Mouth of the Columbia River Regional Sediment Management Plan

August 2011

Prepared for Lower Columbia Solutions Group

by

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MOUTH OF THE COLUMBIA RIVER
REGIONAL SEDIMENT MANAGEMENT PLAN
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ACRONYMS

AMP	Adaptive Management Program
AMT	Adaptive Management Team
AUP	Annual Use Plan
cfs	cubic feet per second
cm	centimeter
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DLCD	Oregon Department of Land conservation and Development
DNR	Washington Department of Natural Resources
DSL	Oregon Department of State Lands
DWS	Deep Water Site
EPA	U.S. Environmental Protection Agency
ERDC	Corps Engineer Research and Development Center
ESA	Endangered Species Act
LCSG	Lower Columbia Solutions Group
MCR	Mouth of Columbia River
m	Meter
mcy	million cubic yards
MPRSA	Marine Protection, Research and Sanctuaries Act
NJS	North Jetty Site
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
R&M	Research and Monitoring
ROV	Remotely Operated Vehicle
RSMP/Plan	Mouth of Columbia River Regional Sediment Management Plan
SMMP	Site Management and Monitoring Plan
SWS	Shallow Water Site
USGS	U.S. Geologic Survey
WDOE	Washington Department of Ecology
WDFW	Washington Department of Fish and Wildlife

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EXECUTIVE SUMMARY

Every year, approximately four million cubic yards of sand are dredged by the Corps of Engineers (Corps), Portland District, from the mouth of the Columbia River (MCR) to keep shipping channels open. Jointly funded by the Corps, Environmental Protection Agency (EPA) and the states of Oregon and Washington, the goal of this Regional Sediment Management Plan (RSMP) is to increase the beneficial use of dredged sediment at the MCR to help protect shipping channel jetties, coastal beaches and nearshore habitats from erosion while avoiding and minimizing adverse environmental, resource and navigational safety effects. The Lower Columbia Solutions Group (LCSG) and its partners have developed this RSMP in the belief that the status quo is unsustainable and unacceptable. The loss of an estimated one million cubic yards of material each year from the littoral zone – some traditionally sandy areas are now exhibiting mud, in particular around the South Jetty – suggests that decisions are needed in the short term using existing data.

This RSMP consolidates and organizes work completed over the last decade on regional sediment management planning at MCR into a long-term strategy which will guide sediment management practices, serve as the basis for permitting a network of beneficial use sites, and facilitate the securing of federal and state appropriations to finance ongoing research and monitoring at MCR. Using careful design, effective monitoring and adaptive management, this RSMP is intended to meet a variety of objectives, including:

- Provide a regional rather than a state-by-state approach to sediment management planning in the MCR vicinity;
- Identify a range of available sites for disposal of dredged sediment that can be sustainably and adaptively managed, retain clean sand in the littoral system, and avoid or minimize impacts to benefit biological resources and navigation safety;
- Augment the present and future sediment budget at MCR using dredged material to optimally sustain the inlet and related littoral system;
- Increase stability of the sand shoals that the North and South jetties are built upon and replenish sand in the nearshore, thus reducing wave damage to the jetties and erosion and associated property loss along the northern Oregon and southern Washington coasts;
- Support an integrated regulatory approach for disposal practices and sites authorized under the Marine Protection, Research and Sanctuaries Act (MPRSA); Clean Water Act (CWA); Coastal Zone Management Act (CZMA); and other federal, state and local government authorities;
- Address loss of biological habitat from ongoing erosion and sediment transport in the littoral zone, most notably in the area directly south of the South Jetty;
- Continually improve the understanding of the sediment transport system within the Columbia River littoral cell;
- Ensure that disposal practices will not result in unacceptable adverse effects on the nearshore ocean ecosystem, including Endangered Species Act (ESA)-listed species and commercial and recreational fisheries (i.e. crab and razor clams);
- Design disposal practices to avoid unacceptable adverse effects on navigational safety through, for example, dispersed, thin-layer disposal and rotation of disposal among a network of sites; and
- Create a management plan that is financially, ecologically, and socially sustainable.

Research and science/policy deliberations over the past decade indicate that thin-layer disposal at new beneficial use sites would be expected to increase the flexibility of disposal practices and address specific littoral sediment needs, while having limited risk of impact on navigational safety and biological resources. Thus the RSMP proposes a network of sites to give the dredging program maximum flexibility: three currently authorized sites -- two littoral zone disposal sites (Shallow Water Site and North Jetty Site) and a deep water disposal site (Deep Water Site); and four new sites, two within the nearshore (subtidal) zone and two onshore (intertidal). It also discourages deep water disposal except when weather or other factors preclude use of existing and new nearshore or onshore sites.

The network of sites will be managed to avoid or minimize adverse effects on species of concern and their habitat and to avoid mounding of sediment that creates navigation hazards due to wave amplification. Through an adaptive management approach, effects on physical and biological resources and navigation safety will be regularly monitored and use and management of the network of sites adjusted as needed. An Annual Use Plan (AUP), jointly developed by the Corps and Environmental Protection Agency, will describe the timing, methods of disposal and monitoring for each site, including priorities for site use and disposal methods. It will be modified based on results of pre-disposal surveys and the results of monitoring from the previous year's disposal activities. An Adaptive Management Team (AMT) appointed and convened by LCSG will:

- Advise on and monitor the AUP and recommend modifications to address any unanticipated adverse effects on species of concern or their habitat, or to navigational safety.
- Design baseline studies to provide sufficient scientific knowledge to inform a set of reasonable effects of disposal at each beneficial use site.
- Develop protocols for measuring resources to determine if beneficial or adverse effects have been realized, and design and evaluate options for how to proceed if adverse effects occur.
- Identify minimum thresholds for the amounts of sand disposed of at each site needed to provide for the efficacy of monitoring of the effects of disposal at that site.
- Develop the details of a Research and Monitoring (R&M) program, including priorities responsive to available funding.
- Recommend priority locations for disposal for consideration in the Corps' AUP based upon analysis of available sediment, optimal placement based on tracer studies and sediment transport modeling, monitoring of mounding, and other factors.
- Identify funds and/or other commitments from federal, state and local agencies and interest groups to help implement the proposed R&M priorities.

Biological and physical impacts of dredge disposal will be tracked through an ongoing monitoring program that builds off that currently employed by the Corps as part of its AUP. The goal of this monitoring, especially for newly designated sites, is to determine iteratively whether adaptive measures need to be taken mid-season or during the next dredging season.

This Plan envisions a comprehensive AUP that addresses the dispersal of MCR dredged material at the full network of disposal sites. To accomplish this, the current scope of the AUP would need to be expanded to address the network of existing and new beneficial use sites identified in this Plan, as well as ongoing use of the DWS when necessitated by weather or other factors. While nothing in the Plan is intended to change any existing authorization or regulatory conditions applicable to the management of existing disposal sites, the goal is to

create a single AUP to guide the annual management of all MCR dredged disposal sites pursuant to this Plan that conforms to and does not conflict with EPA's Site Management and Monitoring Plan and with water quality certifications by the states of Oregon and Washington under Section 401 of the Clean Water Act. The RSMP assumes that disposal activities at new beneficial use sites will be conducted under Corps Civil Works authority and not require a Corps regulatory permit; however, the agency will still be required to comply with Clean Water Act Section 404 regulations to ensure that disposal will not violate state water quality criteria.

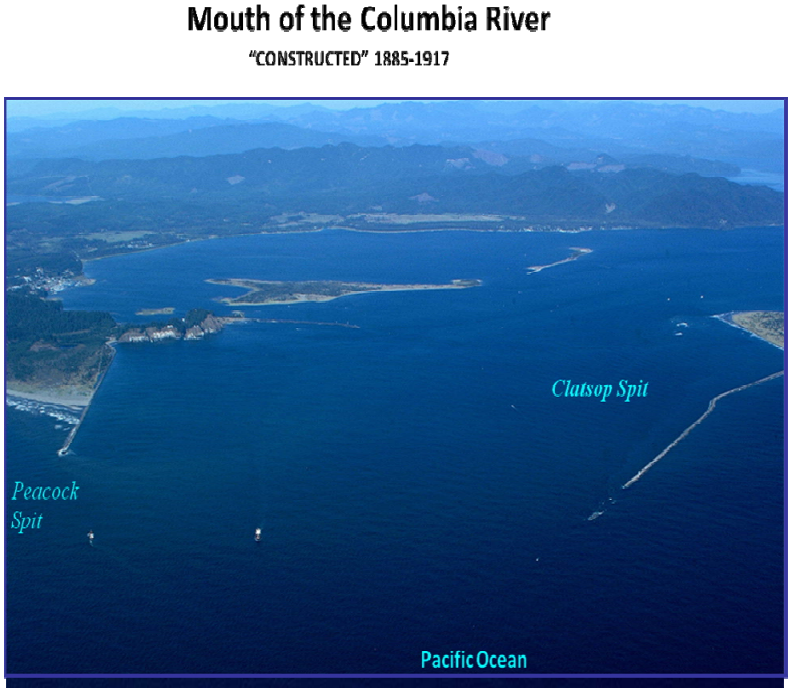
Plan implementation is expected to occur in stages. An initial step will be establishment and convening of the AMT and design of baseline studies and an initial R&M program in Summer/Fall 2011. The initiation of disposal activities within the network of beneficial use sites would be expected in August 2012.

A. INTRODUCTION

This Draft Regional Sediment Management Plan (RSMP) has been prepared by the Lower Columbia Solutions Group (LCSG), a bi-state collaboration of public and private parties. Jointly funded by the U.S. Army Corps of Engineers (Corps), Environmental Protection Agency (EPA) and the states of Oregon and Washington, the goal of this RSMP (Plan) is to increase the beneficial use of dredged sediment at the mouth of the Columbia River (MCR) to help protect shipping channel jetties, coastal beaches and nearshore habitats from erosion while avoiding and minimizing adverse environmental, resource and navigational safety effects. It is intended to serve as the basis for programmatic permitting of a network of beneficial use disposal sites that are adaptively managed through a program of prioritized research and monitoring.

Every year, approximately four million cubic yards (mcy) of sand are dredged by the Corps, Portland District, from MCR to keep shipping channels open. The MCR is the ocean gateway for maritime navigation to and from the Columbia-Snake River navigation system and maintaining safe passage through the navigation channel is critical to the Northwest economy, with more than 12,000 commercial vessels and 100,000 recreational/charter vessels navigating it annually. More than 40,000 jobs along the Lower Columbia River are dependent upon seaport activity.

Currently, the sediment dredged from the MCR is disposed of in-water at three authorized dredged material disposal sites. Two sites are within the nearshore littoral area – an Environmental Protection Agency (EPA)-designated Shallow Water Ocean Disposal Site (SWS) and a North Jetty Clean Water Act Site (NJS). An EPA-designated Deep Water Ocean Disposal Site (DWS) is used when the other sites are at capacity for the season or when the weather is too treacherous to use them. Over the past five years, approximately one-third of the sand dredged at MCR has been taken to the DWS.



Disposal of the sediment dredged from MCR at the currently authorized DWS removes a large portion of this "clean" (uncontaminated) resource from the nearshore zone, where it would be expected to help sustain jetties, beaches, and marine habitat. Additional disposal sites provide an opportunity to address significant erosion issues, obtain needed information on nearshore processes, and divert a sand resource that is otherwise "lost" if it goes to deepwater disposal rather than to beneficial use in the littoral zone.

For the purposes of this RSMP, the MCR region is focused on the Long Beach and Clatsop Plains sub-cells of the larger Columbia River littoral cell and includes the Columbia River

estuary (Gelfenbaum et al., 1999). This project builds on work by LCSG and a number of federal, state and local partners over the past several years on regional sediment management planning, specifically the Oregon Nearshore Beneficial Use and the Southwest Washington Littoral Drift Restoration projects. LCSG is a bi-state partnership convened by the governors of Oregon and Washington in concert with the Council on Environmental Quality and the U.S. Institute for Environmental Conflict Resolution. It was convened in 2002 as a forum for nearly 30 stakeholders to raise issues, collaborate on policy, and develop solutions for sediment management in the Lower Columbia River. The LCSG includes representatives from local, state and federal governments, crabbing and fishing interests, coastal communities, and conservation groups. The LCSG has been serving as the convener and project manager for efforts to develop this long-term strategy for disposal of dredged sediment in the littoral areas north and south of the MCR jetties.

B. PROBLEM STATEMENT

LCSG and its partners have developed this RSMP in the belief that the status quo is unsustainable and unacceptable. The loss of an estimated one million cubic yards of material each year from the littoral zone is expected to not only exacerbate erosion along the north Oregon and south Washington coasts, but to result in breaching of the jetties and exceedingly the expensive emergency repairs to them if that occurs. Additionally, adverse impacts to the biological environment are expected with the deterioration of the nearshore ecosystem.

