GALVESTON BAY
REGIONAL SEDIMENT MANAGEMENT
PROGRAMMATIC SEDIMENT MANAGEMENT PLAN

GALVESTON, TEXAS

PREPARED FOR

US Army Corps of Engineers

PREPARED BY

moffatt & nichol

MARCH 2010

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U.S. Army Corps of Engineers
Planning Section
2000 Fort Point Road
Galveston, TX 77550

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MOFFATT & NICHOL

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1.0 EXECUTIVE SUMMARY

Regional Sediment Management (RSM) is a systems based approach with the goal of better managing sediment across multiple projects, both federal and non-federal, through improved interagency cooperation, science, and engineering practices. As part of implementation of RSM for the Galveston Bay region, this Programmatic Sediment Management (PSM) Plan is a comprehensive guidance and policy implementation document that identifies how RSM can be implemented in an expeditious, cost-effective, and resource protective manner.

The PSM Plan presented herein summarizes existing knowledge of the sediment transport regime within the Galveston Bay region, including fluvial, estuarine, and littoral sediments. The specific sediment transport pathways and rough flux volumes within the system are identified and a preliminary sediment budget is presented. Data gaps are identified with the goal of developing a more comprehensive and quantitative sediment budget for the region. The PSM Plan also presents information on the existing uses and dependencies on coastal sediments, the effect of relative sea level rise on past, present and future RSM activities, sediments currently impacted by various contaminants and Geographic Information System (GIS) resources for the study area.

As part of plan development, a series of meetings with federal and state resource agencies and other key stakeholders were held to identify the RSM needs and opportunities. These include specific projects where dredged sediments may be beneficially used along with general strategies and solutions that can be investigated and implemented. The stakeholders also identified constraints on RSM projects and these are summarized in the PSM Plan.

Based on the identified needs, opportunities, and constraints, a set of RSM strategies and solutions are developed. These strategies and solutions include scientific and engineering investigations to increase knowledge of the sediment systems, regulatory and policy strategies, beneficial use solutions including designs and construction methods, economic analysis strategies, and information sharing programs. The strategies and solutions focus on general types of projects and studies rather than specific sites or projects for beneficial uses of sediments.

Finally an implementation plan is presented. This includes a prioritized list of strategies and solutions, identified data gaps and needed analyses to improve knowledge of the system, and recommended next steps in both short and long-term. The prioritized strategies and solutions include that the USACE:

- Establish, lead and support a Regional Sediment Management working group;
- Address data gaps and improve knowledge of regional sediments;
- Improve beneficial use opportunities for private dredging;
- Develop life-cycle costs for dredged material;
- Maintain and use a RSM needs and opportunities list;

- Implement information sharing;
- Implement beneficial nearshore placement of dredged material;
- Use upland confined dredged material for ecosystem restoration; and,
- Implement dredged material reuse implementation and marketing program.

2.0 INTRODUCTION

2.1 Regional Sediment Management Approach and Goals

The U.S. Army Corps of Engineers (USACE) has historically managed sediment on a project-by-project or ad hoc basis, an approach which often led to unanticipated long-term consequences as natural systems do not always coincide with project, jurisdictional, or state boundaries or other activities impacting sediment sources. Some of these consequences have included induced erosion or sedimentation in nearby areas, inefficient planning for dredged material management, and missed opportunities to more cost-effectively manage sediment resources. Over the past decade, however, the USACE and other federal and state resource agencies have migrated towards a more regional management approach for sediment. This systems based approach is aimed at increasing cooperation and coordination among agencies, adaptive management across multiple projects based on shared goals, improved management through application of best available science and engineering practices, and implementation of policies to achieve maximum long-term economic, social, and environmental benefits.

The Regional Sediment Management (RSM) Program is authorized under Section 516 of the Water Resources Development Act of 1996. RSM provides the basis for a systems-wide approach to sediment management to quantify and manage sediment sources and sinks, minimize dredging requirements and more effectively utilize dredged material as a resource. As a planning and management tool, RSM is a means to identify and involve stakeholders to integrate data on sources of dredged sediment, demands for sediment, and impacts on commerce and the environment to both promote the beneficial uses of dredged sediment and to streamline dredging projects. Using this approach, project managers can use RSM as a tool to decrease overall life-cycle dredging costs while utilizing dredged material in a more environmentally sensitive and cost effective manner (minimizing environmental impacts to the nearshore system).

2.2 Scope and Purpose

The Galveston Bay Regional Sediment Management Plan Development Project (the "project") uses an RSM approach to develop a *Galveston Bay Programmatic Sediment Management Plan* (the "PSM Plan") for the USACE Galveston District to utilize while managing dredged material and other sediment related projects within the vicinity of Galveston Bay.

This PSM Plan was developed using the gathered information and data, which was summarized in the *Data Gathering and Assimilation Report* and completed and submitted to the USACE (M&N 2009).

The PSM Plan is intended to be a comprehensive guidance and policy implementation document used to identify how RSM can be implemented in an expeditious, cost-effective, and resource protective manner. Specifically, the goals of the Plan are to:

- Reduce overall life-cycle costs for dredging operations;

- Develop a regional sediment budget;
- More efficiently utilize Operations and Maintenance (O&M) dollars;
- Aid in restoration of wetlands and eroded shorelines;
- Increase coastal resiliency;
- Involve stakeholders to effectively manage sediment resources;
- Beneficially use or reuse sediments from dredging activities and sediments from existing confined disposal facilities (CDFs);
- Improve water quality; and,
- Maximize other beneficial uses with the intent on managing sediment as a regional resource rather than a project specific resource.

The PSM Plan details opportunities and limitations for regional sediment management within the Galveston Bay system based on a collection of existing data and stakeholder coordination. The Plan identifies strategies for the management of sediment that can be pursued should additional funding sources be identified. The specific scope of the PSM Plan is to:

- Identify sediment pathways;
- Coordinate roles, responsibilities, and authorities for various state, federal, and local agencies along with key stakeholders in Galveston Bay region for sediment management;
- Identify RSM opportunities and constraints within system;
- Develop a management strategy for sediment resources; and,
- Develop a prioritized list of RSM projects, strategies, and cooperative efforts and identify potential funding sources.

2.3 Study Area

Galveston Bay is the largest bay on the Texas coast (600-square miles in area) and is located along the northeastern Texas coastline. The Bay is composed of East Bay, West Bay, Upper Galveston Bay (area north of Red Fish Bar), Lower Galveston Bay (south of Red Fish Bar), Trinity Bay, and other small embayments. Galveston Island, the Bolivar Peninsula, and the Follets Island separate Galveston Bay from the Gulf of Mexico. The Trinity and San Jacinto Rivers are the major fluvial inputs into Galveston Bay, which is surrounded by bayous, wetlands, marshes, seagrass beds, and sand and mud flats.

Galveston Bay is not only one of the area's most important environmental resources, but is also a significant economical asset supporting a wide range of uses, including commercial and recreational fishing, heavy and commercial industry, tourism, and recreation.

The study area of the PSM Plan focuses on the coastal zone in the vicinity of Galveston Bay and the Gulf shoreline (Figure 2-1). The area also includes coastal areas within neighboring Galveston, Harris, Jefferson, Chambers, and Brazoria counties to incorporate the coastal watersheds of the Trinity and San Jacinto Rivers. The study area includes the many navigation channels that provide access to the deep-water ports of Houston, Texas City, and Galveston along with several shallow draft facilities. The Gulf Intracoastal Waterway (GIWW), the country's third busiest waterway, is a navigable inland waterway that runs along the Gulf coast and passes through the south end of the study area.

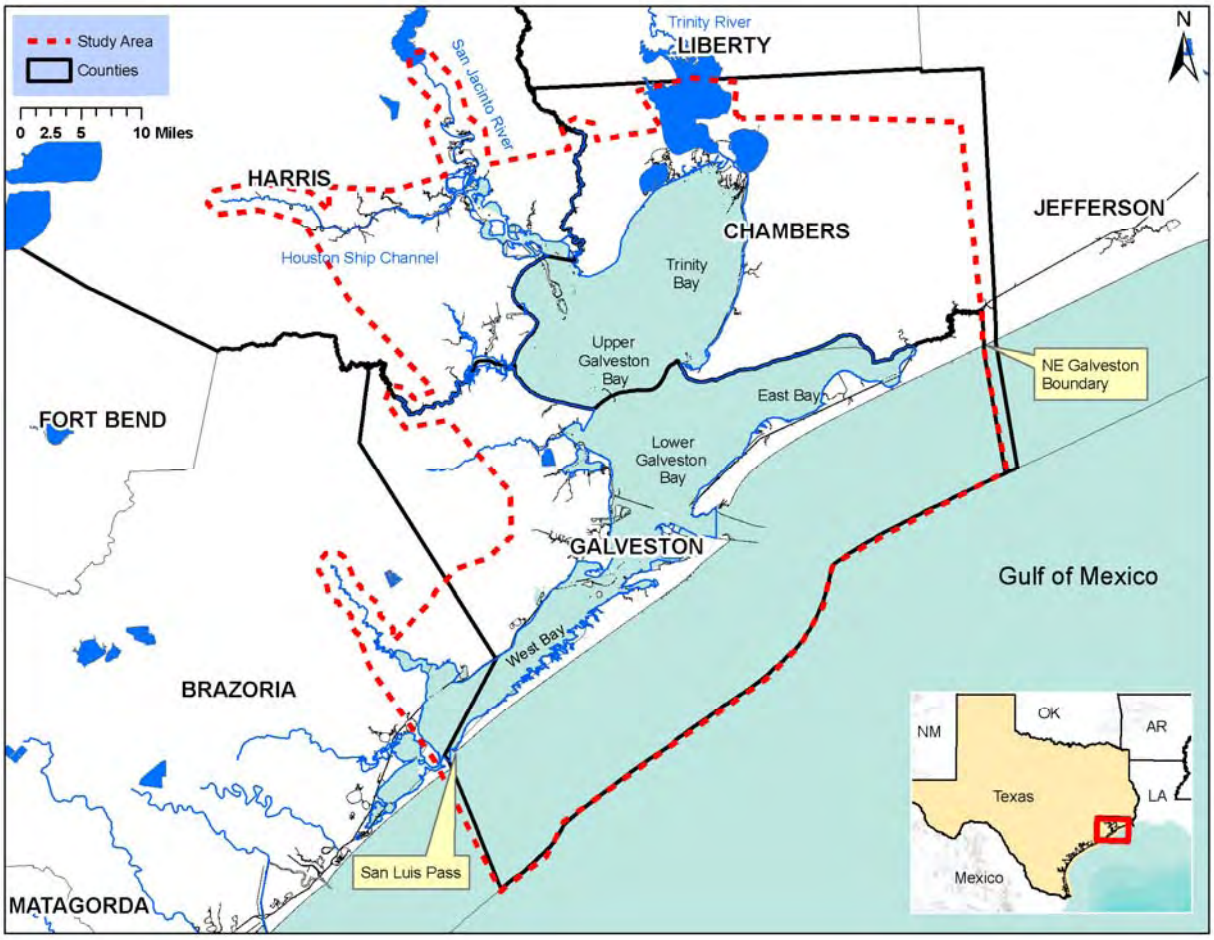


Figure 2-1: PSM Plan Study Area

3.0 EXISTING GALVESTON BAY AREA SEDIMENT SYSTEM

This section summarizes the existing knowledge of the sediment system of Galveston Bay. This includes an assessment of sediment pathways (i.e., a sediment budget), sediment dependencies in the system, relative sea level rise, impacted sediments, and GIS resources.

3.1 Preliminary Sediment Budget

A sediment budget of the study area was developed as part of this PSM Plan to identify, understand, and provide a preliminary quantification of the sediment sinks, sources, and movements. This budget is based on available information and did not include new field data collection. The budget is considered preliminary and should be updated and advanced as discussed at the end of this subsection.

The preliminary budget considered fluvial inputs, including runoff from smaller local tributaries with local land erosion, and shoreline erosion as the major sediment sources, and navigational channels which are actively dredged as the major sediment sinks. Sediment sources were quantified based on prior studies prepared for the Texas Water Development Board (TWDB). Sediment sink volumes were calculated from historical USACE Galveston District and Institute for Water Resources (IWR) navigation channel dredging records.

The sediment budget was entered into Geographic Information Systems (GIS) using the Sediment Budget Analysis System for ArcView (SBAS-A) tool, developed by the USACE Engineer Research and Development Center (ERDC), a component of the eCoastal Toolbox. The sediment budget was developed in the metric system.

For the purposes of quantifying volumes, a bulk density of one tonne per cubic meter was applied. This density is commonly assumed based on typical bulk densities of estuarine, lake sediments, and freshly deposited alluvium (Phillips 2005).

Details on the development of the preliminary sediment budget and recommendations of further work that could determine the source of the sediment deficit are discussed in this section.

3.1.1 Sediment Budget Structure and Cells

The preliminary sediment budget delineated the bay into six cells at logical boundaries based on known sediment pathways within the bay. These cells are listed below and are shown in Table 3-2 (and illustrated in figures later in this section).

- Trinity Bay and East Bay
- Galveston Bay – La Porte
- Galveston Bay –Bayport to Texas City Channel
- Galveston Bay – West Bay (Causeway)

- Galveston Bay – West Bay (Pelican Island)
- West Bay

In addition to these Bay cells, the navigation channels and offshore littoral cells are also delineated. The sediment budget included fluvial sources (i.e. watershed derived) and shoreline erosion as the sediment inputs into Galveston Bay. These sediment sources enter the bay via an identified sediment cell or navigational channel within the sediment budget. Fluvial sediment sources to Galveston Bay were divided into two categories: Major Fluvial Sources and Other Watersheds. The delineation of these sources is shown in Figure 3-2.

Sediment delivered to the bay via aeolian transport has been estimated to be insignificant (Phillips 2005) and was not considered for this sediment budget. Other sources not considered include coastal and marine sources derived from barrier island overwash and fine-grain suspended sediment transported from the Gulf of Mexico into Galveston Bay through Bolivar Roads.

3.1.2 Navigation Channels

Navigation channels represent the largest sinks of sediment within Galveston Bay. Deposited sediment must be removed from the channels via maintenance dredging to sustain adequate channel depths for vessel navigation, and is thereby eliminated from the natural estuarine sediment delivery system. The navigational channels included within the sediment budget are listed below and shown in Figure 3-2.

- Bayport Channel
- Barbours Cut Channel
- Galveston Harbor and Channel
- Greens Bayou
- Entrance Channel
- Houston Ship Channel (HSC) – Bay and Bayou Reaches
- GIWW – Divided into Eastern, Western and Central Reaches
- Chocolate Bayou
- Texas City Channel
- Galveston-Bolivar Ferry Terminal

Sediment deposition rates for navigation channels were estimated through historical USACE dredging records for these channels. The records were searched for consecutive events of channel dredging along the same linear reach. They provided the total volume of material dredged per event and the date of the dredging. From this information, the following formula was used to calculate the sedimentation rates for the navigational channels:

$$\textit{Channel Sedimentation } (m^3/year) = \frac{\textit{Dredging Event Volume } (m^3)}{\textit{Duration between Dredging Events (years)}}$$

The duration varied between channel and by dredging event. For several of the navigation channels, this type of analysis was also recently performed in a *Preliminary Assessment for the Houston-Galveston Navigation Channels (HGNC)* by URS Corporation and Moffatt & Nichol (URS and M&N 2009) and was used for this study. The best estimate of future sedimentation rates from the HGNC report, based largely on recent sedimentation rates, was then used for preparation of this preliminary sediment budget analysis. The sedimentation rates for the navigation channels within the study area are shown in Table 3-1.

Table 3-1: Navigation Channel Sedimentation Rates

Channel Name	Shoaling Rate (tonnes/yr)	Shoaling Rate (CY/yr)
Bayport Channel[1]	750,000	980,000
Barbours Cut Channel[1]	230,000	300,000
Galveston Harbor and Channel[1]	1,370,000	1,790,000
Greens Bayou[1]	40,000	50,000
Entrance Channel[1]	2,190,000	2,860,000
Houston Ship Channel - Bay Reach[1]	2,430,000	3,180,000
Houston Ship Channel - Bayou Reach[1]	1,910,000	2,500,000
GIWW - Eastern Reach[2]	470,000	620,000
GIWW - Central Reach[2]	290,000	380,000
GIWW - Western Reach[2]	300,000	390,000
Chocolate Bayou[2]	120,000	160,000
Texas City Channel[3]	570,000	740,000
Galveston-Bolivar Ferry Terminal[4]	310,000	400,000
Total	**10,980,000**	**14,350,000**

[1] Source: Preliminary Assessment for HGNC (URS and M&N 2009)
[2] Source: USACE IWR Dredging Records for FY 1990-2007
[3] Source: USACE 2007
[4] Source: Personal Communication, TxDOT - Mark Rodriguez (2009)

Based on dredging records and previous work, approximately 11 million cubic meters, or 14.4 million cubic yards (CY), is accumulated within Galveston Bay navigational channels annually. This volume of material dredged from navigation channels is significantly higher than sedimentation rates within the bay estimated for the period prior to recent channel modifications. A recent study estimated average accumulation rates over the bay area of 3.5 to 3.8 mm/year (Phillips 2005). Using this rate, it was estimated that an average of 5.4 to 5.9 million cubic meters of sediment were accumulated in the bay annually. The breakdown of this quantity into

materials accumulating in the navigation channels and other parts of the Bay was not developed by Phillips.

3.1.3 Shoreline Erosion

Shoreline erosion has been found to be a significant source of sediment to the bay. The average historical retreat rate over the bay shoreline is 0.73 meters/year (Phillips 2005). Assuming a shoreline relief of 0.3 meters (Phillips 2005), shoreline erosion volumes were calculated for the bay cells and channels adjacent to a shoreline for their inclusion into the sediment budget. Shoreline lengths were calculated from a polyline shapefile generated by the Texas General Land Office (TGLO), which represents waters under tidal influence. Sediment yields from shoreline erosion are shown in Table 3-2.

At this stage of the sediment budget analysis, the specific erosion rates and relief levels for various sections of the bay shoreline are not well documented and future refinement of the preliminary sediment budget should address this data gap.

Table 3-2: Calculated Shoreline Erosion Volumes within Galveston Bay

Cell Name	Length of Cell Shoreline (m)	Yield (tonnes/yr)
Trinity Bay and East Bay	173,000	38,000
Galveston Bay – LaPorte	7,000	2,000
Galveston Bay – Texas City to Bayport	38,000	8,000
Galveston Bay – West Bay (Causeway)	13,000	3,000
West Bay	154,000	34,000
GIWW – West Reach	43,000	9,000
GIWW – East Reach	94,000	21,000
Galveston Bay – West Bay (Pelican Island)	13,000	3,000
Houston Ship Channel – Bayou Reach	97,000	21,000
Chocolate Bayou	62,000	14,000
Total	**694,000**	**152,000**

3.1.4 Fluvial Sources

Fluvial sediment sources to Galveston Bay include local runoff around the bay margins from small watersheds discharging to the bay and larger tributaries, such as the Trinity and San Jacinto Rivers. Watershed areas and yield values (tonnes/acre) were applied from each watershed to obtain total sediment yields (tonnes). Watershed areas were calculated through the use of the U.S. Geological Survey's (USGS's) Elevation Derivatives for National Applications (EDNA) web-based GIS system. Polygon shapefiles were downloaded from the site for each watershed

and areas were calculated. Sediment yield values (tonnes/acre) were applied from five yield-point areas derived from *Erosion and Sedimentation by Water in Texas* (Greiner 1982) for all watersheds discharging to Galveston Bay except the Trinity River. The Trinity River sediment yield was studied more recently by Phillips et al (2007) and the total yield estimated by Phillips has been used. Accumulative sediment yield data, which includes sediment contributed from all upstream areas combined with sediment from the yield-point drainage area, from each of the five yield point sites utilized for fluvial input calculations are shown in Table 3-1 and Figure 3-1.

Table 3-3: Sediment Yield Point Values

Yield Point No.	Name	Accumulative Sediment Yield (tonnes/ac)
129	Buffalo Bayou – San Jacinto River	0.59
131	Galveston Bay	0.13
132	Cedar Bayou	0.54
133	Mustang Bayou (Chocolate Bayou)	0.39
134	Austin Bayou	0.10

Source: Erosion and Sedimentation by Water in Texas (Greiner 1982)

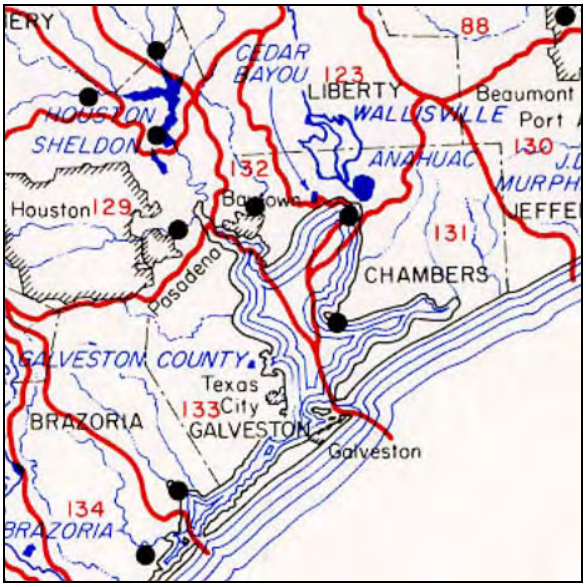


Figure 3-1: Sediment Yield Point Area
Source: Erosion and Sedimentation by Water in Texas (Greiner 1982)

The sediment yield from the Trinity River was derived from *A Sediment Budget for Galveston Bay* (Phillips 2005), which estimated the river to yield approximately 70,000 tonnes/yr to Trinity Bay. The study based this estimate from the measured mean annual load at the Liberty station, which is located approximately 30 miles upstream of the Trinity Bay. It is noted that using the

Greiner (1982) sediment yields for the Trinity River would produce approximately 3.4 million tonnes/yr; however, at this time it has been assumed that the Phillips (2005) data is more accurate based on the extensive studies associated with that estimate.

As discussed above, fluvial sediment sources to Galveston Bay were divided into two categories: Major Fluvial Sources and Other Watersheds. The total yield and acreage of the major fluvial sources are shown in Table 3-4.

Table 3-4: Major Fluvial Yields to Galveston Bay

Name	Yield (tonnes/acre)	Area (acres)	Yield (tonnes/yr)	Sink 1	Sink 2
Cedar Bayou[1]	0.54	264,341	144,000	Trinity Bay and East Bay (100%)	NA
Chocolate Bayou[1]	0.39	95,193	37,000	GIWW - West Reach (100%)	NA
Clear Creek[1]	0.39	163,341	64,000	Galveston Bay - Bayport to Texas City (100%)	NA
Dickinson Bayou[1]	0.39	63,577	25,000	Galveston Bay - Bayport to Texas City (100%)	NA
Double Bayou[1]	0.13	44,454	6,000	Trinity Bay and East Bay (100%)	NA
Oyster Bayou[1]	0.13	197,393	25,000	Trinity Bay and East Bay (50%)	GIWW - East Reach (50%)
San Jacinto River[1]	0.59	1,723,550	1,016,000	HSC - Bayou (100%)	NA
Lower San Jacinto[1]	0.59	54,119	32,000	HSC - Bayou (100%)	NA
Buffalo Bayou East[1]	0.59	19,156	11,000	HSC - Bayou (100%)	NA
Greens Bayou[1]	0.59	134,159	79,000	Greens Bayou (100%)	NA
Buffalo Bayou[1]	0.59	491,196	290,000	HSC - Bayou (100%)	NA
Trinity Bay[2]	0.006	11,391,558	63,000	Trinity Bay and East Bay (100%)	NA
Total		**14,642,037**	**1,800,000**		

[1] Source: Erosion and Sedimentation by Water in Texas (Greiner 1982)
[2] Source: A Sediment Budget for Galveston Bay (Phillips 2005)

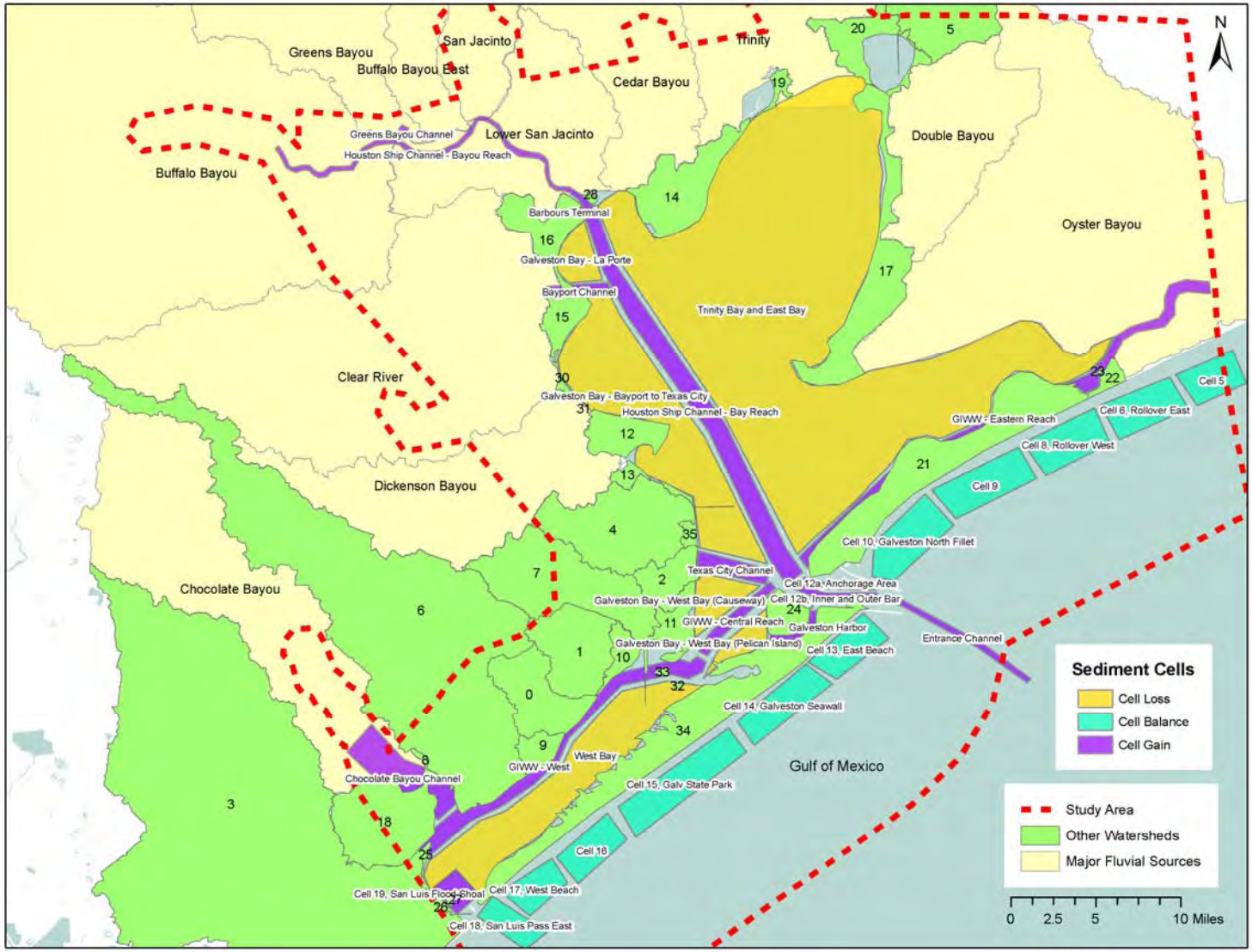


Figure 3-2: Sediment Budget Cells

The sinks associated with the major fluvial yields are listed in the above table and the percentage distributions to adjacent cells shown are the portion of the total watershed yield that was distributed to that cell for the purposes of the sediment budget. Fluvial sources were considered inputs to all adjacent navigation channels or bay cells. In the situation where multiple navigational channels or bay cells were adjacent to a watershed, the watershed yield was divided proportionally among the cells.

It should be noted that the Trinity River's sediment yield was also calculated using the same methodology as the other major fluvial inputs for this sediment budget. This resulted in a yield of 3.4 million tonnes/year, which is approximately 2.7 million tonnes/yr larger than Phillip's value.

Other watersheds includes other significant watersheds to the bay that were not incorporated in the above list and a number of land areas not included in the EDNA system, as shown in Figure 3-2. These areas generally include small areas adjacent to the bay but also include larger areas such as Galveston Island and Bolivar Peninsula. A new shapefile was generated to characterize these areas. The total yield and acreage of the Other Watershed areas are shown in Table 3-5. The other watershed areas within Table 3-5 were given arbitrary number identifications (IDs).

Table 3-5: Other Watershed Yields to Galveston Bay

ID	Yield (T/acre[1])	Area (acres)	Yield (tonnes/yr[2])	Sink 1	Sink 2	Sink 3	Sink 4
0	0.39	11,277	4,400	GIWW - West (100%)	NA	NA	NA
1	0.39	12,773	5,000	GIWW - West (100%)	NA	NA	NA
2	0.39	5,282	2,100	Texas City Channel (100%)	NA	NA	NA
3	0.10	187,713	18,700	GIWW - West (50%)	West Bay (50%)	NA	NA
4	0.39	21,753	8,500	Bayport to Texas City (100%)	NA	NA	NA
5	0.27	90,738	24,700	Upper Galveston and East Bay (100%)	NA	NA	NA
6	0.39	109,954	42,900	GIWW - West (50%)	Chocolate Bayou (50%)	NA	NA
7	0.39	23,040	9,000	GIWW - West (100%)	NA	NA	NA
8	0.39	517	200	Chocolate Bayou (100%)	NA	NA	NA
9	0.39	2,772	1,100	GIWW - West Channel (100%)	NA	NA	NA
10	0.39	2,642	1,000	GIWW - West Channel (100%)	NA	NA	NA
11	0.39	4,195	1,600	GIWW - West Channel (50%)	West Bay Causeway (50%)	NA	NA
12	0.39	5,885	2,300	Bayport to Texas City (100%)	NA	NA	NA
13	0.39	1,183	500	Bayport to Texas City (100%)	NA	NA	NA
14	0.54	12,187	6,600	Upper Galveston and East Bay (100%)	NA	NA	NA
15	0.39	4,018	1,600	Bayport Channel (25%)	Bayport to Texas City (75%)	NA	NA
16	0.39	7,236	2,800	HSC - Bay (50%)	La Porte (50%)	NA	NA
17	0.13	17,645	2,200	Upper Galveston and East Bay (100%)	NA	NA	NA
18	0.39	16,024	6,300	Chocolate Bayou (50%)	GIWW - West (50%)	NA	NA
19	0.27	1,132	300	Upper Galveston and East Bay (100%)	NA	NA	NA
20	0.27	7,311	2,000	Upper Galveston and East Bay (100%)	NA	NA	NA

ID	Yield (T/acre[1])	Area (acres)	Yield (tonnes/yr[2])	Sink 1	Sink 2	Sink 3	Sink 4
21	0.13	25,317	3,200	GIWW-East (90%)	Upper Galveston and East Bay (10%)	NA	NA
22	0.13	1,264	200	GIWW-East (100%)	NA	NA	NA
23	0.13	73	0	GIWW-East (100%)	NA	NA	NA
24	0.39	3,323	1,300	West Bay - Pelican (25%)	GIWW - Central (25%)	Galveston Channel (25%)	Cell 12b(25%)
25	0.39	395	200	GIWW- West (50%)	West Bay (50%)	NA	NA
26	0.39	346	100	San Luis Flood Shoal (100%)	NA	NA	NA
27	0.39	124	0	San Luis Flood Shoal (100%)	NA	NA	NA
28	0.54	205	100	HSC - Bayou (50%)	Upper Galveston and East Bay (50%)	NA	NA
29	0.54	57	0	HSC - Bay Reach (50%)	Upper Galveston and East Bay (50%)	NA	NA
30	0.39	557	200	Bayport to Texas City (100%)	NA	NA	NA
31	0.39	12	0	Bayport to Texas City (100%)	NA	NA	NA
32	0.39	112	0	West Bay (100%)	NA	NA	NA
33	0.39	182	100	GIWW - West (100%)	NA	NA	NA
34	0.39	27,982	10,900	West Bay (25%)	Galveston Harbor Channel (25%)	West Bay - Pelican Island (25%)	Cell 12b (25%)
35	0.39	1,175	500	Bayport to Texas City (100%)	NA	NA	NA
	Total	606,404	160,600				

[1] Source: Erosion and Sedimentation by Water in Texas (Greiner 1982)
[2] Yield values were rounded to the nearest hundredth.

Total fluvial inputs into Galveston Bay for the purposes of this sediment budget were estimated to be approximately two million tonnes per year. This is reasonably close to Phillips "best professional judgment" estimate of approximately 2.4 million tonnes per year or roughly 60 tonnes/km^2/yr. Similar to the shoreline erosion rates, future refinement of the sediment yields from all watersheds is needed to improve the sediment budget.

3.1.5 Deficit Discussion

The collective volumes of all sediment inputs to the bay was found to fall substantially short of the total volume of sinks (i.e. navigation channel dredging). The total mass of sediment sources to the bay consisted of approximately two million tonnes/yr from fluvial sources and 0.2 million tonnes/yr from shoreline erosion. The calculated total sink volume from channel dredging was 11 million tonnes/yr resulting in a total source deficit volume of approximately 8.8 million tonnes/yr.

The source of this large volume of sediment is not known; however it could be attributed to a combination of the following:

- Underestimation of fluvial inputs (including the Trinity River)
- Aeolian input
- Coastal and marine sources derived from barrier island overwash
- Fine-grain suspended sediment transported into Galveston Bay from the Gulf of Mexico through Bolivar Roads.
- Dredged material from navigation channels may have a significantly lower density than the assumed 1 tonne/m^3. This would lead to an overestimate of the actual mass of solids being removed.
- Shoreline erosion may be under-estimated based on a greater active profile height
- Channel wall and shoulder erosion due to ship and storm induced wave action
- Bed load transport particularly from the San Jacinto River
- Dredged material may be escaping from some beneficial use sites and be transported back into navigation channels.
- Navigation channels may be undergoing side-slope adjustment (localized transport) contributing to higher sedimentation rates.
- Sediment being resuspended by waves and currents within the Bay system and transported into navigation channels.

In order to account for this difference in volume (or deficit volume) for the purposes of the sediment budget, it was assumed that it is accounted for solely by resuspension of sediments within Galveston Bay by waves and currents. It was assumed that this resuspension occurs uniformly throughout the Bay and the deficit volume was redistributed to the bay cells based on a weighted average derived from the area of the cell. The distribution of this deficit volume to the bay cells is shown in Table 3-6.

Table 3-6: Assumed Resuspended Sediments for Bay Cells

Cell Name	Area (acres)	Percent of Total (%)	Cell Resuspension (tonnes/yr)
Trinity Bay and East Bay	190,913	71.0	6,314,000
Galveston Bay – La Porte	4,005	1.5	132,000
Galveston Bay – Bayport to Texas City	37,344	13.9	1,235,000
Galveston Bay – West Bay (Causeway)	4,700	1.7	156,000
Galveston Bay – West Bay (Pelican Island)	3,045	1.1	100,000
West Bay	28,779	10.7	952,000
Total	**268,786**	**100.0**	**8,890,000**

The redistribution of the deficit volume is equivalent to an assumption that sediment is being resuspended from the bay bottom (by currents, wind waves, etc.) equally throughout all areas of Galveston Bay. This would correspond to a net vertical erosion rate throughout the Bay of approximately 5 mm/yr, which contradicts findings of Phillips (2005), which estimate a net accumulation of 3.5 to 3.8 mm/yr. (Note, these erosion and accumulation rates are net rates over time. A large portion of the resuspended sediment will flocculate and settle back within the Bay cells, thus the gross erosion rate is likely much larger.)

Some of the deficit may be a transient effect of increased sedimentation after the recent widening and deepening of the Houston-Galveston Navigation Channels (HGNC), which increased total sedimentation rates for these channels from approximately 5 million m^3/yr (7 million CY/yr) to 9 million m^3/yr (12 million CY/yr) (URS and M&N 2009); however, even this increase in channel sedimentation does not account for the near 9 million m^3/yr deficit. The role of sediment influx from the Gulf may be significant and decrease the resuspension rate within Galveston Bay cells needed to balance the sediment budget, but there is not sufficient data to quantify this sediment influx. Likewise, accounting for the potentially lower density of maintenance dredged material may account for a large portion of the deficit. Lastly, the sediment yields from major fluvial sources, particularly the Trinity River, San Jacinto River, and Buffalo Bayou, may be underestimated.

3.1.6 Gulf Shoreline

A sediment budget was developed along the Gulf shoreline by the USACE/ERDC for an area in a study titled *North Texas Sediment Budget* (Morang 2006). Morang's sediment budget was utilized to develop the Gulf shoreline portion of this preliminary sediment budget.

It was necessary to modify the Gulf's sediment budget in confluence areas with Galveston Bay's sediment budget. Cells that required modification included:

- Cell 7, Rollover Pass
- Cell 11, Entrance Channel
- Cell 12a, Anchorage Area
- Cell 12b, Inner and Outer Bar

Gulf shoreline cells are shown in Figure 3-3 through Figure 3-5.

3.1.7 Sediment Budget Analysis Results

The sediment budget prepared for this PSM Plan is preliminary in nature and needs further refinement. As such it should be viewed as a primarily qualitative assessment of sediment pathways. However, this preliminary sediment budget is useful in understanding the sediment management needs, opportunities, and regional context. The preliminary sediment budget also highlights the need for additional scientific work to develop a reliable quantitative sediment budget.

There are several initiatives beginning or underway which may yield useful information for refinement of the sediment budget. The first of these is additional field data collection in Galveston Bay by ERDC with a focus on sedimentation in the HSC. The second effort is by Texas A&M University at Corpus Christi's Harte Research Institute for Gulf of Mexico Studies, led by researcher Jim Gibeaut, which will use satellite remote sensing data in an attempt to quantify the suspended sediment climate within the Bay. Additional refinement of sediment yields from the major watersheds, particularly the Trinity and San Jacinto Rivers and Buffalo Bayou, is needed. Lastly, estimates of erosion and/or accumulation rates within various parts of Galveston Bay are also needed to better understand the sediment fluxes in the region.

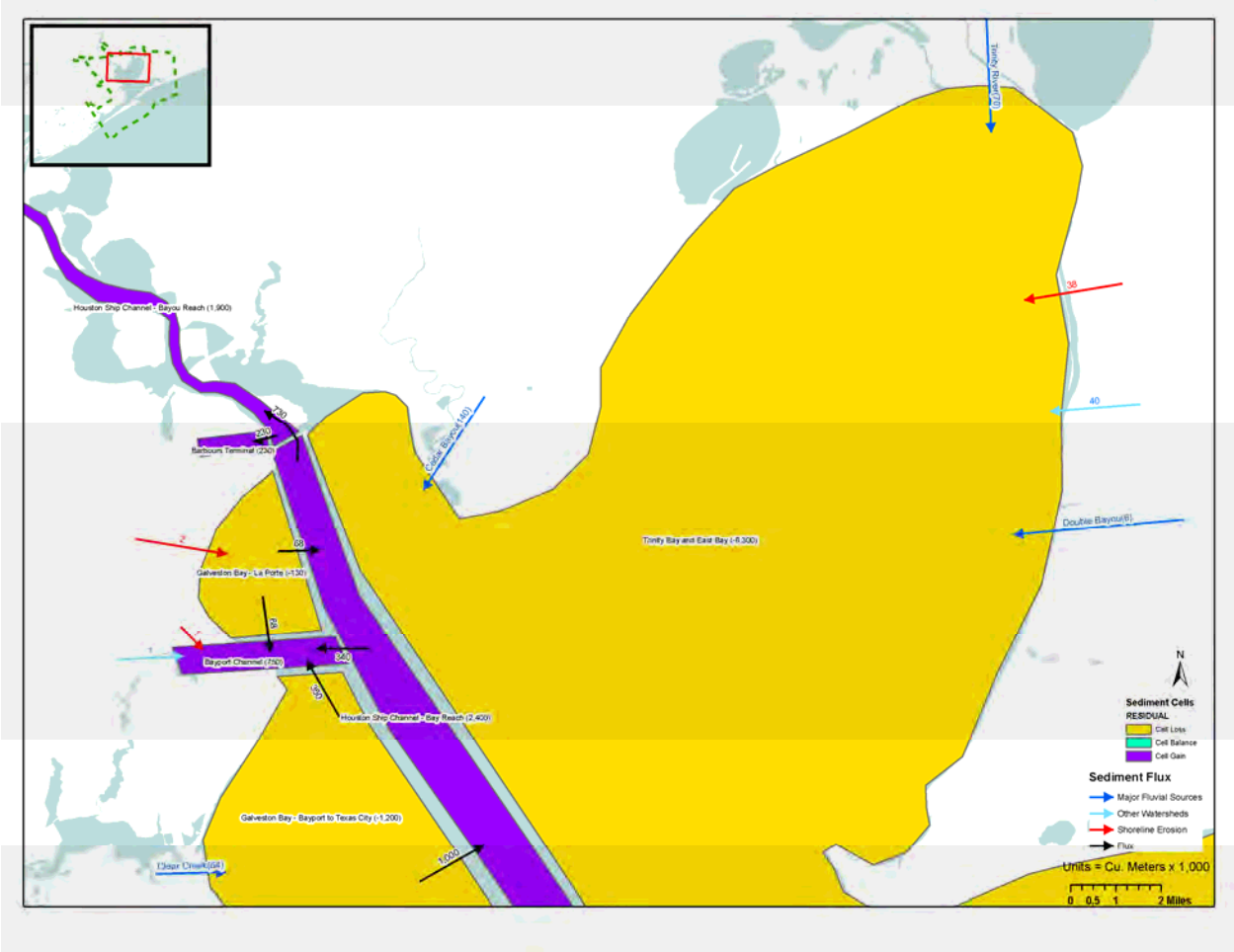


Figure 3-3: Galveston Bay Sediment Budget (Trinity and East Bay)

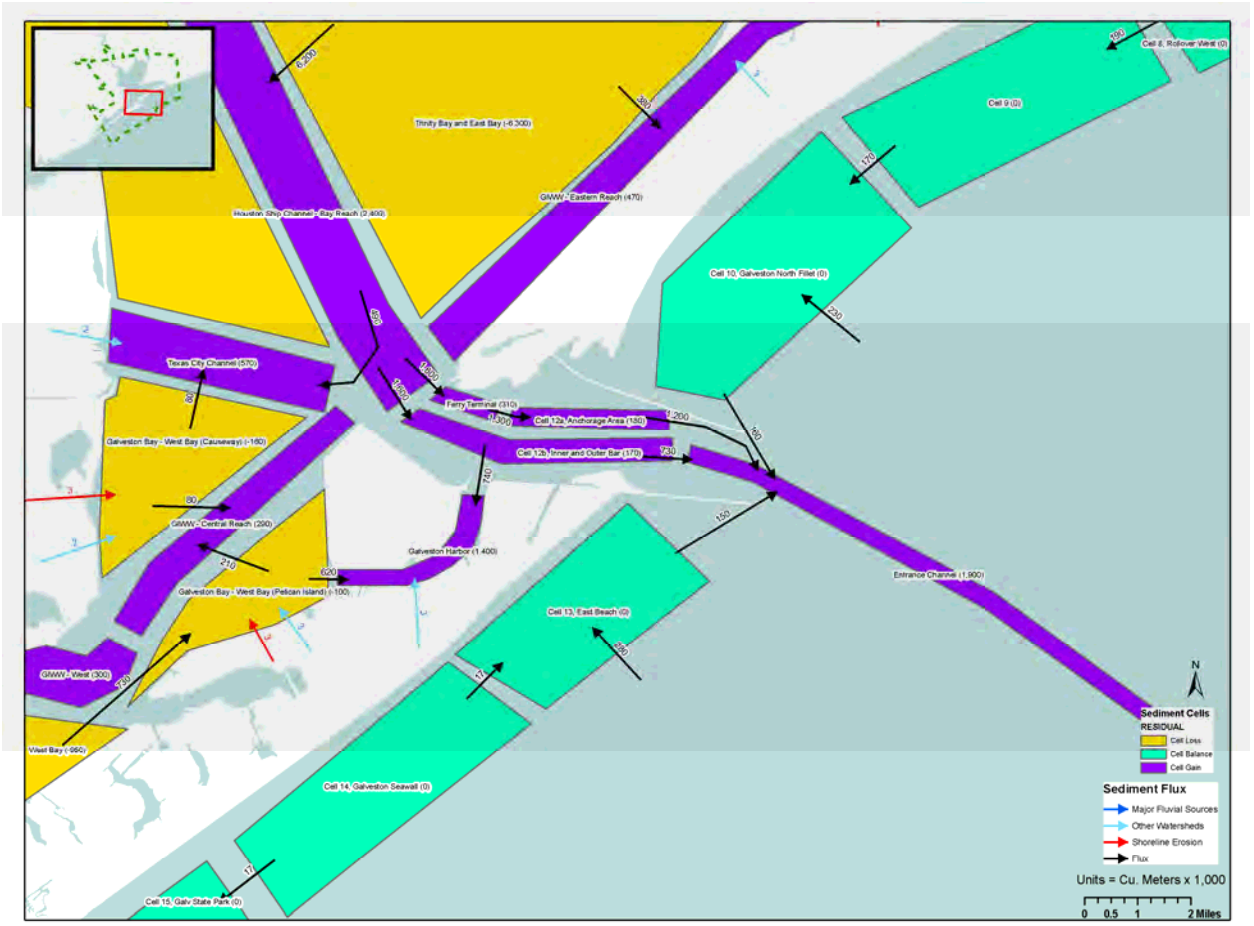


Figure 3-4: Galveston Bay Sediment Budget (Entrance Channel)

