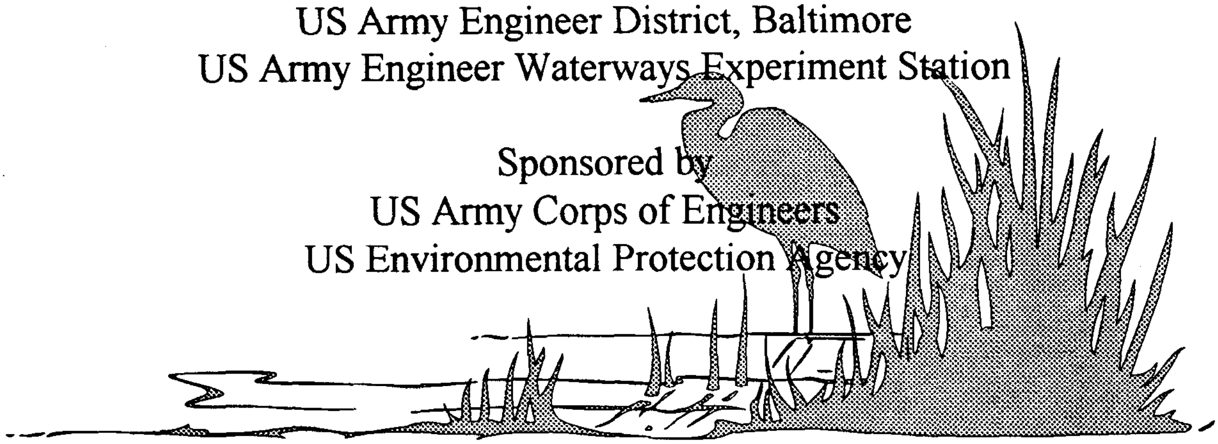
PROCEEDINGS:

INTERNATIONAL WORKSHOP ON DREDGED MATERIAL BENEFICIAL USES

Mary C. Landin, PhD, Editor

Hosted by
US Army Engineer District, Baltimore
US Army Engineer Waterways Experiment Station

Sponsored by
US Army Corps of Engineers
US Environmental Protection Agency



Omni Inner Harbor Hotel
Baltimore, Maryland USA
July 28 - August 1, 1997

IN MEMORY OF
WILLIAM R. MURDEN
1922-1997

This workshop and proceedings is dedicated to the memory of William R. Murden, who for many years was the undisputed mentor and leader of the US Army Corps of Engineers' dredging program. Bill passed away on March 15, 1997. He is survived by his beloved wife Dorothy (Dottie) Gibson Murden, his friend and partner for nearly 50 years.

Bill Murden was elected to the National Academy of Engineering in 1979, elected a Fellow of the Society of American Military Engineers, and at his retirement from 44 years' service in the US Army Corps of Engineers, was awarded the Presidential Award for Meritorious Service. Bill served as a bomber command pilot in World War II, then joined the Norfolk Corps District where he worked for 14 years. He joined Corps Headquarters staff in 1956, where he spent the last 30 years of his career. In the 1960s, Bill was heavily involved in dredging and emergency work in the Panama Canal, and was in charge of US dredging operations in Vietnam during the conflict. In 1979, Bill was promoted to Chief of Dredging Division, and was responsible for the Corps' entire dredging program until his retirement. He strongly encouraged beneficial uses of dredged material and lived to see such uses as wildlife nesting islands, beach nourishment, wetlands restoration and creation, and shoreline protection become routine practices in the Corps.

Bill was very active in PIANC, the National Research Council, the American Society of Mechanical Engineers, the National Waterways Association, and the Western and Eastern Dredging Associations. He remained active in these organizations after his retirement, and he and Dottie formed Murden Marine, Limited, a successful marine engineering consulting firm.

Bill Murden was a friend to all who knew him, and at his funeral was mourned by many colleagues, some of whom came from The Netherlands and other nations to say goodbye. Three retired US generals, and former heads and staff of the Assistant Secretary of the Army for Civil Works, paid their last respects. Bill's funeral service was conducted by his friend LTG John Wall, retired Director of Civil Works and Episcopal priest.

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PROCEEDINGS OF THE DREDGED MATERIAL BENEFICIAL USES INTERNATIONAL WORKSHOP BALTIMORE, MARYLAND JULY 28 - AUGUST 1, 1997

INTRODUCTION: CONCEPT, HISTORY, AND EXAMPLES OF BENEFICIAL USES OF DREDGED MATERIAL

The Concept of Beneficial Uses of Dredged Material

To each of us, the concept of productive, or beneficial, uses of dredged material means something different, and a definition of beneficial uses of dredged material is simply utilizing dredged sediments as resource materials in productive ways. The beneficial use of dredged material is definitely in the eyes of the beholder. To urban managers, land use planners, and engineers, a beneficial use may mean new land open space, for parks, or for expansion of ports, airports, and other infrastructure foundations. To conservationists, a beneficial use would be the restoration or improvement of degraded or lost habitat, or the creation of scarce habitats, through placement of suitable dredged material in a soundly designed and implemented habitat development project.

Historical Aspects of Dredged Material Beneficial Uses

The World

Historically, dredged material has been beneficially used for over 2500 years on the coasts of Europe and Asia, and in the past 250 years on the coasts, rivers, and lakes of North America. The Phoenicians and Romans hand-dredged to deepen and maintain their ports and harbors in the Mediterranean Sea. The Chinese hand-dredged their river estuaries to maintain boat channels. Undoubtedly, any population of people who were sea-farers also faced this challenge and dealt with it in similar fashion.

In more modern times, the Dutch, French, Italians, British, Australians, Chinese, Japanese, Turks, Greeks, citizens of Hong Kong, and other nations use virtually all of their dredged sediments beneficially in ways generally not practiced in the United States. For example, the Dutch, Japanese, and British use dredged material for fast land creation to expand their land base for growing human populations. They are beginning to apply dredged material to habitat restoration as well. The Italians are involved in complex projects such as dredging coupled with providing flood gates for the City of Venice. The Australians and other nations dredge their estuaries to maintain international navigation.

The major dredging nations who belong to the Permanent International Association of Navigation Congresses (PIANC) prepared a book on international beneficial uses of dredged material in 1992. The book, which contains chapters on aquatic, island, wetland, and other natural resources, as well as port, land expansion, and other uses, is available from the US Army Engineer Waterways Experiment Station (WES), Vicksburg, MS 39180-6199 USA, along with other technical documents and engineer manuals on dredged material beneficial uses. The Dredged Material Beneficial Uses Engineer Manual 1110-2-5026 is available both from WES and from the US Army Corps of Engineers Distribution Center. A 1994 National Research Council book that includes beneficial uses as a viable alternative to coastal habitat protection and management is available from Academy Press, Washington, DC. The Handbook of Dredging Engineering (1992) also includes chapters on beneficial uses and is available from McGraw-Hill Publishers, New York.

North America

North American settlers began dredging river estuaries of the Atlantic and Gulf Coasts before the War for American Independence. Parts of the cities of Philadelphia, Baltimore, Washington, New York, Norfolk, Charleston, Savannah, Galveston, New Orleans, Mobile, and numerous other smaller coastal population centers were dredged using horse-pulled equipment (in later years, steam- and other types of engine-driven dredging equipment). This material was used to raise bank elevations, to create uplands and beaches, and to fill lowlands and estuaries. Until the turn of the century, almost all use of dredged material was for urban and industrial expansion.

By the 1890's, the US Army Corps of Engineers and the various major ports and cities of the nation were dredging to provide a 25,000-mile navigation system that was used to transport food, materials and products, and people both within the United States and as exports to the rest of the world. The Corps also has dredged to increase stream capacity for flood water management. While it is well known that dredging and filling was one of the manmade impacts that caused considerable disruption to natural ecosystems during those years, it is pertinent to also note that many habitat-related beneficial uses occurred secondary to project purpose.

For example, Jetty Island, a large island in Puget Sound, was constructed of dredged material in 1891 when the harbor was dredged to provide navigation facilities for Everett, WA. Subsequently, the island has been used for over 100 years by seabirds and other species for nesting, and has provided both wetland habitat and channel protection/stabilization for Everett as well as seasonal, supervised recreational day use for picnicking and bird watching. Dredged material islands on the Gulf and Atlantic coast have provided similar longevity, especially in Florida, North Carolina, and Texas where they have supported hundreds of thousands of nesting waterbirds since the early 1930's when the Intracoastal Waterway System was begun.

In the evolution of thinking by this nation's citizens, dredged sediments are now viewed as providing a resource foundation for the restoration, creation, and enhancement of natural and/or recreational sites such as wetlands and wildlife islands. Still further, planners and managers now consider and plan multiple purposes of large dredged material sites that include commercial and recreational facilities and activities, while still providing natural resource habitats. The evaluation and application of beneficial use of project dredged material is becoming more routine in most Corps District dredging programs.

Examples of Beneficial Uses

Commercial, Industrial, and Urban Uses

Prior to 1970, most dredged material was being used for airports, port expansions, additional living space, and shopping and other commercial enterprises. LaGuardia, Washington National, Portland International, San Francisco International, San Diego International, and numerous other airports have dredged material bases. Likewise, nearly every major port facility in the nation has dredged material foundations. This is especially so for Portland, Oakland, Galveston, Houston, Los Angeles/Long Beach, New York, Philadelphia, and Baltimore. Both Galveston and Portland have hundreds of businesses and homes constructed on dredged material foundations. This type of beneficial use continues today where land expansion is acceptable and natural resources are not impacted.

Manufactured Soil

In the past 10 years, a new technology has arisen for dredged material, that of using low to moderately contaminated dredged material for manufacturing high quality top soil, both for bulk use and bagged for sale in nurseries and garden centers. The process involves dewatering the dredged material, fixing any contaminants, then mixing the processed dredged material with soil amendments such as peat, sand, and vermiculite to make a soil product that is friable, high-quality, and suitable for use in lawns, parks, and gardens, as well as use as a soil dressing and/or amendment in large quantity where existing soils are of poor quality and permeability. This same methodology also has application for other products such as sludge and fly ash.

Sediment Management and Re-Use

The hundreds of dredged material containment facilities currently in use in the United States are nearing or already full to capacity with material. It is very difficult to win approval for new containment sites due to conflicting land uses, high values of near-water real estate, and potential environmental impacts. Therefore, it is of utmost importance for the Corps to re-use dewatered dredged material from containment as much as is feasible. In some cases, this material may be "sold" at a low cost (e.g., $1/cubic yard), or it may be given away. Landowners who have given the Corps easement for disposal of dredged material can also benefit from removing dewatered material for their containment sites, as well as the gain some benefit from selling the material.

Numerous ways to remove dewatered material and use it beneficially have been examined over the past 15 years. One successful operation was the re-use of dewatered sand material from containment sites in the Upper Mississippi River to restore and protect aquatic and wetland habitat in the Weaver Bottoms section of the Upper Mississippi River National Fish and Wildlife Refuge Complex near Winona, MN. Another investigation that has not been proven at this point in time to be economically feasible, but that may become so in the future, is the barging of dewatered material from full containment facilities in Galveston and Mobile Districts to New Orleans District. The dewatered material would then be used for erosion protection, limited subsidence abatement, and wetland restoration along badly impacted areas of coastal Louisiana.

Recreational Uses

Recreational facility and open space creation using dredged material has been practiced for a number of years; some city managers and water management offices are more cognizant of these opportunities than others. For example, East Potomac Park and nearby areas, including the Jefferson Memorial and the 100-year-old Japanese cherry trees growing along the Tidal Basin, are constructed on dredged material in the heart of Washington, DC.

Another example is Mission Bay in San Diego, CA, a large, several-hundred acre recreational complex constructed of dredged material which contains Sea World and numerous other recreational attractions. The park is also home to nesting endangered California least terns. Approximately 200 acres of eelgrass have been restored within the waters of Mission Bay Park. A similar example is Belle Isle in the Detroit River, between Detroit, MI, and Windsor, Ontario, Canada. Dredged material is temporarily contained and re-used on Belle Isle on a regular basis to expand the recreational facilities, which include a zoo, botanical gardens, a beach, open space and ball fields, and numerous other recreational facilities.

A different type of recreational restoration using dredged material occurred in Vancouver, WA, when Lake Vancouver, a historic but sediment-laden oxbow of the Columbia River, was restored by dredging the lake. This huge project was undertaken by the Port of Vancouver in the 1970s. The project from initiation to completion took nearly 10 years, with most of that time absorbed by coordination and regulations. The lake's dredged material was used for agricultural enrichment, island construction, beach nourishment, construction of an engineered flushing system to better maintain the dredged depths of the "new" lake, and recreational land.

Along the Upper Mississippi River, Columbia River, and other large waterways, smaller parks, boat launching ramps, and other recreational facilities have been constructed using dredged material. The hundreds of thousands of recreational boats in the United States that are kept in local private and public marinas are also major utilizers of waterways. These marinas must dredge on a regular basis. As much as possible, they use the dredged material beneficially, although it has historically been more difficult for them to obtain permits for beneficial uses than for public agencies who dredge.

Natural Resource and Agricultural Uses

Nesting Islands. One of the earliest and most spectacular beneficial uses of dredged material has been over 2000 constructed islands that are home to approximately 1,000,000 nesting sea and wading birds (37 species), and that provide migratory and overwintering habitat for several hundred species of waterfowl, shorebirds, waterbirds, songbirds, and raptors. Use of these islands has been well documented over several decades. In the northern Gulf Coast where nearly 700 islands remain available for nesting, over half of them contain nesting colonies each year.

At the present time, few new islands are being built. However, because the older islands erode and change configuration over time, repairs and additions to existing dredged material islands are infrequently taking place. Where habitat types are scarce, some island construction continues. Most nesting waterbirds have adapted to using diked dredged material islands as well as undiked islands, but studies show they are not as successful as waterbirds nesting on undiked islands. In North Carolina, where most coastal waterbirds are nesting on dredged material the construction of diked islands rather than nourishment of existing undiked islands has led to a concentration of nesting birds into fewer colonies that are more likely to be subject to catastrophic disturbance.

Upland Meadows and Forests. Many dredged material containment sites have been constructed since 1974, when federal resource agencies began demanding that most dredged material be confined. Both prior to that time as undiked sites, and continuing now as diked areas, some meadows and forests have either been developed or have been allowed to colonize on upland dredged material areas. Many of these have remained relatively isolated and receive abundant wildlife use. An example is Nott Island, CT, which was built in 1975 by mixing silty dredged material with an existing sandy dredged material site, providing soil amendments (lime, fertilizer), and planting with grasses and legumes. That Connecticut River site remains a viable meadow fringed with salt marsh and has never received post-project management. Other examples are a pine forest planted inside a sandy containment site at Slaughter Creek, Chesapeake Bay, MD, and a pine forest planted inside a sandy containment site near Winona, MI.

Wetlands. Over 100,000 acres of wetlands, both coastal and interior, have been restored or created in the United States using dredged material in the past two decades. This includes the more than 14,000 acres of confined placement sites in the Tennessee-Tombigbee Waterway that are planted and managed by the Corps either as waterfowl overwintering areas, bottomland hardwoods, mixed shrub/tree stands, or other habitats for wildlife. It does not include such historic sites such as the 42-year-old bottomland hardwood forests that colonized on dredged material deposits in the West Pearl River, MS and LA, or the 60+-yr-old dredged material islands in the James River, VA, that colonized with floodplain forests.

In coastal Louisiana, dredged material has been used since 1974 to nourish eroding and subsiding marshes by placing the dredge pipe heads over the natural berms and pumping material to an intertidal elevation, then moving the pipe and repeating the process. According to GIS information compiled by the Corps, the USGS National Wetlands Research Center, and Louisiana Department of Natural Resources, since 1956 the lower Mississippi River area below New Orleans has lost over 110,000 acres of wetlands. At the same time, since 1974 more than 10,000 acres of new dredged material deposits have resulted in wetlands in various stages of development. This still leaves a huge deficit of wetland losses, and it is readily apparent that beneficially using dredged material is not the sole answer to wetland losses in coastal Louisiana.

A number of other coastal Louisiana wetland projects have been aided by dredged material applications. These include Wine Island (a new manmade barrier island), Queen Bess Island (additions to a waterbird nesting island), wetland restoration and shoreline stabilization along parts of the Gulf Mississippi River Outlet, wetland restoration in the Atchafalaya Delta, and wetland restoration along Lake Ponchartrain shorelines. Additional beneficial uses will be evaluated and/or undertaken in coastal Louisiana as planned dredging activities are carried out, including the possible construction of underwater berms for shoreline protection and nourishment, more wetlands, and other types of habitat development.

Wetlands have been restored or created in other Northern Gulf Coast locations besides Louisiana. These include fringe wetlands from Tampa Bay, FL, to below Corpus Christi, TX, and wetlands that accomplish three purposes: (a) stabilize sediment, (b) protect shorelines, and © create marsh. Examples include cordgrass marshes planted on the shorelines of the newest waterbird nesting islands in central Tampa Bay, cordgrass planted on the northwest dike of Gaillard Island in Mobile Bay and Coffee Island in Mississippi Sound (both dredged material islands), and cordgrass planted on at least 15 dredged material locations in Galveston Bay, TX, and several sites along the Texas Gulf Intracoastal Waterway, including Aransas National Wildlife Refuge, West Bay, and Victoria Barge Canal.

Wetland restoration/creation sites on the Atlantic coasts using dredged material are not as numerous as along the Gulf coast. However, there are over 80 wetlands constructed on dredged material from 1975-1996 from Chesapeake Bay to Cape Canaveral, FL. FL, that range in size from 0.5 acre to over 100 acres. Most were built using unconfined hydraulic placement of sandy material. Both "clean" and "mildly-contaminated" material have been successfully used for wetland restoration/creation on the Atlantic coast. Wetland restoration technology in Chesapeake Bay and Galveston Bay includes using custom-built geotextile tubes for temporary erosion control while the new marshes are becoming established. Two such projects are planned for Delaware Bay in the near future at Bombay Hook National Wildlife Refuge, DE, and Egg Island Point Wildlife Management Area, NJ.

Pacific coast restoration/creation dredged material sites are quite different between California and the Pacific Northwest. In California, differences in precipitation, climate, and soil foundations also make significant differences between southern California salt marsh/lagoon restoration using dredged material and northern California salt/brackish/fresh intertidal marsh in the San Francisco/Sacramento delta waterway systems. In southern California, for example, most substrates where dredged material is placed or excavated are sandy or cobbly and provide a firm foundation. Also in southern California, restoration of closed or degraded lagoon systems using combinations of wetland restoration, waterbird nesting islands, and shallow water marine habitat have been constructed successfully at Boca Chica near Long Beach, Batiquitos Lagoon at Carlsbad, and other locations.

In contrast, in northern California, most dredged material contains large silt/clay fractions, and the soft foundation upon which it is placed is subsided peaty soil. Although all California dredged material wetlands tend to be planted in Pacific cordgrass and pickleweed, engineering techniques are quite different, and the resulting marshes and their utilization (biotic diversity and abundance) are much different. Wetlands in California also tend to have wildlife endangered species habitat restoration as goals, while Oregon/Washington wetlands emphasize benthos and fish use, especially salmonid species. Examples of successful dredged material use for wetland restoration/creation in northern California include Muzzi Marsh in Marin County, Salt Pond #3 and Warm Springs at Heyward, Sonoma Baylands at the mouth of the Petaluma River, and Donlin Island and Venice Cut marshes in the San Joaquin River intertidal reaches; several large manmade marshes using dredged material to counteract subsidence are currently planned in San Francisco and San Pablo Bays.

In the Pacific Northwest, no species of cordgrass is native, and the current invasion of smooth cordgrass from the Atlantic and Gulf coasts is creating a furor among ecologists concerned about displacement of food prey items for migrating salmon. Dredged material wetlands in the Pacific Northwest are planted with tufted hairgrass, slough sedge, Lyngbye's sedge, arrowgrass, and other native species. Eelgrass is intertidal in Oregon and Washington, and has been planted intertidally in Puget Sound on dredged material. Examples of successful wetland restoration/creation wetlands include Miller Sands in the lower Columbia River, OR, and Jetty Island and Goglehite Wetland (formerly called Lincoln Avenue Wetland) in Puget Sound, WA.

Aquatic and Marine Habitats. While there are not as many aquatic and marine projects using dredged material as for other types of beneficial uses, such projects have been constructed using both experimental and tested design criteria. They have primarily been oyster bars, clam flats, lobster beds, fishing reefs, and seagrass beds. Most completed projects have consisted of bringing the water bottom up to a more habitat-conducive elevation, slope, and configuration using dredged material, then capping with rock, shell, cobble, or other coarse material that provide better habitat features. Successful examples include oyster bars in Chesapeake Bay, a lobster bed in Long Island Sound, fishing reefs in the Gulf of Mexico, Pacific and Atlantic Oceans, and Great Lakes, clam/mussel beds in the Tombigbee and Ohio Rivers, and seagrasses in several Atlantic and Pacific Coast locations, especially in southern California.

Underwater Berms and Nesting Beaches. Twenty-three underwater berms have been constructed using dredged material for storm attenuation and or beach nourishment and have been studied by engineers for stability and function. Only one of these, the stable berm off Dauphin Island, AL, has been studied in detail for biological parameters to determine fish use and recovery of motile and non-motile organisms. Data show that benthos on the berm has recovered rapidly, and fish use by numerous species of various age classes is greater than the surrounding waters. Results are correlated to slope, configuration, and placement orientation in the current.

Engineering data collected at the Dauphin Island feeder berm indicate the sediment is moving off the berm into the nearshore littoral drift system. The second site where any biological data have been collected as part of project assessment is at the Dam Neck stable berm site off Norfolk, VA, where data collected after project completion indicate that the berm is providing overwintering habitat for blue crabs from Chesapeake Bay.

In Florida and along the southern Atlantic coast, beaches built of dredged material are used by nesting sea turtles. However, human recreation use often interferes with turtle nesting in spite of best intentions, and this dredged material beneficial use requires very careful planning and coordination with local citizens and landowners.

