

**Delaware Estuary
Regional Sediment Management Plan
FINAL**

Prepared By:
Delaware Estuary
Regional Sediment Management Plan
Workgroup

August 8, 2013



DELAWARE ESTUARY REGIONAL SEDIMENT MANAGEMENT PLAN



A comprehensive long-term master plan to identify a new sediment management program, procedures and management practices with regionally-targeted goals, objective and strategies



AUGUST, 2013

INSIDE FRONT COVER

“The Corps of Engineers must focus on starting fewer Civil Works projects, but doing them well and completing them properly, thus delivering benefits sooner and more efficiently and proving our value to the Nation. The Corps of Engineers must shift to a watershed, systems-based approach to water resources decision making working closely with our customers, partners and stakeholders, in order to leverage each other’s knowledge, capabilities and resources.”

MG Temple, Acting USACE Commander (13 February 2012)



Table of Contents

Preamble	P-1
RSM Workgroup (RSMW)	P-3
Executive Summary	ES-1
Problem Statements/Recommended Actions	ES-3
Next Steps/Actions	ES-7
CHAPTER 1 Introduction and RSM Context	1-1
1.1 Introduction	1-1
1.2 The Setting / Study Area	1-1
1.3 The Need for RSM	1-3
1.4 National Policy Direction	1-3
Ocean Blueprint / Recommendation 12-1	1-4
Ocean Blueprint / Recommendation 12-2	1-4
Ocean Blueprint / Recommendation 12-3	1-4
Ocean Blueprint / Recommendation 12-4	1-4
Ocean Blueprint / Recommendation 12-5	1-4
1.5 Regional Policy Direction	1-5
1.6 Public Education and Outreach	1-6
1.7 Regulatory Issues	1-6
1.8 Potential Benefits of RSM	1-7
1.9 RSMP Development Framework	1-8
CHAPTER 2 Delaware Estuary/River Basin: Background	2-1
2.1 Delaware Estuary/River Basin: An Unique Watershed	2-1
2.1.1 Introduction	2-1
2.1.2 Geography of the Delaware River Basin and Estuary	2-1
2.1.3 History	2-2
2.1.4 Ecological Significance	2-3
2.1.5 Economic Importance	2-5
2.2 Ecosystem and Natural Resources	2-7
2.2.1 “Mud-driven” Ecology	2-7
2.2.2 Future Change	2-9
2.3 Restoration and Management	2-10
2.3.1 Restoration Needs	2-11
2.3.2 Management Issues and Monitoring Needs	2-13
2.4 Conclusion	2-13
CHAPTER 3 Workgroup Findings and Problem Statements	3-1
3.1 Introduction	3-1

3.2	Sediment Quantity/Dynamics	3-1
3.3	Dredging and Dredged Material Management	3-5
3.4	Sediment Quality	3-9
3.5	Beneficial Use/Restoration	3-12
3.6	Problem Statements	3-14
3.6.1	Policy Issues.....	3-15
3.6.2	Funding Limitations.....	3-15
3.6.3	Programmatic and Regulatory Issues.....	3-15
3.6.4	Operational Management Concerns.....	3-15
3.6.5	Environmental Management Concerns	3-15
3.6.6	Education and Outreach Needs.....	3-15
3.6.7	Science and Research Needs	3-15
CHAPTER 4	Strategic Direction and Recommended Actions.....	4-1
4.1	Introduction.....	4-1
4.2	Policy Issues	4-2
4.3	Funding Limitations	4-2
4.4	Programmatic and Regulatory Issues	4-4
4.5	Operational Management Concerns.....	4-5
4.6	Environmental Management Concerns	4-6
4.7	Education and Outreach Needs	4-7
4.8	Science and Research Needs.....	4-8
4.9	Summary Recommended Actions.....	4-9
4.10	Establishing Short-term Goals and Setting Resource Management Targets	4-15
4.11	Example Demonstration/Pilot Projects	4-17
4.11.1	Individual Demonstration Projects	4-17
CHAPTER 5	Implementation	5-1
5.1	Overview	5-1
5.2	Prioritized Immediate Implementation Actions	5-1
5.3	Plan Implementation Structure	5-3
5.3.1	Administration of the Plan.....	5-3
5.3.2	Commitment of Resources	5-3
5.4	Economic Benefits.....	5-3
5.5	Funding of Plan Actions	5-4
5.5.1	Overview.....	5-4
5.6	Tracking Progress and Making Adjustments.....	5-4
5.7	Implementation Summary	5-5
Appendix E:	Funding of Plan Actions/Business Model.....	E-1
	Overview	E-1
	Introduction	E-2

Federal Appropriations.....	E-2
1. General Investigation Study Business Line	E-5
2. Construction General Business Line	E-6
3. Continuing Authorities Program (CAP) Business Line.....	E-6
4. O&M Business Line: Philadelphia District Budget Funds	E-6
5. O&M Business Line: National RSM Program Funds	E-7
6. Design/Build Business Line	E-7
7. Cash or in-kind services	E-7
8. Committee Resolutions.....	E-7
Non-Federal Sources	E-8
1. Compensatory Mitigation Bank.....	E-8
2. Matching Funds	E-8
3. Taxes/Fees	E-9
4. NRDA Funds.....	E-10
5. Miscellaneous grants are available such as NOAA/Delaware Coastal Zone Management grant and the Sunoco estuary program (\$25k) funded Heinz/Tinicum marsh restoration.	E-10
6. Shipping tax towards a restoration trust fund which could be levied on the incoming cargo ships and administered by the regional port authorities to assist in shoal maintenance.	E-10
RSM Implementation Business Model Proposal	E-11
Appendix F: References Cited	F-1

List of Appendices

A	Sediment Quantity and Dynamics White Paper
B	Restoration and Beneficial Use White Paper
C	Dredging and Dredged Material Management White Paper
D	Sediment Quality White Paper
E	Funding of Plan Actions/Business Model
F	References

List of Tables

Table ES.1: Recommended Actions	ES-4
Table 3.1: Land Uses in the Delaware River Basin	3-3
Table 3.2: Delaware Estuary Sediment Mass Balance	3-4
Table 3.3: Authorized Federal Channels for the Delaware Estuary	3-6
Table 3.4: Delaware Estuary RSMP Problem Statements.....	3-16
Table 4.1: Recommended Actions Summary Table	4-10

List of Figures

Figure 1.1: Delaware River Basin/Estuary Location Map	1-2
Figure 2.1: Watersheds of the Delaware River Basin (DRBC)	2-1
Figure 2.2: Dredging Photo on the Delaware River.	2-2
Figure 2.3: Horseshoe Crabs in the Delaware Estuary (Elizabeth Horsey, PDE).....	2-4
Figure 2.4: One of more than 500 Oystering Vessels on Delaware Bay.	2-4
Figure 2.5: Wild Rice and Pickerelweed in a Freshwater Tidal Marsh of the Delaware Estuary.	2-5
Figure 2.6: Estimated Annual Economic Value of Key Natural Resource Uses in the Delaware Estuary and River Basin (Kauffman et.al. 2011).	2-6
Figure 2.7: Estimated Ecosystem Service Values for Various Habitat Types in the Delaware Estuary and River Basin (Kauffman et al. (2011).	2-6
Figure 2.8: A Large Container Ship, Oyster Boat, and the Tall Ship, Meerwald, in the Delaware Estuary.	2-7
Figure 2.9: Suspended Sediment Distribution in the Delaware Estuary.	2-7
Figure 2.10: Tidal Wetlands of the Delaware Estuary (Reed et al. 2008.).....	2-8
Figure 2.11: Marsh Loss in Estuarine Emergent Wetlands (Acres) in Different Watershed Regions of the Delaware Estuary, 1996-2006 (PDE 2012).	2-9
Figure 2.12: Flooding in Delaware during High Tide (Shaun Bailey, PDE).....	2-9
Figure 2.13: A Healthy Riparian Corridor along a Stream Helps Retain Sediment in Uplands (Photo: Partnership for the Delaware Estuary).....	2-10
Figure 2.14: Federal Funding from the US. Environmental Protection Agency for Watershed Restoration Compared among Large Coastal Systems (Dawson and Strackbein 2011).	2-11
Figure 2.15: X-Vane in Walnut Brook Stream Restoration (Photo Courtesy of USDA NRCS-NJ)	2-11
Figure 2.16: Streambank Erosion on Walnut Brook (Photo Courtesy of USDA-NRCS-NJ)....	2-12
Figure 2.17: Mussel and Plant-based Living Shoreline Installation to Help Stabilize Erosion and Improve Ecological Value of a Formerly Hardened Shoreline at Matt's Landing, New Jersey (Photos: Partnership for the Delaware Estuary).	2-12
Figure 3.1: Surficial Sediment Characterization of the Delaware Estuary.	3-2
Figure 3.2: Photographs of Dredging Operations	3-7
Figure 3.3: CDF Locations on Delaware River	3-8
Figure 3.4: Aquatic Habitat Restoration Suitability.....	3-10
Figure 3.5: Upland Beneficial Use Suitability	3-11
Figure E.1: General Investigations Appropriation Authority and Process	E-3
Figure E.2: Continuing Authorities Program Construction General Appropriation	E-4
Figure E.3: Delaware Estuary Regional Sediment Management Federal Appropriation Business Lines	E-5

Acronyms and Abbreviations

ARRA	American Resource and Recovery Act
BMPS	Best Management Practices
CAP	Continuing Authorities Program
CCMP	Comprehensive Conservation and Management Plan
CDF	Confined Disposal Facility
CEAP	Conservation Effects Assessment Project
CG	Construction General
CMF	Confined Management Facility
COC	Contaminants of concern
CRI	Conservation Resources Incorporation
DB	Design-Build
DIMS	Dredging Information Management System
DNREC	Delaware Department of Natural Resources and Environmental Conservation
DOTS	Dredging Operations Technical Support Program
DRBC	Delaware River Basin Commission
ETM	Estuary Turbidity Maximum
GI	General Investigation
GO	General obligation
HMTF	Harbor Management Trust Fund
IWR	Institute for Water Resources
NFWF	National Fish and Wildlife Foundation
NGO	Non-governmental organization
NJAFM/NJAWRA	New Jersey Association of Floodplain Managers/New Jersey Section American Water Resources Association
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NOAA	National Oceanic and Atmospheric Administration
NPV	Net present value
NRCS/New Jersey	Natural Resources Conservation Service New Jersey (NRCS/New Jersey)
NRDA	Natural Resource Damage Assessment
O&M	Operations and Maintenance
PCB	Polychlorinated biphenyl
PDE	Partnership for the Delaware Estuary
PED	Pre-Construction Engineering and Design
RDT	Regional Dredging Team
RSM	Regional Sediment Management

RSMIP	Regional Sediment Management Implementation Plan
RSMIW	Regional Sediment Management Implementation Workgroup
RSMP	Regional Sediment Management Plan
RSMW	Regional Sediment Management Workgroup
SE/SC	Soil erosion and sediment control practices
SER	Society Ecological Restoration
SRF	State revolving fund
TNC	The Nature Conservancy
TOT	Transient Occupancy Tax
USACE	U.S. Army Corps of Engineers
USDA-NRCS	U.S. Department of Agriculture - Natural Resources Conservation Service
USEPA	U.S. Environmental Protection Agency
WRDA	Water Resources Development Act
WRP	Water Resources Plan

Preamble

Reliable and sustainable water resources are essential to the economic and environmental well-being of the Delaware Estuary. Over \$12 billion in ecosystem goods and services (such as drinking water, seafood, and flood protection) are provided by the Delaware Estuary. The Delaware River and its watershed is a critically important resource that supplies drinking water to the 1st (New York City) and the 7th (Philadelphia) largest metropolitan areas in the U.S. Over 500,000 jobs, accounting for at least \$10 billion in annual wages, depend on the water resources and natural habitats of the estuary. The Delaware Estuary supports the largest freshwater port in the world, with an economic value of \$2.4 billion per year.

Prudent and sustainable management of the Delaware Estuary's natural resources requires a commitment and focus on integrated region-wide management approaches to protect the ecological integrity and biological diversity of the estuary. Regional management is needed to ensure a healthy environment and provide services to support an expanding and dynamic regional economy for present and future generations. This type of commitment demands regional communication and cooperation that is a challenge in a watershed encompassing four metropolitan States. Mutual understanding of the importance of the estuary has been demonstrated by the development of two critical water resource plans: the Delaware Estuary Comprehensive Conservation and Management Plan (CCMP; 1996), and the Water Resources Plan (WRP) for the Delaware River Basin (2004). These plans are overseen by the multi-State agencies of the Partnership for the Delaware Estuary (PDE) and the Delaware River Basin Commission (DRBC), respectively.

While the Delaware Estuary's water resources may be well managed, sediment resources, which directly and indirectly affect the quality of its water resources, are misunderstood and often neglected. The lack of a regional sediment management program negatively influences some of the most valuable benefits of the Delaware River and Estuary, particularly port commerce, water quality, and ecosystem viability. These in turn directly influence quality of life in the Delaware Estuary region through the cost and availability of goods, impacts to human and environmental health, and restrictions on water-based recreation. Our failure to properly manage sediment is seen in the disparate viewpoints among stakeholders regarding the impacts of sediment management decisions on coastal land use, commercial navigation, wetland loss and restoration, and water quality implications of land use, dredging, and dredged material management.

Regional Sediment Management (RSM) is a way to capitalize on our regional history of cooperation. It offers the potential for more "win/win" solutions, less conflict, and better environmental/economic outcomes. Decision makers utilize a systems-based approach to collaboratively address sediment-related problems within a regional context. Although RSM cannot solve all of the funding challenges and problems facing the region's marine transportation system, it can reduce costs and provide sustainable cost-effective options. RSM also provides a forum and regional perspective for protecting and enhancing the valuable natural resources of the Delaware Estuary.

Two years ago, a group of regional stakeholders including Federal, State (New Jersey, Pennsylvania and Delaware), Regional, Non-government Organization (NGO) and commercial entities interested in and relying upon the resources of the Delaware Estuary, met to evaluate the management of sediment and dredged material. We found that in order to manage sediment regionally, we need to make a rapid and dramatic departure from current practices. It is essential to provide a forum for regional communication on sediment management issues including control of sediments sources, dredging, dredged material management, and restoration needs of the regional ecosystem. We need a better understanding of sediment sources, transport, and ecosystem needs, to fully acknowledge the potential water quality and habitat impacts of dredging and dredged material management, and to advocate and fund a sustainable dredged material management program. This will require a frank and honest dialog that includes the acceptance of realistic targets and goals.

In short, we in the Delaware Estuary are at a crossroads when it comes to sediment management.

If we continue on our current path, we face escalating costs of maintaining waterborne commerce, continued loss of wetlands and beaches, stagnation of recent improvements in water quality and ecosystem health, and an increase in public outcry over management of this critical resource. This RSMP details a shared multi-objective management vision involving navigation/commerce, flood control, and ecosystem restoration for the Delaware Estuary. It also requires improved communication amongst stakeholders, better technology to manage impacts from dredging, sustainable beneficial use of dredged material, a better understanding of the processes that impact the sources, transport, and fate of sediment in the system, and more rigorous programs to educate stakeholders and the general public.

Implementation of this plan necessitates accounting for all of the true costs and benefits of each of the plan's recommendations, and a commitment to providing the necessary financial resources to support the plan. But in the end, the use of RSM in the Delaware Estuary will ensure that the benefits from this national treasure are sustained for current and future generations.

RSM Workgroup (RSMW)

The Regional Sediment Management Workgroup (RSMW) members – the contributors to this Regional Sediment Management Plan for the Delaware Estuary - include:

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Executive Summary

In September 2004, the Commander of the North Atlantic Division of the U.S. Army Corps of Engineers (USACE) joined with four Governors and six Regional Federal Executives (Environmental Protection Agency [EPA], National Park Service [NPS], US Geological Survey [USGS], US Fish and Wildlife Service [USF&WS], and Natural Resources Conservation Service [NRCS]) to adopt the Water Resources Plan for the Delaware River Basin (WRP). The WRP is a 30-year, goal-based framework that serves as a guide for all governmental and non-governmental stakeholders whose actions affect water resources in the Delaware River Basin. Among the plan's 21 goals and 102 objectives was the *call for a regional approach to sediment management* to increase and expand the beneficial use of dredged material.

Regional Sediment Management (RSM) is a relatively new concept advocated by the USACE. RSM takes a broader system-wide look at coastal and riverine management activities and their effects within the context of a regional plan. Instead of the USACE managing navigation (principally dredging) projects in isolation, RSM encourages combining and coordinating Federal projects from multiple USACE business lines (as well as multiple agencies) to achieve greater environmental and economic benefits. It is widely acknowledged that RSM fully captures the systems approach to project management, a major theme of USACE Strategic Planning efforts and the Delaware River Basin WRP.

Within the Delaware River Estuary, RSM involves:

- > Managing sediment and dredged material as resources, not wastes.
- > Understanding sediment movement in the estuary to better design and implement projects and management actions – “engineering with nature”.
- > Developing programmatic linkages between USACE projects involving and affecting sediment in the region that are currently managed in isolated business lines (navigation channel maintenance, flood and storm damage reduction, ecosystem restoration and protection, beneficial use of dredged material).
- > Coordinating sediment/dredged material projects and management activities to achieve greater environmental and operational benefits, as well as cost savings.
- > Improving program effectiveness through collaborative partnerships with multiple government agencies and Non-governmental Organizations (NGOs).
- > Identifying and overcoming policy, regulatory, and institutional impediments to more effectively and efficiently manage sediment/dredged material.
- > Recognizing the benefits of a systems approach to managing sediment and ensuring the sustainability of the natural and man-made components of the estuary.

The Delaware River Basin/Estuary Regional Sediment Management Workgroup (RSMW) consists of Federal, State, Regional, NGO, and commercial entities. It was established in 2009 to develop a better understanding of sediment dynamics and quality in the estuary. One of the goals of the RSM is to evaluate options to effectively manage sediment/dredged material on a regional basis to achieve a sustainable balance between ecological and economic activities.

To better understand sediment-related estuarine processes, the workgroup investigated four technical areas: 1) sediment quantity and dynamics; 2) sediment quality; 3) dredging and dredged material management; and 4) restoration and beneficial use. White papers were developed for each of these technical areas. The RSMW concluded that implementation of a system-wide approach to the management of sediment and dredged material is critical to sustain the estuarine ecosystem and the economy of the region.

Out of the white papers, a set of Problem Statements, goals, and objectives were developed to address these problems. This led to specific recommendations in seven categories of management activities: 1)

Policy Issues; 2) Funding Limitations; 3) Programmatic and Regulatory Issues; 4) Operational Management Concerns; 5) Environmental Management Concerns; 6) Education and Outreach Needs; and 7) Science and Research Needs. **(See Table ES.1 for Problem Statements and Recommended Actions.)**

This Regional Sediment Management Plan (RSMP) provides a blueprint for all stakeholders concerned about the sustainability of the Delaware River/Estuary to collaboratively address sediment-related problems in a holistic manner. A system-based approach can result in the following benefits:

- > Improving environmental conditions in sediment-starved marsh and littoral systems, and assuring that these systems continue to provide vital ecosystem services that benefit the region's human communities and the estuarine environment.
- > Extending the useful life of existing upland dredged material confined disposal facilities.
- > Leveraging resources by coordinating projects and management activities that have complementary and additive benefits to the environment and economy.
- > Clarifying and streamlining the regulatory review processes for sediment management and dredged material beneficial use activities.
- > Expediting habitat restoration and dredged material beneficial use projects through the implementation of a regional planning process that prioritizes beneficial uses and identifies appropriate/optimal placement sites.
- > Facilitating the implementation of sediment-related projects, and improving project-level decisions, by the development of shared regional data management systems, models, and other tools.
- > Facilitating the acceptance of sediment management and dredged material beneficial use projects by local communities through effective outreach activities and the use of a rational, transparent, and collaborative project planning approach.

Potential socio-economic benefits that can result from the implementation of the RSMP include:

- > Improved viability and sustainability of waterborne commerce and associated industries as a result of improved dredged material management activities.
- > Increased benefits to industrial and commercial operations that depend on the natural resources of the estuary due to maintenance of the waterways and the implementation of habitat restoration projects.
- > The direct creation of "green jobs" through the implementation of RSM projects, and the associated multiplier effects on the region's economy.
- > Continued and increased use of the river and estuary for recreation.
- > More sustainable estuary and increase in the quality of life for residents of the region, further encouraging additional economic development on a regional scale.

The Delaware River Estuary RSMP details a shared multi-objective (navigation/commerce, ecosystem restoration, and flood control) management vision for the Delaware Estuary. It requires improved communication among stakeholders, better technology to manage impacts from dredging, sustainable beneficial use of dredged material to meet multiple commercial and ecosystem needs, a better understanding of the processes that impact the sources, transport, and fate of sediment in the system, and more rigorous programs to educate stakeholders and the general public about the importance of sediment/dredged material to the estuary. Implementation of this plan requires cost-benefit accounting across multiple USACE business lines to find the necessary resources to implement and support the plan.

The use of RSM in the Delaware Estuary will ensure that the benefits from this national treasure are sustained for future generations.

Problem Statements/Recommended Actions

The RSM developed a series of Problem Statements reflecting the information evaluated and current understanding of the science. For each Problem Statement a series of recommendations were developed. The Problem Statements and Recommended Actions are summarized in the following Table ES.1.

Table ES.1: Recommended Actions

<i>Recommendation</i>			<i>Ongoing</i>	<i>Short Term (1-3) years</i>	<i>Long Term (4+ years)</i>	<i>Resources Needed</i>	<i>Lead Agency</i>
Funding Limitations (FL)							
#1	FL-1A	Coordinate with legislators and others – use Harbor Maintenance Trust Fund allocations for navigation and green infrastructure projects.	X			\$	RSMIW
	FL-1B	Coordinate with legislators and others - added economic and ecosystem service values of RSM and beneficial use of dredged material.		X		\$	RSMIW
#2	FI-2A	USACE to develop more flexible interpretation of the Federal "least cost standard" to consider full range of economic benefits for dredged material management and beneficial use options.	X			\$	USACE
	FL-2B	USACE to evaluate existing/alternative authorities to more easily beneficially use dredged material, especially for habitat restoration.	X			\$	USACE
#3	FL-3A	Identify Federal/State funding programs to implement RSMP and support beneficial use of dredged material.	X			\$	RSMIW
	FL-3B	Explore private/public funding opportunities with commercial entities and non-governmental organizations.		X		\$	RSMIW
	FL-3C	Identify and evaluate potential demonstration projects - especially for private-public funding.		X		\$	RSMIW
Programmatic and Regulatory Issues (PRI)							
#1	PRI-1A	Joint Federal/State effort to develop consistent programs - dredging operations, dredged material management and beneficial use.		X		\$	Fed/State
	PRI-1B	RDT to determine the practicality of developing general permits for RSM implementation and dredged material beneficial use projects.		X		\$	RDT
#2	PRI-2A	RDT/RSMIW to develop a regional dredged material management plan using an asset management approach.		X		\$\$	RDT/RSMIW
	PRI-2B	Agencies review programs to consider potential project impacts on RSM.		X		\$	Fed/State
	PRI-2C	RDT to continue to convene and share information.	X			\$	RDT
	PRI-2D	Develop regional data sharing capability and analytical tools to evaluate sediment conditions and management strategies.		X		\$\$	States

<i>Recommendation</i>			<i>Ongoing</i>	<i>Short Term (1-3 years)</i>	<i>Long Term (4+ years)</i>	<i>Resources Needed</i>	<i>Lead Agency</i>
Operational Management Concerns (OM)							
#1	OM-1A	Convert upland CDFs to CMFs to facilitate beneficial use of dredged material.		X		\$\$\$	USACE/States
#2	OM-2A	PDE to develop estuary-wide database of potential sites for beneficial use of dredged material.		X		\$\$	PDE
	OM-2B	RSMIW to develop a marketing program to promote the beneficial use of dredged material in the estuary.		X		\$\$	RSMIW
	OM-2C	RDT/RSMIW to Identify, evaluate and implement demonstration projects.	X			\$	RSMIW/RDT
Environmental Management Concerns (EM)							
#1	EM-1A	PDE/States to identify tidal wetlands at risk of loss to be protected through dredged material beneficial use, living shorelines, etc.		X		\$\$	PDE/States
	EM-1B	Coordinate RSMP implementation with other habitat restoration plans.	X			\$	RSMIW/PDE
	EM-1C	RDT to establish interagency workgroup to identify opportunities for beach nourishment using sand dredged from navigation channels.	X			\$	RDT
#2	EM-2A	Coordinate with non-tidal watershed erosion control projects to understand impacts to regional sediment management.		X		\$	RSMIW/NRCS/PWD/States
#3	EM-3A	RDT to review and identify BMPs for dredging and dredged material management operations to reduce water quality impacts.	X			\$	RDT
Education and Outreach Needs (EON)							
#1	EON -1A	Develop an education and outreach campaign to the general public to explain the economic importance of navigation, dredging and dredged material management.		X		\$\$	USACE
#2	EON-2A	USACE/EPA to develop an education and outreach campaign to the general public to change the perception of dredged material as a waste.		X		\$\$	USACE/EPA

Recommendation			Ongoing	Short Term (1-3 years)	Long Term (4+ years)	Resources Needed	Lead Agency
Science and Research Needs (SRN)							
#1	SRN-1A	Develop a better understanding of the estuarine sediment dynamics through a variety of research projects.	X		X	\$\$\$	USACE/DRBC
	SRN-1B	Fully characterize sediment processes and outputs for upstream watersheds.			X	\$\$\$	NRCS/USGS
#2	SRN-2A	Develop a better understanding of the importance of sediment to ecological processes/habitats, in particular wetlands			X	\$\$\$	PDE
	SRN-2B	Implement demonstration projects to gain additional knowledge.		X		\$\$\$	All
#3	SRN-3A	Monitor and evaluate contamination of sediments throughout the system for a target list of contaminants of concern.	X			\$\$	EPA/DRBC/ States
	SRN-3B	RSMIW to develop an interagency workgroup to develop regional criteria for the beneficial use of dredged material in aquatic restoration projects.		X		\$	RSMIW
	SRN-3C	EPA/States to identify contaminated sediment hot spots and related pollutant sources and develop a plan to address them.		X		\$	EPA/States/USGS
#4	SRN-4A	USACE to evaluate the application of engineering modifications and alternative technologies to reduce dredging or change local sediment dynamics.		X		\$\$	USACE
	SRN-4B	USACE to evaluate the use of alternative dredging methods and techniques that could reduce dredging needs.		X		\$\$	USACE

\$ Key: \$ = <\$100,000, \$\$=<500,000, \$\$\$=<1,000,000, \$\$\$\$=>\$1,000,000

RSMIW = Region Sediment Management Implementation Workgroup

USACE = U.S. Army Corps of Engineers

RDT = Regional Dredging Team

PDE = Partnership for the Delaware Estuary

NRCS = Natural Resource Conservation Service

PWD = Philadelphia Water Department

EPA = U.S. Environmental Protection Agency

DRBC = Delaware River Basin Commission

USGS = United States Geological Survey

Next Steps/Actions

Key to the successful implementation of the plan will be the continued engagement of the RSMW members and other affected stakeholders. The RSMW members have prioritized the following short-term and long-term actions to achieve this goal:

- > Regional Sediment Management Implementation Workgroup (RSMIW) to be established with a series of focus groups to continue to guide the plan.
- > Immediate need for funding of priority demonstration projects to show short-term success.
- > An outreach campaign to educate the public on opportunities and implementation.