Current erosion of the beach and offshore bar system threatens the viability of the Columbia River jetty system, the Long Beach Peninsula in Washington and Clatsop Spit in Oregon. As is more fully explained in Section E, nearshore bars that form and move based on seasonal storm activity are being depleted of the sediments required for protection of the beaches and jetty structures. As an example, recent surveys indicate that the depth of marine sands in the nearshore areas between Clatsop Spit and the South Jetty is roughly three feet (one meter) or less in depth. The sand that accreted south of the South Jetty following jetty construction has transported out of the southern Clatsop Plains littoral sub-cell (Moritz, pers. comm.; Buijsman et al., 2003). Presently, new sediment flushed from the MCR is blocked from reaching the southern shoreline by the South Jetty. As a result, the shoreline south of the MCR is receding without the input of sediment into the littoral zone. The protective system of bars parallel to the shoreline is diminishing in size, reducing their wave breaking effect and resulting in increased erosion threats. The beach in this area continues to erode, posing a significant risk of breach near the South Jetty.

Similarly, in the decades since jetty completion, the accreted sand making up Benson Beach north of the North Jetty appears to be migrating north within the northern Long Beach littoral sub-cell (Kaminsky et al., 2000). The present volume of new sediment transported to the north from the MCR is significantly reduced from historic, pre-jetty volumes and is insufficient to offset erosion at Benson Beach.

Ongoing erosion is expected to continue or become more severe as climate change factors increase the frequency and duration of storm events. The impacts of long-term sea level rise and shorter-term ocean condition changes will increase risks of catastrophic erosion events near the Columbia River mouth. The December 2010 *Oregon Climate Change Adaptation Framework Report* describes coastal climate change impacts:

> The coast is vulnerable to a number of climate-related impacts. Oregon's winter storms have been the primary factor for coastal erosion and flooding (Ruggiero, 2008). Maximum wave heights have increased significantly from the period of the late 1970's to 2005, from 9 meters to about 12 meters. ….. It is unclear if the increasing wave heights trend observed in the late 20th century will continue into the future, though the possibility of increasing storm-generated wave heights and the likely trend of rising sea levels may present a substantial threat to the Oregon Coast (Ruggiero et al., 2010).

Confining the currents within the active MCR inlet as a result of the construction of the jetties has not only altered sediment transport processes, but has also modified waves and seafloor topography in the area. The interaction of waves and seafloor topography affects nearshore circulation patterns and, thus, shoreline accretion and erosion rates. As erosion patterns continue, a sediment-starved littoral cell will result in significant ecosystem and physical effects. The prospect of a catastrophic jetty failure or breach at either the South or North jetties will create significant ecosystem changes and result in dramatic impacts to the navigation channel and estuary. These prospects will most likely result in significant short-term support for costly remedial action, but such support will be expended on what would be a difficult and complex undertaking.

The Corps, Portland District, and its Engineer Research and Development Center (ERDC), National Marine Fisheries Service (NMFS); U.S. Geological Survey (USGS; Washington Department of Ecology (WDOE); Oregon State University; Oregon Department of Land Conservation and Development (DLCD) and many others have fostered the development and refinement of multiple computer modeling programs aimed at better understanding the interactions of and processes affecting waves, circulation, and sediment transport at MCR. Models of sediment transport processes indicate that the strategic placement of dredged material within beneficial use dredged material disposal sites can bolster the littoral budget, including the offshore bar system along the Oregon and Washington shores adjacent to the MCR (Gelfenbaum et al., 2005; Byrnes and Griffee, 2006; Ruggiero et al., 2006; Osborne et al., 2007).

C. GOALS AND OBJECTIVES

The MCR RSMP consolidates and organizes work completed over the last decade on regional sediment management planning at MCR into a long-term strategy which will guide sediment management practices, serve as the basis for permitting a network of beneficial use sites, and facilitate the securing of federal and state appropriations to finance ongoing research and monitoring at MCR in support of this Plan. The issues that are addressed by this Plan are multi-faceted and well known; they represent both opportunities and constraints. The Plan has been developed by a Steering Group convened by LCSG to lead the RSMP planning process. It is based primarily on the research conducted for and outcomes of multi-stakeholder workshops conducted by LCSG in 2005, 2007, 2009 and 2010 that led to the conclusion that a regional network of beneficial use sites is needed at this time.

Multiple federal, state and local agencies, as well as commercial and other private stakeholders, have an interest in making more sustainable use of disposed materials in the MCR area and in protecting the shipping channel jetties in order to maintain Columbia River commerce. A fundamental goal of the Plan is to improve the current program of sediment management at

MCR. Using careful design, adaptive management and effective monitoring, this RSMP is intended to meet a variety of objectives, including:

- Provide a regional rather than a state-by-state approach to sediment management planning in the MCR vicinity;

- Identify a range of available sites for disposal of dredged sediment that can be sustainably and adaptively managed, retain clean sand in the littoral system, and avoid or minimize impacts to benefit biological resources and navigation safety;

- Augment the present and future sediment budget at MCR using dredged material to optimally sustain the inlet and related littoral system;

- Increase stability of the sand shoals that the North and South jetties are built upon and replenish sand in the nearshore, thus reducing wave damage to the jetties and erosion and associated property loss along the northern Oregon and southern Washington coasts;

- Support an integrated regulatory approach for disposal practices and sites authorized under the Marine Protection, Research and Sanctuaries Act (MPRSA); Clean Water Act (CWA); Coastal Zone Management act (CZMA); and other federal, state and local government authorities;

- Address loss of biological habitat from ongoing erosion and sediment transport in the littoral zone, most notably in the area directly south of the South Jetty;

- Continually improve the understanding of the sediment transport system within the Columbia River littoral cell;

- Ensure that disposal practices will not result in unacceptable adverse effects on the nearshore ocean ecosystem, including Endangered Species Act (ESA)-listed species and commercial and recreational fisheries (i.e. crab and razor clams);

- Design disposal practices to avoid unacceptable adverse effects on navigational safety through, for example, dispersed, thin-layer disposal and rotation of disposal among a network of sites; and

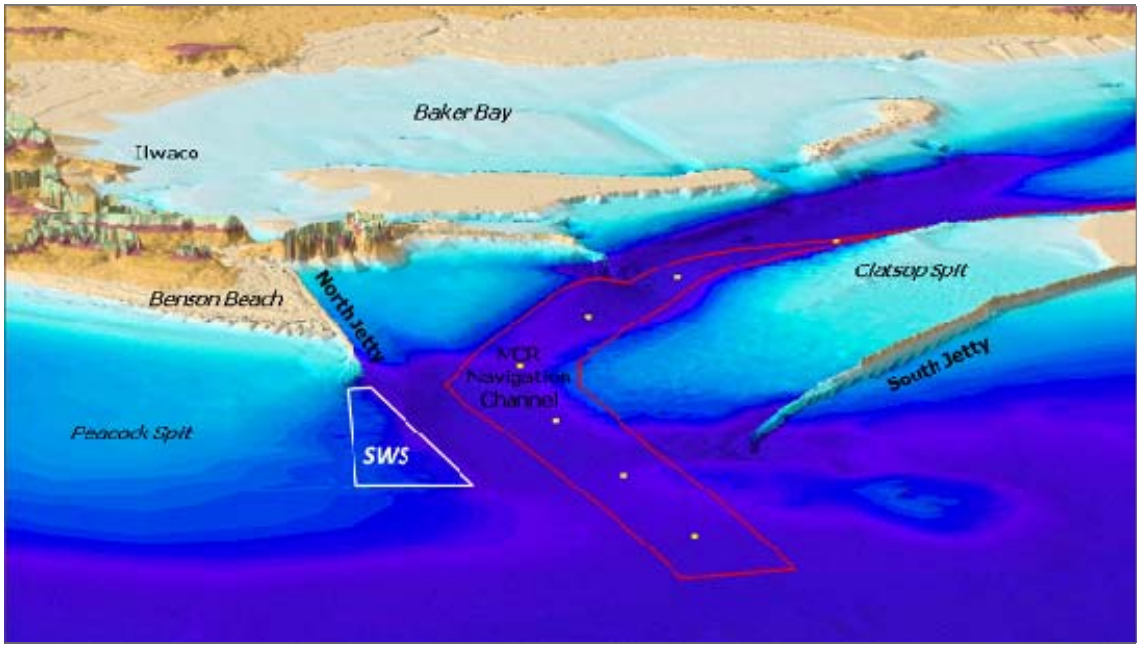
- Create a management plan that is financially, ecologically, and socially sustainable.

Additionally, the RSMP is intended to help implement provisions of the West Coast Governor's Agreement on Ocean Health (WCGA). The WCGA Action Plan states:

> "Sediment management has implications for the coastal economy. In addition to supporting various habitats and marine species, sediment availability and transport are important drivers of the physical appearance and behavior of the coastline. Changes to sediment availability impact beaches, tourism, marina infrastructure, and vessel traffic. Erosion affects critical existing coastal structures, such as jetties."

"Develop regional sediment management plans to maximize beneficial use of sediment in an environmentally responsible manner to protect and maintain critical community economic and environmental infrastructure." (Action 7.4)

While focused on the MCR, the establishment of a network of beneficial use sites is intended to aid in federal and state recovery efforts in the Lower Columbia River basin for fish populations listed under the ESA. Restoration of sediment to the nearshore littoral system would especially benefit juvenile salmonids that feed in the littoral zone near MCR after exiting the Columbia River estuary. As discussed above, this habitat is being lost at an increasing rate.



D. PLAN ELEMENTS

The approximately four mcy of sediment are annually dredged from MCR is classified as fine-medium sand (mean grain size = 0.22 mm). The dredged sand has historically been placed at specific open water disposal sites which have changed through time. Research and science/policy deliberations over the past decade indicate that thin-layer disposal at new beneficial use sites would be expected to increase the flexibility of disposal practices and address specific littoral sediment needs, while having limited risk of impact on navigational safety and biological resources. Other assumptions and conditions upon which the Plan is predicated include:

- More than a decade of sampling indicates that dredged material from MCR consists of "clean" (uncontaminated) fine sediments (typically >98% sand; no presence of chemicals of concern above accepted screening levels).

- Beneficial use effects of adding sediment to the littoral system will not likely be measurable in the short term; it may be a decade or more before any beneficial effects are observed.

- There is a point at which a dredged material disposal site is too deep and too far from the shore to contribute sand to the littoral process. Sediment more readily migrates inland when a disposal site is sufficiently shallow that the current velocity can efficiently move sediment with the flood and ebb tides. As a general guide, dredged material placed inland of 65 feet (20 meters) has been determined to effectively contribute sand to the littoral systems north and south of MCR.

- To achieve Plan goals and objectives, the network of existing disposal sites needs to be expanded to include additional beneficial use sites that can be sustainably and adaptively managed to add clean sediment to the Columbia River littoral system.

- While this Plan is focused on beneficial disposal at this network of sites, nothing precludes the identification of additional sites as potential disposal locations through the adaptive management program described below.

- Disposal at the DWS in effect removes sand from the nearshore system; consistent with the joint EPA/Corps Site Management and Monitoring Plan (SMMP) governing Lower Columbia dredging and disposal activities and sites, a basic RSMP tenet is that dispersing material in deep water should only be employed when weather or other factors eliminate nearshore or onshore options.

- Disposal at beneficial use sites identified in this Plan is limited to MCR sediment and to disposal by the Corps; disposal by others at the EPA-designated DWS is not precluded by this Plan.

- Current disposal practices and erosion patterns may have their own sets of effects on environmental resources and navigation safety. Thus, a key determinant in assessing the viability and use of new beneficial use sites should be comparing potential impacts of disposal at those new sites to those associated with current disposal practices.

- Planning for new disposal sites is recognized as an exercise in risk management that must be responsive to varying values and priorities among key stakeholders; thus, an adaptive approach is needed to managing dredge disposal within the regional network of disposal sites.

- While data gaps continue to be filled, especially for the important biological species present, there is a considerable amount known about the area and a valid basis for expectations about the levels of potential risks to the physical and biological environments.