Forestry, Horticulture, and Agriculture. Numerous interior, upland dredged material placement sites that are no longer in use, or that have up to 10 years between maintenance dredging operations, have been used for forestry, horticulture, and agriculture. Most of these sites have sandy or sandy silt substrates rather than heavy clays. Examples of horticultural/truck crop use include cabbage, sweet corn, and other commercial garden crops growing on dredged material adjacent to the Columbia River, the Intracoastal Waterway in New Jersey, and other locations. Pulpwood plantations, bottomland hardwoods, and riparian forests have been planted on infrequently used sites in the Tennessee-Tombigbee Waterway, the Ohio River Valley, the lower Mississippi River Valley, and the upper Mississippi River. One of the more common agricultural uses of dredged material sites along inland mid-western rivers is cattle grazing; in Vancouver, WA, a cattle feedlot is located in a sandy placement site. In New Jersey, South Carolina and other southern states, soybeans, other row crops, and hay crops are grown in suitable placement sites.

Multiple Purpose Sites. There are some valuable, highly visible, and heavily used multiple purpose dredged material placement sites that include combinations of human habitation, commercial, and recreational use, fish and wildlife habitat, and shoreline protection/sediment stabilization. Mission Bay, Belle Isle, East Potomac Park, and Pointe Mouillee have already been previously mentioned. A number of other sites can meet these requirements and make such sites more attractive to both urban planners and natural resource managers, as well as be more cost-efficient in placement operations. Multiple purpose projects are projected to be the norm for most future dredged material placement sites.

Most confined disposal facilities lend themselves to multiple purpose uses. An example is Hart-Miller Island, an 1100-acre facility in Chesapeake Bay that is slated to become an perched wetland/wildlife habitat and upland park for use by boating Maryland citizens upon completion. Hart-Miller will include bathing beaches, ponds, paths and walks, and other recreational facilities, while still providing habitat for waterbird and other species. Poplar Island, a badly eroded natural island off Maryland's Eastern Shore is being planned to become a multiple-purpose 1100-acre confined disposal facility within the next ten years.

A multiple purpose project that is currently being planned involves use of many millions of cubic yards of dredged material from the Houston, TX, Ship Channel deepening and widening work. An interagency beneficial uses committee has agreed upon a plan of action that will include a human-use destiny island for recreational boaters, a nesting island for waterbirds and other wildlife, fishing reefs, oyster beds, and wetland restoration---all constructed from the dredged material from the project. While the final plan has not yet been approved, the state and federal natural resource, regulatory, and construction agencies responsible for Galveston Bay are quite pleased with the concept of the beneficial uses proposed, and funding for project work was authorized in the Water Resources Development Act of 1996.

Another example of an urban multiple purpose project is the 35-acre wetland restoration using dredged material of Kenilworth Marsh in the heart of Washington, DC, adjacent to the Anacostia River. This site, owned by the National Park Service, is utilizing dredged material from a Baltimore District project to raise the elevation of the degraded lake to an intertidal elevation. The new wetland will be planted in the spring of 1993, and includes canoe channels, observation points, and other human recreational uses, as well as providing a considerable extension of the available natural resource habitats in the District of Columbia. It is funded by the Corps and the National Park Service; non-funding partners include the U. S. Fish and Wildlife Service and the District of Columbia Council of Governments.

Beach Nourishment. Over the past 100 years, the Corps has worked with local and state officials to use beach-quality sand for beach nourishment from Miami Beach to Long Island, and in isolated places in the Great Lakes. Hundreds of miles of beaches have been directly placed by the Corps, and many more miles were placed using Corps guidance. The economic return of constructing beaches is more than 10:1 to the federal taxpayer, because beaches not only provide recreation for international and national visitors, they also provide storm and hurricane attenuation, and serve as sacrificial soft structures to protect shoreline buildings and homes.

Case Studies

To further emphasize the possibilities of beneficial uses, 47 examples of beneficial uses of dredged material are presented following this text. These site descriptions focus on construction technology, goals, design, implementation, costs, monitoring, and other pertinent factors. It should be noted that there are other equally valid beneficial uses of dredged material not listed, including some complex multi-purpose dredged material projects.

Each of these projects have been discussed in great detail in US Army Corps of Engineers technical reports, American Society of Civil Engineers and World Dredging Conference meetings, and the journals of Society of Wetland Scientists and the Western Dredging Association, as well as the fore-mentioned National Research Council and other text books on the subject of beneficial uses of dredged material. Readers are referred to those documents for additional information concerning goals, design, construction, chronology, long-term monitoring, management strategies, and partnering and coordination.

Summary

As the nation maintains its navigable waterways and provides flood protection to its citizens, the resulting dredged material becomes an abundant resource that should not be wasted. Only about 40 percent of such material is used beneficially, and there is much room for improvement. Limiting factors for increased use are costs, the currently defined federal standard for dredging, and need for more proof through research that certain kinds of beneficial uses are in fact successful and predictable.

Wetland restoration and creation has been a highly successful use of dredged material, although it has limitations of costs, transport, achieving precise elevations, and the possible displacement of other habitats. Wildlife islands, which include wetland fringes, and beach nourishment, including sea turtle nesting beaches, are also highly successful uses of dredged material. There are numerous other natural resource benefits to be gained from incorporating suitable dredged material into habitat restoration/creation designs.

Increased efforts among federal and state agencies responsible for dredging and dredged material placement decisions should be made to find ways and funding to use more dredged material for habitat restoration and creation and other natural resource benefits.

AGENDA

Monday, 28 July 1997

1200-1900 PIANC WORKING GROUP MEETINGS
1400-1900 registration---International Ballroom foyer
1800-2100 opening night informal mixer

Tuesday, 29 July 1997

0830-0840 OPENING---Joseph R. Wilson, Headquarters, US Army Corps of Engineers---Grand Ballroom
0840-0845 ANNOUNCMENTS AND INTRODUCTIONS---Norman Francingues, Workshop Moderator
0845-0910 WELCOME---COL George C. Clarke, Deputy Division Engineer, North Atlantic Division, US Army Corps of Engineers, New York, NY
Stephen S. Browning, Director of Engineering and Technical Services Directorate, North Atlantic Division, US Army Corps of Engineers, New York, NY
0910-0935 KEYNOTE ADDRESS---Mr. Michael L. Davis, Deputy Assistant Secretary for Policy and Legislation, Office, Assistant Secretary of the Army for Civil Works, The Pentagon, Washington, DC
0935-1000 KEYNOTE ADDRESS---Mr. Robert H. Wayland III, Director of Office of Wetlands, Oceans, and Watersheds, US Environmental Protection Agency, Washington, DC
1000-1030 Break
1030-1200 FEDERAL POLICY PANEL: AGENCY PERSPECTIVES ON BENEFICIAL USES OF DREDGED MATERIAL
Moderator William Roper, Research and Development, Headquarters, US Army Corps of Engineers
Joseph Wilson, US Army Corps of Engineers, Washington, DC
John Meagher, US Environmental Protection Agency, Washington, DC
John Wolflin, US Fish and Wildlife Service, Annapolis, MD
Billy Teels, USDA Natural Resources Conservation Service, Washington, DC
Thomas Peeling, US Navy, Washington, DC
Russell Bellmer, NOAA National Marine Fisheries Service, Silver Spring, MD
1200-1215 BILL MURDEN MEMORIAL AND DEDICATION--Joseph R. Wilson, David B. Mathis, Norman Francingues, and Robert M. Engler
1215-1230 MLLW
1230-1330 Lunch (on your own)
1330-1500 FEDERAL TECHNICAL PANEL: AGENCY TECHNICAL CONSIDERATIONS AND ADVANCES
Moderator William Roper, Research and Development, Headquarters, US Army Corps of Engineers
Robert M. Engler, US Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS
John Goodin, US Environmental Protection Agency, Washington, DC
John Gill, US Fish and Wildlife Service, Annapolis, MD
Leander Brown, USDA Natural Resources Conservation Service, Laurel, MD
Kurt Frederick, US Navy Northern Division, Lester, PA
Russell Bellmer, NOAA National Marine Fisheries Service, Silver Spring, MD
1500-1530 Break
1530-1700 STATE AND NON-GOVERNMENTAL ORGANIZATION PANEL: THE NON-FEDERAL PERSPECTIVE AND STRATEGIES
Moderator Francingues
Frank L. Hamons, Maryland Port Administration, Baltimore, MD
Thomas Chase, American Association of Port Authorities, Alexandria, VA
Robert E. Randall, Center for Dredging Studies, Texas A&M University, College Station, TX
Donald F. Hayes, Dept. Of Civil Engineering, University of Utah, Salt Lake City, UT
Gregory J. Ducote, Coastal Restoration Division, LA Dept. of Natural Resources, Baton Rouge, LA

1900-2200 PIANC WORKING GROUP MEETINGS---Grand Ballroom

Wednesday, 30 July 1997

0800-0930 **CONCURRENT TECHNICAL SESSIONS 1-4**

TECHNICAL SESSION 1: MANUFACTURED SOIL A---Chair, Charles R. Lee, International A

The Concept of Manufacturing Soil from Dredged Material Blended with Organic Waste Materials and Biosolids---Paul T. Adam and Charles R. Lee

Manufactured Soil from Toledo Harbor Dredged Material and Organic Waste Materials---Wiener Cadet, Charles R. Lee, and Thomas C. Sturgis

Manufactured Soil from Contaminated New York/New Jersey Harbor Dredged Material---Charles R. Lee, Thomas C. Sturgis, Kerwin Donato, and Eric Stern

The Concept of Rehabilitation of Problem Soil Dikes using Manufactured Soils---Charles R. Lee, Thomas C. Sturgis, James Owens, and Peter Milam

TECHNICAL SESSION 2: WETLANDS A---Chair, Mary C. Landin, International B

Twenty-five Years of Long-term Monitoring of Wetland Projects Constructed with Dredged Material, and Comparisons to Natural Wetlands, throughout US Waterways---Mary C. Landin

Habitat Restoration using Dredged Material: The Sonoma Baylands Wetland Restoration Project---Scott P. Miner

Beneficial Use of Dredged Material from the Delaware River Main Channel Deepening Project to Create/Restore/Protect Wetlands in the Delaware Bay---John T. Brady, Anthony J. DePasquale, Jack E. Davis, and Mary C. Landin

Design of Sand Dike for Wetlands and Beach Nourishment at Kelly Island, Delaware---Jennifer L. Irish and Jack E. Davis

TECHNICAL SESSION 3: HART-MILLER ISLAND PANEL---Chair, Wayne Young, International C

From Remnant Estuarine Islands through Constructed Containment Facility to Park and Natural Resources: Seven Policy and Technical Aspects of Hart-Miller Island Conception, Baseline, Planning, Design, Construction, Monitoring, and Management---Frank L. Hamons, Wayne Young, David Bibo, Cecilia Donovan, Michael Hart, Michelle Vargo, and Lawrence Walsh

TECHNICAL SESSION 4: ECONOMICS AND CHALLENGES OF BENEFICIAL USES OF DREDGED MATERIAL---Chair, Carol A. Coch, International D

The Economics of Upland Dredged Material Management and Beneficial Use: A Case Study in San Leandro, California---Gary W. Oates, Gregory P. Mailho, and James M. Haussener

The CVN Homeporting Project in San Diego Bay: A series of Challenging Issues Surrounding the Beneficial Re-Use of Nine Million Cubic Yards of Sediment---Barry J. Snyder and Patrick J. McCay

A Case for Expanding Traditional Uses of Dredged Material---Edwin (Kim) Sterrett and Douglas R. Diener

An Estimation of Average Costs and Percentages of Beneficial Use Disposal from the Maintenance of Federal Navigation Channels by US Army Corps of Engineers District---Jon Truxillo and Mary C. Landin

0930-1000 Break

1000-1200 **CONCURRENT TECHNICAL SESSIONS 5-8**

TECHNICAL SESSION 5: MANUFACTURED SOIL B---Chair, Charles R. Lee, International A

Manufactured Soil from Mobile Harbor Dredged Material--- Thomas C. Sturgis, Charles R. Lee, and Patrick Langan

Feasibility of Manufacturing Soil from Texas Gulf Intracoastal Waterway Dredged Material---Sara J. Graalum and Robert E. Randall

Manufactured Soil from St. Lucie Muck---Thomas C. Sturgis, Charles R. Lee, and Kimberly A. Taplin

Manufactured Soil Concept in the Rehabilitation of Housing Demolition Soil and Military Training Land---Antonio J. Palazzo, Charles R. Lee, Thomas C. Sturgis, and Paul Zang

TECHNICAL SESSION 6: WETLANDS B---Chair, Mary C. Landin, International B

River Corridors and Wetlands Restoration and the Possibilities for the Beneficial Use of Dredged Material ---John W. Meagher

Mississippi River Outlets, Vicinity Venice, Louisiana: Wetland Development and Bird Island Development at Baptiste Collette---Robert L. Gunn

Design and Construction of Breakwater/Shore Protection for Critical Marsh Habitats using Stacked Geotextile Tubes---James T. Few and Daniel W. Anderson

Features in Dredged Material Salt Marshes due to Natural Erosion---Jack E. Davis, William R. Curtis, and Mary C. Landin

TECHNICAL SESSION 7: POPLAR ISLAND---Chair, Jeffrey McKee, International C

Poplar Island Restoration Project: Project Objectives and Organization---Frank L. Hamons, Michael Hart, and Robert Smith

Poplar Island Restoration Project: Planning and Design Aspects---Richard F. Thomas, John R. Headland, Dennis C. Urso, Peter W. Kotulak, and Ram K. Mohan

Poplar Island Restoration Project: Coastal Engineering Aspects---John R. Headland and Peter W. Kotulak

Poplar Island Restoration Project: Dredging Engineering Aspects---Richard F. Thomas, Dennis C. Urso, and Ram K. Mohan

TECHNICAL SESSION 8: ISLAND AND UPLAND HABITATS A---Chair, Thomas R. Patin, International D

Jetty Island Beneficial Use: 1989-1997---Jon P. Houghton and Dennis Gregoire

Restoration of Colonial Waterbird Habitat, Wainwright Island, Carteret County, North Carolina---Trudy N. Wilder

Swash Bay Island Restoration---Douglas H. Stamper and Elizabeth Gray Waring

Colonial Seabird and Mottled Duck Nesting on Dredged Material Islands in the Atchafalaya Delta Wildlife Management Area, Louisiana---Michael R. Carloss

1200-1300 Lunch (on your own)

1300-1430 **CONCURRENT TECHNICAL SESSIONS 9-12**

TECHNICAL SESSION 9: CONTAMINANTS A---Chair, Norman Francingues, International A

Remediation Technologies for Beneficial Uses of Contaminated Sediment---Nancy L. Case and Kevin S. Wood

Innovative Approaches to Contaminated Sediment Cleanup---David W. Templeton, Leslie Williams, and Rick Della

Beneficial Uses of Dredged Contaminated Sediments: Two Case Studies Revisited---Gregory L. Hartman, Douglas Saathoff, David McEntee, and Dick Gilmur

Beneficial Use of Contaminated Dredged Material from Hamlet City Lake---Philip M. Payonk, Charles R. Lee, John W. Simmers, and Henry E. Tatem

TECHNICAL SESSION 10: POLICY AND PLANNING A---Chair, Joseph R. Wilson, International B

Guidelines for the Beneficial Use of Dredged Material in the United Kingdom---T. Neville Burt

Planning for Beneficial Use of Dredged Materials in the United Kingdom: Meeting the Aspirations of Interested Parties---Jan Brooke and Christine Adnitt

The Policy and Funding Framework for US Army Corps of Engineers Participation in Beneficial Use Projects---Richard T. Worthington

EPA Guidance Manual for Identifying, Planning, and Financing Beneficial Use Projects Using Dredged Material ---John Goodin

TECHNICAL SESSION 11: CHESAPEAKE BAY---Chair, John Wolflin, International C

Beneficial Uses of Dredged Material in Chesapeake Bay as Standard Practice for Baltimore Corps District---Robert N. Blama

A Monitoring Study: Eastern Neck Island National Wildlife Refuge Wetland Creation and Erosion Control Project---John W. Gill, Peter McGowan, and Leslie E. Pitt

Future (Planned) Beneficial Uses Projects for Chesapeake Bay in the Baltimore Corps District---Christopher Spaur, Mark Mendelssohn, Steven Garbarino, Audrey F. Calhoun, Richard Kibby, John Wilson, Peter Noy, Charles Weber, Dan Bierly, Robert Gaudette, Jordan Loren, Mark Koenings, Philip Hager, and Terry McGean

Beneficial Use of Dredged Material in the Upper Chesapeake Bay---Wayne Young and Frank L. Hamons

TECHNICAL SESSION 12: ISLANDS AND UPLAND HABITATS B---Chair, Thomas R. Patin, International D

The History, Practice, and Studies of Construction, Nourishment, Protection, Monitoring, and Management of more than 2000 Dredged Material Islands in US Waterways---Mary C. Landin

The Role of Landscape in Use of Dredged Material Islands by Birds---Traci Darnell and Elizabeth Smith

Distribution of the Interior Least Tern (*Sterna antillarum athalassos*) on the Lower Mississippi River---John P. Rumancik Jr. and Mary C. Landin

Hart-Miller Island: Avian Utilization of an Operating Dredged Material Containment Facility, 1983-1997---Eugene J. Scarpulla

1430-1500 Break

1500-1700 **CONCURRENT TECHNICAL SESSIONS 13-16**

TECHNICAL SESSION 13: CONTAMINANTS B---Chair, Norman Francingues, International A

A Regional Approach to Contaminated Sediment Management in Los Angeles County---Madelyn Glickfield and Mark Gold

Production of Useable Material from Contaminated Miami River Sediment by Hydrocyclone Separation of Fine and Coarse Fractions---Glenn R. Schuster, Mitchell A. Granat, and Donald B. Fore

An Innovative "DryDREdgeTM" for Removing Sediment at *in-situ* Moisture Content---T. M. Parchure and R. J. McCormick

Beneficial Uses of Decontaminated New York/New Jersey Harbor Dredged Material---Anne Montague, Charles R. Lee, Kerwin Donato, and Eric Stern

TECHNICAL SESSION 14: POLICY AND PLANNING B---Chair, John Goodin, International B

Partnerships, Planning, and Policy: An Interagency Approach to Beneficial Re-Use of Dredged Material---Justine Smith Barton and Stephanie K. Stirling

Managing Dredged Material Placement Options and Their Trends---Robert J. Homan

The Tampa Bay Initiative---William J. Fonferek

Environmental Restoration from Concept to Construction---Carol A. Coch

TECHNICAL SESSION 15: AGRICULTURAL APPLICATIONS---Chair, Richard A. Price, International C

Use of Dredged Material as a Soil Amendment---Kenneth Dalrymple

Agricultural Use of Yazoo River Dredged Material---Richard A. Price, Paul R. Schroeder, Larry E. Banks, J. G. Sanders, and D. R. Johnson

Beneficial Uses of Dredged Material: Agriculture Use---Robert M. Corletta and Jennifer L. S. Duff

Current Agricultural Applications of Dredged Material in Washington, New Jersey, South Carolina, and Mississippi ---Mary C. Landin

TECHNICAL SESSION 16: AQUATIC AND MARINE HABITATS A---Chair, Jan Brooke, International D

The Response of Benthos to Open Water Disposal---Robert J. Diaz and G. Randall Cutter Jr.

