in Dorchester County (13.8%), Talbot County (8.3%), Dorchester County (13.8%), St. Mary's County (7.2%), and Calvert County (4.4%). The median value of owner-occupied housing units ranged from a high of $159,300 in Anne Arundel County to a low of $81,100 in Somerset County. Additional housing and household information for each of the five counties is provided in Table 2-26, including per capita income and total number of households.

2.12.1.4 *Lower Bay*

Numerous (more than 20) Virginia counties and independent cities have land area that borders the Chesapeake Bay. Population information was obtained and compiled from the U.S. Census Bureau (U.S. Census Bureau, 2004) for the 10 Virginia counties/cities with both shoreline in the Lower Bay and the greatest potential to be impacted by dredging activities: Accomack County, Lancaster County, Northampton County, Mathews County, Gloucester County, Isle of Wight County, Norfolk City, Virginia Beach City, Newport News City, and Hampton City. Demographic information for the Lower Bay areas is presented for each of the 10 areas in Table 2-27.

The 10 Virginia counties/cities evaluated vary widely in population density, ranging from a low of 63.1 persons per square mile in Northampton County to a high of 4,362.8 persons per square mile in Norfolk City.

Total population in the Lower Bay areas ranges widely from a low of 9,207 persons in Mathews County to a high of 425,257 in Virginia Beach. Populations throughout the Lower Bay remained relatively flat over the past decade (period from 1990 to 2000). The Population Percent Change from 1990-2000 ranged from -10.3% in Norfolk City to 20.8% in Accomack County. The percentage of populations less than 5 years of age and over 65 years of age are provided in Table 2-27 for each area. Newport News City has the highest percentage of population less than 5 years of age (7.9%). Lancaster County houses the highest percentage of persons greater than 65 years of age (28.5%).

Of the 10 Lower Bay areas evaluated, minority populations comprise the greatest percentage in Hampton City (51.5%) and Norfolk City (53.0%). Minority populations comprise the smallest percentage of total population in Gloucester County (14.3%) and Mathews County (13.2%).

The homeownership rate in 2000 was highest in Mathews County (84.7%) and Lancaster County (83%), and lowest in the four most urban areas, Norfolk City (45.5%), Newport News City (52.4%), Hampton City (58.6%), and Virginia Beach City (65.6%). The percentage of persons below the poverty level was highest in Norfolk City (19.4%) and Northampton County (20.5%). The median value of owner-occupied housing units ranged from a high of $131,600 in Lancaster County to a low of $78,700 in Northampton County. Additional housing and household information for each of the 10 Lower Bay areas is provided in Table 2-27, including per capita income and total number of households.

2.12.2 Employment and Income

Economic and income information for the Upper Bay, Middle Bay, Lower Bay, and Harbor areas was obtained from the U.S. Census Bureau database (Year 2000 Census data) available online: http://www.census.gov/main/www/cen2000.html (U.S. Census Bureau, 2004). Information in the database was queried by county or independent city, and then compiled for the four geographic areas. The database does not have Chesapeake Bay Watershed-specific delineations available.

General economic characteristics are presented here at the county/independent city level, including percentage of population employed, distribution of occupation types, distribution of industry, and distribution of worker class. Additional economic characteristics, such as income distribution, are available on the U.S. Census Bureau Web site. This more-detailed information is available at the state, county, and municipality level. In addition, all general and detailed information is also available for much smaller geographic areas (e.g., census block level).

Economics and occupations are tied to tourism in this region. Specific industries exist for tourism. For example, marinas and the use of charter boats for sport fishing and sightseeing cater to travelers to the area. Museums are also used to educate tourists about the Chesapeake Bay region.

2.12.2.1 *Upper Bay*

The distribution of occupation types was similar for the four Maryland counties evaluated in the Upper Bay. The majority of workers in each of the four counties provide management and professional services (30% to 40% of workforce). Sales and office occupations are the second most common occupation type (20% to 30%). Service, construction/maintenance, and production/transportation occupations are each held by approximately 10% to 15% of the workforce. Farming/fishing/forestry occupations employ the lowest percentage of the workforce in all four counties. Although quite a small percentage of the workforce in three of the four counties (1% to 1.5% is agricultural), 4% of the workforce in Kent County in 2000 were farmers or fishermen. Percentages for each occupation type for each area in the Upper Bay are listed in Table 2-28.

Table 2-28 also provides an industrial profile for each of the four Maryland counties. The profile divides the various industries into 13 categories. The education, health, and social services category comprised the highest percentage of industry in each of the four Maryland counties. Agriculture and fishing comprised the lowest percentage of industry in Anne Arundel (0.2%) and Baltimore County (0.2%). Agriculture and fishing comprised a slightly higher percentage of industry in Queen Anne's County (3.4%) and Kent County (6.3%).

Levels of unemployment ranged in Upper Bay counties from 1.9% in Queen Anne's County to 2.8% in Baltimore County. The unemployment rates are based on the reported values in the 2000 U.S. Census. The median household income ranged from $39,869 in Kent County to $61,768 in Anne Arundel County.

2.12.2.2 *Baltimore Harbor*

The majority of workers in Baltimore City provide management and professional services (32.4% of workforce), or are in sales and office occupations (27.1% of workforce). Service occupations employ approximately 20% of city workers; production/transportation occupations employ approximately 13.4% of city workers; and construction/maintenance occupations employ approximately 7% of the workforce. Farming/fishing/forestry occupations employ a negligible percentage of the workforce (0.1%). Percentages for each occupation type for each category are listed in Table 2-28.

Table 2-29 also provides an industrial profile for Baltimore City. Education, health, and social services comprised the highest percentage of industry in Baltimore City (26.8%). Industry was fairly well divided over the remaining 12 categories, with the exception of agriculture and fishing. Agriculture/fishing/forestry comprises a negligible percentage of industry in Baltimore City (0.1% of industry).

Baltimore City had a 6% unemployment rate, according to data collected by the 2000 U.S. Census.

2.12.2.3 *Middle Bay*

The distribution of occupation types was similar for the five Maryland counties evaluated in the Middle Bay. These distributions mirrored those in the Upper Bay. The majority of workers in each of the five counties provide management and professional services (23% to 39% of workforce). Sales and office occupations are the second most common occupation type (22% to 25%). Service, construction/maintenance, and production/transportation occupations are each held by approximately 10% to 20% of the workforce. Farming/fishing/forestry occupations employ the fewest percentage of the workforce in all five counties: 0.2% in Calvert County; 2.5% in Dorchester County; 3.8% in Somerset County; 0.7% in St. Mary's County; and 1.7 in Talbot County. Percentages for each occupation type are listed by county in Table 2-29.

Table 2-29 also provides an industrial profile for each of the five Maryland counties. The profile divides the various industries into 13 categories. The education, health, and social services category comprised the highest percentage of industry in each of the five Maryland counties. Agriculture/fishing/forestry comprised the lowest percentage of industry in Calvert County (0.7%) and St. Mary's County (1.1%). Agriculture/fishing/forestry comprised a higher percentage of industry in Dorchester County (4.1%), Somerset County (5.5%), and Talbot County (3.5%).

Levels of unemployment ranged in Middle Bay counties from 2.1% in Talbot and Calvert Counties to 4.9% in Somerset County. The unemployment rates are based on the reported values in the 2000 U.S. Census. The median household income ranged from $29,903 in Somerset County to $65,945 in Calvert County.

2.12.2.4 *Lower Bay*

The distribution of occupation types was similar for the 10 Virginia counties/independent cities evaluated in the Lower Bay. These distributions mirrored those described for the Upper and Middle Bay areas. The majority of workers in each area provide management and professional services (25% to 36% of workforce). Sales and office occupations are the second most common occupation type (20% to 30% of workforce). Service, construction/maintenance, and production/transportation occupations are in approximately similar amounts by the remainder of the workforce. Farming/fishing/forestry occupations employ the lowest percentage of the workforce (<2%) in all Lower Bay areas counties, with the exception of Accomack County. Accomack County reported that 5.9% of its workforce has farming/fishing/forestry occupations. Percentages for each occupation type are listed by county/independent city in Table 2-30.

Table 2-30 also provides an industrial profile for each of the 10 Lower Bay areas. The profile divides the various industries into 13 categories. The education, health, and social services category comprised the highest percentage of industry in 8 of the 10 areas. Manufacturing comprised the highest percentage of industry in Isle of Wight County and Accomack County. Agriculture/fishing/forestry comprised varying rates of industry in the 10 areas, from a low of 0.2% in both Virginia Beach and Norfolk to a high of 7.9% in Northampton County.

Levels of unemployment ranged in Lower Bay counties from 1.8% in Mathews County to 4.7% in Norfolk City. The unemployment rates are based on the reported values in the 2000 U.S. Census. The median household income ranged from $28,276 in Northampton County to $48,705 in Virginia Beach.

2.12.3 Environmental Justice

Executive Order 12898, signed in 1994, is a presidential directive to all federal agencies to make environmental justice a part of all programs, policies, and activities. The order augments Title VI of the Civil Rights Act of 1964 by making the prohibition of discrimination based on race, color, and national origin more specific. Environmental justice is defined by U.S. EPA as “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.” Environmental justice seeks equal protection from environmental and public health hazards for all people regardless of race, income, culture, and social class. Additionally, environmental justice means that no group of people, including racial, ethnic, or socioeconomic groups (which includes low-income and minority populations), should bear a disproportionate share of the negative environmental consequences resulting from industrial, land-use planning and zoning, municipal and commercial operations, or the execution of federal, state, local, and municipal programs and policies.

Environmental justice issues have grown in prominence over the last decade. Given the current negative public perception of dredged material, environmental justice concerns should be evaluated for the DMMP.

2.12.3.1 *Upper Bay*

The State of Maryland is determining how to best ensure environmental justice for its citizens. In 1997, the Maryland General Assembly passed House Bill 1350, establishing the Maryland Advisory Council on Environmental Justice (MACEJ). In addition, the Maryland Commission on Environmental Justice and Sustainable Communities was established by Executive Order 01.01.2001.01 in January 2001. The Commission has been tasked to "examine environmental justice and sustainable communities' issues that may be associated with creating healthy, safe, economically vibrant, environmentally sound communities for all Marylanders in a manner that allows for democratic processes and community involvement." To date, the Commission has prepared three annual reports (available online: http://www.mde.state.md.us/Programs/MultimediaPrograms/Environmental_Justice/implementation/cejsc.asp).

The Commission is also developing a framework and indicators for environmental justice communities, as reported by Mr. Andrew Sawyer, Program Manager for Community Planning and Environmental Justice for MDE (A. Sawyer, personal communication, 2004).

The *Community Planning Framework* characterizes communities using a suite of socioeconomic, environmental, and public health parameters. The framework is a comparative tool by design, and should be supplemented with survey data and anecdotal information. While not a tool to "profile" environmental justice communities, the framework has been developed to identify communities that are at risk to new environmental stresses. To date, this framework has been successfully applied to one project in Prince George's County, Maryland. The recently convened Harbor Team to evaluate dredged material placement issues for the Harbor Channels is an excellent example of community involvement and environmental justice. The Harbor Team fostered community involvement in the earliest stages of dredged material placement site selection, and resulted in the publication of a recommendations report that had community support (Harbor Team, 2003). The team also recommended mitigation options through the beneficial use of dredged material.

According to the Commission's 2003 Annual Report, some communities are more prone to unhealthy environments. In particular, poorer communities are more likely to experience environmental justice concerns. One recommendation states that state agencies should examine opportunities to assist communities facing these concerns. This process can be facilitated by undertaking pilot studies in communities to demonstrate how best to address environmental justice issues.

The *Community Planning Framework* is currently under development. When specific proposed project sites are identified, the current framework should be obtained and applied to evaluate environmental justice concerns.

2.12.3.2 *Baltimore Harbor*

Given the current socioeconomic status of Baltimore, specifically its high level of poverty and unemployment, environmental justice concerns must be evaluated for the Harbor area. See the discussion of environmental justice in Maryland in the previous section for a review of the status of environmental justice issues in Maryland.

2.12.3.3 *Middle Bay*

See the discussion of environmental justice issues in Maryland in the Upper Bay section.

2.12.3.4 *Lower Bay*

The Commonwealth of Virginia has not yet established any specific Commissions or Offices to address environmental justice concerns for its citizens. Kathy Fromme, Director of Policy at VADEQ, noted that an Office of Minority Health has been established in Virginia. This office should be contacted if a proposed project site is located in an area with a high percentage of minority residents (K. Fromme, personal communication, 2004).

The Center for Healthy Communities, a community-academic partnership, has developed a searchable database to assist with the identification of environmental justice communities in Virginia. The database includes a suite of health, environmental, and socioeconomic parameters. Socioeconomic parameters will be primarily those available from the U.S. Census described in the sections above. Environmental outputs include the number of days of poor air quality, and park acreages and impaired waters. Health information will be compiled, and include information such as cancer rates, birth rates, and asthma rates. This database is available online and searchable by zip code at:

http://www.vahealthycommunities.com/default.asp?pageid=1D3241EF-C343-42BA-9EEE-DDD4189166E4. If a proposed project site is selected in Virginia, this system will be a valuable tool for identifying environmental justice communities and should be consulted.

2.13 TRANSPORTATION

The study area is located within one of the nation's most comprehensive transportation networks along the eastern seaboard. The Chesapeake Bay's proximity to the metropolitan areas of Baltimore, Washington, DC, and Norfolk allows access to an extensive infrastructure of aviation, railroads, highway, and navigable waterways. This section describes the transportation network and provides the basis for assessing the impacts. Highways and the metropolitan areas of Baltimore; Washington, DC; and Norfolk are shown in Figure 1-2.

2.13.1 Port of Baltimore

The Port of Baltimore is one of the busiest ports on the East Coast of the United States, handling more than 40 million tons annually of all types of cargo, of which 24.7 million tons is foreign commerce valued at $26 billion (MPA, 2003). Its inland location makes it the closest Atlantic port to the major population and manufacturing centers of the Midwest. Because of its outstanding highway access, nearly one-third of U.S. households are within a day's reach of the Port. The Port has container-handling and auto-handling facilities as well as facilities for loading and unloading a full range of bulk and general commodities. Navigable access to the Port is provided by numerous channels, anchorages, turning basins, and berthing areas that are maintained by the federal government, the state, or private enterprises. The federal navigation channels that serve the Port are an important part of the regional transportation infrastructure. These channels are described in more detail in Chapter 1 and the Port is shown in Figure 1-4.

2.13.1.1 *Bay Navigation*

In addition to the channels that provide access to the Port of Baltimore, there are many federal, state, and privately maintained channels throughout the Bay and its tributaries. These channels provide safe passage for commercial shipping and fishing vessels and recreational boaters.

2.13.1.2 *Railroads*

Major rail service in the region is provided primarily by CSX Transportation, Norfolk Southern, and Amtrak, while commuter service to and from Washington is provided by the State of Maryland through its commuter rail service (MARC). Light rail systems in the Baltimore area, together with two major and modern subway systems in the Baltimore and Washington, DC, areas, provide means of commuter transportation.

2.13.1.3 *Highways and Roadways*

The study area includes an extensive network of interstate roads and highways including I-66, I-97, I-95, I-81, I-83, I-70, I-270, the Washington Beltway (I-495), and the Baltimore Beltway (I-695). U.S. Route 50/301 and the William Preston Lane Memorial Bay Bridge connect the mainland to the Delmarva Peninsula and the Chesapeake Bay Bridge-Tunnel connects the Delmarva Peninsula to the Hampton Roads region of Virginia. Approximately 5,000 private truck haulers and independent common and contract haulers use these highways throughout the study area (CENAB, 2001a). Highways are shown in Figure 1-2.

2.14 NOISE

Noise is defined as unwanted sound that is disruptive and diminishes the quality of the surrounding environment. It is emitted from many sources including airplanes, factories, railroads, power generation plants, and highway vehicles, etc. The magnitude of noise is described by its sound pressure. A logarithmic scale is used to relate sound pressure to a common reference level, as the range of sound pressure varies greatly. This is called the decibel (dB). A weighted decibel scale is often used in environmental noise measurements (weighted-A decibel scale or dBA). This scale emphasizes the frequency range to which the human ear is most susceptible. A 70-dBA sound level can be moderately loud as in an indoor vacuum cleaner. A 120 dBA can be uncomfortably loud, as in a military jet takeoff at 50 ft, and a 40-dBA sound level can be very quiet and is the lowest limit of urban ambient sound.

The degree of disturbance or annoyance of unwanted sound depends on 1) the amount and nature of intruding noise, 2) the relationship between the background noise and the intruding noise, and 3) the type of activity occurring at the location where the noise is heard. Human response to noise varies from individual to individual and is dependent on the ambient environment in which the noise is perceived. Wind, temperature, and other conditions can change the sound volume perceived at distances from the noise source.

To ensure a suitable living environment, the Department of Housing and Urban Development (HUD) has developed a noise abatement and control policy, as seen in 24 CFR Part 51. According to this policy, noise not exceeding 65dBA is considered acceptable. Noise above 65 dBA but not exceeding 75 dBA is normally acceptable, but noise above 75 dBA is unacceptable. Regulatory thresholds by state and local governments can also provide criteria to judge the significance of noise impacts.

MDE's 2002 Annual Enforcement Report mentions that the Noise Control Program has been established to provide assistance to the citizens and local jurisdictions across states regarding compliance with community noise issues that are not handled at the local level. Noise has become an increasingly contentious quality of life issue as the state's population increases and urban development progresses. When a noise-level violation is encountered, primary emphasis is placed on compliance assistance and cooperative resolution.

The distribution and characterization of aquatic and terrestrial biota in the Bay has been provided previously in Chapter 2. Many species in the Bay use noise to communicate, navigate, breed, and locate sources of food. The sensitivity varies among species, location, and season (e.g., breeding, migration, and roosting). Underwater noise influences fish and other marine animal behavior, resulting in changes in their hearing sensitivity, and behavioral patterns. Sound is important to them when they are hunting for prey, avoiding predators, or engaging in social interaction. Fish can also suffer from acoustically induced stress in their own habitat. Changes in vocalization behavior, breathing and diving patterns, and active avoidance of noise sources by marine life have all been observed in response to anthropogenic noise (Michael Stocker Associates, 2002).

The study area for this DMMP/EIS is primarily open water areas within the Bay. The islands being considered for restoration are either uninhabited or contain few residents, and no environmentally sensitive areas such as schools, hospitals, and low-income areas. Existing open water placement areas in Virginia and Maryland are not close to land. As such, background noise levels in these areas are likely low (e.g., in the 30- to 40-dBA range). In terrestrial areas adjacent to the Bay, noise levels will vary depending on the level of urbanization and other factors. In a study done by the University of Maryland Center for Environmental Science (Wainger, 2004), it was found that only a small portion of the inland area properties fall within the zone of occasional noise impacts (properties between 1,600-2,200 ft of project). Noise levels will vary depending on the time of day (e.g., rush-hour traffic) and location (residential versus commercial versus industrial areas, railroads, and major highways).

Noise associated with dredging activities includes the operation of dredges and associated equipment (e.g., bulldozers and graders). These activities can intermittently generate noise levels as high as 85 to 88 dBA (California Department of Water Resources, 2000). The loudest expected sounds of 88 dBA from dredging operations can be expected to be attenuated to levels approaching 55 dBA approximately 2,000 ft from the source. This distance can vary depending on environmental criteria identified above.

2.15 DREDGING NEEDS

The MPA and CENAB continually assess the dredging needs of the Port of Baltimore, with dredged material resulting from both new non-federal construction and maintenance dredging, and the available placement capacity. Table 2-35 shows the anticipated dredging needs for federal and non-federal navigation projects for the next 21 years. The quantities in Table 2-35 have been projected using projections from MPA, historical pay quantities from USACE dredging contracts since 1973, and historical placement quantities for the C&D Canal Approach Channels. A 21-year planning period was selected to capture a significant projected dredging quantity in fiscal year 2025. Contingencies have been added for storm events and unplanned non-federal new work dredging. A 10% contingency was included for the Bay channels to account for the additional sediment loads that could occur during storm events and a 10% contingency was included in the harbor channels to account for dredging projects that cannot be anticipated now but may occur over the next 21 years. Since historical pay quantities have been used for most of the projections, 10% was also added to the Chesapeake Bay Approach Channels (MD), Chesapeake Bay Approach Channels (VA), and the Harbor Channels for non-pay overdepth. A non-pay overdepth amount of 10% was not added to the C&D Canal Approach Channels, since the projected annual quantity of 1.2 mcy already includes an estimated non-pay amount based on data from past dredging events. This accounts for the imprecision associated with dredging to a specified depth.

Over the 21-year period to be covered in the DMMP, there is an estimated total need of approximately 119.7 mcy of capacity for dredged material. Approximately 104.5 mcy of capacity is needed for maintenance dredging of the Baltimore Harbor & Channels and Inland Waterway to the C&D Canal projects with the remaining 15.2 mcy (including new non-federal work contingencies) for new work dredging. Approximately 16 mcy of the maintenance dredging is projected from the Chesapeake Bay Approach Channels (VA), where there is sufficient capacity at the existing open water sites. Therefore, the total projected need is 103.7 mcy. The remaining capacity at the existing placement sites totals 47.7 mcy (consolidated in-place volume) and is shown in Table 2-36.

The total shortfall is 56 mcy of capacity after subtracting the existing capacity of 47.7 mcy from the total projected need of 103.7 mcy from the Maryland channels. The shortfall of 56 mcy is based on a projected cut volume (i.e., amount of material removed during dredging). However, the design of dredged material placement sites should consider the effects of dewatering and material consolidation when determining the capacity of a site. Section 3.3.3 describes the alternative-specific factors that were applied to the site volumes to determine the actual capacity (in cut volume) for each placement alternative (see Appendix C).

CHAPTER 2

TABLES

Table 2-1 Status and Trends for Fixed Benthic Monitoring Sites in the Chesapeake Bay (1985-2001)

Monitoring Station	Location Description	Trend Significance	Trend Direction	Historical Status (1985 - 1987)		Current Status (1999 - 2001)	
				B-IBI Score	**Status**	**B-IBI Score**	**Status**
	C&D Approach Channels (Upper Bay)						
024	Mainstem	Not Significant	No Trend	3.04	Meets Goal	3.00	Meets Goal
026	Mainstem	$p < 0.05$	Improving	3.16	Meets Goal	3.67	Meets Goal
029	Elk River	$p < 0.001$	Improving	2.38	Degraded	3.26	Meets Goal
068	Chester River mesohaline	$p < 0.01$	Improving	3.51	Meets Goal	4.02	Meets Goal
	Baltimore Harbor						
022	Patapsco River, Middle Branch	Not Significant	No Trend	2.08	Degraded	1.22	Severely Degraded
023	Patapsco River	Not Significant	No Trend	2.49	Degraded	2.64	Degraded
201	Patapsco River, Bear Creek	Not significant	No Trend	1.10	Severely Degraded	1.49	Severely Degraded
202	Patapsco River, Curtis Bay	Not Significant	No Trend	1.40	Severely Degraded	1.80	Severely Degraded
	Middle Bay						
001	Calvert Cliffs	$p < 0.01$	Improving	2.93	Marginal	3.74	Meets Goal
006	Calvert Cliffs	$p < 0.05$	Improving	2.56	Degraded	3.22	Meets Goal
015	North Beach	Not Significant	No Trend	2.22	Degraded	2.52	Degraded
036	Potomac River at Rosier Bluff	$p < 0.05$	Improving	3.14	Meets Goal	3.83	Meets Goal
040	Potomac River at Maryland Point	Not Significant	No Trend	2.80	Marginal	2.74	Marginal
043	Potomac River Morgantown (‹5m)	Not Significant	No Trend	3.76	Meets Goal	3.62	Meets Goal
044	Potomac River Morgantown (›11m)	Not Significant	No Trend	2.80	Marginal	1.80	Severely Degraded
047	Potomac River Morgantown (‹5m)	Not Significant	No Trend	3.89	Meets Goal	4.02	Meets Goal
051	Potomac River St. Clements Island (‹5m)	$p < 0.001$	Improving	2.43	Degraded	3.30	Meets Goal
052	Potomac River St. Clements Island (›9m)	Not Significant	No Trend	1.37	Severely Degraded	1.11	Severely Degraded
062	Nanticoke River	$p < 0.01$	Degrading	3.42	Meets Goals	2.69	Marginal
064	Choptank River mesohaline	Not Significant	No Trend	2.78	Marginal	2.78	Marginal
066	Choptank River oligohaline	Not Significant	No Trend	2.60	Degraded	2.89	Marginal
071	Patuxent River at Broomes Island	$p < 0.05$	Degrading	2.59	Degraded	1.93	Severely Degraded
074	Patuxent River at Chalk Point	Not Significant	No Trend	3.78	Meets Goal	3.58	Meets Goal
077	Patuxent River at Holland Cliff	$p < 0.001$	Degrading	3.76	Meets Goal	2.73	Marginal
079	Patuxent River at Lyons Creek	Not Singificant	No Trend	2.75	Marginal	2.55	Degraded
203	Back River	Not significant	No Trend	2.08	Degraded	2.19	Degraded
204	Severn River	Not Significant	No Trend	3.67	Meets Goal	3.59	Meets Goal
	Lower Bay						
CB5.4	Upper Virginia deep mainstem	Not Significant	No Trend	2.39	Degraded	2.2	Degraded
CB6.1	Virginia mainstem (mouth of the Rappahann	Not Significant	No Trend	3.56	Meets Goal	3.6	Meets Goal
CB6.4	Virginia mainstem (mouth of the York River)	Not Significant	No Trend	3.61	Meets Goal	3.5	Meets Goal
CB7.3E	Virginia deep mainstem	Not Significant	No Trend	4.15	Meets Goal	4.0	Meets Goal
CB8.1	Virginia Mainstem, Thimble Shoal	Not Significant	No Trend	4.07	Meets Goal	3.9	Meets Goal
LE3.2	Rappahannock River mesohaline	Not Significant	No Trend	2.04	Degraded	2.0	Degraded
LE3.4	Rappahannock River polyhaline	Not Significant	No Trend	3.38	Meets Goal	2.0	Degraded
LE4.1	York River mesohaline	$p < 0.1$	Degrading	3.21	Meets Goal	2.7	Marginal
LE4.3	York River polyhaline	Not Significant	No Trend	3.24	Meets Goal	4.0	Meets Goal
LE4.3B	York River deep polyhaline	$p < 0.05$	Improving	2.08	Degraded	2.7	Marginal
LE5.1	James River oligohaline	Not Significant	No Trend	2.75	Marginal	3.1	Meets Goal
LE5.2	James River mesohaline	Not Significant	No Trend	2.88	Marginal	2.7	Marginal
LE5.4	James River polyhaline	Not Significant	No Trend	3.78	Meets Goal	3.8	Meets Goal
RET3.1	Rappahannock River turbidity maximum	$p < 0.05$	Degrading	3.56	Meets Goal	2.6	Degraded
RET4.3	York River turbidity maximum	$p < 0.05$	Degrading	3.50	Meets Goal	2.6	Degraded
RET5.2	James River turbidity maximum	$p < 0.01$	Improving	2.01	Degraded	2.9	Marginal
SBE2	Elizabeth River Southern Branch	Not Significant	No Trend	1.85	Severely Degraded	2.3	Degraded
SBE5	Elizabeth River Southern Branch	$p < 0.001$	Improving	1.42	Severely Degraded	2.2	Degraded
TF3.3	Rappahannock River tidal freshwater	Not Significant	No Trend	3.44	Meets Goal	2.7	Marginal
TF4.2	Pamunkey River	Not Significant	No Trend	2.87	Marginal	3.71	Meets Goal
TF5.5	James River tidal freshwater	$p < 0.01$	Improving	2.11	Degraded	3.8	Meets Goal

Notes: Data obtained and re-formatted from Chesapeake Bay Long-Term Montoring Web Site (CBBMP, 2003).
B-IBI = Benthic Index of Biotic Integrity

Table 2-2 Commercial Landings of Oysters in the Chesapeake Bay[a,b]

Year	Commercial Landings of Oysters							
	Upper Bay[a,b]		Harbor Area[a,c]		Middle Bay[a,d]		Lower Bay[e]	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
1990	130,551	$482,622	0	0	248,924	$896,586	28,661	$111,150
1991	221,471	$710,752	0	0	344,541	$1,089,973	11,846	$26,474
1992	130,030	$441,150	0	0	128,879	$414,400	14,141	$67,238
1993	64,579	$189,352	0	0	21,051	$68,295	28,477	$136,978
1994	49,988	$159,075	0	0	32,090	$104,226		
1995	118,334	$320,285	0	0	74,576	$203,159		
1996	23,723	$78,322	0	0	112,424	$402,389		
1997	101,704	$338,047	0	0	83,731	$282,674		
1998	91,861	$305,686	0	0	330,877	$1,079,062		
1999	159,406	$505,291	0	0	219,153	$655,816	17,269	$61,630
2000	197,590	$644,264	0	0	73,261	$234,095	6,885	$22,069
2001	30,128	$92,200	0	0	18,166	$56,127	37,989	$118,794
2002	115,393	$496,373	0	0	14,528	$61,305	18,545	$125,862

[a] Landings data provided by C. Lewis of MD DNR Fisheries Service (MD DNR, 2004).

[b] Landings based on the sub-regions of the Chesapeake Bay designated as NOAA 014 and 025.
NOAA 014 is the mainstem of the Bay and its tributaries north of Worton Point.
NOAA 025 is the mainstem of the Bay that extends from Bay Bridge north to Pooles Island.

[c] No landings were reported to MD DNR for oysters in the Harbor region for any year.
Landings based on the sub-region of the Bay designated as NOAA 066.
NOAA 066 is the Patapsco River (includes Baltimore Harbor).

[d] Landings based on the sub-regions of the Chesapeake Bay designated as NOAA 027 and 029.
NOAA 027 is the mainstem of the Bay from south of the Bay Bridge in MD to the Pataxent River.
NOAA 029 is the mainstem of the Bay from the Patuxent River to the MD-VA line.

[e] Landings data provided by the Virginia Marine Resources Commission (VMRC, 2004).
Data included from their area designated as "System 4," which is the mainstem of the Chesapeake Bay.
Landings from tributaries to the Bay are not included in the dataset reported here, but are available from VMRC

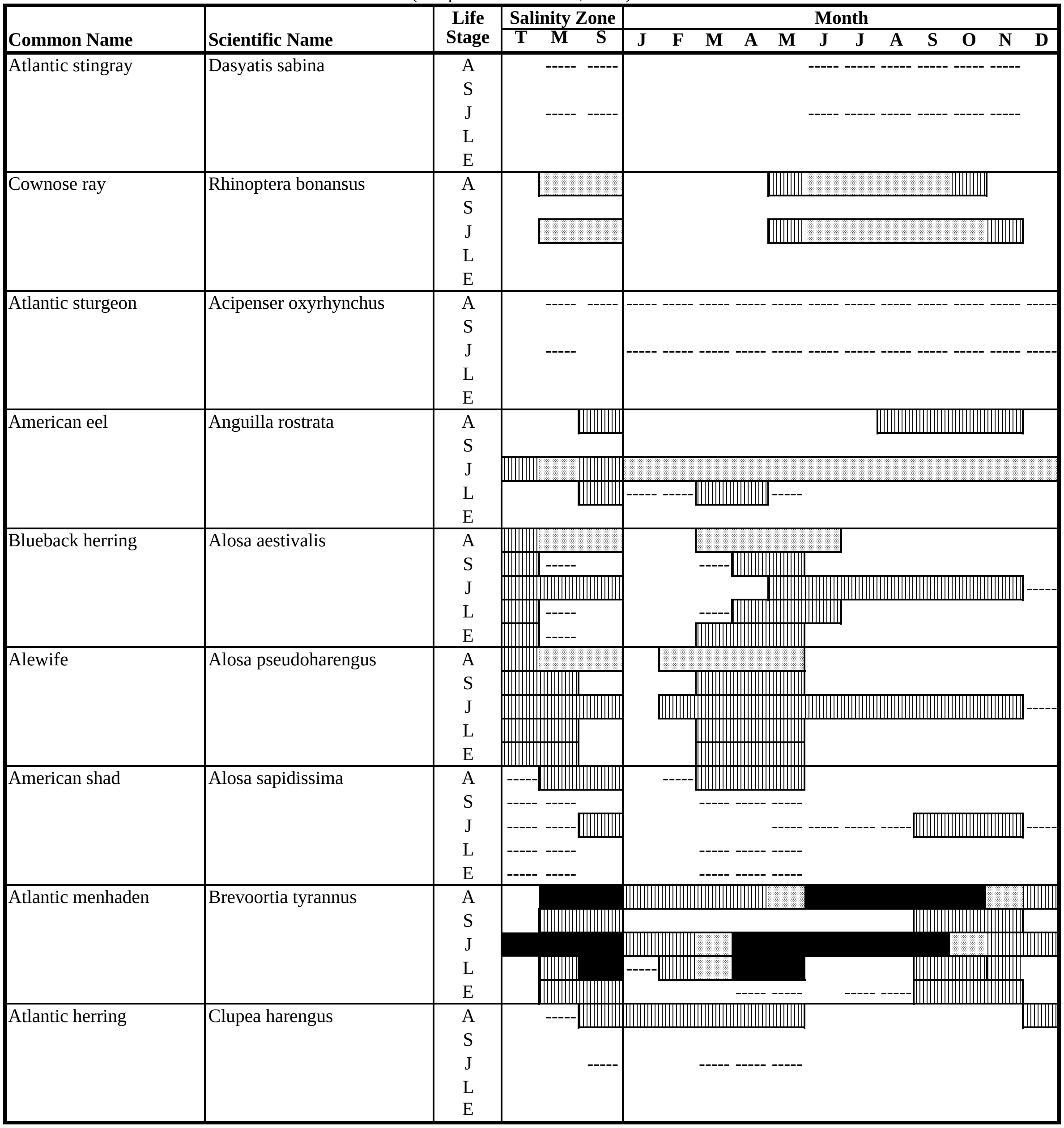
Table 2-3 Commercial Landings of Soft-Shell Clams in the Chesapeake Bay

Year	Upper Bay[a,b]				Harbor Area[a,c]		Middle Bay[a,d]				Lower Bay[e]	
	NOAA 014		NOAA 025		NOAA 066		NOAA 027		NOAA 029		System 4	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
1990	60	$300	701,085	$2,941,801	0	0	299,598	$1,342,935	*	*	*	*
1991	*	*	*	*	0	0	*	*	*	*	*	*
1992	*	*	157,437	$906,308	0	0	41,031	$116,929	*	*	*	*
1993	*	*	395,148	$1,814,640	0	0	556,560	$2,409,637	60	$150	*	*
1994	*	*	211,581	$1,427,891	0	0	206,829	$1,393,886	*	*	*	*
1995	*	*	188,898	$1,024,183	0	0	102,672	$583,864	*	*	*	*
1996	*	*	116,820	$605,550	0	0	90,900	$412,045	*	*	*	*
1997	*	*	106,320	$751,481	0	0	92,619	$589,089	*	*	*	*
1998	*	*	81,820	$547,407	0	0	113,237	$772,777	*	*	*	*
1999	*	*	67,608	$479,470	0	0	65,129	$433,067	*	*	*	*
2000	*	*	33,978	$196,724	0	0	82,886	$504,617	3,579	$22,260	*	*
2001	*	*	38,811	$219,931	0	0	12,312	$62,860	*	*	*	*
2002	*	*	119,292	$514,743	0	0	86,448	$330,461	*	*	*	*

[a] Landings data provided by C. Lewis of MD DNR Fisheries Service (MD DNR, 2004).
[b] Landings based on the sub-regions of the Chesapeake Bay designated as NOAA 014 and 025.
NOAA 014 is the mainstem of the Bay and its tributaries north of Worton Point.
NOAA 025 is the mainstem of the Bay that extends from Bay Bridge north to Pooles Island.
[c] No landings were reported to MD DNR for soft-shell clams in the Harbor region for any year.
Landings based on the sub-region of the Bay designated as NOAA 066.
NOAA 066 is the Patapsco River (includes Baltimore Harbor).
[d] Landings based on the sub-regions of the Chesapeake Bay designated as NOAA 027 and 029.
NOAA 027 is the mainstem of the Bay from south of the Bay Bridge in MD to the Pataxent River.
NOAA 029 is the mainstem of the Bay from the Patuxent River to the MD-VA line.
[e] Landings data provided by the Virginia Marine Resources Commission (VMRC, 2004).
Data included from their area designated as "System 4," which is the mainstem of the Chesapeake Bay.
Landings from tributaries to the Bay are not included in the dataset reported here, but are available from VMRC.
* No data provided.

Table 2-4
Temporal Distribution and Relative Abundance of Fish in the Chesapeake Bay Mainstem

(Adapted from NOAA, 1994)



Life Stage

A Adult
S Spawning Adult
J Juveniles
L Larvae
E Eggs

Salinity Zone

T Tidal
M Mixing
S Seawater

Relative Abundance

(solid black) Highly abundant
(grey) Abundant
(vertical hatching) Common
----- Rare
Blank Not present

Table 2-4
Temporal Distribution and Relative Abundance of Fish in the Chesapeake Bay Mainstem

(Adapted from NOAA, 1994)

Common Name	Scientific Name	Life Stage	Salinity Zone T	M	S	Month J	F	M	A	M	J	J	A	S	O	N	D
Bay anchovy	Anchoa mitchilli	A															
		S															
		J															
		L															
		E															
Channel catfish	Ictalurus punctatus	A															
		S															
		J															
		L															
		E															
Red hake	Urophycis chuss	A															
		S															
		J															
		L															
		E															
Oyster toadfish	Opsanus tau	A															
		S															
		J															
		L															
		E															
Sheepshead minnow	Cyprinodon variegatus	A															
		S															
		J															
		L															
		E															
Killifishes	Fundulus sp.	A															
		S															
		J															
		L															
		E															
Silversides	Menidia sp.	A															
		S															
		J															
		L															
		E															
Northern pipefish	Syngnathus fuscus	A															
		S															
		J															
		L															
		E															
Northern searobin	Prionotus carolinus	A															
		S															
		J															
		L															
		E															

Life Stage

- A Adult
- S Spawning Adult
- J Juveniles
- L Larvae
- E Eggs

Salinity Zone

- T Tidal
- M Mixing
- S Seawater

Relative Abundance

- (solid black) Highly abundant
- (grey) Abundant
- (vertical hatching) Common
- ----- Rare
- Blank Not present

Table 2-4
Temporal Distribution and Relative Abundance of Fish in the Chesapeake Bay Mainstem

(Adapted from NOAA, 1994)

Common Name	Scientific Name	Life Stage
White perch	Morone americana	A
		S
		J
		L
		E
Striped bass	Morone saxatilis	A
		S
		J
		L
		E
Black sea bass	Centropristis striata	A
		S
		J
		L
		E
Yellow perch	Perca flavescens	A
		S
		J
		L
		E
Bluefish	Pomatomus saltatrix	A
		S
		J
		L
		E
Pinfish	Lagodon rhomboides	A
		S
		J
		L
		E
Scup	Stenotomus chrysops	A
		S
		J
		L
		E
Spotted seatrout	Cynoscion nebulosus	A
		S
		J
		L
		E
Weakfish	Cynoscion regalis	A
		S
		J
		L
		E

Salinity Zone: T M S — Month: J F M A M J J A S O N D

Life Stage

A Adult
S Spawning Adult
J Juveniles
L Larvae
E Eggs

Salinity Zone

T Tidal
M Mixing
S Seawater

Relative Abundance

(solid black) Highly abundant
(grey shading) Abundant
(vertical hatching) Common
----- Rare
Blank Not present

Table 2-4
Temporal Distribution and Relative Abundance of Fish in the Chesapeake Bay Mainstem

(Adapted from NOAA, 1994)

Common Name	Scientific Name	Life Stage	Salinity Zone			Month											
			T	M	S	J	F	M	A	M	J	J	A	S	O	N	D
Spot	Leiostomus xanthurus	A		Abundant	Abundant				Common	Abundant	Abundant	Abundant	Abundant	Abundant	Common	Common	
		S															
		J	Common	Abundant	Abundant				Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Common	
		L															
		E															
Northern kingfish	Menticirrhus saxatilis	A		-----	-----					-----	-----	-----	-----	-----	-----	-----	
		S															
		J		-----	-----					-----	-----	-----	-----	-----	-----	-----	
		L		-----	-----						-----	-----	-----	-----			
		E															
Atlantic croaker	Micropogonias undulatus	A		Common	-----	-----	-----	-----	-----	Common	Common	Common	Common	Common	Common	Common	-----
		S															
		J	-----	Abundant	Abundant	Common	Common	Common	Common	Abundant	Abundant	Abundant	Abundant	Abundant	Common	-----	-----
		L															
		E															
Black drum	Pogonias cromis	A		Common	Common				Common	Common	Common	Common	Common	Common	Common	Common	
		S			Common				Common	Common	Common						
		J		Common	Common				Common	Common	Common	Common	Common	Common	Common	Common	
		L			Common				Common	Common	Common						
		E			Common				Common	Common	Common						
Red drum	Sciaenops ocellatus	A		Common	Common					Common	Common	Common	Common	Common	Common		
		S															
		J		Common	Common					Common	Common	Common	Common	Common	Common	Common	
		L			-----								-----	-----			
		E															
Mullets	Mugil sp.	A		Common	Common	Common	Common				Common	Common	Common	Common	Common	Common	Common
		S															
		J		Common	Common	Common	Common				Common	Common	Common	Common	Common	Common	Common
		L															
		E															
Tautog	Tautoga onitis	A		-----	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common
		S		-----	Common				Common	Common							
		J		Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common
		L		-----	Common				Common	Common							
		E		-----	Common				Common	Common							
Gobies	Gobiosoma sp.	A	-----	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant
		S		Abundant	Abundant				Common	Abundant	Abundant	Abundant	Abundant	-----	-----		
		J	-----	Abundant	Abundant					Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant
		L	Abundant	Abundant	Abundant					Common	Abundant	Abundant	Abundant	Common	-----		
		E		Abundant	Abundant				Common	Abundant	Abundant	Abundant	Abundant	-----	-----		
Atlantic mackerel	Scomber scombrus	A		-----	-----	-----	-----	-----									
		S															
		J		-----	-----	-----	-----	-----	-----							-----	-----
		L			-----					-----							
		E															

Life Stage

A Adult
S Spawning Adult
J Juveniles
L Larvae
E Eggs

Salinity Zone

T Tidal
M Mixing
S Seawater

Relative Abundance

(black) Highly abundant
(grey) Abundant
(vertical hatching) Common
----- Rare
Blank Not present

Table 2-4
Temporal Distribution and Relative Abundance of Fish in the Chesapeake Bay Mainstem

(Adapted from NOAA, 1994)

Common Name	Scientific Name	Life Stage	Salinity Zone T	Salinity Zone M	Salinity Zone S	Month J	F	M	A	M	J	J	A	S	O	N	D
Butterfish	Peprilus triacanthus	A		Common	Common				-----	Common	Common	Common	Common	Common	Common	Common	
		S		Common	Common					-----	Common	Common					
		J		Common	Common						Common	Common	Common	Common	Common		
		L		Common	Common						-----	Common	Common				
		E		Common	Common					-----	Common	Common					
Summer flounder	Paralichthys dentatus	A		Common	Common				Common	Common	Common	Common	Common	Common	Common	-----	
		S															
		J		Common	-----	-----	-----	-----	-----	-----	Common	Common	Common	Common	Common	Common	-----
		L		Common	Common	Common	Common	Common	Common								-----
		E															
Windowpane flounder	Scophthalamus aquosus	A		Common	Common				Common	Common	Common	Common	Common	Common	Common		
		S															
		J		Common	Common	-----	-----	-----	Common	Common	Common	Common	Common	Common	Common	-----	-----
		L			-----			-----	-----	-----	-----						
		E															
Winter flounder	Pleuronectes americanus	A		-----	-----	-----	-----	-----	-----	-----							-----
		S		-----		-----	-----	-----	-----	-----							-----
		J		-----	-----	-----	-----	-----	-----	-----							-----
		L		-----		-----	-----	-----	-----	-----							-----
		E															
Hogchoker	Trinectes maculatus	A	Common	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant
		S		Highly abundant	Highly abundant					Abundant	Highly abundant	Highly abundant	Highly abundant	Abundant			
		J	Common	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant	Highly abundant
		L	-----	Highly abundant	Highly abundant					Abundant	Highly abundant	Highly abundant	Highly abundant	Abundant			
		E		Highly abundant	Highly abundant					Abundant	Highly abundant	Highly abundant	Highly abundant	Abundant			

Life Stage

A Adult
S Spawning Adult
J Juveniles
L Larvae
E Eggs

Salinity Zone

T Tidal
M Mixing
S Seawater

Relative Abundance

(black) Highly abundant
(grey) Abundant
(vertical hatching) Common
----- Rare
Blank Not present

Table 2-5

Fisheries Managed by the Mid-Atlantic Fisheries Management Council

Common Name	Scientific Name	Fishery Management Plan (FMP)
Atlantic Mackerel	*Scomber scombrus*	Atlantic, Mackerel, Squid & Butterfish FMP
Long-finned Squid	*Loligo pealei*	Atlantic, Mackerel, Squid & Butterfish FMP
Short-finned Squid	*Illex illecebrosus*	Atlantic, Mackerel, Squid & Butterfish FMP
Butterfish	*Peprilus triacanthus*	Atlantic, Mackerel, Squid & Butterfish FMP
Bluefish	*Pomatomus saltatrix*	Bluefish FMP
Spiny Dogfish	*Squalus acanthias*	Dogfish FMP
Surfclam	*Spisula solidissima*	Surfclam & Quahog FMP
Ocean Quahog	*Arctica islandica*	Surfclam & Quahog FMP
Summer Flounder	*Paralichtys dentatus*	Summer Flounder, Scup, & Black Sea Bass FMP
Scup	*Stenotomus chrysops*	Summer Flounder, Scup, & Black Sea Bass FMP
Black Sea Bass	*Centropristis striata striata*	Summer Flounder, Scup, & Black Sea Bass FMP
Tilefish	*Lopholatilus chamaeleonticeps*	Tilefish FMP
Monkfish	*Lophius americanus*	Monkfish FMP

Table 2-6 Commercial Landings of Finfish in the Upper Chesapeake Bay[a,b]

		1990		1991		1992		1993		1994		1995		1996	
COMMON NAME	**SCIENTIFIC NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
BLUEFISH	*Pomatomus saltatrix*	200	$56	38,752	$8,683	200	$57	120	$83	480	$128	28	$13	6	$3
BUTTERFISH	*Peprilus triacanthus*			138	$43										
CARP	*spp.*	5,135	$617	12,473	$1,430	9,700	$2,328	10,158	$1,980	9,065	$1,740	4,184	$2,457	3,353	$601
CATFISH	*spp.*	957,747	$349,931	672,309	$231,643	911,864	$333,421	652,508	$245,202	1,057,796	$437,596	1,053,819	$976,882	1,117,825	$600,213
CROAKER	*Micropogonias undulatus*			58	$72			10	$6	10	$7	1,400	$721	629	$325
DRUM BLACK	*Pogonias cromis*			5,463	$1,093			65	$16						
DRUM RED	*Sciaenops ocellatus*			26	$13										
EEL COMMON	*Anguilla rostrata*	31,391	$53,927	47,294	$82,804	53,153	$103,581	47,305	$50,421	78,260	$125,156	35,816	$82,083	17,450	$5,726
FLOUNDER SUMMER	*Paralichthys dentatus*			604	$709							16	$29		
FLOUNDER WINTER	*Pseudopleuronectes americanus*			196	$187										
MENHADEN	*Brevoortia tyrannus*			1,214,594	$200,324	2,337	$223	185	$23	60	$6	2,200	$184		
RIVER HERRING	*Alosa spp.*	1,872	$406	5,957	$889	81	$14	1,193	$157	648	$39	7,641	$812	2,095	$215
SEA BASS BLACK	*Centropristis striata*			572	$691										
SEA TROUT GRAY	*Cynoscion nothus*			719	$565	60	$33	215	$229	165	$187	17	$21		
SHAD	*Alosa spp.*													940	$131
SPOT	*Leiostomus xanthurus*	500	$965	2,972	$1,481	150	$28	22	$13						
STRIPED BASS	*Morone saxatilis*	96	$154	71,616	$139,826	28,109	$50,004	25,619	$33,796	42,886	$87,259	71,622	$115,477	75,725	$138,401
WHITE PERCH	*Morone americana*	179,876	$59,080	106,737	$60,770	97,418	$246,692	132,234	$89,955	228,174	$160,449	214,482	$156,249	300,874	$165,371
WHITING	*Menticirrhus saxatilis*	200	$50	9	$2										
YELLOW PERCH	*Perca flavescens*	35,582	$28,024	34,435	24,892.00	29,169	$23,673	50,194	$27,723	44,777	$43,653	53,023	$42,140	27,187	$19,884

		1997		1998		1999		2000		2001		2002	
COMMON NAME	**SCIENTIFIC NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
BLUEFISH	*Pomatomus saltatrix*			12	$4							10	$3
BUTTERFISH	*Peprilus triacanthus*												
CARP	*spp.*	32,183	$7,881	17,484	$4,048	7,268	$1,048	5,934	$830	6,725	$1,452	2,956	$620
CATFISH	*spp.*	889,412	$385,504	1,158,261	$496,823	1,055,008	$372,045	620,796	$286,691	785,799	$257,480	535,656	$171,183
CROAKER	*Micropogonias undulatus*			5	$2								
DRUM BLACK	*Pogonias cromis*												
DRUM RED	*Sciaenops ocellatus*												
EEL COMMON	*Anguilla rostrata*	24,590	$11,432	19,210	$34,107	36,317	$56,335	15,829	$17,681	55,520	$67,549	40,460	$37,343
FLOUNDER SUMMER	*Paralichthys dentatus*	43	$80										
FLOUNDER WINTER	*Pseudopleuronectes americanus*												
MENHADEN	*Brevoortia tyrannus*					4,980	$398			400	$32		
RIVER HERRING	*Alosa spp.*	3,364	$503	6,821	$535	729	$63	22,214	$1,890	22,691	$12,050	397	$80
SEA BASS BLACK	*Centropristis striata*												
SEA TROUT GRAY	*Cynoscion nothus*												
SHAD	*Alosa spp.*	21,025	$1,056			10		15	$4			50	$10
SPOT	*Leiostomus xanthurus*												
STRIPED BASS	*Morone saxatilis*	74,134	$98,492	97,694	$120,779	43,866	$73,966	26,492	$40,466	35,798	$57,638	9,641	$15,499
WHITE PERCH	*Morone americana*	312,460	$125,785	345,306	$182,163	266,955	$102,092	542,737	$219,702	311,531	$108,992	224,616	$73,659
WHITING	*Menticirrhus saxatilis*												
YELLOW PERCH	*Perca flavescens*	39,549	$55,195	65,159	89,744	50,778	86,276	24,337	40,799	22,181	$38,489	16,149	$21,608

[a] Landings data provided by C. Lewis of MD DNR Fisheries Service (MD DNR, 2004).

[b] Landings based on the sub-regions of the Chesapeake Bay designated as NOAA 014 and 025.
NOAA 014 is the mainstem of the Bay and its tributaries north of Worton Point.
NOAA 025 is the mainstem of the Bay that extends from Bay Bridge north to Pooles Island.

Table 2-7 Commercial Landings of Finfish in the Harbor Channels[a,b]

		1990		1991		1992		1993		1994		1995		1996	
COMMON NAME	**SCIENTIFIC NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
BLUEFISH	*Pomatomus saltatrix*											40	$19		
CARP	*spp.*					40	$17								
CATFISH	*spp.*	117	$47	1,320	$444	62	$15	200	$82					150	$76
CROAKER	*Micropogonias undulatus*											100	$62		
EEL COMMON	*Anguilla rostrata*	1,635	$2,104	4,806	$8,158	2,443	$3,003	905	$797	233	$475	7,460	$19,643	300	$74
FLOUNDER SUMMER	*Paralichthys dentatus*											20	$36		
MENHADEN	*Brevoortia tyrannus*											900	$105		
RIVER HERRING	*Alosa spp.*					28	$3								
STRIPED BASS	*Morone saxatilis*					11,388	$17,786	6,881	$11,472	2,329	$3,644	19,628	$27,409	12,571	$18,750
SEA BASS BLACK	*Centropristis striata*					3	$4								
SEA TROUT GRAY	*Cynoscion nothus*					4	$3								
SPOT	*Leiostomus xanthurus*														
WHITE PERCH	*Morone americana*	480	$296	525	$509	1,436	$1,387	2,702	$2,291	640	$500	4,812	$3,551	1,426	$969
YELLOW PERCH	*Perca flavescens*														

		1997		1998		1999		2000		2001		2002	
SPECIES NAME	**SCIENTIFIC NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
BLUEFISH	*Pomatomus saltatrix*												
CARP	*spp.*												
CATFISH	*spp.*	285	$108	70	$31			227	$77	119	$55		
CROAKER	*Micropogonias undulatus*					346	$104					190	$65
EEL COMMON	*Anguilla rostrata*	3,200	$1,774							30	$31		
FLOUNDER SUMMER	*Paralichthys dentatus*												
MENHADEN	*Brevoortia tyrannus*			150	$16	5,000	$350						
RIVER HERRING	*Alosa spp.*												
STRIPED BASS	*Morone saxatilis*	11,413	$15,932	4,411	$4,844	5,881	$9,037	1,484	$2,256	345	$677	4,729	$7,443
SEA BASS BLACK	*Centropristis striata*												
SEA TROUT GRAY	*Cynoscion nothus*					147	$104						
SPOT	*Leiostomus xanthurus*			600	$252								
WHITE PERCH	*Morone americana*	54,869	$21,258	175	$112	294	$197	6,305	$3,412	145	$79	20,912	$7,923
YELLOW PERCH	*Perca flavescens*	4,492	$6,299										

[a] Landings data provided by C. Lewis of MD DNR Fisheries Service (MD DNR, 2004).

[b] Landings based on the sub-region of the Bay designated as NOAA 066.

Table 2-8 Commercial Landings of Finfish in the Middle Chesapeake Bay[a,b]

		1990		1991		1992		1993		1994		1995		1996	
COMMON NAME	**SPECIES NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
BLUEFISH	*Pomatomus saltatrix*	16,554	$3,948	1,608	$414	10,358	$3,834	138	$82	971	$274	192	$120	50	$36
CARP	*spp.*	1,712	$178	3,230	$243	446	$117	267	$51	18,822	$3,716	3,000	$594	95	$22
CATFISH	*spp.*	53,748	$17,206	72,596	$21,960	109,668	$45,021	212,752	$83,907	313,424	$131,750	192,704	$164,456	504,558	$279,561
CROAKER	*Micropogonias undulatus*			25	$36			26	$16	130	$81	50	$19	27	$10
DRUM BLACK	*Pogonias cromis*	150		35,000	$7,000	50	$12								
DRUM RED	*Sciaenops ocellatus*			6,000	$3,000										
EEL COMMON	*Anguilla rostrata*	46,152	$81,268	25,480	$50,407	7,150	$9,784	10,295	$9,157	7,493	$4,260	36,113	$85,461	86,042	$30,875
FLOUNDER SUMMER	*Paralichthys dentatus*	78	$137			615	$919	212	$308	56	$79	631	$1,032	15	$35
FLOUNDER WINTER	*Pseudopleuronectes americanus*	12	$18							212	$439				
MENHADEN	*Brevoortia tyrannus*	132,240	$12,013	210,065	$20,667	241,117	$23,153	4,000	$415	34,320	$5,299	84,390	$9,036	42,550	$4,294
RIVER HERRING	*Alosa sp.*	96	$16	2,109	$195	2,875	$639	800	$95	770	$42	150	$8		
SEA BASS BLACK	*Centropristis striata*			21	$29	30	$45								
SEA TROUT GRAY	*Cynoscion nothus*	150	$169	422	$361	337	$533			1,298	$943	9,531	$10,610	12	$12
SHAD	*Alosa spp.*											10,399	$5,407		
SPOT	*Leiostomus xanthurus*	478	$292	4,280	$2,591	2,483	$1,019	9	$6	424	$282	99	$43	265	$120
STRIPED BASS	*Morone saxatilis*	4,148	$8,393	15,135	$29,921	130,973	$194,117	158,232	$291,124	228,240	$378,034	289,513	$436,099	437,642	$691,699
TUNA	*spp.*											100			
WHITE PERCH	*Morone americana*	58,060	$31,012	19,063	$12,279	80,126	$148,040	107,169	$78,191	165,302	$133,629	211,926	$169,028	232,049	$136,915
YELLOW PERCH	*Perca flavescens*	1,540	$1,218	3,155	$2,102	5,042	$4,259	6,441	$3,645	5,685	$5,554	5,017	$4,102	40	$30

		1997		1998		1999		2000		2001		2002	
SPECNAME	**SPECIES NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
BLUEFISH	*Pomatomus saltatrix*	136	$42	471	$126	465	$154	471	$83	116	$57	603	$170
CARP	*spp.*	490	$111	101	$15	300	$36	5,870	$477	3,726	$472	457	$112
CATFISH	*spp.*	189,404	$90,913	77,019	$36,998	269,022	$96,981	129,027	$64,736	143,174	$53,926	4,804	$1,502
CROAKER	*Micropogonias undulatus*			1,554	$577	552	$180	3,468	$1,142	141	$39	418	$123
DRUM BLACK	*Pogonias cromis*												
DRUM RED	*Sciaenops ocellatus*			4	$3								
EEL COMMON	*Anguilla rostrata*	50,173	$21,867	34,180	$40,419	16,900	$20,084	28,790	$28,476	25,036	$30,353	36,012	$16,189
FLOUNDER SUMMER	*Paralichthys dentatus*	8	$17	20	$42	163	$356	1,185	$1,811	3	$6	140	$231
FLOUNDER WINTER	*Pseudopleuronectes americanus*												
MENHADEN	*Brevoortia tyrannus*	6,080	$599	20,252	$1,850	40,690	$3,370	23,830	$2,285	1,750	$140	900	$72
RIVER HERRING	*Alosa sp.*	222	$44	90	$10	429	$34	10	$1	1,623	$308		
SEA BASS BLACK	*Centropristis striata*					55	$63						
SEA TROUT GRAY	*Cynoscion nothus*	1,055	$440	600	$343	929	$635	4,354	$3,921	1,418	$900	603	$352
SHAD	*Alosa spp.*					100	$50						
SPOT	*Leiostomus xanthurus*			1,058	$435	550	$286	200	$98	2,020	$974	266	$117
STRIPED BASS	*Morone saxatilis*	476,679	$687,193	423,227	$531,862	299,960	$471,649	270,676	$414,610	193,251	$336,296	249,589	$422,461
TUNA	*spp.*												
WHITE PERCH	*Morone americana*	236,979	$93,164	140,740	$80,124	109,831	$55,049	209,752	$96,077	199,613	$74,725	75,714	$21,183
YELLOW PERCH	*Perca flavescens*	10,094	$14,210	8,298	$11,487	29,470	$50,389	19,454	$32,035	29,229	$49,365	53,599	$71,563

[a] Landings data provided by C. Lewis of MD DNR Fisheries Service (MD DNR, 2004).
[b] Landings based on the sub-regions of the Chesapeake Bay designated as NOAA 027 and 029.
NOAA 027 is the mainstem of the Bay from south of the Bay Bridge in MD to the Pataxent River.
NOAA 029 is the mainstem of the Bay from the Patuxent River to the MD-VA line.

Table 2-9 Commercial Landings of Finfish in the Lower Chesapeake Bay[a,b]

		1990		1991		1992		1993		1994		1995		1996	
COMMON NAME	**SCIENTIFIC NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
ALEWIFE	*Brevoortia sp.*	3,813	$709	169	$38	402	$104	32,968	$2,641	6,346	$963	16,347	$1,321	62,687	$6,325
BASS, BLACK SEA	*Centropristis striata*	4,523	$3,299	5,455	$2,437	2,760	$1,712	5,592	$4,928	1,806	$958	3,209	$3,707	1,281	$1,943
BASS, STRIPED	*Morone saxatilis*	66,353	$68,682	60,953	$59,909	38,227	$64,349	87,982	$160,685	79,057	$127,579	218,554	$278,363	455,535	$790,892
BLUEFISH	*Pomatomus saltatrix*	587,008	$170,383	328,279	$60,992	392,442	$57,187	362,472	$111,432	498,615	$156,538	466,596	$150,155	453,054	$148,878
BUTTERFISH	*Peprilus triacanthus*	20,303	$9,420	10,448	$5,128	23,311	$8,308	223,274	$120,628	187,317	$93,590	128,968	$59,127	141,053	$112,241
CATFISH	*spp.*	269	$94	2,178	$551			15	$7	15,128	$2,899	5,522	$1,376	3,811	$778
COBIA	*Rachycentron canadum*	12,610	$13,386	9,965	$13,155	3,544	$3,499	4,347	$7,093	6,313	$3,215	16,679	$26,850	16,054	$20,573
CROAKER, ATLANTIC	*Micropogonias undulatus*	155,535	$4,446	120,916	$520	872,640	$1,442	2,970,530	$4,670	4,070,338	$808	4,316,441	$156	4,707,578	$592
DOGFISH, NK	*spp.*	1,044	$84,235	4,658	$72,365	478	$317,207	56,972	$1,027,714	13,620	$1,439,137	51,643	$1,543,851	5,583	$1,602,389
DOGFISH, SMOOTH	*Squalus canis*		$152		$476		$91	601	$9,801		$3,089		$11,895	273	$1,283
DOGFISH, SPINY	*Squalus acanthias*			600				114,464	$181					23,200	$72
DRUM, BLACK	*Pogonias cromis*	55,548		39,300	$250	52,093		14,714	$37,366	28,462		34,628		27,754	$2,784
DRUM, RED	*Sciaenops ocellatus*	1,614	$22,731	34,888	$12,794	1,798	$24,055	6,972	$3,681	7,642	$10,518	4,944	$10,043	3,574	$16,640
EEL, AMERICAN	*Anguilla rostrata*	21,336	$1,278	18,793	$17,382	16,831	$1,050	44,964	$2,534	60,785	$4,578	27,243	$2,220	46,022	$1,926
FLOUNDER, SUMMER	*Paralichthys dentatus*	39,329	$90,669	72,976	$134,586	52,056	$157,361	129,223	$314,702	88,671	$294,860	55,070	$381,981	79,223	$454,239
HARVESTFISH	*Peprilus alepidotus*	169,673		117,126	$961	96,562		144,802		59,074		86,596		45,810	
HERRING, ATLANTIC	*Clupea harengus*		$245,657	389	$131,382	642	$89,546	1,779	$142,204	576	$57,670	11	$68,218	20,083	$39,742
MACKEREL, ATLANTIC	*Scomber scombrus*	209,324		19,332		2,626		20,060		664		1,946		34	
MACKEREL, KING	*Scomberomorus cavalla*	3,351	$42,008	4,274	$4,898	2,917	$692	566	$11,010	105	$154	599	$974	367	$8
MACKEREL, SPANISH	*Scomberomorus maculatus*	439,674	$3,600	344,810	$2,794	189,606	$1,713	249,142	$1,563	319,436	$290	146,026	$903	249,054	$519
MENHADEN	*Brevoortia tyrannus*	12,378,399	$157,537	8,769,703	$100,283	11,400,880	$78,826	309,403	$114,749	105,039	$153,785	504,351	$95,572	1,228,811	$177,366
MINNOW	*spp.*	1,127,739	$379,721	1,849,547	$305,132	2,288,710	$428,732	4,354,877	$21,682	5,875,790	$8,618	5,284,742	$30,292	4,765,171	$118,100
MULLET	*Mugil spp.*	11,118	$84,875	13,457	$124,408	4,210	$153,377	4,098	$304,943	1,847	$293,982	3,071	$381,705	490	$453,407
PERCH, WHITE	*Morone americana*	2,789		7,130		5		41		3,829	$64	3,790	$4	8,721	
RIBBON FISH	*Trichiuridae*		$1,976,405		$4,186,522		$3,604,955		$7,066,428	274	$4,658,136	570	$3,713,638	179	$3,686,465
SEATROUT, GREY	*Cynoscion nothus*	897,055		700,101		274,282		627,666	$25	962,588		1,169,471		1,117,270	$4
SEATROUT, SPOTTED	*Cynoscion nebulosus*	14,760	$828,282	14,376	$481,943	7,811	$204,422	21,745	$411,141	34,795	$483,694	22,867	$556,068	3,025	$1,054,594
SHAD, AMERICAN	*Alosa sapidissima*	85,633	$22,124	24,198	$19,420	35,428	$6,194	27,947	$19,073	9,027	$24,312	2,053	$29,422	3,627	$3,849
SHAD, GIZZARD	*Dorosoma cepedianum*	5,454	$41,791		$12,535	75	$17,442	27,260	$23,794	121,334	$18,418	41,264	$1,268	99,319	$2,606
SHAD, HICKORY	*Alosa mediocris*		$500				$4	52	$1,363	16	$16,991	4	$5,778	82	$13,913
SPOT	*Leiostomus xanthurus*	1,221,196	$924	1,287,043	$487	1,852,288	$166	2,306,135	$2,659	2,781,642	$1,199	2,639,514	$4,619	2,048,477	$3,583
TAUTOG	*Tautoga onitis*	2,023	$660,246	1,516	$530,558	776	$613,039	1,441	$1,085,015	4,989	$1,069,557	7,949	$902,012	9,772	$788,381
TOADFISH, OYSTER	*Opsanus tau*		$514		$299		$148		$611		$2,795		$4,660		$5,925
WHITING, KING	*Menticirrhus saxatilis*	21,966	$323	44,982	$131	71,570	$30	80,546	$101	37,118	$34	42,592	$14	50,392	$1

[a] Landings data provided by C. Lewis of MD DNR Fisheries Service (MD DNR, 2004).
[b] Landings data provided by the Virginia Marine Resources Commission (VMRC, 2004).
Data included from the area designated as "System 4," which is the mainstem of the Chesapeake Bay.
Landings from tributaries to the Bay are not included in the dataset reported here, but are available from VMRC

Table 2-9 Commercial Landings of Finfish in the Lower Chesapeake Bay[a,b] (Continued)

		1997		1998		1999		2000		2001		2002	
COMMON NAME	**SCIENTIFIC NAME**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**	**Pounds**	**Dollars**
ALEWIFE	*Brevoortia sp.*	123,499	$12,357	22,701	$2,273	34,950	$4,085	8,323	$915	24,811	$2,726	177,512	$19,531
BASS, BLACK SEA	*Centropristis striata*	872	$1,326	253	$384	1,045	$3,414	175	$350	845	$1,794	2	$1
BASS, STRIPED	*Morone saxatilis*	433,987	$570,036	567,895	$570,532	482,118	$844,882	493,778	$716,098	467,196	$738,555	583,266	$976,080
BLUEFISH	*Pomatomus saltatrix*	562,516	$131,646	606,581	$126,475	358,957	$90,712	443,954	$103,822	759,534	$173,088	451,987	$100,636
BUTTERFISH	*Peprilus triacanthus*	93,063	$65,009	62,759	$37,708	102,062	$64,871	92,354	$61,897	36,697	$20,402	44,529	$25,190
CATFISH	*spp.*	2,936	$602	4,754	$967	935	$202	3,204	$739	5,774	$2,888	5,185	$3,166
COBIA	*Rachycentron canadum*	8,624	$9,069	11,328	$11,328	4,569	$8,412	4,048	$6,357	7,308	$13,522	7,713	$14,320
CROAKER, ATLANTIC	*Micropogonias undulatus*	7,299,973	$520	7,888,172	$564	7,429,048	$12,228	7,566,070	$46	7,272,521	$618	7,717,297	$2,234
DOGFISH, NK	*spp.*	84,178	$2,063,837	2,252	$2,316,800	15,011	$2,079,980	9,001	$3,614,912	301	$1,856,101	110	$2,483,620
DOGFISH, SMOOTH	*Squalus canis*	7,362	$15,563		$518		$5,341	292	$2,616		$93	688	$37
DOGFISH, SPINY	*Squalus acanthias*	553	$2,113	7,992		337			$67			11	$151
DRUM, BLACK	*Pogonias cromis*	27,223	$166	14,501	$2,399	17,921	$56	13,665		26,685		20,935	$2
DRUM, RED	*Sciaenops ocellatus*	6,612	$13,638	9,910	$7,263	13,134	$5,379	12,726	$3,966	6,060	$7,703	7,166	$10,150
EEL, AMERICAN	*Anguilla rostrata*	26,416	$3,444	26,675	$5,028	28,207	$12,634	39,391	$10,828	25,161	$7,966	27,147	$8,488
FLOUNDER, SUMMER	*Paralichthys dentatus*	80,989	$698,733	110,101	$218,285	86,990	$177,460	106,000	$169,113	130,330	$147,751	120,351	$140,984
HARVESTFISH	*Peprilus alepidotus*	45,884		48,786		67,824		99,596		77,124		93,030	
HERRING, ATLANTIC	*Clupea harengus*	9,285	$36,722	4,470	$39,034	3,469	$53,608	4,639	$76,716	3,821	$79,410	4,599	$105,144
MACKEREL, ATLANTIC	*Scomber scombrus*	1,102		754		2,786		6,710		7,472		1,838	$418
MACKEREL, KING	*Scomberomorus cavalla*	453	$178	79	$382	81	$644	403	$5,906	184	$2,072	5	$612
MACKEREL, SPANISH	*Scomberomorus maculatus*	79,883	$893	90,101	$158	197,382	$22	110,928	$114	142,791	$330	82,163	$10
MENHADEN	*Brevoortia tyrannus*	1,110,947	$43,221	797,351	$63,148	1,231,025	$167,951	1,432,639	$78,809	1,146,157	$113,874	1,030,353	$61,773
MINNOW	*spp.*	6,097,513	$109,166	3,028,134	$79,780	2,891,554	$101,872	3,165,227	$143,273	2,059,797	$164,454	2,349,336	$158,300
MULLET	*Mugil spp.*	3,234	$698,123	7,489	$213,797	2,493	$176,092	3,056	$161,218	1,294	$146,875	4,037	$137,490
PERCH, WHITE	*Morone americana*	996	$920	1,884		2,064		6,264		16,866		5,298	
RIBBON FISH	*Trichiuridae*	570	$2,606,811	61	$1,977,328	819	$2,465,976	23,538	$2,336,109	32	$1,882,774	1,482	$5,353,960
SEATROUT, GREY	*Cynoscion nothus*	1,026,862	$8	1,466,426		1,179,467		950,013		815,398		921,924	
SEATROUT, SPOTTED	*Cynoscion nebulosus*	8,026	$418,395	17,749	$353,452	35,529	$723,716	12,814	$621,527	18,933	$558,675	21,234	$643,743
SHAD, AMERICAN	*Alosa sapidissima*	11,763	$12,059	10,084	$26,664	1,088	$41,093	2	$13,830		$26,019	3	$20,037
SHAD, GIZZARD	*Dorosoma cepedianum*	59,063	$3,561	13,743	$3,528	3,451	$739	5,376	$1	2,619		9,539	$1
SHAD, HICKORY	*Alosa mediocris*	222	$8,261	230	$1,928	771	$314	709	$429	1,205	$225	10,203	$861
SPOT	*Leiostomus xanthurus*	2,562,795	$14,235	3,409,464	$2,768	2,464,835	$17,255	3,095,384	$10,322	2,629,723	$15,036	2,633,894	$6,938
TAUTOG	*Tautoga onitis*	12,663	$1,065,584	8,220	$1,028,766	14,406	$862,210	7,331	$1,886,801	8,425	$1,068,077	7,965	$1,077,726
TOADFISH, OYSTER	*Opsanus tau*	810	$13,648	1,255	$8,705	775	$17,381	995	$6,618	1,660	$11,280	387	$8,889
WHITING, KING	*Menticirrhus saxatilis*	21,516	$483	11,536	$117	11,942	$12	41,872	$243	64,516	$6	13,542	$51

[a] Landings data provided by C. Lewis of MD DNR Fisheries Service (MD DNR, 2004).
[b] Landings data provided by the Virginia Marine Resources Commission (VMRC, 2004).
Data included from the area designated as "System 4," which is the mainstem of the Chesapeake Bay.
Landings from tributaries to the Bay are not included in the dataset reported here, but are available from VMRC

Table 2-10

Fish Species with EFH for Mainstem of Chesapeake Bay - Maryland and Virginia

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Red hake *(Urophycis chuss)*			S	S	
Windowpane flounder *(Scopthalmus aquosus)*			M,S	M,S	
Atlantic sea herring *(Clupea harengus)*				S	
Bluefish *(Pomatomus saltatrix)*			M,S	M,S	
Atlantic butterfish *(Peprilus triacanthus)*	M,S	M,S	M,S	M,S	
Summer flounder *(Paralicthys dentatus)*		M,S	M,S	M,S	
Scup *(Stenotomus chrysops)*			S	S	
Black sea bass *(Centropristus striata)*			M,S	M,S	
King mackerel *(Scomberomorus cavalla)*	X	X	X	X	
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X	
Cobia *(Rachycentron canadum)*	X	X	X	X	
Red drum *(Sciaenops occelatus)*	X	X	X	X	

Salinity Zone
M = Mixing
S = Seawater

Table 2-11

Fish Species with EFH in MD Tributaries (Choptank River, Potomac River, Patuxent River, and Chester River, Maryland)

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Windowpane flounder *(Scopthalmus aquosus)*			M	M	
Bluefish *(Pomatomus saltatrix)*			M	M	
Summer flounder *(Paralicthys dentatus)*			M	M	
King mackerel *(Scomberomorus cavalla)*	X	X	X	X	
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X	
Cobia *(Rachycentron canadum)*	X	X	X	X	
Red drum *(Sciaenops occelatus)*	X	X	X	X	

Salinity Zone
M = Mixing
S = Seawater

Table 2-12

Fish Species with EFH in James River, Virginia

Species	Eggs	Larvae	Juveniles	Adults
Windowpane flounder *(Scopthalmus aquosus)*			X	X
Bluefish *(Pomatomus saltatrix)*			X	X
Atlantic butterfish *(Peprilus triacanthus)*	X	X	X	X
Summer flounder *(Paralicthys dentatus)*		X	X	X
Black sea bass *(Centropristus striata)*	n/a		X	X
King mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
Cobia *(Rachycentron canadum)*	X	X	X	X
Red drum *(Sciaenops occelatus)*	X	X	X	X
Dusky shark *(Charcharinus obscurus)*		X		
Sandbar shark *(Charcharinus plumbeus)*		X	X	X
Sandbar shark *(Charcharinus plumbeus)*		HAPC	HAPC	HAPC

HAPC – Habitat Areas of Particular Concern

Table 2-13

Fish Species with EFH in Mouth of Chesapeake Bay (Southernmost Portion of Lower Bay)

Species	Eggs	Larvae	Juveniles	Adults
Red hake *(Urophycis chuss)*			X	X
Windowpane flounder *(Scopthalmus aquosus)*			X	X
Atlantic sea herring *(Clupea harengus)*				X
Bluefish *(Pomatomus saltatrix)*			X	X
Atlantic butterfish *(Peprilus triacanthus)*	X	X	X	X
Summer flounder *(Paralicthys dentatus)*		X	X	X
Scup *(Stenotomus chrysops)*	n/a	n/a	X	X
Black sea bass *(Centropristus striata)*	n/a		X	X
King mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
Cobia *(Rachycentron canadum)*	X	X	X	X
Red drum *(Sciaenops occelatus)*	X	X	X	X
Sand tiger shark *(Odontaspis taurus)*		X		X
Atlantic sharpnose shark *(Rhizopriondon terraenovae)*				X
Dusky shark *(Charcharinus obscurus)*		X	X	
Sandbar shark *(Charcharinus plumbeus)*		X	X	X
Sandbar shark *(Charcharinus plumbeus)*		HAPC	HAPC	HAPC

HAPC – Habitat Areas of Particular Concern

Table 2-14

SAV Information Used for Evaluating Habitat Requirements–C&D Canal Approach Channels (Upper Bay)

Segment		2002 SAV (Acres)	2003 SAV (Acres)	Change	2010 Goal (Acres)	Percent of Goal
CB1TF	Northern Chesapeake Bay	3,734.08	3,063.02	-18%	5,225.84	59%
NORTF	Northeast River	30.75	18.63	-39%	35.59	52%
ELKOH	Elk River	176.1	139.96	-21%	667.24	21%
BOHOH	Bohemia River	55.11	**116.59**	112%	**39.39**	**296%**
C&DOH	Chesapeake & Delaware Canal	0	0	0%	0.08	0%
CB2OH	Upper Chesapeake Bay	203.21	85.59	-58%	122.1	70%
SASOH	Sassafras River	336.03	149.83	-55%	309.17	48%
BSHOH	Bush River	141.57	**157.89**	12%	**63.78**	**248%**
GUNOH	Gunpowder River	187.39	197.94	6%	912.54	22%
MIDOH	Middle River	254.73	158.26	-38%	339.46	47%
BACOH	Back River	0	0	0%	0	-
CB3MH	Upper Central Chesapeake Bay	38.32	9.23		381.77	
		-7.95	**-9.23**	+16%*	**-9.2**	**100%***
PATMH	Patapsco River	3.19	2.64	-17%	120.76	2%
MAGMH	Magothy River	84.49	68.28	-19%	220.73	31%
CHSMH	Lower Chester River	82.9	47.32		1,102.76	
		-49.74	-31.99	-36%*	-334.83	10%*
CHSOH	Middle Chester River	0	0	0%	25.58	0%
CHSTF	Upper Chester River	0	0	0%	0	-

(VIMS, 2003b, c)

CBP Segments that have met the 2010 Goal are shown in **bold.**

Table 2-15

SAV Information Used for Evaluating Habitat Requirements–Harbor Channels

Segment		**2002 SAV (Acres)**	**2003 SAV (Acres)**	**Change**	**2010 Goal (Acres)**	**Percent of Goal**
BACOH	Back River	0	0	0%	0	-
PATMH	Patapsco River	3.19	2.64	-17%	120.76	2%

(VIMS, 2003b, c)

Table 2-16

SAV Information Used for Evaluating Habitat Requirements–Chesapeake Bay Approach Channels—MD (Middle Bay)

Segment		2002 SAV (Acres)	2003 SAV (Acres)	Change	2010 Goal (Acres)	Percent of Goal
CB4MH	Middle Central Chesapeake Bay	109.04	8.65	-92%	1,016.58	1%
EASMH	Eastern Bay	1,124.85	662.84	-41%	2,473.04	27%
CHOMH1	Mouth of the Choptank River	2,664.62	1,202.00	-55%	3,256.54	37%
CHOMH2	Lower Choptank River	62.5	0	-100%	606.93	0%
CHOOH	Middle Choptank River	0	0	0%	25.57	0%
CHOTF	Upper Choptank River	0	0	0%	0	-
LCHMH	Little Choptank River	1,175.56	317.23	-73%	1,599.12	20%
SEVMH	Severn River	114.13	89.67	-21%	133.13	67%
SOUMH	South River	14.41	5.51	-62%	185.99	3%
RHDMH	Rhode River	0	0	0%	19.43	0%
WSTMH	West River	0	9.32		86.71	11%
CB5MH	Lower Central Chesapeake Bay	1,984.93	635.12		6,057.05	
		-864.77	-282.98	-67%*	-3,401.31	8%*
HNGMH	Honga River	2,558.72	1,150.35	-55%	3,111.81	37%
FSBMH	Fishing Bay	44.03	6.1	-86%	78.21	8%
NANMH	Lower Nanticoke River	0	0	0%	1.09	0%
NANOH	Middle Nanticoke River	0	0	0%	1.39	0%
NANTF	Upper Nanticoke River	0	0	0%	0	-
WICMH	Wicomico River	0	0	0%	1.25	0%
TANMH	Tangier Sound	6,078.71	3,805.51	-37%	15,370.42	25%
MANMH	Manokin River	294.51	94.95	-68%	1,764.64	5%
BIGMH	Big Annemessex River	316.47	182.29	-42%	815.4	22%
POCMH	Lower Pocomoke River	733.18	674.25	-8%	1,656.69	41%

Table 2-16

SAV Information Used for Evaluating Habitat Requirements–Chesapeake Bay Approach Channels—MD (Middle Bay) (Continued)

Segment		2002 SAV (Acres)	2003 SAV (Acres)	Change	2010 Goal (Acres)	Percent of Goal
POCOH	Middle Pocomoke River	0	0	0%	0	-
POCTF	Upper Pocomoke River	0	0	0%	0	-
PAXMH	Lower Patuxent River	56.91	14.98	-74%	536.49	3%
PAXOH	Middle Patuxent River	8.51	**43.01**	405%	**27.41**	**157%**
PAXTF	Upper Patuxent River	69.07	**87.81**	27%	**2.18**	**4028%**
WBRTF	Western Branch of the Patuxent River	0	0	0%	0	-
POTMH	Lower Potomac River	1,059.71	1,005.11		4,117.36	
		-1,023.20	-893.6	-13%*	-3,122.23	29%*
POTOH	Middle Potomac River	904.49	1,349.40	49%	1,506.38	90%
POTTF	Upper Potomac River	1,483.71	655.31	-56%	1,768.29	37%
MATTF	Mattawoman Creek	320.76	**247.62**	-23%	**111.76**	**222%**
PISTF	Piscataway Creek	255.61	85.7	-66%	317.14	27%
ANATF	Anacostia River	2.7	0	-100%	2.29	0%

(VIMS, 2003b, c)
CBP Segments that have met the 2010 Goal are shown in **bold**.

Table 2-17

SAV Information Used for Evaluating Habitat Requirements—Chesapeake Bay Approach Channels—VA (Lower Bay)

Segment		2002 SAV (Acres)	2003 SAV (Acres)	Change	2010 Goal (Acres)	Percent of Goal
CB6PH	Western Lower Chesapeake Bay	310.49	286.29	-8%	396.86	72%
CB7PH	Eastern Lower Chesapeake Bay	3,966.28	3,718.95	-6%	5,917.12	63%
RPPMH	Lower Rappahannock River	407.46	8.55	-98%	2,178.19	0%
CRRMH	Corrotoman River	311.04	17.59	-94%	208.87	8%
RPPOH	Middle Rappahannock River	0	0	0%	0	-
RPPTF	Upper Rappahannock River	1.39	0	-100%	7.96	0%
PIAMH	Piankatank River	283.95	180.86	-36%	1,318.03	14%
MOBPH	Mobjack Bay	3,538.29	3,422.50	-3%	6,111.64	56%
YRKPH	Middle York River	373.04	359.06	-4%	919.68	39%
YRKMH	Lower York River	0	0	0%	71.37	0%
MPNOH	Lower Mattaponi River	0	0	0%	0	-
MPNTF	Upper Mattaponi River	9.14	74.34	713%	**30.53**	**243%**
PMKOH	Lower Pumunkey River	0	0	0%	0	-
PMKTF	Upper Pumunkey River	69.19	88	27%	62.92	140%
JMSPH	Mouth of the James River	113.51	53.22	-53%	244.5	22%
JMSMH	Lower James River	0.6	0.66	11%	215.1	0%
ELIPH	Elizabeth River	0	0	0%	0	-
WBEMH	Western Branch of the Elizabeth River	0	0	0%	0	-
SBEMH	South Branch of the Elizabeth River	0	0	0%	0	-
EBEMH	Eastern Branch of the Elizabeth River	0	0	0%	0	-
LAFMH	Lafayette River	0	0	0%	0	-
CHKOH	Chickahominy River	75.43	172.03	128%	**140.7**	**122%**
JMSOH	Middle James River	4.71	3.66	-22%	**2.7**	**136%**
JMSTF	Upper James River	33.82	30.48	-10%	647.58	5%
APPTF	Appomattox River	0	0	0%	129.26	0%
CB8PH	Mouth of the Chesapeake Bay	4.22	1.94	-54%	2.37	82%
LYNPH	Lynnhaven & Broad Bays	15.51	0	-100%	27.88	0%

(VIMS, 2003b, c)

CBP segments that have met the 2010 goal are shown in **bold**.

Table 2-18
Common Mammal, Bird, and Herpetile Species Observed or Expected in the Counties Bordering the Chesapeake Bay

Scientific Name	Common Name
MAMMALS	
Blarina brevicauda	Northern short-tailed shrew[a]
Castor canadensis	Beaver
Cervus nippon	Sika deer
Didelphis virginiana	Virginia opossum
Eptesicus fuscus	Big brown bat
Lasiurus borealis	Red bat
Lutra canadensis	River otter
Marmota monax	Woodchuck
Mephitis mephitis	Striped skunk
Microtus pennsylvanicus	Meadow vole
Myocastor coypus	Nutria
Myotis lucifugus	Little brown bat
Odocoileus virginianus	White-tailed deer
Ondatra zibethicus	Common muskrat
Peromyscus leucopus	White-footed mouse
Peromyscus spp.	House mouse
Pipistrellus subflavus	Eastern pipistrelle
Procyon lotor	Common raccoon
Rattus norvegicus	Norway rat
Scalopus aquaticus	Eastern mole
Sciurus carolinensis	Eastern gray squirrel
Sciurus niger	Eastern fox squirrel[a]
Sylvilagus floridanus	Eastern cottontail
Tamias striatus	Eastern chipmunk
Urocyon cinereoargenteus	Common gray fox[b]
Vulpes vulpes (Vulpes fulva)	Red fox
BIRDS	
Accipiter gentiles	Cooper's hawk
Accipiter striatus	Sharp-skinned hawk
Actitis macularia	Spotted sandpiper
Agelaius phoeniceus	Red-winged blackbird
Aix Galericulata	Mandarin duck
Aix sponsa	Wood duck
Ammodramus causdacultus	Sharp-tailed sparrow
Anas acuta	Nothern Pintail
Anas americana	American wigeon
Anas clypeata	Northern shoveler
Anas crecca	Green-winged teal
Anas discors	Blue-winged teal
Anas platyrhynchos	Mallard
Anas rubripes	American black duck
Anas strepera	Gadwall
Anthus rubescens	American pipit
Aquila chrysaetos	Golden eagle
Ardea alba	Great egret
Ardea herodias	Great blue heron
Arenaria interpres	Ruddy Turnstone
Aythya affinis	Lesser scaup
Aythya americana	Redhead
Aythya collaris	Ring-necked duck
Aythya ferina	Common pochard
Aythya marila	Greater scaup
Aythya valisineria	Canvasback
Baeolophus bicolor	Tufted titmouse
Branta bernicla	Brant
Branta canadensis	Canada goose
Bubo virginianus	Great horned owl
Bubulcus ibis	Cattle Egret
Bucephala albeola	Bufflehead
Bucephala clangula	Common goldeneye
Buteo jamaicensis	Red-tailed hawk
Butorides striatus	Green-backed Heron
Butorides virescens	Green Heron
Calidris alba	Sanderling
Calidris alpina	Dunlin
Calidris fuscicollis	White-rumped sandpiper
Calidris mauri	Western sandpiper
BIRDS (continued)	
Calidris maritima	Purple sandpiper
Calidris melanotos	Pectoral sandpiper
Calidris minutilla	Least sandpiper
Calidris pusila	Semi-palmated sandpiper
Cardinalis cardinalis	Northern cardinal
Carduelis tristis	American goldfinch
Carpodacus mexicanus	House finch
Casmerodius albus	Great egret
Cataoptrophorus semipalmatus	Willet
Cathartes aura	Turkey Vulture
Ceryle alcyon	Belted kingfisher
Chaetura pelagica	Chimney swift
Charadrius semipalmatus	Semipalmated plover
Charadrius vociferus	Killdeer
Chen caerulescens	Snow goose
Chlidonias niger	Black tern
Cisthorus paslustris	Marsh wren
Clangula hyemalis	Long-tailed Duck
Clangula hyemalis	Oldsquaw
Colaptes auratus	Common flicker
Columba livia	Rock dove (Pigeon)
Coragyps atratus	Black vulture
Corvus brachyrynchos	Common crow
Corvus ossifragus	Fish crow
Cyanocitta cristata	Blue jay
Cygnus columbianus	Tundra Swan
Cygnus olor	Mute swan
Dendroica coronata	Yellow-rumped warbler
Dendroica pinus	Pine Warbler
Dryocopus pileatus	Pileated woodpecker
Dumetella carolinensis	Gray catbird
Egretta caerulea	Little Blue heron
Egretta thula	Snowy egret
Egretta tricolor	Tricolored heron
Emberizidae	Sparrow sp.
Falco columbarius	Merlin
Falco sparverius	American Kestrel
Fulica americana	American coot
Gavia immer	Common loon
Gelochelidion nilotica	Gull-billed tern
Geothlypis trichas	Common yellow throat
Goldeneye Bucephala clangula	Common
Haematopus palliates	American Oystercatcher
Haliaeetus leucocephalus	Bald eagle
Hirundo rustica	Barn swallow
Hylocichla mustelina	Wood thrush
Junco hyemalis	Dark-eyed Junco
Junco hyemalis	Slate-colored junco
Larus argentatus	Herring gull
Larus atricilla	Laughing gull
Larus californicus	California gull
Larus delawarensis	Ring-billed gull
Larus glaucoides	Iceland gull
Larus hyperboreus	Glaucous gull
Larus marinus	Great black-backed gull
Larus philadelphia	Bonaparte's gull
Limnodromus griseus	Short-billed dowitcher
Limnodromus scolopaccus	Long-billed dowitcher
Limosa fedoa	Marbled godwit
Lophodytes cucullatus	Hooded merganser
Mareca americana	American wigeon
Mareca strepera	Gadwall
Melanerpes carolinus	Red-bellied woodpecker
Melanitta fusca	White-winged scoter
Melanitta nigra	Black scoter
Melanitta perspicillata	Surf scoter
Melospiza georgiana	Swamp sparrow
Melospiza melodia	Song sparrow

Table 2-18 (continued)
Common Mammal, Bird, and Herpetile Species Observed or Expected in the Counties Bordering the Chesapeake Bay

Scientific Name	Common Name
BIRDS (continued)	
Mergus merganser	Merganser
Mergus serrator	Red-breasted merganser
Micropalama himantopus	Stilt sandpiper
Mimus polyglottos	Mockingbird
Molothrus ater	Brown-headed cowbird
Myiarchus crinitus	Great crested flycatcher
Nyctea scandiaca	Snowy owl
Nycticorax nycticorax	Black-crowned night-heron
Nycticorax violaceus	Yellow-crowned night-heron
Olor columbianus	Whistling swan
Otus asio	Screech owl
Oxyura jamaicensis	Ruddy duck
Pandion haliaetus	Osprey
Parus atricapillus	Black-capped chickadee *
Parus bicolor	Tufted titmouse
Passer domesticus	House sparrow
Pelecanus occidentalis	Brown pelican
Pelecanus erythrorhynchose	White pelican
Phalacrocorax auritus	Double-crested cormorant
Phalaropus lobatus	Red-necked phalarope
Phalaropus tricolor	Wilson's phalarope
Philohela minor	American woodcock
Pica pica	Black-billed magpie
Picoides pubescens	Downy woodpecker
Pipilo erythrophthalmus	Eastern Towhee
Plectrophenax nivalis	Snow bunting
Plegadis falcinellus	Glossy Ibis
Pluvialis squatarola	Black-bellied plover
Podiceps auritus	Horned grebe
Podiceps grisegena	Red-necked grebe
Podilymbus podiceps	Pied-billed grebe
Poecile carolinensis	Carolina chickadee
Polioptila caerula	Blue-gray gnatcatcher
Protonotaria citrea	Warbler
Quiscalus major	Boat tailed gackle
Quiscalus quiscula	Common grackle
Rallus limicola	Virginia Rail
Recurvirostra americana	American avocet
Regulus satrapa	Golden-crowned kinglet
Riparia riparia	Bank swallow
Rynchops niger	Black Skimmer
Sapsucker Sphyrapicus varius	Yellow-bellied
Sialia sialis	Eastern bluebird
Sitta carolinensis	White-breasted Nuthatch
Somateria mollissima	Common eider
Spizella passerina	Chipping sparrow
Sterna antillarum	Least tern
Sterna caspia	Caspian tern
Sterna forsteri	Forester’s tern
Sterna hirundo	Common tern
Sterna maximus	Royal tern
Strix varia	Barred owl
Sturnus vulgaris	European starling
Tachycineta bicolor	Tree swallow
Thryothorus ludovicianus	Carolina Wren
Tringa flavipes	Lesser Yellowlegs
BIRDS (continued)	
Tringa melanoleuca	Greater yellowlegs
Turdus migratorius	American robin
Tyrannus tyrannus	Eastern kingbird
Tyto alba	Common barn-owl
Vermivora varia	Black and white warbler
Zenaida macroura	Mourning dove
Zonotrichia albicollis	White-throated sparrow
Herpetiles	
Ambystoma opacum	Marbled salamander
Bufo americanus	American toad
Bufo fowleri	Fowlers toad
Chelydra serpentina	Common snapping turtle
Chrysemys picta picta	Eastern painted turtle
Desmognathus fuscus	Northern dusky salamander
Coluber constrictor constrictor	Northern black racer
Diadophis punctatus	Ringneck snake
Elaphe obsoleta	Eastern rat snake
Hyla versicolor	Gray treefrog
Kinosternon subrubrum	Eastern mud turtle
Lampropeltis triangulum	Milk snake
Malaclemys terrapin terrapin	Northern diamondback terrapin
Nerodia sipedon	Northern brown water snake
Notophthalmus viridescens	Eastern newt
Plethodon cinereus	Eastern red-backed salamander
Pseudacris crucifer	Spring peeper
Pseudemys rubriventris	Red belly turtle
Pseudotriton ruber	Red salamander
Rana catesbeiana	American bullfrog
Rana clamitans melanota	Green frog
Rana palustris	Southern pickerel frog
Rana uticularia	Southern leopard frog
Sternotherus odoratus	Common musk turtle
Storeria occipitomaculata	Red-bellied snake
Terrapene Carolina	Eastern box turtle
Thamnophis sirtalis	Common garter snake

Table 2-18 (continued)

Common Mammal, Bird, and Herpetile Species Observed or Expected in the Counties Bordering the Chesapeake Bay

Source: Table compiled from a variety of sources, including Chesapeake Bay Program 1998; Chesapeake Bay Program, 2004; USACE and VA Fish & Wildlife Information Service online database (http://vafwis.org/WIS/ASP/default.asp).

