DRAFT

Guidelines for Sustainable Maintenance Dredging and Long-Term Dredged Material Management of the Mobile River Federal Navigation Project

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Executive Summary

The project study was limited to the maintenance dredging and management of dredged material beginning at Station 0 + 00 and continuing through the end of the Mobile Harbor Turning Basin (MHTB) near Station 276 + 92. The study objective was to prepare guidelines to assist Mobile District with sustaining the maintenance dredging program associated with the Mobile River Channel and new MHTB.

Over the period of study, December 2009 to November 2010, Resource Management Group, (RMG) participated in three formal in-progress review meetings, numerous working sessions at ISO, and several internal RMG working sessions to gather information, reconcile data discrepancies, and document existing maintenance dredging and disposal area management practices. In addition, RMG held meetings with representatives of the Port (ASPA), the City of Mobile (MAWSS), and various resource agencies to gather information and stakeholder input to this study. This approach to the study was highly successful in bringing together the experience and knowledge needed to analyze and prepare the guidelines summarized in this report.

Guidelines for Sustainable Maintenance Dredging

Successful development and implementation of sustainable maintenance dredging and long-term management of dredged material placement operations for the Mobile River Federal Navigation Project will require support from all levels of management within the District, the Alabama State Port Authority (ASPA), and users of the Federal Project and Mobile Harbor. The guidelines and evaluations described in this report are forward-looking for a period of up to thirty (30) years. The guidelines are grouped under several major categories as follows.

Contracts

Mobile District successfully uses four types of contracts to execute its maintenance dredging projects – rental, unit price, lump sum, and indefinite delivery/indefinite quantity. Although the historical data do not reveal the reason(s) for the dredging practices in the Mobile River channel, the data collected during this study will allow a reporting of some contracting characteristics and the arrangement in which they occur. Specific dredging data values gleaned from historical dredging contract records, while interesting from a purely historical perspective, are not as helpful as data that can be used to identify trends or long-term averages. Trends and averages, particularly if established over a timeframe of the order of the historical database -- some 48.4 years -- are extremely useful for future projections.

Dredging, Dredging Needs, and Dredging Costs

Mobile District has systematically used three principal types of dredges in the Project – Cutterhead, Hopper, and Bucket. There has been very limited use of Specialty dredges. On at least one occasion, a hopper dredge was used for pump-out directly to a CDF (South Blakeley). Hopper dredges capable of offloading directly to an upland CDF as well as Ocean Dredged Material Disposal Sites (ODMDS) should increase the dredging and disposal efficiencies in the

Project by providing a management alternative if one of the historical disposal locations becomes temporally unavailable.

Average annual dredging requirements are unlikely to change dramatically in the foreseeable future. RMG prepared Table ES-1 to present a comparison of the annual dredging needs projected over a 20-30 year time period. Based on a five-year rolling statistical average, annual dredging volumes could range from 773,500 CY to 1.8 MCY. The RMG Team determined and confirmed the long-term average annual shoaling rate for maintenance materials in the Mobile River Navigation Project to be 1.2 MCY, a value that is in agreement with Mobile District's rule of thumb usage. These values should be considered when planning for long-term.

Table ES-1. Comparison of Dredging Needs (20-30 year projections)

	Average Projections (Historical Base)	5-Year Rolling Average - Increase	5-Year Rolling Average - Decrease
Average annualized shoaling volume in Mobile River channel	1.2 MCY	1.8 MCY	773,500 CY
Average annualized maintenance dredging of MHTB	425,000 CY	637,500 CY	274,000 CY
Contract award cycle for channel maintenance dredging	424 days or 14 months	424 days or 14 months	424 days or 14 months
Contract dredged volume in channel.	1.4 MCY	2.1 MCY	902,000 CY
The MHTB contract volume.	495,000 CY	743,750 CY	320,000 CY

Over the past decade or more, pipeline dredging has accounted for roughly 68% of all maintenance dredging work. The costs of pipeline dredging with upland site disposal and disposal site management averages $5.82 per cubic yard versus bucket dredging with ocean disposal averaging $6.24 per cubic yard versus hopper dredging with ocean disposal costs averaging $8.28 per cubic yard.

Management Practices

Since 1998, the District has aggressively managed their upland CDFs to promote and extend their useful life. The degree of management at each site is directly linked to the dredging cycle, time between filling operations, and available funding. The Mobile River dredging frequency depends on shoaling rates, funding, storms, etc., and, not all sections of the river are dredged annually. Never-the-less, the District has tried to maintain at least two years between filling operations to allow sufficient time to manage and prepare each CDF to receive the next allocation of dredged material. Site management techniques or best management practices currently used at the five CDFs have been exceptionally successful in sustaining disposal capacity at these sites and should be continued.

Idealized CDF Life Expectancies

The total *idealized volumetric capacity* of the five upland CDFs is approximately 32.2 MCY. The *idealized* approach described in this report does not consider the practice of aggressive site management used by the Mobile District. It assumes the availability of all of the disposal areas and capacities simultaneously and annually without regard to how they are actually used and/or managed. Therefore the idealized approach becomes a volumetric calculation of maximum CDF capacity and tends to overestimate the actual field capacity. Never-the-less, the calculation provides useful insight as to how much material may be potentially stored at the upland sites over time.

For example, at an annualized placement rate of 1.2 MCY per year (the average annual shoaling rate for the Project without the new turning basin), the idealized life expectancy of the upland CDFs is 26.9 years (i.e., "no loss" of capacity scenario). If North Pinto CDF is used for placement through 2013 and then is lost for future use, the idealized total life expectancy of the remaining CDFs is reduced to 24.4 years. As the annualized placement rate increases, the idealized life expectancy decreases as one would expect. For example, at an annualized placement rate of 1.625 MCY per year (i.e., the total estimated generation rate including the new MHTB), the idealized life expectancy is a more-reduced 19.8 years with North Pinto versus 18.1 years without North Pinto. The importance of maintaining upland sites and the ODMDS as disposal options becomes obvious even in this idealized analysis.

CDF Life Expectancies Using Best Management Practices

A number of best management practices scenarios were analyzed to determine more realistic life expectancies of the upland CDFs. The analysis reflects the more practical use of the disposal sites under existing disposal area management practices that assume the availability of only half of total site acreage for each dredging event (up to two years) where the total site acreage is the same as that for idealized analyses.

An annualized placement of 1,200,000 CY of dredged material per year using all five CDFs was conducted using the maximum available *best management practices* (BMPs) level for each CDF. The life expectancies ranged from 18 years for Mud Lake 7 to over 30 years for North Pinto. Similarly, the impact of removing an average of 700,000 CY of sediment from one of the sumps in the upper river channel every other year (biannually) for placement at the ODMDS or for beneficial use together with a dredging rate of 1.2 MCY/year resulted in life expectancies that exceed 30 years for all five existing CDFs. Similar analyses were conducted to determine the impact of the loss of North Pinto after 2013 on the previously presented sump haul-out conditions. The life expectancies ranged from 26 years for Mud Lake 7 to over 30 years for the remaining CDFs.

The average life expectancies of the upland CDFs are significantly reduced in the absence of the ODMDS for placement of the new turning basin maintenance materials and/or by the loss of North Pinto CDF. (Loss of the ODMDS for materials from the MHTB implies loss of that option for sump materials as well.) Life expectancy projections for the five CDFs under BMPs are a more meaningful reflection of reality than their projected lives under idealized conditions. Under either scenario, the analyses demonstrate dependency on the continued use of ocean

disposal or some type of haul-out for beneficial use of the dredged material to regain capacity in the upland sites.

Although past use of the ODMDS has been discretionary or necessary in emergencies, its use has been credited with providing much needed time for extended upland site management. Scenarios that include scheduled, pre-planned uses of the ODMDS for disposals were evaluated to ascertain impacts on CDF capacities. These examples included various combinations of upland site use placement cycles whereby all upland sites would be used according to a prescribed schedule in combination with the ODMDS. This analysis demonstrated the positive impacts of aggressive site management and use of disposal options such as the ODMDS on sustaining of capacity in the existing CDFs. The choices of upland CDF cycles and ODMDS usage combinations should be a useful tool in managing the upland CDFs together with providing support for planning out-year budgets.

Beneficial Use (BU) Opportunities

Historically, dredged material from the Project has been used for a variety of beneficial uses – the most recognized being habitat restoration and replacement, construction of bird islands, shallow-water feeder berms for shoreline replacement and barrier island restoration. Although not generally acknowledged by the Mobile District and Resource Agencies as a beneficial use, sediment dredged from the Project has been the primary construction material for dikes, roadways and fills at all of the Federal placement sites.

During the course of this study, significant effort was expended to locate reports, papers, and project documents in an attempt to define both physical and engineering properties of Mobile River sediments and dredged material placed into upland sites and used beneficially over the years. There was no single repository for this type of information, and, as such, the search uncovered only a few published and unpublished file documents, which are summarized in Appendix E of this report. More systematic documentation of the beneficial uses in the Project should prove highly useful when assessing the future benefits of such actions.

A list of prioritized concepts was conceived and prepared as part of the coordination meeting on beneficial uses by the representatives of Mobile District and other Federal and State agencies. The sources of dredged material from within the Project to construct potential BU projects were identified and were described in terms of their locations, quantities, and material physical and chemical characteristics. Beneficial uses can provide much needed relief to the upland sites to recover disposal capacity and extend life expectancy. Also, BU projects will help gain significant stakeholder support for the long term viability of the Project.

Recommendations

The following recommendations were prepared to assist Mobile District with identifying and prioritizing future long-term actions and to aid with decision making for the Project.

- Continue to use the proven best management practices already established and being used in the Project. These practices include dredge cycles, dredge types and use of ODMDS in combination with the existing CDFs.

- Aggressively pursue opportunities for beneficial use of pre- and post-managed dredged material. Establish a beneficial uses group (BUG) to assist with developing the implementation requirements for the priority concept(s). This process can serve to satisfy intensive agency coordination that will be needed to obtain approvals for a BU project. The Mobile District, the project sponsor, and other stakeholders can use this process to develop a plan to design beneficial use projects that will be shovel ready in anticipation of future funding opportunities.

- Beneficial use of dredged material is supported through proven concepts and demonstrated technologies, which are currently being used in Mobile District and other USACE Districts throughout Coastal America. This knowledge must be used and transferred to the priority projects under present and future consideration.

- Absent serious national economic problems, the Mobile District must continue to justify funding for dredging and disposal operations and for aggressive management programs at the disposal sites for maximizing future capacity of the existing disposal sites.

- Perform appropriate geotechnical and other analyses at existing CDFs prior to establishing future improvements and assessments for dike raisings.

- Maintain the historical project database by continuing to convert hard copy files to electronic files that can be accessed, sorted, and reported out based on inquires. Currently, much of the historical project file data have been entered into both Excel Workbooks and an Access database. Also, establish a system to electronically archive photographs, maps, surveys, site management activities, etc. Prepare protocols for maintaining these types of files.

- Formalize Real Estate instruments such as rights of entry (ROE), pipeline easements, property ownership, etc., and other site issues for existing dredged material disposal sites with the Federal Project Sponsor (ASPA). Mobile District needs to remind ASPA that providing ROE for the pipeline routes and access to all CDFs is an important responsibility on their part.

- Pursue opportunities for use of privately-owned lands for short- and long-term placement sites. The Mobile District should approach the ASPA to secure use of their site options to receive haul-out material. Coupled with continued best management practices in the upland sites, haul-out of dredged material should pay significant dividends in terms of renewed capacity in the CDFs and identification of future opportunities for beneficial uses.

- Pursue identification of private, non-governmental project users to establish their dredging and placement site needs in the future.

- Reach out to the Project neighbors and concerned local citizens groups to gain continued support of the navigation dredging and dredged material management activities. Consider neighborhood improvement activities in tandem with CDF site management, particularly activities that would benefit from the use of dredged material.

Preface

The development of guidelines and evaluations for sustainable maintenance dredging of the Mobile River Federal Navigation Project (MRFNP) and long-term management of dredged material management for a period of 20 to 30 years was funded by the U. S Army Engineer Mobile District under Contract No.W91278-09-D-0105 as Task Order No. 2. Work was performed by the primary contractor Resource Management Group, Inc. (RMG), Wichita, Kansas, and subcontractor, Waterway Surveys and Engineering, Ltd. (WSE), Virginia Beach, Virginia. The draft report was prepared by a team of engineers and scientists from RMG and WSE. Work on the study began December 17, 2009 and continued through delivery of the draft report on September 28, 2010. Oversight was provided by the staffs of the Mobile District Operations Division and the Irvington Site Office and their invaluable contributions and comments are acknowledged.

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List of Acronyms

AD – Air Dry

ADCNR - Alabama Department of Conservation and Natural Resources

ADEM - Alabama Department of Environmental Management

ASPA – Alabama State Port Authority

BMPs – Best Management Practices

BU – Beneficial Use

BUG – Beneficial Uses Group

BUs – Beneficial Uses

CDF – Confined Disposal Facility

CDFs – Confined Disposal Facilities

CY – Cubic Yards

DOTS – Dredging Operations and Technical Support

EA – Environmental Assessment

ERDC – Engineer Research and Development Center

FONSI – Find of No Significant Impact

Ft – Feet

FY – Fiscal Year

IDIQ – Indefinite Delivery Indefinite Quantity

ISO - Irvington Site Office

MAWSS – Mobile Area Water and Sewer System

MCY – Million Cubic Yards

MHTB – Mobile Harbor Turning Basin

MRFNP – Mobile River Federal Navigation Project

NEP – National Estuary Program

NMFS – National Marine Fisheries Service

NOAA – National Oceanic and Atmospheric Administration

ODMDS - Ocean Dredged Material Disposal Site

PM – Project Manager

PMDH – Projected Maximum Dike Height

PMDHs – Projected Maximum Dike Heights

RMG – Resource Management Group

ROE – Rights of Entry

SIBUA – Sand Island Beneficial Use Area

USACE – U. S. Army Corps of Engineers

WES – U.S. Army Engineer Waterways Experiment Station

WRDA – Water Resources Development Act

WWTP – Mobile Wastewater Treatment Plant

YR – Year

Yrs – Years

Introduction

Background

On December 17, 2009, the U. S. Army Corps of Engineers (USACE), Mobile District awarded Task Order No. 2 under Contract No.W91278-09-D-0105 to Resource Management Group (RMG), Inc. to prepare draft guidelines for sustainable maintenance dredging and long-term dredged material management of the Federal Navigation Project[1] of the Mobile River portion of the Federal Project and the recently constructed Turning Basin (MHTB) for a period of 20 to 30 years.

The general scope of work included technical support for the following major dredging and dredged material management activities associated with the Project and New MHTB:

- Review preliminary assessments and data files
- Assess dredging needs
- Determine disposal capacities and capabilities
- Identify potential for beneficial uses
- Evaluate strategies for dredging, disposal, and management options
- Develop management guidelines for confined disposal areas
- Prepare project report

This report documents the results of the work performed by RMG and its subcontractor, Waterway Surveys and Engineering, Ltd. as part of Task Order No. 2.

Report Organization

This report is divided into two volumes. Volume 1 – Draft Report is the main body of the report, which is further sub-divided into six sections:

1. Introduction
2. Description of Existing Conditions
3. Projections of Future Conditions
4. Potential Challenges and Opportunities
5. Coordination with State, Local, and Federal Agencies
6. Guidelines for Sustainable Maintenance Dredging

[1] Hereafter referred to as the Project

Volume II – Appendices, contains detailed descriptions and presentations of various analyses, evaluations and findings of each of the technical Subtasks of Task Order No. 2 performed during this study.

Project Description and Authorizing Legislation

The Mobile River begins approximately 45 miles north of the city at the confluences of the Alabama and Black Warrior/Tombigbee Rivers. The ASPA State Docks are located about 28 nautical miles north of the Mobile Bay entrance from the Gulf of Mexico and 170 nautical miles east of New Orleans, Louisiana (Figure 1).

The navigation channel dredging in Mobile Bay and Mobile River began in 1826 with enactment of the River and Harbor Act of 1826. Major authorizing legislations to the Project are listed in Table 1.

The authorized project dimensions are:

- 57 by 700 feet for a distance of 7.4 miles across the bar;
- 55 by 550 feet for a distance of 27.0 miles in the bay;
- 55 by 650 feet for a distance of 4.2 miles in the bay;
- 55-foot deep anchorage and turning basin in the vicinity of Little Sand Island;
- 40 by 700 feet from the mouth of Mobile River to the first bend;
- 40 by 775 through the first bend;
- 40 by 600 feet thence to Alabama State docks Pier A, South;
- a turning basin opposite the Alabama State docks approximately 2,500 feet long, 800 feet side at the lower end, and 1,000 feet wide at the upper end.

The current dimensions of the existing navigation channel are:

- 47 feet deep by 600 feet wide across Mobile Bar and 45 feet deep by 400 feet wide in the bay (Figure 1). The 45-foot channel serves McDuffie Terminals located at the mouth of the river.
- 40 foot deep river channel that proceeds north to the Cochrane/Africatown Bridge passing over the Bankhead and Wallace tunnels.