Design of a Submerged Dredged Material Island as Habitat Mitigation, Drayton Harbor, Washington---Jack C. Cox

Experimental Disposal of Dredged Material in the Snake River, Idaho-Washington---David H. Bennett, Teri Barila, and Chris Pinney

Partnered Feasibility and Design for Aquatic and Wetland Habitat Restoration in the Intertidal Hudson River---Mary C. Landin, Jack E. Davis, Rena Weichenberg, Betsy Blair, David Yozzo, and Leonard Houston

Thursday, 31 July 1997

0800-0930 **CONCURRENT TECHNICAL SESSIONS 17-20**

TECHNICAL SESSION 17: CONFINED DISPOSAL FACILITIES---Chair, Donald F. Hayes, International A

The Long-Term Study of Pointe Mouillee CDF and Its Wetland and Aquatic Habitats---Mary C. Landin, Jan J. Hoover, and Eric Dibble

Management of the Times Beach Confined Disposal Facility for Beneficial Use---Jeannie M. Roper, John M. Simmers, and Gerould S. Wilhelm

Beneficial Use of a Confined Disposal Facility as a Commercial Racetrack---John Shuman

Management of Confined Disposal Facilities for Beneficial Uses---John W. Simmers, Jeannie M. Roper, and Gerould S. Wilhelm

TECHNICAL SESSION 18: AQUATIC AND MARINE HABITATS B---Chair, William Muir, International B

Beneficial Use Integrated within an Ecosystem Approach to Fisheries Habitat Restoration at the Hoboken Rail Terminal, Hoboken, New Jersey---Joseph Porrovecchio, Eugene Peck, and Roger Copp

Long-Term Effects of Dredging on Fish Communities: A Case Study of the Lynnhaven Estuary---William Muir and Sharon M. Soppe

DAN-NY: A Manager-Friendly GIS for Viewing Marine Environmental Data and Managing Dredged Material Disposal in Coastal Waters---Scott E. McDowell, Brian A. May, James E. Clausner, and J. Craig Swanson

Wilmington Harbor Ocean Bar Channel Deepening Project: The Wilmington Offshore Fisheries Enhancement Structure---Philip M. Payonk

TECHNICAL SESSION 19: COASTAL CASE STUDIES A---Chair, Ram K. Mohan, International C

Modeling with Dredged Materials and Experimenting with Different Techniques in The Netherlands---R. S. Verheule

An Overview of Beneficial Uses of Dredged Material in a Highly Urban Environment---Robert Will and Kerwin Donato

The Beneficial Use of Dredged Material in New Jersey---Lawrence Schmidt and Joel A. Pecchioli

The Delaware River Deepening Project: Management of Upland Confined Disposal Facilities as Wetland and Wildlife Habitats---Anthony J. DePasquale and John T. Brady

TECHNICAL SESSION 20: DREDGED MATERIAL MANAGEMENT AND RE-USE A, International D ---Chair, Richard Della

Re-Using Dredged Material in the Sacramento-San Joaquin Delta---Aurora F. Amores

In-situ Processing of Dredge Sediments for the Port of New York and New Jersey: Case Studies of Large Volume Upland Placement for Use as Structural Fill and Brownfield Remediation---John Ward, Timothy L. Dunlap, and David A. Ardito

0930-1000 Break

1000-1200 **CONCURRENT TECHNICAL SESSIONS 21-24**

TECHNICAL SESSION 21: CAPPING---Chair, Michael R. Palermo, International A

Beneficial Use of Dredged Material for Subaqueous Capping---Michael R. Palermo

Subaqueous Capping in New England: Wise Use of Dredged Materials---Drew A. Carey, John T. Morris, Peggy Murray, and Thomas J. Fredette

Use of Dredged Material for Capping Solid Waste Landfills---Ram K. Mohan and John B. Herbich

The 1997 Capping Project in the Mud Dump Site---Linda S. Lillycrop and James E. Clausner

TECHNICAL SESSION 22: COASTAL CASE STUDIES B---Chair, Scott P. Miner, International B

Beneficial Uses of Dredged Material: Section 204 Projects Implemented in the New Orleans District---Beth Nord, Edward Creef, and Linda Glenboski Mathies

Beneficial Uses of Dredged Material in the Galveston District---T. Neil McLellan and Herbie A. Maurer

Sand-filled Geotextile Containers---Jeff Wiggin

Loss of Sediment Contaminants from San Francisco Bay through an Upland Contained Disposal Facility---P. R. Krause, G. R. Staba, Sharon Lin, and G. W. Bartow

TECHNICAL SESSION 23: AQUATIC AND MARINE HABITATS C---Chair, Richard Worthington, International C

Utilization of Solidified Organic Sludge Sediments for Marine Environment Conservation and Habitat Creation---Satoru Watanabe, Kanae Matsuzaki, Kazunari Ogawa, and Chokei Itosu

Benthic Recolonization Following Cessation of Dredged Material Disposal in Mirs Bay, Hong Kong---Ray Valente

Tidal Flat Creation for Bird Habitat at Hiroshima Port, Japan---Yasushi Hosokawa, Hitoshi Imamura, and Hajime Hiramoto

TECHNICAL SESSION 24: DREDGED MATERIAL MANAGEMENT AND RE-USE---Chair, Richard Della, International D

Using ADDAMS to Design Beneficial Use Projects---Donald F. Hayes

Soil Washing Potential at Confined Disposal Facilities---Trudy J. Olin and David W. Bowman

Insights from Dutch Experience in Preparing Dredged Sediments for Beneficial Re-use---Christopher C. Lutes, Michael J. Mann, John V. Barron, and Jan Bovendeur

Brick Manufacture from Dredged Material, A Reality!---Luke Cousins, Fred Beason, and John Shuman

1200-1300 Lunch (on your own)

1300-1430 **CONCURRENT TECHNICAL SESSIONS 25-28**

TECHNICAL SESSION 25: INLAND CASE STUDIES---Chair, Trudy J. Olin, International A

Ashtabula River and Harbor, Ashtabula County, Ohio: The Ashtabula River Partnership for Dredging/Disposal of Contaminated Sediments, A Unique and Non-Traditional Approach for a Project Partnership and Funding ---Stephen J. Golyski

Lower Monongahela River Project Locks and Dams 2, 3, and 4: Beneficial Uses Associated with the Disposal of Dredged and Excavated Material---Carmen Rozzi

Management of Peat Bottom Sediments for Water Quality and Recreational Navigation Improvement in Chain O Lakes, Illinois---Karen C. Kabbes

100 Percent Beneficial Use?---Steven D. Tapp

TECHNICAL SESSION 26: GEOTEXTILE APPLICATIONS---Chair, Jack E. Davis, International B

Dredged Material Filled Geotextile Tubes and Containers: Case Histories---Joel Sprague, Anthony Bradley, Dana Toups, and Edward Trainer

Overview of Geocontainer Projects in the United States---Jack Fowler and Edward Trainer

Raising Mississippi River Levees Using Geotextile Tube Technology---Jack Fowler and Edward Trainer

Dewatering Sewage Sludge with Geotextile Tubes---Jack Fowler, Rose Mary Bagby, and Edward Trainer

TECHNICAL SESSION 27: SEDIMENT MANAGEMENT AND EROSION CONTROL---Chair, T. Neil McLellan, International C

Massachusetts Dredged Material Management Plan: Twenty-Year Forecast of Dredging Needs, Sediment Characterization, and Reuse/Disposal Options---Deerin Babb-Brott, Bob Wardwell, Dave Westcott, and Steve Lecco

Beneficial Use of Dredged Material in Nearshore Placement Areas in North Carolina---Daniel L. Small, Philip M. Payonk, and James T. Jarrett

History and Future of Dredged Material Management at Shirley Plantation, Charles City County, Virginia: A Private Perspective---Charles H. Carter III and George Junkin

Uses of Dredged Material to Combat Erosion at Westport, Washington---Alex Sumeri and Eric Nelson

TECHNICAL SESSION 28: CASE STUDIES---Chairs, Mary C. Landin and Thomas R. Patin, International D

A open forum discussion of projects and case studies using dredged material beneficially. Initial discussion and visuals will include Batiquitos Lagoon (California), Gaillard Island (Alabama), Tennessee Tombigbee Waterway

(Tennessee/Mississippi/Alabama), Weaver Bottoms (Minnesota/Wisconsin), and Riverlands (Illinois/Missouri). These are large Corps and ports beneficial uses projects. The floor will be open to discuss any case study the audience brings to the attention of the session chairs.

1430-1500 Break

1500-1630 **CLOSING PLENARY SESSION: WHAT'S IN THE FUTURE FOR BENEFICIAL USES OF DREDGED MATERIAL**, International A

Friday, 1 August 1997 (attendees should choose only one trip)

Trip 1: Kenilworth Marsh. Host: US Army Corps of Engineers Baltimore District. Van or bus trip to wetland site.

Trip 2: Hart-Miller Island. Hosts: Maryland Port Administration, Maryland Environmental Services, Maryland Department of Natural Resources. Van and boat trip to Hart-Miller Island, limited to 15 people due to boat capacity.

TECHNICAL SESSION 1: Manufactured Soil A

Charles R. Lee, PhD, Chair

THE CONCEPT OF MANUFACTURING SOIL FROM DREDGED MATERIAL BLENDED WITH ORGANIC WASTE MATERIALS AND BIOSOLIDS

Paul T. Adam
TERRAFORMS
State College, Pennsylvania USA

Charles R. Lee, PhD
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi USA

Fertile soil can be manufactured from recycled materials that can include dredged material, organic waste materials and biosolids. All dredged material can be used to manufacture soil, however, some dredged material may require reconditioning to some extent, depending on the circumstances. Organic waste materials could include just about anything, such as sawdust from lumber processing, bagasse from sugar cane processing, yard waste, paper processing cellulose mud, waste paper, hurricane debris, *Phragmites*, or *Melaleuca* compost.

Biosolids can be derived from reconditioned municipal sewage sludge, reconditioned cow manure, chicken manure, or reconditioned pig manure. The ingredients will depend on what is available in close proximity. These ingredients can be blended according to a patented formulation, tested in greenhouse screening experiments and demonstrated at field locations. The development of this technology has been possible through Cooperative Research and Development Agreements between US Army Corps of Engineers (Corps), Waterways Experiment Station (WES) and commercial entities such as TERRAFORMS, N-Viro International, Bion Technologies, Inc. and Scotts Company.

Together, each participant contributes to the demonstration of manufactured soil technology and eventually to the commercialization of the process. Specific examples will be discussed in detail in other companion papers at this workshop.

MANUFACTURED SOIL FROM TOLEDO HARBOR DREDGED MATERIAL AND ORGANIC WASTE MATERIALS

Wiener Cadet
US Army Engineer District, Buffalo
Buffalo, New York USA

Charles R. Lee, PhD, and Thomas C. Sturgis, PhD
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi USA

Manufactured soil was evaluated in greenhouse screening tests and demonstrated at Toledo, OH using dredged material, organic waste material and biosolids. Greenhouse screening tests evaluated germination and growth of four plant species: ryegrass, tomato, marigold, and vinca. Various blends of dredged material ranging from 40 to 80 percent, and organic waste materials (sawdust, yard waste)ranging from 10 to 50 percent, and biosolids at 10 percent.

Based on results of the screening tests, a demonstration was conducted to produce 660 cu yd of manufactured soil. The manufactured soil was used to landscape the front entrance to the University of Toledo and the Toledo Botanical Garden. The demonstration was a cooperative effort among the City of Toledo, Toledo Port Authority, CRDA partners (Terraforms and N-Viro), the Corps Buffalo District and WES, and was an overwhelming success. The Buffalo District supplied the dredged material and funded the demonstration. The Port Authority located potential demonstration sites to receive the manufactured soil. Terraforms supplied the patented formula, and manpower to locate blending equipment for the demonstration and onsite technical support. N-Viro International supplied the biosolids for the manufactured soil. WES coordinated all activities for the demonstration. The City of Toledo supplied dump trucks to haul manufactured soil from the processing site at the Corps' Cell 1 confined disposal facility (CDF) to the University of Toledo and to Toledo Botanical Garden.

Commercialization of the manufacture of soil products with up to 800,000 cu yd of dredged material per year has been proposed by Terraforms and interested local entities. At that rate, the existing CDF will be available for accepting dredged material from the Toledo Harbor just about the time the newly constructed CDF will be filled to capacity.

MANUFACTURED SOIL FROM CONTAMINATED NEW YORK/NEW JERSEY HARBOR DREDGED MATERIAL

Charles R. Lee, PhD, and Thomas C. Sturgis, PhD
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi USA

Kerwin Donato
US Army Engineer District, New York
New York, New York USA

Eric Stern
US Environmental Protection Agency, Region II
New York, New York USA

Manufactured soil was produced from New York/New Jersey Harbor fresh anaerobic dredged material and organic waste materials. Greenhouse screening tests were conducted with various blends ranging from 30-80 percent dredged material, 10-60 percent organic waste (sawdust, yard waste), and 10 percent biosolids (Bionsoil^R). Greenhouse screening tests results indicated that a manufactured soil blend could grow grass. The other plant species could not tolerate the salt content of the blend.

A demonstration was conducted at the Port of Newark in which manufactured soil was blended and three different phytoremediation approaches were tested. Phytoremediation I consisted of plant species to contain contaminants within the dredged material. Phytoremediation II consisted of a plant species to remove metals from the dredged material. Phytoremediation III consisted of plant species to biodegrade organic contaminants. All grasses grew and performed well.

THE CONCEPT FOR REHABILITATION OF PROBLEM SOIL DIKE USING MANUFACTURED SOILS

Charles R. Lee, PhD, and Thomas C. Sturgis, PhD
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi USA

James Owens and Peter Milam
US Army Engineer District, Jacksonville
Clewiston, Florida USA

Herbert Hoover Dike was established to protect south central Florida residents from flooding during hurricanes over the area. The dike system was constructed from dredging lake bottom from an interior canal and an outer rim canal. The dredged material consisted of sand and marl. The dike soil pH is approximately 8.3 in most areas. All maintenance vegetation work was accomplished through contracts.

Over the years the desired grass cover (Bahia, Bermuda, and/or St. Augustine grasses) have been replaced or out competed by weeds, such as *Napier* grass and/or *Maidencane*. Application of manufactured soil technology was accomplished in greenhouse screening tests and in a field demonstration. Productive manufactured soil was made and demonstrated using 60 percent in-situ dike soil and organic waste (sawdust, yardwaste, bagasse, or *Melaleuca* compost). Demonstration plots were established with four plant species: Bermuda grass, St. Augustine grass, Bahia grass, or perennial peanut.

Periodic evaluations have indicated that yard waste and N-Viro created a fertile soil and promoted an enormous growth of native weed seed. Weed control had to be implemented to allow the more desired species that were planted to survive. Use of bagasse as the organic waste source resulted in one of the best Bermuda grass coverage. Perennial peanut planting have been slow but are continuously expanding.

TECHNICAL SESSION 2: Wetlands A

Mary C. Landin, PhD, Chair

TWENTY-FIVE YEARS OF LONG-TERM MONITORING OF WETLAND PROJECTS CONSTRUCTED WITH DREDGED MATERIAL, WITH COMPARISONS TO NATURAL WETLANDS, THROUGHOUT U.S. WATERWAYS

Mary C. Landin, PhD, PWS
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi USA

The US Army Corps of Engineers (Corps) Waterways Experiment Station (WES) has constructed a number of wetland and multiple habitat sites over the past 25 years. Over 1,000,000 acres of wetlands have been restored, created, protected, managed, and/or acquired under the Corps' various missions during that time. Prior to the early 1970's, the Corps "built" many wetlands incidentally to navigation and flood control projects, especially in the coastal zone, through the placement of dredged material adjacent to shorelines or during island creation when the Intracoastal Waterway System was constructed, while river, lake, and estuarine navigation channels were maintained, and when navigation channels were deepened and widened for various U. S. major rivers and ports. The Corps is also aware that it changed many wetlands during that same time period due to raising wetland elevations and construction of flood control levees, and similar civil works projects in an era when there was little understanding of the occurring or cumulative impacts.

During early Corps research programs, it constructed seven wetlands in the 1970's and four wetlands in the early 1980's using dredged material for purposes of detailed study and investigation as part of their goals. Broad research objectives for these projects included (1) restoration and/or creation of a functional wetland at a multiagency-chosen project location; (2) comparison of the wetland to similar nearby natural wetlands; (3) develop project plans, designs, contract specifications, and construction information that could be used as guides for similar wetland construction; (4) conduct both environmental and engineering short-term and long-term interdisciplinary evaluation and/or monitoring of these wetlands; (5) based on monitoring, determine the success or failure of these sites, as well as the lengths of time take to function as wetlands; (6) publish these findings in Corps and peer-reviewed literature, and use the information for technology transfer to aid the various Corps missions where wetlands restoration and creation is a factor (now including mitigation and mitigation banking). These sites are: (1) Gaillard Island, lower Mobile Bay, AL; (2) Pointe Mouillee, western Lake Erie, MI; (3) Lake of the Woods, Warroad, MN; (4) Southwest Pass, lower Mississippi River, LA; (5) Nott Island, Connecticut River, CT; (6) Windmill Point, James River, VA; (7) Buttermilk Sound, Altamaha River, GA; (8) Drake Wilson (Two-Mile) Island, Apalachicola Bay, Apalachicola, FL; (9) Bolivar Peninsula, Galveston Bay, TX; (10) Salt Pond #3, south San Francisco Bay, CA; and (11) Miller Sands Island, Columbia River, OR. They were compared to a total of 29 nearby, similar natural wetlands, and each one had from one to three natural wetlands monitored and compared. Although the dredged material wetlands were newly constructed, and are now between 14 and 25 years old, the natural wetlands' known ages ranged from 60 to 4,500 years old.

Since these eleven sites were built, the Corps under its navigation and flood control missions has restored and/or created a number of newer wetlands using dredged material as (as part or all of their substrates) or worked with 404(b)(1) permit applicants to design wetlands that do not yet have as long nor as extensive data sets (some examples are Jetty Island extension and Goglehite Wetland, Puget Sound, WA; several sites in the lower Columbia River, OR; Weaver Bottoms, MN; upper Snake River, Jackson Hole, WY; Kenilworth Marsh, Eastern Neck, and a number of other Chesapeake Bay, MD sites; Winyah Bay, SC; Aransas, West Bay, and numerous other sites in the Texas Intercoastal Waterway; several wetlands in the intertidal Delta and San Pablo Bay area of San Francisco Bay, CA; Riverlands, MO/IL; Lake George, MS; Tennessee-Tombigbee Waterway wetlands, TN/MS/AL---there are numerous others). Most of these sites are being monitored either as part of an agency structured monitoring plan or by volunteer efforts, and several will be the subject of other papers in this workshop. Important wetland restoration projects at Batiquitos Lagoon, CA, and the Houston Ship Channel, TX, that are being carefully monitored were constructed by the Ports of Los Angeles/Long Beach and the Port of Houston, respectively, using information obtained from Corps dredged material wetland research.

The information from the original eleven sites has been published in a series of 40 Corps technical reports, used in the writing of several Corps engineer manuals, two interagency engineer manuals published by the USDA Natural Resources Conservation Service, books and book chapters on wetland restoration and creation, and in numerous peer-reviewed journals and conferences. A more recent utilization of this extensive data set is its extrapolation and use by the Corps regulatory offices for dredge and fill-permitted wetland creation and restoration work. Created mitigation wetlands are still highly subject to failure due to improper location, design, and construction, and the Corps is striving to understand what can be done to make mitigation in practice more reliable and functional.

Engineering monitoring of the eleven sites included structure integrity, elevation changes, hydrology and hydraulics, erosion and/or configuration changes, and physical soil parameters. Environmental monitoring of the eleven sites included colonization and utilization by fish and wildlife species, including benthos and aquatic invertebrates; water quality; biological soil changes; vegetation colonization, survival, productivity, and stabilization; and general condition, health, and sustainability of the wetland. Initially, data were collected prior to construction, during construction, and post-construction (first three years) at intensive levels (monthly, seasonally). In out-years, data have been collected annually from year 4 through year 9, then every 3-5 years afterwards as funds were available. On the oldest wetlands monitored, data sets are 25 years old. Due to limitations of funding in out-years, not all parameters were measured at each sampling period, but observational data were collected instead. Where Corps contracts were in place, contractors collected data and provided reports and/or field data for analysis to the Corps. In the case of Gaillard Island, the State of Alabama took over monitoring in 1987, and have collected those data since that time.

Each of the eleven sites, with their comparison natural wetlands, has an individual set of results and some are very site-specific. Furthermore, the sites represent the diversity in geographic, soils, and climatic conditions under which the Corps must work routinely. Some are coastal and saline and some coastal and fresh intertidal; others are freshwater riverine or lacustrine. They ranged in size from 5 acres to 4600 acres. Summary results of overall wetland survival, growth, and sustainability for wetland restoration and creation, based on these and other Corps studies, are:

(1) Above-ground wetland vegetation biomass, wildlife, and fisheries compared very favorably with natural wetlands, and some were more heavily utilized than the natural reference sites. Exceptions included conditions where sandy substrates did not trap fines very fast (Bolivar Peninsula) or where erosion occurred due to poor location (Windmill Point). The Bolivar Peninsula site didn't match natural wetlands in macroinvertebrates for 15 years, but the Windmill Point did so immediately. Another exception occurred when the manmade site did not adequately develop its own tidal channels or creeks, and access for finfish and shellfish was not adequate (Salt Pond #3 and Bolivar Peninsula).

(2) Below-ground wetland vegetation and biological/chemical components of the substrate took as much as ten years to adequately match those of natural wetlands. Often, the above-ground biomass was abundant in early years, and was being supported by highly nutrient-enriched soils which required less below-ground biomass than older wetlands. Typical wetland soil profiles and chemistry took several years to develop, but once present, persist.

(3) New wetlands built with nutrient-enriched dredged material flourish initially, and even out over time to equal more typical wetland growth patterns. All of the sites exhibited these characteristics.

(4) Some of the studied sites required initial stabilization with temporary breakwaters until the substrates were vegetated and well established due to moderate wave energies and long wind fetches. One site, Pointe Mouillee, required a permanent breakwater due to wave and wind energy, ice, and need to contain contaminants, which has served very effectively. Another site, Windmill Point, had a dike failure, which caused the center of the wetland to wash out and become shallow water riverine habitat.

(5) Sites where careful attention was not paid to water energy, hydrology, and location (siting) within their landscapes resulted in partial failures due to subsidence, erosion or excessive trapping of sediment that changed the intended wetland from one type of a wetland to another type. One site, Bolivar Peninsula was originally to be low marsh, high marsh, and upland. Over time, the site subsided and it is now entirely low marsh. Another site, Southwest Pass, has such a dynamic subsidence rate that for each two acres constructed with dredged material, one acre will subside in about ten years. However, subsidence can be purposely addressed using dredged material. Lake

of the Woods eroded to a point of being completely submerged, but is supporting dense freshmarsh vegetation.

(6) All the sites reached a level of stability over time, and are changing less rapidly now. Although the wetlands appear visually to be stable and unchanging, subtle species changes are noted, and photographic records over time indicate some changes in configuration, elevation, and communities still occurring.

(7) Sites are still providing significant habitats for wildlife and fish abundance and diversity. Each of the eleven sites are supporting one and usually more rare, threatened, and endangered species which utilize the wetlands for all or part of their life requirements. One site, Miller Sands Island, has been listed as critical habitat for salmonid species in the Columbia River.

(8) Substrate (dredged material) stabilization was critical in moderate wave energy conditions, and edge erosion creep is evident where this is the case. Sites evidencing this problem are Salt Pond #3 and Apalachicola Bay.

(9) Statistical analyses of planted wetland vegetation, propagation, fertilization, germination, survival, and reproduction were made at eight sites to help determine what species worked best, and under what conditions. It was determined that under most conditions, vegetative propagules worked better than seeds, no fertilizer was necessary for long-term plant cover, and denser plantings (0.5 m centers vs. 1.0 m centers) did not matter over time. Coastal sites required planting, while freshwater sites most often could colonize naturally. Natural colonization was also documented, and Point Mouillee, Windmill Point, and Lake of the Woods were naturally colonized rather than planted.