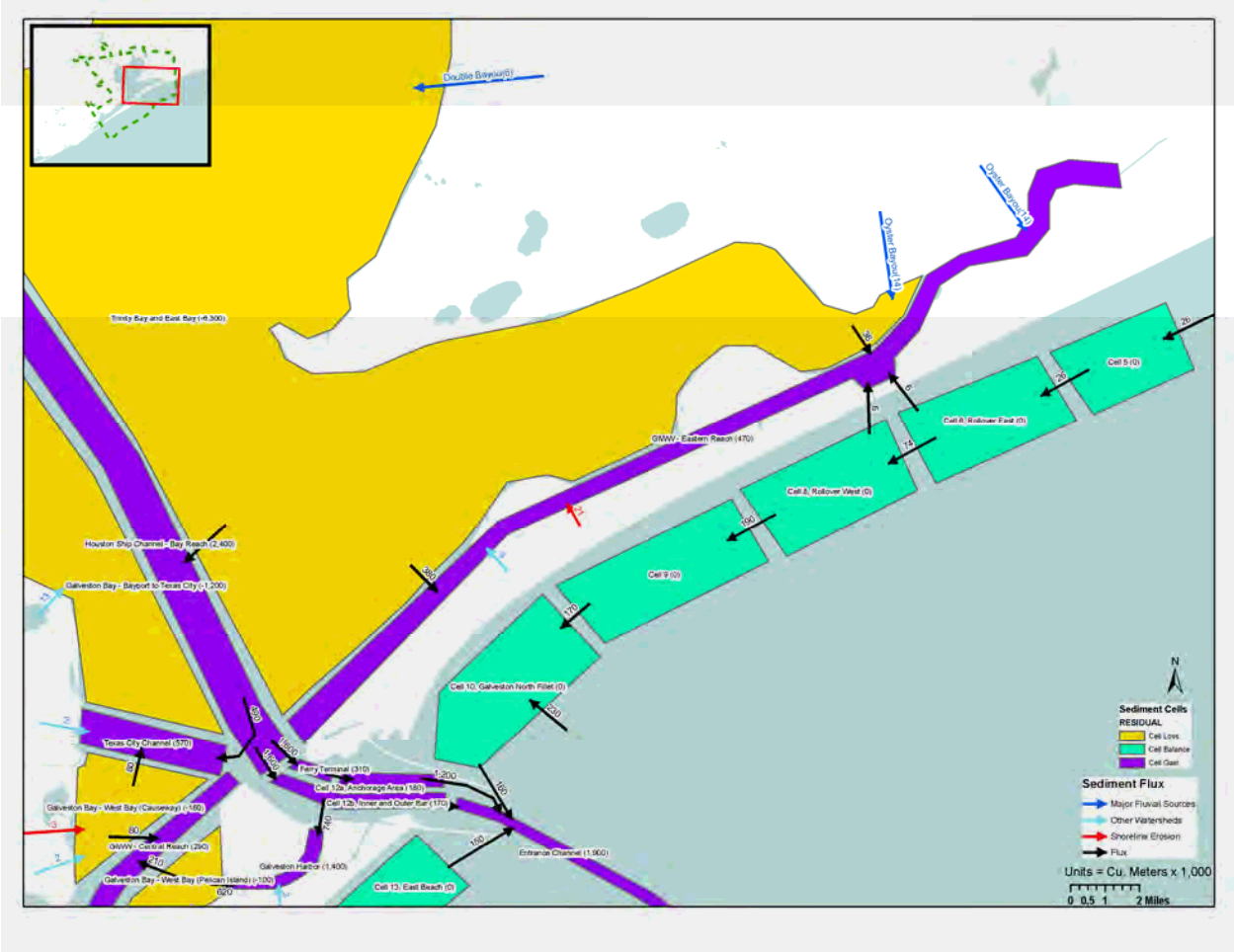


Figure 3-5: Galveston Bay Sediment Budget (Lower East Bay)

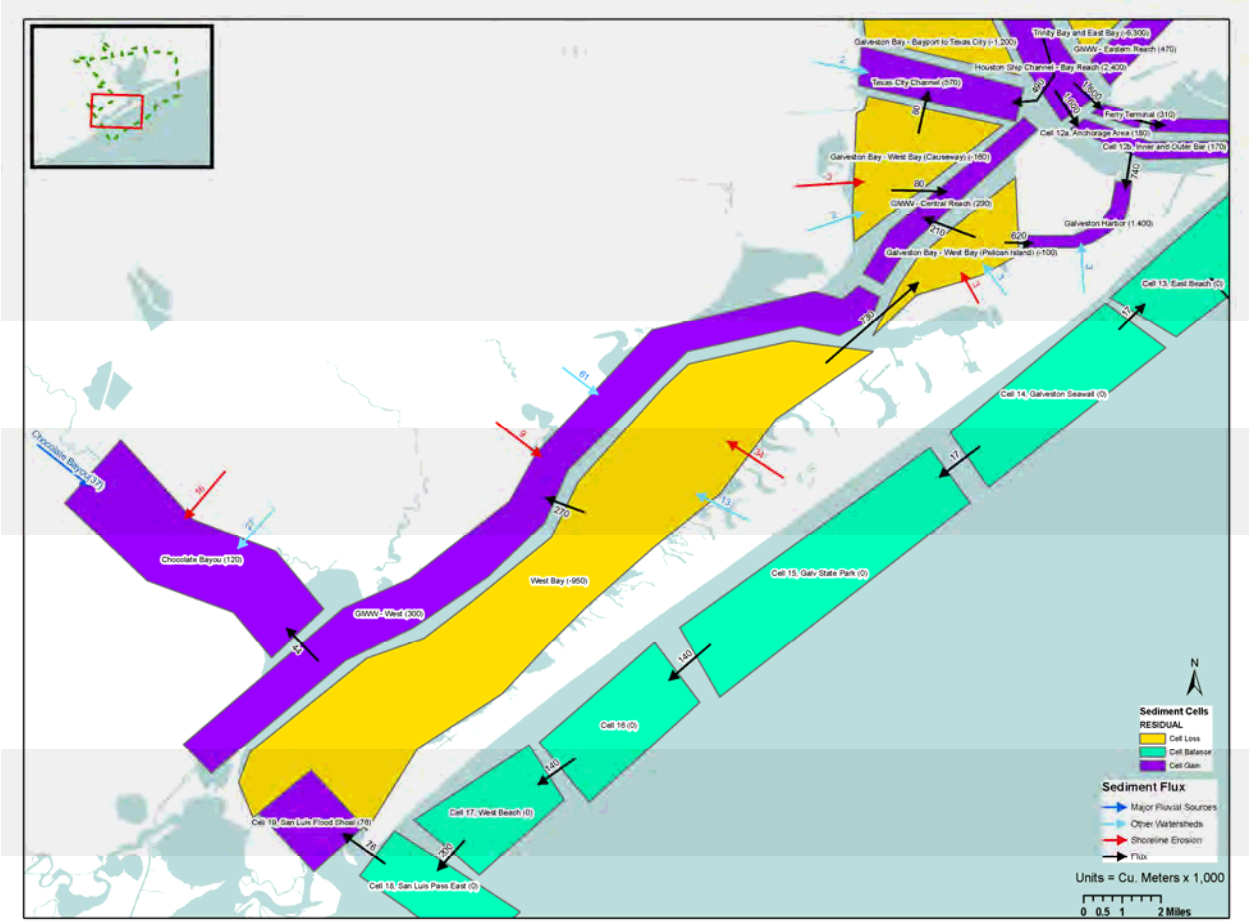


Figure 3-6: Galveston Bay Sediment Budget (West Bay)

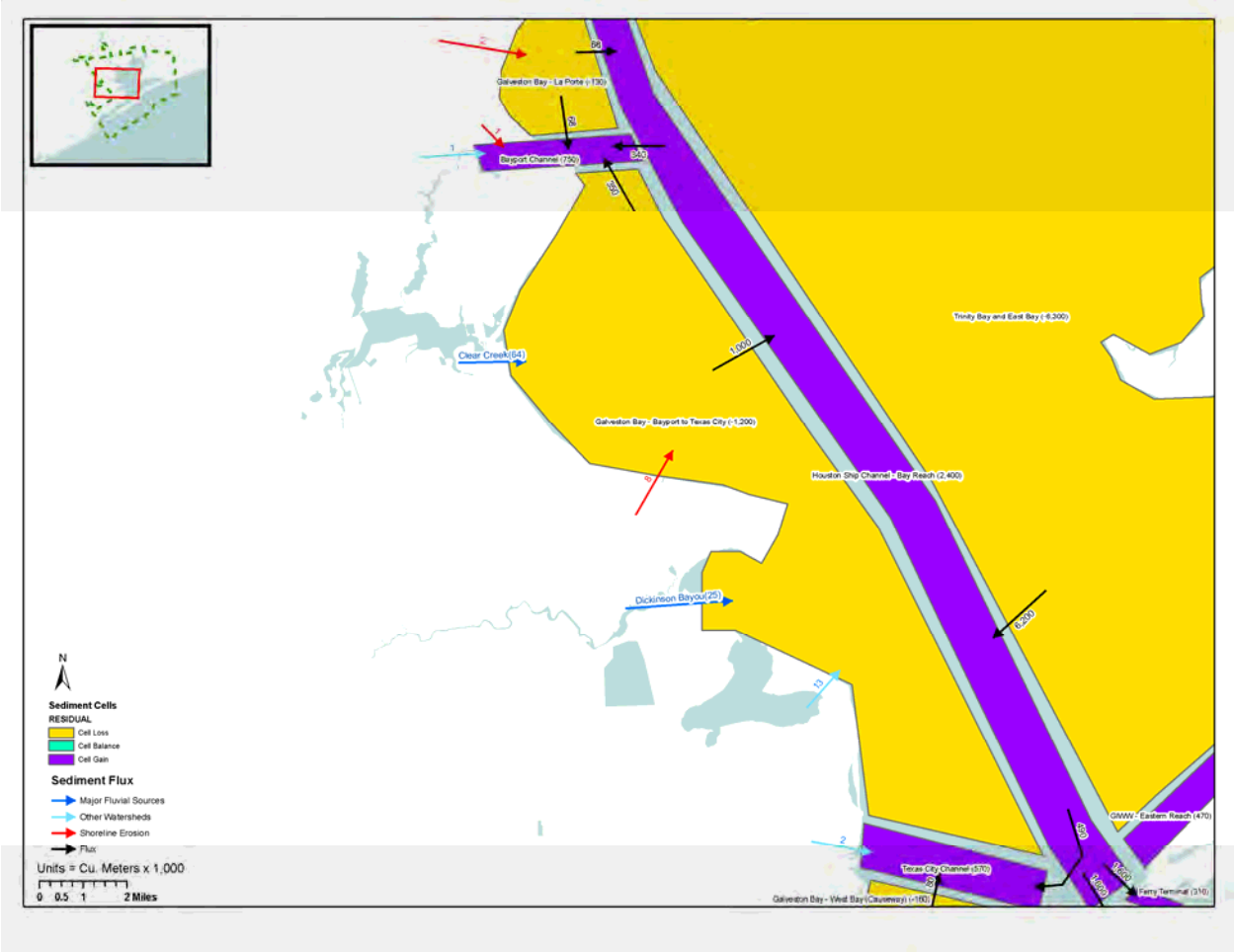


Figure 3-7: Galveston Bay Sediment Budget (Upper Galveston Bay – West)

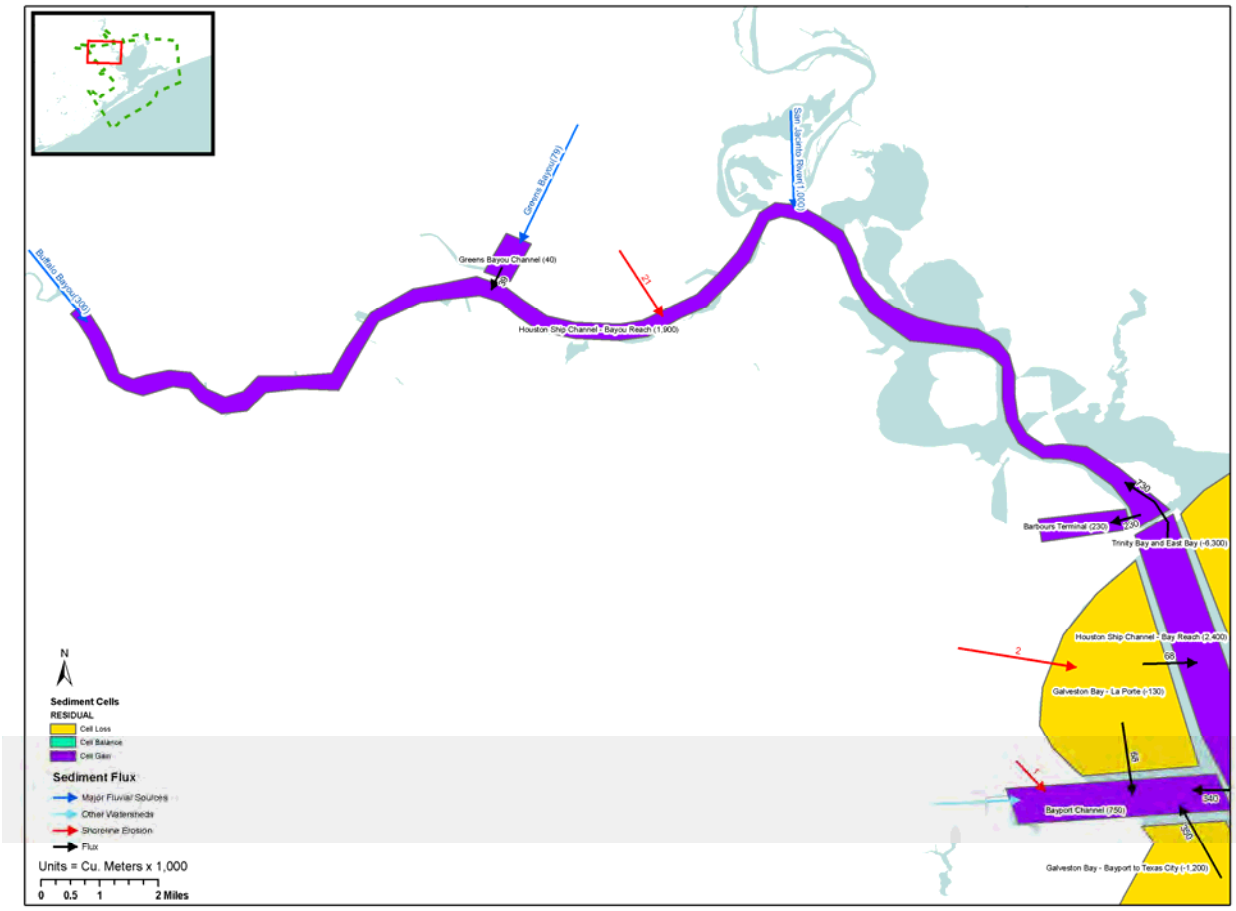


Figure 3-8: Galveston Bay Sediment Budget (Houston Ship Channel)

3.2 Sediment Dependencies

Sediment quality and quantity is fundamental in sustaining the natural ecosystems of Galveston Bay as well as in commerce and supporting and protecting manmade infrastructure.

3.2.1 Navigation

Galveston Bay is a naturally shallow embayment with an average water depth of 6 feet and a maximum non-dredged depth of approximately 10 feet (GBEP 2002). Sediments enter the bay from a number of sources including the San Jacinto River, the Trinity River, nearby bayous, and local and metropolitan runoff maintaining this depth. Since the mid-1800's dredging activities have been conducted to provide deep water access to the many water dependent commercial facilities located throughout the study area. Today large vessels require that these deeper man-made navigation channels, which include the Galveston Channel, HSC, Bayport Channel, and Barbours Cut Channel among others, to undergo regular maintenance dredging due to ongoing sedimentation. Many of these channels also support a large and growing recreational navigation need.

3.2.2 Habitats

The habitats and living resources of the study area are in close proximity to that of important state and national industrial, commercial, and recreational resources. The study area's sensitive natural resources are a critical factor when developing a RSM approach for the area as these resources may constrain sediment volume, in-water work scheduling, and/or the frequency of sediment management activities. For example, environmental windows are often enforced on projects involving in-water work to avoid working in aquatic habitats when populations of threatened or endangered species are present.

The following sections describe some of the key environmental habitats along the Gulf shoreline and in Galveston Bay.

3.2.2.1 Gulf Shoreline Habitats

Beaches in the study area are present on both the seaward side of Galveston Island and Bolivar Peninsula and within Galveston Bay. They provide a transitional zone from terrestrial to open water habitats and support a number of important habitat related functions.

Kemp's Ridley Sea Turtle
Source: http://galveston.ssp.nmfs.gov/seaturtles/

Barrier Islands within the study area include Galveston and Follett's Islands and both have shorelines facing the Gulf of Mexico as does the Bolivar Peninsula. These Gulf shoreline habitats start

at the beach and move landward to include dunes, marshes, grassland and wetlands, all of which are dependent on sediment sources.

Outer Gulf beaches are dynamic and their physical appearance changes continuously. Little plant life can live in this region compared to bay beaches or other marine habitats further landward (e.g. dunes and marshes). However, clams, worms, snails, and other specialized species do utilize sandy beaches for habitat. Shorebirds often feed off the fish and invertebrates found in the surfzone and a number of threatened or endangered sea turtles (e.g. Green, Loggerhead, and Kemp's Ridleys turtles) forage and nest along Gulf beaches including those of Galveston Island and the Bolivar Peninsula (Allen 2009). The number of endangered Kemp's Ridley turtle nests identified on beaches within the study area in spring/early summer each year has been increasing.

3.2.2.2 Bay Habitats

The study area is located within the Gulf Coast Prairies and Marshes ecoregion (EPA 2007). The U.S. Environmental Protection Agency (EPA) has identified the bay as "an estuary of national significance" and has rated it "fair" by the EPA's National Coastal Assessment (NCA) due to its poor water and sediment quality (EPA 2007).

Galveston Bay is a relatively shallow estuary. Major natural habitats within the bay include:

- submerged aquatic vegetation (sea grasses)
- reefs (oysters)
- barrier islands and sand bars
- lagoon and shallow open water
- shellfish growing areas
- salt and brackish marsh
- freshwater marsh (non-tidal)
- riparian/riverine (tidal and floodplain)
- beach and dune (vegetated)
- sand and mud/salt flats

The loss of these habitats has been substantial over the past few decades. Of particular importance are wetlands and marshes, seagrass beds, and oyster reefs as they provide important habitat for a number of species in the study area. These particular habitats are described in more detail below.

Wetlands

It has been suggested that up to approximately 45,000 acres of wetlands, out of upwards of 260,000 acres within the Galveston Bay coastal region have been lost since the 1950's (GBEP 2002). Wetlands provide important ecological and hydrologic functions, providing habitat for many estuarine species, aiding in flood control, and improving water quality. They provide food and shelter resources for the juveniles of many species. They act as buffers protecting the bay

Salt Marsh on Galveston Island
Source: M&N 2009

from excessive nutrient loading during flooding and provide filtering functions for urban water runoff. Wetland vegetation is also resilient and provides erosion control along shorelines.

The types of wetlands in Galveston Bay include salt marshes, brackish marshes, intermediate and freshwater marshes, and swamps (GBEP 2002). Salt marshes have decreased by 21% since the 1950s. (White et al. 1993).

Urban development was identified as the main cause of wetland loss by USFWS (White et al. 1993; Dahl 2000; etc.). Other causes of wetland loss in Galveston Bay include subsidence, sea level rise, and an increase in agriculture, urban, industrial, and transportation uses (White et al. 1993). Dredge and fill activities have also been identified as a cause of wetland loss in the Bay (GBEP 2002).

Seagrasses

Seagrasses provide important food and shelter habitat for many important aquatic species, including finfish, shellfish, and waterfowl. Seagrass beds have decreased from approximately 2,500 acres in the 1950's to 700 acres in 1987 (a 70% loss). They were historically found throughout the study area and are now more commonly found in and around Christmas Bay (H. Young, personal communication, 2009). Reasons for the loss of seagrass beds could include subsidence, effects from hurricanes, and human activities including development, water runoff, and dredging activities, among others (GBEP 2002). The Seagrass Conservation Plan (Pulich and Calnan 1999) outlines management and restoration approaches to reverse the loss of this habitat in Galveston Bay.

Oyster Reefs

Oyster reef habitats in Galveston Bay support Galveston Bay's shellfish industry, provide one of the only types of hard-bottom habitat in the study area (important benthos habitat for a number of aquatic organisms), and can also reduce sediment erosion by stabilizing sediments (Roberts et al 1999). Oyster populations can filter phytoplankton, pollutants, nutrients (such as nitrogen), and suspended sediment (GBEP 2002 and USACE 2002), thereby having the potential for positive impacts on water quality (Verwey 1952; Haven and Morales-Alamo 1971; Dame 2000).

Oyster Reef Restoration Project in Galveston Bay
Source: GBF, http://galvbaydata.org/

One significant reason for oyster reef loss in Galveston Bay is from the historical removal of shell to support construction and the chemical industry (GBEP 2002). Development, urban runoff, dredging, boating, and pollution can also impact oyster bed populations.

Wildlife

Wildlife within Galveston Bay includes species of finfish, shellfish, birds, mammals, reptiles, amphibians, and invertebrates. The Bay also hosts a number of species that have been listed as endangered or threatened under the Endangered Species Act (federal) and the TPWD (state). The endangered Piping Plover winters in Galveston Bay as does the endangered Attwater's Prairie Chicken, Reddish-Egret, White-Faced Ibis, Swallow-Tailed Kite, and Wood Stork (EPA 2009a). Threatened and endangered turtles have also been known to enter Galveston Bay as they travel along the Gulf coast.

3.2.3 Coastal Resiliency

Traditional management of coastal hazards has incorporated the method of attempting to prevent natural disasters. Galveston, Texas is often used as an example. In 1900 it was destroyed by a hurricane and in response the city constructed an expensive 17-foot high sea wall.

Coastal resiliency is a relatively new way to manage coastal hazards. Resiliency was first used in relation with ecosystems (Holling 1973) and more recently applied to coastal systems (Heinz and Ceres 2009, Collini 2008) as coastal vulnerabilities are increasing (e.g. more people move to live along coastlines, natural buffers are lost to increased development and erosion, and storm severity has increased). Coastal resiliency refers to the capacity for coastal systems to recover from the impacts of coastal storms, erosion, climate change, and sea level rise while still retaining their basic functions and structures.

Galveston Bay facing beach showing damage from Hurricane Ike
Source: M&N 2009

Sediments are an important component of coastal resiliency both in terms of erosion caused by the interruption of their natural movements and in utilizing sediments which have accumulated in unwanted areas, such as navigation channels, in the best ways possible. Using dredged material in the study area to restore wetlands could increase coastal resiliency. Wetlands provide an estimated $23.2 billion each year of storm surge and flood protection along the nation's coastlines (Costanza et al 2008). This could also be said for other beneficial use opportunities, such as beach nourishment.

Gulf facing beach on Galveston Island
Source: Galveston State Park website;
http://www.galvestonislandstatepark.org/nature/habitat.html

Widely accepted methods to measure resiliency are still not yet readily available (Collini 2008), however following Hurricane Ike in 2008, more research is being conducted within the study area in an effort to promote long-term, cost effective solutions to coastal management:

- The Heinz Center, Ceres, and other collaborators developed *Resilient Coasts: A Blueprint for Action* in 2009. The report was completed to provide direction for communities and governments to use to increase the resiliency of their coasts.

- The National Oceanic and Atmospheric Administration's (NOAA's) Coastal Services Center (CSC) has developed a website that provides coastal data, tools, and information needed to better manage coastal systems.

- The Texas A&M University (TAMU) is conducting a study (2007 through 2009) at Galveston with the Houston Advanced Research Center (HARC) to develop "Community Resilience Indicators" to enhance coastal community resilience along the Gulf Coast. The intention is to define implementation strategies that will include a collaboratively-developed plan with the CSC that address their available resources.

- The Gulf of Mexico Alliance (GOMA) is incorporating new resilience tools (e.g. indicators or indexes) that can be used by local communities to identify and better manage coastal hazards. Dr. John B. Anderson of Rice University is involved with "Sustainable Galveston," a group within the Department of Earth Sciences and the School of Architecture, which has collaborated in exploring more long-term (50- to 100-year projections) sustainable approaches to coastal development on Galveston Island. The research work is supported in part by the Shell Center for Sustainability. One long term solution being considered is to focus development and tourism to the east part of the island (J. Anderson, personal communication, 2009; refer to Outreach Call Notes in Appendix A).

3.3 Relative Sea Level Rise

The potential continuation of subsidence, and the continuation and potential acceleration of sea level rise, could contribute to the loss of coastal resources both in both Galveston Bay and along the Gulf of Mexico shoreline within the study area. These topics are discussed in this section as they relate to sediment management activities during the Plan's life span.

3.3.1 Eustatic (Global) Sea Level Rise: Historical and Future

Eustatic sea level rise is the change in sea level surface experienced relatively uniformly throughout the oceans (also called global sea level rise). Global sea level rise changes may be due to external factors such as global warming. The eustatic sea level rise plus the local sea level rise (i.e., subsidence, tectonic uplift, smaller scale sea level changes, etc.) gives the total relative sea level rise (RSL) at a particular location.

3.3.1.1 Historical Sea Level Rise

The vast majority of recent assessments of sea level rise are based on the work of the Intergovernmental Panel on Climate Change (IPCC 2007). While some scientists are critical of the conclusions reached by the IPCC, its historical analysis and the use of future scenarios for greenhouse gas emissions and associated climate simulations have been generally accepted.

The most recent assessment report by the IPCC (IPCC 2007, referred to here as the *2007 IPCC Report*) gives the following measured rates for historical sea level rise:

- For the twentieth century: average rate of 1.7±0.5 mm per year (0.56±0.16 ft per century)
- For 1961 to 2003: 1.8±0.5 mm per year (0.59±0.16 ft per century)
- For 1993 to 2003: 3.1±0.7 mm per year (1.00±0.23 ft per century)

These are all global averages. At a given coastal site, the rate of eustatic sea level rise is of less practical importance than the local rate of sea level rise relative to the land. This can be affected by local ocean conditions (e.g., some parts of the ocean may be warming, and therefore exhibiting rising water levels, more rapidly than others). Of more importance in the Galveston region are local land movements – over the twentieth century the land has subsided rapidly in response to groundwater and hydrocarbon extraction. These local effects can be estimated in a number of ways: through long-term tidal measurements, interferometry, Global Positioning Systems (GPS), and large-scale leveling surveys. These local land movements are discussed in the next section, after a discussion of projected global rates.

3.3.1.2 Future Sea Level Rise – IPCC Projections

The 2007 IPCC Report gives a widely quoted projection of 18 cm (0.6 feet) to 59 cm (1.9 feet) for sea level rise in the 21st century. These values represent the difference between the averages from 1980 to 1999 and from 2090 to 2099. The uncertainty derives from two different sources.

1. Different greenhouse gas emission scenarios – future scenarios of world population and economy that predict different levels of greenhouse gas emissions[1]. The *2007 IPCC Report* stresses that no scenario can be considered more likely than others.
2. The second, and larger, uncertainty is associated with limitations to current scientific knowledge. The range of sea level rise projections for a given scenario is based on the range of results from 17 independently developed general circulation models (GCMs).

[1] The IPCC uses six specific scenarios as a basis for model predictions. Three commonly-quoted scenarios are as follows:

A1FI: A future world of very rapid economic growth, with a global population that peaks in the mid-21st century and declines thereafter. The A1FI scenario continues with fossil-intensive technologies and predicts to the most dramatic change in future temperatures and sea levels.

A1B: As A1FI but with a balance between fossil and non-fossil energy sources.

B2: A future world in which there is a rapid change towards a service and information economy, with a global emphasis on economic, social, and environmental sustainability. The global population is similar to that of the A1 families. The B2 scenario predicts the smallest changes in future temperatures and sea levels.

The *2007 IPCC Report* contains a detailed synthesis of the available peer-reviewed science of climate change and sea level modeling. However, it is scientifically conservative. The projections of sea level rise are less tightly bounded than the projections of global temperature, for the following stated reasons:

> "*First, the observational constraint on sea level rise projections is weaker, because records are shorter and subject to more uncertainty. Second, current scientific understanding leaves poorly known uncertainties in the methods used to make projections for land ice*".

Mechanisms that may lead to sea level rise are not included in the IPCC's projections unless there is a broad scientific consensus that they are well and quantitatively understood. The *2007 IPCC Report* is not conservative in the engineering sense, and freely admits that it may underpredict as well as overpredict future sea level rise. In particular, its projections do not include potentially large and nonlinear effects, notably including the potential instability and loss of the Antarctic and Greenland Ice Sheets.

Critics of the IPCC (e.g., Oppenheimer *et al*. 2007) have generally focused on this scientific conservatism: many planners have expressed concerns that the projections are not sufficiently conservative in an engineering sense, and that the upper limits of the IPCC projections do not represent a worst-case scenario. However, the scientific community generally has not attempted further synthesis of the huge range of available models and potential contributions to future sea level rise. Few hard numerical predictions of total sea level rise have been published in the peer-reviewed literature since dissemination of the *2007 IPCC Report*.

3.3.1.3 Semi-Empirical Approach

The models described in the *2007 IPCC Report* underpredict observed sea level rise between 1961 and 2003 (although the match between the models and observations is better for 1993 to 2003). The earlier 2001 IPCC Report (IPCC 2001), generally known as the *Third Assessment Report* or TAR, underpredicted sea-level rise from 1990 to 2006. In an attempt to address these limitations, a semi-empirical approach to predicting sea level rise has been developed (Rahmstorf 2007a). This approach uses existing temperature projections, while using a linear model based on observations from 1880 to 2001 to calculate sea level rise directly from temperature changes. It may capture the effect of mechanisms such as the loss of mass from ice caps, which may already be occurring but which are not yet understood in detail.

The approach is controversial (e.g. Holgate et al. 2007, Schmith et al. 2007, Rahmstorf 2007b), but has been widely quoted and is used in planning literature (e.g., Mote et al. 2008; Cayan et al. 2009). Using the full range of temperature projections from the TAR and incorporating statistical uncertainty in both historical sea level and temperature changes, Rahmstorf increases the estimate of 21st century sea level rise to 50 to 140 cm (1.6 to 4.6 feet) between 1990 and 2100.

3.3.1.4 USACE Policy

The USACE recently released guidance (USACE 2009) stating that the scenarios developed by the National Research Council (NRC 1987) should be used in planning civil works projects potentially affected by sea level rise. Specifically, the following scenarios should be used:

- Current trend in sea level rise, 1.7 mm per year (0.56 feet per century) should be used as the "low sea level rise" scenario;

- Modified NRC Curve I, which assumes 0.5 meters rise between 1986 and 2100 (1.5 feet between 2000 and 2100) should be used as the "medium sea level rise" scenario;

- Modified NRC Curve III, which assumes 1.5 meters rise between 1986 and 2100 (4.8 feet between 2000 and 2100), should be used as the "high sea level rise" scenario.

The NRC curves are not independent projections, in the same way that the IPCC scenarios and the results of the semi-empirical model are projections of sea level rise. Rather, these scenarios are curves used for analysis.

3.3.1.5 Summary of Projections

The chart on the following page summarizes the range of projections developed by the IPCC and Rahmstorf, as well as the NRC curves and a linear continuation of eustatic sea level rise at 1.7 mm per year. With the exception of the NRC curves, the projections have generally not been provided in the form of numerical tables giving the projected sea level rise at intermediate dates: the curves on this chart have been developed by M&N by fitting to published values (tabulated or read from charts). Figure 3-9 shows sea level scenarios specified by the USACE represent the full range of likely values, absent any catastrophic changes (such as dramatic losses to the ice sheets). Unfortunately, there is still little direct evidence to show where in this range reality lies.

3.3.1.6 Regional Variations

The *2007 IPCC Report* expresses regional variations in projected sea level rise through the following figure (Figure 3-10). This figure shows the projected difference between the local sea level rise and the global average by the end of the twenty-first century; red indicates sea level increasing faster than the global average, and blue slower. The projected difference is relatively small (less than 0.05 meters per century) along the Gulf Coast. Therefore, regional variations in sea level rise do not seem to be significant for the Gulf Coast as a whole. Subsidence in the Galveston Bay area is discussed further below.

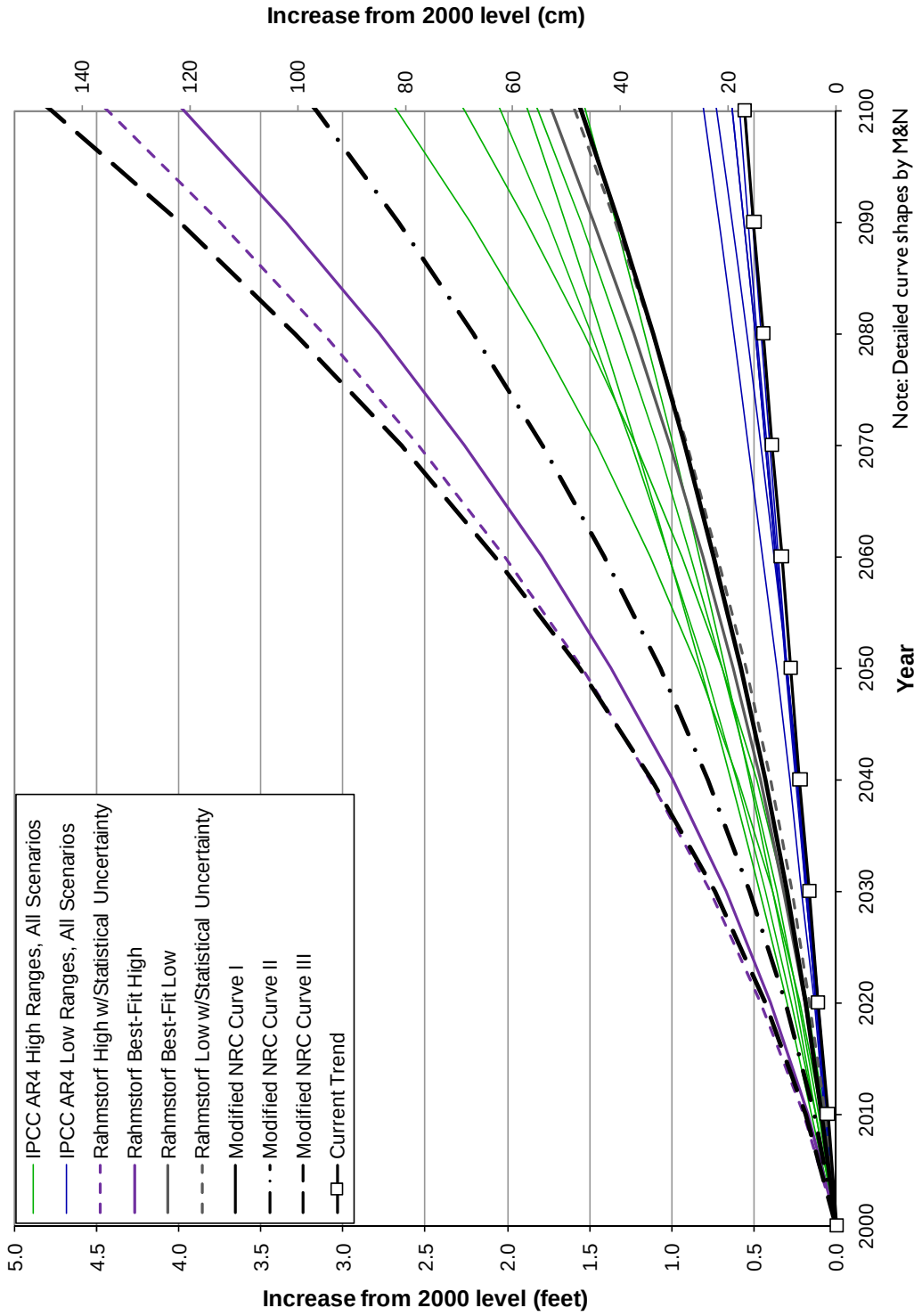


Figure 3-9: Range of Projected Increases in Sea Level: Global Average – Eustatic

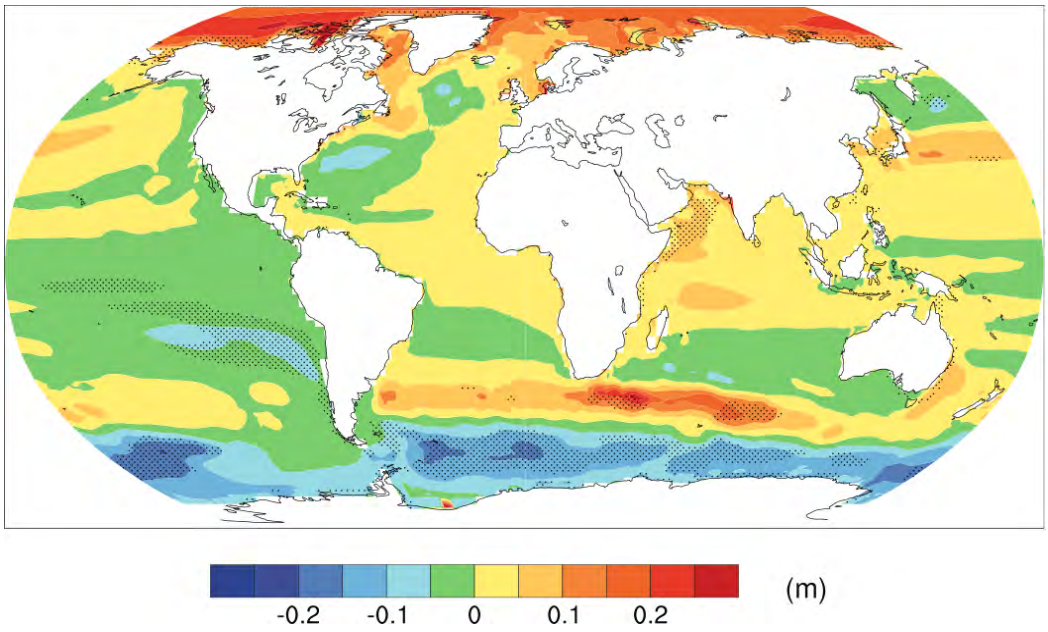


Figure 3-10: Projected Difference between Local and Global Average SLR in 2090

3.3.2 Subsidence and Relative Sea Level Rise

Subsidence is a significant issue in the study area. Subsidence of up to 10 feet has been observed in the Galveston Bay area during the twentieth century, as shown in Figure 3-11 (Harris Galveston Subsidence District 2009a). If this subsidence level were to continue, it would dominate relative sea level rise for many decades.

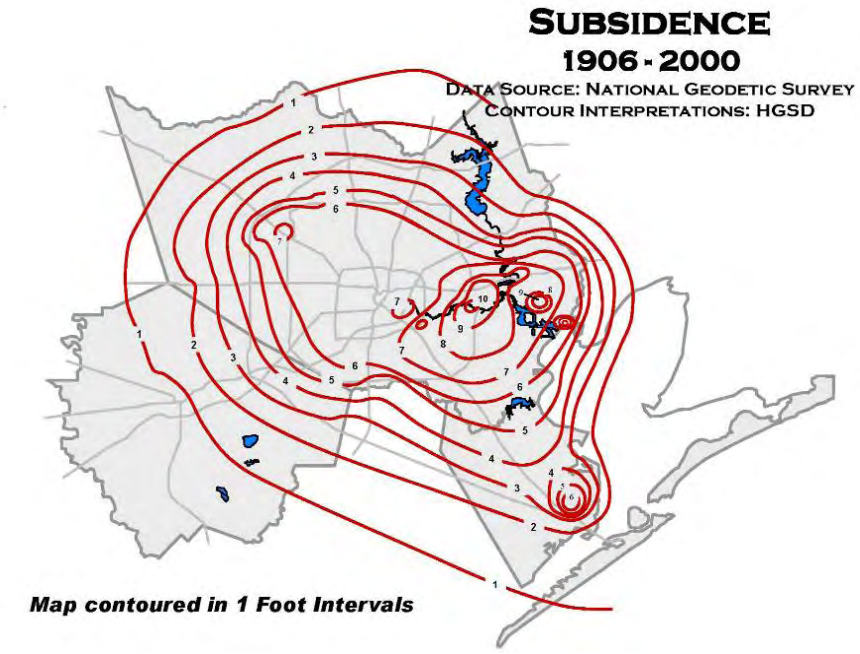


Figure 3-11: Subsidence Contours in the Galveston Area (Source: HGSD)

3.3.2.1 Long-Term Subsidence

Relative sea level rise during the Holocene period (the past 10,000 years) has been investigated through geotechnical investigations of peat and swash-zone deposits dated through radiocarbon and other methods (e.g., Otvos 2004; Milliken et al. 2008). These investigations have been aimed at developing both Gulf-wide sea level curves and analyses of site-to-site variations. They conclude that the rate of relative sea level rise in the region has been of the order 0.4 to 0.6 mm per year (0.13 to 0.20 feet per century) over the past 4,000 years; rates were higher in the early Holocene. The rate of relative sea level rise in the study area appears consistent with that in other, stable areas in the Gulf of Mexico basin (e.g., Florida Keys, Belize, Panama). Similarly, earlier (Pleistocene) rates of sea level rise are consistent across the Texas coast (Paine 1993).

These results suggest that, over the long term (thousands of years), subsidence in the Galveston Bay region has not been significant. Values as low as 0.05 mm per year (less than 0.1 feet per century) have been estimated by the authors quoted above.

3.3.2.2 Twentieth-Century Subsidence

Relative sea level rise in the twentieth century has been measured directly using long-term tide gauges operated by NOAA. The following figures show how the rate of relative sea level rise varies around the Gulf of Mexico, particularly in the upper Gulf area. Five tide gauges with long-term records around the north of the Gulf of Mexico are illustrated in Figure 3-12 Cedar Key, FL, is on a carbonate platform and is believed to be undergoing little subsidence. Four gauges in Texas (including two in the study area) are undergoing varying degrees of subsidence.

Figure 3-12: Tide Gauge Locations

Figure 3-13 shows the monthly mean sea levels, and the best-fit regression line provided by NOAA, for these locations (monthly mean values were obtained online from NOAA 2009; there was apparently a datum change at Freeport in the early 1970s). The additional sea level rise observed at the two study area sites compared to the stable Cedar Key, equivalent to approximately 1.5 feet over the twentieth century, is consistent with the subsidence contour map illustrated above. Subsidence is less at the neighboring locations of Sabine Pass and Freeport. This highlights the fact that subsidence varies both regionally and locally. Assuming that the measurements at Cedar Key accurately represent local sea level rise in the Gulf of Mexico with no subsidence, the subsidence rates at the other gauge locations would be as follows:

- Sabine Pass: 3.86 mm per year (1.27 feet per century);
- Galveston Pier 21: 4.59 mm per year (1.51 feet per century);
- Galveston Pleasure Pier: 5.04 mm per year (1.65 feet per century);
- Freeport: 2.55 mm per year (0.84 feet per century).

Shinkle and Dokka (2004) estimated subsidence rates based primarily on leveling observation data from the NGS, together with GPS observation data collected at Continuously Operating Reference Station (CORS) sites by the NGS, in addition to long-term tide measurements. This study was focused on land subsidence in Louisiana, but extended into eastern Texas as far as Beaumont. At Beaumont, they found subsidence rates of up to 15 mm per year (4.9 feet per century) – much higher than the rates obtained from tide measurements. This may not be inconsistent with the tidal measurements described here, given the locally varying nature of subsidence (e.g., Figure 3-11). However, it does highlight the potentially dramatic effects of future subsidence.

Subsidence in the Galveston Bay area is due to a combination of industrial and municipal groundwater withdrawal; hydrocarbon extraction; and ongoing tectonic activity (Galloway et al. 1999; Gibeaut et al. 2002; Morton et al. 2006; Shinkle and Dokka 2004). There is controversy about the relative importance of these components (Berman 2005), as well as the general validity of the high rates of subsidence obtained by Shinkle and Dokka. Subsidence due to groundwater withdrawal and/or hydrocarbon extraction can be managed if extraction rates are greatly reduced then the rate of subsidence can also be expected to decrease over time. Subsidence due to natural tectonic activity (not including activation of faults due to groundwater and/or hydrocarbon extraction) can be expected to continue into the future.

The most commonly accepted explanation is that natural tectonic subsidence is small relative to human-induced subsidence (groundwater withdrawal and oil-and-gas production). This is the assumption underlying the creation in 1975 of the Harris Galveston Subsidence District by the Texas Legislature. The Subsidence District regulates groundwater withdrawal and monitors subsidence in collaboration with the NGS, the USGS, and other groups. Methods being used to monitor ongoing subsidence include:

- Conventional measurements (geodetic differential leveling, based on the establishment of permanent benchmarks); this provides good quality data but each snapshot in time can be expensive to obtain;

- Borehole extensometers; these provide high quality measurements continuous in time, but each borehole has a small areal application; and,

- GPS (Zilkoski et al 2003); this provides high quality data, but has only been available for a few years (Harris Galveston Subsidence District 2009b).