Limits of Study Area

When evaluating strategies to assure long-term sustainability of dredging and disposal of maintenance materials for the Project, the Mobile District requested that RMG limit their

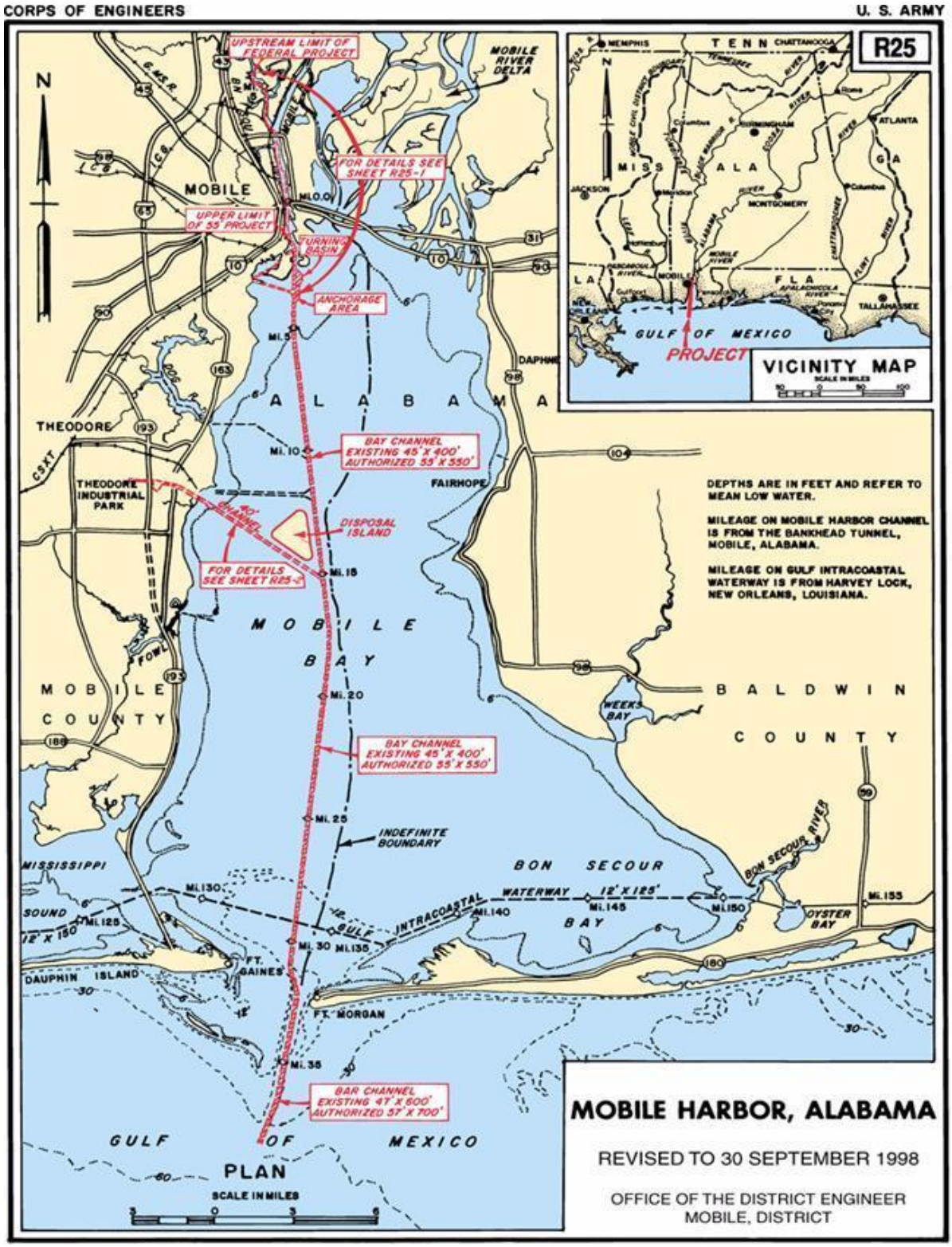


Figure 1. Mobile River Federal Project Location and Vicinity Map

investigation to the Project beginning at Station 0 + 00 and continuing through the end of the new turning basin near Station 276 + 92. Figure 2 shows the Federal Channel and New MHTB,

the five Federally Managed CDFs, and other key features managed by the ASPA such as the McDuffie CDF, etc.

Purpose of the Study

This study provides the Mobile District with information needed to make a determination of whether or not there is reasonable assurance that the Project can be maintained for the next twenty to thirty year and what conditions are needed to achieve that goal. It does not examine project agreements with the sponsor, ASPA, except where there happens to be information readily available in the District files, such as project maps showing easements or pipeline rights of way.

Detailed Scope of Work Items

A copy of the scope of work for Task Order No. 2 of Contract Number W91278-09-D-0105 is attached in Volume II, Appendix A. In addition to project management, meetings, in-progress reporting, and study reports, six detailed technical subtasks were included.

- Sub-task 2.3. Review of preliminary assessments and data files
    - Conduct technical reviews of historical activities involving data collection and preliminary assessments in support of the development of a dredging and dredged material management strategy.
    - Search, review, catalogue and assess the historical project performance data and preliminary evaluations made by the Mobile District in support of the Project.
    - Prepare database updates to present data in a usable format.
- Sub-task 2.4. Assess dredging needs
    - Conduct a dredging needs analysis to include shoaling rate and dredging histories.
    - Include new turning basin in the forecast of dredging needs.
    - Project dredging requirements over a period of 30 years into the future.
- Sub-task 2.5. Determine disposal capacities and capabilities
    - Re-evaluate existing computations of existing upland capacity and compare with existing and future disposal requirements.
    - Evaluate possibility of incorporating new turning basin maintenance into the confined disposal area management strategy.
    - Include an inventory/summary table and maps of all the existing confined disposal areas, their future capacity, and real estate agreements.

Table 1. Mobile River & Bay Authorizing Legislation (1826-2010)

Source: Mark Byrnes, Mark R. Byrnes, Ph.D., Applied Coastal Research and Engineering, 766 Falmouth Road, Suite A-1, Mashpee, MA 02649			
Date	Authorization	Description	Source
May 20, 1826	Congressional Appropriation	A congressional appropriation was made for deepening the harbor of Mobile (Choctaw Pass and Dog River Bar).	ARCE, 1828, p. 40
July 11, 1870	Congressional Appropriation	Congressional appropriations resumed for the improvement of Choctaw Pass and Dog River Bar, according to such plans as would be selected and approved by the Secretary of War.	ARCE, 1971, p. 68, 559
Aug. 5, 1870		A project was submitted to the Chief of Engineers for the improvement of the Harbor at Mobile. This included, "To dredge out Choctaw Pass, Dog River Bar, and the channel above and below Dog River Bar, so as to give a channel which shall be 300 feet wide and 13 feet deep at mean low tide..."	ARCE, 1971, p. 559
March 3, 1879	Congressional Appropriation	By act of Congress, an appropriation was made for deepening the channel up the bay to 17 feet.	ARCE, 1880, p. 1050
March 1880	River and Harbor Act	"The present project for the improvement of this harbor was adopted in March, 1880; the object being to afford a channel of entrance from the Gulf of Mexico to the city of Mobile, of 200 feet width and of not less than 17 feet depth."	ARCE, 1880, p. 133
Aug. 11, 1888	River and Harbor Act	An appropriation was made for Mobile Harbor providing for continuing the improvement on enlarged project for securing a channel 23 feet deep at central depth and 280 feet wide.	ARCE, 1888, p. 159; H. Ex. Doc. 139, 48th Cong., 2nd Sess.
Sept. 19, 1890	River and Harbor Act	The act extended the work up Mobile River to the mouth of Chickasabogue (Chickasaw) Creek. "The entire length of channel under present project is 31.85 miles..."	ARCE, 1891, p. 212
March 3, 1899	River and Harbor Act	Provided an appropriation and that a contract may be entered into with the view of ultimately securing a channel 23 feet deep and 100 feet wide at the bottom, with appropriate slope.	ARCE, 1899, p. 1696-1697
March 2, 1907	River and Harbor Act	Provided for modification of present project so as to provide for appropriations to complete the existing project and for maintenance and such increased depth as may be possible with the funds. The construction of a dredge was also authorized.	ARCE, 1907, p. 370
June 25, 1910	River and Harbor Act	Provided for the formation of a channel 200 feet wide in Mobile Bay and 300 feet wide in Mobile River, with a depth of 27 feet at MLW, the work to include the straightening of the channel between beacons 22 and 16 (just below the city of Mobile) and a turning basin 600 feet by 800 feet at the upper end of the improvement. The work of straightening the channel was not to be undertaken until the present channel was dredged to a depth of 27 feet.	ARCE, 1910, p. 461
Aug. 8, 1917	River and Harbor Act	This act provided for a channel 30 feet deep at MLW and 300 feet wide from deep water in lower Mobile Bay to Chickasaw Creek, about 5 miles above the mouth of Mobile River, a distance of 33.5 miles.	ARCE, 1917, p. 833
July 3, 1930	River and Harbor Act	This act provided for a "channel 32 feet deep at mean low water and 300 feet wide from deep water in Mobile Bay to a point at the north edge of the proposed quarantine anchorage basin; for a channel 32 feet deep at mean low water and 350 feet wide from the north edge of the quarantine anchorage basin to the mouth of Mobile River; for an anchorage basin 32 feet deep at mean low water extending 1,000 feet south	ARCE, 1930, p. 902

Source: Mark Byrnes, Mark R. Byrnes, Ph.D., Applied Coastal Research and Engineering, 766 Falmouth Road, Suite A-1, Mashpee, MA 02649			
Date	Authorization	Description	Source
		from the north edge of the present pier of the Mobile quarantine station and 200 feet west of the west edge of the dredged channel in Mobile Bay; and for a channel 32 feet deep at mean low water, with a width of 500 feet, from the mouth of Mobile River to a point approximately 5,000 feet below the mouth of Three Mile Creek, and a width of 300 feet from that point to the highway bridge across Mobile River about 1,000 feet below the mouth of Chickasaw Creek, for easing the bends at the mouth and about 3,000 feet above the mouth, and for the removal of sunken obstructions."	
Aug. 26, 1937	River and Harbor Act	This act modified the existing project so as to provide an increased channel width in Mobile River: a 500-foot channel 32 feet deep from a point about 5,000 feet south of the mouth of Three Mile Creek to the highway bridge across Mobile River.	ARCE, 1937, p. 678
Oct. 17, 1940	River and Harbor Act	This act modified the existing project so as to provide for a channel 27 feet deep and 125 feet wide from the Mobile River Channel at its mouth through Garrows Bend, to and including a turning basin of the same depth, 800 feet long and 250 feet wide. The act further modified the existing project so as to provide for extension of the channel through Garrows Bend 27 feet deep and 125 feet wide, to and including a turning basin of the same depth, 800 feet long and 600 feet wide.	ARCE, 1941, p. 753
March 2, 1945	River and Harbor Act	Modification of existing project for Mobile Harbor so as to include: 1. Adoption of existing channel through Garrows Bend from Choctaw Point to Arlington pier, 27 feet deep and 150 feet wide in modified location, with two turning basins. 2. Adoption of the existing channel dredged as an emergency measure alongside Arlington pier from the Mobile Bay Channel to turning basin at inner end of Garrows Bend Channel, 27 feet deep and 150 feet wide. 3. An anchorage area 32 feet deep, 200 feet wide and approximately 2,000 feet long on the west side of the Mobile Bay Channel at the quarantine station on Sand Island, by extending the present anchorage southward 500 feet and northward to an intersection with the Mobile River Channel. 4. A channel 700 feet wide in Mobile River from the mouth to the first bend, 775 feet wide through the first bend, 600 feet wide thence to Alabama State docks pier A, south, and a turning basin opposite the Alabama State docks approximately 2,500 feet long, 800 feet wide at the lower end and 1,000 feet wide at the upper end, all to a depth of 32 feet. 5. A channel 25 feet deep and generally 500 feet wide in Mobile River from the highway bridge to the mouth of Chickasaw Creek, thence 25 feet deep and 250 feet wide in Chickasaw Creek to a point approximately 400 feet below Shell Bayou.	ARCE, 1945, p. 825
Sept. 3, 1954	River and Harbor Act	Provided for modification of existing project so as to include enlarging Mobile Bay channel to 40 by 400 feet; deepening Mobile River channel below highway bridge to 40 feet over present widths, including existing turning basins and anchorage areas; widening river channel opposite Magazine Point to provide a 40- by 800- by 1,400-foot turning basin; and closure of Garrows Bend channel by construction and operation of an earth-filled causeway across said channel (work to be done by local interests) (Sec. 104, act of Sept. 3, 1954).	ARCE, 1955, p. 423
July 26, 1970 & Dec. 15, 1970	Section 201 1965 Flood Control Act	Theodore Ship Channel: Provided for a channel 40 feet deep and 400 feet wide, branching from the main ship channel in Mobile Bay at a point about 2.5 miles south of Mobile city limits and extending northwesterly about 5.3 miles to the shore of Mobile Bay, thence via land cut 40 feet deep, 300 feet wide, and about 1.9 miles long to, and including, a trapezoidal turning basin 40 feet deep and approximately 42	ARCE, 1971, p. 10-11, 10-39

Source: Mark Byrnes, Mark R. Byrnes, Ph.D., Applied Coastal Research and Engineering, 766 Falmouth Road, Suite A-1, Mashpee, MA 02649			
Date	Authorization	Description	Source
		acres in area within the Theodore Industrial Park, and an anchorage basin 40 feet deep, 300 feet wide, and about 1,200 feet long located adjacent to the proposed channel near the bay shoreline.	
Oct. 22, 1976	WRDA of 1976 Section 112	The previously approved project (1970) for Theodore Ship Channel was modified in accordance with the report of the Board of Engineers for Rivers and Harbors dated May 28, 1976, so as to provide for a barge channel extension 12 feet deep, 100 feet wide, and approximately 6,000 feet long extending in a westerly direction to a barge turning basin approximately 2 acres in area. Dredged material from the ship channel should now be deposited on one island in the bay in lieu of 5 islands and upland areas.	H. Doc. 376, 95th Cong., 2nd Sess.
Aug. 15, 1985	Supplemental Appropriations Act	Provided for modification of the existing project so as to provide for future development to deepen and widen bay channel to 55 feet by 550 feet from the mouth of the bay to south of Mobile River, about 27 miles long, deepen and widen an additional 4.2 miles of bay channel to 55 feet by 650 feet, provide a 55 foot deep anchorage area and turning basin in the vicinity of Little Sand Island, and construct a 1710 acre disposal area adjacent to the Brookley Industrial Complex.	ARCE, 1999, p. 10-38
Nov. 17, 1986	WRDA of 1986 (PL 99-662)	Modification of FY 1985 Supplemental Appropriation Act. Dredged material from project shall be disposed of in open water in the Gulf of Mexico.	ARCE, 1999, p. 10-38; ARCE, 1987, p. 10-10
January 2006		An Environmental Assessment Draft was prepared by the USACE, Mobile District, regarding the 55 foot deep anchorage area and turning basin to be constructed in the Mobile River between Pinto Island to the north and Little Sand Island to the south, authorized by the Supplemental Appropriations Act of 1985. The estimated amount of sediment to be dredged is 3,000,000 cy. The depth of the turning basin would be 45 feet MLW with 4 feet advanced maintenance and 2 feet for allowable overdepth. Dredged material would be placed at Garrows Bend (1.2 million cy) on land to be reclaimed associated with the Choctaw Point Terminal Project, and the remaining material would be placed in either or both the Sand Island Beneficial Use Area (SIBUA) and Gaillard Island Disposal Site. Sediment consisting of predominantly sand would be placed in the SIBUA site for support and preservation of the Sand Island Lighthouse. "Every attempt will be made to place approximately 500 thousand cy of material in this area. Materials containing higher fractions of fine grained materials will be placed at the Gaillard's Island Site.	USACE Environmental Assessment (Draft)

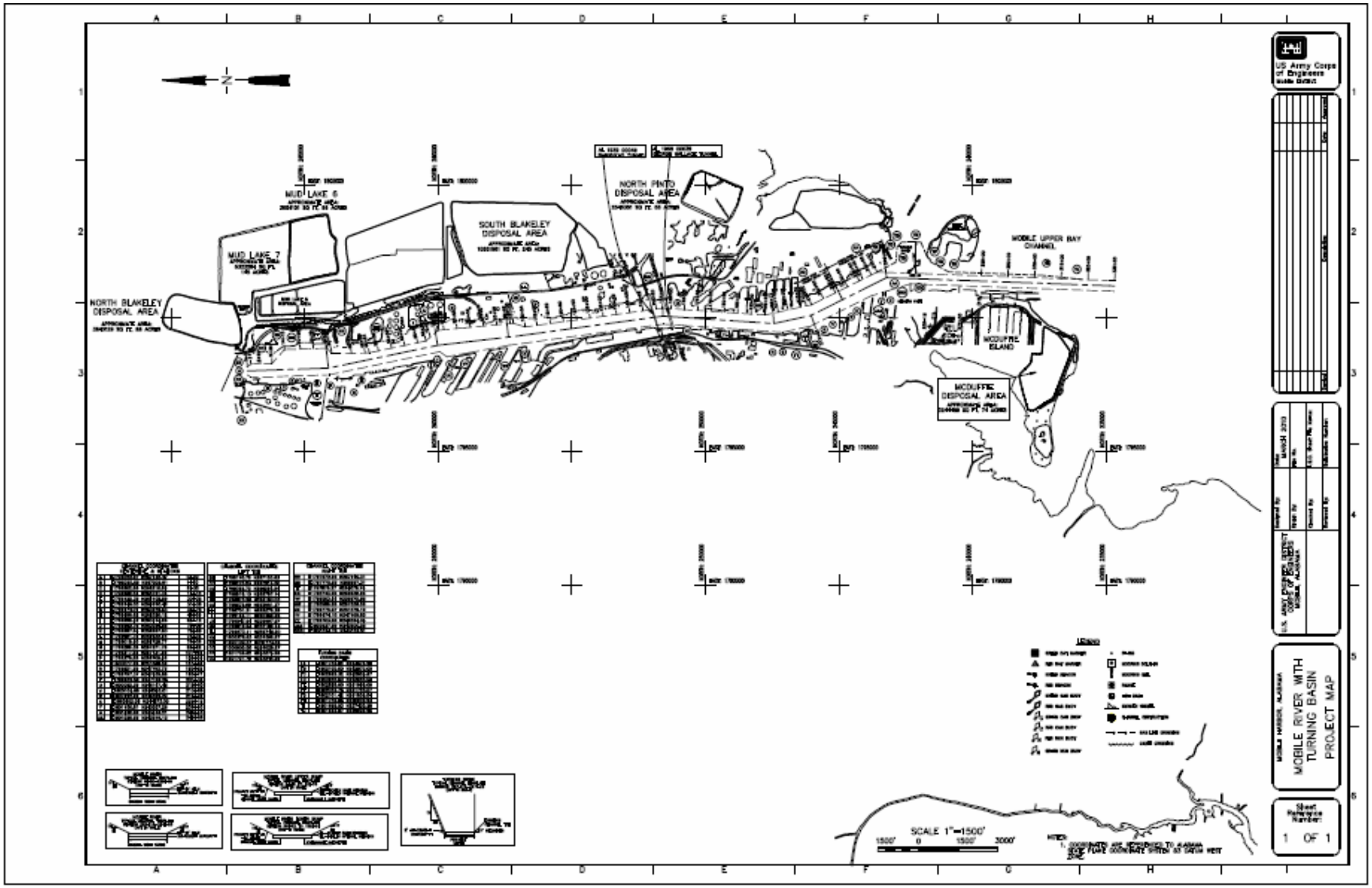


Figure 2. Mobile River and Turning Basin Project Map

- Review existing confined disposal area maintenance practices and planned dike work/material haul out and evaluate effectiveness and recommend alternatives.
- Contact MAWSS (Mobile Area Water and Sewer System) representatives and factor possible material removal from confined disposal areas for this action into the overall strategy.
- Factor into the strategy the ocean disposal alternative to extend the life of the upland sites.
- Identify and summarize all sites that could serve as future disposal areas.
- Identify and summarize the needs of the Alabama State Port Authority regarding annual dredging and existing capacity.