(10) Larger wetlands, whether manmade or natural, tended to be more diverse, and provided for more fish and wildlife use than smaller wetlands, as well as met other wetland functions. Examples of larger sites were Miller Sands Island, Gaillard Island, and Pointe Mouillee, all of which provided significantly more habitat of all types and met other functions than did the smaller wetlands. Extrapolated, larger dredged material, or dredge and fill, wetlands tend to function better than smaller wetlands (although there is still a place for some pocket wetlands within landscapes). This is one of the reasons that the Corps is now more willing to consider use of larger mitigation banks rather than small, piecemeal mitigation projects that are often doomed to failure from conception.

There are many other results from these studies, and all the information gained can be used to build future wetlands or make restorations and repairs to degraded wetlands. If correctly planned, placed, designed, and implemented, with follow-up monitoring and on-site corrections if necessary, wetland restoration and creation using dredged material (dredge and fill) is feasible, predictable, economically efficient, and successful. Realistic goals and objectives, economics, and management plans are critical to make a wetland project work.

No wetland, manmade or natural, will meet all recognized functions of wetlands because not all functions are applicable to each wetland type, and no manmade wetland should be designed to attempt this. There are many reasons for restoring and creating wetlands, and mitigation for dredge and fill, and wetland restoration and creation using dredged material from navigation or flood control projects, are just two of them. Twenty-five years of data proving that dredged material wetlands can be built is a track record of which the Corps is very proud.

HABITAT RESTORATION USING DREDGED MATERIAL: THE SONOMA BAYLANDS WETLAND DEMONSTRATION PROJECT

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The Sonoma Baylands Wetland Demonstration Project is restoring tidal salt marsh on 289 acres of diked land using 1.9 million cubic yards of dredged material. The project site is located on the northern shoreline of San Francisco Bay in Sonoma County, California. Construction of the wetland restoration project was authorized by Congress in 1992. The San Francisco District, Corps of Engineers is currently completing construction of the project.

Initial planning for the Sonoma Baylands project was conducted by the California State Coastal Conservancy and the Sonoma Land Trust. The design of the project incorporates lessons learned through the review of past tidal wetland restoration projects in San Francisco Bay. Rather than attempting to construct an "instant marsh," the project is designed to allow a tidal salt marsh system to naturally develop over a relatively short period of time while minimizing construction costs. Dredged material is being used to accelerate the re-establishment of intertidal marsh elevations on the former tidal wetlands, which had subsided about six feet. The final surface of the restored marsh, including the tidal channel system, will be created by the natural deposition of suspended sediment on top of the dredged material following the restoration of tidal action.

Construction of the Sonoma Baylands project began in June 1994. Approximately 207,000 cubic yards of maintenance-dredged material from the Petaluma River navigation channel were hydraulically placed in a 29-acre pilot unit in Fall 1994. The following year, approximately 1.7 million cubic yards of suitable dredged material from the Oakland Harbor deepening project were placed in the 260-acre main unit by hydraulic pipeline from a temporary barge pump-out site. The pilot and main units were reopened to tidal action by breaching the former bayfront levee in January and October 1996, respectively. The total construction costs, including lands and design costs, are projected to be $7.6 million. These costs include the additional cost of transporting Oakland Harbor dredged material to the restoration site in lieu of ocean disposal.

Other significant project features included the construction of 11,700 linear feet of new levee along the landward periphery of the restoration site to allow the site to be opened to unrestricted tidal action. A series of earth berms was constructed within the restoration site to act as wind-wave barriers, direct channel formation away from the peripheral levee, and facilitate the hydraulic placement of dredged material within the site. Twenty-one electrical resistivity staffs were installed within the pilot and main units to allow remote monitoring of the placement and subsequent consolidation of the dredged material. This was the first known use of electrical resistivity techniques to monitor the hydraulic placement of dredged material.

In addition to describing the history, design and construction of the Sonoma Baylands project, the presentation of this paper will also include the most current results of initial post-construction monitoring of the physical and biological development of the restored wetland.

BENEFICIAL USE OF DREDGED MATERIAL FROM THE DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT TO CREATE/RESTORE/PROTECT WETLANDS IN THE DELAWARE BAY

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Based on the findings of the February, 1992 Delaware River Comprehensive Navigation Study Main Channel Deepening Interim Feasibility Report and Environmental Impact Statement, the Preconstruction Engineering and Design (PED) Study efforts were initiated in March, 1992. The feasibility study recommended modification of the existing Federal Navigation channel from 40 feet at mean low water to 45 feet. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia/Camden waterfront, a distance of about 102.5 miles.

The proposed project includes all appropriate bend widening as well as provision of a two space anchorage at Marcus Hook. Approximately 33 million cubic yards of dredged material would be removed for initial construction over a four year period. Dredged material from the river would be placed in additional confined upland disposal areas. Material excavated from the Delaware Bay would be primarily sand and would be used for beneficial purposes including wetland environmental restoration and underwater sand stockpiling. The proposed channel deepening project was authorized in October 1992 as part of the Water Resources Development Act of 1992.

A critical component of this feasibility study is the design of the beneficial use projects including Kelly Island, Delaware, and Egg Island Point, New Jersey wetland restoration sites to benefit target species. These wetland areas are presently experiencing erosion of from 15 to 30 ft per year. The Kelly Island site will consist of a 60 acre intertidal *Spartina alterniflora* marsh made from a mixture of sand and silt substrate, enclosed by a + 10 ft MLW crest elevation sand dike, approximately 5000 ft long, and from 200 to 350 ft wide, with a sand filled geotextile tube core. It will have a water control structure for post-construction water level management and tidal flushing that allows for the exchange of aquatic organisms. The sand dike will provide spawning habitat for horseshoe crabs (*Limulus polyphemus)*, as well as nesting and feeding areas for waterbirds.

The southeastern side of the existing marsh at Egg Island Point will be protected by a single geotextile tube structure, with a crest elevation of +5 ft MLW, placed on top of a dredged material sand foundation built to elevation 0 feet MLW. The 135 acre area within the lee of the structure will be filled with sandy dredged material to an elevation of + 5 feet MLW, and extend for approximately 1.7 miles along the shoreline. These elevations will be inundated daily during high tide periods. A combination of intertidal marsh and shallow open water habitat is expected to develop behind the tube. The sand placed in the lee of the breakwater should provide abundant horseshoe crab spawning habitat, unless it becomes vegetated. Waterbirds, shorebirds, and juvenile fish will use the low marsh and tidal pools and, any washback of sand into the high marsh zone would provide both additional horseshoe crab spawning areas, and potential tern, gull, and other waterbird nesting areas.

A staggered alignment of single geotextile tubes, 200 ft long, with a crest elevation of +5 ft MLW, with one set of tubes close to the shoreline, and a second set of tubes about 50 feet offshore will be placed along two miles of the northwestern shoreline of Egg Island Point. This area will have no fill material placed behind the tubes, and is designed to reduce the erosion rate of the existing marsh without blocking tidal flow or access by aquatic organisms.

DESIGN OF SAND DIKE FOR WETLANDS AND BEACH RESTORATION AT KELLY ISLAND, DELAWARE

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As part of the Delaware River channel deepening project, Kelly Island, DE is designated a beneficial use site for dredged material placement. The primary project objective is to provide one mile of shoreline protection for the southern end of Kelly Island. The project must use 200,000 cubic yards of silts and at least one million cubic yards of sands removed from the channel. The final project design will consist of 60 acres of restored wetlands with a sandy beach for horseshoe crab, shorebird, and waterbird habitat. Additionally, the project will provide partial protection of the Mahon River entrance.

The sand containment dike must successfully protect the 60-acre wetland for a minimum of 10 years. The wetlands configuration requires a 5,000-ft long containment dike along the -6-ft, MLW, contour. To minimize overtopping which might adversely affect the wetlands, the dike crest elevation will be +10 feet, MLW, representing a 10- to 25-year return water level. In evaluating the optimum design volume for the sand dike, losses in crest width resulting from storm damage and daily longshore transport were evaluated separately.

Storm crest-width losses were evaluated two-dimensionally by employing SBEACH, a numerical model which simulates cross-shore beach- and nearshore-profile response to storm events (Rosati et al., 1993). Using wave parameters representing storm events corresponding to 2- through 25-year return events provided by Ocean and Coastal Technology, Inc. (OCTI), several SBEACH simulations were made. First, initial equilibrium profile adjustment was estimated using the 2-year event and assuming a 1:20 initial side slope. This SBEACH simulation indicates a crest-width reduction of 20 feet and a slope change to 1:40. SBEACH simulations using an initial cross-section which reflects the 1:40 equilibrium slope were run for the various return events. Only the 25-year event simulation showed significant crest-width losses, i.e. 30 feet. This return event is represented by a wave height and period of 8.2 feet and 13.4 s.

Net northerly longshore transport rates predicted by OCTI ranged from 25,000 to 50,000 cu y per year. Assuming sand is removed from the berm's offshore slope in a layer of uniform thickness, the crest width will recede 13.5 ft per year, on average. Summing the computed recession values due to longshore transport over 10 years, the initial equilibrium adjustments, and losses due to a 25-year event results in a minimum crest width of 185 feet. Rounding up to a 200-ft crest width corresponds to a total dike volume equal to 1.7 million cubic yards.

Rosati, J.D., Wise, R.A., Kraus, N.C., and Larson, M., 1993. "SBEACH: Numerical Model for Simulating Storm-Induced Beach Change, Report 3, User's Manual," IR CERC-93-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

TECHNICAL SESSION 3: Hart-Miller Island Panel

Wayne Young, Chair

HART-MILLER ISLAND: FROM REMNANT ISLANDS THROUGH CONTAINMENT FACILITY TO PARK AND NATURAL RESOURCES AREA

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Construction of the 1100-acre Hart-Miller Island Dredged Material Containment Facility (Hart-Miller) was motivated by a statutory and practical need to contain contaminated dredged material from the Patapsco River and to provide placement capacity for channel maintenance and improvement needed to maintain the Port of Baltimore's competitiveness for maritime commerce. The facility was specially constructed and is operated to provide for environmentally sound and safe containment of contaminated sediments. Although not initially billed as a "beneficial use" project, Hart-Miller continues to be developed and used as a multi-purpose site which provides substantial environmental, social, and economic benefits. Under an arrangement between the Maryland Port Administration (MPA), which sponsored construction, and the Maryland Department of Natural Resources (MDNR), which holds title to the property for the State of Maryland, the entire complex will be completely converted into a recreational and natural resource area once deposition of dredged material is concluded. The containment facility was vigorously opposed through litigation that culminated in a US Supreme Court decision which enabled project implementation.

Perimeter dike construction to +18 feet mean low water (MLW) began in 1981 and was completed in 1984. The dike system reunited and protected the fast eroding remnants of Hart and Miller Islands at the mouth of Back River and established a recreational beach between them. The facility has provided shelter for the constructed beach, preserved shallow water habitat surrounding the remnant islands as well as containment island habitat, and provided physical protection for the shorelands to the west from wind-generated waves, winter storms, and the movement of large ice floes. The MDNR established a park facility that today consists of a park ranger station, recreational beach, self-composing toilet systems, boardwalk, observation tower, primitive camp sites, and nature trails. A second-tier dike system to elevation +28 feet MLW was completed in 1989 with an accompanying commitment not to raise the dikes again. This was necessitated when opposition to ope-water placement of dredged material precluded use of this traditional placement alternative.

The containment cells have been operated by the Maryland Environmental Service (MES) for the MPA since 1984. These activities and advice on habitat park development have been reviewed by the State-chartered Hart-Miller Island Citizens Oversight Committee. Discharges from the facility are performed under a state discharge permit administered by the Maryland Department of the Environment, which also conducts a rigorous environmental monitoring program to safeguard Chesapeake Bay's aquatic environment. While active, the containment cells have served as valuable "interim" wildlife refuges for waterfowl, with freshly placed dredged material providing benthic organisms as food sources. MES, under MPA sponsorship, has in recent years conducted an aggressive crust management program to optimize consolidation of dredged material insofar as practical, thereby increasing facility capacity and useful life while concurrently allowing more time to continue the search for suitable alternative placement options. MES experimented with and refined crust management techniques in coordination with the MPA which have proven to be very effective for a large-scale confined disposal facility. Deposition in the South Cell was completed in 1990, after which MES conducted crust management to further consolidate the materials. A concept plan for conversion of the South Cell to wildlife habitat and perched wetlands for wildlife utilization, combined with upland/island forest, was developed by the US Army Engineer Waterways Experiment Station Environmental Laboratory (M. C. Landin) for the MDNR, MPA, and MES in 1993-1994.

Although a very substantial effort was made for over a decade to find and secure alternative placement sites, participants in the multidisciplinary, inter-organizational Dredged Needs and Placement Options Program sponsored by the MPA and facilitated by MES concluded in August 1994 that it was necessary to reconsider increasing the height of the Hart-Miller dikes so that safe navigation in existing channels could be maintained in the near term. After extensive institutional and public coordination and involvement, the State decided to expedite conversion of the South Cell for passive recreation and wildlife habitat, and to raise the North Cell dike system to +44 feet MLW. Modifications to the State wetlands license and discharge permit and the federal Clean Water Act 404 permit were obtained. The Maryland Department of Transportation also committed to establishing a visual screen of native upland/island-adapted tree species on the back slope of the recreational beach (called for in the WES Concept Plan). A phased, $13.4 million, 4-year construction program was developed by the MPA, MES, and the engineering design consultant, Gahagan and Bryant Associates, and begun in mid-1996. MES managed design construction for the MPA. On-site borrow material was excavated from the South Cell using bulldozers and a dragline, transported to the North Cell via off-road dump trucks and placed onto the back slope of the second tier dike. New spillways were constructed. Close coordination by the full construction team consisting of the MPA, MES, engineering design and geotechnical consultants, and dike and spillway sub-contractors overcame significant uncertainties associated with the South Cell borrow areas and other site-specific conditions. The results of this coordination and the use of the rental arrangement for construction equipment and operators rather than a construction contract enabled accelerated construction. Raising the perimeter dike to +44 feet MLW was completed in May 1997 at 50 percent of the cost and three years ahead of schedule.

MES, on behalf of the MPA, arranged for the planting of 200 4-inch-diameter trees in three stands on the western perimeter dike. The planting began in Fall 1996 and was completed in April 1997. Also on behalf of the MPA, MES contracted for the Alliance for the Chesapeake Bay to supply volunteers to plant 6000 smaller trees and cuttings during March-April 1997. MES also donated 20,000 cubic yards of compost made from yard waste which was transported to Hart-Miller under oversight of the MPA and stockpiled in the South Cell for use in the tree buffer plantings and in converting the South Cell into wildlife/wetlands habitat. The Baltimore Corps District, in coordination with the MDNR, MPA, and MES, is conducting a Section 1135 project for the South Cell habitat conversion. The Maryland General Assembly subsequently codified specific termination criteria for conclusion of dredged material deposition and conversion of both cells for recreation and habitat. Meanwhile, the dredged material placement cycle and essential maintenance of harbor and approach channels were continued without interruption.

The seven panelists from MPA and MES will discuss Hart-Miller Island conception, baseline, planning, design, construction, monitoring, and management aspects of the 16-year-old island and solicit questions and comments on their project from workshop participants.

TECHNICAL SESSION 4: Economics and Challenges of Beneficial Uses of Dredged Material

Carol A. Coch, Chair

THE ECONOMICS OF UPLAND DREDGED MATERIAL MANAGEMENT AND BENEFICIAL USE: A CASE STUDY IN SAN LEANDRO, CALIFORNIA

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The City of San Leandro, in the San Francisco Bay Area, has recently implemented a comprehensive management plan for its existing 100-acre onshore dredged material disposal site. The City has, for more than twenty years, used the site for upland disposal of dredged sediments generated during periodic maintenance dredging episodes at the City's nearby marina. This site is the only operating upland dredged material disposal site in the Central and South Bay regions.

As part of a mitigation package developed to satisfy regulatory requirements, the City recently developed a management plan to enable a greater range of beneficial uses for its dredged material. In particular, the plan had the overall purpose of enhancing the value of the Dredged Material Management Site (DMMS) as seasonal shorebird and other water bird habitat in ways that were compatible with its primary function of dredged material drying and temporary storage.

At an initial cost of over $2 million, the City reconfigured the site by constructing new levees and removing previously deposited dredged material to achieve suitable elevations for habitat enhancement. In addition, islands were constructed within the site to increase shoreline edge and to provide resting habitat for water birds, while weirs and culverts were installed to enable appropriate water circulation. With these improvements, the site can be flooded seasonally with tidal water from San Francisco Bay to provide an invertebrate food supply for shorebirds. Introduction of the tidal water was made possible by completion of a separate but related City project to enhance approximately 172 acres of adjacent diked wetlands at a cost in excess of $1 million.

The DMMS began its first full season of operation in the Fall of 1996. Monitoring of the site has thus far indicated increased use by migratory and resident waterfowl and shorebirds.

While implementation of the City's DMMS management plan will likely demonstrate that dredged material management and habitat management can beneficially coexist, the City faces considerable economic pressures as it copes with the high cost of disposing of its dredged material in this manner. Dried dredged material removed from the site has thus far been used beneficially as cover material for nearby sanitary landfills and also in the adjacent San Leandro Shoreline Marshlands wetland restoration project. However, the requirement to "double handle" the material and truck it off-site has resulted in significant expenditures on the City's part. The net unit cost to dredge and dispose of dredged material using the upland DMMS has been as high as $18.00 per cubic yard, more than twice the estimated cost for in-Bay aquatic disposal.

The emerging Long Term Management Strategy for the placement of dredged material in the San Francisco Bay Region emphasizes increased upland disposal coupled with wetland habitat creation and/or restoration. Action alternatives currently under consideration would promote a region-wide doubling to a quadrupling of dredged material managed in this way. While the San Leandro experience appears likely to demonstrate that this approach is environmentally desirable, there remain serious questions with regard to the financial feasibility of this approach, particularly for the smaller ports and harbors of the Bay Area.

THE CVN HOMEPORTING PROJECT IN SAN DIEGO BAY: A SERIES OF CHALLENGING ISSUES SURROUNDING THE BENEFICIAL REUSE OF NINE MILLION CUBIC YARDS OF SEDIMENT

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The Base Realignment and Closure (BRAC) Commission directed that the CVN aircraft carrier assets of Naval Air Station (NAS) Alameda, California, be reassigned to NAS North Island in San Diego Bay, California and to Puget Sound, Washington. Berthing a CVN in San Diego Bay requires a considerable amount of new facilities construction and dredging. To ensure the safe and routine navigation of a CVN, the turning basin adjacent to the existing carrier wharf and the San Diego Bay Navigation Channel must be deepened to -50 ft MLLW. This project will ultimately yield over 9 million cubic yards of sediment. Construction is scheduled to be completed in 1999 in time for the arrival of the USS John Stennis, CVN-74.

Chemical and biological testing of the proposed dredged material indicated that the majority of the sediment was sandy and free of chemical contamination, consequently, 7 million cubic yards of material were permitted for beach replenishment. A smaller portion of the sediment, approximately 2 million cubic yards, was determined to be suitable for placement at the designated open ocean disposal site located 5 miles offshore of San Diego. This material was clean, but not sandy enough for beach placement.

Approximately 100,000 cubic yards of sediment was deemed unsuitable for open ocean placement due to chemical contamination that resulted in significant toxicity in laboratory bioassay analyses.

The greatest beneficiaries of the CVN Homeporting Project will be badly eroded San Diego County beaches ranging from Oceanside to the Mexican border. The Navy and the San Diego Association of Governments (SANDAG) identified potential receiver beaches base on their need and the potential impacts of the disposal operation on sensitive resources (e.g., surfgrasses and reefs).

A secondary benefit of this project is the construction of a 13-acre fill site which will serve as a new carrier wharf. This wharf is situated on top of an Installation Restoration (IR) site which is located in the nearshore area adjacent to the existing aircraft berthing wharf. Development of this fill area will effectively eliminate contact by bay water and sensitive receptors from the IR site sediments.

To mitigate for filling 13 acres of bay bottom, the Navy has designated a 16-acre site at NAS North Island to be excavated back to bay level. This area will be planted with eelgrass, and rock structures will be deployed to serve as fish habitat. Soil excavated from this area, which is historic fill from bay dredging, is being used as habitat enhancement for nearby least tern and snowy plover nesting sites.

A CASE FOR EXPANDING TRADITIONAL USES OF DREDGED MATERIAL

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Beneficial re-use of dredged material from navigation and flood control projects are essential to the sediment budget of West Coast littoral cells. Littoral cell sediment budget issues are merely a sub-set of larger issues associated with watershed management. Unfortunately, upland policies of watershed management, especially flood control and water storage, have driven management decisions and strategy with little regard for downstream issues related to beach erosion and littoral cell sediment deprivation.

In coastal southern California alone, flood control and water resource structures possess sediment impoundment capacities in excess of three billion cubic yards. Additionally, impoundments occur from management decisions related to navigational and commerce purposes on navigable waters. These management decisions have profoundly impacted the coastal environment, changing the shape and nature of the shoreline and altering the biological resources and beneficial uses.

In recent years, local governments, prompted by growing public concern, have sought low cost sources of sediments for beach replenishment including: terrestrial borrow sources, dredged material, and offshore borrow sources. Efforts to utilize these sources have often been stymied because they fall outside the narrow criteria of what is considered "beach compatible" by federal regulatory and resource offices (EPA, Corps, NOAA National Marine Fisheries Service, US Fish and Wildlife Service). Regulatory concerns often focus on excessive fine-grained sediments in potential re-use material, as this fraction is believed to produce significant impacts of biota through burial, turbidity, contaminant exposure, and impacts of exposed hard-bottom habitat. These concerns are often misdirected, as nearshore biota are naturally adapted to large seasonal movement of sediments and changing sediment depths.