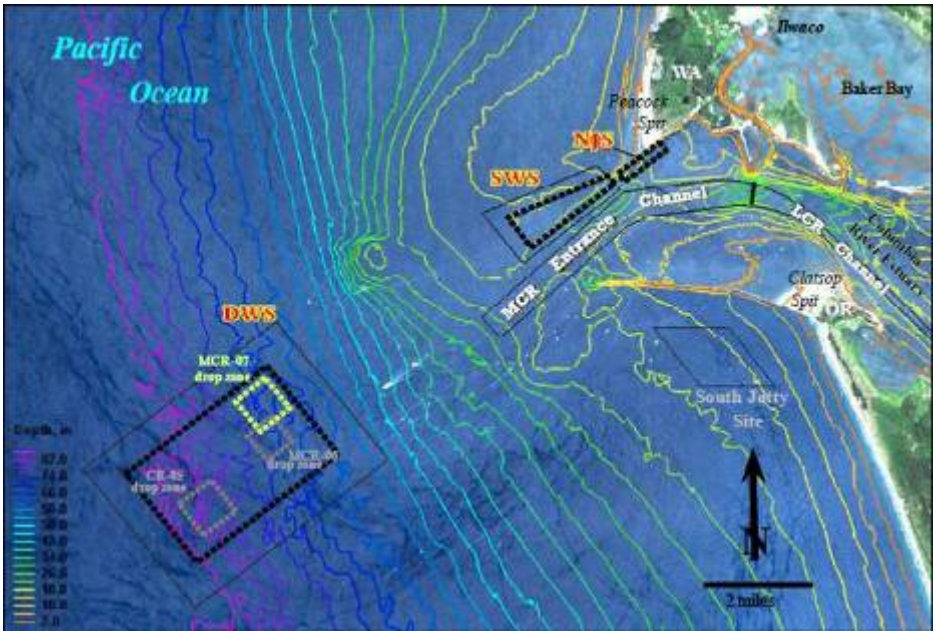
- A minimum amount of sand needs to be provided annually for disposal within the littoral zone in order to demonstrably help sustain jetties, beaches, and marine habitat.

1. NETWORK OF SITES

The locations that comprise the Plan's regional network of sites include three currently authorized sites, two littoral zone disposal sites (Shallow Water Site and North Jetty Site) and a deep water disposal site (Deep Water Site). This Plan expands that existing network to include four new sites, two within the nearshore (subtidal) zone and two onshore (intertidal). Consistent

with the joint EPA/Corps SMMP, it also discourages deep water disposal except when weather or other factors preclude use of existing and new nearshore or onshore sites.

a. Existing Disposal Sites



(1) ***Shallow Water Site*** (SWS) -- Designated by EPA in 2005 under Section 102 of MPRSA, the SWS is a trapezoidal area of 3,100 - 5,600 feet (945 - 1,707 meters (m)) wide x 11,500 feet (3,505 m) long, two miles (3.2 kilometers) offshore from MCR in water depth of 45 - 75 feet (14 – 23 m). The area used for disposal (drop zone) is 1,054 feet to 3,600 feet (321 – 1,097 m) wide by 10,000 feet (3,048 m) long. The SWS is designated for the disposal of material dredged from either the MCR or the Lower Columbia River. In its 2010 Annual Use Plan (AUP), the Corps identifies use of the SWS as essential to maintaining the littoral sediment budget north of MCR, protecting the North Jetty from scour and wave attack, and stabilizing the MCR inlet.

(2) ***North Jetty Site*** (NJS) – This site was established in 1999 under Section 404 of CWA for the purpose of placing dredged material along the North Jetty to help reduce undermining of the jetty by wave and current scour. The NJS is approximately 200 feet (61 m) south of the North Jetty and occupies an area of 1,000 feet x 5,000 feet (305 – 1,524 m). Average water depth is 35 - 55 feet (11 - 17 m). Disposal is limited to MCR dredged material.

(3) ***Deep Water Site*** (DWS) -- Also designated by EPA in 2005 as a Water Ocean Disposal Site under Section 102 of MPRSA, the DWS occupies an area of 17,000 x 23,000 feet (5,180 – 7,010 m) and lies six miles (9.7 kilometers) from MCR in water depths of 190 - 300 feet (58 - 90 m). A 11,000 x 17,000-foot (3,350 – 5,180 m) placement area is defined within the DWS boundaries, with specific “drop zones” for the placement of dredged material. The intent is to confine the dispersal of material within the drop zones to reduce the areal extent of dredged material deposition. The DWS is designated for the disposal of material dredged from either the MCR or the Lower Columbia River. The DWS is used when the SWS and NJS have been used to the maximum extent practicable or when weather conditions or operational constraints preclude use of those sites.

b. New Beneficial Use Sites

Four new disposal sites are intended to provide both nearshore (subtidal) and onshore (intertidal) opportunities for beneficial use of the uncontaminated sand dredged each year at

MCR. Their selection is based on scientific research conducted over the past decade, their potential to positively contribute to retaining sand in the littoral zone, and the expectation that they do not have significantly greater value as habitat than other nearby areas within the littoral zone.

(1) ***South Jetty Nearshore (subtidal) Site*** -- Located south of the South Jetty in waters inside of 60 feet (18 m) deep, this site is projected to have an annual capacity of between 300,000 - 500,000 cubic yards of sediment. This site is located to provide sand needed to reverse considerable ongoing erosion in the shoals and bar system in the nearshore area adjacent to the South Jetty and Clatsop Spit. It has been identified as a geographically centric site in terms of the littoral zone south of the South Jetty and the most proximate area to disperse sand to help stabilize the jetty. It is also expected to be the least productive area within South Jetty vicinity in terms of benthic productivity.

This site is an outgrowth of the Oregon Nearshore Beneficial Use Project, which in turn grew out of a 2005 science-policy workshop sponsored by LCSG. That project began with a demonstration placement of 34,000 cubic yards of even dispersal disposal in 2005 followed by research studies to inform future work. In 2007, a targeted placement of 150,000 - 300,000 cubic yards of dredge material was proposed (but not conducted due to a lack of funding), the goal being to build a berm on the seabed to be monitored to determine the rate and direction of sediment transport. In 2008-2009, a sand tracer study was conducted to help confirm where nearshore sediment goes (see Section E.2).

Within the RSMP project area, the South Jetty nearshore site has been identified as the area in the greatest need of dredged material, with scouring of the seabed expected to accelerate without the input of sediment into the littoral zone. Erosion in this area increases the intensity of waves hitting the jetty; any catastrophic jetty failure or breach will create significant ecosystem changes and result in dramatic impacts to the navigation channel and estuary. Modeling in conjunction with a November 2010 science/policy workshop indicates that this site is ideally located for circulation of sand to the South Jetty. Monitoring will be required after placement to ensure that material placed at the site effectively contributes material to the littoral system and stability to the South Jetty shoals. The use of this site can be expected to be limited by site management provisions that prescribe placement after August 15 when the crab season in Oregon ends.

(2) ***North Head Nearshore (subtidal) Site*** -- Generally located north of the North Jetty and off of North Head in Cape Disappointment State Park in waters inside of 60 feet (18 m) deep, the exact placement of this site has not been defined but probably is between Latitude 46° 19' 50'' and 46° 22' 00". This site is intended to provide sand needed to minimize erosion at Benson Beach and Peacock Spit in the nearshore area north of the North Jetty and contribute to beach accretion.

As with the South Jetty site, this disposal location was identified through a science/policy workshop conducted in 2009 under the auspices of the Southwest Washington Littoral Drift Restoration Project. Management recommendations for this site developed at that workshop include:

- In the short term, annually place approximately 500,000 cubic yards of dredged material that is rotated among a series of adjacent placement cells to minimize mounding and facilitate habitat recovery.

- Through modeling and monitoring, determine the long-term placement capacity based on the dispersive properties of the site.
- Respond to differing wave conditions by utilizing multiple (3-5) "runway approaches" for aligning disposal pathways (dredge track lines).

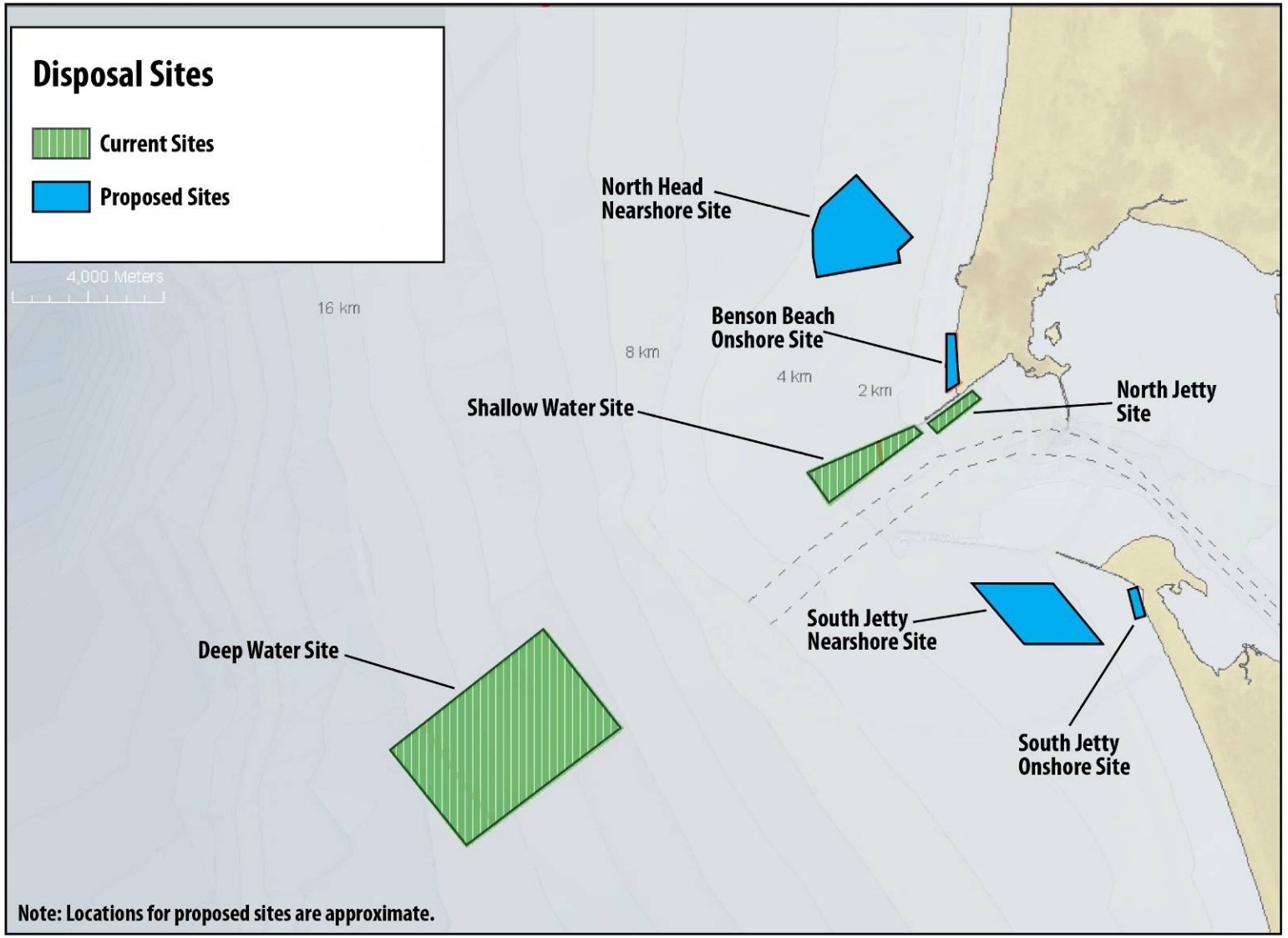
(3) ***South Jetty Onshore (intertidal) Site*** -- This beach nourishment site is located south of the South Jetty along Clatsop Spit. Material deposited onshore in this beneficial use site is intended to build up the immediate shoreline to address concerns that in the next 20 years a breach of Clatsop Spit could be caused by significant storm events and attendant wave action from the ocean. While information specific to disposal at this site is more limited than for the other beneficial use sites, it is assumed that disposal would occur in an area(s) proximate to the South Jetty and especially vulnerable to potential breaching. Consultation will be needed with Oregon Parks and Recreation Department (OPRD) on minimizing effects on clamming and other recreation uses. Additionally, the vicinity of this beneficial use site could be considered in the future for designation as a Western snowy plover managed area if additional habitat is required in order to implement the Western Snowy Plover Habitat Conservation Plan (USFWS, August 2010).

(4) ***Benson Beach Onshore (intertidal) Site*** -- Located north of the North Jetty along Benson Beach, disposal of dredged material at this beach nourishment site is intended to accrete along the immediate shoreline, but may also migrate to the north. Onshore placement would likely be via pump-ashore dispersal hopper dredge to an area located on the shore north of the North Jetty along Peacock Spit.