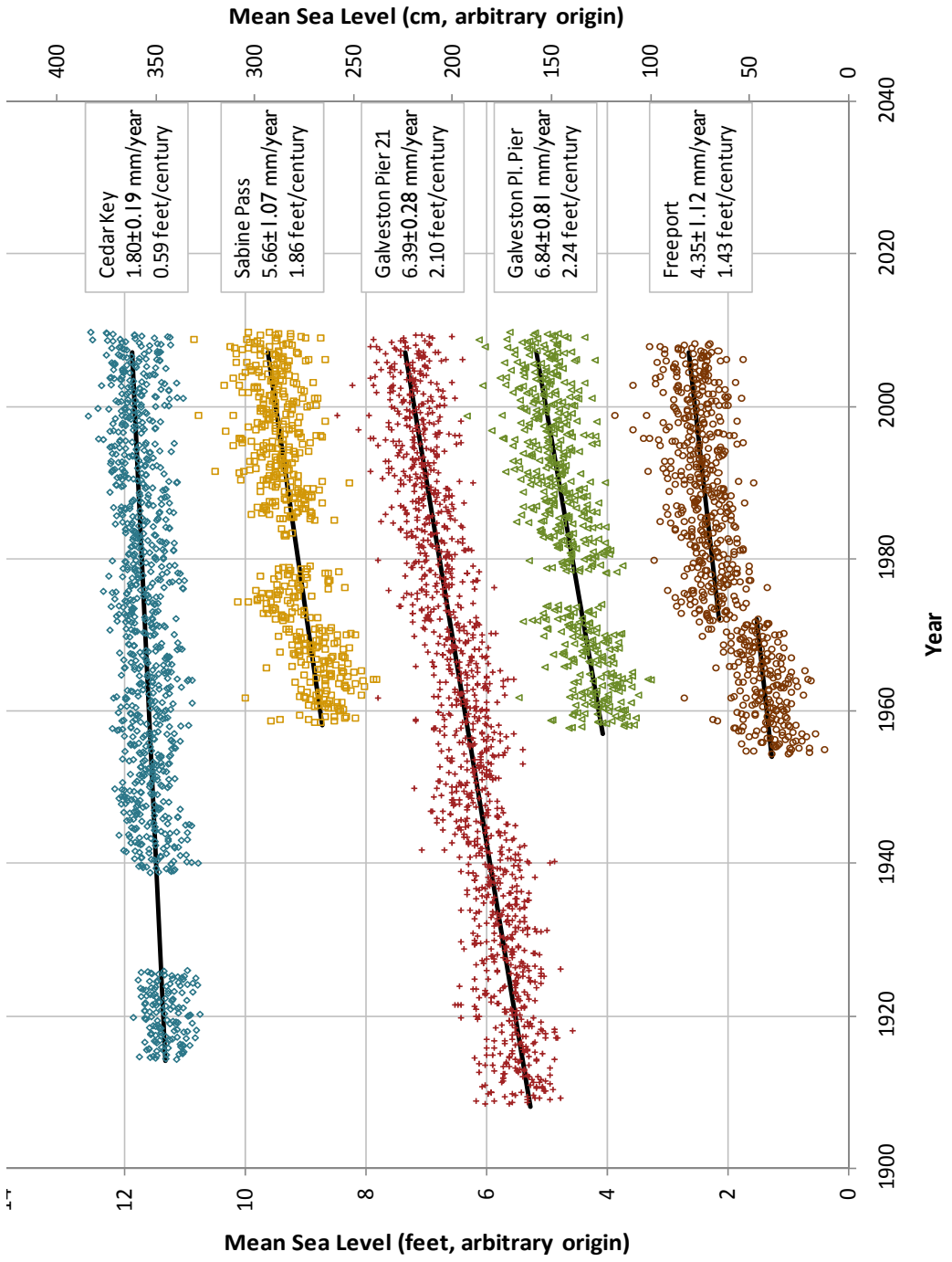


Figure 3-13: Relative Sea Level Increase Measured by Tide Gauges

Other tools that can be used to monitor ongoing subsidence include interferometric synthetic aperture radar (InSAR) (Buckley et al 2002).

Subsidence in some parts of Houston appears to have decreased or even stopped by the 1990s, apparently in response to decreases in groundwater withdrawal (Kasmarek *et al*. 1997; Buckley *et al*. 2003). Figure 3-14 illustrates shows the locations of the monitoring sites used by the Harris Galveston Subsidence District near the coast, and Figure 3-15 shows recent subsidence measurements at three extensometer sites near the coast. The extensometer measurements indicate that the compaction rates in the upper zone have decreased significantly since the early 1970s. Subsidence at lower levels (e.g., due to oil and gas extraction) would not be reflected in extensometers. The measurements at the GPS sites provide an absolute measure of subsidence and are more recent (typically these stations were installed in 2002 or even later). The GPS stations suggest subsidence rates equivalent to 2 feet per century or less – consistent with the results from the tide gauges.

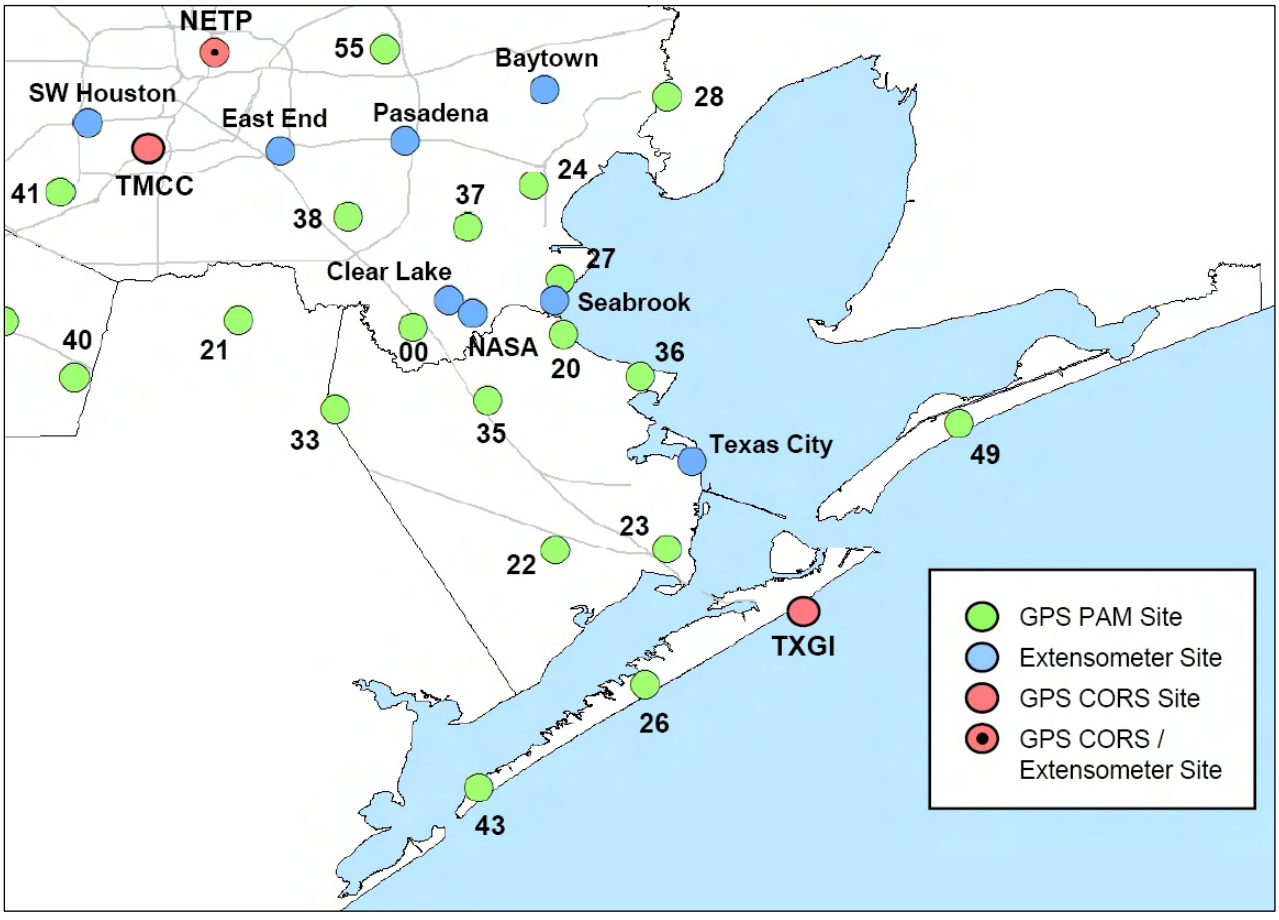


Figure 3-14: Monitor Locations near the Coast

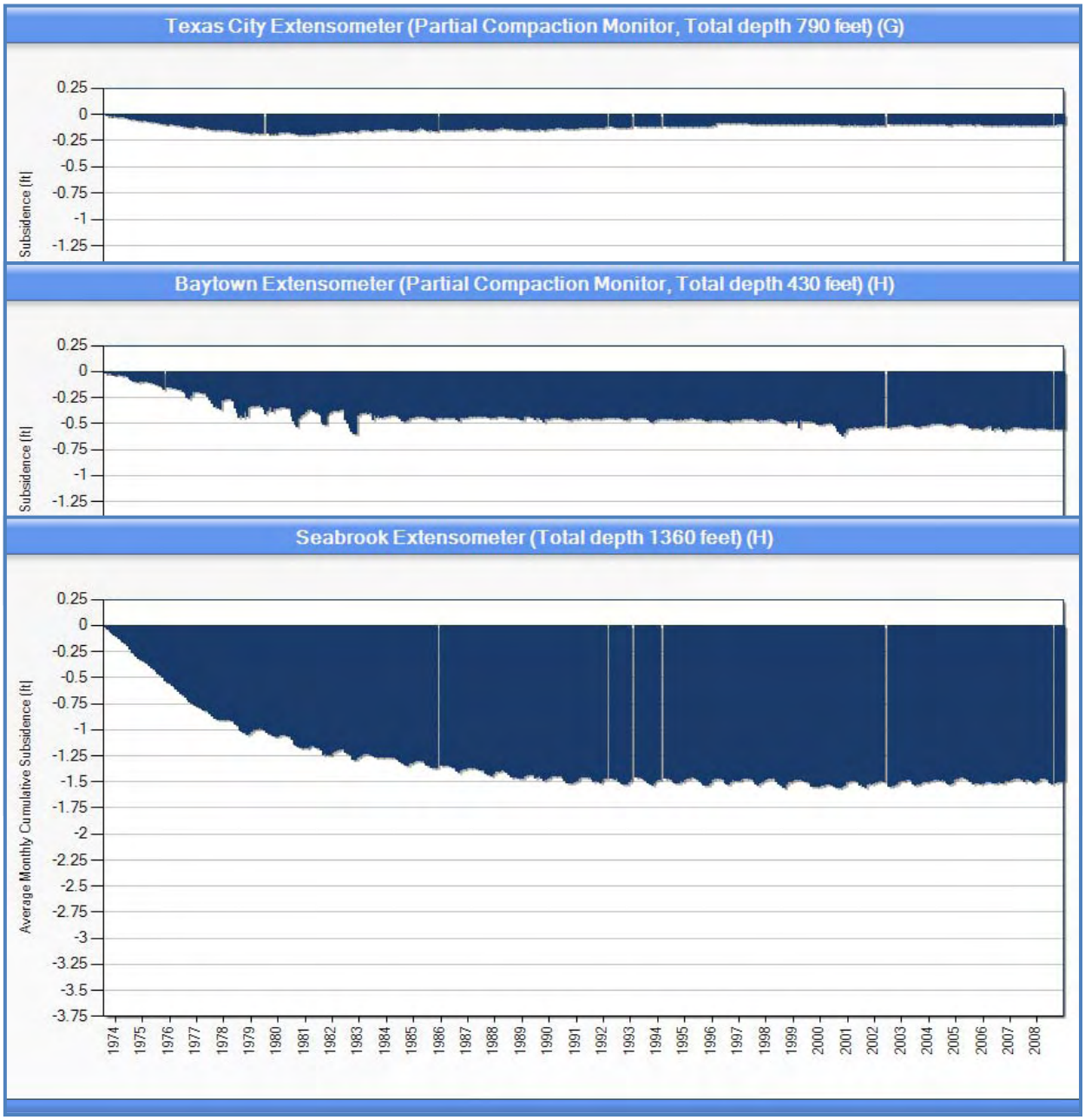


Figure 3-15: Measured Compaction Levels Near Trinity and East Bays

Source: HGSD

3.3.3 Summary

Long-term tidal records suggest a rather constant subsidence rate on the Gulf shoreline of the study area of approximately 1.5 to 2.0 feet per century. Subsidence inland, particularly at near the Upper Galveston Bay/Lower San Jacinto River area, has been much greater than this during the twentieth century – seven feet or more along the northern shore of the bay. However, it appears the worst-case subsidence in this area has slowed or stopped in the recent decades, presumably due to the management of groundwater resources.

For planning purposes, a reasonable assumption is that the subsidence throughout the Galveston region will stabilize at a rate of approximately 1.5 feet per century – consistent with the coastal locations (which are not showing signs of a decreased rate of subsidence). A lower limit would be that the subsidence in the coastal areas will decrease to 1.0 feet per century, consistent with Sabine Pass and Freeport, while that in the northern part of the study area will decrease to nothing over the twenty-first century. An upper limit might be double the mid-point, or 3 feet per century, in the northern part of the study area, based on unanticipated tectonic conditions.

Projections of eustatic sea level rise vary from 0.6 to 4.8 feet over the twenty-first century, with an increase of between 0.3 and 1.6 feet between the years 2000 and 2050. The mid-point assumption based on the USACE 2009 guidance would be an increase of 0.6 feet between 2000 and 2050, and 1.5 feet in the twenty-first century. To summarize, the following limiting cases are suggested:

- Low increase: 0.8 feet between 2000 and 2050 on the Gulf Coast (0.3 feet eustatic increase plus 0.5 feet subsidence), and 0.5 feet on the north shore of upper Galveston Bay (based on a nominal subsidence of 0.2 feet);

- Medium increase: 1.4 feet between 2000 and 2050 (0.6 feet eustatic increase plus 0.8 feet subsidence);

- High increase: 2.4 feet between 2000 and 2050 on the Gulf Coast (1.6 feet eustatic increase plus 0.8 feet subsidence), and 3.1 feet on the north shore of Galveston Bay and Trinity Bay (based on a worst-case subsidence of 1.5 feet).

Subsidence in East and West Bays and the southern part of Galveston Bay would be intermediate between the Gulf Coast and northern values.

3.4 Impacted Sediments

Dredged material can be contaminated chemically (hazardous materials, pollutants), physically (large debris), or biologically (invasive species). The regulation of dredged material disposal within waters of the U.S. and ocean waters is shared between the EPA and USACE. The USACE has developed guidelines pursuant to federal statute which mandates that the physical composition (grain size, water content, etc.) and chemical composition of sediments to be dredged do not negatively impact the environment.

The chemical composition of sediments is one important factor when implementing a RSM approach as it can limit the placement options for dredged material. Contaminated sediments can have adverse effects on water quality, and on aquatic and terrestrial organisms, including plants, wildlife, and humans. Depending on the degree and type of contamination, the use of impacted sediments for some beneficial use alternatives, such as beach nourishment and wetland restoration projects, can be restricted.

A number of studies have been completed within the Galveston Bay area in an attempt to better understand the quality of sediment. However, fewer data points exist for sediment quality parameters compared to those for water quality and large areas of Galveston Bay remain unsampled. Sampling of sediments is often required for dredging activities and, for this reason, the quality of sediments within navigation channels, ports, and harbors is often more understood than that of sediments sampled from other areas.

In general, elevated concentrations of contaminants in Bay sediments can be found in areas with runoff and waste discharges from upland urban or agricultural land uses or sites used currently or historically, for manufacturing or heavy industry. The HSC Bayou Reach is considered to have some of the higher levels of sediment contamination in the Galveston Bay area (Ward and Armstrong 1992). In general, sites sampled in the HSC Bayou Reach and Tabbs Bay exhibit high levels of heavy metals and polycyclic aromatic hydrocarbons (PAHs). Cadmium, mercury, copper, and zinc levels are low within the Galveston Bay system (GBEP 2002) while chromium and lead are elevated when compared to other natural aquatic systems (GBEP 2002).

Higher than background levels of dioxins, byproducts from natural or man-made combustion, chlorine bleaching from paper and pulp production, certain types of chemical manufacturing, and other industrial processes (EPA 2000) have also been identified in water and sediments within the study area. The San Jacinto Waste Pits Superfund Site occupies a 20-acre area on the San Jacinto River near Interstate Highway 10 (I-10). These pits historically received wastes from paper mill activities and portions of the pits are now under water due to subsidence. Sediment samples collected from the pits in the river have exhibited dioxin concentrations up to 70,000 parts per trillion (EPA 2009). Water and tissues samples taken near this site reflect similar high concentrations of dioxins.

3.5 Geographic Information System (GIS) Resources

A number of geographic information system (GIS) data sets exist for the region. Spatial data sets were compiled from various sources for the purposes of creating one coherent sediment management database (geodatabase) for the study area (Appendix B). Agencies from which GIS data was gathered include:

- Galveston Bay National Estuary Program (GBNEP)
- Texas General Land Office (TGLO)
- U.S. Department of the Interior Minerals Management Service (MMS)
- National Ocean Service (NOAA – NOS)

- Port of Houston Authority (POHA)
- Texas Bureau of Economic Geology (BEG
- Texas Water Development Board (TWDB)
- U.S. Army Corps of Engineers (USACE) Galveston District
- U.S. Geological Survey (USGS)
- Houston-Galveston Area Council (HGAC)
- Texas Natural Resources Information System (TNRIS)

Data types collected from these agencies include coastal data relevant to sediment management within Galveston Bay and are listed in Table 3-7.

Table 3-7: Geodatabase Layers

Data Source	Data Types
BEG	Projected Gulf Erosion/Accretion
	Projected Gulf Shorelines
	Gulf Shoreline Change Rates
	Subsidence
TGLO	Bathymetry – 3 league line
	CERPA Projects
	Navigation Channels
	Coastal Barrier Resource System
	Coastal Preserves
	Coastal zone boundary
	Critical erosion areas
	Historic Disposal areas
	Dune protection lines
	Environmental Sensitivity Index – Shoreline Types
	GLO Leases
	Marinas
	National Wildlife Refuges
	Navigation districts
	Oyster habitat locations
	Pipeline locations
	Rookery locations
	Seagrass locations
	Barrier Island washover locations
	IKE shoreline assessment

Data Source	Data Types
NOAA	Texas Shoreline
TAMU	Bathymetry (1 meter contours)
	Habitat Conservation Blueprint Update Restoration Sites
TPWD	River Basins
	Reservoirs
	Hydrologic units
	Major rivers
	Minor bays
USFWS	Piping Plover Habitat
	National Wetland Inventory
	Texas Colonial Waterbird Census
USGS	Shoreline Change Transects
M&N	Coastal Protection Structures (Geotube, Seawall & Groin Locations)
	Galveston Bay Littoral Cells
	Galveston Bay Littoral Cells Flux
	Proposed Beneficial Use Sites
	Existing Disposal Areas
	PSM Plan Study area
USACE/ERDC	Navigation Channel Centerlines
	Gulf Littoral Cells (Morang 2006)
	Gulf Littoral Cells Flux

All data in Table 3-7 was converted into a standard coordinate system for the region (NAD 1983 State Plane Texas South Central Zone Feet) and entered into a geodatabase in accordance with federal spatial data standards. Metadata fields for the data layers were populated with all pertinent information such as the data: source, date of creation, point of contact, etc. The data types and formatting standards were modeled after the USACE Mobile District's eCoastal system. This system hosts an internet mapping service (IMS), which allows public access to a repository of RSM-related data including but not limited to bathymetric surveys, sediment budget layers, channel definitions, dredge histories, and NOAA charts.

A data sharing system similar to eCoastal is recommended to allow sediment management data to be available for access by federal/state agencies, stakeholders and the public for the purposes of planning future sediment management efforts. Coordination efforts with the USACE Mobile District have taken place in the development of the geodatabase to allow an IMS to be implemented for the Galveston District as seamlessly as possible.

4.0 SEDIMENT MANAGEMENT PRACTICES, NEEDS, OPPORTUNITIES, AND CONSTRAINTS

4.1 Current Agency Roles, Responsibilities, and Authorities

The size of the study area and the long term implications of RSM, along with the broad range of disciplines with stake in RSM plans and projects, require compliance with federal, state, and local regulations and communication and coordination with a number of stakeholders.

The RSM program implementation will require full coordination with the following agencies and their relevant regulations, laws, and codes:

4.1.1 Federal Agencies

- U.S. Army Corps of Engineers (USACE) – Responsible for managing and regulating navigation-related channel activities including new work and maintenance dredging. Also serves a regulatory role through Sections 10 and 404 permits (Section 10 for work in navigable waters; Section 404 for dredge/fill activities pursuant to the Clean Water Act).
- U.S. Environmental Protection Agency (EPA) – Permits ocean disposal of dredged material and the cleanup and disposal of contaminated sediment(s).
- National Oceanic and Atmospheric Administration (NOAA) – Oversees the Coastal Zone Management Program (CZMP) to protect ocean and coastal resources.
- NOAA's Fisheries Service (also known as the National Marine Fisheries Service or NMFS) – Responsible for living marine resources and essential fish habitat.
- U.S. Department of the Interior's (DOI's) U.S. Fish and Wildlife Service (USFWS) – Responsible for living resources and habitat including oversight of some threatened and endangered species. Also manages several National Wildlife Refuges within the study area.
- DOI's Minerals Management Service (MMS) – Identifies and authorizes access to sand deposits in federal waters (beyond approximately nine miles offshore for Texas) suitable for beach nourishment or other uses.
- U.S. Geological Survey (USGS) – Conducts research on sources, transport, impacts, disposal, and beneficial use of sediment.

4.1.2 State Agencies

- Texas Commission on Environmental Quality (TCEQ) – Responsible for issuance of Section 401 certifications.
- Texas General Lands Office (TGLO) – Responsible for the operation and management of the Texas Coastal Management Program (TCMP), the Coastal Erosion Planning and Response Act (CEPRA) program, and the Dune Protection Act.

- Texas Parks and Wildlife Department (TPWD) – Protects the state's biological and physical coastal resources, including fish and wildlife.

- Texas Department of Transportation (TXDOT) – Responsible for the management, as a local sponsor, of the GIWW.

4.1.3 Local Agencies

A number of local public agencies have jurisdiction in the study area and individual projects could require discretionary approval from these agencies during implementation of a PSM Plan project. Some of the local agencies with jurisdiction in the study area are listed below:

- City of Galveston – Provides standards for managing property development fronting the Gulf of Mexico in conjunction with the City's zoning standards.
- City of LaPorte – Manages park lands and access to Galveston Bay within city limits.
- City of Seabrook – Manages park lands and access to Galveston Bay within city limits.
- City of Baytown – Manages park lands and access to Galveston Bay within city limits.
- Galveston County – Maintains beaches and parks in unincorporated areas of Galveston County and regulates development in unincorporated areas of the County.
- Harris County – Maintains parks along the shoreline of Galveston Bay and regulates development in unincorporated areas of the County.
- Chambers County – Maintains parks along the shoreline of Galveston Bay and regulates development in unincorporated areas of the County.

4.1.4 Other Authorities Statutes

Individual projects conducted as part of the PSM Plan within the study area would also be required to be in compliance with the following statutes:

- Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act – Governs transportation for placement of dredged material to the ocean for the purpose of disposal. The MPRSA overlaps with the Clean Water Act (CWA); formerly the Federal Water Pollution Control Act Amendments of 1972, jurisdiction and precedence is defined by the function of disposal. Material dredged, transported and placed within the territorial sea for purposes of disposal is regulated under MPRSA. If the material is placed within the territorial sea for purposes other than disposal such as beach nourishment, island creation, and aquatic habitat enhancement, the activity is regulated as fill placement under the CWA. The CWA regulates the placement of dredged and fill material in waters of the U.S. Additional information on the geographical jurisdiction of the MPRSA and the CWA is given in 33 CFR 335-338.

- National Environmental Policy Act (NEPA) of 1969 – Requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed plans and/or actions and their reasonable alternatives.

- Fish and Wildlife Coordination Act of 1958 – Establishes the policy that wildlife conservation is to be given equal consideration with other water resources development. The Act requires any federal agency or permitee proposing to modify a water body to consult with the USFW and other appropriate state agencies.

- National Historic Preservation Act of 1966 – Requires identification of all National Register or eligible properties in a project area and development of mitigation measures for those adversely affected, in coordination with the State Historic Preservation Office (SHPO) and the Advisory Council on Historic Preservation (ACHP).

- Executive Order 12898, Environmental Justice – Directs federal agencies to determine whether a project will have an adverse impact on minority or low-income population group.

- Section 7 (c) of the Endangered Species Act of 1973 – Requires that any federal agency authorizing, funding, or carrying out an action that "may affect" a federally listed threatened or endangered species or its critical habitat consult with the USFWS and NMFS prior to commencing with the action.

- Magnuson-Stevens Fishery Conservation and Management Act of 1996 – Governs the conservation and management of ocean fishing; establishes exclusive U.S. management authority over all fishing within the exclusive economic zone, all anadromous fish throughout their migratory range except when in a foreign waters, and all fish on the Continental Shelf. The Act provides guidance on identifying Essential Fish Habitat (EFH) to further conserve these federally managed fisheries.

- Marine Mammal Protection Act (MMPA) of 1972 – Prohibits the take of marine mammals in U.S. waters.

- Clean Water Act (CWA) of 1977 (which provided major amendments to the Federal Water Pollution Control Amendments of 1972) – Establishes the basic structure for regulating discharges into the waters of the U.S. and gives the EPA the authority to implement pollution control programs. Section 401 (water quality) and 404 (discharge of materials (dredge and fill) to waters of the U.S. (including wetlands).

- Coastal Barrier Improvement Act (CBIA) of 1990 – Reauthorized the Coastal Barrier Resources Act (CBRA) of 1982, which in turn, established the Coastal Barrier Resources System (CBRS) to minimize loss of human life, wasteful federal expenses, and damage to fish, wildlife, and other natural resources by restricting federal expenditures and financial assistance that encourage the development of coastal barriers.

- Rivers and Harbors Act (Section 10) – Requires compliance for the construction of any structure in or over any navigable water of the U.S., the excavation/dredging or deposition of material in these waters, or any obstruction or alteration of a navigable water.

- Federal Water Project Recreation Act – Requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water resource projects.

- Migratory Bird Treaty Act of 1918 – Implements treaties and conventions between the U.S. and other countries for the protection of migratory birds. Under the act, taking, killing or possessing migratory birds is unlawful.

- Executive Order 11988, Floodplain Management – Requires federal agencies to avoid, when possible, any adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development if a practicable alternative is viable.

- Executive Order 11990, Protection of Wetlands – Requires federal agencies to avoid construction or management practices that would adversely affect wetlands unless that agency finds that there is no practicable alternative and that the proposed action includes all measures to minimize harm.
- Executive Order 13186, Responsibility of Federal Agencies to Protect Migratory Birds – Directs federal agencies, whose direct activities will likely result in the take of migratory birds, to coordinate with the USFWS to promote bird populations.
- Executive Order 13112, Invasive Species – Created to prevent the introduction of invasive species and provide for their control, and to minimize the economic, ecological, and human health impacts that invasive species cause.
- North American Waterfowl Management Plan – Authorized by the North American Wetlands Conservation Act of 1989, this international plan conserves waterfowl and other wetland-associated species in North America.

4.1.5 Other Stakeholders

Other stakeholders with interests in RSM activities could include, but is not limited to:

State

- Gulf of Mexico Alliance (GOMA) – Committee consisting of state and federal agencies currently developing the Gulf of Mexico Sediment Management Master Plan (GRSMMP) in an effort to coordinate sediment management activities in the entire Gulf of Mexico Region (GOMA 2009). Efforts are being made to ensure consistency between the PSM Plan and the developing GRSMMP as material becomes available.

- Texas Bureau of Economic Geology (TBEG) – Geologic data collection and research including shoreline change along the Galveston Bay and Gulf coast.
- State colleges and universities

4.1.6 Local

- Beneficial Uses Group (BUG) – Committee formed by the USACE's Interagency Coordination Team (ICT), in partnership with the PHA, to identifying environmentally and economically responsible ways to utilize the material dredged from the HSC expansion project. Other partners include the EPA, NOAA Fisheries Service, USFWS, the U.S. Natural Resources Conservation Service (NRCS), TPWD, and the TGLO.
- Galveston Bay Estuary Program (GBEP) – A continuation of the Galveston Bay National Estuary Program (GBNEP), which oversees activities related to implementation of the Galveston Bay Plan.
- Galveston Bay Foundation (GBF) – Private organization that preserves, protects, and enhances the natural resources of the Galveston Bay estuarine system and its tributaries.
- Galveston Parks Board – A city government entity which manages several shoreline parks on Galveston Island and the public beaches within the City.
- Harris County Flood Control District – Develops and implements flood damage reduction plans for Harris County.
- Harris Galveston Subsidence District (HGSD) – Provides regulation of groundwater withdrawal throughout Harris and Galveston counties to prevent land subsidence.
- Local private property owners and developments:
  - West Galveston Island Property Owners Association (WGIPOA) – Organization of private property owners on the West Galveston Island. Promote preserving and protecting Gulf and Bay shorelines.
  - Pirate's Property Owners Association (PPOA) – Organization of private property owners on the West End of Galveston Island.
- Port of Galveston – Operated by the Galveston Wharves Board and owned by the City of Galveston. Serves as a terminal for both cargo and cruise vessels with water access via the Galveston Harbor and Ship Channel. Partnering with the USACE as local sponsors of the Galveston Harbor and Channel Project.
- Port of Houston Authority (PHA) – Partners with USACE as local sponsor for the HSC.
- Port of Texas City/Texas City Terminal Railway Company – Privately owned port located off the Texas City Channel with both shipping and rail facilities.

- The Nature Conservancy in Texas – Works with communities along Texas shorelines to protect and restore natural habitats.
- TXDOT Galveston-Bolivar Ferry Terminal – Operates the Galveston-Bolivar ferry. Conducts periodic maintenance dredging of terminal.

4.2 Existing Sediment Activities

Local, state, and federal coordination efforts have already begun to improve the management of sediments in the study area. Efforts include beneficial uses of dredged material, such as marsh creation and beach nourishment. More regional efforts include GOMA's current development of a Gulf Regional Sediment Management Master Plan (GRSMMP) for the Gulf of Mexico states (Alabama, Florida, Louisiana, Mississippi, and Texas).

Detail on some of the existing sediment management practices occurring within the study area are summarized below in Section 4.2. The needs, opportunities, and limitations/constraints of these existing sediment activities are then discussed in Sections 4.3 and 4.4.

4.2.1 Dredging

Dredging most frequently occurs within federal navigation channels, navigation channels for privately owned marine terminals, and navigation channels for private developments such as marinas and canals. Generally, federal navigation channel dredging is completed by the USACE in cooperation with a local sponsor for a specific channel. For example, the Port of Houston partners with the USACE when channel dredging activities are needed in the HSC.

Most dredging activities are identified as "maintenance" or "new work". Private dredging activities are carried out by property owners, but are still required to comply with federal regulations in the form of obtaining dredging permits from the USACE. Therefore, quantifying dredging activities in a specific channel can be estimated using USACE permit records.

Dredged Material Management Plans (DMMPs) are prepared for all federal navigation projects.

4.2.1.1 Federal and Port Dredging Activities

A Draft Preliminary Assessment Report, (URS and M&N 2009), looked at historical USACE Galveston District dredging records and estimated future sedimentation rates for the Houston Galveston Navigation Channels (HGNC) Project. The project includes the dredging of the Houston Ship Channel Bay, Houston Ship Channel Bayou, Galveston Harbor, Galveston Ship Channel, and the Offshore Entrance Channel. The report also included data from other nearby federal navigation channels (Bayport, Barbours Cut, and Greens Bayou). Table 3-1 summarizes this information along with additional dredging records from the USACE for the GIWW and Texas City Channel. Research with other state agencies (TXDOT) and local entities (cities, ports, and counties) resulted in only minimal data regarding current dredging activities. Thus other dredging activities in the study area have not been incorporated into this PSM Plan's preliminary sediment budget at this time. The current dredging volume in the study area, based

off of the shoaling rates presented in Table 3-1 is anticipated to be approximately 13.5 million CY (federal dredging activities only).

4.2.1.2 Local Dredging Activities

Local dredging activities are also conducted regularly within the study area. Calls to TXDOT were made during the data gathering efforts for this PSM Plan to estimate recent and anticipated dredging volumes for the Galveston-Bolivar Ferry terminal (refer to Outreach Meeting Notes in Appendix A). An estimate for local and private dredging activities was not obtained at this time. It is much more difficult to estimate accurate volumes for private dredging activities as the USACE is not conducting these activities themselves. While the USACE provides regulatory oversight for private dredging activities through the permitting process, only estimates of proposed dredging and fill volumes are recorded. It is more difficult to obtain accurate follow-up information on the different projects, such as:

- When was dredging/placement completed;
- If not yet completed, when will it be completed; and,
- Was the total amount of material permitted actually dredged/placed, and if not, how much was dredged/placed?

Due to the high levels of uncertainty associated with determining estimates for local and private dredging activities in the study area they are not included in the preliminary sediment budget at this time.

4.2.2 Beneficial Uses of Dredged Material

Dredged material has been used extensively in the past for open water placement, confined placement, and for waterfront development for industrial and urban areas in the study area. These uses have been reduced in recent years for a variety of reasons including:

- Many of these past uses resulted in negative environmental impacts;
- Existing confined disposal facilities (CDFs) are reaching capacity; and,
- Public and governmental support for open water disposal methods has decreased.

This has resulted in more importance being placed on other sediment management options such as the beneficial use of sediments, which is an integral component of a regional approach to sediment management.

Beneficial use is defined as the use of dredged sediments as resource materials in productive ways. Some beneficial uses remove sediments from a system (e.g. if sediments are used to create upland habitat or as construction materials). Other beneficial uses maintain sediments within a system (e.g. shoreline stabilization, beach nourishment, etc.). Some research has looked at the use of contaminated dredged material for beneficial uses. The overall objective is to make the traditional disposal of dredged material unnecessary, or at the least reduce the total volume of material for disposal. Beneficial use can provide a low-cost solution for dredged material

management that is both environmentally responsible and publicly acceptable The USACE recommended categories of beneficial uses (USACE 2009 and 1987) include:

- Habitat restoration/enhancement (wetland, upland, island, and aquatic)
- Beach nourishment
- Aquaculture
- Parks and recreation (commercial and non-commercial)
- Agriculture/horticulture/forestry
- Mine and quarry reclamation
- Landfill cover for solid waste management
- Shoreline stabilization
- Industrial and commercial use
- Material transfer (fill, levees, roads, etc.)
- Construction material

Within the study area, beneficial use has already been practiced extensively by the USACE and other stakeholders compared to other parts of the country. The following examples summarize some of the more recent or ongoing beneficial use activities (both more and less successful) within the study area.

4.2.2.1 Wetland and Marsh Restoration

Dredged sediment has been used to restore subsiding and eroding wetlands and marshes within and around Galveston Bay since the 1970's. The USACE's Waterways Experiment Station (now the Engineer Research and Development Center) conducted marsh restoration studies on Bolivar Peninsular in the 1970's using dredged material. The project required using geotextile tubes to provide protection for marsh vegetation and resulted in effective establishment of marsh habitat. However, some other efforts have been successful while others have been less successful for a number of reasons including excessive erosion or siltation and the overall complex nature of the hydrology, geomorphology, productivity, and sustainability of these systems. Examples of local, state, and federal plans and/or projects where dredged sediment has been proposed and/or used to restore wetland and marsh habitat are listed below.

HSC Sediments

Habitat restoration and creation with dredged material from the HSC resulted in the formation of the BUG in 1992 to oversee beneficial use of this dredged material. With input from the BUG, the PHA and USACE developed the *Recommended Beneficial Uses Plan for Placement of Dredged Material* (BUG Plan) in 1992 to support the proposed dredging project for the HSC.

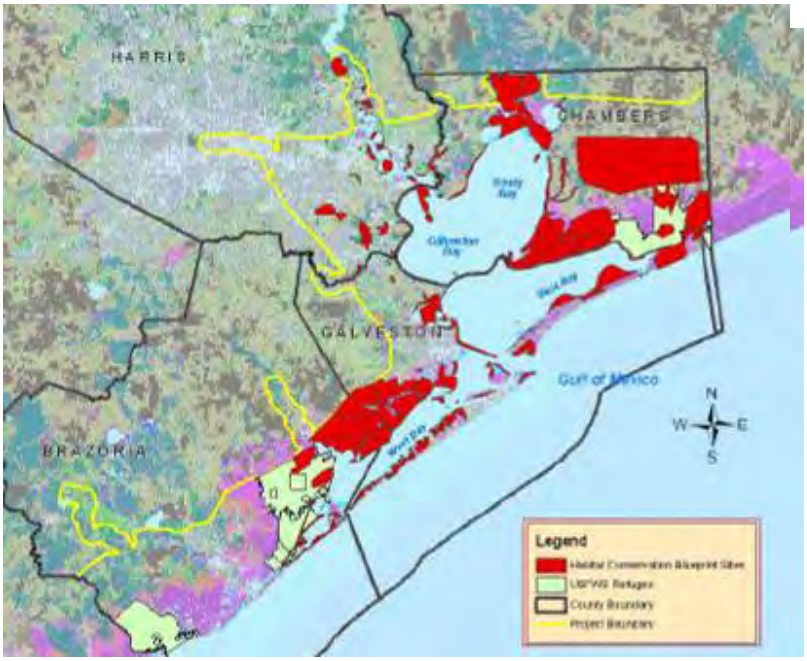
The BUG Plan included construction of approximately 4,250 acres of intertidal salt marsh at three sites, a 6-acre island for birds (Evia Island), restoration of 320 acres on Goat Island and 4 acres on Red Fish Island, and creation of 118 acres of oyster reef habitat. Many of these activities have already been completed in support of the HSC dredging project.

The Galveston Bay Plan and Galveston Bay Habitat Conservation Blueprint

In 1994 the Galveston Bay National Estuary Program (GBNEP) completed the *Galveston Bay Plan* (GBP) which identified and prioritized key impacts to the Galveston Bay system (included Trinity Bay, East Bay and West Bay). Habitat loss was identified as the number one priority problem for the Bay (GBNEP 1994).

The Galveston Bay Foundation (GBF) used both the Texas Coastal Management Program (TCMP) and the GBEP to develop the *Galveston Bay Habitat Conservation Blueprint* (HCB) in 1998. The HCB took inventory of sites that could be conserved or restored in the Galveston Bay area. A list of 167 sites was developed and the locations entered into a GIS database. Funding sources were researched, landowners contacted, and restoration strategies were developed. The goal of the HCB was to restore 24,000 acres of habitat in the Bay by 2010.

In 2007, an update to the HCB was completed that identified the need for an implementation strategy to further assess the success of past projects and determine high-priority needs for future work in Galveston Bay (Biggs and Gallaway 2007). The 2007 update showed that the original HCB had been used successfully by local entities as a tool in restoration projects around the Bay. However, it also noted that many other important habitats had also been degraded at the same time. The 2007 update inventoried existing sites proposed in the 1998 HCB and new sites.



Boundary of Project Area for Habitat Conservation Blueprint Sites
Source: Updating the Galveston Bay Habitat Conservation Blueprint (GBF 2007)

Other Projects

Many other wetland and marsh restoration projects have been completed within the study area using dredged material over the past twenty years. A few are described below:

- *Burnett Bay (GBF)* – The GBF was involved with the 2009 Burnet Bay Habitat Restoration Project (west of the City of Baytown). The project involved bringing in sand to raise the elevation of the site (which has suffered from subsidence over a number of years) and the planting of marsh vegetation to restore intertidal marsh function.

- *West Bay Beneficial Use Marsh (by Chocolate Bayou)* – Completed in the early 1990's this project resulted in some problems similar to those experienced at the restoration work at Atkinson Island (siltation and insufficient flushing of the site).

- *Pierce Marsh Projects* – A number of intertidal and sub-tidal wetland habitat have been restored at Pierce marsh that were lost to subsidence. This site was one of the first to utilize marsh terracing to construct long narrow terraces along the shoreline where original habitat had been lost.

- *San Jacinto Monument (GBF/GBEP)* – Resulted in the use of approximately 80,000 CY of dredge material, which was pumped to the wetland restoration site in San Jacinto State Park. This cost effective approach enabled the reuse of dredged material close to the source thereby reducing transportation costs for material disposal.

- *Clear Creek Wetlands Restoration Project (GBEP and others)* – Resulted in the construction of a 2,600 ft. long containment dike along Clear Creek using approximately 9,000 CY of dredged material. Another 20,000 CY were placed behind the dike and seeded with smooth cord grass (*Spartina alterniflora*).

4.2.2.2 Beach Nourishment and Shoreline Stabilization/Protection

Dredged material has been used for beach nourishment along the sediment starved Gulf shore, for wetland and beach protection from erosion (e.g. geotubes, dune restoration), and for beach and dune restoration following large storms (e.g. Hurricane Ike in 2008) in the study area.

Current beach nourishment projects which have used dredged material include efforts at Rollover Pass, Galveston Island, Bolivar Peninsula, Caplen Shores west of Rollover Pass, and Little Beach.

Recent placement of sand at Little Beach (near Ft. Travis on Bolivar Peninsula) used 400,000 CY of material from an emergency dredging project in the GIWW. Following the damage from Hurricane Ike in December of 2008, the major portion of approximately 400,000 CY of dredged material was used to nourish three sections of impacted beach.

Geotextile tube located on Galveston Bay shoreline
Source: M&N

Dredged material has also been used to fill geotextile tubes at several locations in Galveston Bay region for shoreline protection.

Geotextile tubes are long, oval-shaped tubes made of geotextile fabric which are filled with sand and used to protect shorelines from storm surge and erosion. They are a relatively new approach to shoreline protection and many projects which have utilized Geotextile tubes in the study area are still undergoing monitoring and survey efforts to assess their success (Heilman et al. 2008, Gibeaut et al. 2003, etc.). Several miles of geotextile tubes were used as dune cores on Bolivar Peninsula and Galveston Island, but were largely destroyed by Hurricane Ike and have mostly

been removed. Their value, particularly in lower energy environments such as within Galveston Bay, is still a point of discussion as they require careful installation and maintenance and if exposed to direct wave action they can fail (Gibeaut et al. 2003). However, geotextile tubes can be a practical and cost effective method to provide shoreline protection in lower energy wave environments, such as in protected areas of Galveston Bay, even with their maintenance requirements.

4.3 Identified Sediment Management Needs and Opportunities

Section 4.3 lists some sediment management needs and opportunities identified during the data gathering phase for this Project (refer to Outreach Meeting and Call Notes in Appendix A). These needs and opportunities are not meant to propose specific future projects, but to provide information on the study area that can be used and developed in the future for more specific projects. The needs and opportunities presented here, are limited to those discussed with stakeholders during the data gathering phase and are not necessarily comprehensive. Many of the identified needs and opportunities are specific to certain stakeholders and may not be shared with the USACE or others or comply with USACE policy and requirements.

Additional information should be gathered on individual needs and opportunities prior to detailed planning for specific projects. Table 4-1 summarizes the needs and opportunities listed and described in Section 4.3.

Table 4-1: Summary of Identified Sediment Management Needs and Opportunities

Habitat Restoration	
Burnett Bay	Seabrook Island
Greens Bayou	Seabrook Slough
San Jacinto Monument	East Bay North Shoreline
TAMUG Marsh	Jones Bay
Mainland Marshes	Scott Bay
Anahuac National Wildlife Refuge	Dickinson Bay
Marsh Restoration Bolivar	Pierce Marsh
Marsh Restoration Galveston Island	Soft Material Under Hard Substrate Cap For Oyster Reef Construction
Virginia Point Marsh Restoration and Shoreline Protection	Smith Point
Armand Bayou	
Houston Ship Channel and Adjacent Areas	
Placement Areas 14 and 15	Erosion control for Sylvan Beach area (Bayport to Morgan's Point)
San Jacinto River Waste Pits Superfund	Dredged material from the Bayport Container Terminal
Create marshes on west side of HSC to protect against ship generated waves	Develop new placement areas to meet capacity requirements
Erosion control for the San Jacinto River shoreline	Control sedimentation from Buffalo Bayou
Entrance Channel and Adjacent Areas	
South Jetty	Big Reef
Anchorage Basin	Entrance Channel
Galveston Ship Channel and Harbor and Adjacent Areas	

San Jacinto Placement Area	Upland Placement Area Off of Harborside Drive
Pelican Island Placement Area	Galveston Harbor Expansion
Gulf Intracoastal Waterway and Adjacent Areas	
Rollover Pass	Islands near Galveston Causeway
Bolivar Placement Areas	Chocolate Bayou
Port Bolivar Channel and Catch Basin	Galveston-Bolivar ferry terminal
Pelican Island Spit	Bolivar Ferry Landing Marsh
Texas City Channel and Adjacent Areas	
Private Channels and Marinas	
Coastal Resiliency and Beach Nourishment	
Nearshore (Gulf) Placement	Little Beach
Rollover Pass	Offloading site near Offatts Bayou
West Galveston Island Beach Restoration	
Other Galveston Bay Areas	
San Luis Pass flood shoal	Trinity Delta sediment flow
Confined Placement Areas	
Cap for oil spill cleanup or oil well sites	Use of Dewatered Material from Confined Placement Areas for Construction Fill
Accurate capacity and volume data	Mine placement areas for habitat creation/protection
Other Needs and Opportunities	
Sea level rise	Build habitat restoration sites without levees
Use impounded material in reservoirs	

4.3.1 Habitat Restoration

Identified sediment needs and opportunities for habitat restoration in the study area could include (Figure 4-1):

- *Burnett Bay (GBF)* – The GBF was involved with the 2009 Burnet Bay Habitat Restoration Project (west of the City of Baytown), which did try to seek out an offsite sand source for two years prior to project commencement (no source was identified). There may be opportunity for beneficial use of clean dredged material in the future for subsequent phases of the project (GBNEP project titled Burnet Bay and Marshes – Biggs and Gallaway 2007).

- *Greens Bayou (GBEP)* – The Galveston Bay Estuary Program is acquiring lands in the vicinity of Greens Bayou. There may be future potential for beneficial use of dredged material for restoration of sites in this area.

- *San Jacinto Monument (GBF/GBEP, PHA)* – There is potential need for another phase of marsh restoration at the San Jacinto Monument (GBNEP project titled San Jacinto Battlefield Marsh and Riparian Woodland – Biggs and Gallaway 2007). A significant area of marsh has previously been restored using dredged material at the site. Future phases would require sediment which has not been impacted by any contamination. The Port of Houston has encouraged placement of private material here, but there is a mismatch in needed volumes.