Nearshore infauna avoid or recover rapidly from moderate burial and turbidity, as many are effective burrowers and/or highly mobile. Large organisms like sand dollars tolerate some burial, but often move offshore in winter, affording opportunities for beach replenishment with minimal impact. Eel grass habitats are not plentiful on the open coast, but where these areas occur, beach replenishment should be limited or mitigated by replanting upon project completion. Similarly, nearshore biota including algae are adapted to seasonal changes in turbidity associated with storms, seasonal movement of littoral sediments, and run-off from precipitation. Thus, disposal of fine sediments onto beaches can be managed to reflect natural cycles to reduce replenishment impacts. Furthermore, some biota (e.g., amphipods and cumaceans) are actually attracted to turbidity plumes associated with beach replenishment using dredged material.

The fear that fine-grained sediments deposited on the beach will move and bury exposed hard-bottom habitats has some validity. However, for many areas of the California coastline these exposed hard-bottom habitats are an unnatural condition resulting from mis-management of the watershed. Public sentiment seems to be favoring beaches over cobbles and intertidal rocky habitats.

Finally, it is important to understand that fine-grained sediments in the nearshore environment is part of the natural watershed and littoral cell cycle. On uncontrolled rivers, sediment content during high volume flows typically consists of 85-95 percent suspended loads of clay and silt. These fine-grained sediments are distributed throughout the nearshore environment and then reworked by wave resuspension and littoral transport to areas of deposition. The deposition of fine-grained sediments upon our beaches is not a long-term solution, but it helps supplement littoral sediment losses with few adverse impacts and provides many beneficial uses and the maintenance of vanishing habitats. Critical to the discussion in our presentation is the question: is current regulatory guidance maintaining much higher standards for turbidity and sediments than that occurring naturally?

AN ESTIMATION OF AVERAGE COSTS AND PERCENTAGES OF BENEFICIAL USES FROM THE MAINTENANCE OF FEDERAL NAVIGATION CHANNELS BY U.S. ARMY CORPS OF ENGINEERS DISTRICT

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The volume of material produced by the New Orleans District, U.S. Army Corps of Engineers' (MVN) maintenance dredging projects for Federally-maintained navigation channels are among the greatest volume projects of any Corps dredging projects in the U.S. Because of this, fixed costs as a percentage of total project costs are low. The average cost of the typical MVN dredging project is therefore among the lowest of all such projects in the nation.

The Louisiana Department of Natural Resources (LDNR), Coastal Management Division, has a strong interest in the beneficial use of Louisiana dredged material. Louisiana's coastal zone suffers from a combination of sediment starvation, subsidence, and erosion which are causing the loss of an average of 29 square miles of important coastal wetlands per year. Fortunately, there are numerous shallow open water areas in close proximity to many of Louisiana's Federally-maintained navigable waterways that are favorable for the beneficial use placement of dredged material resource for wetland restoration or enhancement.

Because of LMDR interest, research efforts were undertaken to compare the average costs of dredged material disposal for the MVN to those of other Corps Districts. Pre-dredge estimates of total cubic yardage of material and total project cost were obtained for the years 1990 to 1995 from the Corps Navigation Data Center, Dredging Statistics Program. For each Corps District in the United States that reported dredging information to the Navigation Data

Center, total pre-dredged estimates of quantities of dredged material to be disposed and the total dollar amounts of the winning contract bid for a maintenance event were summed in a Lotus spreadsheet. Average costs per Corps District were computed as the sum of winning contract bids divided by the sum of estimated cubic yards of dredged material per fiscal year. Tables presented summarizes the results for fiscal year 1995.

An additional research need which was identified was the amounts and total percentages of dredged material disposal used beneficially. For the purposes of this study beneficial use was defined as any environmental enhancement project, land creation for development, or any project that has positive benefits to society. A data field titled "disposal type" in the Dredging Statistics Program data base contains codes for dredged material disposal procedure used. Two of the codes within this data field, "beach nourishment" and "wetlands nourishment or creation", are clearly and easily quantified as an environmental enrichment beneficial use. However, the remainder of the data codes are ambiguous as to whether the disposal type can be considered a beneficial use. For example, the disposal type codes "confined", "mixed", and 'upland", all have the potential to be beneficial uses and to have positive environmental enrichment consequence or other benefit to society but the final fate of projects coded in that manner could not be determined. Refinement of the data input and coding is necessary to accurately reflect the actual amounts of dredged material beneficially used each year by the Corps.

For this presentation, the total estimated quantity of dredged material associated with the two unambiguous beneficial use data codes were summed by Corps district for 1995. In addition, the disposal code for "beach nourishment and upland disposal" was arbitrarily halved and summed with the two unambiguous disposal codes to obtain an rough estimate of percentage of dredged material used beneficially by Corps district in that fiscal year.

A telephone survey of dredging professionals employed in Corps districts across the United States was conducted to obtain an ad-hoc estimate of percentage of beneficial uses to compare with the estimate generated from the Dredging Statistics Program data. For Corps districts that could not be contacted, an ad-hoc percentage of district beneficial use of dredged material estimate was provided from Waterways Experiment Station (WES) project files on District work conducted and/or coordinated by WES. In addition, for the MVN, estimates of disposal activities were obtained from the MVN annual Dredging Conference information package for FY 95 and in Consistency Determinations submitted to the LDNR Coastal Management Division for specific dredging projects. The estimate generated by the more detailed information is also compared to the two previous estimates.

Based on the information received through the telephone survey and on the estimates generated with the detailed MVN dredging information, we estimate that 40 percent of all the material dredged by the Corps is used beneficially in some way. We also conclude that the current Dredging Statistics Program data field, "disposal type" is insufficient to compute accurate estimates of material used beneficially in the U.S. In most cases the Dredging Statistics Program data base probably underestimates Corps district beneficial use of dredged material. It would be helpful if protocols were developed by which more accurate beneficial use estimates may easily be generated. We feel that this information would be very useful to the Corps as well as states where navigation and flood control dredging occurs and to the dredging industry.

CORPS DIVISION/DISTRICT (does not reflect 1997 Division name changes within the Corps)	Average Costs to Dredge One Cubic Yard of Material	Percentage of Material Used Beneficially Based on Telephone Survey	Percentage of Material Used Beneficially Based on Dredging Statistics Program Data
LOWER MISSISSIPPI RIVER DIVISION			
VICKSBURG	$1.23	0 %	0 %
MEMPHIS	$0.84	0 %	0 %
NEW ORLEANS	$0.81	25 %	18 %
SAINT LOUIS	$1.26	< 10 %	0 %
NORTH ATLANTIC DIVISION			
BALTIMORE	$4.60	80 - 90 %	10 %
NEW YORK	$7.43	NO INFORMATION	92 %
NORFOLK	$3.47	20 %	9 %
PHILADELPHIA	$2.69	20 %	0 %
NORTH CENTRAL DIVISION			
BUFFALO	$3.65	< 5 %	0 %
CHICAGO	$3.58	<5 %	0 %
DETROIT	$6.42	40 %	30 %
ROCK ISLAND	$2.77 *	< 5 %	0 % *
SAINT PAUL	$5.59*	100 %	0 % *
NEW ENGLAND DIVISION (NO DISTRICTS)			
DIVISION TOTAL	$8.10	< 5 %	9 %
NORTH PACIFIC DIVISION			
ALASKA	$8.17	<10 %	12 %
PORTLAND	$1.72	90 %	< 1 %
SEATTLE	$3.77	90 %	3 %

MISSOURI RIVER DIVISION			
NO INFORMATION AVAILABLE			
PACIFIC DIVISION			
HONOLULU	NO INFO	0 %	NO INFO
OHIO RIVER DIVISION			
HUNTINGTON	$3.88	<5 %	0 %
LOUISVILLE	$4.33	0 %	0 %
PITTSBURGH	$8.58	0 %	0 %
SOUTH ATLANTIC DIVISION			
CHARLESTON	$1.60	40 %	0 %
JACKSONVILLE	$6.91	25 %	95 %
MOBILE	$1.91	20 %	2 %
SAVANNAH	$2.10	30 %	0 %
WILMINGTON	$2.83	100 %	48 %
SOUTH PACIFIC DIVISION			
SACRAMENTO	$11.59	30 - 40 %	0 %
LOS ANGELES	$8.28	20 %	32 %
SAN FRANCISCO	$1.94	25 %	0 %
SOUTHWESTERN DIVISION			
GALVESTON	$0.77	10 %	0 %
LITTLE ROCK	$0.92	0 %	0 %

* Based on 1993 Data, 1995 Data unavailable

TECHNICAL SESSION 5: Manufactured Soil B

Charles R. Lee, PhD, Chair

MANUFACTURED SOIL FROM MOBILE HARBOR DREDGED MATERIAL

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Manufactured soil was tested using dredged material from confined disposal facilities adjacent to Mobile Harbor together with International Paper cellulose mud or sawdust and reconditioned sewage sludge (N-Viro^R). Greenhouse screening tests indicated that plant growth in blends of dredged material and IPC cellulose mud were not as good as expected. While ryegrass grew, tomato, marigold, and vinca did not. Excess sodium in the industrial paper waste cellulose mud may have been a contributing factor. Sawdust improved growth, however, better growth was observed with 40 percent or less dredged material. Additional evaluations will be required to determine the reasons for the unexpected poor growth.

FEASIBILITY OF MANUFACTURING SOIL FROM TEXAS GULF INTRACOASTAL WATERWAY DREDGED MATERIAL

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Each year nearly 10 million cubic yards of sediment are dredged from the Texas Gulf Intracoastal Waterway (GIWW). Since many of the current disposal sites have become filled and more are being filled, alternatives to confined disposal facilities (CDF) are being considered. The Texas Department of Transportation in conjunction with the Center for Dredging Studies at Texas A&M University is investigating alternatives for the disposal of dredged material resulting from the long-term maintenance of the Texas GIWW. One of the proposed alternatives is to use dredged material in combination with other bio-solids to produce an artificial, or manufactured,

soil. The purpose of this paper is to discuss the applicability of manufactured soil as a beneficial use of dredged material and its feasibility for Texas.

Manufactured soil is created using dredged material and recyclable organic waste materials such as bio-solids (sewage sludge), animal manure, yard waste, and bio-mass (cellulose or saw dust). Manufactured soil helps reduce and recycle wastewater sludge and provides an alternative for the long-term management of dredged material disposal sites by reducing the area needed for the placement of dredged material in a confined disposal facility (CDF).

A limited number of studies and test sites have been used to demonstrate the ability of combining dredged material with sewage sludge to create a manufactured soil. Research by the Waterways Experiment Station in conjunction with local Corps of Engineers Districts has produced favorable results in the area of manufactured soil. By using these results, it is hoped that this technology may be applicable to the dredged material from the Texas GIWW.

There are several factors that need to be considered for this technology to be feasible in Texas. The site selection in terms of location, material, and marketing are paramount in determining the most economically feasible alternative. Location in terms of dredged material, sewage treatment facility, and potential markets all must be considered. The chemical composition of the dredged material must be addressed since the material from the Texas GIWW will have a significant salt content. The amount of salt will have an affect on the application of the manufactured soil. There are several salt resistant plants and grasses, and they should be considered as the intended cover that will grow in the manufactured soil.

There are many locations along the Texas coast suitable for this technology. Several areas have been reviewed, and a selection of two potential testing sites has been determined. The sites are Matagorda Bay near the mouth of the Colorado River and Port Bolivar on the Galveston Bay side of Bolivar Peninsula. The economic factors that control the final selection for the test site will be presented. In addition, the equipment required for the manufacturing the new soil product will be discussed.

MANUFACTURED SOIL FROM ST. LUCIE MUCK

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Muck removal from St. Lucie Estuary has been suggested as a way of restoring the estuary to a more productive ecosystem. The potential beneficial use of the muck as an ingredient to manufactured soil products and as an amendment to depleted, droughty sandy soil on the Herbert Hoover dike system surrounding Lake Okeechobee was studied in greenhouse screening tests.

Test results indicate that St. Lucie muck could be used as an amendment to Herbert Hoover soil at a rate up to 10 percent of the blend. Up to 50 percent St. Lucie muck could be used for manufactured soil that would be suitable for grass growth, provided the muck was rinsed to reduce the salinity or other growth suppressing factors. Additional reconditioning will be required for growth of tomatoes, marigold and vinca.

MANUFACTURED SOIL CONCEPT IN THE REHABILITATION OF HOUSING DEMOLITION SOIL AND MILITARY TRAINING LAND

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The manufactured soil concept was applied to barren, infertile housing demolition soil and depleted, sandy soil in military training land at Ft. Drum. Old housing areas were demolished

after new housing was developed on the installation. After demolition, infertile soil containing glass, pieces of roof shingles, wood fragments, nails and anything left over from the demolition was sparsely vegetated and an eyesore. In addition, intensive training with armored vehicles resulted in sparsely vegetated, highly wind and rainfall erodible training soil on many areas.

Greenhouse screening tests were conducted on both types of soils using organic waste materials and biosolids. Sawdust was blended with each soil along with either reconditioned sewage sludge biosolids (N-Viro^R) or reconditioned dairy cow manure (BionSoil^R). Ryegrass, tomato, marigold and vinca were grown in various blends to determine the most fertile mixture. The test results indicate that improved plant growth can be obtained through the appropriate blend of ingredients. The next stage of this technology development is a proposed field demonstration.

TECHNICAL SESSION 6: Wetlands B

Mary C. Landin, PhD, Chair

RIVER CORRIDORS AND WETLANDS RESTORATION AND THE POSSIBILITIES FOR THE BENEFICIAL USE OF DREDGED MATERIAL

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Recent efforts by the Environmental Protection Agency to initiate and support community-based restoration of river corridors should incorporate the use of dredged material where river sediments once sustained floodplain wetlands systems. While much of the historic focus of aquatic environmental statutes and regulations has been on contaminant controls and attaining chemical standards of cleanliness, river and stream health is significantly measured in physical and biological terms as well. Returning wetlands and floodplain habitat to modified river corridors is integral to addressing true watershed health, in both form and function. More commonly used in coastal and island creation projects, dredged material can also be applied to reinvigorate river floodplains that have long been denied sediment by levees and other water control measures.

The objectives of river corridors and wetlands restoration will be presented, including considerations of science, economics, and community participation. Opportunities and examples of dredged material use in restoration will be discussed.

MISSISSIPPI RIVER OUTLETS, VICINITY VENICE, LA: WETLAND DEVELOPMENT AND BIRD ISLAND DEVELOPMENT AT BAPTISTE COLLETTE

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In 1977, the Corps of Engineers enlarged the existing Baptiste Collette Bayou to provide navigation to the east bay area of the Mississippi River delta. Beneficial use of dredged material to develop wetlands was a contract requirement. Height restrictions of 2.5 and 1.5 feet MLG in wetland sites on the east side of the channel and 3.5 feet MLG at bird island sites were specified. In the next four maintenance dredging events, bird islands were the primary use of dredged

material. Material was restricted to a height of 3.5 feet MLG and the size of the islands were limited to five acres. Inspection of sites in 1984 indicated the need to adjust height requirements to achieve the wetland and bird island development goals. The restrictions were revised to a maximum height of 6.0 feet MLG in wetland sites with a final settled height of 2.5 feet MLG. The maximum height of dredged material placed on bird islands was revised to 8.0 feet MLG with a final settled height of 5.0 feet MLG.

In 1989 following a site inspection of the successful manmade wetlands on the east site of the channel, wetland development on the west commenced with the same height restrictions. In 1991, the maximum height for wetland development was revised to 4.0 feet MLG. In 1992 a new wetland disposal technique was incorporated into the plans. Perpendicular mounds were constructed outward from the channel followed by placement between two perpendicular mounds. In 1992 the wetland height restriction was revised to 3.5 feet MLG. The largest increase in acres of habitat occurred between 1992 and 1994. The increase is attributed to the perpendicular mound technique. In 1995 the dredged material height for bird islands was revised to a maximum height of 7.0 feet MLG.

Since the initial construction of the navigation channel through 1994 and with a limited quantity of dredged material (700,000 to 900,000 cubic yards annually), over 542 acres of habitat have been created. Habitat includes marsh, shrub/scrub, bare land and beach. Seventy-six species of salt and fresh water plants have been documented. The bird islands at Baptiste Collette have been nominated as a United States Important Bird Area because it provides essential habitat to significant numbers of breeding Caspian and gull-billed terns and roosting pelicans. Baptiste Collette is a diverse project which spans from the infancy in using dredged material for wetland development to the present. It is an example of the evolution of beneficial use from trial and error dredged material placement in 1976 to placement based on scientific data gathered through the implementation of a Beneficial Use of Dredged Material Monitoring Program with Louisiana State University, Baton Rouge in 1993.

Sources of information for this presentation came from Corps dredging contracts and files, the New Orleans District Beneficial Use of Dredged Material Monitoring Program, 1995 Annual Report, and Louisiana State University Coastal Studies Institute at Baton Rouge, LA.

DESIGN AND CONSTRUCTION OF BREAKWATERS/SHORE PROTECTION FOR CRITICAL MARSH HABITAT USING STACKED GEOTEXTILE TUBES

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The purpose of this presentation is to (1) describe the geotechnical investigations and design process for a single and "stacked" geotextile tube shore protection project, (2) present and discuss observations of the construction (to occur during May and June of 1997) and (3) list additional concerns to be addressed in future planned test construction projects.

The purpose of this test construction is to verify the constructibility and functional performance of a basic design for approximately 2.5 miles of breakwater/shore protection and approximately 25 miles of containment structure for dredged material. The dredged material is to be used in the construction of 1,600 acres of marsh habitat, in accordance with the Gulf Intracoastal Waterway (GIWW) long term Dredged Material Management Plan (DMMP).

The location of the project, on the GIWW, is north of Corpus Christi, Texas, adjacent to the Aransas National Wildlife Refuge (ANWR). Wind-driven waves within the GIWW, and effects of barge wake have caused erosion of the marsh areas in the refuge, the winter habitat for the endangered Whooping Crane. Much of the shoreline has been protected with articulated mat; however, at the project location, Sundown Bay separates the GIWW from the shoreline. Through coordination with US Fish and Wildlife Service (FWS), and other resource agencies, it was agreed that at this location, a breakwater would be most beneficial to the environment since it would both protect the shore from erosion and encourage the development of seagrass in the area behind the breakwater.

Several options were considered, including stone, and earth fill covered with articulated mats. The primary design concern was the soft foundation at the site. It was decided that a design using geotextile tubes could possibly be supported by the poor foundation, and that the design would be cost effective compared to other options. Also, it has been shown that oysters readily attach to the tubes in this area. Although the district has considerable experience with construction of sand-filled geotextile tubes (as discussed in a presentation by McLellan and Maurer in another session), the proposed design, and foundation conditions differ considerably from previous construction. Therefore, it was decided to construct one or more test projects to validate the design and constructibility prior to attempting to build the entire breakwater and begin construction of the Beneficial Use of Dredged Material (BUDM) marsh restoration contained in the DMMP.

The first scheduled test project includes (1) the placement of one 750-foot long, sand filled, 16-foot circumference, geotextile tube, (2) the placement of three "stacked" 500-foot long, sand- filled geotextile tubes, with two parallel tubes as the base and the other placed atop the first two and (3) placement of the three tube configuration described above, but filling the tubes with grout. Foundation conditions at the site generally consist of ten feet of soft to very soft clayey, silty sand, interbedded with thin layers of shell hash.

A considerable amount of foundation investigation work was undertaken to determine the location along the bay with the weakest foundation, which was the desired location for this test project. This proved to be more difficult than was expected. Shallow water limited access to the area. A conventional core drilling rig obtained disturbed samples with a split spoon sampler, but no strength information since undisturbed samples could not be retrieved and the top 10 feet of material could not support the drill stem. Precise information was obtained from electronic CPT tests performed at locations throughout the general area, (as described in WES Report, Cone Penetration Test (CPT) Over-Water Field Investigation and Data Evaluation for Sites along the Gulf Intracoastal Waterway, adjacent to the Aransas National Wildlife Refuge, near Rockport, Texas) but none of the tests were at the test project site. Therefore, the design was based primarily on shear strengths derived from penetration resistance readings taken with a proving ring, using a one square inch standard cone. Readings were taken at depth intervals of 0.25 feet to accurately record the layered nature of the stratigraphy. Once the test site (having the worst foundation) was located, investigations were performed every 100 feet along the proposed centerline of each tube. The cone was pushed to refusal at all locations. The cone results were supplemented with data from an 8 inch hand vane shear test performed at selected depths. Finally, physical samples of material were taken at various depths using PVC pipe, and physical properties and material classification determined.

The required widths of the tubes were calculated based on the Terzaghi bearing capacity equation, using undrained shear strengths determined as described above, using a factor-of-safety of 1.3. The target elevations of the tubes was set at the estimated mean high water elevation of +1.9 Mean Low Tide (MLT). The WES computer program GEOCOPS was used to determine tensile stress in the geotextile tubes during filling, and predict the shape of the filled tubes. A fabric strength of 1000 psi was specified for all tubes. A polyester material is expected to be proposed for the tube fabric. A seam strength of 180 psi was specified for the scour pad seams, as a result of previous seam failures. All other specifications were generally typical of manufacturer recommendations.

Monitoring at the site during construction will consist of elevation profile surveys along the tube centerlines, to be performed before construction, immediately after tube filling, and periodically thereafter, measurements of pressure at the inlet of the tubes during filling, sampling and determination of grain-size distribution of material selected by the contractor to fill the tubes, sampling and determination of grain size distribution of material retained in the tubes and general observation and video recording of the construction process. Expected lessons learned include: (1) problems in stacking sand-filled or grout filled tubes; (2) effectiveness of filling tubes with very fine sand, containing large percentages of silt and clay; (3) constructibility problems associated with filling tubes with grout; and (4) foundation behavior for each of the three designs.

Long-term monitoring will include measuring settlement both within the tube, and resulting from consolidation of the foundation materials, effectiveness of the scour pads (particularly the size of the anchor tubes, and strength of seams), the capability of the polyester fabric to maintain adequate strength over time in the site environment. Additionally, observations will be made regarding the wave-breaking effectiveness to determine optimum top elevation, effects of barnacles, oysters and other attached biomass.