This site was initially identified as a potential disposal area through a 2007 science/policy workshop in conjunction with the Southwest Washington Littoral Drift Restoration Project, an effort by the Coastal Communities of Southwest Washington to develop a long-term strategy for disposal of dredged sediment in the littoral area north of the North Jetty. Following science/policy workshops in 2009, Benson Beach was confirmed as the location in the littoral zone north of the North Jetty that would be expected to have the greatest benefit in terms of beach and drift restoration and habitat impacts, as well as the most appropriate location for a demonstration onshore placement project. A demonstration project jointly financed by Corps and State of Washington appropriations was conducted in 2010 and entailed disposal of almost 400,000 cubic yards of material pumped ashore at Benson Beach.

In keeping with the adaptive management approach described below, a network of sites provides options for disposal reflective of operational, navigational safety, biological and other management considerations. Both nearshore and onshore sites are identified, reflecting improved opportunities for onshore disposal through operational changes (dredge vessel modifications) and the strong potential for regional funding for baseline studies and design of a research and monitoring (R&M) program.

Network of Regional Disposal Sites



Determinations of locations for disposal will be made by the Corps in its Annual Use Plan (AUP) after consultation with an Adaptive Management Team (AMT), recognizing that no single site has the capacity to take all of the dredged material available annually. The opportunity to utilize multiple sites on a rotating basis is expected to reduce the potential for mounding impacts and minimize effects on biological species of concern. Continued use of the existing authorized sites (SWS and NJS) is assumed, with the exception that the DWS will be used only on a contingency basis when funding, equipment, environmental, safety or other issues preclude use of the existing and new beneficial use sites.

Among the new beneficial use sites, priorities for disposal locations would be based on guidelines developed by the AMT, factoring in operational, funding and environmental considerations. All things being equal, interim guidelines for prioritizing disposal among the new beneficial use sites follow:

(1) If funding and equipment are available and in-water work periods allow, the South Jetty Nearshore Site would be a first priority, as this area has been identified as having the greatest need of dredged material, with scouring of the seabed expected to accelerate without the input of sediment into the littoral zone.

(2) If funding and suitable equipment are available, the next priority would be onshore beach nourishment along Benson Beach north of the North Jetty. Material deposited in this area would be primarily intended to minimize erosion at Benson Beach and Peacock Spit and allow for beach accretion.

(3) If funding and equipment constraints are such that onshore disposal at Benson Beach is not practical, the North Head Nearshore Site would then be a priority. The comparative lack of information about this site would need to be addressed before initiating disposal here.

(4) Onshore placement along Clatsop Spit south of the South Jetty is a lower priority at this time due to the high priority for placement within the nearshore area to address degrading bathymetric conditions and to shore up the South Jetty. However, if equipment improvements provide for pump-ashore capabilities, simultaneous nearshore and onshore disposal should be explored.

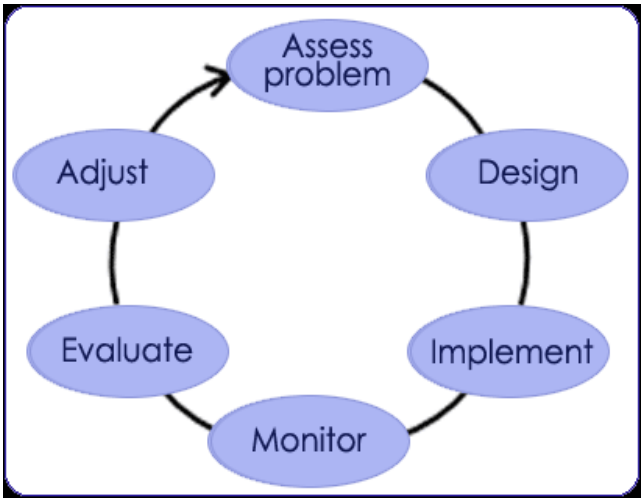
2. ADAPTIVE MANAGEMENT PROGRAM

a. Approach

A fundamental concept of this Plan is an adaptive management approach to disposal at a network of beneficial disposal sites in order to achieve the Plan's goals and objectives and to respond to operational, navigation safety and biological science considerations. The network of sites will be managed to avoid or minimize adverse effects on endangered species and other species of concern, as well as their critical habitat, and to avoid mounding of sediment that creates navigation hazards due to wave amplification. Through an adaptive management approach, effects on physical and biological resources and navigation safety will be regularly monitored and use and management of the network of sites adjusted as needed. This proposed adaptive management approach is an example of risk-based decision-making, or application of the precautionary approach for decision-making under uncertainty.

Adaptive management involves monitoring and actively evaluating new information to determine changes in policy direction or practice. In this case, it is an important part of an overall goal to achieve the desired outcomes of sediment management while still minimizing the risk of unwanted consequences, i.e. detrimental impacts to marine life and navigational safety. Conversely, it can also be used to maximize certain positive outcomes such as improving habitat or protection of the jetties.

The Adaptive Management Process



Source: U.S. Department of Interior (accessed May 18, 2011)
http://www.doi.gov/initiatives/AdaptiveManagement/whatis.html

To avoid adverse navigational safety and biological effects associated with mounding of sediment, the Plan's adaptive management program (AMP) focuses on monitoring the amount of material disposed at each site to ensure a maximum mounding height is not exceeded. For addressing biological considerations, the AMP should be seen in the context of a larger program to minimize risks to Dungeness crab, razor clams, and other species that begins with a) dispersing materials with a very low percentage of fine sediment, b) dispersing sediment that is highly compatible with the native in situ material, c) avoiding "hot spots" of very high aggregations of crabs or clams, and d) using protective dispersal practices such as thin-layer disposal and minimizing multiple burials within a short time period.
Three primary tools will be utilized for purposes of this AMP:

(1) ***Adaptive Management Team*** (AMT) that develops a recommended program of baseline studies and research and monitoring, monitors the disposal program and recommends adjustments as needed;

(2) ***Annual Use Plan*** that describes the timing, methods of disposal and monitoring for each site, including priorities for site use and disposal methods; and

(3) Ongoing ***Research and Monitoring*** (R&M) focused on species of concern.In this context, the AMP is both a way of confirming the effectiveness of those efforts and a type of safety net, should those efforts not work according to plan.

In designing and implementing this AMP, there are several important considerations. First, continuing disposal at currently authorized sites has its own set of impacts and

disposal at new sites needs to be weighed against the consequences of no change. Second, the spatial and temporal variability of many species will make drawing meaningful conclusions from monitoring challenging. Third, ocean conditions in the nearshore sites can be extremely dangerous and often limit when and how monitoring data can be collected. Finally, ensuring a meaningful adaptive management approach, while recognizing uncertainty related to funding, will require clear priorities and innovative partnerships.

b. Adaptive Management Team (AMT)

The MCR Adaptive Management Team (AMT) will serve in an advisory role to LCSG to help inform and make recommendations to the Corps of Engineers, Portland District, and EPA. In part to avoid restrictions under the Federal Advisory Committee Act (FACA) associated with federal agency advisory groups, it will be appointed and convened by and advisory to the LCSG. Interests to be represented on the AMT will include but not the limited to:

- Corps' Portland District
- EPA
- Other federal and state regulatory agencies
- Local governments
- Columbia River Crab Fishermen's Association
- Academic community with expertise in related subject matters

The AMT will be composed of a technical team and a management team. The primary role of the technical team will be to review environmental and resource management surveys and studies (including pre- and post-disposal surveys proposed to implement Plan direction), the Corps' AUP, monitoring reports and other available documentation and make recommendations related to disposal planning and operations. Members of the Science Advisory Team established for purposes of Plan preparation will be invited to participate on the technical team. The management team will be comprised of members of the Steering Group established to develop this Plan and other interests identified by the LCSG. The management team will be responsible for resolving disputes or unresolved issues at the technical team level, monitoring overall Plan implementation, and periodically updating/revising this Plan as needed.

The AMT technical team will be convened both on a regular schedule and an as-needed basis to assess the results of pre-disposal surveys and monitoring from previous years' disposal activities and to recommend modifications to the upcoming AUP or monitoring plan to address any unanticipated adverse effects on species of concern or their habitat, or to navigational safety. It is envisioned that the AMT technical team will meet following the completion of the disposal season to evaluate the results of that year's disposal operations and associated R&M, the goal being to identify any recommended modifications to be incorporated into the coming year's AUP. The specific schedule of meetings will be determined by the technical team in consultation with LCSG. In addition to a schedule of established meeting times, the AMT technical team will meet on an ad-hoc basis when significant unanticipated events and conditions suggest that disturbances may have altered study area conditions. The team will make a determination whether immediate investigation is recommended to determine if, and what sort of, response is needed. Recommendations will be made to the management team and LCSG.

In addition to its role in monitoring and advising on the AUP, the AMT is expected to:

- Design baseline studies to provide sufficient scientific knowledge to inform a set of reasonable effects of disposal at each beneficial use site, recognizing that the scope of such studies will need to be responsive to available funding. To take advantage of current funding opportunities, it is anticipated that the AMT will be convened in Summer/Fall 2011 for this purpose, with the goal to initiate the studies prior to the 2012 dredging season.

- Using the set of reasonable effects on key species described in this Plan (Section F.3) as a starting point, develop recommended protocols for measuring resources to determine if beneficial or adverse effects have been realized, and design and evaluate options for how to proceed if adverse effects occur. This may include "triggers" or levels of impacts that, if exceeded, suggest that disposal practices need to be modified or discontinued in order to avoid unacceptable adverse effects or mitigation measures need to be instituted.

- Identify minimum thresholds for the amounts of sand disposed of at each site that provide for the efficacy of monitoring of the effects of disposal at that site.

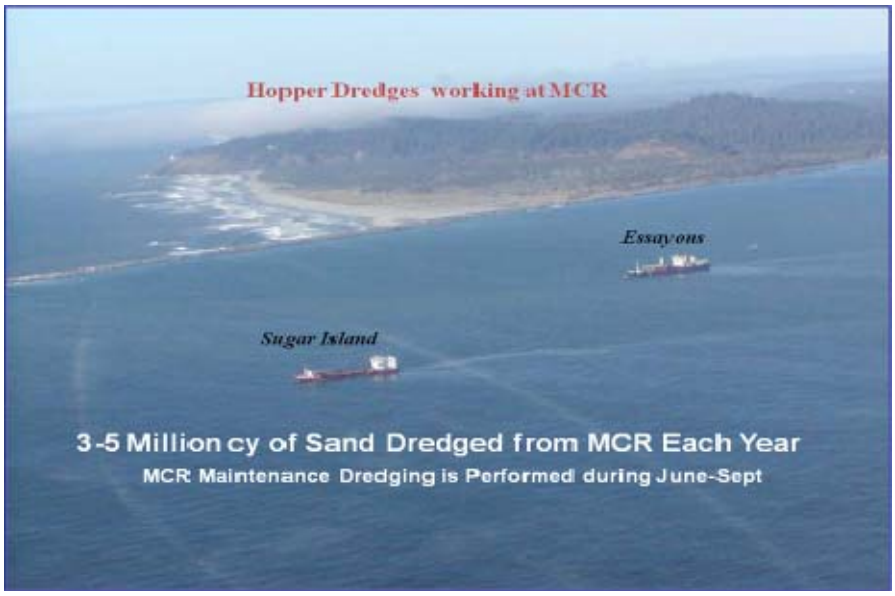
- Develop a detailed R&M program, including priorities responsive to available funding, that builds upon the program outlined below.

- Recommend priority locations for disposal for consideration in the Corps' AUP based upon analysis of available sediment, optimal placement based on tracer studies and sediment transport modeling, monitoring of mounding, and other factors.

- Identify funds and/or other commitments from federal, state and local agencies and interest groups to help implement proposed R&M priorities.

c. Annual Use Plan

An Annual Use Plan (AUP) developed by the Corps and approved by EPA, Region 10, as required by EPA's 2005 Site Management and Monitoring Plan (SMMP), guides the Corps' year-to-year management of EPA-designated dredged material disposal sites at MCR. The SMMP is mandated by Section 102 of the MPRSA and administered by EPA. An Annual Use Plan is required by EPA as part of the SMMP. The AUP currently addresses disposal activities at the SWS and DWS (disposal at the NJS site is authorized under CWA, Section 404). Everyday disposal activities are reviewed for consistency with the AUP through utilization plans that the Corps submits to EPA approximately every two weeks depending on the site capacity and level of activity. The AUP ensures compliance with the SMMP by annually evaluating available disposal site capacity and the timing and placement of dredged material among authorized disposal sites. In addition to providing a framework for management of disposal activities on a day-to-day basis, the AUP describes a program to collect information on those activities via monitoring or assessment of operational data.