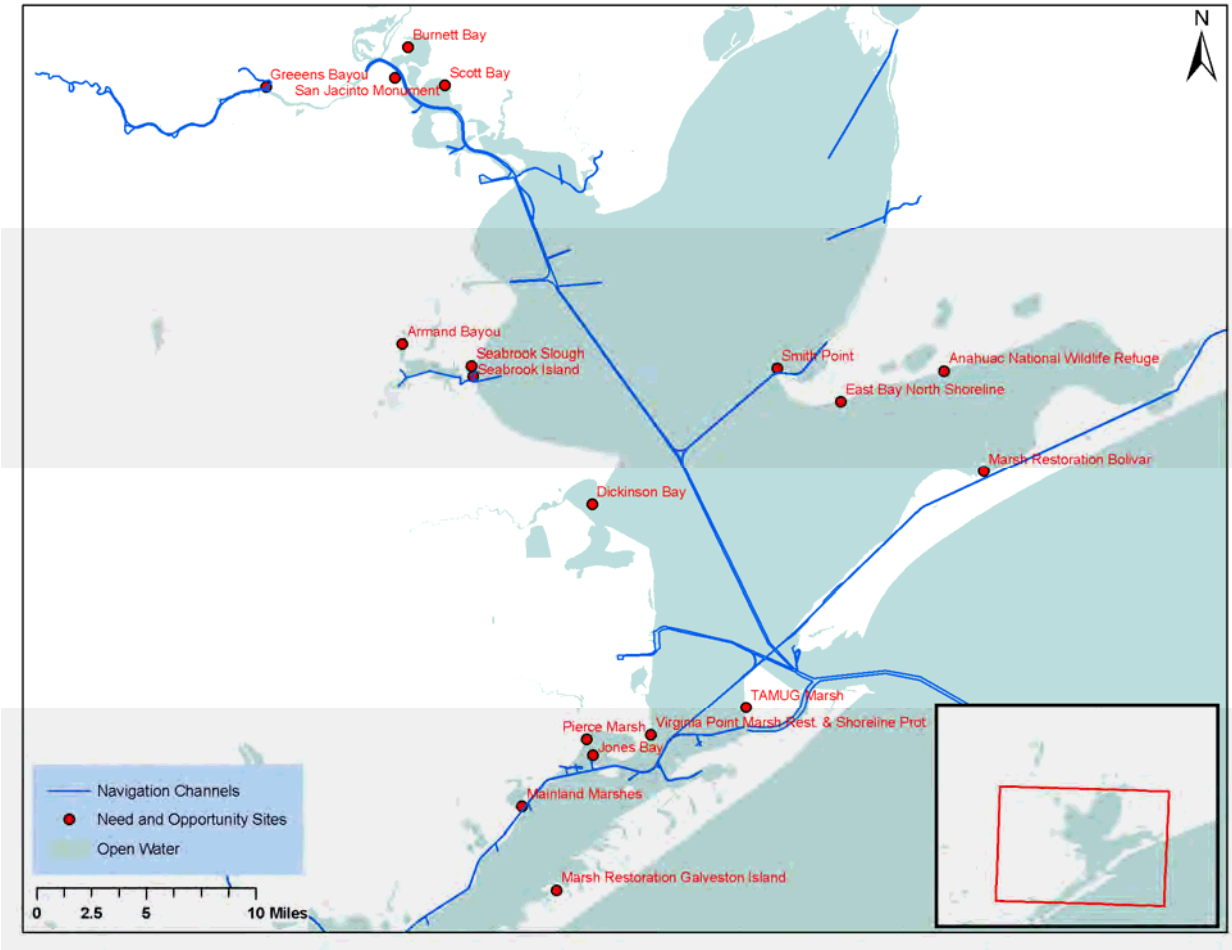


Figure 4-1: Habitat Restoration Needs and Opportunities Map

- *TAMUG Marsh (GBF)* – Marsh restoration has been proposed for Pelican Island just north of the Texas A&M University at Galveston (TAMUG) campus (GBNEP project titled Pelican Island West Shoreline & Marsh – Biggs and Gallaway 2007). The proposed marsh would be part of the TAMUG Wetlands Center. A number of sources of sediment for the marsh have been proposed including beneficially used dredged material from navigation channels serving Galveston.

- *Mainland Marshes (GBF/GBEP)* – There is an on-going loss of wetlands from the "mainland" marshes along the north side of West Galveston Bay (GBNEP projects titled Basford Bayou, Carancahua Lake and Bayou Marshes, and Greens Lake Bar – Biggs and Gallaway 2007). Dredged material from the GIWW may be usable to restore and/or protect some of these areas.

- *Anahuac National Wildlife Refuge (TXDOT, GBF/GBEP)* – There are a number of restoration projects proposed or on-going within or adjacent to the Anahuac National Wildlife Refuge (GBNEP projects titled East Bay Bayou – Mud Bayou Marshes, East Bay

North Shoreline Marshes, and Wallis Lake/Lake Surprise Marshes – Biggs and Gallaway 2007). Many of these projects require relatively small quantities of sediment and are generally unsuitable for direct placement of dredged material. However, some of the dredged material placement areas associated with the GIWW could be used to supply dewatered dredged material. This would increase capacity in these placement areas while providing needed material for protection and restoration efforts.

- *Marsh Restoration Bolivar (GLO)* – The East Bay (north) side of Bolivar Peninsula has experienced significant wetland losses. These losses are primarily due to subsidence and sea level rise. These losses were increased by the recent damage from Hurricane Ike. Given the proximity to the GIWW there may be opportunities for beneficial uses of dredged materials (GBNEP projects titled Baffle Point Marsh, Elmgrove Point Marshes and Flats, Long Point Marsh, Rollover Bay Marsh and Tidal Flats, and Rollover Bay Rookery Islands – Biggs and Gallaway 2007).

- *Marsh Restoration Galveston Island (GLO)* – The West Bay (north) side of Galveston Island has experienced hundreds of acres of wetland losses in recent decades. Similar to other parts of Galveston Bay, sea level rise and local subsidence have been the primary causes of the losses. Much of the upland area of West Galveston Island has also been developed (some of it prior to wetland protection regulations) leaving little space for marshes to migrate to in many areas. Several state and federal agencies have worked together over the past 10 years to plan, design, and/or build a number of projects directly counteracting the losses, including Galveston Island State Park, Jumbile Cove Marsh, McAllis Point, Snake Island Cove, Maggie Cove Marsh, Bird Island Cove Marsh, Delehide Cove to Gangs Bayou Marshes, South Galveston Island Marshes, and Starvation Cove (Biggs and Gallaway 2007). These projects have generally used geotextile tubes for wave protection and borrowed sediments from nearby parts of West Bay to create new emergent wetlands. Potential may exist for some of these sites, or other sites on West Galveston Island, to use dredged material for future projects.


North side of Galveston Island
Source: M&N 2009

- *Marsh Restoration at Virginia Point (GLO) and Shoreline Protection for Virginia Point (GBF)* – Similar to other areas of Galveston Bay, Virginia Point has suffered shoreline retreat and loss of wetlands. Prior to Hurricane Ike there were a number of houses along this shoreline. Subsequent to the storm few if any houses are standing and/or occupied. There have been numerous proposals for marsh restoration and/or shoreline protection for this area (GBNEP project titled Virginia Point Prairie and Marsh – Biggs and Gallaway 2007). Given the proximity to the Texas City Channel and GIWW there may be opportunities for beneficial uses of dredged material.

- *Armand Bayou (GLO)* – Armand Bayou is a privately owned and operated, non-profit nature center. The center is part of the GLO's coastal preserves program. There may be some needs for sediment, or sediment control; however, the GLO was not immediately familiar with specific needs (GBNEP project titled Armand Bayou Nature Center – Biggs and Gallaway 2007).

- *Seabrook Island (GBF)* – Seabrook Island once existed at the mouth of Clear Lake. The channel between the Lake and the Bay was straightened at some point in time. This action along with shoreline retreat created an island just north of the area in Seabrook known as The Point. The island eventually eroded and subsided until completely submerged. The Galveston Bay Foundation has proposed to restore 20 to 24 acres brought up to +1 or +2 feet elevation. Given the proximity to the Houston Ship Channel there may be opportunities for beneficial uses of dredged material for this restoration project; however, the small size of the island may be a deterrent.

- *Seabrook Slough (GBF)* – The area between The Point area in Seabrook and the old town center has subsided over time and become an open water area. Prior plans have been developed to restore this area to intertidal marsh (GBNEP project titled Seabrook Slough – Biggs and Gallaway 2007). Sediment would be required for this project. Given the proximity to the Houston Ship Channel there may be opportunities for beneficial uses of dredged material for this restoration project; however, the small size of the island may be a deterrent.

- *East Bay North Shoreline (GBF)* – The north shore of East Bay is retreating at a rate of 4 to 8 feet per year resulting in erosive bluffs up to 3 feet high and very patchy remnants of intertidal wetlands (GBNEP project titled East Bay North Shoreline Marshes – Biggs and Gallaway 2007). The Galveston Bay Foundation has worked with the USFWS to protect approximately 17,000 feet of shoreline with a small breakwater/revetment. There is need for protection and/or restoration of an additional approximately 100,000 feet for shoreline.

- *Jones Bay (GBF/GBEP)* – Jones Bay is part of a complex of tertiary bays and associated marshes on the north shore of West Bay. Jones Bay is just south of the community of Bayou Vista and north of the community of Tiki Island. The bay is adjacent to the GIWW and separated by a series of islands originally created from sidecast dredged material. Many of the islands at the mouth of Jones Bay have eroded (some completely) and could be re-nourished with dredged material (GBNEP project titled Jones Bay Bird Rookery Islands – Biggs and Gallaway 2007). Additionally, eroded and/or subsided wetlands around the perimeter of the bay are being restored under a variety of initiatives. Most of the northeast shore of Jones Bay has been acquired by Scenic Galveston for conservation and restoration (known as the John M. O'Quin I-45 Scenic Estuarial Corridor and the Virginia Point Peninsula Preserve and referenced as GBNEP project titled I-45 Corridor Marshes (Biggs and Gallaway 2007).

- *Scott Bay (GBF/GBEP)* – Scott Bay is located just east of the confluence of the San Jacinto River and the Bayou Reach of the Houston Ship Channel and north of Goat Island (GBNEP

project titled Scott Bay Marshes – Biggs and Gallaway 2007). This area has lost wetlands due to subsidence and erosion. The site is a potential project for beneficial use of dredged material to restore lost wetlands.

- *Dickinson Bay (GBF/GBEP)* – The Dickinson Bay area, where Dickinson Bayou joins Galveston Bay, has suffered marsh habitat loss due to subsidence and erosion. The shoreline perimeter of the marsh is a candidate project for restoration (GBNEP project titles Dickinson Bay Debris Removal and Dickinson Bay North Shoreline Fringing Marsh – Biggs and Gallaway 2007) and may require sediments for this restoration. Additionally, a series of islands exist within Dickinson Bay which were created from dredged material and are currently used as bird habitat. Restoration of these islands has begun and continues to be a need (GBNEP project titled Dickinson Bay Islands Marshes – Biggs and Gallaway 2007).

- *Pierce Marsh (GBF/GBEP)* – The Pierce Marsh site is located just west of the community of Bayou Vista on the northwest shoreline of Jones Bay. The site is owned by the Galveston Bay Foundation and is being actively restored under phased projects. The most recent restoration involved the beneficial use of dredged material from the Harborwalk Marina development (GBNEP project titled Pierce Marsh Preserve Restoration and Acquisition Project – Biggs and Gallaway 2007). Further needs for restoration exist and may be suitable for further beneficial use of dredged material.

- *Soft Material Under a Hard Substrate Cap For Oyster Reef Construction (GBF/GBEP)* – During discussions with GBF and GBEP, the possibility was raised of using softer dredged material under a hard "cap" of rock (or similar) as an alternative method of oyster reef construction. This may decrease the cost of the construction by using dredged material which is less costly than rock. Many of the areas where thick clay from new work dredging projects was placed in the past have been colonized with oysters, even without the addition of hard substrate. This concept should be investigated further.

- *Smith Point (GLO)* – There are two beneficial use placement areas near Smith Point associated with the federally maintained Channel to Liberty. The first area (BUS1) consists of rock breakwater protection of Smith Point Island with coarse grained material pumped behind the breakwater (GBNEP project titled Smith Point Island Bird Rookery – Biggs and Gallaway 2007). The second (BUS2) used geotextile tubes to enclose approximately 138 acres of a wetland restoration (GBNEP project titled Robbins Memorial Park Marsh – Biggs and Gallaway 2007). The geotextile tubes of this second site have been damaged and require maintenance. This may be an opportunity for beneficial use of dredged material to repair damage and/or continue restoration efforts.

4.3.2 Houston Ship Channel and Adjacent Areas

The USACE and PHA conduct dredging activities in the Houston Ship Channel and adjacent channels (Bayport Channel, Barbours Cut Channel, and Greens Bayou). The USACE conducts periodic maintenance dredging of these channels and the PHA provides dredge placement area

capacity. Potential sediment needs and opportunities for the HSC and other adjacent channels could include (Figure 4-2):

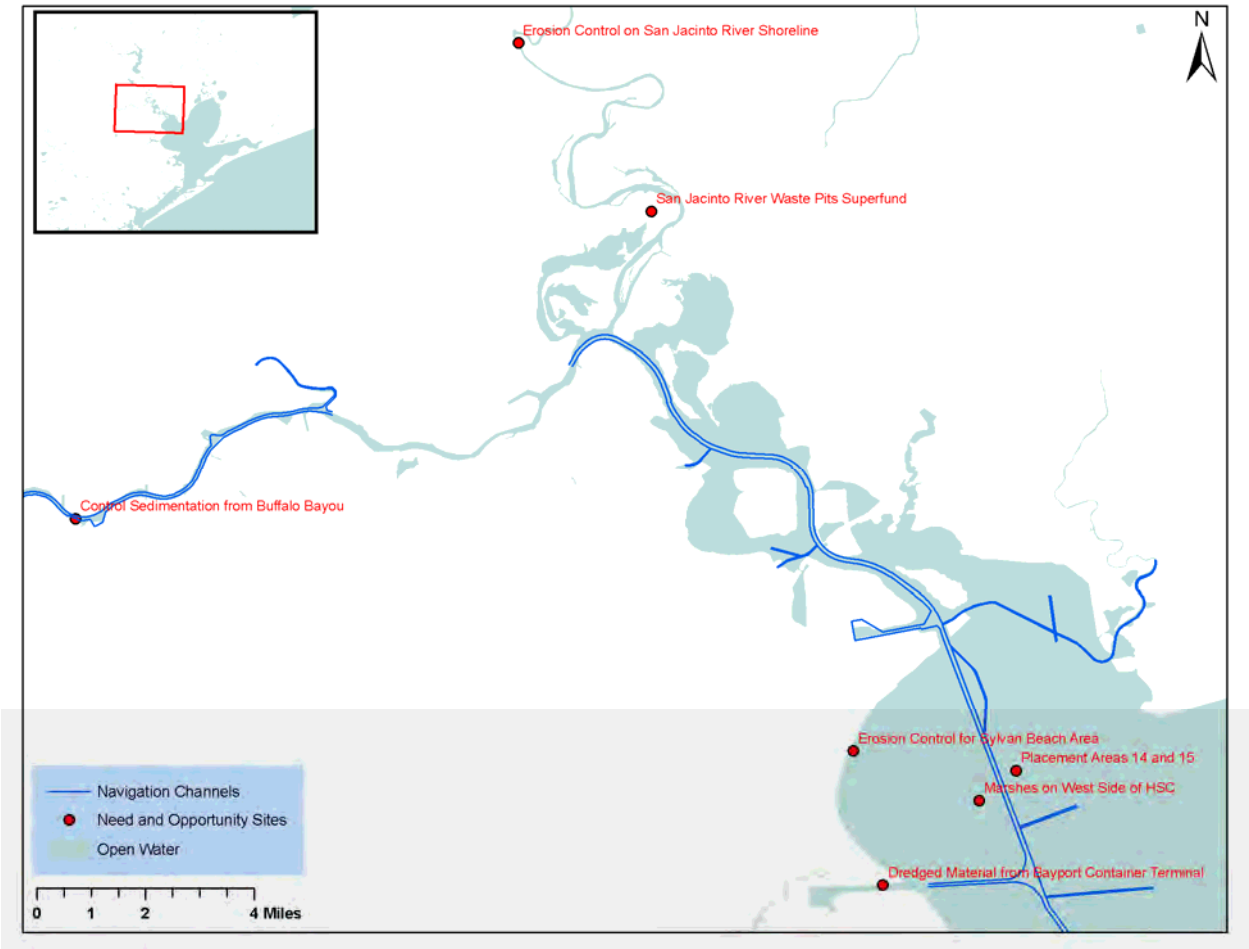


Figure 4-2: Houston Ship Channel and Adjacent Area Needs and Opportunities Map

- *Placement Areas 14 and 15 (GLO)* – Placement Areas 14 and 15 of the Houston Ship Channel project are located east of La Porte. The GLO investigated these cells for re-use of placed material as beach fill for the GLO's Sylvan Beach restoration project in La Porte. These cells have a significant portion of sand. The placement areas were deemed not to have sufficient material available for that project. However, there may be material available for other projects.
- *San Jacinto River Waste Pits Superfund (GBF/GBEP)* – A Superfund site has recently been designated at the location of former waste pits on the San Jacinto River just north of I-10. The originally upland site has become submerged through subsidence. Remedial action is currently being investigated and details are not available. However, it is likely that the project will result in alterations to the sediment transport in the area. Additionally, there may be needs for sediments for capping contaminated areas and/or various restoration projects to mitigate for damages.

- *Ship Generated Waves and Increased Erosion – Marshes On West Side of HSC (PHA)* – Vessels transiting the Houston Ship Channel generate relatively long waves which propagate throughout the Bay. It is likely that ships in the Houston Ship Channel have increased speeds, and thus wave effects, after the recent widening and deepening. ERDC has recently studied theses waves and their effect on sediment transport in the Bay (Tate and Berger 2006 and Tate et al. 2008). ERDC has postulated that these waves are a major factor in sedimentation within the Houston Ship Channel. Erosion in many areas, particularly the western shore of Galveston Bay, has been attributed to these vessel generated waves. The Port of Houston has suggested that the creation of marshes on the west side of the Houston Ship Channel could help contain these vessel generated waves and decrease erosion along existing shorelines. This may be accomplished through beneficial use of dredged material, although project details have not been formulated at this time.

Ship waves along west side of HSC
Source: M&N 2009

- *Erosion Control for the San Jacinto River shoreline (PHA)* – The San Jacinto River is a major contributor of sediment to the Galveston Bay system. Much of this sediment is deposited in the Houston Ship Channel Bayou and Bay Reaches. The Port of Houston recommended that erosion control measures for the shorelines and watersheds of the San Jacinto River be investigated as a means of reducing channel sedimentation. It is possible that on-going urban development over a large portion of the San Jacinto River watershed has resulted in increased sediment load.

- *Erosion Control for Sylvan Beach Area (Bayport to Morgan's Point) (PHA)* – The western shoreline of Upper Galveston Bay, particularly from Bayport to Morgan's Point, reportedly continues to suffer erosion. As discussed previously, ship generated waves are a likely contributor to this erosion. Sediments from erosion of this shoreline likely contribute to sedimentation in the Bay Reach of the Houston Ship Channel. Control of the erosion along this shoreline may decrease sedimentation in the channel.

- *Dredged Material from the Bayport Container Terminal (PHA)* – New work dredged material from the Bayport Container Terminal (located just south of the Bayport Ship Channel) has excellent solid clay material that could be mixed with sediment fines and used for beneficial use sites.

- *Develop New Placement Areas to Meet Capacity Requirements (PHA)* – Sedimentation in the Houston Ship Channel has increased significantly in recent years concurrent with the dredging and completion of the widened and deepened channel. The USACE Galveston District is presently investigating these changes under separate studies. Given the increased sedimentation rates, it is probable that a new dredged material management plan (DMMP)

will be developed. As part of this effort, it may be necessary to develop new placement areas to meet long-term capacity needs for maintenance dredging. The location of these new sites has not been determined, but due to environmental and real estate constraints they may need to be further from the Houston Ship Channel than present placement areas.

- *Control Sedimentation from Buffalo Bayou (PHA)* – Similar to the San Jacinto River, Buffalo Bayou is a major contributor of sediment to the Bayou Reach of the Houston Ship Channel. The Buffalo Bayou watershed is almost completely urbanized. Control of erosion within this watershed and/or detention of sediment upstream of the Houston Ship Channel may help reduce sedimentation in the channel.

4.3.3 Entrance Channel and Adjacent Areas

Sediment needs and opportunities for the Entrance Channel and other adjacent areas could include (Figure 4-3):

- *South Jetty (GLO)* – The GLO has initiated and completed searches for sand resources for re-nourishment of Gulf beaches. Through this effort a sand source has been identified just north of the South Jetty adjacent to the Entrance Channel. The GLO has identified 3 million cubic yards of sand in a submerged ridge which is spilling into the ship channel. This source is proposed for the nourishment of Galveston Island beaches by the GLO in 2010 and permits are being sought to borrow this material using hopper dredges. Borrowing this material may also have beneficial effects of reducing sedimentation in the Entrance Channel.

- *Anchorage Basin (GLO)* – As part of efforts to identify sand resources for beach nourishment the GLO has investigated the material within the Anchorage Basin. The basin is divided into a shallow basin at the west end and deeper basin at the east end. The GLO has identified sand at the west end and is trying to permit use of this material for beach nourishment. The GLO also reported that the deep basin at the east end also has good quality sand for beach nourishment. Both of these sites are part of the federally maintained Houston-Galveston Navigation Channels system.

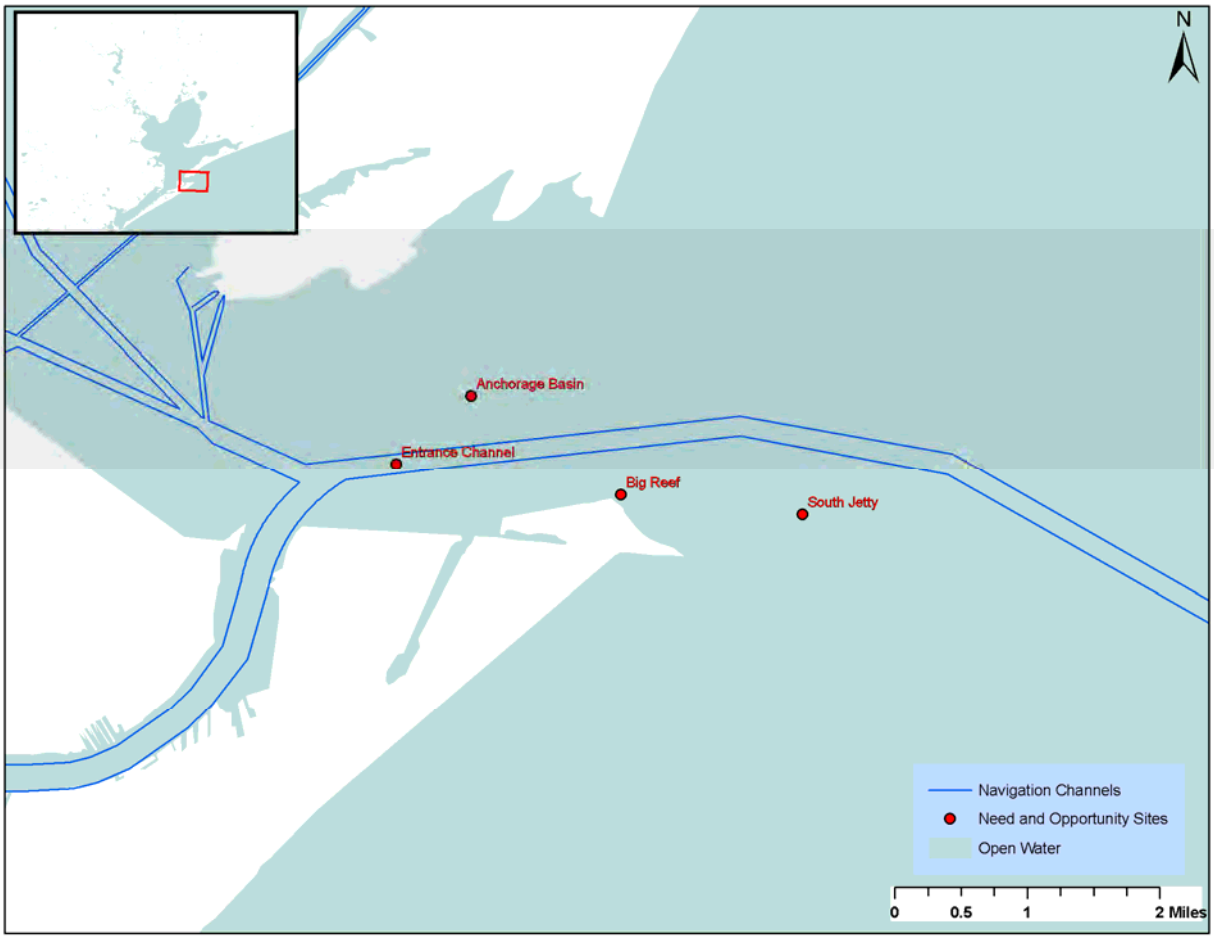


Figure 4-3: Entrance Channel and Adjacent Areas Needs and Opportunities Map

- *Big Reef (GLO)* – The GLO has identified the area known as Big Reef, on the north side of the South Jetty near the Entrance Channel, as a sand source for beach nourishment. The site has been used previously for this purpose by placing material in a temporary upland confined site and then removing and placing on Galveston Island beach via truck haul. The site reportedly replenishes itself through local sediment transport. At present the GLO estimates that another 120,000 cubic yards of material is available to borrow for beach nourishment. The material taken from this site may reduce sedimentation into the Entrance Channel.

- *Entrance Channel (GLO)* – As part of their sand source investigations, the GLO has identified that portions of the Entrance Channel accumulate relatively high quality sand. The GLO believes that some of this material could be used for beach nourishment. This would require changing dredging practices in order to segregate out reaches with good quality material.

4.3.4 Galveston Ship Channel and Harbor and Adjacent Areas

The USACE conducts periodic maintenance dredging of the Galveston Ship Channel and Harbor and the Port of Galveston (as the local sponsor) provides dredge placement area capacity. Potential sediment needs and opportunities for the Galveston Ship Channel and Harbor and adjacent areas include (Figure 4-4):

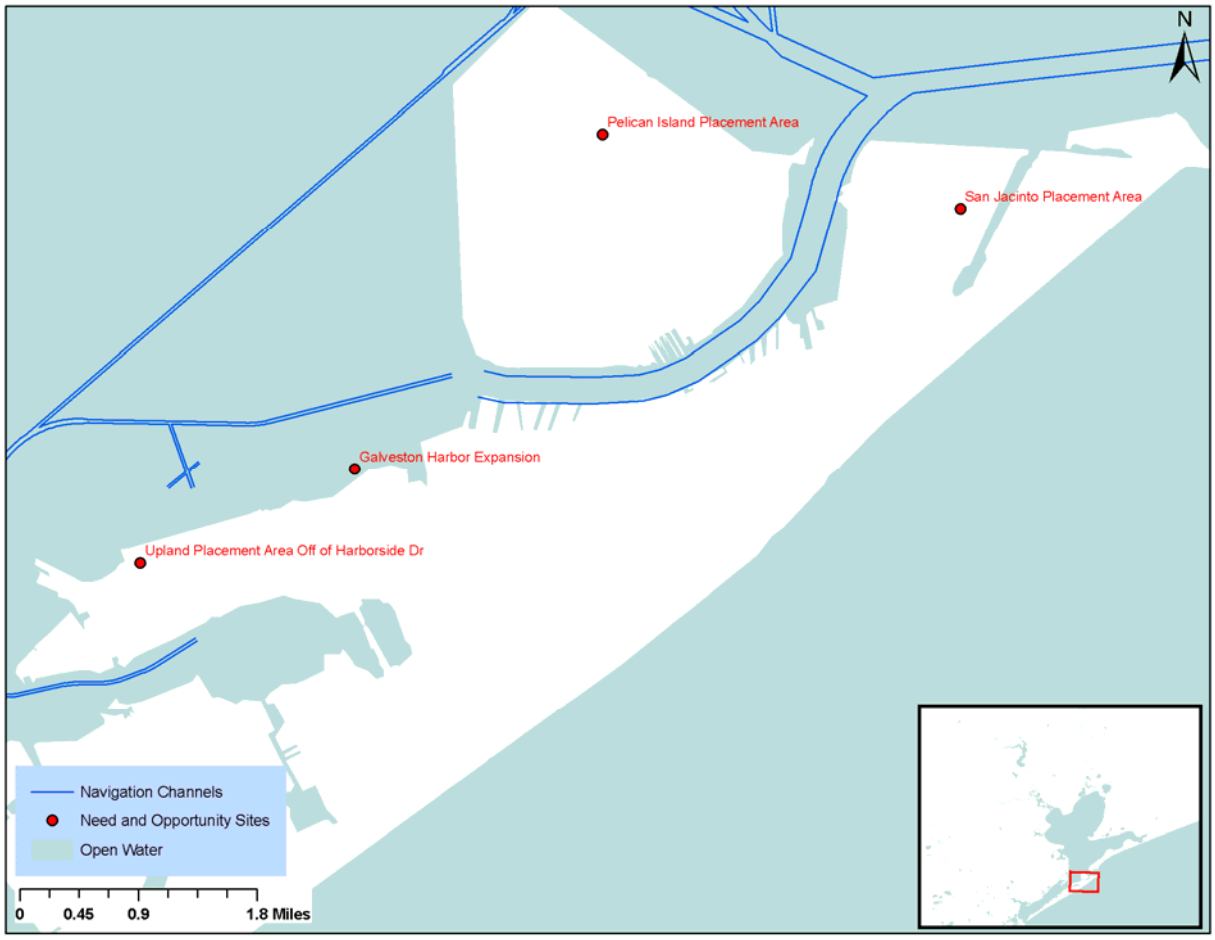


Figure 4-4: Galveston Ship Channel and Harbor and Adjacent Areas Needs and Opportunities Map

- *San Jacinto Placement Area (GLO)* – The San Jacinto Placement Area is located on the east end of Galveston Island adjacent to the Entrance Channel. This placement area has been used primarily for the maintenance of the Galveston Harbor and Channel. The GLO believes that the cell may have areas of sand which may be suitable for reuse for beach nourishment or other purposes and has encouraged exploration of this placement area to identify sediments within it. The exploration of this site may be included in recent grant requests by the GLO under the Coastal Impact Assistance Program (CIAP). It is also noted that the City of Galveston has looked at plans for redeveloping the placement area into residential and

commercial developments; however, there are presently no concrete plans to move forward with this plan.

- *Pelican Island Placement Area (GLO)* – Similar to the San Jacinto Placement Area, the Pelican Island Placement area has historically been used primarily for the Galveston Harbor and Channel project. The GLO has identified 50,000 cubic yards of sand in the northeast corner of the placement area which may be usable for beach nourishment. However, it is difficult to access the site.
- *Upland Placement Area Off of Harborside Drive (GLO)* – There is a confined upland placement area owned by the Harborside Management District (formerly the Galveston County Navigation District #1) located near the intersection of Harborside Drive and 77th St. in Galveston. This side was used after Hurricane Ike as a borrow source for sand placed on the Gulf beaches. There may be further opportunities for similar beneficial uses of dredged material in the future.
- *Galveston Harbor Expansion (HMD)* – A non-federal shallow draft navigation channel currently extends west from the west end of the Galveston Harbor and serves a number of industrial facilities along the north side of Harborside Drive in Galveston. The Harborside Management District (HMD) has proposed expansion of the channel serving this area. The Harborside Management District has requested a Federal Feasibility Study for this channel expansion. Dredging for expansion of the channel will generate approximately 1.7 million cubic yards of dredged material, much of which may be high quality sand. Presently the Harborside Management District has been considering beneficial use of this material to build wetlands along the west side of Pelican Island.

4.3.5 Gulf Intracoastal Waterway and Adjacent Areas

Agencies involved in dredging activities within the GIWW include the USACE and TXDOT. The USACE maintains the federal channel with TXDOT providing the dredged material placement areas, as the local sponsor. Potential sediment needs and opportunities for the GIWW and adjacent areas include (Figure 4-5):

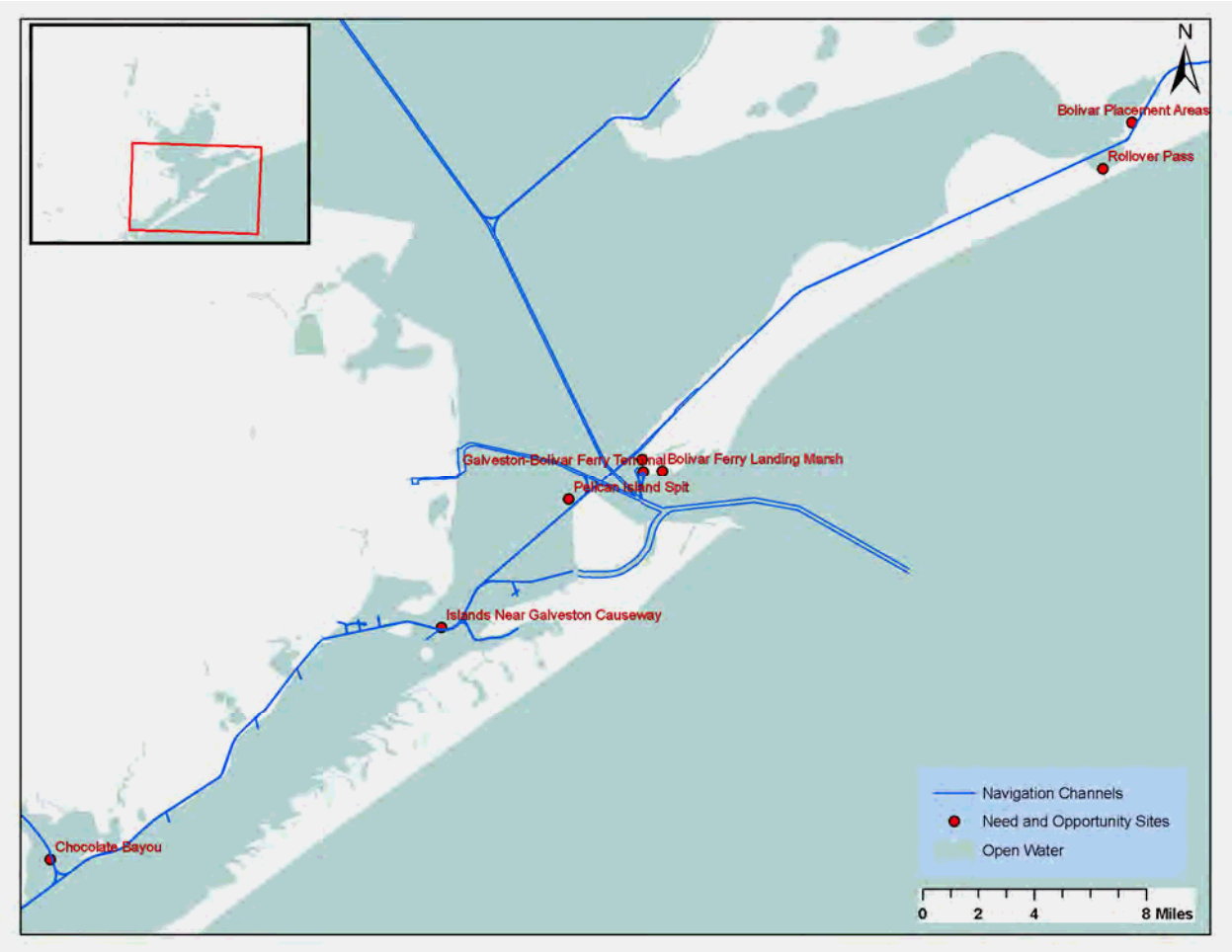


Figure 4-5: Gulf Intracoastal Waterway and Adjacent Areas Needs and Opportunities Map

- *Rollover Pass (GLO)* – Rollover Pass is a manmade inlet between East Bay and the Gulf of Mexico. The original purpose of the pass was to improve fish habitat in East Bay. However, the pass allows a significant amount of sediment to enter into Rollover Bay and the GIWW from the Gulf. The sediment transported into the inlet results in a sediment deficit to adjacent Gulf beaches. The sediment which accumulates in Rollover Bay and the GIWW is generally good quality sand and for the past several years the GLO has paid the differential cost in order for the material to be pumped to the adjacent beaches. ERDC has previously studied a sediment trap configuration that would minimize sedimentation in the GIWW. At present the GLO is considering closing off Rollover Pass. This will change the sediment transport regime in the area, on both the Gulf and East Bay sides of the inlet. It may be possible to beneficially use dredged material to fill in the inlet.
- *Bolivar Placement Areas (GLO, TXDOT)* – GIWW placement areas 36, 41, 42, and 43 have been identified by the GLO has potentially having beach quality sand. GLO is starting a CIAP (Coastal Impact Assessment Program) grant to assess the materials (surveys and geotechnical). Placement Areas 35 and 36 were identified by TXDOT as having a large

quantity of very good quality sand. These sites are accessible only by water. TXDOT also identified Placement Areas 40, 41, and 42 as potentially having good quality sand. Placement Area 42 has road access and could be used as a staging area for material

- *Port Bolivar Channel and Catch Basin (TXDOT)* – The channel to Port Bolivar is federally maintained and reportedly contains generally sandy maintenance dredged material. Material dredged from this channel could be beneficially used for other projects. TXDOT identified that there is a catch basin north of the Port of Bolivar which has a significant amount of sand. The purpose of this catch basin was to decrease sedimentation in the Port Bolivar channel. The sand material in this catch basin may be used for beach nourishment or other beneficial uses. By clearing material out of the catch basin it is assumed that this would lessen sedimentation in the Port Bolivar channel.

- *Pelican Island Spit (TXDOT)* – The Pelican Island Spit is a beneficial use site for the GIWW (GBNEP project titled Pelican Spit Fringing Marsh & Bird Rookery – Biggs and Gallaway 2007). This area of the GIWW experiences heavy shoaling. Currently the barge mooring facility at this site is being expanded.

- *Islands Near Galveston Causeway (TXDOT, GBF/GBEP)* – There are several islands located on both sides for the GIWW west of the Galveston Causeway, including North and South Deer Island. These islands were originally formed from dredged material sidecast from construction and maintenance of the GIWW. Since open water placement has been discontinued these islands have eroded due to waves and subsidence/sea level rise. Dredged material could be used to re-nourish these islands (GBNEP projects titled Jigsaw Island, Jones Bay Bird Rookery Islands, and North Deer Island Marsh & Bird Rookery – Biggs and Gallaway 2007).

- *Chocolate Bayou (TXDOT, GLO)* – In the vicinity of the Chocolate Bayou channel several small islands were created from dredged material during original channel dredging and subsequent maintenance. Many of these islands have eroded away. Additionally many areas of the adjacent shoreline have suffered erosion. There is one current beneficial use site which has been developed by the USACE. The GLO believes that some existing placement areas in the area may contain high quality sand. There have been a number of potential projects identified in the area which may involve sediment needs. Some of these projects include Alligator Point (GBNEP project titled Alligator Point Marshes and Rookeries – Biggs and Gallaway 2007), Long Pond (GBNEP project titled Brazoria National Wildlife Refuge Long Pond Marshes – Biggs and Gallaway 2007), Chocolate Bay (GBNEP project titled Chocolate Bay Marsh and Tidal Flats – Biggs and Gallaway 2007), and Hall's Lake (GBNEP project titled Hall's Lake South Shoreline Protection – Biggs and Gallaway 2007).

- *Galveston-Bolivar Ferry Terminal (TXDOT, GLO)* – The Galveston-Bolivar Ferry is owned and maintained by TXDOT. The Bolivar ferry landing was recently expanded to add a third ferry landing. As part of this expansion the approach channel to the landings was widened. The maintenance dredging requirements for the expanded channel have increased significantly compared to the former channel, especially with the effects of Hurricane Ike, and the channel is presently requiring maintenance on a six month cycle. The material

shoaling into the channel is reportedly reasonably high quality sand. Placement areas in the vicinity generally lack available capacity and beneficial uses of the dredged material have been proposed, including the TXDOT created mitigation marsh near the ferry landing (see Bolivar ferry landing marsh restoration below) and Little Beach. However, due to the short planning horizon for the individual maintenance events and the permitting process timeframe it has been deemed infeasible to modify the permit for the beneficial uses.

- *Bolivar Ferry Landing Marsh (TXDOT)* – This site, located approximately one half mile east of the Bolivar ferry landing, was originally created as a mitigation project for the expansion of the ferry landing. The site may have some capacity for further expansion.

4.3.6 Texas City Channel and Adjacent Areas

The USACE currently performs maintenance dredging on the Texas City Channel. The material from the Texas City Channel is used, in part, for beneficial use as beach fill on the Texas City Dike. Additionally, beneficial use sites for wetland restoration are currently being constructed. No further needs or opportunities for regional sediment management in the Texas City Channel area were identified as part of the data gathering for this study. However, needs and opportunities may exist and should be incorporated into this study as applicable.

4.3.7 Private Channels and Marinas

Potential sediment needs and opportunities for private channels and marinas are less clearly identified. As identified by many of the interviewed stakeholders during the gathering phase of this project (GLO, USFWS/NMFS/TPWD, GBF/GBEP, WGIPOA), improved coordination with smaller private dredging and/or restoration projects is needed.

In addition to the channels and berths maintained by the USACE and local Ports, there are numerous private terminals, marinas, canals, and channels which are dredged. These range in size from large terminals such as ExxonMobil Baytown and Shell Deerpark refineries to small residential canal developments and marinas. However, there is presently little input from federal or state agencies to help these facilities implement regional sediment management and/or beneficial use strategies into their projects. During the USFWS/NMFS/TPWD meeting (refer to Outreach Meeting Notes in Appendix A) it was discussed that standards and best management practices should be implemented from a regulatory perspective for such facilities and that planning assistance should be provided. Additionally, programs should be developed to encourage better use of dredged material by private facilities.

It was also urged that new developments and facilities should show that the long-term capacity exists for placement of their dredged material. One area of particular concern, identified in the meeting with GBF/GBEP, was the Clear Lake area which has a high concentration of marinas and canal lot development including Nassau Bay and Edgewater; however, placement of dredged material into Clear Lake for beneficial use purposes is reportedly not allowed.

The West Galveston Island area is another area with a large concentration of marinas and canal lot developments and the WGIPOA has been actively working with these developments to encourage beneficial uses of dredged material, primarily for wetland restoration. During the meeting with GLO it was identified that many small private dredging and restoration projects in the area could be better coordinated with larger bay efforts.

There is a need to improve coordination between large state/federal dredging efforts and smaller private dredging and/or restoration projects for more efficient use of material. TXDOT also noted that there has been pressure from some agencies for private marinas, etc. to use GIWW placement area which are currently pressed for capacity.

4.3.8 Coastal Resiliency and Beach Nourishment

Potential sediment needs and opportunities to increase coastal resiliency and provide material for beach nourishment include (Figure 4-6):

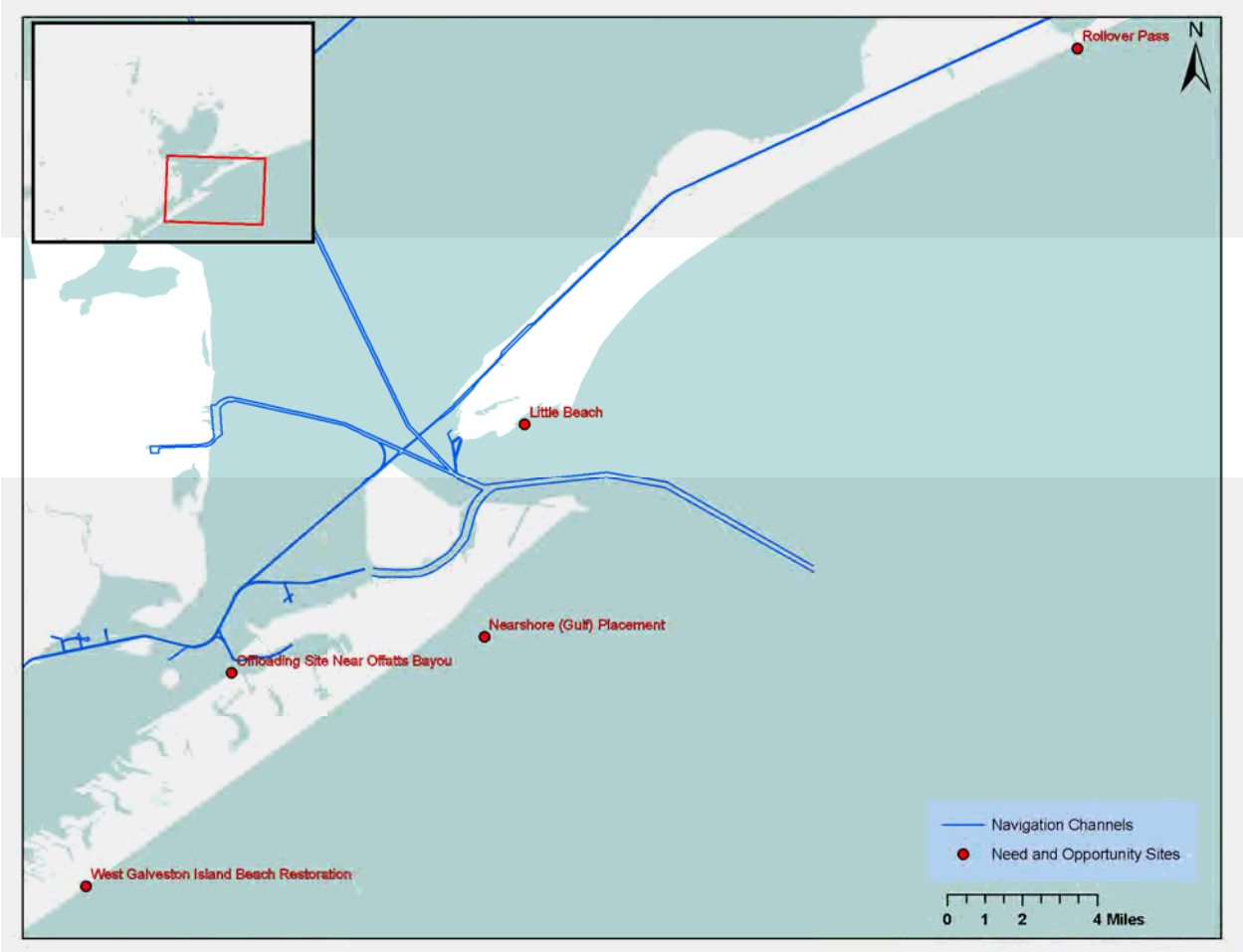


Figure 4-6: Coastal Resiliency and Beach Nourishment Needs and Opportunities Map

- *Nearshore (Gulf) Placement (USFWS/NMFS/TPWD*) – Presently sediments dredged from the Entrance Channel segments of the Houston-Galveston Navigation Channels are placed in an offshore dredged material disposal site (ODMDS). The material contains approximately 40% sand overall (EPA and USACE, 2007) and some portions of the channel may contain a greater percentage of sand. It is unlikely that much of this sand is making its way back into the littoral drift on the Gulf beaches. By bringing the placement area in closer to shore, preferably within the depth of closure (the approximate limit of normal sediment transport from waves), more of the sandy material may enter into the littoral drift and nourish adjacent beaches. This would increase the resiliency to damage from hurricanes and other storms. The placement area could also be designed as a stable (or relatively stable) berm for wave attenuation and/or for fisheries habitat enhancement (by adding relief to the seabed).