Based on the results of this test construction, another test construction will be performed during the summer of 1998, to answer further questions. This test will be at a site having considerably weaker foundations than at Sundown Bay, and will focus primarily on applying what we learn at Sundown Bay to accomplish a successful "floating breakwater" design for the very worst foundation locations in the project area. An effective design and construction in these very challenging foundation areas is necessary, both to complete the proposed breakwater and to ensure accomplishment of the proposed marsh restoration, Whooping Crane habitat, included in the long-term DMMP.

FEATURES IN DREDGED MATERIAL SALT MARSHES DUE TO NATURAL EROSION

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Several lessons have been learned from the wetland restoration project adjacent to the Gulf Intracoastal Waterway (GIWW) in West Bay north of Galveston Island, TX. The wetlands were restored on top of dredged material placed within confining dikes to an intertidal elevation in July, 1992. The project was a demonstration of the beneficial use of dredged material by the US Army Engineer District, Galveston (SWG). Monitoring of the project has been conducted by the US Army Engineer Waterways Experiment Station through the sponsorship of SWG and the US Army Corps of Engineers' Wetlands Research Program.

The project was designed to investigate a variety of erosion protection alternatives. An important consideration for the design of the project was that additional wetlands would be restored with each new dredging cycle on the GIWW which is typically every three to five years. Therefore, the erosion protection for each placement only needed to function over that interval. The erosion protection used at the project was documented by McCormick and Davis (1992) and included unprotected earthen dikes with steep and mild slopes, vegetation, coconut fiber mats, geotextile tubes, and a dynamic revetment. We found that the different levels of erosion protection used at the site produced an irregular pattern of erosion along the shoreline. The result is an increased interface between the bay and the wetlands with open water pools, channels, and mudflats.

Material from subsequent dredging operations should be placed adjacent to (in front of) the existing eroded shoreline. Essentially, what is now an irregular vegetation line along the shore would become the interior of an expanded marsh. The interior of the marsh would therefore have a natural-looking pattern of vegetation with pools, channels, and mudflats included. To construct wetlands with those characteristics would be extremely difficult. But by staging the development of wetlands and allowing the sea to shape the marshes, a higher quality marsh can be obtained. Since less expensive erosion protection is recommended, costs can be saved on the development of a large wetlands restoration project.

McCormick, J.W. and Davis, J.E., 1992 (June). "Erosion Control with Dredged Material at West Bay, TX," Wetlands, Proceedings of the 13th Annual Conference. Society of Wetland Scientists, New Orleans, LA.

TECHNICAL SESSION 7: Poplar Island

Jeffrey McKee, PE, Chair

POPLAR ISLAND RESTORATION PROJECT: PROJECT OBJECTIVES AND ORGANIZATION

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As with any port whose channels require deepening or maintenance dredging, the success of Port of Baltimore depends in part on the implementation of a cost-effective placement site for dredged material. The Port of Baltimore planned and developed the Hart-Miller Island dredged material placement site during the 1980's and this site has served as an innovative example in dredged material management. As the capacity of Hart-Miller Island has diminished over time, it became necessary to develop a new site for clean Port of Baltimore sediments. The new site eventually became the Poplar Island Restoration Project, located in Chesapeake Bay off the Eastern Shore.

This paper provides an overview of the process and rationale that led to the selection of the Poplar Island site. The paper will emphasize the agency/public coordination and consensus-building processes that identified the location of the site and the nature of and rationale for the island restoration. The paper will also elaborate on the goals and philosophy of the port in its endeavors to develop environmentally beneficial dredged material placement sites. This overview paper will serve as a companion to a series of additional presentations following in this session which cover technical issues surrounding the Poplar Island project. The importance of this paper is that serves to summarize the factors that led to development of one of the largest containment island projects in the United States. It will provide attendees of the conference with a good understanding of the efforts required to implement this important dredged material disposal option.

Challenges are both environmental and engineering, as the original Poplar Island has been subjected to massive and persistent erosion over time until less than five acres remain. At the same time, it has provided habitat to a wide diversity of wildlife, especially colonial nesting waterbirds. At the current time, the nesting colonies on the remnant island are temporarily protected by a semi-circle breakwater of sunken barges. The goal is to rebuild Poplar Island using dredged material from the navigation channel. Objectives for the Island include providing a range of habitats (aquatic, wetland, upland, and island) for fish and wildlife.

POPLAR ISLAND RESTORATION PROJECT: PLANNING AND DESIGN ASPECTS

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Gahagan and Bryant Associates Inc.
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John R. Headland, PE, and Peter W. Kotulak, PE
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The Poplar Island Restoration Project is a proposal to restore habitats lost through the erosion of Poplar Island in Chesapeake Bay by the beneficial use of dredged material from the Bay approach channels to the Port of Baltimore. The project is to be carried out under the provisions of the Water Resources Development Act of 1996 and involves restoration of four remnant islands (with a footprint of only five acres) to a pre-erosional 19th Century area of approximately 1100 acres, thereby creating new acreage of aquatic, intertidal wetland, perched wetland, upland, and island habitats for fish and wildlife. The major goals and objectives of this beneficial use site are as follows: (1) optimization of the volumetric capacity of the site for dredged material; (2) preparation of a cost-effective design within available funding; (3) restoration of Poplar Island to its 1847 footprint; (4) creation/restoration of desirable habitats, and (5) design all aspects of the site in an environmentally acceptable manner.

Three alternative alignments (with site areas ranging from 820 to 1340 acres, and dike top elevations ranging from 7 to 20 feet) were considered based on discussions with Maryland Port Administration (MPA), US Army Corps of Engineers (Corps), Maryland Environmental Service (MES), and the Poplar Island Working Group (Gahagan and Bryant Associates, Moffatt and Nichol Engineers, and their associates). Alignment #1 is more or less aligned along the 1847 position of the eastern shoreline of Poplar Island and has an area of 820 acres. Alignment #2 with an area of 1340 acres is an extension of Alignment #1 to the south and east, and fronts on the southern shoreline of Coaches Island. Alignment #3 is more or less in between the other two alignments and has an area of 1100 acres. Several factors were evaluated during the planning phase, including:

(1) water depths (2 to 12 feet)
(2) wind speeds (>90 mph during the 100-yr event)
(3) tidal range (mean of 1.8 feet)
(4) wave action (100-yr wave of 10 feet height and 6 second period)
(5) currents (negligible)
(6) foundation conditions (soft to hard silt clays and sands)
(7) charter oyster bars
(8) location of the remnant islands and Poplar Harbor
(9) 1847 footprint

(10) availability of on-site borrow material

Design analyses considered the following principal aspects of the alternative site layouts:

(1) perimeter dike alignment
(2) capacity and operational life
(3) schedules for site construction
(4) average annual volume of dredged material to be placed
(5) optimized perimeter dike section
(6) construction methodology
(7) access to the site for unloading dredged material
(8) placement of dredged material
(9) habitat development
(10) site monitoring
(11) site management

Perimeter dikes constitute the principal initial cost of the project and were designed to contain fine-grained dredged material placed at the site. Interior dikes were used to separate the wetland and upland cell areas since a large elevation differential will exist between these two types of habitat. It is estimated that depending on the selected site configuration, about 10 to 47 million cubic yards of dredged material will be required for restoring the island. This equates to 6 to 27 years of maintenance volume from the Chesapeake Bay southern approach channels. Further details of the planning and design considerations for this project will be discussed during the presentation.

POPLAR ISLAND RESTORATION PROJECT: COASTAL ENGINEERING ASPECTS

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Poplar Island is one of the success stories regarding the development of a cost-effective and environmentally implementable dredged material placement site for a major United States port. The project involves the artificial re-creation of an eroded island located along the eastern shore of the Chesapeake Bay. This presentation addresses the coastal engineering aspects of the planning and design of the project.

Specific issues addressed in the presentation include: (1) detailed design of the containment dikes with explanation of the optimization design procedures used, (2) physical model testing of the containment structures, (3) construction methodology and costs for the containment structures, and (4) numerical modeling of the impacts of the island development on hydrodynamics, water quality and sedimentation.

POPLAR ISLAND RESTORATION PROJECT: DREDGING ENGINEERING ASPECTS

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The Poplar Island Restoration Project involves restoration of four remnant islands within a footprint of only five acres to a pre-erosional 19th Century area of approximately 1100 acres, thereby restoration acreage of aquatic, intertidal wetland, perched wetland, upland, and island habitats for fish and wildlife. As part of the planning phase of the project, three alternative site alignments with site areas ranging from 820 to 1340 acres, and dike top elevations ranging from 7 to 20 feet were considered. Creation and restoration of desirable fish and wildlife habitats were the primary environmental objectives of the project. Successful habitat development is dependent upon several factors including final elevations of the dredged material, material consolidation, material slopes, tidal range, water quality, and establishment of vegetation. The following were the main dredging engineering issues to be resolved: (1) perimeter dike alignment and material volumes; (2) site access for material placement; (3) site capacity and operational life; (4) habitat development; (5) site monitoring; (6) site management; and (7) construction methodology, schedule and costs.

Perimeter dikes were designed both to contain fine-grained dredged material placed at the site and also to provide protection to the habitats from wave damage, while interior dikes would be used to separate the wetland and upland cell areas (since a large elevation differential will exist between these two types of habitat). A range of dike top elevations from 7 to 20 feet were evaluated. In order to provide access to the site during construction, an access channel was proposed to be constructed. Material from the cannel dredging would be used for dike construction. Site capacity and operational life were developed based on three criteria: (1) volume occupied by dredged material (bulking and consolidation effects); (2) placement rates and lift thickness; and (3) cell areas and cell capacity for various dike elevations. The resulting estimated site capacities ranged from 10 to 47 million cubic yards which equate to about 6 to 27 years of site operational life.

Various habitat development criteria were developed for wetland areas ranging from 50 to 100 percent of the total site area. Site monitoring was estimated based on projected regulatory requirements, while site management needs were developed based on dewatering and crust management plans developed for similar sites. A variety of dredging and placement techniques were evaluated based on the above mentioned unique project requirements. Total site development costs were based on:

(1) evaluation of initial site construction costs, including perimeter dikes, interior dikes, cell spillways, sheetpile bulkhead, construction management, and monitoring before and after construction;

(2) future upland dike raising costs

(3) habitat development costs, including wetland contouring, tidal wetland habitat, and upland habitat; and

(4) annual costs, including management of dredged material placement, habitat management, site maintenance, and site monitoring.

Estimated total site development costs ranged from $59 to $147 million, which translate to approximately $3 to $6 per cubic yard of site capacity. Further details of the dredging engineering aspects of this project will be discussed during the presentation.

TECHNICAL SESSION 8: Island and Upland Habitats A

Thomas R. Patin, PE, Chair

JETTY ISLAND BENEFICIAL USE: 1989-1997

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Jetty Island is a sand dredged material island constructed from sediment removed for a Federal navigation channel at Everett, Washington. It began as a riprap jetty in the 1800's, became a manmade island in 1896, and provided a protected harbor and navigation channel. The Port of Everett obtained ownership in 1929, and has continued island maintenance since that time. Jetty Island has received considerable documented wildlife utilization for many years, including the first recorded nesting by Arctic terns in the lower continental United States (Corps WES study reports).

In 1989, the Port of Everett and the Corps collaborated on a project to develop beneficial use of clean dredged material. The outcome was a 2500-foot-long, 15-foot-high (at MLLW) high sand berm constructed with 323,000 cubic yards of sediment adjoined westward of Jetty Island. The goals of the project were to create 15 acres of intertidal habitat, and continue habitat enhancement of Jetty Island.

The objectives of the project were (1) to balance erosion losses to Jetty Island, (2) create additional dunegrass habitats, (3) create a protected embayment to be colonized by marine invertebrates, and (4) to demonstrate beneficial and economic options for dredged material. A 5-yr monitoring plan was included in the project, and an implementation plan was created to establish physical and biological monitoring. The plan assessed changes in elevation due to erosion or transport of substrate, delineated habitats, observed plant density and biomass, surveyed juvenile salmon use, and surveyed birds and epibenthic fauna. A total of 5568 planting units were planted in 1990. Plant monitoring was achieved by dividing the area into upper and lower zones. Each zone was compared to a reference site with similar plant species. The results indicated that *Jaumea, Atriplex, Elymus,* and *Salicornia* had no significant difference in the upper and lower zone in percent of cover. Fish, benthic, and bird surveys were also conducted. Results from the eelgrass survey found that intertidal eelgrass was shorter with narrow blades and higher density, and subtidal grasses had lower density and had longer and wider blades, than the reference area. Fish monitoring confirmed that juvenile salmon were present in the embayment and at two reference areas. Bird monitoring resulted in more than 23,000 birds counted in 1995, compared to 10,400 birds observed in 1988. By April 1996, all goals, objectives, and success criteria for the project had been met.

The project has met all biological criteria established in the implementation plan and productivity of the embayment greatly exceeded project goals for salmonid habitat. The lower energy regime and mud substrate of the embayment is providing greater and productive habitats for juvenile salmon prey resources than exists on the more exposed sandy beaches. Because the project has met or exceeded all of the established success criteria, no further monitoring on the 1989 project is scheduled. In March 1997, renourishment of the berm will be conducted by the Corps, and further monitoring may be required.

RESTORATION OF COLONIAL WATERBIRD HABITAT, WAINWRIGHT ISLAND, CARTERET COUNTY, NORTH CAROLINA

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Wainwright Island, owned and protected as a wildlife sanctuary by the National Audubon Society, has long been a vital nesting site for many species of colonial waterbirds in Core Sound, and it is the only suitable nesting site between Cape Lookout and Ocracoke, North Carolina (Parnell et al. 1995). North Carolina's largest colony of royal and sandwich terns (approximately 6,000 pairs) was known to once inhabit the island. It continues to support the state's second largest colony of brown pelicans, approximately 950 pairs.

The island has served as a toe-of-the-bank disposal site for the maintenance dredging of the adjacent Federal navigation channel, Wainwright Slough, since the early 1970's. During past maintenance events, the material placed at the toe-of-the-bank resulted in an area at or below mean-low-water which quickly eroded away due to wind and wave action. By 1991, the once 16 acre island had eroded to about 7 acres and the bare ground areas once available for terns had disappeared.

In 1997, through the placement of about 80,000 cubic yards of dredged material from Wainwright Slough, approximately 9 acres of bare ground nesting habitat was restored and made available to the royal and sandwich terns that abandoned the island in 1991. The important and unique features of the operation included: disposal of the material in a manner which did not disturb brown pelicans already nesting on the island, avoidance of established vegetation on the upland portion of the island used by waders and pelicans, avoidance of known areas of submerged aquatic vegetation (SAVs), and known cultural resource sites.

The material placement resulted in the successful disposal of 80,000 cubic yards of material in an area approximately 9 acres in size at a center height of about 10 feet mean-sea-level with gradual side slopes. Through the cooperative effort of the National Audubon Society, and State and Federal resource agencies, the restoration of 9 acres of lost colonial waterbird nesting habitat using dredged material is expected to result in the return of over 6,000 pairs of terns and the continued use of the island by brown pelicans.

Parnell, James F., W.W. Golder, and T. M. Henson. 1995. 1993 Atlas of Colonial Waterbirds of North Carolina Estuaries. NC Sea Grant Publication UNC-SG-95-02. Raleigh, North Carolina.

SWASH BAY ISLAND RESTORATION

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The Norfolk District Corps of Engineers, Waterways and Ports Branch has begun the environmental restoration of two previously-used, diked upland placement sites, located on Virginia's Eastern Shore. The two sites, seven and nine acres in size, were originally *Spartina* marsh, but were diked in the 1960s for the placement of fine-grained dredged material from Swash Bay Channel, a section of the Waterway on the Coast of Virginia Federal Project. The sites had become overgrown with *Phragmites australis,* and had very limited wildlife value.

In 1993, the long-term placement of dredged material from Swash Bay was redesigned and changed to an overboard site, where the bottom could be built to intertidal elevation to create an oyster reef. Value engineering studies showed that there would be a cost savings from no longer having to construct and maintain dikes at the two upland sites. This cost reduction provided an opportunity for the extra funds to be used for regrading the two upland sites.. The Norfolk District has already regraded one of the sites and the other contract is now in the process of being awarded.

The construction plans call for the material from the perimeter dikes to be pushed to the inside of the sites creating a central mound in each. The mound provides a higher elevation area where trees and bushes are being planted. The side slope areas are being planted with intertidal wetland grasses. The planting of vegetation as well as numerous herbicide sprayings to control the *Phragmites* is being jointly funded by The Nature Conservancy, the US Fish and Wildlife Service, and the Virginia Department of Transportation. Other agencies such as the Virginia Institute of Marine Science have provided their expertise in designing the two sites. The completed sites will provide much-needed colonial waterbird habitat, as well as intertidal marsh areas for waterfowl and related species.

COLONIAL SEABIRD AND MOTTLED DUCK NESTING ON DREDGED MATERIAL ISLANDS IN ATCHAFALAYA DELTA WILDLIFE MANAGEMENT AREA, LOUISIANA

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The Atchafalaya Delta is the only actively building delta in the Gulf of Mexico. The growth of the delta is the result of sediments being deposited by the Atchafalaya River via the Old River Control Structure channeling sediments from the Mississippi River. Because the river is an important shipping lane, sediments from the navigation channel are frequently removed by maintenance dredging conducted by the US Army Corps of Engineers (Corps) and placed to create and restore dredged material islands. The material from these dredging operations has been used by the Louisiana Department of Wildlife and Fisheries working cooperatively with Corps and other state and federal agencies to create a series of dredged material islands on the Atchafalaya Delta Wildlife Management Area (ADWMA).

Subsidence and accretion are rapidly changing the configuration of the Louisiana coastline. Colonial seabird nesting sites are lost on an annual basis, due to destruction of habitats due to these forces. Contamination, site destruction, and human disturbance of the colony sites in Louisiana may also affect a significant portion of the seabird population.

Dredged material islands have become important nesting sites for seabirds, providing protection from predators as well as humans (Soots and Parnell 1975, Leberg et. al 1995). Beneficial use of dredged material has created habitat in the ADWMA that has become important for nesting seabird colonies in Louisiana. The increased use of these dredged material islands in the last five years on ADWMA has been significant. These islands are protected from human disturbance, erosion and contamination and provide excellent habitat for colonial seabirds and need to be maintained.

Colonial seabirds first began nesting on dredged material islands in the Atchafalaya Delta in 1990. Nesting species include Black Skimmers (*Rhynchops niger*), Gull-Billed Terns, (*Sternus nilotica*) Forster's Terns (*Sternus fosteri*) and Least Terns (*Sternus antillarum*). Numbers of these nesting species have been increasing annually. These colonies of Black Skimmers, Gull-billed Terns, and Forester's Terns are presently some of the largest colonies found in the Louisiana. The importance of dredged material for these sites is critical.

Mottled Ducks are the only non-migratory ducks in North America. They nest along the Gulf Coast from Florida to Texas. A preliminary study on ADWMA found extremely high nesting densities

of Mottled Ducks on dredged material islands. These densities in some cases were the highest ever seen in North American waterfowl.

Leberg, P. L., P. Deshotels, S. Pius and M. Carloss. 1995. Nest sites of seabirds on dredge islands in coastal Louisiana. Proc. Annu. Conf. SEAFWA.

Soots, R .F. and J. F. Parnell. 1975. Ecological succession of breeding birds in relation to plant succession on Dredge Islands in North Carolina. Natl. Oceanic and Atmos. Admin. Sea Grant Publ. UNC-SG-75-27, Raleigh, N.C. 142pp.

TECHNICAL SESSION 9: Contaminants A

Norman Francingues, Chair

REMEDIATION TECHNOLOGIES FOR BENEFICIAL USES OF CONTAMINATED SEDIMENT

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The ultimate solution for contaminated sediment is a remediation technology that not only cleans contaminated sediment but also provides an end product that can be applied to a beneficial use. Remediation technologies that seek to provide beneficial uses from contaminated sediment fall into three basic categories:

(1) Technologies that manufacture a construction product, such as aggregate, bricks, or cement, from the contaminated sediment.

(2) Technologies, such as hydro-cyclones, that separate clean material from contaminated material, so that the clean material can be used.

(3) Technologies that remove contaminants from the sediment, such as surfactant soil washing technologies.

Two technologies which produce construction materials are LADS Systems, Inc. and Cem-Lock Technology, Inc. Both have proprietary thermal remediation processes to recycle organic and inorganic contaminated dredged sediment into a lightweight construction aggregate and cement production, respectively. In these rotary kiln processes, the sediment contaminants are either converted to their constituent parts by the thermal process, caught in stack filters, or encapsulated in the aggregate or cement.

The LADS system has completed limited bench scale testing on contaminated sediment from the northeast and a pilot scale test on marine sediment in the former Soviet Union. The Port Authority of New York and New Jersey has commissioned a pilot scale test for Cem-Lock's technology.

At this time, these technologies, as well as the hydro-cyclones and soil washing technologies, generally do not have the production capability required for most dredging projects and, as a result, the cost is often high. However, for projects with a small volume of contaminated sediment, or projects which can stockpile the contaminated dredged sediment and then allow the remediation technology to process the material at a slower rate, these technologies may be applicable.

We believe that the appropriate technology for successful treatment of dredge sediment must posses the following three characteristics:

(1) The minimum production must be approximately 4,000 cubic yards per work day.

(2) The material must have a market value as beneficial re-use.

(3) The treatment technology must be cost effective.

A "fixed base treatment facility" is being developed for dredged material in New Jersey to handle Category I, II, and III materials. The treatment combines two technologies, dewatering and stabilization. The dewatering reduces the volume of material that must be treated while stabilization renders the materials nonhazardous and suitable for reuse. The process is applicable to dredged sediment contaminated with volatile organic compounds (VOC's), heavy metals, petroleum hydrocarbons, PCB's, pesticides and chlorinated organic compounds.

This presentation will provide a brief overview of the advantages and disadvantages of technologies that provide the dual benefits of sediment remediation and beneficial use from dredged material and will address in detail LADS' lightweight aggregate from dredged sediment and the fixed base treatment facility in New Jersey.