Notes:

[a] Species population present in upper reaches of Chesapeake Bay.

[b] Species population present in lower reaches of Chesapeake Bay.

Table 2-19

Species of Special Concern Potentially Present in the Counties Bordering the Upper Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
BIRDS						
Asio flammeus	Short-eared owl	G5	SHB	I		QA
Bartramia longicauda	Upland sandpiper	G5	S1B	E		BC
Botaurus lentiginosus	American bittern	G4	S1S2B	I		BC
Circus cyaneus	Northern harrier	G5	S2B			BC
Falco peregrinus	Peregrine falcon	G4	S1B	E		A
Gallinula chloropus	Common moorhen	G5	S2B	I		A
Haliaeetus leucocephalus	Bald eagle	G4	S2S3B	T	LT	A,BC,K,QA
Ixobrychus exilis	Least bittern	G5	S2S3B	I		BC
Lanius ludovicianus	Loggerhead shrike	G4	S1B	E		BC
Laterallus jamaicensis	Black rail	G4	S2S3B	I		A,BC
Lophodytes cucullatus	Hooded merganser	G5	S1B			BC,K
Podilymbus podiceps	Pied-billed grebe	G5	S2B			A,BC
Porzana carolina	Sora	G5	S1B			A
Sterna antillarum	Least tern	G4	S2B	T		A,BC,K,QA
INSECTS (Beetles & Grasshoppers)						
Limotettix sp.	Eastern sedge barrens planthopper	G?	S1			BC
Cicindela patruela	A tiger beetle	G3	S1	T	LT	BC
Cicindela puritana	Puritan tiger beetle	G1G2	S1	E	LT	K
Hydrochara occulta	A hydrophilid beetle	G?	SU			A
Sperchopsis tessellatus	A hydrophilid beetle	G?	S2			A,BC
INSECTS (Butterflies and Moths)						
Autochton cellus	Golden-banded skipper	G4	S1	E		A
Cyclophora nanaria	A geometrid moth	G5	S1?			BC
Erynnis martialis	Mottled duskywing	G3G4	S1	E		BC
Fixsenia ontario	Northern hairstreak	G4T4	S1S2	E		BC
Meropleon titan	A noctuid moth	G2G4	SU			A
Satyrium edwardsii	Edwards' hairstreak	G4	S1	E		BC
Speyeria idalia	Regal fritillary	G3	SH	E		BC
FISH						
Acantharchus pomotis	Mud sunfish	G5	S2			QA
Acipenser brevirostrum	Shortnose sturgeon	G3	S1	E	LE	K
Empidonax alnorum	Alder flycatcher	G5	S2B	I		BC
Etheostoma vitreum	Glassy darter	G4G5	S1S2	E		A
Fundulus luciae	Spotfin killifish	G4	S2?			A,QA
Notropis chalybaeus	Ironcolor shiner	G4	S1			QA
Percina notogramma	Stripeback darter	G4	S1	E		A
HERPETILES (Reptiles and Amphibians)						
Ambystoma tigrinum	Eastern tiger salamander	G5	S2	E		A,K,QA
Clemmys muhlenbergii	Bog turtle	G3	S2			BC
Graptemys geographica	Map turtle	G5	S1	E*		A,BC
Hyla gratiosa	Barking treefrog	G5	S1	E		K,QA
Nerodia erythrogaster erythrogaster	Redbelly water snake	G5T5	S2S3			A
Pituophis melanoleucus	Northern pine snake	G4	SR			A,QA
Rana virgatipes	Carpenter frog	G5	S2	I		QA
INVERTEBRATES (Non-Insects)						
Alasmidonta heterodon	Dwarf wedge mussel	G1G2	S1	E	LE	QA
Alasmidonta undulata	Triangle floater	G4	S1	E		BC,QA
Alasmidonta varicose	Brook floater	G3	S1	E		BC
Elliptio lanceolata	Yellow lance	G2G3	SU			QA
Lampsilis radiata	Eastern lampmussel	G5	SU			BC,K,QA
Leptodea ochracea	Tidewater mucket	G4	SU			K
Strophitus undulatus	Squawfoot	G5	S2S3			K,QA
Stygobromus indentatus	Tidewater amphipod	G3	S1			A,
Stygobromus tenuis tenuis	Tenuis amphipod	G4G5T2T3Q	SU			BC
Phagocata virilis	A planarian	G?	S1			QA
MAMMALS						
Sciurus niger cinereus	Delmarva fox squirrel	G5T3	S1	E	LE	K,QA
Sorex hoyi winnemana	Southern pygmy shrew	G5T4	S2			BC
PLANTS						
Adlumia fungosa	Climbing fumitory	G4	S2	T		BC
Aeschynomene virginica	Sensitive joint-vetch	G2	S1	E	LT	A
Agalinis acuta	Sandplain gerardia	G1	S1	E	LE	BC
Agalinis fasciculata	Agalinis fasciculata	G5	S1	E		BC,K
Agalinis obtusifolia	Blunt-leaved gerardia	G4G5Q	S1	E		BC
Agalinis setacea	Thread-leaved gerardia	G5?	S1	E		A,BC
Agastache scrophulariifolia	Purple giant hyssop	G4	S1S2	T		BC
Agrimonia microcarpa	Small-fruited agrimony	G5	SU			A
Agrimonia striata	Woodland agrimony	G5	S1	E		A
Amelanchier stolonifera	Running juneberry	G5	S2	T		QA

Table 2-19

Species of Special Concern Potentially Present in the Counties Bordering the Upper Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Ammannia latifolia	Koehne's ammannia	G5	S2			BC,K
Antennaria solitaria	Single-headed pussytoes	G5	S2	T		A
Apocynum sibiricum	Clasping-leaved dogbane	G5?	SH	X		K
Arabis missouriensis	Missouri rockcress	G4G5Q	S1	E		BC
Arabis shortii	Short's rockcress	G5	S2	T		A
Aristida curtissii	Curtiss' three-awn	G5T5	SU			A
Aristida lanosa	Woolly three-awn	G5	S1	E		A
Arnica acaulis	Leopard's-bane	G5	S1	E		BC
Arundinaria gigantea	Giant cane	G5	S2			A,BC,K
Asclepias rubra	Red milkweed	G4G5	S1	E		BC
Asplenium bradleyi	Bradley's spleenwort	G4	SH	X		BC
Asplenium pinnatifidum	Lobed spleenwort	G4	S1	E		BC
Aster concolor	Silvery aster	G4?	S1	E		A,BC
Aster depauperatus	Serpentine aster	G2	S1	E		BC
Aster nemoralis	Bog aster	G5	SE?			A
Aster praealtus	Willow aster	G5	S1			A
Azolla caroliniana	Mosquito fern	G5	SU			A
Berberis canadensis	American barberry	G3	SH	X		BC
Betula populifolia	Gray birch	G5	SU			BC
Bidens coronata	Tickseed sunflower	G5	S2S3			BC
Bidens mitis	Small-fruited beggar-ticks	G4?	S1	E		A
Boltonia asteroides	Aster-like boltonia	G5	S1	E		QA
Bouteloua curtipendula	Side-oats grama	G5	S2			BC
Bromus latiglumis	Broad-glumed brome	G5	S1	E		BC
Bromus nottowayanus	Nottoway's brome	G3G4	SH	X		BC
Cacalia muehlenbergii	Great indian-plantain	G4	SH	X		BC
Calopogon tuberosus	Grass-pink	G5	S1	E		A,QA
Calystegia spithamaea	Low bindweed	G4G5	S2			BC
Carex brevior	Fescue sedge	G5?	S2?			BC
Carex conjuncta	Soft fox sedge	G4G5	S1?	E		BC
Carex exilis	Coast sedge	G5	S1	E		A
Carex hyalinolepis	Shoreline sedge	G4G5	S2S3			A
Carex hystericina	Porcupine sedge	G5	S1	E		BC
Carex lacustris	Lake-bank sedge	G5	S2	T		K
Carex lupuliformis	Hop-like sedge	G4	S1?			A,QA
Carex pellita	Woolly sedge	G5	S2?			BC
Carex richardsonii	Richardson's sedge	G4	S1			BC
Carex striatula	Lined sedge	G4G5	S2?			BC
Carex tenera	Slender sedge	G5	SH	X		BC
Carex trichocarpa	Hairy-fruited sedge	G4	S2			BC
Carex vesicaria	Inflated sedge	G5	S1	T		A
Carex vestita	Velvety sedge	G5	S1	E		A,BC
Carex woodii	Wood's sedge	G4				BC
Castanea dentata	American chestnut	G4	S2S3			A,BC
Centrosema virginianum	Spurred butterfly-pea	G5	S2			QA
Ceratophyllum echinatum	Prickly hornwort	G4?	S1	E		QA
Chamaedaphne calyculata	Leatherleaf	G5	S1	T		A
Chelone obliqua	Red turtlehead	G4	S1	T		A
Chenopodium standleyanum	Standley's goosefoot	G5	S1	E		BC
Coeloglossum viride	Long-bracted orchis	G5	S1	E		BC
Coelorachis rugosa	Wrinkled jointgrass	G5	S1	E		QA
Corallorhiza wisteriana	Wister's coralroot	G5	S1	E		A,BC
Cuscuta coryli	Hazel dodder	G5	SH	X		A,QA
Cuscuta indecora	Pretty dodder	G5	SH			A
Cuscuta polygonorum	Smartweed dodder	G5	S1	E		A
Cyperus retrofractus	Rough cyperus	G5	S2			A,K
Deschampsia cespitosa	Tufted hairgrass	G5	S1	E		BC
Desmodium humifusum	Trailing tick-trefoil	G1G2Q	SH	X		A
Desmodium lineatum	Linear-leaved tick-trefoil	G5	S1	E		BC
Desmodium pauciflorum	Few-flowered tick-trefoil	G5	S1	E		A,K
Desmodium rigidum	Rigid tick-trefoil	G?Q	S1	E		BC,K
Desmodium sessilifolium	Sessile-leaved tick-trefoil	G5	SH	X		BC
Desmodium strictum	Stiff tick-trefoil	G4	S1	E		A,BC
Diplazium pycnocarpon	Glade fern	G5	S2	T		A,BC
Dirca palustris	Leatherwood	G4	S2	T		BC
Dryopteris celsa	Log fern	G4	S3.1	T		BC
Eleocharis albida	White spikerush	G4G5	S1	E		A,QA
Eleocharis flavescens	Pale spikerush	G5	S1			A,K
Eleocharis halophila	Salt-marsh spikerush	G4	S1	E		A
Eleocharis intermedia	Matted spikerush	G5	S1	E		A,BC

Table 2-19
Species of Special Concern Potentially Present in the Counties Bordering the Upper Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Eleocharis melanocarpa	Black-fruited spikerush	G4	S1	E		QA
Eleocharis rostellata	Beaked spikerush	G5	S2?			A
Epilobium ciliatum	Northern willowherb	G5	S1	E		BC
Equisetum sylvaticum	Wood horsetail	G5	S1	E		BC
Erianthus contortus	Bent-awn plumegrass	G5	S2	T		QA
Eriocaulon aquaticum	Seven-angled pipewort	G5	S1	E		A
Eriocaulon parkeri	Parker's pipewort	G3	S2	T		BC
Eupatorium leucolepis	White-bracted boneset	G5	S2S3	T		BC
Eupatorium maculatum	Spotted Joe-pye-weed	G5	SU	X		BC
Festuca paradoxa	Cluster fescue	G5	SH	X		A,BC
Filipendula rubra	Queen-of-the-prairie	G4G5	S1	E		BC
Fimbristylis perpusilla	Harper's fimbristylis	G2	S2	E		K,QA
Fraxinus profunda	Pumpkin ash	G4	S2S3			A
Galium hispidulum	Coast bedstraw	G5	S1	E		A
Gaylussacia brachycera	Box huckleberry	G3	S1	E		A
Gentiana andrewsii	Fringe-tip closed gentian	G5?	S2	T		BC
Gentiana villosa	Striped gentian	G4	S1	E		A,BC
Gentianopsis crinita	Fringed gentian	G5	S1	E		BC
Geranium robertianum	Herb-robert	G5	S1	E		BC
Geum aleppicum	Yellow avens	G5	S1	E		A
Glaux maritima	Sea milkwort	G5	SH	X		K,QA
Glyceria acutiflora	Sharp-scaled mannagrass	G5	S1	E		QA
Gymnocladus dioicus	Kentucky coffee-tree	G5	S1			A,BC
Helianthemum bicknellii	Hoary frostweed	G5	S1	E		A,BC
Helonias bullata	Swamp pink	G3	S2	E	LT	A
Hexalectris spicata	Crested coralroot	G5	SH	X		A
Hierochloe odorata	Holy grass	G5	S1	E		BC
Hottonia inflata	Featherfoil	G4	S1	E		K,QA
Hydrastis canadensis	Goldenseal	G4	S2	T		BC
Hypericum adpressum	Creeping St. John's-wort	G2G3	S1	E		QA
Hypericum denticulatum	Coppery St. John's-wort	G5	S1	E		BC
Hypericum gymnanthum	Clasping-leaved St. John's-wort	G4	S1	E		K
Ilex decidua	Deciduous holly	G5	S2			QA
Iris prismatica	Slender blue flag	G4G5	S1	E		BC,K
Iris verna	Dwarf iris	G5	S1	E		A
Juncus brachycarpus	Short-fruited rush	G4G5	SU			QA
Juncus brevicaudatus	Narrow-panicled rush	G5	S2			BC
Juncus caesariensis	New Jersey rush	G2	S1	E		A
Juncus pelocarpus	Brown-fruited rush	G5	S1	E		A
Juncus torreyi	Torrey's rush	G5	S1	E		BC
Juniperus communis	Juniper	G5	SH	X		BC
Krigia dandelion	Potato dandelion	G5	S1	E		A
Lactuca hirsuta	Hairy lettuce	G5?	SH	X		BC
Lechea tenuifolia	Narrow-leaved pinweed	G5	SH	X		A
Leptochloa fascicularis	Long-awned diplachne	G5	SU			A,QA
Limosella australis	Mudwort	G4G5	S2	E		K
Linum intercursum	Sandplain flax	G4	S2	T		BC,K,QA
Linum sulcatum	Grooved flax	G5	S1	E		BC
Ludwigia brevipes	Creeping ludwigia	G4G5	SU			BC
Lupinus perennis	Wild lupine	G5	S2	T		A,BC
Lycopodiella inundata	Bog clubmoss	G5	S2			BC
Lygodium palmatum	Climbing fern	G4	S2	T		A,BC,K
Lysimachia hybrida	Lowland loosestrife	G5	S2	T		QA
Matelea carolinensis	Anglepod	G4	S1	E		A,K,QA
Matelea obliqua	Climbing milkweed	G4?	S1	E		A,BC
Matteuccia struthiopteris	Ostrich fern	G5	S2			BC
Melanthium latifolium	Broad-leaved bunchflower	G5	S1	E		BC
Monotropsis odorata	Sweet pinesap	G3	S1	E		A,BC
Najas gracillima	Thread-like naiad	G5?	SU	X		A,BC
Nelumbo lutea	American lotus	G4	S2			K
Nymphoides aquatica	Larger floating-heart	G5	S1	E		A
Orthilia secunda	One-sided pyrola	G5	SH	X		A
Oxydendrum arboreum	Sourwood	G5	S1	E		QA
Oxypolis canbyi	Canby's dropwort	G2	S1	E	LE	QA
Panicum flexile	Wiry witch-grass	G5	S1	E		BC
Panicum leucothrix	Roughish panicgrass	G4?Q	SU			A
Panicum oligosanthes	Few-flowered panicgrass	G5	S2S3			BC,QA
Paspalum dissectum	Walter's paspalum	G4?	S2	T		QA
Pedicularis lanceolata	Swamp lousewort	G5	S1	E		BC
Phalaris caroliniana	May grass	G5?	SH	X		BC

Table 2-19
Species of Special Concern Potentially Present in the Counties Bordering the Upper Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Phlox pilosa	Downy phlox	G5	S1	E		BC
Platanthera blephariglottis	White fringed orchid	G4G5	S2	T		A,BC
Platanthera ciliaris	Yellow fringed orchid	G5	S2	T		BC
Platanthera cristata	Crested yellow orchid	G5	S2	T		A
Platanthera flava	Pale green orchid	G4	S2			A,BC
Platanthera grandiflora	Large purple fringed orchid	G5	S2	T		BC
Platanthera peramoena	Purple fringeless orchid	G5	S1	T		BC
Platanthera psycodes	Small purple fringed orchid	G5	SU	X		BC
Pluchea camphorata	Marsh fleabane	G5	S1	E		A
Poa languida	Weak speargrass	G3G4Q	SU			BC
Poa palustris	Fowl bluegrass	G5	SH			BC
Polanisia dodecandra	Clammyweed	G5	S1	E		A,BC,K
Polemonium vanbruntiae	Jacob's-ladder	G3	S2	T		BC
Polygala senega	Seneca snakeroot	G4G5	S2	T		BC
Polygonum densiflorum	Dense-flowered knotweed	G5	S1?	E		A,QA
Polygonum ramosissimum	Bushy knotweed	G5	SH	X		A
Polygonum robustius	Stout smartweed	G4G5	SH	X		A
Potamogeton perfoliatus	Clasping-leaved pondweed	G5	S2			A,BC
Potamogeton pusillus	Slender pondweed	G5	S1			QA
Potamogeton richardsonii	Redheadgrass	G5	SH	X		A
Potamogeton spirillus	Spiral pondweed	G5	S1			A,BC
Potentilla arguta	Tall cinquefoil	G5	SU			BC
Prunus maritima	Beach plum	G4	S1	E		A
Prunus pumila	Eastern dwarf cherry	G5	SU			BC
Pycnanthemum pycnanthemoides	Southern mountain-mint	G5	SH	X		BC
Pycnanthemum torrei	Torrey's mountain-mint	G2	S1	E		BC
Pycnanthemum verticillatum	Whorled mountain-mint	G5	S1	E		BC
Pycnanthemum virginianum	Virginia mountain-mint	G5	S2			BC
Quercus macrocarpa	Mossy-cup oak	G5	S1			BC,QA,B
Ranunculus ambigens	Water-plantain spearwort	G4	SH	X		A,QA
Ranunculus flabellaris	Yellow water-crowfoot	G5	S1	E		K
Ranunculus hispidus var nitidus	Hispid buttercup	G5T4	S1?	X		BC
Ranunculus pensylvanicus	Bristly crowfoot	G5	SH	X		B
Ranunculus trichophyllus	White water-crowfoot	G5	S1	E		K
Rhynchosia tomentosa	Hairy snoutbean	G5	S2	T		A
Rhynchospora cephalantha	Capitate beakrush	G5	S1	E		A
Rhynchospora cephalantha	Capitate beakrush	G5	S1	E		BC
Rhynchospora globularis	Grass-like beakrush	G5	S1	E		A
Rhynchospora glomerata	Clustered beakrush	G5	S2	T		A
Rhynchospora scirpoides	Long-beaked baldrush	G4	S2	T		K
Rumex altissimus	Tall dock	G5	S1	E		K
Sagittaria calycina	Spongy lophotocarpus	G5	S2			A,K
Sagittaria engelmanniana	Engelmann's arrowhead	G5?	S2	T		QA
Salix bebbiana	Bebb's willow	G5	SH	X		BC
Salix exigua	Sandbar willow	G5	S1	E		K
Salix tristis	Dwarf prairie willow	G4G5	S1			A,BC
Sanguisorba canadensis	Canada burnet	G5	S2	T		BC
Sarracenia purpurea	Northern pitcher-plant	G5	S2	T		A
Schwalbea americana	Chaffseed	G2	SX	X	LE	A
Scirpus cylindricus	Salt-marsh bulrush	G5	S2			K
Scirpus cylindricus	Salt-marsh bulrush	G5	S2			BC
Scirpus smithii	Smith's clubrush	G5?	SU	X		A,BC
Scirpus subterminalis	Water clubrush	G4G5	S1	E		A
Scirpus verecundus	Bashful bulrush	G4G5	S2S3			BC,QA
Scleria reticularis	Reticulated nutrush	G3G4	S2			BC,QA
Scleria triglomerata	Tall nutrush	G5	S1S2			A
Scleria triglomerata	Tall nutrush	G5	S1S2			BC
Scutellaria leonardii	Leonard's skullcap	G4T4	S2	T		BC
Silene nivea	Snowy campion	G4?	S1	E		A
Silene nivea	Snowy campion	G4?	S1	E		BC
Smilax pseudochina	Halberd-leaved greenbrier	G4G5	S2	T		A,K
Solidago hispida	Hairy goldenrod	G5	SH	X		A,BC
Solidago rigida	Hard-leaved goldenrod	G5	SH	X		A
Solidago speciosa	Showy goldenrod	G5	S2	T		A,K
Sphenopholis pensylvanica	Swamp-oats	G4	S1S2	T		BC
Spiranthes lucida	Wide-leaved ladys' tresses	G5	S1	E		BC
Spiranthes ochroleuca	Yellow nodding ladys' tresses	G4	S1	E		BC
Sporobolus asper	Long-leaved rushgrass	G5	S1			A,BC,QA
Sporobolus neglectus	Small rushgrass	G5	SH	X		BC
Stachys clingmanii	Clingman's hedge-nettle	G2Q	S1	E		BC

Table 2-19
Species of Special Concern Potentially Present in the Counties Bordering the Upper Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Stachys hyssopifolia	Hyssop-leaved hedge-nettle	G5	SU			A,BC,QA
Stachys latidens	Broad-toothed hedge-nettle	G4G5	S1			BC
Stenanthium gramineum	Featherbells	G4G5	S1	T		A
Talinum teretifolium	Fameflower	G4	S1	T		BC
Thaspium trifoliatum	Purple meadow-parsnip	G5	S1	E		BC
Thelypteris simulata	Bog fern	G4G5	S2	T		A
Tofieldia racemosa	Coastal false asphodel	G5	SX	X		A,BC
Torreyochloa pallida	Pale mannagrass	G5?	S1	E		A
Trachelospermum difforme	Climbing dogbane	G4G5	S1	E		A
Triadenum tubulosum	Large marsh St. John's-wort	G4?	S1			A
Trichostema setaceum	Narrow-leaved bluecurls	G5	S1			A,K
Triosteum angustifolium	Narrow-leaved horse-gentian	G5	S1	E		A,BC
Utricularia biflora	Two-flowered bladderwort	G5	S1	E		A
Utricularia cornuta	Horned bladderwort	G5	SH			A
Utricularia fibrosa	Fibrous bladderwort	G4G5	S1	E		A
Utricularia inflata	Swollen bladderwort	G5	S1	E		K,QA
Viburnum lentago	Nannyberry	G5	S1			BC
Viola septentrionalis	Northern blue violet	G5	SU			A
Vitis cinerea	Graybark	G4G5	SU			A,BC
Vitis rupestris	Sand grape	G3	S1			BC
Xyris smalliana	Small's yelloweyed-grass	G5	S1	E		A

[a] Data obtained from Rare Plant and Rare Animal lists sorted by county available on the Maryland Department of Natural Resources' website: http://www.dnr.state.md.us/wildlife/espaa.html

[b] Maryland counties included in Upper Bay analysis: Baltimore, Kent, Anne Arundel, and Queen Anne's counties.

COUNTY CODES
- A Anne Arundel County
- BC Baltimore County
- K Kent County
- QA Queen Anne's County

GLOBAL RANK - Overall Status of Species; rankings adopted by all 50 States.
- G1 Highly globally rare; typically five or fewer occurrences.
- G2 Globally rare; typically five to twenty occurrences.
- G3 Very rare <u>OR</u> distributed in restricted range.
- G4 Apparently secure globally, although it may be rare in parts of its range.
- G5 Demonstrably secure globally, although it may be rare in parts of its range.

STATE RANK
- S1 Highly State rare; critically imperiled in Maryland (five or fewer occurrences).
- S2 State rare; imperiled in Maryland (typically 6 to 20 estimated occurrences).
- S3 Watch list. Rare to uncommon with the number of occurrences n the range of 21 to 100 range.
- S4 Apparently secure in Maryland with typically more than 100 occurrences in the State.
- S5 Demonstrably secure in Maryland under present conditions.
- SA Species accidental or a vagrant in Maryland.
- SE Species established, but not native to Maryland.
- SH Species historically present in Maryland, but not verified for an extended period (>20 or more years).
- SU Species possibly rare in Maryland, but of uncertain status due to lack of information
- SX Species believed to be extirpated in Maryland.
- SZ Species is transitory.
- S? Species has not yet been ranked.
- _B A qualifier at the end of a rank. Species is migrant and the rank refers only to the breeding status.
- _N A qualifier at the end of a rank. Species is migrant and the rank refers only to the non-breeding status.

MARYLAND STATUS - Status determined by MDNR in accordance with Endangered Species Conservation Act.
- E Maryland Endangered Species.
- T Maryland Threatened Species.
- I Species In Need of Conservation (population is limited or declining in the State).
- X Extirpated (species once a viable flora or fauna, but no naturally occurring populations are known to exist).
- * A qualifier denoting the species is listed in a limited geographic area only.

FEDERAL STATUS - Status determined by USFWS in accordance with Endangered Species Act.
- LE Federal Endangered Species.
- LT Federal Threatened Species.
- PE Proposed Federal Endangered Species.
- PT Proposed Federal Threatened Species.

Table 2-20
Species of Special Concern Potentially Present in Baltimore City[a,b]

Scientific Name	Common Name	Global Rank	State Rank	Maryland Status	Federal Status
BIRDS					
Falco peregrinus	Peregrine falcon	G4	S1B	E	
Gallinula chloropus	Common moorhen	G5	S2B	I	
Lophodytes cucullatus	Hooded merganser	G5	S1B		
PLANTS					
Bromus latiglumis	Broad-glumed brome	G5	S1	E	
Calopogon tuberosus	Grass-pink	G5	S1	E	
Carex mesochorea	Midland sedge	G4G5	S2?		
Coptis trifolia	Goldthread	G5	S1	E	
Euphorbia purpurea	Darlington's spurge	G3	S1	E	
Gentiana villosa	Striped gentian	G4	S1	E	
Parthenium integrifolium	American feverfew	G5	S1	E	
Platanthera blephariglottis	White fringed orchid	G4G5	S2	T	
Pycnanthemum pycnanthemoides	Southern mountain-mint	G5	SH	X	
Quercus macrocarpa	Mossy-cup oak	G5	S1		
Ranunculus pensylvanicus	Bristly crowfoot	G5	SH	X	
Salix tristis	Dwarf prairie willow	G4G5	S1		
Solidago speciosa	Showy goldenrod	G5	S2	T	
Tofieldia racemosa	Coastal false asphodel	G5	SX	X	

[a] Data obtained from Rare Plant and Rare Animal lists from MD DNR's website (MD DNR, 2004).

[b] Data in table are those species on MDNR's Baltimore City list, which includes both coastal and upland areas of Baltimore City.

GLOBAL RANK - Overall Status of Species; rankings adopted by all 50 States.

- G3 Very rare OR distributed in restricted range.
- G4 Apparently secure globally, although it may be rare in parts of its range.
- G5 Demonstrably secure globally, although it may be rare in parts of its range.

STATE RANK

- S1 Highly State rare; critically imperiled in Maryland (five or fewer occurrences).
- S2 State rare; imperiled in Maryland (typically 6 to 20 estimated occurrences).
- SH Species historically present in Maryland, but not verified for an extended period (>20 or more years).
- SX Species believed to be extirpated in Maryland.
- S? Species has not yet been ranked.

MARYLAND STATUS - Status determined by MDNR in accordance with Endangered Species Conservation Act.

- E Maryland Endangered Species.
- T Maryland Threatened Species.
- I Species In Need of Conservation (population is limited or declining in the State).
- X Extirpated (species once a viable flora or fauna, but no naturally occurring populations are known to exist).

FEDERAL STATUS - Status determined by USFWS in accordance with Endangered Species Act.

No species in Baltimore City have federal designations at this time.

- LE Federal Endangered Species.
- LT Federal Threatened Species.
- PE Proposed Federal Endangered Species.
- PT Proposed Federal Threatened Species.

Table 2-21

Species of Special Concern Potentially Present in Counties Bordering the Middle Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Birds						
Ammodramus henslowii	Henslow's sparrow	G4	S1B	T		D
Botaurus lentiginosus	American bittern	G4	S1S2B	I		D,So,T
Circus cyaneus	Northern harrier	G5	S2B			D,So,St
Cistothorus platensis	Sedge wren	G5	S1B	T		C,D,So,St
Falco peregrinus	Peregrine falcon	G4	S1B	E		C,D,So
Gallinula chloropus	Common moorhen	G5	S2B	I		T
Haliaeetus leucocephalus	Bald eagle	G4	S2S3B	T	LT	C,D,So,St,T
Ixobrychus exilis	Least bittern	G5	S2S3B	I		So,T
Laterallus jamaicensis	Black rail	G4	S2S3B	I		C,D,So,T
Papilio palamedes	Palamedes swallowtail	G5	SU			So
Picoides borealis	Red-cockaded woodpecker	G3	SHB	X	LE	D
Podilymbus podiceps	Pied-billed grebe	G5	S2B			D,So
Porzana carolina	Sora	G5	S1B			So
Rynchops niger	Black skimmer	G5	S1S2B	T		D,So
Sterna antillarum	Least tern	G4	S2B	T		C,D,So,St,T
Fish						
Acipenser oxyrinchus	Atlantic sturgeon	G3	S1			C
Acipenser brevirostrum[c]	Shortnose sturgeon	G3	S1	E	LE	K
Centrarchus macropterus	Flier	G5	S1S2			St
Fundulus luciae	Spotfin killifish	G4	S2?			C,So,St
Insects (Beetles and Spiders)						
Cicindela dorsalis dorsalis	Northeastern beach tiger beetle	G4T2	S1	E	LT	C,So,St
Cicindela puritana	Puritan tiger beetle	G1G2	S1	E	LT	C
Hoperius planatus	A dytiscid beetle	G?	S2			T
Hydrochus sp.	Seth forest water scavenger beetle	G1	S1			T
Lucanus elephas	Giant stag beetle	G3G5	S1			St
Nicrophorus americanus	American burying beetle	G2G3	SX	X	LE	D
Sphodros rufipes	Red-legged purse-web spider	G4	S1S2			C
Tachopteryx thoreyi	Gray petaltail	G4	S2			St
Insects (Butterflies and Moths)						
Atlides halesus	Great purple hairstreak	G5	S1S2			D
Hermeuptychia sosybius	Carolina satyr	G5	S1S3			C
Mitoura hesseli	Hessel's hairstreak	G3G4	SHX			So
Poanes massasoit chermocki	Chermock's mulberry wing		G4T1	S1	LE	D
Problema bulenta	Rare skipper	G2G3	S1	T		D
Satyrium kingi	King's hairstreak	G3G4	S1	T		D
Invertebrates (Non-insect)						
Alasmidonta heterodon	Dwarf wedge mussel	G1G2	S1	E	LE	St,T
Alasmidonta undulata	Triangle floater	G4	S1	E		T
Stygobromus tenuis tenuis	Tenuis amphipod	G4G5T2T3Q	SU			D,T
Mammals						
Sciurus niger cinereus	Delmarva fox squirrel	G5T3	S1	E	LE	D,So,T
Reptiles and Amphibians						
Ambystoma tigrinum	Eastern tiger salamander	G5	S2	E		D,So
Gastrophryne carolinensis	Eastern narrow-mouthed toad	G5	S1S2	E		C,D,So,St
Nerodia erythrogaster erythrogaste	Redbelly water snake	G5T5	S2S3			D
Rana virgatipes	Carpenter frog	G5	S2	I		D,T
Plants						
Aeschynomene virginica	Sensitive joint-vetch	G2	S1	E	LT	C,So
Agalinis fasciculata	Fascicled gerardia	G5	S1	E		D
Agalinis obtusifolia	Blunt-leaved gerardia	G4G5Q	S1	E		C
Agalinis setacea	Thread-leaved gerardia	G5?	S1	E		C,T
Agrimonia microcarpa	Small-fruited agrimony	G5	SU			D
Alnus maritima	Seaside alder	G3	S3.1			D
Amelanchier obovalis	Coastal juneberry	G4G5	S1	E		T
Amelanchier stolonifera	Running juneberry	G5	S2	T		D
Ammannia coccinea	Scarlet ammannia	G5	SU			D
Ammannia latifolia	Koehne's ammannia	G5	S2			C,D,So,St
Angelica atropurpurea	Great angelica	G5	SH	X		C
Antennaria solitaria	Single-headed pussytoes	G5	S2	T		C,T
Apocynum sibiricum	Clasping-leaved dogbane	G5?	SH	X		C
Aristida curtissii	Curtiss' three-awn	G5T5	SU			C
Aristida lanosa	Woolly three-awn	G5	S1	E		C,D
Arnica acaulis	Leopard's-bane	G5	S1	E		St
Arundinaria gigantea	Giant cane	G5	S2			D
Aster concolor	Silvery aster	G4?	S1	E		C,St
Aster radula	Rough-leaved aster	G5	S1	E		C
Aster spectabilis	Showy aster	G5	S1	E		D
Azolla caroliniana	Mosquito fern	G5	SU			C,St
Berberis canadensis	American barberry	G3	SH	X		C
Bidens coronata	Tickseed sunflower	G5	S2S3			D,So,T

Table 2-21

Species of Special Concern Potentially Present in Counties Bordering the Middle Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Bidens mitis	Small-fruited beggar-ticks	G4?	S1	E		C,D,So
Boltonia asteroides	Aster-like boltonia	G5	S1	E		So,T
Cardamine longii	Long's bittercress	G3	S1	E		D
Cardamine pratensis	Cuckooflower	G5	S			T
Carex buxbaumii	Buxbaum's sedge	G5	S2	T		St
Carex glaucescens	A sedge	G4	S1	E		D
Carex hyalinolepis	Shoreline sedge	G4G5	S2S3			C,D
Carex lacustris	Lake-bank sedge	G5	S2	T		C,D,T
Carex mesochorea	Midland sedge	G4G5	S2?			C
Carex pellita	Woolly sedge	G5	S2?			St
Carex projecta	Necklace sedge	G5	S2			C
Carex silicea	Sea-beach sedge	G5	S1	E		T
Carex striatula	Lined sedge	G4G5	S2?			T
Carex tenera	Slender sedge	G5	SH	X		T
Carex venusta	Dark green sedge	G4	S2	T		St
Carex vesicaria	Inflated sedge	G5	S1	T		So
Centrosema virginianum	Spurred butterfly-pea	G5	S2			C,D,St,T
Ceratophyllum echinatum	Prickly hornwort	G4?	S1	E		D
Chamaecrista fasciculata var marci	Marsh wild senna	G5T3	S1	E		D
Chelone obliqua	Red turtlehead	G4	S1	T		C,St
Chenopodium leptophyllum	Narrow-leaved goosefoot	G5	SX			St
Chenopodium standleyanum	Standley's goosefoot	G5	S1	E		C
Coelorachis rugosa	Wrinkled jointgrass	G5	S1	E		D
Coreopsis rosea	Rose coreopsis	G3	S1	E		D
Crassula aquatica	Pygmyweed	G5	SH	X		So
Croton capitatus	Hogwort	G5	SU			T
Cuscuta coryli	Hazel dodder	G5	SH	X		St,T
Cuscuta indecora	Pretty dodder	G5	SH			D
Cyperus retrofractus	Rough cyperus	G5	S2			D
Desmodium lineatum	Linear-leaved tick-trefoil	G5	S1	E		C
Desmodium ochroleucum	Cream-flowered tick-trefoil	G2G3	S1	E		C,D,T
Desmodium pauciflorum	Few-flowered tick-trefoil	G5	S1	E		C,St,T
Desmodium rigidum	Rigid tick-trefoil	G?Q	S1	E		C,D
Desmodium strictum	Stiff tick-trefoil	G4	S1	E		D
Digitaria villosa	Shaggy crabgrass	G5	SU	X		C
Diplazium pycnocarpon	Glade fern	G5	S2	T		C
Drosera capillaris	Pink sundew	G5	S1	E		St
Dryopteris celsa	Log fern	G4	S3.1	T		T
Elatine minima	Small waterwort	G5	S1	E		D
Eleocharis albida	White spikerush	G4G5	S1	E		So,St
Eleocharis flavescens	Pale spikerush	G5	S1			D
Eleocharis halophila	Salt-marsh spikerush	G4	S1	E		D
Eleocharis melanocarpa	Black-fruited spikerush	G4	S1	E		D
Eleocharis robbinsii	Robbins' spikerush	G4G5	S1	E		D
Eleocharis rostellata	Beaked spikerush	G5	S2?			C
Elephantopus tomentosus	Tobaccoweed	G5	S1?	E		C,So,St
Eragrostis hirsuta	Big-topped lovegrass	G5	S1S2			D,St
Erianthus contortus	Bent-awn plumegrass	G5	S2	T		D,St
Eriocaulon aquaticum	Seven-angled pipewort	G5	S1	E		D
Eriocaulon parkeri	Parker's pipewort	G3	S2	T		D
Eupatorium leucolepis	White-bracted boneset	G5	S2S3	T		D
Eupatorium maculatum	Spotted Joe-pye-weed	G5	SU	X		T
Fimbristylis puberula	Hairy fimbristylis	G5	SU			C
Fraxinus profunda	Pumpkin ash	G4	S2S3			D,So
Fuirena pumila	Smooth fuirena	G4	S2S3			C,D
Geranium robertianum	Herb-robert	G5	S1	E		T
Gratiola viscidula	Short's hedge-hyssop	G4G5	S1	E		St
Gymnocarpium dryopteris	Oak fern	G5	S1	E		T
Gymnopogon brevifolius	Broad-leaved beardgrass	G5	S1	E		C
Helonias bullata	Swamp pink	G3	S2	E	LT	D
Hottonia inflata	Featherfoil	G4	S1	E		So,T
Hypericum adpressum	Creeping St. John's-wort	G2G3	S1	E		D,So
Hypericum denticulatum	Coppery St. John's-wort	G5	S1	E		D
Hypericum drummondii	Drummond's St. John's-wort	G5	SH	X		T
Hypericum gymnanthum	Clasping-leaved St. John's-wort	G4	S1	E		D,So,St
Ilex decidua	Deciduous holly	G5	S2			St
Juglans cinerea	Butternut	G3G4	S2S3			D
Juncus brachycarpus	Short-fruited rush	G4G5	SU			St
Kyllinga pumila	Thin-leaved flatsedge	G5	S1	E		St
Lachnanthes caroliana	Red-root	G4	S1	E		D
Lemna trisulca	Star duckweed	G5	S1	E		C
Leptochloa fascicularis	Long-awned diplachne	G5	SU			C,So,St,T

Table 2-21

Species of Special Concern Potentially Present in Counties Bordering the Middle Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Limnobium spongia	American frog's-bit	G4	S1	E		C
Linum intercursum	Sandplain flax	G4	S2	T		So,St,T
Lobelia canbyi	Canby's lobelia	G4	S1	E		D
Lobelia glandulosa	Glandular lobelia	G4G5	SR	X		D
Ludwigia glandulosa	Cylindric-fruited seedbox	G5	S1	E		So
Lupinus perennis	Wild lupine	G5	S2	T		D
Lygodium palmatum	Climbing fern	G4	S2	T		C
Lysimachia hybrida	Lowland loosestrife	G5	S2	T		D
Matelea carolinensis	Anglepod	G4	S1	E		C,D,T
Melica mutica	Narrow melicgrass	G5	S1	T		C
Melothria pendula	Creeping cucumber	G5?	S1	E		C
Micranthemum micranthemoides	Nuttall's micranthemum	GH	SH	X		D,So
Monotropsis odorata	Sweet pinesap	G3	S1	E		C
Myosotis macrosperma	Large-seeded forget-me-not	G5	S2S3			C,St
Myrica heterophylla	Evergreen bayberry	G5	S1	E		C
Myrica heterophylla	Evergreen bayberry	G5	S1	E		T
Myriophyllum tenellum	Slender water-milfoil	G5	SH	X		D
Nelumbo lutea	American lotus	G4	S2			D
Nymphoides aquatica	Larger floating-heart	G5	S1	E		D
Nymphoides cordata	Floating-heart	G5	S1	E		D
Orthilia secunda	One-sided pyrola	G5	SH	X		C
Panicum oligosanthes	Few-flowered panicgrass	G5	S2S3			T
Paspalum dissectum	Walter's paspalum	G4?	S2	T		T
Pedicularis lanceolata	Swamp lousewort	G5	S1	E		T
Persea borbonia	Red bay	G5	S1	E		So
Platanthera cristata	Crested yellow orchid	G5	S2	T		D,So,St
Platanthera flava	Pale green orchid	G4	S2			C
Pluchea camphorata	Marsh fleabane	G5	S1	E		C,T
Polygala cruciata	Cross-leaved milkwort	G5	S2	T		So
Polygonum densiflorum	Dense-flowered knotweed	G5	S1?	E		C
Polygonum glaucum	Seaside knotweed	G3	S1	E		So,St
Polygonum ramosissimum	Bushy knotweed	G5	SH	X		St
Polygonum robustius	Stout smartweed	G4G5	SH	X		D
Polygonum setaceum	Bristly smartweed	G5	SU			C
Potamogeton foliosus	Leafy pondweed	G5	S1	E		C,So
Potamogeton perfoliatus	Clasping-leaved pondweed	G5	S2			C,St
Potamogeton spirillus	Spiral pondweed	G5	S1			C
Pycnanthemum setosum	Awned mountain-mint	G3?	S3.1	T		D,So
Pycnanthemum torrei	Torrey's mountain-mint	G2	S1	E		D
Quercus shumardii	Shumard's oak	G5	S2	T		C
Rhynchosia tomentosa	Hairy snoutbean	G5	S2	T		C,D
Rhynchospora cephalantha	Capitate beakrush	G5	S1	E		D
Rhynchospora globularis	Grass-like beakrush	G5	S1	E		D
Rhynchospora glomerata	Clustered beakrush	G5	S2	T		C,So,St,T
Rhynchospora harperi	Harper's beakrush	G4?	S1			D
Rhynchospora inundata	Drowned hornedrush	G3G4	S1	E		D
Rhynchospora scirpoides	Long-beaked baldrush	G4	S2	T		D
Rhynchospora torreyana	Torrey's beakrush	G4	S2	T		D
Sabatia difformis	Lance-leaved sabatia	G4G5	S1	E		D
Sagittaria calycina	Spongy lophotocarpus	G5	S2			D
Sagittaria engelmanniana	Engelmann's arrowhead	G5?	S2	T		C
Sagittaria longirostra	Long-beaked arrowhead	G?Q	SU			C
Sarracenia purpurea	Northern pitcher-plant	G5	S2T			D,St
Scirpus cylindricus	Salt-marsh bulrush	G5	S2			D,T
Scirpus subterminalis	Water clubrush	G4G5	S1	E		D
Scleria reticularis	Reticulated nutrush	G3G4	S2			D
Scleria triglomerata	Tall nutrush	G5	S1S2			D
Sclerolepis uniflora	Pink bog-button	G4	S2	T		D
Scutellaria galericulata	Common skullcap	G5	S1			C
Sesuvium maritimum	Sea-purslane	G5	S1	E		C
Solidago speciosa	Showy goldenrod	G5	S2	T		C,D
Sorghastrum elliottii	Long-bristled indian-grass	G5	S1	E		D
Spiranthes odorata	Sweet-scented ladys' tresses	G5	SH	X		D
Spiranthes praecox	Grass-leaved ladys' tresses	G5	S1			St
Sporobolus asper	Long-leaved rushgrass	G5	S1			T
Sporobolus clandestinus	Rough rushgrass	G5	S1	E		C
Sporobolus neglectus	Small rushgrass	G5	SH	X		C
Stachys aspera	Rough hedge-nettle	G4?	S1	E		D,So
Tephrosia spicata	Southern goat's rue	G4G5	S1	E		D
Torreyochloa pallida	Pale mannagrass	G5?	S1	E		St
Trachelospermum difforme	Climbing dogbane	G4G5	S1	E		St
Triadenum tubulosum	Large marsh St. John's-wort	G4?	S1			T

Table 2-21

Species of Special Concern Potentially Present in Counties Bordering the Middle Chesapeake Bay[a,b]

Scientific Name	Common Name	Global Rank	Maryland Rank	Maryland Status	Federal Status	MD County
Triglochin striata	Three-ribbed arrow-grass	G5	S1	E		D,So
Utricularia inflata	Swollen bladderwort	G5	S1	E		D,St
Utricularia purpurea	Purple bladderwort	G5	S1	T		D
Utricularia resupinata	Reversed bladderwort	G4	S1	E		D
Vitis cinerea	Graybark	G4G5	SU			T
Wolffiella floridana	Wolffiella	G5	SH	X		D
Xyris fimbriata	Fringed yelloweyed-grass	G5	S1	E		D
Xyris smalliana	Small's yelloweyed-grass	G5	S1	E		D
Zizaniopsis miliacea	Southern wildrice	G5	S1	E		C

[a] Data obtained from Rare Plant and Rare Animal lists sorted by county available on the Maryland Department of Natural Resources' website: http://www.dnr.state.md.us/wildlife/espaa.html

[b] Maryland counties included in Middle Bay analysis: Calvert, Dorchester, Somerset, St. Mary's, and Talbot Counties.

[c] Additional species identified by Fish and Wildlife Services Web site: http://endangered.fws.gov/50cfr_animals.pdf. Accessed October 8, 2004.

COUNTY CODES

- C Calvert County
- D Dorchester County
- So Somerset County
- St St. Mary's County
- T Talbot County

GLOBAL RANK - Overall Status of Species; rankings adopted by all 50 States.

- G1 Highly globally rare; typically five or fewer occurrences.
- G2 Globally rare; typically five to twenty occurrences.
- G3 Very rare OR distributed in restricted range.
- G4 Apparently secure globally, although it may be rare in parts of its range.
- G5 Demonstrably secure globally, although it may be rare in parts of its range.

STATE RANK

- S1 Highly State rare; critically imperiled in Maryland (five or fewer occurrences).
- S2 State rare; imperiled in Maryland (typically 6 to 20 estimated occurrences).
- S3 Watch list. Rare to uncommon with the number of occurrences n the range of 21 to 100 range.
- S4 Apparently secure in Maryland with typically more than 100 occurrences in the State.
- S5 Demonstrably secure in Maryland under present conditions.
- SA Species accidental or a vagrant in Maryland.
- SE Species established, but not native to Maryland.
- SH Species historically present in Maryland, but not verified for an extended period (>20 or more years).
- SU Species possibly rare in Maryland, but of uncertain status due to lack of information
- SX Species believed to be extirpated in Maryland.
- SZ Species is transitory.
- S? Species has not yet been ranked.
- _B A qualifier at the end of a rank. Species is migrant and the rank refers only to the breeding status.
- _N A qualifier at the end of a rank. Species is migrant and the rank refers only to the non-breeding status.

MARYLAND STATUS - Status determined by MDNR in accordance with Endangered Species Conservation Act.

- E Maryland Endangered Species.
- T Maryland Threatened Species.
- I Species In Need of Conservation (population is limited or declining in the State).
- X Extirpated (species once a viable flora or fauna, but no naturally occurring populations are known to exist).
- * A qualifier denoting the species is listed in a limited geographic area only.

FEDERAL STATUS - Status determined by USFWS in accordance with Endangered Species Act.

- LE Federal Endangered Species.
- LT Federal Threatened Species.
- PE Proposed Federal Endangered Species.
- PT Proposed Federal Threatened Species.

Table 2-22
Species of Special Concern Potentially Present in Subwatersheds Bordering the Lower Chesapeake Bay[a]

Scientific Name	Common Name	Global Rank	State Rank	Federal Status	State Status	Number Occurrences Statewide	Subwatershed ID
BIRDS							
Ammodramus caudacutus	Saltmarsh Sharp-tailed Sparrow	G4	S2B,S3N		SC	5	C4,C10,C11
Asio flammeus	Short-eared Owl	G5	S1B,S3N			2	C4
Charadrius melodus	Piping Plover	G3	S2B,S1N	LT	T	30	C7
Circus cyaneus	Northern Harrier	G5	S1S2B, S3S4N		SC	6	C4,C10
Falco peregrinus	Peregrine Falcon	G4	S1B,S2N		T	25	C10,C11
Haliaeetus leucocephalus	Bald Eagle	G4	S2S3B,S3N	LT	T	576	C1,C4,C6,C7,C8, C10,C11,C12,C13, C14,C15,C16
Lateralius jamaicensis	Black Rail	G4	S2B,S2N			1	C10
Nyctanassa violacea	Yellow-crowned Night-heron	G5	S2B,S3N		SC	7	C8
Porzana carolina	Sora	G5	S1B,S2N			2	C10
Rallus limicola	Virginia Rail	G5	S2B,S3N			4	C10
Rynchops niger	Black Skimmer	G5	S2B,S1N			22	C7
Sterna antillarum	Least Tern	G4	S2B		SC	22	C4,C7,C8
MAMMALS*							
Corynorhinus rafinesquii macrotis	Eastern Big-eared Bat	G3G4TNR	S2		E	29	C8
COLEOPTERA (BEETLES)							
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	G4T2	S2	LT		123	C1,C4,C7,C10, C11,C12,C13,C14, C15,C16, R01
Cicindela trifasciata	A Tiger Beetle	G5	S1			5	C8
Pseudaptinus lecontei	A Ground Beetle	GNR	S1S3			1	C8
ODONATA (DRAGONFLIES & DAMSELFLIES)							
Epitheca costalis	Stripe-winged Baskettail	G4	S2			4	C8
Somatochlora filosa	Fine-lined Emerald	G5	S2			8	C8
LEPIDOPTERA (BUTTERFLIES & MOTHS)							
Calephelis virginiensis	Little Metalmark	G4	SH			6	C8
Papaipema sp. 3	Southeastern Cane Borer Moth	G4	S2S3			3	C8
Satyrium kingi	King's Hairstreak	G3G4	S2S3			4	C8
AMPHIBIANS							
Ambystoma mabeei	Mabee's Salamander	G4	S1S2		T	13	C4,C7
Ambystoma tigrinum	Tiger Salamander	G5	S1		E	5	C4,C7
Hyla gratiosa	Barking Treefrog	G5	S1		T	11	C4,C7
REPTILES*							
Crotalus horridus atricaudatus	Canebrake Rattlesnake	G4TUQ	S1		E	23	C7
Deirochelys reticularia	Chicken Turtle	G5	S1		E	2	C8
ARACHNIDA (SPIDERS & PSEUDOSCORPIONS)							
Barronopsis jeffersi	A Funnel-web Spider	G3	S1S3			1	C8
Castianeira trilineata	A Two-clawed Hunting Spider	G4?	S1S3			1	C8
Drassylus louisianus	A Gnaphosid Spider	G4?	S1S3			1	C8
Pisaurina dubia	A Nursery-web Spider	G4	S1S3			1	C8
HETEROPTERA (TRUE BUGS)							
Bothynotus johnstoni	A Mirid Bug	G3	S1S3			1	C8
Ctenotrachelus shermani	Combneck Assassin Bug	G3	S1S3			1	C8
Melanaethus cavicollis	A Burrower Bug	G4	S1S3			1	C8
Ploiaria carolina	Carolina Thread-legged Bug	G4?	S1S3			1	C8
Ploiaria hirticornis	An Assassin Bug	G3?	S1S3			2	C8
Pnirontis brimleyi	Brimley's Assassin Bug	G2	S1S3	SOC		1	C8
Pycnoderiella virginiana	Seashore Mirid Bug	GU	SU			1	C8
FISH*							
Acipenser brevirostrum	Shortnose sturgeon	G3	S1	LE	E	1	C8
VASCULAR PLANTS							
Arenaria lanuginosa	A Sandwort	G5T5	SH			1	C8
Asclepias purpurascens	Purple Milkweed	G4G5	S2			5	C7
Carex lupuliformis	False Hop Sedge	G4	S1			9	C7,C13
Chamaesyce bombensis	Southern Beach Spurge	G4G5	S2			16	C8,C16
Chelone obliqua	Red Turtlehead	G4	S1			6	C4
Cirsium repandum	Coastal-plain Thistle	G5	SH			2	C8
Cuscuta indecora	Pretty Dodder	G5	S2?			8	C7
Cyperus diandrus	Umbrella Flatsedge	G5	S1			4	C7
Cyperus engelmannii	Engelmann's Umbrella-sedge	G4Q	S1			1	C15
Cyperus plukenetii	A Galingale Sedge	G5	S2			5	C14
Desmodium ochroleucum	Creamflower Tick-trefoil	G2?	SH	SOC		5	C15
Desmodium strictum	Pineland Tick-trefoil	G4	S2			17	C8
Desmodium tenuifolium	Slim-leaf Tick-trefoil	G4	S1			14	C7
Echinodorus tenellus	Dwarf Burhead	G5?	S1			6	C15
Eleocharis baldwinii	Baldwin Spikerush	G4G5	S1			8	C8
Eleocharis equisetoides	Horse-tail Spikerush	G4	S1			2	C10
Eleocharis vivipara	Viviparous Spikerush	G5	S1			5	C8
Erigeron vernus	White-top Fleabane	G5	S2			17	C7,C8

Table 2-22

Species of Special Concern Potentially Present in Subwatersheds Bordering the Lower Chesapeake Bay[a]

Eriocaulon aquaticum	White Buttons	G5	S1			6	C10
Fimbristylis perpusilla	Harper's Fimbristylis	G2	S1	SOC	E	11	C7
Honckenya peploides ssp. robusta	Sea-beach Sandwort	G5T4	SH			1	C8
Hydrocotyle bonariensis	Coastal-plain Penny-wort	G5	S1?			4	C8
Hypericum boreale	Northern St. John's-wort	G5	S2			19	C10
Iva imbricata	Sea-coast Marsh-elder	G5?	S1S2			10	C8
Juncus pelocarpus	Brown-fruited Rush	G5	S1			4	C10
Lipocarpha maculata	A Lipocarpha	G5	S1			4	C8
Lithospermum caroliniense	Golden Puccoon	G4G5	S1			2	C10
Ludwigia brevipes	Long Beach Seedbox	G4G5	S2			17	C8
Lythrum lanceolatum	Lance-leaved Loosestrife	G5T5	SH			2	C7
Mitreola petiolata	Lax Hornpod	G5	S1			9	C4
Nymphoides aquatica	Big Floating-heart	G5	S1			2	C10
Osmanthus americanus	Wild Olive	G5T5	S1			4	C8
Physalis walteri	Sticky Ground-cherry	G4	S2			12	C8
Pinus palustris	Long-leaf Pine	G5	S1			9	C8
Polygonum glaucum	Sea-beach Knotweed	G3	S1S2			13	C4
Pycnanthemum setosum	Awned Mountain-mint	G3?	S1			4	C10
Quercus hemisphaerica	Darlington's Oak	G5	S1			4	C8
Quercus incana	Blue Jack Oak	G5	S2			18	C8
Quercus laevis	Turkey Oak	G5	S2			13	C8
Rhynchospora alba	White Beakrush	G5	S2			10	C10
Rhynchospora fascicularis	Fasciculate Beakrush	G5TNR	S1?			11	C8
Rhynchospora scirpoides	Long-beaked Baldrush	G4	S1			5	C8,C10
Sabatia campanulata	Slender Marsh Pink	G5	S2			23	C7
Solidago tortifolia	A Goldenrod	G4G5	S1			9	C13
Solidago tortifolia	A Goldenrod	G4G5	S1			9	C8
Sparganium androcladum	Branching Burreed	G4G5	SH			1	C8
Spartina pectinata	Freshwater Cordgrass	G5	S2			17	C8
Stipulicida setacea var. setacea	Pineland Scaly-pink	G4G5T4T5	S1			4	C8
Tillandsia usneoides	Spanish Moss	G5	S2			19	C7,C8,C15
Triadenum fraseri	Fraser's Marsh St. John's-wort	G4G5	S1			3	C10
Trillium pusillum var. virginianum	Virginia Least Trillium	G3T2	S2	SOC		33	C6,C7
Utricularia juncea	Southern Bladderwort	G5	S2			11	C10,C15
Utricularia purpurea	Purple Bladderwort	G5	S2			11	C8
Wisteria frutescens	American Wisteria	G5	S2			8	C8
Wolffia columbiana	Columbia Water-meal	G5	S1			5	C10
NON-VASCULAR PLANTS							
Sphagnum macrophyllum	Large-leaf Peatmoss	G3T3?	S2			3	C7
Sphagnum molle	Soft Peatmoss	G4	S2			4	C8
Sphagnum portoricense	Puerto Rico Peatmoss	G5	S1S2			1	C10
COMMUNITIES							
Natural Community	Coastal Plain / Piedmont Acidic Seepage Swamp	GNR	SNR			17	C14
Natural Community	Coastal Plain Depression Pond	GNR	SNR			41	C4,C7
Natural Community	Coastal Plain Semipermanent Impoundment	GNR	SNR			3	C10
Natural Community	Interdune Pond	GNR	SNR			11	C8,C15
Natural Community	Maritime Dune Grassland	GNR	SNR			7	C1,C15,C16,R01
Natural Community	Maritime Dune Woodland	GNR	SNR			6	C1,C8,C15
Natural Community	Maritime Evergreen Forest	GNR	S1			2	C8
Natural Community	Maritime Mixed Forest	GNR	S1			5	C8,C15,C16
Natural Community	Maritime Scrub	GNR	SNR			10	C8,C15,C16
Natural Community	Maritime Swamp Forest	GNR	SNR			3	C8
Natural Community	Mesic Mixed Hardwood Forest	GNR	SNR			25	C15
Natural Community	Non-riverine Pine - Hardwood Forest	GNR	SNR			2	C13
Natural Community	Non-riverine Wet Hardwood Forest	GNR	S2			3	C7
Natural Community	Salt Scrub	GNR	SNR			2	C7
Natural Community	Sea Level Fen	GNR	S1			4	C10
Natural Community	Tidal Mesohaline / Polyhaline Marsh	GNR	SNR			4	C7,C11

[a] Species identified by the Virginia Natural Resources Heritage Program website:
http://192.206.31.52/cfprog/dnh/naturalheritage/select_sub_pre.cfm
Accessed January 20, 2004; searched by sub-watershed.

Table 2-22

Species of Special Concern Potentially Present in Subwatersheds Bordering the Lower Chesapeake Bay[9]

DEFINITIONS

WATERSHED CODES

C1 Chesapeake Bay / Wicomico River
C4 Chesapeake Bay / East River / North River
C6 Chesapeake Bay / Severn River
C7 Chesapeake Bay / Back River / Poquoson River
C8 Lynnhaven River / Little Creek
C10 Chesapeake Bay / Holdens Creek
C11 Chesapeake Bay / Onancock Creek
C12 Pungoteague Creek
C13 Nandua Creek / Occohannock Creek / Nassawadox Creek
C14 Chesapeake Bay / Hungars Creek
C15 Cherrystone Inlet / Kings Creek
C16 Chesapeake Bay / Old Plantation Creek
R01 Chesapeake Bay (Mainstem)

GLOBAL RANK - Overall Status of Species; rankings adopted by all 50 States.

G1 Highly globally rare; typically five or fewer occurrences.
G2 Globally rare; typically five to twenty occurrences.
G3 Very rare OR distributed in restricted range.
G4 Apparently secure globally, although it may be rare in parts of its range.
G5 Demonstrably secure globally, although it may be rare in parts of its range.

STATE RANK

S1 Extremely rare (usually five or fewer occurrences in Virginia).
S2 Very rare (typically 5 to 20 estimated occurrences in Virginia).
S3 Rare to uncommon with the number of occurrences in the range of 20 to 100 range.
S4 Common in Virginia with typically more than 100 occurrences or populations.
S5 Demonstrably secure in Virginia under present conditions.
SA Species accidental or a vagrant in Virginia.
SH Species historically present in Virginia, but not verified for an extended period (>15 or more years).
SU Status uncertain, often because of low search effort or cryptic nature of element.
SX Species believed to be extirpated in Virginia.
SZ Species is transitory.
S? Species has not yet been ranked.
#B A qualifier at the end of a rank. Species is migrant and the rank refers only to the breeding status.
#N A qualifier at the end of a rank. Species is migrant and the rank refers only to the non-breeding status.

VIRGINIA STATUS - Status determined by VA DEQ in accordance with Endangered Species Conservation Act.

LE Virginia Endangered Species.
LT Virginia Threatened Species.
SC Virginia Species of Special Concern.

FEDERAL STATUS - Status determined by USFWS in accordance with Endangered Species Act.

LE Federal Endangered Species.
LT Federal Threatened Species.
SOC Species of Concern
PE Proposed Federal Endangered Species.
PT Proposed Federal Threatened Species.

Table 2-23

Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated March 22, 2004)*

Year	Date	Water Body	Depth (feet)	Capture Site	Gear	Latitude	Longitude	Length-mm	Tag
1996	April 4	Susquehanna Flats	-	Elk Neck	Pound Net	39.30.150	75.59.400	692	-
	April 4	Susquehanna Flats	-	Elk Neck	Pound Net	39.30.150	75.59.400	815	-
	April 4	Chesapeake Bay	-	APG	Pound Net	39.26.900	75.59.400	726	-
	May 7	Chesapeake Bay	-	Kent Island	Pound Net	38.53.640	76.22.512	940	-
	May 14	Chesapeake Bay	-	Kent Island	Pound Net	38.56.900	76.21.900	785	-
	May 17	Potomac River	-	Mouth Potomac Creek	Pound Net	38.21.000	77.17.000	800	*
	June 12	Chesapeake Bay	-	Turkey Point	Catfish Trap	39.25.000	76.01.000	890	*
1997	January 7	Chesapeake Bay	-	N. Millers Island	Gill Net	39.16.150	76.21.500	850	*
	April 10	Chesapeake Bay	-	Rocky Point	Pound Net	39.29.300	76.00.000	860	-
	April 20	Chesapeake Bay	-	Rocky Point	Pound Net	39.29.300	76.00.000	790	-
	April 24	Susquehanna River	-	I-95 Bridge	Hoop Net	39.34.600	76.06.300	930	*
	December 5	Chesapeake Bay	-	Mouth Sassafras River	Gill Net	39.23.400	76.03.900	840	*
	December 5	Chesapeake Bay	-	APG	Gill Net	39.25.000	76.05.500	730	*
	December 9	Chesapeake Bay	12-14'	Howell Pt	Gill Net	39.22.500	76.08.400	1030	*
	December 9	Chesapeake Bay	12-14'	Howell Pt.	Gill Net	39.22.500	76.08.400	850	*
	December 9	Chesapeake Bay	12-14'	Howell Pt.	Gill Net	39.22.500	76.08.400	990	*
	December 30	Elk River	25'	Grove Pt.	Gill Net	39.24.800	76.02.000	950	*
1998	January 19	Chesapeake Bay	10'	Howell Pt.	Gill Net	39.23.000	76.07.500	955	*
	January 22	Chesapeake Bay	12-14'	Howell Pt.	Gill Net	39.22.500	76.08.400	980	*
	February 26	Bohemia River	8'	Veazey's Cove	Gill Net	39.28.600	75.55.000	478	J*
	March 24	Bohemia River	4'	Veazey's Cove	Fyke Net	39.28.600	75.54.400	445	J*
	April 3	Chesapeake Bay	-	APG-W. of Delphs Creek	Fyke Net	39.24.100	76.09.800	395	J*
	April 18	Chesapeake Bay	-	APG-Sandy Pt.	Fyke Net	39.26.800	76.03.800	384	J*
	April 21	Potomac River	-	Mouth of St. Mary's	Pound Net	38.05.465	76.25.203	875	*
	April 22	Chesapeake Bay	-	Worton Point	Gill Net	39.19.400	76.11.200	410	J*

Table 2-23

Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated March 22, 2004)* (Continued)

Year	Date	Water Body	Depth (feet)	Capture Site	Gear	Latitude	Longitude	Length-mm	Tag
	April 23	Chesapeake Bay	-	Worton Point	Eel trap	39.19.500	76.11.900	432	J*
	April 23	Chesapeake Bay	-	APG-Taylors Island	Fyke net	39.23.000	76.10.200	527	*
	April 28	Susquehanna River	-	Port Deposit and I-95 Bridge	Catfish Trap	39.35.300	76.06.300	680	*
	April 30	Chesapeake Bay	-	N.W. of Barren Island	Pound Net	38.25.000	76.19.500	712	*
1999	February 5	Chesapeake Bay	12'	APG-Cherry Tree Point	Gill Net	39.24.500	76.06.500	643	*
	February 11	Sassafrass River	18	Knights Island	Gill Net	39.22.500	75.57.000	643	-, recap
	February 19	Susquehanna River	-	Port Deposit	Gill Net	39.36.150	76.07.000	743	*
	June 8	Fishing Bay	-	Stradding Point	Pound Net	38.13.900	76.02.000	895	*
2000	January 2	Chesapeake Bay	32	Holland Point	Gill Net	38.43.400	76.30.000	757	*
	February 24	Chesapeake Bay	13’	Btwn Grove Pt. & APG	Gill Net	39.23.800	76.06.500	820	*
	February 28	Chesapeake Bay	17’	Btwn Hart-Miller & Pooles Island	Gill Net	39.14.800	76.19.500	643	*
	April 7	Chesapeake Bay	4’	Mouth of Romney Creek	Fyke Net	39.22.200	76.10.700	991	
	April 11	Chesapeake Bay	6’	Black Marsh, Mouth of Patapsco	Fyke Net	39.13.300	76.24.600	610	
	May 3	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	37.54.800	76.15.100	1219	
	May 19	Chesapeake Bay		North of Barren Island	Pound Net	38.25.000	76.19.500	2438	**
	June 5	Hoopers Straits		Crocheron	Pound Net	38.12.400	76.00.300	2134	**, recap
	December 19	Chesapeake Bay		South of Tolchester	Gillnet	39.11.600	76.15.800	1067	
2001	February 6	Susquehanna River	60’	Railroad Bridge near Perryville	Catfish Trap	39.33.250	76.04.900	991	
	February 17	Susquehanna River	60’	Railroad Bridge near Perryville	Catfish Trap	39.33.250	76.04.900	1448	
	March 11	Chesapeake Bay	25’	Turkey Point	Catfish Trap	39.27.500	76.01.000	838	
	March 26	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	37.55.400	76.16.500	1829	
	December 21	Chesapeake Bay		Howell Pt.	Gillnet	39.22.800	76.07.000	793	
2002	March 8	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	38.20.900	77.16.800	872	

Table 2-23

Shortnose Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated March 22, 2004)*
(Continued)

Year	Date	Water Body	Depth (feet)	Capture Site	Gear	Latitude	Longitude	Length-mm	Tag
	March 8	Potomac River		Mouth of Potomac River, Ophelia, VA	Pound Net	38.21.000	77.17.000	860	
	June 5	Susquehanna R.	60'	Railroad Bridge near Perryville	Catfish Trap	39.33.250	76.04.900	-	
2003	March 4	Susquehanna R.		Above 95 Bridge 25' str.	Catfish Trap	39.35.150	76.06.100	-	
	March 17	Susquehanna R.		Above 95 Bridge 18' wtr.	Catfish Trap	39.35.200	76.06.500	-	
	April 21	Chesapeake Bay		Aberdeen	Fyke Net	39.24.100	76.09.800	-	
	May 22	Chesapeake Bay		Cedar Point Hollow	Pound Net	38.14.200	76.23.100	-	
	October 20	Chesapeake Bay		Rocky Point, Hawk Cove	Pound Net	39.15.800	76.23.000	-	
2004	January 2	Chesapeake Bay		Taylors Island Aberdeen	Gillnet	39.23.200	76.09.150	-	
	January 22	Susquehanna River		Susquehanna Flats	Catfish Trap	39.32.500	76.04.000	-	
	March 11	Chesapeake Bay		Mth. Romney Creek	Fyke Net	39.22.400	76.11.000	-	

*Excerpted from Maryland Environmental Service table titled "Atlantic Sturgeon Captures in the Chesapeake Bay and Tributaries (last updated March 22, 2004)" October 19, 2004

Key: (-) not recorded; (*) tagged, (J) possible juvenile, (**) lost sonic tag

Table 2-24 Summary of Demographics in Upper Bay Counties

	Anne Arundel County	Baltimore County	Kent County	Queen Anne's County
Geography				
Land area (square miles)	416	599	279	372
Persons per square mile, 2000	1,177.2	1,260.1	68.7	109
Population				
Population, 2000	489,656	754,292	19,197	40,563
Population, percent change, 1990 to 2000	14.6%	9.0%	7.6%	19.5%
Persons under 5 years old, percent, 2000	6.8%	6.0%	4.6%	6.4%
Persons 65 years old and over, percent, 2000	10.0%	14.6%	19.3%	12.9%
Percent Minority Inhabitants	20.2%	26.6%	21.6%	11.6%
Housing and Household				
Housing units, 2000	186,937	313,734	9,410	16,674
Homeownership rate, 2000	75.5%	67.6%	70.4%	83.4%
Median value of owner-occupied housing units, 2000	$159,300	$127,300	$115,500	$160,000
Households, 2000	178,670	299,877	7,666	15,315
Persons per household, 2000	2.65	2.46	2.33	2.62
Median household money income, 1999	$61,768	$50,667	$39,869	$57,037
Per capita money income, 1999	$27,578	$26,167	$21,573	$26,364
Persons below poverty, percent, 1999	5.1%	6.5%	13.0%	6.3%
Business				
Private nonfarm establishments, 1999	11,981	19,189	667	1,150
Private nonfarm employment, 1999	171,047	307,955	6,577	8,999
Private nonfarm employment, percent change 1990-1999	17.3%	1.9%	10.2%	48.4%

Source: U.S. Census Bureau State & County QuickFacts (U.S. Census, 2004)
Note: Portions of Anne Arundel and Baltimore Counties border the Harbor (Patapsco River and tidal tributaries).

Table 2-25 Summary of Demographics in Baltimore City

Geography	
Land area, 2000 (square miles)	81
Persons per square mile, 2000	8,058.4
Population	
Population, 2000	651,154
Population, percent change, 1990 to 2000	-11.5%
Persons under 5 years old, percent, 2000	6.4%
Persons 65 years old and over, percent, 2000	13.2%
Female persons, percent, 2000	53.4%
Percent Minority	69.0%
Housing and Household	
Housing units, 2000	300,477
Homeownership rate, 2000	50.3%
Median value of owner-occupied housing units, 2000	$69,100
Households, 2000	257,996
Persons per household, 2000	2.42
Median household money income, 1999	$30,078
Per capita money income, 1999	$16,978
Persons below poverty, percent, 1999	22.9%
Business	
Private nonfarm establishments, 1999	13,706
Private nonfarm employment, 1999	297,169
Private nonfarm employment, percent change 1990-1999	-4.5%

Source: US Census Bureau State & County QuickFacts (U.S. Census Bureau, 2004)

Table 2-26 Summary of Demographics in Middle Bay Counties

	Calvert County	Dorchester County	Somerset County	St. Mary's County	Talbot County
Geography					
Land area, 2000 (square miles)	215	558	327	361	269
Persons per square mile, 2000	346.5	55	75.6	238.6	125.6
Population					
Population, 2000	74,563	30,674	24,747	86,211	33,812
Population, percent change, 1990 to 2000	45.1%	1.4%	5.6%	13.5%	10.7%
Persons under 5 years old, percent, 2000	6.8%	5.4%	4.8%	7.2%	5.2%
Persons 65 years old and over, percent, 2000	8.9%	17.7%	14.2%	9.1%	20.4%
Percent Minority	17.0%	31.2%	44.2%	19.6%	18.8%
Housing and Household					
Housing units, 2000	27,576	14,681	10,092	34,081	16,500
Homeownership rate, 2000	85.2%	70.1%	69.6%	71.8%	71.6%
Median value of owner-occupied housing units, 2000	$169,200	$92,300	$81,100	$150,000	$149,200
Households, 2000	25,447	12,706	8,361	30,642	14,307
Persons per household, 2000	2.91	2.36	2.37	2.72	2.32
Median household money income, 1999	$65,945	$34,077	$29,903	$54,706	$43,532
Per capita money income, 1999	$25,410	$18,929	$15,965	$22,662	$28,164
Persons below poverty, percent, 1999	4.4%	13.8%	20.1%	7.2%	8.3%
Business					
Private nonfarm establishments, 1999	1,444	724	415	1,668	1,450
Private nonfarm employment, 1999	14,563	9,572	3,183	22,791	16,390
Private nonfarm employment, percent change 1990-1999	51.0%	-6.8%	4.9%	42.2%	8.2%

Source: U.S. Census Bureau State & County QuickFacts (U.S. Census Bureau, 2004)
Anne Arundel County Data is included in Table 2-24

Table 2-27 Summary of Demographics in Lower Bay (VA)

	Accomack County	Gloucester County	Hampton City	Isle of Wight County	Lancaster County	Mathews County	Newport News City	Norfolk City	Northampton County	Virginia Beach City
Geography										
Land area, 2000 (square miles)	455	217	52	316	133	86	68	54	207	248
Persons per square mile, 2000	84.1	160.6	2,828.0	94.1	86.9	107.5	2,637.9	4,362.8	63.1	1,712.7
Population										
Population, 2000	38,305	34,780	146,437	29,728	11,567	9,207	180,150	234,403	13,093	425,257
Population, percent change, 1990 to 2000	20.8%	15.4%	9.5%	18.7%	6.2%	10.3%	5.1%	-10.3%	0.2%	8.2%
Persons under 5 years old, percent, 2000	6.1%	5.8%	6.3%	6.0%	4.2%	4.6%	7.9%	7.1%	5.5%	7.2%
Persons 65 years old and over, percent, 2000	16.7%	11.8%	10.3%	12.2%	28.5%	21.6%	10.1%	10.9%	21.2%	8.4%
Percent Minority	38.1%	14.3%	51.5%	29.4%	30.4%	13.2%	48.0%	53.0%	47.5%	30.5%
Housing and Household										
Housing units, 2000	19,550	14,494	57,311	12,066	6,498	5,333	74,117	94,416	6,547	162,277
Homeownership rate, 2000	75.1%	81.4%	58.6%	80.8%	83.0%	84.7%	52.4%	45.5%	68.6%	65.6%
Median value of owner-occupied housing units, 2000	$79,300	$111,600	$91,100	$129,300	$131,600	$118,000	$96,400	$88,400	$78,700	$123,200
Households, 2000	15,299	13,127	53,887	11,319	5,004	3,932	69,686	86,210	5,321	154,455
Persons per household, 2000	2.45	2.62	2.49	2.61	2.23	2.32	2.5	2.45	2.39	2.7
Median household money income, 1999	$30,250	$45,421	$39,532	$45,387	$33,239	$43,222	$36,597	$31,815	$28,276	$48,705
Per capita money income, 1999	$16,309	$19,990	$19,774	$20,235	$24,663	$23,610	$17,843	$17,372	$16,591	$22,365
Persons below poverty, percent, 1999	18.0%	7.7%	11.3%	8.3%	12.5%	6.0%	13.8%	19.4%	20.5%	6.5%
Business										
Private nonfarm establishments, 1999	823	777	2,467	527	492	205	3,717	5,378	324	10,185
Private nonfarm employment, 1999	9,050	6,301	48,646	9,275	3,799	1,184	84,667	116,011	3,161	139,147
Private nonfarm employment, percent change 1990-1999	2.2%	25.5%	20.5%	37.1%	4.0%	22.4%	11.3%	0.7%	-1.8%	22.8%

Source: US Census Bureau State & County QuickFacts (U.S. Census Bureau, 2004)

Table 2-28 Selected Economic Characteristics for Upper Bay and Harbor Areas

	Upper Bay Counties								Harbor Area	
	Anne Arundel County		Baltimore County		Kent County		Queen Anne's County		Baltimore City	
	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population
EMPLOYMENT STATUS										
Labor Force	269,772	71.1	396,897	66.6	9,733	62.2	21,849	69.5	287,159	56.6
Employed	250,254	66	379,705	63.7	9,294	59.4	21,186	67.4	256,036	50.4
Unemployed	8,077	2.1	16,521	2.8	427	2.7	610	1.9	30,699	6
OCCUPATION TYPE										
Management, professional, and related occupations	101,255	40.5	149,884	39.5	2,941	31.6	7,686	36.3	83,017	32.4
Service occupations	31,188	12.5	50,193	13.2	1,673	18	2,916	13.8	51,294	20
Sales and office occupations	70,034	28	110,226	29	2,109	22.7	5,469	25.8	69,280	27.1
Farming, fishing, and forestry occupations	254	0.1	419	0.1	372	4	327	1.5	267	0.1
Construction, extraction, and maintenance occupations	24,854	9.9	30,346	8	1,020	11	2,538	12	17,848	7
Production, transportation, and material moving occupations	22,669	9.1	38,637	10.2	1,179	12.7	2,250	10.6	34,330	13.4
INDUSTRY PROFILE										
Agriculture, forestry, fishing and hunting, and mining	575	0.2	914	0.2	581	6.3	721	3.4	289	0.1
Construction	20,383	8.1	22,494	5.9	908	9.8	2,486	11.7	12,939	5.1
Manufacturing	18,283	7.3	34,029	9	1,140	12.3	1,425	6.7	20,082	7.8
Wholesale trade	9,403	3.8	12,893	3.4	240	2.6	910	4.3	6,911	2.7
Retail trade	29,295	11.7	42,862	11.3	892	9.6	2,420	11.4	22,881	8.9
Transportation and warehousing, and utilities	14,251	5.7	18,728	4.9	303	3.3	1,077	5.1	14,285	5.6
Information	8,906	3.6	12,314	3.2	150	1.6	588	2.8	8,218	3.2
Finance, insurance, real estate, and rental and leasing	16,138	6.4	36,030	9.5	422	4.5	1,253	5.9	17,453	6.8
Professional, scientific, management, administrative,	30,234	12.1	40,049	10.5	674	7.3	1,910	9	26,088	10.2
and waste management services										
Educational, health and social services	42,716	17.1	87,102	22.9	2,228	24	3,795	17.9	68,499	26.8
Arts, entertainment, recreation, accommodation and food services	16,468	6.6	24,780	6.5	761	8.2	1,548	7.3	21,174	8.3
Other services (except public administration)	13,929	5.6	18,471	4.9	475	5.1	1,077	5.1	13,460	5.3
Public administration	29,673	11.9	29,039	7.6	520	5.6	1,976	9.3	23,757	9.3
CLASS OF WORKER										
Private wage and salary workers	182,833	73.1	290,586	76.5	6,792	73.1	14,908	70.4	187,469	73.2
Government workers	54,347	21.7	69,886	18.4	1,392	15	4,299	20.3	57,116	22.3
Self-employed workers in own not incorporated business	12,590	5	18,498	4.9	1,052	11.3	1,947	9.2	10,968	4.3
Unpaid family workers	484	0.2	735	0.2	58	0.6	32	0.2	483	0.2
INCOME IN 1999										
Median household income (dollars)	$61,768	---	$50,667	---	$39,869	---	$57,037	---	$30,078	---

Source: U.S. Census Bureau, Census 2000

Note: This information refers to entire counties bordering Upper Bay and Harbor.

Table 2-29 Selected Economic Characteristics of Middle Bay Counties (MD)

	Calvert County		Dorchester County		Somerset County		St. Mary's County		Talbot County	
	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population
EMPLOYMENT STATUS										
Labor force	39,341	71.5	15,144	62.2	10,389	50.3	46,032	71.2	16,789	61.7
Employed	37,604	68.4	14,225	58.4	9,368	45.4	41,453	64.1	16,208	59.6
Unemployed	1,182	2.1	882	3.6	1,004	4.9	1,973	3.1	568	2.1
OCCUPATION TYPE										
Management, professional, and related occupations	13,857	36.8	3,313	23.3	2,321	24.8	16,228	39.1	5,663	34.9
Service occupations	5,545	14.7	2,279	16	1,983	21.2	5,436	13.1	2,684	16.6
Sales and office occupations	9,165	24.4	3,385	23.8	2,201	23.5	9,751	23.5	4,036	24.9
Farming, fishing, and forestry occupations	91	0.2	349	2.5	354	3.8	279	0.7	282	1.7
Construction, extraction, and maintenance occupations	5,630	15	1,844	13	1,095	11.7	5,922	14.3	1,676	10.3
Production, transportation, and material moving occupations	3,316	8.8	3,055	21.5	1,414	15.1	3,837	9.3	1,867	11.5
INDUSTRY PROFILE										
Agriculture, forestry, fishing and hunting, and mining	276	0.7	587	4.1	518	5.5	467	1.1	567	3.5
Construction	5,134	13.7	1,335	9.4	759	8.1	5,249	12.7	1,532	9.5
Manufacturing	1,731	4.6	2,788	19.6	985	10.5	2,517	6.1	1,632	10.1
Wholesale trade	1,018	2.7	558	3.9	339	3.6	807	1.9	488	3
Retail trade	3,781	10.1	1,648	11.6	1,160	12.4	4,532	10.9	1,879	11.6
Transportation and warehousing, and utilities	2,859	7.6	715	5	449	4.8	2,579	6.2	537	3.3
Information	1,115	3	235	1.7	145	1.5	747	1.8	326	2
Finance, insurance, real estate, and rental and leasing	1,448	3.9	549	3.9	232	2.5	1,468	3.5	1,209	7.5
Professional, scientific, management, administrative, and waste management services	3,864	10.3	745	5.2	479	5.1	4,793	11.6	1,620	10
Educational, health and social services	6,397	17	2,804	19.7	2,291	24.5	7,137	17.2	3,382	20.9
Arts, entertainment, recreation, accommodation and food services	2,486	6.6	819	5.8	648	6.9	2,541	6.1	1,414	8.7
Other services (except public administration)	1,882	5	628	4.4	359	3.8	1,824	4.4	748	4.6
Public administration	5,613	14.9	814	5.7	1,004	10.7	6,792	16.4	874	5.4
CLASS OF WORKER										
Private wage and salary workers	25,226	67.1	10,420	73.3	5,804	62	26,881	64.8	11,771	72.6
Government workers	9,952	26.5	2,416	17	2,602	27.8	11,947	28.8	2,305	14.2
Self-employed workers in own not incorporated business	2,302	6.1	1,357	9.5	876	9.4	2,492	6	2,109	13
Unpaid family workers	124	0.3	32	0.2	86	0.9	133	0.3	23	0.1
INCOME IN 1999										
Median household income (dollars)	$65,945	---	$34,077	---	$29,903	---	$54,706	---	$43,532	---

Source: U.S. Census Bureau, Census 2000
Note: This information refers to entire counties bordering Middle Bay.

Table 2-30 Selected Economic Characteristics of Lower Bay Counties (VA)

	Accomack County		Gloucester County		Isle of Wight County		Hampton city		Lancaster County	
	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population
EMPLOYMENT STATUS										
Labor Force	18,116	60.3	17,879	66.8	14,851	64.3	71,790	62.4	4,682	48.7
Employed	16,618	55.3	16,703	62.4	14,085	61	60,810	52.8	4,381	45.6
Unemployed	1,365	4.5	691	2.6	604	2.6	4,277	3.7	301	3.1
OCCUPATION TYPE										
Management, professional, and related occupations	4,026	24.2	5,235	31.3	4,407	31.3	19,518	32.1	1,207	27.6
Service occupations	2,774	16.7	2,531	15.2	1,705	12.1	9,194	15.1	901	20.6
Sales and office occupations	3,675	22.1	3,939	23.6	3,336	23.7	16,932	27.8	1,099	25.1
Farming, fishing, and forestry occupations	982	5.9	243	1.5	126	0.9	162	0.3	85	1.9
Construction, extraction, and maintenance occupations	1,835	11	2,655	15.9	1,842	13.1	6,667	11	489	11.2
Production, transportation, and material moving occupations	3,326	20	2,100	12.6	2,669	18.9	8,337	13.7	600	13.7
INDUSTRY PROFILE										
Agriculture, forestry, fishing and hunting, and mining	1,050	6.3	386	2.3	388	2.8	208	0.3	130	3
Construction	1,357	8.2	1,902	11.4	1,161	8.2	3,906	6.4	424	9.7
Manufacturing	2,945	17.7	1,770	10.6	3,573	25.4	9,429	15.5	314	7.2
Wholesale trade	697	4.2	474	2.8	435	3.1	1,267	2.1	101	2.3
Retail trade	1,963	11.8	1,933	11.6	1,353	9.6	7,882	13	557	12.7
Transportation and warehousing, and utilities	581	3.5	713	4.3	798	5.7	2,514	4.1	197	4.5
Information	199	1.2	312	1.9	293	2.1	1,725	2.8	120	2.7
Finance, insurance, real estate, and rental and leasing	702	4.2	622	3.7	637	4.5	2,963	4.9	288	6.6
Professional, scientific, management, administrative,	940	5.7	1,365	8.2	950	6.7	5,538	9.1	412	9.4
and waste management services										
Educational, health and social services	2,696	16.2	3,480	20.8	2,294	16.3	12,423	20.4	958	21.9
Arts, entertainment, recreation, accommodation and food services	1,567	9.4	1,409	8.4	800	5.7	4,690	7.7	367	8.4
Other services (except public administration)	740	4.5	774	4.6	604	4.3	2,838	4.7	288	6.6
Public administration	1,181	7.1	1,563	9.4	799	5.7	5,427	8.9	225	5.1
CLASS OF WORKER										
Private wage and salary workers	11,945	71.9	11,731	70.2	10,894	77.3	44,616	73.4	3,152	71.9
Government workers	3,029	18.2	3,812	22.8	2,286	16.2	13,867	22.8	675	15.4
Self-employed workers in own not incorporated business	1,591	9.6	1,102	6.6	858	6.1	2,237	3.7	546	12.5
Unpaid family workers	53	0.3	58	0.3	47	0.3	90	0.1	8	0.2
INCOME IN 1999										
Median household income (dollars)	$30,250	---	$45,421	---	$45,387	---	$39,532	---	$33,239	---

Source: U.S. Census Bureau, Census 2000
Note: This information refers to entire counties bordering Lower Bay.