- *Rollover Pass (GLO)* – For the past several years the GLO has paid the differential cost to allow the USACE to place dredged material from the GIWW onto the beaches near Rollover Pass as a locally preferred plan. The placement areas included the beaches at the communities of Caplen Shores (west of Rollover Pass) and Gilchrist (east of Rollover Pass). The quantity of material placed on the beaches is reported by the GLO to be between 75,000 and 150,000 cubic yards per year. With the potential closure of Rollover Pass it is anticipated that the amount of beach quality sand being deposited in the GIWW will greatly diminish and change in character and these beneficial use projects will no longer be viable.

- *West Galveston Island Beach Restoration (GLO)* – The GLO has led or participated in the funding of numerous small to medium scale beach nourishment projects on the West End of Galveston Island. Generally these beach nourishments have placed material on the upper beach berm and/or dune system. The sources of sand have varied and include material dredged from Big Reef and various upland borrow sites on the Island. Many of the nourishment projects were severely damaged by Hurricanes Rita and Ike and have been re-nourished using FEMA storm damage recovery funding. A major beach nourishment for the West End of Galveston Island is presently schedule for construction in 2010.

- *Little Beach (TXDOT, GLO)* – The Little Beach site is located near Fort Travis on the Bolivar Peninsula side of Bolivar Roads, inside of the North Jetty. The site experienced significant erosion and damage from Hurricane Ike. Post-storm the site was used for a one-time, emergency authorization placement of approximately 400,000 cubic yards of dredged material from the GIWW. The material was reportedly generally good quality sand and it was believed that fine-grained materials would quickly winnow out, similar to other beach nourishments. However, at present it has been reported that the fines have not winnowed out of the material to the degree assumed. There may be opportunities for further placement at this site in the future, but it is a relatively small area with limited capacity.

- *Offloading Site Near Offatts Bayou (GLO)* – In an effort in aid import of sand to Galveston Island for re-nourishment of Gulf Beaches, the GLO investigated creating an offloading site for barges carrying sand. The proposed location was near Offatt's Bayou near Sportsman Road and 8-mile Road. The project has not progressed, but may be an opportunity to for

better regional sediment management by transporting sand material via barge from other projects.

4.3.9 Other Galveston Bay Areas

Potential future sediment needs for other bay areas include (Figure 4-7):

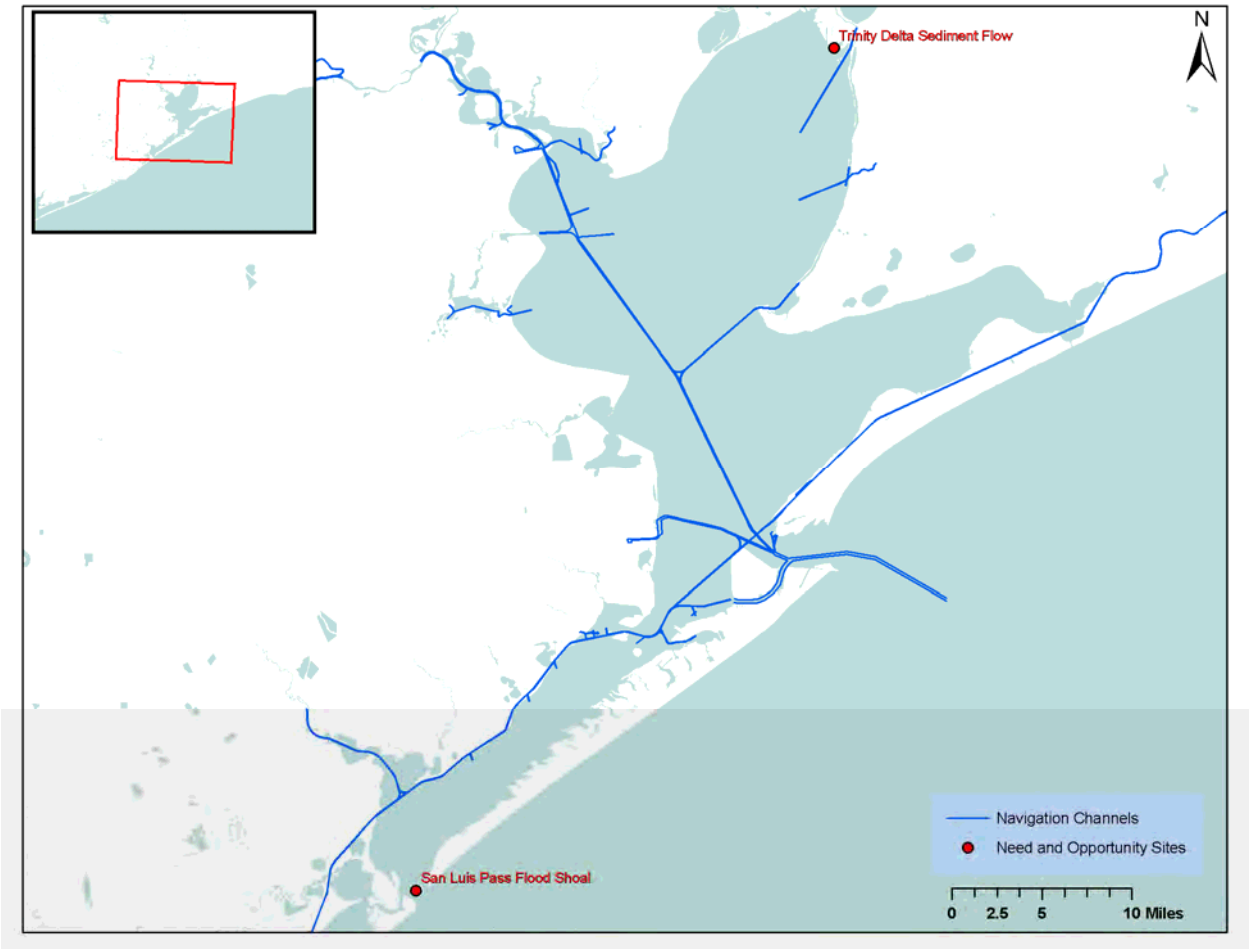


Figure 4-7: Other Galveston Bay Areas Needs and Opportunities Map

- *San Luis Pass Flood Shoal (GLO)* – The San Luis Pass is a natural inlet dividing the West End of Galveston Island from Follett's Island in Brazoria County. The thalweg (i.e. main channel) of the inlet has migrated through time. The inlet, like most Texas inlets, is flood tide dominated. The inlet has significant ebb and flood tide deltas (i.e. shoals) with the flood tide delta being dominant. The inlet has been studied by both the GLO and USACE and is believed to accumulate between 75,000 and 100,000 cubic yards per year of beach quality sand from the adjacent beaches, primarily the Galveston Island side. The GLO has proposed to mine sand from the inlet for re-nourishment of adjacent beaches, primarily Galveston

Island, and is currently pursuing a permit for this activity. Opposition to this project was expressed by USFWS/NMFS/TPWD and the GLO acknowledged that this would be a controversial project if it moves forward.

- *Trinity Delta Sediment Flow (USFWS/NMFS/TPWD)* – The Trinity River Delta, at the north end of Trinity Bay, may be experiencing a decrease in sediment inflow since the construction of upstream dams (Phillips 2005). Presently the Delta is reportedly stable; however, given current relative sea level rise rates, in time it is likely that the Delta will begin to erode and transgress. Rice University researcher John Anderson has studied the Delta through recent geologic history and reports that such a transgressive movement can occur very rapidly. State and federal resource agencies expressed concern over this possibility. It was reported that in the 1990's injection dredging was tried on the lower Trinity River to remobilize sediments towards the Delta, but this was discontinued.

4.3.10 Confined Placement Areas

Potential sediment needs and opportunities for dredged material in confined placement areas include:

- *Cap for Oil Spill cleanup or Oil Well Sites (TXDOT)* – Beneficial re-use of dredged material from confined placement areas to cap oil well sites and or oil spill sites was mentioned as a possible regional sediment management strategy by TXDOT.
- *Accurate Capacity and Volume Data (PHA)* – The Port of Houston noted that estimates of placement area volumes and remaining capacities are limited by surveying techniques. The soft nature of recently placed dredged material makes conventional land surveying techniques impractical. The Port currently uses outside contractors with specialized hydrographic surveying techniques to get better estimates of placement area volumes. It may be possible to use LiDAR (Light Detection and Range) data to estimate elevations; however, this needs to be proven by comparison with other survey techniques. Improving knowledge of placement area volumes and remaining capacities could improve planning for future dredging activities.
- *Use of Dewatered Material from Confined Placement Areas for Construction Fill (PHA)* – Dewatered dredged material may be suitable for construction fill for some projects and applications. However, it is noted that the material does not generally have good geotechnical properties desired for fill material. Additionally, the better dredged material, such as stiff clays from new work dredging, are generally reserved by the USACE for future levee raisings. One possibility raised to the Port of Houston has been using material from Spillman's Island for State Highway 146 construction which is being investigated. The material may also be suitable for sanitary or hazardous landfill cover if properly dewatered. It is possible that a construction contractor or company could make a profit by removing material from placement areas and using this material for upland fill or other beneficial uses.
- *Mine Placement Areas for Habitat Creation/Protection (USFWS/NMFS/TPWD)* – Dredged material in existing confined placement areas could be mined for use in construction of habitat restoration and/or protection projects. This type of construction scheme has been

successfully used on other projects in Texas including the Swan Lake restoration in Galveston Bay and the Old River Cove project on the Sabine-Neches Waterway. While this construction method would require double-handling the dredged material, as opposed to single handling the material by pumping maintenance material directly into a beneficial use cell, it may result in better quality wetlands. Due to the dewatering and more consolidated nature of material from the confined placement areas it would be easier to grade into desired channels, lakes, and other features. Uncertainty due to settlement and consolidation of the material over time would be lessened by using material that has already been dewatered to a greater extent. This would also fit with a desired expressed by USFWS/NMFS/TPWD to minimize new placement areas. In order to implement this strategy it would be useful to inventory what kind and how much material is in the existing placement areas. It is noted that the excavation of the material from a placement area should be well thought out so as to avoid pits within the placement area which may fill with fine-grained sediments and to coordinate with on-going dredging activities.

4.3.11 Other Needs and Opportunities

- *Sea Level Rise (GBF/ GBEP, USFWS/NMFS/TPWD)* – While sea level rise is one of the overarching drivers for the need for habitat restoration and increasing coastal resiliency, it may also present an opportunity for further beneficial uses of dredged material and other regional sediment management strategies. As beneficial uses sites become inundated they may require additional sediments to maintain the needed elevations for wetlands.
- *Use Impounded Material in Reservoirs (USFWS/NMFS/TPWD)* – In some parts of the United States the idea of mining sediments impounded behind reservoir dams is being explored. In the Galveston Bay region there are three upstream reservoirs which could be considered: Lake Livingston (Trinity River), Lake Houston (San Jacinto River), and Lake Conroe (San Jacinto River). It is not clear if this idea is practical in the Galveston Bay region, but it should be explored further.
- *Build Habitat Restoration Sites Without Levees (PHA)* – This idea was presented as a possible alternative to the current practice for beneficial use placement areas. Much of the cost of these placement areas is in the construction of the perimeter levees to contain the maintenance dredged material. This cost may be significantly reduced by not building perimeter containment. This would be similar to the unconfined and semi-confined placement schemes which were used for many years and built up significant wetland and other habitat areas. However, this type of placement may have greater water quality impacts, both in the short-term during initial placement and over the long-term due to resuspension by currents and waves.

4.4 Identified Sediment Management Constraints

In addition to the needs and opportunities discussed in the prior section, a number of constraints were also identified in meetings with stakeholders. The following summarizes these constraints. It is noted that this is not likely to be a comprehensive list of constraints, but is limited to those identified by stakeholders.

4.4.1 Restore Ecosystems in Areas Where They Existed Previously

In many past restoration activities, focus has been placed on meeting acreage requirements for wetland and marsh mitigation. With the loss of coastal habitat gaining attention nationwide, this project-by-project approach to restoration is changing. For the Galveston Bay system much of the intertidal wetland loss has been around the perimeter of the Bay. However, for a variety of reasons, a large portion of the wetland restoration has been conducted in areas where wetlands did not previously exist such as in the center of the Bay. A constraint emphasized in stakeholder meetings with the USFSW/NMFS/TPWD was that future wetlands should be restored in closer proximity to areas where they have been lost.

4.4.2 Mismatch of Sediment Needs and Supplies

As discussed in Section 4.2.1, large quantities of sediments are dredged from navigation channels within the study area on a regular basis. The sediment volume needed for a restoration project is often much smaller than the quantities dredged during a typical channel dredging project. From the USACE's or private entity's perspective, placement of sediment from a channel maintenance dredging project is ideally placed in one location that is as close as possible to the source site to minimize project costs. Use of dredged material from navigation channel dredging projects for marsh restoration can often require use of only a portion of the total volume of dredged material from the channel. The remainder of the dredged material needs to be diverted to another placement site. This can result in an increased dredging cost that needs to be offset by some entity.

4.4.3 Timing

Dredging of the navigation channels within the study area occurs on a regular basis dependant on USACE's or a private entity's fiscal ability and need. In order for RSM strategies to be successfully implemented within the study area, early coordination would be needed to ensure the timing of the individual project was aligned with the channel maintenance project. Also, for private entities the time required to obtain the necessary permits for beneficial use or other RSM solutions is often greater than the dredging cycle time, which often discourages these RSM solutions. Similarly, the timing of some placement alternatives, such as a restoration project, may need to comply with funding and permitting restrictions of its own along with the time required to work with property owners and obtain project funding. Lastly, windows of opportunity for certain dredging activities, due to threatened and endangered species in the region, sometimes limit the practicality of otherwise viable RSM strategies.

4.4.4 Permitting

Permitting and regulatory requirements for dredging and dredged material placement activities are complex, time extensive, and can be costly. The difficulties associated with permitting requirements for these types of projects were brought up numerous times at the multiple agency meetings held for this report (refer to Outreach Meeting Notes in Appendix A). Streamlined programmatic permits are not available for these projects and the complex process provides little

incentive towards the RSM approach for state, local, or private entities or applicants. Given the expensive and complex nature of permitting dredging and dredged material placement activities, private entities are even less likely to be able to complete successful projects than other agencies or entities that deal with these issues on a more regular basis. It is noted that for most projects careful planning and timing can overcome these constraints.

4.4.5 Funding

Discussions with the federal and state agencies and stakeholders during the outreach effort of the Plan identified funding as a sediment management constraint. The majority of beneficial use projects that have presently been implemented have been brought to fruition through local sponsor matches of federal funds. These local matches are often a challenge to obtain as many of these projects are headed by local groups with limited funds. Funding sources utilized by these groups included a variety of federal and state grants and direct Congressional appropriations in some cases.

4.4.6 Federal Standard

The Federal Standard helps to guide the placement alternatives which are chosen for dredged material management on federal projects. The Federal Standard is generally paraphrased as being the "least cost, environmentally acceptable" alternative. It was intended as a reference point for USACE offices to address sediment management issues with a certain level of national consistency while ensuring a "necessary level of flexibility" (Engler et al. 1988). However, many stakeholders (TGLO, TPWD, USFWS, and the NOAA Fisheries Service) cited the Federal Standard as a constraint on RSM strategies and solutions. The constraint was generally viewed as the "least cost" requirement not allowing for many alternatives to be implemented. During stakeholder meetings there was also some discussion on what constitutes "environmentally acceptable" being open to interpretation.

It may be necessary to further define and clarify the original intention of the Standard, how the Standard has been implemented for the region, and how different agencies can better utilize the Standard to support RSM practices in the study area (see Section 5.2.2 for further discussion on this issue).

4.4.7 Sediment Quality

As stated in Section 3.4, sediment quality in the study area is generally known for sites that require frequent dredging due to required data collection efforts prior to dredging. The data generally includes information on the general physical and chemical composition of the material.

However for many beneficial uses, any sediment quality issues, including both physical and chemical characteristics of the sediments, may be detrimental and make the alternative infeasible. There was little data found on standardized sediment quality requirements for beneficial use sites.

Additionally, beneficial use may result in dredged material being used at upland sites but some of these situations can result in complex and sometimes conflicting regulatory requirements (Childs, Abney, and Young 2008). For example, material identified as non-hazardous under the CWA, will also need to meet state and local material and water quality. This adds time and complexity to beneficial use options.

Understanding sediment quality in the study area and the quality of sediment required for beneficial use options is a constraint on many potential RSM strategies and solutions.

4.4.8 Construction Quality Control

There is some concern by state and federal resource agencies that poor construction management has led to problems with some constructed beneficial use sites (e.g. Smith Point) (refer to Outreach Meeting Notes in Appendix A.) Reportedly once permits are received for a project, very little oversight is required of the project applicant (whether it is a private applicant, a state applicant, or the USACE) to confirm that the site is being constructed to the specifications outlined in the construction drawings and project permits. Additionally there is little incentive for dredging contractors to meet any placement specifications as they are most commonly paid on specifications based on dredging volumes. Best Management Practices (BMPs), monitoring requirements and record keeping during and after construction, and contracting incentives could be modified and/or improved to promote the successful construction of a variety of beneficial use sites.

5.0 RSM STRATEGIES AND SOLUTIONS

A number of needs, opportunities, and constraints were presented in the prior section. In this section these projects and ideas are assimilated into a set of strategies and solutions applicable to RSM for Galveston Bay. Recommendations on the implementation of these strategies and solutions are also discussed.

5.1 Knowledge of Sediment Systems

5.1.1 Inventory of Placement Area Materials and Quantities and Availability

One of the key data gaps that was identified by more than one stakeholder was knowledge of how much and what kind of material is in various placement areas. This data gap should be closed by implementing a program of quantifying material of various types in placement areas. This will provide needed information for efforts to beneficially use sediments from these placement areas as well as give better information for the long-term management of the sites.

The process of quantifying material types has been initiated by the GLO for select placement areas as part of their search for sands acceptable for beach nourishment. The lessons learned from their efforts should be integrated into plans to extend exploration to other placement areas. While the GLO's exploration focused only on sand resources, other material types may be beneficially used for other purposes, as discussed elsewhere in this study.

Due to the extremely soft soils, often flooded conditions, and surveying difficulties, special technologies may be required for the quantification of total material quantities within the placement areas. This may include use of LiDAR (Light Detection and Ranging) surveying technologies. Generally, LiDAR technologies are not capable of measuring water depths (except special systems in relatively clear water); therefore, special hydrographic surveying techniques modified for shallow waters may be necessary for flooded cells.

In addition to quantifying the total quantity of materials in the placement areas, classification of the material and quantification of various material types is needed. The engineering properties which would be of most interest include sand/silt/clay breakdown, grain size analysis, Atterberg limits, moisture content, and unit weight. Generally these properties are determined by laboratory testing of materials obtained from soil borings. However, similar to surveying, obtaining geotechnical samples from within placement areas would be very difficult. Generally a strong indication of the material types can be gained from the records of material types placed in the cells, particularly if discharge corridors for various contracts are known.

Newer and/or less traditional geotechnical and geophysical tools and methods may be useful in the effort of classifying material types. These include cone penetrometer tests (CPTs), ground penetrating radar (GPR), electrical resistivity, and shallow seismography. The applicability of these techniques would need to be tailored to the specific placement areas and the desired material classification accuracy.

5.1.2 Develop a Quantitative Galveston Bay Sediment Budget

The preliminary sediment budget (Section 3.1) roughly depicts the sediment sources, sinks, and pathways within Galveston Bay based on the best available existing information. Through the development of this budget, areas were identified that could benefit from future refinement to better understand this complex system. These areas are:

- Fluvial Input Yields – Refinement is needed in the yield values generated for all fluvial inputs to Galveston Bay. Five yield-point areas from Greiner (1982) were utilized to represent the yield per area (tonnes/acre) for all watersheds that discharge to the bay except the Trinity River. The yield-point values from this study represent the particular combinations of land use, cover, rainfall, and soils that occur above that yield. Yield-points were not available for each individual watershed used in the sediment budget. Additionally, the yield-point values do not reflect changes in land use since 1982. The sediment yield from the Trinity River was derived from Phillips (2005). Although this study is specific to the Trinity River, it focuses on the sediment delivery impacts from the Lake Livingston Dam. The Liberty Station is the closest sediment monitoring location in the study to the Trinity Bay and is located approximately 30 miles upstream. Sediment delivery to the Trinity Bay is only estimated in this report.
- Shoreline Erosion Yields – Average shoreline erosion rates and relief heights were utilized from Phillips (2005) and were applied to the entire bay shoreline to generate shoreline erosion volumes for the sediment budget. Specific erosion rates and relief levels for the bay shoreline could be analyzed to improve the accuracy of this shoreline erosion value.
- Re-suspended Sediments within Bay – The preliminary sediment budget identified a large amount of material whose source was unknown (8 million tonnes/year). In order to balance the budget, it was assumed that resuspension of sediments within Galveston Bay from wind waves and currents was the source of this material and, further, that resuspension occurs uniformly throughout the Bay. Resuspension may be the contributor of some or most of this material and should be better studied and understood. Field data collection efforts focused on turbidity and suspended solids within the Bay are important to better understanding this factor. The other potential sediment sources that were excluded from the sediment budget may be a factor and should be analyzed for their potential contribution to this deficit volume. These other potential sources include aeolian inputs, coastal and marine sources derived from barrier island overwash, and fine-grain sediment transported through Bolivar Roads.
- Channel Shoaling Rates – Only a limited number of dredging records were available to be used in the calculation of shoaling rates for some of the navigation channels due to the need for consecutive years of dredging along a reach of channel for comparison. In particular, good dredging records were not located for the Texas City Channel and GIWW. Additionally, utilization of dredging records to calculate shoaling rates may have accuracy issues due to missing records and other data quality problems. More detailed sedimentation studies of the shoaling within the channels would improve these values.

- Flood Shoal Growth – A flood shoal growth value should be applied to San Luis Pass. The sediment budget currently utilizes the Gulf sediment budget value (Morang 2006) that was noted to be incomplete in the study.
- Sedimentation Estimates for Galveston Bay Cells – Estimates of erosion and/or accumulation rates within various parts of Galveston Bay are needed to better understand the sediment fluxes between cells and navigation channels in the region. These studies could modify the sediment pathways identified in the existing sediment budget.
- Maintenance Dredged Material Density – At present the density of maintenance dredged material is assumed to be equal to that of sediments accumulated from other sources. However, the density of the maintenance material may be significantly less and thus affect the sediment budget. This could be confirmed through sampling of maintenance material.

5.1.3 Use Sediments Impounded at Upland Dams/Reservoirs

The impoundment of sediments behind dams in the coastal region is evidenced by surveys of Lake Houston and Lake Conroe, both on the San Jacinto River, by the TWDB (TWDB 2003a and 2003b). These surveys indicate that Lake Houston has been accumulating sediment at a rate of approximately 720,000 m^3/yr (940,000 CY/yr) and Lake Conroe at a rate of approximately 750,000 m^3/yr (980,000 CY/yr).

It is not directly clear how much of this impounded sediment would otherwise have made it into the Galveston Bay system. However, the impounded sediment may be a potential source for sediments for future habitat restoration and coastal resiliency projects. Since the sediments impounded behind dams decrease the capacity of the reservoirs, removal of these sediments would be beneficial to the reservoirs also (if accomplished in an environmentally acceptable manner).

The first step in using impounded sediments is improved knowledge about the sources of sediment which may be available behind these dams. The quantification and classification of sediments impounded behind dams should be undertaken in cooperation with local river authorities and the TWDB. Bathymetric surveys are already being conducted for many of the reservoirs in the Galveston Bay watershed. Geotechnical grab samples could aid in identification of the types of sediments which have accumulated in the reservoirs.

The largest challenge in beneficially using sediments impounded in reservoirs is finding cost effective methods of transporting the sediments to the desired location. Some methods of controlling sediment flows within reservoirs are available (USBR 2006), but may require costly modifications to the dam. These methods would generally return sediments to fluvial environment downstream of the dam. Other options include removal of the sediments through excavation or dredging. The cost of such alternatives may become infeasible, but should be explored for future projects.

5.1.4 Use Sediment Tracers

Sediment tracers provide a method of determining local sediment pathways. These tracers typically consist of an artificial particle which imitates the characteristics of the natural sediment in the area. The tracers have a manmade characteristic, typically phosphorescence, which allow them to be detected and quantified. In some cases multiple tracers can be tracked at one time, giving information on sediment flows from many individual areas.

Sediment tracers could be used to determine sediment pathways in relatively small areas which are sedimentation "hot-spots", such as the lower portion of the HSC Bayou Reach. This may allow for development of engineering solutions to alleviate some of the sedimentation into unwanted areas (i.e., navigation channels).

Sediment tracers can also be used to estimate the sediment transport capacities of various fluvial sources. Sediment tracers can provide information on the relative importance of various sources to sedimentation in a particular area. It is noted that over larger areas, such as the entire Galveston Bay system, sediment tracers become impractical due to the volume of tracer required in order to be detectable at distant locations.

5.2 Regulatory/Policy Implementation

5.2.1 Establish and Support A Regional Sediment Management Working Group

At present, beneficial uses of dredged material have been encouraged on an ad hoc basis by the USACE and state and federal resource agencies. The BUG is the exception to this statement; however, the BUG was formed strictly for the Houston-Galveston Navigation Channels project. In an effort to increase coordination between the USACE, state and federal resource agencies, and non-governmental organizations for all projects in the Galveston Bay Region, a Regional Sediment Management Working Group should be created.

The group should be lead by the USACE and include member-stakeholders from the state and federal resource agencies, local governments (city and county), local ports and other local government entities (flood control districts, etc.), and non-governmental organizations. The group would not have direct regulatory authority, but would allow coordination of RSM issues to help set the regulatory agenda for members and to steer projects in directions which would incorporate RSM principles and strategies. This working group would address RSM issues including beneficial uses of dredged material throughout the region for multiple projects. These projects would include federal, state, local government projects, and private projects.

5.2.2 Federal Standard Considerations

The Federal Standard is defined in USACE regulations as the least costly dredged material disposal or placement alternative (or alternatives) identified by USACE that is consistent with sound engineering practices and meets all federal environmental requirements, including those established under the Clean Water Act (CWA) and the Marine Protection, Research, and

Sanctuaries Act (MPRSA) (see 33 CFR 335.7, 53 FR 14902) (EPA and USACE 2008). This standard is often expressed as the "least cost, environmentally acceptable" alternative. The Federal Standard defines the "base plan" for dredged material placement alternatives for which the costs are assigned to the navigational purpose of the project. Any costs above or beyond the Federal Standard plan, also referred to as the "incremental costs", are shared between the USACE and the local sponsor on a different basis than the costs for the navigational purpose.

5.2.2.1 Environmental Acceptability

The "environmentally acceptable" portion of the Federal Standard is based on conformance to the environmental regulations listed in Section 4.1. Navigation projects generally require environmental documentation under the NEPA. This requires coordination with state and federal resource agencies, often in a local planning group (LPG) such as the BUG, to help define the "environmentally acceptable" alternative(s). As such, federal and state agency representatives can promote changes to what constitutes "environmentally acceptable" by becoming involved in LPGs and ensuring that RSM practices and strategies are incorporated into the final selected alternatives. The NEPA process also requires public notification and commenting, which is another opportunity for RSM to be integrated into a project.

5.2.2.2 Project Costs and Funding Opportunities

In the process of determining a dredged material management plan (DMMP) for a project a number of alternatives are typically screened and prioritized. For these alternatives the portion of the cost attributable to the "base plan" for "navigational purposes" is determined. The remaining portion may be attributable to other purposes such as ecosystem restoration, flood control, and/or flood damage reduction and may be borne by the local sponsor.

Section 4.4.6 identifies stakeholder concerns regarding the Federal Standard by representatives from TGLO, TPWD, USFWS, and the NOAA Fisheries Service. These agencies are concerned that the Federal Standard prohibits the USACE from choosing alternatives that are not the least-cost alternative. However, the USACE can complete higher cost alternatives if the project proponents can obtain funding for the incremental project costs. The Federal Standard was originally intended as a reference point for the USACE to address project economics with a certain level of consistency. It was not meant to limit Federal participation in projects. Restoration is recognized as a mission of the USACE (USACE 2000), and the placement option selected for a project should maximize the net economic development and national environmental restoration benefits. Therefore, a beneficial use option may be selected for a project even if it does not meet the Federal Standard for that project. If a beneficial use option is selected for a project and the use is part of the Federal Standard or base plan option, the costs of that beneficial use are assigned to the navigational purpose of the project and are shared with the non-federal sponsor. In general, assuring the non-federal funding is the point where many otherwise viable alternatives flounder. This should be addressed by the non-federal partners and resource agency partners in a systematic way to help assure sources of non-federal funding.

This approach, where the alternative is environmentally acceptable and a local sponsor chooses to pay the "incremental cost" for a "locally preferred plan", has been successfully used for a

number of dredging cycles for placement of dredged material from the Rollover Bay area of the GIWW onto the Gulf beaches. The GLO has provided funds for this locally preferred alternative. This policy could be used on other projects to increase beneficial uses of dredged material and implement RSM strategies. The locally preferred alternative can also be applied to non-navigation projects (such as flood control projects as listed above) to improve sediment management.

There are other USACE policies and programs which may allow for some of this incremental cost to be borne by the Federal Government. These programs include: (1) Improvement of the Quality of the Environment (Section 1135 of WRDA 1986); (2) Protection, Restoration, or Creation of Aquatic and Related Habitats (Section 204 of WRDA 1992); (3) Placement of Dredged Materials on Beaches (Section 145 of WRDA 1976); and, (4) Achieving Environmental Benefits (Section 207 of WRDA 1996). The first three programs have programmatic appropriations that limit total amount spent by the Federal Government nationwide and also have local match requirements of 25% (1 and 2) to 35% (3). The fourth program, Achieving Environmental Benefits (Section 207 of WRDA 1996) does not have a programmatic appropriation, but requires specific authorization by Congress for each project. This authorization may be most applicable to larger and/or new projects.

Of concern to the USACE is that with cuts to Operations and Maintenance funding, if a project proponent cannot share incremental costs, the USACE must select a least-cost alternative. Improved communication and planning between federal, state, and local agencies and project proponents could support more coordinated project efforts where increased attention is given to beneficial use alternatives and shared funding opportunities. This is especially true for emergency dredging operations, such as those necessary following storms, and periods of larger than normal sedimentation into navigation channels. Dedicated non-federal funding sources would help to ensure that the local funds are available when needed. This would help prevent delays to dredging activities, generally unacceptable to ports and navigation interests, due to funding cycles of other agencies. As stated in Section 4.4.6, it may be beneficial for the USACE to further define and clarify the original intention of the Standard. This would include clarifying how the Standard has been implemented for the region and how different agencies can better utilize the Standard to support RSM practices in the study area.

5.2.3 Dredged Material Management Plans

Coordination with DMMPs could benefit RSM implementation as they provide an immediate vehicle for developing and executing the RSM approach (Martin 2006). DMMPs are updated periodically and can be completed for multiple projects at once. The development of DMMPs with RSM goals and objectives may, therefore, contribute to increased efficiencies and reduced costs.

RSM can also be used to support DMMPs by:

- Expanding the focus of DMMPs from project to regional decisions
- Identifying, quantifying and managing sediment sources and sinks;

- Including an increased number of stakeholders in the decision making process; and
- By addressing the effects of sediment management rather than just looking at dredging and disposal requirements (Martin 2006).

However, regional DMMPs could delay projects given the necessity to accommodate for additional stakeholders, different ideas and priorities, and different funding sources required to support their development. Also, the funding of projects may be complicated by having multiple stakeholders involved in a single DMMP.

5.2.4 Incorporate Environmental Economics

One of the strategies suggested in meetings with state and federal resource agencies for increasing use of beneficial uses of dredged material and implementation of RSM is to utilize environmental economics. Traditional economics used for USACE planning purposes generally do not fully capture the value of "non-market" environmental assets (i.e., wetlands and their functions in improving water quality, providing habitat that supports species for commercial and recreational fishing etc.). Environmental economics attempts to assign monetary values to these assets and their functions. It is often hard to set the value of these assets since they generally cannot be owned and sold or traded in an open market system.

Currently the USACE is working on updating the Principles and Guidelines (P&G) for planning of federal projects. Several organizations, including the American Society of Civil Engineers (ASCE), have urged incorporation of environmental economics into the Corps' planning process. If such policies for economic analysis are included in the updated P&G then their application to beneficial uses of dredged material and RSM should be explored. It is likely that incorporating environmental economics into the planning process would add economic benefits to beneficial use projects and RSM strategies which may allow them to be a part of the Federal Standard placement plan for a given project.

5.2.5 Incorporate RSM into Texas Coastal Management Program

At present the Texas Coastal Management Program (CMP) (Title 31 Texas Administrative Code (TAC) Chapter 16 Rule 501.25) includes language requiring the beneficial use of dredged material where practical and economically viable. The CMP incorporates several principles of RSM, including beneficial uses of dredged material; however, the CMP does not directly address RSM. Incorporation of RSM principles and strategies into the CMP would help increase the use of RSM in project planning and design throughout the State of Texas. This action would have to be taken by the GLO.

5.2.6 Issue Regional General Permit for Beneficial Reuse Projects

To address the identified sediment management constraint of permit authorization timing and complexity, the USACE, Galveston District could coordinate with other regulatory agencies to streamline and abbreviate the permitting process. Specifically the USACE could develop a

Regional General Permit to allow beneficial use projects meeting certain criteria to be processed within a shortened timeframe.

The term General Permit (GP) means a Department of the Army authorization that is issued on a nationwide or regional basis for a category or categories of activities when:

- Those activities are substantially similar in nature and cause only minimal individual and cumulative environmental impacts; or

- The general permit would result in avoiding unnecessary duplication of regulatory control exercised by another Federal, State, or local agency provided it has been determined that the environmental consequences of the action are individually and cumulatively minimal.

The USACE Galveston District already has a GP for maintenance dredging (GP 15926(02) and artificial wave barriers (GP 1908801). A GP for types of beneficial use activities would provide streamlined alternatives that could be better coordinated with dredging activities.

The RGP would be issued a 401 certification by the TCEQ. Having a regional permit in place from these two agencies would allow beneficial use projects to move quickly through the permitting process from these two agencies. The RGP would also lower USACE regulatory staff time by not requiring that an individual permit be issued for each of these beneficial use projects.

Setting the conditions for such a general permit would require extensive coordination. Beneficial use definitions would need to be developed along with best management practices (BMP's) and conditions to limit the impacts to water quality and other natural resources. Coordination of a GP for beneficial use projects would likely be a lengthy and involved process. It is likely that no "one size fits all" permit could be developed to cover all beneficial use projects and extensive restrictions or complex definitions may limit its applicability; however, even a permit which covered the most common types of beneficial uses would improve application of this RMS solution.

5.3 Beneficial Uses

5.3.1 Use Beneficial Nearshore (Gulf) Placement

As mentioned in Section 4.3.8, sediments dredged from the Entrance Channel segments of the Houston-Galveston Navigation Channels are presently placed in an offshore dredged material disposal site (ODMDS). Maintenance material in the Entrance Channel has been found to contain approximately 40% sand and is possibly coarser in some locations of the channel. A proposed strategy is to relocate this disposal site to depths close to or shallower than the depth of closure (DOC). DOC estimates vary in the study area dependant on the time period considered and storm events during that period. However, a DOC of -15 feet NAVD has been used for the design of beach nourishment projects in the region so was adopted for the purposes of this report.

Additional investigation needs to be conducted to site such a placement area. This investigation would include detailed sediment transport analysis for material placed nearshore. The investigation would also include study of the operational requirements for placing material in such shallow depths via hopper dredge. The dredge may be required to pump out material, versus normal bottom dumping, and the economics of such operations would need to be investigated. As an example, a potential nearshore placement site is shown in Figure 5-1. As shown, the placement site would extend from water depths of approximately -15 ft to -10 ft NGVD with the approximate dimensions of 7,000 feet in length and 1,500 feet in width.

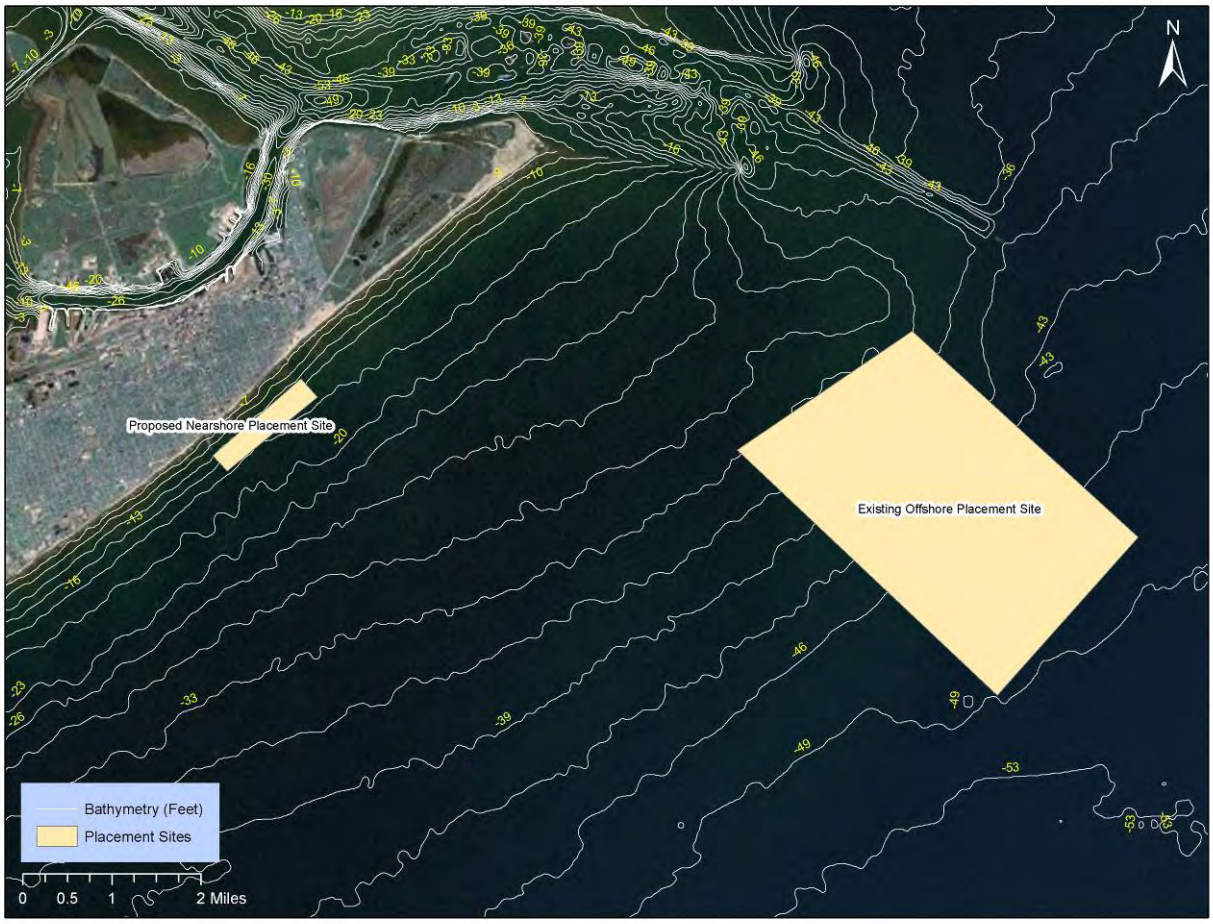


Figure 5-1: Existing and Proposed Offshore Placement Sites

Placement of dredged material from the Entrance Channel in this location would potentially allow a portion of the sediments placed in this location to naturally migrate onshore. The location of the disposal site is in a divergence area of littoral transport along the Galveston Island shoreline. Therefore, material placed in this location could potentially feed Gulf beaches to the east or west of the disposal site. Use of a similar strategy for dredged material placement has been used at the Brazos Santiago Pass with material placed on South Padre Island. The effectiveness of this strategy at that location could be used for guidance.

There are also other approaches to beneficially using the dredged material which would similarly move the placement area closer to shore. The first of these would be to build a stable (or stable with periodic replenishment from maintenance events) berm which would attenuate wave energy. The second would be creation of a mound or berm for fish habitat enhancement by increasing seabed relief. Both of these alternatives may potentially be integrated with the design concept of material migrating on shore. The nearshore placement area could be designed with one or more of these design criteria.

5.3.2 Use Dredged Material for Beach Nourishment and Shoreline Protection

As stated in Section 4.2.2.2, dredged material has been used for many years within the study area for beach nourishment and shoreline protection. However, due to increased shoreline development and sea level rise, there remains an increasing need for large quantities of high quality sand that can be used for additional beach nourishment projects. This need significantly increased following the impact of Hurricane Ike on beaches within the study area in 2008 and is not anticipated to decrease as sediment sources to the study area are limited.

The GLO has investigated reuse of material from several upland confined placement areas for the purpose of beach nourishment. Some investigation has also been conducted on direct placement onto Gulf beaches. Both of these strategies should be considered for navigation projects in the area.

Future focus should include identifying areas where sediment can be reintroduced to coastal systems to feed local beaches in the study area. One possible example is the idea of the nearshore placement project proposed in the previous section.

5.3.3 Use Dredged Material Wetland and Marsh Restoration

The strategy of using dredged material for wetland restoration is currently being successfully used extensively in the study area. However, this strategy still has potential application to many projects in the region where it is not being used. Current wetland and marsh restoration projects often use small quantities of dredged material for projects. This makes it a more costly placement option compared to other options which can take larger quantities of material. If larger restoration opportunities could be identified and developed, the use of dredged material for wetland and marsh restoration would be a more cost effective alternative. Improved coordination and communication between project applicants and resource agencies could also improve the timing issues that often impede the use of dredged material for restoration projects.

5.3.4 Use Dredged Material for Construction Fill/Engineered Applications

Possible upland uses for dredged material could include use as fill for the construction of highways, airports, industrial, and commercial upland sites. Other alternatives include the use of dredged material for composting or topsoil (agricultural/horticultural), cover for hazardous and sanitary landfills, building materials, and landscaping. Dredged material from CDF's can also be

used to construct in-water or shoreline levees and dikes. It can be used to fill geotextile tubes which can be used for shoreline and wetland protection.

Dredged material can be stockpiled at a storage area, either a CDF or in-water stockpile, where it can be dewatered and then transported by truck, barge, or rail to an upland site for use. Stockpiled material can also be separated for different uses based on the quality and characteristics of the dredged material.

Considerations for the use of dredged material for upland uses include:

- Quality and quantity of available material
- Requirement for dewatering
- Cost of transportation to the construction site
- Timing of dredging and construction activities

5.3.5 Use Placement Areas as Staging Areas

As identified in Section 4.3.5 opportunities exist within the study area to use existing placement areas as staging areas for dredged material for other projects. In this way, dredged material can be stockpiled for periods of time allowing for more flexibility in coordinating dredging activities with beneficial use opportunities. This would also help alleviate the constraint of mismatches in volume requirements between dredging projects and restoration projects. This solution could be applied to either upland confined placement areas or in-water placement areas.

5.3.6 Use Dredged Material as Remediation Fill for Contaminated Sites

Clean sediment, particularly from CDF's, can be used to remediate or cap contaminated sites. This strategy might be particularly applicable for the lower San Jacinto River area. This strategy would beneficially reuse sediments and also increase capacity for future projects.

5.3.7 Increase Beneficial Use Opportunities for Private Dredging

One of the needs and opportunities, mentioned by several stakeholders, was improving beneficial use opportunities for non-federal dredging projects. The non-federal dredging projects include small marinas through major commercial/industrial berths and channels. Many of these project face constraints such as a mismatch in quantities between material to be dredged and the needs of restoration projects (Section 4.4.2), the time required to obtain permits for beneficial uses or modify existing permits exceeds the dredging cycle time (4.4.3), the permitting requirements discourage beneficial uses (Section 4.4.4), and sediment quality (grain size and/or contaminants) do not match beneficial use requirements (Section 4.4.7). Also, there may be cases where the private entity conducting dredging operations may not be aware of potential beneficial use opportunities.