- Sub-task 2.6. Identify potential for beneficial uses
  - Identify materials suitable for potential beneficial uses.
  - Review beneficial use activities in Louisiana and Texas to assess how Mobile District could apply some of the practices to Mobile River and turning basin.
  - Develop conceptual ideas on marsh island creation including the Arlington/Brookley area.
  - Coordinate with Mobile District and appropriate Resource Agencies to identify potential feasible beneficial use options and lessons learned that could be applied to the Mobile River.
- Sub-task 2.7. Evaluate strategies for dredging, disposal, and management options
  - Evaluate the most efficient alternatives for ocean disposal (hopper dredge vs. bucket dredge).
  - Compare the costs of pipeline dredging and associated disposal area maintenance against the costs of dredging and ocean disposal.
  - Recommend alternatives and solutions that do not require PGL-47 cost sharing.
  - Examine multiple dredging, disposal, and management options to determine if there is potential for improvements in efficiencies.
- Sub-task 2.8. Develop management guidelines for confined disposal areas
  - Prepare best management practices in the form of guidelines for each of the confined disposal areas.

Approach

RMG's approach to this study was to use a team of senior engineers and scientists with considerable experience in the analysis and development of long-term strategies for dredging, dredged material disposal, and dredged material management, including beneficial uses. The study was accomplished through contacts and in-depth discussions with Staffs of the Mobile District Operations, Planning, and Legal offices and key personnel of the Irvington Site Office. Over the course of study, RMG participated in three formal in-progress review meetings, numerous working sessions at ISO, and several internal RMG working sessions to gather information, reconcile data discrepancies, and document existing maintenance dredging and disposal area management practices.

In addition, RMG held meetings with representatives of ASPA, MAWSS, and various resource agencies to gather information and stakeholder input to this study. Results of the meetings and data calls are documented in the report on each subtask and are contained in the individual appendices in Volume II of this report.

Description of Existing Conditions

Dredging History

This section presents an overview of the historical dredging records found from 1961 to 2010.

Dredging Contracts

The Mobile District performs maintenance dredging and dredging to enhance navigation features of the Mobile River navigation channel by contracting with private dredging firms. Existing historical information pertaining to contracting for maintenance and new work dredging dates from the early 1960's with contract information, logs of operations, history cards and various pieces of ancillary information available in Mobile District files. In addition to historical files, there are personnel -- current employees of the Mobile District, retired personnel from Mobile District, and persons with no former or current association with the Mobile District -- who have considerable knowledge concerning historical aspects of the Project. Interviews with these personnel have provided much perspective to the history of the Federal Project as well as context for the files and records that exist.

The types of contracts historically used by the Mobile District for dredging and disposal activities are primarily of the following types:

- Rental - The District contracts with a company to provide equipment and personnel to perform dredging and disposal under the direction of District personnel. The District compensates the dredging company on a rate per time ($ per hour) basis regardless of the volume of material removed from the area to be dredged or the time required to perform the dredging.

- Unit Price - The District awards a contract to a company who agrees to remove a certain volume from the area to be dredged for a certain fee per unit dredged ($ per cubic yard) regardless of the time required to dredge the material. These contracts typically stipulate a base rate for the expected yardage of material to be removed and a secondary rate if the expected yardage is exceeded. The contract also stipulates that the contractor will not be paid for any material that is removed that is outside the allowable depth (authorized channel depth plus allowed overdepth) or width limits of the navigation project.

- Lump Sum - The District awards a contract to a company who agrees to re-establish channel dimensions for a fixed amount ($ for the job) regardless of the time or yardages involved. The contract usually stipulates damages (deductions from the fixed amount) for dredging outside the allowable depth or width limits of the project or working beyond maximum time limits agreed to in the contract.

- Indefinite Delivery Indefinite Quantity - IDIQ contracts are a recent procurement option, begun in the 1990's, whereby a basic contract is awarded to a contractor who is certified as to his ability to perform the Scope of Work. Contract work is assigned through a series of Task Orders, each with its own Scope, under the contract. The Task Orders are discrete tasks that the contractor is to perform, each having qualifications

such as the time allowed for the task to be completed and the costs to perform the task. IDIQ contracts typically are multiple years in duration but are capped at a certain total dollar amount; task orders are typically one year or less in duration. The sum of expenditures of all task orders must not exceed the total amount authorized for the IDIQ contract.

All dredging contracts allow the awarded contractor an amount for transporting and assembling equipment at the project site prior to beginning work and for dismantling equipment and returning it to its home base after work is completed. This amount is termed "mob and demob" in the dredging contract and is a fixed price regardless of the time required to perform the dredging and disposal operations.

Dredging contract records dating to FY 1961 indicate the following types and number of contracts were used for procuring dredging and disposal services in for Mobile District:

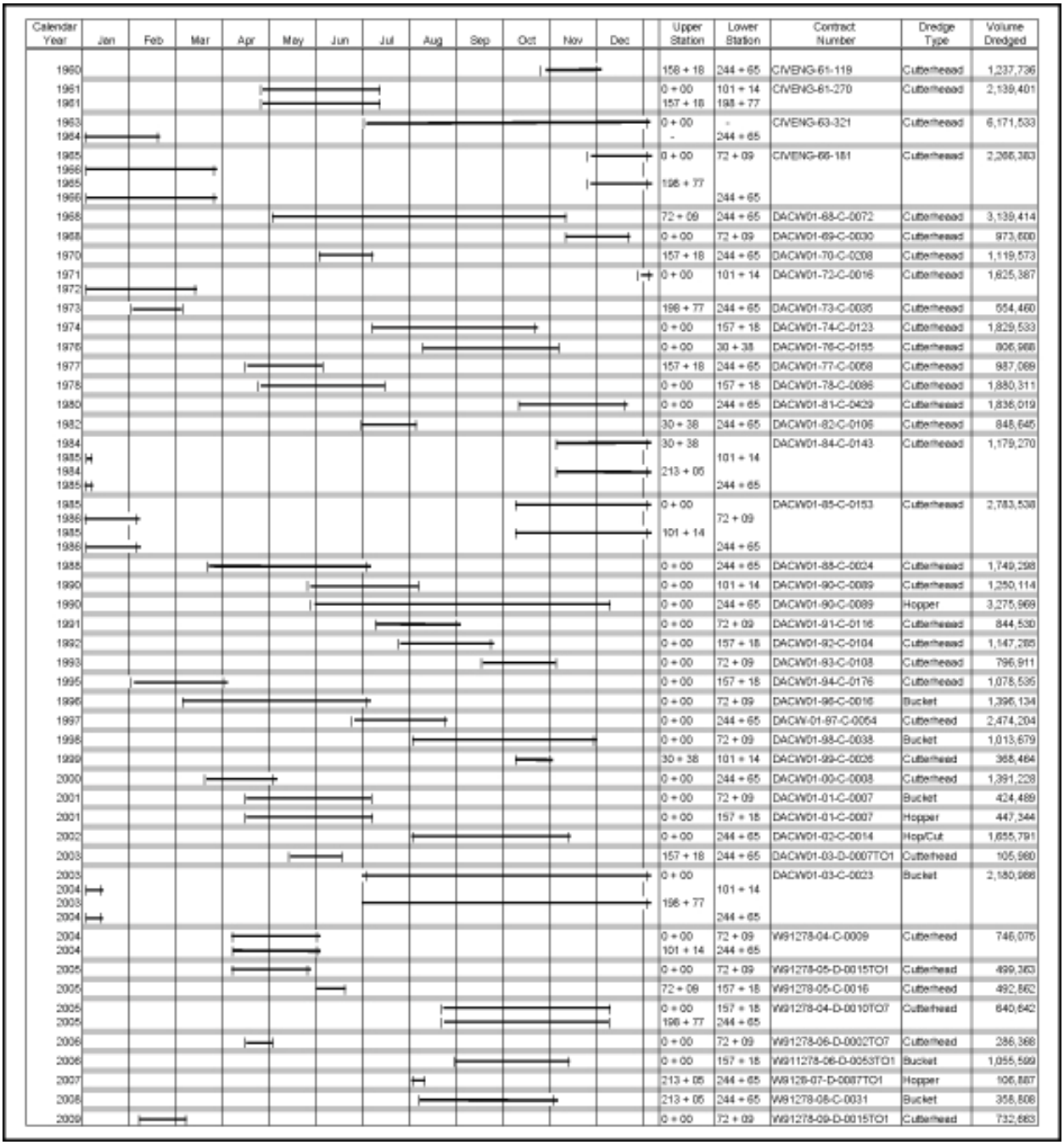
- Rental - 7
- Unit Price - 19
- Lump Sum - 11
- Lump Sum & Rental - 1
- Unit Price & Rental - 3
- IDIQ - 2

Dredging Cycles

Discussions of dredging cycles, or the periodicity of dredging operations, inherently mirror discussions about contracting. Figure 3 shows much of the historical data associated with contracts for the MRFNP in graphical format. This figure indicates the seemingly random pattern of dredging contract activity that has occurred over the 48.4 years of contract records.

Since 1960, the Mobile District has awarded 41 contracts for dredging and disposal operations in the Project. Only six of those contracts included dredging of the entire Mobile River Navigation Channel. The remaining dredging contracts maintained parts of the channel, typically alternating from the upper (northern) end during one funding year to the lower (southern) end the following funding year. Explanations for this practice could include availability of funding during any fiscal year, availability of disposal sites, emergency dredging triggered by unexpected shoal formation, etc. The historical data do not reveal the reason(s) for the dredging practices in the Project, but the data do allow a reporting of some contracting characteristics and the arrangement in which they occur.

As can be seen in Figure 3, most contract data do not easily lend themselves to simple statistical analyses, such as averaging. However, some meaningful relationships that can be veraged are shown in Table 2.



Calendar Year	Upper Station	Lower Station	Contract Number	Dredge Type	Volume Dredged
1960	158 + 18	244 + 65	CIVENG-61-119	Cutterhead	1,237,736
1961	0 + 00	101 + 14	CIVENG-61-270	Cutterhead	2,139,401
1961	157 + 18	198 + 77			
1963	0 + 00	-	CIVENG-63-321	Cutterhead	6,171,533
1964	-	244 + 65			
1965	0 + 00	72 + 09	CIVENG-66-181	Cutterhead	2,266,383
1966					
1965	198 + 77				
1966		244 + 65			
1968	72 + 09	244 + 65	DACW01-68-C-0072	Cutterhead	3,139,414
1968	0 + 00	72 + 09	DACW01-69-C-0030	Cutterhead	973,600
1970	157 + 18	244 + 65	DACW01-70-C-0208	Cutterhead	1,119,573
1971	0 + 00	101 + 14	DACW01-72-C-0016	Cutterhead	1,825,387
1972					
1973	198 + 77	244 + 65	DACW01-73-C-0035	Cutterhead	554,460
1974	0 + 00	157 + 18	DACW01-74-C-0123	Cutterhead	1,829,533
1976	0 + 00	30 + 38	DACW01-76-C-0155	Cutterhead	806,968
1977	157 + 18	244 + 65	DACW01-77-C-0058	Cutterhead	987,069
1978	0 + 00	157 + 18	DACW01-78-C-0086	Cutterhead	1,880,311
1980	0 + 00	244 + 65	DACW01-81-C-0429	Cutterhead	1,836,019
1982	30 + 38	244 + 65	DACW01-82-C-0106	Cutterhead	848,645
1984	30 + 38		DACW01-84-C-0143	Cutterhead	1,179,270
1985		101 + 14			
1984	213 + 05				
1985		244 + 65			
1985	0 + 00		DACW01-85-C-0153	Cutterhead	2,783,538
1986		72 + 09			
1985	101 + 14				
1986		244 + 65			
1988	0 + 00	244 + 65	DACW01-88-C-0024	Cutterhead	1,749,298
1990	0 + 00	101 + 14	DACW01-90-C-0089	Cutterhead	1,250,114
1990	0 + 00	244 + 65	DACW01-90-C-0089	Hopper	3,275,969
1991	0 + 00	72 + 09	DACW01-91-C-0116	Cutterhead	844,530
1992	0 + 00	157 + 18	DACW01-92-C-0104	Cutterhead	1,147,285
1993	0 + 00	72 + 09	DACW01-93-C-0108	Cutterhead	796,911
1995	0 + 00	157 + 18	DACW01-94-C-0176	Cutterhead	1,078,535
1996	0 + 00	72 + 09	DACW01-96-C-0016	Bucket	1,396,134
1997	0 + 00	244 + 65	DACW-01-97-C-0054	Cutterhead	2,474,204
1998	0 + 00	72 + 09	DACW01-98-C-0038	Bucket	1,013,679
1999	30 + 38	101 + 14	DACW01-99-C-0026	Cutterhead	368,464
2000	0 + 00	244 + 65	DACW01-00-C-0008	Cutterhead	1,391,228
2001	0 + 00	72 + 09	DACW01-01-C-0007	Bucket	424,489
2001	0 + 00	157 + 18	DACW01-01-C-0007	Hopper	447,344
2002	0 + 00	244 + 65	DACW01-02-C-0014	Hop/Cut	1,655,791
2003	157 + 18	244 + 65	DACW01-03-D-0007TO1	Cutterhead	105,960
2003	0 + 00		DACW01-03-C-0023	Bucket	2,180,986
2004		101 + 14			
2003	198 + 77				
2004		244 + 65			
2004	0 + 00	72 + 09	W91278-04-C-0009	Cutterhead	746,075
2004	101 + 14	244 + 65			
2005	0 + 00	72 + 09	W91278-05-D-0015TO1	Cutterhead	499,363
2005	72 + 09	157 + 18	W91278-05-C-0016	Cutterhead	492,862
2005	0 + 00	157 + 18	W91278-04-D-0010TO7	Cutterhead	640,642
2005	198 + 77	244 + 65			
2006	0 + 00	72 + 09	W91278-06-D-0002TO7	Cutterhead	286,388
2006	0 + 00	157 + 18	W911278-06-D-0053TO1	Bucket	1,055,599
2007	213 + 05	244 + 65	W9128-07-D-0087TO1	Hopper	105,887
2008	213 + 05	244 + 65	W91278-08-C-0031	Bucket	358,808
2009	0 + 00	72 + 09	W91278-09-D-0015TO1	Cutterhead	732,663

Figure 3. Dredging Contract Information - 1960 through 2009

Table 2. Information Concerning Dredging Contracts

Description	Value
1. Average time between end of one contract and beginning of next	347 days*
2. Average duration of contracts	77 days
3. Average contract cycle time	347 days + 77 days = 424 days
4. Average days to start dredging after begin of FY	266 days
5. Maximum days to start dredging after begin of FY	482 days
6. Minimum days to start dredging after begin of FY	8 days
7. Shortest contract	5 days
8. Longest contract	237 days
9. Maximum amount dredged under any contract	6,171,533 CY in 1963 - 64
10. Minimum amount dredged under any contract	105, 980 CY in 2003
11. Average amount dredged under all contracts	1,412,173 CY

* Days are in total elapsed time rather than work days.

Dredge Types

There are three dominant dredge types used for dredging and disposal activities in the Project. In addition, there have been limited use of specialty dredges (e.g., Bean's Maricarver), but the frequency of use could change if some special beneficial use applications are implemented in the future. The types and characteristics of dredges used in the Project are discussed next.

Cutterhead Dredge

Cutterhead dredges were used exclusively in the Project from the 1960's through the 1980's, and are interspersed with other dredge types until the present time. Through 2009, cutterhead dredges have been used 35 times to excavate and pump dredged material to historical CDFs and other sites. They are efficient, widely available and come in a variety of sizes. These dredges consist of a floating platform on which a dredge pump is located. The dredge suction is fitted with a rotating cutter device that loosens the bottom sediments, allowing them to be caught up in the incoming stream of water and transported to open water or confined disposal

areas. Large cutterhead dredges (typically 20 to 30 inch discharge pipe diameter) have high production rates and can transport dredged material efficiently and economically long distances through pipelines to a CDF. However, cutterhead dredges are not self-propelled and are tethered to discharge lines rendering them unwieldy and slow, a disadvantage when working in a channel with high traffic levels. Also, cutterhead dredges are not capable of working in areas where high waves or strong winds and currents are present.

Hopper Dredge

Hopper dredges are self-contained, self-propelled vessels capable of picking up bottom sediments through drag-arms, storing the sediments on-board and carrying the dredged materials to a disposal area for final placement. A hopper dredge, if properly outfitted, can also pump out of its hoppers and into upland disposal facilities. Hopper dredges are capable and well suited for working in open waters with significant wave action present; however, they can also work in more confined areas such as wider navigation channels where fairly long reaches of open channel is available. They are maneuverable and can move out of the navigation channel as traffic approaches the dredging site. They are not particularly well suited for evacuating maintenance materials from turning basins or other tight quarters where corners must be cleaned. Through FY 2009, hopper dredges have been used for dredging all or parts of the Project four times, the first time being in 1990.

Bucket Dredge

Bucket dredges, also known as mechanical dredges, are basically a crane mounted on the deck of a barge or other work platform with a bucket to excavate bottom materials mechanically. Bucket dredges can work from water-based or land-based platforms, but for maintenance dredging applications, the bucket and crane apparatus are mounted on a floating barge. Materials excavated from the dredging site are placed in a scow moored alongside and the scow is towed to a disposal area where the dredged material is released. Bucket dredges are exceptionally adept at digging deep channel features with high banks of material that also have corners to be cleaned. Bucket dredges have been used for dredging in the Project five times, the first being in 1996.

Specialty Dredge

A specialty dredge or 'niche dredge' is application specific, but may have some advantages for dredging activities in the Project. For applications such as beneficial uses of dredged materials, dredges capable of placing thin layers of dredged sediments or for spraying a slurry containing dredged sediments for re-nourishment purposes may be used.