CHAPTER 1 Introduction and RSM Context

1.1 Introduction

Sediment is an integral and natural component of the Delaware Estuary ecosystem. It is one element of a complex estuarine system that includes natural processes associated with biology, biochemistry, geology, geochemistry, hydrology, tidal hydraulics, and meteorology. Sediment serves a number of functional and structural roles that are critical to the environmental and socioeconomic health of the region. For example,

- > Sediment as riverbed substrate supports a wide variety of habitats and ecosystems.
- > Suspended sediment is the source of turbidity, which is ubiquitous in many parts of the estuary. Turbidity limits the penetration of light in the water column and affects photosynthetic productivity, thus inhibiting the development of eutrophic conditions.
- > Suspended sediment is an important source of substrate when it is deposited in or onto a wetland.
- > Sediment plays a role in the transport of nutrients and contaminants, such as trace metals, pesticides, and polychlorinated biphenyl (PCBs). Suspended sediments can transport these contaminants throughout the estuary, and deposited sediments act as a contaminant sink.
- > Sediment accumulates in navigation channels and harbors of the estuary, interferes with safe and efficient waterway navigation, and necessitates dredging to maintain commerce.

Sediment has a dual nature which makes management challenging: it is a valuable resource in some locations and an unwanted nuisance in others. Scale is also an issue since the natural processes that produce, transport, and deposit sediment operate at regional scales, while management tends to focus on discrete locations, such as a single beach, wetland, or port. The policies that affect sediment management fall under the jurisdiction of diverse programs, within multiple agencies, at all levels of government. This complex approach makes it difficult to manage sediment at the appropriate scale and in consonance with, rather than in conflict with, natural processes.

The prospect of global climate change further complicates matters because of the potential for large-scale changes in the way sediment is produced and transported. Predictions of increased storm activity and changes in runoff patterns may have important effects on sediment delivery from upland areas, while relative sea level rise could affect estuarine and coastal processes.

1.2 The Setting / Study Area

The Delaware River basin is a watershed of 13,600 square miles, stretching from the Catskill and Pocono uplands in southern New York and northeastern Pennsylvania to the coastal plains of Delaware and southern New Jersey (Figure 1.1). The basin is the home and water supply to about nine million people, and is the source of much of the water used by New York City. At Trenton, New Jersey, the river becomes tidal, and begins its approximately 130 mile journey through the Delaware Estuary to the Atlantic Ocean. The Estuary flows past the cities of Philadelphia, Pennsylvania; Camden, New Jersey; and Wilmington, Delaware; and gradually widens to become Delaware Bay. Port facilities along the estuary collectively represent one of the most important ports in the U.S. The U.S. Army Corps of Engineers (USACE) maintains the shipping channel that enables large vessels to utilize this port. Besides being home to industrial and port facilities, the Delaware Estuary also encompasses marvelous natural ecosystems. Managing this resource for multiple uses is one of the great challenges for the many stakeholders that comprise the maritime community of the Delaware Estuary.

Figure 1.1: Delaware River Basin/Estuary Location Map



1.3 The Need for RSM

Before the Delaware Estuary RSM program was initiated in 2009, there was no systematic, collaborative approach to dealing with the challenges and opportunities associated with sediment management in the Delaware estuary region. The present RSM initiative is intended to broaden local knowledge and facilitate watershed collaboration about how, where, and when to manage parts of the sediment system differently and more beneficially than has been previously practiced.

RSM is the integrated management of riverine, estuarine, and littoral sediments to achieve balanced and appropriate solutions to sediment-related needs. The RSM initiative is based on the idea that sediment should be considered a resource that is integral to the economic and ecological vitality of the region. The initiative is intended to be a systems-based approach to address sediment-related problems by designing and implementing solutions that fit within the context of a regional strategy. The Delaware River basin includes the entire watershed that drains to the Estuary. The RSM Workgroup recognizes that sediment management actions can have economic and ecological implications beyond a given site, beyond originally intended effects, and over long time scales. Traditional project planning often does not address these broader implications. The Workgroup believes that the RSM approach will provide opportunities to achieve greater effectiveness and efficiency, as compared to the current practice.

Existing conditions and sediment/dredged material management practices in the Delaware Estuary present certain problems and challenges including the following:

- > Too much sediment is deposited by the River in areas where it is not wanted (e.g. navigation channels) and too little is deposited where it is needed (e.g. tidal wetlands and beaches).
- > Dredged material is typically placed in upland Confined Disposal Facilities (CDFs), with no long-term plan to use it. Sediment is thus sequestered in the CDFs for an indefinite period of time and therefore unavailable as a system resource.
- > The existing CDFs have limited capacity that should be conserved and/or reclaimed whenever possible.
- > Some Delaware Estuary sediment is contaminated at levels that could be detrimental to the aquatic ecosystem, or that would limit beneficial uses of dredged material.
- > Because the Delaware is an interstate waterway, several agencies at multiple levels of government are involved in regulating sediment management activities. Regulatory policies and programs are not coordinated or consistent across the region.
- > There is broad concern among the general public about the human health and ecological consequences of dredging and dredged material placement.

1.4 National Policy Direction

In 2000, the USACE created the RSM Program based on direction from Congress to develop long-term strategies for disposing of dredged materials and to cooperate with States to develop comprehensive plans for coastal resources conservation. Under this program, USACE collaborates with States, communities, and other diverse stakeholders to develop plans to manage sediment across a region. To date, several RSM efforts have been developed around the country. By researching these efforts, and by engaging in dialogue with some of the participants, the Delaware Estuary RSM Workgroup has benefited from the experiences of others. We have also examined the USACE's own assessments of RSM and its potential benefits.

Federal policy related to RSM is indicated in several initiatives. On November 19, 2004 the U.S. Department of the Army signed a Partnership Agreement for Watershed Management with the U.S. Environmental Protection Agency. On July 7, 2005, another U.S. Department of the Army Partnership Agreement was signed with U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS). These agreements recognize that the watershed approach provides a mechanism for

collaborative, integrated and holistic water resources problem-solving. They acknowledge that watershed partners can address multiple objectives and give consideration to the balance of interests and viewpoints at the local, regional, State, and Federal levels. This Plan is one manifestation of that agreement, with a focus on managing sediment in the Delaware River Basin.

The National Ocean Policy Framework authorized by the Oceans Act of 2000 and the President's Ocean Action Plan of 2004 creates a structure for regional coordination and cooperation among the parties affected by sediment. The U.S. Commission on Ocean Policy released an expansive report in September 2004 titled "An Ocean Blueprint for the 21st Century." Chapter 12 of that report focuses on managing sediment and shorelines, and contains several recommendations related to RSM. These recommendations include the following:

Ocean Blueprint / Recommendation 12-1

The National Ocean Council should develop a national strategy for managing sediment on a regional basis. The strategy should incorporate ecosystem-based principles, balancing ecological and economic considerations. In addition, the strategy should:

- > Acknowledge adverse impacts on marine environments due to urban development, agriculture, dams, dredging, pollutant discharges, and other activities that affect sediment flows or quality.
- > Ensure involvement of port managers, coastal planners, land use planners, and other stakeholders in watershed planning.
- > Emphasize watershed management as a tool to address upstream land uses that affect sediment input to rivers and coastal waters.

Ocean Blueprint / Recommendation 12-2

Congress should direct the USACE to adopt regional and ecosystem-based management approaches in carrying out all of its sediment-related civil works missions and modify authorities and processes as necessary to achieve this goal.

Ocean Blueprint / Recommendation 12-3

The USACE should ensure that its selection of the least-cost disposal option for dredging projects reflects a more accurate accounting of the full range of economic, environmental, and other relevant costs and benefits for options that reuse dredged material, as well as for other disposal methods.

Ocean Blueprint / Recommendation 12-4

The National Dredging Team should ensure vigorous and sustained implementation of the recommendations contained in its *Dredged Material Management: Action Agenda for the Next Decade*, moving towards more ecosystem-based approaches. Regional dredging teams, working with regional ocean councils, should establish sediment management programs that expand beyond single watersheds to larger regional ecosystems.

Ocean Blueprint / Recommendation 12-5

The USACE, working with U.S. Department of the Interior, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Environmental Protection Agency (USEPA), in consultation with State and local governments, should develop and implement a strategy for improved assessments, monitoring, research, and technology development to enhance sediment management.

Another indication of the national policy direction is shown by the President's Council on Environmental Quality, which is currently engaged in an effort to modernize the 30-year-old rules that guide Federal investments in water resources. The December 2009 draft report on *Proposed National Objectives*,

Principles and Standards for Water and Related Resources Implementation Studies includes the following principles:

- > Protect and restore natural ecosystems and the environment while encouraging sustainable economic development
- > Account for ecosystem services
- > Utilize watershed and ecosystem based approaches
- > Account for the benefits and costs in appropriate monetary and non-monetary terms
- > Broad collaboration and implementation of study activities

1.5 Regional Policy Direction

This RSMP is intended to be a regional planning initiative to be used by all stakeholders within the Delaware River Basin/Estuary. This RSMP considers and strives for an interface across a broad spectrum of inter-related processes, ecosystems, political boundaries, and resource management needs. This RSMP complements other regional plans and can be utilized by other regional planning initiatives to facilitate decision making and prioritization by stakeholders in the river basin and estuary.

Several regional planning efforts relate to and support the need for a regional approach to sediment management. Two of the most significant plans are the following:

The Water Resources Plan for the Delaware River Basin, produced by the Delaware River Basin Commission (DRBC) in September 2004, is a thirty-year, goal-based framework that is intended to serve as a guide to all stakeholders whose actions affect water resources in the basin. Several of the objectives in the Plan relate to the need for regional approaches to sediment management.

The Comprehensive Conservation and Management Plan (CCMP) produced by the Delaware Estuary Program (now the Partnership for the Delaware Estuary [PDE]) in September, 1996, provides a basis for decision making regarding the resources of the Delaware Estuary. The CCMP does not address sediment as a distinct and separate topic, yet it contains many goals and objectives that are consistent with the goals and objectives of RSM.

Other regional planning initiatives that have a relationship to RSM include the following (the lead organization for each effort is indicated):

- > Regional Restoration Blueprint – PDE
- > Climate Adaptation Plan – PDE
- > Delaware Estuary Living Shoreline Initiative – PDE
- > South Jersey Levee Inventory – New Jersey Department of Environmental Protection (NJDEP) and Natural Resources Conservation Service New Jersey (NRCS/New Jersey)
- > State of Delaware Sea Level Rise Plan
- > City of Philadelphia Waterfront Plan
- > City of Philadelphia Green City Clean Waters
- > Dredged Material Management Plan for Wilmington Harbor – USACE
- > Delaware River Basin Conservation Initiative – The Nature Conservancy (TNC)
- > Delaware Wetlands Conservation Strategy – Delaware Department of Natural Resources and Environmental Conservation (DNREC)
- > Dredged Material Management Plan for Philadelphia to Trenton Project – NJDEP and New Jersey Department of Transportation (NJDOT)

- > Area Contingency Plan [for oil spills] – Port Area Committee, chaired by U.S. Coast Guard
- > City of Camden Waterfront Plan
- > Christina Basin Pollution Control Strategy – DNREC

1.6 Public Education and Outreach

The RSM Workgroup recognizes that public outreach and education are important to the success of the RSM effort. Many people have a negative perception of dredging and dredged material disposal activities. RSM stakeholders should be prepared to remind the public that dredging is necessary if we are going to continue to have an economically viable port. Many people feel sediments are invariably contaminated and dredged material needs to be treated as a dangerous waste. This perception may be based, in part, on the simple fact that estuarine sediments tend to be muddy when wet, and dusty when dry. It might also be influenced by the public's broad association of water pollution with heavy industry that was historically located along the river. A considerable amount of analytical data is available documenting the levels of contamination in Delaware River sediments. Our analysis shows that most of the sediments removed from the system are clean enough for many kinds of beneficial uses. Sediment in the right place and amount is critical to sustaining high value ecosystems in the estuary.

The RSM Workgroup has prepared informational materials for use in public outreach activities and will continue to develop materials to explain the RSM plan and its implementation.

As RSM advocates, we hope to shift the general perception away from sediment as waste and towards sediment as a resource. This effort will require a strategic outreach plan supported by credible data and facts. The success of the plan will depend on gathering broad support for these concepts from resource managers and environmental advocates.

1.7 Regulatory Issues

Sediment, dredging, and dredged material management activities are controlled through a variety of laws and regulations at the Federal, State, and county level. The regulations are enormously complex because of the different environmental media involved (water quality, solid waste management, wetlands and waterways, and others), and because of the differences between the way these environmental media are regulated in each of the four basin States.

Some of the major Federal environmental statutes that apply to sediment-related activities are listed below.

- > National Environmental Policy Act
- > Section 10 of the Rivers and Harbors Act
- > Sections 401, 402, and 404 of the Clean Water Act
- > Endangered Species Act
- > Fish and Wildlife Coordination Act
- > Magnuson-Stevens Fishery Conservation and Management Act
- > Federal Coastal Zone Management Act

There are also laws and regulations at the State level that address sediment related issues and activities. These activities regulated at the State level include:

- > Waterway obstructions and encroachments
- > Underwater construction
- > Coastal construction
- > Protection for wetlands

- > Placement of fill
- > Erosion and sedimentation control
- > Handling of contaminated media, including soils or sediments
- > Discharge of water during dewatering of dredged material
- > Protections for State-listed threatened and endangered species and their habitats

Despite the importance of regulations and State policies for many of the actions discussed in this Plan the RSM Workgroup determined that a detailed discussion of regulatory issues is beyond the scope of the present document. For us to detail the laws and regulations governing even just one kind of activity, for example dredging, would be quite complex. Dredged material placement and dewatering, beneficial use of dredged material, and wetlands restoration, are all impacted by a complex array of Federal and State regulatory programs. More detailed planning for any of these activities would need to include detailed investigation of the regulatory controls that affect the activity and would have to consider the State-specific nature of the regulatory controls.

For those that do business in more than one of the Delaware Estuary States, differences between the States' regulatory programs can be a source of confusion and frustration. For example, one of the most common complaints from dredgers is that placing dredged material in New Jersey is subject to a different set of rules than placing dredged material in Pennsylvania. The need for improved consistency and coordination relates to several of the recommendations that are discussed in the later chapters.

1.8 Potential Benefits of RSM

RSM gives the many stakeholders of the Delaware River/Estuary, including its port community, an opportunity to address sediment-related issues in a holistic and collaborative way. The potential benefits of applying RSM in the Delaware Estuary include the following:

- > Improving environmental conditions in sediment-starved marsh and littoral systems, and assuring these systems continue to provide the vital ecosystem services that benefit communities in the region.
- > Improved dredged material management and beneficial uses, including extending the useful life of existing CDFs. CDF capacity should be conserved and/or reclaimed whenever possible.
- > Leveraging resources by combining activities that have complementary effects, although their original purposes may have been different.
- > Clarifying and streamlining regulatory review processes for sediment management activities.
- > Expediting restoration and beneficial use projects by the use of regional planning that prioritizes beneficial uses and identifies pre-considered placement sites.
- > Facilitating projects and improving project-level decisions by the development of shared regional data management systems, models, and other tools.
- > Facilitating the acceptance of sediment management projects by local communities through a rational, transparent, and collaborative planning approach, and by effective outreach to communities.

Potential economic benefits of RSM, including cost-savings and efficiencies, are varied and numerous. The following economic benefits may be realized through the implementation of RSM recommendations:

- > Waterborne commerce will be viable and associated industries sustainable, through the implementation of RSM principles.
- > Industries that are dependent on the natural resources of the river and estuary will benefit from the sustainable maintenance of the waterways and restoration projects identified.

- > Green jobs can be created through the implementation of RSM projects.
- > Continued and increased recreational use of the river and estuary will be supported by implementation of RSM projects.
- > Increased economic growth, ecological uplift, and a general increase in the quality of life for residents of the region, which will encourage additional economic benefits on a larger scale.

1.9 RSMP Development Framework

In the project Statement developed at the outset of the Delaware River RSM process, the workgroup expressed some basic principles, including the following:

RSM requires developing an understanding of issues and processes including: sediment transport; sediment mass balance; contaminants; sources, sinks, and pathways; scour, deposition, flow management; upland erosion; and linking sediment availability with sediment utilization. The aim is to optimize opportunities to effectively manage sediments in a manner to achieve a sustainable balance between ecological and economic activities. This vision can best be implemented as a joint effort between Federal, State and local entities to ensure local project decisions are made in the context of the sediment system, and not on a 'project-by-project' basis.

In order to develop the technical understanding of issues and processes, the workgroup established four issues of interest: 1) sediment quantity and dynamics; 2) sediment quality; 3) dredging and dredged material management; and 4) restoration and beneficial use. White papers were developed for each of these issue areas.

The production of white papers was followed by the development of targeted goals and objectives for each subject. These led to recommendations that are categorized according to five categories of management activity: 1) Policy/Fiscal/Program Management; 2) Operational Management; 3) Environmental Management; 4) Education and Outreach; and 5) Science and Research. These recommendations are discussed in Chapters 5 and 6 of this Plan.

CHAPTER 2 Delaware Estuary/River Basin: Background

2.1 Delaware Estuary/River Basin: An Unique Watershed

2.1.1 Introduction

The Delaware Estuary is one of the largest estuaries in the U.S. and is unique because of its rich history, industrial importance, socioeconomic diversity, and environmental character. The Delaware River Basin includes parts of five States, four eco-regions, and is home to hundreds of different plant communities and fish and wildlife species. About 9 million people live in the basin, mostly concentrated in the lower estuary region.

A principal feature of the system is the Delaware River, which is the longest undammed river in the eastern U.S. and flows into one of the largest freshwater tidal estuaries in the world. Philadelphia, Trenton, Camden, and Wilmington are located in this freshwater tidal region. The Estuary supports the world's largest freshwater port (approximately 3,000 vessels a year) and is the largest receiving center for crude oil, steel, paper, and meat products. The estuary is a naturally muddy system, helping to sustain more than 400,000 acres of wetlands and governing key water quality and ecological characteristics.

2.1.2 Geography of the Delaware River Basin and Estuary

The Delaware River Basin spans more than 13,600 square miles and stretches from the western slopes of the Catskill Mountains in New York to the mouth of the Delaware Bay between Cape May, New Jersey, and Cape Henlopen, Delaware (DRBC 2008). The system can be divided into ten watersheds for characterization (Figure 2.1). The upper and middle watersheds extending down to the head of tide at Trenton, New Jersey, are more forested and less



Figure 2.1: Watersheds of the Delaware River Basin (DRBC)

developed compared to the watersheds below Trenton. Due to healthy forest cover and good riparian conditions, sediment loads in runoff are generally low in areas that are not disturbed.

The Delaware Estuary consists of four watersheds in the lower half of the basin (6,827 square miles), each with a different ecology and land-use: Schuylkill Valley, Upper Estuary, Lower Estuary, and Delaware Bay (PDE 2008). Each watershed has smaller sub-watersheds grouped together based on the segment of the river or bay to which they drain. Sediment runoff in these lower watersheds is variable and closely tied to the degree of disturbance and the presence of dams. Stormwater runoff is a significant water quality problem in many areas.

The Schuylkill Valley region consists of a large portion of the Schuylkill River Watershed in Pennsylvania. The landscape is mainly forest and mountains in the north, farmland and woodland in the middle, and residential suburbs of Philadelphia in the south. This region contains crucial headwater streams that make their way to the Schuylkill River, which provide drinking water to 1.75 million people.

The Upper Estuary region encompasses the area between Trenton, New Jersey and the Pennsylvania Delaware border, which also includes the cities of Philadelphia and Camden. The main stem of the Delaware River cuts through this region, which makes riverfront industry, development, and several major ports critical economic resources as well as a major sources of legacy industrial contaminants impacting water and sediment quality and quantity. This area contains forest habitat and a rare type of freshwater tidal wetlands that is increasingly imperiled in the Delaware Estuary.

The Lower Estuary region stretches south from the Delaware-Pennsylvania border to the opening of the tidal Delaware River to Delaware Bay. The region is characterized by gently sloping Piedmont topography in the north, relatively flat coastal plain to the south, and a combination of forests, farmland, and tidal and non-tidal wetlands. The Port of Wilmington provides a significant economic resource. Salt and fresh water mix in this portion of the Delaware River, which creates the physical conditions needed to trap sediments, leading to the Estuary Turbidity Maximum (ETM) where the water is muddiest. While this turbidity and trapped mud can be a problem for water quality and some living resources, it is also a crucial ecological resource that helps sustain fringing tidal marshes. It also means that navigation channels in the river often need to be dredged annually to keep shipping lanes open (Figure. 2.2).

The Delaware Bay region from the end of the Delaware River to the Atlantic Ocean is characterized by relatively flat coastal plain topography, extensive salt marshes, some sandy beaches, a mix of large farms and low-lying forests inland, and populous beach towns where recreation and tourism are important to the local economy. A hallmark feature of the Delaware Bay shoreline is a nearly contiguous fringe of coastal wetlands that provide flood protection, sustain fish and shellfish production, and help to maintain water quality. Nutrient runoff from agriculture and increasing development are major concerns along with eroding salt marshes.



Figure 2.2: Hydraulic Dredge on the Delaware River.

2.1.3 History

The formation of the Delaware River valley is believed to have begun during cycles of erosion and uplift approximately 30 to 50 million years ago. Below Trenton, the river follows the bedrock formations of the Piedmont. However, it doesn't follow normal river development patterns at Trenton where it was diverted in a right-angle turn by softer sediments instead of eroding through harder strata up to that point and it is still unclear how the river formed its current path. One theory is that the ancestral Delaware and

Schuylkill Rivers flowed southeast through New Jersey, but were redirected to follow paths of smaller streams flowing parallel to the southwest, eventually creating the existing Delaware River and Bay (State of the Delaware River Basin Report 2008).

The study area is not only significant because of its geology, but it is also one of the few regions in North America that has been urbanized for more than three hundred years (Berger et al. 1994). Since the first settlers, the water resources of the Delaware Estuary have been used for industrial purposes, from gristmills to nuclear power plants. Philadelphia was the first major city of the New World, the initial seat of the U.S., and the principle corridor for commerce that sustained the Industrial Revolution in America. Both historically and today, the Port of Philadelphia is a major strategic port for both national defense and industry.

In 1682, Philadelphia was founded by William Penn, and by 1700, it had 5,000 inhabitants. Penn's settlement grew to become America's pre-eminent city and port. The growth of agriculture was largely responsible for Philadelphia's dominance as a commercial center and for the accelerated transformation of the Delaware Estuary watershed from a wilderness to a pastoral landscape. Large forested areas were cleared, resulting in erosion and loss of topsoil. These soils altered the topography of the estuary. Shoreline dredging, diking, and filling began during this period, resulting in extensive shoreline reconfiguration and tidal marsh loss, especially north of Wilmington. It is estimated that less than 5% of the pre-settlement acreage of tidal freshwater marshes remain, and less than 50% of all coastal wetlands remain across the estuary (PDE 2008).

By 1950, the urban reach of the Delaware River was one of the most polluted stretches of river in the world. Throughout the 1950s, the Philadelphia region of the river had almost zero oxygen during most of the warmer months of the year resulting in massive fish kills and elimination of spawning runs for shad and salmon. Throughout the 1960s and 1970s, increased State, interstate, Federal, and public interest in pollution control, and the passage of the 1972 Clean Water Act, led to dramatic improvements in water quality (PDE 2008). A major indicator of these improvements was the observed increased dissolved oxygen concentrations in the water.

While the four States (Delaware, New Jersey, New York, Pennsylvania) in the Delaware River Basin remain autonomous, the system is also unique because it is the only national watershed having both an interstate-Federal Commission and a National Estuary Program in place (a fifth State, Maryland, only comprises about 8 square miles of the basin and is not a member of the DRBC). The 1961 Compact establishing the DRBC was the first Federal-interstate agreement for basin-scale water resources management. Because of its importance as a natural resource, the intensity of human activities within its watershed, and the breadth and complexity of its issues, the Delaware Estuary was nominated by the Governors of Delaware, New Jersey and Pennsylvania for inclusion in the National Estuary Program in 1988 (a.k.a., PDE).

Today, the Delaware Estuary and River Basin is not pristine, but it is much cleaner than at any time in the past century (DRBC 2008, PDE 2012). Over 90 percent of the estuary meets the swimmable and fishable goals of the Clean Water Act. Consequently, recreational use is growing on the tidal river. Greenway trails are being established, linking historic sites, wildlife areas, and recreational facilities. However, many environmental concerns remain. Population growth by 2100 is expected to increase by 80% and associated future socioeconomic development along with projected changes in climate conditions are expected to put additional pressures on natural ecosystems (PDE 2010). A key to maintaining both environmental and economic health will be managing sediment to ensure it is available where it is needed, and removed or redirected in areas where it is not.

2.1.4 Ecological Significance

The Delaware Estuary and River Basin is globally recognized for its many significant ecological characteristics. The heavily forested upper basin contains world renowned coldwater trout fisheries and rare and endangered freshwater mussels. Three quarters of the non-tidal river (about 150 miles or 241 kilometers) has been included in the National Wild and Scenic Rivers System. More than 200 fish

species live in the watershed (PDE 2006), including important diadromous fish such as American shad and American eels that are able to take advantage of the undammed nature of the main stem Delaware River. In the estuary region, two species of sturgeon have long been imperiled, but recent positive signs suggest that Atlantic sturgeon might be reproducing locally for the first time in decades (PDE 2012). Similar to trout in the upper basin, species such as striped bass, weakfish, and flounder support a vibrant and economically important recreational fishery in the estuary (PDE 2012).