Improving the opportunities for beneficial uses and other RSM strategies and solutions by entities involved in private dredging (owners, engineering, contractors, etc.) can be accomplished through several of the strategies outlined in this report. Development of RSM and beneficial use guidelines by an RSM Working Group (Section 5.2.1) could be disseminated to various entities to help them identify potential alternative uses of dredged material. The RSM Working Group itself could aid in coordination with private entities on potential RSM and beneficial use opportunities. The creation of a regional general permit for beneficial use placement (Section5.2.4) would help to limit the permitting requirements and timeframe which may discourage many private entities from beneficial uses at present. Using placement areas as staging areas (Section5.3.5) and using material from confined placement areas for ecosystem restoration projects (Section5.3.9) may help address the frequent mismatch between desired quantities for restoration projects and the dredging needs for navigation projects. Lastly, development of life-cycle costs for dredged material placement areas (Section5.4.1) may result in changes in disposal costs at upland confined placement areas which may encourage private dredgers to find other placement opportunities.

5.3.8 Place Dredged Material for Ecosystem Restoration without Hard Containment Structures

The use of dredged material for restoration, without the need to place the material within a containment structure (such as within or behind an armored levee or geotextile tube) could significantly reduce the cost of ecosystem restorations. Much of the cost for past restoration projects has been in perimeter construction and protection. The construction technique may result in more natural and functional wetland restoration sites. However, this alternative may also result in increased water quality impacts, particularly where maintenance dredged material is used. Additional planning and design is needed to prove the feasibility of this strategy.

5.3.9 Place Material from Confined Placement Areas for Ecosystem Restoration

Ecosystem restoration projects in the region, wetland restoration projects specifically, have generally used material borrowed from nearby sources (transported via pipeline as a slurry or using land-based construction equipment) or used maintenance dredged material. An alternative method of constructing these projects would be to use previously maintenance dredged material from existing confined placement areas (Section 4.3.10).

Generally, the previously dredged material would be dewatered in a confined placement area, for up to several years, then excavated, transported, and placed at the ecosystem restoration site. Through this dewatering process the volume of the material will generally decrease on the order of 35% (short-term with minimal dewatering effort) to 65% (long-term with intensive dewatering effort) in comparison to the in situ volume in the channel. (For a beneficial use of dredged material for a marsh fill a typical volume decrease is 30%.) Along with this decrease in volume through consolidation, the strength properties of the material are also increased significantly, leading to a dewatered material which is much more workable for grading.

Dredged material could be removed from confined placement areas using a combination of standard land-based construction equipment (draglines, front end loaders,trucks, bulldozers, etc.)

which may require working on mats, specialized marsh equipment (i.e., marsh buggies), and/or marine equipment (barges and barge mounted equipment). The dredged material could be transported directly to an adjacent beneficial use site or loaded onto barges to transport to distant sites. This method of ecosystem restoration may require double or triple handling of material which can increase costs; however, there are several advantages which may offset this potential cost.

The potential advantages include improved wetland products due to:

- Improved topographic relief by using pre-consolidated material which is more easily shaped into desired features,
- Better circulation by improved channelization through use of material which is more easily shaped,
- Greater plant species variety due to improved topographic relief,
- Improved resiliency due to more consolidated sediments which are harder to erode,
- Decreased risk from settlement by using materials which are already consolidated and dewatered,
- Decreased need for perimeter containment and protection due to more consolidated sediments which are harder to erode,
- Increased total long-term capacity for maintenance dredged material, up to double (with a placed material which has decreased in volume from in situ volume in channel by 60% as compared to 30% for typical pumped in placement of maintenance dredged material),
- Increased flexibility on the timing of restoration activities with sites being able to borrow from existing placement areas with material to be replaced later by maintenance material, and
- More competition for construction contracts potentially leading to better pricing.

This alternative may also allow for relatively consolidated dredged material to be used at locations relatively far from the navigation channels which are the source of the material, thus potentially more economically allowing wetlands to be rebuilt in areas where they previously existed without borrowing sediments from nearby areas.

Several wetlands have been created in the Texas Gulf Coast region using material borrowed from dredged material placement areas, including at least one in Galveston Bay. The design and operational constraints of this technique should be further investigated and a conceptual design developed along with construction cost estimates. If the construction and operational constraints can be successfully overcome, the overall life-cycle cost of this alternative should be compared to current beneficial use placement practices. If the alternative of using material from upland placement areas proves to have higher overall costs, these should be weighed against the potentially better wetlands which would be built.

5.4 Cost Analysis

5.4.1 Analyze Life Cycle Costs for Dredged Material

Management of dredged material for navigation requires a number of elements including real estate acquisition, levee construction and maintenance, shoreline protection, dewatering structures, dredged material transport and placement, disposal area management plan (DAMP) activities, and more. Each of these activities and elements has an associated cost. However, due to the nearly indefinite life-cycle of navigation projects and the processes by which projects are planned and maintained, the accumulated costs of all of these elements and activities are not generally determined. Further, the costs for these elements change over time, particularly real estate costs, and the replacement costs for a dredged material placement area may be much higher than its original cost.

A life-cycle cost analysis would accumulate all these costs and the replacement costs for these facilities. This is an important step to understanding the value of dredged material and of dredged material placement area capacity. A life-cycle cost analysis would also allow for better comparison of alternatives for dredged material management on an economic basis.

Ideally the life-cycle costs for each active placement area in the Galveston Bay region would be studied. At a minimum, the life-cycle costs for several different types of placement areas (upland confined, unconfined, beneficial use, offshore, etc.) for multiple federal projects in the region should be determined. This would aid in understanding the economic costs and benefits of each type of placement strategy in the local context of Galveston Bay. It would also provide a basis for estimating the benefit to the federal project of any beneficial uses which would take material from or reduce the capacity requirements of existing and future placement areas.

5.4.2 Develop Cost/Transport Model for Use of Upland Dredged Material

Knowing more precisely the costs associated with use of dredged material from existing upland confined placement areas would facilitate better using this material for many of the beneficial re-use alternatives discussed in this report. The costs will depend on the type of equipment used to remove and transport material from the placement area, the transportation infrastructure available, capital investments needed to access the site, and the distance to the site where it will be used beneficially. Information on additional constraints, such as available windows for loading and transporting material, will be critical to developing usable cost information. With this information an economic model can begin to be developed to determine where and for what uses might this material be used.

5.4.3 Develop a Dredged Material/Sediment Marketing Plan

With development of the cost/transport model discussed above, it is possible to define a market which could be explored to ensure that the appropriate players in that marketplace are aware of the potential to use dredged material for their projects or needs. Specific activities can be developed to identify the marketplace and key players, develop awareness within the

marketplace of the potential opportunities to use dredged material, develop incentives for private uses of dredged material, and encourage entrepreneurship and innovation among market players.

5.5 Information Sharing

As part of the cooperative nature of RSM, information on sediment resources, natural resources, and other factors affecting how sediment resources are managed should be shared among stakeholders. Increased information sharing will aid in allowing all stakeholders to better manage their aspects of sediment resources in the area and will help avoid duplication of efforts for new data gathering and data assimilation.

5.5.1 Share GIS Data

There are presently several agencies with a variety of GIS data resources. Many of these data sources are freely available; however, to date there has not been a concerted effort to gather all of the resources relevant to sediment management in the Galveston Bay region into one unified system. As a part of the current RSM effort, a preliminary set of relevant data is being gathered and assimilated into the USACE's eCoastal geodatabase system. The GLO is also beginning work on a statewide coastal sediments database.

Creating a publicly available internet mapping service (e.g., ArcIMS) would further RSM efforts, both within the Galveston District and externally. Such a service would allow key staff within the Galveston District to access and better utilize dredging records, biological resources data, and information about on-going projects (proposed dredging or restoration activities) or market opportunities (needs and sources of sediment). For stakeholders outside of the Galveston District, such a tool would facilitate better understanding of regional sediment management needs and opportunities. This would likely lead to increased cooperation and generation of new strategies and solutions which may prove effective in meeting the goals and objectives of RSM.

5.5.2 Share Scientific Information

In addition to sharing GIS data, sharing of basic scientific information will also help further RSM goals and objectives. At present there is a wealth of information which has been gathered and generated by various scientific researchers. This information lies in agency reports and internal documents, academic publications, reports by outside consultants, internet sites, and more. Gathering all of this information into a central repository would aid all researchers and users of the information. The repository could be a physical repository or a digital repository and could be located at the Galveston District, another agency (such as the GLO or GBEP), or at an academic institution.

5.5.3 Improve Monitoring and Reporting

Many projects, both federal and non-federal, which incorporate some sediment related activities, such as dredging, beneficial use placement, erosion control, ecosystem restoration, etc., are required to perform regular monitoring. The information gathered from these monitoring reports

may be helpful in implementing lessons learned on other projects. Other documentation for projects, such as design memoranda, planning reports, permit and NEPA supporting documentation, etc. would also be useful for the larger stakeholder community. As such, sharing these reports would benefit all of the RSM stakeholders in the region, particularly project planners and designers.

6.0 RSM IMPLEMENTATION

6.1 Prioritized Strategies and Solutions

A number of RSM needs and opportunities, primarily gathered from stakeholder input, are presented in Section 4.0 of this report. From this list of needs and opportunities, a set of strategies and solutions is presented in Section 5.0. Each of these strategies and solutions has merit and should be fully considered. Based on stakeholder input and judgment as to the strategies and solutions which will likely have the greatest impact and/or be the easiest to implement, a prioritized list of strategies and solutions is presented in this section.

As noted below, this PSM Plan should remain a living document. The principles of adaptive management should be applied to the conclusions and recommendations of this study and it should be updated regularly as new information becomes available and priorities shift.

6.1.1 Establish, Lead, and Support a Regional Sediment Management Working Group

As discussed in Section 5.2.1, while the BUG exists to address beneficial uses of dredged material for the Houston-Galveston Navigation Channels, there is not presently a similar organization which advocates and focuses RSM needs and opportunities, strategies, and solutions for the entire Galveston Bay region. The USACE would be a logical choice to establish and lead such a group; however, there are several other state and local agencies which may also take the leadership role for this effort. Such a group could be formed as a Local Planning Group (LPG) and organized to consist of members of state and federal resource agencies, local governments (city and county), local ports and other local entities (flood control districts, etc.), and non-governmental organizations. The group would not have direct regulatory authority, but could coordinate RSM issues and help ensure that RSM strategies and solutions are incorporated into all projects in the region. The RSM Working Group should develop guidelines for how RSM should be incorporated into various types of projects – navigation, flood control, beach nourishment, wetland restoration, etc. – and provide these guidelines to area project managers. Such guidelines would aid project managers, planners, and engineers in developing projects which incorporate RSM principles and strategies from inception. The group could include representatives from, and/or coordinate with other sediment management groups in the area (BUG, GOMA), incorporating information and data from these groups and coordinating with existing and revised DMMPs. An RSM Working Group may also help build momentum and raise awareness among agencies which have not traditionally placed emphasis on their sediment management impacts on Galveston Bay (for instance the TWDB or Harris County Flood Control District).

6.1.2 USACE Initiate and Lead a Federal Standard Workshop

As discussed in Section 5.2.2, there is generally a great deal of uncertainty and dissatisfaction on the part of many stakeholders on the application of the Federal Standard for dredged material placement. While it is beyond the scope of this plan to address changing the Federal Standard,

giving all stakeholders a more complete picture of the Standard and its intent would be beneficial. This could improve an agency's ability to use the standard to support interests they may have for RSM in the study area.

As part of the overall strategies for implementation of the PSM Plan, the USACE should work with state and federal resource agencies, local sponsors, and non-governmental organizations (such as Galveston Bay Foundation, the Nature Conservancy, etc.) to foster a clearer understanding of the Federal Standard. This should include the various authorizations which may allow the Federal Government to share the costs in alternatives which are not (wholly or in part) considered the Federal Standard for placement of dredged material for the navigation purposes of the project. This may be accomplished through dedicated workshops conducted by the Galveston District on the subject. Such workshops may also consider and foster discussion of how RSM practices and strategies can be best integrated into the Federal Standard for projects in the Galveston Bay region.

6.1.3 Implement Beneficial Nearshore Placement of Dredged Material

The concept of placing material currently placed in the offshore Placement Area Number 1 for the Entrance Channel closer to the Gulf Beach (Section 5.3.1) had very broad support among stakeholders. Using this solution would likely result in transport of the portion of material suitable for beach replenishment into the active littoral zone. There remains uncertainty as to what the fate of the fine-grain portion of the dredged material would be. Therefore, it is recommended that this alternative be studied further. Some of the techniques which could be used to assess this alternative include numerical modeling of the fate of the dredged material and/or use of sediment tracers as a guide. If the assessment shows that the benefits of this alternative outweigh any detriments, including increased costs and any negative impacts to the environment, then a demonstration project should be carried out and monitored. If the placement alternative proves successful then it should be utilized to the maximum extent possible to keep sediments within the active littoral zone for Gulf beaches. This strategy could be implemented by the Galveston District, with cooperation from the local sponsor, or could be led by the local sponsor as a locally preferred plan.

6.1.4 Use Upland Confined Dredged Material for Ecosystem Restoration

Ecosystem restoration projects in the region, wetland restoration projects specifically, have generally used material borrowed from nearby sources (transported via pipeline as a slurry or using land-based construction equipment) or used maintenance dredged material. An alternative method of constructing these projects would be to use previously maintenance dredged material from existing confined placement areas (Section 5.3.9). The potential advantages include improved wetland products, increased total capacity for maintenance dredged material, and more competition for construction contracts potentially leading to better pricing. This alternative may also allow for dredged material to be used at locations relatively far from the navigation channels which are the source of the material, thus potentially allowing wetlands to be rebuilt in areas where they previously existed without borrowing sediments from nearby areas.

Once the construction and economic feasibility of this alternative are proven, a demonstration project could be used to test the solution. If the demonstration project proves successful this solution should be applied to wetland restoration projects throughout the region. This strategy could be implemented by the Galveston District, but could also be effectively implemented by any of the federal, state, or local partners who are seeking to complete restoration projects.

6.1.5 Improve Beneficial Use Opportunities for Private Dredging

One of the needs and opportunities, mentioned by several stakeholders, was improving beneficial use opportunities for non-federal dredging projects. Many of these projects face constraints such as a mismatch in quantities between material to be dredged and the needs of restoration projects, timing, complex permitting requirements, and sediment quality. Also, there may be cases where the private entity conducting dredging operations may not be aware of potential beneficial use opportunities. In general, raising awareness of RSM strategies and solutions among all state and local agencies along with the general public would be helpful in disseminating these potential opportunities to entities undertaking private dredging. This goal should be undertaken by all involved parties with an interest in the Galveston Bay environment.

Improving the opportunities for beneficial uses and other RSM strategies and solutions by entities involved in private dredging (owners, engineering, contractors, etc.) can be accomplished through several of the strategies outlined above. Development of RSM and beneficial use guidelines by an RSM Working Group (Section 5.2.1) could be disseminated to various entities to help them identify potential alternative uses of dredged material. The RSM Working Group itself could aid in coordination with private entities on potential RSM and beneficial use opportunities. The creation of a regional general permit for beneficial use placement (Section 5.2.4) would help to limit the permitting requirements and timeframe which may discourage many private entities from beneficial uses at present. Using placement areas as staging areas (Section 5.3.5) and using material from confined placement areas for ecosystem restoration projects (Section 5.3.9) may help address the frequent mismatch between desired quantities for restoration projects and the dredging needs for navigation projects. Lastly, development of life-cycle costs for dredged material placement areas (Section 5.4.1) may result in changes in disposal costs at upland confined placement areas which may incentivize private dredgers to find other placement opportunities.

6.1.6 Develop Life-Cycle Costs for Dredged Material

As existing placement areas are filled, the costs for developing new sites may be much higher. These costs need to be taken into consideration when developing alternatives for placement of dredged material. As discussed in Section 5.4.1, developing a life-cycle cost for dredged material placement areas would allow for better comparison of dredged material management alternatives. While some alternatives may present what initially appear to be high costs, such as removing material from confined placement areas for re-use, when compared to the replacement costs for placement area capacity they may be more practical. The life-cycle cost analysis would also provide a basis for estimating the benefit to the federal project of any beneficial uses which would take material from or reduce the capacity requirements of existing and future placement

areas. This strategy can be implemented by the Galveston District or a local sponsor initiating a study to determine life-cycle costs for some or all of the placement areas in the region. If a finite set of placement areas are chosen they should include a wide variety of sites to results can be extrapolated to other sites.

6.1.7 Maintain and Use RSM Needs and Opportunities List

It was generally urged by stakeholders interviewed that this PSM Plan not focus upon individual beneficial use needs and opportunities, but rather present such alternatives as a potential list which will change through time. Accordingly, no individual projects have been presented in this implementation section.

The list of needs and opportunities in Section 4.0 provide a baseline that can be used for projects in the Galveston Bay region. These needs and opportunities have been generally arranged according to proximity to existing federal navigation channels along with types of solutions (i.e., beach nourishment, wetland restoration, etc.). This should allow future and existing projects to have a ready source of information for potential RSM solutions and strategies early in the planning process.

The needs and opportunities, along with constraints, presented in Section 4.0 are based on stakeholder input gathered at a series of meetings in the summer and fall of 2009. These represent a snapshot in time of the issues and potential projects which were priorities at that time. With the completion of various projects and changes in priorities and strategies over time, the needs and opportunities will also change. Thus, this list should be updated on a regular basis.

Maintaining and updating an RSM needs and opportunities list should be a primary goal for a Regional Sediment Management Working Group. This list could be compiled by and shared among all of the stakeholders in RSM, including federal, state, and local agencies along with non-governmental partners.

6.1.8 Implement Information Sharing

The PSM Plan strongly recommends information sharing between agencies within the study area working on sediment management related activities. Information sharing would provide better knowledge of all of past, present and future projects and studies in the area. This information could be used in the design and planning of future projects. As discussed in Section 3.5, hosting a web GIS tool such as eCoastal would allow GIS information to be shared readily with all interested parties. GIS data has been collected from the study area in a format that is consistent with this type of data hosting. If the Galveston District were to implement such a system, the data would ideally be periodically updated to allow stakeholders to rely on the website for sediment management data. Other involved stakeholders, such as the Texas General Land Office, or an academic institution, such as Texas A&M University Galveston or the University of Texas' Bureau of Economic Geology, might also be capable of implementing and maintaining such an information sharing system. Stakeholders active in sediment management in the region should be encouraged to submit project locations, study locations, monitoring data, etc. for

hosting on this centralized data hosting website. In addition to GIS resources, other scientific information such as agency reports and internal documents, academic publications, reports by outside consultants, internet sites, and more should also be collected into a central repository and shared with all stakeholders.

6.1.9 Implement Dredged Material/Marketing Program

In conjunction with development of a cost/transport model for use of upland confined dredged sediments (Section 5.4.2) it is recommended that a marketing program be developed and implemented for these sediments (Section 5.4.3). Such a plan would identify and reach out to potential players in a market for dredged material. The program should look at ways to incentivize this market and also to encourage entrepreneurship and innovation in the marketplace. This effort could be led by the Galveston District or by one of the local sponsors, such as the Port of Houston.

6.2 Data Gaps and Needed Analyses

- Data gaps exist that need to be addressed as part of implementation of the Plan. Development of this PSM Plan focused on collecting available relevant data and analyses. However, there is undoubtedly additional relevant information which has not been uncovered. New data should be collected and new analyses performed to inform decision-makers involved with the sediment management effort. Some suggestions for such new data and analyses are listed below. Improve and update fluvial sediment yield data for all watersheds to develop a more accurate sediment budget for the bay.

- Monitor shoreline erosion for the Gulf and Galveston Bay shorelines and improve estimates of shoreline erosion volumes to improve the sediment budget.

- Analyze sedimentation rates within the Galveston Bay.

- Improve estimates of sediment resuspension within Galveston Bay and sedimentation or erosion rates in open bay areas.

- Quantify fine-grain sediment being transported into Galveston Bay from the Gulf of Mexico through Bolivar Roads.

- Improve estimates of sedimentation rates for federal channels.

- Develop methods to better track and record private dredge and fill activities.

- Inventory placement area materials and quantities.

- Inventory Dredged Material Markets

6.3 Recommended Next Steps

A series of short- and long-term steps are listed below that will need to take place in order to carry out the plan.

6.3.1 Short-Term Steps (2 to 5 Years)

- Establish Regional Sediment Management working group
- Initiate Federal Standards workshop(s) to better define and clarify the intent of the Standard for other agencies
- Address data gaps
- Share GIS data and information and develop dredged material information framework
- Initiate coordination for Regional General Permit for beneficial uses
- Develop life-cycle cost model for dredged material sites
- Develop demonstration project for beneficial nearshore placement
- Develop demonstration project for ecosystem restoration with upland confined dredged material
- Develop marketing initiative

6.3.2 Long-Term Steps (5 to 10 Years)

- Maintain and update Programmatic Sediment Management Plan
- Implement beneficial nearshore placement Implement ecosystem restoration with upland confined dredged material
- Improve project monitoring and information sharing
- Improve beneficial use opportunities for private dredging
- Implement Regional General Permit for beneficial uses
- Implement marketing initiative for dredged material

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APPENDIX A

OUTREACH MEETING AND CALL NOTES

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Meeting Notes

Attendees	Phone	Email
Juan Moya – TGLO (attended late session in pm)	(512) 475-3735	juan.moya@glo.state.tx.us
Ray Newby – TGLO	(512) 475-3624	ray.newby@glo.state.tx.us
Chris Webb – M&N (attended via phone)	(562) 426-9551	cwebb@moffattnichol.com
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 9/8/2009

Time: 10:00am to 12:00pm &
3:00 pm to 4:00 pm

Location: General Land Office
Coastal Resources Conference Room
1700 N. Congress Ave., Suite 935
Austin, Texas 78701-1495

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from that agency/group/stakeholder that should be considered during development of the RSM Plan.

Introductions were made between Moffatt & Nichol (M&N) and the Texas General Lands Office (TGLO). Individual attendees at this meeting are listed above.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the US Army Corps of Engineers (USACE), Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area for this meeting included most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands. Larry Wise (M&N) also stated that the study area will include key inflow water bodies to the Galveston watershed not necessarily shown within the existing study area boundary lines. Ray Newby (TGLO) requested that the study area be expanded along the southwest boundary line to include Chocolate Bayou west of San Luis Pass (see Figure 2-1 for revised study area).

Proposed RSM Plan Activities

On behalf of the USACE, Galveston District (contact: Bob Heinly), M&N is conducting meetings to gather existing data and input relevant to this effort, such as:

- Existing studies and data on erosion, water and nutrient inflow, sediment quality/quantity characteristics, and dredging and placement activities within the study area; and,
- Agency/stakeholder/organization needs and opportunities, and constraints.

Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Further discussion between M&N and the GLO resulted in the gathering of the following information:

- GLO oversees the Texas Coastal Management Program (CMP). CMP guidelines include beneficial use principals, but not necessarily RSM principals. CMP includes coastal consistency and USACE and others are required to submit consistency documents.
- GLO also has the Open Beaches Act and Dune Protection Act authorities which govern permitting of beach front activities and sand quality guidelines for beach nourishment.
- Ray Newby (TGLO) suggested that M&N and the USACE may want to consider contacting the following individuals/organizations/agencies/stakeholders for further information relevant to the RSM effort:
  - Lou Muller (Executive Director for Galveston Parks Board) for east Galveston Island beach data
  - Sediment sampling and testing data from Rob Hauch at the USACE
  - Vessel & sediment interaction data from ERDC (Charlie Berger).
  - Apollo Environmental Strategies, Inc. is a local contractor that has a lot of experience in the Galveston Bay area completing coastal restoration projects and may have construction related information applicable to the RSM Plan.
  - John Anderson 2007 book titled *The Formation and Future of the Upper Texas Coast: A Geologist Answers Questions About Sand, Storms and Living by the Sea*
  - RSM workshop information from Jeff Waters (USACE's ERDC)
  - Updated Habitat Conservation Blueprint Plan from GBF/GBEP
  - Heather Biggs (Sea Grant at Texas A&M University) for additional GIS data
  - James (Jim) Gibeaut at the Harte Research Institute in Corpus Christi for bay erosion rates
  - Junji Matsumoto, chief modeler for the Texas water Development Board (TWDB) for any relevant GIS data (specifically from TWDB's circulation and salinity model called TxBlend)
  - Gulf of Mexico RSM under the Gulf of Mexico Alliance Habitat Restoration & Conservation Program. Larry Parson of the USACE Mobile Dist. has played large role. A document is due out in October or November and a workshop on the Federal Standard is planned.

Needs/Opportunities

Larry Wise and Brian Leslie (M&N) asked Ray Newby (TGLO) if he could lay out potential needs and opportunities for this RSM Plan.

- Ray Newby (TGLO) identified a number of locations and sites within Galveston Bay that may experience significant maintenance dredging and/or sites which may require sediment placement capacity, may provide beneficial use opportunities, or may require beach nourishment. Specific sites and information regarding these sites are listed below.
  - Rollover Pass, a narrow man-made channel connecting the Gulf of Mexico to the East Bay (east embayment of Galveston Bay) on the Bolivar Peninsula, is dredged annually (approximately $1 million spent on annual dredging costs). Most of this material goes upland for disposal while approximately 150,000 cubic yards (cy) to 300,000 cy on a 2 year cycle is used for local beach nourishment activities. USACE's Engineer Research and Development Center (ERDC) studied a sediment trap configuration for Rollover Pass to minimize sedimentation of the Gulf Intracoastal Water Way (GIWW), located north of

Rollover Pass. TGLO is investigating closing Rollover Pass to reduce maintenance dredging costs of the Pass and nearby GIWW and to reduce adjacent beach erosion. Currently $6 million has been obtained in appropriated funding to complete this project. The environmental review process is scheduled to begin in early 2010. TGLO is considering the construction of a fishing pier on the Gulf side of Rollover Pass as part of this project.

- The Texas Department of Transportation (TXDOT) Galveston-Bolivar Ferry Terminal, which operates the Galveston-Bolivar ferry, experiences heavy shoaling since the adding of third landing and requires regular maintenance dredging to maintain the depth and width of the ferry berths. Little Beach is a potential beneficial use of the material.
- Discussion of Galveston Bay placement areas provided the following information:
  - Placement Areas (PA's) 36, 41, 42, and 43 are used by TXDOT for maintenance of the GIWW and may contain beach quality sand. GLO is starting a CIAP (Coastal Impact Assessment Program) grant to assess the materials (surveys and geotechnical). TXDOT "owns" some of the Bolivar PA's and others have Corps easements. TXDOT recently purchased PA 42.
  - Cells 14 and 15 are used by the Port of Houston Authority (PHA) for placement of dredged material from the Houston Ship Channel (HSC). These cells were considered for the Sylvan Beach project in La Porte. They have available sand but not sufficient volume of material necessary for beneficial use.
  - San Jacinto PA in Galveston may have sand. Exploration may be covered under GLO's CIAP project (Ray was not positive).
  - At the Pelican Island PA the GLO has found approximately 50,000 cy in the north corner, but not easily accessible.

- TGLO beach nourishment projects currently include Rollover Pass, Caplen Shores west of Rollover Pass, and Little Beach, a small proposed project at Fort Travis.
- Recent placement of sand at Little Beach (near Ft. Travis on Bolivar Peninsula) used 400,000 cy from GIWW emergency dredging; however, fines have not winnowed out yet as anticipated.
- Phil Glass of the US Fish and Wildlife Service (USFWS) would like to see TGLO get involved with beneficial use efforts at Smith Point. Geotubes were originally installed at this location by the USACE, but currently require repair.
- San Luis Pass flood shoal is gaining approximately 100,000 cy per year, but is an area of potential controversy. The sand has been proposed for use for beach nourishment. Most sand appears to be coming from Galveston side. Currently some federal and state agencies, along with some environmental groups, would like to see this area protected from any future work/development. There was a recent Joint Evaluation Meeting (JEM) on using material as a sediment source for beach nourishment at San Luis Pass.
- There is a potential for beneficial use of materials for beach nourishment from areas such as South Jetty (approximately 3 million cy in a submerged ridge which is spilling into the ship channel, GLO seeking permit for hopper dredging) and the Anchorage Basin (west end of shallow basin has sand and GLO is trying to permit for beach nourishment and the deep basin also has good quality material). Also borrow of material from Big Reef (capacity for possibly 120,000 cy of material) for beach nourishment.
- Entrance Channel dredging could be broken into segments and segments with higher sand content used for beach nourishment. There is high shoaling rate at the end of the jetties.
- Several sources of beach nourishment sand were discussed including Big Reef, excavated sand, and an upland PA off of Harborside Drive in Galveston used post-Ike (owned by Navigation District).
- Larry Wise (M&N) presented Bob Engler's idea (M&N) regarding the placement of dredged material offshore for the purpose of beach nourishment (by introducing sand closer to shore on the Gulf side of Galveston Island so that it can enter the littoral system). Ray Newby (TGLO) was supportive of this idea.
- Many small private dredging and restoration projects in the area could be better coordinated with larger bay efforts. There is a need to improve coordination between large state/federal dredging efforts and smaller private dredging and/or restoration projects for more efficient use of material.

- Galveston Bay needs to increase its overall marsh restoration activities at places such as Bolivar, Galveston Island (backside – State Park, Jumbile Cove, McAllis Point), and Virginia Point. Sand for these projects has typically been borrowed from adjacent areas of the Bay, but there is an opportunity to bring in sand.
- Other areas with restoration and capacity/source opportunities include Armand Bayou (currently suffering from subsidence), which is under GLO's coastal preserves program, and Chocolate Bayou. The USACE is running out of capacity in existing placement areas, but there may be beach quality sand in some placement areas. There are also TXDOT placement areas in the vicinity. The dredging is on a 4 year cycle. Luis Saenz and Carl Brown at USACE were suggested contacts.
- Other projects, sites, and/or individuals and organizations that may warrant further investigation by or discussion with M&N for this RSM Plan include:
  - An offloading site was considered for an area near Offatts Bayou (near Sportsman Road and 8-mile Road) but a project has never been completed here.
  - Dennis Rocha who worked on the City of La Porte Sylvan Beach Restoration Project
  - West Galveston Island Beach Restoration effort
  - Tabbs Bay effort by the Galveston Bay Foundation (GBF)
  - Trinity River Delta (John Anderson of Rice University and Julie Wellner of the University of Houston).

Constraints

Larry Wise and Brian Leslie (M&N) asked Ray Newby (TGLO) if he could lay out potential constraints for beneficial use of dredged material and this RSM Plan. Ray Newby (TGLO) identified the following:

- Funding and planning are typical constraints. The Corps' annual dredging conference has been helpful and the District has been very cooperative on beneficial use opportunities.
- Planning efforts and costs can increase due to existing regulatory work windows and other varying permitting requirements. Turtles are a concern along with Piping Plovers (Section 7 consultations).
- Existing planning efforts are at the project level not the regional level.
- Sediment volume needs and sources are usually not identical. For example, dredging activities in Galveston Bay often work with many thousands or millions of cy of material while beneficial use projects more commonly utilize smaller volumes (hundreds or maybe a few thousand cy of material).
- The USACE Federal Standard (i.e., existing DMMPs) does not support RSM efforts.
- RSM language is not incorporated into the Texas Coastal Management Program (TCMP).
- Coordination of the appropriate quantity of good quality material for beneficial use efforts is lacking.
- The existing sediment budget for the Bay area is insufficient.
- Projects that utilize geotubes require higher maintenance costs.
- Resource agencies have generally been on-board with activities, but they do have concerns for shallower water areas.

GIS Data

Larry Wise and Brian Leslie (M&N) asked Ray Newby (TGLO) and Juan Moya (TGLO) for opportunities to share Geographic Information System (GIS) data with M&N for this effort.

- Juan Moya (TGLO) described the TGLO effort on a large bay-wide GIS database (TXSED). TGLO is currently collecting existing data from a number of sources. The project is in its preliminary stages and Juan Moya (TGLO) is currently overseeing development of the database. TXSED will incorporate historical and existing dredging activities, PAs, beneficial use sites, and beach nourishment sites into the database. Input data will include location, vertical description, and other physical description variables. The goal is for TGLO to create a usable database for public who could then compile their own data results from the available information.
- Ray Newby (TGLO) suggested the potential for TGLO and USACE to work together on this GIS effort together.

- Juan Moya (TGLO) is very interested in sharing their data with USACE and would also like to receive data from the USACE (shape files and dredging records for all Galveston Bay USACE channels). One concern would be on how TGLO and USACE would coordinate and define their agency's public information rules. This would require further discussion.

Action Items identified by M&N & TGLO for follow-up include:

- Brian Leslie (M&N) will send M&N ftp site information to Ray Newby (TGLO) – ***completed***
- Brian Leslie (M&N) will revise the study area boundary pursuant to comments from TGLO – ***completed***
- Brian Leslie (M&N) will coordinate a call or meeting with Daniel Gao (TGLO) for a follow-up discussion on TGLO's existing GIS data and GIS "lessons learned" – ***started***
- Juan Moya (TGLO) requested data from M&N and the USACE (shape files and dredging records for all Galveston Bay USACE channels). Larry Wise (M&N) will forward this request to Bob Heinly (USACE, galveston District) – ***in progress***
- Ray Newby (TGLO) will upload as much relevant information (reports and publications) for the RSM effort to M&N's ftp site – ***started***. Some of these documents may include:
  - 2002 TGLO study of hydrology at Rollover Pass
  - 2002 ERDC study of sedimentation Rollover Pass
  - Geotubes report w/beach nourishment history
  - Gilchrest beach nourishment project (2000-2001)
  - Reports on the Big Reef project
  - CP&E sand source reports – M&N has obtained one of these reports to date titled *Reconnaissance Geotech and Geophysical Investigations to Identify Offshore Sand Sources for Beach Nourishment in Galv and Jeff Counties*
  - Virginia Point Alternatives Analysis
  - Beneficial use investigation data from Anchorage Basin and Pelican Island
  - San Luis Pass Inlet Management Plan completed by Coast & Harbor
  - Core sampling data completed by Gahagan & Bryant Associates, Inc.

These notes by M&N are intended to summarize information presented at this meeting. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Meeting Notes

Attendees	Phone	Email
Dr. Carla Guthrie - TWDB	(512) 463-4179	Carla.Guthrie@twdb.state.tx.us
Chris Webb – M&N (attended via phone)	(562) 426-9551	cwebb@moffattnichol.com
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 9/8/2009
Time: 1:00am to 2:00pm

Location: General Land Office
Coastal Resources Conference Room
1700 N. Congress Ave., Suite 935
Austin, Texas 78701-1495

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from that agency/group/stakeholder that should be considered during development of the RSM Plan.

Introductions were made between Moffatt & Nichol (M&N) and the Texas Water Development Board (TWDB). Individual attendees at this meeting are listed above.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area for this meeting included most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands. Larry Wise (M&N) stated that the study area will include key inflow water bodies to the Galveston watershed not necessarily shown within the existing study area boundary lines. The current study area will be modified along the southwest boundary to include Chocolate Bayou west of San Luis Pass pursuant to comments from TGLO (see Figure 2-1 for revised study area).

Proposed RSM Plan Activities

On behalf of the USACE, Galveston District (contact: Bob Heinly), M&N is conducting meetings to gather existing data and input relevant to this effort, such as:

- Existing studies and data on water and nutrient inflow and sediment quality/quantity within the study area; and,
- Agency/stakeholder/organization needs and opportunities, and constraints.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Further discussion between M&N and the TWDB resulted in the gathering of the following information:

- TWDB focuses mostly on freshwater inflows and less on sediment and nutrient inflows to Galveston Bay. TWDB work does not specifically focus directly on water quality. This effort is completed by the Texas Commission on Environmental Quality (TCEQ). However, TWDB, which focuses on hydrodynamic and water resource data, does collect Galveston Bay salinity levels and make them available off their website.
- Carla Guthrie (TWDB) would be happy to forward any relevant information on to M&N and the USACE. Most of the studies that she knows of have been completed in partnership with the US Geological Survey (USGS) and a drilling contractor called TransAmerican Underground (TAUG). Carla Guthrie (TWDB) will also discuss this meeting with Ruben Solis (TWDB Director for the Surface Water Resources Division) and forward any additional recommended data.
- Texas Rainfall-Runoff Model (TXRR) for coastal hydrology developed by TWDB, the Texas Parks and Wildlife Department (TPWD), and the Texas Natural Resources Conservation Commission (TNRCC).
- TWDB uses TXBLEND model for hydrodynamics.
- TWDB collects some information on sediments captured by dams.

Needs/Opportunities and Constraints

Larry Wise and Brian Leslie (M&N) asked Carla Guthrie (TWDB) if she could to try lay out any potential needs and opportunities for this RSM Plan. Carla Guthrie (TWDB) identified the following needs and opportunities:

- Maintain the necessary sediment and nutrient input for Galveston Bay and the Trinity Delta
- Support the conservation / restoration of wetlands and sea grass beds in the Galveston Bay watershed

Action Items identified by M&N & the TWDB for follow-up include:

- Carla Guthrie (TWDB) will send Brian Leslie (M&N) links for any relevant data/reports – ***completed***

These notes by M&N are intended to summarize information presented at this meeting. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Meeting Notes

Attendees	Phone	Email
Raul Cantu – TXDOT	(512) 486-5121	rcantu@dot.state.tx.us
Chris Webb – M&N (attended via phone)	(562) 426-9551	cwebb@moffattnichol.com
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 9/8/2009
Time: 2:00am to 3:00pm

Location: General Land Office
Coastal Resources Conference Room
1700 N. Congress Ave., Suite 935
Austin, Texas 78701-1495

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from that agency/group/stakeholder that should be considered during development of the RSM Plan.

Introductions were made between Moffatt & Nichol (M&N) and the Texas Department of Transportation (TXDOT). Individual attendees at this meeting are listed above.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area for this meeting included most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands. Larry Wise (M&N) stated that the study area will include key inflow water bodies to the Galveston watershed not necessarily shown within the existing study area boundary lines. The current study area will be modified along the southwest boundary to include Chocolate Bayou west of San Luis Pass pursuant to comments from TGLO (see Figure 2-1 for revised study area).

Proposed RSM Plan Activities

On behalf of the USACE, Galveston District (contact: Bob Heinly), M&N is conducting meetings to gather existing data and input relevant to this effort, such as:

- Existing studies and data on erosion, water and nutrient inflow, sediment quality/quantity characteristics, and dredging and placement activities within the study area; and,
- Agency/stakeholder/organization needs and opportunities, and constraints.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Further discussion between M&N and TXDOT resulted in the gathering of the following information on TXDOT practices and placement areas (PAs):

- The Gulf Intracoastal Water Way (GIWW) is a man-made inland water system that accommodates significant barge traffic between Gulf of Mexico ports. The GIWW was originally built in 1904/1905. The USACE is the federal sponsor and, up until 1975, non-federal sponsors for the GIWW consisted of local counties, navigation districts, and governments. In 1975, TXDOT became the local non-federal sponsor for the GIWW.
- TXDOT is currently responsible for 28 PAs used to dispose of dredged material from the GIWW. TXDOT manages the real estate and land easement issues for use of these PAs for the GIWW, some of which are designated for co-use with other projects. Currently TXDOT owns, via fee title, PA 42 and 58A.
- The GIWW Advisory Committee was formed by TXDOT to work on developing environmentally appropriate and economically feasible PAs for the GIWW. The Committee is comprised of a number of Texas agencies and TXDOT welcomes all input at its GIWW planning meetings.
- The section of the GIWW near Rollover Pass requires maintenance dredging every 18 to 24 months. Rollover Pass is a narrow man-made channel connecting the Gulf of Mexico to the East Bay (east embayment of Galveston Bay) on the Bolivar Peninsula. Since its construction in the 1950s, sedimentation into the East Bay, and the nearby section of the GIWW, has increased. Dredged material from this section of the GIWW is placed in PAs 35 and/or 36. Prior to Hurricane Ike, PAs 35 and 36 had a large quantity of very good quality sand. Access to PAs 35 and 36 is currently only by water. Existing PAs located north of Rollover Pass are currently at capacity and contain mix of sand and mud. PAs south of the GIWW also have available good quality material (i.e. cells 40, 41; cell 42 has a good quantity of shell hash material). There is also a catch basin at the Port Bolivar flare with sand. PAs by High Island (PA 28-33) could be mined for the TGLO's closure plans of Rollover Pass.
- There is a mooring facility on Pelican Island which is currently being enlarged. There is a beneficial use site located on the island, Pelican Island Spit, that may be worth further investigation (although it may already be identified for use with the mooring facility expansion project) and Texas City Channel. Pelican Island Spit area of the GIWW experiences heavy shoaling issues as well.
- The Texas City Channel Deepening and Widening Project has looked at a PA near Pelican Island, and the Pelican Island Spit.
- The area near the Galveston Causeway and Railroad Bridge could be further studied for use as new open water placement areas. Open water placement was discontinued, but many of the islands and areas which were open PA's are now being lost to erosion.
- Ben Boren (USACE Operations Division) identified a potential beneficial use site for dredged material west of San Luis Pass and opportunities for the area north of Chocolate Bayou have also been identified in the past by others. Oysters have colonized PA's and the effect of placement on them is not known. However the potential to use San Luis Pass area for new PAs may be challenged by agencies/organizations that recognize the area as critical for wildlife habitat.
- TXDOT volume capacity information for the GIWW PAs should be available in the USACE's Section 216 studies for sites in the study area.
- Sediment grain size and characteristics for the GIWW and the GIWW PAs should be available from Rob Hauch (USACE).
- The Galveston-Bolivar ferry terminal is a separate division from TXDOT. Raul Cantu (TXDOT) recommended that M&N contact Bill Mallini (current ferry supervisor) directly to introduce the RSM Plan and gather relevant

information about the facility. The terminal and its berths experience heavy shoaling and require maintenance dredging every six months. It is difficult to find available capacity in a PA or at a beneficial use site given the short amount of time available to complete these mandatory dredging activities. The marsh area created near the Bolivar ferry landing and Little Beach are both potential beneficial use sites for the material.

- The channel to Port Bolivar, located at the west tip of the Bolivar Peninsula, is a federal navigation channel and is, therefore, maintained by the USACE.
- The PAs where neither TXDOT nor the USACEs are landowners, but just have easements, should be considered for mining of the dredged material=.

Needs/Opportunities

Larry Wise and Brian Leslie (M&N) asked Raul Cantu (TXDOT) if he could identify potential needs and opportunities for the RSM Plan. He identified the following:

- Increase marsh restoration projects (i.e., Little Beach near the Galveston-Bolivar ferry terminal and Anahuac National Wildlife Refuge, which is experiencing subsidence).
- Consider using dredge material as a cap for oil spill cleanup or oil well sites (i.e. Anahuac National Wildlife Refuge). PA 31 could be used as a staging area for future burrow material for the Refuge.
- Increase coordination efforts between dredging and placement activities to better utilize sediment volume needs and sources.
- PA 42 has road access and could be used as a staging area for material.

Constraints

Larry Wise and Brian Leslie (M&N) asked Raul Cantu (TXDOT) if he could identify potential constraints for the RSM Plan. He identified the following:

- Pressure by some regulatory agencies (ex. NOAA Fisheries Service) and private developments (ex. Harborwalk) exists to increase the use of GIWW PAs for other projects and to utilize cells 41, 42, and 43. This is difficult given TXDOT's current funding requirements.
- Timing and Permitting requirements can be extensive due to the support studies necessary to obtain permits and the need to complete frequent dredging activities.
- The requirement for uniform taking of material from borrow sites (holes cannot remain) increases project costs.
- As placement opportunities in the bay become more difficult, erosion is increasing.
- The use of dredged material for construction fill is limited because the USACE uses the highest quality material for construction of the levees.
- There is often a mismatch between the quantities of material needed and what is practical from a dredging standpoint. There is a possibility to use placement areas as "staging areas" for material to be taken later.

Action Items identified by M&N & TXDOT for follow-up include:

- Raul Cantu (TXDOT) suggested that M&N may want to contact the following individuals and organizations to gather relevant data and information for this RSM Plan effort:
  - Captain Bill Mallini (Supervisor) at the Galveston-Bolivar ferry terminal directly to obtain information on dredging activities and placement needs – ***started***
  - Local flood control districts for information on subsidence, erosion and flooding concerns in the study area – ***started***
  - Harborwalk (a private organization, which conducts dredging activities in the Bay and is interested in using TXDOT PAs for dredged material placement) – ***started***
- Raul Cantu (TXDOT) suggested that M&N check the USACE website for a report on Sievers Cove from the Sec. 216 Feasibility Study for the GIWW, High Island to Brazos River and beneficial use as it may include useful information for this RSM Plan effort – ***started***

These notes by M&N are intended to summarize information presented at this meeting. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Meeting Notes

Attendees	Phone	Email
Bob Stokes – GBF	(281) 332-3381 ext. 211	bstokes@galvbay.org
Jeff DallaRosa - GBEP	(281) 486-1240	jdallaro@tceq.state.tx.us
Steven R. Johnston - GBEP	(281) 486-1240	sjohnsto@tceq.state.tx.us
Chris Webb – M&N (attended via phone)	(562) 426-9551	cwebb@moffattnichol.com
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 9/9/2009
Time: 10:00am to 12:00pm

Location: Galveston Bay Foundation
17324-A Highway 3
Webster, TX 77598

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from that agency/group/stakeholder that should be considered during development of the RSM Plan.

Introductions were made between Moffatt & Nichol (M&N) and the Galveston Bay Foundation (GBF) and the Galveston Bay Estuary Program (GBEP). Individual attendees at this meeting are listed above.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.

  Bob Stokes (GBF) asked what the drive was behind this effort. Larry Wise (M&N) replied with a brief summary of the Water Resources and development Act (WRDA) and the USACE desire to make maintenance dredging operations as efficient and cost effective as possible. WRDA is the key legislation used to authorize USACE in water projects or to implement USACE policy change.
- *Study Area:* The proposed study area for this meeting included most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands. Larry Wise (M&N) stated that the study area will include key inflow water bodies to the Galveston watershed not necessarily shown within the existing study area boundary lines. The current study area will be modified along the southwest boundary to include Chocolate Bayou west of San Luis Pass pursuant to comments from TGLO (see Figure 2-1 for revised study area).