Table 2-30 Selected Economic Characteristics of Lower Bay Counties (VA)

	Mathews County		Newport News city		Norfolk city		Northampton County		Virginia Beach city	
	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population	Number of Persons	Percent of Population
EMPLOYMENT STATUS										
Labor Force	4,242	56	92,586	68.3	123,360	67.1	5,581	53.6	234,257	72.9
Employed	4,046	53.5	78,194	57.7	87,490	47.6	5,177	49.7	194,923	60.7
Unemployed	134	1.8	4,604	3.4	8,632	4.7	389	3.7	8,247	2.6
OCCUPATION TYPE										
Management, professional, and related occupations	1,105	27.3	23,862	30.5	25,443	29.1	1,401	27.1	69,937	35.9
Service occupations	692	17.1	13,764	17.6	16,712	19.1	1,033	20	28,988	14.9
Sales and office occupations	926	22.9	21,555	27.6	24,253	27.7	1,032	19.9	58,697	30.1
Farming, fishing, and forestry occupations	65	1.6	202	0.3	156	0.2	341	6.6	247	0.1
Construction, extraction, and maintenance occupations	623	15.4	8,171	10.4	9,392	10.7	520	10	19,554	10
Production, transportation, and material moving occupations	635	15.7	10,640	13.6	11,534	13.2	850	16.4	17,500	9
INDUSTRY PROFILE										
Agriculture, forestry, fishing and hunting, and mining	76	1.9	211	0.3	168	0.2	411	7.9	421	0.2
Construction	432	10.7	5,506	7	6,428	7.3	359	6.9	14,509	7.4
Manufacturing	516	12.8	11,946	15.3	6,197	7.1	634	12.2	12,581	6.5
Wholesale trade	102	2.5	1,777	2.3	2,571	2.9	187	3.6	5,809	3
Retail trade	475	11.7	9,992	12.8	11,318	12.9	498	9.6	26,738	13.7
Transportation and warehousing, and utilities	335	8.3	2,988	3.8	5,028	5.7	332	6.4	8,668	4.4
Information	53	1.3	2,028	2.6	2,794	3.2	62	1.2	6,836	3.5
Finance, insurance, real estate, and rental and leasing	162	4	3,527	4.5	5,509	6.3	211	4.1	16,768	8.6
Professional, scientific, management, administrative, and waste management services	300	7.4	7,391	9.5	8,672	9.9	240	4.6	21,319	10.9
Educational, health and social services	824	20.4	15,093	19.3	18,153	20.7	1,242	24	39,891	20.5
Arts, entertainment, recreation, accommodation and food services	239	5.9	7,786	10	9,350	10.7	415	8	17,411	8.9
Other services (except public administration)	245	6.1	3,772	4.8	4,685	5.4	291	5.6	10,053	5.2
Public administration	287	7.1	6,177	7.9	6,617	7.6	295	5.7	13,919	7.1
CLASS OF WORKER										
Private wage and salary workers	2,839	70.2	58,376	74.7	65,893	75.3	3,597	69.5	146,625	75.2
Government workers	783	19.4	16,419	21	18,043	20.6	1,034	20	37,731	19.4
Self-employed workers in own not incorporated business	424	10.5	3,256	4.2	3,421	3.9	508	9.8	10,148	5.2
Unpaid family workers	0	0	143	0.2	133	0.2	38	0.7	419	0.2
INCOME IN 1999										
Median household income (dollars)	$43,222	---	$36,597	---	$31,815	---	$28,276	---	$48,705	---

Source: U.S. Census Bureau, Census 2000

Note: This information refers to entire counties bordering Lower Bay.

Table 2-31
Stratigraphy of the Chesapeake Bay Miocene Epoch to Present—Stratigraphy Unit Correlation for Virginia and Maryland

after Mixon (1985)

Age	Virginia (western shore)		Virginia/southern Maryland (eastern shore)		Virginia/Maryland including aquifers	Southern Maryland
Late Pleistocene	Talbot Formation		Parsonburg Sand		No data	No data
	Tabb Formation	Poquoson Member	Kent Island, Wachapreague, Sinepuxent, and Ironshire			
		Lynnhaven Mamber				
		Sedgefield Member, Joynes Neck Sand				
			Nassawadox Formation	Occohannock Member		
				Butlers Bluff Member		
				Stumptown Member		
	Omar Formation (Accomack Member)		Omar Formation (Accomack Member)		Omar Formation (Accomack Member)	Omar Formation (Accomack Member)
Pliocene						
					Brandywine sand	Beaverdam Formation
	Yorktown-Cohanssey		Yorktown-Cohanssey		Yorktown-Cohanssey	Not recognized
Miocene						
	Eastover Formation	Cobham Bay Member	St. Mary's Formation			Yorktown and Cohanssey
		Claremont Manor Member				
						St. Mary's Formation
	St. Mary's Formation				St. Mary's Formation	
	Choptank Formation		Choptank Formation		Choptank Formation	Not Studied
	Calvert Formation		Calvert Formation		Calvert Formation	
	Not present		Not present		Not present	

Table 2-32
Chesapeake Bay Hydrostratigraphy
Cretaceous Period to Present

Period	Epoch		Virginia Stratigraphic Formation	Hydrogeologic Unit	Eastern Shore Stratigraphic Unit	Maryland Stratigraphic Unit
Quaternary	Holocene		Holocene Deposits	Columbia Aquifer	Holocene Deposits	Columbia Group
	Pleistocene		Pleistocene Undifferentiated		Kent Island, Wachapreague, Sinepuxent, and Ironshire	
					Nassawadox Formation	
					Omar Formation (Accomack Member)	
Tertiary	Pliocene		Bacon Castle Fm	Yorktown Confining Unit	Yorktown-Cohanssey Fm	Yorktown Fm
		Chesapeake Group	Yorktown Fm	Yorktown-Eastover aquifer		
	Miocene		Eastover Fm			
			St. Marys Fm	St. Marys Confining Unit	St. Marys Fm	St. Marys Fm
				St. Marys aquifer		
			Choptank Fm			Calvert Fm.
			Calvert Fm	Calvert Confining Unit	Calvert Fm	
			Old Church Fm	Chickahominy-Piney Point aquifer		
	Paleocene			Aquia		Aquia
Cretaceous	Late		Upper Potomac	Monmouth		Monmouth
				Magothy		Magothy
				Potomac		Potomac

Table 2-33
Chesapeake Bay Watershed Land-Based Sediment Loads and Cap Load Allocations[a]

	Major Tributary	Jurisdiction	SEDIMENT 1985	SEDIMENT 2000	SEDIMENT 2002	SEDIMENT Land-Based 2010 Cap Load Allocation[b]
Upper Bay	Susquehanna	PA	0.965	0.859	0.878	0.793
	Susquehanna	NY	0.172	0.149	0.145	0.131
	Susquehanna	MD	0.040	0.036	0.037	0.037
	Susquehanna	All	1.178	1.043	1.060	0.962
	Upper Bay Totals	All	1.178	1.043	1.060	0.962
Middle Bay	Eastern Shore MD	MD	0.319	0.218	0.225	0.116
	Eastern Shore MD	DE	0.054	0.057	0.055	0.042
	Eastern Shore MD	PA	0.006	0.006	0.006	0.004
	Eastern Shore MD	VA	0.002	0.002	0.002	0.001
	Eastern Shore MD	All	0.382	0.282	0.288	0.163
	Western Shore MD	MD	0.163	0.132	0.136	0.100
	Western Shore MD	PA	0.001	0.001	0.001	0.001
	Western Shore MD	All	0.164	0.133	0.137	0.100
	Patuxent	MD	0.201	0.130	0.135	0.095
	Potomac	VA	0.828	0.753	0.720	0.617
	Potomac	MD	0.528	0.420	0.477	0.364
	Potomac	WV	0.400	0.354	0.330	0.311
	Potomac	PA	0.272	0.229	0.227	0.197
	Potomac	DC	0.006	0.006	0.006	0.006
	Potomac	All	2.033	1.762	1.760	1.494
	Middle Bay Totals	All	2.780	2.307	2.320	1.852
Lower Bay	Rappahannock	VA	0.418	0.336	0.335	0.288
	York	VA	0.158	0.130	0.127	0.103
	James	VA	1.266	1.198	1.174	0.925
	James	WV	0.013	0.011	0.011	0.010
	James	All	1.278	1.209	1.186	0.935
	Eastern Shore VA	VA	0.021	0.018	0.020	0.008
	Lower Bay Totals	All	1.876	1.693	1.668	1.333
	BAY TOTAL		5.834	5.043	5.048	4.147

[a]Delivered loads to the Chesapeake Bay in units of million tons sediment/year.

[b]These land-based sediment allocations will be assessed and, if necessary, revised by the tributary teams as part of a comprehensive strategy of management actions necessary to achieve the local underwater bay grasses restoration goals.

Source: www.chesapeakebay.net/pubs/doc-85-01_ Loads_2010_Allocations_060403.xls, March, 31, 2004

Table 2-34
Summary of Sediment Originating from Chesapeake Bay Watershed Sources

	Sediment Loads (million tons/year)					Percentage of Total Sediment Load from Various Land Uses		
	1985 Loads	2000 Loads	2002 Loads	Goal	% Reduction from 2002	Agriculture	Urban/ Suburban	Forest
New York	0.172	0.149	0.145	0.131	9.7	56	17	27
Pennsylvania	1.244	1.094	1.112	0.995	10.5	71	11	17
Maryland	1.252	0.936	1.011	0.712	29.6	70	21	9
District of Columbia	0.006	0.006	0.006	0.006	0.0	0	97	2
Delaware	0.054	0.057	0.055	0.042	23.6	85	8	7
West Virginia	0.413	0.365	0.341	0.320	6.2	69	15	16
Virginia	2.693	2.437	2.379	1.941	18.4	55	19	26
All States	5.834	5.044	5.048	4.15	17.9			

Source: Tributary Strategy Highlights, April 29, 2004

Table 2-35
Baltimore Harbor Channel DMMP
Projected Dredging Quantities (CY)

QUANTITY DREDGED BY CHANNEL REACH AND FISCAL YEAR

CHANNEL REACHES		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
VIRGINIA CHANNELS																							
CAPE HENRY CHANNEL		1,552,000	0	0	0	1,552,000	0	0	0	1,552,000	0	0	0	1,552,000	0	0	0	1,552,000	0	0	0	1,552,000	9,312,000
YORK SPIT CHANNEL		655,000	0	0	0	655,000	0	0	0	655,000	0	0	0	655,000	0	0	0	655,000	0	0	0	655,000	3,930,000
RAPPAHANNOCK SHOAL		0	0	10,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,000	20,000
TOTAL		**2,207,000**	**0**	**10,000**	**0**	**2,207,000**	**0**	**0**	**0**	**2,207,000**	**0**	**0**	**0**	**2,207,000**	**0**	**0**	**0**	**2,207,000**	**0**	**0**	**0**	**2,217,000**	13,262,000
Contingency	**10%**	**220,700**	**0**	**1,000**	**0**	**220,700**	**0**	**0**	**0**	**220,700**	**0**	**0**	**0**	**220,700**	**0**	**0**	**0**	**220,700**	**0**	**0**	**0**	**221,700**	1,326,200
TOTAL		**2,427,700**	**0**	**11,000**	**0**	**2,427,700**	**0**	**0**	**0**	**2,427,700**	**0**	**0**	**0**	**2,427,700**	**0**	**0**	**0**	**2,427,700**	**0**	**0**	**0**	**2,438,700**	14,588,200
Non-Pay Overdepth	**10%**	**242,770**	**0**	**1,100**	**0**	**242,770**	**0**	**0**	**0**	**242,770**	**0**	**0**	**0**	**242,770**	**0**	**0**	**0**	**242,770**	**0**	**0**	**0**	**243,870**	1,458,820
TOTAL VIRGINIA CHANNELS		**2,670,470**	**0**	**12,100**	**0**	**2,670,470**	**0**	**0**	**0**	**2,670,470**	**0**	**0**	**0**	**2,670,470**	**0**	**0**	**0**	**2,670,470**	**0**	**0**	**0**	**2,682,570**	**16,047,020**
CHESAPEAKE BAY APPROACH CHANNELS (MD)																							
CRAIGHILL ENTRANCE		370,000	0	370,000	0	370,000	0	370,000	0	370,000	0	370,000	0	370,000	0	370,000	0	370,000	0	370,000	0	370,000	4,070,000
CRAIGHILL CHANNEL		0	211,000	0	211,000	0	211,000	0	211,000	0	211,000	0	211,000	0	211,000	0	211,000	0	211,000	0	211,000	0	2,110,000
CRAIGHILL ANGLE		757,000	0	757,000	0	757,000	0	757,000	0	757,000	0	757,000	0	757,000	0	757,000	0	757,000	0	757,000	0	757,000	8,327,000
CRAIGHILL UPPER RANGE		0	0	171,000	0	0	171,000	0	0	171,000	0	0	171,000	0	0	171,000	0	0	171,000	0	0	171,000	1,197,000
CUTOFF ANGLE		0	397,000	0	397,000	0	397,000	0	397,000	0	397,000	0	397,000	0	397,000	0	397,000	0	397,000	0	397,000	0	3,970,000
BREWERTON EXTENSION		440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	440,000	9,240,000
TOLCHESTER CHANNEL		0	438,000	0	438,000	0	438,000	0	438,000	0	438,000	0	438,000	0	438,000	0	438,000	0	438,000	0	438,000	0	4,380,000
SWAN POINT CHANNEL		0	0	0	0	724,000		0	0	0	0	0	0	724,000	0	0	0	0	0	0	0	724,000	2,172,000
TOLCHESTER S-TURN		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0
TOTAL		**1,567,000**	**1,486,000**	**1,738,000**	**1,486,000**	**2,291,000**	**1,657,000**	**1,567,000**	**1,486,000**	**1,738,000**	**1,486,000**	**1,567,000**	**1,657,000**	**2,291,000**	**1,486,000**	**1,738,000**	**1,486,000**	**1,567,000**	**1,657,000**	**1,567,000**	**1,486,000**	**2,462,000**	35,466,000
Contingency	**10%**	**156,700**	**148,600**	**173,800**	**148,600**	**229,100**	**165,700**	**156,700**	**148,600**	**173,800**	**148,600**	**156,700**	**165,700**	**229,100**	**148,600**	**173,800**	**148,600**	**156,700**	**165,700**	**156,700**	**148,600**	**246,200**	3,546,600
TOTAL		**1,723,700**	**1,634,600**	**1,911,800**	**1,634,600**	**2,520,100**	**1,822,700**	**1,723,700**	**1,634,600**	**1,911,800**	**1,634,600**	**1,723,700**	**1,822,700**	**2,520,100**	**1,634,600**	**1,911,800**	**1,634,600**	**1,723,700**	**1,822,700**	**1,723,700**	**1,634,600**	**2,708,200**	39,012,600
Non-Pay Overdepth	**10%**	**172,370**	**163,460**	**191,180**	**163,460**	**252,010**	**182,270**	**172,370**	**163,460**	**191,180**	**163,460**	**172,370**	**182,270**	**252,010**	**163,460**	**191,180**	**163,460**	**172,370**	**182,270**	**172,370**	**163,460**	**270,820**	3,901,260
TOTAL CHESAPEAKE BAY APP (MD)		**1,896,070**	**1,798,060**	**2,102,980**	**1,798,060**	**2,772,110**	**2,004,970**	**1,896,070**	**1,798,060**	**2,102,980**	**1,798,060**	**1,896,070**	**2,004,970**	**2,772,110**	**1,798,060**	**2,102,980**	**1,798,060**	**1,896,070**	**2,004,970**	**1,896,070**	**1,798,060**	**2,979,020**	**42,913,860**
HARBOR CHANNELS																							
BREWERTON CHANNEL		0	0	334,000	0	0	334,000	0	0	334,000	0	0	334,000	0	0	334,000	0	0	334,000	0	0	334,000	2,338,000
BREWERTON ANGLE		0	0	323,000	0	0	323,000	0	0	323,000	0	0	323,000	0	0	323,000	0	0	323,000	0	0	323,000	2,261,000
FT. McHENRY CHANNEL		0	213,000	0	213,000	0	213,000	0	213,000	0	213,000	0	213,000	0	213,000	0	213,000	0	213,000	0	213,000	0	2,130,000
EAST CHANNEL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEST CHANNEL		0	0	0	0	0	0	0	0	0	90,000	0	0	0	0	0	0	0	0	0	0	0	90,000
Subtotal		**0**	**213,000**	**657,000**	**213,000**	**0**	**870,000**	**0**	**213,000**	**657,000**	**303,000**	**0**	**870,000**	**0**	**213,000**	**657,000**	**213,000**	**0**	**870,000**	**0**	**213,000**	**657,000**	6,819,000
																							0
BRANCH CHANNELS																							0
FERRY BAR CHANNEL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	420,000	0	0	0	0	0	0	420,000
CURTIS BAY CHANNEL		0	506,000	0	0	0	0	0	506,000	0	0	0	0	0	506,000	0	0	0	0	0	506,000	0	2,024,000
CURTIS CREEK CHANNEL		51,000	0	0	0	0	51,000	0	0	0	0	51,000	0	0	0	0	51,000	0	0	0	0	51,000	255,000
EAST DUNDALK MARINE CHANNEL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEST DUNDALK MARINE CHANNEL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DUNDALK/SEAGIRT CONNECTING CHANNEL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEAGIRT MARINE CHANNEL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTH LOCUST POINT MARINE CHANNEL		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal		**51,000**	**506,000**	**0**	**0**	**0**	**51,000**	**0**	**506,000**	**0**	**0**	**51,000**	**0**	**0**	**506,000**	**420,000**	**51,000**	**0**	**0**	**0**	**506,000**	**51,000**	2,699,000
																							0
ANCHORAGES																							0
FT. McHENRY ANCHORAGE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RIVERVIEW ANCHORAGE I		0	0	0	0	0	0	0	0	0	0	0	0	250,000	0	0	0	0	0	0	0	0	250,000
RIVERVIEW ANCHORAGE II		110,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110,000
Subtotal		**110,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**250,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	360,000
TOTAL FEDERAL MAINTENANCE		**161,000**	**719,000**	**657,000**	**213,000**	**0**	**921,000**	**0**	**719,000**	**657,000**	**303,000**	**51,000**	**870,000**	**250,000**	**719,000**	**1,077,000**	**264,000**	**0**	**870,000**	**0**	**719,000**	**708,000**	9,878,000
NON-FEDERAL MAINTENANCE		**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	**300,000**	6,300,000
																							0
NEW WORK																							0
Dundalk & Seagirt 50' Berth		0	1,700,000	1,600,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,300,000
Other State New Work		40,000	20,000	40,000	1,190,000	0	0	0	0	0	2,225,000	2,225,000	0	0	0	0	0	0	0	0	0	0	5,740,000
Potential New Work (Private Sector)		2,000,000	345,000	480,000	375,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,200,000
Subtotal		**2,040,000**	**2,065,000**	**2,120,000**	**1,565,000**	**0**	**0**	**0**	**0**	**0**	**2,225,000**	**2,225,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	12,240,000
																							0
TOTAL		**2,501,000**	**3,084,000**	**3,077,000**	**2,078,000**	**300,000**	**1,221,000**	**300,000**	**1,019,000**	**957,000**	**2,828,000**	**2,576,000**	**1,170,000**	**550,000**	**1,019,000**	**1,377,000**	**564,000**	**300,000**	**1,170,000**	**300,000**	**1,019,000**	**1,008,000**	28,418,000
Unidentified New Work	**10%**	**0**	**0**	**0**	**0**	**0**	**0**	**30,000**	**101,900**	**95,700**	**282,800**	**257,600**	**117,000**	**55,000**	**101,900**	**137,700**	**56,400**	**30,000**	**117,000**	**30,000**	**101,900**	**100,800**	1,615,700
TOTAL		**2,501,000**	**3,084,000**	**3,077,000**	**2,078,000**	**300,000**	**1,221,000**	**330,000**	**1,120,900**	**1,052,700**	**3,110,800**	**2,833,600**	**1,287,000**	**605,000**	**1,120,900**	**1,514,700**	**620,400**	**330,000**	**1,287,000**	**330,000**	**1,120,900**	**1,108,800**	30,033,700
Non-Pay Overdepth	**10%**	**250,100**	**308,400**	**307,700**	**207,800**	**30,000**	**122,100**	**33,000**	**112,090**	**105,270**	**311,080**	**283,360**	**128,700**	**60,500**	**112,090**	**151,470**	**62,040**	**33,000**	**128,700**	**33,000**	**112,090**	**110,880**	3,003,370
TOTAL HARBOR CHANNELS		**2,751,100**	**3,392,400**	**3,384,700**	**2,285,800**	**330,000**	**1,343,100**	**363,000**	**1,232,990**	**1,157,970**	**3,421,880**	**3,116,960**	**1,415,700**	**665,500**	**1,232,990**	**1,666,170**	**682,440**	**363,000**	**1,415,700**	**363,000**	**1,232,990**	**1,219,680**	**33,037,070**
C&D APPROACH CHANNELS - Philadelphia District																							
C & D APPROACH CHANNELS		1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	25,200,000
TOTAL		**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	**1,200,000**	25,200,000
Contingency	**10%**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	**120,000**	2,520,000
TOTAL C&D APPROACH		**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**1,320,000**	**27,720,000**
TOTAL VIRGINIA CHANNELS		**2,670,470**	**0**	**12,100**	**0**	**2,670,470**	**0**	**0**	**0**	**2,670,470**	**0**	**0**	**0**	**2,670,470**	**0**	**0**	**0**	**2,670,470**	**0**	**0**	**0**	**2,682,570**	16,047,020
TOTAL MARYLAND CHANNELS		**5,967,170**	**6,510,460**	**6,807,680**	**5,403,860**	**4,422,110**	**4,668,070**	**3,579,070**	**4,351,050**	**4,580,950**	**6,539,940**	**6,333,030**	**4,740,670**	**4,757,610**	**4,351,050**	**5,089,150**	**3,800,500**	**3,579,070**	**4,740,670**	**3,579,070**	**4,351,050**	**5,518,700**	103,670,930
TOTAL		**8,637,640**	**6,510,460**	**6,819,780**	**5,403,860**	**7,092,580**	**4,668,070**	**3,579,070**	**4,351,050**	**7,251,420**	**6,539,940**	**6,333,030**	**4,740,670**	**7,428,080**	**4,351,050**	**5,089,150**	**3,800,500**	**6,249,540**	**4,740,670**	**3,579,070**	**4,351,050**	**8,201,270**	**119,717,950**

Table 2-36: Capacity of Existing Placement Sites (mcy)
As of December 2004

Site	Capacity
Pooles Island Open Water Sites	4.7
Hart-Miller Island	10.0
PIERP	27.0
Cox Creek CDF	6.0
Virginia Open Water Sites*	Sufficient
Total	47.7

* Includes Dam Neck and Norfolk Ocean sites, Wolf Trap Alternate, and Rappahannock Deep Alternate
* Capacities are Consolidated In-Place Volumes

CHAPTER 2

FIGURES

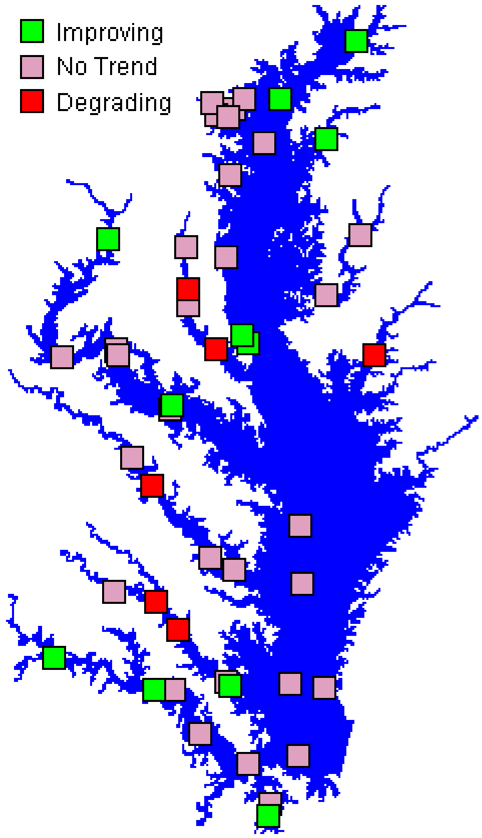


Figure 2-1 Locations and status of fixed benthic monitoring stations in the Chesapeake Bay. (Source: Figure directly excerpted from Chesapeake Bay Monitoring Program Web site)
http://www.baybenthos.versar.com/results/intmap.htm

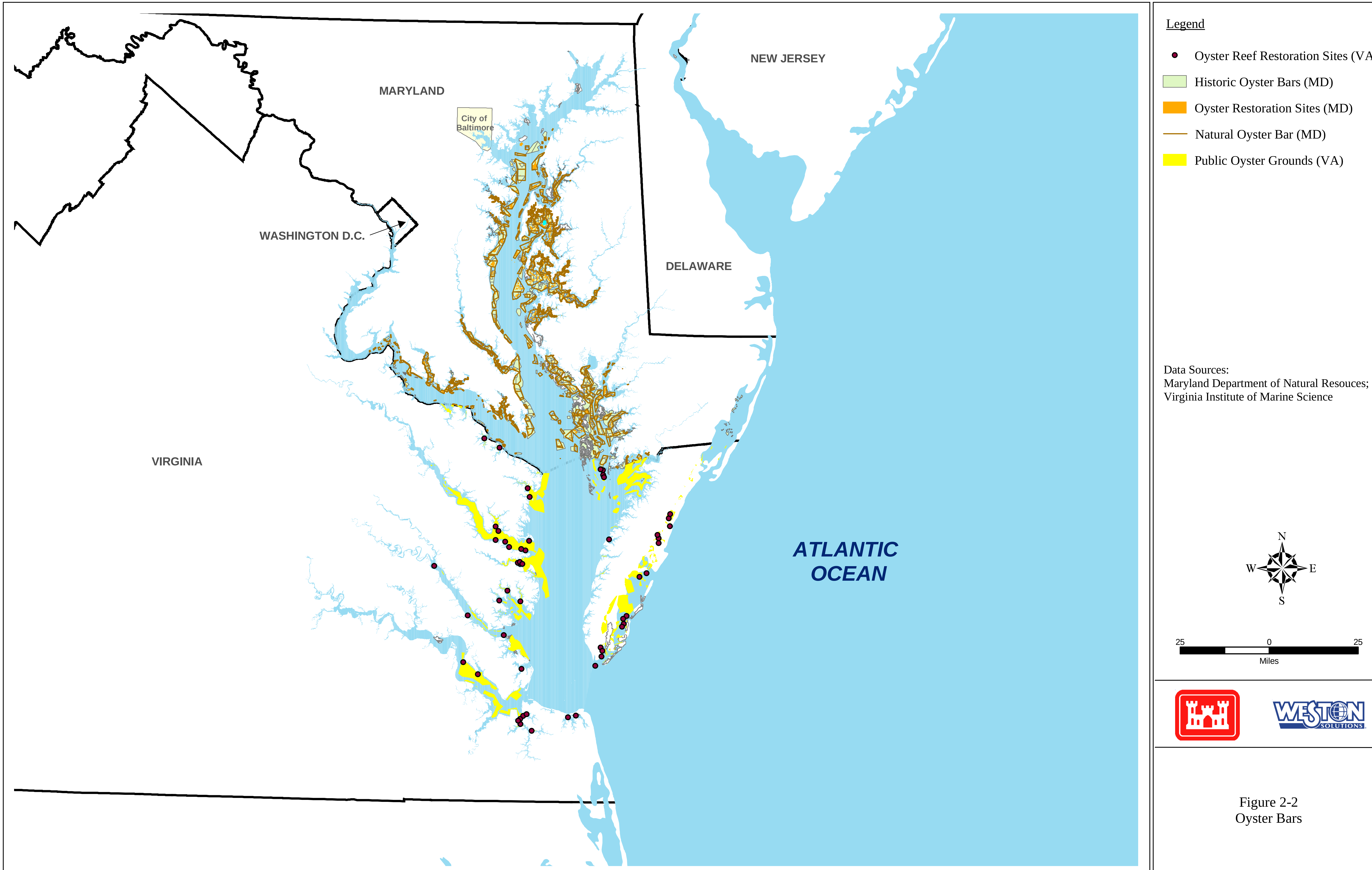


Figure 2-2
Oyster Bars

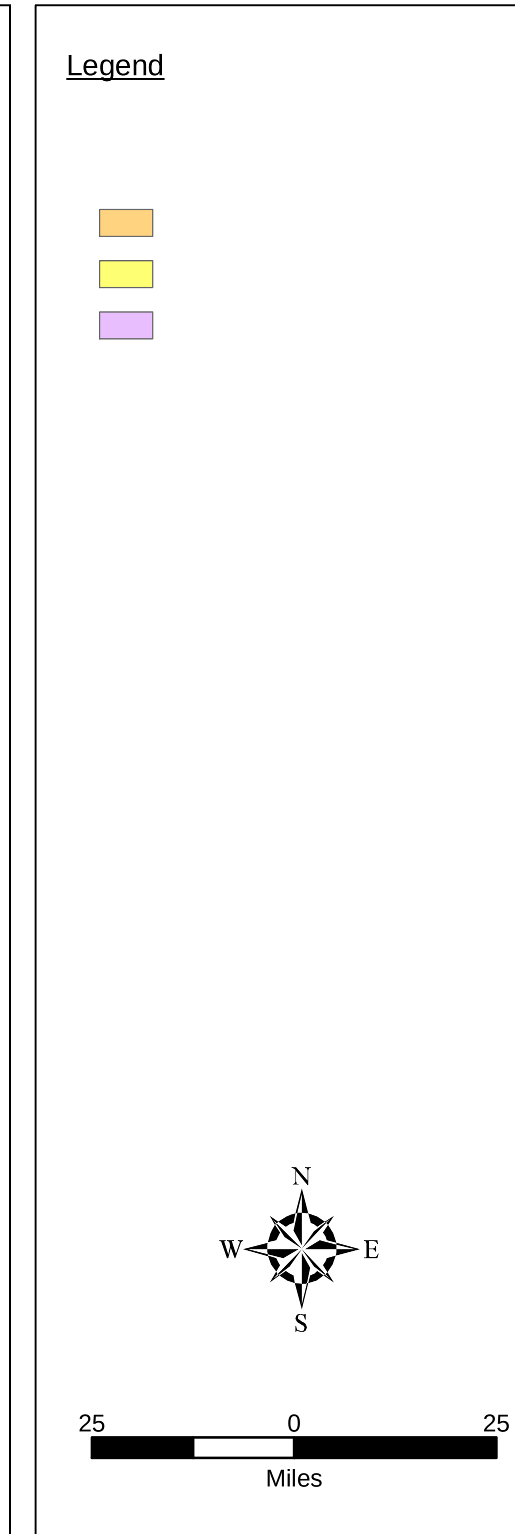
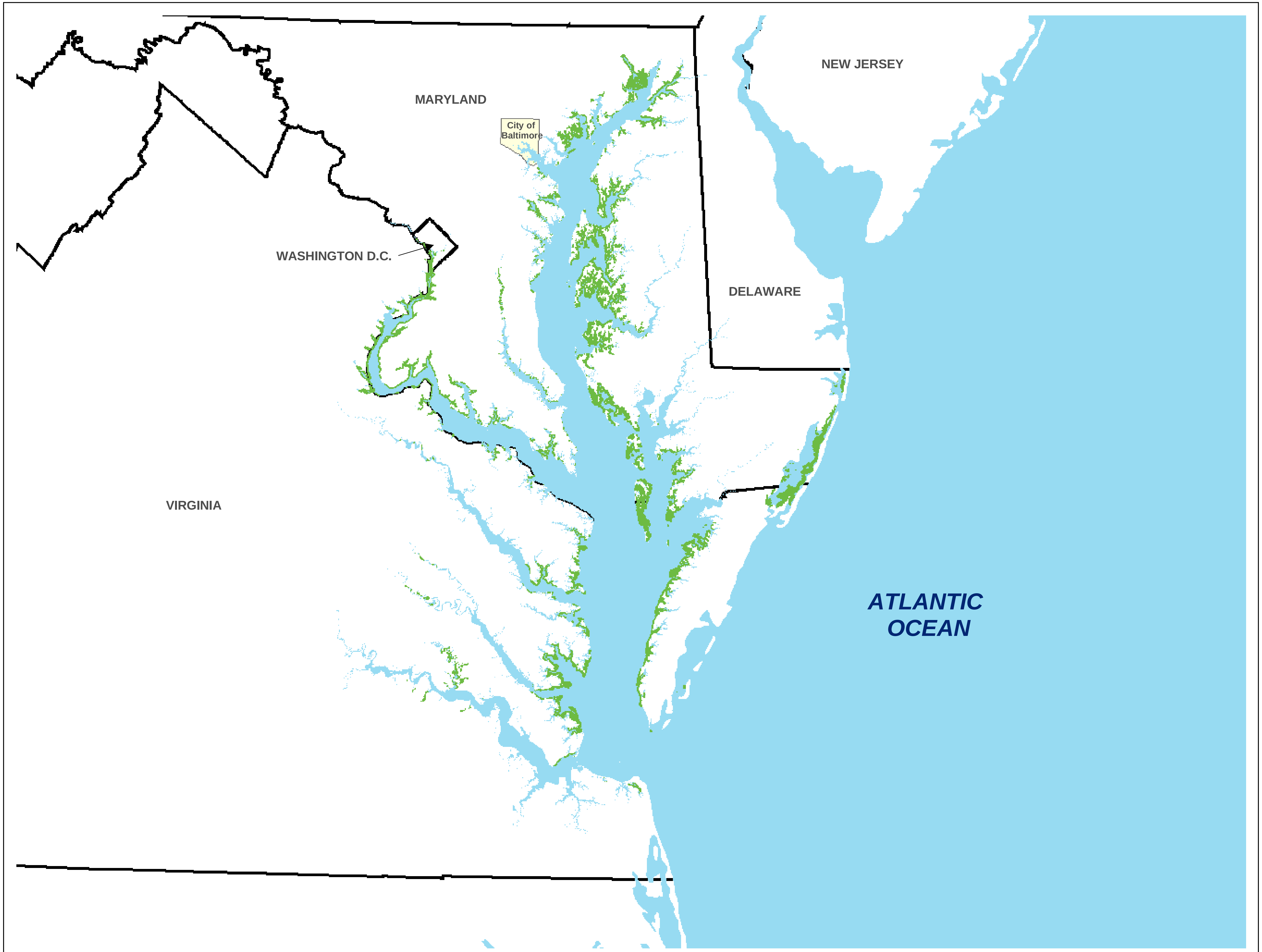


Figure 2-3
Soft Shell Clam Abundance



Legend

SAV

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Virginia Institute of Marine Science

N
W E
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25 0 25
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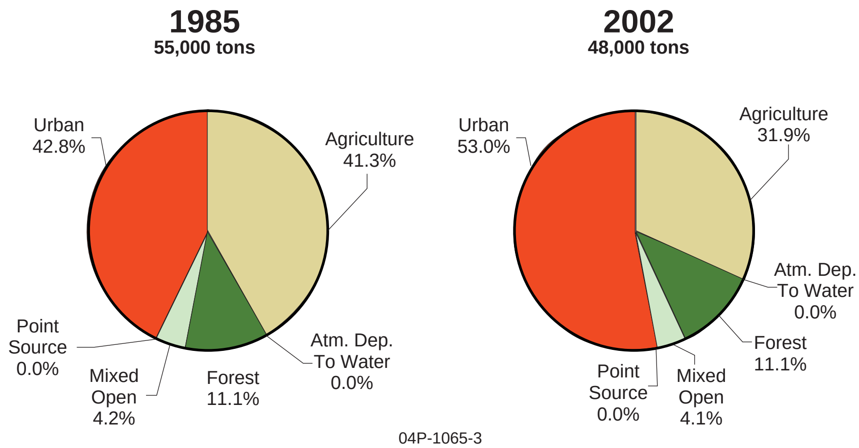
Figure 2-4
Submerged Aquatic Vegetation

Figure 2-5
Major Pathways of Sediment Transport in Chesapeake Bay



Excerpted from: *Patapsco/Back River: Final Version for 1985-2002 Data*

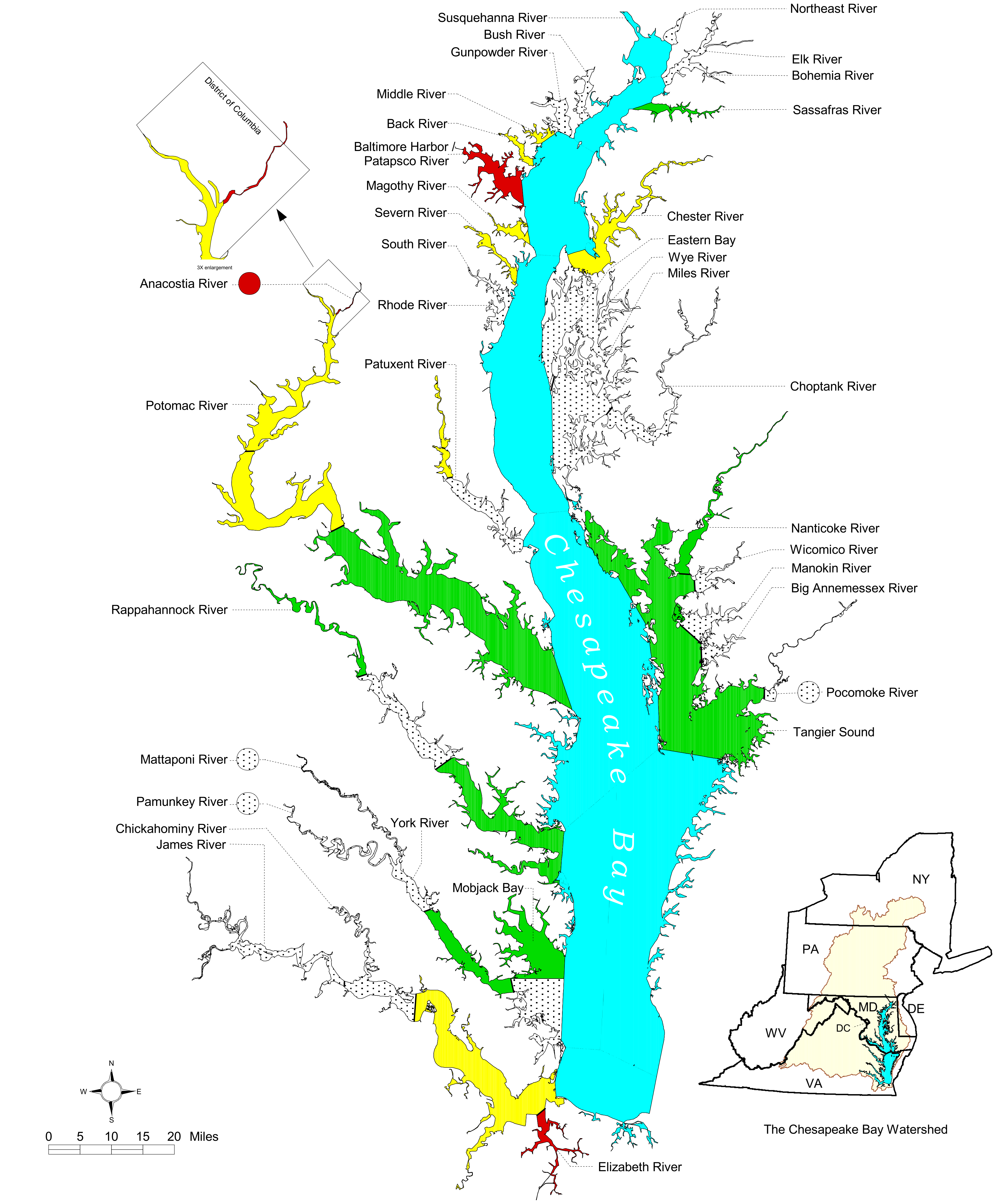
Basin Summary Team and Chesapeake Bay Program Tidal Monitoring and Analysis Workgroup January 29, 2004

Figure 2-6 Sediment Contribution of Patapsco/Back River By Source

Figure 2-7
Chesapeake Bay Monitoring
Stations Location Map

Status of Chemical Contaminant Effects on Living Resources in the Chesapeake Bay's Tidal Rivers

Chesapeake Bay Program



- Region of Concern - area with probable adverse effects
- Area of Emphasis - area with potential adverse effects
- Area with Low Probability for Adverse Effects
- Area with Insufficient or Inconclusive Data
- Not characterized due to historically low levels of chemical contamination

In the Chesapeake Bay region, scientists and managers carried out a multi-step effort to characterize the status of chemical contaminant effects on living resources - fish, shellfish, crabs, worms, grasses, etc. - inhabiting the Bay's tidal rivers. The result of this characterization is a report, "Targeting Toxics: A Characterization Report - A Tool for Directing Management & Monitoring Actions in the Chesapeake Bay's Tidal Rivers", which includes this map. The information gathered for this report and map will be used by Chesapeake Bay Program decision makers to target specific tidal rivers for monitoring and management efforts. It is also part of the 1999 Toxics Reevaluation and Revision effort.

Produced in April 1999

For more information call 1-800-YOUR BAY or visit www.chesapeakebay.net

Figure 2-9
River Names

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3. ALTERNATIVES

This chapter presents the descriptions of placement and beneficial use alternatives, the screening of these alternatives, and the trade-off analysis that leads to the recommendation of alternative suites that will be carried through the Tiered EIS process and then forward for detailed study.

For the purpose of this programmatic DMMP, the new sites and innovative use alternatives have been developed on a programmatic basis, rather than on a site-specific basis. Although several new site options are in various stages of evaluation, the purpose of this DMMP is to conduct a programmatic level evaluation of the alternatives. The result of this programmatic level evaluation is the recommendation of alternatives that should undergo further evaluation (i.e., reconnaissance and feasibility studies) in order to select the best specific site and design. The selection of new specific sites will be performed following the completion of this programmatic DMMP through site-specific reconnaissance and feasibility studies and in compliance with NEPA. They may include already completed, ongoing, or planned studies. Additional study authority and/or funding may be required to conduct these follow-on studies.

3.1 "NO ACTION" ALTERNATIVE

The "No Action" alternative is used as a basis for comparison to the recommended plan. Because the proposed action is to develop a plan to improve the existing conditions, the consequences of no action (i.e., lack of sufficient placement capacity) are particularly important because they define the need for the DMMP. This alternative consists of a continuation of the current maintenance dredging at the constructed channel dimensions and placing the dredged material at the existing placement sites without modification. The existing placement sites for each of the channel approaches are as follows:

- C&D Canal Approach Channels
  - Pooles Island Open Water Site

    The Pooles Island Open Water Site refers to a group of existing, individually designated open water placement sites in Maryland in the immediate vicinity of Pooles Island as shown in Figures 3-1 and 3-5. The designated sites are located south and east of the Island, just to the west of the lower reach of the C&D Canal Approach Channels. The designated open water placement sites G-North, G-West, G-East, G-Central, G-South, and Site 92, as shown in Figure 3-5, have been used over the years for the overboard placement of dredged material from the channels in the upper region of the Bay. Areas G-West, G-East, and Site 92 can accept more material.

Overall, the Pooles Island site has an estimated 4.7 million cubic yards (mcy) of capacity remaining and due to a state law (MD Senate Bill 830; Maryland Environmental Code (5), Subtitle 11) passed in 2001, cannot be expanded to accept any more material if the capacity is exhausted prior to the mandatory closure date of 31 December 2010. The Pooles Island site is currently being used for the placement of dredged material from the lower approach of the C&D Canal Approach Channels. As noted in Table 2-35, the total projected dredging need of these channels for the planning period is estimated at 27.7 mcy. As such, continued maintenance dredging of the lower approach without other placement alternatives (e.g., the designation of a new placement site or expansion of the Pooles Island site) will result in a 23-mcy capacity shortfall for the 21-year planning period.

- Harbor Channels and Anchorages
  - Hart Miller Island (HMI) Dredged Material Containment Facility (DMCF)

    HMI DMCF is an approximately 1,200-acre man-made island located near Hawk Cove at the mouth of the Back River in Baltimore County, Maryland as shown in Figure 3-1. Construction of the Island was completed in 1984 to provide for containment of dredged material from the Baltimore Harbor & Channels 50-ft project and the subsequent maintenance of federal channels and anchorages. The HMI, which consists of two separate, diked areas, has an estimated remaining capacity of 10 mcy and state law (MD Senate Bill 830; Maryland Environmental Code (5), Subtitle 11) requires the site to stop accepting dredged material after 2009. The site is currently used for the placement of dredged material from the Harbor channels and, occasionally, material from the Chesapeake Bay Approach Channels (MD).

  - Cox Creek Confined Disposal Facility (CDF)

The Cox Creek CDF is an existing 102-acre containment facility along the southern shore of the Patapsco River just east of the Francis Scott Key Bridge as shown in Figure 3-1. The previously used facility is in the process of being modified to accept more dredged material from the Harbor. The existing height of the dikes is approximately +24 ft MLLW, with plans to further raise the dikes to the maximum permitted height of +36 ft MLLW. The dike raising would increase the remaining capacity to approximately 6 mcy.

State law (MD Senate Bill 830; Maryland Environmental Code (5), Subtitle 11 prohibits the placement of dredged material from Baltimore Harbor in an unconfined manner in the Bay or its tributaries. As noted in Table 2-35, the total projected dredging need of Harbor channels and anchorages for the planning period is estimated at 33 mcy. As such, continued maintenance dredging of the Harbor Channels, without other placement alternatives (e.g., the expansion of HMI DMCF and Cox Creek CDF, or the construction of new containment facilities) will result in a 17-mcy capacity shortfall for the 21-year planning period.

- Chesapeake Bay Approach Channels (MD)
  - Poplar Island Environmental Restoration Project (PIERP) and Beneficial Use

    PIERP is an ongoing environmental restoration and beneficial use project located just off the Chesapeake Bay coastline, about 34 miles south of Baltimore in Talbot County, Maryland as shown in Figure 3-2. PIERP is being restored to its former size and important ecological function while helping to ensure the economic vitality of the region. Approximately 40 mcy of dredged material would be placed to develop 570 acres of wetlands and 570 acres of uplands. Dredged material from the Brewerton Eastern Extension channel project, the Tolchester Channel S-Turn straightening project, and maintenance material from the Chesapeake Bay Approach Channels (MD) has already been placed at the site. It is estimated that the site has approximately 27 mcy of remaining capacity. As noted in Table 2-35, the total projected dredging need of the Chesapeake Bay Approach Channels (MD) for the 21-year planning period is estimated at 43 mcy.

As such, continued maintenance dredging of the Chesapeake Bay Approach Channels (MD) without other placement alternatives will result in a 16-mcy capacity shortfall for the 21-year planning period.

- Chesapeake Bay Approach Channels (VA)
  - Rappahannock Shoal Deep Alternate Open Water Site

    The Rappahannock Shoal Deep Alternate site is located approximately 1 mile west of the Rappahannock Shoal Channel in the Virginia waters of the Bay as shown in Figure 3-3. The site has an area of approximately 3,100 acres and has been used for the placement of material from the periodic maintenance dredging of the Rappahannock Shoal Channel. It is estimated that the site has sufficient capacity for the dredged material that is projected (see Table 2-35) to be removed from the Rappahannock Shoal Channel during the 21-year planning period.

  - Wolf Trap Alternate Open Water Site

    The Wolf Trap Alternate site is located in the Virginia waters of the Bay near Mathews County, Virginia as shown in Figure 3-3. The site has an area of approximately 4,400 acres and is currently used for the placement of material from the periodic maintenance dredging of the York Spit Channel. It is estimated that the site has sufficient capacity for the dredged material that is projected (see Table 2-35) to be removed from the York Spit Channel during the 21-year planning period.

  - Norfolk Ocean Open Water Site

    The Norfolk Ocean Open Water Site is located in the Atlantic Ocean, approximately 15 miles southeast of Cape Charles, VA, as shown in Figure 3-3. At nearly 42,000 acres in size, it has sufficient capacity for the projected quantity (see Table 2-35) of dredged material to be removed from the Virginia channels during the 21-year planning period.

  - Dam Neck Ocean Open Water Site

The Dam Neck Ocean Open Water Site is a 1,600-acre site located in the Atlantic Ocean, approximately 3 miles off the coastline of Virginia Beach, VA, as shown in Figure 3-3. Currently, only suitable dredged material from the Cape Henry Channel is allowed to be placed at the Dam Neck site. The site has sufficient capacity for the projected quantity (see Table 2-35) of dredged material to be removed from the Cape Henry Channel during the 21-year planning period.

Although the Dam Neck and Norfolk Ocean Sites, Wolf Trap Alternate and Rappahannock Deep Alternate Placement Sites have adequate capacity for the Chesapeake Bay Approach Channels (VA) for the next 21 years, the most recent Maryland State and CENAB data suggest that there will be a capacity shortfall for the C&D Canal Approach Channels, Harbor Channels, and the Chesapeake Bay Approach Channels (MD) within the next 10 years.

3.2 DREDGED MATERIAL PLACEMENT ALTERNATIVES CONSIDERED

This section presents a description of the alternatives that have been developed for evaluation in the DMMP. A general description of the alternative is first presented, followed by the specific components that apply to each of the applicable channel approaches. The alternatives are presented first for the existing sites, then expansion of existing sites, then new sites, and finally innovative uses of dredged material. The existing sites represent currently permitted and active open water placement sites. Expansion of existing sites includes currently operating open water, containment facilities, and island restoration sites. New sites include a number of new open water, containment, and restoration sites. Innovative use alternatives include agricultural placement and wetlands restoration, and the reuse of dredged material that has been placed in containment facilities for construction materials, capping, and mine reclamation.

The dredged material placement alternatives considered here include all options that are legally implementable from a federal perspective. All placement alternatives have been developed under an assumption that suitable dredged material would be used for a given alternative type and location. Suitable material is defined as having physical and chemical characteristics compatible with the placement location and compliant with all applicable federal regulations. Numerous alternatives are considered illegal or have constraints placed upon their use by Maryland State Law (Senate Bill 830), which was passed in 2001. The constraints include a prohibition on open water placement of dredged material in the open waters of the Chesapeake Bay, except continued use of open water placement at Pooles Island up to 7.4 mcy or until 31 December 2010. Other dredged material placement prohibitions include placing dredged material from Baltimore Harbor in an unconfined manner in the Bay or its tributaries, the prohibition of raising the dikes at HMI or laterally expanding HMI, and the prohibition of placing dredged material in the Bay or its tributaries within 5 miles of the Hart-Miller-Pleasure Island chain in Baltimore County. In addition, new dredged material containment facilities or other water-dependent facilities need to comply with Maryland's Critical Area law.

The descriptions of the alternatives include technical assumptions regarding the size, configuration, material requirements, in-place volume, and other parameters used to estimate quantities for cost estimating and site capacity determinations. As previously discussed, the DMMP evaluates the alternatives on a programmatic level. Therefore, the assumptions presented do not represent a specific site, but a programmatic site with a general location. Selection of specific sites, configurations, and other design parameters would be determined for selected alternatives as part of follow-on detailed studies (e.g., Feasibility Studies) and tiering under NEPA.

Table 3-1 lists the alternatives presented in this section and the approach channels that are applicable to each. Figures 3-1, 3-2, and 3-3 represent the geographical regions of the Upper Bay, Middle Bay and Lower Bay, respectively. Appendix B provides design data for the various alternatives.

3.2.1 Existing Sites

3.2.1.1 Open Water Placement

Open water placement is the discharge of dredged material in oceans, rivers, lakes, or estuaries by means of a pipeline or release from a hopper dredge or barge. The discharged material settles through the water column and deposits on the bottom of the placement site. Dredged material may be placed in an open water placement site hydraulically or mechanically. The most common open water placement methods are illustrated in Figure 3-4. Hydraulically dredged material is discharged through a pipeline a short distance from the intake pipe or transported to the placement site and deposited from a hopper. Mechanically dredged material is placed in a bottom-dump barge or scow and towed to the placement site for discharge.

Several existing open water placement sites are evaluated for the DMMP. These sites include the Dam Neck Open Water Placement site, Norfolk Ocean Open Water Placement site, Pooles Island Open Water Placement site, Rappahannock Shoal Deep Alternate Open Water Placement site, and Wolf Trap Alternate Open Water Placement site. Technical assumptions used for the estimation of costs and capacity for each site are described in the following sections.

3.2.1.1.1 Dam Neck Ocean Open Water Placement

The Dam Neck Ocean Open Water Placement site is an existing U.S. EPA-designated site located approximately 3 nm east of the Dam Neck/Virginia Beach and 7 nm south of the mouth of the Chesapeake Bay as shown in Figure 3-3. The site serves as the federal standard for the Cape Henry Channel of the Chesapeake Bay Approach Channels (VA).

The Dam Neck Ocean Open Water Placement site is approximately 2.1 nm by 0.9 nm in dimension, with an area of approximately 8 square nm (40 CFR 228.15). The water depth ranges from 30 ft to 50 ft. The remaining capacity as of the March 1998 Site Management and Monitoring Plan for the Dam Neck Ocean Disposal site was estimated at 50 mcy (E. Waring and S. Powell, 2004). Actual capacity may be somewhat greater as a result of consolidation. Therefore, the site possesses sufficient capacity for the projected 9.3 mcy of dredging from the Cape Henry Channel (Table 2-35), and further expansion is not required to meet the 20-year dredging needs of the Chesapeake Bay Approach Channels (VA).

For this alternative, it is assumed material would be dredged from the Chesapeake Bay Approach Channels (VA) with a hopper dredge. Material would be placed within the hopper and transported to the Dam Neck Open Water Placement site, where it would be released through the hopper's split-hull or bottom doors. The transport distance from the midpoint of the Chesapeake Bay Approach Channels (VA) to the placement site is 39 nm.

3.2.1.1.2 Norfolk Ocean Open Water Placement Site

The Norfolk Ocean Open Water Placement site is an existing site located in the Atlantic Ocean, approximately 17 miles off the Virginia coastline as shown in Figure 3-3. The site is available for use as a placement site for the Chesapeake Bay Approach Channels (VA). Because of the large capacity of this placement site, this alternative could also be considered for use for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).

The Norfolk Ocean Open Water Placement site is circular in shape, with a radius of approximately 4 nm and an area of approximately 41,500 acres. The water depth ranges from 43 to 85 ft (MPA, n.d.) with varying grade elevations of the bottom. The remaining in-place volume of the site in 1990 was estimated at 1.34 bcy, as cited in the *Port of Baltimore Dredged Material Management Master Plan* (MPA, 1990). Although approximately 1 mcy has been placed at the site annually since 1990, it is assumed that the site possesses sufficient capacity with a minimum allowable water depth of -65 ft MLLW. This alternative is capable of meeting the dredging needs for the Chesapeake Bay Approach Channels (VA), as well as the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) over the 20-year period.

For this alternative, it is assumed material would be dredged from the C&D Canal Approach, Chesapeake Bay Approach (MD), or Chesapeake Bay Approach Channels (VA) with a hopper dredge. Material would be placed within a barge or hopper and transported to the Norfolk Ocean Open Water Placement site, where it would be released from the barge or hopper dredge. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 163 nm; Chesapeake Bay Approach Channels (MD), 153 nm; and Chesapeake Bay Approach Channels (VA), 39 nm.

Placement of dredged material is restricted to clean sediments. Use of this site is subject to the approval by U.S. EPA under the authority of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended (CENAB, 1981).

3.2.1.1.3 Pooles Island Open Water Site

The Pooles Island Open Water Site refers to a group of existing open water placement sites located near Pooles Island. Specifically, the open water placement sites are located on the northwest side of the Upper Chesapeake Bay at the mouth of the Gunpowder and Bush Rivers in Harford County, Maryland as shown in Figure 3-1. The site is in the Upper Bay region and serves as the federal standard for the C&D Canal Approach Channels.

The placement sites associated with Pooles Island are Areas G-North, G-East, G-West, G-Central, G-South, and Site 92, as shown in Figure 3-5 as well as sites D, E, F, and H to the north of Pooles Island (Halka and Pangeotou, 1992). It is uncertain, however, whether any of these sites could be approved for use. According to the information from the Maryland

Geological Survey, only Site 92, G-East, and G-West can accept more material. It is estimated that Site 92 can accept an additional 4.7 mcy prior to closure. Although Areas G-East and G-West can accept more material, neither are considered to have available capacity due to current Maryland state law.

For this alternative, it is assumed material would be dredged from the center of the C&D Canal Approach Channels—Lower Approach with a clamshell dredge. Material would be placed into dump scows and transported to the Pooles Island Open Water Placement site. Transport distance from the center of the C&D Canal Approach Channels—Lower Approach to the placement site is 4 nm.

3.2.1.1.4 Rappahannock Shoal Deep Alternate Open Water Site

The Rappahannock Shoal Deep Alternate Open Water Placement site is an existing site located approximately 1 mile west of the Rappahannock Shoal Channel, as shown in Figure 3-3. The site is in the Lower Bay region and serves as the federal standard for the Rappahannock Shoal Channel of the Chesapeake Bay Approach Channels (VA).

The Rappahannock Shoal Deep Alternate Open Water Placement site is approximately 4.5 nm by 0.8 nm in dimension and has an area of 3,100 acres. The average water depth is 39 ft. The remaining capacity of the site is estimated to be sufficient for material from the Rappahannock Shoal Channel. No additional dredged material has been placed at the site since 1989.

For this alternative, it is assumed material would be hydraulically dredged from the Chesapeake Bay Approach Channels (VA) with a hopper dredge. Material would be transported to the Rappahannock Shoal Deep Alternate Open Water Placement site, where it would be released from the hopper. Transport distance from the respective channels to the placement site is 25 nm.

3.2.1.1.5 Wolf Trap Alternate Open Water Site

The Wolf Trap Alternate Open Water Placement site is an existing site located in the Virginia waters of the Chesapeake Bay, east of Mathews County, VA as shown in Figure 3-3. The site is in the Lower Bay region and serves as the federal standard for the York Spit Channel of the Chesapeake Bay Approach Channels (VA).

The Wolf Trap Alternate Open Water Placement is approximately 3.0 nm by 1.0 nm in dimension with an area of 2,500 acres. The average water depth is 39 ft. The remaining in-place volume of the site is 33 mcy, as calculated by subtracting the allowable water depth of 9 m (Anderson, 2004) from the average water depth and multiplying by the area. The site possesses sufficient capacity and further expansion is not required. It is assumed that this alternative is capable of meeting the 20-year dredging needs of York Spit Channel and, with the Commonwealth of Virginia's approval, a portion of the C&D Canal Approach Channels and the Chesapeake Bay Approach Channels (MD).

For this alternative, it is assumed material would be dredged from the York Spit Channel with a hopper dredge and the C&D Canal Approach, or Chesapeake Bay Approach (MD) Channels with a clamshell dredge. The dredged material would be transported to the Wolf Trap Alternate Open Water Placement site, where it would be released from the hopper or the scow. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 148 nm; Chesapeake Bay Approach Channels (MD), 135 nm; and Chesapeake Bay Approach Channels, (VA) 34 nm.

3.2.2 New Sites or Expanded Existing Sites

3.2.2.1 Artificial Island Creation (AIC)

An artificial island is created or formed by the placement of dredged material within a constructed perimeter dike in a location where an island did not previously exist. In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the AIC site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells are placed at a low elevation that would allow tidal inundation. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike (minus any designed freeboard).

AIC is evaluated as an alternative for the Lower Bay and Upper Bay regions of the DMMP, and each consists of 50% uplands and 50% wetlands. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

Lower Bay

The representative area for AIC within the Lower Bay region is north of Watts Island, Virginia and to the east/leeward side of Tangier Island, Virginia, as shown in Figure 3-3. The site is considered a placement alternative for the Chesapeake Bay Approach Channels (VA).

The proposed AIC site is rectangular in shape, with dimensions of approximately 8,000 ft by 5,500 ft and an area of 1,000 acres. The average water depth is 6 ft. The island would be divided into 50% upland and 50% wetland. Design assumptions for the Lower Bay AIC alternative are based on Alignment 1 (see Figure 3-6) of the *James Island Habitat Restoration Project, Dredging and Site Engineering Reconnaissance Study* (GBA, 2003) Development. Alignment 1 of the James Island project has a dog-leg shape and an exterior dike length measuring 32,100 linear feet (lf). The James Island Alignment 1 exterior dike length is used for this estimate to account for an irregular shape to accommodate available material, currents, channel locations, and habitat creation.

The exterior dike has a length of 32,000 lf and is set at an elevation of +20 ft MLLW (crest width of 20 ft and slope of 3:1). Final grade elevation would be determined during the design development phase. The in-place volume of the exterior dike is approximately 3.0 mcy. To better facilitate dewatering of the dredged material, the site is divided into six smaller interior cells. The interior dike for the wetland portion is +2 ft MLLW in height (crest width 10 ft and slope of 2:1) and has a length of 8,000 lf. For the upland cells, the interior dike is +14 ft MLLW in height (last lift overtops dike) with a crest width of 10 ft and 2:1 slope. The upland dike length is also 8,000 lf. The dike separating the upland and wetland areas has the same dimensions as the exterior dike and a length of 5,500 lf. The total interior dike volume is 0.9 mcy. The in-place volume of the site is 24.2 mcy and includes the 3.8 mcy required for dike construction. It is assumed that the interior/exterior dike construction utilizes existing material from inside the footprint of the facility. The site capacity is equal to the cut volume (amount removed during dredging) of dredged material divided by a consolidation factor of 0.7, or 34.6 mcy. This consolidation factor accounts for the reduction of dredged material volume as it dewaters and consolidates after placement, resulting in additional capacity.

For this alternative, it is assumed material would be dredged from the Chesapeake Bay Channels (VA) with a hopper or clamshell dredge. Material would be transported to the site by hopper dredge or barge and pumped directly to the placement location. Transport distance from the center of the respective channel to the placement site is 37 nm.

Upper Bay

The representative area for AIC within the Upper Bay Region is west of Tolchester Channel (Gales Lump Reef) as shown in Figure 3-1. The site is considered as a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

The proposed AIC site is rectangular in shape with dimensions of approximately 8,000 ft by 5,500 ft and an area of 1,000 acres. The average water depth is 12 ft. The island would be divided into 50% upland and 50% wetland. Similar to the design for the Lower Bay region, the design assumptions for the Upper Bay AIC alternative are based on Alignment 1 of the James Island Habitat Development. Alignment 1 of the James Island project has a dog-leg shape and an exterior dike length measuring 32,100 lf. The James Island Alignment 1 exterior dike length is used for this estimate to account for an irregular shape to accommodate available material, currents, channel locations, and habitat creation (MES et al., 2002).

The exterior dike is 32,000 lf and is set at an elevation of +20 ft MLLW (crest width of 20 ft and slope of 3:1). The in-place volume of the exterior dike is approximately 4.4 mcy. To better facilitate dewatering of the dredged material, the 1,000-acre site is divided into six smaller interior cells. The total length of the interior dike perimeter is 21,500 lf. The interior dike for the wetland portion is +2 ft MLLW in height (crest width 10 ft and slope of 2:1) and has a length of 8,000 lf. For the upland portion, the interior dike is +16 ft MLLW in height (last lift overtops dike) with a crest width of 15 ft and 2.5:1 slope. The upland dike length is also 8,000 lf. The dike separating the upland and wetland areas has the same dimensions as the exterior dike and a length of 5,500 lf. The total interior dike volume is 1.6 mcy. The in-place volume of the site is 33.9 mcy, which includes the 6.0 mcy required for dike construction. It is assumed that the interior/exterior dike construction utilizes existing material from inside the footprint of the facility. The site capacity is equal to the cut volume (amount removed during dredging) of dredged material divided by a consolidation factor of 0.7, or 48.4 mcy. This consolidation factor accounts for the reduction of dredged material volume as it dewaters and consolidates after placement, resulting in additional capacity.

For this alternative, it is assumed suitable material would be dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a scow and transported to the site where it would be pumped from the scow using a hydraulic unloader. Transport distances from the respective channels to the placement site are as follows: Harbor Channels, 13 nm; C&D Canal Approach Channels, 4.4 nm; and Chesapeake Bay Approach Channels (MD), 6 nm.

3.2.2.2 Beach Nourishment

Beach nourishment is described as the placement of large quantities of beach-quality sand to widen an existing beach. Generally, beach nourishment projects are carried out along a beach where a moderate and persistent erosional trend exists. Material from new work or maintenance dredging projects may be used for beach nourishment if the material characteristics closely match the sediment composition of the beach material. Dredged material used in beach nourishment projects may be dredged and placed by either mechanical or hydraulic means.

The proposed beach nourishment sites include public beaches in Virginia Beach, VA; Willoughby Spit/Ocean View, VA; and Buckroe Beach, VA, as shown in Figure 3-3. The sites are in the Lower Bay region and are considered a placement alternative for the Chesapeake Bay Approach Channels (VA), namely the Cape Henry Channel, for which the sediment characteristics closely match the beach material.

In order to estimate capacity, the volume of material placed on beaches in the vicinity of the proposed beaches for this alternative, Sandbridge Beach, VA (1.5 mcy) and Ocean Park Beach, VA (0.45 mcy), was obtained from published reports. Because published data were not available for the Buckroe Beach, VA, location, the average erosion rate for Rudee Inlet, VA (0.5 mcy/year) was used to determine an estimated volume of material that would be required to mitigate the annual erosion rate. Based on these assumptions, this alternative could generate an in-place volume of 5 mcy over a 21-year period. It is assumed that the material would be placed on approximately 124 acres of each proposed beach in 1-mcy increments. The length of shoreline associated with each beach would be 27,000 ft. Material would be placed on a 1:20 slope from a beach wall out 200 ft into the water. Fill elevations would be determined during the design development phase. It is assumed that two of the beaches would be replenished twice and the other beach once over the 21-year period. The site capacity is equal to the cut volume (amount removed during dredging) of dredged material divided by a consolidation factor of 0.9, or 5.6 mcy. This consolidation factor accounts for the reduction of dredged material volume as it dewaters and consolidates after placement, resulting in additional capacity.

For this alternative, it is assumed material would be dredged from the Chesapeake Bay Approach Channels (VA) – Cape Henry Channel by a hopper dredge with pumpout capabilities and that material consistency is suitable. The hopper dredge would travel to an offshore location close to the beach nourishment site and would be moored to a buoy. Material would be pumped from the dredge through 8,000 to 10,000 ft of pipeline onto the beach, using a minimum of one booster pump as required. Transport distance from the center of the respective channel to the placement site is 12 nm.

3.2.2.3 Capping

Subaqueous capping is the controlled, accurate placement of suitable dredged material over contaminated sediments at the bottom of a water body. Suitable dredged material can be used to cover either existing contaminated sediments or previously placed contaminated dredged material. Typically, contaminated material is placed in a mounded configuration and covered with a mound of clean material, perhaps 3 ft or more in thickness. The cap prevents the migration of contaminated material and isolates it from benthic organisms. Conventional dredging equipment and techniques are frequently used for a subaqueous capping project, but these practices must be controlled more precisely than for conventional open water placement. Previous studies have shown that both fine-grained and sandy material can be effective subaqueous materials; however, the physical characteristics of the subaqueous capping sediment should be compatible with the contaminated sediment and of sufficient grain size to remain in place.

Subaqueous capping is evaluated as an alternative for the Lower Bay and Upper Bay regions of the DMMP. The alternative involves the use of clean dredged sediments as a subaqueous cap over contaminated sediments. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

Lower Bay

The representative area for subaqueous capping is a contaminated site within the Lower Bay region in the Elizabeth River, Virginia, as shown in Figure 3-3. The site is considered a placement alternative for the Chesapeake Bay Approach Channels (VA).

The Elizabeth River subaqueous capping site is approximately 20 acres in size. It is assumed that 3 ft (2 ft of dredged material and 1 ft of sand) would be spread over 20 acres of contaminated sediments; however, specific application areas may be limited. The in-place capacity of the site is 97,000 cy. It is assumed that the granular material would be transported from the Cape Henry Channel and is included in the site capacity. Because the material is placed as a subaqueous cap, it is assumed the material would exhibit minimal consolidation. There may also be minor losses due to erosion. Therefore the site capacity (cut volume) is approximately equal to or slightly greater than the in-place volume.

For this alternative, it is assumed material would be mechanically dredged from the Chesapeake Bay Approach Channels (VA) with a clamshell dredge. Material would be placed within a dump scow and transported to the southern branch of the Elizabeth River subaqueous capping site. Although the known sites of contaminated sediment are in waters too shallow for barge access, this alternative assumes there are locations outside of the federal channel deep enough for barge placement. Otherwise, the dredged material would have to be pumped from the barge. Transport distance from the respective channel to the placement site is 29 nm.

Upper Bay

The representative area for subaqueous capping is a contaminated site within the Upper Bay region in the Patapsco River, Maryland, as shown in Figure 3-1. The site is considered a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).

The Patapsco River subaqueous capping site is approximately 250 acres in size. It is assumed that 4 ft (2 ft of dredged material and 2 ft of sand) of dredged material would be spread over 250 acres of existing harbor sediments that would not be dredged. This would raise the existing bottom by 4 ft and provide a capacity of 0.81 mcy. It is assumed that the granular material would be transported from a sand borrow source near Sparrows Point and is not included in the site capacity for dredged material. Because the material is placed as a subaqueous cap, it is assumed the material would exhibit minimal consolidation. There may also be minor losses due to erosion. Therefore the site capacity (cut volume) is approximately equal to or slightly greater than the in-place volume.

For this alternative, it is assumed that clean material necessary to provide the intended containment for contaminated sediment in the harbor would be mechanically dredged from the C&D Canal Approach Channels-Lower Approach or the Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a dump scow and transported to the Patapsco River subaqueous capping site. The scow would be accurately positioned before placement of the material. The dredged material would then be released from the hull of the scow. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels-Lower Approach, 16 nm; Chesapeake Bay Approach Channels (MD), 8 nm.

3.2.2.4 Confined Aquatic Disposal (CAD)

Confined aquatic disposal (CAD) is a process where dredged material is disposed of at the bottom of a body of water, within a natural depression, a depression constructed specifically for the placement, or within a depression created during sand mining. The difference between CAD and open water placement is that the deposited material is confined to the designated area, preventing lateral or vertical movement. Typical configurations for facilities for contaminated sediments, shown in Figure 3-7, would include both. As shown in Figure 3-7, the CAD would be constructed within an existing depression if available or by constructing subsurface lateral containment dikes (using clean material) to form the containment cells. Once the dredged material is placed within the CAD facility, the material would be capped with a layer of suitable clean sediment. The capacity of a CAD facility depends on the quantity of the dredged material, the volume of the depression or the constructed facility, and the availability of suitable locations to site the facility.

Costs associated with CAD facilities vary widely depending on many parameters, including the physical and chemical characteristics of the dredged material to be deposited, the type of CAD facility construction, and distance between the dredging location and the CAD facility. Because CAD does not involve land transport, it is a cost-effective alternative compared to upland placement alternatives. Furthermore, dewatering is not required, which reduces costs compared to land-based alternatives.

The proposed CAD site for the DMMP is near Sollers Point in the Patapsco River, MD, as shown in Figure 3-1. The site is in the Upper Bay region and is considered a placement alternative for the Harbor Channels, namely the Patapsco River.

The CAD site near Sollers Point is 100 acres in size. The average water depth is approximately 16 ft. Dredged material would be placed into a 25-ft-deep pit after sand mining operations in the Patapsco River. The CAD would be covered with a 4-ft cap consisting of 2 ft of clean dredged material and 2 ft of sand. The average grade would be determined during the design development phase. The in-place volume of the site is 3.7 mcy. It is assumed that the granular material (sand) would be transported from a sand borrow source and is not included in the site capacity. Because this alternative is placed below the water level, it is assumed the material would exhibit minimal consolidation. There may also be minor losses due to erosion. Therefore, the site capacity (cut volume) is approximately equal to or slightly greater than the in-place volume.

For this alternative, it is assumed material would be dredged from the Harbor Channels by a clamshell dredge and placed in a scow. Based on dispersion model data, the scow would be accurately positioned over the CAD site before the dredged material was released from the scow. Transport distance from the center of the respective channels to the placement site is 1 nm.

3.2.2.5 Confined Disposal Facility (CDF)

A CDF is an engineered structure for the containment of dredged material. CDFs are bound by confinement dikes or structures to enclose the placement area, thereby isolating the dredged material from its surrounding environment. The three types of CDFs examined for the DMMP are upland, nearshore, and island as shown in Figure 3-8. An upland CDF consists of a fully diked facility located above the water line and out of wetland areas. A nearshore CDF has at least one or more sides adjacent to the shoreline. Island CDFs are completely surrounded by water.

CDFs may be used for coarse and fine-grained material. The material is placed into the CDF either hydraulically or mechanically. Placing the material directly into the CDF from the dredging site through pipelines is the most economical method. If the dredging site is upland or at an excessive distance from the CDF, material may be transferred to the CDF via barge or truck and then placed into the facility. In any case, the dredged material consists of a certain percentage of slurry when it is pumped into the facility. Depending on the placement method, slurry material initially deposited in the CDF may occupy several times its original volume because of water content. Design of the CDF must account for this additional volume during the drying phase. Following placement, the dredged material is allowed to consolidate, settle, and dewater. Dewatering is through evaporation, or percolation through the dike walls or into the ground. CDFs that use weirs to enable surface water to exit the facility must be designed with sufficient retention times to ensure adequate sediment settling occurs. Effective crust management techniques can be used to improve dewatering and thereby maximize placement capacity. Crust management techniques include the use of pontoon excavators and low ground pressure equipment (depending on the stage of dewatering involved) to create a preferential drainage channel to allow the water to drain more quickly (Wikar, 2000).

Dredged material placement within a CDF has several benefits. CDFs can prevent or substantially reduce the amount of sediment material re-entering the environment when properly designed, operated, and maintained. CDFs can provide a permanent storage location for dredged material and would naturally vegetate when left undisturbed. Finally, CDFs can be used as processing and/or blending areas for beneficial use activities.

The size, design, and cost of a CDF are site-specific. Factors include location; physical nature of sediments to be placed (e.g., grain size, organic content, etc.); physical nature of project footprint; chemical nature of sediments (contaminated versus clean); volume of sediments to be stored; pumping/transport distance placement method; and the design life of the facility. Additional costs are incurred through the operation and maintenance (O&M) of the CDF.

Six CDF alternatives are evaluated in the DMMP, including the construction of new CDFs along the Patapsco River and the expansion of an existing C&D Canal Upland Site (Pearce Creek), Craney Island, Cox Creek, and HMI. Design assumptions for each site are described in the following sections.

3.2.2.5.1 New Confined Disposal Facility

Construction of a new CDF along the Patapsco River in Maryland, as shown in Figure 3-1, is considered a placement alternative for the Harbor Channels.

Our assumption is that the proposed CDF would not be an environmental restoration component; however, this could be added during later stages of the planning process. The site is approximately square in shape, with dimensions of approximately 2,100 ft by 2,100 ft and an area of 100 acres. The average water depth, or potential fill depth, is -12 MLLW. The CDF is contained by a single exterior dike that is 8,400 ft in length. The exterior dike has a crest width of 15 ft and is set at an elevation of +10 ft MLLW. Side slopes are 3H:1V. The in-place volume of the exterior dike is approximately 0.6 mcy. The interior dike is constructed to an elevation of +8 ft MLLW and has a total length of 4,200 ft. The crest width is 15 ft with side slopes of 2H:1V. The in-place volume of the interior dike is 0.2 mcy. The in-place volume of 2.5 mcy is equal to the total airspace volume of the site (3.23 mcy) minus the 0.8 mcy required for interior/exterior dike construction. The site capacity is equal to the cut volume (amount removed during dredging) of dredged material divided by a consolidation factor of 0.7, or 3.6 mcy. This consolidation factor accounts for the reduction of dredged material volume as it dewaters and consolidates after placement, resulting in additional capacity. The exterior dike would be constructed using clean local borrow material, while the internal dike could use material from within the bottom of the cell.

For this alternative, it is assumed material would be mechanically dredged from the Harbor Channels using a clamshell dredge and placed into a barge. The barge would be transported to the site where the dredged material would be pumped directly into the CDF using a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 2 nm.

3.2.2.5.2 Lower Bay (Craney Island West Berm Extension)

Craney Island is an existing 2,500-acre CDF located along the James River in Virginia, as shown in Figure 3-3. The site is in the Lower Bay region and is considered a placement alternative for the Chesapeake Bay Approach Channels (VA); however, these channels are outside of the legally authorized area that can use Craney Island for dredged material placement. Existing legislation would have to be changed to allow material from outside the vicinity of Norfolk.

This alternative consists of a vertical expansion of the existing Craney Island facility. The existing dikes would be raised 8 ft to generate an additional 190.4 mcy of capacity for dredged material in the Norfolk area; however, only the 21-year dredge cut volume for the Chesapeake Bay Approach Channels (VA) of 16 mcy is considered here. The existing berm would be reinforced by expanding the western berm 150 ft to the west. No dredged material would be used in the berm expansion as it would consist of sand and riprap.

For this alternative, it is assumed material would be dredged from the Chesapeake Bay Approach Channels (VA) with a hopper dredge. Material would be placed within the hopper and transported to the Craney Island CDF site, where it would be placed within the CDF directly from the hopper or by a hydraulic unloader, pipeline, and booster. Transport distance from the respective channels to the placement site is 34 nm.

3.2.2.5.3 C&D Canal Upland Sites Expansion (Pearce Creek)

The representative area for CDF expansion among the existing nearshore C&D Canal Upland site is the Pearce Creek CDF as shown in Figure 3-1. The Pearce Creek CDF is located along the Elk River. The site is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

Pearce Creek CDF is 260 acres in size. In order to increase capacity, this alternative proposes the vertical expansion of the exterior dike. The exterior dike is 13,500 ft in length and set at an elevation of 50 ft above grade. The vertical expansion would increase the crest elevation to 60 ft above grade and would be achieved by adding to the interior slope so as not to increase the overall footprint of the existing CDF. The new dimensions of the exterior dike consist of a 20-ft crest width and 3:1 side slopes. Protective armoring would be installed along the 10-ft vertical extension of one side of the dike that is exposed to wave action (approximately 25% of total dike length). The remainder of the vertical extension would be stabilized with vegetation. The proposed vertical expansion of the Pearce Creek CDF would increase the site's in-place volume by 3.1 mcy. The site capacity (cut volume) is equal to the in-place volume divided by 0.7, or 4.4 mcy.

The expanded dike would be constructed from clean local borrow materials. The expansion of the dike vertically without changing the outside toe of slope of the existing dike would require construction of the dike on existing dredged materials. In order to provide adequate foundation support for the dike, further consolidation and strength gain of the dredged material would be required. For this alternative, it is assumed that a high-strength geotextile would first be installed across the footprint of the new dike extension over the dredged materials. The new dike footprint would then be surcharged with a 20-ft-high soil load that would be used to further consolidate and provide strength gain of the underlying dredged materials. After the dredged material has gained sufficient strength, the outer wedge of the surcharge pile would be removed, and the remaining wedge would be the interior dike slope. The time required for sufficient consolidation of the dredged material may be many years. In order to accelerate the consolidation, wick drains may be used with a horizontal drainage layer between the surcharge pile and the dredged materials.

For this alternative, it is assumed material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the Pearce Creek CDF, where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 35 nm; C&D Canal Approach Channels, 18 nm; and Chesapeake Bay Approach Channels (MD), 28 nm.

3.2.2.5.4 Cox Creek Expansion

Cox Creek is an existing 112-acre CDF located along the Patapsco River near the Francis Scott Key Bridge as shown in Figure 3-1. The site is located in the Upper Bay region and is considered a placement alternative for the Harbor Channels.

The Cox Creek CDF comprises a total area of 133 acres with approximately 102 acres available for dredged material placement. In order to increase capacity, this alternative proposes the vertical expansion of the exterior dike. The exterior dike is 8,900 ft in length and set at an elevation of 24 ft above grade. A currently authorized project is to raise the dike to an elevation of 36 ft. For this alternative, vertical expansion would further increase the crest elevation by 10 ft to 46 ft above grade, and would be achieved by adding to the interior slope so as not to increase the overall footprint of the existing CDF. The new dimensions of the exterior dike consist of a 20-ft crest width and 3:1 side slopes. Protective armoring would be installed along the 10-ft vertical extension of one side of the dike (approximately 25% of total dike length). The remainder of the vertical extension would be stabilized with vegetation. The increased capacity due to vertical expansion of the exterior dike is based on placement of dredged material within the CDF to a height 2 ft below the crest elevation. The proposed vertical expansion of the Cox Creek CDF would increase the site's in-place volume by 1.3 mcy. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 1.9 mcy.

The expanded dike would be constructed from clean local borrow materials. The expansion of the dike vertically without changing the outside toe of the existing dike would require construction of the dike on existing dredged materials. In order to provide adequate foundation support for the dike expansion, further consolidation and strength gain of the dredged material would be required. For this cost estimate, it is assumed that a high-strength geotextile would first be installed across the footprint of the new dike extension over the dredged materials. The new dike footprint would then be surcharged with a 20-ft-high soil load that would be used to further consolidate and provide strength gain of the underlying dredged materials. After the dredged material has gained sufficient strength, the outer wedge of the surcharge pile would be removed, and the remaining wedge would be the interior dike slope. The time for sufficient consolidation of the dredged material may be many years. In order to accelerate the consolidation, wick drains may be used with a horizontal drainage layer between the surcharge pile and the dredged materials.

For this alternative, it is assumed material would be dredged from the Harbor Channels with a clamshell dredge. Material would be placed with a barge and transported to the Cox Creek CDF, where it would be pumped into the site using a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 1 nm.

3.2.2.5.5 HMI Expansion

HMI is an existing island CDF located east of Back River Neck in Baltimore County, Maryland, as shown in Figure 3-1. The site is located in the Upper Bay and is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD). HMI is divided into an 800-acre north and a 360-acre south cell. The average water depth surrounding the CDF is 10 ft, as determined from NOAA charts for the HMI vicinity. No grade change is assumed for this alternative.

This alternative consists of the vertical and horizontal expansion of the exterior dike to increase capacity. The portion of the exterior dike (south cell) to be vertically expanded is 16,000 ft in length and has an elevation of +18 ft MLLW. The vertical expansion would increase the crest elevation 10 ft to +28 ft MLLW (15-ft crest width, 3:1 side slope). The additional placement capacity created by the vertical dike expansion is 2.5 mcy. The horizontal expansion of the site includes a 300-acre lateral expansion to the south. The new exterior dike is 12,000 ft in length and would have an elevation of +18 ft MLLW (15-ft crest width, 3:1 side slope). The horizontal expansion has an in-place dike volume of 1.2 mcy and would be constructed from clean local borrow material. The additional capacity from the combined vertical and lateral expansion of the HMI DMCF would increase the site's in-place volume by 17.5 mcy. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 25.0 mcy.

For this alternative, it is assumed material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the HMI DMCF, where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 11 nm; C&D Canal Approach Channels, 6 nm; and Chesapeake Bay Approach Channels (MD), 9 nm.

3.2.2.6 Large Island Restoration

Large Island Restoration (LIR) is the restoration of a historic island footprint through the construction of perimeter dikes and the placement of dredged material. For the purposes of this study, LIR refers to the restoration of islands whose historic area is more than 200 acres.

LIR is performed by the placement of dredged material within a constructed perimeter dike in a location where an island has suffered land loss due to erosion, sea-level rise, or subsidence. In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the LIR site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells are placed at a low elevation that would allow tidal inundation. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike (minus any designed freeboard).

LIR is evaluated as an alternative for the Lower Bay and Middle Bay regions of the DMMP, and each island consists of 50% uplands and 50% wetlands. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

Lower Bay

The representative area for LIR within the Lower Bay region is New Point Comfort Island, VA, as shown in Figure 3-3. The site is considered a placement alternative for the Chesapeake Bay Approach Channels (VA).

According to historical surveys, New Point Comfort Island was historically 240 acres in size. CENAO's current proposal for island restoration is 10 to 20 acres; however, for cost estimating purposes and to maximize capacity, the full 240-acre restoration is assumed for this alternative. The proposed LIR site is rectangular in shape, with dimensions of approximately 4,000 ft by 2,600 ft. The average water depth is 4 ft as determined from NOAA maps of the proposed Point Comfort site. The island would be divided into 50% upland and 50% wetland. The configuration of this alternative with regard to upland and wetland areas was based on existing grades as shown on NOAA maps.

The exterior dike has a crest width of 15 ft and is set at an elevation of +11 ft MLLW in the upland portion and +6 ft MLLW in the wetland portion. The exterior dike length is 13,200 ft and has side slopes of 3H:1V. It is assumed that sufficient material to construct the dikes is available within the proposed project area. The in-place volume of the exterior dike is 0.3 mcy. To ensure efficient dewatering for habitat creation and management, the site is divided into six 40-acre interior cells by transverse dikes across the width of the area. The interior dike for the wetland portion is +1 ft MLLW in height (crest width is 10 ft, slope is 2:1). The wetland dike length is 3,300 ft. For the upland cells, the interior dike is +9 ft MLLW in height with a crest width of 10 ft and a 2:1 slope. The upland dike length is also 3,300 ft. The transverse dike separating the upland and wetland areas has the same dimensions as the exterior upland dike and a length of 4,770 ft. The in-place volume of the interior dikes is 0.2 mcy. The capacity of the LIR is based on filling the wetland portion up to +0 ft MLLW and the upland portion to +9 ft MLLW. The in-place volume for the alternative is 2.5 mcy in the upland portion and 0.8 mcy in the wetland portion. The in-place volume includes the 0.5 mcy required for dike construction since it is assumed that the interior/exterior dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 4.7 mcy.

For this alternative, it is assumed material would be mechanically dredged from the Chesapeake Bay Approach Channels (VA) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be pumped through a hydraulic unloader to a location behind the exterior dike. Transport distance from the center of the respective channels to the placement site is 10 nm.

Middle Bay

The representative area for LIR within the Middle Bay region is in Dorchester County, Maryland, as shown in Figure 3-2. The site is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

The proposed LIR site is rectangular in shape, with dimensions of approximately 8,000 ft by 5,500 ft and an area of 1,000 acres. The average water depth is 6 ft as determined from NOAA charts in the proposed Dorchester County area. The island would be divided into 50% upland and 50% wetland. Design assumptions for the Middle Bay LIR alternative are based on Alignment 1 of the James Island Habitat Development. Alignment 1 of the James Island project has a dog-leg shape and an exterior dike length measuring 32,100 lf, as shown in Figure 3-6. The James Island Alignment 1 exterior dike length is used for this estimate to account for an irregular shape to accommodate available material, currents, channel locations, and habitat creation. No grade change was assumed for this alternative (MES et al., 2002).

The exterior dike is 32,000 lf and is set at an elevation of +20 ft MLLW (crest width 20 ft and slope 3:1). The in-place volume of the exterior dike is 3.0 mcy. To better facilitate dewatering of the dredged material, the site is divided into six smaller interior cells. The total length of the interior dike perimeter is 21,500 lf. The interior dike for the wetland portion is +2 ft MLLW in height (crest width 10 ft and slope of 2:1) and has a length of 8,000 ft. For the upland cells, the interior dike is +14 ft MLLW in height (last lift overtops dike) with a crest width of 15 ft and a 2.5:1 slope. The upland dike length is also 8,000 ft. The dike separating the upland and wetland areas has the same dimensions as the exterior and a length of 5,500 ft. The total interior dike volume is 0.9 mcy. The in-place volume of the site is 24.2 mcy, which includes the 3.8 mcy required for dike construction. It is assumed that the interior/exterior dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 34.6 mcy.

For this alternative, it is assumed material would be mechanically dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be offloaded from the scow and pumped through a hydraulic unloader to a location behind the exterior dike. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 60 nm; C&D Canal Approach Channels, 64 nm; and Chesapeake Bay Approach Channels (MD), 50 nm.

3.2.2.7 Pooles Island Open Water Site Expansion

The Pooles Island Open Water Site refers to a group of existing open water placement sites located near Pooles Island in the Upper Bay region as shown in Figure 3-1. Specifically, the open water placement sites are located on the northwest side of Upper Chesapeake Bay at the mouth of the Gunpowder and Bush Rivers in Harford County, Maryland. Expansion of this site is considered a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay

Approach Channels (MD). It should be noted that state (MD Senate Bill 830; Maryland Environmental Code (5), Subtitle 11) law places a restriction on the volume of material that can be placed at remaining Pooles Island sites and prohibits unconfined placement of dredged materials. These restrictions would have to be addressed in expanding Pooles Island.