INNOVATIVE APPROACHES TO CONTAMINATED SEDIMENT CLEANUP

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Innovative approaches to contaminated sediment cleanup reserve costly removal techniques for navigation channels and sediments with high levels of contamination and employ a wide range of cleanup alternatives. One such method used dredged material to create beneficial outcomes, such as upland creation to support development projects. Therefore, waterfront owners and operators can realize further cost-savings by reducing chemical input (pollution sources), focusing effort and money on the most contaminated sediments, and integrating sediment disposal with development needs.

Long-term results from dredging navigation channels or cleaning up contaminated sediments can be realized only when on-going pollution to drainage ditches, streams, rivers, lakes, and bays is reduced or eliminated. Eliminating pollution sources will reduce the need for additional cleanup and will ensure that future dredged material can be used for open-water disposal.

Waterfront owners and operators should consider applying *a risk-based approach* to all sites with the potential for contaminated sediments to ensure that the severity of environmental concern is considered in conjunction with the cost of disposing of these sediments. With an understanding of waterfront maintenance dredging and site development needs, waterfront owners and operators can use this approach to evaluate and categorize contaminated sediments.

Because *a risk-based approach* considers the full range of remediation options, waterfront owners and operators can ensure that technical and financial resources are allocated to the sediments with the highest contamination and greatest environmental concern, while low and moderate levels of contaminated sediments receive only the level of effort they warrant.

BENEFICIAL USES OF DREDGED CONTAMINATED SEDIMENTS: TWO CASE STUDIES REVISITED

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David McEntee
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Two sediment remediation projects have been completed in Commencement Bay at the mouth of the Puyallup River in Puget Sound, Washington. The St. Paul Waterway Area Project was completed in June, 1988, and included the creation of 17 acres of shallow subtidal/intertidal habitat on the cap of a confined aquatic disposal site. The Sitcum Waterway Remediation Project was completed in 1993, and created a 24-acre nearshore fill for marine terminal use, and the creation of 19.5 acres of intertidal habitat and 1.6 acres of upland habitat.

Both of the project designs depended upon the continuing natural sedimentation process from the Puyallup River to assure future stabilization of the intertidal mitigation sites, one on each side of the mouth of the river. The mitigation sites are located in a high wave environment that cause transport and erosion of the intertidal habitat at both sites, and the sediment cap over contaminants in the St. Paul Waterway.

The Sitcum Project included a nearshore disposal site for confinement of contaminated sediment. Of concern was the fill condition after construction and its ability to handle future container facility loading.

A summary of the status of the nearshore fill site terminal development, the habitat site productivity and changes, and the confinement of the contaminated sediment, will be presented.

BENEFICIAL USE OF CONTAMINATED DREDGED MATERIAL FROM HAMLET CITY LAKE

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Hamlet Lake in North Carolina over the years silted in and had a depth of water decrease which resulted in severely limited recreational uses. The Corps was authorized to evaluate the removal of sediment from the Lake to restore the water quality and recreational use.

Sediment from Hamlet Lake that was contaminated with petroleum hydrocarbons was evaluated in a phyto-remediation approach to decontaminate and produce a soil material that could be used to landscape the surrounding lakeshore of Hamlet Lake. Organic sediment from the Lake was mixed with disposal site sand and horse manure in different blends. Bermuda grass was grown in the mixtures.

After 6 months, the petroleum hydrocarbon concentrations in blends containing 40-60 percent sand and 10 percent manure were reduced to 70 percent of the original concentration. The resulting soil blend could be used as landscaping soil for shrubs and trees around the Lake from which the dredged material was removed.

TECHNICAL SESSION 10: Policy and Planning A

Joseph R. Wilson, Chair

GUIDELINES FOR THE BENEFICIAL USES OF DREDGED MATERIAL IN THE UNITED KINGDOM

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HR Wallingford was commissioned by the United Kingdom Government's Department of the Environment to produce practical guidelines on the beneficial uses of dredged material. The document, published in April 1997, forms the basis of this presentation.

Beneficial uses of dredged material is by no means a new concept, indeed it is probably as old as dredging itself for applications such as reclamation. However, there is now a developing emphasis on environmental management which has resulted in a change in approach whereby dredged material is regarded as a resource rather than a waste. Many beneficial uses have now been tried in different parts of the world. The guidelines which will be presented are the result of three years of literature research, discussions with a wide range of organisations in Europe and the USA, observing some schemes at first hand, and in a few cases, studying them in detail using numerical models.

The guidelines seek to present in a consolidated form the experience gained as a basis for assessing what the realistic options are. The dredging industry will benefit from these guidelines as they are now required by MAFF to demonstrate that possible beneficial uses have been considered before a disposal license will be granted. They will also benefit those with a responsibility for planning and management of dredging works and coastal defence.

Guidance is given on how to characterise the material for assessment purposes and some general issues concerning contamination, transport, dewatering, storage and environmental value, all having cost implications. A check list is presented as an introduction to the detailed guidance given in further sections of the guidelines. For each type or class of use guidance is given on the type of material which is suitable, design criteria, and monitoring. These are illustrated where appropriate by examples.

PLANNING FOR BENEFICIAL USE OF DREDGED MATERIALS IN THE UNITED KINGDOM: MEETING THE ASPIRATIONS OF INTERESTED PARTIES

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Christine Adnitt
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Communication with interested parties is a vital part of planning and implementing successful beneficial use projects. Dredging and disposal, in the minds of many individuals, are still perceived as "environmentally damaging" practices. More attention needs to be paid to promoting the benefits (environmental, social and economic) of dredging and the wide range of options available for beneficial use. In the UK, this is particularly relevant because the licensing authority for dredged material disposal (MAFF; the Ministry of Agriculture, Fisheries and Food) requires that applicants give full consideration to potential beneficial use options before granting a licence for disposal at sea (if there is no practicable beneficial use option).

Related to this exercise in increasing awareness and understanding, it is essential that those organisations with interests in environmental management are encouraged to play an active role in the planning of beneficial use projects. The basis for such participation must be an open, honest and, where necessary, non-technical discussion about the options available and the consequences of each. This applies equally, whether the group involved is already "informed" about the issues (e.g., nature conservation specialists) or not (eg. a local residents association).

It is important to ensure that the expectations of interested parties are not raised too high. If, for example, the particular option under consideration has not been tested before in the environment for which it is being considered, this must be made clear in order to ensure that people understand the risks of failure. Related to this, if it is a pilot project which is being promoted, the risks must be properly explained. If there will be short term disruption (eg. traffic, dust and noise during the placement and working of the material), the public must be made aware that there will be short term costs in order to secure a longer term benefit.

Similarly, in trying to "sell" the idea of a beneficial use habitat creation project, it is easy to forget that the habitat being created may not be fully functional for twenty or thirty years. Again, interested parties must be made aware.

Monitoring and feedback, both when the project is being implemented and post-implementation are also critical to the overall success of a particular initiative. If the construction process is delayed for example, interested parties should be advised of the revised timetable. In some cases it may be possible for interested parties to be represented on the group which is responsible for reviewing the results of monitoring and for making decisions on any necessary follow-up actions. For a major project, it may be appropriate to issue newsletters and/or to hold meetings in order to inform interested parties of progress, any problems encountered, preliminary results, etc.

There is a great deal of experience, relevant to beneficial use projects, which can be drawn on to ensure that communication is effective and that the aspirations of interested parties are met. This paper draws on the following case studies to present a variety of experiences in dealing with the expectations of interested parties, gaining their confidence and their support, and keeping them informed.

PROJECT ISSUES	CONSULTATION WITH INTERESTED PARTIES PROJECT, UNITED KINGDOM
Southampton Water Capital Dredging	beach nourishment and habitat creation
Bristol Channel Aggregates	awareness raising, role of newsletters, research in UK, and public seminars
Lincolnshire Coast Beach Nourishment scheme, UK	need for accurate baseline data to facilitate liaison with fishermen
Dredging of North Creek, Grand Turks, Turks, and Caicos Islands	awareness raising, use of dredged material to restore mangrove habitats
EIA for Lantau Port Development	handling "first time" consultation (i.e.,. Hong Kong groups unfamiliar with being consulted)

Lessons which can be learned from these experiences are highlighted, and conclusions are presented in the form of guidance.

THE POLICY AND FUNDING FRAMEWORK FOR US ARMY CORPS OF ENGINEERS PARTICIPATION IN BENEFICIAL USE PROJECTS

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The US Army Corps of Engineers dredges about 300 million cubic yards of material annually to improve and maintain Federal harbor and channel projects. Only about 30 percent of this material is currently used in a way that produces environmental or economic benefits. The policy and funding framework is in place for greater beneficial use of dredged material.

The obstacle of a lack of Federal authority for beneficial use projects has been largely overcome. Historically, the Corps participation in projects to beneficially use dredged material were limited to efforts associated with the Corps research program or those beneficial uses that were the least cost disposal alternative. The authority for Corps financial participation in beneficial use began to broaden with the passage of the Water Resources Development Act of 1986 (WRDA 86).

Section 1135 authority and funding has been used for projects to beneficially utilize dredged material to improve environmental quality. While the Section 1135 authority and program can be used for beneficial use projects using dredged material, it was primarily aimed at the environmental modification of flood control projects. The Corps recognized the need for a specific authority and program for use of dredged material to create aquatic and related habitat.

As a result of Administration and Congressional initiatives, Section 204 of the Water Resources Development Act of 1992 (WRDA 92), as amended, authorized the Corps to carry out projects for the protection, restoration, and creation of aquatic and ecologically related habitats including wetlands in connection with dredging for construction, operation or maintenance of authorized Federal navigation projects. Projects are cost-shared on a 75 percent Federal and 25 percent non-Federal basis for the incremental costs of the beneficial use project with the non-Federal sponsor responsible for the project operation, maintenance, replacement and rehabilitation costs. A second authority for beneficial use projects is Section 145 of the Water Resources Development Act of 1976 as amended by Section 933 of WRDA 86. This authority allows for the placement of suitable dredged material on beaches. The incremental cost of the material placement must be shared with a non-Federal sponsor on 50-50 basis and the cost of the placement must be justified by the shore protection benefits which result from the placement.

In addition to these continuing authorities, the Corps has the authority under Section 216 of the River and Harbor Act of 1970 to review completed projects and recommend to Congress that navigation projects be modified to use dredged material for environmental restoration purposes.

To accomplish beneficial use projects, funding and authority must both be available. To date, Federal funding of beneficial use projects has not been a significant obstacle. The Section 204 program, which is the Corps' primary beneficial use authority, has been funded at a level of $2-$3 million since initial funding in Fiscal Year 94. The Fiscal Year 97 appropriation included $1.5 million for the Section 204 program and $9.5 million for the Poplar Island restoration project in the Chesapeake Bay. Funding has been provided to complete the specifically authorized Sonoma Baylands project in San Francisco Bay, and WRDA 96 authorized a $160 million ($120 million Federal and $40 million non-Federal) marsh creation project in conjunction with the deepening and subsequent maintenance of the Houston-Galveston navigation project. The President's Fiscal Year 98 budget includes $119 million for the Houston Galveston project including funding for the initial marsh creation efforts.

EPA GUIDANCE MANUAL FOR IDENTIFYING, PLANNING, AND FINANCING BENEFICIAL USE PROJECTS USING DREDGED MATERIAL

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The US Environmental Protection Agency has prepared a guidance document which provides a framework for identification, selection, financing, and implementation of projects for the beneficial use of dredged material (expected to be published in 1997). Specifically, this document: (1) enumerates opportunities for various beneficial uses; (2) provides detailed information on available financing considerations and mechanisms; (3) suggests potential actions and partnerships that may improve the likelihood of beneficially using dredged material at the local level; (4) provides examples of existing beneficial use projects; and (5) provides current policy relevant to long-term planning for beneficial uses of dredged material.

Every year in this country, the dredging of shipping channels, ports, harbors, canals, lakes, and reservoirs produces large quantities of sediment. Most of this dredged material is clean and suitable for beneficial uses such as beach restoration, shore protection, agricultural uses, habitat enhancement, and many other applications. Although dredged material has been used for beneficial purposes for many years, it has not been used to its full economic, social, and environmental potential. This situation is due partially to the costs associated with such uses, as well as the prevailing view that dredged material is a waste product.

In recent years, however, there has been a growing awareness of the vast potential of dredged material as a resource. The expanding interest in beneficial use projects is due in part to the growing difficulty of locating new dredged material disposal areas, rising disposal costs, private initiatives, and forward-looking Federal, State, and local governmental policies. Recognizing these factors, this EPA guidance is intended to facilitate beneficial use projects by providing a comprehensive framework for project proponents.

TECHNICAL SESSION 11: Chesapeake Bay

John Wolflin, Chair

BENEFICIAL USES OF DREDGED MATERIAL IN CHESAPEAKE BAY AS STANDARD PRACTICE FOR BALTIMORE CORPS DISTRICT

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The Baltimore District, Corps of Engineers has used the concept of beneficial use of dredged material as a standard practice. With traditional placement sites becoming scarce, and upland areas becoming unavailable, beneficial uses is the option of first choice. State and Federal resource agencies around the Chesapeake Bay have endorsed the concept of beneficial uses of dredged material. Maintenance dredging of the Federal channel in Chester River allowed the Corps the opportunity to use dredged materially beneficially in a dual role.

The project used dredged material by placing it behind offshore breakwaters to successfully restore wetland habitat and helped retard erosion of a National Wildlife Refuge located on Eastern Neck island. The area was planted to create a wetland which would additional provide habitat in the area. In addition to this concept some innovative methods were employed at the site, including wetland mats for better wetland stability and geotextile tubes for added protection of the site.

In addition to the Eastern Neck NWR project, dredged material has been successfully used to restore wetland habitats at Kenilworth Marsh on the Anacostia River, Barren Island, Smith Island, and a number of other locations in Chesapeake Bay. Most of these used geotextile tubes as durable but temporary breakwaters, with dredged material placed behind them and planting as wetlands.

A MONITORING STUDY
EASTERN NECK ISLAND NATIONAL WILDLIFE REFUGE
WETLAND CREATION AND EROSION CONTROL PROJECT

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Eastern Neck Island National Wildlife Refuge, located in Kent County, Maryland, was selected as a demonstration site for the construction of a wetland creation and erosion control project incorporating beneficial use of dredged material. Eastern Neck was selected as an environmentally preferable alternative to the historic disposal site utilized for maintenance material coming from the Corps Chester River Channel.

Fine-grained, sandy dredged material was used to construct 2.02 hectares of estuarine, emergent wetlands. Project objectives were: (1) provide an environmentally preferable alternative to unconfined, overboard dredged material disposal; (2) stop or minimize erosional losses of ecologically valuable habitats; and (3) create/restore wetland habitat. This two growing season monitoring study was undertaken to determine if project objectives had been met, and the potential for expanded application of beneficial uses of dredged material in Chesapeake Bay. Modifications to the erosion control design used at Eastern Neck could have improved dredged material stability. Changes in plant materials and planting methods could have improved the rate of wetland habitat development.

Fish and wildlife utilization of the 2.02-ha planted (created) habitat included 19 species of birds, two species of reptiles, 12 species of fish, and five species of mammals. Study findings suggest the approach used at Eastern Neck, with modification, could be applied elsewhere in Chesapeake Bay for purposes of habitat protection and creation.

FUTURE (PLANNED) BENEFICIAL USES PROJECTS FOR CHESAPEAKE BAY IN THE BALTIMORE CORPS DISTRICT

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Audrey F. Calhoun
George Washington National Parkway, National Park Service
McLean, Virginia USA

John Wilson, Robert Gaudette, and Jordan Loren
Maryland Department of Natural Resources
Annapolis, Maryland USA

Mark Koenings
Assateague Island National Seashore, National Park Service
Berlin, Maryland USA

Charles Weber
Dorchester County, Maryland

Philip Hager
Planning Commission, Town of Snow Hill
Snow Hill, Maryland USA

Terry McGean
City Engineer, Town of Ocean City
Ocean City, Maryland USA

Washington Sailing Marina and Columbia Island Marina. The Baltimore Corps District is preparing a feasibility study for the National Park Service(NPS) under the Support for Others Program. Both marinas are owned by the NPS. The Washington Sailing Marina is located opposite of the Washington National Airport. The Columbia Island Marina is adjacent to the Pentagon. Both marinas provide access to the Federal navigation project in the Potomac River. The purpose of this feasibility study is to examine the navigation-related problems affecting the users of both marinas, identify a range of solutions for implementation by the National Park Service, and minimize potential impacts to the natural environment that may result from the dredging of the marinas. Potential beneficial use sites were evaluated as part of this report. Consideration was given to impacts that wetlands creation and associated bird populations would have on air traffic safety at the airport.

Section 1135 Work on Hart-Miller Island South Cell. The proposed project involves modifications to the existing 1100-acre dredged material containment facility near Baltimore, Maryland. This facility is the authorized placement site for dredged material removed from the Baltimore Harbor and Channels Federal navigation project, which serves the Port of Baltimore. The feasibility study will focus on the evaluation of alternatives to develop the 300-acre South Cell into a wildlife sanctuary. Although some consideration will be given to human use (mainly educational), the intent of the study is to develop natural habitat utilizing the on-site material to shape island features. Potential alternatives will include variations of upland and wetland habitats, shallow water ponds, osprey nests, and educational nature trails. Avian wildlife species will be the major beneficiaries of the project.

Rooster Island, Dorchester County, Maryland. Rooster Island was previously a large sand spit containing wetlands and other vegetation, located on the eastern shore of Maryland . It protected Hambrooks Bay and the adjacent shorelines. Due to the lack of a continuous sediment source, the island has eroded away, and all that remains are intertidal and subtidal shoals. The feasibility study recommended a plan including the placement of 31,000 cubic yards of sand where Rooster Island used to be, protection of the sand fill with a 2,400-foot-long breakwater, stabilizing the fill with stone groins, and planting the sand with marsh grasses and upland vegetation.

Bodkin Island Section 204 Project. Bodkin Island, on the eastern shore of Maryland, has historically provided both upland nesting areas and brood habitat for large numbers of black duck. The size of the island has been reduced from 4.5 acres in 1950 to .94 acres in 1986, at which time it was stabilized by breakwaters. The proposed project includes increasing the total acreage of Bodkin Island to 7.5 acres using 50,000 cubic yards of dredged material from the nearby Chester River Federal Navigation Channel. The island was originally designed using riprap protection, but estimates proved too costly. Current plans now are for using geotextile tubing in lieu of riprap to reduce costs. A large geotextile tube will be used to create a containment dike around the existing island. A 60-foot-wide protective marsh barrier contained by a small geotextile tube will be placed around the larger containment area to provide additional erosion protection. Once the dredged material settles, the island will be shaped and planted with various species of vegetation. The expected outputs of the proposed project are restoration of waterfowl habitat and increases in black duck populations.

Smith Island Project. Ninety-five percent of the 8,000-acre island in the southern Chesapeake Bay is classified as wetlands. A project completed in 1994 involving use of geotextile tubing backfilled with dredged material and planted as salt marsh was carried out by Operations Division, Baltimore District. Projects currently under consideration include additional shoreline stabilization of a highly erosive area and restoration of land masses and eroded coves. Each of these projects involves the placement of geotextile tubes. The landmass restoration involves filling gaps in a peninsula using geotextile tubes and backfill. The cove restoration project would use dredged material filled tubes placed as jetties or segmented breakwaters. Future study will consider the long-term management of dredged material around the island. Such a management plan could include island creation, shoreline restoration, oyster bar creation, and marsh nourishment with dredged material.

Ocean City Water Resources (OCWR) Study. The OCWR study identified a need for creation/restoration of salt marsh and colonial waterbird habitat in the Maryland coastal bays. Beneficial use of dredged material was identified as the best means of fulfilling these habitat needs. Two island creation projects are proposed at South Point spoils and Dog Island Shoals. The South Point Spoils project will use material dredged from the Federal Sinepuxent Channel to restore and augment a regionally significant waterbird colony. The project will consist of stabilizing the perimeter of the existing 2.3- acre island, and constructing several acres of waterbird habitat and salt marsh on three additional islands to create a larger archipelago of bird habitat islands.

The Dog Island Shoal island creation project will be designed for both public and private placement of material. Initial construction will consist of a 3 acre island to be constructed by the Corps to provide barren substrate habitat suitable for beach-nesting colonial waterbirds using material dredged from Federal channels. Subsequently, privately-dredged material will be placed contiguously to the Corps' island to construct salt marsh until a total island size of 25 acres is reached. Private dredging currently generates about 5,000 cubic yards of material per year. This volume would serve to create approximately one acre of salt marsh per year at the site. The island will thus provide a dredged material placement site for the next 20 to 25 years for private dredgers.

BENEFICIAL USE OF DREDGED MATERIAL IN THE UPPER CHESAPEAKE BAY

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The intentional use of dredged estuarine and marine sediments as a natural resource in the Chesapeake Bay region is not new. The concept was introduced in the mid-1970s by the US Army Corps of Engineers through several small-scale wetland restoration projects in the lower and middle Bay. In its 1991 report, an interorganizational task force appointed by the Governor of Maryland recommended the beneficial use of dredged material as a principal option for solving the Port of Baltimore's longstanding shortfall in placement capacity for dredged material.

Millions of cubic yards of sediments are dredged each year from the navigation approach channels serving the Port of Baltimore and the Chesapeake and Delaware Canal. Most of this material is potentially suitable for use as a natural or economic resource. The prospect of using dredged material benefically on a large scale rather than disposing of it as a waste by-product has gained very strong broad-based conceptual support within the region. Yet it has proven very difficult to move from concept to application in the upper Chesapeake Bay.

Expanding the beneficial use concept from small-scale projects to a principal role in solving dredged material placement needs has been problematic. Although many environmentally-oriented projects have been proposed, only the first phase of the planned restoration of Poplar Island has obtained the sufficient institutional and public support necessary to enable implementation.