Dredged Quantities

Dredged quantities from the Project can be reported in two ways: actual volumes dredged under each contract, or meaningful averages that are expected to recur on a routine basis (annualized basis). Since data are available to report values for each quantity, both will be discussed next.

Sufficient information was recorded for contracts dating back to 1960 that the amounts and general locations along the navigation channel from which maintenance materials were

dredged could be identified. A Microsoft Access® table was constructed (see Table AD-1, Appendix C) that contains information from contract documents, history cards and logs of operations for all contracts for dredging Mobile River navigation channel from 1960 to 2009. From Table AD-1, actual volumes dredged under each contract can be obtained. Figure 3 shows much of this contract information, together with the type of dredge used and the channel stations within which the dredging occurred. Important dredging volumes from Table C-4 and the Microsoft Access® table AD-4 have been extracted and are presented in Table 3.

Table 3. Dredged Volumes from Mobile River Navigation Channel

Description	Volume, CY
Total volume dredged over 48.4 years	57,899,088
Maximum amount dredged under any one contract (1963-64)	6,171,533
Minimum amount dredged under any one contract (2003)	105,980
Volume dredged prior to construction of sumps (1992)	38,498,791
Volume dredged after construction of sumps (thru 2009)	19,400,297

Many of the specific volumes dredged under a specific contract, while interesting from a purely historical perspective, are not as helpful as volumes that can be used to identify trends or long-term averages. Trends and averages, particularly if established over a timeframe of the order of the historical database -- some 48.4 years -- are extremely useful for future projections. The same data tables used to develop Table 3 to discern specific volumes can also yield the long-term averages that can be so very useful in anticipating future dredging and disposal requirements.

Examples of useful averages of dredging quantities taken from Table 3 and from the Appendix C, Microsoft Access® Table AD-4 are listed below in Table 4.

Table 4. Average Dredging Values for Mobile River Navigation Channel

Description	Volume, CY
Average annualized volume dredged over 48.4 years	1,196,056
Average volume dredged per contract over 41 contracts	1,412,173
Average annualized volume dredged before construction of sumps (1960 - 1992)	1,212,011
Average annualized volume dredged after construction of sumps (1992 - 2009)	1,166,190

Discussion of Dredging Contracts and Dredged Quantities

Table 4 shows that the average annualized volume dredged over the 48.4 year period of historical records is 1,196,056 CY. It can also be argued that this average annualized volume dredged is equivalent to the average annual shoaling volume for the Mobile River Navigation

Channel. This average annual shoaling rate of 1,196,056 CY taken from dredging records is very close to the "rule of thumb" the Mobile District uses for the average expected shoaling rate which is 1,200,000 CY.

In addition, since the average contract cycle time for dredging in the Mobile River Navigation Channel is 424 days (see Table 2), the expected average dredged volume for that contract is the expected shoaling in 424 days. This average shoaling is the ratio 424 days/365 days times the average annual shoaling, or 1.16 times 1,196,056 CY or 1,389,391 CY. This value is very close to the average annual volume dredged per contract which is 1,412,173 CY (see Table 4).

For the purpose of projecting dredging requirements for the Project for 30 years into the future, the average annual shoaling value of 1.196 MCY, or the more familiar 1.2 MCY, is statistically valid. Other considerations that also must be included in the projections are discussed in later sections of this report.

Dredging Costs

An analysis was conducted on the different costs of dredging by type of dredge and disposal site combination (see Appendix F). Over the past decade or more, pipeline dredging has accounted for roughly 68% of all maintenance dredging work. The costs of pipeline dredging with upland site disposal and disposal site management averages $5.82 per cubic yard versus bucket dredging with ocean disposal averaging $6.24 per cubic yard versus hopper dredging with ocean disposal costs averaging $8.28 per cubic yard.

Dredged Material Placement and Management

This section presents a brief overview of the historical development of a system of CDFs for placement and management of dredged material from the maintenance dredging of the Project. In addition, information is presented on the current and theoretical volumetric capacities of each site and a description of their use and current site management practices.

Historical Development and Management of CDFs

Originally, the practice of upland disposal was described as “wild spoiling”, which referred to pumping dredged material onto the marshes and uplands without confinement such as dikes. However, in the early 1970’s, after passage of the Federal Water Pollution Control Act, dredged material was redirected to CDFs constructed to encompass the formerly uncontrolled placement sites. North Blakeley Island CDF (previously known as North Pole Cat Bay) was the first of the CDFs to be developed in the early 1970’s. South Blakeley CDF was begun in the mid-1970s along with one or more private CDFs that supported disposal needs of the project. During the 1970s, North Blakeley and South Blakeley CDFs continued to be the primary disposal sites with several one-time placements in private CDFs. In the early 1980’s, the ALCOA Mud Lakes (adjacent to Mud Lakes 6 & 7) were brought online and operated in tandem with North Blakeley and South Blakeley CDFs to maintain the Federal Project. In the mid-1980’s, a backlog of shoals continued and the District had to incorporate the open water option again. The District obtained use of what was termed the Mobile Bay Open Water “Step-Down” disposal process in addition to using the North Blakeley, South Blakeley and ALCOA CDFs in an attempt to overcome the backlog.

However, in the late-1980s, construction began on Mud Lake 6 and Mud Lake 7, which initially came on-line in 1990. These two sites were combined with a multiple dredge contract using both a cutterhead dredge with use of Gaillard Island CDF and a hopper dredge (used for the first time) haulout to the ODMDS.

In the early-1990s, the Mobile District began a planned use of all four CDFs by specifying placements of dredged material in restricted lift thicknesses (3 ft. to 5 ft.) allowing dewatering and management of the dredged material to recover as much CDF storage space as practical, thereby, extending the life of the CDFs. This operational "rule of thumb" was selected as a "not to exceed" value so the CDFs could be effectively and efficiently managed. This management strategy was further enhanced by using either a bucket dredge with barge or a hopper dredge with disposal at the ODMDS. A dredging and disposal strategy was devised to incorporate the rotation of the CDFs based upon their size (acreage), degree of preparation (dewatering and dike raising) and their proximity to dredging locations (shoals). The rotation typically involved the use of one large site in combination with two medium sites and a combination of one large site with a small site to allow "rest-time" for additional site management.

In 1998, the Mobile District issued its first IDIQ contract to start an intensive CDF management program in the four upland CDFs existing at that time (North Blakeley, Mud Lake 6, Mud Lake 7 and South Blakeley). The contract specified only unique equipment that was proven capable of working in CDFs by demonstrating superior operating methods.

In 2000, the North Pinto CDF was added to the array of upland CDFs. That addition increased the number of CDFs to five. The addition of the North Pinto CDF to the site rotation enhanced the management options and strategy described earlier.

In 2001, the first large hopper dredge (Stuyvesant) was used in the Mobile River Channel and the material was hauled to the ODMDS offering much needed CDF rest-time (management time). In 2002, the Columbia was the first hopper dredge for maintenance dredging that used pumpout directly into South Blakeley CDF.

Currently Used CDFs

Presently, the Mobile District manages five upland diked dredged material confined disposal facilities (CDFs) supporting the Project maintenance dredging. These CDF sites include North Blakeley, Mud Lake 6, Mud Lake 7, South Blakeley and North Pinto. The locations of the five sites were previously shown in Figure 2. There layouts are shown in an aerial photograph presented in Figure 4.

In order to forecast the life of the existing CDFs, an estimate of the initial or starting volumetric capacity of each site is needed. An analysis was performed (see Appendix D) to determine the existing volumetric capacity in each of the five sites. The results of this evaluation are shown in Table 5, together with the total volume of the five sites, 10.5 MCY. Using an average shoaling rate of 1.2 MCY, a "rule of thumb" that one volume of sediment in the shoal being dredged occupies one volume of material in the site, and no active management, the time to fill all five sites to their present capacity is about 8.75 years.

Figure 4. Aerial View of Mobile River Showing Upland CDFs and New Turning Basin

Additional detailed information for each CDF is presented in Appendix D and Appendix G of Volume II of this report.

Site Management Practices

CDF management has as its primary goal extension of the life of each CDF by dewatering, decanting, desiccation, and consolidation of the deposited dredged material. Initially, the deposited layer of dredged material (slurry) is allowed to settle and separate the free draining water, which is discharged as effluent through a weir or outlet structure from the site. Given

Table 5. Summary of Existing Upland CDFs – Current Volumetric Capacities

(Data Sources: Appendix D and Appendix G)							
Site Name	Survey Of: (Mo/Yr)	Total Surface Area (Acres)	Floor Elev. (Ft)	Dike Elev. (Ft)	In Spur Dikes (MCY)	Dike Perimeter (Ft)	Current Volumetric Capacity (MCY)
North Blakeley	3/2010	85.4	12	30	0.228	8,035	1.442
Mud Lake 6	3/2010	84.3	12	24	0.346	7,705	0.646
Mud Lake 7	5/2008	143.4	6	24	0.360	10,880	3.044
South Blakeley	2/2009	237.6	25	46	1.549	14,205	4.620
North Pinto	4/2009	65.4	10	23	0.007	6,640	0.766
TOTALS		616.1			2.229		10.518

sufficient time, further dewatering, desiccation, and consolidation can occur resulting in the removal of trapped pore water as seepage from the dredged material. Natural exposure to the sun, wind, and gravity and ditching throughout the site bottom (floor) to provide routes for the pore water to escape allow the effluent to be returned to the waterway. Unfortunately, time is required for the free water to be expelled and discharged through the water control weir structure and does not allow active management to begin immediately after dredged material placement. After a crust has formed, this dried dredged material can be removed (scraped from the surface) and relayed or relocated to temporary storage sites (spur dikes), beneficially used onsite for items such as dike raising, road construction, etc., and/or hauled offsite for other beneficial uses. A detailed discussion of best management practices and guidelines for CDFs is presented in Appendix G, where over forty (40) years of the collective knowledge and experiences of past and present staffs of the Irvington Site Office (ISO) have been captured, especially the "Fifteen Commandments of Disposal Area Work" prepared by the ISO (see Appendix H).

CDF Use Strategy

Since 1998, the Mobile District has used a very aggressive management approach to promote and extend the useful life of their CDFs. The degree of management in each site is directly linked to the dredging cycle, time between filling operations, and available funding. The Mobile River dredging frequency depends on shoaling rates, funding, storms, etc., and, as discussed previously, not all sections of the river are dredged annually. Never-the-less, the District has tried to maintain at least two years between filling operations to allow sufficient time to manage and prepare each CDF to receive the next allocation of dredged material.

Currently, the District attempts to avoid overloading any one site during the dredged material filling operation. The dredging and filling strategy includes the use of one-half of the total available footprint acreage of the five sites for each dredging event (e.g., essentially an average of one dredging event each year) to successfully manage an annualized average dredging volume (1.2MCY) while maintaining a "manageable lift thickness" equal to or less than a five (5) ft wet-bulked thickness. This rule of thumb assumes that a three (3) ft sediment thickness in the channel will "bulk" by a factor of 1.66 to five (5) ft of slurry when hydraulically dredged and pumped into the CDF. This dredging and filling strategy has required the District to use the five CDFs in various combinations, each totaling about one-half of the available site acreage during alternate years to maintain the 24 months deemed essential for site management, which reduces pore water content and bulked thicknesses, to extend the life of the CDFs.

In addition to the aggressive management of the CDFs, management of shoals in the upper sections of the river with the two sumps has afforded an opportunity to separate coarse grain sediments suitable for a variety of beneficial uses onsite or elsewhere. The District routinely pumps this high quality construction material to the closest available CDF, which has resulted in cost savings. Also, the District has periodically hauled sump material to the ODMDS as a means of extending the time between filling operations in some of the CDFs. The use of this disposal option appears to be an essential management strategy for preparing the CDFs for the next dredging cycle.

Beneficial Uses

Background

Most dredged material can be a valuable resource and should be considered for a variety of beneficial uses. The USACE Technical Support (DOTS) program webpage below classifies beneficial uses into three broad categories; engineered uses, agricultural and product uses, and, environmental enhancement.

http://el.erdc.usace.army.mil/dots/budm/intro.cfm?Topic=Intro

Historically, dredged material from the Project has been used for a variety of beneficial uses for environmental enhancements, the most recognized being habitat restoration and replacement, construction of bird islands, shallow-water feeder berms for shoreline replacement, and barrier island restoration. Although not generally acknowledged by the Mobile District and Resource Agencies as a beneficial use, sediment dredged from the Project has been the primary construction material for dikes, roadways and fills at all of the Federal placement sites.

During the course of this study, significant effort was expended to locate reports, papers, and project file documents in an attempt to define both physical and engineering properties of Mobile River sediments and dredged material placed into upland sites and used beneficially over the years. There was no single repository for this type of information, and, as such, the search uncovered only a few published and unpublished file documents, which are summarized in Volume II - Appendix E of this report.

Three types of materials suitable for a number of beneficial use applications in the vicinity of the study area include coarse grain sediments from the upper sump, maintenance dredging of the fine-grained river shoals, and material confined in the upland placement sites. However, the vast percentage of the material dredged from the Project is characterized as fine-grained silts/soft clays or mixtures of sand/silt/clay.

Historical Beneficial Uses

A review of the Project files, particularly at the ISO, identified several key projects that qualify as beneficial uses for dredged material from the Mobile River. Most of these beneficial uses can be classified as construction uses although some of them provided habitat restoration.

Habitat Restoration

In 2010, Mobile District began construction of the expansion of the Sand Island Beneficial Use Area (SIBUA) disposal site located near Dauphin Island, Mobile County, Alabama. The expansion consists of extending the 4,500 foot wide southern boundary of the SIBUA approximately 2,000 feet to the south. This expanded area will provide sufficient depths for access of the dredge equipment while continuing to allow for the placement of maintenance dredged material from the Mobile Bar Channel in a manner that returns this material to the local littoral system. Construction of the New MHTB in the Lower Mobile River has resulted in the beneficial use of dredged material at SIBUA for a portion of the deeper sediments (> 6ft to project depth). Construction was completed on August 6, 2010 and approximately 516,000 CY had been placed at the SIBUA.

Environmental Restoration

A cooperative agreement was reached with the ASPA in 2001 to provide dredged material from Mud Lakes 6 and 7 for environmental restoration filling of the lower ALCOA seepage ditch. A significant quantity of dredged material from the Mud Lakes was placed as fill material to cover and control the seepage being collected in a ditch between the ALCOA ponds and Mud Lake 6 and Mud Lake 7.

Although there is no written documentation regarding the volume of material placed in the seepage ditch, an estimated 525,000 CY of fill material could still be placed at this site. Unfortunately, the ASPA has indicated in a response to RMG's data inquiry that the Mobile District should suspend indefinitely any further filling of the ditch.

Landfill Cover and Manufactured Soil

During 1998-1999 approximately 535,000 CY of dewatered dredged material were removed from North Blakeley Island Disposal Area and hauled to the City of Mobile landfill near the Airport for a landfill closure project. In addition, evaluations were conducted during this time frame to determine the feasibility of using a manufactured soil from dredged material in horticulture and as an agricultural land amendment. Auburn University was contracted to develop a "manufactured soil" from dredged material in North Blakeley CDF. This contract ended because of cost and marketing issues.

Dike Raisings at CDFs

Millions of cubic yards of dredged material have been used in construction of the five dredged material placement sites, which are currently being filled and managed by the Mobile District. Dewatered dredged material was used primarily for construction and subsequent raising of dikes at North Blakeley, South Blakeley, Mud Lake 6, Mud Lake 7, and North Pinto CDFs. Cross-sections of the dikes for assessment of projected dike heights were developed in Subtask 2.5 (Appendix D). Approximately, 5.1 MCY of dewatered dredged material will be needed to raise the dikes in the future to their projected maximum dike height.

In 2003, approximately 11,000 CYs of dredged material were removed from North Blakeley and the common dike between Mud Lake 6 and Mud Lake 7 and hauled to ASPA's McDuffie CDF for incremental raising of the dikes.

Fill for Battleship Park Site

Historically, there was a haul-out of dredged material from North Blakeley CDF to South Blakeley CDF. During this operation, approximately 200 dump truck loads were diverted and delivered to the local Boy Scout Organization to raise elevations in a low area at the Alabama Battleship Park. No written documentation describing these actions was discovered in the files but Mobile District Environmental Staff indicated that an Environmental Assessment (EA) was prepared on the project with a FONSI determination. Figure 5 shows one of the dump loads after it had been deposited at the site.

Figure 5. Dumping of Dredged Material hauled from S. Blakeley CDF to Battleship Park

Construction Activities at Gaillard Island

In 1990, approximately 3,275,000 CY of sediment was dredged from the Mobile River by the Hopper Dredge Eagle 1 and pumped into Gaillard Island for a variety of construction purposes. This was the only time dredged material from the Mobile River section of the Federal project was found to be taken to Gaillard Island.

The shaded cells with an "x" in Table 6 represent potentially compatible beneficial uses by types of dredged materials found in the Project. A project-by-project specific assessment will be required to determine the engineering requirements, environmental benefits, and costs associated with a particular potential beneficial use.

Table 6. Beneficial Use Options by Material Type

	Dredged Material Sediment Type				
Beneficial Use Options	Rock	Gravel & Sand	Consolidated Clay	Silt/Soft Clay	Mixture
Engineered Uses					
Land Creation	x	x	x	x	x
Land Improvement	x	x	x	x	x
Berm Creation	x	x	x		x
Shore Protection	x	x	x		x
Replacement Fill	x	x			x
Beach Nourishment	x	x			
Capping		x			x
Agricultural/Product Uses					
Construction Materials	x	x	x	x	x
Aquaculture			x	x	x
Topsoil				x	x
Environmental Enhancements					
Wildlife Habitats	x	x	x	x	x
Fisheries Improvement	x	x	x	x	x
Wetland restoration			x	x	x
Source: http://el.erdc.usace.army.mil/dots/budm/intro.cfm?Topic=Sediment					

Projections of Future Conditions

Dredging Needs (20-30 Years)

Background

Future dredging needs for the Project are a function of shoaling rates and patterns in the navigation channel, tempered by availability of contractual options, dredge types, disposal options and costs. Historical data records contain contracts and dredged material volumes that took into account a variety of outside influences, including major storms that dumped additional sediment into the Project. The types and impacts of many of these events on dredging practices and dredged volumes were not always recorded, but even so, the long-term averages derived from these data are very consistent. Using historical data and perspectives as guides, a projection of future dredging needs can be developed with reasonable accuracy and high confidence.