As described in Section 3.1, all placement sites, with the exception of Site 92, G-West, and G-East associated with Pooles Island, have reached capacity, can no longer retain additional sediments, or have minimal remaining capacity. Therefore, this alternative consists of a 350-acre expansion of the Pooles Island Open Water site between G-West and Site 92. Assuming an 8.5-ft lift to approximately -11 ft MLLW, the expansion would provide an additional site capacity of 5 mcy.

For this alternative, it is assumed material would be dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed into dump scows and transported to the expanded portion of the Pooles Island Open Water Placement site where it would be released from the scow. Transport distances from the center of the respective channels to the placement site are as follows (in nautical miles): C&D Canal Approach Channels, 4 nm; and Chesapeake Bay Approach Channels (MD), 15 nm.

3.2.2.8 PIERP Expansion

Island expansion is the vertical and/or horizontal expansion of an existing island through the placement of dredged material within a constructed perimeter dike. In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the expanded area of the Island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the Island expansion site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells would be placed at a low elevation that would allow tidal inundation. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike (minus any designed freeboard).

PIERP is an existing island restoration project located approximately 34 miles south of Baltimore in Talbot County, MD, as shown in Figure 3-2. Average water depth at the site is 6 ft. The site is located in the Middle Bay region and is considered a placement alternative for the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).

PIERP is currently 1,140 acres in size. In order to provide additional capacity for the DMMP, this alternative proposes raising the existing dikes and a 600-acre lateral expansion to the northeast. The lateral expansion would create additional habitat, consisting of 50% uplands and 50% wetland habitats. An embayment of approximately 80 to 130 acres is included in these wetland habitats. No additional habitat would be created by vertical expansion.

For the vertical expansion, the existing exterior dike is 20,000 ft in length and set at an elevation of +20 ft MLLW. The vertical expansion would increase the crest elevation to +25 ft MLLW (crest width 15 ft and slope 3:1). The in-place volume of the vertically expanded dike is 0.7 mcy. The in-place volume of the site due to vertical expansion is 4.2 mcy, which includes the material required for dike construction. It is assumed that suitable borrow material for dike construction is available on-site. The lateral expansion of PIERP includes the creation of 600 acres to the northeast of the existing site. The new exterior dike would have an elevation of +20 ft MLLW (20-ft crest width and slope 3:1), and an in-place volume of 2.2 mcy. To ensure efficient dewatering for habitat creation and management, the expanded site is divided into four smaller interior cells. The interior dike for the wetland portion is set at an elevation of +0 ft MLLW (crest width 20 ft and slope of 3:1), and has a length of 11,700 ft. For the upland portion, the interior dike is set at an elevation of +15 ft MLLW (crest width 20 ft and slope 3:1), and also has a length of 11,700 ft. The dike separating the upland and wetland areas has the same dimensions as the interior upland dike and a length of 8,700 ft. The total interior dike volume is 3.0 mcy. With fill heights to +15 ft MLLW and +0 ft MLLW in the upland and wetland areas, respectively, the proposed lateral expansion of PIERP would create an increased in-place volume of 12.6 mcy, which includes the material required for dike construction. The site capacity (cut volume) for vertical and lateral expansion of PIERP is equal to the total in-place volume divided by a consolidation factor of 0.7, or 24 mcy.

For this alternative, it is assumed material would be dredged from the C&D Canal Approach Channels or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to PIERP where it would be pumped into the facility by a hydraulic unloader. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 30 nm; Chesapeake Bay Approach Channels (MD), 21 nm.

3.2.2.9 Rappahannock Shoal Deep Alternate Open Water Site Expansion

The Rappahannock Shoal Deep Alternate Open Water Placement site is located approximately 1 mile west of the Rappahannock Shoal Channel as shown in Figure 3-3. The site is in the Lower Bay region and expansion of the site serves as a placement alternative for the C&D Canal Approach and Chesapeake Bay Approach Channels (MD and VA). However, a 1981 agreement between the Virginia Secretary of Commerce and Resources and the Maryland Secretary of Transportation designated this site and the Wolf Trap site for the placement of dredged material "…for that part of Baltimore's 50-foot channel project located in Virginia waters."

As described in Section 3.2.1.1.4, the existing Rappahannock Shoal Deep Alternate Open Water Placement site is approximately 27,000 ft by 5,000 ft in dimension and has an area of 3,100 acres. The average water depth is 39 ft. The remaining site capacity is sufficient for the dredged material from the Rappahannock Shoal Channel. Expansion of the site by 1,000 acres to the northwest would provide an additional 5 mcy of site capacity.

For this alternative, it is assumed material would be mechanically dredged from the C&D Canal Approach or Chesapeake Bay Approach Channels (MD and VA) with a clamshell dredge. Material would be placed in a dump scow and transported to the expanded portion of the Rappahannock Shoal Deep Alternate Open Water Placement site where it would be released from the scow. Transport distances from the center of the respective channels to the placement site are as follows: C&D Canal Approach Channels, 99 nm; Chesapeake Bay Approach Channels (MD), 90 nm; and Chesapeake Bay Approach Channels (VA), 25 nm.

3.2.2.10 Shoreline Restoration

Shoreline erosion is persistent throughout Chesapeake Bay because of wave action, sea-level rise, and/or subsidence. Shoreline restoration is the process of restoring and/or mitigating a shoreline to its original or desired position prior to any natural or man-made disturbance. Clean dredged material may be used in shoreline restoration and can provide environmental and economic benefits. Material placed at a particular site would need to be compatible with existing sediment and site characteristics (e.g., coarse-grained material would be used to restore sandy locations). Shoreline restoration has the potential to create habitat and improve water quality while reducing the loss of valuable waterfront property and protecting sensitive habitats. The material may be placed at the site mechanically from a truck or barge, or it may be transported into the site as a slurry by a hydraulic pipeline.

Shoreline restoration is evaluated as an alternative for the Lower Bay, Middle Bay, and Upper Bay regions of the DMMP. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

Lower Bay

The representative area for shoreline restoration within the Lower Bay region is the Virginia portion of the Delmarva Peninsula in the general vicinity of Cherrystone Inlet as shown in Figure 3-3. The site is considered a placement alternative for the Chesapeake Bay Approach Channels (VA).

The shoreline restoration alternative for the DMMP near Cherrystone Inlet involves the restoration of a peninsula using dredged material. Coarse-grained dredged material that is compatible with existing sediments would be placed behind a newly constructed exterior dike to create low-marsh and high-marsh habitats. The proposed shoreline restoration site is three-sided (two dikes extending perpendicular from the shoreline and one longer dike parallel to the shoreline, thereby restoring the eroded peninsula) with dimensions of 3,200 ft by 1,500 ft. The area is 110 acres. The average water depth is 4 ft, as determined from NOAA charts of the Old Town Neck, VA, vicinity. No grade change was assumed for this alternative.

The exterior dike is 6,200 ft in length and constructed to an elevation of +6 ft MLLW. The crest width is 10 ft and side slopes are 3:1. The volume of the exterior dike is 0.1 mcy. The seaward side of the dike would be armored to provide protection against waves and currents with dredged material filled to an elevation of +0 ft MLLW. Material would be added in two 2-ft lifts. The in-place volume of the site is 0.7 mcy and includes the 0.1 mcy required for dike construction. It is assumed that the dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.9, or 0.8 mcy. Culverts and backwater spillways would be constructed to allow tidal inundation.

For this alternative, it is assumed material would be dredged from the Chesapeake Bay Approach Channels (VA) with a clamshell dredge. Material would be placed within a barge and transported to the shoreline restoration site, where it would be pumped within the dike by a hydraulic unloader. Transport distance from the center of the respective channels to the placement site is 7 nm. It is assumed dredged material would be placed over a 2-year period, and that the material would require 4 years of settlement prior to final grading and establishment of hydraulic controls.

Middle Bay

The representative area for shoreline restoration within the Middle Bay region is northwest Dorchester County, Maryland, as shown in Figure 3-2. The site is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

The shoreline restoration alternative for the DMMP in northwest Dorchester County, Maryland, involves the restoration of a peninsula using dredged material. Dredged material would be placed behind a newly constructed exterior dike to create low-marsh and high-marsh habitats. The proposed shoreline restoration site is three-sided (two dikes extending perpendicular from the shoreline and one longer dike parallel to the shoreline, thereby restoring the eroded peninsula) with dimensions of 5,100 ft by 1,500 ft. The area is 175 acres. The average water depth is 4 ft, as determined from NOAA charts of the Dorchester County vicinity. No grade change was assumed for this alternative.

The exterior dike is 8,100 ft in length and constructed to an elevation of +6 ft MLLW. The crest width is 10 ft and side slopes are 3:1. The volume of the exterior dike is 0.14 mcy. The seaward side of the dike would be armored to provide protection against waves and currents with dredged material filled to an elevation of +0 ft MLLW. Material would be added in two 2-ft lifts. The in-place volume of the site is 1.1 mcy and includes the 0.14 mcy required for dike construction. It is assumed that the dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.9, or 1.2 mcy. Culverts and backwater spillways would be constructed to allow tidal inundation.

For this alternative, it is assumed suitable material would be dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the NW Dorchester County, Maryland shoreline restoration site where it would be placed within the dike by a hydraulic unloader. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 50 nm; C&D Canal Approach Channels, 50 nm; and Chesapeake Bay Approach Channels (MD), 40 nm.

Upper Bay

The representative area for shoreline restoration within the Upper Bay region is west of Rock Hall, Maryland, as shown in Figure 3-1. The site is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

The shoreline restoration alternative for the DMMP west of Rock Hall, MD, involves the restoration of a peninsula using dredged material. Dredged material would be placed behind a newly constructed exterior dike to create low-marsh and high-marsh habitats. The proposed shoreline restoration site is three-sided (two dikes extending perpendicular from the shoreline and one longer dike parallel to the shoreline, thereby restoring the eroded peninsula) with dimensions of 3,200 ft by 1,500 ft. The area is 110 acres. The average water depth is 4 ft, as determined from NOAA maps of the Rock Hall vicinity. No grade change was assumed for this alternative.

The exterior dike is 6,200 ft in length and constructed to an elevation of +6 ft MLLW. The crest width is 10 ft and side slopes are 3:1. The volume of the exterior dike is 0.1 mcy. The seaward side of the dike would be armored to provide protection against waves and currents. With dredged material filled to an elevation of +0 MLLW, material would be added in two 2-ft lifts. The in-place volume of the site is 0.7 mcy, which includes the 1.1 mcy required for dike construction. It is assumed that the interior/exterior dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.9, or 0.8 mcy. Culverts and backwater spillways would be constructed to allow tidal inundation.

For this alternative, it is assumed suitable material would be dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Material would be placed within a barge and transported to the shoreline restoration site west of Rock Hall, MD, where it would be placed within the dike by a hydraulic unloader. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 13 nm; C&D Canal Approach Channels, 6 nm; and Chesapeake Bay Approach Channels (MD), 6 nm.

3.2.2.11 Small Island Restoration

Small Island Restoration (SIR) is the restoration of a historic island footprint through the construction of perimeter dikes and the placement of dredged material. For the purposes of this study, SIR refers to the restoration of an island whose historic area is less than 200 acres.

SIR is performed by the placement of dredged material within a constructed perimeter dike in a location where an island has experienced land loss because of erosion, sea-level rise, or subsidence. In most cases, the dike encloses the placement area and isolates the dredged material from the surrounding environment. The perimeter dike is constructed of sand and requires heavy, protective armoring on the seaward side to prevent erosion from waves and currents. Interior dikes are constructed to separate the island into several smaller cells. The smaller cells enhance the overall management and dewatering of the dredged material, and allow the creation of distinct upland and wetland habitats.

Dredged material would be transported to the SIR site by scow, pumped through a hydraulic unloader, and deposited behind the perimeter dike. Material pumped into designated wetland cells are placed at a low elevation that would allow tidal inundation. In upland cells, dredged material may be filled to an elevation close to that of the perimeter dike (minus any designed freeboard).

SIR is evaluated as an alternative for the Lower Bay and Middle Bay regions of the DMMP, and each consists of 50% uplands and 50% wetlands. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

Lower Bay

The representative area for SIR within the Lower Bay region is at the mouth of Mobjack Bay, Virginia, as shown in Figure 3-3. The site is considered a placement alternative for the Chesapeake Bay Approach Channels (VA).

The proposed 100-acre SIR site is square in shape and has dimensions of approximately 2,090 ft by 2,090 ft. The exterior dike length is 8,350 ft. The average water depth is 6 ft, as determined from NOAA maps of the proposed Mobjack Bay site. The island would be divided into 50% upland and 50% wetland. The configuration of this alternative with regard to upland and wetland areas was based on existing grades as shown on NOAA charts.

The exterior dike has a crest width of 20 ft and is set at an elevation of +10 ft MLLW. Side slopes are 3H:1V. The exterior dike length is 8,350 ft and has an in-place volume of 0.3 mcy. To ensure efficient dewatering for habitat creation and management, the site is divided into four smaller interior cells. The interior dike for the wetland portion is +0 ft MLLW in height (crest width 10 ft and slope of 2:1) and has a length of 1,043 ft. For the upland portion, the interior dike is +8 ft MLLW in height (crest width of 15 ft and 2:1 slope) and has a length of 1,043 ft. The dike separating the upland and wetland areas is set at an elevation of +10 ft MLLW (crest width 25 ft and slope 2:1) and has a length of 2,950 ft. The total in-place volume of the interior dikes is 0.1 mcy. The capacity of the SIR is based on filling the wetland portion up to +0 ft MLLW and the upland portion to +8 ft MLLW. The in-place volume for this alternative is 1.6 mcy and includes the 0.4 mcy required for dike construction. Since it is assumed that the interior/exterior dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 2.3 mcy.

For this alternative, it is assumed material would be mechanically dredged from the Chesapeake Bay Channels (VA) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be offloaded from the scow and pumped through a hydraulic unloader to a location behind the exterior dike. Transport distance from the center of the respective channels to the placement site is 13 nm.

Middle Bay

The representative area for SIR within the Middle Bay region is Parsons Island, Maryland, as shown in Figure 3-2. The site is considered as a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

The proposed 100-acre SIR site is square in shape and has dimensions of approximately 2,090 ft by 2,090 ft. The exterior dike length is 8,350 ft. The average water depth is 6 ft, as determined by NOAA charts. The island would be divided into 50% upland and 50% wetland.

The exterior dike has a crest width of 20 ft and is set at an elevation of +10 ft MLLW. Side slopes are 3H:1V. The exterior dike length is 8,350 ft and has an in-place volume of 0.3 mcy. To ensure efficient dewatering for habitat creation and management, the site is divided into four smaller interior cells. The interior dike for the wetland portion is +0 ft MLLW in height (crest width 10 ft and slope of 2:1) and has a length of 1,043 ft. For the upland portion, the interior dike is +8 ft MLLW in height (crest width of 15 ft and 2:1 slope) and has a length of 1,043 ft. The dike separating the upland and wetland areas is set at an elevation of +10 MLLW (crest width 15 ft and side slope 2:1) and a length of 2,950 ft. The total interior dike volume is 0.1 mcy. The capacity of the SIR is based on filling the wetland portion up to MLLW and the upland portion to +8 ft MLLW. The in-place volume of the site is 1.6 mcy and includes the 0.4 mcy required for dike construction. It is assumed that the interior/exterior dike construction utilizes existing material located inside the footprint of the facility. The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7, or 2.3 mcy.

For this alternative, it is assumed suitable material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) with a clamshell dredge. Dredged material would be placed into an adjacent scow and transported to the site. Material would be pumped through a hydraulic unloader to a location behind the exterior dike. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 28 nm; C&D Canal Approach Channels, 23 nm; and Chesapeake Bay Approach Channels (MD), 13 nm.

3.2.3 Innovative Uses

3.2.3.1 Agricultural Placement

Agricultural placement is the application of dredged materials to agricultural (farm) land for the purpose of sediment management and rehabilitation or improvement of the land. Wet placement is a method in which fine-grained dredged sediments are applied directly onto the agricultural land application site to amend excessively drained cropland, thereby improving water retention and crop yield. Wet placement does not require prior dewatering of dredged material before application. Instead, material is dredged and placed in a barge that is towed as close as possible to the agricultural land application site. A temporary dike is constructed around the site and a hydraulic unloader pumps the material into the confined area. Following dewatering and consolidation, the dredged material is tilled into the existing soil.

Agricultural placement is evaluated as a beneficial use alternative for the Lower Bay and Middle Bay regions of the DMMP. Design assumptions associated with this alternative for each region are detailed in the following paragraphs.

Lower Bay Region

The representative area for agricultural placement within the Lower Bay region is in Isle of Wight County, Virginia, as shown in Figure 3-3. The site is considered a placement alternative for the Chesapeake Bay Approach Channels (VA).

The agricultural placement alternative for the DMMP in Isle of Wight County, Virginia, involves application of dredged material across 325 acres of land. The application would consist of two 8-inch lifts across three approximately 100-acre sites over a period of 3 years and allowed to dewater in-place. Application rates assume a 3-week period per lift during dredging operations. Following soil amendment, as necessary, each lift would be tilled prior to the next lift placement.

Temporary erosion and sedimentation (E&S) and stormwater controls are needed until dredged material is tilled into the soil. Controls would include the installation of temporary dikes to divide the site into 10-acre cells. The cross section of the exterior dike includes a 3-ft crest elevation (2-ft freeboard), 1-ft crest width, and 3:1 side slopes. The cross-sectional area is 30 square feet (sf). The exterior dike length required for each 100-acre site is 8,400 ft. The cross section of the interior dike includes a 2.5-ft crest elevation, 1-ft crest width, and 3:1 side slopes. The cross-sectional area is 30 sf. Approximately 8,400 lf of interior dike are required for each 100-acre site. The site capacity created by this alternative is 0.5 mcy (cut volume).

For this alternative, it is assumed material would be mechanically dredged from the Chesapeake Bay Approach Channels (VA) by a clamshell dredge. Dredged material would be placed into an adjacent barge and transported to a moored barge close to the application site. The moored barge would be used to stage the material during the relatively slow agricultural placement operation rather than tying up the transport barges waiting for offloading. The moored barge could be moved into and out of place at high tide, allowing it to be moored in relatively shallow water. Material would be transferred hydraulically from the transport barge into the moored barge. Dredged material would be hydraulically pumped via pipeline from the moored barge onto the agricultural placement site. The length of the pipeline would be adjusted as needed in order to place material evenly within each cell. Transport distance from the center of the respective channels to the placement site is 38 nm.

Middle Bay

The representative area for agricultural placement within the Middle Bay region is near Dorchester County/Wicomico Counties, Maryland, in areas with significant excessively drained soils as shown in Figure 3-2. The site is considered a placement alternative for the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD).

The agricultural placement alternative for the DMMP is in Dorchester County/Wicomico Counties, Maryland, and involves the application of dredged material across 325 acres of land. The application would consist of two 8-inch lifts across three approximately 100-acre sites over a period of 3 years and allowed to dewater in place. Application rates assume a 3-week period per lift during dredging operations. Following soil amendment, as necessary, each lift would be tilled prior to the next lift placement.

Temporary E&S and stormwater controls are needed until dredged material is tilled into the soil. Controls would include the installation of temporary dikes to divide the site into 10-acre cells. The cross section of the exterior dike includes a 3-ft crest elevation (2-ft freeboard), 1-ft crest width, and 3:1 side slopes. The cross-sectional area is 30 sf. The exterior dike length required for each 100-acre site is 8,400 ft. The cross section of the interior dike includes a 2.5-ft crest elevation, 1-ft crest width, and 3:1 side slopes. The cross-sectional area is 30 sf. Approximately 8,400 lf of interior dike is required for each 100-acre site. The site capacity created by this alternative is 0.5 mcy (cut volume).

For this alternative, it is assumed suitable material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) by a clamshell dredge. Dredged material would be placed into an adjacent barge and transported to a moored barge close to the application site. The moored barge would be used to stage the material during the relatively slow agricultural placement operation rather than tying up the transport barges waiting for offloading. The moored barge could be moved into and out of place at high tide, allowing it to be moored in relatively shallow water. Material would be transferred hydraulically from the transport barge into the moored barge. Dredged material would be hydraulically pumped via pipeline from the moored barge onto the agricultural placement site. The length of the pipeline would be adjusted as needed in order to place material evenly within each cell. Transport distances from the center of the respective channels to the placement site are as follows: Harbor Channels, 90 nm; C&D Canal Approach Channels, 90 nm; and Chesapeake Bay Approach Channels (MD), 80 nm.

3.2.3.2 Building Products

Technologies have been developed over the years to use dredged material to manufacture construction products, although full-scale commercial production is not yet available for most products. Depending on the sediment characteristics and processing requirements, dewatered dredged material may be used in the following applications: concrete aggregates (sand or gravel); backfill material or in the production of bituminous mixtures and mortar (sand); raw material for brick manufacturing (clay with less than 30% sand); ceramics, such as tile (clay); pellets for insulation or lightweight backfill or aggregate (clay); and raw material for the production of riprap or blocks for the protection of dikes and slopes against erosion (rock).

Dredged material may also be used as construction fill for site grading and structural fill. Techniques may be used to improve the structural properties of dredged material for use as construction fill, such as amendments to reduce the moisture content and improve the strength of the material. Amendments can include lime, cement, and fly ash. The type, combination, and amount of amendment material depends on the moisture content, the amount of fines (clays and silts), and organic content of the dredged material. Greater amounts of amendment are typically required if the dredged material has a high water clay and/or organic content. The amount and type of amendment would also be dictated by the required physical properties of the finished product.

Beneficial use of dredged material in building products, namely brick production, is evaluated as an alternative for material dredged from the Harbor Channels, C&D Canal Approach Channels, Chesapeake Bay Approach Channels (MD), and Chesapeake Bay Approach Channels (VA). Design assumptions associated with this alternative are detailed in the following paragraphs.

The building product selected for beneficial use is nonstructural brick that can be used in pedestrian walkways and decorative landscaping. This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected maintenance dredging. An existing CDF has been designated for each area channel as follows: Harbor Channels-Cox Creek CDF; C&D Canal Approach Channels-Pearce Creek CDF; Chesapeake Bay Approach Channels (MD)-HMI DMCF; Chesapeake Bay Approach Channels (VA)-Craney Island CDF. (These channels are currently outside of the area permitted to use Craney Island and changes in the restrictions would be required.) It is assumed for the purpose of this cost estimate that material would be transported by truck to an existing facility located within 100 miles of the respective CDF for the manufacture of the brick. It is further assumed that no further treatment of the dewatered dredged material is required. This alternative uses 0.5 mcy (per channel area) of dredged material over a period of 5 years and would produce enough 4-inch-thick brick pavers to cover approximately 466 acres.

For this alternative, dewatered dredged material would be excavated from each channel's respective CDF for use in brick production. The excavated material would provide 0.5 mcy of additional storage at each existing CDF. It is assumed suitable material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, Chesapeake Bay Approach Channels (MD), or Chesapeake Bay Approach Channels (VA) by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped within the CDF by a hydraulic unloader. Transport distances from the center of the respective channels to the existing CDF are as follows: Harbor Channels, 1 nm; C&D Canal Approach Channels, 18 nm; Chesapeake Bay Approach Channels (MD), 10 nm; and Chesapeake Bay Approach Channels (VA), 28 nm.

3.2.3.3 Capping

Capping is a relatively new beneficial use concept and consists of the covering of solid waste landfills or abandoned contaminated industrial sites, known as "brownfields," with large quantities of dewatered dredged material. Dredged material often possesses important cover material characteristics such as workability, moderate cohesion, and low permeability. In addition, all forms of dredged material from silts to gravel make excellent cover, with the exception of peat and highly organic material. Although fine-grained sediments do not have the physical properties needed for a final cap that requires high strength and stability, the material can be amended (i.e., with lime, fly ash, cement, etc.) so that it is a suitable foundation for many types of redevelopment, such as parks, golf courses, parking lots, or light industrial use. Amendments would be similar to those discussed in Section 3.2.3.2.

Beneficial use of dredged material in landfill or brownfield capping is evaluated as an alternative for suitable material dredged from the Harbor Channels, C&D Canal Approach Channels, Chesapeake Bay Approach Channels (MD), and Chesapeake Bay Approach Channels (VA). Design assumptions associated with this alternative are detailed in the following paragraphs.

This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected dredging. The capacity would be filled by other suitable material. An existing CDF has been designated for each channel area as follows: Harbor Approach Channels - Cox Creek CDF; C&D Canal Approach Channels - Pearce Creek CDF; Chesapeake Bay Approach Channels (MD) – HMI DMCF; and Chesapeake Bay Approach Channels (VA) - Craney Island CDF. It is assumed for the purpose of this cost estimate that the landfill or brownfield facility is located within 30 miles of the respective CDF. It is further assumed that the dewatered dredged material would require blending with sandy material to improve structural properties for use as a final cap. This alternative uses 0.5 mcy (per channel) of dredged material over the life of the project.

For this alternative, it is assumed dewatered dredged material would be excavated from each channel's respective CDF for use as final cover at a landfill or brownfield site. The excavated material would provide 0.5 mcy of additional storage at each existing CDF. Material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, Chesapeake Bay Approach Channels (MD), or Chesapeake Bay Approach Channels (VA) by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped into the CDF using a hydraulic unloader. Transport distances from the center of the respective channels to the existing CDF are as follows: Harbor Channels, 1 nm; C&D Canal Approach Channels, 18 nm; Chesapeake Bay Approach Channels (MD), 10 nm; Chesapeake Bay Approach Channels (VA), 28 nm.

3.2.3.4 Mine Placement

Mine reclamation is the use of clean, dewatered dredged material to reclaim land that has been damaged by surface mining or used to fill subsurface mines. For evaluation under the DMMP, mine reclamation is defined as large-scale use of dredged material to either fill deep-depth mines or use as surface cover, either alone or blended with other materials. The history of mining in the Appalachian region presents opportunities for beneficial use of dredged material through mine reclamation; however, potential sites are a considerable distance from the Bay.

The representative area for mine placement is in western Maryland. Beneficial use of dredged material for mine reclamation is evaluated as a placement alternative for material dredged from the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD). Design assumptions associated with this alternative are detailed in the following paragraphs.

This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected maintenance dredging. The capacity would be filled by other suitable material. An existing CDF has been designated for each channel as follows: Harbor Channels - Cox Creek CDF; C&D Canal Approach Channels - Pearce Creek CDF; and Chesapeake Bay Approach Channels (MD) – HMI DMCF. It is assumed for the purpose of this cost estimate that the mine placement site is located in western Maryland. Once transported to the mine site by truck, the dewatered dredged material would require blending with available coal fly ash (depending upon its characteristics) before placement and compaction. Once placed and compacted, the site is seeded, fertilized, and mulched.

For this alternative, it is assumed dewatered dredged material would be excavated from each channel's respective CDF and transported by truck to the abandoned mine. The excavation of dewatered material would open up 0.5 mcy of additional capacity at each existing CDF. This capacity would be reused by placement of newly dredged materials. The new material could be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the respective channels to the existing CDF are as follows: Harbor Channels, 1 nm; C&D Canal Approach Channels, 18 nm; and Chesapeake Bay Approach Channels (MD), 10 nm. Transport distances from the respective CDF to the mine site are as follows (in miles): Harbor Channels, 115 mi; C&D Canal Approach Channels, 140 mi; and Chesapeake Bay Approach Channels (MD), 115 mi.

3.2.3.5 Quarry Placement

Quarry reclamation is the use of clean, dewatered dredged material to reclaim land that has been damaged by quarry excavation or used to fill abandoned quarries. For evaluation under the DMMP, quarry reclamation is defined as large-scale use of dredged material to either fill deep-depth quarries or use as surface cover, either alone or blended with other materials.

The representative area for quarry placement is in Cecil County, Maryland (Furnace Bay) (see Figure 3-1). Beneficial use of dredged material for reclamation at an abandoned sand quarry is evaluated as a placement alternative for material dredged from the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD). Design assumptions associated with this alternative are detailed in the following paragraphs.

This beneficial use alternative begins with the excavation of dewatered dredged material from an existing CDF, which would in turn provide additional capacity for projected maintenance dredging. An existing CDF has been designated for each channel as follows: Harbor Channels - Cox Creek CDF; C&D Canal Approach Channels - Pearce Creek CDF; and Chesapeake Bay Approach Channels (MD) – HMI DMCF. It is assumed for the purpose of this cost estimate that the quarry placement is located in Cecil County, Maryland (Furnace Bay). Once transported to the quarry site by truck, the dewatered dredged material would be unloaded, stockpiled, and then placed and compacted. It is assumed that the quarry is below grade around all sides and therefore no containment berms are needed. It is further assumed no amendments would be needed until the last 5 to 10 ft of fill material in order to provide a bridge for the underlying dewatered materials. For the last 5 ft of material, it assumed that the dredged material would be blended with 50% granular material to establish this “bridge layer” to reduce long-term subsidence and allow for site reuse. This alternative uses approximately 7.5 mcy of dredged material over a period of 21 years.

For this alternative, dewatered dredged material would be excavated from each channel’s respective CDF and transported by truck to the abandoned mine. The excavated material would provide approximately 10.7 mcy of additional storage (cut volume) amongst the existing CDFs over the 21-year period. Material would be mechanically dredged from the Harbor Channels, C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD) by a clamshell dredge. Material would be placed within a barge and transported to the respective CDF where it would be pumped directly into the CDF using a hydraulic unloader. Transport distances from the respective channels to the existing CDF are as follows: Harbor Channels, 1 nm; C&D Canal Approach Channels, 18 nm; and Chesapeake Bay Approach Channels (MD), 10 nm. Transport distances from the respective CDF to the quarry site are as follows: Harbor Channels, 40 mi; C&D Canal Approach Channels, 23 mi; and Chesapeake Bay Approach Channels (MD), 40 mi.

3.2.3.6 Wetland Restoration

Wetlands restoration is the use of dredged material to reclaim wetlands that have already been lost to open water as a result of erosion, subsidence, sea-level rise, and other factors. Dredged material is placed at depths of 2 to 5 ft in open water depressions that were once wetlands. These areas are usually surrounded by wetlands that are at risk of being lost because of subsidence and the erosive effects of currents and wave energy within these open water depressions. Research also suggests that introducing iron-rich dredged material from the upper part of the bay to these open water depressions, by buffering sulfide production, would significantly improve water quality and fish habitat in these depressions during wetland reclamation.

The amount and distribution of dredged material on wetlands is site-specific, and factors influencing its use include wetland proximity to dredging operations, physical and chemical nature of sediments, and volume of sediments. Actual application depths differ from one wetland to another, but it must be thick enough to raise the wetland elevation to the desired wetland type and allow natural revegetation. Multiple lifts over a long period of time may be required to prevent sea level rise from converting the wetland area back to open water.

The representative area for wetland restoration is the Blackwater NWR (Refuge) in Dorchester County, Maryland, as shown in Figure 3-2. The Refuge is located along the eastern shore of Maryland, approximately 55 miles south of Baltimore and directly south of the Choptank River. Beneficial use of dredged material for wetland restoration at the Refuge is evaluated as a placement alternative for the C&D Canal Approach Channels, and Chesapeake Bay Approach Channels (MD). Design assumptions associated with this alternative are detailed in the following paragraphs.

Historically, the marshes at Blackwater NWR have suffered severe damage by nutria, erosion along its shoreline, and loss due to sea-level rise and subsidence. As well, direct and indirect human impact such as marsh burning, road construction, and wildlife management practices have accelerated marsh loss. The alternative consists of the placement of 2 ft of dredged material over 1,000 acres of degraded wetlands at the Refuge. The site capacity estimated for this alternative is approximately 3.2 mcy.

For this alternative, it is assumed material would be mechanically dredged from the Harbor Channel, C&D Canal Approach Channels, or Chesapeake Bay Approach Channels (MD) by a clamshell dredge and placed into a barge. The barge would travel to an offshore location close to the Refuge and be moored to a buoy. Temporary containment, such as an earthern berm, would be constructed around the area of application. Material would be pumped from the barge using a hydraulic unloader through a network of pipelines, using booster pumps as required. A shallow-barge or other floating platform would move the inflow pipe along the edge of the application area during the process. Transport distances from the center of the respective channels to the Refuge are as follows: Harbor Channels, 65 nm; C&D Canal Approach Channels, 65 nm; and Chesapeake Bay Approach Channels (MD), 56 nm.

3.3 SCREENING PROCESS

3.3.1 Methodology

Seventy-seven dredged material placement alternatives were developed to accommodate dredged material from Port of Baltimore Channels (Table 3-1). In order to compare the alternatives against one another to determine the most feasible means to manage 21 years of dredged material, three quantitative criteria and two qualitative criteria were developed.

The quantitative criteria include Environmental Impact, Capacity, and Cost. Environmental Impact is described in terms of a habitat index and reflects the net amount and quality of habitat that would be created by an alternative. Capacity is the amount of dredged material that a particular alternative would accommodate during its facility life and is measured in terms of cubic yards. Cost is the total cost, in dollars, and cubic yard cost, in dollars/cy, of an alternative to include initial study; permitting and design; site development and closeout; dredging, transport, and placement; habitat development; and operation and maintenance.

The qualitative criteria used to compare alternatives are Technical/Logistical Risk and Acceptability Risk. Technical/Logistical Risk is defined as the likelihood that an alternative would not provide the expected capacity or environmental benefit during the 21-year planning window of the DMMP due to implementation factors. Acceptability Risk is defined as the likelihood that an alternative would be significantly delayed or would not proceed because of prohibition by a state law or by significant regulatory or public opposition. Both technical/logistical risk and acceptability risk are measured on a relative scale of 1 (low risk) to 5 (high risk).

The following sections provide further detail about the quantitative and qualitative criteria and the comparison of alternatives.

3.3.2 Environmental Impact Evaluation

USACE Guidance

Most of the dredged material placement alternatives under consideration are expected to generate environmental benefits. Levels and types of environmental benefits vary significantly from one alternative to another and, like most environmental benefits, cannot be compared using conventional (dollar-based) measures of value.

In situations where dollar measures of value cannot be used to compare the benefits of environmental projects, USACE guidance recommends comparing expected environmental outcomes using biophysical indicators of environmental gains and losses (e.g., habitat acres created multiplied by habitat suitability units per acre). Because of the challenge of dealing with nonmonetized benefits, the concept of significance of outputs plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, and information about risks and acceptability, information about the significance of ecosystem outputs that would be generated by various projects help determine which projects should be recommended. The significance of project outputs should be reflected in various measures of institutional, public, and/or technical importance. As a practical matter, unless specific estimates of the market or nonmarket values associated with an output are available, this means that some stakeholder group, law, policy, regulation, or scientific finding indicates that a particular resource or output is important.

Environmental Benefit Indicators

Twenty-eight different types of environmental indicator systems were considered to compare the environmental benefits associated with material placement alternatives. These candidate indicator systems were identified during the data collection phase of the DMMP project and are listed, with their sources, in Table 3-2. Most were suitable for comparing similar types of restoration projects, such as wetland restoration or forest restoration, and were based primarily on site-by-site differences. None of them were suitable for comparing alternatives with different environmental goals (e.g., fish versus bird habitat) or for use in a programmatic context where general types of alternatives are being compared without reference to specific sites (e.g., a large island restoration versus shoreline restoration).

The review established that none of the generally available environmental indicator systems were suitable for comparing the widely differing environmental benefits associated with the dredged material placement alternatives being considered as part of the federal DMMP for the Port of Baltimore. Quantifying differences in expected environmental benefits associated with these alternatives would require specialized sets of indicators that trace various pathways of environmental gains and losses and assign relative weights to expected outcomes. Fortunately, such a system had already been developed and applied to many of the placement alternatives under consideration as part of the process used by the State of Maryland to develop its DMMP for Port of Baltimore Channels.

BEWG Indicators

In 2002, as part of the state's DMMP development process, MPA reconvened the "Bay Enhancement Working Group" (BEWG), a group consisting of environmental scientists from state and federal agencies and representatives of environmental and citizens groups who met periodically to assess and compare the environmental aspects of dredged material placement options (see Table 3-3). During 2002 through 2004, the BEWG met every month or so to assess and compare potential environmental benefits associated with the 27 dredged material placement alternatives being considered by the state.

To facilitate these comparisons, the BEWG developed a set of 52 parameters related to the environmental suitability of proposed placement options. The parameters were divided into 10 categories based upon similar attributes, including water quality, wetlands, human use attributes, etc. (see Table 3-4). A brief description of each resource parameter is presented in Appendix B, BEWG Process and Parameter Description. The BEWG then assigned each parameter a weighting factor based upon the consensus of the group. Next, each parameter was assigned a raw score of +1, -1, or 0 for each alternative under consideration based upon existing data and historical information, as well as the collective experience and knowledge of the BEWG and the technical study team. A "+1" was assigned to a given parameter if the option is expected to protect or enhance *existing* resources of that type in or immediately adjacent to the option footprint. A "–1" was assigned if the resource is present and long-term negative impacts (or further degradation) are expected as a result of option development. A "0" was assigned when no negative impacts are expected to existing resources at or immediately adjacent to an option. It was also used in cases where there was not enough conclusive evidence to make a definitive evaluation, or evidence was ambiguous. Additional caveats were made to some scores as described in Appendix B “Environmental Parameters Table” and “Caveats for BEWG Scoring of CENAB DMMP.”

Over a 2-year period (2001 and 2002) BEWG ranked each of the state DMMP placement alternatives with respect to each environmental indicator, and then used a standardized weighted sum of those rankings to generate an overall environmental score for each alternative. They did so using alternatives with defined engineering assumptions and constraints that allowed the BEWG to assign realistic scores for each alternative in the absence of site-specific locations for each alternative. Appendix B provides a full description of the BEWG process, the BEWG environmental indicator system, and the alternative assumptions.

In terms of the underlying technical observations used to compare alternatives, the BEWG indicators are not as rigorous as those used in most specialized habitat evaluation procedures. However, BEWG indicators were determined to be superior to other indicator systems in terms of being applicable and acceptable to regional scientific and environmental communities. Besides facilitating the comparison of the full range of placement options on the basis of bio-physical indicators, the BEWG indicator system incorporates weights that reflected the importance of each indicator in terms of Bay health and socioeconomic significance. The environmental scientists that participated in the BEWG not only provided their expert opinion regarding biophysical outcomes, but also represented the interests of all of the relevant state and federal resource agencies who are charged with protecting the public interest. As a result, the BEWG indicators reflect not only a useful assessment of expected biophysical outcomes, but also the results of many tradeoffs and judgments that were made by various state and federal agencies as they negotiated over the relative importance of various environmental factors (e.g., fish versus birds, nutrients versus sediments, etc.). In the absence of economic measures of value, the weights assigned to the BEWG indicators by representatives of public resource agencies are the most reasonable basis for comparing the environmental benefits of alternative placement options.

For the above reasons, it was concluded that the BEWG indicators provided the only credible and practical option for comparing environmental benefits associated with programmatic placement alternatives. However, it was also concluded that some additional work would be needed to adapt the BEWG indicators for use as part of federal DMMP development. Appendix B describes the BEWG process and the development and application of BEWG indicators as they were used as part of the state DMMP process.

Adapting BEWG Indicators for the Federal DMMP

The BEWG indicators were developed to meet the requirements of the state DMMP, which are slightly different from the requirements of the federal DMMP. The following sections describe four additional steps that were taken to modify or supplement the BEWG indicators to make them suitable for use as part of the federal DMMP.

Step 1: Programmatic alternatives

The placement alternatives and federal standards identified during the federal DMMP process were presented to BEWG in early 2004. Because the alternatives were programmatic (not site-specific), the BEWG was presented with general information about design standards, and "typical" project specifications, site conditions, and landscape contexts for each alternative. Based on these descriptions, BEWG scored the federal alternatives using the same process as that used to score the state DMMP options (see Appendix B).

Several alternatives included in the federal DMMP were based on alternatives that had already been scored by the BEWG as part of the state DMMP process (e.g., Agricultural Placement was considered in the state DMMP, Small Island Restoration – Middle Bay was based on Parsons Island, which was scored in the state process, and so on). For these alternatives, the BEWG scores were arrived at using the state DMMP development process as a basis for scoring the corresponding federal DMMP alternative. The BEWG slightly adjusted scores related to a few environmental parameters when conditions at the state (site-specific) alternative were considered to differ somewhat from the conditions at the "typical" site being used as a basis for assessing the corresponding federal (programmatic) alternative. Using the same set of environmental parameters used to score the state alternatives, the BEWG then scored each of the federal alternatives for which there were no comparable state alternatives.

Step 2: Scale to eliminate negative scores

Most of the alternatives considered by the BEWG as part of the DMMP are expected to generate positive environmental benefits. Because of how BEWG indicators were developed and weighted, however, the cumulative BEWG score for over half of the alternatives being considered were negative. For purposes of comparing the relative environmental rankings of alternatives, the absolute values of overall BEWG scores and whether they were positive or negative were not important. However, having negative overall BEWG scores for many alternatives that are actually expected to result in positive net environmental benefits causes problems when these scores are used in any kind of quantitative analysis.

At a meeting of the DMMP development team and the BEWG on 8 June 2004, BEWG agreed that for purposes of performing tradeoff analysis and developing the federal DMMP, it would be acceptable to scale the overall BEWG score for each alternative so that the least environmentally beneficial alternative received a score of zero and all other alternatives received positive scores. Adjusting BEWG scores in this way involved adding the value of the lowest negative score to the unadjusted BEWG score for all alternatives and has no effect on the relative environmental ranking of alternatives. The unadjusted (normalized BEWG scores) and adjusted (normalized +1.91) BEWG scores for each of the federal DMMP alternatives are presented in Table 3-5. The methodology used to normalize and adjust the BEWG scores is presented in detail in Appendix B.

Step 3: Constrain definition of environmental benefits

As part of the state DMMP process, BEWG deliberated considerably about assigning indicator values to options that involved removing dredged material from the Bay, but resulted in no direct change in the quantity or quality of Bay habitat. Such options include the placement of dredged material in abandoned coal mines, on agricultural lands, or at confined upland or ocean placement sites. For purposes of the state DMMP process, BEWG decided to assign positive indicator values to some of these options on the assumption that removing sediments from the Bay had some favorable impact on Bay habitat because it eliminated a potential source of nutrients and toxics.

For purposes of developing a federal DMMP, however, the criteria that are used to establish that a project is environmentally beneficial are different from the criteria used by BEWG. To be considered an environmentally beneficial use of dredged material, an alternative must be shown to result in some direct increase in the quantity or quality of habitat. Environmental benefits can be associated with “harm avoided” if the use of dredged material can be shown to prevent the loss or degradation of habitat (e.g., prevent wetland erosion). However, merely removing dredged material that is not considered contaminated from the Bay is not, by itself, considered an environmental benefit for purposes of comparing alternatives as part of the federal DMMP.

The federal DMMP development team discussed this issue and various definitions of environmental restoration and environmental benefits with the BEWG at a meeting on 8 June 2004. At that meeting the BEWG agreed that it would be acceptable, for purposes of the federal DMMP, to assume that an alternative must create, restore, or enhance some type of habitat to generate environmental benefits.

Step 4: Account for project magnitude

As part of the state DMMP process, the BEWG was asked to compare alternatives that were associated with specific sites (e.g., a 2,000-acre James Island restoration project versus a 2,000-acre Barren Island restoration project, each with 50% uplands and 50% wetlands). These sizes and locations were taken into account as BEWG decided whether each alternative would have an impact on a given parameter. However, BEWG’s use of only +1, 0, or -1 for scoring each environmental parameter limited the ability to account for differences in the expected magnitudes of impacts in the scoring of alternatives. The use of dredged material to restore wetlands, for example, was assigned a –1, 0, or +1 for various indicator values without regard to whether the project design resulted in 100, 1,000, or 10,000 acres of restored wetlands.

Although the federal DMMP process was programmatic, BEWG was given design considerations discussed in Section 3.3.1 for each alternative that included the approximate size of a “typical” project. However, while the size of an alternative was usually expected to affect its environmental impacts, the limitation in the BEWG environmental scoring system meant that BEWG scores did not allow the magnitude of these expected impacts to be quantified. For example, the acreage of Small Island Restoration – Middle Bay was 100 acres and the acreage of Large Island Restoration – Middle Bay was 1,000 acres. Yet, both alternatives received the same

+1 scores for Wildlife Habitat, and, based on BEWG indicators, would appear to generate the same environmental benefits, even though a Large Island Restoration would provide up to 10 times more wildlife habitat.

This limitation of the BEWG indicators needed to be addressed as part of the federal DMMP for two reasons. First, since the federal DMMP is intended to be "programmatic," the BEWG scoring of specific size projects within a project type would not be suitable for comparing projects of different sizes within that project type. Second, ignoring the magnitude of environmental outcomes within a programmatic study would bias results against highly favorable environmental restoration projects. An option that included 3,000 acres of wetland restoration, for example, could be expected to have costs approximately three times higher than an option that involved 1,000 acres of wetland restoration, but would receive the same environmental score. This would always make larger environmental restoration projects appear less cost-effective than smaller projects in terms of achieving environmental benefits, even though the opposite may be true.

A vote of BEWG during a meeting on 8 June 2004 established that the BEWG accepted the use of its indicators as a measure of habitat benefits per unit area. BEWG agreed, in other words, that BEWG scores for a particular federal alternative could be multiplied by the acreage of habitat created by that alternative to generate an overall "habitat benefit index" that would be proportional to the size of each project. Using this approach, those alternatives that do not create, restore, or enhance habitat (e.g., Agricultural Placement) do not create habitat benefits (see Step 3 above). Therefore, while these alternatives still retain their BEWG scores, these scores would be multiplied by zero acres of habitat created, resulting in an overall habitat benefit index of zero (see Table 3-5).

3.3.3 Capacity Evaluation

Site volumes and capacities were developed for each of the DMMP alternatives. A summary of site capacities is presented in Table 3-6. Site capacity was a criterion used in the evaluation of the DMMP alternatives in order to develop a suite of alternatives that would meet the 20-year capacity goal of the project.

Site volume and capacity are dependent upon the specific type of alternative, and the assumptions developed in their calculation are described in Section 3.2. For each alternative, a conceptual engineering approach was developed to calculate the consolidated in-place volume for the site. A consolidation factor was applied to the site volume to account for the dewatering process and to calculate the site capacity (cut volume). The consolidation factor as provided by CENAB was alternative-specific and ranged from 0.7 to 0.9. For alternatives involving placement of dredged material on land, such as CDFs or Artificial Islands, a total consolidation factor of 0.7 was used to account for gravity drainage from the material and natural compaction under the weight of the material. For alternatives using thin lift application where drainage and compaction forces would be lower (such as wetland restoration), a consolidation factor of 0.9 was used. These factors have been derived based on experience at Poplar Island and other existing sites and agreed upon by the project team. Although there would be some consolidation of the material in subaqueous applications, these forces are considered minimal and consequently a factor was not used.

3.3.4 Cost Evaluation

Detailed cost estimates were developed for each of the DMMP alternatives. A summary of the cost/cubic yard for each alternative is presented in Table 3-6. Alternative cost was a criterion used in the evaluation of the DMMP alternatives in order to develop a suite of alternatives that would meet the 20-year capacity goal of the project.

Cost estimates were calculated on an alternative-specific basis using the detailed engineering assumptions described in Section 3.2. Concept-level cost spreadsheets for each alternative and its respective channel(s) are located in Appendix C. Each spreadsheet provides a comprehensive overview of factors affecting project cost, including assumptions/basis for estimate, project capacity and site volume, operating life, and average one-way haul distance for dredged material. Individual cost components of the estimate include, where applicable, initial costs (preliminary study and design, permitting), site development costs (mobilization/demobilization, containment dike construction), dredging costs (mobilization/demobilization, dredging, transportation, placement), habitat development costs (planning and design, grading, planting), and O&M costs (O&M monitoring and reporting, dredged material management). The individual contingency factors reflect the relative uncertainty in the application of each alternative, which affects the uncertainty in the resulting cost estimate. For example, well-proven and conventional placement alternatives such as open water placement have relatively little uncertainty in their implementation as well as a reasonable body of actual data cost. Therefore, the uncertainty associated with their relative cost is low (20%). For innovative approaches that may not have yet been implemented at field scale, there is significantly more uncertainty in their methods, production rates, etc., and relatively little reliable cost data for individual operations, resulting in a high uncertainty (e.g., 50%) for their overall cost. Contingency factors for each alternative take into consideration unknowns, such as engineering and constructability issues. A contingency factor was developed by experienced WESTON and CENAB engineering personnel for each alternative, and is shown in Table 3-7. The contingency factors were applied to the subtotal cost to calculate the total project cost. The unit cost ($/cy) for each alternative was determined by dividing the total project cost by the site capacity.

3.3.5 Technical and Logistical Risk Evaluation

The BEWG indicators of environmental benefits were "outcome-based"; they reflected BEWG's assessment of the environmental benefits that would accrue if environmentally beneficial projects could be designed and carried out successfully and performed as intended. BEWG did not address technical and logistical questions about the "implementability" of various beneficial use options, made no judgments about whether the environmental benefits associated with one alternative were more or less likely to be realized than those associated with another alternative, and did not weight indicators of environmental benefit on the basis of expected (risk-adjusted) environmental outcomes.

For purposes of developing the federal DMMP, alternatives need to be compared based on realistic expectations about environmental benefits, and this required that differences in risks associated with the "implementability" of alternatives be taken into account. Large island restoration, for example, is an alternative that has been undertaken successfully in the Bay and elsewhere, while the use of dredged material in large-scale wetland restoration is relatively rare and poses significant logistical and engineering challenges.

In order to take account of implementation risk, a joint state/federal team of dredged material placement experts met on 16 June 2004 at a DMMP Management Roundtable (see Table 3-8) to review the logistical and technical factors that affect the likelihood that each alternative would perform as expected, in terms of placement capacity and/or environmental benefits within the 21-year planning window. After a discussion regarding what was known about each of the alternatives and their underlying technological and logistical requirements, the group ranked implementation risk for each alternative on a scale of 1 (low risk) to 5 (high risk) (see Table 3-9). The group ranked alternatives on the basis of the stage of development of the underlying technology using the following criteria:

1. Alternative is routine and/or cost-effective (e.g., beach nourishment).
2. Alternative requires development of specialized techniques and material.
3. Alternative requires standardization of methods.
4. Alternative is in the initial implementation stage (e.g., building products).
5. Alternative is in the basic science, engineering, and experimentation stage.

Alternatives being routinely carried out in this region or elsewhere were considered low risk and assigned a 1. Alternatives that have barely passed the proof of concept stage or are only in the initial stages of experimentation were considered high risk and were assigned a 4 or 5. The group concluded that alternatives with a technical/logistical risk ranking of 4 or 5 were too risky to be implementable within the 21-year planning horizon being used for this DMMP. Therefore, these alternatives were screened out before suites of alternatives (combinations of alternatives that meet the 20-year-minimum dredged material placement need) were developed for further analyses.

Alternatives that were eliminated based on technical/logistical risk included Agricultural Placement, Building Products, and Mine Placement in western Maryland. With technological advances, some of these alternatives may become less risky in the future, and therefore may be reconsidered and included in suites that would be evaluated as part of a future DMMP review.

3.3.6 Acceptability Risk Evaluation

The implementation risks associated with some alternatives involves primarily technical and logistical factors described above, but the implementation risks associated with other alternatives involve primarily legal and political constraints. For example, Maryland law prohibits the placement of dredged material in an unconfined manner in the Chesapeake Bay and its tributaries. This constitutes a state ban on some alternatives, including New Open Water (Deep Trough) and Pooles Island Site Expansion; this law may also prevent capping in the Patapsco River. Another alternative, Artificial Island Creation – Upper Bay, faces significant public opposition that may be reflected in legal and political challenges that could prohibit or significantly delay implementation.

Acceptability risk, the likelihood that legal and political challenges would adversely affect project implementation, may appear to be considered more manageable and less important than technical and logistical risks, the likelihood that physical constraints would inhibit a project. However, laws and public opinion can be much slower to change than technology, and within the context of a DMMP that covers at least 20 years, acceptability risk may be more of an impediment than technical and logistical risk. For example, the number of years required to overcome engineering and logistical challenges and reduce the technological risks associated with innovative wetland restoration projects could be much fewer than the number of years required to change the Maryland state law banning open water placement of dredged materials.

On 16 June 2004 a joint state/federal team of dredged material placement experts that made up the DMMP Management Roundtable ranked alternatives (see Table 3-9) in terms of their local acceptability using the following criteria:

1. No law to prohibit alternative/minor public or regulatory issues.
2. No law to prohibit alternative/moderate public or regulatory issues.
3. No law to prohibit alternative/significant public or regulatory issues.
4. Law prohibiting alternative/minor public or regulatory issues.
5. Law prohibiting alternative/significant public or regulatory issues.

The group then agreed that alternatives that were illegal or faced significant public opposition (Scored 3, 4, or 5 using the criteria listed above) should not be included in suites of alternatives being considered to meet the 20-year-minimum placement needs of the Port of Baltimore.

The group felt that those alternatives, although not illegal, faced such stiff opposition from the public and/or regulators that they could not succeed in providing sufficient placement within the 21 years covered by the DMMP. For example, a prohibition on artificial island creation was included in a Maryland House bill, and although not passed into law, it signals that if such an alternative was recommended, it would likely generate significant public opposition and potentially legislative prohibition.

Alternatives that were eliminated based on acceptability risk included Artificial Island Creation, CAD-Patapsco River, CDF-Lower Bay, Cox Creek Expansion, HMI Expansion, Mine Placement – Cecil County & Western Maryland, Pooles Island Open Water Site Expansion, and New Open Water (Deep Trough).

Eliminating alternatives that do not comply with Maryland state law or face strong local opposition prevented some low-cost/high environmental benefit suites of alternatives from being recommended. The tradeoff analysis presented in subsequent sections shows the cost, in terms of dollars and foregone environmental benefits, of limiting the consideration of alternative to those that comply with Maryland state law and local public opinion.

3.3.7 Screening Summary

In summary, five criteria were developed to compare alternatives against one another: environmental impact, capacity, cost, technical/logistical risk, and acceptability risk. Table 3-10 summarizes the criteria for each of the alternatives.

3.4 TRADE-OFF ANALYSIS

3.4.1 Alternative Suite Formulation

The primary goal of the DMMP is to provide sufficient material placement capacity to meet the 20-year-minimum dredging needs in each of the four geographic subareas. Few of the dredged material placement alternatives listed in Table 3-10 can meet material placement requirements by themselves. The rest need to be combined into "suites" of alternatives that together meet the placement needs of one or more subareas.

The following sections describe the process that was used to identify all possible suites for each subarea, and narrow the focus of analysis to a limited number of suites for each subarea. The process that was used to reduce the many thousands of possible suites to the several hundred that became the focus of the tradeoff analysis was carried out separately for each geographic subarea. For each geographic subarea, the first step was to enter all technically/logistically feasible placement alternatives into a computer program to identify all possible combinations of alternatives. Those combinations of alternatives that met the subarea's 20-year placement capacity requirements were then identified as "suites" and were evaluated further. Because all suites met the placement capacity requirements, the next step was to compare suites on the basis of three other factors: costs, environmental benefits, and risks. A preliminary screening of suites eliminated those that were clearly inferior to other suites in terms of costs, environmental benefits, or both. Suites with high acceptability risk (see Section 3.3.6) were then screened out to generate the final set of suites that became the focus of the tradeoff analysis. The following sections detail how this process was carried out for each subarea.

3.4.1.1 Harbor Channels

The total projected need for Harbor Channels is 33 mcy over 21 years. Suites of alternatives for Harbor Channels must include alternatives that are designed to accommodate contaminated dredged material. Ninety percent (30 mcy) of Harbor material is presumed to be contaminated, thus 3 mcy are presumed to be clean (suitable) and have no placement restrictions. Note that for the purposes of building suites of alternatives for the Harbor Channels, the federal perspective on clean versus contaminated material in Baltimore Harbor was used. Although some material from Harbor Channels is considered "clean" by federal standards, according to Maryland state law, any material inside the North Point/Rock Point line is legislatively defined as contaminated.

Existing capacity for Harbor Channel dredged material is 16 mcy. This includes 10-mcy capacity (excluding cap) at HMI and 6-mcy capacity at Cox Creek. Both of these existing sites can accommodate contaminated material. For the purpose of this analysis, therefore, it was assumed that of the 17 mcy net capacity need, at least 14 mcy would need to be placed in facilities designed to contain contaminated material. Alternatives considered that could accept contaminated material are Confined Aquatic Disposal – Patapsco River, Confined Disposal Facility – Patapsco River, Cox Creek Expansion, and HMI Expansion.

To create suites for the Harbor Channels, all possible combinations of technically/logistically acceptable (see Section 3.3.5) alternatives were separately identified for contaminated and clean material alternatives. In total, 39 combinations of alternatives suitable for contaminated material and 575 combinations of alternatives suitable for clean material were considered.

Each set of combinations was then screened for appropriate total capacity. Net need is 17 mcy, so combinations of alternatives were selected if they met this need or exceeded it by up to 1 mcy. Thus, for contaminated material, appropriate capacity could be as low as 14 mcy or as high as 18 mcy (17 mcy + 1 mcy). This screening resulted in four combinations remaining for contaminated material. Additionally, the HMI Expansion alternative has capacity beyond what is needed for 20 years, and was included with the combinations under consideration for contaminated material.

For clean material, acceptable capacity was 0 to 4 mcy. After screening for capacity, nine combinations of alternatives remained for clean material.

The contaminated and clean material combinations were then joined, resulting in 16 suites of alternatives that can meet both contaminated material and overall capacity needs (Figure 3-9). These suites were then screened for acceptability (see Section 3.3.6); any suite containing an alternative with an acceptability risk greater than 2 was eliminated. After this screening, only suite HN (4 CDFs in Patapsco River) remained (see Figure 3-10).

3.4.1.2 C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD)

The C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) are located close to each other. These channels are similar in terms of the type of material dredged and the alternatives available for dredged material placement. The distinction between the channels is largely administrative in that the Philadelphia District of the U.S. Army Corps of Engineers (CENAP) manages the C&D Canal Approach while the CENAB manages the Chesapeake Bay Approach Channels (MD). For these reasons, the projected need for these two subareas was combined prior to suite creation. The projected need for the combined C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) is 70.6 million cy over the next 21 years. Existing capacity totals 31.7 mcy; this includes 27 mcy at PIERP at 4.7 mcy at Pooles Open Water Site. Therefore, net need is 38.9 mcy.

<u>**Anchor-based Approach**</u>

Technically/logistically acceptable (see Section 3.3.5) alternatives for the combined C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) ranged in placement capacity from 500,000-cy capacity (e.g., Capping - Landfills) to nearly infinite capacity (e.g., New Open Water (Deep Trough), and several large alternatives come close to meeting placement needs on their own (e.g., Large Island Restoration-Middle Bay). An initial review of alternatives indicated that all suites needed at least one large-capacity alternative to meet placement needs. Therefore, to facilitate suite construction, an “anchor-based” approach was employed whereby each suite included at least one large capacity alternative supplemented by various combinations of smaller technically/logistically feasible alternatives to meet the total placement capacity need. For the combined C&D Canal Approach Channels and Chesapeake Bay Approach Channels

(MD), the anchors were New Open Water (Deep Trough), PIERP Expansion, Large Island Restoration – Middle Bay, Artificial Island Creation – Upper Bay, and Norfolk Ocean Open Water Placement.

The open water alternatives considered as anchors can accommodate any amount of dredged material; so all combinations of smaller alternatives were added to these open water anchors. Because island alternatives must be constructed to meet specific design specifications, they do not have the flexible capacity of the open water alternatives examined. To create suites with these islands as anchors, their capacity was supplemented with combinations of small alternatives such that the total capacity of the suite was within 1 million cy of the projected need. Additionally, large-capacity alternatives were combined to create a few suites that have capacity beyond what is needed for 20 years (e.g., PIERP Expansion combined with Large Island Restoration – Middle Bay). When a large-capacity alternative was added to an anchor, the costs and environmental benefits were calculated by including only that portion of the large alternative that is needed within the 21-year planning horizon. For example, when a PIERP Expansion is used to supplement the capacity of a Large Island Restoration, only 5.8 mcy of its 24-mcy capacity is necessary to meet the 20-year-minimum placement capacity need. Total cost of that suite, therefore, was estimated as the sum of total cost for the Large Island Restoration plus a prorated portion of the cost of the PIERP Expansion (5.8 mcy multiplied by the estimated cost per cubic yard for the PIERP Expansion alternative).

To create the complete set of suites for the combined C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD), all technically/logistically feasible, nonanchor alternatives were entered into a computer program that generated all possible combinations of these alternatives. The resulting combinations of alternatives were ordered according to capacity, and combinations of appropriate size were combined with each anchor. For example, the PIERP Expansion Anchor has a capacity of 24 mcy. All combinations of smaller alternatives with capacity of 16.4 to 17.4 mcy (for a total capacity of 40.4 to 41.4 mcy) were identified to create a set of suites that meet the 20-year projected need with PIERP Expansion as an anchor. The same process was used to create the set of suites for the Large Island Restoration – Middle Bay anchor. For the open water alternatives (New Open Water (Deep Trough) and Norfolk Ocean Open Water Placement), each combination of smaller alternatives with a total capacity of less than 40.4 mcy was combined with the volume of open water capacity necessary to meet the 20-year-minimum projected need (e.g., if the combination of small alternatives totaled 20 mcy, then 20.4 mcy of open water placement was used to meet the 20-year need). For the Artificial Island Creation – Upper Bay anchor, no smaller alternative were necessary because this alternative meets the 20-year need by itself. The total number of suites identified using this algorithm was over 14,000 (see Figure 3-11a).

Screening Suites for Cost-effectiveness

The tradeoff analysis compares suites of alternatives based on the following three criteria:

- Dollar Costs ($ per cy)
- Placement Capacity (number of cubic yards)
- Environmental Impacts (Habitat Benefit Index)

The first step in performing the tradeoff analysis was to reduce the number of suites under consideration by eliminating those suites that were clearly inferior to other possible suites.

Because all suites meet overall placement capacity, the following three decision rules were used to make this determination:

- Rule 1: If Suite A has lower costs and higher environmental benefits than Suite B, eliminate Suite B.
- Rule 2: If Suite A has lower costs and the same environmental benefits as Suite B, eliminate Suite B.
- Rule 3: If Suite A has higher environmental benefits and the same costs as Suite B, eliminate Suite B.

These decision rules were applied to roughly 14,000 suites associated with various large-capacity anchors, and resulted in five natural groupings of cost-effective suites which included the lowest cost combinations of alternatives that could achieve various levels of environmental benefits. Applying all three decision rules to eliminate suites that were inferior in terms of cost, environmental benefit, or both reduced the number of suites to be considered in the tradeoff analysis for the combined C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) from over 14,000 to approximately 590 (see Figures 3-11a and 3-11b).

The remaining 590 suites were then screened for acceptability risk (Section 3.3.6). Any suite that contained an alternative with an acceptability risk greater than 2 was screened out. This screening reduced the number of suites being considered from 590 to 92 (Figure 3-12).

Included in the remaining 92 suites were suites with Large Island Restoration – Middle Bay, PIERP Modification, and Norfolk Ocean Open Water Placement as anchors. The Norfolk Ocean alternative offers no environmental benefits and has exceptionally high cost per cubic yard. Because each of the 72 suites containing Norfolk Ocean as the anchor has higher cost and lower benefit than a suite that is identical except for having a different anchor, the 72 suites containing the Norfolk Ocean anchor were screened out (see Figure 3-12). After this screening only the 20 legal suites that contained either Large Island Restoration or PIERP Modification as anchors remained (see Figure 3-13).

3.4.1.3 Chesapeake Bay Approach Channels (VA)

The projected need for the Chesapeake Bay Approach Channels in Virginia is 10 mcy over the next 21 years. Current placement sites for Virginia Bay Approach Channels are Dam Neck Ocean Open Water Placement, Rappahannock Shoal Deep Alternate Open Water Placement, and Wolf Trap Alternate Open Water Placement. Capacity at these existing sites is more than adequate to meet the need for these channels over the next 20 years. This means that the net need for the Virginia Bay Approach Channels is zero, so there is no need to evaluate suites of placement alternatives for this subarea.

3.4.2 Suite Analysis

The final step in the DMMP process is the evaluation of suites of alternatives that meet the net dredged material capacity requirements for each of the four geographic areas to select a recommended plan. A management roundtable meeting was convened on 29 June 2004 for the purpose of evaluating the suites of alternatives. The Harbor Channels did not require evaluation because there exists only a single technically/logistically and legally/politically acceptable cost-effective suite (multiple confined disposal facilities in the Patapsco River), as described in Section 3.4.11. Likewise, the Chesapeake Bay Approach Channels (VA) did not require evaluation because it has been determined that the existing dredged material placement capacity is sufficient, as described in Section 2.4.1.3. Therefore, the management roundtable focused its attention on the C&D Canal Lower Approach Channels and Chesapeake Bay Approach Channels (MD).

The roundtable used both cost-effectiveness (CE) analysis and incremental cost analysis (ICA) to develop the recommended plan. Based on CE analysis, the roundtable identified the least-cost suite to be the one that includes PIERP Expansion with Large Island Restoration-Middle Bay ("PC" in Figure 3-13).

The roundtable then used ICA to examine how adding alternatives that had higher environmental rankings than PIERP Expansion and Large Island Restoration-Middle Bay to a suite that included those two alternatives would affect cumulative costs and environmental benefits. Adding most environmentally beneficial alternatives (e.g., Shoreline Restoration-Upper Bay, Small Island Restoration-Middle Bay) to this suite slightly increased environmental benefits but had relatively high costs per cubic yard of placement capacity. The Wetland Restoration-Dorchester County alternative was a significant exception. Although adding this alternative provided relatively little in terms of reliable short-term material placement capacity, it contributed significantly to the environmental benefits provided by the suite at relatively modest incremental costs. In fact, adding 2,000 acres of Wetland Restoration-Dorchester County to the suite that already included PIERP Expansion and Large Island Restoration-Middle Bay resulted in a nearly 500% increase in environmental benefits from the suite, but increased overall costs by only 15%.

In the final analysis, therefore, the roundtable chose a suite that combined the alternatives in the Least Cost suite with the alternative that provides the most habitat benefit as the recommended plan: PIERP Expansion, Large Island Restoration-Middle Bay, and Wetland Restoration-Dorchester County.

These three alternatives were chosen as the recommended plan for following reasons: 1) Although it does not provide adequate long-term capacity, PIERP Expansion has a relatively high chance of federal funding success given the existing authority for PIERP and the current federal policy of funding no "new starts." 2) To attempt Large Island Restoration-Middle Bay and Wetland Restoration-Dorchester County (LA in Figure 3-13) without PIERP Expansion carries too high a risk of capacity shortfalls if study, development, and implementation of wetland restoration techniques, or federal authorization of a Large Island Restoration-Middle

Bay site are delayed. 3) The combination achieves capacity in a cost-effective manner with the large-capacity alternatives (PIERP Expansion and Large Island Restoration-Middle Bay) while providing significant habitat benefit through Wetland Restoration-Dorchester County. 4) The combination provides a reasonable amount of remaining capacity beyond a 21-year window, thus reducing risk and capacity development costs in out-years.

3.5 FEDERAL STANDARD

The federal standard is defined in 33 C.F.R. § 335.7. The federal standard is the dredged material placement alternative(s) identified by USACE that represents the least costly alternative(s) consistent with sound engineering practices and compliant with federal environmental laws, which include the environmental standards established by Section 404(b)(1) of the Clean Water Act evaluation process or ocean dumping criteria. The federal standard may therefore include alternatives that fully comply with federal law, but may be restricted by state laws. For example, the State of Maryland has passed laws that severely restrict the placement of material in the open waters of the Bay, and limit placement of material from the Harbor to existing containment sites that have defined closure and capacity restraints. The federal standard includes options that, in the absence of these state laws, can provide sufficient potential capacity for 20 years of anticipated federal maintenance needs, comply with federal laws, and are based on sound engineering practices.

There are three economic purposes for establishment of the federal standard. First, the federal standard limits the federal investment to a justified level of costs. Second, it serves as a basis for cost-sharing purposes. Finally, the federal standard establishes baseline costs to be used for any economic analyses. Any cost in excess of the federal standard is either borne by the non-federal sponsor (the State of Maryland, in this case) or shared with USACE under other authorities if the ultimate placement site is in the federal interest. For example, Section 204 of the WRDA of 1992, and later amended by Section 207 of WRDA 1996, provides authority for USACE to implement projects for the protection, restoration, and creation of aquatic and ecologically related habitats in connection with construction, operation, or maintenance dredging of an authorized federal navigation project. Section 201 of WRDA 1996 provides for USACE cost sharing in the construction of new placement sites and the improvement/expansion of existing placement sites. The cost sharing is limited to the federal standard with the only federal interests in the incremental cost being ecosystem restoration or placing suitable material on beaches. Therefore, the incremental cost of the increased costs over the federal standard for the Harbor CDFs would be non-federal.

Currently, the federal standard for the Port of Baltimore Approach Channels to be addressed in the DMMP has four components, as defined by the channels that are authorized for maintenance dredging. These channels, as described in Section 1.5, include the C&D Canal Approach Channels, Harbor Channels, Chesapeake Bay Approach Channels (MD), and Chesapeake Bay Approach Channels (VA). Details of the federal standard are presented in the following sections, along with economic justification of continued maintenance dredging.

3.5.1 C&D Canal Approach Channels—Pooles Island

The first component of the DMMP federal standard is the open water placement of sediment from the C&D Canal Approach Channels south of the Sassafras River. Pooles Island is located in the Upper Chesapeake Bay as shown in Figure 3-1. Pooles Island has an estimated current permitted capacity of 4.7 mcy. State law passed in 2001 mandates the closure of Pooles Island in 2010 or when the current capacity is fully utilized; however, absent this state law, the Pooles Island open water site could be expanded to provide additional capacity for maintenance material from the lower approach channels to the C&D Canal for the next 20 years.

3.5.2 Harbor Channels—HMI

The second component of the DMMP federal standard is the placement of material from the Harbor Channels (that is, areas upstream of the North Point to Rock Point line at the mouth of the Patapsco River) at HMI. Under state law, material from the Harbor Channels is presumed contaminated, and therefore unsuitable for open water placement and most beneficial use projects that require clean dredged material. The estimated current capacity of HMI is 10 mcy. State law mandates closure of HMI in 2009; however, absent this state law, vertical and lateral expansion of HMI could provide sufficient capacity for 20 years of maintenance dredging. In addition, the upland Cox Creek site is permitted to accept Harbor dredged material, and has an estimated current capacity of 6 mcy (dike height + 36 MLLW). Expansion of this site or reuse/ recycling of material from this facility could extend the life of this containment site. Accordingly, it is anticipated that the federal standard beyond 2009 for the Harbor material would be expansion of HMI or construction of a similar containment facility (e.g., Cox Creek).

3.5.3 Chesapeake Bay Approach Channels (MD)—Deep Trough

The third component of the DMMP federal standard is open water placement of dredged material from the 50- and 35-ft channels in the Maryland portion of the Chesapeake Bay into the "Deep Trough." The Deep Trough is part of a deep water trench, about 20 miles long, and up to 160 ft in depth as shown in Figure 3-2. The trough is generally aligned along a north-south axis in the eastern center of the mainstem of the Chesapeake Bay and is a remnant of the ancient Susquehanna River channel when this portion of the Bay was a riverine environment. Previous studies conducted by CENAB have concluded that open water placement in this area would meet the applicable federal standard. The federal standard for the dredged material from the Chesapeake Bay Approach Channels (MD) is the Deep Trough site; however, placement of material in the Deep Trough is not permitted under state law. Absent this state law, there is sufficient capacity to accommodate 20 years of maintenance material from the 50- and 35-ft Chesapeake Bay Approach Channels (MD).

3.5.4 Chesapeake Bay Approach Channels (VA)

The fourth component of the DMMP federal standard is the open water placement of dredged material from the Virginia channels into the existing placement sites in the Chesapeake Bay and Atlantic Ocean. There currently are no issues with continued use of these sites within the 21-year planning period of the DMMP. The existing open water sites include the EPA/USACE designated Dam Neck and Norfolk Ocean Sites, the Wolf Trap Alternate Site, and the Rappahannock Shoal Deep Alternate site. The locations of these open water placement sites are shown in Figure 3-3.

3.5.5 Economic Justification of Continued Maintenance

As discussed in Section 1.9, the DMMP process began with the Preliminary Assessment (see Appendix G), which CENAB finalized in July 2001. Since a Preliminary Assessment establishes whether more detailed study is required to prepare a management plan, a required component of the Preliminary Assessment is an economic analysis to determine whether continuing O&M costs (including maintenance dredging) of the overall project and separable increments are warranted. The Preliminary Assessment concluded that continued maintenance of the Baltimore Harbor and Channels Projects is warranted. Although this analysis did not provide separate justifications for the 42-ft and 50-ft projects, a more-detailed analysis using updated information was completed by CENAB in January 2005, which examined the costs and benefits of the 50-ft project, the 42-ft project, and the C&D Canal and its approach channels maintained by the Philadelphia District. This economic analysis is provided as Appendix F and concludes that continued maintenance dredging of the Baltimore Harbor and Channels project to their currently maintained depths is justified.

The benefit analysis for continued maintenance of the 50-ft Baltimore Harbor & Channels project evaluated the transportation cost savings for the inbound movement of iron ore to Baltimore Harbor and the outbound movement of coal from Baltimore Harbor. The transportation cost savings were evaluated by updating vessel operating cost information and commodity tonnage information used to evaluate increasing channel depths from 42 ft to 50 ft in the 1981 General Design Memorandum (GDM) project authorizing document. The updated evaluation was done using current vessel operating cost information as published by the Corps of Engineers HQUSACE and a 5-year average of the most recently available Waterborne Commerce Statistical Center (WCSC) commodity tonnage information. The updated annual benefits amount to $12.2 million. The average annual operation and maintenance cost for the period from 2000-2004 at current price levels for the 50-ft project channels is $9.5 million. Because expected annual benefits exceed annual maintenance dredging costs, the evaluation demonstrates that continued maintenance of the 50-ft Baltimore Harbor and Channels project is warranted.

A separate benefit analysis for continued maintenance of the 35-ft C&D Canal approach channels evaluated the benefits and costs associated with continued maintenance of the channels to a depth of 35 ft. The evaluation used transportation cost savings information from a John Martin & Associates 2004 report (see Appendix F) and WCSC vessel and barge traffic information to identify expected benefits at 3-ft intervals from 20 ft to 35 ft. These benefits were compared to the cost to maintain the channels at 3-ft intervals from 20 ft to 35 ft. The maintenance costs used in the analysis were generated using maintenance dredging information from the Corps of Engineers Baltimore District and the Corps of Engineers Philadelphia District. The benefits and costs at each 3-ft interval were compared. The total benefits identified for maintenance of the 35-ft channel amount to $11.7 million. The total costs for maintenance of the 35-ft channel depth amount to $8.4 million. This evaluation demonstrates that continued maintenance of the 35-ft C&D Canal approach channels project is warranted.

3.6 RECOMMENDED PLAN

The overall goal of the DMMP is to develop a plan to maintain, in an economically and environmentally sound manner, channels necessary for navigation in the Port of Baltimore, conduct dredged material placement in the most environmentally sound manner, and maximize the use of dredged material as a beneficial resource. Using both quantitative and qualitative analysis, the CENAB DMMP Team proposes follow-on study and optimization of the following alternatives, shown in Figure 3-14, which provide a minimum of 20 years of dredged material management for the Port of Baltimore:

- Continued maintenance dredging of the Virginia Channels and use of open water sites in Virginia.
- Continued maintenance dredging of the Maryland Channels and use of existing placement sites in Maryland.
- Multiple new confined disposal facilities for harbor material in Patapsco River.
- PIERP Expansion.
- Large Island Restoration—Middle Bay.
- Wetland Restoration—Dorchester County.
- Continue to pursue opportunities to innovatively use dredged material.

The total cost associated with the recommended plan over 21 years is $1,199,700,000 and the associated environmental benefit, as described by a habitat index score, is 8,855. This habitat score is based on the creation and restoration of upland and wetland habitat as part of the PIERP Expansion (habitat score of 727), and the Large Island Restoration-Middle Bay (habitat score of 690), and Wetland Restoration-Dorchester County (habitat score of 7,438). In contrast, the total cost of the federal standard is $456,500,000, with no anticipated environmental benefits. Included in Table 3-11 is a breakdown of the total cost and habitat index score for each element of the recommended plan and federal standard.

The habitat index score for the recommended plan was produced mainly as a result of positive impacts to wetlands, water birds, and water quality as a result of the wetland restoration in Dorchester County. A full review of the environmental impacts for each alternative within the environmental plan can be found in Appendix B.

CHAPTER 3

TABLES

Table 3-1 USACE Baltimore Harbor & Channels DMMP Alternatives

Dredged Material Management Placement Options	Harbor Channels	C&D Approach Channels	Ches Bay Approach (MD)	Ches Bay Approach (VA)
Agricultural Placement -- Maryland	■	■	■	
Agricultural Placement -- Virginia				■
Artificial Island Creation -- Lower Bay				■
Artificial Island Creation -- Upper Bay	■	■	■	
Beach Nourishment -- Virginia				■
Building Products	■	■	■	■
C&D Canal Upland Sites Expansion	■	■	■	
Capping -- Brownfields	■	■	■	■
Capping -- Landfill	■	■	■	■
Capping -- Elizabeth River, VA				■
Capping -- Patapsco River, MD		■	■	
Confined Aquatic Disposal Area -- Patapsco River, MD	■			
Confined Disposal Facility -- Lower Bay				■
Confined Disposal Facility -- Patapsco River, MD	■			
Cox Creek Expansion	■			
Hart-Miller Island Expansion	■	■	■	
Large Island Restoration -- Lower Bay				■
Large Island Restoration -- Mid Bay		■	■	
Mine Placement -- Cecil County, MD	■	■	■	
Mine Placement -- Western Maryland	■	■	■	
Norfolk Ocean Open Water Placement		■	■	■
Pooles Island Open Water Site Expansion		■	■	
PIERP Expansion		■	■	
Rappahannock Shoal Deep Alternate Open Water Site Expansion		■	■	■
Shoreline Restoration -- Lower Bay				■
Shoreline Restoration -- Mid Bay	■	■	■	
Shoreline Restoration -- Upper Bay	■	■	■	
Small Island Restoration -- Lower Bay				■
Small Island Restoration -- Mid Bay	■	■	■	
Wetlands Restoration -- Dorchester County, MD		■	■	
Dam Neck Ocean Open Water Placement (Existing)				BASE
Hart-Miller Island (Existing)	BASE	■	■	
New Open Water Placement -- Mid Bay (Deep Trough)		■	BASE	
Pooles Island Open Water Site (Existing)		BASE		
Rappahannock Shoal Deep Alternate Open Water Site (Existing)				BASE
Wolf Trap Alternate Open Water Placement (Existing)		■	■	BASE

Table 3-2

Ecosystem Assessment Methods

	Name	Acronym	Reference
1	Wetland Rapid Assessment Methodology	WRAP	Miller and Gunsalus 1996
2	Wetland Functions and Values	Descriptive Approach	CENAD, 1995
3	Hydrogeomorphic Approach	HGM Approach	Smith et al., 1995, Brinson et al., 1996, Ainslie et al., 1998
4	Water Quality Index	WQI	Lodge et al., 1995
5	Minnesota Routine Assessment Method	MIN RAM	MBWSR, 1996, 1998
6	Guidance for Rating Values of Wetlands	NC Method	NCDEHNR, 1995
7	Indicator Value Assessment	IVA	Hruby, 1995
8	Evaluation for Planned Wetlands	EPW	Bartoldus et al., 1994
9	Wetland Value Assessment Methodology	WVA	EWG, 1994
10	Oregon Method	Oregon Method	Roth et al., 1993, 1996
11	Ontario Method	Ontario Method	OMNR 1993a,b
12	Coastal Method	Coastal Method	Cook et al., 1993
13	Wisconsin Rapid Assessment Methodology	WI RAM	WDNR, 1992
14	New Hampshire Method	NH Method	Ammann & Stone, 1991
15	VIMS Method	VIMS Method	Bradshaw, 1991
16	Synoptic Approach for Wetlands	Synoptic Approach	Abbruzzese et al., 1990a,b
17	Habitat Assessment Technique	HAT	Cable et al., 1989
18	Minnesota Wetland Evaluation Methodology	WEM	MRAMEWF, 1998
19	Wetland Evaluation Technique	WET2	Adamus et al., 1987, 1991
20	Index of Biotic Integrity	IBI	Karr 1981, 1987, 1990
21	Connecticut Method	Connecticut Method	Ammann et al., 1986
22	Hollands-Magee Method	Hollands-Magee Method	Hollands & Magee, 1985
23	Habitat Evaluation Procedure	HEP	USFWS, 1980, 1981
24	Reppert Method	Reppert Method	Reppert et al., 1979, 1981
25	Larson-Golet Method	Larson-Golet Method	Golet, 1976 Heeley & Motts, 1976; Larson, 1976; Golet and Davis, 1982; Wencek, 1986
26	Smardon Method	Smardon Method	Smardon, 1983
27	Wildlife Habitat Appraisal Procedure	WHAP	TPWD, 1991
28	Pennsylvania Habitat Evaluation Procedure	PAM HEP	Palmer et al., 1985, USFWS, 1980

Table 3-3

Agencies and Organizations Participating in the Bay Enhancement Working Group (BEWG)

US Army Corps of Engineers, Baltimore District
US Army Corps of Engineers, Philadelphia District
US Environmental Protection Agency, Region III
US Fish and Wildlife Service
NOAA National Marine Fisheries Service
NOAA Chesapeake Bay Office
Maryland Port Administration
Maryland Geological Survey
Maryland Department of Natural Resources
Maryland Department of the Environment
Maryland Environmental Service
Citizens' Advisory Committee
Chesapeake Bay Foundation

Table 3-4

BEWG Categories and Parameters

Category	Parameter	Weight
Water Quality	Dissolved Oxygen	3
	Nutrient Enrichment	3
	Turbidity	3
	Salinity	4
	Ground Water	5
Aquatic Habitat	Shallow Water Habitat (Tier II & Tier III)	4
	SAV	5
Wetlands	Tidal Wetlands	5
	Nontidal Wetlands	5
Aquatic Biology – Finfish/Shellfish	Benthic Community	3
	Finfish Spawning Habitat	4
	Finfish Rearing Habitat	4
	Larval Transport	6
	Habitat of Particular Concern	5
	Essential Fish Habitat	3
	Commercially Harvested Species and Habitat	4
	Thermal Refuge	4
	Recreational Fishery	4
Special	Protected Species (RTE) (SSPRA)	5
Waterbirds	Waterfowl Use	4
	Wading and Shorebird Use	4
Terrestrial	Wildlife Habitat	2
	Forests	3
	Streams	4
	Lakes & Ponds	2
	Other Natural Avian Habitat	2
	Prime or Unique Agricultural Land	3
Physical Parameters	Substrate/Soil Characteristics	3
	Hydro-dynamics effects	4
	Toxic Contaminants	4
	CERCLA/UXO Potential	5
	Fossil Shell Mining	3
	Floodplains	2
Human Use Attributes	Recreational Value	2
	Aesthetics	2

Table 3-4

BEWG Categories and Parameters
(Continued)

Category	Parameter	Weight
	Noise	2
	Cultural Resources	3
Human Use Attributes (continued)	Air Quality	3
	Infrastructure	3
	Existing Land Use	3
	Commercial Socioeconomics	4
	Community Socioeconomics	4
	Environmental Justice	4
	Public Health	5
	Public Safety	5
	Navigation	3
Beneficial Attributes	Beneficial Use Wetlands	4
	Beneficial Use Uplands	2
	Beneficial Use - Adjacent Habitat Enhancement	2
	Beneficial Use - Faunal	2
	Beneficial Use - Recreational Enhancement	2
	Shoreline Protection	2

Table 3-5

BEWG Scores, Habitat Created, and Habitat Benefit Index for Each Federal DMMP Alternative

Alternative	Normalized BEWG Score	Normalized Score +1.91	Acres Habitat Created	Habitat Benefit Index
Agricultural Placement - Maryland	0.5000	2.409	0	0
Agricultural Placement - Virginia	0.5000	2.409	0	0
Artificial Island Creation - Lower Bay	-1.3077	0.601	1,000	601
Artificial Island Creation - Upper Bay	-0.9474	0.962	1,000	962
Beach Nourishment - Virginia	0.2093	2.118	0	0
Building Products	1.4545	3.364	0	0
C&D Canal Pierce Creek Upland Sites Expansion	-0.7097	1.199	0	0
Capping- Landfill	0.9600	2.869	0	0
Capping- Brownfields	0.9600	2.869	0	0
Capping- Elizabeth River, VA	0.8947	2.804	20	56
Capping- Patapsco River, MD	0.8947	2.804	250	701
Confined Aquatic Disposal Pit - Patapsco River, MD	0.2368	2.146	0	0
Confined Disposal Facility - Lower Bay	-1.1860	0.723	0	0
Confined Disposal Shoreline Facility - Patapsco R	-0.2286	1.681	0	0
Cox Creek Expansion	-0.2778	1.631	0	0
HMI Expansion	-0.9070	1.002	0	0
Large Island Restoration - Lower Bay	-0.2174	1.692	240	406
Large Island Restoration - Mid Bay	0.4783	2.387	1,000	2,387
Mine Placement - Cecil County, MD	1.6667	3.576	0	0
Mine Placement - Western Maryland	1.6667	3.576	300	1,073
Norfolk Ocean Open Water Placement (Existing)	0.0000	1.909	0	0
Pooles Island Open Water Site Expansion	-1.0000	0.909	0	0
PIERP Expansion	-0.6977	1.211	600	727
Rappahannock Shoal Deep Alternate Open Water Site Expansion	-1.9091	0.0	0	0
Shoreline Restoration - Lower Bay	-0.5000	1.409	110	155
Shoreline Restoration - Mid Bay	-0.3810	1.528	175	267
Shoreline Restoration - Upper Bay	-0.0698	1.839	110	202

Table 3-5

BEWG Scores, Habitat Created, and Habitat Benefit Index for Each Federal DMMP Alternative (Continued)

Alternative	Normalized BEWG Score	Normalized Score +1.91	Acres Habitat Created	Habitat Benefit Index
Small Island Restoration - Lower Bay	-0.2128	1.696	100	170
Small Island Restoration - Mid Bay	-0.2200	1.689	100	169
Wetland Restoration - Dorchester County, MD	1.8095	3.719	1,000	3,719
Dam Neck Ocean Open Water Placement (Existing)	0.0000	1.909	0	0
HMI (Existing)	0.3864	2.295	0	0
New Open Water (Deep Trough)	-0.7419	1.167	0	0
Pooles Island Open Water Site (Existing)	-0.7879	1.121	0	0
Rappahannock Shoal Deep Alternate Open Water Site (Existing)	-1.0345	0.875	0	0
Wolf Trap Alternate Open Water Placement (Existing)	-1.2667	0.642	0	0

Table 3-6

Unit Cost, Capacity, and Normalized BEWG Score +1.91 for Federal DMMP Alternatives

Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Positive, Normalized BEWG score
Agricultural Placement- Maryland	$51	$51	$50		500,000	2.4090
Agricultural Placement- Virginia				$43	500,000	2.4090
Artificial Island Creation- Lower Bay				$18	34,600,000	0.6010
Artificial Island Creation- Upper Bay	$12	$11	$12		48,400,000	0.9620
Beach Nourishment- Virginia				$12	5,600,000	2.1180
Building Products	$117	$120	$118	$124	500,000	3.3640
C&D Canal Pierce Creek Upland Sites Expansion	$20	$16	$19		4,400,000	1.1990
Capping- Landfill	$37	$39	$38	$36	500,000	2.8690
Capping- Brownfields	$68	$70	$69	$68	500,000	2.8690
Capping- Elizabeth River, VA				$28	97,000	2.8040
Capping- Patapsco River, MD		$12	$11		810,000	2.8040
Confined Aquatic Disposal Pit- Patapsco River, MD	$5				3,700,000	2.1460
Confined Disposal Facility- Lower Bay				$11	10,000,000	0.7230
Confined Disposal Shoreline Facility- Patapsco River	$16				3,600,000	1.6810
Cox Creek Expansion	$19				1,900,000	1.6310
HMI Expansion	$12	$11	$12		25,000,000	1.0020
Large Island Restoration- Lower Bay				$16	4,600,000	1.6920
Large Island Restoration- Mid Bay	$20	$20	$18		34,600,000	2.3870
Mine Placement- Cecil County, MD	$52	$49	$52		10,700,000	3.5760
Mine Placement- Western Maryland	$65	$72	$66		2,000,000	3.5760
Norfolk Ocean Open Water Placement		$28	$27	$11	sufficient	1.9090
Pooles Island Open Water Site Expansion		$5	$6		5,000,000	0.9090
PIERP Expansion		$19	$18		24,000,000	1.2110
Rappahannock Shoal Deep Alternate Open Water Site Expansion		$20	$19	$8	5,000,000	0.0000
Shoreline Restoration- Lower Bay				$41	790,000	1.4090
Shoreline Restoration- Mid Bay	$41	$41	$39		1,260,000	1.5280

Table 3-6

Unit Cost, Capacity, and Normalized BEWG Score +1.91 for Federal DMMP Alternatives (Continued)

Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Positive, Normalized BEWG score
Shoreline Restoration- Upper Bay	$42	$40	$40		790,000	1.8390
Small Island Restoration- Lower Bay				$26	2,300,000	1.6960
Small Island Restoration- Mid Bay	$28	$26	$25		2,300,000	1.6890
Wetland Restoration- Dorchester County, MD	$38	$38	$35		3,200,000	3.7190
Dam Neck Ocean Open Water Placement				$5	sufficient	1.9090
HMI (Existing)	$6	$5	$6		10,000,000	2.2950
New Open Water (Deep Trough)		$6	$5		sufficient	1.1670
Pooles Island Open Water Site (Existing)		$5			4,700,000	1.1210
Rappahannock Shoal Deep Alternate Open Water Site (Existing)				$5	sufficient	0.8750
Wolf Trap Alternate Open Water Placement		$19	$17	$5	sufficient	0.6420

Unit costs for the federal standard were provided by CENAB (November 2004).