While EPA's management authority extends only to the two EPA-designated disposal sites, this Plan envisions a comprehensive AUP that addresses the dispersal of MCR dredged material at the full network of disposal sites. To accomplish this, the current scope of the AUP would need to be expanded to address the network of existing and new beneficial use sites identified in this Plan, as well as ongoing use of the DWS when necessitated by weather or other factors. The goal is to create a single AUP to guide the annual management of all MCR dredged disposal sites pursuant to this Plan that conforms to and does not conflict with EPA's SMMP and with water quality certifications by the states of Oregon and Washington under Section 401 of the Clean Water Act. Because the AUP for EPA-designated sites is already part of EPA's SMMP, the Corps' AUP would now include a larger network of beneficial use disposal sites to be used in conjunction with the existing EPA-designated sites. The expanded AUP thus becomes the annually-revisited implementation strategy for the MCR RSMP.

Pursuant to requirements of the SMMP, the amount of dredged material that can be placed in an open water disposal site is limited by the site's capacity to disperse or accumulate the material without adversely affecting the environment or navigation. The principal site management constraint under the SMMP is to avoid modification of a disposal site's bathymetry (via dredged material mounding) that could potentially result in excessive wave amplification, due to wave shoaling over mounded dredged material.

The AUP is based on adaptive management, meaning that as sites are used, they are monitored to verify that the sites are being managed according to capacity targets. If a given disposal site is at or near its target capacity, then site management changes accordingly.

Monitoring of material placement includes daily tracking of the placement of material within each disposal site and frequent bathymetry surveys at the disposal sites during the dredging season. Minimum site monitoring requirements for each active disposal site at MCR are a pre-disposal bathymetry survey (beginning of season), post-disposal survey (end of season), and a two x two mile area on Peacock Spit. Special studies are also conducted as needed to assess the potential effects of dredged material placement within MCR disposal sites.

The EPA-approved AUP is coordinated with state agencies and the public via email and an informational meeting conducted in the local area (Ilwaco/Astoria) prior to start of dredging. The AUP is also posted on the Corps' website. A press release is issued to newspapers and radio stations in the local area prior to start of dredging and disposal activities. Key crab fisherman

who fish in the area of the SWS and the NJS are notified via telephone two weeks in advance of the dredge starting work in these sites.

d. Research and Monitoring Program

An ongoing R&M program will guide adaptive management decision-making. The existing base of knowledge provided through previous efforts in both Oregon and Washington, including demonstration beneficial use placement projects, sand tracer studies, other research, and a series of science/policy workshops, will be utilized to guide the design of pre-dispersal and post-dispersal data collection and monitoring of biological and physical impacts of dredge disposal. The monitoring program will build off monitoring currently employed by the Corps as part of its AUP.

The goal of the monitoring program, especially for the newly designated sites, is to determine iteratively whether adaptive measures need to be taken mid-season or during the next dredging season. At the beginning/end of each season, the AMT will assess which components of the agreed-upon R&M program are ready to be implemented based on funding availability and other considerations. The AMT will also acknowledge data gaps and identify methods and priorities to address them. It is anticipated that post-disposal monitoring of new beneficial use sites will be more intensive in the initial year(s) after those sites are put into use, with the results of that initial monitoring guiding the design of any ongoing monitoring. Considerations for development of R&M measures include:

- Baseline surveys and monitoring to assess disposal impact on biological resources are both critical. Continuous gathering of data is necessary because of insufficient current knowledge. In particular, the AMT will need to determine whether adequate baseline studies already exist for particular sites or need to be conducted before disposal begins. The AMT will hold pre-sampling discussions on experimental design, control site selection and other elements of the adaptive management program. It will also provide advice on design, sampling replication, adaptive options for changing disposal and/or sampling methods in the future, up to and including selecting a different nearshore disposal location.

- Following the dredging season for at least the first three years after its establishment, the AMT will prepare a report using data and findings from the Corps and other parties conducting R&M. The need for subsequent reports will be determined by the AMT.

- Costs and technical capacity will be evaluated by the AMT to ensure that new and untested survey methods are practical in the field.

- The design of the R&M program will include the process for allowing time for review and analysis of monitoring data and advising on adaptive adjustments.

- A research/monitoring plan specific to the South Jetty area should be a priority, since it is understood that the South Jetty area is undergoing rapid sediment loss.

- The AMT and other members of the scientific community should be advised about upcoming disposal plans which can be turned into research opportunities. Specifically, prior to Plan implementation, the AMT should inform the Corps of what pre-disposal research needs are and potential opportunities for Before-After/Control-Impact (BACI) work.

There is a strong potential for funding from the Corps regional sediment management program to help finance baseline studies and an initial R&M program beginning in Summer/Fall 2011. Absent that funding, the financing of baseline studies and R&M would likely need to be negotiated by the LCSG among the Corps and other federal agencies, states and other partners. An ongoing effort will be required to secure funding for an R&M program, especially for out years.

As a starting point for AMT consideration in developing an R&M program, proposed baseline studies and monitoring measures are identified below.

Beneficial Effects
A program of continuous monitoring will be needed to determine any beneficial effects of adding sediment to the littoral zones north and south of MCR. Stabilizing or reducing erosion rates will be difficult to measure in the short term. Beach profile transects monitored by the Oregon Department of Geology and Mineral Industries (DOGAMI) and core samples will be key indicators. The AMT will need to identify other appropriate indicators to measure beneficial effects over time.

Navigational Safety
Monitoring for navigational safety will focus on five primary strategies (see Section F.2 for additional explanation):

(1) Continuation of the bathymetric monitoring conducted by the Corps as part of its AUP, including a pre-disposal bathymetric survey of the contours of the nearshore disposal sites to determine capacity and as a baseline for management within the dredging season. The pre-disposal surveys will also be used to determine a disposal strategy for the season that minimizes mounding and any resultant wave amplification. Following the season, a similar post-disposal survey of the contours of the nearshore disposal area will be conducted, the primary focus being to determine whether mound induced wave amplification has exceeded a maximum threshold of 10% over baseline conditions. These data could also be used to assess likely environmental and ecosystem effects. The post-disposal surveys will then be used to develop adaptively a disposal strategy for the next season;

(2) To assess whether mound induced wave amplification has exceeded a maximum threshold of 10% over baseline conditions, design and validate an appropriate wave model to predict relevant wave transformation.

(3) Avoiding adverse navigational safety and biological effects associated with mounding of sediment by employing dispersed, thin layer, and/or respraying of reliquidfied sand (also referred to as pump off or rainbow spray) disposal, based upon the AUP and adaptive management needs;

(4) Monitoring of shoaling within the MCR navigation channel associated with migration of disposal sediment from beneficial use sites; and

(5) Ongoing modeling and monitoring of data to improve predictive and real-time information on waves and wind.

Biological Sciences

Biological information for the four new beneficial use sites is not as well developed as the physical information. Spending years studying the biological activity at these sites, however, would result in considerable amounts of sediment continuing to leave the littoral system. This Plan instead envisions a combination of initial baseline studies coupled with monitoring of particular populations over time. Based on current scientific knowledge and understanding of MCR dynamics, the SAT advising on this Plan recommended that Dungeness crab should be the priority species addressed in the R&M program, with razor clams and fish species in a less critical category.

Recommended baseline study and monitoring priorities for Dungeness crabs and razor clams follow (see Section F.3 for additional background information). For Dungeness crabs, there is little known regarding dispersal during the molting stage when crabs may be most vulnerable to habitat changes. Both onshore disposal sites are currently understood not to be sites with high populations of razor clams or other benthic invertebrates. However, recreational clamming is an extremely popular activity in the vicinity of the South Jetty onshore site and baseline information is needed to determine how this recreational activity may be impacted. Monitoring of burial effects on benthic invertebrates will be conducted at all disposal sites. The priorities below refer largely to the two nearshore sites. The need for and scope of baseline studies and monitoring specific to each disposal site, at least at the South Jetty onshore site, will need to be defined by the AMT. Analysis of recreational razor clam fishery impacts in the intertidal areas proximate to the disposal and control sites will be coordinated with ODFW and WDFW.

A number of fish species (e.g., green sturgeon, rock fish, starry flounder and other bottom fish) use the disposal areas in unknown quantities at various times of the year. It is recommended that the R&M program take advantage of opportunities to collect data on fish species using the disposal sites, times of year, numbers, changes in populations present, etc. However, it should be understood that this will be an opportunistic monitoring process to determine presence/absence, rather than a targeted monitoring operation.

In all monitoring activities outlined below, any significant differences between data for the control sites and the disposal sites will be referred to the AMT for analysis and recommended action. In any given year, the survey tools available may be constrained or expanded based on funding, equipment availability or other factors.

Species	Baseline Study Priorities and Methods	Monitoring Priorities And Methods	Other Research as Funding Allows	Pre- and Post-Disposal Monitoring
Dungeness Crab	Priority: Determine distribution and migration timing of juvenile and adult crabs through MCR utilizing acoustic tags Methods: Using the most appropriate technologies, acquire basic information about crab movements in and around the two nearshore disposal sites, especially the timing of migration, which likely is coincident with the dredging/disposal activities in late summer/fall.	Priority: Determine the comparative distribution of crabs inside and outside of nearshore disposal areas. Methods: ▪ Time series measurements in a BACI sample design to determine abundance, sex, size, and temporal distribution. ▪ Sample units may include traps, dredges, and video. ▪ Link crab metrics with physical and sedimentary time series data. Priority: Determine effects of sediment dispersal on crab mortality. Methods: ▪ Field measurements of survival (tethered) or motility (acoustically tagged) crabs during dredge disposal. Control and impact (deposition sites), using various year classes/sizes. Subsequent comparison of field and lab results. ▪ Depending upon availability, use of ROVs for identification of softshell population and burial effects.	Similar to the experiments conducted by Vavrinec, et al. 2007, laboratory studies to estimate survival of crabs (of various year classes/sizes but especially small juveniles) to sediment deposition.) The data can be used to delineate the sediment-survival response curve for year classes. Research focused on effects on recently molted crabs, especially in nearshore sites. Use of ROVs for identification of softshell population and burial effects.	At the two new nearshore sites, ROV surveys would be the preferred methods to provide critical inventory data to serve the priorities outlined above. Two weeks prior to the first scheduled disposal within a site, the site would be surveyed with an ROV camera to determine whether the area appears to be a “hot spot” for a significant aggregation of crab that exceeds normally expected distribution. If the ROV survey finds a significant aggregation of crab, the site may not be used until the crab density decreases to a normally expected density. Control sites will also be surveyed for comparison purposes. In the event that the ROV survey cannot determine abundance and density due to conditions or turbidity, a combination of bottom trawl and crab pot samples may be used to determine abundance and density data. Following the disposal season, a similar ROV survey of the disposal and control sites will be conducted, with the same weather-dependent fallback options.

Razor Clams		Priority: Determine abundance, size structure, and condition of razor clams within the study site both before and after the deposition of dredged materials though a BACI Paired Species design study. Methods: ▪ Determine sediment transport through monitoring variability in the depth of burial and the grain size distribution of the deposited materials. ▪ Use experimental methods including designated control (no sediment deposition) and impact (sediment deposition) areas within the study site. Priority: Assess seasonal changes in the shell size and age structure of the razor clam populations at MCR. Annual beach topography surveys may be helpful. Methods: Analyze size/age frequency data at sites that have been identified as potential disposal areas, and at sites that are designated as control areas. This will allow the identification of timing and locations for any distinctive recruitment events when small juvenile clams are incorporated into the population of adults.	Laboratory studies to determine effects of burial on juvenile razor clam survival. Methods: ▪ Repeat single-episode experiments with juvenile razor clams (shell length 2-3 cm) to develop an understanding of the potential susceptibility of recently-settled razor clams to burial events. ▪ Design sediment burial experiments to investigate the effects of sequential burial events on the small juvenile razor clams.	Two weeks prior to the first scheduled disposal within a site, the site and control site will be surveyed to determine relative abundance of subtidal species razor clams. This information will provide a baseline for comparison and an effects determination. Following the disposal season, a similar post-disposal survey will be conducted to determine relative abundance of subtidal species razor clams.

3. PLAN MANAGEMENT AND IMPLEMENTATION

Placing responsibility for RSMP implementation solely with the Corps is not the intent. Rather, the RSMP is a regional initiative led by the LCSG that is intended to serve as the basis for programmatic permitting of a network of beneficial use disposal sites. It is intended to guide EPA and Corps management of sediment disposal at this network of sites through development of annual use plans, baseline studies and ongoing R&M. The LCSG will be responsible for overseeing implementation of the Plan, including establishment and convening of the AMT, and for periodic update and revision of the Plan as needed. As a strategy document developed and overseen by the LCSG, it needs to be recognized as guidance to the EPA and Corps, which can choose to continue to dispose of dredged sediment at the SWS, NJS and DWS under current federal and state regulatory authorizations. Nothing in the Plan is intended to change any existing authorization or regulatory conditions applicable to the management of those sites. Rather, it is intended to provide operational flexibility for all sites, including the existing authorized sites. It is also assumed that the commitment of those regulatory agencies and other partners to the development of this Plan is a commitment to cooperation in the design and implementation of beneficial use disposal operations and attendant R&M program.