Proposed RSM Plan Activities

On behalf of the USACE, Galveston District (contact: Bob Heinly), M&N is conducting meetings to gather existing data and input relevant to this effort, such as:

- Existing studies and data on erosion, water and nutrient inflow, sediment quality/quantity characteristics, and dredging and placement activities within the study area; and,
- Agency/stakeholder/organization needs and opportunities, and constraints.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Bob Stokes (GBF) was concerned that future phases of this work may not be funded. Larry Wise (M&N) agreed that this could occur but responded that the USACE is aware of the value of completing a full RSM effort for Galveston Bay.

Data Gathering

Following a request from M&N, Bob Stokes (GBF) gave a brief summary of GBF while Jeff DallaRosa (GBEP) gave a brief summary of the GBEP. Both identified a few local ongoing/recent projects in the study area.

- The GBF is a nonprofit organization created to preserve, protect and enhance Galveston Bay. The GBF targets and reacts to Bay projects, some of which respond to new restoration opportunities. Examples are TAMUG marsh (using beneficial use of dredged material, have CEPRA application in), Burnett Bay (based on strategic planning from the blueprint, brought in stakeholders), and Seabrook Island (proposed island off of "the Point" in Seabrook).
- The GBEP is a non-regulatory Texas Commission on Environmental Quality (TCEQ) program. GBEP focuses on preserving the Bay and providing ecosystem management and restoration.
- The GBF was involved with the 2009 Burnet Bay Habitat Restoration Project (west of the City of Baytown), which did try to seek out an offsite sand source for two years prior to project commencement (no source was identified). The project involves bringing in sand to raise the elevation of the site (which has suffered from subsidence over a number of years) and the planting of marsh vegetation to restore intertidal marsh function.
- Perry Cole may be able to provide information on current efforts at Pelican Island for this RSM plan. Currently Pelican Island continues to grow in size due to the placement of sediment from dredging activities in the Houston Ship Channel (HSC).
- Sites that may require sediment in the future include:
    - The Seabrook Island Restoration Project, located off the peninsula, could use sediment in the future
    - The East Bay shoreline requires shoreline protection
    - Shoreline protection for Virginia Point (difficult due to the existing oyster reefs)
    - Greens Bayou (the GBEP is acquiring land in this area)
- Both GBF and the GBEP try to work with the Natural Resource Uses (NRU) subcommittee to support their efforts.
- Jeff DallaRosa (GBEP) mentioned that most restoration work up to this point has focused on the West Bay region due to the number of wetlands in the area.
- Jeff DallaRosa (GBEP) is interested in meeting again once the USACE has a Draft RSM Plan completed and ready for review.
- Permission was granted to M&N and the USACE (from GBF and GBEP) to use their data on the RSM Plan.
- Both GBF and GBEP supported the use of new beneficial use techniques for construction to increase ecological function. Geotubes can work effectively if installed correctly (i.e., lower elevation like Jumbile Cove). Reefballs have been installed successfully on Sportsman Road (lessons learned: require larger size reefballs than those installed but the smaller ones did still function as anticipated)

- Nationwide permits can be obtained quickly for beneficial use opportunities.

Needs/Opportunities

Larry Wise and Brian Leslie (M&N) asked Bob Stokes (GBF) and Jeff DallaRosa (GBEP) if they could identify potential needs and opportunities for the RSM Plan.

- Potential for placement capacity could be available at the following locations:
  - The San Jacinto River Waste Pits superfund site, located on the river's sand bar just north of the Interstate Highway 10 bridge and possibly another marsh restoration phase of work at the San Jacinto Monument.
  - Seabrook Island – 20 to 24 acres brought up to +1 or +2 feet and Seabrook Slough
  - Jones Bay (however has oyster reefs at the site and is pretty shallow)
  - Clear Lake (local rules do not allow sediment placement inside the lake)
  - Nassau Bay and the Edgewater (a private marina dredging project located near Clear Lake)
  - Scott Bay
  - West Bay (to increase elevation of +2.2 to +2.7 feet for variability and to account for sea level rise)
  - Along the GIWW at former sidecast islands. Steve Johnston (GBEP) also mentioned an interest in Dickinson Bayou (could be opportunities for more sidecast islands).
  - Marsh restoration at Anahuac National Wildlife Refuge
  - Capacity at Pierce marsh
  - Mainland marshes are a potential alternative for sediment placement
- Contact private developments or smaller restoration organizations (i.e., Clear Creek Environmental Foundation) to coordinate dredging and beneficial use efforts.
- Consider using soft material under a hard substrate cap for oyster reef construction.
- Jeff DallaRosa's (GBEP) key need is for knowledge of how sea level rise will impact Galveston Bay wetlands and marshes.
- Regulatory issues have not been a concern in the past as early input and coordination is provided by both GBF and the GBEP to the regulatory agencies.

Constraints

Larry Wise and Brian Leslie (M&N) asked Bob Stokes (GBF) and Jeff DallaRosa (GBEP) if they could identify potential constraints for the RSM Plan. They identified the following:

- Scheduling the right type and quantity of sediment at the right time is difficult.
- Funding (paying for sediment) is difficult for non-governmental organizations (NGOs) and non-federal match requirements are often a limiting factor. Funding comes from private donations / foundation grants and state / federal grants.
- Negotiations with private landowners take time.
- Marsh plants are becoming tougher to obtain for projects due to increasing demand.

Action Items Identified for Follow-up

- Contact Phillip Smith (Habitat Restoration Coordinator for GBF) for GBF sediment quality requirements – ***completed***
- If an up-to-date version of the Habitat Conservation Blueprint Plan is not available online, request a copy from Bob or Jeff – ***completed***
- Download a copy of the State of the Bay Report from the GBEP website – ***completed***
- Contact Heather Biggs of Sea Grant at the Texas &M University (TAMU) for relevant GIS data – ***started***

These notes by M&N are intended to summarize information presented at this meeting. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Meeting Notes

Attendees	Phone	Email
David Casebeer - PHA	(713) 670.2589	dcasebeer@poha.com
Dr. Lloyd Saunders - PHA	(713) 670-2605	lsaunders@poha.com
Chris Webb – M&N (attended via phone)	(562) 426-9551	cwebb@moffattnichol.com
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 9/10/2009

Time: 9:00am to 11:00am

Location: Port of Houston Authority
111 East Loop North
Houston, Texas USA 77029

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from that agency/group/stakeholder that should be considered during development of the RSM Plan.

Introductions were made between Moffatt & Nichol (M&N) and the Port of Houston Authority (PHA). Individual attendees at this meeting are listed above.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area for this meeting included most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands. Larry Wise (M&N) stated that the study area will include key inflow water bodies to the Galveston watershed not necessarily shown within the existing study area boundary lines. The current study area will be modified along the southwest boundary to include Chocolate Bayou west of San Luis Pass pursuant to comments from TGLO (see Figure 2-1 for revised study area).

Proposed RSM Plan Activities

On behalf of the USACE, Galveston District (contact: Bob Heinly), M&N is conducting meetings to gather existing data and input relevant to this effort, such as:

- Existing studies and data on erosion, water and nutrient inflow, sediment quality/quantity characteristics, and dredging and placement activities within the study area; and,
- Agency/stakeholder/organization needs and opportunities, and constraints.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November, 2009
- Final Galveston Bay RSM due to the USACE at the end of January, 2010

Data Gathering

Further discussion between M&N and the PHA resulted in the gathering of the following information from Lloyd Saunders and David Casebeer (PHA):

- Private dredging activities within the Port of Houston area often use port placement areas (PAs) for disposal of dredged material. There are also several private PAs in the area. However, the PHA does not maintain specific information about these private dredging activities, just those activities completed directly by the PHA.
- Ten-year permits are received from the USACE for maintenance dredging terminals. The permit usually identifies several possible PAs and then the PHA selects the final PA(s) to be used at the time of dredging.
- The PHA coordinates with both the Harris County Flood Control District (HCFCD) and the Buffalo Bayou Partnership.
- While the PHA is not currently conducting any dredging activities in the San Jacinto River, it is tracking the dioxin issue at the new superfund site (the San Jacinto River Waste Pits site) located on the river's sand bar just north of the Interstate Highway 10 bridge.
- Key concerns for the PHA at this time include increased erosion along the Houston Ship Channel (HSC) and vessel speeds within the HSC.
- The PHA owns the upland PAs north of Beltway 8 with Fee Title ownership. Below Beltway 8, PAs are under "*navigational servitude*" (land below navigable waters can be subject to the public's right for navigation). PA cells 14 and 15 were created by sidecast dredging (navigational servitude). The Bayport cruise terminal and turning basin are currently under a land lease with the GLO. Atkinson Island is subject to navigational servitude except for one piece of its peninsula. Submerged lands adjacent to the Houston Ship Channel (HSC) in Harris County changed over to the PHA in 1927.
- Within the PHA's PAs, 95% of the dredged material originates from the maintenance dredging of federal channels while 5% of the material originates from private dredging activities.
- The USACE is 100% responsible for channel dredging, and reimburses the PHA for DAMP of the PA's for the 45-foot project. While the PHA accounts for approximately 15% of total tonnage on HSC it acts as the local cost share sponsor and doesn't receive funding from other HSC users. The new work dredging is cost shared 65% USACE / 25% PHA plus an additional 10% from PHA over the life of the project.
- The Beneficial Use Group (BUG) was a committee formed by the USACE's Interagency Coordination Team (ICT), in partnership with the PHA, to identify environmentally and economically responsible ways to utilize material dredged for the HSC expansion project. The BUG tried to minimize open water placement and present new beneficial use ideas. Its focus is not on the entire Galveston Bay area.
- Accurate capacity and volume data for the PAs is not currently available as the USACE does not survey the interior of the sites. Brian Leslie (M&N) asked if Light Detection and Ranging (LIDAR) could be used for this effort. Lloyd Saunders (PHA) stated that LIDAR may not be effective at picking up sediment surface conditions given the sediment characteristics of the material at these PAs. Currently the PHA uses Rob Roman (Hydrographic Consultants Ltd) for any required survey work.
- Dredged material from the Bayport Container Terminal (located just south of the Bayport Ship Channel) has excellent solid clay material that could be mixed with sediment fines and used for beneficial use sites. If the USACE observes good clay material in dredged sediment, it is often used for levee construction.
- After the widening and deepening project ships are moving faster in the channel and have larger displacements. Ship generated waves have been a problem for several areas such as Eagle Point Marina and the La Porte area. Additional marshes on the west side of the channel may be a way to reduce this impact.

- The PHA has limited Geographic Information System (GIS) available. Most of it is project specific and focuses on the identification of submerged lands and pipelines. It may not be broad enough for RSM Plan efforts.
- PA capacities change frequently and USACE data is probably the most up-to-date (although existing data may change significantly over the next 18 months).

Needs/Opportunities

Larry Wise and Brian Leslie (M&N) asked Lloyd Saunders and David Casebeer (PHA) if they could identify potential needs and opportunities for the RSM Plan. They identified the following:

- Supportive of effort to control sedimentation from Buffalo Bayou.
- Erosion control is needed for the San Jacinto River shoreline (a major contributor to shoaling in the HSC) and for the Sylvan Beach area (Bayport to Morgan's Point), which exhibits some of the highest erosion rates in Galveston Bay.
- Reduce marsh and oyster bed loss
- New marsh sites developed west of the HSC may help mitigate for ship waves from high vessel speeds in the channel.
- Develop new placement areas to meet capacity requirements.
- Building levees requires stiff clay and rock armor, but it may be better to consider building placement sites without any levees.
- Potential for upland beneficial use could include using material from Spillman's Island for State Highway 146 construction.
- The PHA is not directly involved with the construction of marsh sites, only the USACE completes this type of beneficial use effort. Currently PHA material is placed only at upland sites (material criteria is available on the PHA website). In general, marsh creation can be difficult. The BUG identifies issues with creating a functional and active marsh. Marshes often require the inclusion of additional channels to improve overall function and rarely require significant volumes of material in the first place.
- Additional placement at the San Jacinto Battlefield, located near on the San Jacinto River, may be a potential beneficial use opportunity. The Texas Parks and Wildlife Department (TPWD) own the San Jacinto Battlefield property, which currently suffers from subsidence. The site may require clean material for further marsh restoration efforts. PHA has encouraged placement of private material there, but there is a mismatch in needed volumes.
- The PHA has not yet considered life-cycle and land costs for the development of future PAs. Currently use a PHA fee of $4.12/cy for PHA and $1.50/cy for USACE for private dredging. The cost of DAMP activities alone is $4/cy. Further cost analysis is required to determine if a contractor/company could make a profit by removing material from PAs and using this material for upland or other beneficial uses.
- Larry Wise (M&N) presented Bob Engler's idea (M&N) regarding the placement of dredged material offshore for the purpose of beach nourishment (by introducing sand closer to shore on the Gulf side of Galveston Island so that it can enter the littoral system). Lloyd Saunders (PHA) was supportive of this idea but cautioned that the Environmental Protection Agency (EPA) does not support offshore disposal.
- The Gulf Intracoastal Water Way (GIWW), a man-made inland water system that accommodates significant barge traffic between Gulf of Mexico ports, contains more sand than does the HSC, which contains more silt. GIWW sand could be a potential source of good quality material.

Constraints

Larry Wise and Brian Leslie (M&N) asked Lloyd Saunders and David Casebeer (PHA) if they could identify potential constraints for the RSM Plan. They identified the following:

- The quality of available material is limiting in the study area (i.e., most clay material is used for constructing the levees and maintenance material, such as that of the HSC, has a high silt content).
- Planning efforts and project costs for beneficial use efforts are often high due to mandatory environmental and regulatory requirements.

- Sediment volume needs and sources are usually not identical (differences in scale).
- Flexibility with beneficial use efforts is lacking (i.e., it can be relatively streamlined to permit a project if it is in line with the BUG but more difficult if it is not).
- More difficult to make a functional marsh than originally thought (ex. increased expense for channels, varying the elevations, and requires more monitoring).
- There is a concern that overall maintenance requirements and costs for placement areas and beneficial use sites could increase as these sites subside over time.
- PA material that may be reused may need to undergo additional testing for contaminants and this could increase overall costs.
- Any new placement areas (upland or beneficial use) may need to be east of the Trinity River.
- The use of dredged material for upland beneficial use may be effective if the beneficial use site is located close to the original dredging activity, or the original PA, as transportation costs for moving dredged material can be high.
- The requirement for uniform taking of material from borrow sites (holes cannot remain) increases project costs.

Action Items Identified for Follow-up

- Look up the Better Bay Organization for BUG meeting minutes – ***completed***
- David Casebeer (PHA) will provide contact information for contractor (Mike Howell from JD Abrams) – ***completed***

These notes by M&N are intended to summarize information presented at this meeting. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Meeting Notes

Attendees:	Phone	Email
Jamie Schubert – TPWD	(281) 534-0135	william.schubert@tpwd.state.tx.us
Heather Young – NOAA Fisheries Service	(409) 766-3699	Heather.Young@noaa.gov
Rusty Swafford – NOAA Fisheries Service	(409) 766-3699	Rusty.Swafford@noaa.gov
Woody Woodrow – USFWS	(281) 286-8282	woody_woodrow@fws.gov
Cherie O'Brian – TPWD	(281) 534-0132	cherie.obrien@tpwd.state.tx.us
Donna Anderson - USFWS	(281) 286-8282	donna_anderson@fws.gov
Chris Webb – M&N (attended via phone)	(562) 426-9551	cwebb@moffattnichol.com
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 9/10/2009
Time: 2:00pm to 4:00pm

Location: Texas Parks and Wildlife Department
1502 Pine Drive (FM 517)
Dickinson, Texas 77539

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from that agency/group/stakeholder that should be considered during development of the RSM Plan.

Introductions were made between Moffatt & Nichol (M&N) and the Texas Parks and Wildlife Department (TPWD), National Oceanic and Atmospheric Administration (NOAA) Fisheries Service, and the US Fish and Wildlife Service (USFWS). Individual attendees at this meeting are listed above.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area for this meeting included most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands. Larry Wise (M&N) stated that the study area will include key inflow water bodies to the Galveston watershed not necessarily shown within the existing study area boundary lines. The current study area will be modified along the southwest boundary to include Chocolate Bayou west of San Luis Pass pursuant to comments from TGLO (see Figure 2-1 for revised study area).

Proposed RSM Plan Activities

On behalf of the USACE, Galveston District (contact: Bob Heinly), M&N is conducting meetings to gather existing data and input relevant to this effort, such as:

- Existing studies and data on erosion, water and nutrient inflow, sediment quality/quantity characteristics, and dredging and placement activities within the study area; and,
- Agency/stakeholder/organization needs and opportunities, and constraints.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

A discussion on sediment management between M&N, the TPWD, NOAA Fisheries Service, and USFWS resulted in the gathering of the following information:

- There were a number of questions related to the schedule for this effort (very tight) and whether or not the final RSM would incorporate all of the necessary data to provide a comprehensive overview of Galveston Bay. Larry Wise (M&N) responded to these concerns by agreeing that the schedule is tight. The current work effort is preliminary and M&N will be working hard to identify data gaps as well as available data for the RSM Plan. M&N will also propose strategies in the RSM Plan for USACE to use in further RSM development.
- Woody Woodrow (USFWS) suggested that the RSM Plan should incorporate information on how sediments are managed in Galveston Bay today. The RSM Plan should incorporate a description of the Water Resources and Development Act (WRDA) and existing USACE regulations, including the Federal Standard (a USACE standard developed for the placement of dredged material).
- Rusty Swafford (NOAA Fisheries Service) is concerned with the recent change in sedimentation on the Houston Ship Channel (HSC) and how the USACE will resolve this in the proposed RSM Plan. It would not be accurate to rely solely on historical dredging and placement data. Current practices need to be differentiated from practices used even five to ten years ago.
- Larry Wise (M&N) clarified that this effort does not include the development of a new Dredged Material Management Plan (DMMP), nor will it focus only on the Houston-Galveston Navigation Channels (HGNC). The RSM Plan will provide broad focus on all USACE sediment activities (both present, past and proposed) in the study area.
- Rusty Swafford (NOAA Fisheries Service) emphasized that it will be just as important to identify key data gaps and propose necessary strategies and studies needed to fill those gaps as it will be to identify relevant data.
- The Coastal Bend Bays and Estuaries Program (CBBEP) is proposing to mine existing placement areas (PAs) to build additional water bird rookeries along channel causeways.
- It was suggested that M&N should contact Jerry Mohn (West Galveston Island Property Owners' Association or "WGIPOA) for information on private dredging activities that he is aware of near West Galveston Island. WGIPOA recently conducted a private survey of local, non-federal dredging activities in the West Galveston island area (not Bay-wide).
- An initiative under America's Wetlands and the Gulf of Mexico Alliance (GOMA) Habitat Conservation and Restoration Team. They recently completed Gulf Regional Sediment Management Master Plan (GRSMMP) Draft Framework Report (August 2009). Cherie O'Brian (TPWD) will send this document to M&N.
- Heather Young (NOAA Fisheries Service) asked if other USACE districts had received RSM funding. Larry Wise (M&N) stated that the Great Lakes District had along with the Columbia River RSM effort which M&N had worked on, but was not familiar with all others. RSM funding levels and approaches vary for other USACE districts.
- The USACE should conserve key habitat in Galveston Bay as identified in the Galveston Bay Habitat Conservation Blueprint initially developed by the Galveston Bay Foundation (GBF) in 1998.

- Larry Wise (M&N) presented Bob Engler's idea (M&N) regarding the placement of dredged material offshore for the purpose of beach nourishment (by introducing sand closer to shore on the Gulf side of Galveston Island so that it can enter the littoral system). All agency attendees seemed supportive of the idea of keeping material within the system.
- Cherie O'Brian (TPWD) recommended that the USACE consider completing more than one type of demonstration project for any future RSM work.
- Concern was raised regarding the Texas Department of Transportation's (TXDOT's) use of its placement areas (PAs). Currently TXDOT does not use all of its funding for beneficial use efforts. This could be due to TXDOT concern that future funding for Gulf Intracoastal Water Way (GIWW) PAs could be lost if the PAs are not utilized as much as possible.
- Clear Lake does not allow dredged material to be placed in the lake (does not support beneficial use efforts).
- Concern was raised that Corps is often re-dredging the same material.
- Trinity River sediment flow is a concern. Injection dredging was tried in early 1990's but discontinued.
- The group would like to be part of the review process for the RSM Plan and would appreciate another meeting and/or opportunity to comment on a draft version of the RSM Plan. Larry Wise (M&N) will pass this request on to Bob Heinly (project manager at the USACE).
- In general, the group would like the RSM Plan to see incorporate background on the current sediment standards and management processes that impact the study area.
- Most bioresource information on M&N's draft study maps, showing areas of seagrasses and oyster reefs, is out of date and Donna Anderson (USFWS) mentioned that the Piping Plover habitat has been updated. M&N will only be able to incorporate available Geographic Information System (GIS) data into the RSM Plan. This limitation will be identified in the RSM Plan as a data gap as there is limited available survey data for these resources.
- The RSM Plan should also describe how it will interact with the Beneficial Uses Group (BUG) and existing Dredged Material Management Plan(s) (DMMPs) for the study area.

Needs/Opportunities

Larry Wise and Brian Leslie (M&N) asked the TPWD, NOAA Fisheries Service, and the USFWS to identify potential needs and opportunities for the RSM Plan. They identified the following:

- Representatives from all attending agencies wanted to stay away from identifying specific areas for BU work. Focus should be towards identifying available data, data gaps, proposing some broad-based ideas and strategies for future study, and emphasis for the current ecosystem approach along with other agency initiatives in Galveston Bay. Prioritization should be based on needs and services provided, not on specific projects.
- Protection of key and protected habitat and species.
- Protect habitat in consideration of sea-level rise. Use most recent sea level rise data available and recent USACE guidance on sea level rise.
- Create marshes in areas where they existed previously (not the middle of the Bay).
- Place material offshore to nourish local beaches.
- Ecosystem based management (holistic) approach.
- Cooperative conservation efforts.
- Restoration of water and sediment processes.
- Educate private land holders on beneficial use to try to gain access to these sites (Greens Lake "thin placement" given as an example).
- Work with smaller private dredging projects such as marinas, etc. Standards and best management practices should be implemented from a regulatory perspective. Developments should show long-term capacity for their dredging needs. Private developers and landowners need planning assistance but there is currently none available.
- Improve the management of USACE beneficial use site construction activities.

- Restore water and sediment processes in Galveston Bay.
- Identify sources of material for beach nourishment.
- Reduce open water disposal.
- Minimize the use of upland disposal sites and mine any available material in these sites.
- Inventory what kind and how much material is in the existing PAs and fill any remaining data gaps for what material is in the overall study area, including the GIWW.
- Use material from existing PAs (has been done at Swan Lake and Old River Cove on the Sabine-Neches Waterway where material was placed onto a barge and then transported off the site). The use of material from existing PAs has also been considered for the Bessie Heights marsh project (located along the lower Neches River). Currently, the Coastal Bend Bays & Estuaries Program (CBBEP) is proposing to use material out of existing PAs.
- Consider using material impounded behind reservoir dams.
- Determine how the proposed RSM Plan will interact with the BUG and the existing DMMMPs.
- Nationwide permits can be obtained quickly for beneficial use opportunities.
- Develop incentives (funding, support for planning and permitting, etc.) for beneficial use efforts.

Constraints

Larry Wise and Brian Leslie (M&N) asked the TPWD, NOAA Fisheries Service, and the USFWS to identify potential constraints for the RSM Plan. They identified the following:

- Long term (cumulative) impacts of existing and proposed sediment management activities should be addressed.
- The Federal Standard and USACE priorities are out of date and do not reflect current ecosystem management strategies. They should consider habitat creation.
- Cost-share by the local sponsor can be difficult to obtain. Dedicated sources of local match monies are needed for beneficial use efforts.
- Planning efforts and costs can increase due to existing Section 7 in-water work windows.
- Sediment volume needs and sources are usually not identical (differences in scale).
- Sediment quality standards for beneficial use sites differ from that for placement areas and the necessary testing methods (analytical and bioassay) can be expensive. Contaminant issues have been observed at areas near the San Jacinto River, around ExxonMobil, and further up the Buffalo Bayou.
- Multiple handling of material for offshore disposal is not cost effective and should be considered in cost analyses.
- Incorporate long term costs, costs to society, environmental costs, loss of costs to economy (commercial fishing and recreational fishing) into USACE economics.
- Scheduling the type and quantity of sediment for the right time is difficult.
- Obtaining funding for sediment activities is difficult for non-government organizations and non-federal match requirements are usually limiting.
- Negotiations with private landowners take time.
- State-wide and locally, there is a lack of financial support, regulatory guidance, and incentives to increase use of beneficial use sites in the study area. There is also a lack of any incentives for private property owners and a lack of incentives for the state to do more than the minimal level of mandated environmental mitigation.
- Poor construction management of beneficial use efforts (i.e. Smith Point) is a concern. Best Management Practices (BMPs), monitoring requirements and record keeping during and after construction, and contracting (contractors currently paid for dredging not for meeting environmental specifications) should be modified and/or improved.
- Not enough long-term sediment capacity studies have been completed for the study area.
- Identify both the problems and weaknesses of the current sediment regulations and the system.

- Avoid identifying specific projects that will hinder the ability for beneficial use efforts to be "flexible" and reactive to current conditions and needs.
- Support the continuation or reinstatement of monitoring activities for water level gauges in the study area given the potential for long-term impacts due to subsidence, sea level rise, etc.
- Salinity alone should not be used to estimate nutrient inflow to Galveston Bay.
- Sea level rise is not currently considered from a 50- to 100-year perspective. Utilize the most recent sea level rise data available for the RSM Plan.
- San Luis Pass should be protected from any development. Bolivar Flats is also an important area for habitat.
- The TGLO should support beneficial use through their submerged land leases.
- Some projects have ignored beneficial use recommendations from the resource agencies (i.e. using Texas Point for Sabine Pass; recommendations for Chocolate Bayou).
- The Continuing Authorities Programs (CAPs) should be used but they do not currently have adequate funding.

Action Items Identified for Follow-up

- Contact Jerry Mohn (West Galveston Island Property Owners' Association or "WGIPOA") for private dredging project information – ***started***
- Cherie O'Brian (TPWD) will send M&N a copy of the Gulf of Mexico Alliance Habitat Conservation and Restoration Team GRSMMP Draft Framework Report dated August 2009 – ***completed***
- Look at Laguna Madre effort for RSM guidance and general "*lessons learned*" – ***started***

These minutes by M&N are intended to summarize information presented at this meeting. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Call Notes

Attendees	Phone	Email
Mark Rodriguez – TXDOT Galveston-Bolivar Ferry Terminal	(409) 256-8500	mrodriz@dot.state.tx.us
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 10/02/2009

Time: 2:00pm to 2:45pm (CST)

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from the TXDOT Ferry Terminal that should be considered during development of the RSM Plan.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Margaret Schwertner (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area includes most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Further discussion between M&N and TXDOT resulted in the gathering of the following information:

- The Galveston-Bolivar Ferry terminal currently has three ferry landings and three access channels (approximate depth of -22 feet).
- Dredging activities at the ferry terminal have tripled over the past three years since the terminal rehabilitation project, most likely due to: a) the addition of a third ferry landing and channel to the facility; and, b) Hurricane Ike. Prior to this project, if one channel silted in, or was undergoing maintenance dredging, only one channel could remain open for ferry operations. The third landing and channel were necessary to provide operational redundancies for the ferry service. The project resulted in a third channel and landing to maintain. Currently,

approximately 350,000 cubic yards (cy) of material was dredged this year from the terminal. Another 150,000 cy may need to be dredged as well.

- TXDOT anticipates that the annual quantity of dredged material may decrease over time (to less than the 450,000 cy necessary to stabilize the facility).
- In the past, up to 200,000 cy of dredged material was permitted for placement at Site A. The ferry terminal now has more material to dispose of and requires more space for dredged material. Note: The ferry terminal can still use Site A but it lacks capacity for current ferry terminal quantities. Texas Parks and Wildlife Department (TPWD) do not like Site A being used for dredged material placement and the ferry tries to only use the site in emergency instances.
- Site 41 is available for use by the TXDOT ferry terminal. However, Site 41 is located approximately 4.5 miles away from the terminal. This increases the cost for dredged material placement significantly.

Needs/Opportunities

Over the next ten years, the ferry terminal will most likely continue to use Sites 41 and A (unless other placement options become available). Some options that the ferry terminal has considered include:

- Beneficial use of material at Little Beach (near the terminal). However, the US Army Corps of Engineers (USACE) ended up utilizing the site for dredged material placement for USACE projects.
- Beneficial use of material (beach placement) on the west side of Fort Travis near the rock groin. Particle size was an issue and this option also tied in with Little Beach, which was eventually used by the USACE.
- Sites 42 and 43 are possible options for dredged material placement. Site 42 is only 2 miles away from the terminal, has road access, and TXDOT has heard that the USACE is considering its expansion. Site 43 is right next to the Gulf Intracoastal Waterway (GIWW). Both sites could receive good sized quantities of material from the ferry terminal dredging activities. TXDOT owns these sites but does not maintain the rights to use the sites (leased to USACE for GIWW use).
- Pelican Island could be an option, but it's being viewed as a site for use with a Port of galveston terminal expansion project.
- Beach at Fort San Jacinto: A beach area of approximately one to one and a half miles in length by East Beach, behind the USACE building was discussed as a definite option as well.

Constraints

The following constraints were identified by TXDOT:

- The quantity of material to be dredged, and the overall cost to dredge the material, are the biggest issues currently facing ferry terminal dredging activities.
- Costs increase for sites the further they are from the ferry terminal. Approximately 40 t0 50% of total dredging costs could be reduced if closer placement sites were available.
- Size of Beneficial Use projects often require small quantities of material, much smaller than the quantities of material that the ferry terminal needs to dredge annually.

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Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Call Notes

Attendees	Phone	Email
James C. Gibeaut – Harte Research Institute for Gulf of Mexico Studies (HRI), Texas A&M University – Corpus Christi (TAMU-CC)	(361) 825-42060	james.gibeaut@tamucc.edu
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 10/07/2009

Time: 10:00am to 11:00am (CST)

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather data on shoreline erosion and potential needs, opportunities, and constraints from Dr. James C. Gibeaut of the Harte Research Institute for Gulf of Mexico Studies (HRI), Texas A&M University – Corpus Christi (TAMU-CC) that should be considered during development of the RSM Plan.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area includes most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Discussion between M&N and Dr. Gibeaut resulted in the gathering of the following information:

- Dr. Gibeaut agreed with M&N's approach to use R. A. Morang's work to develop a sediment budget for the Gulf side of the study area.
- Erosion rates for the West Bay have been developed but the rates available for the remainder of Galveston Bay are not up-to-date (utilizes old data from 1980's). Refer to Paine, J. G., and R. A. Morton. 1986. Historical

shoreline changes in Trinity, Galveston, West, and East Bays, Texas gulf coast. The University of Texas at Austin, Bureau of Economic Geology Geological Circular 86-3, 58 pp.

- Better rates are also available for the backside of the Bolivar peninsula. The data may be available on the Bureau of Economic Geology (BEG) website. Check the following sites for data:
    - The Texas Shoreline Change Project website at http://www.beg.utexas.edu/coastal/intro.htm
    - The Texas Coastal Hazards Atlas website at http://www.beg.utexas.edu/coastal/hazardsIndex.htm
- Dr. Gibeaut is starting to map shoreline types as part of his research to classify shorelines according to their sensitivity to oil spills (ESI or Environmental Sensitivity Index). This information will be available mid-2010.
- Dr. Gibeaut asked M&N why Christmas Bay was not included in the study area.
- Another new 2-year project will look at the water turbidity climate in Galveston Bay (uses AVHRR & MODUS satellite data similar to the data used for Mobile Bay). The project will also look at the correlation between turbidity and vertical accretion.

Needs/Opportunities

RSM Needs and opportunities were discussed:

- Larry Wise (M&N) presented Bob Engler's idea (M&N) regarding the placement of dredged material offshore for the purpose of beach nourishment (by introducing sand closer to shore on the Gulf side of Galveston Island so that it can enter the littoral system). Dr. Gibeaut was supportive of the idea in general, or even the use of a near-shore dredged material placement area.
- Dr. Gibeaut mentioned that there is good quality sand in the entrance channel to Galveston Bay.

Constraints

The following constraints were identified:

- Beach nourishment (BN) can be a problem as it is a long-term commitment that never ends. People end up relying on it for property values, etc. We need to better manage setback areas before conducting beach nourishment activities.
- Material supply for BN on the gulf-side of the study area is minimal.
- On the bay-side of the study area, wetland subsidence is an issue (especially of subsidence due to oil and gas activities) and how to mitigate for this issue. Examples of this include:
    - The subsidence and faulting at the Caplen Oil Field on Bolivar Peninsula where acres of marshland has been replaced by mudflats. Dr. Gibeaut suggested Morton's article, "Evidence of regional subsidence and associated interior wetland loss induced by hydrocarbon production, Gulf Coast region", which can be found at http://coastal.er.usgs.gov/gc-subsidence/. The article correlates marsh loss to subsidence.
    - Another example is the subsidence bowl located near Seabrook. Dr. Gibeaut suggested looking up the "Buckley" papers on this for additional information. Larry Wise has this data.
- Rollover Pass is another issue of concern. Larry updated Jim on the TGLO's plans for the pass.
- Dr. Gibeaut cautioned against any dredging or development in San Luis Pass as the existing sediment provides substrate for wetlands.

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Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Call Notes

Attendees	Phone	Email
Dr. John B. Anderson – Department of Earth Science at Rice University	(713) 348-4884	johna@esci.rice.edu
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com
Brian Leslie – M&N	(619) 220-6050	bleslie@moffattnichol.com
Margaret Schwertner – M&N	(206) 622-0222	mschwertner@moffattnichol.com

Date: 10/08/2009

Time: 2:00pm to 2:45pm (CST)

Meeting Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather data on Sea Level Rise (SLR) and potential needs, opportunities, and constraints from Dr. John B. Anderson (Department of Earth Science at Rice University, Houston, Texas) that should be considered during development of the RSM Plan.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area includes most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Discussion between M&N and Dr. Anderson resulted in the gathering of the following information:

- Dr. Anderson is involved with "Sustainable Galveston," a group within Rice University's Department of Earth Sciences and the School of Architecture, who have collaborated in exploring more long-term (50- to 100-year projections) sustainable approaches to coastal development of Galveston Island. The research work is supported in part by the Shell Center for Sustainability. Sustainable Galveston is considering some possible long-term ideas for Galveston island:

  - Both island tourism and the island population could benefit from being concentrated to the east part of the island.
  - A report is due out in December of 2009 (M&N requested an advance copy and Dr. Anderson did not see this being a problem).
- Dredged material could be reused to raise the elevation of the East End Flats.
- Beach nourishment is not very cost efficient or effective for the west end of Galveston Island or on the gulf-side of the Bolivar Peninsula (material simply washes away after being placed on the beach).
- Wetland restoration projects are good projects to be supported but they remove sediment sources from the system.

Needs/Opportunities

RSM Needs and opportunities were discussed:

- Sediment supply for the Trinity Delta will become a major problem in the future. Any impacts from the installation of the Lake Livingston Dam (constructed in 1969) may not yet be impacting Galveston Bay (effects may take some time before they start to be noticed). However, impacts from the dam are anticipated in the future. Geologically, deltas retreat landward under similar circumstances and this is anticipated for the Trinity Delta (expected to decrease in size in the future).
- Systems have thresholds that react quickly when they do react. Sediment sources to the Trinity Delta have been reduced by a number of factors (such as the installation of the dam) and response approaches need to be identified to deal with the delta once it does start to react to the loss of sediment sources to the system.
  - For example, increase sediment sources to the system now, before the delta starts to significantly recede.
  - Consider talking to Dr. Jonathan Phillips of the University of Kentucky's Department of Geography for sediment budget analysis information.
- Sea Level Rise (SLR) is increasing. However, Dr. Anderson cautions that a lot of emphasis has been placed on one tide gauge (Pier 21 tide gauge) and this could result in an unrepresentative rate of SLR for the area. (The Pier 21 tide gauge is located where there is a high level of subsidence.) Subsidence in other parts of Galveston Bay is minimal
  - Refer to Anderson and Rodriguez (eds), 2008, Response of Upper Gulf Coast Estuaries to Holocene Climate Change and Sea-Level Rise, Geological Society of America Special Paper 443.
- Any online data that M&N and the USACE obtain from Rice University and wish to use for the RSM project should simply reference Rice University.

Constraints

The following constraints were identified:

- Overall increase in SLRs and a decrease in sediment input to the system. (Sediment budget for the system will be negative). Therefore sediment sources for the system need to be identified.
- Beneficial Use (BU) projects are an effective way to use dredged material from a geological standpoint.
- Larry Wise (M&N) presented Bob Engler's idea (M&N) regarding the placement of dredged material offshore for the purpose of beach nourishment (by introducing sand closer to shore on the Gulf side of Galveston Island so that it can enter the littoral system). Dr. Anderson was supportive of the idea if the right quality and quantity of material is used. It would also depend on the overall ecological impacts. For example, the negative ecological impacts would need to be outweighed by the benefits of getting sand into the littoral system. If not enough material was used, it may not be worthwhile carrying out at all.
- In the past, areas just outside the North and South Jetties were used for material placement. This actually buried an ebb tidal delta limiting a good quantity of source sand from the system. Dredged material should not be placed on either side of the jetty areas.

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Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Call Notes

Attendees	Phone	Email
Jerry Mohn – W. Galv. Isl. Property Owners Assoc. (WGIPOA)	(409) 737-5768	mohn@msn.com
Larry Wise – M&N	(206) 622-0222	LWise@moffattnichol.com

Date: 10/09/2009

Meeting Call Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from the West Galveston Island Property Owners Association (WGIPOA), particularly on beneficial uses of dredged material for private canal subdivisions/marinas, that should be considered during development of the RSM Plan.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area includes most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Further discussion between M&N and WGIPOA resulted in the gathering of the following information:

- The West Galveston Marsh Restoration Program is a group that has formed under WGIPOA looking specifically at beneficial uses of dredged material from the various canal subdivisions/marinas. Jerry Mohn provided notes from their last two annual meetings. Projects/participants include Terramar, Bay Harbor, and Tiki Harbor.
- Discussed the Texas Parks and Wildlife Department (TPWD) Starvation Cove project which has successfully used some dredged material from adjacent subdivisions.

Needs/Opportunities

Some alternatives and projects that the WGIPOA has considered include:

- Use of material from the South Jetty area for beach nourishment.
- Discussed bringing offshore placement area in closer to shore, WGIPOA would support this.
- Beneficial use of dredged material should be encouraged for private developments.
- Discussed the proposed extension of the Galveston Harbor and potential beneficial use of dredged material for TAMUG wetland center.

Constraints

The following constraints were identified by WGIPOA:

- Funding, especially for shoreline protection/restoration projects on the Gulf shoreline.
- Threatened and Endangered Species requirements including monitoring and time limits (windows).

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Attachment A – INFORMATION PROVIDED BY WGIPOA

West Galveston Island Marsh Restoration Program

July 21, 2008

Meeting NOAA Facility: 1:45-4:00 PM

GLO Presentation – Ray Newby

- GLO would like to develop a comprehensive master plan for marsh restoration
- Contract and funding partner
  - CEPRA
    - CEPRA VI - next legislative session for funds for marsh restoration projects
      - ✓ 25% match required for beach and dune
      - ✓ 40% match required for bays projects
    - No in kind funds are reimbursed until the execution of the contract
  - CIAP
    - FY07 approval of projects and funding in early 2009
      - ✓ Once MMS gives approval, you have 4 years to spend the money
    - 2nd round FY08 due 7/30/08
      - ✓ CLAB (Coastal Land Advisory Board) possible meeting in November, 2008, for project approvals
    - Can seek reimbursement for funds used for a project after 8/5/2005
- Master Plan – develop an overall monitoring program
  - Monitoring of restored habitat or restoration site
    - ✓ Each subdivision pay for a portion of the monitoring
    - ✓ Monitoring work done by volunteers
  - Sediment transport and shoaling study

Update of Projects:

- Bay Harbor – Betsy Redfield and John Halsey updated the current situation
  - Over $200,000 of funds raised so far but still $50,000 short. CEPRA V contributed $100,000; $25,000 from US Fish & Wildlife; $25,000 from Beach & Bay Foundation; and, $50,000 from the Coastal Counties Restoration Initiative.
    - No news on the Fish America $50,000 grant through the Coastal Beach & Bay Foundation. Unconfirmed sources advise no grants for any west bay projects.
    - $2000 donation from the Kempner Foundation
    - Need to raise as much as $80,000 to $100,000 and the total target is to accumulate $400,000.
  - Plan to sign engineering contract in 60 to 90 days with start up in a year.

- Terramar – Pat Kirk updated the status of the Terramar project.

- **The project is short $125,000 of funds. So far, $115,000 from the subdivision with the possibility of another $15,000; $25,000 from US Fish & Wildlife.**
  - **Applying for a $140,000 CIAP grant.**
- **Dredging costs are projected at $135,000**
- **US Army Corp permit was approved and received**
- **Dredge major channel 2600 feet and go 4 feet deep and 50 feet wide.**
  - **Create 2 acres of marsh area**
  - **Create a 400 foot temporary marsh protection terrace will built in front of County Pocket Park #4**
- **Start the project in Fall of 2009**

- **<u>Tiki Island</u> – Phil Hopkins, Cynthia Celli, Tim Cullather and Tim Rainey gave an update on the dredge program for the island.**
  - **Total estimated area of navigable interior canals, perimeter and access channels is approximately 4,724,000square feet or 108 acres**
  - **The maintenance activities planned at present include approximately 70-75,000 cubic yards, 6 foot original depth; area has not been dredged since 1992**
  - **Engaged Shelmark Engineering for permitting**
    - **Multiple sites for restoration programs**
    - **Shelmark is proposing a maintenance program that incorporates a 20 year plan**
    - **Shelmark will submit a maintenance permit to the USACE**
    - **Estimate total project cost $800,000 plus. Tiki has not yet received any grant commitments, but have raised approximately $350,000 from property owners.**
  - **and right now all funds on hand are from Tiki property owners**
  - **Split the island into two geographic areas; north and south side**
    - **Beneficial use Site #4 (North/East side) – estimated values**
      - ✓ **10 acre site, accommodate 77,000 cubic yards at a depth of 4 feet.**
      - ✓ **1000 linear feet of shoreline will be protected**
    - **Beneficial use Site #8A (South/West side) – estimated values**
      - ✓ **Over time to place 170,000 cubic yards; Protect 2500 linear feet of shoreline**
      - ✓ **Building berms or temporary marsh protection terraces rather than sand socks**

- **<u>Sun Set Cove/Snake Island:</u> Sand socks have been installed. The GBF awarded more funds for restoration and US Fish plans to investigate to see if sea grasses have come back.**

<u>New Developments</u>

- **<u>Sweetwater:</u> Has submitted for a permit and it went out for public notice.**

- **<u>Spoonbill Bay</u>: Applying for excavation permit in August/September for 32 acres. Plan to fill 9 acres and use sand socks and berms**

- **<u>Reserve at Bay Harbor Phase II</u> (Rush Development):**
  - **The development will require approximately 63 feet of open water excavation, which will be leased from the State.**
  - **Use the open water excavation to build lots.**
  - **95% of the boat access channel is an upland excavation.**
  - **There will be a lease from the State of Texas through the GLO.**

- **<u>Sweetwater:</u> Shelmark Engineering is performing civil engineering services for the project.**

- **<u>Spoonbill Bay</u>:**
  - **Applying for excavation permit in August/September.**
  - **Plans include a 32-acre beneficial use area to be utilized over an extended time period.**
  - **Plans included in the USACE permit submittal an initial fill of approximately 9.67-acres in the beneficial use area (from the open water excavation) to establish sand socks, marsh mounds and creation areas.**

- **<u>Reserve at Bay Harbor Phase II</u> (Rush Development):**
  - **The development will require approximately <u>63 feet</u> of open water excavation, which has been leased from the State.**
  - **95% of the boat access channel is an upland excavation.**
  - **Use the upland excavation material to raise the existing grade for the construction of residential lots.**

Respectfully Submitted
Jerry Mohn
West Galveston Island Property Owners Asso

West Galveston Island Marsh Restoration Program

July 13, 2009

Meeting NOAA Facility: 1:35-3:15 PM

Update of Projects:

- **Bay Harbor – Betsy Redfield updated the current situation. Main project is to dredge the navigation channel and use the dredge material as beneficial use to restore Bird Island for habitat restoration projects. Total costs for the project is now $425,000.**
  - **The GLO withdrew the $100,000 from CEPRA V. Bay Harbor is filing again for the same amount for the CEPRA VI for $225,000.**
  - **US Fish & Wildlife will extend their $50,000 grant.**
  - **$25,000 from Beach & Bay Foundation**
  - **$50,000 from the Coastal Counties Restoration Initiative.**
  - **An application has been filed with Gulf of Mexico Foundation for $25,000.**

- **Terramar – Pat Kirk sent an update on the status of the Terramar project.**
  - **The project is ready to begin with most of the funds coming from the subdivision. An acceptable dredging bid has been received and construction should begin in the next two weeks and take two weeks to complete.**
  - **GBA engineers working on final details**
  - **Received $75,000 from US Fish & Wildlife and Gulf of Mexico Foundation through NOAA.**
  - **Plan to plant vegetation in September and working with Artist Boat to assist.**
  - **Project is to dredge major channel 2600 feet and go 4 feet deep and 50 feet wide.**
    - **Create 2 acres of marsh area**
    - **Create a 400 foot temporary marsh protection terrace will built in front of County Pocket Park #4**

- **Tiki Island – Phil Hopkins, Cynthia Celli, Tim Cullather and Tim Rainey gave an update on the dredge program for the island.**
  - **First phase plan is to restore 10 acres with 73,000 cubic yards of dredged materials.**
  - **Project costs estimated at $915,000 and have raised so far $485,000 from property owners. Applying for a CMP grant and Gulf of Mexico Foundation grant.**
  - **Shelmark Engineering is handling design and a maintenance permit**
  - **Building berms or temporary marsh protection terraces rather than sand socks**
  - **Shelmark is proposing a maintenance program that incorporates a 20 year plan to restore two wetland sites:**

- ❖ **Initial Beneficial Use Site is adjacent to north side of island**
  - **10 acre site, accommodate 77,000 cubic yards at a depth of 4 feet.**
  - **1000 linear feet of shoreline and adjoining marsh will be protected.**
  - **Expected to be completed with B. U. material from 2009-2010 maintenance dredging.**
- ❖ **Future Beneficial Use Site is about 1000 yards west of island**
  - **24 acre site, accommodate 170,000 cubic yards.**
  - **Adjacent to TxDOT site for ICWW dredging materials.**
  - **2500 linear feet of shoreline will be protected.**
  - **Expected to be competed with future maintenance dredging materials over next 20 years.**

➢ **Good news: Since the last meeting, Phil Hopkins was elected Mayor of Tiki Island. Congratulations.**

- **<u>Snake Island:</u> Heather Young reported the latest developments.**
  - ➢ **The Galveston Bay Foundation awarded $100,000.**
  - ➢ **Plan to install two more sections of sand socks and to change the alignment of existing tubes to facilitate more seagrass growth.**
  - ➢ **Sea grasses have come back and GBF plans in two months to transplant some to other areas.**

- **<u>Starvation Cove:</u> Cherie O'Brien had a power point presentation on the proposed project called the "Starvation Gap Wetland and Water Quality Protection Project"**
  - ➢ **In the process of selecting an engineering company.**
  - ➢ **Desire to partner with adjacent subdivision (Spanish Grant, Pirates Cove and Laffites Cove) to beneficially use the dredged material from their entrance canals and this will be coordinated during the design phase of the project.**
  - ➢ **Funding $150,000 from Galveston Bay Estuary Program, $900,000 from CIAP (3 components to this).**
  - ➢ **TPWD is the Administrative and on-the-ground Project Manager**
  - ➢ **Extend the sand socks to the Spanish Grant entrance channel.**

- **<u>Galveston Island State Park/Jumbilee Cove:</u> Cherie O'Brien presented a power point on this project called the "Recovery Act Restoring Estuarine Habitat in West Galveston Bay". The funding is $5,148,369 from NOAA through the American Recovery & Reinvestment Act; $897,597 non-federal which includes $647,597 from the Texas General Land Office, a $250,000 in-kind plant donation from NRG Texas, and $10,000 in-kind staff time from TPWD. GLO is the Administrative Project Manger managing the fiscal and contracting activities of the project. TPWD will manage the on-the-ground construction activities for the project. The following description of the project is from the funding application:**

The Galveston Island State Park (GISP)incorporates the restoration of approximately 198.5 acres of inter-tidal marsh complex utilizing dredge material from a 100-acre nearby borrow site. This proposed project will be in an area of the GISP that historically consisted of high and inter-tidal marsh with tidal-inlets. The area is now mostly shallow water. This area of the GISP is also the location of a marsh terracing restoration project constructed in 1999-2000. The terraces were constructed by excavating bottom sediments and stacking the sediments to intertidal elevations directly adjacent to the excavation area. The arrangement of the GISP terraces is a checker-board pattern of square cells with open corners. This technique has been successfully applied in several cases, and is most successful when utilized in areas with high clay content in the excavated sediment. However, the sediments at the GISP are mostly sand and silt with very little clay material. Initially, the sandy material was able to be stacked to intertidal elevations and was planted with marsh vegetation that persisted for several years. However, the terraces have slowly eroded and lost elevation and the majority of the terraces no longer support vegetation. While the majority of the terraces no longer support vegetation, they are not completely gone. The majority of the terraces are still intact but are now subtidal. This project component will utilize material that will be hydraulically dredged from a designated borrow site and placed inside the terrace footprint; creating a mosaic of intertidal marsh, salt marsh/salt flat and protected shallow open water.