The analyses presented here will rely on averages of historical values for predictions of future dredging needs using the assumption that future dredging practices and management activities will be similar to those in past years. The first analysis will consider long-term data (48.4 years of observations). A further analysis will consider historical observations whose frequency of occurrence is unknown, but can be expected to be encountered at some point during the next 30 years. There are other factors, however, such as extreme meteorological events and policy decisions, whose magnitudes and uncertainty are such that no analysis can correctly consider their impacts on future dredging needs. The assumptions used in each set of analyses will be clearly stated so that use of the predictions can be done in light of the variables considered.

Projections Based on Long-term Historical Average Conditions

Future dredging requirements based strictly on analyses performed on long-term historical dredging and contracting records reveal the following characteristics:

- The average annualized shoaling volume in the Mobile River navigation channel will be 1.2 MCY.
- The average annualized maintenance dredging requirement of the new MHTB is estimated at 425,000 CY.
- A contract will be awarded every 424 days or 14 months for maintenance dredging of the Mobile River navigation channel.
- Each dredging contract will result in a dredged volume of approximately 1.4 MCY from the Mobile River navigation channel.
- The MHTB will be dredged under the same contract with the navigation channel and will have a maintenance volume of approximately 495,000 CY.

With the exception of maintenance requirements of the new MHTB, the average expected values shown above are very reliable if meteorological conditions, land-use practices and other factors influencing sediment yields to the Mobile River system remain essentially the same and

if contracting practices of Mobile District continue unchanged. The maintenance requirement of the new MHTB is, at present, an estimated value. Since the time required for shoaling in MHTB to reach a state of equilibrium with its surroundings may be many years with higher shoaling rates expected in the first few years, the estimated average value will suffice for predictive purposes.

Historical Events of Undocumented Origin and Type

While there is little documented historical data relating storm or other events directly to maintenance dredging, there is reason to speculate that events occurred during the 48.4 years of available records that increased and decreased dredging quantities significantly over an extended period.

Increased Dredging

An examination of 5-year rolling averages of dredged volumes shows that some unrecorded event(s) occurred during the years 1986 through 1990 such that annualized dredged volumes averaged 1,811,784 CY per year or more than 600,000 CY per year over the long-term annualized average of 1,200,000 CY per year (See Appendix C, Table C-4). If the event(s) that caused this shoaling and associated dredging were to reoccur at some point in the next 20 to 30 years, future dredging requirements could reflect the following characteristics for an extended period of time:

- The average annualized shoaling in the Mobile River navigation channel will be 1.8 MCY for a period of up to five years.
- The average annualized maintenance dredging requirement of the new MHTB will be 637,500 CY for a period of up to five years.
- A contract will be awarded every 424 days or 14 months for maintenance dredging of the Mobile River navigation channel.
- Each dredging contract will result in a dredged volume of approximately 2.1 MCY from the Mobile River navigation channel for a period of up to five years.
- The new MHTB will be dredged under the same contract with the navigation channel and will have a maintenance volume of approximately 745,000 CY for a period of up to five years.

Decreased Dredging

Table C-4 also shows that a five-year period of much lower than average dredging was experienced, beginning in FY 1991 and extending through FY 1995. Here, the long-term annualized average was about 780,000 CY. Specifically, future dredging requirements could reflect the following characteristics for an extended period under a scenario that included these conditions:

- The average annualized shoaling in the Mobile River navigation channel will be 773,500 CY for a period of up to five years.

- The average annualized maintenance requirement of the new MHTB will be 274,000 CY for a period of up to five years.
- A contract will be awarded every 424 days or 14 months for maintenance dredging of the Mobile River navigation channel.
- Each dredging contract will result in a dredged volume of approximately 902,000 CY from the Mobile River navigation channel for a period of up to five years.
- The new MHTB will be dredged under the same contract with the navigation channel and will have a maintenance volume of approximately 320,000 CY for a period of up to five years.

Lower shoaling and associated dredging requirements may prove to be an opportunity for additional facility maintenance as well as opportunities to prepare promising sites for beneficial use applications.

Quite obviously, there is no way to establish the likelihood of a single event or a sequence of events occurring such as those that caused the increased dredging requirements of 1986 through 1990 or decreased dredging requirements of 1991 through 1995. However, it is reasonable to expect that increased or decreased dredging requirements of the order shown above may recur at some point in time and for a period of one-to-five years in length during the next 20 to 30 years.

Disposal Needs (20-30 Years)

To establish a *best-case scenario* for disposal volumes from the Project and to estimate the expected life of upland disposal, the five existing CDFs were idealized for geometry and for disposal practice. The idealized capacity is based on assignment of a Projected Maximum Dike Height (PMDH) for each of the CDFs along with a currently-defined floor elevation can be used to calculate the maximum volume of material that can be placed in the CDFs. The idealized in-fill rate for each of the CDFs is based on an annualized dredging rate of 1.2 MCY with placement into each CDF each year based on the individual CDF areas -- thus each CDF reaches maximum capacity simultaneously with all others. The characteristics of material placed in the CDFs are assumed to be immediately equivalent to the in-situ characteristics of material removed from the navigation channel. Therefore, no reductions in pore water concentrations or of floor elevations within the CDFs are assumed to occur over the life of the CDFs. Thus, this idealized life expectancy is based on the time in years to fill the total available capacity with dredged material using the assumptions of no management and no bulking of the dredged material.

To assess more realistic scenarios, including some that offer placement at ODMDS, various disposal options were analyzed to incorporate management of disposal sites and placement of differing amounts of dredged material into the sites on an alternating basis. The geometries and capacities used in the idealized analyses also were used in this analysis. The management effects (i.e., floor reductions, times to accomplish management objectives, etc.) were derived from field experience and are described in Appendix G. The quantities of dredged material

placed in the disposal sites are specified in the various scenarios, but are reported as annual amounts.

Idealized Volumetric Capacities of Existing CDFs

The RMG Team collected all available information on the five CDFs from site visits and map studies of the most recent topographic surveys provided by the Mobile District. For geometries, field surveys were used to establish beginning conditions of floor elevation, perimeter dike elevations and spur dike volumes. In addition, CAD files of the surveys were used to generate digital terrain models, where appropriate, to estimate areas and perimeter values of the sites. The PMDHs were established using Mobile District guidance for the South Blakely CDF with field experience and professional judgment applied to the other CDFs. The disposal site idealized volumetric capacities were calculated using the PMDH for each CDF multiplied by the area of that CDF with adjustments for ponding depth and safety allowance. The cumulative idealized volumetric capacity for the five sites is the sum of the capacities of each site, again allowing for ponding depth and freeboard (safety factor) practices of Mobile District. In addition, the cumulative volumetric capacity is reduced by the volume of the interior spur dikes but increased by the approximately 600,000 CY destined for placement on the exterior of the South Blakely CDF dike and by the volume needed to build the dikes to the PMDH. A more detailed description of the calculation of idealized volumetric capacities of the five CDFs can be found in Appendix D.

Table 7 shows the idealized volumetric capacities of the five currently-used CDFs. The total projected maximum idealized volumetric capacity was computed to be 32.2 MCY.

Table 7. CDF Idealized Volumetric Capacity

Confined Disposal Facility CDF	Area (Acres)[1]	Projected Maximum Dike Elevation Ft	Total Idealized Volumetric Capacity (CY)[1,2]
North Blakely	69	50	4,157,000
Mud Lake 6	70	46	3,593,000
Mud Lake 7	129	46	9,118,000
South Blakely	196	65	12,028,000
North Pinto	48	47	3,346,000
Totals	512		32,242,000

[1]Taken from tables in Appendix D.
[2]Idealized volumetric Capacity includes interior capacity plus the volume to build projected maximum dike height cross-sections minus the volume in spur dikes.

Life Expectancy of Existing Disposal CDFs Using Idealized Conditions

The RMG Team determined the average annual shoaling rate for maintenance materials in the MRFNP to be 1,200,000 CY, a value that is in agreement with Mobile District's rule of thumb usage (see Appendix C). Consequently, the idealized life expectancy (time to fill to full capacity) of the five CDFs using the historical annual average shoaling in the navigation channel is approximately 27 years (32,242,000 CY÷1,200,000 CY/YR) based solely on a simple volumetric arithmetic calculation and in-situ channel volumes with no considerations for bulking or management of dredged materials. Other times-to-fill can be estimated using this approach. Table 8 (taken from Appendix D) shows the times needed to reach projected maximum capacity of all CDFs for a range of volumes of dredged materials placed in the CDFs. It should be noted that since each CDF is filled at a rate proportional of its volume to the total volume, all CDFs will reach maximum capacity at the same time, regardless of size.

Disposal Site Management Practices for CDFs

Background

The idealized approach previously described does not consider the practice of site management used by the Mobile District. The Mobile District began their management efforts in the 1980's in collaboration with other USACE Districts (e.g., Charleston) with similar disposal practices. The concept of management of disposal sites for the purpose of recovering and sustaining useable storage capacity was pioneered in research and development programs at the U.S. Army Engineer Waterways Experiment Station (WES) (currently the Engineer Research and Development Center - ERDC) in the 1970's and continuing at present. Initial management activities at disposal sites in Mobile District were "add-ons" to dredging contracts and were more-or-less trial and error in nature. When reviews of the early efforts revealed significant positive gains in storage capacity, the District began to incorporate these efforts into their planning for out-year funding requests. In FY 98, the District began efforts under Indefinite Delivery Indefinite Quantity (IDIQ) contracts to formally fund and execute a disposal site management program. Since beginning their site management efforts, Mobile District has acquired a wealth of observations of disposal site responses to management practices. Among these are the following strategic observations:

- Smaller sites respond more quickly to management practices than larger sites,
- The amount of dredged material placed in any site should not exceed five feet of wet-lift thickness,
- Floor elevation reductions, equivalent to site capacity increases, are predictable for various management levels, and,
- Sites usage should be alternated such that one-half of total site acreage is used for dredging and disposal while management activities are performed on the remaining acreage.

Table 8. Estimated Time to Fill Projected Capacity versus Annualized Volume Requiring Placement in CDFs

Annualized Volume Requiring Placement in CDFs (CY) (a)	Estimated Time to Fill Projected CDF Capacity (Yrs) (b)	Annualized In Place Lift Height (Ft) (c)
500,000	64.5	0.6
550,000	58.6	0.7
600,000	53.7	0.7
650,000	49.6	0.8
700,000	46.1	0.8
750,000	43.0	0.9
800,000	40.3	1.0
850,000	37.9	1.0
900,000	35.8	1.1
950,000	33.9	1.2
1,000,000	32.2	1.2
1,050,000	30.7	1.3
1,100,000	29.3	1.3
1,150,000	28.0	1.4
1,200,000	26.9	1.5
1,250,000	25.8	1.5
1,300,000	24.8	1.6
1,350,000	23.9	1.6
1,400,000	23.0	1.7
1,450,000	22.2	1.8
1,500,000	21.5	1.8
1,550,000	20.8	1.9
1,600,000	20.2	1.9
1,650,000	19.5	2.0

(b) = 32,242,000/(a)
(c) = (a)/(512*1613.3)
where:

32,242,000 is the total projected capacity of the five CDFs in CYs
512 is the total interior area of the five CDFs in acres
1613.3 is the number of CY per acre-ft

Lift Thickness

The limit of the volume of dredged material to place in a CDF translates into a limitation on "lift thickness." The District has learned, over many cycles of dredged material placement and management, that limiting volumes placed in any CDF such that a "wet" lift thickness of five (5) feet or less will allow free water and pore water to escape in a timely manner for the management process. Here, wet lift thickness refers to the depth above the existing floor of just-introduced dredged materials. This thickness includes carrier water introduced by the dredging process as well as pore water that was present in the dredged solids that were excavated from the channel bottom. In addition, a two-foot layer of water above the wet lift thickness, termed the ponding depth, will be present in each CDF as disposal operations continue, but will drain away quickly. The District has also learned that a lens of material in the channel bottom that is to be dredged will "bulk" to a volume of 1.65 times its in situ volume when dredged and placed in a disposal facility. The practice of determining volumes to place in CDFs, then, revolves around determining the volume of shoaled material in the navigation channel whose thickness after carrier water and ponding water is removed, will be five (5) feet or less. This turns out to be an in situ lens thickness of no more than three (3) feet. Channel reaches with shoal thicknesses greater as well as less than three feet are commonplace, but the dredging program managers will determine the volume from those reaches that constrains wet lift thicknesses of the dredged material to five feet or less when pumped into a CDF.

Removal of Water

Carrier and ponding water removal begins immediately upon placement of dredged materials in a CDF. Each CDF is designed such that dredged material is introduced at a point far removed from the water control structure, the weir. As the bulked dredged material approaches the weir, gravitational settlement of dredged solids results in a clarifying layer of water at the surface of the ponding layer that is released through the weir. The weir is periodically adjusted downward until this release of carrier water slows and essentially ceases. At this point, the lift depth of newly-introduced dredged material will equal the wet thickness requiring further management. This initial process may take a few days to a few weeks, depending on the carrier water content, the size of the CDF, and the diligence of management of the weir.

Pore water removal constitutes a major portion of the time and effort of site management and is accomplished in two parts. Initial efforts in this process begin with mechanical working of the site by constructing shallow ditches around and across the CDF leading to the location of the weir(s). These ditches convey pore water from the dredged materials to and through the weir. As pore water is removed, the dredged material consolidates and develops a crust which can be removed in successive mechanical efforts. This crust material is "relayed" to the periphery of the site to be used for purposes the District may deem appropriate. This effort may take a few months to more than one year, depending on initial lift thickness, the size of the CDF, meteorological conditions, and the amount of drying required by the District.

The first part of the process, that of "Air Drying", allows pore water to escape, and reduces the volume of the solids in CDFs substantially. For an initial five-foot wet lift in the smaller CDFs (North Blakely, Mud Lake 6 and North Pinto), this reduction is approximately one foot and requires about one year to achieve. For larger CDFs (Mud Lake 7 and South Blakely), the

process requires a longer time but achieves the same reduction in volume. The second part of the process involves mechanically re-handling dredged materials, exposing new surfaces to the atmosphere for additional drying. This process requires about one year and the reduction is an additional foot in lift thickness. At this point, the volume of dredged materials in the CDFs is approximately the volume removed from the navigation channel. The management effort for this reduction in disposed maintenance materials required about two (2) years for the smaller CDFs and about three (3) years for the larger CDFs.

Projection of Disposal Site Life

An analysis was conducted to reflect a more realistic use of the disposal sites under existing disposal area management practices that assumes availability of only half of total site acreage for each dredging event (total site acreage is assumed to be the same as that for idealized analyses). Observations of past site management efforts showed that floor elevation reductions are predictable for five-foot wet lifts and certain levels of management. For instance, air dry (AD) refers to a one foot (1 ft.) reduction in floor elevation and takes place in about 12 months for the smaller CDFs. The term "AD+1" is a two foot (2 ft.) reduction in floor elevation possible in a smaller CDF in about 24 months or in large CDFs (like Mud Lake 7 or South Blakeley) when the intense management period is 32 to 36 months in length. The longer management period for the larger CDFs is related to the dimensions of the facility and the longer distances pore water must travel to exit the CDF. A complete description of the various levels of management is given in Appendix G of this report.

Using the above approach, the estimated life (years to capacity) of individual CDFs was determined for an annualized dredged material placement rate of 1,200,000 CY/YR on alternate years with no ocean placement and with two management intensity levels for the maximum projected dike heights. This calculation accounts for removal of the dredged material needed to construct the dike to the projected maximum height. The results of this analysis are presented in Table 9.

Table 9. Estimated Time to Reach Full Capacity (Yrs) of Individual CDFs under Typical Management Conditions

	AD	AD + 1
Mud Lake 6	18	24
North Blakeley	20	26
Mud Lake 7	18	NA
South Blakeley	22	NA
North Pinto	22	>30
Average Life		24

This analysis shows the combined average life expectancy of the disposal sites is 24 years based on the current management practices of alternate-year use without use of the ocean for the upper sumps or haul-outs for beneficial uses. This compares with an estimated life of the CDFs from the idealized life evaluation of 26.8 years.

Estimated duration to full capacities for a variety of dredging and disposal scenarios is presented in Appendix G. The analyses presented in Appendix G show that use of the ODMDS for placement of Navigation Channel shoal material may be crucial for long-term sustainability of disposal options for the Project.

Potential Challenges and Opportunities

Background

The Mobile District currently dredges, places and manages shoal materials deposited in the Mobile River navigation channel and will be responsible for maintenance materials from the New Mobile Harbor Turning Basin (MHTB) that was completed in August 2010. To assure the sustainability of the Project, the Mobile District must anticipate and be prepared to address a number of difficult challenges over the life of the Project, especially during the next 20 to 30 years. Some of these challenges will likely include:

- Potential changes in dredging requirements (volumes) perhaps due to changes in watershed characteristics, improvements (expansion) to the Federal Channel, and extreme weather-related events such as hurricanes
- Innovations in dredging equipment and methods such as large hopper dredges with pumpout capability
- Changes in program funding and cost sharing
- Changes in the availability of disposal sites (e.g., upland and ocean) due to capacity limits, more stringent sediment testing requirements and political and policy issues
- Implementation of beneficial uses

This section addresses the above items by discussing the potential challenges and identifying opportunities as potential solutions.

Changes in Dredging Requirements

Average annual dredging requirements are unlikely to change dramatically in the foreseeable future. Factors that could influence average annual dredging and disposal include climate change with associated sea-level change, land-use practices in the watershed resulting in an increased sediment yield into the navigation project and project dimension changes such as channel deepening that encourages increased sedimentation. These factors are of unknown certainty and, even if they were to come about, their impacts would be very gradual thus allowing time for remedial or corrective actions to compensate.

Of more concern are changes in dredging requirements that are more short-lived but more dramatic in nature. These challenges take the form of storm-induced shoaling that injects much greater shoaling into the navigation channel and even funding shortfalls due to a struggling national economy that reduces maintenance and management options for an extended period. Dealing with such dredging requirements is problematic since their occurrences or duration cannot be easily predicted. However, development of contingencies for such issues is wise.