The AMT will report annually its findings and recommendations to the LCSG, as well as to the Corps and EPA. Especially critical will be cooperation in securing additional federal, state and local funding to help finance the research and monitoring to better inform effective adaptive management. Upon completion of plan development, the LCSG and its Steering Group are committed to periodically convene to assess the status of RSMP implementation and to cooperatively identify and pursue funding needed to ensure its success.

It is proposed that this RSMP and its adaptive management program serve as a single plan for management of both existing and new beneficial use sites by integration with the AUP. The AUP prepared by the Corps and approved by EPA could be expanded to include disposal activities at the new beneficial use sites as well as continued operation of the SWS, NJS and DWS.

The RSMP assumes that disposal activities at new beneficial use sites will be conducted under Corps Civil Works authority and not require a Corps regulatory permit; however, the agency will still be required to comply with CWA Section 404 regulations. EPA will oversee the Corps' authorization compliance with joint EPA/Corps guidelines as well as public interest review. Additionally, under Section 401 of the CWA, the states of Oregon and Washington will need to certify that disposal will not violate state water quality criteria.

Plan implementation is expected to occur in stages and is dependent upon available funding. As an initial implementation action, an AMT will be established and convened both to design baseline studies and an initial R&M program and to assist in securing the funding needed for such. Assuming that adequate funding can be secured, a general timeline for the initial phases of Plan implementation would be:

Timeframe	Activity
Summer 2011	Develop cooperative agreements for Plan implementation and funding
Summer/Fall 2011	Establish and convene AMT to design baseline studies and initial R&M program
Summer 2012	Conduct baseline studies
August 2012	Initiate disposal within network of beneficial use sites
September 2012-Summer 2013	Conduct post-disposal monitoring
Winter 2013	AMT reviews data from 2012 and develops any recommended modifications to disposal or monitoring program for incorporation into 2013 Annual Use Plan.

E. BACKGROUND

1. BRIEF HISTORY OF THE MOUTH OF THE COLUMBIA RIVER

The 1,200-mile long Columbia River is head-watered in the Canadian Rockies and its drainage basin is 259,000 square miles. It enters the ocean between the states of Oregon and Washington. The MCR is the ocean gateway for maritime navigation to and from the Columbia-Snake River navigation system. In 2009, *Smithsonian* magazine published an article entitled "Crossing the Bar" which colorfully summarizes why the jetty project was initiated in the 1880's and continues today.

> The bar, where the river's mighty current collides with ocean swells, is one of the most treacherous harbor entrances on the planet. Winter storms whip the sea into a ship-hungry maelstrom that long ago earned this patch of water the nickname 'Graveyard of the Pacific.' Pilots guide ships at every major harbor around the world, but the bar pilots here have distinguished themselves by working a potent brand of maritime mojo in the face of what a 19th century naval officer called 'the terrors of the bar'."(*Smithsonian*, February 2009).

The Columbia River bar is reputed to be the second most treacherous in the world and the most treacherous in the United States. Approximately 2,000 vessels and 700 people have been lost in this area. The original entrance contained two natural channels with depths of about 18 feet (5.5 m) or shallower which often shifted widely within the course of several tidal cycles.

The deep draft navigation project now consists of a dredged navigation channel six miles long that extends through a jettied entrance connecting the Columbia River estuary with the Pacific Ocean. It provides for a 2,640-foot (805 m) wide channel with the northerly 2,000 feet (610 m) of the channel to be maintained at –55 ft MLLW (mean lower low water) (plus 5 feet for over-dredging), and the southerly 640 feet (195 m) of the channel to be maintained at –48 ft MLLW (plus 5 feet for advanced maintenance dredging).

Annually, approximately $16 billion worth of U.S. products bound for world markets and 48 million tons of incoming cargo pass through MCR. More than 12,000 commercial vessels and 100,000 recreational/charter vessels navigate through the MCR annually. According to the Pacific Northwest Waterways Association, more than 40,000 jobs along the Lower Columbia River are dependent upon seaport activity. On average, marine activity in the Lower Columbia River creates $1.8 billion in personal income and $208 million in state and local tax revenue.

The present navigation channel and configuration of the inlet are the result of continuous improvement and maintenance efforts which have been undertaken by the Corps, Portland District, since 1885. Approximately 12 million tons of quarried stone have been used to construct and maintain three MCR jetties. The North and South jetties were constructed during 1885 - 1917 and are the two most important features that act to maintain the stability of the entrance to the Columbia River. Jetty A was completed in 1939. The overall length of the North and South jetties is 2.35 miles (3.8 km) and 6.62 miles (10.7 km), respectively. The central project feature at MCR is the navigation channel. The tidal range at MCR is 8.5 feet (2.6 m) and average wave height during the winter is 12 feet (3.7 m). Instantaneous flow through the MCR can exceed 1.5 million cfs during ebb tide and currents within the navigation channel typically attain five knots.

Construction of the MCR jetties re-formed a broad and treacherously variable five-mile wide inlet into a stable two-mile wide inlet having a consistent deep channel suitable for navigation. During the last 110 years, the re-direction of currents through the jettied entrance of MCR resulted in the discharge of 500 - 800 mcy of sand from the estuary to the ocean and re-orientation of the tidal inlet. Much of the present-day Peacock Spit and Clatsop Spit were formed by sand discharged from MCR during and after jetty construction.

However, these spits and tidal shoals have been eroding since the completion of jetty construction in 1939. The formation of these large sand bodies provided a surplus of sediment to the coast and resulted in rapid shoreland accretion, 5-10 miles north and south of MCR. Over time, the surplus of littoral sand at MCR has run its course; the surplus is turning or may already have turned to deficit. It is now understood that the littoral dynamics north and south of MCR are drastically different from open coast areas away from the entrance. In the vicinity of the MCR, the system provides a turbulent combination of changing bathymetric contours; receding of ebb tidal shoals, sand spits, and recently accreted shores; and asymmetric tidal flows, coastal currents, and wave action.

Specifically, the inlet has undergone a two-stage process since the time of jetty construction. Stage one was initiated at the time of initial jetty construction (1885), when a huge volume of sediment was discharged oceanward as the inlet width was reduced from five to two miles wide. This was a time of rapid morphological growth along the ocean margins of the inlet resulting in high rates of shoreland accretion. Stage two began shortly after the phased completion of the North and South jetties (1917) and continued until the process of inlet sediment discharge was completed (~1940). This was a time when the accretionary morphology, formed in stage 1, no longer had the surplus sediment supply to continue the process of “rapid accretion.” The morphology began to be re-aligned within the inlet’s wave and current environment. The stage two processes, however, will evolve and persist.

In the years since completion of the jetties, the shoreward sediment budget adjacent to the MCR has become deficient by approximately 0.7-1.1 mcy per year (Moritz et al., 2007; Kaminsky, 2005). The 40-foot (12 m) depth contour of the seafloor has migrated towards the shores of both northwestern Oregon and southwestern Washington adjacent to the MCR, but not in an equal manner. The north and south shoreline morphology adjacent to the MCR has shifted from a symmetrical form to a highly asymmetric current condition. For example, soon after construction of the North and South jetties was completed, a huge surge of sediment was flushed from the MCR and the northern shoreline experienced a focused accretion of material that resulted in the stabilization of Peacock Spit primarily north of the North Jetty and the

formation of Benson Beach adjacent to it. However, sediment is currently eroding away from Peacock Spit at a rate of approximately 2.5 - 4.2 mcy per year, which is three times the northern shoreline's estimated pre-jetty amount of sediment received from the MCR. At the same time, the present *southerly* discharge rate of sediment from the MCR appears to be close to zero (Gelfenbaum et al., 2001; Kaminsky, 2005.

These increasingly disjunct erosion/accretion processes threaten jetty stability and navigability at the MCR inlet, as well as shoreline erosion in the immediate area. The North and South jetties were built on the flood-ebb tidal shoals of the MCR with the dual purpose of utilizing the shoals to protect the jetties from the full brunt of waves and currents, as well as confining the currents within the active MCR inlet to prevent encroachment of shoals into the navigation channel. However, the scientific understanding of ocean systems and available monitoring technologies have vastly improved since jetty construction, and it is now clear that the present rate of recession of the tidal shoals of the MCR is resulting in rapid erosion of the sand shoal foundations of each jetty and increased water depth near the jetties. As the near-jetty water depth increases, the intensity of waves hitting the jetties increases and further exacerbates the erosion of the jetties' shoal foundations. The deterioration or sudden failure of a jetty could significantly impact the inlet's navigability and exacerbate erosion of adjacent shorelands (Moritz et al., 2007; Gregoire et al., 2008). The Corps is conducting a major jetty rehabilitation study to address these structural concerns.

2. SUMMARY OF PLANNING PROCESS

The MCR has been the subject of multiple physical and biological studies over several decades. Studies sponsored by the Corps have been summarized in the 2007 *Summary of Physical and Biological Studies at the MCR Sponsored by the U.S. Army Corps of Engineers*. Studies conducted since 2005 under LCSG auspices are available for review at the LCSG web site www.lowercolumbiasolutions.org. These studies focus on better understanding sediment transport processes, wave and circulation patterns, and the potential impacts of dredge disposal on species and habitat within the MCR region. For example, since 2002, more than a dozen different research projects have collected in situ and remotely sensed data, performed various data analyses, applied and calibrated wave/circulation/sediment transport/morphology change models, and investigated species distribution, diversity, and burial impacts specifically within the MCR region (ERDC, Aug. 2007; Vavrinec et al., 2006).

In addition to these scientific studies, science/policy workshops were convened by LCSG in 2005, 2007, 2009 and 2010 with scientists, technical specialists and policy-makers to discuss nearshore physical processes and their policy implications for sediment management.

In 2004, the Oregon Nearshore Beneficial Use Project was initiated by LCSG to collaboratively address the depletion of sand in the nearshore environment south of the South Jetty. To address scientific information needs and share this information with decision-makers, LCSG and the Oregon State University Institute for Natural Resources commissioned a series of scientific white papers and convened joint workshops. Among the conclusions were that a limited demonstration project should be conducted to determine the feasibility of "thin layer" disposal in the nearshore environment. Other conclusions from the workshop included:

- Mounding should be avoided that creates navigational hazards due to wave amplification.

- Crab information is lacking.
- No long-term impacts on the benthic community are expected with disposal.
- ESA-listed fish species are likely to be unaffected, but there are questions about such issues as avoidance behavior of juvenile salmon and other species and burial of flatfish and bottom fish.
- Concerns about impacts to bird populations focus on marbled murrelets.
- Impacts on marine mammals are negligible.
- A bi-state policy on sediment management is needed.

A first phase Columbia Nearshore Beneficial Use Project demonstration project entailed 34,000 cubic yards of evenly dispersed disposal in the nearshore area south of the South Jetty in 2005. It was followed by a series of research studies to inform future work. In addition to the Coastal Zone Management Plan consistency determination issued by the State of Oregon, EPA Region 10 issued an Ocean Research Permit to the Port of Astoria for this placement. In 2006, $300,000 in federal funding was received to conduct modeling studies on sediment transport and wave amplification in order to address concerns about navigation safety and protection of the South Jetty.

Between September – December 2006, the Corps contracted for a sediment tracer study to assess the fate of dredged material disposed of at SWS. The tracer study was augmented with additional seabed sampling in spring/summer 2007. Part of the assessment was to investigate whether the dredged sediment placed at SWS is transported north and augments the sediment in the nearshore and onshore areas north of the North Jetty, including Benson Beach. Results indicate a clearly defined but gradual movement of particles to the north and west away from SWS onto Benson Beach and beaches to the north.

A 2007 Science-Policy Workshop focused on sediment trends in Southwest Washington's nearshore zone, specifically the area north of the North Jetty. Among the conclusions:

- Local changes in the wave field create the possibility of significant wave amplification.
- A coordinated approach to future wave modeling and observation is required to remove present uncertainties about wave amplification.
- Enough information exists to proceed with a beneficial use disposal project.
- Further scientific study is needed to determine long-term erosion mitigation and policy.
- Disposal in the outer (western) portion of the SWS needs to be closely monitored as it is likely to have the least beneficial impact in feeding the littoral zone. Because it is necessary to traverse this area in order to access nearshore areas to the north, wave amplification effects on navigation safety resulting from disposal mounding also need to be routinely monitored.