Table 3-7

Summary of DMMP Alternative Contingency Factors

Alternative	Contingency Factor
Agricultural Placement- Maryland	50%
Agricultural Placement- Virginia	50%
Artificial Island Creation- Lower Bay	25%
Artificial Island Creation- Upper Bay	25%
Beach Nourishment- Virginia	20%
Building Products	50%
C&D Canal Pierce Creek Upland Sites Expansion	25%
Capping- Landfill	25%
Capping- Brownfields	30%
Capping- Elizabeth River, VA	25%
Capping- Patapsco River, MD	25%
Confined Aquatic Disposal Pit- Patapsco River, MD	30%
Confined Disposal Facility- Lower Bay	25%
Confined Disposal Shoreline Facility- Patapsco River	25%
Cox Creek Expansion	25%
HMI Expansion	25%
Large Island Restoration- Lower Bay	25%
Large Island Restoration- Mid Bay	25%
Mine Placement- Cecil County, MD	50%
Mine Placement- Western Maryland	50%
Norfolk Ocean Open Water Placement	20%
Pooles Island Open Water Site Expansion	20%
PIERP Modification	25%
Rappahannock Shoal Deep Alternate Open Water Site Expansion	20%
Shoreline Restoration- Lower Bay	35%
Shoreline Restoration- Mid Bay	35%
Shoreline Restoration- Upper Bay	35%
Small Island Restoration- Lower Bay	30%
Small Island Restoration- Mid Bay	30%
Wetland Restoration- Dorchester County, MD	50%
Dam Neck Ocean Open Water Placement	20%
HMI (Existing)	20%
New Open Water (Deep Trough)	20%
Pooles Island Open Water Site (Existing)	20%
Rappahannock Shoal Deep Alternate Open Water Site (Existing)	20%
Wolf Trap Alternate Open Water Placement	20%

Table 3-8

16 June 2004 Management Roundtable Participants

Agency/Organization	Attendee
US Army Corps of Engineers, Baltimore District	Dan Bierly
	Scott Johnson
	Dennis Klosterman
	Jeff McKee
	Gwen Meyer
	Donald Snyder
	Michael Snyder
	Chris Spaur
Maryland Port Administration	Frank Hamons
	Katrina Jones
	Steve Storms
	John Vasina
Citizens' Advisory Committee	Fran Flanigan

Table 3-9

Qualitative Risk Rankings

Bold values indicate risk score beyond cutoff criteria for further consideration.

Alternative	Technical/Logistical		Legal/Political	
Agricultural Placement - MD	**4**	Studies have been done in this and other areas; specific constraints of project (size of farm field, type of soils, distance from barge to field) make it challenging	2	Likely regulatory issues with groundwater, putting salt on land; may be difficulties with public opposition at the site
Agricultural Placement - VA	**4**	same as Agricultural Placement - MD	2	Same as Agricultural Placement - MD
Artificial Island Creation- Lower	2	Would be similar to PIERP, so many techniques now standard; development of wetlands and habitat still being worked out, so not yet into routine applications	**3**	No law against it, but significant public opposition exists
Artificial Island Creation- Upper	2	Same rationale as Artificial Island Creation - Lower	**3**	Same rationale as Artificial Island Creation - Lower
Beach Nourishment- VA	1	Done routinely in study area as well as other areas	1	Some minor regulatory concerns; generally has public support
Building Products	**4**	Has been done in Germany; not too much study here	2	Could inundate brick industry; would be subsidizing industry; potential regulatory issues with emissions and outflow, although assumed to be manufactured at existing facility
C&D Canal Upland Sites Expansion	1	Assuming there is foundation material to support dike raising, this type of project has successfully been done before	2	Local community concerns about groundwater (Pierce Creek)
Capping- Landfill	2	Smaller, similar projects have been done before; may be more logistically challenging given larger quantities (more trucks, etc).	2	May be regulatory issues; likely public opposition associated with trucking necessary to move material out of CDF to capping site

Table 3-9

Qualitative Risk Rankings (Continued)

Alternative	Technical/Logistical		Legal/Political	
Capping- Brownfields	2	Same rationale as Capping - Landfill; assumes more amendments than landfill capping and does not consider remediation	2	Same rationale as Capping – Landfill
Capping- Elizabeth River	2	Has been done on a large scale off NY Harbor; some uncertainty as to whether cap stays in place; associated regulatory challenges fall under legal/political	2	Regulatory issues associated with how the capping is carried out
Capping- Patapsco River	2	Same rationale as Capping – Elizabeth R	2	Public would rather have material removed completely, but would be okay with capping; probably not against prohibition on open water placement because it's a beneficial use
CAD - Patapsco River	2	Same rationale as Capping – Elizabeth R	**3**	May be against state prohibition on open water placement; certainly other regulatory and public issues associated with potential for resuspending toxics
CDF - Lower	1	Assuming partial expansion of existing site; similar projects have been done before	**5**	Expansion of existing Craney Island site; legislation from 1946 that allows material only from Norfolk Harbor and vicinity to be placed there
CDF - Patapsco River	1	Similar projects have been completed elsewhere; similar to islands, but no habitat development assumed, therefore more confidence in successful outcome;	2,**3, 4,5**	If CDF is within 5 miles of HMI, it is against state law and therefore a 5. If CDF is within 5 miles of HMI, but is part of a larger suite of projects that includes community enhancements, then it will have public support and should be scored a 4. If the project is outside of the 5-mile HMI buffer and is part of a larger suite of projects, including community enhancement, it should be scored a 2. If it is outside of the 5-mile HMI buffer and does not include community enhancements, it should be scored a 3.

Table 3-9

Qualitative Risk Rankings
(Continued)

Alternative	Technical/Logistical		Legal/Political	
Cox Creek Expansion	1	Assumes vertical expansion; similar projects have been done before	**3**	Significant public opposition exists (based on comments at the CAC meeting)
HMI Expansion	1	Assumes all upland, no habitat development; similar projects have been successfully done before	**5**	Against state law – supposed to close in 2009
Large Island Restoration- Lower	2	Same rationale as Artificial Island Creation – Lower	2	Some regulatory and public acceptance issues exist
Large Island Restoration- Mid	2	Same rationale as Artificial Island Creation – Lower	2	Same rationale as Large Island Restoration – Lower
Mine Placement- Cecil County	3	Large logistical constraints – many trucks needed, potential difficulty in maintaining efficiency of placement given need to move material over land	**3**	Significant public opposition at placement sites and some regulatory issues
Mine Placement- Western MD	**4**	Similar rationale to Mine Placement – Cecil County; material would need to be moved farther, need for rail infrastructure	**3**	Same rationale as Mine Placement – Cecil County
Norfolk Ocean (Existing)	1,2	1 for VA – routinely done; 2 for MD – would need more, larger scows	2	Some moderate regulatory issues
Pooles Island Open Water Site Expansion	1	Expansion of existing site, therefore alternative considered routine	**5**	Against state law – due to close in 2009; significant public opposition to expansion
PIERP Expansion	2	Same rationale as Artificial Island Creation – Lower	2	Some regulatory issues and moderate public opposition
Rappahannock Shoal Deep Alternate Open Water Site Exp	1	Routinely done	2	Regulatory issues associated with sandbar shark EFH. A 1981 agreement between the State of Maryland and the Commonwealth of Virginia only allows the placement of dredged material from Virginia waters.

Table 3-9

Qualitative Risk Rankings
(Continued)

Alternative	Technical/Logistical		Legal/Political	
Shoreline Restoration- Lower	2	Uncertainties associated with wetland creation similar to island restoration projects; some discussion of scoring a 1 – may be somewhat easier because of land access and more predictable hydrology; consensus on scoring a 2	2	Some regulatory and some public issues
Shoreline Restoration- Mid	2	Same rationale as Shoreline Restoration - Lower	2	Same rationale as Shoreline Restoration – Lower
Shoreline Restoration- Upper	2	Same rationale as Shoreline Restoration - Lower	2	Same rationale as Shoreline Restoration – Lower
Small Island Restoration- Lower	2	Same rationale as Artificial Island Creation - Lower	2	Same rationale as Shoreline Restoration – Lower
Small Island Restoration- Mid	2	Same rationale as Artificial Island Creation - Lower	2	Same rationale as Large Island Restoration – Lower
Wetland Restoration- Dorchester	3	Score assumes Fish and Wildlife Service is most concerned with fill open water and not specific elevations; if FWS wants control over final elevations, should be scored a 4	1	Few public or regulatory challenges
Dam Neck (Existing)	1	Routinely done	1	Few public or regulatory challenges because it is an existing site
HMI Island (Existing)	1	Routinely done	1	Few public or regulatory challenges because it is an existing site
New Open Water (Deep Trough)	1	Similar projects are routinely done	**5**	Against state law
Pooles Island (Existing)	1	Routinely done	2	Few regulatory challenges because it is an existing site; some public opposition from fishermen
Rappahannock Shoal Deep Alternate (Existing)	1	Routinely done	1	Few public or regulatory challenges because it is an existing site

Table 3-9

Qualitative Risk Rankings (Continued)

Alternative	Technical/Logistical		Legal/Political	
Wolf Trap Alternate (Existing)	1	Routinely done	1	Few public or regulatory challenges because it is an existing site. A 1981 agreement between the State of Maryland and the Commonwealth of Virginia only allows the placement of dredged material from Virginia waters.

Table 3-10

Quantitative & Qualitative Criteria Summary Table

Shading indicates alternatives not included in any suite due to high risk ranking. See footnotes for additional detail.

Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Habitat Benefit Index	Technical/ Logistical Risk[a]	Acceptability Risk[b]
Agricultural Placement - Maryland	$51	$51	$50		500,000	0	4	2
Agricultural Placement - Virginia				$43	500,000	0	4	2
Artificial Island Creation - Lower Bay				$18	34,600,000	601	2	3
Artificial Island Creation - Upper Bay	$12	$11	$12		48,400,000	962	2	3
Beach Nourishment - Virginia				$12	5,600,000	0	1	1
Building Products	$117	$120	$118	$124	500,000	0	4	2
C&D Canal Pierce Creek Upland Sites Expansion	$20	$16	$19		4,400,000	0	1	2
Capping - Landfill	$37	$39	$38	$36	500,000	0	2	2
Capping - Brownfields	$68	$70	$69	$68	500,000	0	2	2
Capping - Elizabeth River, VA				$28	97,000	56	2	2
Capping - Patapsco River, MD		$12	$11		810,000	701	2	2
Confined Aquatic Disposal Pit - Patapsco R	$5				3,700,000	0	2	3
Confined Disposal Facility - Lower Bay				$11	10,000,000	0	1	5
Confined Disposal Shoreline Facility - Patapsco R	$16				3,600,000	0	1	2,3,4,5[c]
Cox Creek Expansion	$19				1,900,000	0	1	3
HMI Expansion	$12	$11	$12		25,000,000	0	1	5
Large Island Restoration - Lower Bay				$16	4,600,000	406	2	2
Large Island Restoration - Mid Bay		$20	$18		34,600,000	2,387	2	2
Mine Placement - Cecil County, MD	$52	$49	$52		10,700,000	0	3	3
Mine Placement - Western Maryland	$65	$72	$66		2,000,000	1,073	4	3
Norfolk Ocean Open Water Placement		$28	$27	$11	sufficient	0	1,2	2
Pooles Island Open Water Site Expansion		$5	$6		5,000,000	0	1	5
PIERP Expansion		$19	$18		24,000,000	727	2	2
Rappahannock Shoal Deep Alternate Open Water Site Expansion		$20	$19	$8	5,000,000	0	1	2
Shoreline Restoration - Lower Bay				$41	790,000	155	2	2

Table 3-10

Summary Table
(Continued)

Alternative	Harbor ($/cy)	C&D ($/cy)	MD Bay ($/cy)	VA Bay ($/cy)	Capacity (cy)	Habitat Benefit Index	Technical/ Logistical Risk[a]	Acceptability Risk[b]
Shoreline Restoration - Mid Bay	$41	$41	$39		1,260,000	267	2	2
Shoreline Restoration - Upper Bay	$42	$40	$40		790,000	202	2	2
Small Island Restoration - Lower Bay				$26	2,300,000	170	2	2
Small Island Restoration - Mid Bay	$28	$26	$25		2,300,000	169	2	2
Wetland Restoration - Dorchester County, MD		$38	$35		3,200,000	3,719	3	1
Dam Neck Ocean Open Water Placement				$9	sufficient	0	1	1
HMI (Existing)	$9	$8	$9		10,000,000	0	1	1
New Open Water (Deep Trough)		$6	$5		sufficient	0	1	5
Pooles Island Open Water Site (Existing)		$5			4,700,000	0	1	2
Rappahannock Shoal Deep Alternate Open Water Site (Existing)				$7	sufficient	0	1	1
Wolf Trap Alternate Open Water Placement		$22	$20	$8	sufficient	0	1	1

[a]Alternatives with a Technical/Logistical Risk score of 4 or 5 were considered too risky to be implementable within the 20-year planning horizon being used for this DMMP and were removed from consideration prior to suite formulation.

[b]Alternatives with an Acceptability Risk score of 3, 4, or 5 (those that were illegal or faced significant public opposition) were not included in suites of alternatives being considered to meet the 20-year-minimum placement needs of the Port of Baltimore. These alternatives remained under consideration during suite formulation, but suites containing these alternatives were removed prior to selection of the recommended plan.

[c] Confined Disposal Shoreline Facility-Patapsco was scored 2, 3, 4, and 5 for Acceptability Risk since, depending on the ultimate design, the CIF would be more or less “acceptable” to the public. The presumed design of the CIFs included in the Recommended Plan have features such as community enhancement that render its acceptability risk a”2.”

Table 3-11

Comparison of Recommended Plan and Federal Standard

Recommended Plan

Geographic Channel Area	Dredged Material Placement Site	Net capacity need met by site (mcy)	Unit cost for placement	Cost for Placement Site	Habitat Benefit Index of Placement Site
Harbor Channels	CDF's in Patapsco River	14	$ 16	$ 224,000,000	0
C&D Canal Approach Channels & Chesapeake Bay Approach Channels (MD)	PIERP Expansion	24	$ 19	$ 456,000,000	727
	Large Island Restoration - Mid Bay	10	$ 19	$ 190,000,000	690
	Wetland Restoration - Dorchester County (Blackwater Refuge)	6.4	$ 38	$ 243,200,000	7,438
Chesapeake Bay Approach Channels (VA)					
Cape Henry Channel	Dam Neck Open Water Site	6.7	$ 9	$ 60,300,000	0
York Spit Channel	Rappahannock Shoal Deep Alternate Open Water Site	0.2	$ 7	$ 1,400,000	0
Rappahannock Shoal Channel	Wolf Trap Alternate Open Water Site	3.1	$ 8	$ 24,800,000	0
TOTAL		64.4		$ 1,199,700,000	8,855

Federal Plan

Geographic Channel Area	Dredged Material Placement Site	Net Capacity need met by site (mcy)	Unit cost for placement	Cost for Placement Site	Habitat Benefit Index of Placement Site
Harbor Channels	HMI Expansion	14	$ 12	$ 168,000,000	0
C&D Canal Approach Channels & Chesapeake Bay Approach Channels (MD)	Open Water Placement (Deep Trough)	40.4	$ 5	$ 202,000,000	0
Chesapeake Bay Approach Channels (VA)					
Cape Henry Channel	Dam Neck Open Water Site	6.7	$ 9	$ 60,300,000	0
York Spit Channel	Rappahannock Shoal Deep Alternate Open Water Site	0.2	$ 7	$ 1,400,000	0
Rappahannock Shoal Channel	Wolf Trap Alternate Open Water Site	3.1	$ 8	$ 24,800,000	0
TOTAL		64.4		$ 456,500,000	0

CHAPTER 3

FIGURES

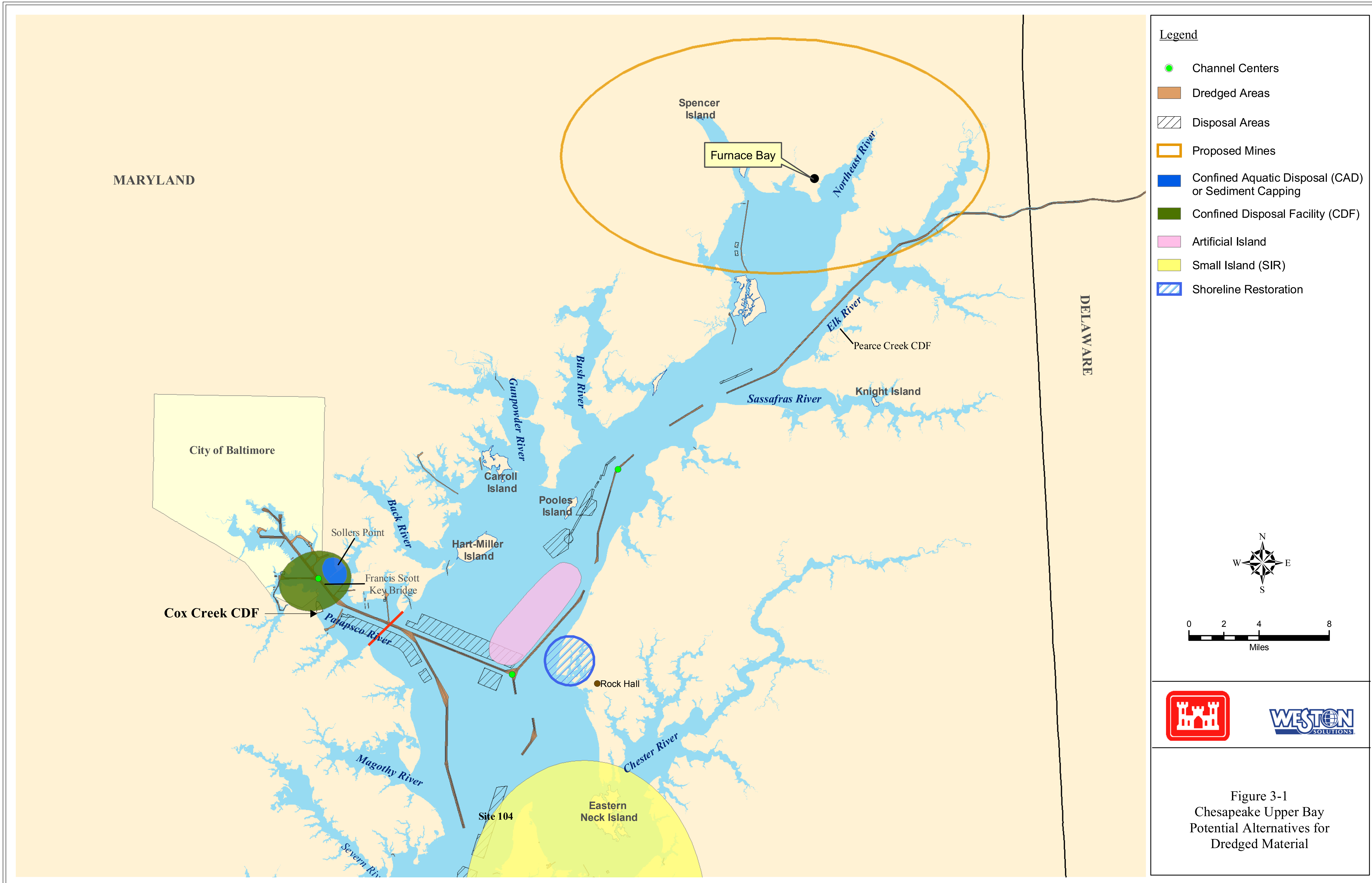
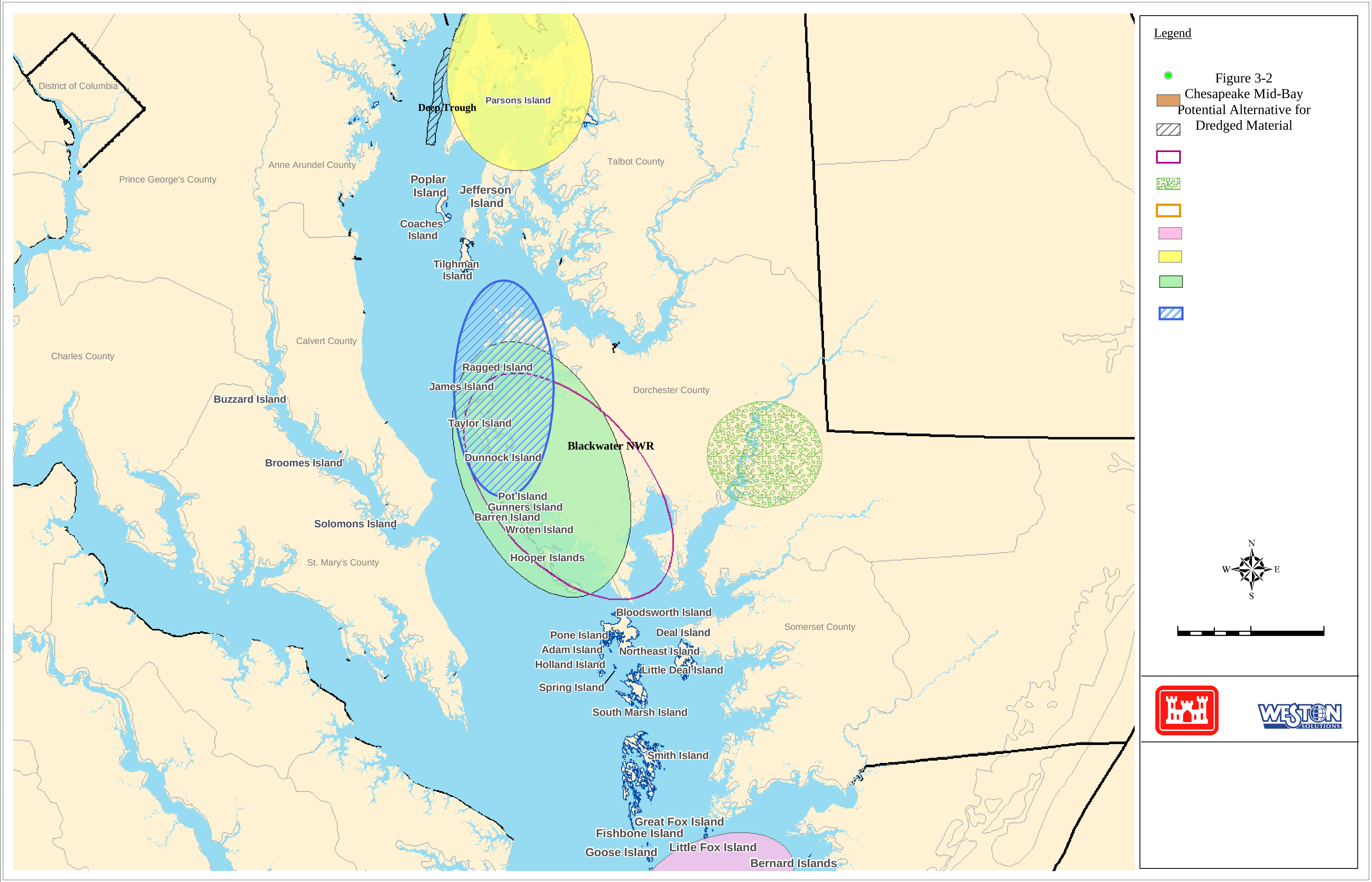
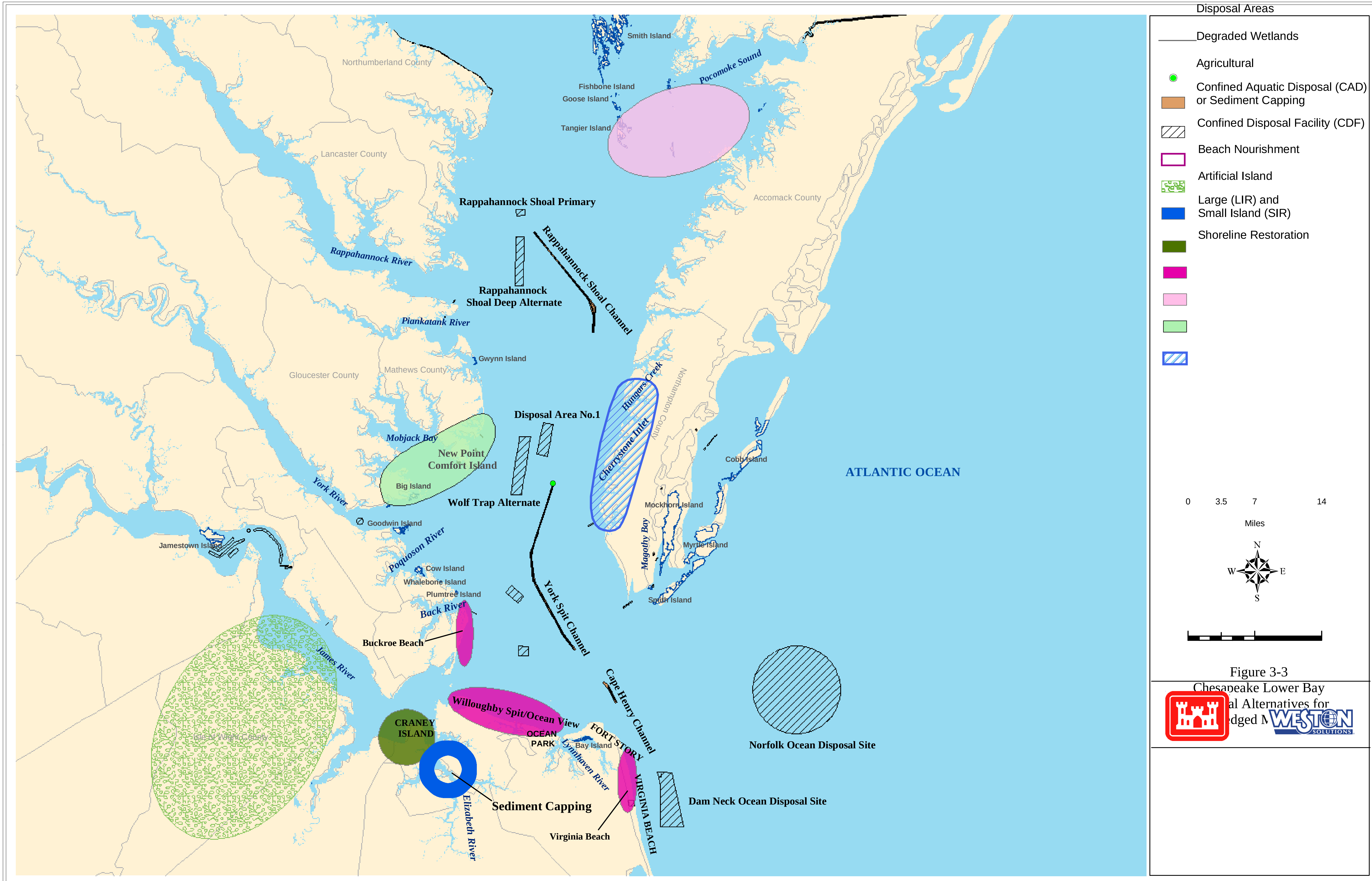


Figure 3-1
Chesapeake Upper Bay
Potential Alternatives for
Dredged Material



Legend
Figure 3-2
Chesapeake Mid-Bay
Potential Alternative for
Dredged Material
District of Columbia
Prince George's County
Anne Arundel County
Deep Trough
Parsons Island
Talbot County
Poplar Island
Jefferson Island
Coaches Island
Tilghman Island
Calvert County
Charles County
Ragged Island
James Island
Buzzard Island
Dorchester County
Taylor Island
Blackwater NWR
Dunnock Island
Broomes Island
Pot Island
Gunners Island
Barren Island
Wroten Island
Solomons Island
St. Mary's County
Hooper Islands
Bloodsworth Island
Pone Island
Deal Island
Somerset County
Adam Island
Northeast Island
Holland Island
Little Deal Island
Spring Island
South Marsh Island
Smith Island
Great Fox Island
Fishbone Island
Little Fox Island
Goose Island
Bernard Islands
N
W
E
S



Disposal Areas
Degraded Wetlands
Agricultural
Confined Aquatic Disposal (CAD) or Sediment Capping
Confined Disposal Facility (CDF)
Beach Nourishment
Artificial Island
Large (LIR) and Small Island (SIR)
Shoreline Restoration
0 3.5 7 14
Miles
N
W
E
S
Figure 3-3
Chesapeake Lower Bay
Smith Island
Northumberland County
Pocomoke Sound
Fishbone Island
Goose Island
Tangier Island
Lancaster County
Accomack County
Rappahannock Shoal Primary
Rappahannock River
Rappahannock Shoal Channel
Rappahannock Shoal Deep Alternate
Piankatank River
Gwynn Island
Gloucester County
Mathews County
Hungars Creek
Northampton County
Disposal Area No.1
Cherrystone Inlet
Mobjack Bay
New Point Comfort Island
Big Island
Wolf Trap Alternate
Cobb Island
ATLANTIC OCEAN
York River
Goodwin Island
Mockhorn Island
Jamestown Island
Poquoson River
Magothy Bay
Myrtle Island
Cow Island
Whalebone Island
Plumtree Island
York Spit Channel
Back River
Smith Island
Buckroe Beach
James River
Cape Henry Channel
Willoughby Spit/Ocean View
CRANEY ISLAND
OCEAN PARK
Bay Island
FORT STORY
Isle of Wight County
Norfolk Ocean Disposal Site
Lynnhaven River
VIRGINIA BEACH
Sediment Capping
Elizabeth River
Dam Neck Ocean Disposal Site
Virginia Beach

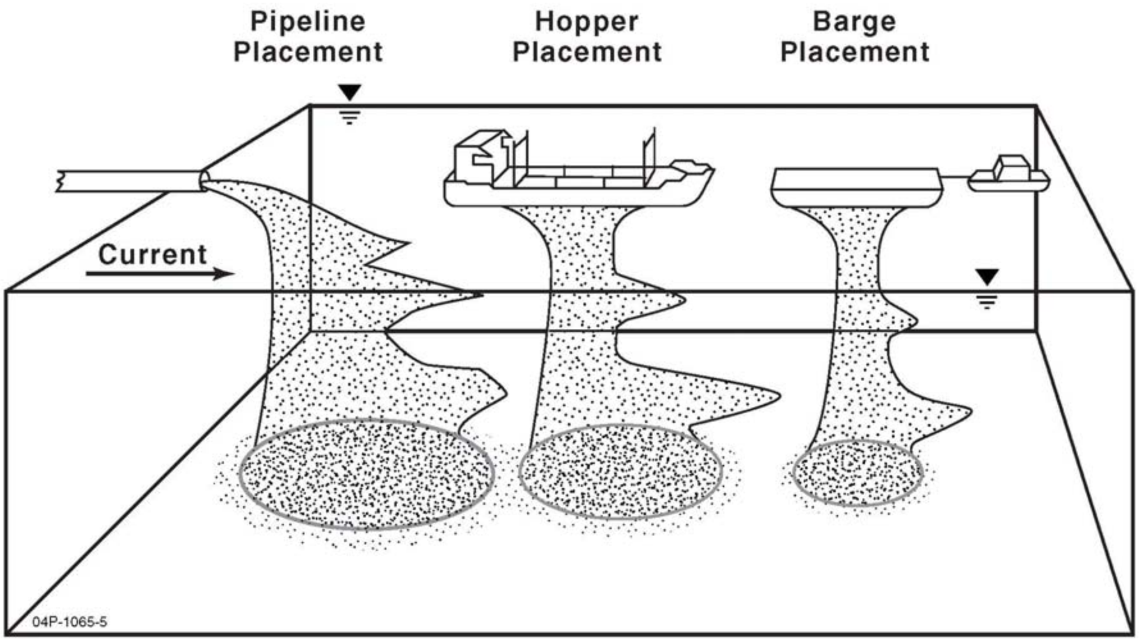


Figure 3-4 Open Water Placement Methods (EPA, USACE, 1992, rev. 2004)

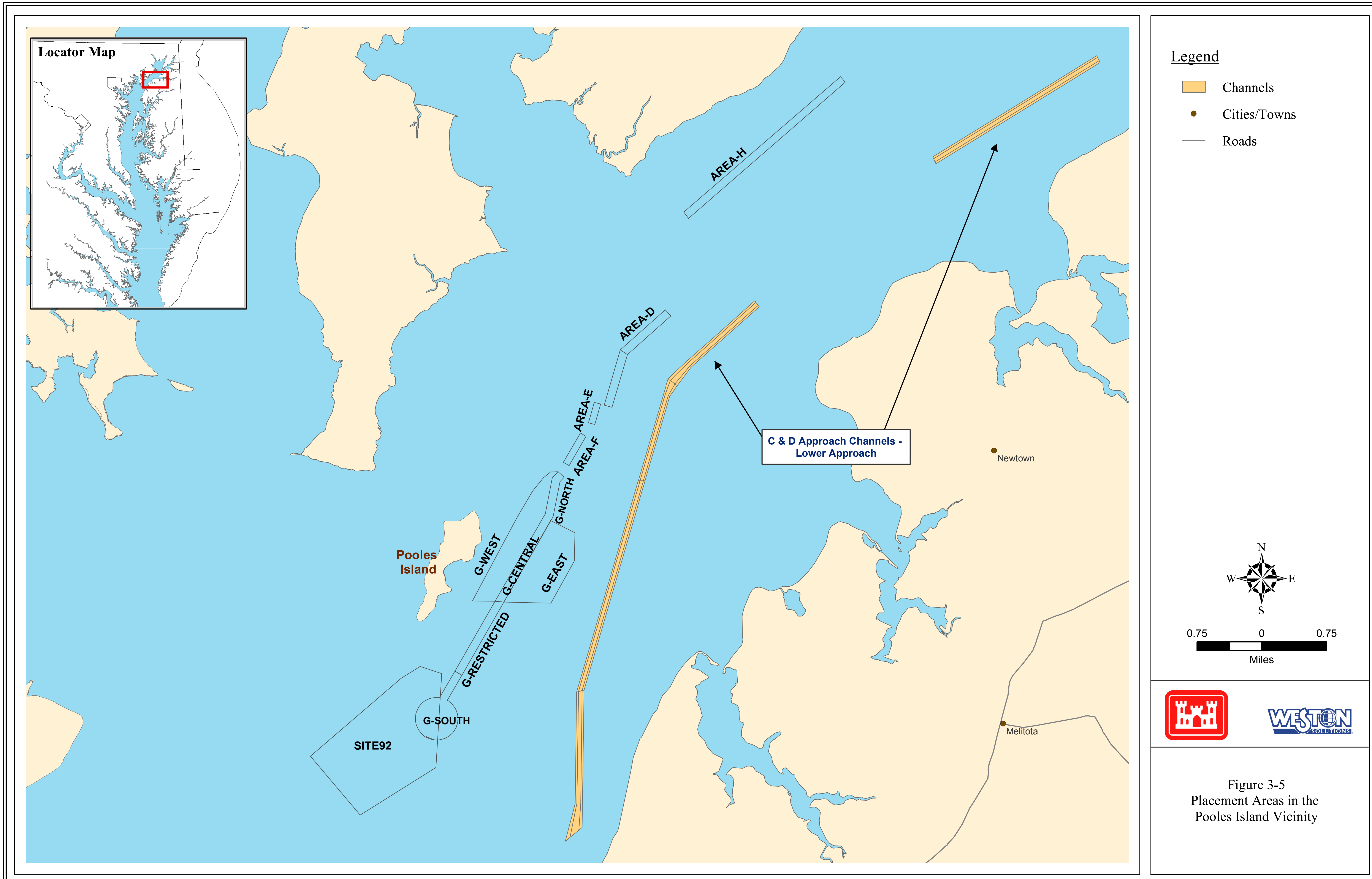


Figure 3-5
Placement Areas in the
Pooles Island Vicinity

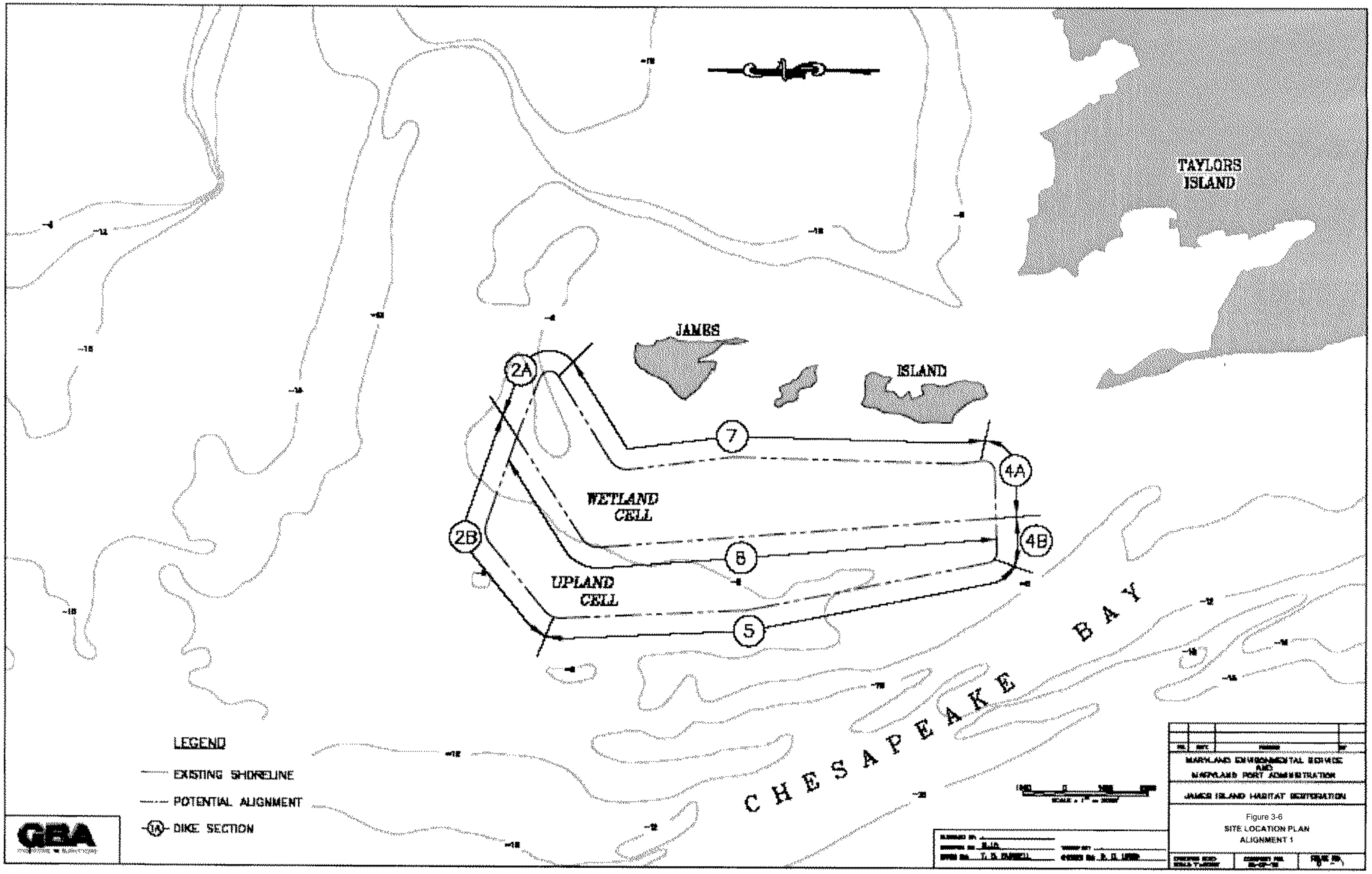


Figure 3-6
SITE LOCATION PLAN
ALIGNMENT 1

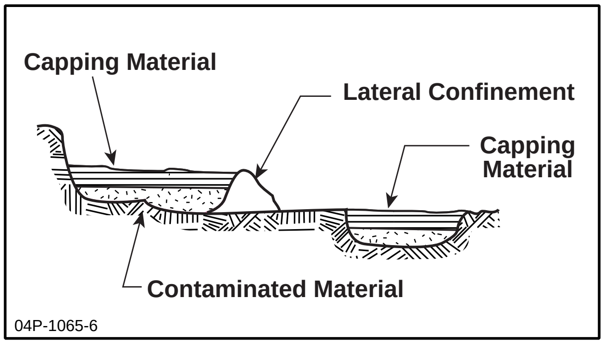


Figure 3-7 Confined Aquatic Disposal

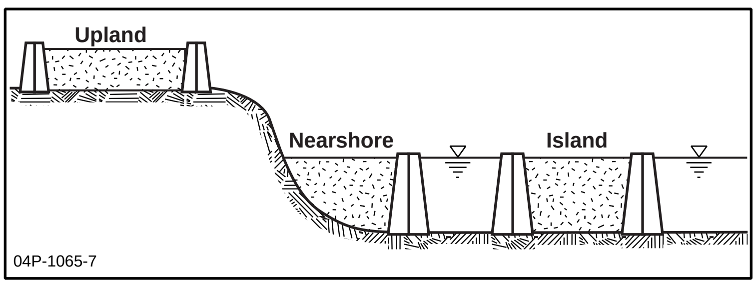


Figure 3-8 Types of Confined Disposal Facilities

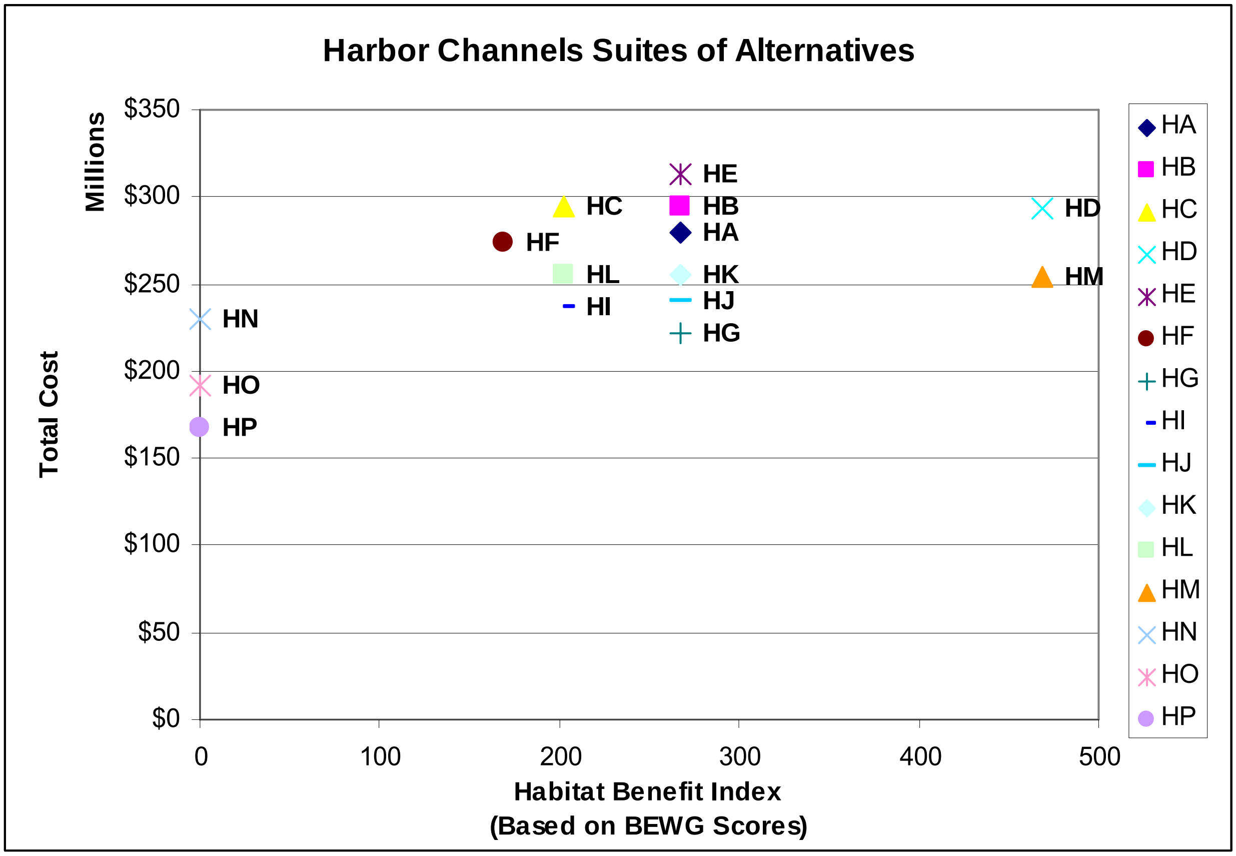


Figure 3-9 Suites of Alternatives for Harbor Channels. Each suite meets contaminated capacity and overall capacity needs. The key for this figure follows.

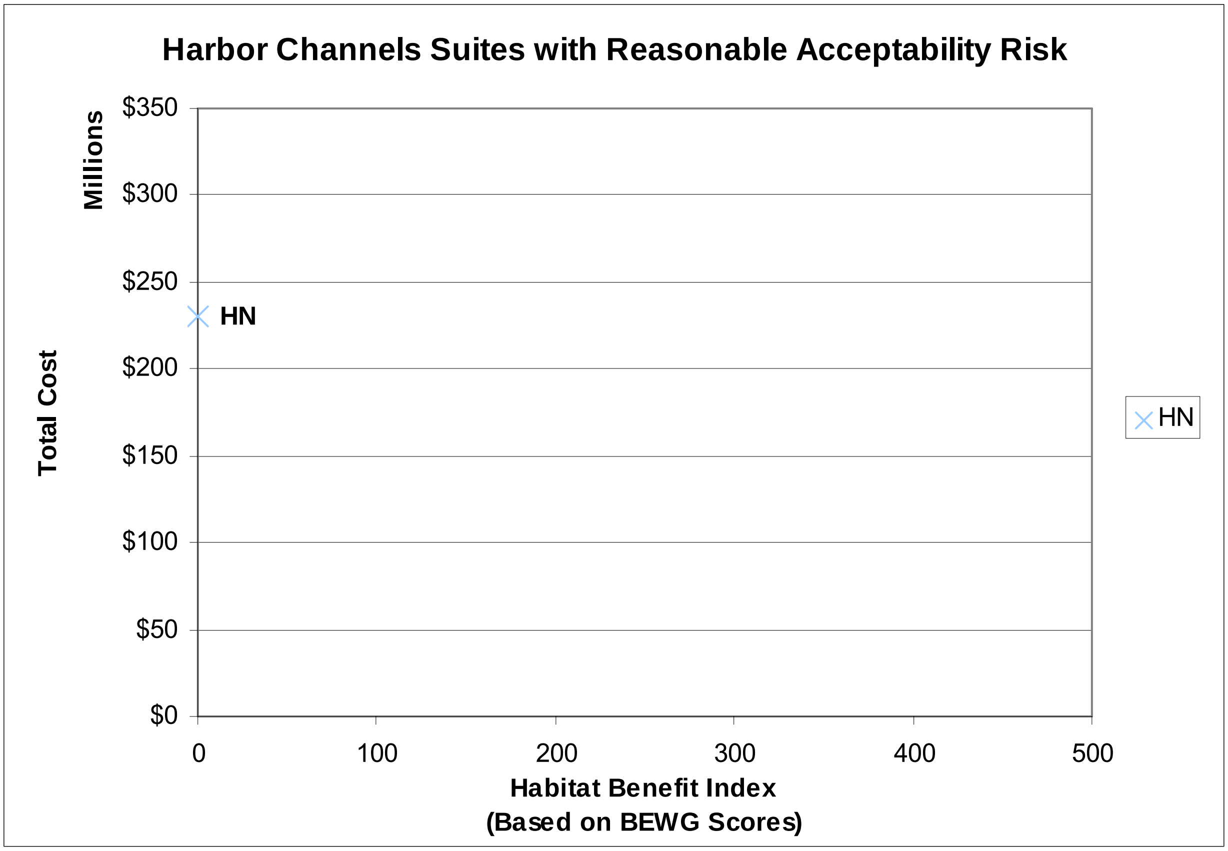


Figure 3-10 Suite of alternatives with reasonable acceptability risk for Harbor Channels

Key for Figures 3-9 and 3-10: Harbor Channel suites.

Suite	Alternatives
HA	3 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Landfill; Shoreline Restoration - Mid
HB	3 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Brownfield; Shoreline Restoration - Mid
HC	3 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Landfill; Capping - Brownfield; Shoreline Restoration - Upper
HD	3 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Shoreline Restoration - Mid; Shoreline Restoration – Upper
HE	3 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Landfill; Capping - Brownfield; Shoreline Restoration - Mid
HF	3 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Small Island Restoration - Mid
HG	Confined Aquatic Disposal Pit; 2 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Shoreline Restoration - Mid
HH	Confined Aquatic Disposal Pit; 2 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Landfill; Shoreline Restoration – Upper
HI	Confined Aquatic Disposal Pit; 2 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Brownfield; Shoreline Restoration – Upper
HJ	Confined Aquatic Disposal Pit; 2 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Landfill; Shoreline Restoration – Mid
HK	Confined Aquatic Disposal Pit; 2 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Brownfield; Shoreline Restoration – Mid
HL	Confined Aquatic Disposal Pit; 2 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Capping - Landfill; Capping - Brownfield; Shoreline Restoration - Upper
HM	Confined Aquatic Disposal Pit; 2 Confined Disposal Shoreline Facilities; Cox Creek Expansion; Shoreline Restoration - Mid; Shoreline Restoration - Upper
HN	4 Confined Disposal Shoreline Facilities
HO	Confined Aquatic Disposal Pit; 3 Confined Disposal Shoreline Facilities
HP	HMI Expansion

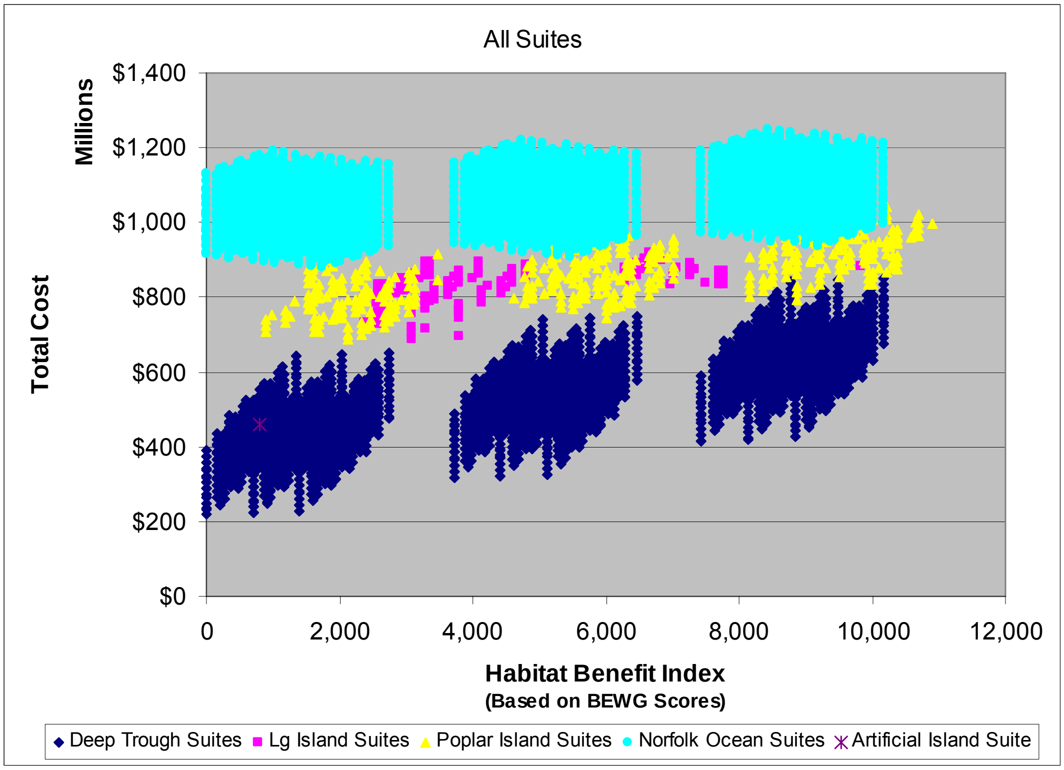


Figure 3-11a All suites for combined C&D and Maryland Bay Approaches

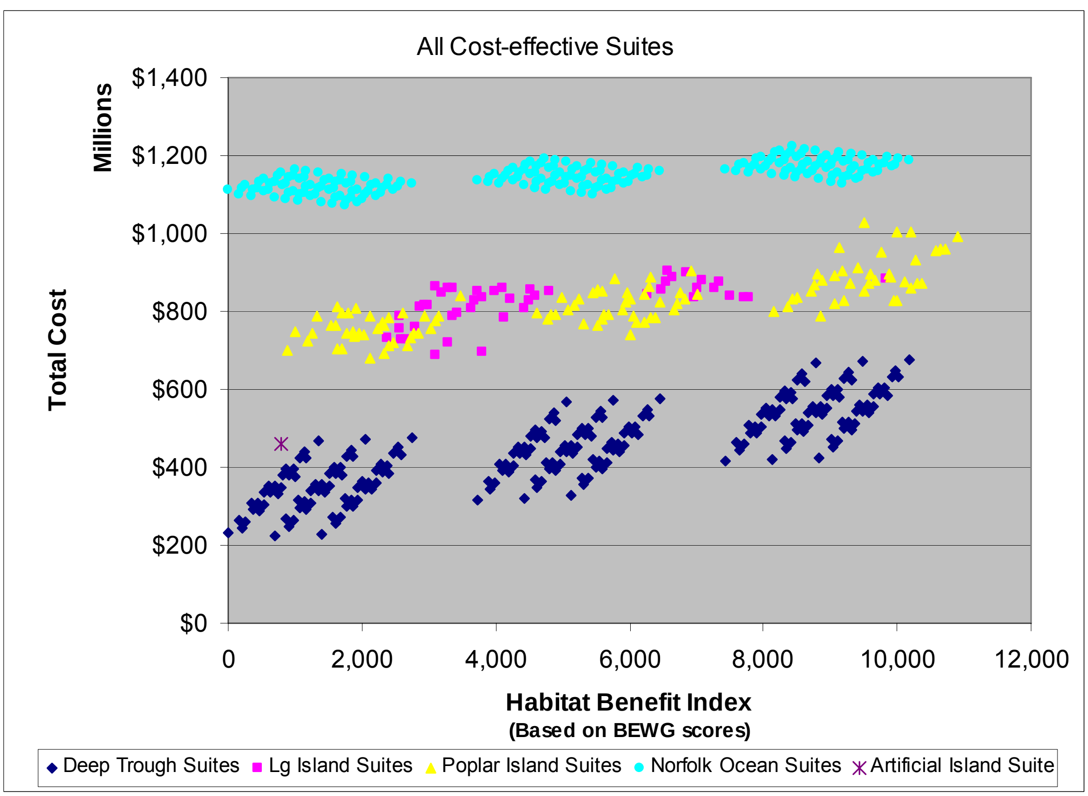


Figure 3-11b Remaining suites for combined C&D and Maryland Bay Approaches after cost-effectiveness screening

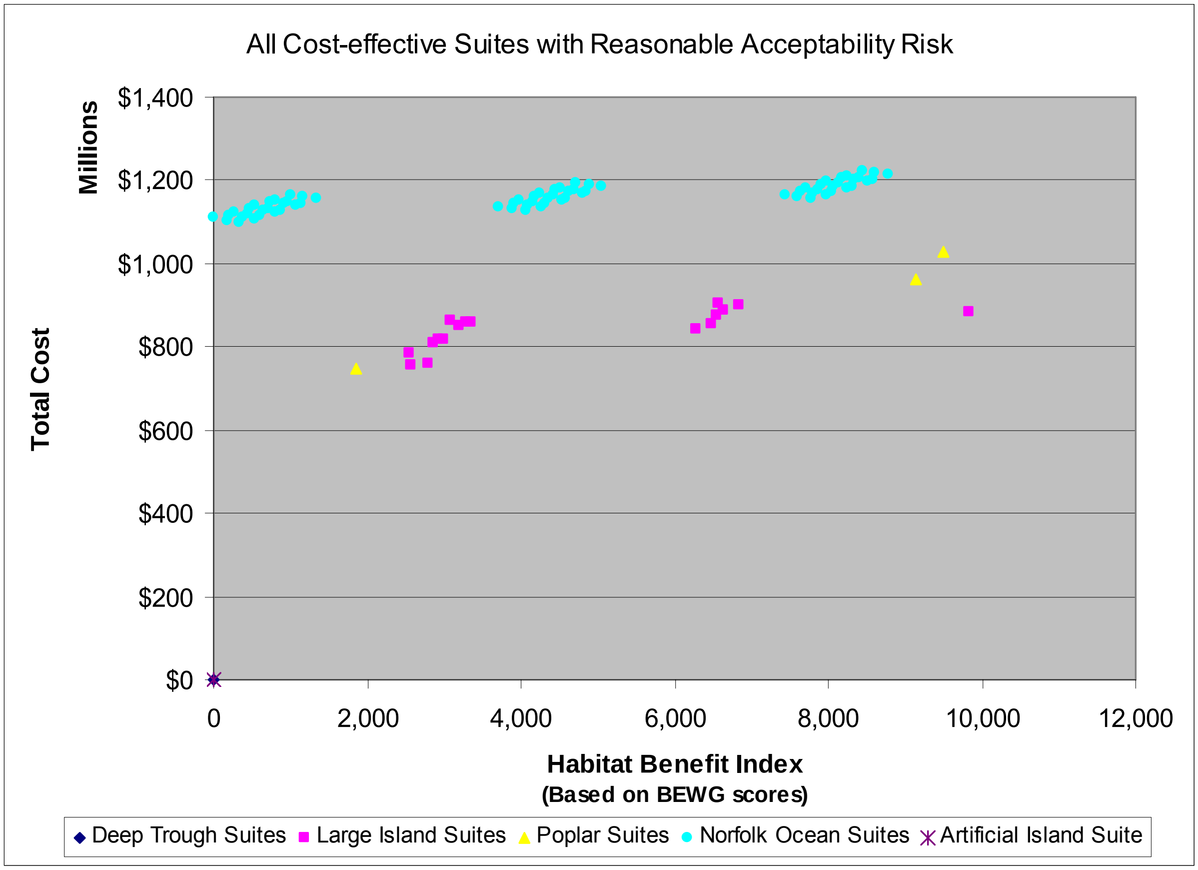


Figure 3-12 Suites with reasonable acceptability risk for combined C&D and Maryland Bay Approaches

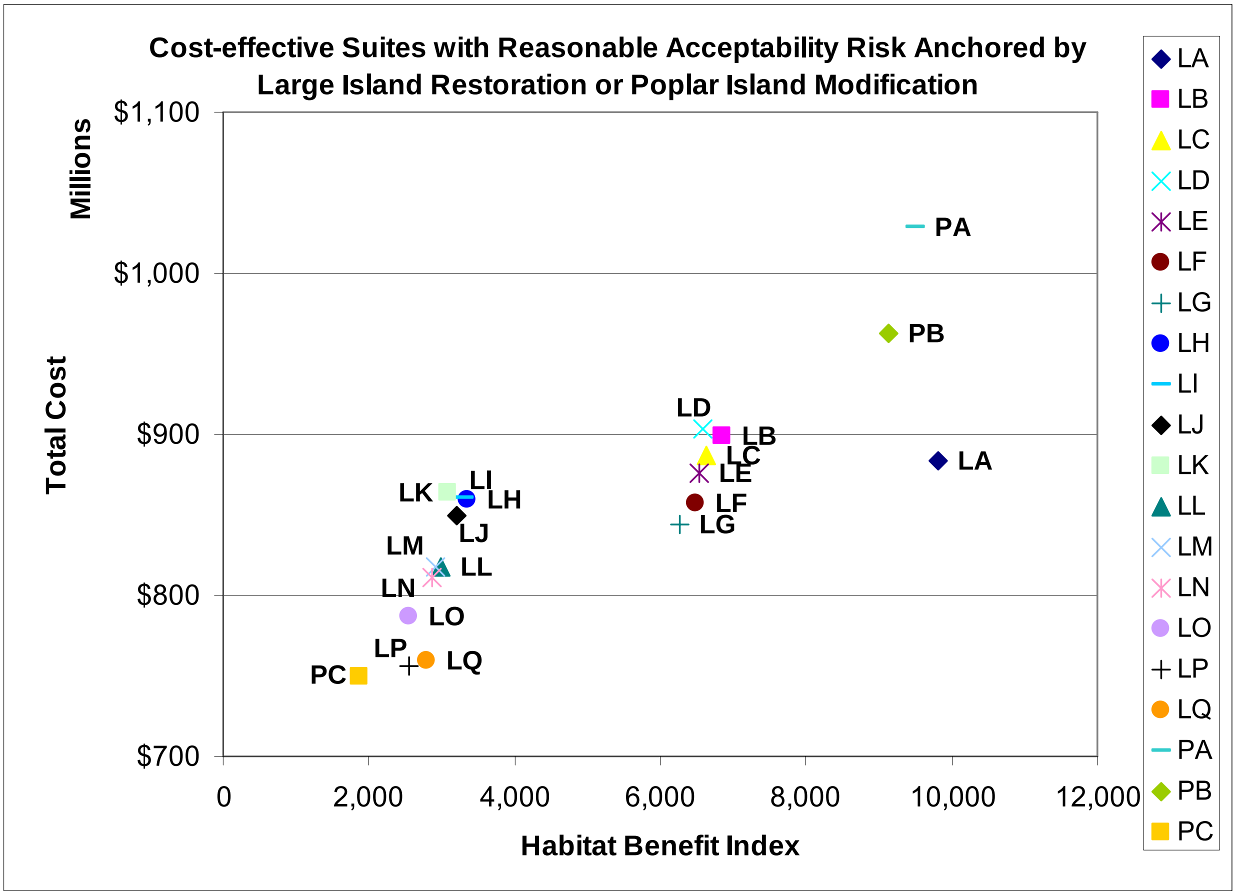


Figure 3-13 Cost-effective suites with reasonable acceptability risk anchored by Large Island Restoration or PIERP Modification. Note that the y-axis has been truncated. The key for this figure follows.

Key for Figure 3-13: Cost-effective suites with reasonable acceptability risk anchored by Large Island Restoration or PIERP Modification

Suite	Alternatives
LA	Large Island Restoration - Mid; 2 Wetland Restoration
LB	Large Island Restoration - Mid; 2 Shoreline Restoration - Mid; Shoreline Restoration - Upper; Wetland Restoration
LC	Large Island Restoration - Mid; Capping - Landfill; 2 Shoreline Restoration - Mid; Wetland Restoration
LD	Large Island Restoration - Mid; Capping - Landfill; Capping - Brownfield; Shoreline Restoration - Mid; Shoreline Restoration - Upper; Wetland Restoration
LE	Large Island Restoration - Mid; Shoreline Restoration - Mid; Small Island Restoration; Wetland Restoration
LF	Large Island Restoration - Mid; Shoreline Restoration - Upper; Small Island Restoration; Wetland Restoration
LG	Large Island Restoration - Mid; Capping - Landfill; Small Island Restoration; Wetland Restoration
LH	Large Island Restoration - Mid; 3 Shoreline Restoration - Mid; Small Island Restoration
LI	Large Island Restoration - Mid; Capping Landfill; 2 Shoreline Restoration - Mid; Shoreline Restoration - Upper; Small Island Restoration
LJ	Large Island Restoration - Mid; Shoreline Restoration - Mid; Shoreline Restoration - Upper; 2 Small Island Restoration
LK	Large Island Restoration - Mid; Capping - Landfill; Capping - Brownfield; 2 Shoreline Restoration - Mid; Small Island Restoration
LL	Large Island Restoration - Mid; Shoreline Restoration - Mid; 2 Small Island Restoration
LM	Large Island Restoration - Mid; Capping Landfill; Shoreline Restoration - Upper; 2 Small Island Restoration
LN	Large Island Restoration - Mid; C&D Upland Expansion; Shoreline Restoration - Mid; Shoreline Restoration - Upper
LO	Large Island Restoration - Mid; C&D Upland Expansion; Small Island Restoration
LP	Large Island Restoration - Mid; PIERP Modification
LQ	Large Island Restoration - Mid; Large Island Restoration - Mid
PA	PIERP Modification; Capping - Landfill; Capping - Brownfield; 3 Shoreline Restoration - Mid; Shoreline Restoration - Upper; 2 Small Island Restoration; 2 Wetland Restoration
PB	PIERP Modification; C&D Upland Expansion; 3 Shoreline Restoration - Mid; Small Island Restoration; 2 Wetland Restoration
PC	PIERP Modification, Large Island Restoration - Mid

Figure 3-14
Proposed Recommended Plan

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4. ENVIRONMENTAL CONSEQUENCES OF THE RECOMMENDED PLAN

Dredged material management alternatives for each of the four geographic areas were subject to a comprehensive screening process as described in Chapter 3. Its purpose was to identify the preferred alternatives, or recommended plan, to accommodate maintenance and new work dredging for the Baltimore Harbor and Channels project for at least the next 20 years. The recommended plan for dredged material placement is described below and shown in Figure 3-14:

- Continued maintenance dredging of the Virginia Channels and use of Open Water Placement in Virginia for material resulting from the York Spit, Rappahannock, and Cape Henry Channels (Dam Neck Open Water Placement; Rappahannock Shoal Deep Alternate Open Water Placement; Wolf Trap Alternate Open Water Placement).
- Continued maintenance dredging of the Maryland Channels and optimized use of existing dredged material management sites including Pooles Island Open Water Site, HMI DMCF, Cox Creek CDF (+36 ft dike height), and PIERP.
- Multiple Confined Disposal Facilities in the Patapsco River for Harbor material.
- PIERP Expansion for C&D Canal Lower Approach Channels and Chesapeake Bay Approach Channels (MD).
- Large Island Restoration – Middle Bay for C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).
- Wetland Restoration – Dorchester County for C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD).
- Continue to pursue opportunities to innovatively use dredged material.

This chapter evaluates, in a programmatic manner, the environmental impacts of the preferred alternatives and continued maintenance dredging. Environmental impacts include direct impacts, which are caused by the action and occur at the same time and place, and indirect impacts, which are caused by the action and are later in time or farther removed in assistance but still reasonably foreseeable (40 CFR 1508). For the PIERP Expansion alternative, the information is more site specific because of the limited options for expanding the existing PIERP Restoration project and available information from the PIERP Restoration project. For the Multiple Confined Disposal Facilities (CDFs) alternative, the assessment is limited to the placement of CDFs in the Harbor area, which would primarily impact shallow water areas adjacent to developed or former industrial land. Impacts derived from large island restoration-Middle Bay and wetland restoration are non-site specific because of the conceptual nature of these alternatives.

Existing dredged material management facilities that will continue to be used as placement sites have been previously assessed and permitted. Therefore, they will not be considered here except for an overview of the site and environmental consequences. Those facilities include Pooles Island Open Water Disposal, HMI DMCF, PIERP, Cox Creek CDF, and open water placement at existing, permitted sites including Dam Neck Open Water Placement, Rappahannock Shoal Deep Alternate Open Water Placement, and Wolf Trap Alternate Open Water Placement.

Compliance with federal regulations ensures that maintenance dredging of navigation channels and dredged material placement is environmentally acceptable. The following is a list of federal regulations and executive orders that, depending on location, could be applicable to a project. The applicable regulatory and policy requirements should be considered during the planning processes.

Federal Statutes

The American Indian Religious Freedom Act (AIRFA) (42 U.S.C.A. 1996)
Anadromous Fish Conservation Act (16 U.S.C. 757a to 757g)
Antiquities Act (16 U.S.C. 431).
Archaeological and Historic Preservation Act (16 U.S.C. 469a-1)
Archaeological Resources Protection Act (16 U.S.C. 470aa-470ll)
Clean Air Act (CAA) (42 U.S.C. 7401 et seq.)
Clean Water Act (33 U.S.C. 1251 et seq.)
Coastal Barrier Resources Act (16 U.S.C. 3501 et seq.)
Coastal Zone Management Act (16 U.S.C. 1451-1564)
Endangered Species Act (ESA) (16 U.S.C. 1531-1544)
Estuary Protection Act (16 U.S.C. 1221 et seq.)
Farmland Protection Policy Act (7 U.S.C. 4201 et seq.)
Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661 et seq.)
Magnuson-Stevens Fishery Conservation and Management Act
(16 U.S.C. 1801-1882; 90 Stat. 331; as amended)
Historic Sites Act of 1935 (16 U.S.C. 461)
Land and Water Conservation Fund Act (LWCFA) (16 U.S.C.A. 4601-11)
Marine Mammal Protection Act (16 U.S.C. 1374)
Marine Protection, Research and Sanctuaries Act (a.k.a. Ocean Dumping Act) (33 U.S.C. 1401 et seq.)
Migratory Bird Conservation Act (16 U.S.C. 715 et seq.)
National Environment Policy Act (42 U.S.C. 4321 et seq.)
National Historic Preservation Act (NHPA) (16 U.S.C. 470)

Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C.A. 3001)
Noise Control Act (42 U.S.C. 4901 et seq.)
North American Wetlands Conservation Act (16 U.S.C. 4401 et seq.)
Occupational Health and Safety Act (29 U.S.C. 651 et seq.)
Rivers & Harbors Act (33 U.S.C. 401-418)
Safe Drinking Water Act (42 U.S.C. 300F et seq.)
Solid Waste Disposal Act (42 U.S.C. 6901 et seq.)
Water Resources Development Acts (33 U.S.C. and 42 U.S.C.)
Water Resources Planning Act (42 U.S.C. 1962 et seq.)
Watershed Protection and Flood Prevention Act and the River and Harbor Flood Control Act (16 U.S.C. 1001)
Wild and Scenic Rivers Act River and Harbor Flood Control (16 U.S.C. 1278 et seq.)
Wilderness Act (16 U.S.C.A. 1131 et seq.)

Executive Orders, Memoranda, etc.

Protection and Enhancement of Environmental Quality (E.O.11514)
Protection and Enhancement of Cultural Environment (E.O. 11593)
Floodplain Management (E.O.11988)
Protection of Wetlands (E.O.11990)
Prime and Unique Farmlands (CEQ Memorandum, 11 Aug. 80)
Environmental Justice (E.O.12898)
Recreational Fisheries (E.O.12962)

State Statutes

CEQ regulations (40 CFR 1506.2) also require consideration of the consistency of a proposed action with approved state, regional, and local requirements, including but not limited to those applicable requirements included in Maryland Environmental Code 5-1101 and 5-1102.

4.1 EXISTING PLACEMENT SITES

4.1.1 Pooles Island Open Water Site

The open water placement sites associated with Pooles Island are Areas G-North, G-East, G-West, G-Central, G-South, and Site 92, as shown in Figure 3-5, as well as sites D, E, F, and H to the north of Pooles Island (Halka and Pangeotou, 1992). G-West was utilized for placement beginning in 1994 and continued through 1997. Site 92 began accepting dredged material in 1998 and is currently in the eighth placement year (2005/2006). The estimated sediment capacity at Site 92 is at least 9- to 10-mcy cut capacity. Open water placement at Pooles Island is mandated to end by 31 December 2010.

Extensive environmental monitoring efforts have been conducted at the Pooles Island sites, particularly for Area G-West and Site 92. These studies have addressed many of the impacts resulting from placement of dredged material, including impacts to benthic species, fisheries, sediment turbidity, and nutrient releases. Results in every case have been within predicted, acceptable ranges (Coastal & Estuarine Geology Program, 2000). Therefore, the continued placement of dredged material into Site 92 should have localized, temporary impacts.

4.1.2 Hart-Miller Island DMCF

HMI is an operating dredged material containment facility and placement of material occurs in an existing, diked cell. Continued operation of HMI is anticipated to have minor impacts on the environment. Minor changes in sediment quality and composition are expected within the cell during material placement, but no significant changes are expected outside the cell. There are no cultural resources, SAV, vegetation, and terrestrial, wetland, or aquatic resources to be impacted. No significant impacts to water quality or aquatic resources are expected as a result of the proposed action. The HMI Exterior Monitoring Technical Review Committee (TRC) reported that, based on annual monitoring performed for 16 years at HMI, no significant impact to the benthic community or to benthic populations in adjacent areas due to dredged material placement has been observed (MDE, 1999). Coordination with NMFS on EFH in the placement areas indicated that the HMI lies within the general reach of EFH for bluefish, winter flounder, and summer flounder. However, the placement site is fully contained and would not impact EFH. Birds utilizing the placement sites could be temporarily displaced during the intermittent filling activities but would return after filling activities cease (CENAB, 2001a).

Impact assessments for these sites indicated that placement activities would not negatively impact air quality in the area due to the relatively small outputs of the construction equipment and the intermittent nature of the placement activities.

The proposed project is not expected to result in the use or production of hazardous materials. No hazardous, toxic, or radioactive substances (HTRS) sites are known to exist within the vicinity of the HMI placement site.

Because HMI is an existing facility, a certain amount of noise already occurs at the site. This project is not expected to increase noise levels above those of normal placement activities.

Dredging and placement activities are expected to interfere minimally with recreational boating activities because the work would be conducted primarily during the late fall and winter, when recreational boating on the Bay is at a minimum (CENAB, 2001a).

4.1.3 Cox Creek Containment Facility

The Cox Creek Containment Facility is an existing near-shore, confined placement facility located in Anne Arundel County, Maryland (Figure 3-1). The site is owned by the Maryland Port Administration (MPA), and is composed of two adjoining properties: the CSX placement cell and the Cox Creek placement cell. The total site acreage is approximately 133 acres. The Cox Creek cell is located on the northern portion of the site, and has a total area of 61 acres. The CSX cell is located on the southern portion of the site, and has a total area of 72 acres. The two cells have perimeter dikes and are separated by a cross dike. Fifty acres of the Cox Creek placement cell and 52 acres of the CSX placement cell are contained within the dikes (Maryland Port Administration, 2002).

The State of Maryland is developing the Cox Creek dredged material containment facility by constructing a new dike on the channel side of the existing structure. The project would provide 6 million cubic yards of placement capacity over an operational life of approximately 12 years for Baltimore Harbor dredging projects. The Cox Creek Containment Facility project includes construction of a 3,800-ft-long stabilization berm along the eastern portion of the existing dikes and construction of a 5,010-ft-long stone revetment. The existing dikes are in the process of being raised from 24 ft above mean lower low water (MLLW) to a final height of 36 ft above MLLW. The increase of the height of the dike from 24 to 36 ft above MLLW would have no additional impacts to waters of the United States, including jurisdictional wetlands, because the work is planned to take place within the existing dike. However, the stabilization berm has impacted 4.87 acres of shallow tidal waters of the Patapsco River (Maryland Port Administration, 2002). These impacts were mitigated through the creation of a tidal wetland project consisting of a mixture of open water and vegetated tidal marsh.

Construction of the project has resulted in the loss of shallow-water tidal areas, which provide habitat for finfish and a variety of estuarine organisms. No tidal wetlands were impacted by the project. There were no impacts to historic and cultural resources. The project adversely impacted benthic communities inhabiting the area to be filled. No direct impact to waterfowl is anticipated due to time of year restrictions for the project. No impact to recreation is anticipated since the area is predominantly industrial. The project is not expected to degrade water quality on a long-term basis (CENAB 2002c).

The Cox Creek CDF is a previously used facility in the process of being modified to accept more dredged material. Since Cox Creek is already diked, the impacts of the continued placement of dredged material placement are expected to be similar to those expected at the HMI DMCF and PIERP.

According to an environmental assessment done for permit 97-66511-1, SAV and nontidal, emergent wetlands have been found within one of the disposal cells. Placing dredged material in this cell would cause a permanent loss of a small area of emergent non-tidal wetlands. Various mammals, amphibians, and reptiles have been observed at or may be expected to inhabit or use the placement sites, but due to their high mobility, impacts are expected to be minimal. Birds utilizing the placement sites could be temporarily displaced during the intermittent filling activities but would return after filling activities cease (MPA, 2002).

The Cox Creek dredged material containment facility is slated to receive dredged materials from the Baltimore Harbor channels west of the North Point-Rock Point line. The sediments from the Baltimore Harbor are considered contaminated by Maryland law, and must be placed in a containment facility. Processing or treating dredged material to produce environmentally safe material or beneficial use products may achieve renewable capacity for the facility. This material may be marketed, utilized, or otherwise placed off-site (Maryland Port Administration, 2002).

4.1.4 Poplar Island Environmental Restoration Project (PIERP)

PIERP is an ongoing project of environmental restoration and the beneficial use of dredged material. The impacts from this project are associated with operations and restoration activities. The dikes and project footprints have already been constructed and the impacts previously assessed.

During operations, minor changes in sediment quality and composition are expected within the placement sites, but no significant changes are expected outside placement areas. There are no cultural resources, SAV, vegetation, and terrestrial, wetland, or aquatic resources to be impacted (CENAB, 2001a). Increased turbidity and sedimentation from dredged material placement would cause short-term impacts that would temporarily affect the water quality in the project area (CENAB, 2001a) (EA 2005). No significant impacts to the benthic community or to benthic populations, due to dredged material placement, are expected since the placement sites are already diked and/or partially filled. Coordination with NMFS on EFH in the placement areas indicated that Poplar Island lies within the general reach of EFH for bluefish, winter flounder, and summer flounder. However, the placement site is fully contained and ongoing activities would not impact EFH. Some waterfowl and other birds would be displaced from the Poplar Island area during placement operations. This disturbance is expected to be insignificant and temporary, since the birds are expected to return after placement operations cease (CENAB, 2001a).

Impact assessments for these sites indicated that placement activities would not negatively impact air quality in the area due to the relatively small outputs of the construction equipment and the intermittent nature of the placement activities. Dredging and placement activities are expected to interfere minimally with recreational boating activities because the work would be conducted primarily during the late fall and winter, when recreational boating on the Bay is at a minimum (CENAB, 2001a).

There would be a significant environmental benefit from the project resulting from the construction of approximately 1,100 acres of a mixture of wetlands, uplands, and near-shore and shoal habitats. More general information on the positive and negative impacts of PIERP is found throughout Section 4 for the Large Island Restoration alternative assessment.

4.1.5 Rappahannock Shoal Deep Alternate Open Water Site

Open water placement of dredged material at the Rappahannock Shoal Deep Alternate placement site is not likely to have significant adverse impacts on the water column or benthic communities (Diaz and Cutter, 1997). Dredged material to be placed at Rappahannock Shoal Deep will be dredged from the Chesapeake Bay Approach Channels (VA) with a hopper dredge. Placement of this material will be via the hopper's hull. Upon dumping, dredged material will partition into a main cloud, which will descend vertically, and a turbidity cloud. The main cloud will descend to the bottom at a high velocity, leaving behind a small turbidity cloud, which will contain a small amount of total solids and settle within a few hours. This temporary increase in turbidity in the water column when dredged material is released will cause short-term impacts, including lower levels of dissolved oxygen for a few hours following material placement at the immediate site.

The existing benthic community will be buried under a layer of dredged material. This will affect the short-term vertical distribution of benthic biomass by direct burial and, therefore, its availability to predators. However, in the long term, there is no evidence that deposited material affects the vertical distribution of organisms (Wilber, 1996). If organisms are buried, repopulation should start to occur after placement activities have ceased and recover within a season (Diaz and Cutter, 1997). The similarity of sediment type between the material to be dredged and the sediments already in the placement area will speed up benthic reestablishment. To minimize possible impacts to blue crabs, dredging and material placement should not be performed from 1 June through 31 December (VIMS, 2005). If dredged material is placed in minor thicknesses over a short amount of time, few benthic organisms would be killed (Spaur, 2005).

Although the Rappahannock Shoal Deep Alternate placement site is an important area for commercially important fishery resources, the infrequent (approximately once every 10 years) placement of dredged material is not expected to have an adverse effect on these resources.

4.1.6 Wolf Trap Alternate Open Water Placement Site

Open water placement of dredged material at the Wolf Trap placement site is not likely to have significant adverse impacts on the water column or benthic communities (Diaz and Cutter, 1997). Dredged material to be placed at Wolf Trap will be dredged from the York Spit Channel with a hopper dredge. Placement of this material will be via the hopper's hull. Upon dumping, dredged material will partition into a main cloud, which will descend vertically, and a turbidity cloud. The main cloud will descend to the bottom at a high velocity, leaving behind a small turbidity cloud, which will contain a small amount of total solids and settle within a few hours. This temporary increase in turbidity in the water column when dredged material is released will cause short-term impacts, including lower levels of dissolved oxygen for a few hours following material placement at the immediate site.

The existing benthic community will be buried under a layer of dredged material. This will affect the short-term vertical distribution of benthic biomass by direct burial and, therefore, its availability to predators. However, in the long-term, there is no evidence that deposited material affects the vertical distribution of organisms (Wilber, 1996). If organisms are buried, repopulation should start to occur after placement activities have ceased and recover within a season (Diaz and Cutter, 1997). The similarity of sediment type between the material to be dredged and the sediments already in the placement area, and the frequency of use will speed up benthic reestablishment. The Wolf Trap placement site is in the lower Bay spawning ground of the blue crab (VIMS, 2005). To minimize possible impacts to blue crabs, dredging and material placement should not be performed from 1 June through 31 December (VIMS, 2005). If dredged material is placed in minor thicknesses over a short amount of time, few benthic organisms would be killed (Spaur, 2005).

In addition to environmental impacts associated with open water placement, the Wolf Trap site is susceptible to wave-induced velocities that may cause sediments to become resuspended in the water column. The site is relatively shallow, with a depth of 39 ft, and the area can experience wind speeds of 35 miles per hour or greater. The combination of water depth and high wind speeds cause wave-induced velocities that could resuspend deposited materials. This generally occurs less than 48 hours per year. Material eroded out of this placement site would be expected to move northward in the Bay or locally to deeper parts of the Bay floor (USACE, 1981).

Although the Wolf Trap placement site is an important area for commercially important fishery resources, the continued, periodic (approximately every 3 to 4 years) placement of dredged material is not expected to have an adverse effect on these resources.

4.1.7 Dam Neck Ocean Open Water Site

There is little evidence of long-term adverse environmental impacts; however, there would be short-term impacts during dredged material placement. Dredged material to be placed at Dam Neck will be dredged from the Cape Henry Channel with a hopper dredge. Placement of this material will be via the hopper's hull. Upon dumping, dredged material will partition into a main cloud, which will descend vertically, and a turbidity cloud. The main cloud will descend to the bottom at a high velocity, leaving behind a small turbidity cloud, which will contain a small amount of total solids and settle within a few hours. This temporary increase in turbidity in the water column when dredged material is released will cause short-term degradation of water quality, affecting habitat for fish, free-swimming invertebrates, and benthos.

Impacts to the area receiving dredged material can include smothering/suffocation of bottom organisms by clogging gill surfaces/membranes, physical abrasion and ingestion of excess solids; destruction of demersal fish eggs and/or spawning habitat; as well as the resulting potential increase of disease. The similarity of sediment type between the material to be dredged and the sediments already in the placement area, and the frequency of use, will speed up benthic reestablishment. To minimize environmental effects of ocean water placement, the Dam Neck site is limited to placement of sandier materials. If dredged material is placed in minor thicknesses over a short amount of time, few benthic organisms would be killed (Spaur, 2005).

The placement of dredged material at the Dam Neck open water placement site may have an indirect impact to the breeding, spawning, nursery, and passage activities of commercially important finfish and shellfish in and out of the Chesapeake Bay. Most of these activities do not occur within the placement site but in offshore waters or in the adjacent Chesapeake Bay estuarine waters that are offshore or inshore of the site. Increased turbidity and sedimentation will cause short-term impacts that will directly affect the water quality in the project area. The migration of sea turtles near the site during the spring may also be disrupted due to the placement of dredged material. Minimal impacts on blue crab, bay anchovy, and sand shrimp larvae are expected. The placement of dredged material will result in the permanent loss benthic organisms within the project area (CENAO, 1990). Possible impacts can be minimized by adhering to time-of-year restrictions on dredging and material placement.

4.2 PHYSICAL CONDITIONS

4.2.1 Continued Maintenance Dredging

4.2.1.1 C&D Canal Lower Approach Channels

Continued maintenance dredging of the channels would have minimal effects on the physical conditions of the estuary such as tidal range, current velocities, and circulation. The change in cross-sectional area of the Bay resulting from an increase in channel depth would be insignificant relative to the overall cross section of the existing bay. Dredging the channel would slightly alter the hydraulic conductivity of the Bay, increasing flow in the channel and reducing currents at the margins. This could, in turn, slightly alter sediment transport patterns within the Bay. Although sediment transport effects are also thought to be minimal, an extensive sediment transport model would be required to confirm this assumption.

4.2.1.2 Harbor Channels

Continued maintenance dredging of the channels would have minimal effects on the physical conditions of the estuary such as tidal range, current velocities, and circulation. The change in cross-sectional area of the Bay resulting from an increase in channel depth would be insignificant relative to the overall cross section of the existing bay. Dredging the channel would slightly alter the hydraulic conductivity of the Bay, increasing flow in the channel and reducing currents at the margins. This could, in turn, slightly alter sediment transport patterns within the Bay. Although sediment transport effects are also thought to be minimal, an extensive sediment transport model would be required to confirm this assumption.

4.2.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging of the channels would have minimal effects on the physical conditions of the estuary such as tidal range, current velocities, and circulation. The change in cross-sectional area of the Bay resulting from an increase in channel depth would be insignificant relative to the overall cross section of the existing bay. Dredging the channel would slightly alter the hydraulic conductivity of the Bay, increasing flow in the channel and reducing currents at the margins. This could, in turn, slightly alter sediment transport patterns within the Bay. Although sediment transport effects are also thought to be minimal, an extensive sediment transport model would be required to confirm this assumption.

4.2.1.4 Chesapeake Bay Approach Channels (VA)

Continued maintenance dredging of the channels would have minimal effects on the physical conditions of the estuary such as tidal range, current velocities, and circulation. The change in cross-sectional area of the Bay resulting from an increase in channel depth would be insignificant relative to the overall cross section of the existing bay. Dredging the channel would slightly alter the hydraulic conductivity of the Bay, increasing flow in the channel and reducing currents at the margins. This could, in turn, slightly alter sediment transport patterns within the Bay. Although sediment transport effects are also thought to be minimal, an extensive sediment transport model would be required to confirm this assumption.

4.2.2 New Sites and Expanded Existing Sites

4.2.2.1 PIERP Expansion

Expansion of PIERP would affect water depth within the area of expansion. It is also possible that some localized effect on currents/flow and consequently scouring of the bay bottom or additional deposition of sediment could occur. Design of the expansion would consider interactions between the new land mass and the flow patterns in the area. No effect on local wind patterns would be expected.

4.2.2.2 Large Island Restoration - Middle Bay

Restoration of a large island would affect water depths within the area of restoration. It is also possible that some localized effect on currents/flow and consequently scouring of the bay bottom or additional deposition of sediment could occur. Design of the restoration would consider interactions between the new land mass and the flow patterns in the area. No effect on local wind patterns would be expected.

4.2.2.3 Wetland Restoration – Dorchester County

Restoration of wetlands away from the shore of the bay is not expected to affect water depth, flow patterns, or wind except at the local restoration site, where such effects are intended.

4.2.2.4 Confined Disposal Facilities in the Patapsco River

New CDFs constructed abutting or extending into the harbor could affect water depths within the area of the CDF. It is also possible that some localized effect on currents/flow and consequently scouring of the bay bottom or additional deposition of sediment could occur near the new land mass. Design of the facility would consider interactions between the new land mass and the flow patterns in the area. No effect on local wind patterns would be expected.

4.3 GEOLOGY AND SOILS

4.3.1 Continued Maintenance Dredging

4.3.1.1 C&D Canal Approach Channels

Continued maintenance dredging of the C&D Canal Approach Channels is not expected to affect the geology and soils in the study area. Maintenance dredging would, of course, disrupt the sediment within the dredged area, and some transport of suspended sediment during dredging could occur.

4.3.1.2 Harbor Channels

Continued maintenance dredging of the Harbor Channels is not expected to affect the geology and soils in the study area. Maintenance dredging would, of course, disrupt the sediment within the dredged area, and some transport of suspended sediment during dredging could occur.

4.3.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging of the Chesapeake Bay Approach Channels (MD) is not expected to affect the geology and soils in the study area. Maintenance dredging would, of course, disrupt the sediment within the dredged area, and some transport of suspended sediment during dredging could occur.

4.3.1.4 Chesapeake Bay Approach Channels (VA)

Continued maintenance dredging of the Chesapeake Bay Approach Channels (VA) is not expected to affect the geology and soils in the study area. Maintenance dredging would, of course, disrupt the sediment within the dredged area, and some transport of suspended sediment during dredging could occur.

4.3.2 New Sites and Expanded Existing Sites

4.3.2.1 PIERP Expansion

Implementation of the proposed alternative is not expected to have a direct, long-term effect on geology at the project site, but would impact soils. The project would utilize dredged material from the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) to raise the existing upland dikes and expand the island by 600 acres, creating additional upland and wetland habitats. The perimeter and interior dikes would be constructed using borrow material located on-site and undercutting of the foundation may be necessary prior to dike construction. The perimeter dikes would be protected from waves and currents by large armor stone placed on the exterior slopes. The armor stone would originate from off-site quarries.