Innovations in Dredging Equipment

Dredging technology is anything but static with hopper dredge capacities exceeding 30,000 cubic yards being placed into service. In addition, improvements in maneuverability for hoppers, such as powerful bow and stern thrusters may allow these dredges to operate in quarters that were formally unsuited for them. Hopper pumpout capability is being included in most new hopper dredge design and methods for mooring at pumpout locations are improving. This technology holds promise for application in the Mobile Bay and Mobile River projects if use of the ODMDS in the Gulf of Mexico continues to be allowed.

Specialty dredges or disposal options exist that could prove useful for placing material from the Project at beneficial use sites. In general, placing dredged material at BU sites requires more precision in both horizontal and vertical dimensions. This means that material placement will not be allowed to disperse beyond strict areal limits and, in many cases, will be required to be placed in thin lifts. Securing use of such equipment under contract would be a major advantage for Mobile District in implementing beneficial use projects.

Changes in Program Funding

Consideration of the unpredictability of Program Funding for the Project is beyond the scope of this report. However, that said, absent serious national economic problems, the Mobile District must continue to justify funding for dredging and disposal operations and for aggressive management programs at the disposal sites for maximizing future capacity of the existing disposal sites.

Availability of Disposal Sites and Management Options

The continued availability of dredged material disposal sites and the successes of disposal site management practices are aspects of project sustainability that are discussed in the remaining sections of this report. A potentially serious challenge to the overall sustainability of the project is changes (e.g., reductions) in total available disposal site capacity due to a variety of circumstances, including policy, regulatory, legal, real estate agreements, funding, environmental, socio-political, etc.

For example, ASPA, as the non-Federal sponsor for maintenance of the MRFNP and the new MHTB, arranges long-term rights of use by the Mobile District to gain access to the sites and to continue placement of dredged materials into these sites. Ownership of some portions of North Blakely Island CDF as well as portions of North Pinto CDF are in the hands of private parties, but ASPA continues to arrange long-term rights of entry for access by the Mobile District. However, as land values in the area of the Federal Project increase and as needs for industrial use of that land become more urgent, there remains the possibility that the lands in the hands of private owners will be diverted from use by the Mobile District with the resultant loss of parts of currently available disposal areas. Equally troubling for the District would be the termination of easements for transits of discharge pipelines carrying dredged slurries to the CDFs across private property adjacent to the CDFs. Appendix D provides detailed discussions regarding the long-term availably of disposal areas operated and managed by the Mobile District. However, after WRDA '86 it became policy to only grant the United States a right-of-entry (ROE) to use the real estate for project purposes. These ROEs typically do not have an

expiration date and remain in effect for the life of the project unless the real estate can no longer be used for dredged material disposal for some reason.

The current easement for a large portion of the North Pinto disposal area expires in 2013. This easement is from the Alabama State Department of Conservation to ASPA. The Alabama Department of Conservation owns the area because it was originally bay bottoms and was filled by the disposal process. It is not anticipated that a renewal of the easement will be a problem, but the District should urge ASPA to pursue renewal before it expires. Likewise, there is no issue about a ROE for use of South Blakeley CDF, but all of the easements for access and pipeline placement have expired but one. ASPA needs to be reminded that providing the Mobile District with ROEs for the pipeline routes and access to all CDFs is an important responsibility on their part.

Potential Changes in Disposal Site Capacities

A series of spreadsheets was developed and several graphs prepared to allow the reader to assess site capacities for many combinations of dredging rates and placement site-use scenarios (See Appendix D). Computations of times to achieve maximum site capacity for both idealized volumetric capacity estimates (see Appendix D) and projected maximum dike height elevations with site management (see Appendix G) were done.

Mobile District expressed specific interest in the potential impacts of three additional scenarios:

1. How will the five upland sites be impacted by loss of the ODMDS for placement of maintenance materials from the new Mobile Harbor Turning Basin?
2. What will be the impact on the remaining four CDFs with the potential loss of North Pinto in 2013?
3. What will be the combined impacts of the potential losses of North Pinto and the ODMDS?

Idealized Analysis

Figures 6 through 8 present the idealized volumetric capacities responding to each of the three questions list above. These graphs assume:

- The dikes at all five CDFs will be raised to their respective projected maximum dike elevations using material from the respective CDF to construct each dike.
- The total idealized volumetric disposal values as developed in Appendix D will be available in each CDF.
- Dredged material volumes are annualized without regard to specific dredging cycles or events.

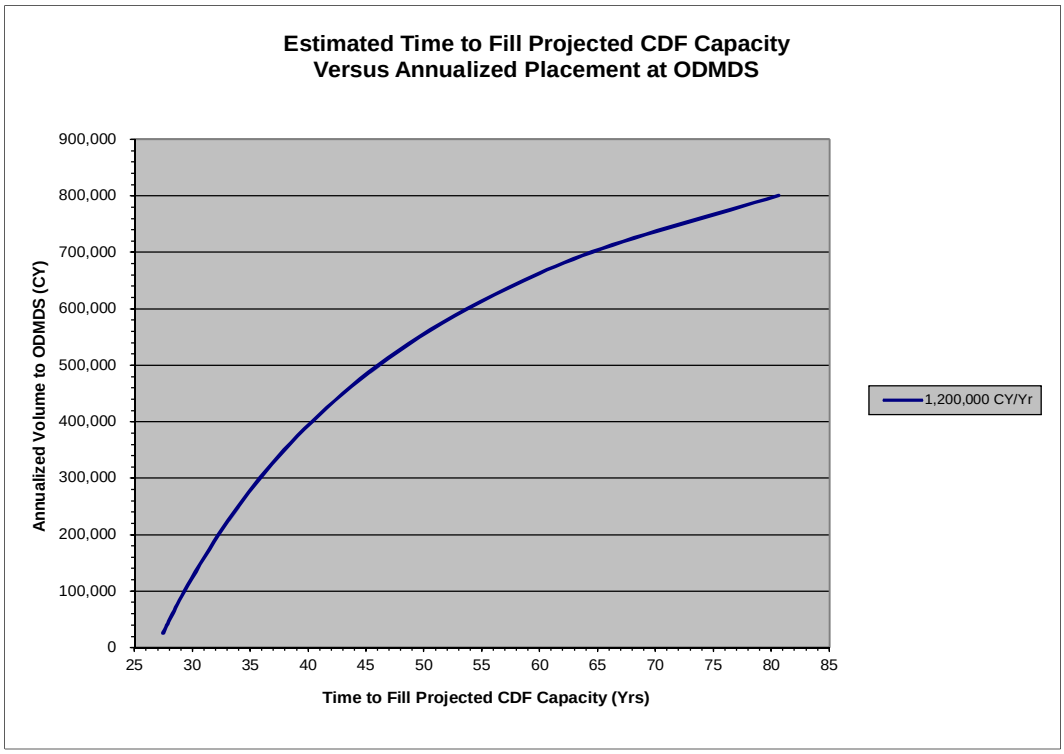


Figure 6. Estimated Time to Fill Idealized Projected CDF Capacity Versus Annualized Placement at ODMDS

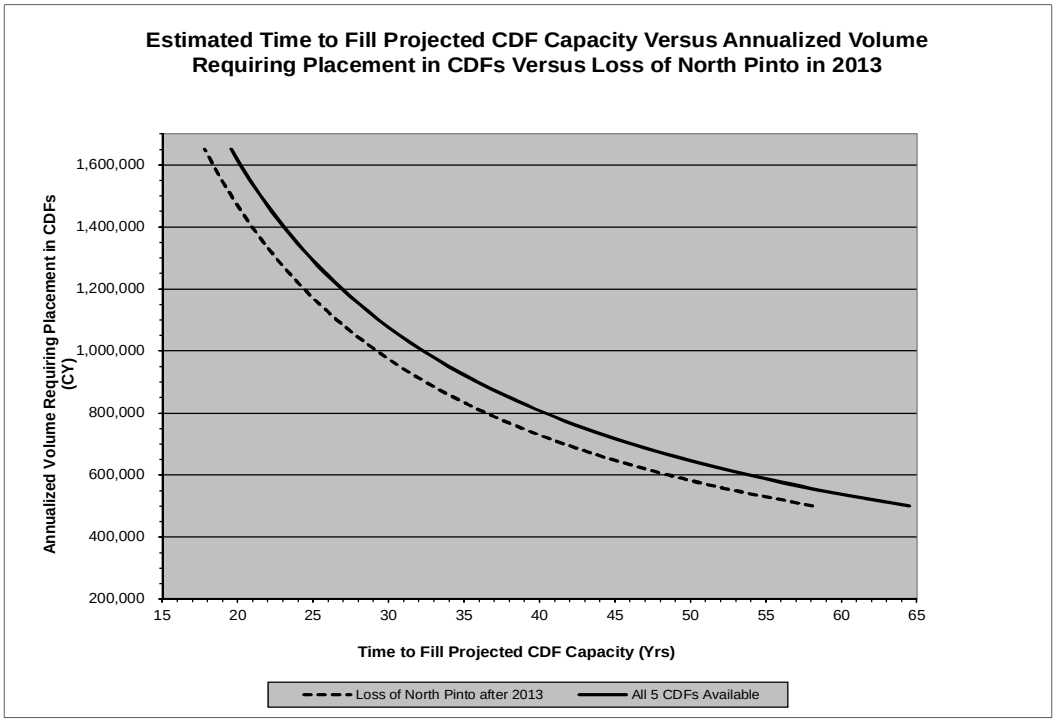


Figure 7. Estimated Time to Fill Idealized Projected CDF Capacity Versus Annualized Volume Requiring Placement in CDFs Versus Loss of North Pinto in 2013

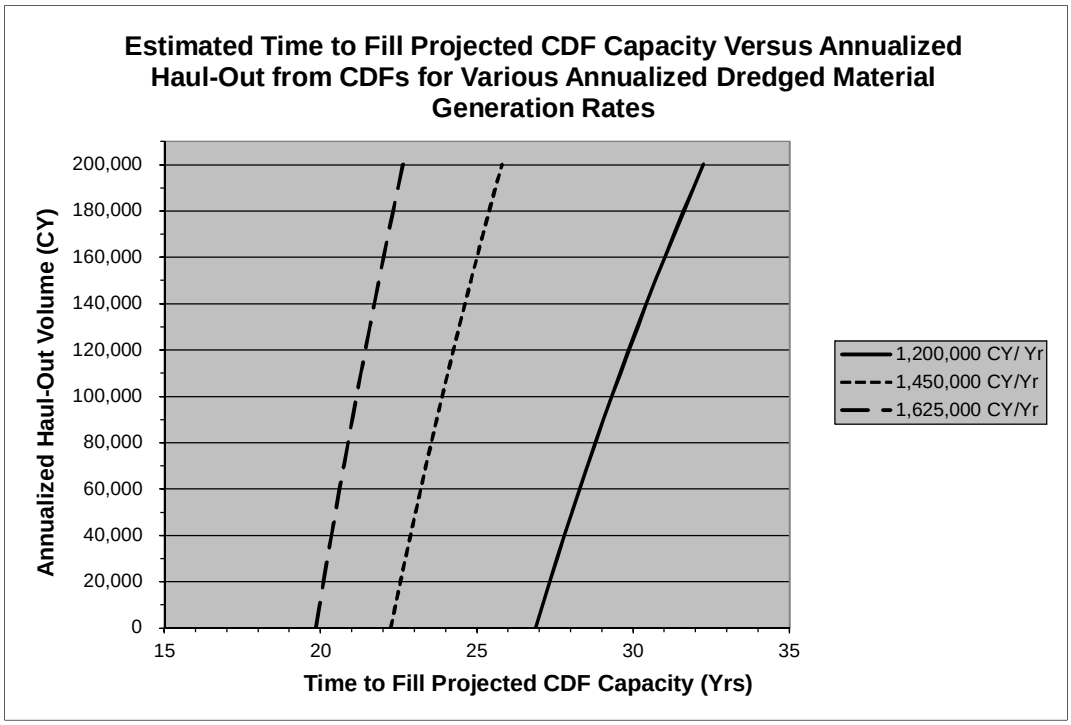


Figure 8. Estimated Time to Fill Idealized Projected CDF Capacity Versus Annualized Haul-Out from CDFs for Various Annualized Dredged Material Generation Rates

- The total acreage for all CDFs is used for each placement. Equal lifts of dredged material are placed in each CDF each placement cycle. The volume placed in each CDF is therefore proportional to the relative surface area in each respective CDF.
- No allowance is made for consolidation due to enhanced management in the CDFs. It is assumed that the lifts are sufficiently thin that the dredged material will consolidate between placement cycles such that the volume occupied in the CDF is equal the original volume in the channel. Lift heights are calculated to verify that each lift is less than three feet, which is considered a maximum to allow consolidation between placement events.

At an annualized placement rate of 1,200,000 CY per year (the average annual shoaling rate for the Project without the new MHTB), the projected idealized life expectancy of the five CDFs is 26.9 years (see Figure 6). It must be remembered that simple volumetric calculations were used to determine the "time to fill". If North Pinto CDF is used for placement through 2013 and then is lost for placement, the idealized life expectancy of the remaining CDFs is 24.4 years (Figure 7). The overall impact is a reduction of 2.5 years of life expectancy. As the annualized placement rate increases, the life expectancy decreases as one would expect. At an annualized placement rate of 1,625,000 CY per year (the total estimated generation rate including the new turning basin), the impact is a reduction of 7.1 years of life expectancy, 19.8 years with North Pinto CDF, versus a reduction of 8.8 years of life expectancy, or 18.1 years without North Pinto CDF (Figure 7). When compared with the 26.9 years "no loss" scenario, all three scenarios

reduce the time to fill from as little as 2.5 years to as much as 8.8 years as can be seen in Table 10.

Table 10. Time to Fill Scenarios (Idealized Volumetric Calculation)

Scenario	Annual Quantity (Cubic Yards, CY)	Time to Fill (Years)	Deviation from No Loss of Disposal Capacity (26.9 Yrs)
1. All CDFs available, new turning basin material placed at ODMDS	1,200,000	26.9	0
2. Potential loss of ODMDS for maintenance dredging of the new turning basin	1,625,000	19.8	-7.1
3. Potential loss of North Pinto CDF beginning in 2013	1,200,000	24.4	-2.5
4. Potential combined losses of North Pinto CDF in 2013 and ODMDS	1,625,000	18.1	-8.8

Haul-Out Under Idealized Conditions

The graph shown in Figure 8 was developed to predict the impact of haul out of dredged material from the CDFs on the idealized useful life of the five CDFs. This graph presents the estimated time to fill the total projected idealized CDF capacity versus annualized haul out from the CDFs for three annualized dredged material generation rates: 1,200,000 CY per year (average annual channel shoaling); 1,625,000 CY per year (average annual channel shoaling plus annual volume in MHTB); and 1,450,000 CY per year (average annual channel shoaling plus reduced annual volume in MHTB). For example, an annualized haul out rate of 50,000 CY will result in increases in the life expectancies of the CDFs of 1.1, 0.7, and 0.8 years, respectively, for the three generation rates. As expected, higher haul-out rates produce even longer life expectancies for the disposal facilities.

Estimates of increase in the life expectancy for the combined CDFs for one-time events also can be calculated for idealized conditions. The graph shown in Figure 9 was developed to predict the impact of a one-time event such as a haul out or diversion of a specific volume of material from the CDFs on their estimated useful life. The graph is based on an annualized placement volume of 1,200,000 CY per year. For example, haul out and placement of 2,000,000 CY into the ASPA Leachate Pond (former ALCOA site) will add 1.7 years to the estimated life of the existing CDFs based on an annualized placement rate of 1,200,000 CY.

Table 11 shows the additional annualized dredged material idealized haul out volume in excess of the volume removed to construct the projected maximum dike required to achieve a 30 year

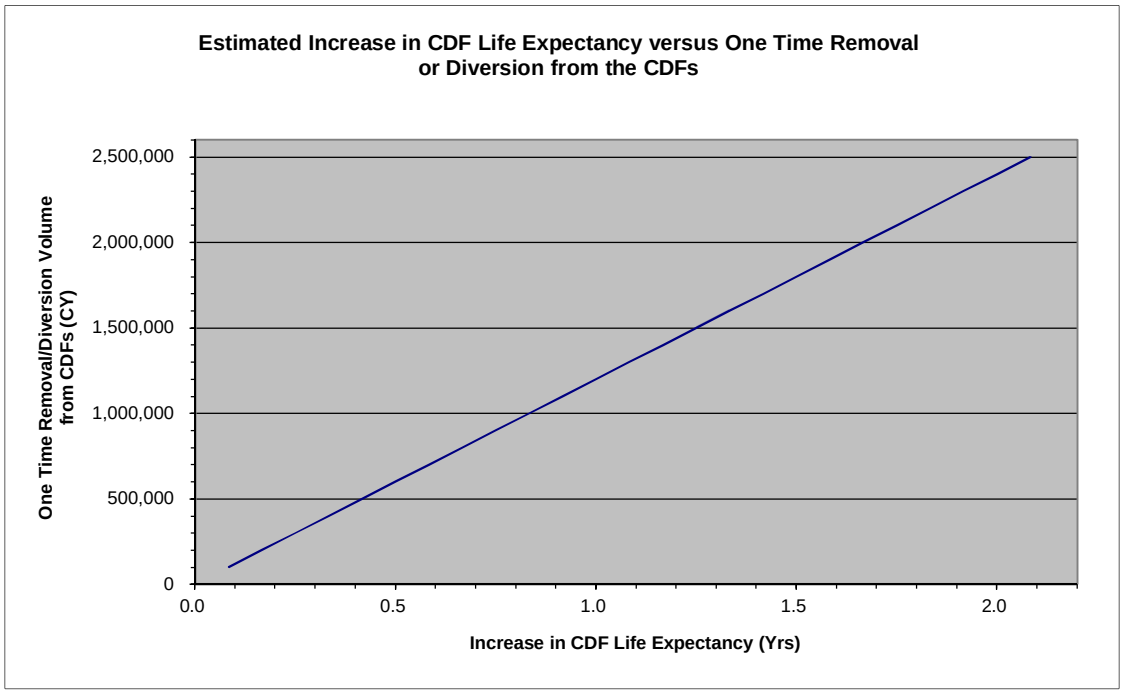


Figure 9. Estimated Increase in CDF Life versus One-Time Removal or Diversion

life expectancy for the CDFs. This scenario includes a management intensity of AD+1 at annualized dredged material placement rate of 1,625,000 CY/YR without an ocean placement cycle. In this example, approximately one (1.0) MCY would need to be hauled out of the combined sites annually to maintain a 30 year life expectancy for the CDFs at the projected maximum dike heights.