This component of the project would be engineered, bid and constructed first. Much of the information required to design the restoration of this area already exists due to the previous restoration project at this site. The area has an existing Coastal Lease that would require a minor amendment for the footprint of the marsh restoration area and the borrow site. An application for Nationwide Permit (NWP) 27 has been submitted and approved for the GISP component. An application (NWP) 27 for the Jumbile Cove component will be submitted the week of July 20th. -

<u>New Developments:</u> Rhonda Gregg, Shelmark Engineering, was not able to attend the meeting but provided the following information:

- **<u>Spoonbill Bay</u>:**
  - **A lot of open water dredging and beneficial use material**
  - **Plan to fill 9 acres and use sand socks and berms**
  - **Not pursuing any outside funding**
  - **Project is out for Public Notice**

- **<u>Reserve at Bay Harbor Phase II</u> (Rush Development):**
  - **The development will require approximately 63 feet of open water excavation; the remainder is an upland excavation. There will not be any BU material.**
  - **Received a conservation easement.**
  - **Received a US Army and is requesting the City for an extension of the Special Use Permit**

Respectfully Submitted
Jerry Mohn
West Galveston Island Property Owners Asso

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Call Notes

Attendees	Phone	Email
Perry Culp – Harborside Management District (HMD)		gpc@swbell.net
Larry Wise – M&N	(206) 622-0222	LWise@moffattnichol.com

Date: 10/20/2009

Time: 9:30 am – 10:30 am

Meeting Call Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Introduce the US Army Corps of Engineers (USACE's) Galveston Bay Regional Sediment Management Plan (the "RSM Plan") to different federal, state, and local agencies, along with important stakeholder groups and organizations who may have interests in the development of the RSM Plan; and,
- Gather a list of potential needs, opportunities, and constraints from the Harborside Management District (HMD), particularly on beneficial uses of dredged material, that should be considered during development of the RSM Plan.

RSM Plan Overview

An overview of the Galveston Bay Regional Sediment Management Plan (the "RSM Plan") was provided by Larry Wise (M&N).

- *Goals and Objectives:* M&N was hired by the USACE, Galveston District to complete a broad-brush RSM Plan for Galveston Bay. The purpose being to summarize available data and studies, identify data gaps, and to propose strategies and more comprehensive work that the USACE can further refine and develop through future efforts. The goals of the RSM Plan include (but are not limited to): the reduction in life-cycle costs for dredging activities; a more efficient use of USACE operations and maintenance dollars; support of restoration efforts and coastal resiliency; and, maximize the beneficial use of dredged sediments.
- *Study Area:* The proposed study area includes most of Galveston Bay, key rivers and streams feeding the bay, and adjacent lakes and wetlands.

RSM Plan Milestones

The timeline for completing the Galveston Bay RSM Plan is short. The emphasis is not to complete a detailed RSM Plan at this time but to comprehensively identify existing data and data gaps, needs/opportunities and constraints, and other key issues necessary for the USACE to move towards completing more comprehensive RSM efforts for Galveston Bay, with an ultimate goal of completing a unique demonstration project in two to three years time.

- Draft Galveston Bay RSM due to the USACE at the end of November 2009
- Final Galveston Bay RSM due to the USACE at the end of January 2010

Data Gathering

Further discussion between M&N and HMD resulted in the gathering of the following information:

- HMD includes the bay side of Galveston Island from 51st St. bridge to the Ryan Marine Services facility.
- HMD is a subdivision of the City of Galveston and has taxing authority.
- There is an existing 12 foot (ft) deep channel which HMD is seeking to deepen to 20 to 25 ft. A portion (first phase) has been deepened to 16 ft, but has already shoaled in to 13 ft.

- A USACE Sec. 10/404 permit exists for the first phase of the project and includes upland confined placement of dredged material.
- Material consists of approximately 3 ft of silt with high quality sand below. Some geotechnical information is available. Approximately 350,000 cubic yards (CY) is estimated for in Phase I and 1 MCY is estimated for Phase II.
- In 2002 the HMD sought Federal participation in the project through a Feasibility Study and a preliminary study was conducted by the Galveston District as summarized in the attached Milestone Report. Since 2004 the Feasibility Study has not moved forward.

Needs/Opportunities

Some alternatives that the HMD has considered include:

- Considered placing material just offshore of the channel as a "barrier island".
- Considered Swan Lake, but distance of 4.7 miles is restrictive.
- Considered Pelican Island Benefical Use Site, but distance of 3.7 miles is restrictive.
- Considered placement at islands along the Gulf Intracoastal Waterway (GIWW) west of the Causeway.
- Considered placing material at the Texas A&M University of Galveston (TAUG) wetland center. Initially the wetland center was not interested, but the Galveston Bay Foundation (GBF) took on the project and submitted it to the Texas general Lands Office (TGLO) for the Texas Coastal Erosion Planning and Response Act (CEPRA) grant funding. The project was listed as an alternate for CEPRA. Multiple letters of support exist.

Constraints

The following constraints were identified by HMD:

- Funding

These notes by M&N are intended to summarize information presented on this conference call. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

Attachment A – INFORMATION PROVIDED BY HMD

30 June 2004

Milestone Report

1. Project Name: Galveston Harbor Extension, Galveston, Texas (previously: Galveston County Navigation District #1 Navigation Improvement, Galveston, Texas).

2. Authority: The authority for this study is Section 107 of the River and Harbor Act of 1960, as amended. This authority permits the Corps of Engineers to undertake the investigation, design, and construction of small navigation projects.

3. Location: The project is located on the north shore of Galveston Island immediately south of the GIWW in Galveston, Texas.

4. Problem: The Harborside Management District requested a study, in a letter dated 22 September 2003 (Enclosure 1), of the feasibility of a commercial navigation channel that would permit the entry and use of the harbor by larger oil field service vessels, jack-up rigs and floating structures, and seagoing tugs and barges that cannot presently navigate in the area.

5. Solution Considered: The navigation improvements consist of a10,500 ft entrance channel and channel extension and includes deepening of approximately 4,500 ft of the GIWW (Enclosure 2). The proposed channel is designed for one-way traffic with a design vessel size of 52' x 240' with 20' draft. The channel design depth is -26' MLT and includes 4' advanced maintenance depth and 2' allowable overdraft. The channel would be 150' wide and contain three turning basins with diameters of 375'.

6. Project Costs: Project first costs for the proposed navigation improvements were estimated at $10,846,342 (Enclosure 3). This amounts to an annual cost of approximately $1,168,237.

7. Project Benefits: The estimated annual benefits are approximately $3,834,612 (Enclosure 4). These projected benefits were derived from transportation cost reductions at only three of the several facilities currently located on the proposed channel. Due to limited time and costs associated with this preliminary analysis, only transportation cost reduction benefits were evaluated. Additional benefits would be realized with the channel deepening including; shift of mode benefits, shift in origin-destination benefits, and new movement benefits.

8. Economic Analysis: With average annual costs of $1,168,237 and average annual benefits of $3,834,612, the benefit-to-cost ratio is approximately 3.3. The complete economic analysis is attached as Enclosure 4.

9. Amount of Feasibility Study Funds Expended to Date: $50,000.

10. Additional Funds Required to Complete Feasibility Study: $1,158,700

11. Status of Feasibility Cost Sharing Agreement: Currently being negotiated.

12. Map: See Enclosure 1.

Harborside Management District

7500 Harborside Drive
Galveston, Texas 77554

September 22, 2003

District Engineer
U. S. Army Corps of Engineers
Galveston District
Attn: Mr. Byron D. Williams
P. O. Box 1229
Galveston, Texas 77553-1229

Dear Sir :

I request that the U.S. Army Corps of Engineers, Galveston District, continue an investigation of a port channel deepening at Galveston, Texas, under the authority of Section 107 of the River and Harbor Act of 1960. Harborside Management District is willing to serve as the study sponsor and will replace Galveston County Navigation District #1.

I understand that the Study would be Federally financed and 100 percent Federally funded to the limit of $100,000. If the total cost of the study exceeds $100,000, I understand that the remaining study costs will be shared equally between the Corps and Harborside Management District. If studies indicate a viable solution, our objective will be to proceed with construction. We are capable of fulfilling our financial obligations for construction and operation and maintenance; in general, providing a minimum of 20 percent of the construction cost for the general navigation facilities including furnishing lands, easements, right-of-way, relocations, dredge material disposal areas, and berthing and fleeting areas. We are also aware that both the Corps and our responsibilities will be delineated in the Project Cooperation Agreement, which both parties will execute before construction commences.

If you need additional information, please contact.

John L. Sullivan at (409) -740-4200 or Fax (409) 740-4228

Sincerely,

John L. Sullivan
President

Enclosure 1

GALVESTON HARBOR EXTENTION
COST ESTIMATE
Dredging with material to New PA
with Bridge Concrete instead of Riprap

13-May-04

02:04 PM

ACCT CODE	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTING.	%	TOTAL PRICE
NON-FEDERAL COST								
02	RELOCATIONS							
	Utilities							
	8" Pipeline - Sta -7+500	1,150	LF	209.00	240,350	60,088	25%	300,438
	8" Pipeline - Sta -8+100	1,460	LF	209.00	305,140	76,285	25%	381,425
02	TOTAL -- RELOCATIONS				545,490	136,373		681,863
12	NAVIGATION, PORTS & HARBORS							
	Dredging Docks ***	640,944	CY	1.61	1,031,920	257,980	25%	1,289,900
12	TOTAL -- NAVIGATION, PORTS & HARBORS				1,031,920	257,980		1,289,900
30	ENGINEERING AND DESIGN				197,200	39,400		236,600
31	CONSTRUCTION MANAGEMENT				118,300	39,400		157,700
	TOTAL -- NON-FEDERAL COST				**1,892,910**	**473,153**		**2,366,063**
FEDERAL COST								
12	NAVIGATION, PORTS & HARBORS							
1201	Mobilization & Demobilization	1	LS	205,000.00	205,000	51,250	25%	256,250
	Dredging GIWW _ STA 7+000 - 3+600	299,248	CY	1.27	380,045	95,011	25%	475,056
	Dredging Newpt Terminal Ch	379,604	CY	1.57	595,978	148,995	25%	744,973
	Dredging Harbor Ch Extention	1,026,000	CY	1.56	1,600,560	400,140	25%	2,000,700
1202	New PA							
	Hydraulic Levee Perimeter	16,800	LF	115.00	1,932,000	483,000	25%	2,415,000
	Rock Perimeter**	47,000	TON	20.00	940,000	235,000	25%	1,175,000
12	TOTAL -- NAVIGATION, PORTS & HARBORS				5,653,583	1,413,396		7,066,979
30	ENGINEERING AND DESIGN				706,700	141,300		848,000
31	CONSTRUCTION MANAGEMENT				424,000	141,300		565,300
	TOTAL -- FEDERAL COST				**6,784,283**	**1,695,996**		**8,480,279**
	TOTAL -- EXISTING CONDITIONS				**$ 10,846,342**			

*** Note - Need to dredge dock so can use new channel.

** Note - Assumed Concrete Provided at no cost by contractor and is of the correct sizing.

Enclosure 3

Galveston Harbor Navigation Improvements
CAP Section 107
Preliminary Economic Analysis for Milestone Report
Enclosure 4
29 June 2004

Introduction. This document presents a comparison of the transportation costs for the existing project with those for increased channel depth to 20' for the Galveston Harbor. All estimates are based on interviews with business owners and supplemented with Economic Guidance Memorandum 00-05, FY 2000 Shallow Draft Vessel Operating Costs.

Preliminary Transportation Cost Analysis. Harbor users were surveyed to determine their current operating practices and the changes that would occur with the harbor deepening. One business is currently required to operate their fleet of vessels light-loaded. With the channel deepening, the light-loaded trips would be eliminated and fewer trips would be required. In addition, other businesses are required to off-load their vessels at an alternate site. The vessel contents are vacuumed then trucked to their respective businesses at the harbor. The contents are then loaded onto barges. With the channel deepening project, the users would eliminate the vacuum/truck step of their operations.

The above transportation cost reductions represent immediate project benefits. Additional benefits would be realized with the channel deepening, including shift of mode benefits, shift in origin-destination benefits and new movement benefits. Due to the limited time and costs associated with this preliminary analysis, only transportation cost reduction benefits were explored in detail. During the feasibility phase of the study, the other navigation benefit categories will be investigated.

Cost Savings due to elimination of Light-Loading.

5,256	(no. trips/yr light-loaded)
- 4,380	(no. trips/yr fully loaded)
876	annual reduction in trips with channel deepening
x $272	estimated vessel operating cost/hr.
x 10	no. hrs./trip
$ 2,382,720	annual cost savings

Cost Savings due to elimination of Vacuum/Truck.

908	(no. trips/yr)
x $1,599	(weighted avg. $/trip for vacuum/trucking)
$1,451,892	annual cost savings

Total Estimated Annual Cost Savings

$2,382,720
+ $1,451,892
$3,834,612

Preliminary Benefit/Cost Analysis. *Change original to reflect text cost data outlined below.* The first cost to deepen the harbor to 20' is estimated at $10,846,342. Based on the Federal discount rate of 5.625 percent and a 50-year planning period, the annual cost, including Operations and Maintenance and Interest During Construction, is $1,168,237. The annual transportation savings benefits are $3,834,612 and the derived benefit-to-cost ratio is 3.3 to one. Given the positive net excess, continuation of the feasibility phase of study is recommended.

Investment	Dec 03
Estimated First Cost	$10,846,342
Annual Interest Rate	5.625%
Project Life (yrs)	50
Construction Period (months)	6
Compound Interest Factor	6.07
Capitol Recovery Factor	0.060
Interest During Construction	$127,903
Investment Cost	$10,974,245
Annual Charges	
Interest	$617,301
Amorization	$42,782
Operation & Maintenance ($yr)	$508,154
Replacements	$0
Total Annual Charges	$1,168,237
Annual Benefits	
Cost Reduction Benefits	$3,834,612
Net Benefits	$2,666,375
Benefit-to-Cost Ratio	3.3

GALVESTON HARBOR EXTENSION, GALVESTON, TX
SECTION 107 MILESTONE REPORT

REVIEW COMMENTS:

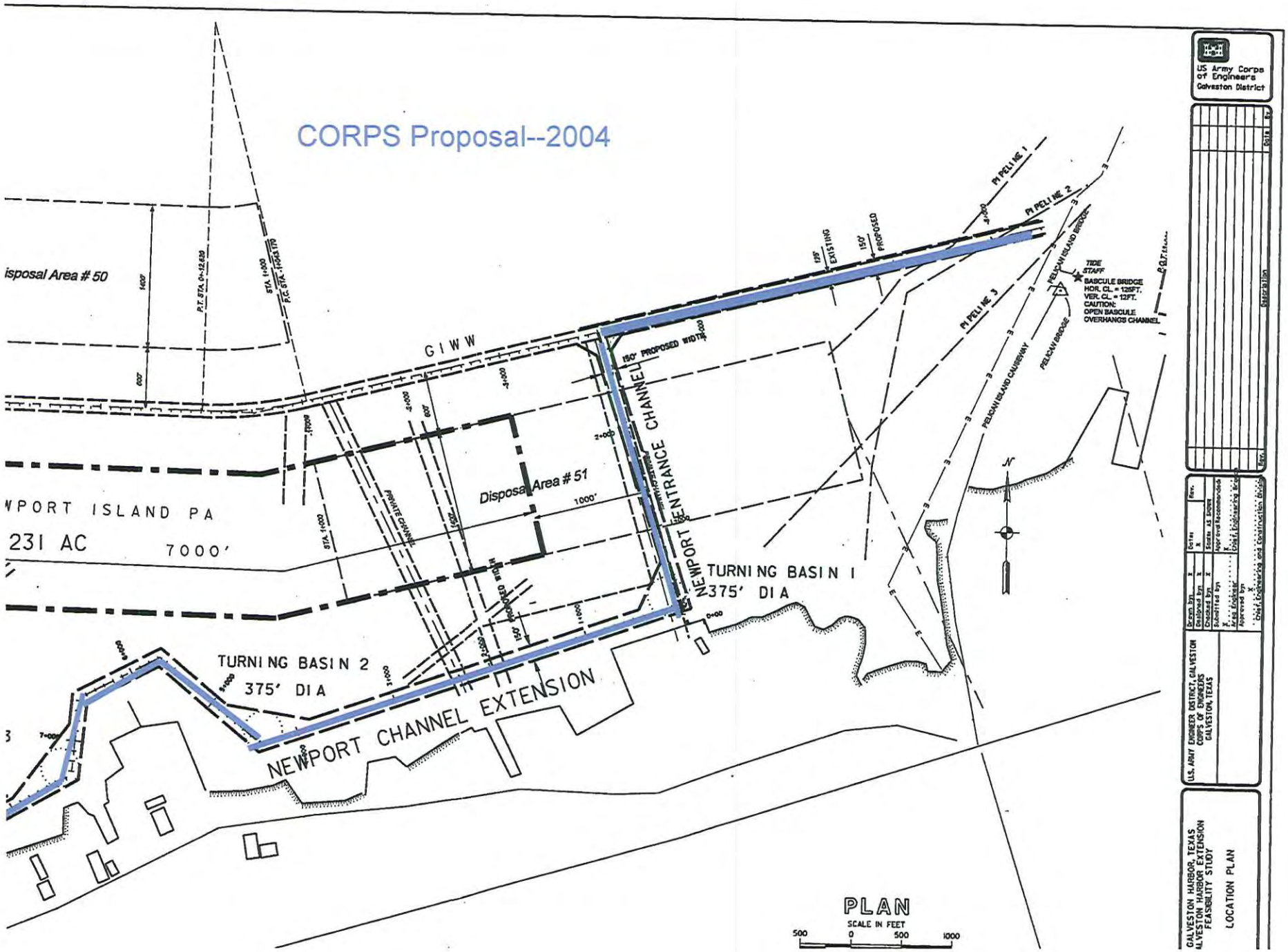
1. Per Chapter 4, Section D of the CAP Management Plan, the Milestone Report should include a **determination on navigational servitude**.
2. The sponsor's letter, dated September 22, 2003, (Enclosure 1) does not indicate that Harborside Management District understands the **cost sharing requirements** and the **Federal per project cost limitations**.
    a. The March 3, 2003, Confidential Briefing notes discuss the use of funds from Federal programs to fund 80% of the project cost. Does this mean the Sponsor assumes that the Federal share of the project would be 80%? Based on the 26- foot depth of the channel, the Federal share would be 75% and the Sponsor's share would be 25%.
    b. Enclosure 3 Galveston Harbor Extension Cost Estimate projects the total project cost to be $11.7M, of which the total Federal cost is estimated at $10.9M and the non-Federal cost at $0.8M. These costs do not include the cost of the feasibility study, which has an estimated cost of $1.2M.
3. Section 107 authority has a per project **Federal cost limit of $4M**. Adding the cost of the feasibility study, which is part of the total Federal cost, the $4M Federal project limit is exceeded by $7.5M. The **sponsor must bear all cost over the $4M**. The Federal limit for future OMRR&R would be approximately $5M. Does the **Sponsor understand that their financial obligation would be approximately $8.3M?**
4. In accordance with HQ's policy on **CAP projects exceeding Federal statutory per project limits**, the District must notify the sponsor that the Office of the Assistant Secretary of the Army (OASA) determines whether the Sponsor has the financial capability to fund all cost over the Federal cost sharing limit. This determination must be made before providing additional funds to continue the study.
    a. Once the District has notified the Sponsor that the project exceeds the Federal per project limit, the Sponsor must agree in writing to pay the cost exceeding the Federal cost sharing limit.
    b. The District submits a package to OASA thru the Division Regional Integration Team (RIT). That package includes:
        i. Memo from Division recommending OASA's approval
        ii. The non-Federal Sponsor's letter agreeing to pay the additional cost
        iii. A CAP Project Fact Sheet
        iv. Financial Analysis of Sponsor's Obligations
5. I need responses to the above comments, before a determination to approve or disapprove the Milestone Report can be made

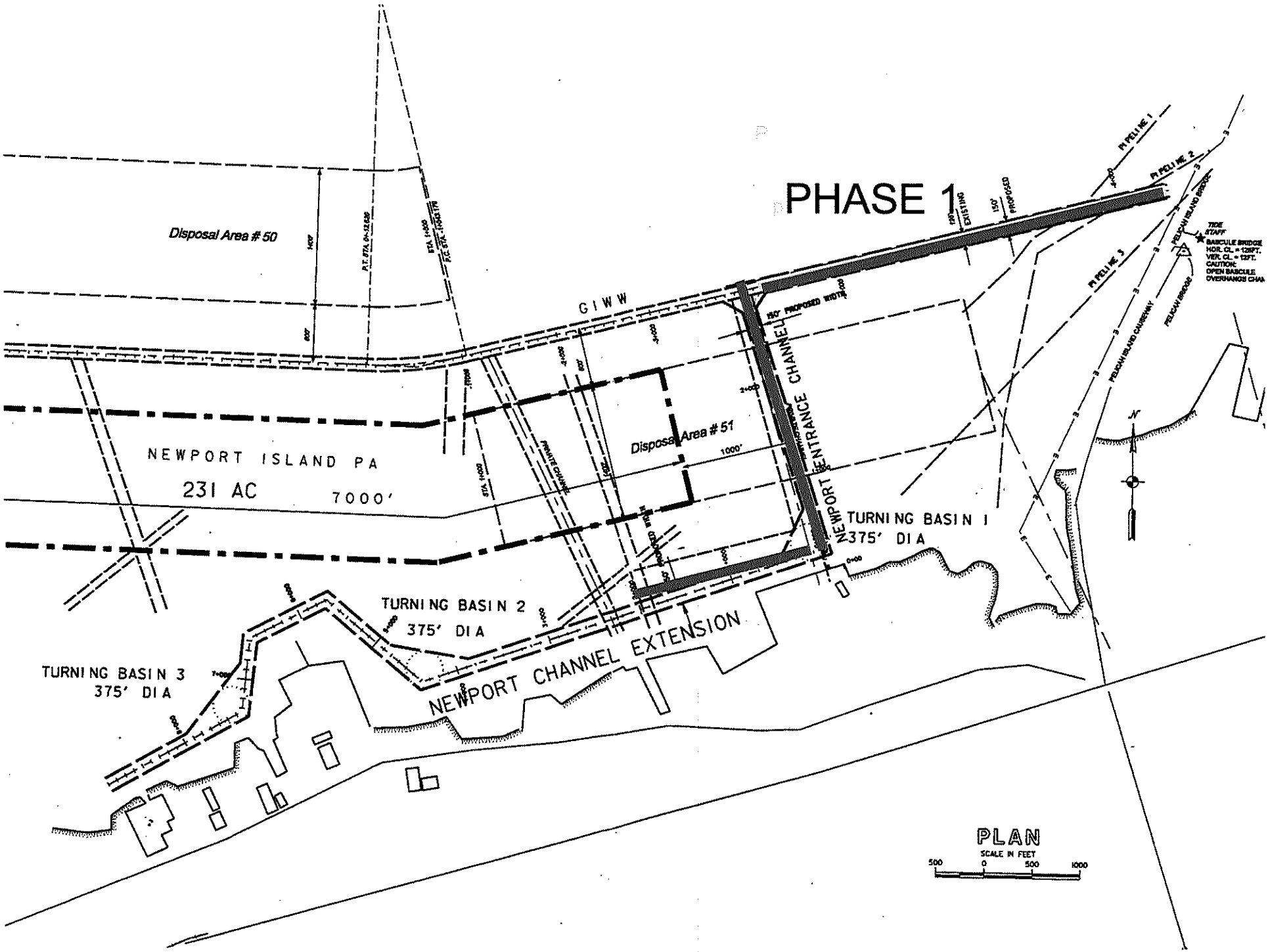
TAMUG WETLANDS MARSH PROJECT

TEXAS A&M GLAVESTON
HARBORSIDE MANAGEMENT DISTICT
SULLIVAN LAND AND CATTLE COMPANY


Harborside Management
District
Galveston, TX
Image © 2008 DigitalGlobe
Image Houston-Galveston Area Council
94°50'14.44" W
Jan 15, 2006


Harborside Management District
John Sullivan Pier
Galveston, TX
Image Houston-Galveston Area Council


CORPS Proposal--2004
isposal Area # 50
Disposal Area # 51
GIWW
NEWPORT ENTRANCE CHANNEL
NEWPORT CHANNEL EXTENSION
TURNING BASIN 1
375' DIA
TURNING BASIN 2
375' DIA
PELICAN ISLAND CAUSEWAY
PELICAN BRIDGE
TIDE STAFF
BASCULE BRIDGE
HOR. CL. = 125FT.
VER. CL. = 12FT.
CAUTION:
OPEN BASCULE
OVERHANGS CHANNEL
PI PELI NE 1
PI PELI NE 2
PI PELI NE 3
PRIVATE CHANNEL
PLAN
SCALE IN FEET
500 0 500 1000
US Army Corps of Engineers
Galveston District
U.S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS
GALVESTON HARBOR, TEXAS
GALVESTON HARBOR EXTENSION
FEASIBILITY STUDY
LOCATION PLAN


PHASE 1
Disposal Area # 50
Disposal Area # 51
GIWW
NEWPORT ISLAND PA
231 AC
7000'
NEWPORT ENTRANCE CHANNEL
TURNING BASIN 1
375' DIA
TURNING BASIN 2
375' DIA
TURNING BASIN 3
375' DIA
NEWPORT CHANNEL EXTENSION
PELICAN ISLAND CAUSEWAY
PELICAN BRIDGE
PELICAN ISLAND BRIDGE
PLAN
SCALE IN FEET
500
0
500
1000


Swan Lake 4.7 Miles
Pelican Island 3.7 Miles
Wetland Demo Marsh
Project
Image Houston-Galveston Area Council
Image © 2008 DigitalGlobe
Image NASA
94°51'07.31" W
Jan 15, 2006


Marsh
Project
Seawall Pkwy
Todd Rd
J F Fields
© 2009 Tele Atlas

Pertinent Facts

- The Harborside Management District [HMD] was formed by the passage of Texas S.B. No 1912 by the Senate and the House on May 12, 2003 and May 20,23003, respectively. The primarily purpose of the formation was to work with the CORPS to deepen the existing channel to allow servicing of the newer deeper draft crew boats, service vessels, seagoing tugs and barges and yachts.

- The project was well supported by the CORPS and all other interested parties. It progress through a Milestone report by the CORPS which reflected a 3.3 to 1 cost benefit ratio. The project was abandoned due to lack of funds by the CORPS.

- We began our efforts to reinstate the project a few months ago. The CORPS permit to dredge Phase 1 [slide 5] is in existent. It will have to be amended to allow the beneficial use of the dredge material to construct the Marsh Project.

- Our current estimate for dredge material is approximately 350K CYS which would build a marsh of approximately 50 acres assuming an average depth of four feet.

CEPRA Project No. _____
(Agency Use Only)

PROJECT GOAL SUMMARY (PGS) APPLICATION FORM

For Erosion Response Project Funding Under the
Coastal Erosion Planning and Response Act (CEPRA)
Cycle 6

Potential project partners must submit all required information using this form.

Applicant Information

PGS Application Submittal Date (mm/dd/yy): 06/30/09 Date Received: _____
(Agency Use Only)

Project Title: Pelican Island Beneficial Use Marsh Restoration and Shoreline Protection

Name of Potential Project Partner: Galveston Bay Foundation

Physical Address: 17330 Highway 3

City: Webster Zip+4: 77598 - 4133

Point of Contact (POC): Courtney Miller Title: Grants Administrator

Phone: 281 - 332 - 3381 ext.: 214 Fax: 281 - 332 - 3153

Email: cmiller@galvbay.org

Authorizing Official (if different from POC): Bob Stokes Title: President

Project Type (check all that apply)

- ☐ Beach Nourishment
- ☒ Shoreline Protection
- ☐ Study/Research Project
- ☐ Other (describe):
- ☐ Dune Restoration
- ☒ Marsh Restoration or Protection
- ☐ Debris Removal
- ☐ Demonstration Project

For Beach Nourishment and Dune Restoration projects only:

Does project incorporate beneficial use of dredged material (BUDM)? ☐ yes ☐ no
Is a sand source identified for beach nourishment? ☐ yes ☐ no
If "Yes" to either of the above two questions, please respond to the following:

1. Location of sand source:
2. Owner of sand source:
3. Cost of sand per cubic yard:
4. Is the source permitted by the US Army Corps of Engineers? ☐ yes ☐ no
   If no, please attach, if available:
   a. sieve analysis of sand
   b. chemical analysis of sand
   c. archeological survey of borrow area
5. Quantity of sand available (cubic yards):
6. Describe any availability restrictions:

Project Length

For Beach Nourishment and Shoreline Protection projects, linear length of project: 4,000 lf

For Marsh Restoration projects, linear length and acreage: 4,000 lf, 20-30 acres

Project Location

County or counties where project is located: Galveston

State Representative name(s) /district(s) where project is located: Craig Eiland / District 23

State Senator name(s) /district(s) where project is located: Mike Jackson / District 11

US Congressional Representative name(s) /district(s) where project is located: Ron Paul / District 14

Erosion Rate at Project Location

Describe the erosion rate (feet/year) in the vicinity of the project: Erosion rates of 3.0 – 11.7 ft/year were calculated within the project area by comparing the position of the line of vegetation on geo-referenced aerial photographs from 1996, 2004, and 2006 (wet/dry shoreline on photographs are unreliable). Exhibit 3 (attached) shows the historical positions of the shoreline in the project shoreline in 1996, 2004, and 2006. Erosion rates were the highest at the north end of the project area. An excel spreadsheet is also attached showing the calculated rates at six transects within the project area and at the spit where the causeway is located.

Cite the source of information: LEAP Engineering 2009, from 1996, 2004 and 2006 aerial photograph analysis

Funding Summary

Total CEPRA Funds Requested: $2,750,000.00

Total Partner Federal Match Funding: $200,000.00

Total Partner Non-Federal Match Funding: $3,550,000.00

Total Project Cost: $6,500,000.00

Sources of Match Funding

In the table below, list secured or potential sources of match funding including any federal funding sources and in-kind services. Do not include CEPRA funding in this table. Accurately list timelines and limitations associated with funding sources:

Funding Source for Match	Cash Amount	In-Kind Amount	Is funding committed for the Cycle 6 biennium? (Y/N)	Funding Availability Date (mm/dd/yy)	Funding Expiration Date (mm/dd/yy)	Other Constraints (describe)
Texas A&M University	$2,500,000.00		Y			
Harborside Mgmt. District		$1,000,000.00	Y			
Restore America's Estuaries-NOAA Partnership	$200,000.00		N	05/01/10	04/30/12	GBF intends to write this amount into its annual allotment from RAE-NOAA over a period of 2 years.
NRG		$25,000.00	Y			Donation of marsh vegetation and services

GBF		$25,000.00	Y			Available as the value of volunteer time
TOTALS	$2,700,000.00	$1,050,000.00				

Beach Access and Use Plan Eligibility

Does the local government(s) within whose jurisdiction(s) the study or project is proposed have a Beach Access and Use Plan in place? ☒ yes ☐ no

If yes, name of the local jurisdiction: Galveston County

Hazard Mitigation Eligibility

Is there a Hazard Mitigation Plan in place for the proposed project area? ☒ yes ☐ no

If yes, name of local jurisdiction responsible for hazard mitigation: Galveston County

Is the proposed project eligible for FEMA disaster Public Assistance or mitigation funds under the Hazard Mitigation Grant Program? ☒ yes ☐ no

Project Description

Provide a narrative of the project description that addresses each of the following:

Describe the location and geographic scope of the erosion problem:

The erosion problem identified in this proposal is located along the western shore of Pelican Island in Galveston County. The specific location begins at the berth of the Texas Clipper II and extends westward and northward to the Gulf Intracoastal Waterway (GIWW), a total distance of approximately 2.7 miles. Of this length of shoreline, particular attention will be given to an approximately 0.75 mile (4,000 lf) reach located immediately west and north of the Pelican Island Causeway.

Describe the desired outcome(s) of the proposed project:

The desired outcomes of the proposed project are to protect upland resources from erosion, create intertidal marsh habitat, beneficially use available dredge material, and provide an opportune site for academic research and community volunteer activities.

Discuss any prior erosion response work, including a listing of any known erosion response studies and investigations in the vicinity of the proposed project, and whether the proposed project compliments existing erosion response measures:

The proposed project stems from an Alternatives Analysis (AA) conducted by Pacific International Engineering for the Texas General Land Office CEPRA program in October 2002. A copy of this AA is attached to this proposal. Funds were never raised to implement shoreline protection along the project shoreline, as recommended in the AA. The university used what funds it did have available to install a bulkhead in front of one of its buildings along this eroding shoreline. Funds are now successfully being sought to implement shoreline protection and marsh restoration measures identified in the AA.

Describe the proposed work sequencing including, if applicable, whether the proposed project will be divided into phases (e.g. reconnaissance study, preliminary engineering, alternatives analysis/feasibility study, permitting, engineering design, construction):

Reconnaissance studies, preliminary engineering, and alternatives analysis were completed in 2002, and resulted in an Alternatives Analysis Technical Memorandum prepared by Pacific International Engineering for the Texas General Land Office CEPRA program (Cycle 2). A copy of the report is attached to this proposal. Permitting is

anticipated to begin in September 2009. Engineering and design, construction, and marsh grass planting will be the focus of the proposed work.

Recommend the preferred erosion response alternative that would address the problem, if known:

Construction of an approximately 4,000 lf offshore rock breakwater and an estimated 20-30 acre marsh located between the breakwater and the existing eroding shoreline. Marsh construction will make use of available dredge material from the nearby Harborside Channel. The marsh will be sprigged with plugs of smooth cordgrass (*Spartina alterniflora*) for additional erosion control and habitat creation benefits.

Project Benefits

Describe the effect and benefits of the proposed project on public safety, access and public infrastructure and property threatened by erosion:

The proposed project will serve to protect the western shore of Pelican Island from continued erosion, which threatens public infrastructure and property of Texas A&M University at Galveston. Already, the university has had the need to construct a bulkhead on a stretch of shoreline facing one of its campus buildings. This project will protect up to 4,000 feet of shoreline along public property threatened by erosion. Currently, the eroded shoreline is not accessible and presents a safety concern due to the presence of a bluff up to 10 feet in height. This project will also ameliorate those accessibility and safety concerns by creating a gently sloping fringing marsh shoreline and protecting the shoreline with an offshore rock breakwater. The access and safety components of this shoreline project will create opportunities for student research and community volunteer work.

Describe the effects and benefits of the proposed project on private infrastructure and property threatened by erosion:

The project will utilize dredge material from the nearly Harborside Channel, which must be dredged to remove material that has settled there as a result of erosion of sediments from uplands and surrounding areas on private properties along the Harborside Channel. The eroded material within the channel will be dredged and beneficially used to construct marsh habitat.

Describe the effects and benefits of the proposed project on natural resources threatened by erosion:

Continued erosion on the western shoreline of Pelican Island has resulted in a steep shoreline bluff of up to 10 feet in height in some places. This project will beneficially utilize maintenance dredge material to restore the gentle slope and intertidal elevations of the shoreline between the existing bluff and the planned offshore rock breakwater. Intertidal marsh habitat created with this project is essential for over 90% of the recreationally and commercially harvested finfish and shellfish caught in Galveston Bay and the Gulf of Mexico. These marsh habitats provide important nursery grounds for recreationally and commercially important aquatic species such as Gulf menhaden (*Brevoortia patronusi*), sand seatrout (*Cynoscion arenarius*), Southern flounder (*Paralichthys lethostigma*), red drum (*Sciaenops ocellata*), bay anchovy (*Anchoa mitchilli*), and other marine forms to develop into juveniles.

Describe whether the proposed project will provide for the beneficial use of dredged material from the construction and maintenance of navigation inlets and channels of the State:

The proposed project will beneficially use available dredge material obtained through the maintenance dredging of the nearby Harborside Channel on Galveston Island. The Harborside Management District prefers to send its material to this project for beneficial use, and Mr. Sullivan has committed to contributing $1 million to the dredging effort.

Describe how project costs are reasonable relative to benefits:

The most evident cost-benefit lies in the fact that, if *not* for this proposed project, Texas A&M University-Galveston would opt to use its funds to armor the shoreline directly by expanding the bulkhead. All of the project benefits provided by a beneficial use marsh restoration project would be lost to a bulkheaded shoreline. By taking advantage of the donation of dredge material, $1 million in donated dredging costs, and the donation of plant material, the proposed project can far surpass the benefits of the alternative.

Another cost-benefit of this project results from the use of rock for shoreline protection. Of the multitude of shoreline protection materials and/or techniques utilized around the Galveston Bay area, rock was selected for this project due to its long lifespan, survivability, low maintenance requirements, habitat benefits, and proven results. Rock is considered perhaps the longest lasting method employed for shoreline protection. The rock breakwater's long lifespan will reflect directly on the lifespan of the project as a whole and will provide greater benefits over a longer period of time.

Project Permitting

List all required local, state, and federal permits that have been or will need to be acquired to undertake the proposed project:

Permit Type	Estimated Date of Receipt (Month/Year)	Who will obtain permit?
Section 10/404 permit, USACE	09/2010	GBF
Coastal lease, GLO	09/2010	GBF
Marsh grass transplanting permit, TPWD	Variable; approximately 1 mo. prior to marsh planting events	GBF

Elaborate on any known permitting or regulatory issues that will need to be addressed:

Multiple discussions on this project indicate that the permitting process will raise no unanticipated issues. Agency representatives, including those from NOAA and TPWD, expressed interest in seeing this project take place.

For proposed Gulf beach projects, describe how the proposed project will comply with the local beach and dune plan, floodplain administration, and beach access:

N/A

Project Phasing and Timeline

Is this project a single-phase project or one phase of a multi-phase project?

☒ Single-Phase Project

☐ One phase of a multi-phase project

Can the project or phases proposed in this application be completed between 9/1/2009 and 8/31/2011? ☒ yes ☐ no

Describe the phases of the proposed project, if applicable, including a description of the phases that would extend into future funding cycles:

The proposed work will be completed within one project phase. Permitting and planning for dredging operations will begin in September 2009. Engineering will begin in February/March 2010. Plans, specs, and estimates will be compiled in May/June 2010, with final review and approval in July. The bidding process will occur in August 2010, and GBF will select a contractor and award a contract in September 2010. Construction of the rock breakwater followed by dredging for marsh construction will take place in October 2010 through January 2011. Following a period allowing for settlement of the dredge material, the marsh restoration site will be planted with smooth cordgrass in April/May 2011 as part of GBF's annual Marsh Mania event.

Describe anticipated delays due to permitting timelines, match funding approval/timelines, habitat issues, tourist and bird-nesting season provisions, or approval process timelines from local governing bodies:

While the permitting process should be strictly procedural, the permit for this project is not expected to be received until fall 2010. By the time the permit is issued, the project should be at the point of awarding a construction contract.

Does an adequate financial infrastructure exist to maintain the project/perform post-project monitoring following construction? ☒ yes ☐ no

If yes, please describe:

GBF will assume responsibility for monitoring and maintenance of the project following construction. The use of rock for construction of the breakwater will provide a virtually maintenance-free shoreline protection structure. In the event that the marsh vegetation does not meet survival and/or density parameters, GBF's established Marsh Mania program will provide the volunteer labor to replant at the site, if/as needed. GBF is a 501(c)(3) non-profit organization established in 1987 under the laws of the State of Texas. GBF has spent nearly 18 of its 22 years successfully managing federal and state grants in support of wetlands conservation and restoration work.

Attachments/Supporting Documentation

Project Location Map

Attach to this application a map with sufficient detail to show the specific geographic location and boundary of the proposed project.

Attached:
Exhibit A – Project Vicinity Map
Exhibit B – Project Area
Exhibit C – Historical Shoreline Change
Excel spreadsheet showing the calculated rates of erosion at six transects within the project area and at the spit where the causeway is located.

Letters of Support

Please attach to this application letters of support you have received from potential co-sponsors, elected officials, affected jurisdictions, and other stakeholders with an interest in the project. While letters in support of your proposed project are not required, they are strongly recommended.

A letter of support from Texas A&M University-Galveston is attached.

Galveston Bay Regional Sediment Management Plan
Agency Outreach & Coordination Call Notes

Attendees	Phone	Email
Randy Boyd – RLB Contracting, Inc.	(361) 552-2104	
Larry Wise – M&N	(713) 977-7372	LWise@moffattnichol.com

Date: 12/1/2009

Meeting Call Purpose

For Moffatt & Nichol (M&N), on behalf of the US Army Corps of Engineers (USACE), to:

- Gather information on RLB past experience with construction of wetland restoration project at Swan Lake using confined dredged material from Texas City placement areas.

Data Gathering

Discussion between Larry Wise (M&N) and Randy Boyd (RLB Contracting, Inc.) resulted in the gathering of the following information:

- Swan Lake restoration project was built by constructing a perimeter dike around the restoration area and then pumping out the water.
- Land-based construction equipment was used including trucks, scrapers, bulldozers, etc.
- The project resulted in an increased capacity within the placement area of 0.5 million cubic yards.
- Working with confined dredged material is possible, but requires that the contractor "knows what he's doing".
- It was reported to RLB that the cost per acre for the restored marsh was cheapest on the Texas Gulf Coast.
- When comparing using material which has dewatered in a confined placement area versus maintenance material pumped directly into a beneficial use cell, it's important to consider the percent solids. Maintenance material may be 20% solids, versus 80% solids in dewatered material. This has to be considered when comparing volumes of material placed.
- Using already dewatered material decreases risks to project performance due to settlement. Since the material has already substantially dewatered and consolidated, there's less uncertainty on future settlement.
- The idea of using dredged material from confined placement areas is worth considering.
- The material in placement areas is good, but needs to be dewatered. Actively managing dewatering of placement areas is highly effective.

These notes by M&N are intended to summarize information presented from this conference call. They are not intended to be a transcript of the discussion and conversation. Please notify M&N of any revisions or misinterpretations necessary.

APPENDIX B

GIS DATA CD

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