The island is surrounded by shallow open water with an average depth of 5 to 6 ft. The placement of dredged materials into this area would make long-term alterations to the current slope and elevation of the area and permanently cover any soils and sediments in the project footprint. The new elevation and slope for the area would be determined by the plans of the engineers designing the island's restoration. Once the exterior dike is deployed and the dredged material is put into place, the new slope and elevation would become a long-term fixture of the island.

Island restoration would slow the erosion of soils on exposed shorelines in the lee of the expansion area. This would result in a long-term reduction in soil erosion along shorelines in these areas.

4.3.2.2 Large Island Restoration – Middle Bay

Implementation of the proposed alternative is not expected to have a direct, long-term effect on geology at the project site, but would impact soils. This restoration project will utilize dredged material from the C&D Canal Approach and Chesapeake Bay Approach Channels (MD). The perimeter and interior dikes would be constructed of sandy soils available on-site, and undercutting of the foundation may be necessary prior to dike construction. The perimeter dikes would be protected from waves and currents by large armor stone placed on the exterior slopes. The armor stone would originate from off-site quarries.

The island is surrounded by shallow open water. The placement of dredged materials into this area would dramatically make long-term alterations to the current slope and elevation of the area and permanently cover any soils and sediments in the project footprint. The new elevation and slope for the area would be determined by the plans of the engineers designing the island's restoration. Once the exterior dike is deployed and the dredged material is put into place, the new slope and elevation would become a long-term fixture of the island.

Island restoration would slow the erosion of soils on exposed shorelines in the lee of the expansion area. This would result in a long-term reduction in soil erosion along shorelines in these areas.

4.3.2.3 Wetland Restoration – Dorchester County

Implementation of the proposed alternative is not expected to have a long-term effect on geology at the project site, but would impact soils. Wetland restoration will involve the placement of dredged material from the C&D Canal Approach Channels and the Chesapeake Bay Approach Channels (MD) to restore degraded wetlands at the Blackwater NWR, Dorchester County, Maryland. The dredged material from this portion of the Bay is suited for this application because of the iron-rich nature of the material, which would buffer sulfide production. The elevated iron would improve water quality and fish habitat.

The existing shallow depressions of open water habitat, former wetlands lost due to sea-level rise, subsidence, and other disturbances (e.g., nutria) would be restored to a wetland environment through the placement of 2 to 5 ft of dredged material. The dredged material would be held in place using a temporary dike, constructed of dredged material contained in a geotextile tube. This temporary dike would be removed within 2 years of placement. The placement of dredged material into this area will cause long-term changes in the elevation and soils of the area, allowing for wetland soil creation.

4.3.2.4 Confined Disposal Facilities in Patapsco River

Implementation of the proposed alternative is not expected to have a direct, long-term effect on geology within the footprint of the project site, but would impact soils. Dredged material from the Harbor Channels would be placed in these facilities. The sites would be situated along the shoreline in approximately 12 ft of water. The interior and exterior dikes would be constructed of sandy material located on-site and undercutting may be necessary prior to dike construction. The design of these facilities would allow for the containment of contaminated dredged material, isolating it from the environment.

Minor, short-term effects to the soils and topography of the upland side of the proposed sites, resulting from earthmoving and other activities, are expected during construction.

Soils and sediments within the footprint of each CDF would be permanently impacted (covered) by the proposed action. However, new soil and sediments would be created depending on the CDF design.

4.4 WATER QUALITY

4.4.1 Continued Maintenance Dredging

4.4.1.1 C&D Canal Approach Channels

Adverse water quality impacts from continued maintenance dredging develop mainly through resuspension of sediments into the water column. Salinity generally increases with depth in Chesapeake Bay waters. However, maintenance dredging is not expected to create a significant change in salinity that would impact aquatic resources. Channel dredging would also result in a slight increase in turbidity and siltation with no significant environmental impact expected (CENAB, 1997).

Natural turbidity is low and any impact associated with clamshell dredging is expected to be temporary and minor. Increases in turbidity, water contamination, and nutrient release are potential impacts of sediment resuspension. Dissolved oxygen levels in the channel are naturally lower in warmer months and any effects on dissolved oxygen during dredging events would be minimal.

The dredging process is not expected to release concentrations of dissolved constituents that will impact water column organisms or affect human health. Release of nitrogen compounds and other contaminants occurs during dredging activities and subsequently from newly exposed sediment surfaces. Studies of nitrogen flux rates from Bay sediments have indicated that an average rate of 0.03 pounds per square meter (CENAB, 2001c) can be expected over a short time period of days or weeks after dredging. Other experiments indicated that phosphorus is not released from Bay sediments at the temperatures and oxygen levels that occur in the Upper Bay during fall, winter, and spring dredging season. The severity of these impacts depends on the characteristics of sediments removed, the amount of dredging required, and on the dredging methods used. Appropriate management practices such as proper filling of barges to avoid overflow and a routine inspection program can minimize the incidental release of sediment to the water column (CENAB, 2001a).

4.4.1.2 Harbor Channels

Research indicates that long-term impacts of dredged material on water quality have generally been slight (CENAB, 1981). Salinity generally increases with depth in waters of the Baltimore Harbor. Continued maintenance dredging is not expected to create a significant change in salinity that would impact aquatic resources (CENAB, 1997). Natural turbidity in the Harbor Channels is greater than in the Bay as a result of ship traffic. Turbidity associated with dredging is expected to be a temporary and minor addition to natural turbidity. Release of nitrogen and other nutrients would have minor short-term impacts on the water column in these areas.

Testing of Harbor sediments shows that portions of the sediments are contaminated, with the most polluted material in the Inner Harbor. The resuspension of contaminated sediments may result in the temporary release of toxic chemicals into the water column. However, there is generally little net mass release of heavy metals and long-term impacts are expected to be negligible (CENAB, 1997). Dredging activity closer to the open Bay would release suspended sediments into the open Bay but these are expected to contain fewer contaminants (CENAB, 1981). Dredging has the potential to exacerbate the problem of low dissolved oxygen, which is common in Baltimore Harbor. Immediately after dredging, the duration, extent, or frequency of low dissolved oxygen would temporarily increase but return to normal shortly thereafter (CENAB, 1997).

4.4.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging of these channels will be conducted using methods similar to those in the C&D Canal Approach Channels region and is expected to produce similar impacts (see Section 4.4.1.1). These include temporary resuspension of sediment (increased turbidity) and release of nitrogen, other nutrients, and other contaminants if present.

4.4.1.4 Chesapeake Bay Approach Channels (VA)

Dredging-related resuspension of sediments from Virginia Channel sections is not expected to have significant adverse impact on the water column because analysis has shown that these sediments have constituent levels characteristic of “clean sediment.” Turbidity plumes would be short and minor because of the coarse grain size of the material. Dissolved oxygen levels are expected to depress slightly but recover a few hours following dredging, and according to the Chesapeake Bay Hydraulic Model, the effect on salinity should not be too significant (CENAB, 1981). Release of nitrogen, other nutrients, and other contaminants would have minor short-term impacts on the water column in these areas.

4.4.2 New Sites and Expanded Existing Sites

4.4.2.1 PIERP Expansion

The water is considered of good quality in the vicinity of PIERP, with salinity and temperature fluctuations typical of mesohaline reaches of the Bay. Impacts from low dissolved oxygen are not expected during construction because shallow water depths allow for good oxygenation throughout the year (EA, 2003e). Furthermore, dredged material will be placed in confined areas, resulting in little impact to adjacent open water.

Short-term impacts to water quality would be expected from construction, and during the placement of dredged material. Effects from placement of dredged material could occur as ponded water is discharged during placement, and during dewatering of the dredged material. These effects could include discharge of water with some elevated levels of suspended solids and nutrients. Although impacts would be short term, it is recommended that all discharges be monitored closely during construction of the dike system and during dredged material placement (EA, 2003e). Monitoring should include turbidity and total suspended solid levels.

Construction of dikes for the PIERP Expansion would use sandy material dredged from on-site. Prior sediment quality studies (1994-1995) around the PIERP remnants showed a roughly 90% sand content with contaminant concentrations below sediment quality guideline values for marine sediments. Therefore, there is no significant impact expected from contaminant release into the water column (EA, 2003e). Dredged material placed within the diked area would be the same as that currently going into the project site.

Expansion of the PIERP Project should improve overall water quality in the vicinity of the Island by protecting the shorelines of adjacent islands from further erosion, thereby reducing the amount of suspended solids in the water column. No impacts to groundwater are expected because of confining local geology and the nature of the sediment to be placed (EA, 2003e). Also, the construction of wetlands as a component of the expansion could also improve water quality.

4.4.2.2 Large Island Restoration - Middle Bay

Short-term adverse impacts on water quality and sediments are expected during both dike construction and the placement of dredged materials. These activities would result in short-term increases in total suspended solids levels and turbidity, and possibly increased sedimentation in the surrounding area. Total suspended solids and turbidity levels should be monitored during the dike construction and dredged material placement phases of the proposed environmental restoration project. The water quality monitoring requirements and permitted levels are expected to be similar to those parameters and criteria used for the PIERP Habitat Restoration Project (WESTON, 2002a).

Large impacts to salinity, pH, and dissolved oxygen are not expected because most of the potential areas are well-mixed shallow water environments. It is possible that water discharged during dredged material consolidation could contain elevated nutrient levels depending on the characteristics of the dredged material. The potential impact of nutrient releases from the proposed project on phytoplankton are unknown. Because the dredged material for this project would originate from outer channel areas, the quality of dredged material is expected to be good. Nutrient levels should be monitored as part of a proposed project (WESTON, 2002a).

In the long term, the proposed project is expected to improve TSS levels in the vicinity of the project by reducing the level of shoreline erosion, and protecting sensitive areas in Dorchester County. Minimal impacts to groundwater are expected because of confining local geology and the nature of the sediment to be placed (EA, 2003b). Also, the construction of tidal wetlands as a component of the expansion could also improve water quality.

4.4.2.3 Wetland Restoration - Dorchester County

Short-term impacts on water quality are expected during both the system construction and the placement of dredged material. Impacts of system construction would be minimal because few of the system components require extensive excavation or would displace large productive wetland or open water areas. As well, natural turbidity in the area is high. Construction and material placement activities could result in short-term increases in total suspended solids levels and turbidity. The release of suspended solids is expected to be minimal with use of temporary containment structures to reduce the discharge of turbid water until the placement areas can revegetate. Suspended solids that do escape from placement sites would likely settle in other vegetated areas, minimizing release into the Bay.

It is possible that water discharged during placement could contain elevated nutrient levels depending on the characteristics of the dredged material. However, sediment placed at these sites would generally be considered “clean sediment.” As discussed in Section 3.2.3.6, the sulfide buffering effect of dredged material placement could significantly reduce the rate of oxygen depletion and therefore improve water quality during wetland reclamation. Assuming that dredged material is placed at depths thick enough to restore degraded wetlands, restoration efforts should reduce the erosive losses from current and wave activity and therefore improve long-term water quality overall.

4.4.2.4 Confined Disposal Facilities in Patapsco River

The water quality in the mouth of the Patapsco River reach is considered poor because of a variety of anthropogenic stressors (e.g., industrial discharges, runoff, and sewage outfalls). Recent evaluations of the toxics loads within the lower Patapsco River have indicated that contaminants may be present at concentrations great enough to affect aquatic resources. Unlike other tributaries of the Bay, the Patapsco River did not show improvement in the concentrations of carbon and nitrogen-containing compounds in 2002 when compared to previous years (EA, 2003a).

Sediments in this region could have elevated levels of metals, nutrients, and other contaminants from industrial and municipal sources as well as from numerous nonpoint sources. Increase in turbidity and contaminant release would be potential impacts during facility construction. Because deep, soft clayey sediments occur frequently in this region of the Harbor, sand to build dikes may have to be imported. Any unsuitable material excavated from the construction site would need to be placed within an existing CDF.

During construction, sandy material would be used to construct dikes, and, due to its low chemical oxygen demand/biochemical oxygen demand (COD/BOD), is not expected to have significant impact on water quality. Because of the shallow water depth within nearshore placement sites, hypoxia and/or anoxia are not expected to occur as they do in deeper areas of the Harbor. Water temperature, current velocities, and salinity fluctuations in this region are typical and no impacts are expected. However, perimeter dikes of nearshore facilities could protect shorelines from further erosion (EA, 2003a).

Effects from placement of dredged material could occur as ponded water is discharged during placement, and during dewatering of the dredged material. Discharge water would be expected to include higher-than-background levels of suspended solids, nutrients, and elevated levels of contaminants. However, this is a short-term condition, only lasting during the inflow period each year, and any discharges would meet MDE permit requirements. Potential contamination of groundwater is a concern for dredged material placement. No negative impacts are expected for local drinking water users because Baltimore utilizes a surface water system for its consumptive water needs. However, there remains potential impact to groundwater resources, surface water to which they discharge, and the receiving water ecosystems. Monitoring would be conducted during discharge, and long-term monitoring, including groundwater monitoring as necessary, would be conducted to verify no long-term negative effects (EA, 2003a).

It is recommended that construction and operation activities associated with a proposed project follow management plans similar to those implemented for the HMI DMCF, which has operated for years and meets state water quality limits.

4.4.3 Floodplain

4.4.3.1 Continued Maintenance Dredging

Continued maintenance dredging would not result in any change in water surface elevation and would therefore have no impact on floodplains.

4.4.3.2 New Sites and Expanded Existing Sites

4.4.3.2.1 PIERP Expansion

Placement of dredged material for the expansion of Poplar Island would result in raising the elevation of existing open water areas above the existing 100-year and 500-year floodplain elevations. However, because of the size of the proposed project footprint relative to the Chesapeake Bay, there would be no impact on floodplains. In addition, the dredged material would come from channels within the region of Poplar Island, resulting in no net placement of fill beyond what may be required to construct the dikes.

4.4.3.2.2 Large Island Restoration – Middle Bay

Placement of dredged material for island restoration would result in raising the elevation of existing open water areas above the existing 100-year and 500-year floodplain elevations. However, because of the size of the proposed project footprint relative to the Chesapeake Bay, there would be no impact on floodplains. In addition, the dredged material would come from channels within the region of the island restoration site, resulting in no net placement of fill beyond what may be required to construct the dikes.

4.4.3.2.3 Wetland Restoration – Dorchester County

The beneficial use of dredged material to restore degraded wetlands identified under this alternative is not anticipated to result in significant impacts to floodplain areas. The proposed restoration would involve the placement of fill into open water depressions that were once wetlands. This would include areas within the 100-year floodplain. Placement of this fill would have minimal impact on the overall water surface elevation, and would not have significant impact on the 100-year floodplain elevation in the area. Specific wetland areas considered for placement of dredged material would require analysis of floodplain issues.

4.4.3.2.4 Confined Disposal Facilities in the Patapsco River

Placement of dredged material into CDFs would result in raising the elevation of existing open water areas above the existing 100-year and 500-year floodplain elevations. However, because of the size of the proposed project footprint relative to the Baltimore Harbor area and the Chesapeake Bay, there would be no impact on floodplains. In addition, the dredged material would come from channels within the region of the island restoration site, resulting in no net placement of fill beyond what may be required to construct the dikes.

4.5 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

4.5.1 Continued Maintenance Dredging

4.5.1.1 C&D Canal Approach Channels

Periodic sediment sampling and testing of the sediments in the C&D Canal Approach Channels has not detected levels of HTRW that would preclude unconfined upland or aquatic placement. No impacts are expected from HTRW during continued maintenance dredging and subsequent placement of the dredged material. If dredged sediments exhibit any RCRA characteristics, their handling and disposal is subject to RCRA Subtitle C requirements (and corresponding state regulations).

4.5.1.2 Harbor Channels

Historically, Baltimore has been home to a wide array of heavy manufacturing and industrial companies. While environmental laws implemented in the 1970s have halted chemical releases by these industries into Baltimore Harbor, residual HTRW chemical contamination still remains in the sediments. By law, the State of Maryland has mandated that all dredged material taken from the Harbor (within the North Point-Rock Point Line) be considered contaminated, and thereby places limits on its use and placement. The federal government is not bound by the state law; however, there is evidence that some material dredged within the Harbor area would be considered contaminated by federal standards. There is the potential for short-term releases of contamination into the water column during dredging operations. These impacts have been shown to be short term and no long-term effects have been identified. If dredged sediments exhibit any RCRA characteristics, their handling and disposal is subject to RCRA Subtitle C requirements (and corresponding state regulations).

4.5.1.3 Chesapeake Bay Approach Channels (MD)

Periodic sediment sampling and testing of the sediments in the Chesapeake Bay Approach Channels (MD) has not detected levels of HTRW that would preclude unconfined upland or aquatic placement. No impacts are expected from HTRW during continued maintenance dredging and subsequent placement of the dredged material. If dredged sediments exhibit any RCRA characteristics, their handling and disposal is subject to RCRA Subtitle C requirements (and corresponding state regulations).

4.5.1.4 Chesapeake Bay Approach Channels (VA)

Periodic sediment sampling and testing of the sediments in the Chesapeake Bay Approach Channels (VA) has not detected levels of HTRW that would preclude unconfined upland or aquatic placement. No impacts are expected from HTRW during continued maintenance dredging and subsequent placement of the dredged material. If dredged sediments exhibit any RCRA characteristics, their handling and disposal is subject to RCRA Subtitle C requirements (and corresponding state regulations).

4.5.2 New Sites and Expanded Existing Sites

4.5.2.1 PIERP Expansion

The PIERP site is in an undeveloped location and thus has a low likelihood for the presence of HTRW materials.

Dredged materials from the C&D Canal Approach Channels, the Chesapeake Bay Approach Channels (MD), and potentially material from the Harbor Channels that is considered "clean," would be placed at this dredged material placement site. Because periodic USACE testing of the channels has revealed no record of HTRW-contaminated material in the sediments of the C&D Canal Approach Channels or the Chesapeake Bay Approach Channels (MD), and only Harbor material deemed acceptable under Section 404 of the Clean Water Act would be used, the presence of HTRW materials is not a concern.

4.5.2.2 Large Island Restoration – Middle Bay

Based on the assumption that the Large Island Restoration site would be in an undeveloped, remote location, the likelihood of HTRW material presence is low. When a specific project location is identified later in the planning process, HTRW potential would need to be further assessed.

Dredged materials from the C&D Canal Approach Channels and the Chesapeake Bay Approach Channels (MD) would be placed at this dredged material placement site. Because periodic USACE testing of the channels has revealed no record of HTRW-contaminated material in the sediments of the C&D Canal Approach Channels or the Chesapeake Bay Approach Channels (MD), and only Harbor material deemed acceptable under Section 404 of the Clean Water Act would be used, the presence of HTRW materials is not a concern.

4.5.2.3 Wetland Restoration – Dorchester County

Because of its undeveloped and remote location, Blackwater NWR has a very low likelihood for the presence of HTRW.

Dredged materials from the C&D Canal Approach Channels and Chesapeake Bay Approach Channels (MD) would be placed to restore degraded wetlands at Blackwater NWR. Because periodic USACE testing of the channels has revealed no record of HTRW-contaminated material in the sediments of the C&D Canal Approach Channels or the Chesapeake Bay Approach Channels (MD), and only Harbor material deemed acceptable under Section 404 of the Clean Water Act would be used, the presence of HTRW materials is not a concern.

4.5.2.4 Confined Disposal Facilities in Patapsco River

The potential exists for the presence of HTRW material and unexploded ordnance in the Harbor sediment near potential project sites. HTRW material and/or unexploded ordnance recovered during construction operations would be handled and disposed of in an appropriate manner to prevent any impact to the environment.

The proposed facilities, located near the shore along the Patapsco River in Baltimore Harbor, would be designed under current regulatory guidelines to accommodate potentially contaminated dredged materials and segregate this material from the environment. The dredged material taken from the Harbor has the potential to contain HTRW materials, but through containment and regular leachate monitoring, the presence of any HTRW should not impact the surrounding environment.

4.6 AIR QUALITY IMPACTS

As noted in Section 2.5, all sections of the Bay have surrounding land areas that are not achieving the national ambient air quality standards for ozone, which are designed to protect human health. However, all areas of the Bay that include recommended plan alternatives are in attainment except for the Harbor (CDF) alternative. The monitored air quality values are somewhat higher where influenced by the major metropolitan areas of Baltimore; Washington, DC; and, to a lesser extent, Hampton Roads, VA. Whether due to pollutant transport or spreading development, however, areas outside of the metropolitan areas are also in nonattainment. Prediction of air quality is tenuous and must be done on a regional basis. In addition, the emissions resulting from the various dredging placement alternatives are not well defined; therefore, only a qualitative assessment of the relative impacts of the alternatives can be performed. The major characteristics of the alternatives that are assumed to impact air emissions are the type of dredging, the means and distance of transporting dredged material, the type of dredged material placement, and the location of dredged material placement (whether wetland or upland). The major means of generating emissions would be exhaust (combustion) emissions from the dredge, towboat, and earth-moving equipment. These emissions would include nitrogen oxides (NO_x), carbon monoxide (CO), and, to a lesser extent, particulate matter (PM), sulfur oxides (SO_x), and volatile organic compounds (VOCs). Nitrogen oxides and VOC are precursors to the formation of ozone in the atmosphere (via a chemical reaction driven by sunlight). Additional PM or dust would be generated by the movement or wind erosion of dry material. However, mechanically generated windblown dust would be more likely to be PM-10 (particles less than or equal to 10 µm in diameter), rather than the PM-2.5 (particles less than or equal to 2.5 µm in diameter) that is more predominantly generated by diesel engines (EPA geoselect Web site). There are a number of design alternatives and emission control measures that can be taken for the various air pollution sources. This qualitative assessment assumes that each type of equipment has the same air pollutant-generating characteristics for each placement alternative.

Additionally, assessments would be required to determine the air pollutant-generating characteristics for each placement alternative.

4.6.1 Continued Maintenance Dredging

Use of a clamshell dredge and transport of dredged material by barges powered by towboats is common to all of the alternatives, as is some type of hydraulic placement of the dredged material. Therefore, emissions from the dredge and hydraulic system would be roughly the same for the same amount of material handled. Thus, the major variable affecting emissions and resulting air quality of the alternatives would be the distance the material is transported, which would determine the time the towboat is operated for each barge load. Although a study for the Port Authority of New York & New Jersey shows that NO_x emissions from dredging are generally larger (by a factor of 2 to 10) than those from transporting, the transporting emissions are still substantial (Starcrest Consulting Group, LLC, 2002). Therefore, maintenance dredging has the potential for low- to moderate- short-term impact.

4.6.2 New Sites and Expanded Existing Sites

4.6.2.1 PIERP Expansion

Dredged material would be placed at the PIERP Expansion site using a hydraulic unloader. Because the material is placed wet without the use of earth-moving equipment, the dust emissions from this operation would be expected to be negligible, thus creating no short-term impacts to air quality.

Once the dredged material that is placed in the upland cells at the PIERP Expansion site dries, there is a potential for wind erosion of dust. Wind erosion could be minimized by vegetation and other control measures. In wetlands, the material would remain wet and would not become airborne. Therefore, long-term impacts to air quality due to PIERP Expansion are expected to be minimal.

4.6.2.2 Large Island Restoration – Middle Bay

Dredged material would be placed at the Large Island Restoration site using a hydraulic unloader. Because the material is placed wet without the use of earth-moving equipment, the dust emissions from this operation would be expected to be negligible, thus creating no short-term impacts to air quality.

Once the dredged material that is placed in the upland cells at the Large Island Restoration site dries, there is a potential for wind erosion of dust. Wind erosion could be minimized by vegetation and other control measures. In wetlands, the material would remain wet and would not become airborne. Therefore, long-term impacts to air quality due to Large Island Restoration are expected to be minimal.

4.6.2.3 Wetland Restoration – Dorchester County

Dredged material would be placed at the Blackwater NWR using a hydraulic unloader. Because the material is placed wet without the use of earth-moving equipment, the dust emissions from this operation would be expected to be negligible. The material placed in the wetlands would remain wet and not become airborne. Therefore, both short-term and long-term impacts to air quality due to Wetland Restoration in the Blackwater NWR are expected to be negligible.

4.6.2.4 Confined Disposal Facilities in the Patapsco River

Dredged material would be placed at the CDFs in the Patapsco River using a hydraulic unloader. Because the material is placed wet without the use of earth-moving equipment, the dust emissions from this operation would be expected to be negligible, thus creating no short-term impacts to air quality are expected to be minimal.

Once the dredged material that is placed in the CDFs dries, there is a potential for wind erosion of dust. Wind erosion could be minimized by vegetation and other control measures. Therefore, long-term impacts to air quality are expected to be minimal.

4.7 AQUATIC RESOURCES

4.7.1 Continued Maintenance Dredging

4.7.1.1 C&D Canal Lower Approach Channels

Continued maintenance dredging is conducted using a mechanical clamshell bucket dredge. This type of dredging uses the clamshell bucket to grab sediment from the channel bottom and hoists the sediment through the water column so that the contents can be offloaded to a barge for placement or beneficial reuse.

Although all aquatic resources are in some manner affected, mechanical dredging is more disruptive to the benthic environment than it is to the water column. Although benthic populations are already low due to frequent dredging and hypoxic/anoxic conditions, any remaining benthic invertebrates, oysters, soft-shell clams, over-wintering blue crabs, and some bottom feeder finfish that exist within the channel would be permanently lost as a result of the dredging. However, shoals dredged from these channels are a small percentage of the total bottom area.

Dredging has the potential to be especially detrimental to blue crabs and the commercial blue crab fishery because blue crabs burrow in the substrate while overwintering in the deeper waters. Therefore, a small percentage of blue crabs may be permanently lost if dredging is to occur during the winter months.

Because of their high mobility, most finfish are expected to be able to avoid contact with the clamshell bucket and to be temporarily displaced during the dredging operation. Therefore, it is highly unlikely that finfish would suffer significant impacts as a result of mechanical dredging. Lastly, mechanical dredging would, in the vicinity of the dredging operation, temporarily increase the level of turbidity and suspended solids (CENAB, 1997).

An Essential Fish Habitat (EFH) impact (see Chapter 2) assessment done by CENAB for the Upper Bay area suggested that only juvenile and adult summer flounder and juvenile bluefish likely occur in the area of the C&D Canal Approach Channels (CENAB, 2002a). Continued maintenance dredging would occur during winter months, when summer flounder and bluefish are absent. Therefore, continued maintenance dredging should have no direct impacts on summer flounder and bluefish or other EFH (CENAB, 2002a).

4.7.1.2 Harbor Channels

Continued maintenance dredging throughout the Harbor Channels would also be conducted using a mechanical clamshell bucket dredge. Therefore, the environmental impacts to aquatic biota for these channels are expected to be similar to or less than those expected for the C&D

Canal Approach Channels because the Harbor Channels tend to be more hypoxic/anoxic and contain a greater amount of contaminants.

4.7.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging is conducted using a mechanical clamshell bucket dredge. Therefore, the environmental impacts for these channels are expected to be similar to or less than those expected for the C&D Canal Approach Channels because the Chesapeake Bay Approach Channels (MD) tend to be more hypoxic/anoxic and contain a greater amount of contaminants.

4.7.1.4 Chesapeake Bay Approach Channels (VA)

Continued maintenance dredging is conducted using a hydraulic, self-propelled hopper dredge. This type of dredging uses suction to remove sediment from the channel bottom. The slurry, bottom sediment, and bay water removed from the channel are then pumped into the hopper, where they are retained for placement or beneficial reuse (CENAB, 2003).

Hydraulic dredging has the potential to be disruptive to both the benthic environment and the water column. Although benthic populations are already low due to existing hypoxic/anoxic conditions, benthic invertebrates, over-wintering blue crabs, and some bottom feeder finfish that exist within the channel would be permanently lost as a result of the dredging. However, shoals dredged from these channels are a small percentage of the total bottom area. Benthic invertebrates generally recolonize these dredged areas quickly (often within one season) and the impacts are not significant (Diaz and Cutter, 1997). Based on channel depth, oysters, which are generally found in depths in between 8 and 25 ft, should not be impacted.

Dredging has the potential to be especially detrimental to blue crabs and the commercial blue crab fishery because blue crabs burrow in the substrate while overwintering in the deeper waters. Therefore, a percentage of blue crabs may be permanently lost if dredging is to occur during the winter months.

Despite their mobility, finfish in the area during dredging operations have the potential to be suctioned into the hydraulic dredge along with the slurry. Similar to mechanical dredging, hydraulic dredging would also temporarily increase the level of turbidity and suspended solids and nitrogen in the vicinity of the dredging operation (CENWW, 2002).

MAFMC and SAFMC have designated EFH for bluefish and summer flounder (juvenile and adult) and juvenile red drum within the area of the Chesapeake Bay Approach Channels (VA). Spanish mackerel, king mackerel, and cobia were not known to occur in the proposed area (Murdy et al., 1997). It was CENAO's opinion that the adverse effects on bluefish EFH would be minor and that the adverse effects on the EFH for summer flounder and red drum would occur either in the fall, while both species are out of the area, or in the spring when they can move away from the work area (CENAO, 2002). Minor impacts, if any, would similarly be anticipated for EFH species from maintenance dredging in the Chesapeake Bay Approach Channels (VA).

4.7.2 New Sites and Expanded Existing Sites

4.7.2.1 PIERP Expansion

4.7.2.1.1 Benthic Invertebrates

In comparison to similar areas throughout the Chesapeake Bay, the benthic habitat surrounding PIERP supports fewer benthic taxa (EA, 2002a). As a result of the island expansion project, any existing benthic communities within the proposed footprint will be buried (CENAB, 1996; EA, 2002a). It is anticipated that the expansion will result in the permanent loss of up to 600 acres of benthic habitat and the destruction of nonmotile benthos. Wetland habitat construction within the expansion area is likely to include the creation of some benthic habitat, but it is assumed that it would not be a large amount or comparable to the amount of permanently lost habitat because the wetland would be higher in elevation, and therefore inappropriate for the species that currently inhabit the benthic area surrounding PIERP (CENAB, 1996).

4.7.2.1.2 Oysters and Commercial Oyster Harvesting

The Middle Chesapeake Bay supports the commercial harvesting of oysters; however, the yearly catch size is quite variable and is on the decline because of the increase in oyster diseases, MSX and Dermo. To date there are no known oyster fossil shell resources within the proposed PIERP expansion area (EA, 2002a). Several known Natural Oyster Bars (NOBs) exist in the vicinity of PIERP and provide a hard-type substrate for oyster-reef habitat. The locations of the NOBs are known and proposed expansion footprint options would be designed to avoid all direct impacts to NOB. Because the project would avoid the NOB where remaining oysters are believed to be concentrated, and few oysters are present in the NOB, direct and indirect impacts to oysters are expected to be minimal (CENAB, 1996; EA, 2002a).

4.7.2.1.3 Soft-Shell Clams and Commercial Soft-Shell Clam Harvesting

Soft-shell clams are one of two commercially important bivalves native to the area, the other is razor clams. The benthic habitat in the vicinity of PIERP supports the existence and commercial harvesting of soft-shell clams. Recent studies reflect declines in local populations in this area (CENAB, 1996; EA, 2002a). Additionally, minimal soft-shell clam harvesting took place in this vicinity in 2002 because of ongoing construction of PIERP (EA, 2002a). All bivalve species existing within a footprint of the containment dike would be permanently lost; however, since soft-shell clams and other bivalve species occur inside and outside the proposed alignment, populations are expected to reestablish adjacent to the proposed island after construction (CENAB, 1996).

4.7.2.1.4 Blue Crabs and Commercial Blue Crab Harvesting

Blue crabs are among the highest valued commercial species throughout the Middle Chesapeake Bay. The benthic habitat in the vicinity of PIERP supports the seasonal existence and commercial harvesting of blue crabs. Because of the shallow depths surrounding the island, in the summertime blue crabs tend to occur in greater numbers around PIERP. It is possible that the species could overwinter in the vicinity of PIERP, but PIERP is not a prime location compared to other areas in this section of the bay that contain deeper waters (EA, 2002a). The most significant permanent loss resulting from the project would be that of blue crab summer habitat; however, it is thought that once the expansion is complete, the created marsh creeks once established would provide valuable habitat for all stages of the crabs' life cycle, specifically the younger stages (CENAB, 1996). Additionally, because the crabs are highly mobile, they are expected to be able to vacate the area during construction, except for those that are already contained within the dike and those that may be overwintering within the area, should construction take place in the winter. Lastly, commercial crabbing is expected to be temporarily displaced from the immediate vicinity until the PIERP Expansion project is complete; however, the industry is not expected to experience significant losses during construction (EA, 2002a).

4.7.2.1.5 Finfish

The shallow waters surrounding PIERP provide habitat and feeding grounds for many species of finfish common throughout the Chesapeake Bay. Poplar Harbor, located on the east side of PIERP, provides shelter for juvenile finfish and SAV growth (EA, 2002a).

As a result of the project, most of the area's affected fish species would be those smaller, resident species with limited mobility, specifically young fish using the area for nursery grounds. The affected fish may be entrained within the material being moved or trapped within the confined dike area and destroyed as the material is placed (CENAB, 1996).

Short-term detrimental effects on the early life stages of some fish species, specifically the egg and larval stages, are expected as a result of the increased turbidity during preconstruction and construction activities. Suspended particles readily adhere to many of the fish eggs, resulting in the eventual burial of demersal eggs, and a reduction in the buoyancy of pelagic eggs. Suspended sediments are also known to impair the feeding of larval and juvenile fish by limiting their sight and ability to detect prey. Fish species that have demersal eggs (e.g., silversides, gobies, and blennies) are most sensitive to PIERP expansion. However, these fish are very common throughout the Middle Bay region, and are expected to suffer temporary and minor population declines as a result of the PIERP Expansion (CENAB, 1996).

4.7.2.1.5.1 Essential Fish Habitat

PIERP is located within a region of the Bay containing designated EFH for nine species of fish. These include windowpane flounder (*Scopthalmus aquosus*), Spanish mackerel (*Scomberomorus maculates*), king mackerel (*Scomberomorus cavalla*), cobia (*Rachycentron canadum*), red drum (*Sciaenops occelatus*), Atlantic butterfish (*Peprilus triacanthus*), black sea bass (*Centropristus striata*), bluefish (*Pomatomus saltatrix*), and summer flounder (*Paralicthys dentatus*) (EA, 2002a).

Windowpane flounder, Spanish mackerel, king mackerel, cobia, Atlantic butterfish, and black sea bass are either transients or not anticipated to be in the project area and would not be impacted. Table 4-1 provides additional information on these species. The remaining species, listed in Table 4-1, bluefish (juveniles), summer flounder (juveniles and adults), and red drum (juveniles), may utilize the proposed environmental restoration area for at least a portion of the year, and are the species of most concern for the project. Summer flounder and bluefish regularly occur in the PIERP area (EA, 2002a). Juvenile red drum have been caught in the area in recent sampling (NOAA, 2001; EA, 2004b).

The proposed environmental restoration would replace an area of benthic and shallow water habitat with marsh and upland habitat. The loss of this aquatic habitat would reduce the size of the available fish habitat surrounding PIERP, primarily for those species that are bottom feeders (e.g., summer flounder). The construction of the dike enclosure, while negatively impacting the benthic and shallow water habitats, has the potential to serve as a wave shadow that may benefit certain Habitat Areas of Potential Concern (HAPC), particularly SAV beds that are critical to early life stages of many finfish (WESTON, 2002a).

Because the proposed environmental restoration areas are located in an area of designated EFH, NMFS will need to be consulted for recommendations in order to determine potential impacts on EFH (WESTON, 2002a).

4.7.2.1.5.2 Summer Flounder

Summer flounder is an obligate bottom feeder that preys on shrimp, small fish, and benthic invertebrates. Juveniles and adults spend the winters in the ocean waters, and usually enter the Chesapeake Bay in the late spring. Summer flounder are more common in the lower Bay than in the middle or upper Bay. During colder weather months they typically move offshore into ocean waters. Juveniles and adults prefer sandy bottom and/or SAV beds. SAV has been identified as HAPC for summer flounder. A complete loss of open water (including sandy bottom) and the benthic macroinvertebrate community in the open water habitat the island would occupy would occur. This would reduce the biomass available for summer flounder consumption, and create competition for food sources in other areas. However, open water habitat (including habitat with sandy bottom) and associated macroinvertebrates that serve as forage species for summer flounder are abundant elsewhere in the Bay, and no detrimental impacts to the summer flounder population are expected. The new land mass would permanently displace summer flounder from the project area, and cause a net loss of summer flounder habitat. Natural processes causing Bay expansion would likely provide comparable replacement open water habitat in the Bay within a several-year period. The restored tidal marsh and likely increase in SAV habitat would benefit juvenile summer flounder, partially compensating for open water habitat loss. Although summer flounder juveniles and adults may be in the project area during construction in warmer weather months, because of their high mobility, summer flounder are expected to be able to avoid detrimental impacts from construction activities around PIERP (EA, 2002a).

Red drum occur over a wide range of water depths and variety of bottom types. Juvenile red drum utilize inlet mouths, tidal creeks/channels, inter and subtidal flats, oyster reefs, and shallow estuarine waters; SAV beds have been identified as HAPC for the juvenile red drum within Chesapeake Bay. Juveniles enter the Bay in August and move to deeper areas of the Bay or offshore in ocean waters by November (Murdy et al., 1997). Juvenile red drum eat mostly fish, although larger juveniles and adults also consume crustaceans and plant material. A complete loss of the benthic macroinvertebrate community in the open water habitat the island would occupy is expected, consequently reducing the biomass available for red drum consumption, and creating competition for food sources in other areas. However, open water habitat and associated forage species for red drum are abundant elsewhere in the Bay, and no detrimental impacts to the red drum population are expected. The new land mass would permanently displace red drum from the project area, and cause a net loss of red drum habitat. Natural processes causing Bay expansion would likely provide comparable replacement open water habitat in the Bay within a several-year period. The restored tidal marsh and increased SAV habitat would benefit juvenile red drum. Although red drum juveniles may potentially be in the project area in summer or fall, because of their high mobility they can readily avoid detrimental impacts from construction activities.

4.7.2.1.5.3 Bluefish

The bluefish is an aggressive swimmer that feeds throughout the water column. Unless they are spawning, juveniles and adults are typically found in the Chesapeake Bay between May and October, with juveniles utilizing shallower waters than adults (EA, 2002a; WESTON, 2002a). Bluefish juveniles utilize salt marsh creek habitat. Adults are uncommon north of Annapolis, MD, except during years of greater Upper Bay saltwedge encroachments (CENAB, 2002a). Juvenile bluefish feed on smaller fish and invertebrates, while the larger individuals feed primarily on Atlantic menhaden (*Brevoortia tyrannus*), bay anchovies (*Anchoa spp*.), and Atlantic silversides (*Menidia menidia*) (EA, 2002a). The PIERP expansion results in the permanent loss of feeding habitat for adult and juvenile bluefish; however, open water habitat is abundant elsewhere in the Bay, and no impacts to the bluefish population is expected. Salt marsh habitat created by the project would partially compensate for impact of open water habitat and forage base loss. Natural processes causing Bay expansion would likely provide comparable replacement open water habitat in the Bay within a several-year period. Although bluefish juveniles and adults may be in the project area during any construction in warmer weather months, because of their high mobility, these fish would be able to avoid detrimental impacts from construction activities around PIERP (EA, 2002a).

4.7.2.1.5.4 Commercially Important Finfish

The Middle Chesapeake Bay and the area surrounding PIERP support the commercial harvesting of finfish (EA, 2002a). Five finfish species make up approximately 90% of the Middle Chesapeake Bay landings. Each of the five species, Atlantic menhaden, American eel, white perch, striped bass, and catfish, use the area during different seasons throughout the year and during varying life stages (MD DNR, 2004k). The proposed PIERP Expansion project would result in a permanent loss of habitat important to commercial species. However, the fish habitats to be converted are abundant in the region and not limiting to the species of concern. In addition, these finfish are highly mobile and are expected to vacate the area during immediate construction, and return to the area following its completion (CENAB, 1996). No long-term impacts on the commercially important finfish species are anticipated, as each of the five species are common through the Middle Chesapeake Bay Region.

4.7.2.1.5.5 Shallow Water Habitat (SWH) and SAV

The substrate surrounding PIERP is primarily sand with clays and finer materials in some areas. The shallow water habitat ranges from approximately 3 ft deep to approximately 12 ft, measured at mean low water. Shallow water areas provide nursery grounds for certain fish species, hunting and foraging opportunities for waterfowl and predatory fish, and resting areas for certain species of waterfowl. Many wildlife species use shallow water habitats exclusively because life history requirements cannot be met in deeper portions of the Bay. SAV requires shallow water (i.e., waters ≤ 6 ft) for successful establishment (EA, 2002a).

Over-flight SAV monitoring between 1994 and 2001 shows no SAV surrounding PIERP, Coaches, or Jefferson Islands. However, several on-site surveys found SAV in 1995 and 2001 to have been reappearing in higher densities in the area referred to as Poplar Harbor, a small bay area located on the island's east side (EA, 2002a). SAV locations should be mapped during project design stages so that SAV and sheltered areas, likely to support SAV in the future, would not be impacted as a result of the project (CENAB, 1996; EA, 2002a).

Expansion of Poplar Island would convert 333 to 1,199 acres (size dependent on alignment selected) of Bay bottom, which is predominantly shallow-water habitat, to upland and marsh habitats (EA, 2002c). It is expected that the constructed dike and island expansion would provide greater protection to the existing persistent SAV beds in Poplar Harbor by reducing the effects of wave action (CENAB, 1996).

4.7.2.2 Large Island Restoration – Middle Bay

4.7.2.2.1 Benthic Invertebrates

As a result of the project, all benthic invertebrates existing within the proposed dike footprint would be permanently lost (MES et al., 2002). A study to assess the species present and the ecological value of the benthic habitat would be necessary once a specific island and footprint for the proposed dike have been selected. Regardless of the location, benefits of the proposed large island restoration project include the addition of tidal marsh benthic habitat, which would replace a portion of the permanently lost benthic and shallow water habitat (WESTON, 2002a). The tidal marsh benthic community would differ from the permanently lost shallow water habitat.

4.7.2.2.2 Oysters and Commercial Oyster Harvesting

Several NOB locations have been identified in the Middle Chesapeake Bay region. Consultation with MD DNR is recommended to determine the exact locations of the known NOB in relation to the island selected, as well as the seasonal restrictions that would be required to be put in place to avoid direct impacts to the oysters during restoration. Large Island Restoration is expected to improve water quality by reducing the amount of erosion and associated suspended solids (MES et al., 2002). The improvement of water quality would improve potential habitat conditions for local oyster populations. Therefore, impacts to the commercial oyster industry would be minimal.

4.7.2.2.3 Soft-Shell Clams and Commercial Soft-Shell Clam Harvesting

As a result of the project, all soft-shell clams existing within the proposed dike footprint would be permanently lost (MES et al., 2002). A study to assess the species and the ecological value of the benthic habitat would be necessary once a specific island and footprint for the proposed dikes have been selected. Soft-shell clam landings in the Maryland portion of Chesapeake Bay between 1994 and 2003 were consistently recorded at levels less than 1% of the highest landings recorded in 1964, which was 680,000 bushels (MD DNR, 2003). Because of the reported degraded state of the soft-shell clam landings throughout the Bay, minimal impacts are expected on the industry. Restoration is expected to improve water quality by reducing the amount of erosion and the associated suspended solids (MES et al., 2002). Improved water quality conditions would improve potential habitat conditions for local soft-shell clam populations.

4.7.2.2.4 Blue Crabs and Commercial Blue Crab Harvesting

It is anticipated that the most significant permanent loss is most likely that of benthic and shallow water habitat at the location where the dike would be constructed. It has been observed around several of the large islands in the Middle Chesapeake Bay investigated for island restoration that the acreage that would be permanently lost likely serves as summer habitat for the blue crab. Because the crabs are highly mobile, they are expected to be able to vacate the area, thereby avoiding any direct impacts (EA, 2002a). It is anticipated that once the restoration is complete, the created marsh creeks would provide habitat for all stages of the crabs’ life cycle, specifically the younger stages (CENAB, 1996). Lastly, commercial crabbing is expected to be temporarily displaced from the immediate vicinity until the island restoration project is complete; however, the industry is not expected to experience significant losses during construction (WESTON, 2002a).

4.7.2.2.5 Finfish and Commercial Finfish Harvesting

Five finfish species make up approximately 90% of the Middle Chesapeake Bay landings. Each of the five species, Atlantic menhaden, American eel, white perch, striped bass, and catfish, use the area during different seasons throughout the year and during varying life stages (MD DNR, 2004k). The proposed Large Island Restoration project would result in a permanent loss of habitat for commercial species. However, these finfish are highly mobile and are expected to vacate the area during construction, and return following its completion (CENAB, 1996). It is expected that the commercial finfish landings would not be severely impacted as a result of the restoration because these species are common throughout the Bay (MES et al., 2002; WESTON, 2002a).

4.7.2.2.6 Essential Fish Habitat

The Middle Chesapeake Bay region contains designated EFH for nine species of fish. The nine finfish species are identical to those listed for the waters surrounding PIERP. EFH species listed include windowpane flounder, Spanish mackerel, king mackerel, cobia, red drum, Atlantic butterfish, black sea bass, bluefish, and summer flounder (WESTON, 2002a; EA, 2002a).

Windowpane flounder, Spanish mackerel, king mackerel, cobia, Atlantic butterfish, and black sea bass are transient or absent from the area and would not be impacted by the project. Table 4-1 provides additional information on these species. The remaining species, bluefish (juveniles), summer flounder (juveniles and adults), and red drum may utilize the proposed environmental restoration area for at least a portion of the year, and are the species of most concern for the project. Summer flounder and bluefish have been reported in the area regularly and are expected to occur around most islands frequently (EA, 2002a). Red drum juveniles have been sampled in the James Island area (MES et al., 2002).

Because of their high mobility, bluefish, summer flounder, and red drum would be able to avoid construction activities and find suitable habitat elsewhere. Impacts to EFH of bluefish, summer flounder, and red drum are expected to be similar to the PIERP Expansion alternative (Section 4.7.2.1.5.1).

The proposed environmental restoration would replace an area of benthic and shallow water habitat with marsh and upland habitat. The loss of this aquatic habitat would reduce the size of the available fish habitat surrounding the remnant island, primarily for those species that are bottom feeders (e.g., summer flounder). The construction of the dike enclosure, while negatively impacting the benthic and shallow water habitats, has the potential to serve as a wave shadow that may benefit certain Habitat Areas of Potential Concern (HAPC), particularly SAV beds that are critical to early life stages of many finfish (WESTON, 2002a). Because the proposed environmental restoration areas are located in area of designated EFH, NMFS would need to be consulted for recommendations in order to determine potential impacts on EFH (WESTON, 2002a).

4.7.2.2.7 Shallow Water Habitat (SWH) and SAV

Any SWH and SAV located within the restoration footprint, which is yet to be proposed, would be permanently lost. Depending on the proximity of construction activities to the SAV beds, construction may temporarily increase turbidity in the area, therefore having a negative effect on SAV (MES et al., 2002). Any benthic invertebrate waterfowl or fish species who use SWH for hunting and foraging, resting, or as a nursery ground would be temporarily displaced.

Long-term effects of restoration would help to reduce wave flow, create quiescent areas conducive to SAV bed development, protect the islands from erosion, reduce turbidity and concentrations of suspended solids, and therefore improve conditions for SAV growth (MES et al., 2002; WESTON, 2002a). All benthic and shallow water habitat impacted would be permanently replaced with created upland and wetland habitat (MES et al., 2002).

4.7.2.3 Wetland Restoration – Dorchester County

Wetland restoration at the Blackwater NWR would utilize suitable quality, mechanically dredged material from the C&D Canal Approach Channels and the Chesapeake Bay Approach Channels (MD) to fill and reclaim approximately 1,000 to 2,000 acres of former wetlands, which as a result of nutria, erosion, subsidence, and sea-level rise, have become 2- to 5-ft depressions of open water habitat. Restoration of the depressions is necessary to protect surrounding wetlands from future degradation. Placing dredged material over the areas where subsidence and erosion have degraded wetlands would help to increase the elevation to that of a regularly inundated wetland, and help to protect these areas from continued erosion. The proposed wetland restoration is expected to benefit aquatic resources by reducing the amount of suspended solids eroding into the water column, which improves water quality and available fish habitat, by providing areas of restored benthic and shallow water habitat, and by restoring valuable habitat for native bird and wildlife species (Price, 2004).

CENAB conducted an EFH impact analysis for tidal marsh restoration demonstration project at Blackwater NWR (CENAB, 2002b). The analysis identified summer flounder and windowpane flounder (juvenile and adult for both) as potential EFH species at Blackwater NWR, although there was no actual evidence indicating that either species occurs in the potential impact area. Indirect impacts to each finfish species could occur from altered habitat conditions and/or altered predation rates as a result of altered access to the site by predators. It was CENAB's opinion that direct impacts to both summer flounder and windowpane flounder would be negligible and there would be no significant indirect impacts from temporary food web impacts. They also determined that there would be no cumulative effects on the population of either species and only minimal short-term adverse effects on EFH.

4.7.2.3.1 Benthic Invertebrates

Raising the elevation of shallow, often anoxic open water areas and exposed, eroding wetlands would result in an improvement of both invertebrate taxa richness and diversity (Berger/EA Joint Venture, 2004; Price, 2004). The addition of vegetation and substrate stability would result in a greater diversity of benthic habitats and support for the food web of the Chesapeake Bay.

4.7.2.3.2 Oysters and Commercial Oyster Harvesting

The area of the proposed action at Blackwater NWR does not serve as habitat for oysters. Therefore, it is not anticipated to have any direct impacts on oysters. There may be an indirect benefit to oysters in other areas through improved water quality and reduced sediment transport as wetland areas are revegetated and soils and sediments stabilized.

4.7.2.3.3 Soft-Shell Clams and Commercial Soft-Shell Clam Harvesting

The area of the proposed action at Blackwater NWR does not serve as habitat for soft-shell clams. Therefore, it is not anticipated to have any direct impacts on soft-shell clams. There may be an indirect benefit to soft-shell clams in other areas through improved water quality and reduced sediment transport as wetland areas are revegetated and soils and sediments stabilized.

4.7.2.3.4 Blue Crabs and Commercial Blue Crab Harvesting

Restoration of degraded wetlands and open water depressions to functional intertidal marsh areas would provide improved habitat for blue crabs. There is no commercial fishing at the Blackwater NWR.

4.7.2.3.5 Finfish

4.7.2.3.5.1 Essential Fish Habitat

CENAB conducted an EFH impact analysis for a tidal marsh restoration demonstration project at Blackwater NWR (CENAB, 2002b). Chesapeake Bay waters in the area of Blackwater NWR are designated by NMFS as EFH for seven species of finfish. The assessment concluded that only summer flounder and windowpane flounder (juvenile and adult for both) were potential EFH species at Blackwater NWR, although there was no actual evidence indicating that either species occurs in the potential impact area. Indirect impacts to each finfish species could occur from altered habitat conditions and/or altered predation rates as a result of altered access to the site by predators. It was CENAB's opinion that direct impacts to both summer flounder and windowpane flounder would be negligible and there would be no significant indirect impacts from temporary food web impacts. They also determined that there would be no cumulative effects on the population of either species and only minimal short-term adverse effects on EFH. Similar minimal impacts would be anticipated from the proposed wetland restoration project at Blackwater NWR.

4.7.2.3.5.2 Commercially Important Finfish

The restoration of degraded and lost tidal wetlands would provide breeding, feeding, and refuge areas for a variety of fish species that utilize the marsh and tidal creek complexes that make up these areas. There is no commercial fishing at Blackwater NWR. However, the proposed action would indirectly benefit commercial fishing by providing habitat and nursery for a variety of fish species, support the Chesapeake Bay food web, improve water quality in the area, and serve as a source of detritus to support food webs in the open waters of the Bay.

4.7.2.3.6 Shallow Water Habitat (SWH) and SAV

Shallow water habitat would be lost from the proposed action. However, the existing habitat has low value. The restoration of wetlands in these areas would benefit the Chesapeake Bay, which has lost significant areas of tidal wetlands vital to maintaining a balanced ecosystem in the Bay (Stevenson et al., 2000). Isolated, interior ponds that support SAV in the Blackwater NWR would indirectly benefit from the proposed action by reducing the salinity and turbidity in these areas, which limit the growth of SAV species in these areas.

4.7.2.4 Confined Disposal Facilities in the Patapsco River

4.7.2.4.1 Benthic Invertebrates

Fixed benthic monitoring stations in Baltimore Harbor have recorded severely degraded conditions inclusive of various types of pollution, toxic contamination, low dissolved oxygen concentrations, excess phytoplankton growth, poor water clarity, and nutrient runoff (CBBMP, 2004). As a result of the proposed project, any existing benthic invertebrates located within the proposed CDF footprint would be permanently buried. Because the aquatic environment and benthic habitat in Baltimore Harbor are currently degraded, it is anticipated that this loss would not severely impact the benthic invertebrate population in Chesapeake Bay (EA, 2003a).

4.7.2.4.2 Oysters and Commercial Oyster Harvesting

There is no record of any NOB existing in Baltimore Harbor, and no commercial oyster harvesting has been reported (EA, 2003a). Nearshore CDF construction is not anticipated to have any negative environmental impact on oysters or oyster harvesting in the Harbor.

4.7.2.4.3 Soft-Shell Clams and Commercial Soft-Shell Clam Harvesting

There is a low abundance of soft-shell clams within the Harbor, and no commercial harvesting of the species has been reported (EA, 2003a). Nearshore CDF construction would permanently bury any soft-shell clams that exist within the proposed CDF footprint. Because of the Harbor’s small population of the species and degraded benthic conditions, any soft-shell clams that are lost as a result of CDF construction would not have a great impact on the Bay-wide soft-shell clam species abundance.

4.7.2.4.4 Blue Crabs and Commercial Blue Crab Harvesting

Baltimore Harbor supports a minimal percentage of commercial blue crab landings for Chesapeake Bay. Blue crab harvests have been reported to the south and east of the Francis Scott Key Bridge, but are reported to be in an overall decline between 1990 and 2002 (MD DNR, 2004b). “Restricted consumption” advisories have been implemented for blue crabs in the entire Patapsco River, meaning that the general population is advised to restrict the amount and frequency of consumption. Blue crabs located or overwintering within the proposed footprint of the CDF would be permanently lost; however, it is not typical for blue crabs to overwinter in the harbor. Similar to finfish, blue crabs are expected to be able to avoid the direct impacts of construction by displacing themselves from the construction area (EA, 2003a). It is believed that the blue crab population and commercial harvesting impacts would be minimal as a result of the proposed nearshore CDF construction in Baltimore Harbor.

4.7.2.4.5 Finfish and Commercial Finfish Harvesting

Commercial fishing in the vicinity of Baltimore Harbor is predominantly limited to the lower Patapsco River southeast of the Francis Scott Key Bridge. The area northwest of the Francis Scott Key Bridge does not support a commercial finfish industry. Based upon NMFS screening during the state BEWG process, Baltimore Harbor and the Patapsco River are not classified as EFH for any species protected by the Magnuson-Stevens Act. There is a fairly significant commercial fishery for finfish and blue crab located just south of the Francis Scott Key Bridge in the vicinity of Sparrows Point (Donovan, 2004). Fish consumption advisories have been instituted for Baltimore Harbor, for the area upstream of the Francis Scott Key Bridge. “Restricted consumption” advisories have been implemented for American eel and channel catfish, meaning that the general population is advised to restrict the amount and frequency of consumption. Additionally, a “no consumption” advisory was instituted for brown bullhead, advising the general population against its consumption (EA, 2003a).

The construction of a nearshore CDF in the Patapsco River is not expected to result in negative impacts to local finfish. Because they are highly mobile, finfish are expected to avoid the direct impacts of construction. Fish in the area would be displaced from any existing shoreline habitat; however, when complete, dike armoring would replace a portion of the lost habitat (EA, 2003a).

Because this area does not support significant fishery, long-term impacts as a result of CDF construction are not anticipated.

4.7.2.4.6 Shallow Water Habitat (SWH) and SAV

Historically, some shoreline areas throughout the Harbor have been reported to support SAV growth. In 1998, VIMS aerial survey results reported 145 acres of SAV in the Patapsco River, 21 acres above the CBP goal of 124 acres. Additionally, small pockets of SAV were noted throughout the River, but were too small to be detected by aerial mapping (VIMS, 2004c). More recent documents, published in 2003, report no SAV at several locations that have been taken into consideration for CDF construction: Dead Ship Anchorage, Sollers Point, and Thom's Cove (EA, 2003a). Any SAV existing within the footprint of the proposed CDF would be permanently lost. In order for the project design to incorporate avoidance of impacts to known SAV beds, survey results should be consulted once a specific location(s) is selected. Any SWH existing within the footprint of the proposed CDF would be permanently lost. Any waterfowl, benthic invertebrates, or fish species who use SWH for hunting and foraging, resting, or as a nursery ground would be permanently displaced.

4.8 WETLANDS

4.8.1 Continued Maintenance Dredging

4.8.1.1 C&D Canal Approach Channels

Continued maintenance dredging within the navigable channels would not directly impact any existing wetlands in the Upper Chesapeake Bay Region.

4.8.1.2 Harbor Channels

Continued maintenance dredging within the navigable channels would not directly impact any existing wetlands in the Harbor Channels area (CENAB, 1997).

4.8.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging within the navigable channels would not directly impact any existing wetlands in the Middle Chesapeake Bay Region.

4.8.1.4 Chesapeake Bay Approach Channels (VA)

Continued maintenance dredging within the navigable channels would not directly impact any existing wetlands in the Lower Chesapeake Bay Region.

4.8.2 New Sites or Expanded Existing Sites

4.8.2.1 PIERP Expansion

The proposed PIERP Expansion is not anticipated to have any long-term negative impacts on the restored Island's existing wetlands. Some short-term impacts are anticipated to be associated with the construction phase of the project—increased turbidity, noise, visual impacts, a temporary impact to aquatic organisms, and the potential to impact the area's larger organisms including birds, turtles, and mammals.

Because the goal is to create habitat on the Island, 50% of the area within the expansion footprint is planned to be wetlands, while the other 50% would be uplands. Therefore, the project would result in an overall increase in the total amount of wetlands (EA, 2002a). The expansion is expected to increase PIERP's biotic productivity; improve water quality; and provide breeding and foraging grounds for birds, wildlife, commercially and recreationally important fish, bird, and wildlife species; and rare, threatened, and endangered (RTE) species. It is thought the benefits created by the wetlands would support increased recreation, education, and research on and around PIERP (CENAB, 1996), and protect SAV and reduce the erosion of Jefferson Island into Poplar Harbor.

4.8.2.2 Large Island Restoration – Middle Bay

The proposed Large Island Restoration project is not anticipated to have any long-term negative impacts to the selected island's existing wetlands. Planning for large island restoration would include minimizing impacts to existing tidal wetland systems. However, some changes in the tidal dynamics of these systems are anticipated. The impact would vary depending on the restoration location and resulting changes in water movement and sediment transport due to the implemented plan. Examples include increased tidal flow and duration in existing tidal wetland areas resulting in enhancement of existing wetlands and the potential conversion of nontidal wetlands to tidal; reduced tidal flow into wetlands and resulting degradation; and the protection of tidal and nontidal wetlands from the erosive force of waves and currents.

Large Island Restoration is expected to have long-term positive effects on both the island selected for restoration, and the area surrounding the island. Depending upon the bay currents and the orientation of the island site selected, this alternative has the potential to stabilize any existing erosion along the banks of the island selected. Restored wetlands may improve water quality by stabilizing erosion and reducing suspended solids. Upland and wetland habitat would be restored, attracting fish, birds, and wildlife to the area. The creation of wetlands and tidal channels would provide additional habitat that is potentially suitable for SAV growth (MES et al., 2002). Additionally, habitat would be created immediately adjacent to the dike that would be appropriate for common shoreline fish and animal species. Some short-term impacts are anticipated to be associated with the construction phase of the project—increased turbidity, noise, visual impacts, a temporary impact to aquatic organisms, and the potential to impact the area's larger organisms including birds, turtles, and mammals. All shallow water habitat that is impacted would be permanently replaced with upland and wetland habitat, increasing the amount of wetland systems in the area (WESTON, 2002a).

4.8.2.3 Wetland Restoration – Dorchester County

The internationally significant wetlands of the Blackwater NWR are rapidly degrading and disappearing from a combination of sea level rise, subsidence, nutria and waterfowl herbivory, roads and other tidal obstructions, erosion from wind and storm-driven waves, frequent burning for wildlife management, and perhaps groundwater withdrawal (Stevenson et al., 2000; Price, 2004). The result has been the conversion of ecologically prime wetlands into a complex of shallow, often anoxic open water depressions and devegetated marsh surfaces with marginal habitat value. In order to reverse some of these losses, it is proposed to use dredged material to raise the elevation of these areas to provide suitable conditions for the establishment of wetlands with improved habitat value and other wetland functions such as substrate stabilization, water quality, and food web support.

Wetland restoration at the Blackwater National Wildlife Refuge (NWR) would utilize suitable quality, mechanically dredged material from the C&D Canal Approach Channels and the

Chesapeake Bay Approach Channels (MD) to fill and reclaim approximately 1,000 to 2,000 acres of former wetlands that have become 2- to 5-ft depressions of open water habitat. Restoration of the depressions is necessary to protect surrounding wetlands from future degradation. Placing dredged material over the areas where subsidence and erosion have degraded wetlands would help to increase the elevation to that of a regularly inundated wetland, and allow for the establishment of a desired vegetative cover help to protect these areas from continued erosion. The proposed action would further protect and indirectly enhance adjacent wetland and open water areas.

The proposed action would result in the filling of open water areas and related loss of shallow water aquatic habitat. However, as previously mentioned, these aquatic areas have low habitat value, impact adjacent areas, and promote the continued erosion of degraded wetlands and transport of sediment to deeper open water areas. Therefore, the proposed action would result in direct benefits to existing low quality open water and wetland complexes, while improving conditions in adjacent areas. The proposed wetland restoration is expected to benefit aquatic resources by reducing the amount of suspended solids eroding into the water column, therefore improving water quality and available fish habitat, provide areas of restored benthic and shallow water habitat to be utilized by benthic organisms, and restore valuable habitat for fish and other aquatic species vital to the Chesapeake Bay ecosystem (Price, 2004).

4.8.2.4 Confined Disposal Facilities in the Patapsco River

As a result of Baltimore Harbor's extensive industrial and commercial development, a majority of the tidal wetlands that once existed within the Harbor have been destroyed, or their environmental quality greatly reduced. Wetlands remaining in the area are dominated by the aggressive and invasive common reed (*Phragmites australis*), which degrades the quality of the wetland by eradicating the native vegetation and reducing the system's overall functions and values (CENAB, 1997). Construction of the proposed CDFs has the potential to directly impact wetlands, should they exist at the locations where the dikes connect with the existing shoreline (EA, 2003a). Once potential areas have been selected for CDF construction, additional research is required to determine the total proposed impacts to wetlands.

4.9 TERRESTRIAL RESOURCES

4.9.1 Continued Maintenance Dredging

4.9.1.1 C&D Canal Approach Channels

Continued maintenance dredging could potentially cause short-term impacts on terrestrial resources (mammals, marsupials, birds, and herpetiles). The only terrestrial species potentially impacted by maintenance dredging are waterfowl and the diamondback terrapin. Mechanical clamshell bucket dredging used in this region produces turbid plumes by releasing sediment into the water column. Waterfowl and diamondback terrapin can avoid the immediate impacts of channel dredging, but turbidity plumes caused by dredging may indirectly affect them through adverse impacts to benthic and aquatic food sources (CENAP, 1996). These impacts would be minimal because most species of wildlife feed over relatively large areas.

Because of the relative absence of terrestrial species in the dredging area, no substantial impacts are expected from maintenance dredging activities. Navigable channels are also distant enough from island and mainland shores to avoid significantly impacting terrestrial wildlife inhabiting Upper Bay shorelines.

4.9.1.2 Harbor Channels

Waterfowl and diamondback terrapin can avoid the immediate impacts of continued maintenance channel dredging in the Baltimore Harbor, and no significant noise-related impacts are expected assuming that resident wildlife is accustomed to industrial operations. Predatory birds could be exposed to contaminants by consuming aquatic organisms that accumulate contaminants released to the water column following dredging activity. However, observations indicate that even during open water placement operations, essentially no uptake of metals or PCBs by fish or most invertebrates occurs (CENAB, 1981). Therefore, the potential risk to predatory birds is minimal.

4.9.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging of the Chesapeake Bay Approach Channels (MD) would also be conducted using a mechanical clamshell bucket dredge with no substantial impacts to terrestrial resources expected.

4.9.1.4 Chesapeake Bay Approach Channels (VA)

Continued maintenance dredging in the Lower Bay could potentially cause short-term impacts on terrestrial resources. Waterfowl and diamondback terrapin can avoid the immediate impacts of channel dredging, but turbidity plumes caused by dredging may indirectly affect them through adverse impacts to benthic and submerged vegetative food sources (CENAP, 1996). This impact is not expected to be significant because hydraulic hopper dredging used in this region releases relatively little sediment into the water column.

Because of the relative absence of terrestrial species in the dredging area, no substantial impacts are expected from maintenance dredging activities. Navigable channels are also distant enough from island and mainland shores to avoid significantly impacting terrestrial wildlife inhabiting Lower Bay shorelines.

4.9.2 New Sites or Expanded Existing Sites

4.9.2.1 PIERP Expansion

Existing terrestrial wildlife on PIERP would be largely unaffected by construction of the placement facilities because most construction activities would occur from the water. Elevated noise and construction activity may cause some terrestrial wildlife to avoid areas near restoration sites, but these impacts would be temporary and would diminish after the construction is completed. Monitoring during the construction of Phase I and Phase II for the PIERP Restoration Project has demonstrated that most resident wildlife within the PIERP archipelago acclimate quickly to restoration activities (EA, 2003e). Time-of-year restrictions for restoration construction are in place for bald eagles (December 15 to June 15), herons (February 15 to July 15), and terns (May 1 to July 31). There is also an area in the northeast section of the island where no construction can take place because of bald eagles (EA, 2004a).

As described in Section 2.8.2, 28 species of birds have been identified in the PIERP Archipelago during site reconnaissance visits. Expansion of PIERP would create approximately 600 acres of upland and wetland habitat that would provide feeding, nesting, and protective habitat for numerous avian and herpetile species although natural predators may arise that could impact these benefits. Diamondback terrapins require remote, sandy beaches to lay eggs. However, suitable terrapin breeding habitat is becoming increasingly scarce in the Chesapeake Bay because of human development and activities, sea-level rise, and erosion. Experience has proven that the Island is well situated and isolated enough for terrapin, and expansion of the restoration effort would create additional breeding habitat (CENAB, 2004a).

4.9.2.2 Large Island Restoration - Middle Bay

Because most island restoration construction would occur in shallow water areas adjacent to islands, direct impacts on terrestrial biological resources during the construction phase are expected to be minimal. Avian utilization of open water is usually minor compared to that of the wetland and upland island habitat. Some terrestrial species inhabiting islands, particularly nesting birds, would likely avoid shores of an island restoration site during construction activities. This impact would be short-term, occurring primarily during the construction, and, to a lesser extent, placement phases.

As described in Section 2.8.2, large islands of the Middle Bay region are known to support brown pelican colonial nesting areas, great blue heron rookeries, and active bald eagle nests, as well as breeding habitat for other significant avian species. Great blue herons lay eggs in March and April, incubate the eggs for 1 month, and fledglings leave the nest by early July. Brown pelicans lay eggs from late winter to early spring, and incubate the eggs for 30 days. Bald eagles lay eggs between January and March, incubate the eggs for 35 days, and the fledglings leave the nest in 10 to 12 weeks. If construction occurs during the late spring and early summer, the potential impact on nesting birds would be higher than at other times of the year. During this period, active nests would already be established and eggs or young would be present. Construction activities earlier in the year could discourage nesting along shorelines closest to the work zone as well as on any small remnant islands in the area. It is recommended that construction activities associated with a proposed project follow a schedule similar to the one implemented for PIERP, but which would be specific to the terrestrial habitat resources of the selected project in order to minimize impacts to nesting birds that use project islands or their remnants (WESTON, 2002a).

Middle Bay islands are known to support a variety of mammals, including white-tailed deer, sika deer, raccoon, muskrat, red fox, and meadow vole (EA, 2003b,d,g) (EA, 2002b). Middle Bay islands are also known to support diamondback terrapin and various other reptiles and amphibians (WESTON, 2002a). As mentioned for the PIERP, the design of dikes could include consideration for the migration of wildlife to minimize impacts in newly restored areas.

The placement of dredged material would provide additional upland and wetland habitat for Chesapeake Bay species. Offshore islands are preferred by nesting and feeding colonial water birds because of their distance from human disturbances. However, natural predators may arise that could impact the avian population. The wave buffering action of large islands also enhances the growth of aquatic vegetation in protected areas and could indirectly benefit foraging terrestrial wildlife. Currently, the shoreline habitat of potential restoration sites is eroding at an accelerated rate. The addition of dikes would reduce or eliminate this erosion and stabilize the shoreline habitat (WESTON, 2002a).

4.9.2.3 Wetland Restoration - Dorchester County

Terrestrial resources are not expected to be severely impacted by either the construction of piping networks or storage of material because placement activities would be transient and dredged material would be pumped from a moored base over water. Elevated noise and construction activity may cause some terrestrial wildlife to avoid areas near restoration sites, but these impacts would be temporary and would diminish following the completion of construction. Diamondback terrapin populations have the potential to be impacted by the placement of dredged material. Impacts to terrapin and nesting birds may be mitigated through appropriate construction scheduling and operations management. Project-related sedimentation increases in adjacent areas may adversely impact SAV, therefore impacting waterfowl by degrading a valuable food source. Practices implemented for the PIERP restoration project may serve as a guide for this and other potential projects.

Open water pools permanently replaced by terrestrial habitat may displace muskrat populations inhabiting degraded areas. Restored vegetated areas, however, would provide vital nesting, foraging, and protective habitat for a wide variety of terrestrial species, including muskrats, and would protect surrounding wetland areas from further losses.

4.9.2.4 Confined Disposal Facilities in Patapsco River

Terrestrial resources would be largely unaffected by construction of the placement facilities because most construction activities would occur from the water and in areas of existing development or former industrial sites, which have low habitat value. Wildlife use is sparse in the Inner Harbor and few disturbances are expected, assuming that resident species are acclimated to industrial operations and would acclimate quickly to construction activity. Wildlife using adjacent habitat may avoid the area during construction and filling, but this would be a short-term effect. Resident bird species such as great blue and greenback herons, cormorants, and osprey that are known or expected to nest in the harbor area could be displaced temporarily (EA, 2003a). Time-of-year restrictions, however, may be imposed upon construction activities to mitigate impacts to sensitive species.

Only material from west of the North Point-Rock Point line would be placed in the proposed facilities. The sediments that would be contained within the proposed site(s) would come from Baltimore Harbor and are expected to have elevated levels of contaminants that are unsuited for habitat restoration and confined disposal (EA, 2003a). These sediments would not be considered suitable for habitat restoration and therefore no beneficial impacts to wildlife are expected.

4.10 RARE, THREATENED, AND ENDANGERED (RTE) SPECIES

4.10.1 Continued Maintenance Dredging

4.10.1.1 C&D Canal Approach Channels

Continued maintenance dredging operations are not expected to significantly impact federal or state-listed RTE species in the Upper Bay. The shortnose and Atlantic sturgeons, peregrine falcon, least tern, and bald eagle are state or federally listed RTE species expected to occur in the Upper Bay. Most sensitive species can avoid the direct impacts of channel dredging, but turbidity plumes caused by dredging may indirectly affect them through adverse impacts to finfish, benthic, and submerged vegetative food sources (CENAP, 1996). CENAB is currently preparing a shortnose sturgeon (SNS) Biological Assessment.

Although few studies have been conducted on the subject, there are potential impacts to the shortnose sturgeon that could occur from dredging activity. Potential impacts include (1) physical injury or death to sturgeon due to entrainment by the draghead of hopper dredges; (2) injury to larvae or juveniles from dredging operations; (3) the disruption of migrations due to physical disturbances and noise; (4) the settling of suspended material on the spawning ground or foraging locations; and (5) if the material is contaminated, toxin uptake by sturgeon.

Short-nose sturgeon typically prefer deeper waters and are benthic foragers, which would magnify the potential for dredging interactions (NOAA, 2003b). Dredging has the potential to destroy benthic feeding areas, disrupt spawning migrations, and deposit fine sediments in spawning habitats. Fish capture and/or mortality, either incidental or intentional, would result in the removal of sturgeon individuals from an already small fish population unless appropriate measures are taken to return the sturgeon to the water without harm. Any decrease in sturgeon population size is problematic because fewer adults are available for reproduction, resulting in smaller future populations and potentially lower levels of genetic variation in the population (WESTON, 2002b). These impacts from dredging operations may be avoided by imposing work restrictions during spawning and migration periods and through the use of alternative dredge types (CENWW, 2002). Continuing consultations with MDNR, USFWS, and NMFS are recommended to ensure regulatory compliance and mitigation of impacts to rare species.

4.10.1.2 Harbor Channels

The shortnose sturgeon, peregrine falcon, and the bald eagle are state or federally listed species that are potentially present in Baltimore Harbor. Peregrine falcons (Maryland endangered) have been consistently observed nesting in downtown Baltimore at the Inner Harbor and on the Francis Scott Key Bridge. Their diet generally consists of pigeons, but they occasionally prey on waterbirds. Falcons could potentially be exposed to contaminants by consuming birds that have accumulated contaminants released to the water column. However, prey species are migratory and are not likely to bioaccumulate toxins at a level that would harm the falcons or reduce their reproductive success (CENAB, 1997). There is also a pair of nesting eagles, which fledged chicks, near Masonville (Boraczek, 2004).

4.10.1.3 Chesapeake Bay Approach Channels (MD)

The least tern, peregrine falcon, northern harrier (Maryland Rare), black skimmer, short-nosed sturgeon and Atlantic sturgeon (Maryland Rare) species, and the bald eagle are state or federally listed species expected to occur in the Middle Bay. Most sensitive species can avoid the direct impacts of channel dredging, but turbidity plumes caused by dredging may indirectly affect them through adverse impacts to benthic and submerged vegetative food sources (CENAP, 1996). Because dredging methods used in the Middle Bay are like those used in the C&D Canal Approach Channels, impacts to the shortnose sturgeon would be similar to those described for the Upper Bay.

4.10.1.4 Chesapeake Bay Approach Channels (VA)

The shortnose sturgeon, peregrine falcon, least tern (SC), bald eagle, Northern harrier (SC), yellow-crowned night-heron (SC), humpback whale, West Indian manatee, and a number of sea turtle species are state or federally listed species that are potentially present in the Lower Bay. In the *Draft Information Report on Lower Bay Uses of Dredged Material* (CENAO, 1994) it is noted that with the exceptions of the piping plover and peregrine falcon, all sensitive species are considered to be transient. However, an earlier study (CENAO, 1985) reported that protected marine turtle species occur on more than an occasional or transient basis and that the Lower Bay serves as an important nursery and summer foraging area for several populations of juvenile sea turtles. Although many sensitive species can avoid the direct impacts of channel dredging, hopper dredges can and do entrain sea turtles. The dredging of these channels has been coordinated with NMFS and biological opinions and incidental take statements have been issued. Any dredging that occurs from April 1 through November 30 must conform to the Biological Opinion requirements, which include turtle deflectors on dragheads, turtle observers on board the dredge, etc. Turbidity plumes caused by dredging may indirectly affect sensitive species through adverse impacts to finfish, benthic, and submerged vegetative food sources (CENAP, 1996). Impacts to these species could be mitigated in the Lower Bay through consultation with VADEQ, USFWS, and NMFS.

4.10.2 New Sites or Expanded Existing Sites

4.10.2.1 PIERP Expansion

As described in Section 2.9, several reconnaissance studies demonstrated that Middle Bay islands provide breeding and foraging grounds for several federal or state RTE species. Federally listed bald eagles were cited as either residents, potential residents, or foragers on all islands investigated (Holland, James, Poplar, Barren, and Sharps Islands). State-listed least tern have been sighted on PIERP as well as its restored areas between 1994 and 2001. It is possible that expansion of the site would temporarily displace some RTE species, although time-of-year restrictions during construction should mitigate these impacts (EA, 2003e).

Federally listed species such as the shortnose sturgeon and sea turtles would be transient inhabitants of the island's expansion areas and impacts would be minimal. Consultation with USFWS and MDNR about the status of listed avifauna in the vicinity of PIERP would be needed before initiating more in-depth feasibility and design studies (EA, 2003e). Expansion of the PIERP restoration project would ultimately provide up to 600 acres of additional habitat for certain RTE species.

4.10.2.2 Large Island Restoration – Middle Bay

The bald eagle, a federal and state-listed threatened species, is a well-documented and observed breeding species in the Middle Bay region. The Maryland Rare northern harrier is a state-listed RTE species; however, the Maryland list of RTE species is based on their breeding status. Protected species of sturgeon, Atlantic (Maryland Rare) and SNS, are known to be transient near the large islands of the Middle Bay. Although little impact would be expected, continuing consultations with MDNR, USFWS, and NMFS would be needed for these and other sensitive species. Coordination with resource agencies, for instance, has allowed construction of the PIERP project to proceed with no impacts to the bald eagles (EA, 2003a).

Although restoration areas would be different from the current shallow water habitat found along the shores of eroded remnant islands, the placement of dredged material would provide additional upland and wetland habitat for sensitive Bay species. Offshore islands could be preferred by sensitive species because of their distance from human disturbances. However, unless large terrestrial predators are managed, a large island could support a significant predator population that is a threat to sensitive species. The wave-buffering action of large islands also enhances the growth of aquatic vegetation and could indirectly benefit these species by enhancing foraging habitat. The addition of dikes would reduce or eliminate this erosion and stabilize the shoreline habitat (WESTON, 2002a).

4.10.2.3 Wetland Restoration – Dorchester County

Numerous federal- and state-designated RTE species occur in the wetland habitat of the Blackwater NWR. The federally listed bald eagle and least tern and the state-listed peregrine falcon are some of the avian species that could be impacted by construction and/or placement activities. Most impacts would be considered temporary because these species are mobile feeders and project operations may be scheduled to mitigate impacts on nesting birds. Only minimal impacts are expected for federal- and state-listed plant species due to small space requirements of placement equipment.

Dredged material placement would restore approximately 1,000 acres of former wetlands, which as a result of nutria invasion, erosion, subsidence, and sea-level rise, have become 2- to 5-ft depressions of open water habitat. Restored vegetated areas would provide vital nesting, foraging, and protective habitat for sensitive species and would protect surrounding wetland areas from further losses.

4.10.2.4 Confined Disposal Facilities in Patapsco River

Material placed in confined disposal facilities of the Baltimore Harbor would not be considered suitable for habitat restoration and therefore no beneficial impacts are expected. USFWS identified state-listed peregrine falcon as an endangered species observed nesting on the Francis Scott Key Bridge near potential placement areas. Their diet generally consists of pigeons, but they occasionally prey on waterbirds. Falcons could potentially be exposed to contaminants by consuming birds that have accumulated contaminants released from dredging-related operations. However, prey species are migratory and are not likely to bioaccumulate toxins at a level that would harm the falcons or reduce their reproductive success (CENAB, 1997). Formal consultations for all RTE species would be needed with NMFS, USFWS, and MDNR if a project is to be developed further.

4.11 RECREATION

4.11.1 Continued Maintenance Dredging

4.11.1.1 C&D Canal Approach Channels

Continued maintenance dredging of the navigable channels would have short-term impacts on recreation in the Upper Chesapeake Bay. This would primarily be a temporary increase in turbidity, which has the potential to impact recreational and commercial fishing. Notification to mariners would minimize disturbance because commercial and recreational fishermen would likely avoid fishing in the vicinity of ongoing dredging. The proposed channel dredging is not expected to conflict with boating because recreation boaters have the ability to navigate around the ongoing dredging operations. Recreational impacts would also be limited if dredging is performed during the winter months. All recreational activities are projected to resume normal practice following project completion (CENAB, 1997).

4.11.1.2 Harbor Channels

Continued maintenance dredging of the navigable channels would have short-term impacts on recreation in Baltimore Harbor. This would primarily be a temporary increase in turbidity, which has the potential to impact recreational and commercial fishing. Fishermen would likely avoid fishing in the vicinity of ongoing dredging. The proposed channel dredging is not expected to conflict with boating because recreational boaters have the ability to navigate around the ongoing dredging operations. However, short-term impacts in the Harbor may result in increased boat traffic and congestion, unless the dredging is performed in the winter months. All recreational activities are projected to resume normal practice following project completion (CENAB, 1997).

4.11.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging of the navigable channels would have short-term impacts on recreation in this area of the Middle Chesapeake Bay. This would primarily be a temporary increase in turbidity, which has the potential to impact recreational and commercial fishing. Commercial and recreational fishermen would likely avoid fishing in the vicinity of ongoing dredging. The proposed channel dredging is not expected to conflict with boating because recreation boaters have the ability to navigate around the ongoing dredging operations.

Recreational impact would also be limited if dredging is performed during the winter months. All recreational activities would resume normal practice following project completion (CENAB, 1997).

4.11.1.4 Chesapeake Bay Approach Channels (VA)

Continued maintenance dredging of the navigable channels would have short-term impacts on recreation in the Lower Chesapeake Bay. This would primarily be a temporary increase in turbidity, which has the potential to impact recreational fishing. Commercial and recreational fishermen would likely avoid fishing in the vicinity of ongoing dredging. The proposed channel dredging is not expected to conflict with boating because recreational boaters have the ability to navigate around the ongoing dredging operations. Recreational impact would also be limited if dredging is performed during the winter months. All recreational activities would resume normal practice following project completion (CENAB, 1997).

4.11.2 New Sites and Expanded Existing Sites

4.11.2.1 PIERP Expansion

Recreational activities in the vicinity of PIERP include fishing, boating, bird watching, hunting, picnicking, and sightseeing. Charter boats and private recreational fishing boats utilize the area adjacent to PIERP's north end; however, shallow depths around the island naturally restrict power and sailing vessels requiring a deeper draft. Intermittent barge traffic may temporarily restrict, limit, or inconvenience recreational boat traffic in the vicinity of PIERP. Boating and fishing would be permanently displaced from the areas where upland and wetland restoration occurs. All on-island activities would be temporarily restricted during construction. Activities that benefit from limited human involvement, such as duck hunting, bird watching, and fishing, would be temporarily impacted during the construction phase of the expansion project. Waterfowl hunting may be temporarily displaced from the area around PIERP during construction activities, but exists in many other locations throughout the Middle Bay region, and would have minimal impact (CENAB, 1996; EA, 2002a).

Newly created upland and wetland habitat within the Island's proposed expansion area is expected to increase the amount of fish, birds, and wildlife using the area, therefore permanently enhancing the above-mentioned recreational activities on and around PIERP. Additionally, the containment dike is expected to provide new habitat structures, inclusive of salt marsh and reef, which would attract sport fish species to the area, therefore enhancing the recreational fishery in the area (CENAB, 1996; EA, 2002a).

The current project appears to be having a beneficial impact on fishing in the area and no impact on the existing hunting conditions. The construction of fish mounds in the vicinity has proven beneficial for recreational fishing (Mendelsohn, 2004).

4.11.2.2 Large Island Restoration – Middle Bay

Recreational activities in the vicinity of the large islands of the Middle Bay region include fishing, boating, bird watching, and hunting. Most recreational activities would be temporarily displaced during restoration. Transport of necessary construction equipment would use a barge and tugboats; however, this traffic is expected to have minimal impact on boating during restoration. Boating and fishing would be permanently displaced from the areas where upland and wetland habitats are restored. Boating is anticipated to resume in the project vicinity immediately following construction, while fishing would resume once the mobile species return to the area. Likewise, seasonal hunting is expected to resume within the restored areas following construction and the return of the species to the area (MES et al., 2002; WESTON, 2002a).

4.11.2.3 Wetland Restoration – Dorchester County

Wetland restoration is not anticipated to have any substantial impacts on recreation at the Blackwater NWR. Current activities include bird watching, biking, fishing, hiking, and deer hunting (USFWS, undated). Some activities may be detoured or temporarily suspended during restoration. However, recreation is expected to resume as normal following restoration completion (Price, 2004).

4.11.2.4 Confined Disposal Facilities in the Patapsco River

The proposed CDF construction is not anticipated to have significant impacts on recreation within the Patapsco River. Fishing and boating activities may be temporarily displaced from the vicinity during construction and operation. The CDF footprint would permanently replace aquatic habitat and impact fishing and boating activities. All other activities should resume in the vicinity, and according to their normal pattern, upon completion of construction (CENAB, 1997).

Depending on the location chosen for the CDFs, local parks, community centers, and other recreational resources may be impacted and should be evaluated during facility siting.

4.11.3 Wild and Scenic Rivers

Currently, there are no federally designated sections of rivers within the Chesapeake Bay area (www.nps.gov/rivers). Therefore, the proposed actions and recommended alternatives would not have any impact on designated rivers.

4.12 CULTURAL RESOURCES

Panamerican Consultants, Inc., conducted a reconnaissance-level cultural resources survey for the CENAB DMMP. The purpose of the survey was to identify known cultural resources within proposed dredged material placement sites. Cultural resources include archaeological sites, buildings, structures, objects, and districts. Based on the history and topography of each DMMP alternative, a determination of the potential for additional cultural resources was formulated.

Each existing and proposed alternative was examined relative to all known cultural resources, as well as the potential to yield additional significant cultural resources. Sections 4.12.1 and 4.12.2 summarize the cultural resources report as it pertains to the recommended plan alternatives. The full text of the report, including potential impacts to all alternatives that were considered, is included as Appendix E.

Prior to any site-specific project activities, alternative areas should be subject to a Phase I investigation to determine the presence or absence of potentially significant cultural resources that may be impacted by proposed project activities. Following the collection and analysis of data acquired during any additional Phase I survey, recommendations can then be made regarding any potentially significant cultural resources. Recommendations include avoidance, or additional testing of potentially significant sites in the form of Phase II testing to determine National Register of Historic Places (NRHP) eligibility (if avoidance is not an option). After consultation with the State Historic Preservation Officer (SHPO) and a determination of effect (upon the property) is decided, a consultation discussing avoiding, minimizing, or mitigating adverse effects on the property follows. Once a suitable agreement is reached among all participating parties, a Memorandum of Agreement (a legal document that states the compliance to Section 106 of the National Historic Preservation Act (NHPA) requirements has been met and agreed upon) is drafted in a written document. The proposed project may then proceed.

4.12.1 Continued Maintenance Dredging

Continued maintenance dredging of the authorized federal channels is performed periodically within existing channel footprints. Any potential cultural resources in the channels, had they existed, would have been removed beforehand. Therefore, there would be no effect on cultural resources by continued maintenance dredging.

4.12.2 New Sites and Expanded Existing Sites

4.12.2.1 PIERP Expansion

A total of 10 archaeological sites are on file at Maryland Historic Trust (MHT). Eight of these sites are located on the remnants of PIERP (i.e., North Point, Jefferson Island) and considered to be within the Area of Potential Effect (APE). Results of archival research identified numerous NRHP properties and Historic Districts located within Talbot County, Maryland. However, none of these are located within or near the proposed APE and are therefore not pertinent to this reconnaissance-level survey. The proposed alternatives have been designed to avoid impacts.

A number of archaeological sites have been documented on and near PIERP; therefore, the potential exists for additional sites within the APE. In addition, a number of documented vessel losses have been reported in the PIERP area. Review of Hurry and Beard’s shipwreck inventory identified five vessels reportedly lost near PIERP. The proposed alternatives have been designed to avoid impacts.

4.12.2.2 Large Island Restoration – Middle Bay

The representative area for this alternative is located within Dorchester County, Maryland. Located along the east shoreline of the Delmarva Peninsula, the APE includes a large section of the eastern shoreline of Chesapeake Bay. Numerous cultural resources are located within the

APE; however, only those on or near the shoreline would likely be affected by proposed project activities.

A number of NRHP properties and Historic Districts have also been identified within Dorchester County, Maryland. A total of 25 properties and districts are currently listed within the county. Of these, 10 are located within the APE. To the extent possible, island alignments would be designed to avoid impacts to these resources.

There is the potential that additional cultural resources exist within the proposed APE. Extensive shoreline erosion and the historic use of the region suggest additional sites may include shoreline sites, inundated prehistoric sites, and shipwrecks.

4.12.2.3 Wetland Restoration – Dorchester County

The representative area for this alternative is located within the Blackwater NWR, Dorchester County, Maryland. There are 12 documented archaeological sites within the proposed APE. Numerous NRHP and architectural properties are located within Dorchester County, Maryland. However, none are located within the proposed APE (Blackwater NWR). Although there are approximately 40 reported historic shipwrecks within Dorchester County, none are reported within the proposed APE, except for 18DO187 (the Blackwater Canoe). Because of known archaeological sites within the area, the potential exists for additional cultural resources within the APE.

Because this proposed APE includes the federally owned Blackwater NWR, coordination with the Refuge Manager and National Fish and Wildlife Service Regional Archaeologist is necessary prior to any proposed project activities. This also includes any additional cultural resources survey. Any proposed work within federally owned property (i.e., Blackwater NWR) or Indian lands requires a federal permit.

The Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-470mm) requires a permit for any excavation or removal of archaeological resources located on federally owned property or Indian lands. The Act also includes both civil and criminal penalties for any violations of permit requirements, as well as for unauthorized removal, damage, or vandalism of archaeological resources located on public lands. The land manager for the federal agency that owns or manages the public land to be investigated is responsible for issuing permits. In order to qualify for a permit, the proposed investigations must comply with the following criteria:

- The research must be conducted by a qualified professional.
- The investigation must advance archaeological knowledge in the public interest.
- The resources removed would remain the property of the United States. The recovered resources plus any associated records and data must be delivered promptly to a qualified repository for curation.
- The research must not be inconsistent with any land management plan, policy, objective, or requirement applicable to the property under consideration.

Permit procedures may vary depending on the policies of the particular federal agency that owns or controls the property slated for investigation. Some agencies do not require a permit for investigations conducted to fulfill the agency's own responsibilities under Section 106 of the NHPA for a proposed undertaking.

Project sponsors should contact the land manager of the appropriate federal agency to determine if a permit is required and initiate the application process, if necessary (Shaffer and Cole, 1994).

Prior to specific project activities, a review of *Archaeological and Geomorphological Reconnaissance at the Blackwater National Wildlife Refuge, Dorchester County, Maryland* (Millis et al., 1998) may help determine the potential for additional cultural resources within the APE. Millis et al. developed a predictive model to identify areas of high and moderate potential for archaeological remains within the Blackwater NWR. Results of the predictive model determined that many of the shoreline, bay islands, peninsulas, and river mouths are considered high-probability areas for additional cultural resources.

4.12.2.4 Confined Disposal Facilities in the Patapsco River

The proposed nearshore CDFs are located along the Patapsco River, in the City of Baltimore, Baltimore County, and Anne Arundel County. Results of the archival research identified a total of 39 sites within the area. However, only seven known archaeological sites are considered to be within the APE. While these archaeological sites are located within the APE, they would likely not be affected by proposed project activities.

Additional research identified a number of NRHP properties and Historic Districts within the Baltimore area. No adverse effects to these NRHP properties are anticipated relative to proposed confined disposal facilities along the Patapsco River, Maryland. Because of known archaeological sites, NRHP properties, Historic Districts, and shipwrecks within the APE, the potential exists for additional cultural resources within the proposed APE.

4.13 SOCIOECONOMICS

4.13.1 Overview

The regional socioeconomic impacts of continued maintenance dredging and the beneficial use of dredged material follow three discrete pathways: 1) regional impacts associated with maintaining shipping traffic and cargo handling at the Port of Baltimore; 2) regional impacts associated with spending on dredging, material placement, and environmentally beneficial use projects; and 3) regional impacts associated with the outcomes of environmentally beneficial material use projects.

These regional impacts can be measured as the sum of: 1) impacts generated by direct spending on dredging and related activities; and 2) impacts of the shipping and cargo-handling activities and environmental improvements that would be lost to the region without dredging. These are usually characterized by comparing direct, indirect, and induced jobs, incomes, business sales, and state and local taxes in the region with and without dredging. This section would provide a preliminary profile of these impacts based on what is known from a programmatic perspective, which means that specific levels of spending and material placement locations and characteristics are not known.

4.13.2 Sources of Impacts

4.13.2.1 Continued Maintenance Dredging

Continued maintenance dredging of the federal channels would provide long-term economic benefits to the Port of Baltimore, the regional economy and the national economy. A recent Port of Baltimore supported report estimated the statewide economic impacts of cargo arriving/departing from the Port of Baltimore via the northern approach (through the C&D

Canal) by vessels/barges that require at least a 35-ft channel depth. In 2003, cargo arrival at and departure from the Port of Baltimore supported 7,519 direct, induced, and indirect jobs and generated $386 million in direct, induced, and indirect personal income. Excluding the value of the cargo moving via the Canal, maintenance of the northern approach generated $420 million of business revenue. State and local governments in Maryland received $49 million in tax revenue.

Because these vessels/barges could use the southern approach and their cargo could be handled by shallower draft vessels, it is not clear what portion of these impacts would be lost to the state if the northern approach channels were not maintained. These numbers, therefore, represent the maximum shipping related economic impacts of dredging and only refer to those impacts associated with the northern approach to the port.

The direct federal spending on dredging, transport, and placement (DTP) in MD and VA waters results in significant regional impacts that would not occur without dredging. Because dredging is capital and energy intensive, rather than labor-intensive, and involves significant imports of labor and other inputs from outside the region the regional "multiplier" impacts of this spending are relatively small. However, because the level of direct regional federal spending on dredging is large regional economic impacts from DTP are significant.

Table 4-2 provides estimates of direct, indirect, and induced economic impacts on the Maryland and Virginia economies per $ million in direct federal spending on maintenance dredging in the waters of each state.

4.13.3 New Sites and Expanded Existing Sites

4.13.3.1 PIERP Expansion

Socioeconomic impacts generated by Poplar Island Expansion are the sum of the impacts associated with dredging, transport and placement, site construction, environmental restoration spending, and site operations and maintenance (Table 4-3).

4.13.3.2 Large Island Restoration Middle Bay

Socioeconomic impacts derived from restoration of a large island in the Middle Bay are the sum of the impacts associated with dredging, transport and placement, site construction, environmental restoration spending, and site operations and maintenance (Table 4-4).

4.13.3.3 Wetland Restoration Dorchester County

Socioeconomic impacts of large scale wetland restoration in Dorchester County are generated from spending on dredging, transport and placement, and operations and maintenance (Table 4-5).

4.13.3.4 Confined Disposal Facility Patapsco River

Total socioeconomic impacts associated with a confined disposal facility are the sum of impacts associated with dredging, transport, and placement, placement site construction, and placement site operations and maintenance (Table 4-6).

4.13.3.5 Chesapeake Bay Approach Channels (VA)

This alternative involves only open water placement, thus its socioeconomic impacts are derived solely from dredging, transport and placement impacts in Virginia (Table 4-2).

4.14 TRANSPORTATION

4.14.1 Continued Maintenance Dredging

4.14.1.1 C&D Canal Approach Channels

Continued maintenance dredging of the C&D Canal Approach Channels to the authorized depth of 35 ft would have a long-term beneficial impact on Bay navigation. Regular maintenance dredging would allow deep-draft vessels to safely navigate the upper region of the Bay and the approach to the C&D Canal. The C&D Canal Approach Channels provide a waterway for deep-draft commercial shipping to travel westerly through the C&D Canal and visit the Port of Baltimore. Maintenance dredging of the channels ensures safe transportation.

Although dredges and the associated support craft could a have temporary, short-term negative impact on navigation, disruption during operations would be minimized through notification to mariners.

There is expected to be no impact on highways and/or railroads due to continued maintenance dredging.

4.14.1.2 Harbor Channels

Continued maintenance dredging of the existing authorized Harbor projects, including the approach channels, branch channels, and anchorages within the Harbor, would have a long-term beneficial impact on navigation within the Port of Baltimore. These projects provide access to various public and private terminals serving the Port. The Port is considered an economic engine for the entire region and continued maintenance of the Harbor projects would allow safe passage and berthing for the commercial vessels that call on the Port.

The movement of dredges, barges, and associated support craft does have the potential to negatively impact the passage of commercial ships in the tighter confines of the Harbor. These impacts would be short term and disruption during operations would be minimized through notification to mariners. If hydraulic cutterhead dredges are used, submerging the pipeline as much as practicable would also minimize disruption.

There is expected to be no impact to highways and/or railroads due to continued maintenance dredging.

4.14.1.3 Chesapeake Bay Approach Channels (MD)

Continued maintenance dredging of the Chesapeake Bay Approach Channels (MD) to their respective authorized depths would have a long-term beneficial impact on Bay navigation. Regular maintenance dredging would allow deep-draft vessels to safely navigate this region of the Bay. The Chesapeake Bay Approach Channels (MD) provide passage for commercial ships to and from the Harbor Channels and the upper region of the Bay. Deep-draft ships that call on the Port of Baltimore must use these channels to enter the Patapsco River.

Although dredges and the associated support craft could a have temporary, short-term negative impact on navigation, disruption during operations would be minimized through notification to mariners.

There is expected to be no impact to highways and/or railroads due to continued maintenance dredging.

4.14.1.4 Chesapeake Bay Approach Channels (VA)

Continued maintenance dredging of the Chesapeake Bay Approach Channels (VA) to their authorized depth of 50 ft would have a long-term beneficial impact on Bay navigation. Regular maintenance dredging would allow deep-draft vessels to safely navigate from the Atlantic Ocean northward into the Bay and to the Port of Baltimore. The Cape Henry Channel and York Spit Channels are critical for vessel traffic separation by providing dedicated channels away from ships entering or leaving Hampton Roads, VA. Deep-draft ships that call on the Port of Baltimore directly from the Atlantic Ocean must use these channels to travel northward.

There is expected to be no impact to highways and/or railroads due to continued maintenance dredging.

4.14.2 New Sites and Expanded Existing Sites

4.14.2.1 PIERP Expansion

The expansion of PIERP has the potential to impact local boat traffic for the duration of construction. Barges and service craft would be used to transport equipment, personnel, construction materials, and dredged material to the Island. Waterways around the Island would be impacted with dredges, construction equipment and barges, requiring that restrictions be placed on the waters surrounding the Island. All of these impacts to navigation would be minor and temporary. Once construction at the site has been completed, waterway restrictions would be lifted and transportation should return to normal. The total amount of dredged material that would be used in the expansion of the Island is 24 mcy (cut volume), or a total of approximately 4,800 barges of material over the life of the project.

During construction and dredged material pumping operations, disruption to local navigation would be minimized through notification to mariners.

During implementation of the alternative, there may be a temporary increase in rail traffic for the transport of materials (e.g., armor stone for the dikes) during construction. The rail traffic would be at another location where barges could be loaded for transport to the project site.

During construction of the alternative, there would be a temporary increase of traffic to and from the sites as workers commute and materials and equipment are delivered. After construction, traffic would be limited to commuting employees who operate the facility and tours visiting the existing project.

4.14.2.2 Large Island Restoration – Middle Bay

Restoring a large island in the Middle Bay Region has the potential to impact local boat traffic for the duration of construction. Barges and service craft would be used to transport equipment, personnel, construction materials, and dredged material to the island. Waterways around the island would be impacted with dredges, construction equipment, and barges, requiring that restrictions be placed on the waters surrounding the island. All of these impacts to navigation would be minor and temporary. Once construction at the site has been completed, waterway restrictions would be lifted and transport should return to normal. The total amount of dredged material that would be used in the expansion of the island is 34.6 mcy (cut volume), or a total of approximately 6,920 barges of material over the life of the project.

During construction and dredged material pumping operations, disruption to local navigation would be minimized through notification to mariners.

During implementation of the alternative, there may be a temporary increase in rail traffic for the transport of materials (e.g., armor stone for the dikes) during construction. The rail traffic would be at another location where barges could be loaded for transport to the project site.

During construction of the alternative, there would be a temporary increase of traffic to and from the sites as workers commute and materials and equipment are delivered. After construction, traffic would be limited to commuting employees who operate the facility.

4.14.2.3 Wetland Restoration – Dorchester County

This alternative would cause temporary, minor impacts to boat traffic in the vicinity of the site. On the water, dredged material would be held in barges moored along the shoreline, and pumped onto shore using a hydraulic unloader, booster pumps, and a series of pipes and support barges. The total amount of dredged material that would be used in this restoration is 3.2 mcy, or approximately 640 barges of material over the life of the project. A limited area of water adjacent to the construction/offloading site would need to be restricted to allow the barges to moor and move along the shoreline.

During construction and dredged material pumping operations, disruption to local navigation would be minimized through notification to mariners.

During construction of the alternative, there would be a temporary increase of traffic to and from the sites as workers commute and materials and equipment are delivered.

4.14.2.4 Confined Disposal Facilities – Patapsco River

Construction of the proposed CDFs would have temporary, short-term impacts on navigation within the Harbor. Waterways around the CDF sites would be impacted with dredges, construction equipment, and barges, requiring that restrictions be placed on the waters surrounding the sites. All of these impacts to navigation would be minor and temporary. Once construction at a site has been completed, waterway restrictions would be lifted and transportation should return to normal. After construction, minimal barge traffic would continue to the sites to offload dredged material.

The total amount of dredged material that would be placed at each CDF is approximately 3.6 mcy, or approximately 720 barges of material per site over the life of the facility. Because of the confined nature of the Harbor and its channels, nearshore construction activities could impact ship traffic more significantly than in the Bay. Disruption to local navigation would be minimized through notification to mariners.

During implementation of the alternative, there may be a temporary increase in rail traffic for the transport of materials (e.g., armor stone for the dikes) during construction. The rail traffic would be at another location where barges could be loaded for transport to the project site.

During construction of the alternative, there would be a temporary increase of traffic to and from the sites as workers commute and materials and equipment are delivered. After construction, traffic would be limited to commuting employees who operate the facility.

4.15 NOISE

4.15.1 Continued Maintenance Dredging

Noise impacts are expected to be similar at all of the channel sites. Noise impacts to the natural and human environment are expected to be localized and short-term, occurring during maintenance dredging.

Dredging could potentially occur 24 hours a day, 7 days a week. While dredging activities would generate noise from a variety of equipment, the primary sources of equipment noise would include the dredges, the associated pumps and generators, and tugboats used to position the dredges and scows. Other equipment, such as tending boats and survey boats, do not contribute substantially to the noise associated with dredging activities. Scows would be associated with the dredging operation and tugboats would be used to move them to the reuse and placement site. Noise also builds up from commercial and recreational boat traffic, truck engines, tugs, dredging equipment, crew boats, and backup warning signals.

Noise associated with dredging activities includes the operation of dredges. These activities can intermittently generate noise levels as high as 85 to 88 dBA (California Department of Water Resources, 2000). The loudest expected sounds of 88 dBA from dredging operations can be expected to be attenuated to levels approaching 55 dBA (with levels exceeding 65 dBA considered acceptable according to the Department of Housing and Urban Development Policy 24 CFR Part 51) approximately 2,000 ft from the source. This distance can vary depending on environmental criteria identified above. Most noise-sensitive areas (e.g., residences, schools, hospitals) do not fall within the noise impact zone.

Besides noise impacts to the residents living around the Bay area, there are also consequences for underwater noise as this can impact fish and other marine animal behavior. Sound is important to them when they are hunting for prey, avoiding predators, or engaging in social interaction. They can also suffer from acoustically induced stress in their own habitat. Changes in vocalization behavior, breathing and diving patterns, and active avoidance of noise sources by marine life have all been observed in response to anthropogenic noise.

4.15.2 New Sites and Expanded Existing Sites

4.15.2.1 PIERP Expansion

Noise impacts to the natural and human environment are expected to be localized and short-term, occurring during construction and operations of the PIERP Expansion. Earth-moving equipment and engines from barges, dredges, and launches would contribute to noise at the project site during construction. Unloaders, on-site equipment, and tugs transporting scows to and from the site would contribute to noise at the project site during operations. Dredging activities can intermittently generate noise levels as high as 85 to 88 dBA (California Department of Water Resources, 2000) and earth-moving equipment can generate levels as high as 95 dBA at 50 ft. However, noise-sensitive areas (e.g., residences, schools, and hospitals) are located approximately 1 nm from areas affected by construction and operation activities at PIERP.

According to the PIERP Project, most construction noises ceased after Phase II construction of the project, although minor noises from earth-moving and dredged material offloading equipment continued through filling and management activities (EA, 2002a).

Underwater noise during construction of the PIERP Expansion would be similar to the short-term impacts described in Section 4.15.1, Continued Maintenance Dredging.

4.15.2.2 Large Island Restoration – Middle Bay

Noise impacts due to Large Island Restoration in the Middle Bay would be localized, short term, and similar to those impacts described for PIERP Expansion in Section 4.15.2.1.

4.15.2.3 Wetland Restoration – Dorchester County

Noise impacts to the natural and human environment are expected to be localized and short term, occurring during construction and operations of the Wetland Restoration at Blackwater NWR. Tugs transporting scows to and from the site and material placement equipment would contribute to noise. However, noise-sensitive areas (e.g., residences, schools, and hospitals) are located well outside of the areas affected by wetland restoration activities at Blackwater NWR.

Underwater noise during construction and operations of the Wetland Restoration at Blackwater NWR would be similar to the short-term impacts described in Section 4.15.1, Continued Maintenance Dredging.

4.15.2.4 Confined Disposal Facilities in Patapsco River

Noise impacts from the construction and operation of CDFs in the Patapsco River would be similar to the short-term impacts described for PIERP Expansion in Section 4.15.2.1. However, because of the potential location of the facilities within the Inner Harbor area, there are some properties that might fall within a noise impact zone (Wainger, 2004).

During follow-on studies, consideration should be given to mitigation opportunities. Noise mitigation opportunities should be reasonably available by selecting quieter running equipment and by providing supplemental noise shielding around engines and pumps. Noise level reductions of 10 dBA or more should be possible by selecting dredging equipment that produces noise levels below 80 dBA at 50 ft or by installing acoustical shielding panels around the sides of engine and pump equipments on the dredge. If quieter equipment and supplemental noise shielding do not suppress noise in the residential areas, then dredging operation can be limited to daytime for work that occurs close to noise-sensitive areas.

4.16 SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

Pursuant to NEPA regulations (40 CFR 1502.16) an Environmental Impact Statement must consider the relationship between short-term uses of the environment and maintenance and enhancement of long-term productivity.

4.16.1 Continued Maintenance Dredging

As described in Chapter 4, continued maintenance dredging as authorized under the Baltimore Harbor and Channels project would cause a number of short-term impacts to the environment. Such disturbances during dredging activities would consist of noise and visual impacts, water quality and air quality impacts, a temporary loss of benthic communities, and minor disturbances to navigation.

The negative short-term effects stated above are not significant when compared with the positive effects of maintaining the channels to their authorized depths. Based on the results of the benefit versus annual operation and maintenance cost analysis in Appendix F, the continued maintenance of the Baltimore Harbor and Channels project is warranted. The benefits of maintaining a safe navigable waterway into the Port of Baltimore more than offset the temporary impacts to the environment during dredging operations.

4.16.2 New Sites and Expanded Existing Sites

Implementation of the recommended plan for new placement sites and expanded existing placement sites would have both short-term and long-term impacts to the environment. Construction activities would cause temporary negative effects to the environment, including wildlife, aquatic organisms, air and water quality, wetland disturbances, and an increase in barge and truck traffic. Implementation of the recommended plan would permanently change existing land use and soil conditions, and cause the loss of shallow-water habitat at each of the individual sites, the long-term benefits of providing dredged material capacity, habitat creation navigational channels, island restoration, and restoring degraded wetlands. Although there are numerous potentially negative impacts, the placement sites have been chosen so that the long-term benefits outweigh the negative impacts. Furthermore, with the implementation of mitigation measures as discussed in Section 4.18, many of the impacts associated with the recommended plan could be reduced to insignificant levels.

4.17 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

40 CFR 1502.16 specifies that an Environmental Impact Statement should address any significant irreversible or irretrievable commitments of resources resulting from implementing the proposed action (recommended plan).

4.17.1 Continued Maintenance Dredging

Continued maintenance dredging requires the use of both natural and socioeconomic resources. Although dredging activities would remove benthic organisms, potentially including commercially important species, recolonization of the benthic community would eventually occur, preventing an irreversible impact.

Socioeconomic resources include capital resources, labor resources, fuels, and construction material. Continued maintenance dredging requires capital and a labor force that is dedicated during the life of the project. The energy that is required to operate dredges, move barges and equipment, and transport workers would cause an irretrievable consumption of fuels and lubricants.

4.17.2 New Sites and Expanded Existing Sites

The placement of dredged material at new placement sites and expanded existing placement sites would consume both natural and socioeconomic resources. Large amounts of capital would be required to design, construct, and operate the projects and would not be available for the development of other projects. Construction activities and follow-on operations would require fuels and supplies that would result in a permanent loss of energy resources. Building dikes to expand PIERP, restore a large island, and construct multiple CDFs would require sand, roadway stone, armor stone, geotextiles, and other construction materials.

Construction and follow-on operations at each of the alternative sites would result in a change of land use by permanently filling in areas of shallow water habitat. The alternatives that have a habitat restoration component, and existing land and/or habitat functions would be modified. Land use changes associated with any rezoning or permitting processes would likely be considered an irreversible and irretrievable loss of resources because the authorized and permitted use of each site would render use of the land for another purpose infeasible.

4.18 CUMULATIVE EFFECTS AND MITIGATION

4.18.1 The DMMP/EIS Cumulative Effects

Under NEPA, federal agencies are required to consider the cumulative impacts of their actions on the natural and human environment. The Council on Environmental Quality (CEQ) regulations for implementing NEPA defines cumulative impacts as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions (40 CFR 1508.7).”

This cumulative effects analysis assesses whether the proposed actions assessed in this DMMP/EIS and other past, present, and reasonably foreseeable future actions could potentially have cumulative impacts on humans or natural resources over the 21-year planning period of the DMMP.

The geographic scope of this cumulative effects analysis is consistent with the affected environment assessment area defined in Chapter 2. As appropriate, actions outside the DMMP project study area (e.g., dredging in other Bay tributaries and the C&D Canal Approach Channel section above the Sassafras River) are considered in this analysis. In addition, the preferred alternatives identified in this DMMP have the potential to impact resources outside of the study area. An example is the use of stone obtained from sources outside of the study area to armor dikes for island restoration.

The timeframe focus is on the 21-year DMMP evaluation period, but can include previous dredging periods and placement areas. This cumulative impact analysis also includes the impacts of recurring activities (e.g., periodic maintenance dredging of navigation channels) over the 21-year period.

Other past, present, and reasonably foreseeable projects or actions that could, when added to the recommended plan alternatives, result in cumulative impacts include:

- Construction and previous expansion of the Hart-Miller Island Facility DMCF.
- Vertical Expansion of the Cox Creek CDF to the permitted dike elevation of +36 ft.
- Land uses in the study area.
- The closure of the Pooles Island Open Water Disposal Sites.
- The closure of the Hart-Miller Island DMCF.
- Past and present dredging and disposal activities undertaken by USACE (see Table 4-7 for a list of currently authorized navigation projects throughout the Bay), as well as dredging undertaken by the state and private sector throughout the study area.
- Construction of the Poplar Island Environmental Restoration Project and the PIERP Expansion Feasibility Study.
- The Mid-Bay Island Restoration Feasibility Study.

- Sediment and nutrient reduction programs implemented in the 64,000-square-mile-Chesapeake Bay watershed.
- Proposed water quality standards for the Chesapeake Bay.

4.18.2 Cumulative Effects

The likely cumulative effects of the resource areas examined in this DMMP/EIS, within the context of both the 21-year timeframe of the plan and other past, present, and reasonably foreseeable future actions, are summarized below. The cumulative effects of each of the six alternatives are expected to be similar except as noted.

4.18.2.1 Physical

The cumulative impacts of these actions are considered to be minimal. Altering the bathymetry of existing dredged material placement sites (open water and island restoration) and proposed elevations may impact currents and sediment transport pathways. The construction of the PIERP Expansion project and Large Island Restoration would provide some protection from wave erosion to existing remnant islands and the shoreline of the mainland. Natural processes that produce a net growth of the Bay by several hundred acres per year would effectively compensate areally for open water converted to the newly restored islands.

4.18.2.2 Aquatic Resources

The total aquatic area impacted from past, present, and anticipated future dredging operations, including dredging, transport, and placement, is significant when the miles of channels, and the size of past, existing, and future dredged material placement areas in aquatic systems are considered. However, a review of the short-term and long-term impacts on aquatic resources from these actions indicates that the negative impacts are generally short term in nature, and the long-term impacts are insignificant, can be mitigated for, or are beneficial.

Benthic Communities

Ongoing maintenance dredging and placement in open water areas has immediate short-term impacts on benthic communities. However, studies have indicated that many of these disturbed areas recolonize quickly (often within one season) and the impacts are not significant (Diaz and

Cutter, 1997). Permanent loss of open water habitat from island restoration would impact blue crab habitat, but there is a benefit in protecting shallow water areas and potentially increasing the size of sensitive habitats (e.g., SAV) in the wave shadow of restored islands. In addition, island restoration projects could be sited to minimize impacts to blue crab and other important species habitats and protect sensitive aquatic habitats. The inclusion of tidal wetland construction (e.g., PIERP Expansion) and restoration (e.g., Blackwater NWR) as a component of island restoration would provide benthic habitat for sensitive and commercially valuable species, including all stages of the blue crab life cycle.

Finfish and EFH

Given the mobility of finfish and ability to control the timing of dredging and placement operations, impacts to fish are primarily considered short term and minor. While the loss of aquatic habitat from construction of dredged material placement sites in shallow water areas may be considered significant, the impacted species are primarily smaller, resident species with limited mobility as well as those species that are bottom feeders. The construction and restoration of tidal wetland habitat proposed for existing and proposed island and wetland restoration projects provides valuable tidal wetlands that serve as nesting and breeding areas as well as sources of detritus and other food sources for fish.

Impacts to EFH from ongoing dredging and placement in open water placement areas has been shown to be minimal or not significant (CENAO, 2002; CENAB, 1999c). While island and wetland restoration would result in the permanent loss of shallow water habitat in areas designated as EFH, the cumulative impacts to EFH and associated species is expected to be minimal for these kinds of actions (CENAB, 2004a). The wave shadow produced from island restoration may benefit HAPCs and designated EFH.

Continued maintenance dredging and dredged material management activities as well as proposed placement alternatives identified in the DMMP would have repeated, minor resource impacts, but these impacts would not be cumulatively significant.

Shallow Water Habitat (SWH) and SAV

The dredging and placement of dredged material in designated open water placement areas would have no impact to SWH and SAV habitats because designated open water placement areas are not considered SWH and SAV are not located there due to deep depths. Placement options that include filling shallow water areas would result in the loss of this aquatic habitat. However, the Bay is naturally growing by several hundred acres per year. Although the net impacts to shallow water habitat acreage are unknown, it is likely that increasing Bay size would offset cumulative losses of shallow water habitat to dredged material placement projects within a several-year to decades period. Placement sites can be designated to minimize the loss of SAV habitat. The wave shadow created from island restoration projects may benefit HAPCs and SAV beds critical to early life stages of many finfish species (WESTON, 2002a).

Continued maintenance dredging and dredged material management activities as well as proposed placement alternatives identified in the DMMP would have negative impacts on shallow water habitat, but these impacts would not be considered cumulatively significant when compared to the benefits gained from tidal wetland restoration and construction as well as protection of existing SWH and SAV.

4.18.2.3 Wetlands

Past, present, and forseeable future dredging would have minimal, if any, negative impact on wetlands due to the location of most navigation channels. The ongoing beneficial use of dredged material to restore eroding islands and shorelines, as well as proposed future use of dredged material (e.g., island restoration and wetland restoration), would have significant benefits to wetlands through the restoration, enhancement, and creation of both tidal and nontidal at several existing and proposed dredged placement sites.

4.18.2.4 Terrestrial Resources

Past, present, and forseeable future dredging and dredged material placement would have minimal, if any, negative impact on terrestrial resources because of the location of most navigation channels and existing and forseeable placement sites. The ongoing beneficial use of dredged material to restore eroding islands and shorelines, as well as proposed future use of dredged material (e.g., island restoration and wetland restoration), would have significant benefits to terrestrial resources through the restoration, enhancement, and creation of both tidal and nontidal wetlands at several existing and proposed dredged material placement sites.

4.18.2.5 Endangered Species

Ongoing and future maintenance dredging and open water placement would result in minimal impact to aquatic and terrestrial endangered species. Depending on the selected island(s) for restoration, endangered species such as the bald eagle and least tern could be temporarily impacted from construction and operation of the island restoration facility. A long-term benefit to endangered species could be achieved by creating habitat suitable for nesting, roosting, and feeding for select species using dredged material.

According to a NOAA Biological Opinion on the effects of the Army Corps of Engineers dredging in the Virginia Channels, dredging should be minimized from April 11 to November 30 to prevent the incidental take of sea turtles, which may be present during this time. If dredging must occur during this time period, measures must be undertaken to reduce the impacts to sea turtles, and other endangered species (such as shortnose sturgeon and humpback whales). Sea turtle deflectors must be used on the hopper dredge and endangered/threatened species observers must be present. Relocation trawling is also a possibility (NOAA, 2003b).

The movements of shortnose sturgeon appear to depend upon the season, fish size, and the specific river system. This species does not participate in coastal migrations. Nonspawning movements include rapid, directed post-spawning movements to downstream feeding areas in spring, and localized, wandering movements in summer and winter (WESTON, 2002b). Taking into consideration the behavior of shortnose sturgeon in the Bay, dredging windows should be limited to noncritical periods (NOAA, 1998).

4.18.2.6 Recreation

Ongoing and forseeable maintenance dredging would have minimal impact on recreation because recreational boaters can avoid the dredging areas. Some positive effects of related actions (e.g., construction and maintenance of marinas and boat launch areas) would result.

Three of the preferred alternatives (PIERP Expansion, Large Island Restoration, and CDFs in the Patapsco River) would result in the loss of shallow water habitat and possible recreational fishing and crabbing areas. However, additional recreational fishing areas (e.g., reefs around the edge of a Large Island Restoration) may be created from some of the preferred alternatives. No adverse cumulative effects on recreation are expected to result.

4.18.2.7 Cultural Resources

Continued maintenance dredging of existing channels, marinas, and other areas should have no cumulative impact on cultural resources. Similarly, existing placement sites would have no cumulative impacts due to past disturbance, construction, and dredged material placement. The potential impact on cultural resources from the development of new dredge placement sites would need to be evaluated, but with careful planning, cultural resource impacts should be minimal. Overall, there should be no cumulative impacts to cultural resources.

4.18.2.8 Socioeconomics

Cumulative socioeconomic impacts associated with continued maintenance dredging are evaluated in Section 3.5.5.

4.18.2.9 Transportation

Continued maintenance dredging would result in continued commercial and recreational navigation in Chesapeake Bay. No changes to regional transportation are anticipated to result from the DMMP alternatives. Failure to continue maintenance dredging in federal channels would eventually limit the size of ships that could navigate to Baltimore Harbor.

No impacts to ground or air transportation are expected to occur for existing or forseeable actions related to dredging and dredged material management.

4.18.2.10 Geology and Soils

There are no anticipated impacts on geology, groundwater, or soils from the actions identified in the DMMP/EIS. There would be cumulative positive effects from the beneficial use of dredged material to restore island, wetlands, and protect islands and shorelines on the mainland from continued erosion.

4.18.2.11 Water Quality/Water Resources

Dredging, dredged material placement at open water sites, the construction of dredged material placement facilities, and the management of dredged materials result in minimal short-term adverse cumulative impacts on water quality. The impacts include resuspension of sediments, nutrients (including nitrogen compounds) and possible contamination (Harbor material). There is also the possibility of increased sedimentation in the surrounding area. Dissolved oxygen levels may be reduced, causing short-term hypoxia and/or anoxia. While adverse, these impacts are expected to be short term, localized, and insignificant.

The long-term adverse cumulative effects from continued maintenance dredging, the construction of new dredge placement facilities, and ongoing and future management of dredged materials are anticipated to be insignificant. There would be positive impacts on water quality from the proposed DMMP actions, including improvements in overall water quality by decreasing shoreline erosion and the creation of wetlands to filter water. There would also be positive impacts on water quality through management of contaminated sediments in confined facilities. Overall, past, present, and future dredging and dredged material management actions are not anticipated to create cumulative significant adverse impacts to water quality and water resources.

4.18.2.12 Hazardous, Toxic, and Radioactive Waste (HTRW)

The DMMP alternatives and related actions would not have adverse HTRW impacts, and no cumulative effects with respect to HTRW are anticipated to result. Sites selected for dredged material placement would need to be evaluated to make sure that there are no HTRW issues.

4.18.2.13 Air Quality

No cumulative negative long-term air quality impacts would result from the DMMP alternatives and related actions. Short-term increases in emissions would occur during dredging, construction of placement sites, and placement of dredged material, but these are not anticipated to be significant.

4.18.2.14 Noise

No cumulative negative long-term noise impacts to the natural or human environment would result from the DMMP alternatives and related actions. Short-term impacts would be localized.

4.18.3 Mitigation

No cumulatively significant adverse environmental effects are anticipated to result from the alternatives considered. Therefore, it is anticipated that no mitigation specific to cumulative impacts would be required. Past, present, and forseeable beneficial uses of dredged material to preserve and protect eroding islands and shorelines, sensitive habitats, and to create additional wetland and terrestrial habitats would result in a significant positive impact to the Bay.

For all dredging and dredged material placement options, mitigation measures should be implemented to avoid and minimize negative environmental impacts and to maximize environmental benefits or compensate for impacts if necessary.

SECTION 4

TABLES

Table 4-1

Potential Species with EFH in the Project Areas (EA, 2002)

Species with EFH in the project area	Location description
Windowpane flounder (*Scophthalmus aquosus*)	This species typically does not occur north of Bloodsworth Island at the MD/VA border, therefore no impacts are anticipated for windowpane flounder.
Spanish mackerel (*Scomberomorus maculates*)	This species prefers higher salinities, and is therefore not expected to be in the project area. Spanish mackerel has been occasionally recorded north of the bay bridge when the salinity was high.
King mackerel (*Scomberomorus regalis*)	King mackerel is an open water schooling fish with all life stages primarily oceanic. No life stages for this fish have been recorded in the PIERP or Middle-Bay areas; therefore, no impacts on this species area anticipated.
Cobia (*Rachycentron canadum*)	Minimal impacts are anticipated for cobia because this species generally remains in the more saline areas of the Bay. However, juveniles and non-spawning adults occasionally migrate into mesohaline waters during the summer and early fall.
Red drum (*Sciaenops ocellatus*)	Red drum typically does not occur north of the Patuxent and Choptank Rivers, and are rare in the project area. No impacts to this species are anticipated in the PIERP area; however, this species may be present in the waters of the lower Middle Bay.
Atlantic butterfish (*Peprilus triacanthus*)	This species is generally not found in the Maryland waters of the Chesapeake Bay because it prefers a deep pelagic environment, approximately 30 ft deep, for all of its life stages. No impacts are anticipated for this species as a result of the PIERP expansion or the Middle Bay island restoration projects.
Black sea bass (*Centropristis striata*)	This species is generally not found in the Maryland waters of the Chesapeake Bay because it prefers an environment with higher salinities, and is typically an offshore species. No impacts are anticipated for this species as a result of the PIERP expansion or the Middle Bay island restoration projects.
Bluefish (*Pomatomus saltatrix*)	Feeding displacement is expected as a result of the PIERP expansion; however, due to their high mobility, adult and juvenile bluefish are expected to be able to avoid construction activities around PIERP.
Summer flounder (*Paralichthys dentatus*)	A reduction in the benthic macroinvertebrate community is expected, consequently reducing available biomass for summer flounder consumption, and temporarily displacing them from the project. Juveniles and adults spend the winters in the ocean waters, and usually enter the Chesapeake Bay in the late spring. Due to their high mobility, summer flounder are expected to be able to avoid construction activities around PIERP.

Table 4-2

State Impacts Per $Million in Direct Spending

Maryland		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$1,000,000	$660,635	$201,845	$1,862,480
	Employment (FTEs)	8.8	6.4	2.6	17.8
	Labor Income ($)	$30,994	$237,711	$77,459	$346,164
	Employee Compensation ($)	$24,389	$209,758	$69,938	$304,085
	Indirect Business Taxes ($)	$1,266	$27,201	$13,002	$41,469
Virginia		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$1,000,000	$648,102	$188,275	$1,737,264
	Employment (FTEs)	9.3	6.3	2.5	17.9
	Labor Income ($)	$29,041	$226,844	$68,025	$321,296
	Employee Compensation ($)	$21,759	$201,843	$62,002	$276,487
	Indirect Business Taxes ($)	$1,186	$26,582	$12,326	$39,626

Table 4-3

Economic Impacts of PIERP Expansion (Average Annual Impacts Over 12 Years)

DTP		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$16,200,000	$10,702,287	$3,269,889	$30,172,176
	Employment (FTEs)	142.4	103.2	42.2	287.7
	Labor Income ($)	$502,103	$3,850,918	$1,254,836	$5,607,857
	Employee Compensation ($)	$395,102	$3,398,080	$1,132,996	$4,926,177
	Indirect Business Taxes ($)	$20,509	$440,656	$210,632	$671,798
Site Development		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$7,566,667	$3,064,825	$3,070,160	$13,701,652
	Employment (FTEs)	46.3	35.1	39.6	121.0
	Labor Income ($)	$2,760,910	$1,326,232	$1,178,191	$5,265,333
	Employee Compensation ($)	$2,317,413	$1,203,115	$1,063,790	$4,584,318
	Indirect Business Taxes ($)	$63,499	$121,937	$197,762	$383,199
Habitat Development		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$1,225,000	$324,299	$487,676	$2,036,975
	Employment (FTEs)	8.0	5.6	6.1	19.7
	Labor Income ($)	$520,614	$128,604	$187,148	$836,366
	Employee Compensation ($)	$443,461	$106,123	$168,977	$718,561
	Indirect Business Taxes ($)	$32,301	$13,255	$31,414	$76,969
O&M		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$3,108,333	$1,037,769	$1,411,651	$5,557,753
	Employment (FTEs)	48.2	11.8	18.2	78.2
	Labor Income ($)	$1,423,863	$455,393	$541,729	$2,420,984
	Employee Compensation ($)	$1,254,526	$400,825	$489,127	$2,144,479
	Indirect Business Taxes ($)	$48,281	$38,556	$90,931	$177,768
Total Poplar Island Expansion		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$28,100,000	$15,129,180	$8,239,376	$51,468,556
	Employment (FTEs)	244.8	155.7	106.2	506.7
	Labor Income ($)	$5,207,490	$5,761,147	$3,161,903	$14,130,541
	Employee Compensation ($)	$4,410,502	$5,108,142	$2,854,890	$12,373,534
	Indirect Business Taxes ($)	$164,590	$614,403	$530,740	$1,309,733

Table 4-4

Economic Impacts of Large Island Restoration in the Middle Bay (Average Annual Impacts Over 12 Years)

DTP		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$30,308,333	$20,022,746	$6,117,586	$56,448,665
	Employment (FTEs)	266.3	193.0	79.0	538.3
	Labor Income ($)	$939,376	$7,204,624	$2,347,653	$10,491,654
	Employee Compensation ($)	$739,190	$6,357,415	$2,119,704	$9,216,310
	Indirect Business Taxes ($)	$38,370	$824,417	$394,069	$1,256,856
Site Development		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$5,691,667	$2,305,370	$2,309,382	$10,306,419
	Employment (FTEs)	34.8	26.4	29.8	91.0
	Labor Income ($)	$2,076,764	$997,595	$886,238	$3,960,597
	Employee Compensation ($)	$1,743,164	$904,986	$800,186	$3,448,336
	Indirect Business Taxes ($)	$47,764	$91,721	$148,757	$288,243
Habitat Development		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$1,533,333	$405,925	$610,425	$2,549,683
	Employment (FTEs)	10.0	7.0	7.7	24.7
	Labor Income ($)	$651,653	$160,974	$234,253	$1,046,880
	Employee Compensation ($)	$555,080	$132,834	$211,508	$899,423
	Indirect Business Taxes ($)	$40,431	$16,591	$39,321	$96,342
O&M		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$4,408,333	$1,471,796	$2,002,046	$7,882,175
	Employment (FTEs)	68.3	16.8	25.8	110.9
	Labor Income ($)	$2,019,366	$645,852	$768,296	$3,433,514
	Employee Compensation ($)	$1,779,208	$568,462	$693,695	$3,041,365
	Indirect Business Taxes ($)	$68,473	$54,681	$128,961	$252,116
Total Large Island Restoration		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$41,941,667	$24,205,837	$11,039,439	$77,186,942
	Employment (FTEs)	379.5	243.3	142.3	765.0
	Labor Income ($)	$5,687,160	$9,009,045	$4,236,441	$18,932,646
	Employee Compensation ($)	$4,816,642	$7,963,698	$3,825,093	$16,605,433
	Indirect Business Taxes ($)	$195,039	$987,410	$711,109	$1,893,557

Table 4-5

Economic Impacts of Wetland Restoration in Dorchester County (Average Annual Impacts Over 12 Years)

DTP		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$3,575,000	$2,361,770	$721,596	$6,658,366
	Employment (FTEs)	31.4	22.8	9.3	63.5
	Labor Income ($)	$110,804	$849,817	$276,916	$1,237,536
	Employee Compensation ($)	$87,191	$749,885	$250,028	$1,087,104
	Indirect Business Taxes ($)	$4,526	$97,244	$46,482	$148,252
O&M		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$675,000	$225,360	$306,551	$1,206,911
	Employment (FTEs)	10.5	2.6	4.0	17.0
	Labor Income ($)	$309,204	$98,892	$117,641	$525,737
	Employee Compensation ($)	$272,431	$87,042	$106,218	$465,691
	Indirect Business Taxes ($)	$10,485	$8,373	$19,746	$38,604
Total Wetland Restoration		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$4,250,000	$2,587,130	$1,028,147	$7,865,277
	Employment (FTEs)	41.9	25.3	13.3	80.5
	Labor Income ($)	$420,007	$948,709	$394,557	$1,763,273
	Employee Compensation ($)	$359,621	$836,927	$356,246	$1,552,795
	Indirect Business Taxes ($)	$15,011	$105,616	$66,229	$186,855

Table 4-6

Economic Impacts of a Confined Disposal Facility Along the Patapsco River (Average Annual Impacts Over 5 Years)

DTP		Direct	Indirect	Induced	Total
	Business Sales ($)	$3,480,000	$2,299,010	$702,421	$6,481,430
	Employment (FTEs)	30.6	22.2	9.1	61.8
	Labor Income ($)	$107,859	$827,234	$269,557	$1,204,651
	Employee Compensation ($)	$84,874	$729,958	$243,384	$1,058,216
	Indirect Business Taxes ($)	$4,406	$94,659	$45,247	$144,312
Site Development		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$2,480,000	$1,004,507	$1,006,255	$4,490,762
	Employment (FTEs)	15.2	11.5	13.0	39.7
	Labor Income ($)	$904,897	$434,677	$386,156	$1,725,730
	Employee Compensation ($)	$759,540	$394,325	$348,661	$1,502,525
	Indirect Business Taxes ($)	$20,812	$39,965	$64,817	$125,595
O&M		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$1,980,000	$661,056	$899,218	$3,540,274
	Employment (FTEs)	30.7	7.5	11.6	49.8
	Labor Income ($)	$906,997	$290,084	$345,080	$1,542,161
	Employee Compensation ($)	$799,130	$255,324	$311,573	$1,366,027
	Indirect Business Taxes ($)	$30,755	$24,560	$57,923	$113,238
Total Confined Disposal Facility		**Direct**	**Indirect**	**Induced**	**Total**
	Business Sales ($)	$7,940,000	$3,964,572	$2,607,893	$14,512,466
	Employment (FTEs)	76.4	41.2	33.7	151.3
	Labor Income ($)	$1,919,754	$1,551,995	$1,000,793	$4,472,542
	Employee Compensation ($)	$1,643,543	$1,379,607	$903,618	$3,926,768
	Indirect Business Taxes ($)	$55,973	$159,185	$167,987	$383,144

Table 4-7

Authorized River and Harbor Projects

River and Harbor Projects	State	River and Harbor Projects	State
Accotink Creek	VA	Nan Cove	MD
Anacostia River Basin	DC & MD	Nanticoke River, Nanticoke	MD
Annapolis Harbor	MD	Nanticoke River (Including Northwest Fork)	DE & MD
Aquia Creek	VA	Nanticoke River at Bivalve	MD
Back Creek, Anne Arundel County	MD	Neabsco Creek	VA
Baltimore Harbor and Channels	MD	Neale Sound	MD
Betterton Harbor	MD	Neavitt Harbor	MD
Black Walnut Harbor	MD	Nomini Bay and Creek	VA
Bonum Creek	VA	Northeast River	MD
Branson Cove	VA	Occoquan Creek	VA
Breton Bay	MD	Ocean City Harbor & Inlet & Sinepuxent Bay	MD
Broad Creek	MD	Oxford	MD
Broad Creek River	DE	Parish Creek	MD
Cambridge Harbor	MD	Patuxent River	MD
Chesapeake Bay Study, Hydraulic Model and Shelter	MD	Pocomoke River	MD & VA
Chester River	MD	Potomac and Anacostia Rivers Collection and Removal of Drift	DC
Choptank River	MD	Potomac River and Tributaries at & Below Washington Hydrilla Control Program Elimination of Waterchestnut	DC
Claiborne Harbor	MD	Potomac River at Alexandria	VA
Colonial Beach (Shore Protection)	VA	Potomac River at Lower Cedar Point	MD
Corsica River	MD	Potomac River at Mount Vernon	VA
Crisfield Harbor	MD	Potomac River below Washington	DC
Cypress Creek	MD	Potomac River North Side of Washington Channel	DC
Duck Point Cove (Hearns Creek)	MD	Queenstown Harbor	MD
Elk River and Little Elk River	MD	Rhodes Point to Tylerton	MD
Fishing Bay	MD	Rock Hall Harbor	MD
Fishing Creek	MD	Shad Landing State Park Marina	MD

Table 4-7

Authorized River and Harbor Projects
(Continued)

River and Harbor Projects	State	River and Harbor Projects	State
Fort McHenry, Corps of Engineers Reservation	MD	Slaughter Creek	MD
Goose Creek	MD	Smith Creek	MD
Harbor of Baltimore (Prevention of Obstructions & Injurious Deposits)		St. Catherine Sound	MD
Herring Bay and Rockhold Creek	MD	St. George Creek	MD
Herring Creek	MD	St. Jerome Creek	MD
Honga River and Tar Bay (Barren Island Gaps)	MD	St. Michaels Harbor	MD
Island Creek	MD	St. Patrick's Creek	MD
Island Creek, St. George Island	MD	St. Peters Creek	MD
Knapps Narrows	MD	Susquehanna River above & below Havre de Grace	MD
La Trappe River	MD	Susquehanna River at Williamsport	PA
Little Creek, Kent Island	MD	Tilghman Island Harbor	MD
Little Wicomico River	VA	Town Creek	MD
Lower Machodoc Creek	VA	Tred Avon River	MD
Lower Thorofare, Deal Island	MD	Tuckahoe River	MD
Lowes Wharf	MD	Twitch Cove & Big Thorofare River	MD
Madison Bay	MD	Tyaskin Creek	MD
Manokin River	MD	Upper Machodoc Creek	VA
McMillan Reservoir, Washington	DC	Upper Thorofare, Deal Island	MD
Middle River and Dark Head Creek	MD	Warwick River	MD
Monroe Bay and Creek	VA	Washington Harbor	DC
Muddy Hook and Tyler Coves	MD	Wicomico River	MD

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5. IMPLEMENTATION

As described in Chapter 3, the federal standard is defined as the dredged material placement option identified by USACE, which represents the least costly option consistent with sound engineering practices and meeting all federal environmental standards, including those established by Section 404 of the Clean Water Act (CWA) of 1972 and Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, as amended.

The federal standard for the Baltimore Harbor and Channels project is expected to remain in effect for the 21-year period of evaluation. As discussed in Chapter 3, placing dredged material at HMI and at the Pooles Island Open Water Placement Site are components of the DMMP federal standard for the Harbor Channels and C&D Canal Approach Channels, respectively. Maryland state law mandates that HMI close in 2009 and the Pooles Island site close in 2010. Because the State of Maryland is precluded by state law from expanding HMI or placing dredged material in Maryland waters of the Chesapeake Bay after 2010, other options (recommended plan) have been identified and must be implemented to keep the channels of the Port maintained.

5.1 RECOMMENDED PLAN

As described in Section 3.6, the recommended plan comprises continued maintenance dredging of the Baltimore Harbor and Channels and Inland Waterway to the C&D Canal projects, continued use of existing placement sites, and development of new dredged material placement alternatives. In developing the schedule for implementation of each component of the recommended plan, consideration has been given to the authorization process, planning and design, construction, dredging needs by channel reach, and both the projected annual and total dredged material capacity at each site. Figure 5-1 is a projected timeline for the implementation of the recommended plan.

- **Continued Maintenance Dredging of the Virginia Channels and Use of the Existing Open-Water Sites in Virginia—**The existing open-water placement sites, Rappahannock Shoal Deep Alternate, Wolf Trap Alternate, and the Dam Neck Ocean, have sufficient capacity for the 20-year-minimum period to remain as the federal standard for the Virginia channels. As such, dredged material from the Rappahannock Shoal, York Spit, and Cape Henry channels will be placed at their respective designated placement sites under the existing authority of the Baltimore Harbor and Channels 50-ft Project. Continued maintenance of these channels at their constructed dimensions will be federally and non-federally funded. The federal government is responsible for 100% of the maintenance costs associated with maintaining the channels to a 45-ft depth. The additional costs of maintaining the channels to the 50-ft depth are shared 50/50 with the non-federal sponsor. No additional studies are anticipated unless the current constructed channel dimensions have to be increased and/or a new federal action necessitates the preparation of a NEPA document.

- **Continued Maintenance Dredging of the Maryland Channels and Use of Existing Sites in Maryland—**The existing HMI DMCF, Cox Creek CDF, PIERP, and Pooles Island Open Water Placement sites have an estimated remaining capacity of 47.7 million cubic yards. The capacity of these sites should continue to be used and optimized until their capacity is exhausted or they are required to be closed by state law.

- **Multiple Confined Disposal Facilities for Harbor Material—**The federal standard for the dredging and subsequent placement of Harbor material is the continued use of HMI. Since Maryland state law mandates that HMI close in 2009 and the Cox Creek CDF does not have sufficient capacity for the remainder of the 20-year-minimum period, additional options had to be evaluated. Although the expansion of HMI has been determined to be the federal standard for the remainder of the 20-year period, this option is precluded by Maryland state law and is therefore not implementable with the State of Maryland as a sponsor.

  In order to meet the annual placement needs of the Harbor material, two (100 acres each) of the proposed CDFs, or equivalent, must be available to accept dredged material in fiscal year 2010. The remaining two (100 acres) sites must be available in fiscal year 2014 to avoid excessively overloading the Cox Creek CDF. Additional studies, including feasibility, conceptual design, and a NEPA document, will be required to determine the specific sites and evaluate any potential environmental impacts. Any incremental study costs beyond that required for the federal standard will be a non-federal cost unless other authorities are used.

  Construction of the new confined disposal facilities would be cost shared with the non-federal sponsor, in accordance with the provisions of Section 201 of WRDA 1996, only if the CDFs are considered GNF facilities (i.e., facilities that meet the federal standard as the least-cost, environmentally acceptable placement option). Since the new CDFs would not be GNF facilities, the federal cost share for these facilities would be limited to the increment of costs associated with continued use of HMI. In addition, the funding of capacity requirements related to non-federal dredged material is a non-federal responsibility.

  Although specific congressional authorization is not required for placement facilities needed for the operation and maintenance of authorized federal navigation projects that meet the federal standard (USACE Planning Guidance Letter (PGL) Number 47), additional authority may be required if the CDFs would include any feature that involves the beneficial use of dredged material (e.g., wetlands). Consequently, each CDF will have its own feasibility study and potential authorization, which may allow a provision for cost sharing based on the underlying project purpose and authority.

- **PIERP Expansion—**Because of the mandated closure of the Pooles Island Open Water Site in 2010, the expansion of the PIERP is necessary to meet the projected capacity needs of the material to be dredged from the C&D Canal Approach Channels (Lower Approach) and the Chesapeake Bay Approach Channels (MD). The expanded sections of Poplar Island must be available to accept material in 2011 to avoid excessively overloading the existing cells at the PIERP.

  USACE and the State of Maryland are currently partnering on the PIERP under the existing project authority (Section 537 of WRDA 96). Modifying the PIERP by raising the dikes and/or expanding the footprint, as included in the recommended plan, is currently being investigated through a General Reevaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS) under the existing PIERP authorization. Raising the dikes and expanding the footprint of PIERP will exceed the cost and/or project limitations and will likely require congressional authorization. If the cost beyond the federal standard is justified by the environmental outputs of the plan using cost effectiveness and incremental cost analysis rationale, the federal government may share the additional costs of those features based on authorities for ecosystem restoration. It is anticipated that any cost sharing of the implementation beyond the federal standard would be the same as the agreement for the existing project, which is 75% federal and 25% non-federal. However, if the additional costs are not justified based on these environmental outputs but are required based on non-federal restrictions, non-federal financing may be required for costs beyond the federal standard. The GRR/Supplemental EIS is scheduled to be completed after the DMMP.

- **Large Island Restoration-Middle Bay—**The existing cells at the PIERP are projected to reach their maximum capacity in 2015 or early 2016. The proposed 600-acre expansion, if approved and authorized, will not provide the annual and total dredged material capacity required for the 20-year-minimum period. Restoring a large island in the Middle Bay region is the preferred method to meet the additional capacity needs. The large island needs to be operational before 2015 to avoid overloading the expanded area of the PIERP, or earlier if the expansion of the PIERP is not approved and authorized.

  USACE and the State of Maryland are currently partnering on a feasibility study under the Eastern Shore of Maryland General Investigation authority. However, the implementation of the project will require congressional authorization. The project would likely be authorized under Section 204 of WRDA 92, as amended by Section 207 of WRDA 96 (these sections provide authority for USACE to implement projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with construction, operation, or maintenance dredging of an authorized federal navigation project). If the cost beyond the federal standard is justified by the environmental outputs of the plan using cost effectiveness and incremental cost analysis rationale, the federal government may share the additional costs of those features based on authorities for ecosystem restoration. It is anticipated that any cost sharing beyond the federal standard would be the same as the agreement for the PIERP, which is 75% federal and 25% non-federal. However, if the additional costs are not justified based on these environmental outputs but are required based on non-federal restrictions, non-federal financing may be required for costs beyond the federal standard.

- **Wetland Restoration-Dorchester County—**Restoring wetlands at Blackwater NWR Dorchester County, Maryland, and the surrounding area could provide significant environmental benefit and additional dredged material capacity for the 20-year-minimum period and beyond. Additional studies will be required to determine the specific locations for dredged material placement and evaluate any potential environmental impacts. Preparation of a feasibility study would be required under an appropriate congressional authorization (either current or future authority). Any incremental study costs beyond that required for the federal standard would be cost-shared based on the authority, but would most likely be 50/50 between the non-federal sponsor and the USACE.

  The incremental cost, or cost beyond the federal standard, associated with the restoration of wetlands at Blackwater NWR, Dorchester County, Maryland, and the surrounding area could be non-federally financed, or could be cost shared with USACE under separate authorities, such as Section 204 of WRDA 1992, as amended by Section 207 of WRDA 1996. If the cost beyond the federal standard is justified by the environmental outputs of the plan using cost effectiveness and incremental cost analysis rationale, the federal government may share the additional costs of those features based on other authorities for ecosystem restoration. However, if the additional costs are not justified based on these environmental outputs but are required based on non-federal restrictions, non-federal financing may be required for costs beyond the federal standard.

- **Continue to pursue opportunities to innovatively use dredged material.** A number of innovative dredged material placement alternatives were eliminated prior to development of the recommended plan because of their high cost, high technical uncertainty, and high implementation risk. This includes beneficial use alternatives such as the use of abandoned mines as placement sites, agricultural soil improvement with dredged material, and use of dredged material to produce building products. These alternatives should continue to be evaluated over the next 5 to 10 years to determine whether improvements in technologies can make these alternatives environmentally sound and cost effective.

5.2 FINALIZING THE EIS

This Tiered EIS has been prepared pursuant to the NEPA of 1969 (42 U.S.C. 4321 et seq.) and Council on Environmental Quality NEPA Regulations (40 CFR Parts 1500-1508). Following the preparation and distribution of the Draft Programmatic DMMP and Tiered EIS and holding public hearings to solicit public comment on the document, a Final Programmatic DMMP and Tiered EIS will be published for public distribution. Not less than 30 days after the publication of the EPA's Notice of Availability of the Final Programmatic DMMP and Tiered EIS, USACE may issue a ROD documenting its decision concerning the proposed action. Signing the ROD will complete the federal requirements for finalizing the Tiered EIS process and Phase II of the overall DMMP process. The decision that is documented in the ROD will determine the necessary project-specific feasibility studies to be undertaken in Phase III of the DMMP process, during which project-specific NEPA documents will be prepared.

5.3 DMMP REVIEWS

The DMMP will be reviewed and updated approximately every 5 years, or as necessary to reflect significant changes in statutory, regulatory, scientific, or environmental conditions.

CHAPTER 5

FIGURE

Figure 5-1 BALTIMORE HARBOR AND CHANNELS DMMP

IMPLEMENTATION SCHEDULE (fy) - DREDGED MATERIAL QUANTITIES (cy) BY PLACEMENT SITE

Placement Sites and Alternatives	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	REMAINING CAPACITY (cy)
		WRDA		WRDA		WRDA		WRDA		WRDA		WRDA		WRDA		WRDA		WRDA		WRDA		
Harbor Channels																						
Hart-Miller Island Containment Facility (EXISTING)					Cap	Cap																
OPERATING LIFE	2,751,100	2,750,000	2,750,000	1,748,900	2,500,000	2,500,000																0
Cox Creek Containment Facility (EXISTING)																						
OPERATING LIFE	0	642,400	634,700	536,900	330,000	600,000	363,000	600,000	600,000	821,880	716,960	154,160	Capacity	Exhausted								0
New Confined Disposal Facilities - Patapsco River																						
New CDF #1 and #2 (2x≈100 acres)																						
AUTHORIZATION		Authorization																				
PLANNING + DESIGN		Planning &	Design																			
CONSTRUCTION				Construction																		
OPERATING LIFE						743,100	0	632,990	557,970	1,300,000	1,200,000	630,770	332,750	616,495	833,085	341,220	181,500	707,850	181,500	616,495	609,840	0
New CDF #3 and #4 (2x≈100 acres)																						
AUTHORIZATION						Authorization																
PLANNING + DESIGN						Planning &	Design															
CONSTRUCTION								Construction														
OPERATING LIFE										1,300,000	1,200,000	630,770	332,750	616,495	833,085	341,220	181,500	707,850	181,500	616,495	609,840	0
C & D Canal Approach and Chesapeake Bay (MD) Approach Channels																						
Pooles Island Open Water Site (EXISTING)																						
OPERATING LIFE	1,320,000	1,320,000	1,320,000	740,000	Capacity	Exhausted																0
Poplar Island Restoration Project (EXISTING)																						
OPERATING LIFE	1,896,070	1,798,060	2,102,980	2,378,060	1,592,110	824,970	2,683,600	2,683,600	2,683,600	2,683,600	2,683,600	2,720,862	Capacity	Exhausted								0
Poplar Island Expansion																						
AUTHORIZATION	Authorization																					
PLANNING + DESIGN	Planning &	Design																				
CONSTRUCTION				Construction																		
OPERATING LIFE							532,470	434,460	739,380	434,460	532,470	335,220	1,989,776	1,452,000	1,452,000	1,452,000	1,452,000	1,452,000	1,452,000	1,452,000	1,452,000	7,385,764
Large Island Restoration - Mid Bay																						
AUTHORIZATION	Authorization																					
PLANNING + DESIGN	Planning &	Design																				
CONSTRUCTION								Construction														
OPERATING LIFE											0	168,888	1,833,446	1,397,172	1,702,092	1,397,172	1,495,182	1,604,082	1,495,182	1,397,172	2,578,132	19,531,480
Wetlands Restoration - Dorchester County																						
AUTHORIZATION								Authorization														
PLANNING + DESIGN								Planning &	Design													
CONSTRUCTION										Construction												
OPERATING LIFE											0	100,000	268,888	268,888	268,888	268,888	268,888	268,888	268,888	268,888	268,888	TBD
Chesapeake Bay Approach Channels (VA)																						
Rappahannock Deep Alternate Open Water-Site (EXISTING)																						
OPERATING LIFE	0	0	12,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,100	SUFFICIENT
Wolf Trap Alternate Open Water-Site (EXISTING)																						
OPERATING LIFE	792,550	0	0	0	792,550	0	0	0	792,550	0	0	0	792,550	0	0	0	792,550	0	0	0	792,550	SUFFICIENT
Dam Neck Ocean Open Water-Site (EXISTING)																						
OPERATING LIFE	1,877,920	0	0	0	1,877,920	0	0	0	1,877,920	0	0	0	1,877,920	0	0	0	1,877,920	0	0	0	1,877,920	SUFFICIENT
TOTAL	8,637,640	6,510,460	6,819,780	5,403,860	7,092,580	4,668,070	3,579,070	4,351,050	7,251,420	6,539,940	6,333,030	4,740,670	7,428,080	4,351,050	5,089,150	3,800,500	6,249,540	4,740,670	3,579,070	4,351,050	8,201,270	
		Authorization		Planning & Design		Construction		Operating Life												**Total**	119,717,950	

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6. RECOMMENDATIONS

Within the next 20 years, there will be a critical shortage of dredged material placement capacity for continued maintenance dredging of the Baltimore Harbor and Channels. Feasible alternatives for managing dredged material have been carefully considered, including use of dredged material as a beneficial resource. Through a rigorous and systematic process, dredged material placement alternatives have been compared for capacity, cost, environmental benefit and/or impact, and implementation risk, resulting in the selection of a recommended plan. The recommended plan consists of seven dredged material management alternatives that together will provide sufficient dredged material placement capacity for continued maintenance dredging through the next 20 years, with some capacity remaining for out-year use. These seven management alternatives are continued maintenance dredging of the Virginia channels and use of existing open water sites in Virginia; continued maintenance dredging of the Maryland channels and use of the existing placement sites in Maryland including Pooles Island Open Water Site, Hart-Miller Island DMCF, Cox Creek CDF, and PIERP; construction of multiple CDFs in the Patapsco River, MD; and expansion of the currently authorized PIERP; large island restoration in the Middle Bay; wetland restoration in Dorchester County, Maryland, at Blackwater National Wildlife Refuge; and continue to pursue opportunities to innovatively use dredged material.

A number of innovative dredged material placement alternatives were eliminated prior to development of the recommended plan because of their high cost, high technical uncertainty, and high implementation risk. This includes beneficial use alternatives such as the use of abandoned mines as placement sites, agricultural soil improvement with dredged material, and use of dredged material to produce building products. I recommend the continued technical development of these innovative uses be pursued in partnership with the State of Maryland. At such time as these alternatives can be refined for full-scale use, they should be considered for inclusion in the recommended plan.

The recommended plan is anticipated to have little adverse impact on the quality of the environment and the restoration alternatives will have the potential to provide environmental benefit by restoring critical habitat and protecting the environment from further degradation.

I recommend that the alternatives included in the recommended plan continue into the feasibility study phase to further refine the placement options, maximize capacity and environmental benefit, and mitigate any adverse impacts.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction and operations and maintenance programs nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the non-federal project partner (the State of Maryland), interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Robert J. Davis, Jr.
Colonel, U.S. Army Corps of Engineers
District Engineer

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7. LIST OF PREPARERS

The U.S. Army Corps of Engineers Baltimore District was assisted in preparing the Baltimore Harbor & Channels Dredged Material Management Plan (DMMP) and Tiered Environmental Impact Statement (EIS) by Weston Solutions, Inc., under contract number DACA31-00-D-0023-0047. WESTON was assisted by Dennis King & Associates and Panamerican Consultants. Also consulted by WESTON for this effort was Mr. John Burns of John Burns Associates for input and review.

Included in Table 7-1 is an alphabetical list of people from the project delivery team, U.S. Army Corps of Engineers Baltimore District, and the Maryland Port Administration Team who were involved in developing this DMMP/EIS.

CHAPTER 7

TABLE

Table 7-1

DMMP/EIS Development Team

Name	Organization	Title - Role in DMMP/EIS
Weston Solutions Team		
John Burns	John Burns Associates	USACE Compliance Review
Larry Donovan	Weston Solutions, Inc.	USACE Compliance Review
Chris Dorman	Weston Solutions, Inc.	Civil Engineer – Dredging
Barry Dubinski	Weston Solutions, Inc.	Senior Biologist – Affected Environment and Environmental Impacts
Kurt Frederick	Weston Solutions, Inc.	Technical Director
Dennis King	Dennis King & Associates	Environmental Economist – Alternatives Evaluation & Impacts
Mandy Loeffler	Weston Solutions, Inc.	Coastal Engineer – Alternative Design and Cost Estimating
William Lowe	Weston Solutions, Inc.	Senior Civil Engineer – Dredging and Alternatives Evaluation
Corinne Murphy	Weston Solutions, Inc.	Project Manager
Cecelia Oswald	Weston Solutions, Inc.	Biologist – Affected Environment and Environmental Impacts
David Pohl	Weston Solutions, Inc.	Senior Civil Engineer – Alternative Design and Cost Estimating
Elizabeth Price	Dennis King & Associates	Environmental Economist – Alternative Evaluation and Impacts
Lisa Wainger	Dennis King & Associates	Environmental Economist – Alternative Evaluation and Impacts
Sonny Rutkowski	Weston Solutions, Inc.	Senior Coastal Engineer – Alternative Design and Cost Estimating
Michael Krivor	Panamerican Consultants, Inc.	Cultural Resource Evaluation
U.S. Army Corps of Engineers, Baltimore District		
William Abadie	Planning Division	NEPA Specialist/Biologist
Kenneth Baumgardt	Planning Division	Cultural Resource Specialist
Dan Bierly	Planning Division	Port of Baltimore, Team Leader Civil Engineer

Table 7-1

DMMP/EIS Development Team
(Continued)

Name	Organization	Title - Role in DMMP/EIS
Michele Gomez	Planning Division	Biologist
Mallecia Hood	Planning Division	Biologist
Tom Hughes	Planning Division	Economics Team Leader
Scott Johnson	Programs and Project Management Division	Project Manager Professional Engineer
Denny Klosterman	Planning Division	Economist
Jeffrey Lorenz	Office of Counsel	Assistant District Counsel
Jeff McKee	Operations Division	Deep Draft Navigation, Section Chief
Mark Mendelsohn	Planning Division	Biologist
Gwen Meyer	Planning Division	Study Team Leader
Christopher Spaur	Planning Division	Biologist
Maryland Port Administration Team		
Fran Flanigan		Community Outreach
Frank Hamons		Maryland Port Administration Deputy Director
Dr. Stephen Storms		Port Administration Study Manager

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9. PUBLIC REVIEW PROCESS AND RESPONSE TO COMMENTS

Public involvement in the review of Draft EISs is stipulated in 40 CFR Part 1503 of the CEQ's regulations implementing NEPA. These regulations provide for active solicitation of public comment via scoping meetings, public comment periods, and public hearings. This chapter is prepared to respond to the specific questions and comments raised by individual commentors during the public comment period on the Draft Baltimore Harbor and Channels Dredged Material Management Plan and Tiered Environmental Impact Statement.

9.1 PUBLIC REVIEW PROCESS

9.1.1 Filing and Distribution of the Draft TEIS

The Formal Notice of Intent (NOI) to prepare a DMMP and EIS for the Baltimore Harbor and Channels Project was published in the Federal Register on 24 May 2002. Three separate scoping meetings to solicit input for the DMMP study were held in June 2002: June 12 at the Queen Anne's County Library, Stevensville, MD; June 18 at the Community College of Baltimore County in Dundalk, MD; and June 20 at the Anne Arundel Community College, Arnold, MD.

On 9 February 2005, the DMMP/Draft TEIS, along with a copy of the public hearing notice, was distributed to agencies and officials of federal, state, and local governments, citizens groups, and private citizens. Copies of the DMMP/Draft TEIS were also on display at the Queen Anne's County Public Library, Essex Branch of the Baltimore County Public Library, Anne Arundel County Public Library, St. Mary's County Public Library, Somerset County Public Library, and the Dorchester County Public Library.

9.1.2 Public Review Period and Public Meetings

Public review and comment on the DMMP/Draft TEIS occurred from 9 February 2005 through 28 March 2005. During that period, public meetings were held on 7 March 2005 at the Queen Anne's County Public Library, Stevensville, MD, and on 10 March 2005 at the Essex Campus of the Community College of Baltimore County, Baltimore, MD. Transcripts from the meetings are included in Appendix H.

9.2 RECEIPT OF COMMENTS

Comments on the DMMP/Draft TEIS were received in three forms: letters, emails, and oral statements made at the public meetings. All substantive comments are reviewed and addressed in this chapter.

9.2.1 Identification of Comments

Each comment submission received, whether written or contained only in the transcripts of the public meetings, was assigned one of the following letter codes:

F – Federal agencies and officials
S – State agencies and officials
L – Local agencies and officials
G – Groups and associations
P – Public (Individuals)
O – Oral (comments delivered at the public meetings in March 2005)

These labels were assigned for the convenience of readers and to assist in the organization of this document. Within each of the categories, each submission was assigned a number, such as F-1, S-1, and so on. In addition, each separate comment was assigned a separate subnumber. Thus, if an agency or citizen made three different comments, they are designated as F-1.1, F-1.2, F-1.3, or as P-1.1, P-1.2, P-1.3, etc.

All written submissions and the transcripts from the public meeting in March 2005 have been included in Appendix H. The alphanumeric code associated with each written submission is marked at the top of the first page of each letter; the subnumbers of the individual comments are marked in the right margin. Comment letters or emails are printed in numerical order.

9.2.2 Comment Summary Table

The Comment Summary Table (Table 9-1), following this text, contains a complete list of all commentors and responses to comments. The list allows readers to find answers to the specific questions they have raised. Unless noted, comments were received as part of the 45-day comment period.

CHAPTER 9

TABLE

Table 9-1
Response to Comments Summary

Name/Agency	Comment Code	Comment	Response
Federal Government Comments			
United States Department of the Interior, USFWS/John P. Wolflin	F-1.1	I am writing at this time in support of the wetland restoration DEIS alternative in Dorchester County, Maryland, that includes Blackwater National Wildlife Refuge.	Comment noted. Restoration of wetlands in Dorchester County is an integral component of the DMMP/TEIS recommended plan. However, the Corps will require funding to initiate a Feasibility Study.
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.1	Details on the site locations and areas of impact are not provided for the construction of multiple confined disposal facilities (CDF's) in the Patapsco River. Since the construction of these CDFs will result in significant losses of estuarine habitat, this should be an option of last resort. If no feasible alternative exist, a mitigation plan will need to be developed to compensate for the loss of estuarine habitat. These sites should be designed so that they would have an environmental restoration component.	Comment noted. The DMMP/TEIS has been prepared using a programmatic approach. Specific site locations for the construction of multiple CDFs will be evaluated during follow-on feasibility studies, which will include consideration of environmental restoration and any appropriate mitigation.
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.2	We believe that the south cell of the Hart-Miller Containment Facility should be considered as an option to reduce the need for CDF construction in the Patapsco River. Previous estimates by the Corps indicated that the south cell dikes could be raised to provide capacity for many millions of cubic yards of material.	Expansion of the Hart-Miller Island (HMI) containment facility (vertical and lateral expansion) was considered but eliminated due to the low probability of implementation, since Maryland State law precludes expansion and requires HMI to close by December 31, 2009.
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.3	Our understanding is that Pooles Island was only intended to be used on an interim basis to help meet a near-term shortfall in available disposal capacity. Since the Poplar Island placement site is operational with a capacity of 40 mcy, it appears that the near-term shortfall has been eliminated. Therefore, consideration should be given to discontinuing the use of the Pooles Island site.	The use of the Pooles Island site will provide a lower cost option than transporting the C & D Canal Approach Channels material to Poplar Island. In addition, continued use of the site until its mandated closure would minimize any overloading of Poplar Island. Poplar Island is currently not authorized to take dredged material from the C & D Canal Approach Channels.
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.4	We understand that the Rappahannock Shoal Alternate and Wolf Trap Alternate open water sites are only used infrequently, and that monitoring has not revealed substantial adverse impacts. We do recommend that the Plan include a statement that when future planning is conducted for the dredging of these channels, considerations would be given to portions that would use the material for habitat improvement projects at islands along bay shorelines.	Follow-on periodic reviews of the DMMP will reevaluate the feasibility of cost effective habitat improvement projects and other beneficial uses for the Virginia channel material.

Table 9-1
Response to Comments Summary
(Continued)

Name/Agency	Comment Code	Comment	Response
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.5	The Cape Henry channel contains relatively coarse grain sediments that could possibly be used for beach replenishment, instead of disposal at the Dam Neck open water site. We recommend that the Plan include a note that when future dredging operations are planned, the grain size of the material would be examined to determine the potential for beach replenishment.	Comment noted. Dredged material from the Cape Henry Channel has been placed on Virginia area beaches in the past and continues to be periodically evaluated for placement on some beaches. However, the Cape Henry Channel material is more susceptible to wind, wave, and current erosion and is not stable enough on high energy beaches to stay on the beach for a very long time. The Cape Henry Channels material is therefore not a suitable source of sand for beach nourishment purposes, and the added costs of placing the material on the beach and the fact that the material will not remain on the beach for very long makes the use of the sand as beach nourishment material generally uneconomical.
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.6	We fully endorse the further study of the Dorchester County wetland restoration alternative. We believe that such a project would be a key element of a watershed restoration program and reflect an ecosystem approach to management in the Chesapeake Bay.	See response to Comment F-1.1
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.7	Page 2-11, Lines 8-10. The sentence, "Sea level is rising at a rate of 0.16 inches/year (1.3 ft/century) near the mouth of the Bay; this rate decreases northward, possibly due to lesser isostatic rebound" is incorrect in the use of the term "rebound". Rebound implies uplift, however the USGS reference cited actually used the term "isostatic adjustment" to represent sinking, or downwarping, of the Chesapeake Bay area. The apparent differential rate of sea level rise between the southern and northern parts of the bay may be a result of sediment compaction resulting from groundwater extraction in the Hampton Roads, Norfolk, and Portsmouth area. It is suggested that the sentence be revised to read: Sea level is rising at a rate of 0.16 inches/year (1.3 ft/century) near the mouth of the Bay; this rate decreases northward.	Lines 8-10 have been revised as indicated.
United States Department of the Interior, Office of the Secretary/Michael T. Chezik	F-2.8	Page 4-14, Lines 15-18. The sentence states: "Although potential contamination of groundwater is always a concern for dredged material placement, no negative impacts are expected because Baltimore utilizes a surface water system for its consumptive water needs." Potential effects on ground-water quality and receiving ecosystems should also be examined and addressed in	Lines 15-18 have been revised as appropriate.

Table 9-1
Response to Comments Summary
(Continued)

Name/Agency	Comment Code	Comment	Response
		the design of the long-term monitoring plan.	
USEPA/William J. Hoffman	F-3.1	EPA concurs with the analysis of impacts and findings and the tiered process used to develop the DMMP and DTEIS.	Comment noted
USEPA/William J. Hoffman	F-3.2	EPA has rated the "no action" alternative, which consists of the continuation of current maintenance dredging and placing dredged material at existing placement sites without modification, and the new Alternative proposing wetlands restoration in Dorchester County, MD as "LO" (Lack of Objection). We have assigned the rating "EC" (Environmental Concerns) to the remaining three alternatives, which include the proposed multiple new Confined Disposal Facilities (CDF's) in the Patapsco River, the Poplar Island Environmental Restoration Project (PIERP) expansion and the Large Island Restoration (LIR) Middle Bay. EPA has also rated the overall adequacy of the DTEIS document as "1" (Adequate).	Comment noted. Follow-on studies for CDFs, PIERP expansion and LIR will evaluate the proposed sites in detail and impacts will be addressed in the EIS for each site.
USEPA/William J. Hoffman	F-3.3	We suggest that the recommendation for continued use of Open Water Placement in Virginia include the Norfolk Ocean Placement Site. EPA believes that this site should be pursued as part of a viable mix of options for Mid and Upper Bay disposal needs in the long term management process.	The use of the Norfolk Ocean Placement for the Maryland Bay material was evaluated but was dropped from consideration as a component of the recommended plan due to high costs and lack of environmental benefit. Periodic reviews of the DMMP/TEIS will re-evaluate this alternative as a viable option.
USEPA/William J. Hoffman	F-3.4	EPA strongly endorses the development of beneficial uses of dredged material. Further development of the Dorchester County Blackwater Wildlife Refuge wetlands alternative needs to address expansion of this site beyond that proposed in the DTEIS. Any future study of this alternative should expand the effort to identify funding opportunities to provide future significant environmental benefits by enhancing this valuable ecological asset.	Comment noted. Pending receipt of funds, a follow-on feasibility study and NEPA document would address the expansion of this alternative beyond that proposed in the TEIS.
USEPA/William J. Hoffman	F-3.5	EPA is very concerned that the expansion of Poplar Island (PIERP) and the creation or restoration of a large island (LIR) in the Middle Bay has the potential to impact large areas of subaqueous habitat. We support the optimization of the vertical expansion of Poplar Island to the extent possible. Detailed analysis of a Mid-Bay LIR needs to be performed to determine specific ecosystem impacts.	Two separate detailed analyses are currently ongoing, the *General Reevaluation Report (GRR) and Supplemental Environmental Impact Statement (SEIS) for Poplar Island Environmental Restoration Project, Chesapeake Bay Maryland* and the *Mid-Chesapeake Bay Island Restoration Feasibility Study, Chesapeake Bay Maryland* to determine the specific ecosystem

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			impacts.
USEPA/William J. Hoffman	F-3.6	We strongly concur with the recommendation for the continued technical development of innovative alternatives dropped from study at this time due to high cost, technical uncertainty, or high implementation risk.	Comment noted; the innovative use alternatives require further study to develop feasible, cost-effective options.
USEPA/William J. Hoffman	F-3.7	EPA also recommends that the control of non-point source sediment loadings from the Upper Chesapeake Bay Watershed be pursued to reduce the need for future dredging and placement capacity by reducing sediment loadings to the Bay.	Comment noted; the control of non-point source sediment loading is critical in reducing the need for future dredging and contributes to improving the overall health of the bay. Although this analysis is beyond the scope of the DMMP effort. The upper Bay watershed, including the input from the Susquehanna River is being considered in other studies currently ongoing or proposed. These efforts are not focused primarily on the impact of sediments from the watersheds on the navigation channels, although it is a consideration. The Corps acknowledges there is tremendous interest in studying the potential impacts of and solutions to the sediment in the reservoirs behind the lower Susquehanna River dams (Conowingo, Safe Harbor, and Holtwood). There is an ongoing Corps study on erosion along the Chesapeake Bay shorelines. In addition, the Chesapeake Bay Agreement lists reduction of sediment as a goal for restoration. Although all these efforts are focused more on the environmental impact of sediment, there would likely be an ancillary benefit of reducing the future need for dredging.
State Agency and Official Comments			
EA/MES (on behalf of MPA)	S-1.1	Page x. There are two pages of acronym list numbered "x", please correct.	The redundant page has been removed.
EA/MES (on behalf of MPA)	S-1.2	Page xiii. Fix Table 3-3 title formatting.	The title formatting has been corrected.

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EA/MES (on behalf of MPA)	S-1.3	Page ES-14. Figure is difficult to read, please enlarge font on figure labels.	The fonts have been enlarged.
EA/MES (on behalf of MPA)	S-1.4	Page ES-16. Please enlarge font so table is readable, page also needs a page number.	The table has been enlarged into two tables.
EA/MES (on behalf of MPA)	S-1.5	Page 1-19, Lines 19-20. This sentence conflicts with the statement on p. ES-6, line 15-16.	Page ES-6 was revised as appropriate.
EA/MES (on behalf of MPA)	S-1.6	Page 2-17, Lines 7, 18, 24. Please fix heading titles.	Heading titles are correct.
EA/MES (on behalf of MPA)	S-1.7	Page 2-47, Line 25. Rename this section to “Harbor/Upper Bay” or create separate section addressing the Harbor Channels.	Section heading was revised as appropriate.
EA/MES (on behalf of MPA)	S-1.8	Page 2-48, Line 1. Fix section heading.	Section heading is correct.
EA/MES (on behalf of MPA)	S-1.9	Page 2-74, Line 21. Insert “can be” or “was” after “trawl collections”.	Line 21 was revised as indicated.
EA/MES (on behalf of MPA)	S-1.10	Page 2-79, Line 4. Please include an approximate depth to clarify for the reader.	Sentence has been revised for clarity.
EA/MES (on behalf of MPA)	S-1.11	Page 2-79, Line 26. Change blue text reference and to black.	Correction made.
EA/MES (on behalf of MPA)	S-1.12	Page 2-84, Line 18. Insert a parenthesis before CBP, 2004m.	Correction made.
EA/MES (on behalf of MPA)	S-1.13	Page 2-98, Line 3. Correct “double-breasted” to double-crested”.	Correction made.
EA/MES (on behalf of MPA)	S-1.14	Page 2-99, Line 7. Pluralize “waterbird”.	Correction made.
EA/MES (on behalf of MPA)	S-1.15	Page 2-99, Line 23. Decapitalize “Area”.	Correction made.
EA/MES (on behalf of MPA)	S-1.16	Tables 2-7, 2-8 and 2-9. Fix cell formatting and margins in tables.	Cell formatting and margins have been corrected.
EA/MES (on behalf of MPA)	S-1.17	Section 2 Figures. Fix text on cover page of section 2 figures.	The text on the cover page is correct.
EA/MES (on behalf of MPA)	S-1.18	Figure 2-1. Fix text in Figure 2-1 title	The text in Figure 2-1 title is correct.
EA/MES	S-1.19	Figure 2-6. Fix text in Figure 2-6 title.	The text in Figure 2-6 title is correct.

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(on behalf of MPA)			
EA/MES (on behalf of MPA)	S-1.20	Page 4-22, Line 2. CENWW is not on the acronym list, please correct reference or add to the acronym list	CENWW has been added to the acronym list.
EA/MES (on behalf of MPA)	S-1.21	Page 4-23, Line 26. Correct "founder" to "flounder".	Correction made.
EA/MES (on behalf of MPA)	S-1.22	Page 4-27, Line 12. Correct sentence to read "…located in an area…".	Correction made.
EA/MES (on behalf of MPA)	S-1.23	Pages 4-40, 41. Would sections 4.7.2.3.2 thru 4.7.2.3.6 be more appropriate under the wetlands restoration "aquatics" section 4.6.2.3?	Sections 4.7.2.3.1 thru 4.7.2.3.6 have been moved to Section 4.6.2.3 as requested.
EA/MES (on behalf of MPA)	S-1.24	Page 4-48, Line 2. Should "black swimmer" be changed to "black skimmer"?	Line 2 was revised as indicated.
EA/MES (on behalf of MPA)	S-1.25	Page 4-70, Line 12. Change "CQE" to "CEQ".	Correction made.
EA/MES (on behalf of MPA)	S-1.26	Page 4-73, Line 21. Delete "to" after "…net impacts of this…".	Correction made.
EA/MES (on behalf of MPA)	S-1.27	Page 4-77, Line 8. Reword to read, "…to create cumulative significant adverse impacts to water quality and water resources."	Line 8 was revised as indicated.
EA/MES (on behalf of MPA)	S-1.28	Figure 5-1. Increase font size so figure is readable.	Font size has been enlarged.
EA/MES (on behalf of MPA)	S-2.1	Generally like the new structure better. One caution: the existing or proposed sites are not introduced until after the existing conditions now, so there is no up front context for the studies that are referenced. Suggest inserting references to the pertinent sections or maps in Section 3 when talking about existing conditions studies.	Section 2 (Affected Environment) is intended to provide general information on the four regions of the Chesapeake Bay identified in the EIS. It is not intended to focus the information presented on existing or proposed disposal sites. Though some information presented for a region(s) is based on studies of existing or proposed disposal sites. Therefore, reference to pertinent sections or maps in Section 3 was not considered appropriate.
EA/MES (on behalf of MPA)	S-2.2	More recent information should be used in the existing conditions section. The citizens and the agencies are aware of the current information and may be expecting to see it in the text. This is especially important for the Harbor.	The DMMP/TEIS has been prepared using a programmatic approach. After specific sites are selected (e.g., locations of the new CDFs in the Harbor region), follow-on feasibility studies will contain more specific information regarding the affected environment at each potential site.

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EA/MES (on behalf of MPA)	S-2.3	Have the references in sections 3 & 4 been confirmed? For example see p. 4-11, line 9. This references a Harbor report but the section is talking about WQ at PIERP. There seems to still be several places in Section 4 where multi-entity references attributed are not referencing the correct report.	The references in Sections 3 and 4 have been confirmed and any changes made to ensure accurate representation of information and recognition of the source of information.
EA/MES (on behalf of MPA)	S-2.4	Page 1-21, Line 1. Use of "alternative" seems to vary and may confuse the reader – make the use on p.1-19, line 26 and p.1-20, line 11-12 consistent.	Comment Noted; p. 1-19 refers to the "initial" alternatives list.
EA/MES (on behalf of MPA)	S-2.5	Page 2(3?)-13, Lines 3-10. It is not clear where the assumption of local borrow and clean material for external dikes is specified for AIC. This is spelled out for some diked alternatives, but not all and needs to be consistent.	Lines 27-29 on Page 3-12 state the assumption.
EA/MES (on behalf of MPA)	S-2.6	Pages 2-18 to 23. Some information on erosion and loading was added, but information on contents of bottom sediment or reference to information in Section 1.	References have been added to information in Section 1.
EA/MES (on behalf of MPA)	S-2.7	Pages 2-23 to 33. This section is better but still too focused on crabs. For example, flounder (an EFH species) could be mentioned. Chris Spaur should have lots of details on pycnocline depth in the context of DO?	The discussion of blue crabs in this section is intended to be representative of the impact impaired water quality (low dissolved oxygen concentrations) can have on organisms living on or near the bottom of aquatic systems in the Bay. It is not considered or intended to be comprehensive
EA/MES (on behalf of MPA)	S-2.8	Page 2-47, Line 29. Should the Anacostia River be included here since it is off of the Potomac?	Reference to the Anacostia River has been deleted.
EA/MES (on behalf of MPA)	S-2.9	Pages 2-47 to 49. Harbor fish consumption advisories should be addressed here.	Section 2.4 has been revised to include more current data.
EA/MES (on behalf of MPA)	S-2.10	Page 2-63, Line 3. Was there a WRDA 2004? If not please update text.	There was not a WRDA 2004. The reference to WRDA 2004 has been deleted.
EA/MES (on behalf of MPA)	S-2.11	Page 2-82, Lines 13-21. A point should made somewhere in this section that SAV densities are highly variable. This is not included in the text anywhere. Acreages for any given year are somewhat meaningless because they could be ½ as much or twice as much the next year.	Text has been revised as appropriate.
EA/MES (on behalf of MPA)	S-2.12	Page 2-88, Lines 16-17. The riverine data is not really meaningful here. Please add Chesapeake Bay acreages.	Riverine details included in Chesapeake Bay and Island acreages text has been clarified in Section 2. The wetland data presented include the portions of the Chesapeake Bay associated with each watershed for which data

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			are presented. This also includes islands and wetlands considered extensions of each watershed.
EA/MES (on behalf of MPA)	S-2.13	Pages 2-113, Line 18 and 4-54, Lines 11-14. The text states that there are no Chesapeake Bay Area rivers in the Federal Wild and Scenic Rivers Act, however a citation in the upcoming MidBay EIS states that the Maryland General Assembly has designated at least nine rivers as "scenic or wild".	The intent of this section was to identify federal wild and scenic rivers. It is acknowledged that both Maryland and Virginia have rivers in the Bay region designated as Scenic and Wild (Maryland) and Scenic (Virginia). The text was modified to reflect this.
EA/MES (on behalf of MPA)	S-2.14	Page 2-114, Line 17. It should be noted that most of Anne Arundel County is in the Middle-Bay study area.	See response to Comment S-2.15.
EA/MES (on behalf of MPA)	S-2.15	Page 2-116, Lines 3-5. Anne Arundel County should be included in the list since it is in the Mid-Bay region from Annapolis south	Lines 3-5 have been revised as indicated.
EA/MES (on behalf of MPA)	S-2.16	Chapter 4, General Comment. Information on child safety and OSHA should be mentioned in this section.	The DMMP EIS is a programmatic assessment which lays the groundwork for the future selection of disposal options and sites identified under the recommended plan. Both child safety and OSHA will be addressed in detail in the feasibility studies and tiered EISs and EAs prepared for these future actions. The public will be provided the opportunity to comment on these future actions through the NEPA process.
EA/MES (on behalf of MPA)	S-2.17	Page 4-6, Lines 6-14. Please note in these sections that there would be disruption to sediments in the dredging process.	The text was revised as appropriate.
EA/MES (on behalf of MPA)	S-2.18	Page 4-9. The white paper by Peddicord is still not referenced.	Comment noted. The text is appropriate. The white paper has not been finalized and therefore not appropriate as a reference.
EA/MES (on behalf of MPA)	S-2.19	Page 4-10. A discussion of nitrogen on channel and dredged releases to each of the dredging and placement options is not addressed in this section.	The section has been expanded to include a discussion on nitrogen.
EA/MES (on behalf of MPA)	S-2.20	Page 4-12, Lines 19-22. Table 3-1 indicates that harbor material will also be used. This needs to be reconciled with the statement that "dredged material for this project will originate from the outer channels."	Comment Noted. Table 3-1 does not indicate that harbor material would be used for LIR.
EA/MES (on behalf of MPA)	S-2.21	Page 4-16, Line 5-26. Please include some discussion of UXO in these sections.	Section 4.4.12 (Harbor Channels) already includes a discussion on UXO. Although the possibility exists for the presence of UXO in

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			other regions of the Bay, it is generally not anticipated to be encountered in the regularly maintained channels outside the Harbor.
EA/MES (on behalf of MPA)	S-2.22	Page 4-38, Line 6-22. A discussion concerning how tidal flow may impact existing wetlands was not addressed. Text should state that further investigation may be required if the site has existing wetlands to ensure flushing of wetlands.	Text has been added to this section addressing the potential impacts to tidal flow and existing wetlands.
EA/MES (on behalf of MPA)	S-2.23	Section 4-17, General Comment. There remains little new regional context detail here. The point about potentially significant increases in wetlands in the mainstem is not really applicable, for example.	The focus of the cumulative actions section was on regional impacts from dredging and the placement of dredged material. The DMMP/TEIS is a programmatic assessment which lays the groundwork for the future selection of disposal sites and actions as identified under the recommended plan. Cumulative impacts will be addressed in detail for the specific actions and sites selected for analysis in the EISs and EAs prepared for these future actions. The public will be provided the opportunity to comment on these future actions through the NEPA process.
EA/MES (on behalf of MPA)	S-2.24	Page 4-71, Lines 7-20. A point needs to be made that some of these projects may be implemented simultaneously. Also, should Blackwater restoration be included in the project list?	These impacts are cumulative by definition. Adding the restoration of wetlands in Dorchester County (Blackwater) would be redundant since this alternative is a component of the recommended plan.
EA/MES (on behalf of MPA)	S-2.25	Page 6-1, Line 13. This sentence is questionable for use on multiple CDF's because by definition CDF's do not typically provide environmental benefits.	The text was revised as appropriate.
Maryland Department of Natural Resources (MDNR)	S-3.1	General Comment. MDNR had hoped that the Tiered EIS (TEIS) format would allow placement options that had inherent difficulties because of cost and/or capacity limits to have more of an "even playing field" with higher capacity options such as large island restoration. Smaller scale projects cannot compete directly with large island restoration in terms of cost, capacity or environmental benefits/acre of habitat restored. MDNR would like to discuss the possibility of a wide array of placement options for future projects. Smaller scale projects and innovative use projects could be considered as placement options despite cost and	Smaller scale projects were considered but did not make the recommended plan due to lower capacity and higher costs. Small-scale beneficial use projects continue to be implemented throughout the Bay Region for small navigation (i.e., shallow draft) projects.