The Delaware Estuary hosts the largest concentration of spawning horseshoe crabs in the Western Hemisphere (Dove and Nyman 1995, PDE 2006; Figure 2.3). Hundreds of thousands of shorebirds depend upon horseshoe crab eggs to fuel their northward migrations and breeding. They stop along the shorelines of Delaware Bay to rest and feed almost exclusively on horseshoe crab eggs. During peak activity, this is the second-highest concentration of shorebirds in North America. In addition to their ecological importance, the blood of horseshoe crabs is important for pharmaceutical drug-testing and nonlethal crab harvests represent their commercial value.



Figure 2.3: Horseshoe Crabs in the Delaware Estuary (Elizabeth Horsey, PDE).

Other important commercial shellfish are blue crabs and oysters. Blue crabs are the most important commercial fishery in the watershed (PDE 2012), and many of the harvested crabs are exported to sustain demand in neighboring watersheds such as the Chesapeake Bay. The Eastern oyster is regarded as a keystone species that has a large effect on its environment relative to its abundance (Figure 2.4). The Eastern oyster supports a viable industry and provides critical ecological functions by filtering water and enriching bottom habitat. Oysters are also a cultural-historical resource that was a key dietary staple pre-industrialization and for Native Americans.

Oyster harvesting reached its pinnacle in Delaware Bay in the 1880s with 2.4 million bushels harvested by more than 500 oyster vessels on the bay. Oyster harvests dropped first due to overfishing in the early 20th century and then because of non-native oyster diseases that arrived in the 1950's (MSX) and 1970's (Dermo); Delaware Bay oysters continue to be caught and regarded as a high quality seafood product. For the first time in 2011, the Delaware Bay oyster fishery was described as a "sustainable" seafood product. This is in large part due to recent shell planting investments and careful cooperative management by State agencies, industry professionals and scientists. The future of oysters in Delaware Bay will depend on continued restoration investments that adapt to changing conditions (Kreeger et al. 2010, 2011).



Figure 2.4: Example of an Oyster Vessel on Delaware Bay.

Numerous other ecologically significant fish and wildlife call the Delaware River Basin home, including Federally-endangered species such as dwarf wedgemussels in the upper basin, bog turtles in the middle basin, and shortnose sturgeon in the estuary (DRBC 2008, PDE 2008). The eastern brook trout is the official State fish of both New Jersey and Pennsylvania, but brook trout habitat has been virtually eliminated in urban tributaries due to land-use changes, development, acid rain, deforestation, and warming trends. In response, freshwater mussel species that depend on brook trout for their reproduction, such as eastern pearlshells (*Margaritifera margaritifera*), also have declined and only now exist below cold water reservoirs (Kreeger et al. 2010). Most of the 12 native species of freshwater mussels from the Delaware River Basin are State or Federally listed as imperiled, which is symptomatic of the nationwide decline of this mollusk taxon (PDE 2008). The loss of once mighty mussel beds in streams and rivers is thought to have contributed to declines in water quality due to lost water filtration

benefits. Mussel beds filter suspended sediments and decrease bed transport by stabilizing bottom sediments.

The watershed contains a wide range of natural habitats, including 185 discrete vegetation community types and 35 ecological systems (Westervelt et al. 2006). Many of these are rare or unique, including serpentine barrens containing rare wildflowers and freshwater tidal marshes with wild rice and pickerelweed (Figure 2.5). One of the most notable features of the entire basin is the 405,000 acres of wetlands in the watersheds of the estuary. Wetlands comprise a greater portion of basin area (10.8%) than the national average (5.5%), mainly because of the near contiguous fringe of coastal marshes that surround the tidal estuary (PDE 2012). Tidal wetlands are the most productive habitat in the system and perform many vital services. They are critical to protecting inland areas from tidal and storm damage; provide water storage to protect against flooding; provide important habitat to a wide variety of wildlife, including waterfowl; serve as a filter to remove contaminants and help sustain water quality; provide spawning and nursery habitat for commercial fisheries; support active and passive recreation; and provide aesthetic value. Unfortunately, both forests and coastal wetlands continue to be degraded and lost in the Delaware Estuary (PDE 2012) and they are increasingly threatened by climate change (Kreeger et al. 2010).



Figure 2.5: Wild Rice and Pickerelweed in a Freshwater Tidal Marsh of the Delaware Estuary.

Sediment is an important structural and functional component of many natural habitats in the Delaware River Estuary. For example, suitable beach areas are needed for horseshoe crabs to lay their eggs and for migratory birds to feed on those eggs. Tidal wetlands require adequate supplies of sediment for their health and maintenance. Blue crabs, anadromous fish, and other species need sediment with specific characteristics for spawning, feeding, etc. Managing sediment at a variety of spatial and temporal scales is necessary to maintain the health of the Delaware River Estuary ecosystem.

2.1.5 Economic Importance

In addition to the global ecological significance of the Delaware Estuary and its watershed, it is also regionally and globally important as a center of commerce. Although about 9 million people live within the Delaware River Basin, the system supplies drinking water to 15.2 million people due to exports. The region also has one of the world's highest concentrations of heavy industry, and the urban corridor contains the world's largest freshwater port complex. More than 2,500 large vessels per year visit the ports, supplying approximately 70 percent of the petrochemical gasoline and heating oil needed to fuel the East Coast, as well as other imports, and is worth \$19 billion in annual revenue.

A recent study by the University of Delaware's Institute for Public Administration and the PDE found that the natural resources of the Delaware Estuary watershed provide tremendous economic value to our region (Figure 2.6). Using economic activity as a measure of market value, the Delaware Estuary contributes over \$10 billion in annual economic activity from recreation, water quality and supply, hunting and fishing, forests, agriculture and parks (Kauffman et al. 2011). These market values are calculated from the sale/purchase of watershed goods such as drinking water, fish, or hunting supplies.

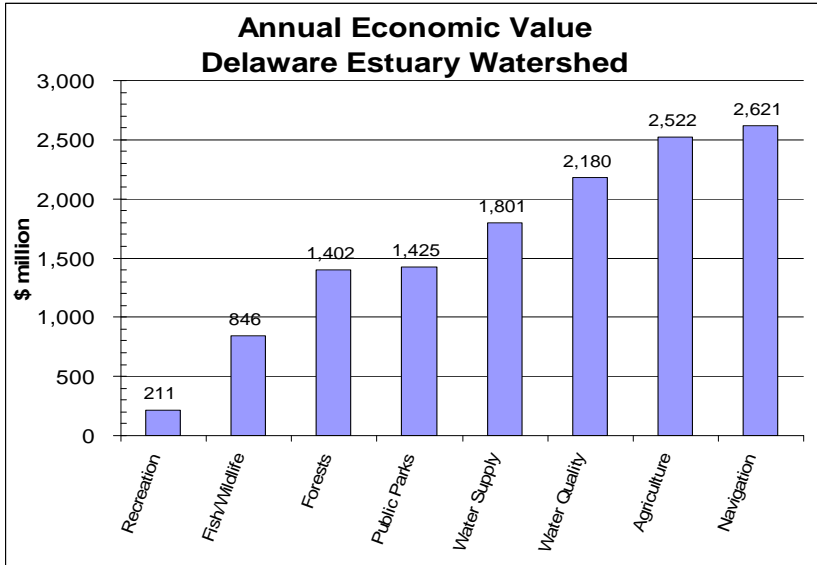


Figure 2.6: Estimated Annual Economic Value of Key Natural Resource Uses in the Delaware Estuary and River Basin (Kauffman et.al. 2011).

Non-market values can also be calculated based on the benefits that natural ecosystems provide to society, such as pollution removal by forests, water filtration by shellfish reefs and wetlands, public willingness to pay for water quality, forest and wetland carbon storage benefits, and health benefits of parks (Figure 2.7). The value of these benefits from ecosystems in the Delaware Estuary watershed is \$12 billion (2010 dollars) with net present value (NPV) of \$392 billion, using a discount rate of 3% over 100 years.

Ecosystem services by State: Delaware (\$2.5 billion, NPV \$81.9 billion), New Jersey (\$5.3 billion, NPV \$173.6 billion), Pennsylvania (\$4.1 billion, NPV \$132.0 billion), and Maryland (negligible). Totals were rounded down to avoid double counting and ensure values are not overstated. Total non-market values are comparable to market values (compare Figures 2.6 and 2.7), making any programmatic effort to preserve them at least as important as preserving direct capitalized products and services.

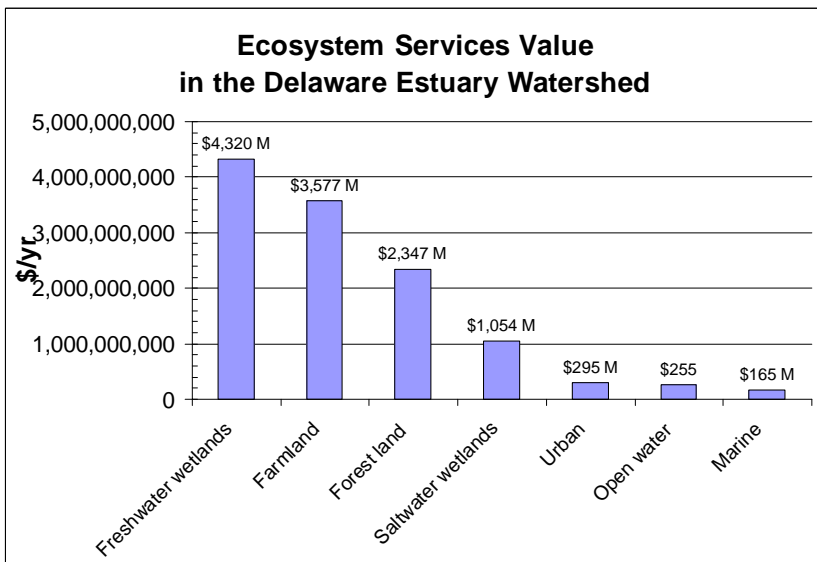


Figure 2.7: Estimated Ecosystem Service Values for Various Habitat Types in the Delaware Estuary and River Basin (Kauffman et al. (2011).

Another perspective on the economic importance of the Delaware Estuary and River Basin is the number of jobs that are supported from use of natural lands, goods, and services. More than 500,000 direct and indirect jobs having \$10 billion in annual wages are associated with coastal, farm, ecotourism, water/wastewater, recreation, and port industries (Kauffman et al. 2011) (Figure 2.8). Totals referenced above were rounded down to avoid double counting and ensure values are not overstated. Jobs directly associated with the Delaware Estuary watershed (i.e., water/sewer construction, water utilities, fishing, recreation, tourism, and ports) employ 192,785 people with \$4.3 billion in annual wages.

2.2 Ecosystem and Natural Resources

2.2.1 “Mud-driven” Ecology

Fine sediment (mud) is an integral component of the Delaware Estuary, more so than most large American estuaries, because of complex geological and hydrodynamic interactions that we are still striving to understand. The large freshwater tidal estuary, combined with a sizeable drainage basin, functions as a sediment trap whereby river-derived suspended sediments get concentrated within the mixing zone between fresh and salt water. The lack of dams on the mainstem Delaware River likely also helps preserve the natural “muddy” character of the estuary since there are no dams to trap sediments. New sediment enters the system from a variety of sources including direct stormwater runoff, river bank erosion, loading from tributaries (bank erosion, channel bottom scour, upland sheet, rill, and gully erosion from various land uses, dam removals), and tidal action. Most of the material (60%) is carried down the Delaware River from the watershed above Trenton. Another 20% comes from the Schuylkill and Christina Rivers (*Sediment Quantity and Dynamics White Paper*, Appendix A).

The mixing zone extends for tens of river miles and the location of the mixing zone varies in time and space with river flow conditions. As a result, the direct ecological effects of this “estuary turbidity maximum” (Figure 2.9) extend over a broad expanse of the middle and lower estuary (generally between Wilmington, DE and the near the Chesapeake and Delaware (C&D) Canal where the river opens to the bay). In this region, sediments accumulate in the water column, on the bottom, and along the shores, helping to sustain abundant tidal marsh habitats that depend on some river-derived sediment to keep pace with sea level rise. Above and below this sediment-rich, high-



Figure 2.8: A Large Container Ship, Oyster Boat, and the Tall Ship *Meerwald* in the Delaware Estuary.

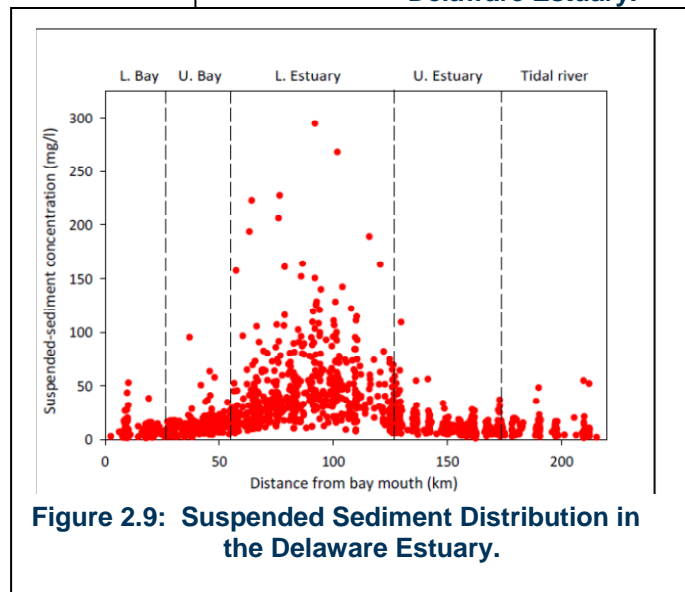


Figure 2.9: Suspended Sediment Distribution in the Delaware Estuary.

turbidity mixing zone, the Delaware Estuary generally has higher-than-average sediment concentrations as well, although turbidity can be low at times in the upper estuary and in Delaware Bay. Scientists are working to determine how effectively the estuary and associated wetlands trap sediment supplied by rivers.

High sediment concentrations can have either positive or negative ecological effects, depending on the habitats or species. For example, high turbidity can impair filter-feeding organisms such as oysters and mussels, which are keystone species in the Delaware Estuary. These animals feed mainly on phytoplankton and other organic particles, and high concentrations of suspended sediments can therefore reduce their food quality and particle sorting efficiency. Furthermore, high turbidity reduces light availability in the water column, which can constrain production of phytoplankton.

But this same light shading effect can be beneficial for water quality in nutrient laden areas of the estuary by constraining nutrient-fueled (over)production of algal blooms that lead to eutrophication problems (anoxia, fish kills). Despite having some of the highest nutrient loadings of any major estuary in the U.S., the Delaware Estuary does not routinely experience stereotypical eutrophication stress (e.g. Chesapeake, Barnegat Bays) thanks in part to naturally high suspended sediment conditions.

A second major ecological benefit of high sediment concentrations is believed to be the contribution to coastal wetland health and survival. Tidal marshes are a signature habitat of the Delaware Estuary, fringing most shores and providing critical ecosystem goods and services (see above; Figure 2.10). Healthy marshes build themselves up and keep pace with sea level rise by retaining some dead plant production (peat) as well as capturing suspended sediments (mud). The naturally high sediment loads help to support the health of tidal wetlands.

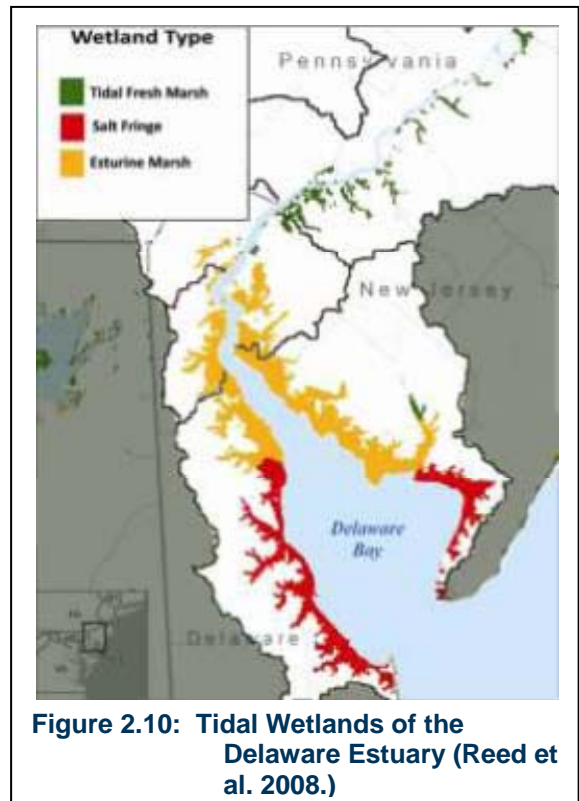


Figure 2.10: Tidal Wetlands of the Delaware Estuary (Reed et al. 2008.)

Since the tidal portion of the watershed is regarded as naturally “muddy” with key features that depend on high sediment concentrations, sediments should be valued and managed as a critical natural resource in this portion of the watershed. Above the head of tide in the system, these same sediments are regarded as a water quality impairment when suspended in high concentrations. Here, sediment runoff must be controlled to preserve ecological integrity.

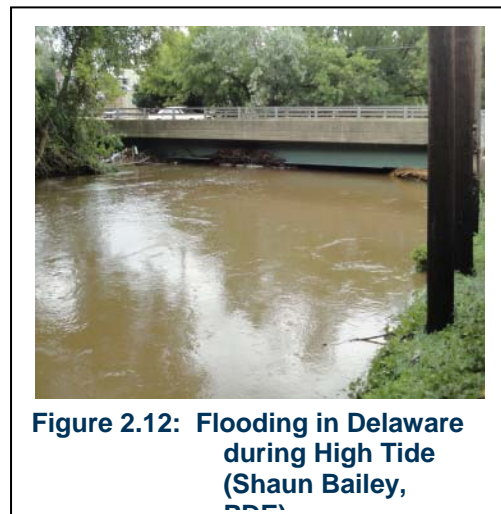
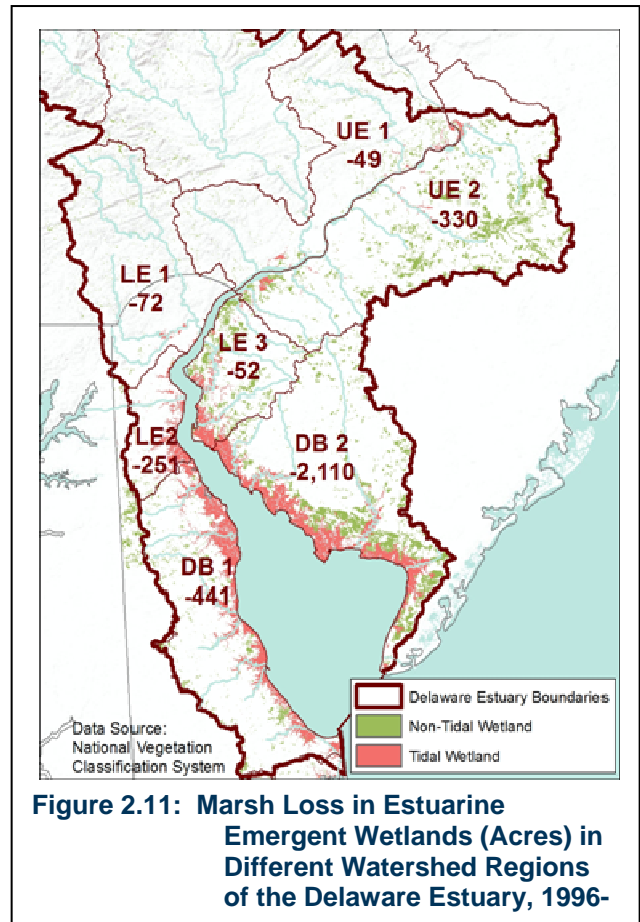
The Delaware Estuary is naturally “muddy” and rich in coastal wetlands, which is more similar in many ecological features of the Mississippi River delta than other large Mid-Atlantic estuaries. Managing high sediment concentrations can be challenging for sustaining water quality in streams and rivers as well as port operations that require deep navigation channels. Since the late 1800s, providing access for waterborne commerce has necessitated the dredging of large quantities of sediments; most being placed in upland CDFs on the banks of the Delaware River, and thereby removed from the estuarine system. The ecological effects of this removal are not well understood. Some important tidal habitats require sediment subsidies and suspended sediments may help abate nutrient-associated water quality problems in the estuary.

The most recent quantitative sediment budget compiled for the estuary reveals that sediment sources and sinks are roughly balanced, but it is unclear whether this balance represents a natural equilibrium state or disequilibrium state. River inputs, bottom erosion and marsh erosion appear to be significant contributors of sediment within the system while predominant sinks removing sediment from the system include dredging, accumulation by marshes, and sub-tidal shoal development. Since river inputs of sediment have been decreasing and maintenance dredging of navigation channels represents a major sediment sink, there should be less sediment currently in the system than historically; however, the balanced sediment budget might be subsidized by enhanced erosion of bottom habitats and coastal wetlands (Figure 2.11). These important processes for estuary-wide sediment dynamics merit thoughtful scientific analysis. Careful sediment management is paramount to balancing ecological and economic needs.

2.2.2 Future Change

Like elsewhere in the U.S. and world, the Delaware Estuary watershed and its natural resources will face many challenges with climate change (Kreeger et al. 2010). Sediment supply from the watershed is likely to increase due to projected increases in precipitation by 7-9% by 2100, with more falling in winter and during heavy precipitation events. The additional runoff in pulsed events will erode more land surface and increase sediment loads unless mitigation measures are taken. More recent future projections past 2040-2050 will be available in the 2012 Technical Report for the Delaware Estuary and Basin.

Increased rates of sea level rise are likely to affect sediment dynamics (and ecology) in many different ways. The current consensus is that sea level will rise by 0.5 to 1.5 meters or more by 2100. Sea-level rise will result in larger tidal volumes that bring more salt water up the estuary. Higher sea level will increase estuary tidal volume, enhancing tidal ranges in the upper estuary and increase saltwater concentrations (salinity). Models suggest that the increase in river runoff from added precipitation will not be sufficient to buffer this increase in salinity, especially during the summer. Increased salinities would likely cause an up-bay shift in the location of the mixing zone, which largely governs the location of the prevailing sediment trap (estuary turbidity maximum). Species and habitats that are adapted to, or depend on, high and low sediment conditions will be affected geographically (Figure 2.12). Coastal wetlands may not be able to keep pace with sea level rise *en masse* once the rate exceeds a maintenance threshold whereby sediment capture and vegetation production are insufficient to enable wetland surfaces to accrete fast enough. Associated wetland losses are predicted to be 25-75% of 2000



acreage by 2100 (Kreeger et al. 2010). If realized, the erosion of accumulated peat and sediment from converting marshes will dramatically increase suspended sediment loads and mud flat and shallow subtidal (shoaling) habitats (Figure 2.13).

Climate change will occur alongside other changes in the fabric of the watershed. Continued rises in human population (expected 80% increase by 2100) will increasingly tax our natural and built infrastructure, with anticipated loss of open space, fragmentation of natural habitats, and rising demands for clean water. Climate change and continued watershed change will interact in complex ways. Environmental resource managers will require new ways to predict climate impacts in order to adapt appropriately. Sediment management will be similarly affected, requiring advanced, integrative modeling that can forecast future sediment conditions that will result from three interacting variables: 1) system alterations for which we have control over (e.g. flow management, dams, stormwater control, channel deepening, maintenance dredging, living shorelines), 2) watershed changes associated with population increase and development that we have less control over, and 3) global and regional climate changes that we have still less control over.



Figure 2.13: A Healthy Riparian Corridor along a Stream Helps Retain Sediment in Uplands (Photo: PDE).

2.3 Restoration and Management

The RSMP is intended to serve as a watershed-based guide for improving the effectiveness of sediment management for the betterment of both economic and ecological conditions. The intent is for the plan to be implemented by all entities that are interested in and impacted by regional sediment issues/challenges, including restoration. There are several other regional plans that have a nexus in sediment management in the Delaware Estuary and River Basin. These include, but are not limited to:

- > Comprehensive Conservation Management Plan (CCMP) for the Delaware Estuary, prepared by the Delaware Estuary Program (1996)
- > Delaware River Basin Plan, prepared by the Delaware River Basin Commission (2004)
- > Regional Restoration Blueprint, prepared by the Partnership for the Delaware Estuary (2010)
- > Climate Adaptation Plan for the Delaware Estuary, prepared by the Partnership for the Delaware Estuary (2010)
- > Marine Bivalve Shellfish Conservation Priorities Plan, prepared by the Partnership for the Delaware Estuary (2011)
- > The Nature Conservancy-National Fish and Wildlife Foundation (TNC-NFWF) Conservation Priorities (2011)
- > Shoreline Restoration Plan for the Delaware River currently being prepared by The Nature Conservancy.
- > Living Shorelines Plan for the Delaware Estuary and River, currently being prepared by the Partnership for the Delaware Estuary.
- > Dredging, Blasting and Overboard Disposal in the Delaware River Basin (2011 – Delaware River Basin Fish and Wildlife Management Cooperative Fisheries Technical Committee)
- > South Jersey Levee Inventory (2010)

The success of the RSMP will depend on the coordination among the advocates for these plans, focusing on common priorities and resulting in enhanced leveraging of limited funds.

2.3.1 Restoration Needs

Due to the variety of anthropogenic activities that have occurred within the Delaware Estuary and River Basin, the ecosystem/natural resources have been impacted. Conservation, enhancement, and restoration of these resources are needed to preserve crucial life-sustaining conditions and economic vitality. Restoration needs are described in more detail in the *Restoration and Beneficial Use White Paper* included as Appendix B. Despite

these needs, the level of restoration investment per capita and basin area is much lower in the Delaware River Basin compared to other large American estuaries (Figure 2.14). Increased investment in conservation and restoration would significantly facilitate attainment of sediment management goals, especially if increased restoration effort follows strategic regional restoration principles (PDE 2009) and addresses strategic priorities (TNC 2011). These strategic plans for restoration promote proactive approaches to maximize environmental benefits in areas of greatest need across the watershed. Enhanced monitoring is also needed to track the success of current restoration projects and to refine targeting of habitats where restoration is most needed.