Table 11. Annualized Dredged Material Idealized Haul-Out Volume for a 30 Year Life

	Area	Required Dike Height at AD+1*	Projected Maximum Dike Height	Required Reduction	Required Haul Out
	(Acres)	(Ft)	(Ft)	(Ft/YR)	(CY/YR)
Mud Lake 6	70	79	46	1.10	124,113
North Blakeley	69	80	50	0.99	109,950
Mud Lake 7	129	91	46	1.50	312,831
South Blakeley	196	106	65	1.35	428,438
North Pinto	48	71	47	0.79	61,494
				Total	1,036,827

*Note: Required dike height for Mud Lake 7 and South Blakeley are based on Management Intensity AD since AD=1 is not available for these facilities in a two-year alternating cycle.

Since the idealized approach does not factor in the practicality of dredging, site management and how the sites are actually used, a contrasting analysis was conducted and will be discussed in the following section.

Extending Life Expectancies of CDFs Using Best Management Practices

RMG also evaluated additional scenarios for extending the lives of the CDFs to achieve 30 years of capacity by using BMPs (see Appendix G). This analysis reflects a more realistic use of the CDFs with placement of dredged material into the facilities in alternating years and best management practices rules are applied. The assessment methodology used in the analyses is based on calculating the required dike heights to contain each placement of dredged material under a variety of best management practices and placement alternatives, and comparing the required dike height to the projected maximum dike height to determine the filling times or projected life expectancies. Several examples of the most likely or more realistic scenarios in terms of their potential life expectancies in the future are discussed next.

a. Current Best Management Practices. The first series of analyses conducted were for annualized placement of 1,200,000 CY of dredged material per year using all five CDFs. Using the maximum available best management practice level for each CDF, the life expectancies ranged from 18 years for Mud Lake 7 to over 30 years for North Pinto. These results are shown in Table 12. These conditions include no placement of dredged material from the Mobile River Channel at the ODMDS, available BMPs levels "AD" and "AD+1", and use of dredged material from the respective CDF for dike raising and maintenance.

Table 12. All Five CDFs (1.2 MCY/YR)

	Management Level	
CDF	AD	AD+1
Mud Lake 6	18	24
North Blakeley	20	26
Mud Lake 7	18	NA
South Blakeley	22	NA
North Pinto	22	>30

b. Loss of ODMDS for MHTB. The second series of analyses assesses the impact of placing the dredged material from the new MHTB into the CDFs along with the material from the Mobile River Channel for a total annualized placement volume of 1,625,000 CY. Using the maximum available BMPs level for each CDF, the life expectancies ranged from 12 years for Mud Lake 7 to 18 years for North Pinto. These values are significantly less than the previous scenario of 1.2 MCY channel material only. These results are presented in Table 13.

Table 13 Five CDFs (1.625MCY/Yr)
with Loss of ODMDS for MHTB

	Management Level	
CDF	AD	AD+1
Mud Lake 6	12	14
North Blakeley	14	16
Mud Lake 7	12	NA
South Blakeley	14	NA
North Pinto	16	18

c. Loss of North Pinto. Another series of analyses assesses the impact of the loss of North Pinto after 2013. The initial analyses were conducted using an annualized placement volume of 1,200,000 CY. Using the maximum available BMPs level for each CDF, the life expectancies ranged from 16 years for Mud Lake 7 to 22 years for North Blakeley, representing an approximate average loss of 4 years over the scenario where all five CDFs are available over the study period (See Table 14).

Table 14. Loss of North Pinto (1.2 MCY/YR)

	Management Level	
CDF	AD	AD+1
Mud Lake 6	16	20
North Blakeley	18	22
Mud Lake 7	16	NA
South Blakeley	18	NA
North Pinto	3	3

A second analysis was done assessed the impact of the loss of North Pinto using an annualized placement volume of 1,625,000 CY (also assumes loss of ODMDS). Table 15 was prepared for the comparison with the previous results presented in Table 14.

Table 15. Loss of North Pinto (1.625 MCY/YR)

	Management Level	
CDF	AD	AD+1
Mud Lake 6	10	12
North Blakeley	12	14
Mud Lake 7	12	NA
South Blakeley	12	NA
North Pinto	3	3

Again using the maximum available BMPs level for each CDF, the life expectancies using the projected maximum dike height ranged from 12 years for Mud Lake 6, Mud Lake 7, and South Blakely to 14 years for North Blakeley; generally resulting in a 2 year decrease over the scenario where all five CDFs were available using the same filling assumptions.

d. Haul-out of Upper Sumps. The final analyses assess the impact of haul out of an average of 700,000 CY of sediment from one of the sumps in the upper Project Channel every other year (biannually) for placement at the ODMDS or for beneficial uses. These analyses assume a dredging rate of 1.2 MCY/Yr with five CDFs available for the study period. Table 16 was prepared for comparison with the previous results and assumes the maximum available BMPs level for each CDF. These analyses project life expectancies that exceed 30 years for all five CDFs.

Table 16. Sump Haul-Out (700,000 CY/YR)

	Management Level	
CDF ID	AD	AD+1
Mud Lake 6	28	>30
North Blakeley	>30	>30
Mud Lake 7	>30	NA
South Blakeley	>30	NA
North Pinto	>30	>30

e. Haul-out of Upper Sumps with Loss of North Pinto. The final example analysis assesses the impact of the loss of North Pinto after 2013 with the previously presented sump haul-out conditions (700,000 CY biannually). Table 17 presents the project life expectancy using the PMDH and the maximum available BMPs level for each CDF. The life expectancies ranged from 26 years for Mud Lake 7 to over 30 years for the remaining CDFs.

Table 17. Sump Haul-Out (700,000 CY/YR)
with Loss of North Pinto

	Management Level	
CDF ID	AD	AD+1
Mud Lake 6	26	>30
North Blakeley	28	>30
Mud Lake 7	26	NA
South Blakeley	>30	NA
North Pinto	3	3

The projected times to capacity of the CDFs are significantly reduced without use of the ODMDS for the new MHTB and upper sumps, and/or by the loss of North Pinto CDF. The BMPs estimated times-to-fill capacities of the five CDFs are significantly less than their idealized projected lives as expected due to the differences detailed earlier in this report. This

assessment demonstrates the dependency of life expectancies of the CDFs on the continued use of ocean disposal or some type of dredged material haul-out, beneficial use option to regain capacity in the upland sites.

Haul-Out Examples for Potential Beneficial Uses

Removal of dewatered and consolidated dredged material from a CDF to an offsite location for beneficial use has high potential for future disposal opportunities. One of the more challenging phases of the management process is finding suitable sites to place haul-out material from each of the five upland CDFs. The option of hauling out interior spur dike material from the sites has been around for several years but only used on a very small scale. In the past, three issues surrounding haul-out have slowed any significant progress out of its use; an efficient haul-out methodology, limited funding, and adequate sites to receive the haul-out material. Recently, the method of haul-out has improved considerably through trial and error and with the use of different types and sizes of loading and hauling equipment. Potential haul-out opportunities shown in Table 18 are also discussed in detail in Appendix F. The practices of haul-out for

Table 18. Haul-Out Options for Potential Beneficial Uses

Site Option	Owner	Potential Capacity, CY	Agreement	Availability
Upper ASPA (ALCOA) Leachate Ditch	ASPA	450,000 to 550,000	1996 Written Agreement between ASPA and District	Not Currently Offered by ASPA
ASPA (ALCOA) Leachate Ponds	ASPA	2,000,000	None. ASPA and MAWSS are discussing a potential agreement to allow USACE to fill pond with dredged material.	Not Currently Offered by ASPA
Lower ASPA (ALCOA) Leachate Ditch (Grand Canyon)	ASPA	Unknown (700,000 to 1,500,000 in 1996)	None.	Not Currently Offered by ASPA
South Blakeley East Side Dike Stabilization	ASPA	450,000 to 550,000	Management by ISO for exclusive use by USACE	Yes

beneficial use of dredged material from the upland CDFs are highly recommended to extend the life of the upland CDFs. However, implementation of promising haul-out projects identified as part of this study will require considerable coordination with the project sponsor and project stakeholders (see Appendix E). The Mobile District should approach the ASPA to secure use of their site options to receive haul-out material. The topic of project coordination is also

addressed in the next section of this report. Coupled with continued best management practices in the upland sites, haul-out should pay significant dividends in terms of renewed capacity in the CDFs and identification of future opportunities for beneficial uses.

Non PGL-47 Cost Sharing Options

The Alabama State Port Authority (ASPA), as the non-Federal sponsor, would become involved in a PGL-47 cost sharing process regarding the Mobile River Federal Navigation Project if anticipated or unforeseen events rendered existing disposal facilities insufficient for disposal requirements of the Project. In such a case, the Mobile District would be compelled to re-assess overall project dredged material disposal requirements taking into account presently available disposal options and future requirements and determine minimum additional upland disposal site capacity necessary to replace the acreage lost or additional acreage needed. The Mobile District would need the ASPA to furnish the additional acreage and operational CDF within a reasonable timeframe at the expense of ASPA. Keeping this scenario in mind, the ASPA could elect to provide the additional storage capacity by furnishing a new site(s) or expanding existing Mobile District's CDFs. In either case, the ASPA would be required to participate in a PGL-47 cost sharing process to provide the necessary new site improvements such as retaining structures (dikes) and water control features (weirs).

A potential alternative for consideration might be joint-use of the two ASPA (formerly ALCOA) mud lake sites. The combined surface area of these sites is approximately 200 acres and has been used for several years to contain ASPA and private user dredged material. These two sites appear to have been used in such a way that attempts to maintain or restore capacity have met with limited success. It may be possible for the Mobile District to approach the ASPA seeking an agreement for shared use of these sites. The proposed agreement would allow the Mobile District to perform standard site management practices in return for a defined volumetric use of the existing CDFs for placement of dredged material from Mobile River on a periodic basis. Even though portions of PGL-47 may be applicable with such an agreement, the cost-sharing portion assigned to ASPA could be minimized through elimination of ASPA costs for site management. If determined to be feasible, acquisition of capacity in the two mud lake sites totaling 200 acres (or 322,600 CY per ft of space) could be a potential replacement for the North Pinto site containing approximately 75 acres (120,975 CY per foot) if lost to commercial development.

Multiple Management Options

Option 1: Continue the highly successful management currently used at confined disposal sites

Site management techniques currently used at the five CDFs have been exceptionally successful in sustaining disposal capacity at these sites. The previous discussions and analyses presented support this conclusion. Without the intensive management of the maintenance materials placed in the sites, long-term use of the sites would surely be compromised. Loss of North Pinto CDF or any other CDF would require continued use of intensive site management to condition sites for the next dredging cycle as well as for any material haul out that could be arranged.

Option 2: Use hopper dredges with direct pump-out capability

Hopper dredges that can place dredged materials at upland disposal sites as well as ODMDS placement sites can increase dredging and disposal efficiencies by providing an option to be exercised if one of the historical disposal locations is temporally unavailable. For example, under a 2002 rental hopper dredge subcontract, the small hopper dredge Columbia was able to average 5.25 loads per day pumping out through a 24-inch discharge line directly into South Blakeley CDF. Estimating that the hopper dredge Glen Edwards could also average 5.25 loads per day with 5,938 cubic yards per load, the average daily production would possibly be 31,000 to 32,000 cubic yards. This scenario could possibly provide a more timely restoration of project depth than usually seen from a standard cutterhead dredging event.

Option 3: Establish a structured disposal schedule that uses ODMDS and confined upland disposal

A structured disposal-use schedule for dredged materials from maintenance dredging that includes placement at the ODMDS and takes into account the times required for management activities at upland sites will likely assure greater capacity over a longer time for upland CDFs. For example, the option of using ocean disposal for Project maintenance dredging began in 1996. Since then, use of the ODMDS has been discretionary and has been credited with providing much needed extended upland disposal site management periods. A more structured approach that could possibly improve efficiency is examining various combinations of upland site use placement cycles whereby all upland sites would be used according to a set schedule in combination with the ODMDS. The various upland CDFs-ODMDS combinations could be a useful tool in managing the upland CDFs along with providing support for planning out-year budgets.

Summary

There are numerous operational scenarios in addition to the ones presented that can be conceived and evaluated with respect to their impact on the life expectancies of the upland CDFs. The assessments conducted for this study illustrate the importance of providing the maximum possible time for dredged material management and maximum possible diversion or haul out of dredged material from the CDFs on minimizing required dike heights and extending the life expectancy of the CDFs. Placing emphasis on dredged material management and finding even periodic alternate beneficial uses of dredged material can be very effective in extending the life of the existing CDFs and reducing the near-term requirement for building new CDFs.

Coordination with State, Local, and Federal Stakeholders

Alabama State Port Authority (ASPA)

The RMG Team and a representative of Mobile District Operations Division met with representatives of the ASPA at the State Docks Office in Mobile, Alabama on February 4, 2010. A copy of the memorandum for record of the meeting with ASPA is located in a folder in Appendix H/Meetings_Notes/ASPA. The purpose of the meeting was to coordinate specific plans for study and to solicit information from ASPA as part of their role as the Federal project sponsor for maintaining the Project. Specifically, RMG explained the scope of their effort and discussed the following items:

- Lease agreements, rights of way, easements
    - Agreement with USACE for use of North Pinto CDF expiring in 2013
    - Austel USA wants to swap land for corner easement at North Pinto CDF
- Existing ASPA disposal areas (D/A)
    - ALCOA site – being managed and currently removing about same amount of material as placed each year.
    - Small site at South Pinto
    - Site at Theodore
    - McDuffie Coal Terminal – the Port's biggest concern. Stated that it couldn't raise McDuffie disposal area due to foundation conditions.
    - Haul-out of material from the Choctaw Mobile Container Terminal to a landfill
- Property for future placement
    - None planned, but ASPA had worked a land swap with a landowner for the Sand Island Fire Test Facility across from the McDuffie Coal Terminal docks that they might use as a CDF.
- Private Dredging Quantities
    - Initially, State Docks agreed to help identify private dredging, amounts and where the material is placed.
- Plans for ALCOA leachate ponds with Mobile Area Water and Sewer System (MAWSS)
    - RMG was directed to contact Les Brown and Malcolm Steeves of MAWSS for the plans and stated that MAWSS took borings but there was no follow up

contact. The concept was to trade the leachate ponds for the Williams Coal Plant site At McDuffie Island.

- Beneficial Uses
  - ASPA mentioned the potential for a Brookley beneficial use project and stated that they were considering use of Galliard Island but did not know if the material would be suitable (no testing available).
  - Haul-out of material for beneficial use to fill along the previously filled upper ALCOA ditche adjacent to Mud Lakes 6 and 7.
  - Plans for the "Grand Canyon". State Docks said that Bender, Inc. owned the land in the west end and that the ASPA was annually placing material over the side of the dikes along their portion of the canyon. This practice would continue.

The meeting ended with RMG stating that they would develop a list of follow up questions for the ASPA, which was sent by RMG on February 18, 2010. A copy of the questions and ASPA's responses (received on April 20, 2010) are contained in a folder in Appendix H/ASPA/Data Calls. Key responses from the ASPA included the annual dredging quantity, frequency and disposal site (Table 19) for each dredging project, a map showing the locations of their disposal areas,

Table 19. ASPA Dredging and Disposal Requirements

DREDGING EVENT			
NAME	DISPOSAL SITE	FREQUENCY	QUANTITY Per YR
Main Docks Maintenance Dredging	Mud Lakes	Annually	150,000 CY
McDuffie Docks Dredging	McDuffie	Semi Annually	250,000 CY
Mobile Middle Bay Port	Gaillard	10 to 15 years	250,000
Choctaw Point Dock	ICTF and others	BiAnnually	100,000
Pinto Terminal Dock Dredging (New)	Pinto Terminal	BiAnnually	100,000

and the estimated cost to haul out and dispose of dredged material in a licensed landfill ($15-$20/CY). The breakdown for each activity by percentage of the total cost is shown in Table 20.

Unfortunately, the ASPA could not furnish any additional information about the dredging requirements or dredged material disposal plans for the Private companies using the Federal Project. When asked about additional uses of material from Mud Lakes 6 & 7 by haul-out for beneficial use as fill along the previously filled adjacent upper ALCOA ditche, ASPA said they

Table 20. Activity Cost Breakdown as a Percentage of Total Cost

Activity	Percentage of Total Cost
Mob/Demob and Related Start Up	13
Construction and Site Set Up	11
Load Out	25
Hauling Material	32
Tipping/Disposal Fee	19

were not willing to pursue this option as this time; however, they were willing to test the material in McDuffie to determine suitability for beneficial uses somewhere in Mobile Bay. On May 18, 2010, RMG sent a follow up request for clarification of some of the responses to the dredging questions. As of the time this draft report was being written, ASPA had not sent a reply (Appendix H/ASPA/Data Calls).

Mobile Area Water and Sewer System

The RMG Team met with representatives of MAWSS and the Regional Waste Water District (RWWD) at the City of Mobile Wastewater Treatment Plant (WWTP) Office on March 2, 2010. A copy of the memorandum for record of the meeting with MAWSS is located in a folder in Appendix H/Meetings_Notes/MAWSS. The purpose of the meeting was to discuss MAWSS's plans for the construction of a regional waste water treatment plant (WWTP) at a site formerly owned by ALCOA, currently owned by the State of Alabama, and operated as leachate holding and treatment ponds by ASPA. To assess the suitability of the ALCOA site for construction of the new regional WWTP, soil borings and samples were taken and analyzed for both physical and chemical characteristics. A copy of the geotechnical report subsequently was furnished to RMG. Currently, MAWSS has evaluated no methods for filling the ponds with dredged material. However, they are eager to proceed with an agreement to have the USACE and ASPA pursue this option since the proposed ALCOA site is ideal for the new regional wastewater treatment plant in that it is located in an existing industrial zone with no residential neighbors. In anticipation of the meeting with RMG, MAWSS's survey firm, McCrory-Williams, made a preliminary calculation of the volume of material that would be needed to fill the leachate ponds. They determined that volume to be about 2 MCY; MAWSS instructed McCrory-Williams to furnish the backup calculations to RMG.