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		capacity limitations.	
(MDNR)	S-3.2	Page 1-2, Lines 14-15. The "need" should be more specific than just "insufficient dredged material placement capacity for the next 20 years." The reader should know at the beginning of the report how insufficient existing capacity is long before it is finally revealed at the end of Section 2: Affected Environments (note immediately after Section 2-14 Noise. This juxtaposing seems out of context). The reader should also be informed early on the breakdown of the dredging volumes between maintenance and new work dredging that were used to determine that insufficient placement capacity existed for the next 20 years. The 20-year period should be stated with starting and ending point (2005-2024(not 2025)). The discussion on the specific needs is finally presented in section 2-15 and Table 2-23.	Lines 14-15 refer specifically to the conclusions of the Preliminary Assessment prepared in 2002. A reference to Appendix G has been added and Page 1-2 has been revised. Text has been revised to reflect a 21-year (fiscal years) period.
(MDNR)	S-3.3	Page 1-8, Line 4. Sediment in C&D Lower Approach Channel are clayey silts (not silty clays) as correctly reported on Page 1-13, Line 15.	Line 4 has been corrected as indicated.
(MDNR)	S-3.4	Page 1-17, Line 14. Is the Norfolk District part of BEWG?	The reference to Norfolk District has been deleted.
(MDNR)	S-3.5	Chapter 2, General Comment. It is not clear if the capacities listed in Table 2-36 are the "consolidated in-place volumes" or "site volumes". If capacities are site volumes, then site capacity (cut volume) is 70 mcy, and the shortfall over 20 years is 30.7 mcy [106.4-5.7-(49/0.70)], rather than 57mcy [106-49]. This needs clarification in Section 2.15 Dredging Needs, Pages 2-127, and Line 23 through 2-128, Line 4. Various sections refer to Site 104 as being the affected environment (for example, Pages 2-66, Line 25, and 2-73, Lines 20, 24 & 25). Is this recycled material from the Site 104 EIS or should it be Deep Trough, the stated Federal standard in section 3.5.3 and several Tables in Section 3?	The capacities are consolidated in-place volumes. A footnote has been added to Table 2-36 and Section 2.15 has been revised for clarification. The intent of the information presented from the Site 104 EIS is to characterize the affected environment in the Upper Chesapeake Bay. Information from other site specific reports and studies is also presented in these sections. This material is not intended to characterize the Deep Trough discussed in the referenced section (3.5.3).
(MDNR)	S-3.6	Page 2-16, Line 3. Section 2.2.1.4 Hydrostratigraphy describes the aquifers in the Lower Bay (Virginia). The information is based on the work of Meng and Harsh (1988), Hydrogeologic Framework of the Virginia Coastal Plain. Although some of the aquifers listed are relevant to the Maryland coastal plain, the important aquifers affecting the Middle and Upper Bay are not addressed, for example the Aquia, Magothy, Monmouth and Potomac aquifers. These aquifers are	Section 2.2.1.4 has been revised as appropriate.

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		older than the Miocene but would be most affected by five of the six alternatives.	
(MDNR)	S-3.7	Page 2-102, Lines 24-25. The "Fish, Wildlife and Heritage Administration" has not existed within the Department of Natural Resources for some time. The coordination described in this section was with the Department's Wildlife and Heritage Service.	Lines 24-25 were corrected as indicated.
(MDNR)	S-3.8	Page 2-107, Lines 19-22. The statement that the diamondback terrapin is currently under review by the Department for possible inclusion on the "RTE Animals of Maryland List" is incorrect and the portion of the sentence after the comment in Line 21 should be removed and the comma replaced with a period.	Reference to diamondback terrapin has been removed.
(MDNR)	S-3.9	Page 2-127, Lines 23-24. Redo the math for the total shortfall based on a 20-year need, and specify remaining capacity at existing sites as either consolidated in-place volume or site volume.	Text has been revised to reflect a 21-year period. The remaining capacity has been clarified as consolidated in-place volume.
(MDNR)	S-3.10	Chapter 3, General Comment. Understanding capacities in this section is confusing. It would be helpful to define the various capacity, cut volume, site volume, in-place volume, consolidated in-place volume). A glossary would be helpful. The sentence, "The site capacity (cut volume) is equal to the in-place volume divided by a consolidation factor of 0.7m, or XX mcy" is stated numerous times. In this context the "or XX mcy" value can be confused for an alternative conversion factor. This sentence needs to be reworded to avoid confusion with the consolidation factor, or, the value can be given in a following sentence. There should be an additional summary table showing how the volumes and conversion factors add up to the total site capacity referenced in each section (total capacity) is given in Table 3-6 but does not alleviate the confusion of the total was calculated).	Section 3 has been revised as appropriate.
(MDNR)	S-3.11	Page 3-2, Line 11. Table 1-6 referenced here and for the other alternatives is missing or should be Table 2-35. As noted before, the projects are for 21 years, not 20 years.	"Table 1-6" has been changed to "Table 2-35".
(MDNR)	S-3.12	Page 3-5. <u>Section 3.2 Dredged Material Placement Alternatives Considered</u> references various Site constraints on the placement of dredged material but fails to mention the need to comply with the State Critical Area law.	In general, the development of dredged material placement alternatives considered those legally implementable from a federal perspective. Consideration of the risks associated with implementing alternatives was a component of the screening process used to select the

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			recommended plan (Section 3.3.5, 3.4 and 3.5). This considered regulatory and policy constraints. In addition, the Section 4 introduction identifies federal statutes and executive orders and related regulations that might apply to the recommended plan. It is recognized that implementation of the selected alternatives and sites will need to comply with applicable state and local regulations and policies. The text has been revised to include a reference to Maryland's Critical Area law.
(MDNR)	S-3.13	Page 3-8, Line 29. Areas G-West and G-East along with Site 92 can accept more material. Senate Bill 830 allows for 7.4 mcy of "permitted" cut volume from 2001 to 2010. A total of 2.7 mcy was placed at Site 92 from 2001 to 2004. A "permitted" cut volume of 4.7 mcy remains for 2005 through 2010. At the project rate of 1.45 mcy/yr, the site would close in 2007.	Section 3.2.1.1.3 has been revised to reflect the current capacity of Site 92.
(MDNR)	S-3.14	Page 3-11, Line 26. In this line and other places, the phrase, "…does not exclude…" is the same as "…and includes…" which is used on Page 3-30, Line 10. Change to "includes" for consistency.	Text has been revised.
(MDNR)	S-3.15	Page 3-51, Line 21. Capacity Evaluations: Cite source(s) for consolidation factors used.	The consolidation factors have been derived based on experience of dredged material placement at Poplar Island and other existing sites. The text has been revised.
(MDNR)	S-3.16	Page 3-52, Line 7. Site capacity at open water placement sites does not equal site volume. Placed sediments are affected by consolidation and erosion; thus a consolidation/erosion factor should be applied to the Upper Bay capping (3.2.2.3) and Pooles Island open water site expansion alternatives (3.2.2.7) when calculating capacity. Through six years of placement at Site 92, this factor would be 0.67.	Line 7 has been revised as appropriate.
(MDNR)	S-3.17	Table 3-3. Maryland Geological Survey (not Geologic).	Correction made.
(MDNR)	S-3.18	Figure 3-5. Uppermost placement site is Area H (not Area D).	Figure 3-5 has been corrected.
(MDNR)	S-3.19	Chapter 8, General Comment. The distribution list should be updated to reflect current personnel and agency names.	Comment noted. The distribution list will be updated.
State of Maryland	S-4.1	The Plan and EIS makes no mention of Critical Area.	The DMMP/TEIS is a

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Critical Area Commission Chesapeake and Atlantic Coastal Bays/Dawnn McCleary		COMAR 27.02.05.04B(3) states that "Evidence that the factors listed in COMAR 27.02.05.04B(2), have been considered in planning for new or expanded water-dependent facilities shall be included in the agency's project description and statement of findings as provided in Regulations 27.02.05.02 of this chapter.	programmatic assessment which lays the groundwork for the future selection of specific disposal sites and actions identified under the recommended plan. Compliance with federal, state and other applicable regulations and policies will be addressed in detail in the feasibility studies and tiered EISs and EAs prepared for these future actions. The text has been revised to include a reference to Maryland's Critical Area law.
State of Maryland Critical Area Commission Chesapeake and Atlantic Coastal Bays/Dawnn McCleary	S-4.2	After attending the January 26, 2005 Joint Evaluation Meeting with your agency, it was brought to our attention that the MPA is proposing to construct a dredge material containment facility (DMCF) at Masonville in City of Baltimore and create a restoration/environmental enhancement of Masonville Cove which would impact the Critical Area. Such a proposal by MPA will need formal approval from the Critical Area Commission.	The DMMP/TEIS did not identify a specific DMCF in Baltimore Harbor. However, it is acknowledged that the State of Maryland Critical Area Act requirements for siting a DMCF within the Harbor must be addressed in the follow-on site specific studies and EISs.
Virginia Department of Environmental Quality/Ellie L. Irons	S-5.1	*Solid and Hazardous Waste Management*: The Draft Plan/EIS did not address either solid or hazardous waste issues or sites in Virginia.	Information regarding VA sites is included in Section 2.4 and Section 4.4. Information in these sections has been verified and updated as appropriate.
Virginia Department of Environmental Quality/Ellie L. Irons	S-5.2	*Water Quality and Wetlands*: Depending on the amount of material to be dredged and the type of disposal method, a Virginia Water Protection Permit may be required for dredged material disposal. There is little or no discussion of sediment testing. The Draft Plan/EIS does not discuss avoidance and minimization of impacts regarding the disposal areas, according to DEQ's Division of Water Quality. Neither is there mention of potential new upland disposal sites. DEQ recommends exhausting all Maryland alternatives for disposal of material from areas dredged in Maryland before considering disposal of that material in Virginia.	Comment noted. The recommended plan identifies open water placement sites in the Virginia portion of the Chesapeake Bay only for material dredged from the Virginia channels and does not include placing material dredged from Maryland waters at Virginia sites in the Chesapeake Bay.
Virginia Department of Environmental Quality/Ellie L. Irons	S-5.3	*Wildlife Resources:* DGIF supports the measures described in the EIS to minimize adverse impacts upon wildlife species of the dredging to be accomplished under the management plan. This includes following time-of-year restrictions from dredging activities to avoid sea turtle impacts.	CENAB acknowledges the agency support of the measures described in the EIS to minimize impacts upon wildlife species and has imposed environmental "dredging windows" in its contracts.

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Virginia Department of Environmental Quality/Ellie L. Irons	S-5.4	*Marine Resources:* With regard to the placement of dredged material from the York River Entrance Channel at the Wolf Trap Alternate Placement Area, the Virginia Institute of Marine Science has studied the impact of such placement on the blue crab spawning stock in the vicinity of the Wolf Trap site. The Institute recommends that an alternative dredged material placement site should be identified in the future to avoid impacts to blue crab spawning grounds. The Institute also recommends that dredging and dredged material placement in Wolf Trap site take place during the five months from January 1 through May 31, and states that these activities are not advisable between June 1 and December 31. Both the Rappahannock Shoal Deep and the Wolf Trap disposal sites are important areas for commercially important fishery resources, any planning efforts must consider these resources.	Comment noted. CENAB is committed to dredged material placement in an environmentally sensitive manner. It understands the need to assess the impacts of dredged material placement at existing sites through both the permitting and monitoring process. The Corps will continue to comply with the time-of-year restrictions regarding the placement of dredged material.
Virginia Department of Environmental Quality/Ellie L. Irons	S-5.5	*Prior Agreements on Disposal Sites:* The Marine Resources Commission indicates that in a 1981 agreement between the Virginia Secretary of Commerce and Resources and the Maryland Secretary of Transportation, the Commonwealth of Virginia conditionally designated the Rappahannock Shoal Deep and the Wolf Trap disposal sites for the placement of dredged material "for that part of Baltimore's 50-foot Channel Project located in Virginia waters". These conditions specifically require that the material to be disposed of in these sites, or any subsequently designated alternate sites, originate from the portion of the Baltimore Channel in Virginia waters.	See response to Comment S-5.2. Table 3-9 and Section 3.2.2.9 have been revised.
Virginia Department of Environmental Quality/Ellie L. Irons	S-5.6	*Local and Regional Comments:* The Hampton Roads Planning District Commission indicates that the proposed dredging management plan is consistent with local and regional plans and policies. The Accomack-Northampton Planning District Commission indicates that the proposed activities do not conflict with regional plans. Accomack County has no comment.	CENAB acknowledges the comments received from local and regional agencies in Virginia indicating that the proposed actions in Virginia are consistent with local and regional plans.
Virginia Department of Environmental Quality/Ellie L. Irons	S-5.7	*Solid and Hazardous Waste Management:* Any sediment that is suspected of contamination, or hazardous or solid wastes that are generated, transported, disposed, stored, or treated in Virginia, must be tested and handled in accordance with applicable federal, state, and local laws and regulations.	The recommended information is relevant and has been added to the final report in Sections 2.4 and 4.4.

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Virginia Department of Environmental Quality/Allen Brockman	S-6.1	Neither solid waste nor hazardous waste issues nor sites in Virginia were addressed in the report, nor did the report include a search of Virginia's waste-related data bases.	Refer to Response to Comment S-5.1. Information at the time of the draft indicated that mapping/listing of state lead sites was not available; however, this search has been rechecked for the final report and information updated as appropriate.
Virginia Department of Environmental Quality/Allen Brockman	S-6.2	DEQ encourages all construction projects and facilities to implement pollution prevention principles, including the reduction, reuse, and recycling of all solid wastes generated. All generation of hazardous wastes should be minimized and handled appropriately.	Comment noted. The recommended plan does not include any new construction in Virginia.
Virginia Department of Environmental Quality/Catherine Harold	S-7.1	A Virginia Water Protection permit application may be required dependent upon which type of disposal method is determined and the amount to material to be dredged.	Comment noted.
Virginia Department of Environmental Quality/Catherine Harold	S-7.2	There is little to no discussion of sediment testing, possible pollutants, or their concentrations found in sediment and potential effects the dredging operation will have on pollutant resuspension. There is mention of a sediment information (Section 2, page 18), but no data is provided for document support.	CBP toxics database information on sediment contamination was noted in Section 2.4, page 2-48. Discussion of possible effects of dredging on bay water quality were noted in Section 4.3. This information has been reviewed and updated as appropriate.
Virginia Department of Environmental Quality/Catherine Harold	S-7.3	The report does not discuss avoidance and minimization regarding the disposal areas. There is no mention of potentially new upland disposal sites.	New upland sites were not evaluated since the existing designated open-water sites in Virginia have sufficient capacity for the planning period.
Virginia Department of Environmental Quality/Catherine Harold	S-7.4	We recommend strict adherence to erosion and sediment control practices, and further encourage the project proponent to monitor construction activities to make certain that erosion and stormwater management practices are adequately preventing sediment and pollutant migration into surface waters, including wetlands.	Comment noted. The Corps employs best management practices for erosion and sedimentation control during construction.
Virginia Department of Environmental Quality/Harold J. Winer	S-8.1	The permissibility of and restrictions concerning overboard disposal of dredged material at these sites is addressed in Virginia Water Protection permits issues under Virginia Law and regulations.	Comment noted.
Virginia Department of Game and Island Fisheries/Andrew K. Zadnik	S-9.1	We support the measures described to minimize adverse impacts upon wildlife resources under our jurisdiction due to this project. We recommend that the design of any restored/created islands or wetlands take into consideration the needs of wildlife. This should include designing the dykes to facilitate movements by semi-aquatic species, such as turtles.	Comment Noted. The feasibility study and design phase will take into consideration the needs of the appropriate wildlife species.

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Commonwealth of Virginia, Marine Resources Commission/Tony Watkinson	S-10.1	A 1981 agreement between the Virginia Secretary of Commerce and Resources and the Maryland Secretary of Transportation, the Commonwealth of Virginia conditionally designated the Rappahannock Shoal Deep and the Wolf Trap disposal sites for the placement of dredged material "for that part of Baltimore's 50-foot Channel Project located in Virginia waters". These conditions require that the material be disposed in these, or any subsequently designated alternate sites, originate from within that portion of the Baltimore Channel in Virginia water.	See response to Comment S-5.5
Commonwealth of Virginia, Marine Resources Commission/Tony Watkinson	S-10.2	Both the RSD and WT sites have been shown to be important areas for commercially important fishery resources, particularly hard clams in the RSD area and blue crabs in the WT area. These resources must be considered in any planning efforts.	The Corps is committed to dredged material placement in an environmentally sensitive manner. It understands the need to assess the impacts of dredged material placement at existing open water disposal sites in Virginia through the permitting (and required monitoring) process.
State of Maryland Dredged Material Management Program Citizens' Advisory Committee/Francis Taylor	S-11.1	We encourage the Corps to work closely with MPA and to continue to integrate the State DMMP, which is currently being developed, with their own in order to prevent duplication in effort. It appears that this proposal meets the need for placement capacity well beyond the required 20 years.	Comment noted.
State of Maryland Dredged Material Management Program Citizens' Advisory Committee/Francis Taylor	S-11.2	The Corps' addressed the multitude of environmental concerns inherent to dredging. They used a modified environmental screening tool developed by the Bay Enhancement Work Group. This resulted in a thorough analysis of a large number of options and a set of recommendations that maximize both capacity and environmental benefits.	Comment noted.
State of Maryland Dredged Material Management Program Citizens' Advisory Committee/Francis Taylor	S-11.3	We are pleased that the "tiered" approach of the Corps plan meshes well with the more specific recommendation of the Harbor Team. We hope to see those recommendations implemented in a timely manner as the process moves forward.	Comment noted.
State of Maryland Dredged Material Management Program Citizens' Advisory Committee/Francis Taylor	S-11.4	We urge to Corps to strengthen the emphasis on innovative reuse of dredged material in this DMMP. Implementation of innovative reuse would be delayed because cost effective strategies are not immediately apparent. As a result of specific goals set by the Harbor Team in their 2003 report to the Management Committee, the CAC believes that greater emphasis must be placed on innovative reuse. It must be one of	CENAB recommends the continued technical development of innovative uses be pursued in partnership with the State of Maryland. Text has been added to the Recommendations section of the DMMP.

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		the recommended strategies in the final plan. Measured resources must be devoted to following up on the recommendation that emerged from Innovative Reuse Forum sponsored by the MPA in December 2004	
Maryland Department of Planning/Linda C. Janey	S-12.1	The Maryland Department of Natural Resources (MDNR) stated that the Tiered EIS should more specifically express the need for additional dredged material placement capacity in Chapter 1. Important aquifers that affect the Middle and Upper Chesapeake Bay are not addressed in Chapter 2. Also, an additional summary table, in Chapter 3, would clarify how the volumes and conversion factors add up to the total site capacity.	See response to Comment S-3.2 and Comment S-3.5. Text has been added regarding aquifers.
Maryland Department of Planning/Linda C. Janey	S-12.2	The City of Baltimore sought to convene a meeting with the Applicant to discuss the timeline for the Plan, the siting off proposed new containment facilities on the Patapsco River, and the possible alternatives to the latter method of relocating dredged material.	The request should be directed to the Maryland Port Administration which is conducting the feasibility study for a new CDF.
Maryland Department of Planning-State Clearing House Review/Linda C. Janey	S-13.1	See Comments S-14.1 through S-15.2 and L-1.1	See response to Comments S-14.1 through S-15.2 and L-1.1
Maryland Environmental Service/Cecelia Donovan	S-14.1	See Comments S-2.1 through S-2.25	See response to Comments S-2.1 through S-2.25.
Maryland Department of Housing and Community Development (DHCD)/Susan B.M. Langley, Ph. D.	S-15.1	Appendix E. There is a need for additional archeological surveys if existing facilities are expanded (i.e. Hart Miller Island and Pooles Island open water site), creation of new islands (West of Tolchester Channel), restoration (Parson's Island and Mid-Bay Shoreline), use of open water dumping of spoils (the Deep Trough), or upland deposal sites (Cecil County). Our experience has shown that the potential for cultural resources in any of these options range from the region's earliest, Paleo-Indian sites, to historically significant shipwrecks. We request that the Corps maintain consultation with Maryland Historical Trust (MHT) staff, including myself. Please forward all detailed plans as they become available to me as well as MHT's Office of Preservation Services staff.	Comment noted. Once specific sites and the project details are known, follow-on Feasibility Studies will initiate and conduct the appropriate consultation and documentation required by Section 106 of the NHPA.
Maryland Department of Housing and Community Development (DHCD)/Susan B.M. Langley, Ph. D.	S-15.2	Further consultation with our office, by the Corps and consultants will be necessary to fulfill compliance with Section 106 of the National Historic Preservation Act of 1966, as amended. All surveys need to be performed in accordance with the "Standards and Guidelines for Archeological Investigations in Maryland" (Shaffer and Cole 1994), Archeology and Historic Preservation:	Comment noted. See response to Comment S-15.1.

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		secretary of the Interior's Standards and Guidelines (1983) and direct consultation with Maryland Historical Trust underwater archeologists.	
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.1	MDE suggests consideration and exploration of innovative and alternative use technologies as a formal DMMP recommendation. In order to have alternative/innovative use as a viable dredged material management option, Maryland must continue to support and encourage its technological development.	The Corps, in partnership with the State of Maryland, will continue to pursue the evaluation of innovative use technologies and alternatives. At such time when these alternatives can be refined for full-scale, economical use, they will be considered for inclusion in the recommended plan.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.2	MDE encourages the Corps of Engineers to consider the idea of a dredged material re-handling/pre-processing facility that will further support alternative/innovative use concepts. Current dredged material containment facility design and operating procedures do not allow for effective segregation of dredged material. A facility designed with multiple cells to encourage dewatering, separation, and stockpiling of dredged material could supply a steady source of sediment for innovative use projects (i.e., brick or building products manufacturing, mine reclamation, wetland creation, shore stabilization, etc.). Such a facility would also promote overland transport of dewatered dredged materials to suitable sites. This facility would also function as a throughput, never filling up, creating unlimited capacity and minimizing the need for future containment facilities throughout Chesapeake Bay.	Comment noted. Follow-on feasibility studies for the construction of new containment facilities will evaluate a number of different options, including a rehandling/pre-processing location of dredged material for subsequent innovative use projects.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.3	MDE recommends that the design of each dredged material containment facility, particularly those receiving contaminated material (i.e., the Patapsco River CDFs), include a contingency plan to effectively manage or treat effluent discharge. Special treatment cells or a cascading design whereby effluent is moved from one cell to the next as different phases of treatment proceed prior is one such design. Due to the extremely large volumes of water associated with these facilities, it is very difficult to manage the discharge after a water quality concern has been identified. MDE feels each facility should have the infrastructure in place to treat effluent in stages as it moves towards final discharge.	Comment noted. Follow-on feasibility studies for the construction of new containment facilities will evaluate various methods to manage and treat effluent discharge.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.4	Any solid waste including construction, demolition and land clearing debris, generated from the subject project, must be properly disposed of at a permitted solid waste acceptance facility, or recycled if possible. Contact the Solid Waste Program at (410) 537-3318 for additional information.	Comment noted.

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Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.5	Page ES-12, Table ES-2. The PIERP alternative should consider lateral and vertical expansion as independent projects and analyze the costs, capacities, habitat benefits, technical/logistical risk, and acceptability risks independently.	Comment noted. The expansion of the PIERP is currently being evaluated in the GRR/SEIS as a project that includes both lateral and vertical expansion.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.6	Page ES-15, Line 23. Recommend rewording sentence. Rather than "outweigh", MDE suggests you use the term "mitigate".	The use of "outweigh" is appropriate in this context of a programmatic study. Once alternatives are more clearly defined in follow-on site specific studies, it will then be determined if and to what level mitigation is required.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.7	This sentence is incorrect, the GRR does not analyze dike raising independently, only in conjunction with a lateral expansion.	Lines 17-19 on Page ES-23 have been revised as appropriate. The GRR initially evaluated raising the dikes independently but was modified to include a lateral expansion.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.8	1. Tables. Tables 1-2 through 1-4 should have a totals column tallying the total cubic yardage of all channels.	Quantity totals have been added to Tables 1-2 through 1-5
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.9	Page 2-4, Section 2.1.1.5. The presence of the turbidity maximum zone in the Upper Bay should be mentioned in this discussion of tides and currents.	A paragraph has been added discussing the turbidity maximum zone.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.10	Page 2-23 through 2-27. This discussion of the percent contribution of sediment among the various states and regions of the Bay is extremely confusing. It's difficult to make the percentages add up. Perhaps a table summarizing the percent contribution information would be helpful.	Pages 2-23 have been revised as appropriate.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.11	Page 2-55, Section 2.6.1.1. May want to mention in this section that the index period for the Chesapeake Bay IBI is July 15th through September 30th.	A sentence has been added to the end of Section 2.6.1.1.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.12	Page 2-58. May want to specifically mention the influence of relatively pristine ocean water in the lower bay which helps mitigate water quality impacts to the lower Bay region.	A sentence has been added to Section 2.6.1.2.4.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.13	Pages 2-59 through 2-61, Section 2.6.1.3. For this section on benthic assessments, it would be helpful to mention the months in which the sampling was conducted.	Comment noted. The sampling was conducted at various times depending on the specific project study.
Maryland Department of the Environment	S-16.14	Page 2-60, Section 2.6.1.3.3. MDE conducted the baseline benthic monitoring for Site 92. No mention of	Comment noted.

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(MDE)/Joane D. Mueller		the results of these baseline studies are made in this section.	
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.15	Page 3-19, Line 26. There is a typo here. Says an 8-foot dike raising of a 30 acre facility will result in 190.4 mcy of capacity. This cannot be correct.	The "30-acre" refers to the dike area not the total area of the 2,500-acre facility. The reference to 30 acres has been deleted to avoid confusion.
Maryland Department of the Environment (MDE)/Joane D. Mueller	S-16.16	Page 3-20, Section 3.2.2.5.3. The Pearce Creek upland disposal facility has been associated with groundwater contamination. MDE would not allow any use of the site, unless perhaps if treated with lime or calcite simultaneous with dredged material inflow. This concept is currently being pilot tested at the Courthouse Point upland facility and results/analysis are pending.	Comment noted. Expansion of the Pearce Creek CDF was evaluated but dropped from further consideration due to public opposition and potential groundwater concerns.
Local Agencies and Officials			
Wicomico County Planning Department/Gary Pusey	L-1.1	The DMMP/TEIS is consistent with our plans, programs, and objectives	Comment noted.
Harford County Health Department/Susan Kelly	L-2.1	The DMMP/TEIS is generally consistent with our plans, programs, and objectives, but attached qualifying comment is submitted for consideration.	Comment noted.
Harford County Health Department/Susan Kelly	L-2.2	Agricultural Placement – MD Is Harford County agricultural land under consideration?	The agricultural placement alternatives are not components of the recommended plan. However, these alternatives were developed after selecting large areas of excessively drained soil near a navigable waterway. For Maryland, these areas are primarily in Dorchester and Wicomico Counties.
Harford County Health Department/Susan Kelly	L-2.3	Mine Placement – Cecil County, MD Depending on the location on Cecil County could impact Susquehanna and threaten drinking water intakes?	Comment noted. Using dredged material to reclaim abandoned mines or quarries are not components of the recommended plan. However, in the event that specific sites are considered in the future, site-specific feasibility studies and NEPA documents would evaluate any potential impacts to drinking water.
Harford County Health Department/Susan Kelly	L-2.4	Shoreline Restoration – MD Is Harford County shoreline under consideration?	Although the shoreline restoration alternatives are not components of the recommended plan, the entire Bay region was evaluated after

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			comparing the current GIS shoreline data with historical data from 1840. Since 1840, there has been a loss of shoreline throughout the Bay region. However, the most significant loss has occurred further south than Harford County (i.e., Talbot and Dorchester Counties). Shoreline restoration in these areas would provide significantly more capacity for dredged material. The DMMP will be reviewed every five years and all the alternatives will be evaluated for further consideration in the future.
Group and Association Comments			
Coastal Conservation Association Maryland/Donald W. Silliman	G-1.1	CCA MD supports the concept of embayment in the Poplar Island Expansion Project and other innovative ideas to mitigate lost essential fish habitat from implementation Maryland's Dredge Material Management Plan.	Comment noted. This concept is being addressed in the Poplar Island GRR/SEIS.
Coastal Conservation Association Maryland/Donald W. Silliman	G-1.2	CCA MD requests that the representatives of the various agencies and partners that have influence on the content of the draft EIS provide alternative options that include the NMFS proposed embayment.	The DMMP/TEIS has been prepared using a collaborative process with significant input from federal, state, and local agencies.
Chesapeake Bay Foundation/Jennifer Aiosa (Comment received during DMMP/TEIS) scoping process in June 2002)	G-2.1	CBF has worked with may State and Federal agencies, including the Corps, in good faith to help the Maryland Port Administration improve their process for evaluating and selecting dredged material disposal capacity. Slowly this process has gained support. After more than a year and a half of State-led effort, the Corps begins a separate, though similar, process confusing the general public and leaving many participants in the State's process to wonder how much of their work will have been in vain. CBF recognizes the Corps' responsibilities under Federal guidelines; we request the Baltimore District utilize the work that has gone into the ongoing State efforts. Also recognizing that time represents one of the greatest obstacles to meeting future disposal capacity, capitalizing on sound information developed and discussed among a myriad of State, Federal and private sources would save valuable time and resources and continue forward progress.	See response to Comment G-1.2. CENAB is an integral player in the State's program and has representatives on the State's Executive, Management, and ad hoc working committees. To avoid any duplication of effort, the Draft DMMP/TEIS has been prepared using a cooperative process with involvement of key government and non-government stakeholders, and has incorporated work performed under the State's DMMP.
Chesapeake Bay Foundation/Jennifer Aiosa (Comment received	G-2.2	CBF understands that subtleties associated with the Corps' ability to evaluate open water disposal and other State-barred disposal options as part of the federal DMMP process. However, publicly	The open-water placement alternatives have been evaluated using input from federal, state, and local agencies, and public citizens.

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during DMMP/TEIS) scoping process in June 2002)		perpetuating the idea that open water disposal could be used in Maryland for Port dredged material undermines extensive work on the part of many of your Federal, State and local partners. Unfortunately, discussing open water disposal, even in terms for developing a federal base plan and determining cost-share ratios gets lost in translation for many citizens and leads to confusion, or worse, mistrust.	Evaluating all reasonable alternatives and establishing the base plan is required by federal regulations.
Chesapeake Bay Foundation/Jennifer Aiosa (Comment received during DMMP/TEIS) scoping process in June 2002)	G-2.3	CBF firmly believes that the Corps of Engineers should capitalize on the current opportunity to more closely evaluate the actual dredging needed rather than relying solely on the Maryland Port Administration's assessment of dredging demand. Dredged material disposal capacity should be recognized as a finite resource and allocated accordingly. Dredging projects with questionable merit or economic justification should be postponed until reasonable dredged material capacity can be developed and brought online to accommodate maintenance dredging.	The dredging need has been evaluated independently by the Corps using historical data. A comprehensive analysis that justifies continued maintenance dredging is included in Appendix F.
Public Comments			
Rebecca Kolberg/Greater Pasadena Council, Maryland Port Administration's DMMP Citizens Advisory Committee	P-1.1	The recommended plan includes as one placement alternative, the "optimized use" of the Cox Creek Confined Disposal Facility (CDF). In the executive summary on page 20, it also states "other past, present and reasonably foreseeable projects or actions that could, when added to the recommended plan alternatives, result in cumulative impacts include: Vertical expansion of the Cox Creek CDF." It is unclear whether these statements refer to the current plans supported by the community to re-open the dredge site and raise the dikes to the maximum permitted height of 36 feet OR if they refer to the "Cox Creek Expansion" alternative outlined in section 3, pgs 21-22, which proposes an additional vertical expansion that "would further increase the crest elevation by 10 ft to 46 ft.	The statement refers to the current plans to raise the dikes to the maximum permitted height of +36 feet. The sections describing the recommended plan have been revised for clarification.
Rebecca Kolberg/Greater Pasadena Council, Maryland Port Administration's DMMP Citizens Advisory Committee	P-1.2	As a citizen and as the Greater Pasadena Council's representative on dredge management issues, I would like to go on record as saying that the USACE and the MPA should not assume the local community will support a vertical expansion of the Cox Creek CDF above the currently authorized 36 feet.	Raising the dikes (beyond the currently permitted elevation of +36') at the Cox Creek CDF was initially evaluated as an alternative but dropped from further consideration due to significant public opposition.
Jeff Thomas/National Wild Turkey Federation	P-2.1	In these days of shrinking wildlands I hope those involved in this dredging project will consider the importance of using the dredge material to create new wetlands as the Friends of Blackwater have proposed.	Comment noted. Restoration of wetlands in Dorchester county is an integral component of the DMMP recommended plan. However, the Corps will need to conduct a Feasibility Study before recommending a specific plan for

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			wetlands restoration.
George W. Adams	P-3.1	Option 29, Wetlands Restoration in the Blackwater National Wildlife Refuge, is a valuable use of the material and funds, and, based on your careful analysis; it is the best potential use of this valuable material.	See response to comment P-2.1.
George W. Adams	P-3.2	Within the structure of your analysis in Appendix B, I suggest that the BNWR wetlands restoration should be scored a +1 instead of zero in the category "Community Socioeconomics". BNWR and the surrounding marshes are vitally and increasingly important to the economics of Dorchester County. They are an increasing draw for tourism and for vacation homes, on which Dorchester County is dependent.	Members of the Bay Enhancement Working Group evaluated two socioeconomic parameters; commercial income & assets and community assets. Although restoration of wetlands in Dorchester County would provide some enhancement to local community assets, the BEWG concluded that, based on current information, restoring 1,000 acres (as presented in the DMMP/TEIS) would not warrant a score of '1'. A follow-on Feasibility Study/NEPA document for the restoration of wetlands in Dorchester would provide more specific details of the proposed project. This study would provide an additional opportunity for analysis and public comment on the potential socioeconomic impacts of the project.
Charles Carter/ Port Tobacco at Weanack	P-4.1	I see that the Agricultural placement/beneficial use in the Baltimore DMMP/TEIS was rejected as an alternative for disposal for Technical/Logistical Risk. I see that the logistics for agricultural placement are for 6" lifts over small areas one at a time. I am surprised anyone would consider such small increments.	The agricultural placement alternatives that were evaluated in the Baltimore Harbor & Channels DMMP/Tiered EIS have been developed using a different concept than reclaiming sand mining areas. The concept is to pump dredged material onto degraded farmland behind temporary containment, allow the material to dewater, and amend the existing soil by tilling the material into the topsoil to increase crop yield. Only two 6"-8" lifts would be done since the dredged material is used for amendment and not to restore significant topography that was lost due to disturbance. Using an extensive GIS database, locations of existing farmlands that have excessively drained soil in

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			Maryland and Virginia were identified. This resulted in identifying areas east of the Nanticoke River in Wicomico County, Maryland and in the Isle of Wight County, Virginia. Material from maintenance dredging of the upper Chesapeake Bay Approach channels (Maryland) and the Rappahannock Shoal & York Spit channels (Virginia) would be used for the Wicomico County and Isle of Wight County areas respectively. Conceptual cost estimates were prepared for the entire process that included upfront studies and permitting, access agreements, farmland lease/compensation, design, construction of temporary containment, maintenance dredging, material transportation, material placement and dewatering, lime amendment and tilling, and monitoring. Since the DMMP is a long-term, programmatic management study, and does not evaluate new alternatives at specific locations, a 50% contingency was then added to allow for the uncertainties in this kind of project. Your work along the James River is similar to the mine and quarry reclamation alternatives (see Volume II, Appendix C of the DMMP) that were evaluated in the DMMP. However, most of the potential areas that were evaluated in Maryland are located significantly inland which would induce high costs associated with material rehandling and transportation (truck or rail).
Charles Carter/ Port Tobacco at Weanack	P-4.2	My company, Port Tobacco at Weanack, uses dredge material to restore land along the James River that was mined for sand and gravel. We are taking 550,000 - 625,000 cubic yards from the Woodrow Wilson Bridge project to restore 40 acres to agricultural productivity and to pre-mining elevations.	See response to comment P-4.1

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Charles Carter/ Port Tobacco at Weanack	P-4.3	I am somewhat at a loss to understand the $43/cy (Virginia) and $50-51/cy (Maryland) alternatives for Agricultural Placement. I do not understand how my numbers are half of the Va and Md alternatives unless the lower volume, small placement increments and dredge planning have a doubling effect upon the costs?	See response to comment P-4.1
W.R. Carter, III	P-5.1	The option of disposing spoil material from within the Baltimore Harbor as a restoration technique for wetlands within the Blackwater National Wildlife Refuge in the DTEIS-DMMP appears to have overlooked the possibility of introducing sediment contaminants into the materials cycling pathways of Blackwater Refuge.	Sediments from Baltimore Harbor are not being considered for placement at the Blackwater National Wildlife Refuge. The text has been revised.
W.R. Carter, III	P-5.2	Although Sections 4.2.2.3 and 4.4.2.3 states that only spoils found acceptable under Section 404 of the CWA would be used at Blackwater, such a finding would require that reviewers rigorously examine the potential for the cycling of contaminants. Because of the paucity or absence of treatment for this issue in the DTEIS-DMMP, one cannot be assured that such rigor will occur, despite the efforts of an extensive list of technical preparers of this document and those of the Bay Enhancement Working Group.	See response to Comment P-5.1
Marcia Drenzyk, Former Chairman and member of the Cox Creek Advisory Committee	P-6.1	Section 3, Pages 21-22. The following is proposed in the Cox Creek Expansion alternative: proposing an additional vertical expansion that “would further increase the crest elevation by 10 ft to 46 ft”. This alternative would make the final dredged site the same height of the adjacent parking lot. In addition, there has been no presentation to the local communities or any permits to allow that height.	See response to Comment P-1.2
Marcia Drenzyk, Former Chairman and member of the Cox Creek Advisory Committee	P-6.2	I recommend you delete that reference to adding another 10 feet in height to the DMMP recommendation until you hold public hearings and meetings with the local communities and the Port obtains permits for such a large change to the plan for the site.	See response to comment P-1.2
Lisa Mayo Stephen & Cheryl Schwarz Carol Ryce Russell Gray Bo Rogers	P-7.1	I strongly support the use of clean dredged materials to restore wetlands in Dorchester County, specifically at Blackwater National Wildlife Refuge and Fishing Bay Wildlife Management Area. (Note: Substantially similar emails were sent by these individuals in support of restoring wetlands at Blackwater/Dorchester County).	Comment Noted. Restoration of wetlands in Dorchester County is an integral component of the DMMP recommended plan. However, the Corps will require funding to initiate a Feasibility Study.
James & JoAnn	P-8.1	We heartily support the use of clean dredged materials	See response to comment P-7.1

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Schlachter		to restore wetlands in Dorchester County.	
Trish Witkowski	P-9.1	I have heard that over 8,000 acres of marsh have been lost, which is very concerning. Please encourage your staff to move forward on this important restoration program (Blackwater National Wildlife Refuge).	See response to comment P-7.1
John M. Williams	P-10.1	The placement 'Demand–Capacity Shortfall' is erroneously overestimated (by more than 100%), and the economic analyses performed to justify continued, full-depth maintenance dredging are defective and inadequately documented. Some are inaccurate, some are questionable – to such an extent that the wrong conclusions appear to have been deduced.	See response to comments P-10.2 through P-10.32. The Demand-Capacity Shortfall has been revised from 57 mcy to 56 mcy. This is a result of not adding the 10% non-pay overdepth amount to the annual dredging quantities from the C & D canal Approach Channels (it was already included in the 1,200,000 cy/yr amount) and reducing the remaining capacity of Site 92 (Pooles Island) from 6.0 mcy to the current capacity of 4.7 mcy (as of December 2004). The economic analyses are correct and appropriate for the purposes of a DMMP. The Baltimore Harbor & Channels Projects are existing authorized projects, so the intent of these analyses is to demonstrate that continued maintenance is warranted to the already authorized depths, as opposed to determining the optimum depths for new work dredging. A BCR is not required for justification of continued maintenance. Appendix E of the USACE Planning Guidance Notebook, ER 1105-2-100 states that Management Plans must " demonstrate continued maintenance is economically warranted based on high priority (non-recreation) benefits". Although continued maintenance of the Baltimore Harbor & Channels Projects is warranted based on high priority benefits, the analysis required for a DMMP should not be confused with the NED Benefit Evaluation Procedures: Transportation, Deep-Draft Navigation in ER 1105-2-

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			100. These procedures are intended for construction or improvements of deep-draft navigation features. "Deep-draft navigation features include **construction of new harbors and channels** and **improvements** to existing or natural harbors on the seacoasts". The analysis of the Baltimore Harbor and Channels project presented in Appendix F demonstrates that continued maintenance of the project is warranted based on high priority transportation cost savings.
John M. Williams	P-10.2	The "Recommended Plan" of the DMMP Report cannot be rationalized. For Bay-origin material, rather than a suite of three placement options, it would be possible to maintain the entire existing navigation channel system for the next 20+ years (assuming it is all warranted) via only the expansion of Poplar Island. Further, if revised economic assessments conclude that full-depth maintenance dredging of both access channel systems is no longer warranted – the revised placement needs for 20 years can be satisfied via the remaining capacity at the Poplar Island disposal site (without any expansion).	The economic analysis in appendix F of the Draft DMMP/TEIS has concluded that continued maintenance dredging of the 50-foot Baltimore Harbor and Channels Project and the 35-foot C&D Canal approach channels project is warranted.
John M. Williams	P-10.3	Request that the DMMP process and schedule be modified to include a re-release of a revised Draft DMMP Report followed by an appropriate period for public review and comment before progressing to the preparation of the Final DMMP and Tiered EIS.	The DMMP/TEIS has been revised appropriately. The changes that were made were not significant enough to warrant a re-release of the Draft document.
John M. Williams	P-10.4	For matters as critically important to a 20-year, dredged material management plan as the magnitude of the dredging needs (cubic yards) and the economic justification of continued maintenance dredging of each separable channel segment (BCR>1), the discussion is grossly deficient.	See response to Comments P-10.1, P-10.2 through P-10.32. A BCR>1 is required under the NED Benefit Evaluation Procedures. Again, the NED analysis is for improvements to existing projects or the construction of new channels or harbors. If the DMMP recommended improvements to the existing project, which it does not, a NED Benefit Evaluation would be required. USACE Engineer Pamphlet, EP 1165-2-1, Chapter 12 describes the NED Benefit Evaluation procedure for navigation improvements. A BCR

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			is not required for justification of continued maintenance. USACE Engineer Regulation ER 1130-2-520 states that "Authorized navigation projects will be maintained to full constructed channel dimensions when feasible and justified".
John M. Williams	P-10.5	*Federal Standard - Base Plan:* Even if there were no State of Maryland legal restrictions on the three Maryland options, there is not sufficient capacity in two of the Maryland-based options for a 20-year DMMP. Consequently, this quartet of disposal options as stipulated in the Draft DMMP Report is an inadequate and inappropriate Base Plan.	The federal standard as described in Section 3.5 is appropriate for the planning period. Absent Maryland state law, Hart-Miller Island and the Pooles Island sites could be expanded.
John M. Williams	P-10.6	If the Maryland-legislated constraints were non-existent, the base plan ('federal standard) would be (1) open water placement near Pooles Island for material from the Lower Approach Channel until that site is full (about 6 mcy of capacity remains for future placement) and then open water placement in the Deep Trough for subsequent dredging from the Lower Approach Channel, (2) open water placement in the Deep Trough of material from the other Approach Channels in the Bay, (3) open water placement at Virginia sites of material dredged from Virginia waters, and (4) placement on Hart-Miller Island of material from Harbor channels with expansion of that site when capacity becomes limited. <u>This</u> is the base plan that should be used for the DMMP	The expansion of the Pooles Island site is a lower cost alternative than transporting the dredged material to the Deep Trough. In the event that an expanded Pooles Island site could no longer accept material before the end of the planning period, the base plan would become the Deep Trough.
John M. Williams	P-10.7	The Report text in Section 3.5.1 should be revised. Based on prior studies, and communication with J. Halka, Maryland Geological Survey, there is NOT sufficient residual placement capacity at the Pooles Island location for 20 years of maintenance dredging of the Lower approach Channel (about 19 mcy).]	Section 3.5.1 does not state there is sufficient capacity at the Pooles Island site only that absent state law, the site could be expanded to provide additional capacity. Areas G-East and G-West have additional capacity and other areas could be expanded.
John M. Williams	P-10.8	*Placement Needs:* (Table 2-35). Several corrections warranted. (1) use only data for <u>20</u> years, not 21. (2) Use <u>actual</u> historical data on maintenance dredging requirements for the Lower Approach Channel (C&D Canal channels system) rather than the unsubstantiated estimate of 1.2 mcy/yr (3) do not add an EXTRA 10 percent to account for "Storm Events" in each and every year into the future (Table 2-35) since <u>historical</u> dredging quantities already implicitly INCLUDES "storm events".	(1) USACE Planning Guidance Notebook 1105-2-100 states "All federally maintained navigation projects must demonstrate that there is sufficient dredged material disposal capacity for <u>a minimum</u> of 20 years." Table 2-35 projects the required dredging quantities by fiscal year. Consequently, the FY 2025 year needed to be considered so that a significant projected dredging quantity (8,201,270 cy) could be included in the planning

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			period. The text has been revised to clarify the duration of the planning period. (2) 1.2 mcy/yr is the projected annual amount that already includes substantial non-pay overdepth based on historical quantities that were actually placed. The 10% non-pay overdepth line has been deleted from the C&D Approach Channels in Table 2-35. (3) It is prudent to add a 10% contingency for storm events every year since it is impossible to predict the number of events, when they will occur, and their severity during the planning period. This does not implicitly assume that no storm events occurred in the prior decade, only that the potential exists for a <u>very significant</u> event or events to occur in the next 21 years (e.g., USGS data shows that Hurricane Agnes [June 21-27, 1972] delivered 16.5 times the normal inflow of water to the Bay).
John M. Williams	P-10.9	*Existing Placement Capacity:* Two corrections warranted. (1) use Bay-origin, maintenance dredging material as a capping material. (2) Revise residual placement capacity at Poplar Island (shows as 27 mcy (Table 2-36) to reflect recent communication with CENAB that as of the end of 2004 the residual capacity was at least 30 mcy (maybe even 31 mcy) because of improved consolidation of placed sediments.	(1) It cannot be assumed that 5.0 mcy of "clean" Bay material without amendment would be suitable for a cap of Hart-Miller Island. In most cases, the physical characteristics (i.e., gradation, organic content, and permeability) of the material from the Chesapeake Bay Approach Channels make it not suitable for direct use as a vegetative cover. Therefore, the actual capacity available for a cap using maintenance material would be less than 5.0 mcy. The State of Maryland is currently studying the required volume and material characteristics necessary to provide a suitable cap for the closure of Hart-Miller Island. When this information is available it will be incorporated in a follow-on review and update of the DMMP. (2) The placement needs analysis has been prepared using the current data at the time. During periodic reviews

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			of the DMMP, adjustments in existing capacities will be made as improvements in dewatering and material management show additional capacity.
John M. Williams	P-10.10	*Justification of Continued Maintenance – 50-Foot Project:* Review of Baltimore Maritime Exchange (BME) data for vessel movements at the Port of Baltimore in the year 2002 finds that approximately 20% of the vessels (bulkers) transporting either iron ore or coal to/from Baltimore had a loaded sailing draft of $\leq$ 40 feet. To include these as "benefiting" vessels for maintaining a 50-ft deep channel system overestimates anticipated benefits by approximately 10% (assuming the shallower draft bulkers have about half the capacity of the deeper draft bulkers).	The intent of the continuation of maintenance analysis in Appendix F for the 50-foot Baltimore Harbor and Channels project is to demonstrate that continued maintenance of the project is warranted. We used a 5-year average (1999-2003) of outbound lignite coal and inbound iron ore movements as a basis for the analysis of transportation cost savings per ton. These are the commodity movements that correspond to those used in the 1981 GDM. This approach does not include foreign inbound and Canadian outbound lignite coal or inbound coke coal movements during the period of analysis. These commodity movements comprise about 30-35 percent of all coal movements in the 5-year analysis period. It is likely that a significant portion of these movements occurred on vessels that would require the 50-foot channel project, but no transportation cost savings were claimed for these movements.
		The minimum underkeel clearance routinely utilized by deep-draft vessels transiting the main southern (50-ft) channels is 2.5 feet. This value is substantiated by pilots (3) and by review of BME data showing numerous transits with drafts at 47.5 ft – and none with drafts any greater. Using a minimum underkeel clearance of 2.5 feet instead of 5 feet as employed in the adapted computations (2) reduces the light-loading unit savings ($/ton) to just 55% of the erroneous '5-foot' values. (Key factor = (30+6) inches / (60+6) inches = 0.545)	The 1981 GDM used 5-foot underkeel clearances based on engineering guidance at the time. Underkeel clearances today would likely be estimated at about 2.5 feet. However the GDM uses the 5-foot underkeel clearances at both the 42-foot depth and the 50-foot depth. According to the GDM, a 37-foot draft vessel could transit the 42-foot channel and a 45-foot draft vessel could transit the 50-foot channel. This indicates that (45-37 = 8) there is a gain of 8 feet of additional draft. Assuming an

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			underkeel clearance of 2.5 feet, a 39.5-foot vessel could transit the 42-foot channel and a 47.5-foot draft vessel could transit the 50-foot channel. This indicates that (47.5-39.5 = 8) there is a gain of 8 feet of additional draft. Therefore there is a gain of 8 feet of water regardless of which underkeel clearance is assumed. To refine the analysis further, a detailed analysis of the current fleet would be required. This extra federal expenditure is not needed to demonstrate that continued maintenance is warranted.
		Additionally, benefits computed in the DMMP Report are based on the average quantity of pertinent commodities moved in the 5-year time span from 1997-2001. Using Waterborne Commerce Statistics Center data (4) to update the 5-year average to the period from 1999-2003 finds little change in import iron ore movements – but a continuing decline of export coal tonnage.	The average tonnage in Appendix F has been revised using 1999-2003 Waterborne Commerce Statistics Center data.
		Finally, these recalculated benefits are about 10% too high considering that about 20% of the loaded bulkers are not sailing with drafts > 40 ft. (Item 1 above) … hence the revised estimated benefits to coal and ore carriers are about $6,300,000 versus dredging costs cited in the Draft DMMP of $10,812,057 producing an apparent BCR of only 0.58! Based on these simple corrections and revisions to the economic analysis provided in the Draft DMMP Report, continued full-depth maintenance of the main channel (50 ft) to Baltimore does NOT appear to be economically warranted!	The analysis in Appendix F compares the transportation cost savings and the maintenance dredging cost using data from the most recently available 5-year period. Maintenance dredging costs include costs that would be incurred for maintenance of a 42-foot channel depth. These costs would be incurred with or without the 50-foot channel project. The cost to dredge the increment of material from a 42-foot depth to a 50-foot depth is significantly less than the total annual maintenance cost used in the analysis. On the other side of the equation, the transportation cost savings computed include only those attributable to vessels carrying coal and iron ore that typically require channel depths greater than 42 feet. As such, the transportation cost savings for the increment of maintenance dredging associated with the increment from 42 to 50 feet amounts to an annual amount of $12.2 million. The 5-year annual average maintenance dredging costs for maintenance of

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			both the 42-foot channel project and the 50-foot dredging project amount to $9.5 million. The fact that the transportation cost savings for only the increment from 42 feet to 50 feet is greater than the total project maintenance dredging cost indicates that continued maintenance of the 50-foot channel project is warranted.
John M. Williams	P-10.11	*Economic Analysis – 35-Foot C&D Canal Approach Channels; Sailing Drafts:* The values utilized in Table 9, Appendix F, for sailing drafts of vessels and barges transiting the C&D Canal and Channels are problematic and appear to be misreadings of the WCSC data. This problem leads to additional logic errors in subsequent considerations.	Table 9, Appendix F has been revised using 1999-2003 data. This trip data was derived directly from WCSC Trip by Draft data for the C & D Canal and approach channels.
John M. Williams	P-10.12	Economic Analysis – 35-Foot C&D Canal Approach Channels; Key Parameters: The economic analysis for the 35-ft channel system is predicated on an assertion about tug/barge operating costs ($/hr) and an assumption about tug/barge operating speeds in coastal service (kts). No Corps' approved tug/barge operating parameters or costs were cited. Computed benefits attributable to barge traffic are inversely proportional to the operating speed that is assumed for impacted tug/barges in open-water. The DMMP analysis <u>assumed</u> that value to be 8 kts. The only support provided for that speed value was that it had also been <u>assumed</u> in the Martin analysis (5). However, Tug/barges operating in coastal service are reported to have speeds of 8-10 kts when towing and 10-14 kts when pushing. (7) Consequently, a recalculation of benefits (travel cost savings) using an 'assumed' speed of 10 kts for tug/barges yields a value of $10,484,000 … a reduction of 14% from the DMMP	Hourly rates were based upon the John Martin report. John Martin of Martin and Associates is a nationally recognized expert. John Martin utilized interviews with the users of the channel. Martins report was reviewed by the Corps as well as peer reviews by Anirban Basu, MPP, MA, JD Chairman & CEO, Sage Policy Group, Inc. & Senior Lecturer in Economics, Towson University and Thomas M. Corsi, Ph.D., Michelle Smith Professor of Logistics, Associate Director, Supply Chain Management Center, Robert H. Smith School of Business, and University of Maryland College Park. Martin Associates interviewed every barge/tug operator that uses the C&D Canal and approach channels. Users were asked to identify their hourly operating cost for barges/tugs in their fleet. A cost of $750 per hour was identified consistently by barge and tug operators. This operating cost was confirmed by comparison with charter rates for barges and tugs operating on the C&D canal. The Corps of Engineers does not

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		value. Benefits computed in the DMMP Report are based on the average number of vessels and barges transiting the 35-ft waterway in the 5-year time span from 1998-2002. The number of deep draft vessels using the route has been in a long-term, continual decline (10% per year) and the number of transiting barges has also declined in recent years. Consequently, a more realistic estimate of current benefits can be deduced from using current traffic levels. Employing Waterborne Commerce Statistics Center data (4) to update the 5-year averages to 2003 traffic values results in the computed benefits of $12,152,500 to $9,754,000 … a 20% reduction!	currently publish a vessel operating cost for the type of barges and tugs used on the C&D canal and approach channels. Because direct user interview information is a valid and reliable source of technical information for application to navigation studies, a value of $750 per hour was used to compute trip costs in the analysis. Martin Associates interviewed every barge/tug operator that uses the C&D Canal and approach channels. Users were asked to identify an expected **average** barge/tug speed for their barges/tugs if they needed to operate on open water as opposed to operating on the on the C&D canal and approach channels. Users consistently responded that the expected **average** speed would be 8 knots per hour on open water. The use of an **average** speed of 8 knots per hour in the analysis takes into account the many uncertainties that affect barge/tug speed on open water. Based on the U.S. Water Resources Council's Principles and Guidelines (P&G), direct, anonymous user interview information is a valid and reliable source of technical information for application to navigation studies. A sensitivity analysis has been added at the end of the justification analysis to test the sensitivity of the tug/barge speed assumption and the tug/barge operating cost used for the justification of continued maintenance. The Corps will use a 5-year average to compute damages consistent with the use of averages throughout the report. Using only the most recent data for benefits but an 11-year average for costs is not consistent. Furthermore, a more current dredging cost

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			utilizing a 5-year average would reduce maintenance cost by almost 50%. Barge traffic had been increasing through the years 1998-2001 with only reduction in 2002 and 2003.
John M. Williams	P-10.13	*Port-related jobs:* The Report cites 115,400 as the number of "direct and Port-related jobs in Maryland". (Page 1-17) This value and statement are not correct. There are 15,740 direct jobs associated with activities at the Port of Baltimore. The total number of direct, induced, indirect and related jobs totals 112,400 in the states of Maryland, West Virginia, Ohio and Pennsylvania.	Page 1-17 has been revised to "32,956 jobs (direct, induced, and indirect)".
John M. Williams	P-10.14	The text and analysis should be upgraded to incorporate the existing channel depths for each branch channel and a tabulation should be prepared showing the number of annual user vessels having sailing drafts within 8 ft of the channel depth for each branch channel at one-foot sailing draft intervals. From such information, it can be discerned if all channel segments should be routinely maintained at full depths or at some lesser values	This analysis is not required for a DMMP. The justification of the total project evaluated branch channels using the number of vessels as indicators for justification. The Baltimore District evaluates channel usage and defers maintenance as appropriate based on the drafts of vessels using the channels.
John M. Williams	P-10.15	*"Baseline costs."* The Report states "The federal standard limits federal investment to a justified level of costs, serves as a basis for cost-sharing, and establishes baseline costs for economic analyses." (Page ES-8) Where in ER 1105-2-100, or other Corps' guidance, does it specify that the 'federal standard' (base plan) is the baseline for costs in economic analyses, i.e. that the BCR is to be based on the base plan? Please provide the text of the pertinent guidance.	The statement is correct. It is the Corps' policy to accomplish the disposal of dredged material associated with construction or maintenance dredging of navigation projects in the least costly manner, consistent with sound engineering practice, and meeting all federal environmental standards. (See Code of Federal Regulations, 33 CFR 335.4 & 335.7 and USACE Policy Guidance Letter, PGL 40). The Baltimore District evaluates channel usage and has deferred maintenance, or dredged to less than authorized depths, in channels when traffic doesn't require authorized depths.
John M. Williams	P-10.16	*Projected Dredging Quantities:* Table 2-35 indicates that "Non-Federal Maintenance" dredging in the Harbor will be 300,000 cy/year ('pay' basis). No historical data or discussion is provided to substantiate the value. What is the basis for this assumption? Please interpret the 300,000 cy/year value in comparison with the annual average value of 150,000	The annual non-federal quantity of 300,000 cy/year was provided and verified by the Maryland Port Administration and is considered to be a prudent planning estimate.

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		cy/year (pay) for "private sector" dredged material placed at Hart-Miller Island for the period from 1983-2002. (10) [The 150,000 cy (pay) was deduced from a value of 161,650 cy (scow).]	
John M. Williams	P-10.17	*New Work Dredging - Harbor:* In the overview tabulation of *Projected Dredging Quantities*, Table 2-35, the Draft Report includes partially identified Harbor dredging projects totaling 7.8 mcy (+ non-pay overdepth') for the years 2005-2008. What are these projects and what will they provide for the Port? Why are they not mentioned and discussed in the Report in *Section 2.15 Dredging Needs*?	The projects will provide deepening and/or enlarging of non-federal branch channels and berths. The text in Section 2.15 has been revised.
John M. Williams	P-10.18	*New Work Dredging - Harbor:* In the overview tabulation of *Projected Dredging Quantities*, Table 2-35, the Draft Report includes a line item for "Unidentified New Work" in the Harbor Channels section. This line item has a 'zero' value for the first 6 years … and is thereafter set at 10% of the total Harbor dredging (federal maintenance + non-federal maintenance + new work). What is the rationale and justification for this category? Why is the projected value 'zero' until 2010 and then an apparently arbitrary value of 10% thereafter?	These are not specific, identified projects, but a planning contingency for a reasonable projection of potential projects. The "Unidentified New Work" projects are projected based on past dredging operations by the Port and is an appropriate contingency for long-term planning purposes. The Harbor Team also concurred in the use of a new work contingency.
John M. Williams	P-10.19	*New Work' – Harbor:* The Report indicates the existence of an "Other State New Work" project slated for 2014-2015 that generates 4.45 mcy (pay) of dredging (Table 2-35). Accounting for the associated "unidentified new work" and "non-pay overdepth" raises the total projected placement need for this unidentified project to 5.4 mcy. This quantity is 1/3 of the projected 'shortfall' in placement capacity over the next 20 years for Harbor-origin dredgings. What is this unspecified project? Why is a 'new work' dredging project of this magnitude not described and discussed in the Report?	This non-federal project (2014-2015) was provided by the MPA. MPA is currently evaluating three alternatives (Masonville, Sparrows Point, BP Fairfield) for terminal development and the construction of new dredged material containment facilities/community enhancement projects within the Harbor. This project is planned in the event that the third alternative must be constructed.
John M. Williams	P-10.20	*Economic Analyses – Time Horizon:* In outlining the plans for performing the economic analysis, the *Project Management Plan* explicitly stated, "The analysis will factor in estimated usage of the channels through 2025." Why was estimated vessel and barge usage of the channels accessing the Port of Baltimore in years beyond 2002 or 2003 <u>not</u> included in the economic analyses? Since vessel and barge usage is generally declining,	See response to comment 10.12. Barge traffic had been increasing through the years 1998-2001 with only reduction in 2002 and 2003. This bears watching but does not

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		and maintenance costs are gradually increasing, please explain why these factors were not considered in the economic analyses	indicate a trend.
John M. Williams	P-10.21	*Economic Analysis – 50-ft Project:* The Report states "The total cost to maintain the channels associated with the 50-foot project is $10,812,000." (Appendix F, page 9). Does this cost value include maintenance dredging of the Virginia channels? Does this cost value include maintenance dredging of the non-Federal channels in the Harbor? Does this cost value include the non-Federal "cost-share" for maintenance of channels with depths >45 feet? What are the actual values for the non-Federal costs? What are the bases and origins of the "Nominal Cost" values presented in Table 5 (Appendix F)? Why use 2002 as the base year for the costs and benefits considerations when more recent data is available and the year 2003 was used for the assessment of maintaining the 35-foot project?	The total cost to maintain the 50-foot project includes dredging, E & D, and S & A costs that are the responsibility of the federal government and the State of Maryland for maintaining the federal channels. This cost includes maintenance dredging of the Virginia channels. This cost does not include maintenance dredging of the non-federal channels in the Harbor. This cost includes the non-federal "cost-share" for maintenance of channels >45 feet. The origins of the Nominal Cost are Corps of Engineers financial records (actual expenditure data). The analysis has been revised to include the most current benefit and cost data available.
John M. Williams	P-10.22	*Economic Analysis – 50-ft Project:* The Draft Report assumed a depth of 50 feet was needed to handle all of the export coal and import iron ore traffic. However, in 2003 only 51 vessels with sailing draft >44 ft used the waterway and only 77 vessels transited with sailing drafts >41 ft. (4) How can a Federal expenditure of $10.8 million be justified for only 50-75 vessel transits ($140,000 to $200,000 per transit)? Why did the analysis not assess the efficacy of maintaining the waterway to lesser depths?	The costs are justified based on commodity tons not the number of vessel transits. The benefits resulting from this expenditure concludes that maintenance is warranted. Assessing the effectiveness of maintaining the waterway to lesser depths is not required since continued maintenance to the 50 ft. depth is justified.
John M. Williams	P-10.23	*Economic Analysis – 35-Foot C&D Canal Approach Channels:* Assuming the calculations supporting Tables 6-8 are correct, the DMMP economic analysis concludes that, using the "Federal standard" for placement, the annual maintenance dredging costs total $8,479,000. A recent MPA-sponsored analysis of the dredging costs for the 35-ft channel system concluded the equivalent costs were $9,500,000. Please explain the difference	The MPA-sponsored analysis serves a different purpose and uses rounded values for both quantities and annual O&M costs. The estimated annual maintenance dredging volumes in this report were based on a 12-year history and Dredging, Transportation and Placement (DTP) costs were estimated on the production rates and time required to perform the work. The CENAB analysis uses

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			actual historical costs and dredging quantities over an 11-year period. Tables 6-8 have been revised to indicate a total annual maintenance quantity of 1,723,084 cy with a total maintenance cost of $8,350,443.
John M. Williams	P-10.24	*Economic Analysis – 35-Foot C&D Canal Approach Channels:* From the information provided in the Draft Report it is not possible to develop or confirm any of the cost numbers in Tables 6, 7 and 8 of Appendix F. How were these values computed? Please provide the bases and specifics for the calculations utilized. [e.g., explain how the various unit costs for dredging ($/cy) were deduced; explain why there are no apparent 'economies of scale' such that unit costs ($/cy) are lower when larger quantities are dredged – with particular attention to the costs and quantities cited in Tables 6 and 7; explain with appropriate detail how the dredging quantities and associated costs for depths less than 35 ft were ascertained ; explain how these USACE-deduced values of the quantities to be dredged compare with those previously estimated (6).] At a channel depth of 35 ft, the average annual dredging quantity of CENAP's channels totals 1,057,295 cy in Attachment 4 versus 1,123,382 cy in Table 7. Please explain this apparent inconsistency.	The values were computed using historical pay quantities for dredging and their associated costs. Tables 6, 7, and 8 have been revised using 1994-2004 data. The "economies of scale" are built into the costs, since these are actual costs from previous dredging contracts. The discussion on page 12 of the analysis is an accurate description of the methodology used to estimate the quantities needed to be dredged at lower depths.
John M. Williams	P-10.25	*Economic Analysis – 35-Foot C&D Canal Approach Channels:* The analysis was based on computed 'transportation cost savings' of vessels and barges that used the 35-ft deep C&D Canal access route to/from Baltimore and more northern ports instead of the longer route via the main channel and Cape Henry. The analysis valued the differential in sailing times as if the vessels and barges would be immediately unloaded upon berthing at their destination (i.e., used only "at sea" hourly costs). Why did the analysis not take into consideration the recognized factor that most vessels (and barges) sit idle at berth for many hours after arriving before unloading? Arriving vessels wait at berth prior to unloading because land-side labor has fixed shift start-times … and charges a significant overtime premium for any labor shift with a start-time other than 8:00 am. Frequently this means that some, or all, of the transit time ostensibly "saved" via use of a speedier route is actually not productively utilized (and hence has an associated diminished economic savings). Close study of the time spent in port by vessels reveals that, most of the time, vessels commence unloading operations at	Navigation schedules are designed for vessels and barges to arrive in advance of unloading time. Preparation activities take place before actual unloading commences. These unloading preparation activities are not expected to vary between the with continued maintenance dredging of the C&D Canal and approach channels condition and the without continued maintenance dredging of the C&D Canal and approach channels condition. Therefore, the measurable difference between the without maintenance dredging condition and the with maintenance dredging condition is the "at sea" operating cost. This cost was the focus of the analysis.

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		8:00 am … regardless of the time of day or night that they berthed or the access route utilized. The economic significance of this matter can be discerned when one compares the "at sea" and "in port" hourly operating costs for vessel or barges.	
John M. Williams	P-10.26	*Table 1-1:* For the Table providing information on the Maintenance Dredging Average Annual Quantity (cy) for the C&D Approach Channels, use historical data rather than the unsubstantiated estimate of 1,200,000 cy provided by CENAP. Specifically, use either data provided by CENAP (April 2004) to Gahagan & Bryant Associates for the period 1992-2003 that finds an average annual maintenance quantity of 0.85 mcy for the Lower Approach Channel (and 0.15 mcy for the Upper Approach Channel) or use data provided in the DMMP Report, Appendix F, Attachment 4 for 1993-2003 that finds an average annual maintenance quantity of 0.88 mcy for the Lower Approach Channel (and 0.16 mcy for the Upper Approach Channel).	See response to Comment P-10.8
John M. Williams	P-10.27	*Table 1-6:* No Table 1-6 exists in the Report, yet it is cited on pages 3-2, 3-3, 3-4, 3-5 and 3-7. Either the material for Table 1-6 should be incorporated in the Report or the text needs to be changed.	References to "Table 1-6" have been changed to "Table 2-35".
John M. Williams	P-10.28	*Page 2-11:* The Draft Report states "The Susquehanna discharges an annual average of 2.5 megatons of sediment." (line 22) However, Table 2-33 reports the annual sediment load to be 1.04 - 1.06 million tons per year (years 2000 and 2002) This is a <u>big</u> discrepancy and warrants clarification. *Page 2-19:* The Draft Report states "The Conowingo Reservoir is currently trapping about 50% to 70% of suspended sediment that would otherwise be discharged to the Bay. Approximately 42 million tons of sediment storage capacity remains (2003)" (line 28). Some interesting considerations follow from this information. *Page 2-20:* Relative to the filling of the pool behind the Conowingo Dam, the text states "there is not an estimated time period in which the reservoirs will fill …" (line 3). There are several USGS estimates which indicate that the sediment accumulation will reach a steady-state sometime in the 2018 - 2023 period. Since this is within the 20-year time horizon of the DMMP, these projections should be included in the Report and their implications for dredging discussed. (see foregoing item). *Page 2-21:* The Draft Report states "Currently, more than 5 million tons of sediment enter the Bay from land-based sources … ." (line 7) Is this quantity just	The sections have been revised as appropriate. This is not expected to affect prediction of dredged material quantities for the DMMP since those predictions are based on historical data from dredging and not on estimates of bay sediment inputs. However, dredging will likely increase after the pool reaches steady state.

Table 9-1
Response to Comments Summary
(Continued)

Name/Agency	Comment Code	Comment	Response
		from rivers and streams as indicated by Tables 2-33 and 2-34 … or is it the total sediment load? The value is inconsistent with the statement of Page 2-25 "erosion processes carry approximately 11 million cubic yards of sediment into the Bay." (line 13) The text needs clarification at these points.	
John M. Williams	P-10.29	*Port of Baltimore Commerce:* In section 2.13.1 the Draft Report cites Baltimore as "handling more than 30 million tons annually of all types of cargo from around the world." Suggest correcting that value since … for the year 2003 … Foreign commerce via Baltimore totaled 24,096,000 tons and Total commerce (Foreign + Domestic) totaled 40,183,000 tons.	The text has been revised.
John M. Williams	P-10.30	*Dredging Quantity – Virginia Channels:* The Draft Report text is inconsistent and erroneous in several locations relative to the requisite quantity of material to be dredged from the Virginia portion of the main channel system. The correct values (to be consistent with Table 2-35 and Figure 5-1) are 16.05 mcy for a 21-year period (2005-2025) and 13.36 mcy for a 20-year period (2005-2024). The text at pages ES-3, ES-4 and 3-61 (and probably elsewhere) needs to be revised accordingly.	The text has been revised.
John M. Williams	P-10.31	*Economic Analysis – 35-Foot C&D Canal Approach Channels:* The discussion on page 12 (Appendix F) indicates that some procedure was devised for ascertaining the requisite dredging quantities to maintain the channels at depths less than the full authorized depth (35 ft). However the procedure is not clear from the text and there is no way to assess its appropriateness or accuracy. Suggest revision of the text and incorporation into the Final Report the necessary figures (graphics) and example calculations to clarify this matter.	The discussion on page 12 is an accurate description of the methodology used to estimate the quantities needed to be dredged.
John M. Williams	P-10.32	*Swan Point Channel:* As part of the DMMP, consider allowing the Swan Point Channel to silt in to its natural depth of about 27 feet, as there is insufficient deep draft vessel and barge traffic through the channel to justify the maintenance expense. The economically significant commerce movements via barge from Norfolk/Hampton Roads to the Delaware River ports would still be able to transit the route if the depth were 27 feet. This variant would reduce annual dredging needs by about 100,000 cy … extending the life of the Poplar Island disposal site and save well over $500,000 annually.	Maintenance dredging of the Swan Point Channel is justified for safety reasons (See Appendix F, Attachment 2).
John M. Williams	P-10.33	*Acceptability Risk Evaluation:* Strongly suggest that the "Acceptability Rating" for the 'C&D Canal Upland	Although the Corps acknowledges your opinion that the

Table 9-1
Response to Comments Summary
(Continued)

Name/Agency	Comment Code	Comment	Response
		Sites Expansion' be revised from a '2' to a '3' because there is significant (not 'moderate') public opposition to any further use of the Pearce Creek disposal site AND because the Maryland Department of the Environment is on record as refusing to grant a Water Quality Certification for placement of dredged materials at the site. [Table 3-9]	"Acceptability Rating" should be revised from a '2' to a '3, changing this number will have no effect on the outcome of the recommended plan since this alternative has been dropped from further consideration. Therefore, reconvening the Management Group to possibly change the number is not warranted.
Barbara Medina	P-11.1	Supports the recommendations in the Draft DMMP/TEIS.	Comment noted.
William M. Giese, Jr. and Elizabeth M. Giese	P-12.1	Supports the Draft DMMP/TEIS, particularly using dredged material to restore marshlands at Blackwater NWR.	Comment noted. Restoration of wetlands in Dorchester County is an integral component of the DMMP/TEIS recommended plan. However, the Corps will require funding to initiate a Feasibility Study.
Debbie Dilley	P-13.1	Supports sending "clean" dredged material to Blackwater NWR for the restoration of wetlands.	See response to Comment P-12.1.
Peggy Tillier	P-14.1	Supports using "clean" dredged material to restore wetlands in Dorchester County.	See response to Comment P-12.1.
Oral Comments (Delivered at the March 7, 2005 public meeting)			
Steve Storms/Maryland Port Administration	O-1.1	The Maryland Port Administration supports fully the Corps' activities in developing their Dredge Material Management Plan, and we're very pleased with the progress that has been made, and especially pleased that our two respective DMMPs have been so well integrated through the use of shared resources.	Comment noted.
Bruce Coulson/Dorchester County Shore Erosion Group & Representing a Member of the CAC	O-2.1	We've been following this Corps' DMMP Plan. Since it started I have been on the CAC. We support it. People in Dorchester County support this plan, restoring mid-bay islands and wetland restoration.	Comment noted. Restoring a mid-bay island and wetlands restoration are integral components of the DDMP/TEIS recommended plan. However, the Corps must complete the Mid-Bay Island Feasibility Study and receive Congressional authority and funding before constructing the mid-bay island. The Corps will also require funding to initiate a Feasibility Study for the wetlands restoration alternative.
Joseph Coyne/Dorchester County Council & the Dorchester County Shore Erosion Group	O-3.1	I just want to say that we have received sound support from the citizens of Dorchester and we strongly urge the adoption of this plan for the use in Dorchester County.	Comment noted

Table 9-1
Response to Comments Summary
(Continued)

Name/Agency	Comment Code	Comment	Response
Oral Comments (Delivered at the March 10, 2005 public meeting)			
Harbor Development Office of the Maryland Port Administration/ Nathaniel Brown	O-4.1	We work with the Army Corps of Engineers on a number of our dredging projects. I simply want to state for the record the Maryland Port Administration supports the federal DMMP.	Comment noted.
Robert Fantom	O-5.1	Concerned about the continued use of the Pooles Island Open Water Placement site, Upper Bay turbidity and the loss of natural reef habitat.	USACE records indicate that prior to 1965 material dredged from the C&D Canal approach channels was placed within about 1500 feet of the channels. During deeping of the approach channels in 1965-1968, much of the material was placed within the areas of the currently designated sites around Pooles Island. All open-water placement of maintenance dredging material (C&D Canal approach channels) since 1977 has been placed within the designated areas around Pooles Island. An environmental assessment prepared in 1997 along with ongoing periodic monitoring of the active Pooles Island placement sites have determined that their continued use will not cause a significant adverse impact to the environment. The Pooles Island sites will close when Site 92 reaches its total capacity of 7.4 mcy or by December 31, 2010. The hydrology of the upper region of the Chesapeake Bay is very dynamic. There are lots of natural forces that contribute to sediment distribution and turbidity. Sediment from the Susquehanna River, runoff, and the mixing of salt and freshwater are significant factors that contribute to increased turbidity in this region.
Albert Marani	O-6.1	Are you not going to dump in the open water around Pooles Island anymore? Are you going to continue to dump until 2010?	Maryland state law allows that the Pooles Island Site 92 to be used until it reaches its capacity of 7.4 mcy or until December 31, 2010, whichever comes first.
John Williams	O-7.1	In reviewing the document and trying to establish numeric precision, I find some of the basic undergirding premises for the entire DMMP study are	

Table 9-1
Response to Comments Summary
(Continued)

Name/Agency	Comment Code	Comment	Response
		flawed. The placement demand capacity shortfall is erroneously overestimated. I would urge first with a projection of placement needs that you use actual historical data rather than estimates from the Philadelphia District for the 35 foot channel. Second, that you recognize historical data of a decade-plus duration which also already includes storm events, and you don't need an extra 10% for that. I also suggest you use 21 years in your analysis. The net result of that on the demand side for the Maryland channels would reduce the projected demand by 20% from 69 million cubic yards to 56.	See response to comment P-10.8 See response to comment P-10.8
John Williams	O-7.2	In terms of your available capacity, I think you need to include the 5 million cubic yards of capping capacity at Hart-Miller Island and take into consideration the remaining capacity of Poplar Island to reflect more current information. The net result of those two factors would increase capacity for the Maryland channels by 25% from 33 to 41 million cubic yards. The net effect of both of these factors reduces the shortfall that you have by 50% from 36 to 15 million cubic yards. The implications of that are that your recommended plan would not need three alternatives, expansion of Poplar, the construction of a large island, and some pumping in the Blackwater refuge. In fact, you could accommodate the existing shortfall with only a single alternative and save a great deal. I think the calculations need to be reviewed.	See response to Comment P-10.9
John Williams	O-7.3	The economic justification of continued maintenance is defective. Portions of that analysis are inaccurate and the whole conclusions may be wrong. I find that the cost values used do not represent reality, but are based on the hypothetical case of dumping into the bay because it is less expensive. I take issue with that, specifically with the analyses for the two major parts, the 50 foot channel system and the 35 foot channel system. Relative to the 50 foot channel system, the analysis adapted the 1981 economic justification. Unfortunately, there is a significant math error in the current analysis relative to the under keel clearance. It also does not use current commodity movements. When you combine those two factors, it reduces the apparent BCR from 1.41 to 0.65, and it does appear that continued maintenance of the main channel is not economically warranted. Surely there must be a better analysis to support that. With regards to the 35 foot channel system, the analysis is predicated on historical data, 1998 to 2002, and some assertions from Mr. Marder concerning the operating characteristics; however, if you use more current traffic for the canal	See response to Comments P-10.10 through 10.12, Comment P-10.14, Comments P-10.20 through 10.25. The analysis is correct and appropriate for justifying the continued maintenance.

Table 9-1
Response to Comments Summary
(Continued)

Name/Agency	Comment Code	Comment	Response
		for the year 2003, it reduces the apparent benefits by 22%, and if you use a more realistic nine knots instead of eight knots, it reduces the apparent benefits another 7-1/2 percent. The net effect of both of those would reduce the apparent BCR to essentially 1.0. The analysis needs closer attention so what I would recommend is that we're all interested in having this analysis be as accurate as possible using the best set of numbers so that proper decisions can be made. I would urge that the Corps go back and look closely at all of those factors.	
William Huppert	O-8.1	Communication about this meeting was lacking.	In addition to the Notice of Availability (included meeting notice) that was sent with the distribution of nearly 1,000 copies of the Draft DMMP and TEIS, an advertisement was placed in 10 different local and regional newspapers during the period 02/28/05 through 03/04/05.
William Huppert	O-8.2	I don't understand why you should be doing this open dumping until 2011. I think it's time to stop that completely.	See response to Comment O-6.1.
William Huppert	O-8.3	What toxins -- when you do all of this dredging, what is spread out there off Pooles Island?	The material that is placed at the Pooles Island site is dredged from the C&D Canal approach channels, not the Baltimore Harbor channels. Periodic sediment sampling and testing, along with an extensive monitoring program, have not determined that the placement of this dredged material will cause any significant adverse effects to the environment.
William Huppert	O-8.4	Over the past several years the shipping on the C & D Canal has been decreasing quite rapidly. Then I looked at the amount of the spoils that are going to be dredged from there, and "it's a tremendous 40 billion yards". When I saw that, and then we're talking about the economic benefits, and if the shipping is constantly decreasing on the C & D Canal, why aren't we factoring that in there? That concerns me very much. It doesn't seem an economically sound policy to me.	A comprehensive analysis for the justification of continued maintenance of the Baltimore Harbor and Channels projects has been prepared and is included as Appendix F of the DMMP. The analysis concluded that continued maintenance of the 50-foot Baltimore Harbor and Channels Project and the 35-foot C&D Canal approach channels project is warranted.

Attachment 9-1

Response to Comments from Dr. Williams
Received 23 March 2005

Base Plan/Federal Standard

I would like to clarify the terms “Base Plan” and “Federal Standard.” The term “Federal Standard” comes from the U.S. Army Corps of Engineers’ (USACE) Operations & Maintenance (O&M) regulations of 26 April 1998 (Code of Federal Regulations (CFR)) 33 CFR 209, 335, 336, 337, and 338. The Federal Standard is defined in 33 CFR 335.7 as “*Federal standard* means the dredged material disposal alternative or alternatives identified by the Corps which represent the least costly alternatives consistent with sound engineering practices and meeting the environmental standards established by the 404(b)(1) evaluation process or ocean dumping criteria.” The Federal Standard is a benchmark for determining the level of federal funding that will be allocated for the disposal of dredged material from an authorized federal channel. Where the project sponsor prefers a more costly disposal alternative, the Federal Standard determines the share of project costs contributed by the USACE. The DMMP defines the “Base Plan” for managing dredged material using the same criteria as the Federal Standard. The Base Plan and Federal Standard are virtually synonymous. Individual dredging activities or projects may have a single placement method determined as the “Federal Standard” or “Base Plan” or a navigation project(s) that requires dredging from several geographic areas over a 20-year time frame may have several “Federal Standards” or “Base Plans” that may include more than one placement method, each of which meets the “Federal Standard” criteria. Based on our numerous meetings with the Citizens Advisory Committee (CAC) and other public groups, we found that the term “Federal Standard” was more easily understood. The term “Base Plan” generated a negative impression among the public that it was a “Plan” that we intended to implement rather than the basis for cost-sharing. We chose to use Federal Standard for the sake of clarity and understanding among our public stakeholders. The term “Federal” also clarifies that it represents the Federal perspective and, therefore, does not imply that it is the State’s position and is not limited by State laws, such as those that ban open water placement in Maryland waters.

Benefit to Cost Ratio (BCR)

Two documents have guided our DMMP preparation and analysis: (Engineer Regulation) ER 1105-2-100, Planning Guidance Notebook, and Policy Guidance Letter (PGL) 47, Cost Sharing for Dredged Material Disposal Facilities and Dredged Material Disposal Facility Partnerships. Both documents clearly indicate that justification of continued maintenance is based on a review of appropriate indicators. ER 1105-2-100 provides examples of indicators such as annual O&M costs per ton of cargo, volume and frequency of traffic, and vessel dimensions. Also in ER 1105-2-100, the Federal interest in continued O&M of an existing project for its navigation purpose is defined by the project of maximum scale and extent, within project authorization, for which continued maintenance is warranted in terms of vessel traffic and related factors.

ER 1130-2-520, paragraph 8-2.a(2) states, “Dredging of any and all navigation projects shall be justified to reflect the current level of navigation activity at the project, to provide rationale for the channel dimensions to be dredged, the frequency of dredging, and, as a minimum, the justification shall be in accordance with current budgetary guidance.” An example of current budgetary guidance would be Engineer Circular (EC) 11-2-187, for Federal fiscal year 2006. In Annex V of this document the performance measure for operation and maintenance of navigation infrastructure is “percent of time navigation infrastructure with high levels of commercial traffic sustains its functional purpose.” There is no mention of calculating BCR related to the justification of maintenance of Federal navigation projects. ER 1105-2-100, when discussing scoping of management studies, states: “Technical studies and analysis should be scoped to the minimum level needed to establish project features and elements that will form an adequate basis for the plan implementation schedules and cost estimate.” The intent of the regulations and policies is to review the “indicators” of a healthy navigation system, as a minimum, and then to increase the level of analysis incrementally as necessary for decisionmakers to be satisfied that continued maintenance is warranted.

In contrast to economic justification of maintenance work, the performance measures for investment in navigation infrastructure improvements or construction are “BCR,” “remaining BCR,” and “annual net benefits.” The budget strategy outlined in EC 11-2-187 also clearly distinguishes between new construction and O&M. The ranking criteria for new construction projects includes BCR or remaining BCR, while O&M ranking is based on cumulative National Economic Development (NED) benefits and cumulative O&M costs. The traditional NED benefit cost analysis that you are trying to apply is clearly not intended to be used for evaluating the justification of continued maintenance. Given this, the DMMP shows ample benefits to justify continued maintenance of the channels serving the Port of Baltimore and the Chesapeake & Delaware (C&D) Canal.

In your letter, you cited EP 1165-2-1, Water Resources Policies and Authorities - Digest of Water Resources Policies and Authorities, Chapter 12, Navigation, 15 February 1996, as support for your assertion that “economic justification is determined by comparison of NED benefits and costs.” EP 1165-2-1, Chapter 12 was updated on 30 July 1999. The policy involved has not changed, however. Paragraph 12-1 clearly states that “The merits of Civil Works projects for ***improvement*** (emphasis added) of navigation are currently measured against a single Federal objective — national economic development — in accord with the Water Resources Council’s (WRC) Principles and Guidelines (P&G).” The WRC P&G in Section VII – NED Benefit Evaluation Procedures: Transportation (Deep-Draft Navigation) in introductory paragraph 2.7.1 states: “this subpart presents the procedure for measuring the beneficial contributions to the national economic development (NED) associated with the deep draft navigation features of water resources plans and projects. Deep-Draft navigation features include construction of new harbors and channels and improvements to existing or natural harbors on the sea coasts to meet the requirements of ocean-going and Great Lakes shipping.” Maintenance dredging is not considered “construction” or “improvements” and does not require a BCR or NED analysis.

NED Costs and Benefits

Associated Costs and Direct Costs

In your letter you state that direct and associated costs must be considered when evaluating navigation projects. You cite page 99 of the Principles and Guidelines as proof that these costs must be considered. As with the citation from the P&G in the above discussion of BCR, the Foreword to the P&G, Section 1, “Purpose of Scope,” states, “These principles are intended to ensure proper and consistent planning by Federal agencies in the formulation and evaluation of water and related land resources implementation studies.” This guidance is pertinent to construction of new projects or improvements to existing projects; not to O&M of existing projects. The DMMP economic analysis is being prepared for existing navigation projects. The Corps is not recommending new or improved navigational features; therefore, these costs are not appropriate to consider in this analysis.

Although the inclusion of associated costs is not appropriate for this analysis, your contention that the cost of Poplar Island should be included in the justification of maintenance of the navigation project is an excellent example of the purpose of the Federal standard. EP 1165-2-1, paragraph 19-23, in reference to Section 204, states, “Where the ecosystem restoration project is not part of the base plan for the navigation purpose, the base plan serves as a reference point for measuring the incremental costs of the ecosystem restoration project that are attributable to the environmental purpose… PGL 40 further elaborates on this point, “Beneficial uses which are not part of the Base Plan for the navigation purpose will be considered separable elements of the management plan and will be pursued under relevant authorities and separate funding sources. It further states, “Incremental costs for planning, design and implementation for environmental restoration and protection are not navigation operation and maintenance costs.”

Clearly, the intent of this policy is that the costs and benefits of the navigation project and the independently justified ecosystem restoration beneficial use of dredged material projects are to be considered separately. The beneficial use project costs are not to be considered as associated costs of the navigation project. The habitat created or restored through the beneficial use of dredged material is not necessary to realize the benefits of navigation.

As for the other specific associated costs that you mention, maintenance of non-Federal channels and berthing areas, I refer you to Table 2-35 and Appendix A Table 1 of the draft report, both of which clearly show dredging of 300,000 cubic yards per year from non-Federal sources as components of the total dredging need. Section 3.4.1.1 of the report refers to a need for harbor material of 33 mcy, including 6.3 mcy non-federal, over the 21-year planning period. The costs to the non-Federal entities are associated costs and, as discussed above, were not considered in the DMMP analyses.

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