The RSMP focuses on environmental restoration needs that are most directly related to sediment, such as ensuring that necessary sediments are available for habitats and species where and when they are needed, and ensuring that deleterious sediments are reduced where and when they are most problematic. Of special interest are restoration activities that meet multiple objectives, such as the **active** placement (beneficial use) of dredged sediments in places where sediment is in short supply for natural habitat integrity. Of equal interest are projects that promote the **passive** capture of suspended sediment in places where it is needed, such as along riparian corridors (Figures 2.14, 2.15, and 2.16) and tidal shorelines (Figure 2.17). These are all projects that could decrease

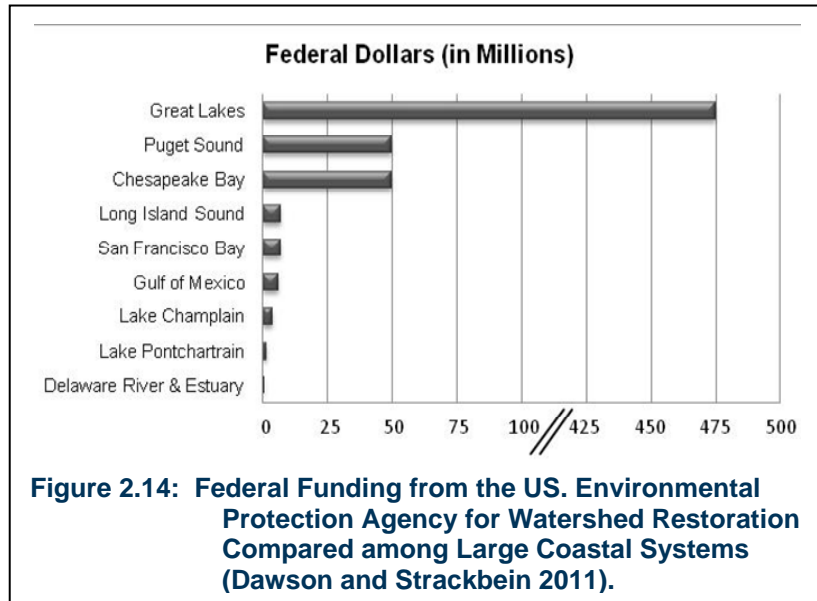


Figure 2.14: Federal Funding from the US. Environmental Protection Agency for Watershed Restoration Compared among Large Coastal Systems (Dawson and Strackbein 2011).

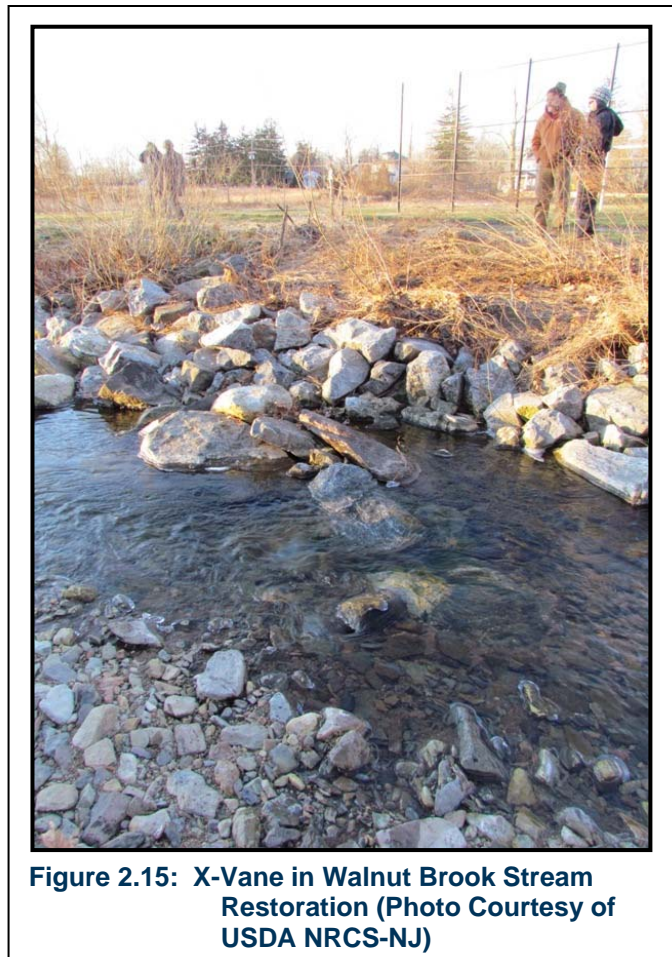


Figure 2.15: X-Vane in Walnut Brook Stream Restoration (Photo Courtesy of USDA NRCS-NJ)

maintenance dredging costs. There are numerous other restoration needs within the basin/estuary that are beyond the scope of this plan.



Restoration needs dependent on sediment or sediment-related processes (or resulting from dredging activities for dredged material management) that could be supported by the RSMP include tidal marsh

creation, restoration, and enhancement; beach/dune development; stream restoration (reduce erosion and resultant sediment loads to the basin/estuary); island creation, and living shorelines.

2.3.2 Management Issues and Monitoring Needs

The science and management community of the Delaware Estuary and River Basin has identified the following specific management issues that have a nexus to sediment management:

- > Maintaining freshwater quantity and quality
- > Assuring public health (e.g. drinking water)
- > Managing nutrient (nitrogen) overload/imbalance (and associated dissolved oxygen)
- > Assessing ecological impacts of dredging (including bottom and marsh erosion, sediment removal from the system)
- > Loss of habitat and population status of key species (e.g., oysters, horseshoe crabs, freshwater mussels, shad, sturgeon)
- > Sources, transport and effects of sediment-borne contaminants of concern

Federal and State agencies have already collected a tremendous amount of monitoring data connected to sediment management (e.g. DRBC 2008, PDE 2008, 2012) and numerous relevant scientific studies are also in progress (Sommerfield and Velinsky 2011, Stammerman 2011, Walsh et al. 2011). More work is needed to predict future conditions and develop strategic tactics for best sediment management and restoration. Sustained and enhanced monitoring is also needed (PDE 2012).

2.4 Conclusion

The Delaware Estuary and River Basin is a unique watershed and one of the most important estuaries in the U.S. The urban region of the tidal river consists of the greater Philadelphia municipal area, the fourth largest municipality in the country. Here, the combined port complex handles thousands of large ships per year, servicing 70% of the oil needs for the east coast. The geologic and hydrodynamic features are characterized by the longest undammed river in the east, draining more than 13,600 square miles, and containing about 9 million people. Clean drinking water is supplied to more than 15 million people including water exports. Associated with its rich history is a substantial pollutant legacy, but the system has undergone a very successful water quality improvement over the last few decades.

The lower, tidally influenced portion of the system is considered mud-dominated, which helps provide natural controls of harmful algal blooms and other eutrophication problems because of light shading in the water column. High suspended sediments in the water result from the large freshwater tidal "mixing zone" which extends over 50 river miles. This large freshwater tidal area, which traps sediment, is ecologically vital, helping to sustain nationally rare types of wetlands as well as a nearly contiguous fringe of marshes along the shores of Delaware Bay.

From a management perspective, the Delaware Estuary system is also unique because of its strong, watershed-based management structure despite encompassing parts of five States. For example, the Delaware River Basin Commission, Partnership for the Delaware Estuary and Philadelphia District of the USACE are all inter-State and operate by watershed-wide management structures. There is also consistent, long-term monitoring for water resources that helps to track status and trends and provide baseline metrics for assessing future changes. Finally, the watershed is home to a sizeable brain trust, having more than 100 academic institutions.

For all of these reasons, the Delaware system is an ideal "laboratory" to study sediment dynamics and to test new approaches for integrated sediment management.

CHAPTER 3 Workgroup Findings and Problem Statements

3.1 Introduction

The goal of RSM is to manage sediment as a resource critical to the economic and environmental vitality of the region, rather than as a localized waste product or pollutant. Where sediment is removed from the natural estuarine system by dredging, it is desirable to maximize its beneficial use. Until the present Delaware Estuary RSM program was initiated in 2009, there was no systematic, collaborative approach to dealing with the challenges and opportunities associated with sediment in the estuary. To date, almost all dredging projects, habitat restoration projects, and attempts at beneficial use of dredged sediments have been accomplished on an *ad hoc*, project-specific basis. The present RSM initiative is intended to broaden local knowledge about how, where, and when to manage parts of the sediment system differently and more beneficially than previously.

The initial step is to understand the sediment processes/dynamics and resultant quantities for management, quality of the sediments to be managed, methods for dredging and managing sediment removed from the system, and potential for ecological restoration and beneficial use of the sediments removed.

Sediment is an integral component of the Delaware Estuary; it plays an important role in the biological, biochemical, and physical processes and its continuous accumulation in navigation channels and berths necessitates dredging. A thorough understanding of the estuary's sediment system is needed in order to develop a defensible RSMP. The Delaware Estuary RSMW developed a set of white papers to establish what is known about the system and its sediment, which are the basis of this chapter. Four white papers were developed: Sediment Quantity and Dynamics, Restoration and Beneficial Use, Dredging and Dredged Material Management, and Sediment Quality. The white papers are included in Appendices A-D, respectively.

This chapter summarizes the general findings of the RSMW for these sediment management topics. The RSMW synthesized the findings of the white papers into a prioritized list of Problem Statements for sediment management within the Delaware Estuary, which are presented at the end of the chapter.

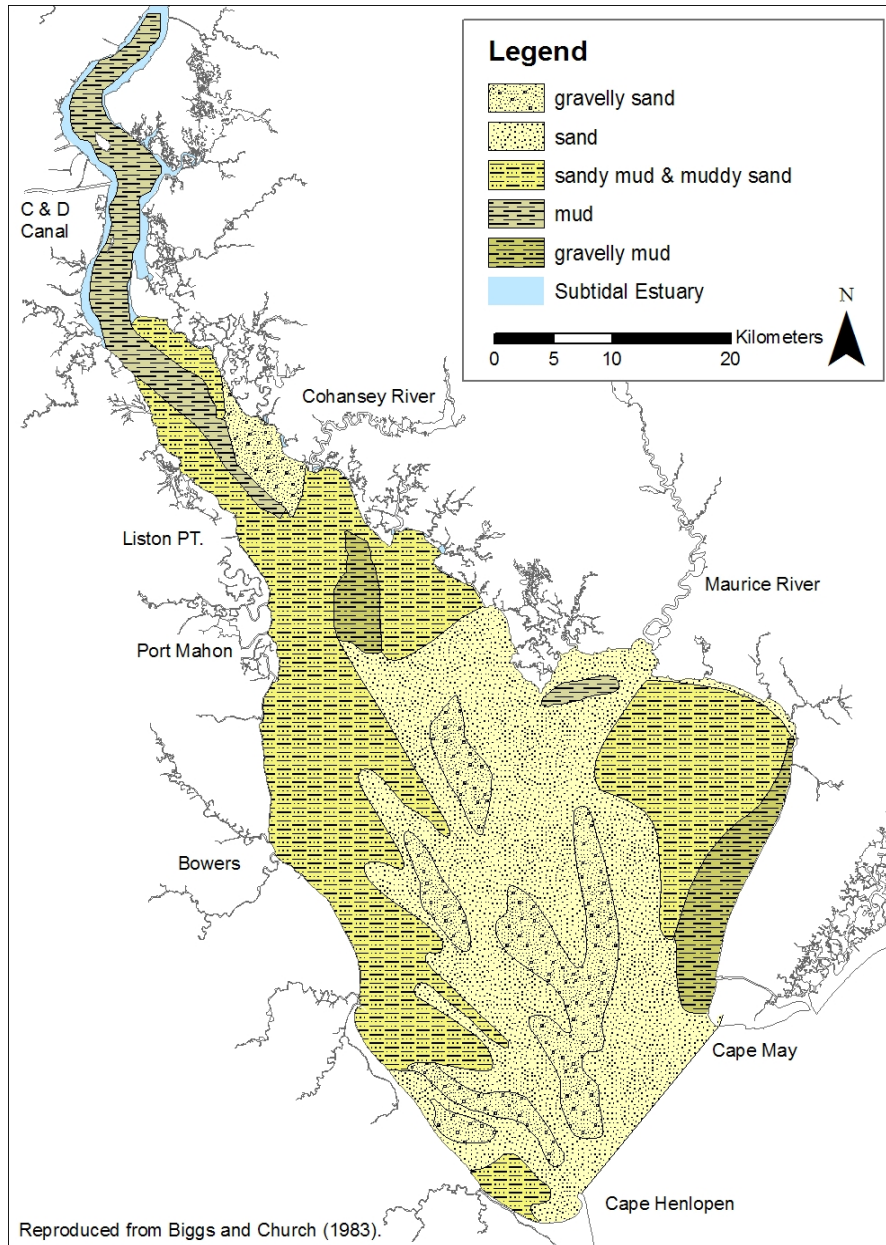
3.2 Sediment Quantity/Dynamics

Benthic habitats and bottom sediments in the Delaware River estuary have been described and mapped (Figure 3.1). Studies have also been completed that directly measured currents, salinity, and suspended sediment at multiple locations in the estuary.

Sediment is the end product of the soil erosion process, which includes detachment, transport, and deposition of the detached soil particle as sediment. New sediment enters the Delaware River Estuary system from a variety of sources, including direct stormwater runoff, river bank erosion, loading from tributaries (due to bank erosion, channel bottom scour, and upland erosion), and tidal action (i.e. from the Atlantic Ocean). Sediment sources and quality are related to the various land use/cover characteristics in the watershed landscape and associated management practices. Table 3.1 shows the land uses in the Delaware River Basin.

The Conservation Effects Assessment Project (CEAP) in the Delaware River Basin consists of 186 sample points representing 342,200 cropped hectares (845,600 acres). The study of CEAP benchmark watersheds revealed that channel contributions are a significant source of sediment. A number of additional studies, in particular those evaluating the effects of historical/current anthropogenic alterations to the stream channels and watersheds, have demonstrated that tributary stream bank erosion is a major source of sediments and associated pollutants (nutrients, etc.).

Figure 3.1: Surficial Sediment Characterization of the Delaware Estuary.



Map of bottom sediment types in the lower Delaware Estuary and Bay. Figure reproduced from Biggs and Church (1983).

Table 3.1: Land Uses in the Delaware River Basin

Land Use	Sq KM	Square Miles	Acres	Percent of River Basin
Agriculture	8,611	3,325	2,127,808	24.4
Barren	144	56	35,584	0.4
Developed	4,819	1,861	1,190,912	13.8
Forest	16,286	6,288	4,024,256	46.1
Water	2,645	1,021	653,568	7.5
Wetland	2,747	1,061	678,848	7.8
TOTAL	35,252	13,611	8,710,976	100

Source: DRBC: NOAA, 2006

Fine-grained sediment derived from watershed runoff/stream bank erosion, and transported in suspension, is the chief source of new inorganic (mineral) sediment in the estuary. The combined sediment load of the piedmont river tributaries is quantitatively the most important source term in the sediment budget. The principal locations at which new upland sediment sources enter the estuary includes the Delaware River at Trenton, the Schuylkill River at Philadelphia, and the Brandywine River (Christina) at Wilmington. Most of this new sediment (56%) originates in the Delaware River watershed above the head-of-tide at Trenton. Another 39% of this sediment comes from the Schuylkill River and 5% from the Christiana River watersheds equating to approximately 1.3 million metric tons per year. The amount of new sediment discharged into the estuary each year is highly correlated with the freshwater discharge from these three upper basin watersheds into the estuary. The Delaware River Estuary acts to trap and store these sediments within the system. The efficiency of this trapping is incredible; radionuclide dating of river sediments indicates that much of the sediment retained in the system can be attributed to erosion from 19th century agriculture.

The Delaware Estuary has been extensively modified by urban and industrial development over the past two centuries. Since the late 1800s, providing access for waterborne commerce has necessitated the construction and deepening of navigation channels and berths, resulting in the dredging of large quantities of sediment. Since 1955, the vast majority of dredged material has been placed in upland CDFs located along the banks of the Delaware River. Dredging plays a dominant role as a sediment sink, which permanently removes sediment from the estuarine system.

The most recent quantitative, published sediment budget for the estuary found the overall sediment sources and sinks are roughly balanced. Bottom erosion is the largest contributor of sediment transported within the system. The major sinks removing sediment from the system (i.e. making it unavailable for future transport throughout Delaware River and Bay) are dredging and sediment accumulation in marshes (Table 3.2). Other aspects of the overall budget, such as sediment transfer between the Lower Estuary and the Bay, are poorly understood.

Table 3.2: Delaware Estuary Sediment Mass Balance.

1950-1985 Estuary Sediment Mass Balance			
Sources		Sinks	
Bottom Erosion	3.4	Dredging	2.8
Rivers	1.3	Marshes	2.1
Phytoplankton	0.23	Subtidal Shoals	0.63
Waste/Industrial	0.17		
TOTAL SOURCES	5.1	TOTAL SINKS	5.5
Note: Sources and sinks shown in millions of metric tons per year			

The zone of the highest suspended sediment concentration and muddy bottom, referred to as the ETM (estuarine turbidity maximum), occurs in the range between Artificial Island, NJ and New Castle, DE (80-100 km above the bay mouth). The ETM results from complex interactions of freshwater inflows from upstream sources with denser more saline water from the Atlantic Ocean. Studies from the 1970s to the present consistently note the importance of gravitational circulation causing a net inflow of more saline water along the deeper center of the estuary and its influence on maintaining the ETM.

Understanding the ETM is important in formulating effective regional sediment management measures. The principal processes related to the development of the ETM include fluvial transport, tidal transport, gravitational circulation, and tidal pumping. The ETM is the zone with the greatest mass of mobile sediment, the most active and complex sediment transport mechanism, and the location of several navigation channel segments where most maintenance dredging is performed (Marcus Hook, Deepwater and New Castle ranges of the Delaware River and Wilmington Harbor on the Christina River). Of all the sources and sinks in the estuarine sediment budget, dredging and dredged material disposal practices offer the greatest opportunity for development of a sustainable plan to balance the estuarine sediment system.

While extensive research has been conducted on sediment transport processes in the tidal portions of the Delaware River, much less research has been conducted in Delaware Bay. This lack of attention has occurred despite the fact that the Bay constitutes about 80% of the total estuary surface area and 63% of the estuary's volume. This region is ecologically important for its tidal marshes and marine habitats for a diversity of organisms, including oysters, horseshoe crabs and migratory shorebirds. There has been a persistent decline in the extent of shoreline marsh due to erosion and subsidence. This loss of fringing wetlands is evident from comparison of surveys and maps of the shoreline that extend back to at least 1849. Sandy barrier shorelines have also been observed to be eroding or retreating over the course of the past several decades. The causes of these losses are uncertain, but may be a combination of sea level rise, and increased ship traffic.

The research activities in the Bay have provided insight into various aspects of sediment transport in the estuary. Of particular interest was the export of sediment out of the Bay; bottom erosion was found to be dominant on the east (New Jersey) side of the bay, with buoyant outflow of sediment occurring in shallow areas along the shorelines. Fine-grained sediment (clay and silt) that accumulates in nearshore shallow regions of the lower Bay is subsequently exported to the coastal marshes located along the Atlantic Ocean side of the Cape May peninsula. In contrast, the more saline inflow from the Atlantic Ocean is concentrated in the central deeper navigation channel, with the Bay acting as a sink for coarse-grained sediment (sand) entering during flood tide at Cape May and Cape Henlopen.

Much work remains to be done to fully understand of the dominant processes transporting sediment into and out of the Delaware Bay. Some of the remaining questions include:

- > How does the estuary's geometry affect bottom erosion (or bottom accretion)?
- > What is the role of tidal marshes as a sediment source or sink? Further monitoring and study is needed to better understand the quantitative impacts of marsh accretion (a sediment sink) and marsh erosion (a sediment source).
- > Can basin-wide sources, sinks, and processes be better understood by considering coarse and fine-grained sediments separately?
- > How do biological and chemical properties influence the behavior and fate of suspended sediment?
- > What are the causative factors for the progressive decline in average annual volume of dredging from navigation channels?
- > Why do sediment fluxes occurring in the deeper central portion of the estuary behave differently compared to those in shallower marginal areas to the east and west?
- > What are the processes in play that cause erosion of fringing marshes, and interior marshes reverting to shallow open water?

The present estuary sediment budget is spatially incomplete. A sediment budget has been established for the Philadelphia to Bombay Hook section of the Delaware River; however, this reach represents only approximately 20% of the total area of the estuary. A quantitative assessment of historic dredging of the navigation channel from Philadelphia to Trenton would be to improve our understanding of sediment transport processes. Given the complexity of the estuarine sediment transport system, development of a robust sediment transport model will be instrumental in the development of the RSM initiative.

3.3 Dredging and Dredged Material Management

Dredging and dredged material management in the Delaware River and Estuary are performed primarily for the purposes of constructing, improving, and maintaining a maritime transportation system. Vessels that use the navigational infrastructure of the Delaware River range in size from small recreational vessels that are less than 25 feet in length and draw less than 10 feet of water up to large commercial vessels that are hundreds of feet long and draw 40 feet of water or more. Since the natural depth of the Delaware River cannot accommodate all uses in all places, a system of channels has been constructed that provides access from the land to deeper water. There are 130 miles of engineered waterway in the Delaware River that are connected to numerous public and privately owned berths and terminals.

Most of the navigation channels in the Delaware River and Estuary were constructed by the USACE. The construction depth of these channels was authorized by Congress. Since the main channel is a Federal channel, local and private channels, as well as berths and terminals, are practically limited in depth to that of the main channel (Table 3.3). The USACE, in partnership with the Philadelphia Regional Port Authority, is currently deepening the main channel from Philadelphia to the Atlantic Ocean from 40 to 45 feet. This deepening will require the dredging of over 16 million cubic yards of sediment. Authorized channel depths in the rest of the navigation system in the Delaware River and Bay range from 6 feet (Mispillion River) to 40 feet.

Table 3.3: Authorized Federal Channels for the Delaware Estuary

Project Description	Distance in Miles	Depth in Feet	Width in Feet
Delaware River <i>Philadelphia to Trenton</i>	24	40	400
	5	35	300
	1	<i>varies</i>	200
		<i>(20-8)</i>	
Delaware River <i>Philadelphia to the Sea</i>	55	40	1000
	43	40	800
	9	40	800 to 400
Delaware River <i>At Camden</i>	4	<i>varies</i>	800
		<i>40 to 18</i>	
Schuylkill River	3.5	33	300 to 400
	1	26	200
	2.5	22	200
Christiana River <i>Wilmington Harbor</i>	1	38	340
	0.5	35	400
	4	21	250 to 200
	4	<i>10 to 7</i>	<i>200 to 100</i>
Salem	4.10	16	150
	1.00	16	100
Murderkill River	8.5	7	60
Mispillion River	2.4	6	60
Cedar Creek	0.71	5	80
	0.47	5	50

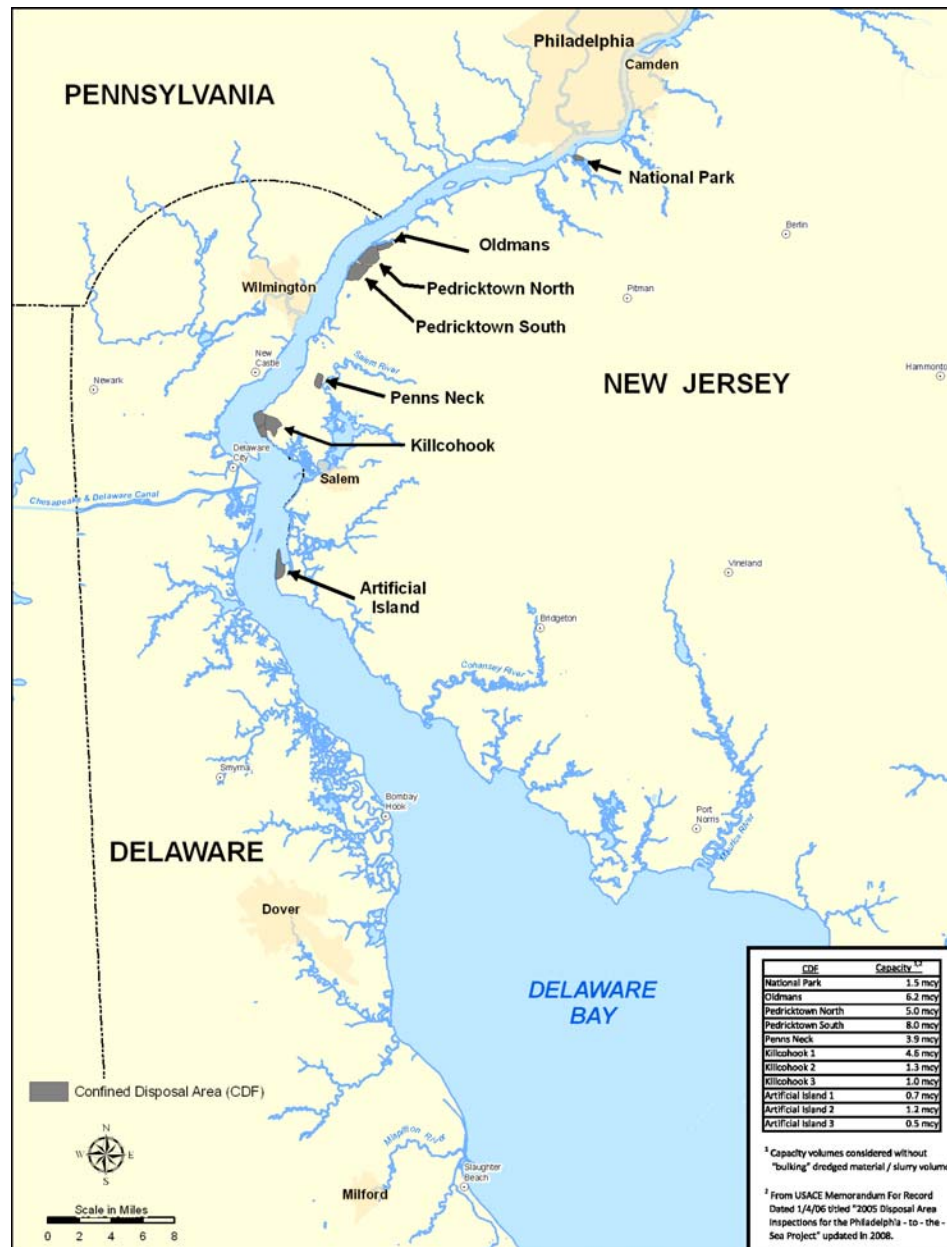
Maintenance of this system requires that approximately 4 million cubic yards of sediment be dredged and managed every year. About 95% of the dredging is performed by the USACE to maintain authorized depths in the main access channels; the remainder is performed by private entities. Most sediment is dredged hydraulically using cutterhead or trailing suction hopper dredges and pumped via pipeline to upland confined disposal facilities (CDFs) on the shore. These facilities range in size from approximately 100 acres to 700 acres. Dredged material placed in CDFs is dewatered through a gravity assisted drainage system and the water discharged back to the Delaware River through a weir. Some private dredging is performed using conventional bucket dredges (Figure 3.2), but the sediment is usually taken to a holding area near shore and hydraulically pumped into a CDF. Not all dredged material is taken upland. Approximately 100,000 cubic yards of sand are dredged annually from the Brandywine Range in the lower Bay and deposited at Buoy 10. Regardless of the method of dredging, all activities are regulated by the USACE and the State in which the dredging and dredged material management occurs.