In August 2008, the Corps initiated a sand tracer study in the nearshore area south of the South Jetty to evaluate sediment dispersal in this area. Results indicate dispersal toward the north and the South Jetty, with some dispersal to the west and significantly more to the east and then south along Clatsop Plains and the beach. The pattern of deposition to the north suggests transport from the end of the South Jetty in a west-northwest direction across the channel to the north and around the ebb shoal to the north as far as the south end of Long Beach, WA. In general, it appears that dredged sand deposited in the nearshore area south of the South Jetty will widely disperse; some of the material that moves north and west toward the navigation channel would be expected to be retained within the proximity of the South Jetty and lead to deposition both along the jetty and the Clatsop Plains shoreline.

In April and June 2009, two science-policy workshops were conducted in conjunction with the Southwest Washington Littoral Drift Restoration Project to address mound-induced wave amplification and safety implications for small boat navigation, as well as biological information needed to proceed with selection of nearshore beneficial use sites for sediment disposal. An overall goal identified by workshop participants was to eliminate deep water disposal through the identification of new nearshore beneficial use sites. To advance that goal, specific conclusions and recommendations included:

- Proceed with the planned Benson Beach and Oregon nearshore demonstration projects to assess the viability and effects of nearshore disposal.
- Consolidate previously identified potential disposal areas near North Head into a single new "North Head" site to be assessed as a permanent nearshore disposal site.
- Avoid navigation safety in areas of dredged material disposal by avoiding mounding altogether. Also address life safety issues generally by improving prediction and real-time information on waves and wind.
- For biological species, a key determinant is evidence of any greater effect than what occurs with current dredging practices.
- Primary species of concern are Dungeness crabs, ESA-listed fish species, and a poorly-understood clam species.
- The issue of thick versus thin layers of placement needs to be addressed.
- Limited resources should be used wisely, relying on currently available monitoring techniques and focusing on the most sensitive life stages.
- Adaptively manage disposal sites.

Initially proposed in the 2007 science/policy workshop and reaffirmed in the 2009 workshops, the Southwest Washington Littoral Drift Restoration Project proposed a proposed $3.5 million demonstration project at Benson Beach. Environmental permitting was completed in 2008 for placement of up to one million cubic yards in the intertidal zone north of the North Jetty in the Benson Beach area. The State of Washington contributed $1.69 million in incremental funding for the project, which was added to $1.8 million in Corps maintenance funding. Monitoring activities were funded under the Corps' Regional Sediment Management program. In 2010, almost 400,000 cubic yards of material was placed at Benson Beach as part of a pump-ashore demonstration project.

Also as a result of the 2009 workshops, a variety of cooperative activities and studies were undertaken, including enhancements to the existing ARGUS beach monitoring system at North Head, initiation of a detailed wave analysis for the area south of the South Jetty and other potential RSM areas at MCR, evaluation of nearshore circulation south of the South Jetty using remote sensed data, deployment of a CDIP wave-ride buoy at the approaches to MCR, and continuation of the sediment tracer study for the area south of the South Jetty.

In response to the 2009 workshops, LCSG initiated the current regional sediment management planning effort in early 2010, with the goal to develop a program of potential new beneficial use activities, including a regional network of disposal sites, an adaptive management program for their use, and identification and prioritization of research and monitoring measures. As part of this RSM planning effort, a policy workshop was conducted in August 2010, leading to a combined science/policy workshop in November 2010. Those conversations framed much of the approach to this Plan, including direction from the Steering Group leading the planning process that the Plan recognize:

- The considerable volume of scientific research conducted over several decades for the MCR and adjacent nearshore areas, as well as the deliberations and consensus emanating from the series of science/policy workshops conducted over the past six years. While it is recognized that there are information gaps, especially for the biological environment, there is a considerable amount known about the area and valid bases for expectations about the levels of potential risks to the physical and biological environments.

- That there is consensus among the many parties participating in the planning process to date on the locations for new beneficial use sites. The identification of those sites has in turn been based on the demonstration projects and associated research conducted in the nearshore littoral zones.

- The value of collaboration in planning for the MCR as evidenced by the number of projects originating in science/policy workshops that have been implemented, particularly navigational aid projects.

F. MANAGEMENT CONSIDERATIONS

1. OPERATIONAL AND REGULATORY CONSIDERATIONS

a. Operational Considerations

As previously noted, the MCR is considered one of the world's most dangerous coastal inlets. These dangerous conditions constrain the timing and method of dredge material disposal in the area. In addition, MCR dredge material disposal is subject to other constraints including in-water work windows; costs of conducting work; availability of dredges with the equipment and capability to perform required work; disposal site use management and monitoring requirements imposed by EPA and the states; and coordination with local fishermen and mariners at various disposal sites.

Weather conditions and wave and current intensity at the MCR limit dredge operations primarily to the months of June – mid-October, with some work conducted into November as weather permits. Typically two hopper dredges are required to complete the work each year. Hopper dredges that are used at the MCR can operate 24 hours per day, seven days per week. More than 1,000 annual load cycles are necessary to maintain the MCR.

A typical load cycle for one hopper dredge involves 0.75 - 1.5 hours to fill its hopper, 0.5 - 1.5 hours to transit to and return from the disposal site, and 3 - 12 minutes to place one load of dredged material into a given disposal site. This disposal sequence is difficult to modify, not only because of the time it takes to complete the MCR maintenance dredging, but also because the hopper dredges serve other locations and do not work continually at the MCR. When

planning the dredging season, a variety of conditions are analyzed and captured in the Corps' AUP including shoaling conditions and dredging requirements, capacity of disposal sites, timing of site use, type and availability of dredges, and other factors.

Two of the proposed new beneficial use dredged material disposal sites are located nearshore in waters 60 feet (18 m) in depth or shallower, while the other two sites would be located onshore. A hopper dredge used in nearshore areas must be capable of safely navigating and maneuvering in relatively shallow areas and disposing of material in a measured and relatively thin layer, generally averaging less than 12 cm in depth. Another operational constraint is that, under most conditions, a loaded hopper dredge cannot safely move parallel to the waves or shoreline while disposing of material; it needs to start at the closest point to the shore and move out perpendicularly, heading directly into the waves. At a June 2011 West Coast dredging conference, it was announced that improved capabilities for disposal from retrofitted hopper dredges are expected, which may help facilitate both nearshore and onshore disposal within the study area.

As dredged material is discharged from a dredging vessel, the resulting mound height is influenced by factors such as vessel speed, water depth, and discharge technique (i.e.,. open-hull dump versus bottom door and whether the bottom doors are fully or only partially open). The speed of the dredge vessel during a disposal event has the most significant effect on the depth of discharged dredged material. The slower the dredge moves while discharging, the higher the centerline mound will be. Based on the results of Pearson et al. (2006), a maximum dredge thickness of 12 centimeters (cm) is reasonably expected at the centerline of the placement, decreasing to the outside edges. Using the Short-term Fate (STFATE) dredged material disposal model developed by ERDC, a matrix of disposal conditions was developed for the dredges used in the Lower Columbia River dredging operations. The results indicate that the mound from a single disposal event n waters 45 feet (13.7 m) in depth could have a maximum thickness of 12.6 cm at the centerline of the disposal event Similar modeling results were reported for the Oregon Nearshore Beneficial Use Project which estimated a maximum layer of sediment approximately 9 cm deep from a disposal event in slightly deeper (60+ feet; 18 m) water. An important note is that the maximum dredged material depth decreased dramatically with distance from the centerline of the disposal event.

One potential disposal practice which could minimize the layer of sediment is dispersed spraying of reliquidfied sand (also referred to as pump off or rainbow spray). This practice mixes the sediment from a hopper dredge with water to create slurry that is sprayed into a disposal area, which can be done while a dredge is moving or anchored. The time necessary for dispersed spray is similar to the time required for pump-ashore, which is to say, considerably greater than for the thin layer discharge through partially open bottom doors as described above. The sprayed sediment creates a temporary turbidity plume, but because of the grain size of the MCR sediment, the turbidity will quickly disperse and is not likely to create water quality issues. There is some potential for entrainment as water is pumped through the dredge's sea chest. Entrainment is not likely to be a significant issue, unless the dredge is operating in an area that is inhabited by significant numbers of juvenile salmonids, such as estuarine areas. The dispersed spray method significantly increases the time required to dispose of a full hopper dredge, making the practice more costly. Dredge equipment capable of dispersed spray is also limited. Although this practice holds promise for minimizing effects on benthic species, the costs and timing may create practicability issues that limit its viability. These issues are similar to costs and timing constraints associated with pump-ashore practices.

There is general agreement that onshore placement is the best way to replenish eroding beaches, protect the bases of jetty structures, avoid mounding and associated wave amplification, and avoid the potential for material filling the navigation channel. However, onshore disposal is more logistically and fiscally difficult and the rate of sediment dispersal is relatively low. Discharging dredged material at the two onshore sites would be more challenging than nearshore disposal. At this time, a contract dredge would be required for these practices. In addition to equipment constraints, the short dredging season makes onshore disposal challenging and limited, because of the amount of material that must be dredged within the short dredging season. For example, the 2008 North Jetty berm repair project was interrupted by an unusual August storm.

There is a limited pool of contractors and their dredges that can physically work at the MCR. The Jones (Merchant Marine) Act, requires that only U.S.-flagged, built, and crewed vessels can be utilized to conduct work in the United States. There are only three dredging companies that have dredges that can definitely work at MCR, with six suitable dredges among them. Most of the dredges are located on the East Coast and require a trip through the Panama Canal to arrive on the Pacific Coast. Typically, the project is maintained with two hopper dredges. Any increase in time required would require the use of a third dredge with large mobilization cost and questionable availability, given work load in other parts of the country.

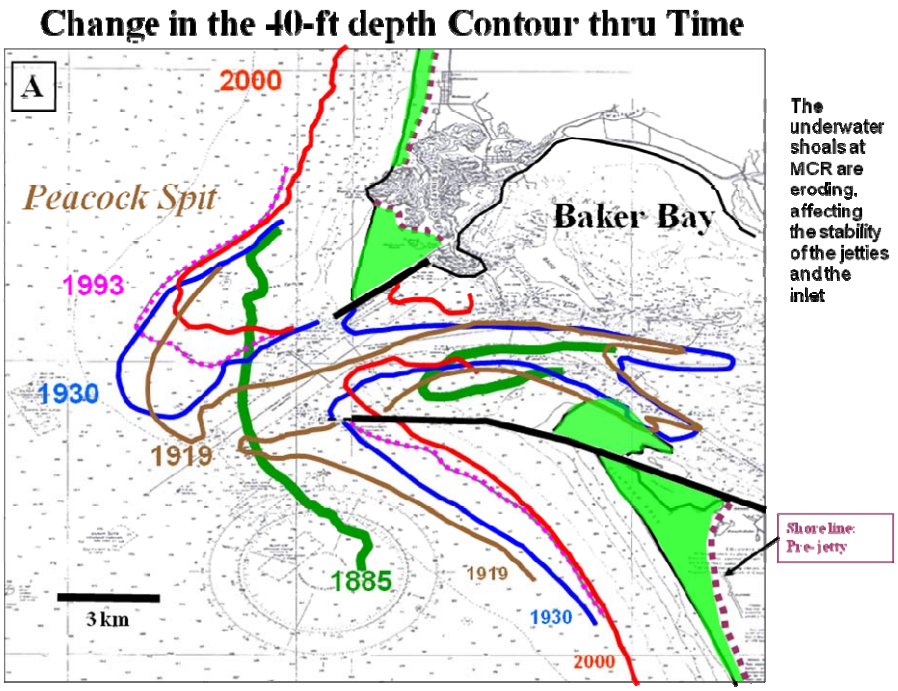
b. Regulatory Considerations

Disposal of dredge material at MCR beneficial use sites is constrained not only by operational considerations, but also by a myriad of government regulations. Among these are federal, state and local laws including, but not limited to, the National Environmental Policy Act (NEPA); Clean Water Act (CWA); Marine Protection, Research and Sanctuaries Act (MPRSA); Endangered Species Act (ESA); Marine Mammal Protection Act; Magnuson-Stevens Fishery Conservation and Management Act; Fish and Wildlife Coordination Act, and Coastal Zone Management Act (CZMA). In Washington, dredge material and placement is regulated by Washington Department of Natural Resources (WDNR) under its Dredged Materials Management Program. For onshore disposal in Oregon, both Oregon Department of State Lands (DSL) and Oregon Department of State Parks and Recreation (OPRD) may have jurisdiction under their responsibilities for submerged/submersible lands management and beach nourishment, respectively. An Ocean Shore Alternative Permit will be required from OPRD to determine impacts to recreation, natural resources, and scenic and safety values. Onshore disposal will also entail compliance with County land use plans and regulations in both Clatsop (OR) and Pacific (WA) counties. Each new beneficial use will have its own unique set of regulations and authorizations with which to comply, the scope, sequencing and timing of which will be determined in further consultation with the appropriate regulatory agencies. The development of this regulatory roadmap will be an LCSG priority following Plan adoption.