MAWSS alluded to a series of discussions with ASPA and plans that were made over the past decade. MAWSS is anxious to move forward with the regional plan and wishes both the ASPA and the Corps will begin filling the ALCOA leachate ponds with dredged material. MAWSS recognizes that agreements will be needed to move this project forward. According to MAWSS, the agreement(s) will need to contain four basic provisions:

1. The USACE will need to agree to provide the volumes of dewatered, dredged material over the next 5 to 10 years to fill the leachate ponds.

2. The ASPA must ensure that the appropriate real estate agreement is in place for the filling of the leachate ponds.

3. MAWSS will treat the leachate water during and after filling of the site and during and after construction of the new WWTP.

4. MAWSS will swap the land at the Williams WWTP (about 28 acres with the provision that 1-2 acres be retained for a large transfer pumping station) for title to the leachate ponds at the ALCOA site for construction of the new Regional WWTP. The agreement to swap the Williams WWTP site for the Blakely Island site could be made at any time, but the actual transfer of the Williams WWTP site could not take place until a regional WWTP was constructed and operating on the new site and the influent from the Williams Plant was being pumped to the new plant for treatment. At such a time, the Williams Plant could be abandoned and the property transferred to the ASPA.

The meeting seemed to be extremely insightful and encouraging in that MAWSS was very willing to share information and data concerning plans for the new regional waste water treatment plant. The beneficial use of dredged material from the USACE-managed CDFs as construction fill in the ASPA's leachate ponds has potentially considerable merit, especially, when considering a need to extend the useful life of the existing CDFs.

Follow-Up Contacts with ASPA/MAWSS

A representative of RMG contacted ASPA and MAWSS on March 19, 2010 and April 12, 2010, respectively, regarding the concept of filling the ALCOA Leachate Ponds with dredged material. The purpose of both contacts was to clarify various items and issues discussed at meetings held on February 4, 2010 and March 2, 2010 with each agency. A summary of the discussions with each contact is contained in Appendix_ H/Meetings_Notes/MAWSS. Essentially, ASPA expressed concerns over the leachate treatment matter and considered this issue to be at a stalemate between senior staffs at MAWSS and ASPA. It should be noted that MAWSS insists that it is both capable and prepared to take over treatment of the leachate at any time. A law firm has been retained to prepare an agreement that would eventually bring the ASPA and MAWSS together on the proposed project.

As stated earlier, the Regional Waste Water District's proposal presented by MAWSS to use material from the USACE-managed placement site(s) as construction fill in the ASPA's leachate treatment ponds has considerable merit. However, based on the current status of the leachate treatment issue, the Mobile District may wish to pay close attention to the discussions between ASPA and MAWSS, especially regarding a role that the Mobile District may play as a catalyst to move this project forward.

Federal and State Resource Agencies Meeting

The success of finding affordable and environmentally acceptable long-term placement sites that use dredged material from the Project in a beneficial way relies heavily on the interdisciplinary approach to identifying compatible uses of dredged materials and sites. An interdisciplinary approach is very important in identifying that a beneficial use is technically feasible, economically acceptable, environmentally sustainable, and agreeable to stakeholders. If any of these considerations is overlooked a proposed beneficial use concept cannot move forward.

A meeting to discuss potential BUs for dredged material from the Mobile River and new MHTB was held at the State of Alabama's Five Rivers Center Conference room on August 31, 2010 at the request of Mobile District and RMG. Notes from the meeting can be found in Appendix H-Meetings_Notes/Meeting with Resource Agencies. A number of Agencies were represented, including the Alabama Department of Environmental Management (ADEM), Alabama Department of Conservation and Natural Resources (ADCNR), NOAA National Marine Fisheries Service (NMFS), Mobile Bay National Estuary Program (NEP), USACE Mobile District Operations and Planning, Irvington Site Office (ISO), and Resource Management Group (RMG).

Three sources of dredged material (upper sumps, five upland confined disposal facilities [CDFs], and shoals in the river channel) and their physical characteristics (ranging from coarse grained sands in sumps, to mixtures of sands/silts/clays in the CDFs, to fine-grained silts and clays in the river shoals) were identified as potential types for beneficial use. The following items were used to begin the group's discussion of potential BU concepts:

- Locations for restoration or extension of existing wetlands; Agencies' preferences;
- Creation of new wetland areas such as the three cells south of Arlington channel and west of the shipping channel;
- Restoring historical open water placement areas adjacent to the channel to serve as nourishment for coastal erosion of shorelines, and;
- Use of placement sites to stockpile material for thin-layer placement over marshes.

Subsequent to the meeting, RMG prepared meeting notes to capture the major points made by various agency representatives. Each participant was asked to discuss his/her ideas about beneficial uses, including advantages and disadvantages, to state their agencies preferences, if possible, and to offer additional comments and concepts after the meeting if they wished. Each person had at least two separate opportunities to speak and comment on others' discussion points at anytime.

Afterwards, the BU concepts that were discussed in relative detail at the meeting were ranked as follows:

1. Little Sand Island Expansion of Wetland off south end of the Island
2. Trapezoidal wetland concept somewhere in bay

3. Goat Island expansion off north end of the Island

4. Deep hole filling for SAVs off Brookley

5. Wetlands south of I-10 and Hwy 90 Causeway

6. Shoreline stabilization with wetlands

7. Unconfined open water thin layer

8. Oyster habitat enhancement

The above list of prioritized concepts was conceived and prepared as part of the meeting by the representatives of Mobile District and the other Federal and State agencies. The sources of dredged material to construct potential BU projects were identified in the Project and were described in terms of their locations, quantities, and material physical and chemical characteristics. The District, the project sponsor, and other stakeholders can use this information to develop a plan to design beneficial use projects that will be shovel ready in anticipation of future funding opportunities. Projects that are ready for construction most often receive funding from a variety of sources, especially when cost sharing funds become available.

RMG envisions several steps that the District can take in order to be prepared to develop further the highest priority BU concept(s). These include:

- Identify a District BU Project Manager (PM) to coordinate and develop a path forward for implementing BU projects. The PM would be responsible for seeking funding, preparing schedules, cost estimates, agency coordination, and other PM-type duties.

- Continue to identify potential BU concepts and re-prioritize the current list of projects as needed.

- Develop a concept design for the top one or two priority projects.

- Implement the meeting recommendation to form a Beneficial Uses Group (BUG) for the Mobile River and Bay projects.

- Use a beneficial uses group (BUG) to assist with developing the implementation requirements for the priority concept(s). This process can serve to satisfy intensive agency coordination that will be needed to obtain approvals for a BU project.

- Identify opportunities to promote long-term beneficial use of dredged material from the Mobile Harbor Federal Navigation Project with the public and private sectors.

- Pursue the Regional Waste Water District's proposal presented by MAWSS to use material from the USACE-managed placement site(s) as construction fill in the ASPA's leachate treatment ponds. However, based on the current status of the leachate treatment issue, the District may wish to pay close attention to the discussions between

ASPA and MAWSS, especially regarding a role that the Mobile District may play as a catalyst to move this project forward.

Successful development and implementation of long-term BU of dredged material will require the support from all levels of management within the Mobile District, the Alabama State Port Authority, and users of the Federal Project and Mobile Harbor. The importance of finding long-term solutions for the management of dredged material is of mutual interest to all project stakeholders. Beneficial use of dredged material is supported through proven concepts and demonstrated technologies, which are currently being used in Mobile District and other USACE Districts throughout Coastal America. This knowledge must be used and transferred to the priority projects under present and future consideration. Another vital part of the process of promoting BU will be to involve the public in the form of an outreach effort.

Guidelines for Sustainable Maintenance Dredging

Successful development and implementation of sustainable maintenance dredging and long-term management dredged material placement operations for the Mobile River Federal Navigation Project will require the support from all levels of management within the Mobile District, the Alabama State Port Authority (ASPA), and users of the Federal Project and Mobile Harbor. The guidelines and evaluations described in this report were developed for a period up to thirty (30) years. The guidelines are grouped under several major categories as follows.

Contracts

Mobile District has successfully used four types of contracts to execute its maintenance dredging projects – rental, unit price, lump sum and indefinite delivery/indefinite quantity. Although the historical data do not reveal the reason(s) for the dredging practices in the Mobile River channel, the data collected during this study allowed reporting of some contracting characteristics and the arrangement in which they occurred. Many of the specific volumes dredged under a specific contract, while interesting from a purely historical perspective, are not as helpful as volumes that can be used to identify trends or long-term averages. Trends and averages, particularly if established over a timeframe of the order of the historical database -- some 48.4 years -- are extremely useful for future projections.

Dredging, Dredging Needs, and Dredging Costs

Mobile District has systematically used three principal types of dredges in the Project – Cutterhead, Hopper, and Bucket. There has been very limited use of Specialty dredges. On at least one occasion, a hopper dredge was used for pump-out directly to a CDF (South Blakeley). Hopper dredges that can place dredged materials at upland disposal sites as well as ODMDS placement sites can increase dredging and disposal efficiencies by providing an option to be exercised if one of the historical disposal locations is temporally unavailable.

Average annual dredging requirements are unlikely to change dramatically in the foreseeable future. RMG prepared Table 21 to present a comparison of the annual dredging needs projected over a 20-30 year time period. Based on a five-year rolling statistical average, annual dredging volumes could range from 773,500 CY to 1.8 MCY. The RMG Team determined and

confirmed the average annual shoaling rate for maintenance materials in the MRFNP to be 1.2 MCY, a value that is in agreement with Mobile District's rule of thumb usage.

Table 21. Comparison of Dredging Needs (20-30 year projections)

	Average Projections (Historical Base)	5-Year Rolling Average - Increase	5-Year Rolling Average - Decrease
Average annualized shoaling volume in Mobile River channel	1.2 MCY	1.8 MCY	773,500 CY
Average annualized maintenance dredging of MHTB	425,000 CY	637,500 CY	274,000 CY
Contract award cycle for channel maintenance dredging	424 days or 14 months	424 days or 14 months	424 days or 14 months
Contract dredged volume in channel.	1.4 MCY	2.1 MCY	902,000 CY
The MHTB contract maintenance volume.	495,000 CY	745,000 CY	320,000 CY

Over the past decade or more, pipeline dredging has accounted for roughly 68% of all maintenance dredging work. The costs of pipeline dredging with upland site disposal and disposal site management averages $5.82 per cubic yard versus bucket dredging with ocean disposal averaging $6.24 per cubic yard versus hopper dredging with ocean disposal costs averaging $8.28 per cubic yard.

Management Practices

Since 1998, the Mobile District has used a very aggressive management approach to promote and extend the useful life of their CDFs. The degree of management in each site is directly linked to the dredging cycle, time between filling operations, and available funding. The Mobile River dredging frequency depends on shoaling rates, funding, storms, etc., and, not all sections of the river are dredged annually. Never-the-less, the District has tried to maintain at least two years between filling operations to allow sufficient time to manage and prepare each CDF to receive the next allocation of dredged material. Site management techniques or best management practices currently used at the five CDFs have been exceptionally successful in sustaining disposal capacity at these sites and should be continued.

Idealized CDF Life Expectancies

The total idealized volumetric capacity of the five upland CDFs is approximately 32.2 MCY. The idealized approach described in this report does not consider the practice of aggressive site management used by the Mobile District. Also, it assumes disposal takes place at each of the disposal areas annually and simultaneously and that both large and small sites respond identically. Therefore the idealized approach becomes a volumetric calculation of maximum

CDF capacity and tends to overestimate the actual field capacity. Never-the-less, the calculation provides useful insight as to how much material may be potentially stored at the upland sites over time.

For example, the total idealized volumetric capacity of the five upland CDFs is approximately 32.2 MCY. At an annualized placement rate of 1.2 MCY per year (the average annual shoaling rate for the Project without the new turning basin), the idealized estimated life of the five upland CDFs is 26.9 years ("no loss" of capacity scenario). If North Pinto CDF is used for placement through 2013 and then is lost for placement, the idealized estimated total life of the remaining CDFs is 24.4 years. As the annualized placement rate increases, the reduction in estimated life decreases as one would expect. At an annualized placement rate of 1.625 MCY per year into the CDFs (annualized shoaling rate plus MHTB maintenance volume), their idealized life is 19.8 years with North Pinto CDF available and 18.1 years with loss of North Pinto. When compared with the 26.9 years "no loss" scenario, the three scenarios presented here reduced times to fill the CDFs by as little as 2.5 years to as much as 8.8 years. The importance of maintaining upland sites and use of the ODMDS as disposal options becomes obvious even in this idealized analysis.

CDF Life Expectancies Using Best Management Practices

A number of *best management practices* (BMPs) scenarios were analyzed to determine a more realistic life expectancy of the upland CDFs. This analysis reflects the more practical use of the disposal sites using current disposal area management practices that assumes placement of all maintenance material in one half the total site acreage one year and alternating to the remaining half the next year. The response of each CDF, both large and small, to site management was considered in calculating the time to reach capacity. In this case, some CDFs filled faster than others.

With an annualized placement of 1,200,000 CY of dredged material per year and using the maximum available *best management practices* level for each CDF, the life expectancies ranged from 18 years for Mud Lake 7 CDF to over 30 years for North Pinto CDF. Similarly, the impact of removing an average of 700,000 CY of sediment from one of the sumps in the upper river channel every other year (biannually) for placement at the ODMDS or for beneficial use, and placing the remaining volume of maintenance material in the CDFs using best management practices resulted in life expectancies that exceed 30 years for all five existing CDFs. Similar analyses were conducted to determine the impact of the loss of North Pinto after 2013 with sump haul-out and the life expectancies ranged from 26 years for Mud Lake 7 to over 30 years for the remaining CDFs.

These analyses demonstrate that the average lives of the upland CDFs are significantly reduced by the loss of the ODMDS for placement of the new turning basin and upper sumps maintenance materials, and/or by the loss of North Pinto CDF. The times to projected maximum capacity projected using BMPs are believed to be much more realistic than the life expectancies calculated using idealized conditions. However, each approach demonstrates dependency of adequate long-term site capacity on the continued use of ocean disposal or some type of haul-out beneficial use of the dredged material.

Although, use of the ODMDS has been discretionary, it has been credited with providing much needed time for extended upland site management. Perhaps, a more structured approach that could possibly improve project efficiency would be to examine various combinations of upland site use placement cycles whereby all upland sites would be used according to a prescribed schedule in combination with the ODMDS. The choice of upland CDFs and ODMDS combinations could be a useful tool in managing the upland CDFs along with providing support for planning out-year budgets.

Numerous operational scenarios were conceived and evaluated with respect to their impact on the life expectancies of the upland CDFs. The assessments conducted for this study illustrate the importance of providing the maximum possible time for dredged material management and maximum possible diversion or haul out of dredged material from the CDFs for minimizing required dike heights and extending the life expectancy of the CDFs. Placing emphasis on dredged material management and finding even periodic alternate beneficial uses of dredged material can be very effective in extending the life of the existing CDFs and reducing the near - term requirement for building new CDFs.

Beneficial Use (BU) Opportunities

Historically, dredged material from the Project has been used for a variety of beneficial uses – the most recognized being habitat restoration and replacement, construction of bird islands, shallow-water feeder berms for shoreline replacement and barrier island restoration. Although not generally acknowledged by the Mobile District and Resource Agencies as a beneficial use, sediment dredged from the Project has been the primary construction material for dikes, roadways and fills at all of the upland CDFs.

During the course of this study, significant effort was expended to locate reports, papers, and project file documents in an attempt to define both physical and engineering properties of Mobile River sediments and dredged material placed into upland sites and used beneficially over the years. There was no single repository for this type of information, and, as such, the search uncovered only a few published and unpublished file documents, which are summarized in Appendix E of this report. More systematic documentation of the beneficial uses in the Project should prove highly useful when assessing the future benefits of such actions.

A list of prioritized concepts was conceived and prepared as part of the coordination meeting on beneficial uses by the representatives of Mobile District and the other Federal and State agencies. The sources of dredged material to construct potential BU projects were identified in the Project and were described in terms of their locations, quantities, and material physical and chemical characteristics.

Recommendations

The following recommendations were prepared to assist Mobile District with identifying and prioritizing future long-term actions and to aid with decision making for the Project.

- Continue to use the proven best management practices currently in use in the Project. These practices include both the types and combinations of dredge types and CDF site management together with placement of dredged material at the ODMDS.

- Aggressively pursue opportunities for beneficial use of pre- and post-managed dredged material. Establish a beneficial uses group (BUG) to assist with developing the implementation requirements for the priority concept(s). This process can serve to satisfy intensive agency coordination that will be needed to obtain approvals for BU projects. The Mobile District, the project sponsor, and other stakeholders can use this process to develop plans for designs of beneficial use projects that will be shovel ready in anticipation of future funding opportunities.

- Beneficial use of dredged material is supported through proven concepts and demonstrated technologies, which are currently being used in Mobile District and other USACE Districts throughout Coastal America. This knowledge must be used and transferred to the priority projects under present and future consideration.

- Absent serious national economic problems, the Mobile District must continue to justify funding for dredging and disposal operations and for aggressive management programs at the disposal sites for maximizing future capacity of the existing disposal sites.

- Perform appropriate geotechnical and other analyses at existing CDF sites prior to designing and installing future improvements and assessments or dike raisings.

- Maintain the historical project database by continuing to convert hard copy files to electronic files that can be accessed, sorted, and reported out based on inquires. Currently, much of the existing historical project file data have been entered into both Excel Workbooks and an Access databases. Also, establish a system to electronically archive photographs, maps, surveys, site management activities, etc. Prepare protocols for maintaining these types of files.

- Formalize Real Estate instruments such as rights of entry (ROE), pipeline easements, property ownership, etc., and other site issues for existing dredged material disposal sites with the Federal Project Sponsor (ASPA). Mobile District needs to remind ASPA that providing ROE for the pipeline routes and access to all CDFs is an important responsibility on their part.

- Pursue opportunities for use of privately-owned lands for short- and long-term placement sites. The Mobile District should approach the ASPA to secure use of their site options to receive haul-out material. Coupled with continued best management practices in the upland sites, haul-out of dredged material will pay significant dividends in terms of renewed capacity in the CDFs and identification of future opportunities for beneficial uses.

- Pursue identification of private, non-governmental project users to establish their dredging and placement site needs in the future.

- Reach out to Project neighbors and concerned local citizens groups to gain continued support of the navigation dredging and dredged material management activities. Consider neighborhood improvement activities in tandem with CDF site management.