Figure 3.2: Photographs of Dredging Operations



There are eleven known Federal confined disposal areas located along the banks of the Delaware River and Bay (Figure 3.3). The capacity in these facilities ranges considerably, depending on location. Currently, the Federally-owned facilities along the lower section of the Delaware River (from Philadelphia to the Atlantic Ocean) have approximately 40 million cubic yards of capacity, more than enough for 20 years of dredging. The State-owned CDFs along the upper section of the Delaware River from Trenton to Philadelphia are at or near capacity. The type of material stored in the CDFs varies in both physical and chemical makeup, from clean sand and gravel to silts and clays contaminated by a variety of chemicals of concern at various concentrations. Many of the facilities have never been formally inventoried. Some of the more valuable sand and gravel is periodically removed by private construction firms under contract to the States or the USACE. The State of New Jersey is currently inventorying the facilities along the New Jersey side of the Delaware River to determine the nature and potential value of material stored there.

Figure 3.3: USACE CDF Locations on Delaware River



Because most dredged material in the Delaware Estuary consists of fine-grained silty sediment, it is often categorized as waste. However, sediment is the backbone of the riverine and estuarine ecosystem and is a critical natural and ecological resource. The physical makeup of the sediment is determined by a combination of land use and hydraulic characteristics and ranges from gravel to fine silt and clay. The physical makeup drives the ecology of a given section of river. The Delaware Estuary is naturally silty, especially in the estuarine regions between Philadelphia and Liston Point. Silt is a critical component of the natural cycles of wetland accretion and loss and also acts to minimize algal blooms due to the limited ability for light to penetrate this "muddy" water column. In addition to the mineral component, there is a natural organic component made up of detritus from various sources. Sewage inputs from human and agricultural sources increase the organic component, which can result in anaerobic sediment conditions with accompanying malodor. Due to increased sewage treatment and better waste management, this condition is rare. The public perception of dredged material as "sludge" or "spoil" has not changed, and

this misperception has resulted in tension between the public and the maritime community regarding both dredging and dredged material management.

Federal regulatory and resource agencies and their counterparts in each of the three States bordering the Delaware River/Estuary (DE/NJ/PA), have independent regulatory programs to manage dredged material. Each State evaluates sediment differently and each has different standards for defining sediment quality for potential reuse. These differences present challenges in developing a single consistent program for the comprehensive management of sediment and dredged material in the Delaware Estuary/River Basin. Some regulatory agencies consider sediments to be pollutants or solid waste, and manage them accordingly. Overcoming these challenges and developing a common vision of sediment and dredged material as a valuable resource will facilitate opportunities for dredged material management.

3.4 Sediment Quality

The legacy of pollutant discharges to the Delaware River estuary is reflected in the sediment. Years of unregulated industrial and municipal discharges, stormwater runoff, atmospheric deposition, and spills have resulted in contamination of some sediment, especially in the area between Trenton and Wilmington. While coarse sediment particles (i.e. sand and gravel) rarely hold onto contaminants, the fine grained particles (silt and clay) can tightly bind contaminants. If undisturbed, these contaminants can remain in the sediment for decades. Dredging inevitably re-suspends sediments and if these sediments are contaminated, contaminants can be released to the water column. Disposal of the dredged material transfers the chemical burden to upland CDFs, where it can potentially limit beneficial use. It is critical that managers have a firm understanding of the chemical makeup of sediment/dredged material as they develop the RSM and determine the best strategies for dredging and dredged material management.

- > Although there is a relatively extensive database of sediment chemistry, it is limited due to areas of interest, collection and analysis methods, and age. Despite these problems, the RSMW has performed a screening level analysis on close to 1,000 sediment chemistry samples collected between 1990 and 2009 to determine the nature and extent of this contamination. The screening looked at a subset of contaminants of concern (COCs) chosen because of their documented ties to regulatory and non-regulatory benchmarks¹. The concentrations were compared to human and aquatic life toxicity thresholds to categorize sediment in one of three categories:
- > Probably suitable for beneficial use (aquatic habitat restoration, upland);
- > Potentially suitable for beneficial use; or
- > Probably not suitable for beneficial use.

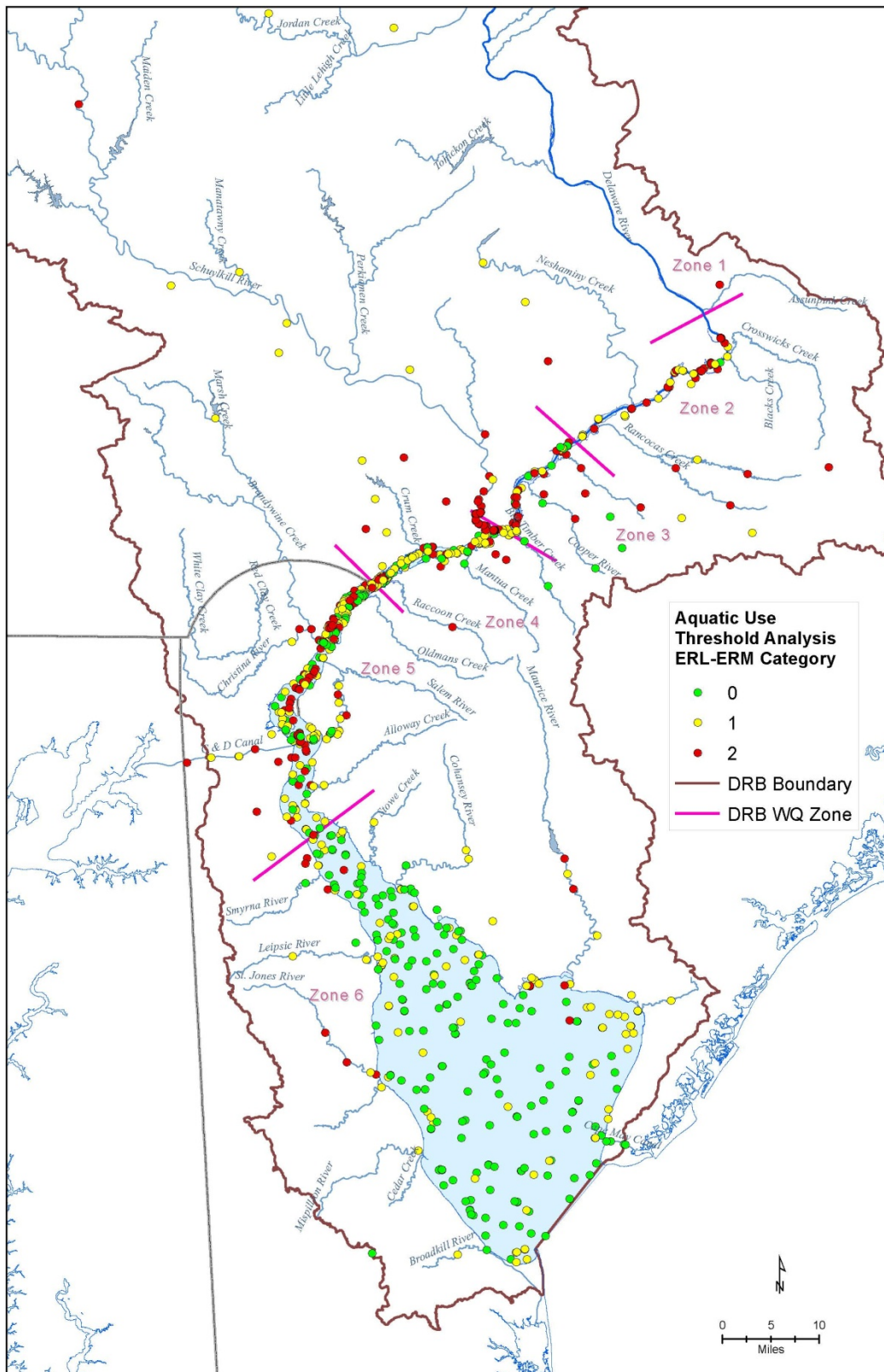
Figures 3.4 and 3.5 show the results of the aquatic habitat restoration and upland beneficial use suitability analyses, respectively. The results of these analyses are not specific enough to be used for project specific purposes. However, they can serve as a broad characterization of sediment quality in the estuary.

Approximately 70% of the samples are indicative of sediment that is probably/potentially suitable for aquatic habitat restoration projects (Categories 0 and 1 in Figure 3.4). About 98% of the sediment samples appear to be suitable for some type of upland beneficial use (the “<LUS” and “>LUS and <HUS” categories in Figure 3.5).

To further evaluate this information, the RSMW segmented the river using the same system used by the Delaware River Basin Commission (Water Quality Zones 2-6, with Zone 2 extending from Trenton to Philadelphia, and Zone 6 being in the Delaware Bay).

¹ Contaminants of concern used in screening analysis were: total PCBs, total dioxin/furan TEQ, DDT and metabolites, chlordane, dieldrin, benzo(a)pyrene, mercury, arsenic, cadmium, cobalt, copper and lead.

Figure 3.4: Aquatic Habitat Restoration Suitability ERL = Effects Range Low (~10% probability of toxicity to benthic biota). ERM – Effects Range Median (~50% probability of toxicity to benthic biota).



These data show that sediment in Zone 6 is probably not contaminated at levels that would present a problem for aquatic life, and dredged material from Delaware Bay is likely suitable for all beneficial uses, including habitat restoration. In contrast, sediment in Zones 2 and 3 is more likely to be a concern for aquatic life and dredged material from this area is probably not suitable for habitat restoration. Sediment in Zones 4 and 5 is probably intermediate in its potential use for habitat restoration.

More of the area evaluated appears to contain sediment suitable for upland beneficial use. Sediment dredged from Zone 6 is most likely suitable for unrestricted upland use, and sediment from the rest of the river would probably be suitable for either unrestricted or restricted upland use. Very few samples from isolated areas near known sources of contamination or the mouths of some tributaries would not be suitable for any beneficial use. More detailed information, including the sources of the sediment data and analytical procedures, can be found in the *Sediment Quality White Paper* (Appendix D).

The analysis also revealed that while sediment quality is highly heterogeneous throughout the system, there are some important trends. Sediment from DRBC Zone 2 tends to be high in cadmium and the pesticides DDT (as well as the metabolites DDD and DDE) and chlordane. Zone 3 sediment does not have chlordane in biologically significant amounts, but it does have cadmium, DDTs and PCBs. Zone 4 sediment still tends to exceed thresholds for DDT and PCBs, but not cadmium. Zone 5 sediment does not have high DDT, but it does have arsenic and PCBs.

In addition to the trends, a number of data gaps were identified:

- > The database, and consequently this analysis, could use more data from areas such as private berths and terminals and longitudinal cores from areas outside of the navigation system.
- > Additional samples from all areas need to be analyzed using state of the art methods to allow for better interpretation of sediment suitability, especially for aquatic restoration uses.
- > Additional information on sediment “hot spots” is needed to determine the extent and source of the contamination observed.
- > Additional studies are needed to evaluate the ecological impacts associated with contaminants of concern, including benthic toxicity and bioaccumulation tests and sediment pore water chemistry. This information will also better inform managers of the risks associated with beneficial use of dredged material for ecological restoration initiatives.
- > Finally, comprehensive project-specific testing and evaluation of dredged material is needed to support regulatory review of beneficial use applications by State and Federal agencies.

3.5 Beneficial Use/Restoration

Sediment is a critical resource of the Delaware River and Estuary. This RSMP is intended to be a blueprint for how sediment can be managed in such a way as to ensure that:

- > Sediments are present where they are needed for ecological processes;
- > Sediments are removed from areas where they impede navigation;
- > Sediments dredged from the system are beneficially used;
- > Environmental impacts from dredging and dredged material management are minimized;
- > Human induced erosion in the system is minimized;
- > Contaminated sediments are identified and contained or removed from the system; and
- > Sediments entering the system remain “clean/suitable” enough for all uses.

Environmental *restoration* is the purposeful effort to return an ecosystem from a degraded and damaged condition to a State of health and integrity. *Beneficial use* is the practice of placing or using dredged material for some valuable purpose, as opposed to simply disposing of the material. Many of the RSM goals can be accomplished through a program of beneficial use and restoration. However, there are

numerous impediments to initiating such a program in the Delaware Basin. As mentioned previously, there is still a lack of understanding of some of the basic sediment quality and quantity information needed, as well as the role that sediment plays in ecological processes. Understanding these issues will take time and resources, but lack of information is not the only serious impediment to sustainable sediment management. There are two more critical issues: One is the lack of sustainable program to facilitate cooperation between the programs responsible for major sediment sources (watershed), sinks (dredging), and needs (tidal wetlands). The second is the need for new sources of funding, or creative uses of existing funding mechanisms that will allow dredged material to be used for restoration.

Sediment is a critical resource to both man and nature. Sediment is useful for both construction and remediation activities on shore, as well as being critical to ecological processes in the benthic communities and for natural maintenance of tidal wetlands and marshes. Healthy wetlands and marshes protect human-built infrastructure from damage due to high winds, tidal surges and sea level rise. Sound management of sediment will involve moving sediment (or encouraging it to move) from locations where it is an impediment and placing it (or encouraging it to remain) in areas where it is needed.

Beneficial use of dredged material has been implemented successfully in many regions of the country, including the Delaware Basin. Over 3.5 million cubic yards of dredged material previously stored in CDFs has been removed for beneficial use over the past 30 years. While this is not an insignificant amount, it is less than the amount of sediment dredged from the system in one year. To secure the long term sustainability of the CDFs, the amount of material beneficially used needs to be significantly increased. The lack of coordinated interest in promoting beneficial use is partly due to the fact that there has, to date, been sufficient capacity to store dredged material in upland CDFs. Managing dredged material in this manner has been highly cost effective. The USACE is mandated by Congress to utilize the "least cost environmentally acceptable alternative" when it comes to dredging and dredged material management. These two factors combine to discourage the USACE from seeking alternative disposal or use options. Such alternatives usually come with an immediate increase in costs, despite the long term benefits for both transportation and the environment. Consequently, it will be necessary to find innovative funding strategies and financial partners in order to implement beneficial use and restoration initiatives in the near term.

Current trends indicate that this management alternative may not always be as readily available as it is today. In the Philadelphia to Trenton reach of the main channel, some CDFs are at or near capacity. While the lower Delaware River main channel currently has ample capacity for maintenance, the ongoing deepening project will utilize a considerable portion of the available capacity. It would be difficult and expensive for the government to establish new CDFs to supplement the available capacity in any part of the estuary. This is due in part to increased competition for available waterfront land for residences, recreation, and habitat conservation, as well as the fact that the general public tends to have a negative view of dredging.

In addition to more effective education and outreach, one of the solutions to this problem is to either reduce the amount of sediment that needs to be dredged or to continually renew the capacity of existing disposal facilities. Reduction in sediment loading is a watershed management issue, whereas capacity renewal can be rigorously managed through beneficial use. Numerous programs already address stream bank and bed erosion, through the regulation of stormwater, construction, and agricultural/forestry activities. These programs have not been entirely successful at keeping ahead of the ever increasing development pressure in the watershed. Better planning and innovative engineering, combined with riparian restoration programs are needed in many areas if sediment loads are to be reduced.

Renewing CDF capacity through a rigorous beneficial use program is more a function of desire and funding than practical application. The nature of sediment in the estuary should not be problematic for many upland beneficial uses. Sand and gravel have many uses and come with some economic value of their own. Finer-grained material is often challenging to beneficially use. Almost all of the beneficial use in the estuary has been of sand and gravel for construction of highway berms, golf courses, remediation, and general construction. Finer grained materials could be used for landfill closure and capping, capping and filling of contaminated industrial property (brownfields), or habitat restoration; however, there has

been relatively little of this done in the Delaware Estuary to date. Material from some privately owned CDFs (Money Island and Biles Island) are mined to be used as landfill cover. In most cases, these placement alternatives have high costs that make them unattractive when compared to the conventional option of placement in a CDF. The State of New Jersey is currently starting the process of characterizing the sediment stored in CDFs along the Delaware River to determine if they could be practically excavated for use. This would not only restore capacity in existing CDFs, but might also encourage the remediation and reuse of numerous abandoned industrial properties in southern New Jersey.

Of particular interest to the RSMW is the potential to use dredged material beneficially to restore degraded habitat and beaches. While using clean sandy dredged material for beach replenishment is a widely accepted and ongoing process throughout the U.S., there is currently no mechanism for this in the Delaware Estuary. Delaware and New Jersey have used borrow sites near the beaches for their replenishment work, instead of working with the USACE to obtain sand dredged from the channel. The use of dredged material for habitat restoration is even less common, owing to multiple impediments, including cost. There have been notable successes in nearby areas such as the Chesapeake Bay watershed. Some attempts to restore degraded shoreline habitats in the Delaware Bay have been successful, but these have focused on capturing suspended sediments rather than beneficial use of dredged material. There is no reason to believe that a large scale project using dredged material to enhance living shorelines in the Delaware Estuary would not be successful, but it will be necessary to secure financial backing, cooperation of the regulatory agencies to find permitting mechanisms, as well as careful evaluation of the risk associated with chemical contamination (if present) of the dredged material.

The RSM stakeholders are not only interested in the potential to utilize dredged material for restoration, but also in the restoration of degraded sediment dependent habitats for their own sake. Restoration initiatives can be divided into active and passive. Active restoration involves placing sediment (presumably dredged material, but not necessarily) at a designated location, while passive restoration refers to activities that will increase sediment retention by controlling erosion or enhancing deposition, or both. Considerable detail on the need for this activity is provided in the *Restoration and Beneficial Use White Paper* (Appendix B). In some cases, restoration activities may actually reduce the need for dredging for navigational purposes by reducing erosion in upstream watersheds. Reducing sediment loading to the estuary may exacerbate the existing sediment deficits and concomitant loss of estuarine wetlands. Restoration of sediment quality is another interesting initiative that would not only improve benthic habitat quality, but would increase the beneficial use potential of dredged material. Ultimately, it will be necessary to determine the restoration initiatives that are in the best interest of the estuary that can be tied to navigational interests.

3.6 Problem Statements

The RSMW has summarized our current understanding of the interrelationships between the estuarine ecosystem and the marine transportation system of the Delaware River and Estuary. As outlined above, there is much that we do not understand about the system and there are numerous impediments to sound regional sediment management. We can divide the problems and challenges into several major categories:

- > Policy Issues
- > Funding Limitations
- > Programmatic and Regulatory Issues
- > Operational Management Concerns
- > Environmental Management Concerns
- > Education and Outreach Needs, and
- > Science and Research Needs

These functional categories will serve as the basis for organization of the remainder of the RSMP. The following summarizes the general types of information to be categorized in each of the functional categories.

3.6.1 Policy Issues

The Policy Issues category includes problems and recommendations regarding Federal, State and regional policies that directly or indirectly affect the other functional categories identified for RSM. This includes high level policy such as, for example, the “Federal least cost standard”.

3.6.2 Funding Limitations

As with many initiatives, funding is critical to success and RSM is no exception. The Funding Limitations category includes problems and recommendations regarding a broad category related to sources of funding and procedures for securing funding related to RSM activities.

3.6.3 Programmatic and Regulatory Issues

The Delaware Estuary encompasses several State jurisdictions and several regional regulatory agencies. The Programmatic and Regulatory Issues category includes problems and recommendations regarding Federal, State, regional and municipal plan coordination, restrictions/opportunities and consistency for supporting other recommendations and opportunities identified for RSM and beneficial use.

3.6.4 Operational Management Concerns

The Operational Management Concerns category includes problems and recommendations regarding the technical operations associated with dredging and habitat restoration programs and their optimization and cost effectiveness.

3.6.5 Environmental Management Concerns

Separate from the “physical” operation management concerns described above, the Environmental Management Concerns category includes problems and recommendations regarding better ways to minimize adverse impacts from sediment management related activities throughout the watershed, including dredging operations, discharges, watershed management, and others.

3.6.6 Education and Outreach Needs

A very comprehensive category is the Education and Outreach Needs category which includes problems and recommendations regarding mechanisms to inform a variety of stakeholders at various levels, including: Federal, State, regional and local resource agencies on the benefits and needs for RSM; commercial entities directly involved in dredging programs; NGOs and other interested parties that could help facilitate the RSM concept; and the general public to understand the benefits of RSM and the beneficial use of sediment.

3.6.7 Science and Research Needs

The Science and Research Needs category includes problems and recommendations regarding the collection of scientific and engineering data needed to inform the RSMW and Federal and State agencies in making appropriate decisions regarding sediment dynamics in the estuary and proposed implementation projects. The RSMP is based on current understanding of the science and processes within the estuary. The research and science needs are very broad and comprehensive for a system of this diversity and magnitude.

These problems and challenges are enumerated in Table 3.4 (Policy Issues are discussed in Section 4.2). What can and should be done to address these problems and challenges is the subject of the next chapter and will be organized by similar categories.

Table 3.4: Delaware Estuary RSMP Problem Statements.

Funding Limitations (FL)	
FL#1	<i>The Federal government, largely through USACE navigation dredging projects, is the primary source of potential funding for regional sediment management and dredged material beneficial use activities in the estuary. However, the USACE funding levels are unpredictable from year-to-year, and are not likely to be sufficient to implement such projects.</i>
FL#2	<i>As currently implemented in the Delaware Estuary, the least cost Federal Standard limits the Philadelphia District of the USACE to the placement of dredged material in upland CDFs. The relatively low cost of this disposal method limits the USACE's ability to fund and implement alternative dredged material management and beneficial use options.</i>
FL#3	<i>The development of new funding partnerships between government agencies, commercial interests (including ports and marinas), and non-governmental organizations is essential for successful implementation of the RSMP and the increased beneficial use of dredged material in the Delaware Estuary.</i>
Programmatic and Regulatory Issues (PRI)	
PRI#1	<i>There are inconsistent and uncoordinated regulatory and management programs for sediments, dredging, and dredged material</i>
PRI#2	<i>Dredged material is currently managed on a project-by-project basis, rather than using a coordinated system-wide approach.</i>
Operational Management Concerns (OM)	
OM#1	<i>Current dredged material management options used by the USACE and private entities in the estuary are not sustainable over the long term – upland CDFs managed solely as disposal sites have finite capacity. Also see Problem SRN #4.</i>
OM#2	<i>There is a lack of available dredged material management alternatives in the estuary, particularly beneficial uses of dredged material for habitat restoration purposes.</i>
Environmental Management Concerns (EM)	
EM#1	<i>Tidal wetlands and sandy shorelines are being lost in the Delaware Estuary due to the combined effects of erosion, climate change/sea level rise, and an inadequate supply of suspended sediment.</i>
EM#2	<i>Non-tidal streams in the Delaware estuary watershed appear to have excessively high rates of bed and bank erosion, resulting in adverse impacts to these streams and increased sediment loads to the estuary. Also see Problem SRN #2.</i>
EM#3	<i>Current dredging and dredged material management operations in the estuary may be resulting in adverse impacts to surface water quality.</i>

Education and Outreach Needs (EON)

EON#1	<i>The general public is un- or misinformed regarding the critical nature of the USACE navigation mission and the importance of waterborne commerce to the economy and quality of life in the region.</i>
EON#2	<i>The environmental risks posed by dredging and the beneficial use of dredged material are poorly understood by the general public.</i>

Science and Research Needs (SRN)

SRN#1	<i>Our current understanding of sediment sources to, and transport and fate mechanisms within, the Delaware Estuary are incomplete. This limits the development of fully effective regional sediment plans and projects.</i>
SRN#2	<i>Our knowledge of the connections between ecological processes and sediment dynamics in the estuary are inadequate to comprehensively guide implementation of the RSMP.</i>
SRN#3	<i>We do not have a complete understanding of sediment quality in the Delaware Estuary, and its role in the estuarine ecosystem.</i>
SRN#4	<i>Large quantities of sediment are deposited in navigation channels and berths, where they must be dredged. It is not known if it is practical to implement alternative dredging methods and technologies that could reduce dredging needs, reduce the disposal of dredged material in upland CDFs, and contribute to better sediment/dredged material management in the estuary.</i>

CHAPTER 4 Strategic Direction and Recommended Actions

4.1 Introduction

Chapter 3 stresses that, to date, there has been no systematic, collaborative approach to dealing with the challenges and opportunities of managing sediment and dredged material in the Delaware Estuary. Chapter 4 presents a set of recommended actions that have the primary goal of using a coordinated regional sediment management approach to better manage sediment/dredged material in the estuary. These recommended actions have been developed to address the most significant problems identified by the RSMP Workgroup. For management, funding, and implementation purposes, they have been separated into the following functional categories:

- > Policy Issues
- > Funding Limitations
- > Programmatic and Regulatory Issues
- > Operational Management Concerns
- > Environmental Management Concerns
- > Education and Outreach Needs
- > Science and Research Needs

Each of the problems discussed in Chapter 3 is addressed within that functional category in which it is most closely related. It must be recognized that many of these problems will also be addressed to varying degrees by the recommended actions for other problems.

A few key overarching principles drive the basic strategic direction of the RSMP, and thus what kinds of recommended actions have been developed to address the identified problems:

- > The RSMP should be based on national policy direction that addresses sediment management, including the recommendations in the U.S. Commission on Ocean Policy “An Ocean Blueprint for the 21st Century” (September 2004) and the Council on Environmental Quality’s “Proposed National Objectives, Principles, and Standards for Water and Related Resources Implementation Studies” (December 2009). [See Section 1.4, page 1-3]
- > The RSMP should incorporate ecosystem-based principles and management systems that consider the diverse array of services provided by the Delaware Estuary ecosystem. The RSMP should seek to maximize the ecological and economic benefits of the Delaware Estuary, considering appropriate monetary and non-monetary values.
- > The RSMP strategy should emphasize the coordinated and cooperative development and implementation of estuary- and watershed-wide sediment/dredged material management activities by all stakeholders in the region. This includes the involvement of all of the appropriate Federal and State regulatory and natural resource management agencies, as well as port and marina operators, non-governmental organizations (environmental, fishing, recreation, etc.), and other interested parties.
- > The RSMP should be considered to be a living document that is periodically reviewed and updated in response to the successful implementation of its various components, increased knowledge and understanding of the estuarine ecosystem, and changing environmental, economic, and regulatory conditions in the estuary and region.

The concept of the base plan or least cost “Federal standard” is intended to guide and promote cost efficiency by the USACE in the management of dredged material from individual dredging projects. Thus, interpretation of what constitutes a base plan for a dredging project can be an obstacle to regional sediment management and the beneficial use of dredged material. USACE guidance States that the base plan is the least costly alternative that is consistent with sound engineering practice and meets environmental requirements. This least cost factor should not function as a constraint to making wise dredged material management decisions. This is discussed further in “The role of the Federal standard in the beneficial use of dredged material from U.S. Army Corps of Engineers new and maintenance navigation projects”, USEPA and USACE, (undated), 16 pp.