Compliance with all of these laws is best accomplished through cooperative partnerships with the various regulatory agencies in order to align attainment of necessary regulatory requirements in time to conduct work within the in-water work timeframes for the beneficial use sites. This RSMP is intended to help minimize the time to meet regulatory requirements and attain authorizations, while maximizing involvement and input from the regulatory agencies during the planning, execution and monitoring phases.

2. NAVIGATION SAFETY AND PHYSICAL SCIENCE CONSIDERATIONS

Seafloor habitat is largely a function of the historical and extant geology, disturbance regime (e.g., wave and current exposure), and living marine organisms that inhabit the area (e.g., structure forming invertebrates and algae, ecosystem engineers such as "bio-turbators").Therefore long-term changes in the MCR area may have implications for navigation safety. Nearshore disposal can potentially cause navigational hazards if too much sand is mounded in one area, thus mound-induced wave amplification is a life-safety issue that is addressed with respect to the siting and management of disposal sites.



In the 2007 science/policy workshop, consensus was reached that wave amplification has occurred at historical dredged sediment disposal sites at MCR. However, there was considerable debate regarding wave amplification as a criterion for safe navigation, the use of historic baseline data as a criterion, and the dependency of the predicted wave conditions at a disposal site on the type of wave model used. It was suggested that more high quality in-situ data may be needed to improve confidence with wave modeling results to better inform decision- makers. Agreement was also needed on the type of wave model used for these studies. An improved and better defined protocol for the application of models to evaluate wave conditions, and appropriate metrics used to evaluate the implications of disposal practice with respect to navigation safety should be defined. At and subsequent to the 2009 science/policy workshop, these issues were largely addressed through agreement by both scientists and policymakers on the following points, which are incorporated as part of this Plan:

- Navigation safety in areas of dredged material disposal can best be enhanced by avoiding mounding which could have a measurable effect on navigation safety at the ocean surface. Mounding should be routinely monitored so that any induced wave amplification does not exceed a maximum recommended 10% over baseline conditions.

- To avoid the potential for adverse navigational safety and biological effects associated with mounding of sediment, dispersed, thin layer, and/or respraying of reliquidfied sand (also referred to as pump off or rainbow spray) disposal will be employed, based upon the AUP and adaptive management needs.

- General life-safety issues at MCR may also be addressed by improving prediction and real-time information on waves and wind in critical navigation areas and where wave model discrepancies are large.

- Directional wave measurements are desirable at the MCR for (1) wave model calibration and ground-truthing of wave models, and for (2) boater safety and safe-transit planning.

- To improve data collection, new buoys should be installed at MCR and wind monitoring should be expanded on North Head and integrated with wind measurements from the Clatsop Spit area.

- Criteria to use in modeling the potential for wave amplification should include: shoaling, refraction, diffraction, non-linearity, wind effects, and reflection.

- Additional cooperation with the scientific community is needed to (1) design and validate an appropriate wave model to predict relevant wave transformation, and (2) review bathymetry data and identify a baseline.

- A common bathymetric grid should be used for all modeling that includes datasets for: (1) baseline, both pre-project conditions and periodic adjustments to account for erosion/accretion; (2) annual pre-dredge conditions; and (3) annual post-dredge conditions. The grid resolution should be based on morphology and modeling (5 model pts/ wavelength).

- A new bathymetric offshore survey is needed that includes Astoria Canyon.

- Benthic habitat and sediment properties should be mapped.

3. BIOLOGICAL SCIENCE CONSIDERATIONS

To advise on science issues associated with preparing this Plan, the LCSG established a Science Advisory Team (SAT) comprised of experts in both physical and biological sciences, all of whom are familiar with the unique physical and biological processes that occur at the MCR. The SAT's primary responsibilities were to prioritize the knowledge gaps in scientific understanding about the MCR system, and to provide scientifically-based monitoring recommendations. Based upon consultation with the SAT and results of the many studies that have been conducted in conjunction with science/policy workshops, key biological considerations include:

- With thin layer placement methods, minimal biological impacts would be expected with dispersal. In addition, the late summer timing of placement reduce concerns about impacts on some species.

- Many biological questions/concerns diminish with consistent use of sediments that are only ~3% fine sediments, which is the case with "clean material" used in the MCR.

- The following summary of potential impacts to biological species known to be present in the project area is derived from more than a decade of research and science/policy workshops and SAT deliberations.

a. Dungeness Crab

From both biological science and economic perspectives, the primary species of concern is Dungeness crabs (*Cancer magister*).

Source: Curtis Roegner, NOAA Fisheries, Nov. 2010

Dungeness crabs utilize the MCR area as a primary habitat that is especially important for mating and egg development (McCabe et al., 1985). The MCR area is a major Dungeness crab fishing location with most crab fishing occurring north of the North Jetty and south of the South Jetty to Cannon Beach in water depths of generally less than 150 feet. Recent laboratory experiments and modeling efforts provide understanding of impacts to Dungeness crabs during dredged-material disposal events. Vavrinec et al (2007) conducted laboratory experiments to examine impacts of sediment disposal on Dungeness crabs from direct burial and from tumbling in the horizontal surge current. These experiments were designed to expand on previous research (Pearson et al., 2006). No crab mortality or injury resulted from the surge current experiments. The crabs readily moved during the surge current experiments, but it is not clear whether movement was voluntary or forced. Crabs that landed upside-down were able to right themselves faster than sediment could settle and result in burial. Burial depth and crab size were found from logistic regression analysis to affect survival from burial events.

Survivorship curves suggest that the larger the crab and the more shallow the burial depth, the more likely crabs are to recover a respiratory pathway and survive burial. Burial tests conducted on age 2+ crabs (subadult) in large tanks that allowed for a more realistic, unrestrained escape response resulted in a 53% survival probability for females and 80% for males buried to 12 cm (~5 in), which was the highest modeled depth in the 2005 thin-layer pilot project. (The predominant area of disposal received significantly less accumulation). Survival probability increased to nearly 100% under the same test conditions for age 3+ crabs (adult). Crab mortality rate from burial is anticipated by Vavrinec et al to be less *in situ* because of the relocating effects of the horizontal surge currents produced during dredged material discharge. It is important to note that most relevant crab studies have been lab-based and thus have limitations when extrapolating to actual MCR field conditions, where deposition rates and crab movement opportunities may differ. Nonetheless, this Plan assumes that there is sufficient understanding to proceed with deposition, particularly using thin-layer dispersal methods, subject to identified research and monitoring priorities.

Conclusions from prior science/policy workshops note that there is incomplete scientific information quantifying impacts to crab from past dredge disposal at MCR, including the lack of analysis of crab mortality from disposal or analysis of ecosystem function or crab food web requirements. There has also been limited analysis of juvenile crab refuge requirements and the importance of bottom debris to survival. Concerns identified about impacts to crab from

disposal include: direct burial, loss of refuge for immature crab, loss of stable mature food supply for 'Harvest Ready' crab, fragmentation of fishing grounds, and any large reductions in production over time. From an effects perspective, the life history stages and uses of most concern are the commercial fishery and breeding adults. 0+ and 1 + juveniles at disposal sites would be expected to be a very small fraction of coastal production.

To mitigate potential adverse effects, migration routes and disposal during spikes in abundance should be avoided so as to not unreasonably degrade the marine environment. To best assess and monitor potential impacts to this species, it will be critical to determine whether the proposed disposal areas are crab aggregation areas, recognizing that abundance in any given area at any particular time does not necessarily reflect future numbers. Monitoring should focus on sub-adult and legal males and breeding adults. Sampling of older stages, rather than larval and 0+, would be the most effective use of limited monies. Monitoring should occur over a long enough time span to assess repetition (minimum of three years). The best timeframe for monitoring would be late summer/fall.

b. Benthic Invertebrates

The conclusion of the 2005 and 2009 science-policy workshops was that distribution of benthic species is inherently patchy and variable and effects on the benthic invertebrates would be inconsequential as long as the sediment being dispersed is similar in size to the native sediments. (This conclusion was recently confirmed by a draft Biological Impact Assessment report from the California Coastal Sediment Management Group.)

While the MCR is a major Pacific razor clam (*Siliqua patula*) harvesting location, the specific intertidal zones being proposed are not understood to carry significant populations of razor clams. Most of the harvested razor clams occur on the intertidal beaches that are exposed during low tides. This benthic community is characterized by species who have adapted to a high energy environment, including waves, sediment movement, storms, freshwater, and strong tides. The members of this community are highly motile rapid burrowers, quick tube builders or rapid colonizers.

Razor clams found in subtidal waters deeper than 30 feet (9 meters) may serve as the broodstock for the intertidal populations and are, therefore, of commercial interest although they also might be from another stock entirely. These subtidal razor clams could be impacted during the discharge of dredged material due to their limited ability to move horizontally (Lassuy and Simons, 1989).

Those impacts, however, should be considerably reduced by the use of thin-layer dispersal methods. Laboratory experiments (Vavrinec et al, 2007) conducted on Pacific razor clams to predict survival rates of clams exposed to sediment burial of varying depths and frequencies indicate that survival of adult razor clams was 100% after burial to depths of 3.5 cm and 12 cm. Razor clam survival decreased to 89% after burial to a depth of 18 cm, and 70% after burial to a depth of 24 cm. These experiments were conducted using adult razor clams with an average shell length of 11.8 cm. An additional burial experiment was conducted with smaller razor clams (average shell length of 7.1 cm), and survival was 100% after burial to a depth of 12 cm. Therefore, limiting dredged material disposal to one discharge event per 24 hours and no more than 12 cm depth of material per discharge event is anticipated to minimize loss to the subtidal broodstock population of commercial interest.

Conclusions from a 2009 science/policy workshop included that the additional sand provided by onshore disposal could benefit intertidal razor clam stocks along beaches affected by erosion. Some effect to the community would be expected following disposal, but this would not necessarily have a long-term negative impact. The time frame for recovery would be variable depending on project-specific details such as thickness of material disposed, timing, etc.

Also noted by the SAT is a poorly known clam species (*Tresuspajaroana,* a species of horse or gaper clam) that the SAT believes could potentially (though unlikely) be in the proposed nearshore disposal areas.

c. Marine Birds

Multiple marine bird species breed over winter and migrate along the coast. However, abundance relative to other parts of the coast is low for some species such as the marbled murrelet, a federally- and state-listed species. Bird community composition is different during spring and fall migration relative to summer. Bird counts indicate the important of the edge of the Columbia River plume for supporting resident (particularly common murres, cormorants, pelicans, and gulls) and migrating marine bird species (grebes, scoters and winter gulls).

Impacts on abundance and distribution of marine birds will be very localized and not expected to be a significant issue. In terms of potential effects, loss of food for foraging species is the primary concern. ESA-listed marbled murrelets may be affected only if the project has a substantial negative effect on their benthic prey. The impact of decelerating erosion could be potentially positive in the long-term for dune-dependent species such as snowy plovers and streaked-horned larks, both listed species. Localized abundance and distribution should be monitored, as well as changes in foraging behavior (specifically, foraging success and diet).

d. Marine Fish

Given the location of the four new sites and the lack of fine sediments in disposed materials, migratory fish, such as juvenile salmonids and green sturgeon, are unlikely to be adversely affected by disposal at the MCR. It is assumed that those species, for the most part, can simply move out of impacted areas. Even though the natural background of turbidity in the MCR vicinity can be quite high, suspended sediment in the water column related to the thin layer disposal of marine sands is very short term in nature. While questions remain about issues such as the avoidance behavior of juvenile salmon and other species, turbidity at MCR is not expected to significantly impact fish species at MCR. The innate variability of fish populations inhabiting the area will make monitoring and evaluation of disposal impacts difficult. Flatfish and bottom fish would best be monitored through trawl surveys. An alternative would be to conduct benthic sampling of infauna and epifauna as a proxy for composition and the availability of prey for fishes before and after surveying. Monitoring for juvenile fish could be conducted in conjunction with Dungeness crab monitoring.

e. Marine Mammals

Science/policy workshop conclusions are that marine mammals are very rarely found in the MCR area. One species that must be considered is Steller sea lion, which is listed as

threatened under the ESA. The likelihood of impact from disposal would be low, as marine mammals in the area already are exposed to vehicle traffic through and in the vicinity of the MCR navigation channel. Disposal operations should be timed to avoid timing conflicts with gray whale migration. Surveys for abundance of marine mammals in the area could be conducted in conjunction with any bird surveys to achieve greater efficiency of survey funds. Surveys for marine mammals before, during, and after dredge material placement will provide data on presence/absence but will be difficult to correlate with any dredge disposal activities because of the wide ranging nature of these animals and the relatively chance event that they are seen in the project area.

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