4.2 Policy Issues

The policies of many public agencies have been shaped by the view that sediment/dredged material is a pollutant or a carrier of pollutants. At both the Federal and State level (Delaware and Pennsylvania), dredged material is literally or figuratively managed as waste with regulatory limitations on its beneficial use. This policy also affects the public perception of dredged material, which is viewed as contaminated waste material (spoil) that must be regulated and managed accordingly.

The exception to this policy and regulatory paradigm is the State of New Jersey, where dredged material is specifically excluded from solid waste regulations. In New Jersey, dredged material is considered a resource and the policy of the State is to promote the beneficial use of dredged material wherever practical. This does not mean that New Jersey ignores potential sediment/dredged material contamination issues, but that solutions to dredged material management and beneficial use problems are addressed in a flexible manner.

In order for sediment and dredged material to be comprehensively managed to maximize benefits to the Delaware Estuary ecosystem and the economy of the region, the following changes in policy are needed:

- > Federal and State agencies should cease to consider dredged material as a waste, and instead evaluate and regulate its potential as a resource. This change in policy would result in changes to how dredged material is managed and regulated, including beneficial use.
- > The beneficial use of dredged material should be actively promoted by the Federal government and all of the States in the region, wherever practical, considering the full economic and non-economic costs and benefits of its use.

4.3 Funding Limitations

The primary funding source for the management of sediment and dredged material is the USACE, which is responsible for dredging the Federal navigation channels in the estuary. It is important to recognize

The Corps and its project sponsors have identified that the increased efficiency and overall benefits associated with Delaware Estuary Regional Sediment Management practices are beneficial to management objectives as well as the natural resources that are enhanced through the beneficial use of dredged material. However, the 2007 WRDA Bill included language stating that RSM projects will be tied solely to navigation projects where: (a) there is a Federal navigation project, and; (b) there is sufficient sand available from the dredging of that project to meet the regional water resource planning and management needs. Currently, navigation projects are severely backlogged due to insufficient Federal funding to maintain the nation’s waterways. Subsequently, many RSM initiatives are not able to be implemented due to funding constraints. By using a portion of the limited funding that is appropriated for channel and harbor maintenance to carry out RSM projects, less funding is available to address the primary goal of channel and harbor maintenance work. The end result is that RSM additions to navigation projects are often not carried out because the reduction in channel length dredged is not acceptable.

The conduct of RSM will realize additional benefits through the ecosystem restoration and shore protection, two other business lines of the Corps. Currently, these benefits are not counted in the formulation of a benefit/cost analysis for navigation work. This disincentive should be addressed by the Administration, Congress and the Corps so RSM initiatives are measured and funded based on the service provided across business lines, not just according to the navigation business line.

that funding for the USACE navigation business line varies from year to year. The current low cost to the USACE of dredged material disposal in the Delaware Estuary creates a significant challenge to realizing the larger vision of regional sediment management and to fully implementing the RSMP. In order to advance regional sediment management in the estuary, the additional costs and benefits of beneficially using dredged material will require re-thinking existing funding and financing policies for USACE projects.

The development of partnerships between stakeholders involved in dredging, dredged material management, and environmental protection/restoration have been hampered by a lack of effective and transparent communication. While the interests, needs, concerns, and obligations of the region's stakeholders may sometimes conflict, opportunities to identify and act upon shared interests in a coordinated and cooperative manner have been few and far between. Such coordination and cooperation could reduce the costs of dredging and dredged material management, increase the beneficial use of dredged material, and result in greater benefits to the Delaware Estuary ecosystem and the regional economy.

The RSMP recommends actions to identify additional project sponsors and alternative funding sources (public and private). The development of new public-private partnerships will facilitate the funding of, and non-Federal cost-sharing requirements for, incremental project costs above the least cost "Federal standard".

Problem FL #1: The Federal government, largely through USACE navigation dredging projects, is the primary source of potential funding for regional sediment management and dredged material beneficial use activities in the estuary. However, the USACE funding levels are unpredictable from year-to-year, and are not likely to be sufficient to implement such projects.

Recommended Actions:

- A. The RSM Implementation Workgroup (RSMIW; including members of Federal, State, and Regional agencies, non-governmental organizations, and commercial entities) to work with Federal agencies and legislators to ensure that Harbor Maintenance Trust Fund monies are used to fund harbor maintenance needs, including navigation and green infrastructure projects.
- B. RSMIW to work with Federal agencies and legislators to develop a better understanding of the added economic and ecosystem service values of the RSM approach, and to encourage the use of such funds to implement the RSMP and/or support the beneficial use of dredged material in the estuary.

Problem FL #2: As currently implemented in the Delaware Estuary, the least cost Federal Standard limits the Philadelphia District of the USACE to the placement of dredged material in upland CDFs. The relatively low cost of this disposal method limits the USACE's ability to fund and implement alternative dredged material management and beneficial use options.

Recommended Actions:

- A. The USACE should evaluate the development of a more flexible policy interpretation and application of the least cost "Federal standard" to the management of dredged material in the Delaware Estuary. This evaluation should consider the full range of the economic and non-economic costs and benefits of alternative dredged material management and beneficial use options, as well as the objectives of the multiple mission areas of the agency.
- B. The USACE-Philadelphia District should evaluate the use of existing/alternative authorities that will make it easier to beneficially use dredged material in the estuary, particularly for habitat restoration purposes such as the USACE Continuing authorities Program (Section 1135, 204 & 206) or the 2005 Beneficial Use of Dredge Material Study authority.

Problem FL #3: The development of new funding partnerships between government agencies, commercial interests (including ports and marinas), and non-governmental organizations is essential for successful implementation of the RSMP and the increased beneficial use of dredged material in the Delaware Estuary.

Recommended Actions:

- A. The RSMIW to identify and evaluate existing Federal and State funding programs that could potentially be used to implement the RSMP and/or support the beneficial use of dredged material in the estuary.
- B. RSMIW to coordinate with NGOs and others to conduct outreach activities with commercial interests and non-governmental organizations to explore the development of new and alternative public-private funding strategies to implement the RSMP and/or support the beneficial use of dredged material in the estuary.
- C. RSMIW and RDT to identify and evaluate potential RSMP and dredged material beneficial use demonstration/pilot projects that could serve as initial efforts in the development and implementation of public-private funding strategies (Section 5.10).

4.4 Programmatic and Regulatory Issues

Because the Delaware Estuary is an interstate waterway, there are several jurisdictions that have overlapping authorities to regulate and manage sediment and dredged material. Currently, these various Federal and State regulatory programs are somewhat inconsistent and generally uncoordinated. This is a problem particularly for organizations (including USACE) that conduct sediment/dredged material management operations in multiple jurisdictions. Effective sediment/dredged material management solutions need to work across State lines. The development of consistent regulatory standards would facilitate regulatory and management processes. The Federal and State programs should be evaluated and modified to facilitate implementation of the RSMP, and for the consistent regulation and beneficial use of sediment/dredged material in the estuary.

Implementing some of the recommended RSMP actions will require a variety of Federal, State, and local permits and approvals. The development of general permits by the USACE and State regulatory agencies could facilitate the implementation of the RSMP and dredged material beneficial use projects.

Problem PRI #1: There are inconsistent and uncoordinated regulatory and management programs for sediments, dredging, and dredged material management in the Delaware Estuary at the Federal and State levels.

Recommended Actions:

- A. The Federal and State regulatory agencies with project management and/or review responsibilities in the Delaware Estuary should initiate a joint effort to develop consistent programs (including guidelines, standards, regulations, and best management practices) for dredging operations and dredged material management and beneficial use activities.
- B. The RDT, an interagency workgroup, should be convened to evaluate the practicality of developing general permits to address regulatory concerns and potential environmental impacts associated with the implementation of RSMP and dredged material beneficial use projects.

Problem PRI #2: Dredged material is currently managed on a project-by-project basis, rather than using a coordinated system-wide approach.

Recommended Actions:

- A. A regional dredged material management plan should be developed for the Delaware Estuary by the RDT/RSMIW with technical support for specific entities. The plan should use an asset management approach and include an analysis of the current dredged material management system and its condition, what is needed to maintain and/or enhance the functionality of the system, alternative sediment/dredged material management technologies and methods, necessary funding, and a prioritization of dredged material management projects throughout the estuary.
- B. Federal and State regulatory agency review programs should consider the potential impacts of proposed projects to regional sediment management in the Delaware Estuary, and how such projects could be modified to support achievement of the RSMP goals and targets.
- C. The Delaware Estuary Regional Dredging Team (RDT) should continue to share information about and discuss dredging operations to be conducted in the estuary, as well as associated management practices, including the beneficial use of dredged material.
- D. States to develop regional data sharing capability and analytical tools (such as the Dredged Material Management System (DMMS) and Waterway Linear Segmentation (WLS) developed by New Jersey) to evaluate future sediment conditions under alternative management strategies. USACE to continue to integrate data across Districts.

4.5 Operational Management Concerns

Most of the sediments dredged from the Delaware Estuary are disposed of in upland CDFs. Dredging acts as one of the largest sinks removing sediment from the estuarine ecosystem. The impacts of this removal of sediment from the estuary are not fully understood, although it is suspected that there are some negative impacts to various estuarine habitats (for example, tidal wetlands). One way to mitigate potential negative impacts is to beneficially use sediment/dredged material in habitat restoration projects. Other beneficial uses of dredged material include as landfill cover or in mine reclamation projects, which can result in economic benefits to the region.

Given the large volume of dredged material generated by the USACE navigation projects, implementation of the following Operational Management recommendations will largely fall to the USACE. The States also have roles to play: for example, New Jersey is working to restore capacity in its upland CDFs located along the Philadelphia to Trenton reach of the Delaware River. Dredged material disposal limitations also impact the ability of port and marina operators to dredge facilities, so these entities should also be involved in implementing recommended actions.

Problem OM #1: Current dredged material management options used by the USACE and private entities in the estuary are not sustainable over the long term – upland CDFs managed solely as disposal sites have finite capacity. Also see Problem SRN #4.

Recommended Actions:

- A. Upland CDFs should be converted by all CDF owners/operators (USACE, States and private entities) to Confined Management Facilities (CMFs), in which dredged material is placed (not disposed), dewatered, and then excavated and beneficially used. Management practices to place dredged material in these CMFs in a manner that would facilitate their future beneficial use should be developed and evaluated for implementation.

Problem OM #2: There is a lack of available dredged material management alternatives in the estuary, particularly beneficial uses of dredged material for habitat restoration purposes.

Recommended Actions:

- A. An estuary-wide inventory/database of potential sites and projects that could beneficially use dredged material should be developed and updated as needed by PDE. This inventory/database should be considered by all stakeholders in the estuary/region when developing dredging and sediment management projects (Section 5.10).
- B. The RSMIW, a workgroup including members from the USACE, State and Federal natural resources management agencies, and port and private marina interests, should be formed to develop a marketing program to promote the beneficial use of dredged material in the estuary.
- C. RSMIW and RDT should identify and evaluate potential dredged material beneficial use demonstration/pilot projects that could serve as initial efforts in the development and implementation of alternative dredged material management strategies (also see FL Problem #2 and EM Problem #1, and Section 5.10). Including:
 - > Filling land for development and construction purposes (roads, infrastructure, etc.)
 - > Sanitary landfill cover
 - > Shoreline enhancement
 - > Stream channel stabilization
 - > Tidal, non-tidal, sub-tidal and upland habitat restoration

4.6 Environmental Management Concerns

The multiple roles of sediment in the Delaware Estuary ecosystem, and the impacts of current dredging and dredged material management activities on these functions, are complex and incompletely understood. However, certain resource management needs are becoming clear, based on information gathered by ongoing efforts to understand and monitor the system.

Past habitat protection and restoration activities in the Delaware Estuary have typically not been developed or implemented taking sediment dynamics or regional sediment management concerns into consideration. Coordination of such projects with dredging operations, or the potential beneficial use of dredged material in their construction, has been rare.

Problem EM #1: Tidal wetlands and sandy shorelines are being lost in the Delaware Estuary due to the combined effects of erosion, climate change/sea level rise, and an inadequate supply of suspended sediment.

Recommended Actions:

- A. PDE and the States to identify tidal wetlands at risk of being lost that could be protected/restored using passive sediment capture mechanisms, active sediment/dredged material beneficial use activities (for example, thin-layer placement), living shorelines, or other methods.
- B. RSMIW with PDE and others to coordinate implementation of the RSMP with existing/future regional habitat restoration plans (for example, TNC and PDE studies, USACE Beneficial Use Reconnaissance Study), with a focus on beneficially using dredged material to the maximum extent practicable.
- C. The RDT (which includes the USACE and the States) should establish an interagency workgroup to identify the opportunities for, and coordinate the use of, suitable sand dredged from navigation channels for beach nourishment projects in Delaware Bay.

Problem EM #2: Non-tidal streams in the Delaware estuary watershed appear to have excessively high rates of bed and bank erosion, resulting in adverse impacts to these streams and increased sediment loads to the estuary. Also see Problem SRN #2.

Recommended Actions:

- A. RSMIW, with NRCS, State agencies and PWD, to coordinate implementation of the RSMP with non-tidal watershed erosion control and sediment management projects managed by the NRCS and State watershed/water quality management agencies to ensure that the potential impacts of these projects (positive and negative) are understood (SRN Problem #1).

Problem EM #3: Current dredging and dredged material management operations in the estuary may be resulting in adverse impacts to surface water quality.

Recommended Actions:

- A. The RDT should undertake a review of current dredging and dredged material management operations in the estuary and identify Best Management Practices (BMPs) to reduce potential impacts to surface water quality resulting from these operations. These BMPs should be incorporated as permit conditions by State and Federal regulatory programs and implemented on a consistent basis throughout the estuary.

4.7 Education and Outreach Needs

The general public is generally poorly informed about both the importance of navigation to the region's economy and the importance of sediment to the health of the estuarine ecosystem. For the most part, the general public takes for granted the economic and quality of life benefits resulting from the waterborne transport of goods to and from the port facilities located in the estuary. Dredged material is generally considered to be a waste material (or "spoil"), and assumed to be contaminated by pollutants that pose a risk to the environment and public health. Most people do not recognize that dredged material should be considered a resource whose appropriate beneficial use can result in environmental improvements.

Education and outreach programs are essential and the development and implementation of such programs are critical to the success of the RSMP.

Problem EON #1: The general public is un- or misinformed regarding the critical nature of the USACE navigation mission and the importance of waterborne commerce to the economy and quality of life in the region.

Recommended Actions:

- A. The USACE and regional port interests should develop and implement an education and outreach program to the general public (including county and local governments, and non-government organizations and schools) to better explain the economic importance of dredging and dredged material management in the estuary.

Problem EON #2: The environmental risks posed by dredging and the beneficial use of dredged material are poorly understood by the general public.

Recommended Actions:

- A. EPA/USACE to develop and implement an education and outreach program to change the perception of dredged material from that of a contaminated waste/spoil to a resource and explain the potential impacts (positive and negative) of various dredged material beneficial use alternatives.

4.8 Science and Research Needs

The work completed in support of the RSMP, including the four white papers in Appendices A-D, has evaluated the existing data and knowledge concerning the multiple roles of sediment in the Delaware Estuary ecosystem. These studies identified the limitations in our knowledge and the data/information gaps that need to be filled to develop a more complete and comprehensive understanding of sediment in the estuary. The Problem Statements and Recommended Actions in this section are meant to address these data and information needs. The RSMP Workgroup did not identify any critical flaws in our current understanding of the functions of sediment in the estuary that should inhibit the implementation of the RSMP.

As a living document, the RSMP should be revised in the future consistent with the best available scientific understanding of the Delaware Estuary ecosystem.

Problem SRN #1: Our current understanding of sediment sources to, and transport and fate mechanisms within, the Delaware Estuary are incomplete. This limits the implementation of effective regional sediment management.

Recommended Actions:

- A. USACE, academia, the States, DRBC, and local partners to develop a better understanding of estuarine sediment dynamics through the development of the following:
 - > a refined sediment budget that encompasses the entire Delaware Estuary and includes coarse and fine-grained sediment fractions;
 - > a model of sediment transport mechanisms and fluxes at the ETM in the Delaware River;
 - > a model(s) of sediment transport and fate processes and fluxes between the main navigation channel and adjacent shallower areas (including tidal marshes); and
 - > a model of sediment transport mechanisms between the Atlantic Ocean, Delaware Bay, and the ETM.
- B. NRCS, USGS, and academia to fully characterize sediment supply, erosion rates, and delivery ratios for various land uses from the upstream (non-tidal) watershed to the estuary. This effort should utilize the procedures of the Natural Resources Inventory and the Conservation Effectiveness Assessment Program.

Problem SRN #2: Our knowledge of the connections between ecological processes and sediment dynamics in the estuary are inadequate to comprehensively guide implementation of the RSMP.

Recommended Actions:

- A. PDE and academia to use the models and data obtained through the implementation of the recommended actions to address SRN Problem #1 to develop a better understanding of the importance of sediment to ecological processes in the Delaware Estuary. In particular, the role(s) of sediment in maintaining tidal wetlands is in need of additional study.
- B. All parties to implement demonstration projects to gain additional data and knowledge about the relationships between sediment quantity and quality and the structure and function of aquatic habitats in the estuary.

Problem SRN #3: We do not have a complete understanding of sediment quality in the Delaware Estuary, and its role in the estuarine ecosystem.

Recommended Actions:

- A. EPA, DRBC and States to monitor and evaluate contamination of sediments throughout the system, for a target list of contaminants of concern, including periodic updating of the RSMP Sediment Quality Database.
- B. RSMIW to convene an interagency workgroup to develop regional criteria for the beneficial use of dredged material in aquatic habitat restoration projects, with specific consideration of the toxicity (acute and chronic) and bioaccumulation of contaminants of concern to aquatic biota.
- C. EPA, USGS, and States to identify sediment hot spots with elevated levels of contaminants that pose risks to the aquatic ecosystem and would, if dredged, preclude their beneficial use in aquatic habitat restoration and/or upland projects. Evaluate potential ongoing pollutant sources that could be causing this sediment contamination and develop a plan to address these sources.

Problem SRN #4: Large quantities of sediment are deposited in navigation channels and berths, where it must be dredged. It is not known if it is practical to implement alternative dredging methods and technologies that could reduce dredging needs, reduce the disposal of dredged material in upland CDFs, and contribute to better sediment/dredged material management in the estuary.

Recommended Actions:

- A. USACE to evaluate the application of engineering modifications (for example, to navigation channels and the Delaware River) and alternative technologies (active and passive) that could change local sediment dynamics in shoaling areas and reduce sediment deposition in navigation channels and berthing areas.
- B. USACE to evaluate the use of alternative dredging methods and technologies (including water injection dredging and long distance pumping) that could reduce the need to dredge and/or the volume of dredged material that must be managed.

4.9 Summary Recommended Actions

A summary of the recommended actions detailed in Sections 4.2 through 4.8 is included as Table 4.1. The recommended actions in Table 4.1 are organized by the problem Statements identified in Chapter 3.

Table 4.1: Recommended Actions Summary Table

Funding Limitations (FL)	
FL#1	<i>The Federal government, largely through USACE navigation dredging projects, is the primary source of potential funding for regional sediment management and dredged material beneficial use activities in the estuary. However, the USACE funding levels are unpredictable from year-to-year, and are not likely to be sufficient to implement such projects.</i>
	<p>A. RSMIW, a workgroup including members of Federal, State, Regional, non-governmental organizations, and commercial entities, to work with Federal agencies and legislators to ensure that Harbor Maintenance Trust Fund monies are used to fund harbor maintenance needs, including navigation and green infrastructure projects.</p> <p>B. RSMIW to work with Federal agencies and legislators to develop a better understanding of the added economic and ecosystem service values of the RSM approach, and to encourage the use of such funds to implement the RSMP and/or support the beneficial use of dredged material in the estuary.</p>
FL#2	<i>As currently implemented in the Delaware Estuary, the least cost Federal Standard limits the Philadelphia District of the USACE to the placement of dredged material in upland CDFs. The relatively low cost of this disposal method limits the USACE's ability to fund and implement alternative dredged material management and beneficial use options.</i>
	<p>A. The USACE-Philadelphia District should evaluate the development of a more flexible policy interpretation and application of the least cost "Federal standard" to the management of dredged material in the Delaware Estuary. This evaluation should consider the full range of the economic and non-economic costs and benefits of alternative dredged material management and beneficial use options, as well as the objectives of the multiple mission areas of the agency.</p> <p>B. The USACE-Philadelphia District should evaluate the use of existing/alternative authorities that will make it easier to use beneficially use dredged material in the estuary, particularly for habitat restoration purposes.</p>
FL#3	<i>The development of new funding partnerships between government agencies, commercial interests (including ports and marinas), and non-governmental organizations is essential for successful implementation of the RSMP and the increased beneficial use of dredged material in the Delaware Estuary.</i>
	<p>A. The RSMIW to identify and evaluate existing Federal and State funding programs that could potentially be used to implement the RSMP and/or support the beneficial use of dredged material in the estuary.</p> <p>B. RSMIW to coordinate with NGOs and others to conduct outreach activities with commercial interests and non-governmental organizations to explore the development of new and alternative public-private funding strategies to implement the RSMP and/or support the beneficial use of dredged material in the estuary.</p> <p>C. RSMIW and RDT to identify and evaluate potential RSMP and dredged material beneficial use demonstration/pilot projects that could serve as initial efforts in the development and implementation of public-private funding strategies (Section 5.10).</p>

Programmatic and Regulatory Issues (PRI)

PRI#1	<i>There are inconsistent and uncoordinated regulatory and management programs for sediments, dredging, and dredged material</i>
	<p>A. The Federal and State regulatory agencies with project management and/or review responsibilities in the Delaware Estuary should initiate a joint effort to develop consistent programs (including guidelines, standards, regulations, and best management practices) for dredging operations and dredged material management and beneficial use activities.</p> <p>B. The RDT, an interagency workgroup, should be convened to evaluate the practicality of developing general permits to address regulatory concerns and potential environmental impacts associated with the implementation of RSMP and dredged material beneficial use projects.</p>
PRI#2	<i>Dredged material is currently managed on a project-by-project basis, rather than using a coordinated system-wide approach.</i>
	<p>A. A regional dredged material management plan should be developed for the Delaware Estuary by the RDT/RSMIW with technical support for specific entities. The plan should use an asset management approach and include an analysis of the current dredged material management system and its condition, what is needed to maintain and/or enhance the functionality of the system, alternative sediment/dredged material management technologies and methods, necessary funding, and a prioritization of dredged material management projects throughout the estuary.</p> <p>B. Federal and State regulatory agency review programs should consider the potential impacts of proposed projects to regional sediment management in the Delaware Estuary, and how such projects could be modified to support achievement of the RSMP goals and targets.</p> <p>C. The Delaware Estuary Regional Dredging Team (RDT) should continue to share information about and discuss dredging operations to be conducted in the estuary, as well as associated management practices, including the beneficial use of dredged material.</p> <p>D. States to develop regional data sharing capability and analytical tools (such as the Dredging Material Management System (DMMS) and Waterway Linear Segmentation (WLS) developed by New Jersey) to evaluate future sediment conditions under different alternative management strategies. USACE to continue to integrate data across Districts.</p>

Operational Management Concerns (OM)

OM#1	<i>Current dredged material management options used by the USACE and private entities in the estuary are not sustainable over the long term – upland CDFs managed solely as disposal sites have finite capacity. Also see Problem SRN #4.</i>
	<p>A. Upland CDFs should be converted by all CDF owners/operators (USACE, States and private entities) to Confined Management Facilities (CMFs), in which dredged material is placed (not disposed), dewatered, and then excavated and beneficially used. Management practices to place dredged material in these CMFs in a manner that would facilitate their future beneficial use should be developed and evaluated for implementation.</p>
OM#2	<i>There is a lack of available dredged material management alternatives in the estuary,</i>

	<i>particularly beneficial uses of dredged material for habitat restoration purposes.</i>
	<p>A. An estuary-wide inventory/database of potential sites and projects that could beneficially use dredged material should be developed and updated as needed by PDE. This inventory/database should be considered by all stakeholders in the estuary/region when developing dredging and sediment management projects (Section 5.10).</p> <p>B. The RSMIW, a workgroup including members from the USACE, State and Federal natural resources management agencies, and port and private marina interests, should be formed to develop a marketing program to promote the beneficial use of dredged material in the estuary.</p> <p>C. RSMIW and RDT should identify and evaluate potential dredged material beneficial use demonstration/pilot projects that could serve as initial efforts in the development and implementation of alternative dredged material management strategies (also see FL Problem #2 and EM Problem #1, and Section 5.10). Including:</p> <ul style="list-style-type: none"> > Filling land for development and construction purposes (roads, infrastructure, etc.) > Sanitary landfill cover > Shoreline enhancement > Stream channel Stabilization > Tidal, non-tidal, sub-tidal and upland habitat restoration
Environmental Management Concerns (EM)	
EM#1	<i>Tidal wetlands and sandy shorelines are being lost in the Delaware Estuary due to the combined effects of erosion, climate change/sea level rise, and an inadequate supply of suspended sediment.</i>
	<p>A. PDE and the States to identify tidal wetlands at risk of being lost that could be protected/restored using passive sediment capture mechanisms, active sediment/dredged material beneficial use activities (for example, thin-layer placement), living shorelines, or other methods.</p> <p>B. RSMIW with PDE and others to coordinate implementation of the RSMP with existing/future regional habitat restoration plans (for example, TNC and PDE studies, USACE Beneficial Use Reconnaissance Study), with a focus on beneficially using dredged material to the maximum extent practicable.</p> <p>C. The RDT (which includes the USACE and the States) should establish an interagency workgroup to identify the opportunities for, and coordinate the use of, suitable sand dredged from navigation channels for beach nourishment projects in Delaware Bay.</p>
EM#2	<i>Non-tidal streams in the Delaware estuary watershed appear to have excessively high rates of bed and bank erosion, resulting in adverse impacts to these streams and increased sediment loads to the estuary. Also see Problem SRN #2.</i>
	<p>A. RSMIW, with NRCS, State agencies and PWD, to coordinate implementation of the RSMP with non-tidal watershed erosion control and sediment management projects managed by the NRCS and State watershed/water quality management agencies to ensure that the potential impacts of these projects (positive and negative) are understood (SRN Problem #1).</p>

EM#3	<i>Current dredging and dredged material management operations in the estuary may be resulting in adverse impacts to surface water quality.</i>
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- A. The RDT should undertake a review of current dredging and dredged material management operations in the estuary and identify Best Management Practices (BMPs) to reduce potential impacts to surface water quality resulting from these operations. These BMPs should be incorporated as permit conditions by State regulatory programs and implemented on a consistent basis throughout the estuary.

Education and Outreach Needs (EON)

EON#1	<i>The general public is un- or misinformed regarding the critical nature of the USACE navigation mission and the importance of waterborne commerce to the economy and quality of life in the region.</i>
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- A. The USACE and regional port interests should develop and implement an education and outreach program to the general public (including county and local governments, and non-government organizations and schools) to better explain the economic importance of dredging and dredged material management in the estuary.

EON#2	<i>The environmental risks posed by dredging and the beneficial use of dredged material are poorly understood by the general public.</i>
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- A. EPA/USACE to develop and implement an education and outreach program to change the perception of dredged material from that of a contaminated waste/spoil to a resource and explain the potential impacts (positive and negative) of various dredged material beneficial use alternatives.

Science and Research Needs (SRN)

SRN#1	<i>Our current understanding of sediment sources to, and transport and fate mechanisms within, the Delaware Estuary are incomplete. This limits the implementation of fully effective regional sediment management.</i>
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- A. USACE, academia, DRBC and local partners to develop a better understanding of estuarine sediment dynamics through the development of the following:
- > a refined sediment budget that encompasses the entire Delaware Estuary and includes coarse and fine-grained sediment fractions;
 - > a model of sediment transport mechanisms and fluxes at the ETM in the Delaware River;
 - > a model(s) of sediment transport and fate processes and fluxes between the main navigation channel and adjacent shallower areas (including tidal marshes); and
 - > a model of sediment transport mechanisms between the Atlantic Ocean, Delaware Bay, and the ETM.
- B. NRCS, USGS, and academia to fully characterize sediment supply, erosion rates, and delivery ratios for various land uses from the upstream (non-tidal) watershed to the estuary. This effort should utilize the procedures of the Natural Resources Inventory and the Conservation Evaluation Assessment Program.

SRN#2	<i>Our knowledge of the connections between ecological processes and sediment dynamics in the estuary are inadequate to comprehensively guide implementation of the RSMP.</i>
<p>A. PDE and academia to use the models and data obtained through the implementation of the recommended actions to address SRN Problem #1 to develop a better understanding of the importance of sediment to ecological processes in the Delaware Estuary. In particular, the role(s) of sediment in maintaining tidal wetlands is in need of additional study.</p> <p>B. All parties involved with projects to implement demonstration projects to gain additional data and knowledge about the relationships between sediment quantity and quality and the structure and function of aquatic habitats in the estuary.</p>	
SRN#3	<i>We do not have a complete understanding of sediment quality in the Delaware Estuary, and its role in the estuarine ecosystem.</i>
<p>A. EPA, DRBC and States to monitor and evaluate contamination of sediments throughout the system, for a target list of contaminants of concern, including periodic updating of the RSMP Sediment Quality Database.</p> <p>B. RSMIW to convene an interagency workgroup to develop regional criteria for the beneficial use of dredged material in aquatic habitat restoration projects, with specific consideration of the toxicity (acute and chronic) and bioaccumulation of contaminants of concern to aquatic biota.</p> <p>C. EPA, USGS, and States to identify sediment hot spots with elevated levels of contaminants that pose risks to the aquatic ecosystem and would, if dredged, preclude their beneficial use in aquatic habitat restoration and/or upland projects. Evaluate potential ongoing pollutant sources that could be causing this sediment contamination and develop a plan to address these sources.</p>	
SRN#4	<i>Large quantities of sediment are deposited in navigation channels and berths, where they must be dredged. It is not known if it is practical to implement alternative dredging methods and technologies that could reduce dredging needs, reduce the disposal of dredged material in upland CDFs, and contribute to better sediment/dredged material management in the estuary.</i>
<p>A. USACE to evaluate the application of engineering modifications (for example, to navigation channels and the Delaware River) and alternative technologies (active and passive) that could change local sediment dynamics in shoaling areas and reduce sediment deposition in navigation channels and berthing areas.</p> <p>B. USACE to evaluate the use of alternative dredging methods and technologies (including water injection dredging and long distance pumping) that could reduce the need to dredge and/or the volume of dredged material that must be managed.</p>	

4.10 Establishing Short-term Goals and Setting Resource Management Targets

This Section identifies specific RSM targets to both facilitate implementation of the RSMP and to measure progress in regional sediment management over the immediate term (less than one year), short term (less than five years) and the long term (the next five to seven years, and beyond). The short term goals are set to address priority items and ultimately to reach these specific targets. Some of these targets relate to specific Recommended Actions identified to address specific Problem Statements, while others satisfy multiple actions. The RSMIW will implement a system to track the success/failure of the RSMP to meet these targets, as well as the implementation of the Recommended Actions presented in this chapter. It is understood that some targets are easily quantified while others will be harder to quantify. The RSMW believes targets are necessary to move the plan forward however, many target's values were not identified as necessarily "critical" numbers to achieve success in implementing the RSMP. Success will ultimately be demonstrated in the health of the estuary's natural resources and improvements in water quality, as well as our ability to sustain commerce within the estuary.

Governance Targets

- > Convene the RSMIW immediately following completion of the RSMP.
- > Develop a funding committee within the first year to prepare a RSMP funding strategy for presentation to Federal and State agencies and the maritime community.

Hydro-modification and Sediment Loading Targets

- > Reduce sediment contributions from the Delaware River main stem by 50% (350,000 tons produced according to Mansue and Commings, 1974) for stream channel sources) over 25 years.
- > Reduce sediment contributions from Piedmont Plateau tributaries by 50% (304,490 tons produced according to Mansue and Commings, 1974) for stream channel sources) over 25 years.
- > Restore approximately 465 miles of stream banks on the main stem Delaware River and Piedmont Plateau tributaries over the next 25 years (this represents 2 percent of the total stream length based on the Lockatong and Wickecheoke Creek study by NRCS).
- > Reduce or minimize the rate of shoreline recession where tidal wetlands meet open water.
- > Stabilize at least 10 miles of tidal shoreline within five years.
- > Within five years, develop a more complete "sediment budget" and quantitative understanding of the multiple roles and sources of sediment in the Delaware Estuary ecosystem.

Beneficial Use Targets

- > Maximize the beneficial use of dredged material (particularly for habitat restoration) and minimize the removal of sediment from the estuarine system.
- > Restore 10,000 acres of wetlands and protect (via 10 miles of shoreline stabilization) 10,000 acres of wetlands within three years.
- > Evaluate and, if appropriate/feasible, use thin layer application of dredged material in at least one habitat restoration project over the next three years.
- > Perform one pilot project that will improve benthic habitat in each DRBC Water Quality Zone of the Delaware River within five years.
- > Restore and maintain functioning tidal wetlands wherever possible. Support the accretion of tidal wetlands through active and passive means of augmenting sediment supply.

- > Within two years, develop and implement a program to assess and beneficially use sand from navigation dredging projects for beach nourishment in Delaware Bay.

Operational Targets

- > Convert five upland CDFs (USACE, State, or privately-owned) to CMFs within five years.
 - Existing dredged material in these upland CDFs is to be excavated and beneficially used. Subsequently, dredged material will be placed in these facilities only for dewatering purposes prior to excavation and beneficial use.
 - Maximize the beneficial use of dredged material, with a priority given to using suitable dredged material for habitat restoration projects. Within the next five years, directly use dredged material from a navigation project for a beneficial use project, without interim placement and dewatering at an upland CDF/CMF.
- > Within two years, identify contaminated sediment hot spots in the estuary that contribute to navigation dredged material being deemed unsuitable for any potential beneficial use.
 - If appropriate, perform a remedial dredging project on one of these hot spots by 2020.
- > Incorporate the majority of the recommendations made by the USACE Dredging Operations Technical Support (DOTS) Program for BMP enhancements in upland CDFs within two years of completion of this plan, provided the recommendations are consistent with the goals for RSM and CDF/CMF management.
- > Within two years, State and Federal regulatory programs managing sediment, dredging, and dredged material will be coordinated / consistent to the maximum extent practicable.

Education/Outreach Targets

- > Develop an education and outreach plan within one year of completion of the RSMP.
- > Attend five public venues a year for the next five years and present information regarding the RSMP.
- > Prepare at least one publication per year regarding RSM in the Delaware Estuary for the next five years.
- > Present scientific findings resulting from the RSMP at three scientific venues in the first year, and at a minimum one venue per year for the next five years. Venues could include: PDE Environmental Summit, New Jersey Association of Floodplain Managers/New Jersey American Water Resources Association (NJAFM/NJAWRA) Flood Managers Conference, Society of Ecological Restoration (SER)-Mid-Atlantic Conference, and others.
- > Introduce curriculum developed by NJ Marine Sciences Consortium to schools in other States.
- > Develop two RSM educational programs targeted to children and visit five schools in each of the States within the next two years.

Science and Research Targets

- > Complete at least one study in the next two years in both the upper watershed and the lower estuary.
- > Complete at least one study in the next five years in the upper watershed to analyze the nature and extent of non-tidal tributary sediment sources to the estuary.
- > Work with USDA-NRCS to prioritize the Delaware River Basin (DRB) to as a priority National Initiative (similar to the Chesapeake Bay Watershed and others) using the National Resource Inventory and Conservation Evaluation Assessment Project documentation for the DRB.

- > Within five years of plan completion, define those areas in the estuary that support a healthy benthic ecosystem. Within 5 years of plan completion, determine what actions could be performed to improve benthic quality. Over the next three years, develop a plan to identify methods to evaluate the aerial extent (i.e. acres) of sediments that support a healthy aquatic ecosystem.
- > Further evaluate the potential impacts on sediment quality of the contaminated sediment “hot spots” identified in the *Sediment Quality White Paper* (Appendix D) within five years.

4.11 Example Demonstration/Pilot Projects

The RSMW has identified a number of potential demonstration/pilot projects that represent the types, breadth and scale of potential implementation opportunities for RSM. The list of projects comes from the stakeholders participating in the RSMW as well as potential projects identified by others as a result of outreach activities conducted by the RSMW to date.

4.11.1 Individual Demonstration Projects

RSMW implementation efforts should identify sediment management and beneficial use demonstration project options that can be implemented without the need for detailed modeling and analyses. Success for RSM may depend on the ability to initiate small scale demonstration projects, due to funding considerations. As knowledge and practical experience is gained from the implementation of ecosystem restoration demonstration projects, practitioners should identify and develop plans to restore larger and more complex sites. However, should funding be available and engaged stakeholders be identified for larger scale opportunities that meet RSM goals, managers are encouraged to implement such projects.

The majority of pilot projects identified address five major themes:

- > Water quality (operational) enhancements from existing upland confined dredged material disposal facilities
- > Thin layer application of dredged material on wetlands in strategic areas subject to subsidence and/or sea level rise
- > Stabilization of shorelines using living shoreline and other ecologically beneficial approaches (oyster reefs, etc.)
- > Reducing sediment loads from upstream tributaries using stream restoration/bank stabilization techniques
- > Alternatives to current dredging methodologies, such as injection dredging, that bypass the need for dredged material disposal in upland CDFs, or technologies that by-pass sediments away from traditional sediment sinks in navigational areas

The prioritization of the demonstration projects is based on RSMW discussions of several criteria. The criteria considered to select prioritized projects include opportunities, constraints, contribution to RSM, and funding.

Prioritized demonstration projects identified to date include:

- > Maurice River, NJ ecosystem restoration/shore protection
- > Salem River, NJ ecosystem restoration/shore protection
- > Mispillion inlet, DE ecosystem restoration/shore protection
- > USFWS National Wildlife Refuge (Prime Hook and Bombay Hook) and Egg Island Point ecosystem restoration/shore protection
- > Wilmington Harbor, DE shoaling reduction
- > Natural transport processes from River to Bay restoration (to pre-1890)

- > Wetland creation demonstration project to create CDF capacity at the Artificial Island, Killcohook or Pedricktown upland CDFs
- > Upland CDF dredged material processing/transport facility to create capacity at the CDF
- > Thin-layer application of dredged material at a specific wetland location
- > Island restoration at Tinicum Island, PA. or Pea Patch Island, DE
- > Gorgas Run, PA., ecosystem restoration implementation
- > Harrison Avenue Landfill, NJ ecosystem restoration/wetland creation

The initial phase of implementing the RSMP should include the selection, design, and funding of demonstration/pilot projects. These will typically be smaller-scale projects based on techniques and methods successfully used in other parts of the country, but minimally (if at all) used to date in the Delaware Estuary. A key component of these demonstration/pilot projects will be monitoring their success, including cost benefit and life cycle cost analyses. The knowledge and experience gained from these demonstration/pilot projects should then be used to identify and develop larger and more complex projects.

The USACE has completed its Delaware River Dredged Material Utilization Study - a reconnaissance study of 50 potential dredged material use opportunities and projects in the Delaware Estuary, with 12 recommended for additional evaluation (USACE, 2011). The Congressional authorizing language for this study specifically cites evaluating the “transferring of dredged material, as it relates to comprehensive watershed and regional sediment management (RSM)”. Currently, there are no Federal projects within the Delaware Estuary (for example, habitat restoration, shoreline stabilization, flood control) that beneficially use dredged material. The USACE (2011) study also presents estimated costs for the projects and a suite of potential funding strategies that could be used, depending on the size, scope, and duration of a project.

Examples of the types of projects identified in USACE (2011) include the following:

- > Convert upland CDFs to CMFs: USACE Pedricktown CDF; State of New Jersey Burlington Island CDF, NJ; Reed Point South CDF, DE
- > Wetland creation or other water quality BMP near upland CDF: USACE Pedricktown CDF, NJ
- > Thin layer placement of dredged material for wetlands restoration
- > Landfill/Brownfield remediation: Harrison Ave. Landfill, Camden, NJ; Maple Beach, DE
- > Living shorelines: various locations in New Jersey and Delaware
- > Abandoned mine reclamation: numerous potential locations in PA (for example, the Poconos and Montgomery County) and northwest New Jersey
- > Shoreline stabilization/erosion control: Bombay Hook and Prime Hook National Wildlife Refuges, DE; Bayview, Slaughter, Fowler, Kitts Hummock, and Broadkill Beach, DE
- > Ecosystem restoration: Port Mahon, Mispillion Inlet, and Big Stone Beach, DE; Gorgas Run/Wissahickon Creek, PA
- > Island Restoration: Tinicum Island, PA; Chester and Monds Islands, NJ; , Pea Patch and Reedy Islands, DE

CHAPTER 5 Implementation

5.1 Overview

This Chapter is dedicated to setting the framework for governance of the implementation of the RSMP. The RSMW anticipates that a Regional Sediment Management Implementation Plan (RSMIP) will not be needed for the next phase of the project. Rather, the RSMW will continue to operate with the same members as the Regional Sediment Management Implementation Workgroup (RSMIW). The RSMIW will develop action plans and tracking documents for specific elements identified in the RSMP. The RSMIW will work in smaller sub-committees where necessary to focus on particular recommendations and implementation elements. While the RSMW has made detailed recommendations and identified a list of potential implementation projects, further details are needed to determine how the recommendations made in the RSMP will be fulfilled. The RSMIW will develop details on prioritizing implementation projects and completion of the recommendations. Lacking an RSMIP, this document sets the baseline/framework for regional managers to consider beneficial use of sediments in their programs and decisions for managing resources in the Delaware Estuary/Basin.

Table ES.1 (also Table 4.1) provides a summary of the primary recommendations/actions for the RSMP which will be the guiding document for the RSMIW. The RSMIW will focus on the highest priority topics, such as:

- > Identifying and securing funding actions at every level – implementation, research, outreach
- > Identification and implementation of high priority demonstration projects
- > Development of a dredged material management plan for the upper basin

Assignments for lead agencies are noted on the table. While the RSMIW is intended to serve as the mechanism for coordination, many recommendations will be implemented by specific RSMIW member agencies. Some recommendations will require inclusion of multiple stakeholders as well. The recommendations consist of several categories of activities, such as advocacy, physical actions/improvements and coordination efforts. This diversity of needs requires all levels of financial support and durations to be accomplished.

This Chapter includes suggestions from the RSMW on priorities and strategies for implementation as well as baseline information for the RSMIW to use in developing the RSMIP. Estimates for the potential resources needed for implementing the RSMP and the commitments deemed necessary are also outlined in this section.

This Chapter includes discussion regarding:

- > Prioritized Immediate Implementation Actions
- > Plan Implementation Structure
- > Economic Benefits
- > Funding of Actions
- > Tracking Progress

5.2 Prioritized Immediate Implementation Actions

A number of recommended RSM actions and strategies are presented in Chapter 4 of the RSMP. Each of these recommended actions has merit and should be fully considered. This section identifies a prioritized list of immediate implementation actions to further the momentum generated by the RSMW to date.

RSMP strategies for the Delaware Estuary will be implemented by all the stakeholders in the Delaware Estuary as appropriate. The RSMW recommends that the PDE and RSMIW (which includes representatives from New Jersey, Pennsylvania and Delaware) serve as the advocates for the implementation of the RSMP. The most effective implementation of the plan will include top-down support as well as State regulatory agencies support of the plan.

The first task of this implementation strategy is to develop and disseminate the RSMP. Immediate tasks suggested by the RSMW include:

Initial Effort

- > Develop the RSMIW
- > Adopt the vision, objective and recommended action(s) among the RSMIW, stakeholders and advocates
- > Assign detailed responsibilities
- > Develop education/outreach program
- > Collaborate with the RDT to facilitate Dredged Material Management (DMM) and Beneficial Use (BU) opportunities
- > Develop an online sediment tracking/management project registry towards a programmatic sediment management bank
- > Develop a website to track success
- > Create a team (sub-committee) of stakeholders to identify, evaluate and educate members on funding options
- > Create a team (sub-committee) to develop a dredged material management plan for the upper basin
- > Create a team (sub-committee) to address/coordinate prioritization of or direct stakeholders to demonstration projects
- > Create a team (sub-committee) to address each of the Problem Categories identified in the plan

Funding and Benefits

- > Identify funding sources for priority demonstration projects
- > Demonstrate benefits/cost savings for RSM strategies to consider benefits across multiple business lines including navigation, ecosystem restoration and flood risk management.
- > Garner administrative funding early on to support plan implementation
- > Establish a long-term funding mechanism
- > Craft metrics for assessing progress

Strategy/Project Development (Ongoing)

- > Evaluate, prioritize and perform RSMP White Paper recommendations as summarized in in this Chapter
- > Identify areas of wetland loss/potential demonstration projects
- > Develop and perform implementation strategies and demonstration projects proposed in the RSMP
- > Evaluate private berth dredged material management and beneficial use opportunities

Miscellaneous

- > Develop and maintain a web site and a GIS throughout the project
- > Project closure: Document successes/obstacles, benefits, costs and incorporate into outreach
- > Monitoring and adaptive management

The RSMP should remain a *living document*. The principles of adaptive management should be applied to the conclusions and recommendations of this plan and it should be updated regularly as new information becomes available and priorities shift.

5.3 Plan Implementation Structure

5.3.1 Administration of the Plan

The RSMW is recommending that the RSMP be developed by an RSMIW comprised of the same stakeholders as the RSMW. In addition, the RSMW recommends that the PDE serve as the advocate to the stakeholders in the estuary/basin to provide continued support for the regional plan and to ensure that components of the RSMP are referenced in the State of the Estuary and State of the Basin plans/documents.

RSMW has prepared an estimate for resources/commitments needed for plan administration described later in this chapter. Critical to the success of this plan is the continued engagement of the RSMW stakeholders and the support for their participation in the process and plan development and ultimate execution.

5.3.2 Commitment of Resources

The RSMW recommends that a RSMIW be established to develop and coordinate the implementation of the plan. The RSMW suggests that the RSMW membership continue on the RSMIW. RSMIW would require a commitment of staff time to develop the plan, similar to that completed for the RSMP coordination and development. A schedule and plan for preparing the plan needs to be developed by the group. The RSMW anticipates that the commitment will be limited to periodic attendance at meetings, coordination, review, and tracking. Some sub-committees comprised of subsets of RSMIW members will be organized to focus on specific implementation tasks. Member participation is anticipated to be directed to those agencies already involved in the subject matter of the sub-committee. Continued participation by all of the RSMW stakeholders in the RSMIW is vital to the successful implementation of this initiative.

Although demonstration projects have been identified, developing cost estimates for these projects would be very difficult at this time. Some projects are very small in scale while others are more comprehensive and orders of magnitude larger.

No funding is being requested from the RSMIW members for implementation of the RSMP. No funding is being requested for implementation project identification, assessment, design or construction. The implementation plan will identify specific funding sources for implementation projects identified and supported by the plan. It is hoped that the RSMP will be used by various stakeholders throughout the region to implement additional projects not included in the plan and that the RSMIW will keep a ledger of completed and identified projects related to RSM.

Seed money for developing the recommendations of the plan will be needed and the USACE is pursuing funds to continue with this effort in the Delaware River Basin and Estuary.

5.4 Economic Benefits

Economic benefits of regional sediment management within the Delaware Estuary/Basin are varied and numerous and described throughout the RSMP. The following economic benefits are anticipated through the implementation of the RSMP plan and recommendations:

- > Green jobs will be created through the implementation of RSM projects
- > Waterborne commerce will be viable and associated industries sustainable through the implementation of RSM principles;
- > Industries dependent on the natural resources of the river and estuary will benefit as well from the sustainable maintenance of the waterways and the implementation projects identified;
- > RSM implementation projects will also provide economic benefits through continued and increased recreational use of the estuary; and
- > RSM implementation projects will result in increased economies, ecological uplift and therefore a general increase in quality of life, thereby encouraging additional economic benefits on a regional scale.

As phases of the implementation plan and demonstration projects are completed, the RSMW recommends that an accounting of the benefits for each action be conducted as part of the RSMP tracking plan.

5.5 Funding of Plan Actions

5.5.1 Overview

The RSMW has identified as Priority Number 1 the need for funding to realize RSM goals and targets. The RSMW recognizes that something needs to change in the Delaware Estuary/Basin regarding approaches to funding if RSM it to be realized. Several ideas for creative/alternative funding have been developed. The RSMW recognizes that the USACE controls a major source of sediment to be managed in the estuary/basin and Federal, in particular USACE, funding mechanisms need to be continued to be explored. As this plan is meant as a tool for all regional managers in the basin/estuary, other funding mechanisms have been identified and potential new funding streams identified.

A Delaware Estuary RSM Implementation Business Model proposal is presented composed of Federally-appropriated and non-Federal funding sources. The realization of these funds, whole or in part, would enable the management and implementation of RSM components within the Delaware Estuary. A detailed description of program actions associated with the Business Model is discussed in Appendix E.

The Business Model consists of a series of recommendations to acquire Federal appropriations, non-Federal funds, and develop partnerships with regional, State and municipal entities. These recommendations should be instituted by the Delaware Estuary RSMIW.

A dedicated source of funding is highly desirable if the regional program is to be successful in its implementation. Appendix E offers a number of Federal appropriation and non-Federal funding sources and a business model proposal for funding the implementation of the RSM program in the Delaware Estuary. These three RSM components include program management/administration, strategies and demonstration projects.

5.6 Tracking Progress and Making Adjustments

The RSMIW will be charged with tracking progress of the implementation plan. Constant evaluation is needed to determine if the goals were met, if strategies are working and if improvements are being realized. As projects are being implemented and recommendations acted upon, the group will need to evaluate if adjustments are needed and if so, develop revised actions/strategies to realize the plan's goals.

The RSMP is an ambitious plan covering a broad geographic region; it is potentially the most comprehensive RSMP prepared to date. Metrics on various levels should be identified by the RSMIW and tracking ledgers developed incorporating those metrics. An initiative of this scale needs to maintain positive momentum so metrics and goals need to include short term/immediate successes as well as long term comprehensive successes. Metrics should be developed for each of the categories established in

the plan: Policy, Funding, Programmatic/Regulatory; Operational Management; Environmental Management; Education and Outreach; and Science/Research.

As metrics are met and positive outcomes realized, there should be a plan to advertise these successes and to recognize those parties that facilitated the success in order to achieve multiple metric targets and maintain support for this long term initiative.

5.7 Implementation Summary

Chapter 5 includes recommendations on governance and guidelines for the next phase of the project – Implementation. Critical to the success of the RSMP will be continued engagement by the RSMW partners. As part of this Chapter immediate actions were identified for continuing the efforts to manage sediment on a basin wide scale and to initiative specific projects identified by the RSMW in the RSMP. Continued advocacy by the USACE for this plan will require short term success in the completion of demonstration projects identified in the plan. In particular focus on the projects identified in the Reconnaissance Feasibility Study for Beneficial Use completed by the USACE will be a great first step. For these projects a partner with some cost share capability is all that is needed.

While USACE participation is noted as vital to success (due to the linkage to the majority of sediment management in the Basin), success of the RSMP will be dependent on all stakeholders embracing the plan and making regional sediment management integral to decision making. Broad scale continued engagement from the RSMW and RDT members in this process will be paramount to success.

The RSMW members recognize that there are significant challenges, and yet great opportunities, for regional sediment management. Continued momentum building is important and the group understands that immediate efforts in establishing the foundation/governance structure (the proposed RSMIW) are the first priority while simultaneously focusing attention to high priority demonstration/pilot projects their funding and ultimate implementation. Larger scale projects, and therefore larger scale improvements, will be possible as these successes are realized.

Appendix A

Sediment Quantity and Dynamics White Paper

Appendix B

Restoration and Beneficial Use White Paper

Appendix C

Dredging and Dredged Material Management White Paper

Appendix D

Sediment Quality White Paper

Appendix E

Funding of Plan Actions/Business Model

Appendix E: Funding of Plan Actions/Business Model

Overview

A dedicated source of funding is highly desirable if the Regional Sediment Management Plan (RSMP) is to be successfully implemented. A Delaware Estuary Regional Sediment Management Plan Implementation Business Model proposal is presented that includes potential Federally-appropriated and non-Federal funding sources, and recommendations to develop partnerships with regional, State and municipal entities. The realization of these funds, in whole or in part, would enable the management and implementation of RSMP components within the Delaware Estuary.

Several **over-arching recommendations** to realize the funding sources needed to implement the RSM program are summarized by the importance in performing outreach with several entities about specific management guidelines, strategies and projects, including:

- > Coordinate with legislators to communicate RSMP needs in the Delaware Estuary to obtain and structure Federal appropriations.
- > Garner stakeholder, public and non-Federal sponsor support/partnership to develop broad-based support of the RSM Program based around individual strategies and projects.

Key components to realize **Federal appropriation funding sources** are to:

- > Continue the development of the Delaware River Dredged Material Utilization General Investigation (GI) Study to identify the feasibility of, and selected plan for, RSMP and beneficial use strategies and projects within the Delaware Estuary. Individual projects could then be designed and constructed with USACE Construction General business line funds.
- > Identify, develop, and propose individual strategies and projects to the national Continuing Authorities Program (CAP). Three different authorities should be considered:
 - Section 204 of Water Resources Development Act (WRDA) '92 - Beneficial Uses of Dredged Material for Ecosystem Restoration
 - Section 1135 of WRDA '86 - Project Modifications for the Improvement of the Environment
 - Section 206 of WRDA'96 – Aquatic Ecosystem Restoration

CAP funds could address planning, engineering and design, construction, and outreach elements.

- > Pursue funding from the National RSM Program and the USACE-Philadelphia District budget to cover Construction and Operations and Maintenance (O&M) project components.
- > Propose new Design-Build (DB) authority for the next WRDA titled “Delaware Estuary Wetland Restoration and Shoreline Protection, NJ/DE/PA” to actually construct projects.

Non-Federal sources are also important to funding RSMP components. The first and most important effort of the RSMP Implementation team should be to develop relationships with non-Federal partners on specific individual RSMP strategies and projects to acquire non-Federal funding to support the Delaware Estuary RSM Program. The development of partnerships with State and municipal stakeholders will facilitate cost-sharing of incremental costs above the Federal standard/base plan, as well as provide funds for monitoring, permitting and testing activities. Specifically, a plan to realize **non-Federal funding sources** includes the following:

- > Develop a compensatory mitigation bank and/or in-lieu fee program, or utilize the USACE Compensatory Mitigation Bank System.
- > Develop a cost-sharing program funded by bonds, supplemental taxes and fee programs.

- > Place prioritized projects into the Partnership for the Delaware Estuary Alliance Project Registry to be considered for Natural Resource Damage Assessment (NRDA) mitigation grants.

Introduction

A dedicated source of funding is highly desirable if the Delaware Estuary Regional Sediment Management Program (RSMP) is to be successfully implemented. This Funding Sources Appendix identifies a number of potential Federal appropriation and non-Federal funding sources, and proposes a business model for funding the implementation of the RSMP.

Prioritized funding sources which should be pursued to fund RSMP components include:

- > Federal Appropriations (USACE and non-USACE)
- > Cash and n-kind services from Federal and State agencies
- > Compensatory mitigation bank and/or in-lieu fee programs
- > Matching funds from regional, State and local entities
- > Taxes and fees from regional, county and local entities, such as property tax assessments, transient occupancy tax, and sediment utility/development impact fees
- > NRDA funds

A more detailed analysis of potential funding sources should be considered during the RSMP implementation phase to determine the optimum balance of revenue streams. A strategy should then be prepared and implemented to pursue those potential funding sources most likely to be realized. The ultimate funding source strategy will depend on several factors, the most important of which will be the state of the economy and the prevailing political climate. Each of these funding sources involves multiple partners and public/private partnerships. The realization of funding is strongly dependent upon building public and stakeholder interest, creation of green jobs, State-level Executive support/advocacy, and Congressional attention.

The following section contains a detailed discussion of specific potential RSMP funding sources. For each funding source, a discussion is presented which summarizes the source, the most appropriate uses of the funds, and recommended actions for the RSMP. A proposed business model to acquire funding to implement RSMP components is presented in "RSMP Implementation: Business Model Proposal" at the end of this appendix.

Federal Appropriations

The appropriation of Federal funds is believed to represent the best funding opportunity. The cornerstone of this source is USACE-Federally appropriated funds.

However, a longer-term goal of the RSMP should be to potentially restructure the Federal appropriation process to facilitate the engagement/combining of multiple USACE mission areas (navigation, flood control, ecosystem restoration). This would enable the calculation of new and potentially improved economics (benefits/costs) that consider the engagement/combination of multiple mission areas rather than individual mission areas (see the USACE Institute for Water Resources (IWR) Report "RSM Benefits: A Closer Look" for a more detailed discussion).

Figure E.1: General Investigations Appropriation Authority and Process

**GENERAL INVESTIGATIONS APPROPRIATION
AUTHORITY AND PROCESS**

General Investigation New Start Project			
Reconnaissance Phase	Feasibility Phase	Preconstruction Engineering & Design (PED)	Construction
<ul style="list-style-type: none"> • Full Fed cost of \$100K-\$200K • Identifies Project Study Plan and cost share responsibilities of Sponsor • 9 to 12 months 	<ul style="list-style-type: none"> • Cost share with Sponsor 50/50 • Avg. cost \$1 to \$3 million • Non-Federal share can be in-kind • 3 to 5 years 	<ul style="list-style-type: none"> • Cost share with Sponsor, % varies • 1 to 2 years 	<ul style="list-style-type: none"> • Cost share with Sponsor, % varies • Time varies

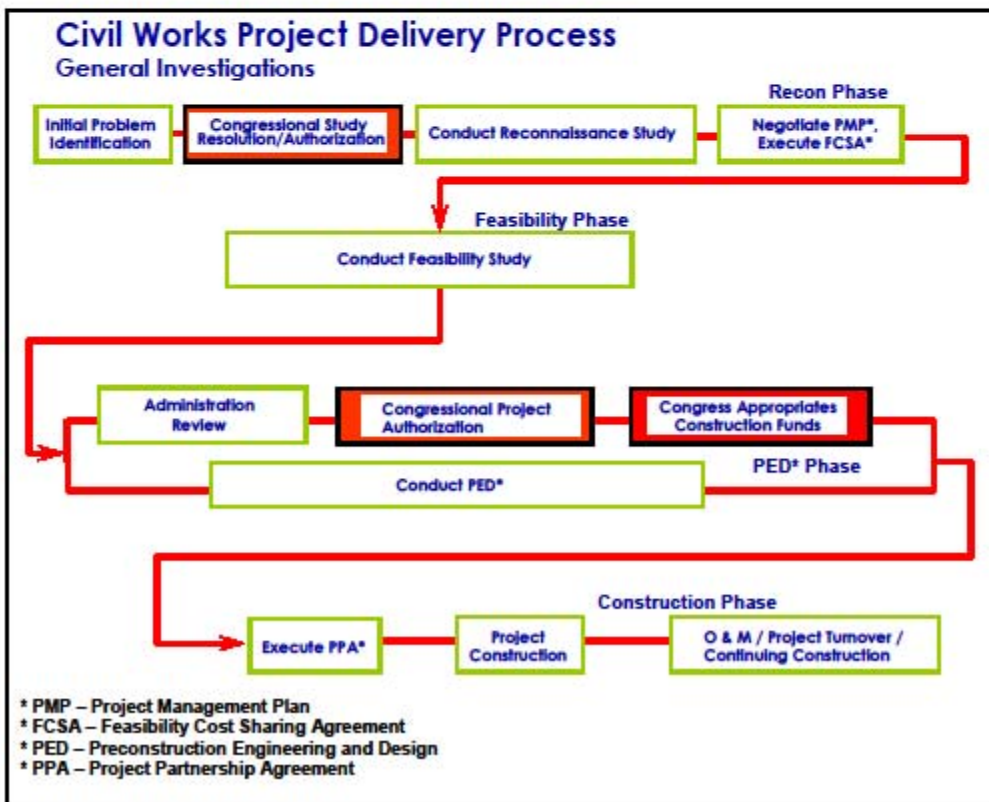



Figure E.2: Continuing Authorities Program Construction General Appropriation

**CONTINUING AUTHORITIES PROGRAM
CONSTRUCTION GENERAL APPROPRIATION**

 <p align="center">CAP (Continuing Authorities Program)</p>					
Section	Authority	Purpose	Cost Share % (Fed/Non-Fed)	Federal Project Limit	Annual Program Limit
14	Emergency Streambank Protection	Protection for public and nonprofit facilities	65/35	\$1,500,000	\$15M
103	Beach Erosion Control	Protection of public shorelines	65/35	\$3,000,000	\$30M
107	Small Navigation Projects	Small river and harbor improvements	Non-Fed share 10 to 50% depending on depth	\$7,000,000	\$35M
111	Mitigate Shore Damage Attributed to Navigation Works	As a result to a Federal navigation project	Same as original project	\$5,000,000	n/a
204	Beneficial Uses of Dredged Material	Dredged material to create aquatic habitat and wetlands	65/35	\$5,000,000	\$15M
205	Flood Damage Protection	Small flood damage reduction projects	65/35	\$7,000,000	\$55M
206	Aquatic Ecosystem Restoration	Restore degraded aquatic ecosystems in the public interest	65/35	\$5,000,000	\$50M
208	Snagging and Clearing for Flood Control	Removal of snags and trees in navigable streams and tributaries in the interest of flood control	65/35	\$500,000	\$7.5M
1135	Modifications for Improvement of the Environment	Restoration in a degraded ecosystem resulting from Corps project operations	75/25	\$5,000,000	\$40M

The establishment of a long-term funding strategy/mechanism for project management/administration and implementation is recommended. For example, an appropriation strategy goal is hereby proposed that includes the realization of a \$1.2 Million Federal appropriation towards facilitation of the Delaware Estuary RSM program. This appropriation strategy includes a \$200,000 appropriation from each of the six USACE business lines over the next five years. These business lines include planning (GI), Construction General (CG), CAP, O&M funds from both the Philadelphia District budget and the National O&M RSM Program, and DB (Figure E.3). While GI and CAP appropriations will be used to conduct planning elements such as feasibility studies, the remaining business lines (including the CAP) will be used to design, construct and maintain RSM components.

Figure E.3: Delaware Estuary Regional Sediment Management Federal Appropriation Business Lines

Project Phase		Construction General	Continuing Authorities Program	Philadelphia District O & M Funds (i.e. Beneficial Use Line Item)	National O&M RSM Program Funds	Design-Build
Planning	Feasibility Study/Plan		Feasibility Study/ Implementation Plan			
Pre – Construction Engineering & Design		Design and P&S	Design and P&S			Design and P&S
Construction		Construction: Cover incremental costs	Construction: Cover incremental costs	Construction: Cover Base Plan/ Federal Standard	Construction: Cover Base Plan/ Federal Standard	Construction: Cover incremental costs
Operations & Maintenance				O&M or Non-Federal Resp		
Project Management & Outreach						

The business lines of this program include:

1. General Investigation (GI) Study Business Line

This business line is used for planning purposes, including the development of a feasibility study (Figure E.1). For example, the Delaware River Dredged Material Utilization General Investigation Feasibility Study, currently in Reconnaissance Study Phase, is assessing the feasibility of specific beneficial use projects for the Delaware River. Given the support of a non-Federal sponsor, one or more specific beneficial use projects can be considered in the Pre-Construction Engineering and Design (PED) phase and eventually in the Construction General (CG) phase using funds from either the CG or other construction business lines (Figure E.1). These funds could also be used to potentially fund RSM advocates to foster State and local partnerships resulting in a unified vision, sharing resources, and co-leadership of RSM actions.

The authority for the aforementioned GI Study, the Beneficial Use of Dredged Material on the Delaware River, Delaware, New Jersey, and Pennsylvania, Senate Committee on Environment and Public Works Resolution, October 26, 2005, should be considered for additional future GI studies in the Delaware Estuary.

The timeframe for delivery of a project through the GI phase for actual construction is time-intensive (4-6 years), which should be considered as a factor when assessing these funding sources and project implementation.

Action: Develop and identify individual beneficial use opportunities to be included in the Delaware River Dredged Material Utilization GI Study Reconnaissance Report. The recommended opportunities will be identified for Delaware, New Jersey and Pennsylvania, and further evaluated in the feasibility study for selected plan determination.

2. Construction General (CG) Business Line

Construction General-budgeted funds would be used to construct projects for which a selected plan has been identified in a feasibility study.

Action: Construct the selected plan previously identified in the Delaware River Dredged Material Utilization GI Study. A separate authorization and non-Federal sponsor will need to be identified for the project to be considered for the CG phase.

3. Continuing Authorities Program (CAP) Business Line

The CAP Program (Figure E.2) establishes a process by which the USACE can respond to a variety of water resource problems including shoreline and streambank erosion, navigation, flood damage reduction and environmental restoration without the need to obtain specific congressional authorization for each project. This decreases the amount of time required to budget, develop, and approve a potential project for construction.

Under the CAP Program, the USACE is authorized to plan, design, construct, maintain and manage small projects (relative to other business lines) within specific Federal funding limits. The total cost of a project is shared among the Federal government and a non-Federal sponsor(s) (Figure E.2).

Three CAP authorities which could be used to facilitate RSMP efforts in the Delaware Estuary and are anticipated to have future appropriation streams include:

- > Section 204 of WRDA '92 – The Beneficial Uses of Dredged Material for Ecosystem Restoration authority represents a good opportunity to cover project costs associated with the transport of material directly from the navigation channel to placement locations. Section 2037 of WRDA '07 amends Section 204 to consider RSM components, including the design and implementation phase, and addresses the incremental construction costs of RSM projects above the base plan or Federal Standard.
- > Section 1135 of WRDA '86 –Project Modifications for the Improvement of the Environment represents a good opportunity to cover project costs associated with the transport of material out of a Confined Disposal Area for beneficial use.
- > Section 206 of WRDA'96 – Aquatic Ecosystem Restoration develops aquatic ecosystem restoration and protection projects that improve the quality of the environment, are in the public interest, and are cost effective within the Delaware Estuary. This authority represents a good opportunity to cover project costs associated with the creation of subaqueous habitat using dredged material.

Action: Identify and develop individual proposals for individual strategies and projects for these three authorities.

4. O&M Business Line: Philadelphia District Budget Funds

The development of an individual O&M Beneficial Use Line Item to be applied directly to identified RSMP projects should be considered for the costs of dredging projects associated with the base plan or Federal standard. The use of O&M budget funds rather than General Investigation budget funds (as performed

by other USACE Districts) will expedite RSM projects by eliminating the feasibility phase of a GI Study. However, this component would most likely require an increase in the Philadelphia District O&M budget.

Action: Inquire about the possibility of developing a separate line item under the Philadelphia District O&M budget.

5. O&M Business Line: National RSM Program Funds

Funding from the National O&M RSM Program would be used to improve sediment management in the Delaware Estuary through sustainable dredging/placement practices. and provide guidance for future implementation of specific RSM actions towards the incorporation of RSM as standard business practice. Funds should also be used to demonstrate the improvement of regional efficiencies by engaging cross-mission objectives of the USACE (i.e., navigation, flood risk management, and environmental quality regarding sediments) towards the improvement of life cycle costs/benefits.

These funds should demonstrate a cost savings to both the national and Philadelphia District O&M. Potential projects include planning, designing, and constructing demonstration projects which increase CDF capacity, channel availability, or reduce dredging expenses. These funds could also be used to potentially fund RSM advocates to foster State and local partnerships resulting in a unified vision, sharing resources, and co-leadership of RSM actions.

Action: Develop proposals for consideration under the National O&M RSM Program for future funding cycles.

6. Design/Build Authority

Funding from this authority would be used to plan, design, and construct projects without the feasibility phase aspect of a GI Study. Existing Design/Build authorities for the Delaware River basin address only southeastern PA environmental infrastructure (i.e. waste water treatment and related facilities and water supply, storage, treatment, and distribution facilities). A new authorization would have to be proposed which considers RSMP and dredged material beneficial use elements for the Delaware Estuary, or portions thereof.

Action: Propose new DB authority for the next WRDA titled "Delaware Estuary Wetland Restoration and Shoreline Protection, NJ/DE/PA" to actually construct projects.

7. Cash or in-kind services

Cash or in-kind services such as equipment, laboratory, and services could be potentially obtained from Federal agencies other than the USACE including the US Department of Agriculture (Food Safety Division, Natural Resources Conservation Service and the Office of Environmental Markets), US Department of Commerce/National Oceanographic and Atmospheric Administration, US Department of the Interior (Fish and Wildlife Service, National Park Service, US Geological Survey), US Department of Transportation, and the USEPA.

Action: Communicate with individual Federal agencies about cash or in-kind services for specific RSMP strategies and demonstration projects.

8. Congressional Committee Resolutions

Additional congressional committee resolutions and other Federal legislation could be used as authority for additional GI efforts. However, the Delaware River Dredged Material Utilization Study is adequate at the present time to satisfy known feasibility study level analyses concerning RSM and dredged material beneficial use opportunities in the Delaware Estuary. The committee resolutions discussed below can be considered for use as an authority if needed for future RSM and beneficial use projects:

- > US Senate Committee Resolution dated July 20, 2005 'Delaware River and its Tributaries, New Jersey, New York, and Pennsylvania'

- > US House of Representatives Resolution dated May 22, 2002 'Susquehanna and Delaware River Basins, Pennsylvania'
- > Specter Amendment to the Surface Mining Control and Reclamation Act that allows for Federal 100% cost share of transporting and disposing of the dredged material in PA abandoned mines
- > Federal Emergency Supplemental Appropriations for Disaster Response Measures
- > American Resource and Recovery Act (ARRA)

While enactment of the Emergency Supplemental Appropriations for Disaster Response Measures and ARRA Acts are not anticipated in the near future, RSM strategies and demonstration projects should be identified and prioritized so that should supplemental appropriations become available, planning, design and/or construction projects can be implemented in an effective manner.

- > Delaware River Basin Conservation Act (H.R. 4698): If passed, the USF&WS would be instructed to create a coordinated conservation strategy for the basin, including a competitive grant program for projects aimed to improve habitat, water quality, and flood control.

Action: No action at this time, as the existing GI Study currently satisfies feasibility study activities.

Non-Federal Sources

Several potential non-Federal funding sources are discussed, in order of priority, to facilitate implementation of the RSMP in the Delaware Estuary.

1. Compensatory Mitigation Bank

A compensatory RSM Mitigation Bank will serve as a dedicated ongoing funding source through in-lieu fee programs, mitigation banking, compensation mitigation obligations, supplementary environmental projects, and PDE funding.

This process could be commenced by developing a proposal to develop a new business model to create a dedicated RSM Mitigation Bank that would fund the beneficial use component of projects that involve multiple partners and public-private partnerships. This proposal would synthesize aspects of ongoing mitigation banking models including those of the Schuylkill Action Network, EPA/State provisions for Supplemental Environmental Projects (linked to enforcement actions), and the PDE Alliance to consider RSM Plan elements and strategies to best utilize bank funds.

The USACE has developed a USACE Compensatory Mitigation Bank (based on the 10 April 2008 Final Compensatory Mitigation Rule) which has limited use in the Delaware Estuary. This bank could be organized so that when a permit applicant wants to construct a project which affects a wetland, that applicant will have to buy credits from the RSM Mitigation Bank, the funds of which could subsequently be used to fund a RSM project in the future.

Action: Develop a Delaware Estuary RSM Compensatory Mitigation Bank, and coordinate with other organizations that have employed a mitigation bank and have established projects and funding - such as the Schuylkill Action Network, Conservation Resources Incorporation (CRI), Delaware Department of Natural Resources and Environmental Control, National Fish and Wildlife Foundation (NFWF), and the Philadelphia Water Department - to determine how to apply their business models.

2. Matching Funds

Another option is to set up a matching fund to cover a percentage of the incremental costs of RSMP projects beyond the base plan/Federal Standard.. The matching fund could take many forms, several options of which are identified below.

- a) Regional Fund to be administered by a Tri-State manager; funding would come from regional bonds and supplemental taxes. A regional sales tax could be used to provide a potential funding source to meet the RSM needs of the Delaware Estuary. A regional sales tax would

generate the greatest amount of flexibility and stability as the revenues would be controlled regionally and such funds would be better protected against inflation. The regional tax could be tied directly to specific regional sediment management needs strategies and projects.

- b) State Fund to be administered at the State level with funding from State bonds, supplemental taxes, and use fees.

State revolving fund (SRF) programs provide below market rate loans and other financing for various water resource projects. Federal appropriations and State matching funds are combined to capitalize these projects. However, these SRF programs generally are not of significant quantity to fund large projects.

- c) Local Fund to be administered by the municipality, the funding of which would come from municipal bonds and supplemental taxes. Municipalities raise capital by issuing bonds through the municipal bond market. Utility bonds represent a large part of municipal bond activity and consist of both general obligation (GO) debt and revenue supported debt.

Municipalities could support incremental costs, permits and testing for locally preferred plans associated with infrastructure and restoration projects from annual operating funds and/or borrowing.

The matching fund could utilize Federal or non-Federal funding sources, including the potential funding sources identified above. Alternatively, this fund could be an entirely new and separate funding source for regional sediment management. The estuary municipalities could impose a supplemental fee for the issuance of grading permits within their jurisdiction. If set aggressively enough (i.e., high fee) then this fee could be used as an incentive for project sediment suppliers to place suitable inland sediment on estuary shorelines by making it more expensive to do otherwise. Alternatively, the fee could be set at low to modest levels to allow development to move forward without substantial cost increases while slowly and incrementally building the fund.

Action: Identify any existing examples of fee systems in use, and perform outreach with municipal or regional entities within the Delaware Estuary of a potential RSM demonstration project to prioritize fees, programs, bonds, and supplemental tax options.

3. Taxes/Fees

Regional, county and municipal taxes/fees could be created to facilitate RSM elements on a local or regional scale. Individual taxes and fees include:

- > Property Tax Assessments
 - Property tax assessments have been imposed by many cities and counties to help finance General Obligation bonds for local flooding and storm-water management programs. This type of tax could be used to cover regional sediment management components within the Delaware Estuary.
- > Transient Occupancy Tax
 - A Transient Occupancy Tax (TOT) could be used as a method for funding the region's sediment management program. A TOT would provide a reliable funding source based on the fact that TOTs have been implemented throughout the country with a great degree of success. This tax would levy a TOT and all the funds from that tax are dedicated to RSM management activities and actual demonstration projects.
- > Sediment Utility or Development Impact Fees
 - A sediment utility fee or development impact fee is administered by a Soil and Water Conservation District to inspect and identify the impact of a construction or development activity on existing conditions of soil erosion and sediment control practices (SE/SC) on residential, commercial, and industrial development sites.

- A portion of this local or regional fee could be used to demonstrate the impact that the new development has on sediment transport through the watershed, to generally help fund regional sediment management needs, and to offset the cost of a RSM strategy or demonstration project.
- > Parking/Rental Car/Hotel Occupancy Fees
 - A fee could be levied on parking within individual municipalities along the Delaware Estuary to provide funding for RSM components. This fee could be levied as an increase in existing parking fees where such fees exist, or as new parking fees in areas where no such fees exist. Parking fees could be levied at city and State beaches or parks, or in downtown and redevelopment districts within coastal municipalities.
 - A fee could be levied on rental car leases within a County or the region to provide funding for RSM activities. This fee could be levied on a cost per day basis (e.g., \$0.25/day) or as a percentage of the rental price.
 - Similar fees could be identified based on hotel occupancy for tourists using the navigation highway and benefiting from the natural resources dependent on sediment.
- > Inland Sediment Transport Offset Fund
 - The beneficial use of Delaware Estuary dredged material at other sites should be made financially-attractive and become a viable option for private industry.
 - Economic incentives or funding for project proponents (e.g., construction industry, local municipalities) and sediment suppliers (e.g., dredging community) should be provided to do the work. Funding or incentives are necessary because, in many cases under current Federal guidelines, it may be more expensive in certain instances (in the immediate term on a real cost basis) to beneficially use the sediment than to place the material in upland CDFs. Sediment users may also find it more expensive to process and permit beneficial use projects in comparison to these other options. Consequently, funding or incentives are necessary to offset these additional costs, thereby making it financially viable for project proponents and sediment suppliers to beneficially use sediment.

Action: Identify any existing examples of tax and fee systems in use, and perform outreach with municipal or regional entities in the vicinity of a potential RSM demonstration project to prioritize such programs.

4. NRDA Funds

Potential projects for consideration for NRDA mitigation grants should be entered into the PDE Alliance Project Registry. Note that mitigation funding for RSM components is only possible if the actual damage event affected sediment.

Action: Identify potential projects and input into the PDE Alliance Project Registry.

5. Miscellaneous grants are available such as NOAA/Delaware Coastal Zone Management grant and the Sunoco estuary program (\$25k) funded Heinz/Tinicum marsh restoration.

Action: Identify potential projects and reach out to different grant programs to identify potential grants.

6. Shipping tax towards a restoration trust fund which could be levied on the incoming cargo ships and administered by the regional port authorities to assist in shoal maintenance.

Action: Perform outreach with several Port Authorities in the area to discuss this possibility.

RSM Implementation Business Model Proposal

A RSM Implementation Business Model is proposed to fund RSM components including program management, strategies and demonstration projects.

A business model is defined as:

“A plan implemented by an organization/company to generate revenue and make a profit from operations. The model includes the components and functions of the business, as well as the revenues it generates and the expenses it incurs.”

The Delaware Estuary RSM business model considers both a legislative strategy to obtain Federal funds and a strategy to obtain non-Federal funds.

Federally-appropriated funds (Figure E.3) FY13 would be initiated in Feb 2012 during USACE Congressional visits. A \$1.2 Million Federal appropriation goal, including the appropriation of \$200,000 from each of the six business lines over the next five years, will be requested by the USACE-Philadelphia District for the implementation of the RSM Program.

A strategy for the allocation of Federally-appropriated funds includes the following components:

- > Continue the development of the Delaware River Dredged Material Utilization GI Study to identify the feasibility of, and selected plan for, RSM and beneficial use strategies and projects within the Delaware Estuary. Individual projects could then be designed and constructed with CG business line funds.
- > Identify, develop and propose individual strategies and projects to the national CAP program. Three different authorities to consider include Section 204 of WRDA '92 - Beneficial Uses of Dredged Material for Ecosystem Restoration; Section 1135 of WRDA '86 - Project Modifications for the Improvement of the Environment, and Section 206 of WRDA'96 – Aquatic Ecosystem Restoration.
- > Pursue funding from the National RSM Program and the Philadelphia District Budget to cover construction and O&M project components.
- > Propose new Design Build authority for next WRDA titled “Delaware Estuary Wetland Restoration and Shoreline Protection, NJ/DE/PA” to actually construct projects.

Non-Federal sources are important to funding RSM components. A plan to realize **non-Federal funding sources** includes the following:

- > Develop a compensatory mitigation bank and/or in-lieu fee program such as the USACE Compensatory Mitigation Bank System.
- > Develop a cost-sharing program funded by bonds, supplemental taxes and fee programs.
- > Place prioritized projects into the PDE Alliance Project Registry to be considered for NRDA mitigation grants.

The first and most important effort of the RSM Implementation team should be to develop relationships with non-Federal partners about specific individual RSM strategies and projects to acquire non-Federal funding to support the Delaware Estuary RSM Program. The development of partnerships with State and municipal stakeholders will facilitate cost-sharing of the incremental costs of RSM projects above the Federal standard/base plan.

Appendix F

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Appendix F: References Cited

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