The linking of the beneficial use concept to a specific geographic location has focused attention on environmental, economic, and social tradeoffs which, in most cases, have individually or collectively worked against the acceptance or practicality of the options that were proposed and assessed. The conversion of habitat from one type to another, especially with respect to fisheries habitat impacts, has been a major factor in determining whether or not the environmental value that would be gained justifies making radical modifications to existing site conditions. Past and on-going efforts to advance the practical application of the beneficial use concept in the upper Chesapeake Bay will be discussed in this presentation. Case studies will be presented for many of the proposed beneficial use projects. A perspective on the general applicability of beneficial use as a practical solution for dredged material placement needs for shipping channels in the upper Bay will be presented.

TECHNICAL SESSION 12: Island and Upland Habitats B

Thomas R. Patin, Chair

THE HISTORY, PRACTICE, AND STUDIES OF CONSTRUCTION, NOURISHMENT, PROTECTION, MONITORING, AND MANAGEMENT OF MORE THAN 2000 DREDGED MATERIAL ISLANDS IN U. S. WATERWAYS

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Over 100 years of dredging and open-water placement operations by the US Army Corps of Engineers, as well as wetland and water resource activity by the US Fish and Wildlife Service refuge program, some state agencies including port authorities, and private organizations such as Ducks Unlimited Inc., have resulted in numerous man-made islands being constructed and maintained throughout U. S. coastal waters, riverine systems, and the Great Lakes. The Corps has constructed over 2000 of these islands using dredged material as part of navigation, flood control, and national defense projects. It continues to maintain a high interest in developing and maintaining such islands because of its responsibility in using environmentally acceptable dredged material placement methods and sites, the ever-increasing shortage of upland disposal sites, the need for wildlife habitat in waterway areas, and the islands' multi-purpose aspects.

As human populations moved to the coast, lake, and river shorelines, natural wildlife habitat areas have been altered and occupied. Dredged material islands have provided critical habitat in many waterway areas, specifically for colonial sea and wading birds, waterfowl, other waterbirds, and migratory raptors and songbirds. Primary wildlife species needing nesting habitat on dredged material islands include 37 species of pelicans, cormorants, anhingas, herons, egrets, ibises, spoonbills, gulls, terns, and skimmers. Several of these species are on federal- or state-endangered species lists, and an estimated 1,000,000 are nesting on dredged material islands in any given year, especially along the Gulf and Atlantic coasts from Long Island to Mexico and in the Great Lakes.

To understand how and why these species used dredged material, a number of studies have been undertaken by the Corps over the past 21 years. Configuration, topography, substrate, elevation, island structures (dikes, breakwaters, buildings), location, surrounding water use, regional habitat needs, species and/or guild life requirements, vegetation, and other factors were examined. Regional studies of dredged material islands, some of which were compared to remaining natural islands, focused on North Carolina, Texas, Florida, New Jersey, the Pacific Northwest, the Great Lakes, the Upper Mississippi River, and the Gulf of Mexico. This resulted in design and construction techniques, methodologies, and strategy recommendations for building and managing man-made wildlife islands which are published in Corps technical reports, Corps dredged material beneficial uses engineer manual 1110-2-5026, the Handbook of Dredging Engineering (McGraw-Hill Publishers), and in peer-reviewed journals and proceedings.

Some of the most important findings include:

(1) Each wildlife species or guild has specific life requirements that can be compatible with construction activities if care is taken to avoid working during dredging windows and breeding seasons close to colonies.

(2) Habitats for nesting species using any of four different nesting substrates (bare ground, sparse vegetation, shrub, or tree) can all be accommodated through placement of dredged material using a rotational strategy for maintenance dredging scheduled events.

(3) Islands not less than five acres and generally smaller than 50 acres in size are optimum, but some smaller and some much larger islands can also be successful if isolation, location, topography, elevation, and substrate requirements are met (especially CDFs).

(4) Slopes of more than a 3-ft rise over 100 feet are too steep and eggs roll out of nests and are lost.

(5) Colonies on undiked islands are much more successful than colonies nesting on diked islands.

(6) New dredged material should be placed several months before the breeding season to allow sorting of material and to provide a firm substrate for nests. Placement in the fall of a previous year allows sorting to occur over winter months prior to spring staging and nesting.

(7) Sand/shell/cobble substrates are much more acceptable for nesting than are silts and clays, although silts and clays still have some nest use.

(8) Nesting colonies affect the vegetation on islands, and can change plant communities, including killing nest trees through feces accumulation.

(9) Undisturbed bare ground habitats are in scarcest supply in all U.S. waterways, and birds requiring bare substrate are often forced to nest in highly unsuitable places such as roofs and parking lots.

(10) Islands should be at least 6-10 feet above mean high water or flood stage during the breeding season.

(11) Island should be located not less than 0.5 miles from a shoreline to prevent predators from accessing an island, and to discourage recreational boaters. A compromise between distance from shore and flying distance for avian parents to acquire food for chicks may be necessary, but

islands as far as five miles off shore receive heavy nesting use in the Great Lakes and the Gulf of Mexico.

(12) Birds in colonies vary in their site-tenacity, and while tree-nesting species will persist to the detriment of their nesting success at a site well beyond the site's utility, bare ground nesting species will often move from island to island from year to year or within years. Bare ground nesting species will nest more than once in a breeding season if disturbed at first and second nesting attempts and may change island locations to do so.

(13) Some species will only nest in proximity to other species, e.g., royal and sandwich terns almost always nest together in one colony.

(14) Rock, riprap, and steep dike structures can serve as death traps to young birds, and need openings in them to allow unfledged chicks to move unimpeded to the water.

(15) Shallow water feeding habitat in proximity to the island for breeding adult birds aids in nesting and fledging success.

(16) Pest or exotic vegetation will probably require vigorous control to protect nest site integrity.

(17) Nest predators colonizing islands will require control.

(18) Human use of islands requires management, and islands should be posted against trespass during the breeding season.

(19) Islands can be actively repaired and upgraded using more dredged material during the breeding season if birds coming in to nest in early spring can be enticed to relocate to safer parts of the island.

(20) Erosion control on islands can be accomplished using maintenance dredged material with positive effects on active bird colonies.

(21) Coordination with and education of all interested parties, including local fishermen and environmental groups, should be on-going throughout the planning, design, construction, and monitoring phases of wildlife island development.

The Corps continues to build and/or add to existing dredged material islands each year, and to work with partners, stakeholders, and local citizens to assure wildlife habitat requirements are met and enhanced. The engineering and environmental interdisciplinary aspects of island construction are highly important, as is island management through rotational placement of dredged material in long-term management strategies. THE most difficult obstacle is non-technical and is identified in Item 21 above----getting all parties concerned to allow the Corps to use its expertise and experience to accomplish this work. This is often even more of a challenge than limited financial resources.

THE ROLE OF LANDSCAPE IN USE OF DREDGED MATERIAL ISLANDS BY BIRDS

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In an effort to offset loss of Whooping Crane critical habitat to erosion, creation of marsh habitat from dredge material has been undertaken by the Mitchell Energy Corporation (MEC) and the US Army Corps of Engineers (Corps) near the Aransas National Wildlife Refuge. Two cells of wetland habitat were constructed by MEC in 1991 and in 1993, respectively, using material obtained from a navigation channel and adjoining drilling basin, as well as bay bottom material composed primarily of sandy silt. Two islands of wetland habitat were also constructed by Corps in 1993 using material obtained from maintenance dredging of the Gulf Intracoastal Waterway. These four created marsh habitats differ in geomorphology and hydrology, and were constructed using a variety of levee designs.

This study assesses habitat function of these created marsh habitats, through comparison of their plant community assemblages and habitat utilization by avian species with that of natural Whooping Crane habitat. Landscape level comparisons of created and natural study sites were undertaken using aerial photos and topographic survey data. Habitat use by all avian species observed in natural and created marsh sites was characterized with regard to landscape features.

Topography of the created marshes differed markedly from that of the natural sites. Differences also existed in the areal extent of vegetated, subtidal, and irregularly flooded exposed substrate habitats within study sites. There was little similarity between vegetation communities of the created and natural marsh sites, resulting primarily from dominance of the created sites by *Spartina alterniflora*, a species which was uncommon in the natural sites. There were also differences in use of the sites by birds groups including gulls and terns, perching birds, shorebirds, wading birds, and rails and bitterns. Waterfowl use was low in all sites.

Within the study sites, each bird group was associated with one or more habitat types. Although overall numbers of birds were highest in the natural marsh, densities were higher for each bird group within their preferred habitat types in one or more of the created sites than in the natural reference sites.

For most bird groups, abundance within the created sites increased with increased area of preferred habitat types. Therefore, differences in use of the sites by birds can largely be explained by differences in landscape features. The areal extent of various habitat types within the study sites is influenced by geomorphology, hydrology, and vegetation. Geomorphology and hydrology, which influence vegetation community development, are features that can be manipulated during construction of dredge material habitats. Design modifications are suggested that could potentially improve the function of dredge material marsh islands as habitat for targeted avian species, including Whooping Cranes.

DISTRIBUTION OF THE INTERIOR LEAST TERN (*Sterna antillarum athalassos*) ON THE LOWER MISSISSIPPI RIVER

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The interior population of the least tern was listed as endangered in 1985. Available data at that time indicated a total population of 1200 birds with about 650 least terns occurring on 200 miles of the lower Mississippi River between Cairo, IL and Osceola, AR. Since 1985, aerial and ground surveys by the Corps of Engineers have recorded up to 6,970 least terns if as many as 74 nesting colonies on 650 miles of the lower river between Cape Girardeau, MO and Natchez, MS. This is over half the total interior least tern world population. Although numbers appear to have increased significantly, part of this difference can be accounted for due to the inadequate data existing prior to 1985.

Nesting colonies are found on the large, isolated, bare gravel and sand bars within almost every dike field in the river. The terns feed along edges of shorelines, over fast moving water flowing across dikes at flood stage, in clear water pools within dike fields, and in other areas where they can see their fish prey (they are visual feeders). Minimal predation and human disturbance, in addition to the high population numbers, indicate a healthy least tern population on the lower Mississippi River.

HART-MILLER ISLAND: AVIAN UTILIZATION OF AN OPERATING DREDGED MATERIAL CONTAINMENT FACILITY, 1983-1997

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The Hart-Miller Island Dredged Material Containment Facility is the property of the Maryland Port Administration (MPA) and is operated under contract by the Maryland Environmental Service (MES). The island is located at the mouth of Back River on the Chesapeake Bay, approximately 6.5 miles east of Baltimore. The first tier perimeter dike was constructed from 1981-1984. This 6-mi-rectangular, 18-foot high (MLW) dike connected the highly eroded Hart and Miller Islands and created an impoundment of 1140 surface acres. In 1983, a cross dike was built, separating the impoundment into the North and South Cells. The second tier perimeter dike was constructed in 1988 and 1989, reaching an elevation of 28 feet MLW. In 1996 and 1997, the dike of the North Cell was raised to 44 feet MLW. Dredged material in-flow to the South Cell commenced in 1983, and continued until 1990. In-flow to the North Cell began in 1985 and continues.

Avian Monitoring. Occasional avian monitoring began on Hart and Miller Islands in the mid-1970s prior to construction of the containment facility. Monitoring continued during the dike construction phase and began on a regular basis in 1983. An informal agreement between representatives of MES, MPA, Maryland Department of Natural Resources (MDNR), and the Maryland Ornithological Society (MOS) has allowed continuance of the monitoring activities up to the present time. The monitoring was coordinated by Robert F. Ringler from 1983 through 1991, Robert W. Dixon from 1992 through 1995, and Eugene J. Scarpulla form 1996 to the present.

Avian Habitat on Hart-Miller Island. Six general habitat types exist on Hart-Miller Island at the present time: structures, grassy dikes, deciduous woodlands, perched marsh, upland common reed stands, and mudflats and pools. Structure habitat consists of building, towers, piers, and nest boxes. Four species nest on or in structures. Grassy dike habitat (1-3 feet high) occurs on the outside of the first and second tier perimeter dikes. Three species are probable nesters in this habitat. Deciduous woodland habitat is found in two areas on the old Hart Island section of the island complex. There are 25 nesting species in these island forest areas.

There are two types of marsh habitat, shortgrass tidal marsh on the old Hart Island section and non-tidal perched reed marsh on both the old Hart and old Miller Island sections, as well as inside the island. Combined, the marshes support nine probably nesting species. High marsh/upland reed habitat covers the entire South Cell. Although eight species are probable breeders in the Cell, they are widely scattered at this time. Reed sites typically offer little value for wildlife. When dredged material was actively been pumped into the South Cell, it was characterized by extensive mudflats and pools, and a much more diverse birdlife.

Mudflat and pool habitat is the most extensive on the island at this stage of its construction and filling, covering the entire North Cell. This is the current site for active dredged material placement. The ever-changing flats and pools are not typically used for bird nesting, but four species nest along the edges where the cell meets the perimeter dike.

All of the nesting species on Hart-Miller Island are typical of the nearby mainland. These species are not what makes the island unique. Rather, it is the mudflats and pools of the dredged material in-flow operation that makes Hart-Miller Island one of the most significant ornithological sites in Maryland. Four avian groups are currently the primary users of the North Cell and formerly the users of the South Cell. These groups are the shorebirds, gulls, terns, and waterfowl.

Avian Utilization During the Dredged Material In-Flow. Shorebirds visit Hart-Miller Island during the spring and fall migration. Occasionally, shorebird numbers can reach 10,000 per survey day. Hart-Miller Island has become the premier shorebird migration location in Maryland. Thirty-nine species have occurred on the island.

Gulls are present on the island not only during migration, but also throughout the summer. Most of the summering birds are sub-adults (non-breeding). Late summer brings adults and juveniles due to post-breeding dispersal. Gull numbers can exceed 10,000 per survey day. Twelve species of gulls have occurred on the island.

Terns have a seasonal abundance similar to the gull species. Terns also visit the island during spring and fall migration as well as during summer months. Terns can peak in late summer and early fall due to post-breeding dispersal. Numbers can approach 2000 per survey day. Eight species of terns have frequented the island.

Waterfowl numbers on the island proper are dependent on the amount of open water available in the pools. If there is sufficient open water, high numbers can be present on the island. If there is little open water, waterfowl can still be present offshore. Numbers are generally highest during the spring and fall migration and during winter. Numbers have reached 20,000 per survey day, including both on-island and offshore birds. Twenty-eight species have occurred on or around the island.

Future Considerations. Designs for Hart-Miller Island after the dredged material operation is completed should incorporate habitat management plans for the four primary avian user groups. Due to the lack of shorebird habitat in Maryland, special consideration should be given to this group during their migration periods. Considerations should also be given to gulls and terns, not just as migrants and non-breeders, but also for nesting potential. Two species of fulls and two species of terns have nested on the island. Furthermore, if it is compatible with the three previous management plans, waterfowl habitat could be considered. Waterfowl habitat is of lesser significance at Hart-Miller Island due to the abundance of this habitat throughout the Chesapeake Bay.

TECHNICAL SESSION 13: Contaminants B

Norman Francingues, Chair

A REGIONAL APPROACH TO CONTAMINATED SEDIMENT MANAGEMENT IN LOS ANGELES COUNTY

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This presentation addresses contaminated sediments that reach the Pacific Ocean in Los Angeles County. Each year, during a short, intense rainy season, tons of soil erode and flow through waterways, binding with pollutants accumulated during long dry seasons on streets, lawns, industrial yards, and rooftops. Pollutants that bind with fine sediments include chemicals and heavy metal pollutants in current use and historic use (e.g. DDT in soils farmed decades ago). When these contaminated sediments reach the ocean and mix with salt water, they are too polluted to meet Clean Water Act standards for disposal in territorial waters. In addition, these sediments have consistently accumulated in port channels, at river mouths and near the entry to Marina Del Rey, caused shoaling problems that are a hazard to boat traffic.

The problems of stormwater contaminated sediments is exacerbated by pollution coming from within current port and marina operations, the enormous expansion of both the Ports of Los Angeles and Ports of Long Beach and operation of the 6500 boat slip Marina Del Rey. A total of 3.3 million cubic yards of contaminated sediments is the current estimate for dredge and disposal over the next few years in the Los Angeles region.

The reasons why historic management techniques used to address both clean and contaminated sediments no longer work will be discussed in the presentation. With increasingly polluted sediments and historic solutions no longer working, responsible agencies tried incremental approaches to emergency dredging and disposal projects. A variety of emergency incremental solutions were used, including deposition in the wave zone, deposition in CADs within the Ports (waters within the manmade harbors are not considered territorial waters of the United States, subject to Clean Water Act contaminated sediment standards), and dumping sediments into old borrow pits formed to create offshore oil islands in Long Beach waters.

The problems associated with these emergency projects, the knowledge of the continuously increasing volume of contaminated sediments, and lack of scientific information about long term effects or on alternative solutions first led to the formation of the multi agency

Marina Del Rey Task Force, and then to the Regional Contaminated Sediment Task Force, initiated by the Environmental Protection Agency the Army Corp and the Coastal Commission in cooperation with other key agencies to deal with all three areas. The controversy and difficulty of in-water disposal for large volumes of contaminated sediments gave rise to new authority for the Corps to expend funds on land disposal and reuse and aquatic restoration (Water Resources Development Act of 1996), thus allowing the Corps and other agencies to participate fully in a watershed approach to preventing contaminated sediments from reaching the ocean.

We will conclude our presentation by describing how the recently combined Marina and Ports Regional Sedimentation Task Force is organized, the strategies being pursued, and the possibilities for solutions, including watershed pollution prevention, a truly acceptable, monitored, ocean disposal site or regional CAD site, and the need for a cost competitive technology for upland disposal, treatment and reuse options for contaminated sediments.

PRODUCTION OF USEABLE MATERIAL FROM CONTAMINATED MIAMI RIVER SEDIMENT BY HYDROCYCLONE SEPARATION OF FINE AND COARSE FRACTIONS

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The Miami River, Florida, maintenance project involves dredging 5.5 miles of channel from the river mouth to the end of the Miami River Federal Project. The volume of dredged material to be removed is estimated at 1,000,000 cubic yards. The failure of bioassays in 1992, failure of a bioassay at one station in 1988, and the known presence of pollutants such as arsenic, cadmium, copper, chromium, lead, mercury, silver and zinc have indicated the unsuitability of sediments from the Miami River for ocean disposal and environmentally acceptable upland sites are not readily available. Miami River sediments are predominantly fine silts and clays with a coarse fraction (>200 mesh) that ranges from 20% to 60% by weight. The use of Hydro-cyclone technology to separate contaminated fine sediments from the uncontaminated coarse fraction was investigated as a means of reducing the volume of contaminated material that must be disposed of and the production of clean coarse aggregate useable for construction fill or other purposes.

The investigation included separation of four Miami River sediment samples by Hydro-cyclone, analysis of the fine fraction for heavy metals and bioassay of the coarse fraction to determine if the coarse fraction retained any significant toxicity after separation from the fine material.

Physical, chemical and bioassay tests indicate the coarse fraction produced by Hydro-cyclone is completely suitable for use as construction fill, aggregate or other similar uses.

AN INNOVATING "DryDREDdgeTM" FOR REMOVING SEDIMENT AT *In-situ* MOISTURE CONTENT

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The cost of removing, transporting and disposing contaminated sediments is several times that for the non-contaminated material. In particular, when incineration of sediment is involved, high water content increases the total cost very rapidly because of energy wasted in evaporating the water associated with sediment.

An innovative equipment developed through a cooperative research project between the US Army Corps of Engineers and DRE Technologies Inc. has been described in this paper. The new dredger named as the DryDREdgeTM , is capable of removing sediment at its *in-situ* water content. Hence the main advantage of the new system is the reduced overall volume of sediments and water to be handled and treated. In addition, precise dredging capability will be advantageous in closely following the pre-determined limits of contaminated sediments and also in avoiding obstacles such as unexploded ordnance at certain sites. The dredging and disposal costs with the use of new technique are expected to be 40 to 70 percent lower than that with the use of presently employed conventional dredgers. The equipment is portable and small in size. Hence it can be easily transported and deployed at small projects such as dredging of marinas and industrial lagoons where access near the piles and other structures inside basins is severely restricted.

The dredger meets the following criteria of an equipment suitable for dredging contaminated sediments: (1) ability to remove fine sediments consisting of silt and clays which may be highly compacted, (2) minimum resuspension and dispersal of bed sediments since they adversely affect the aquatic plants and water quality, (3) minimum mixing with and removal of ambient water, (4) precise excavation, (5) debris screening, and, (6) ease of transport and deployment.

The dredge has a specially designed sealed clamshell mounted on a rigid, extensible boom. The open clamshell is hydraulically driven into the sediment at a low speed, minimizing sediment disturbance and resuspension. The clamshell is then hydraulically closed and sealed, trapping a plug of sediment at its *in-situ* water content. The sediment is deposited in the hopper of a positive displacement pump which delivers it through a pipeline to the disposal site. Depending on the site conditions, the hopper can be equipped for debris screening, size reduction, vapor emission control, sediment homogenization, and blending of additives to modify flow properties. The sediment pumped in a plastic flow regime may have consistency of a toothpaste. Depending on the *in-situ* moisture content and the degree of hazard posed by the sediment, the disposition may be direct feed to a thermal treatment or stabilization process, direct feed to on-site land disposal, or direct feed to an enclosed transport vehicle.

The dredger has been successfully used for dredging a small, shallow lake at Waterways Experiment Station, Vicksburg and industrial lagoons in Arkansas and Kentucky.

BENEFICIAL USES OF DECONTAMINATED NEW YORK/NEW JERSEY HARBOR DREDGED MATERIAL

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The decontamination of contaminated dredged material from New York/New Jersey Harbor has been evaluated and demonstrated under the auspices of the US Environmental Protection Agency's Section 405 Decontamination Technologies Demonstration Program. The beneficial uses and potential markets for the decontaminated dredged material has been identified.

Potential commercial markets will use decontaminated dredged material as a substitute for existing materials, if the dredged material can be reconditioned to meet existing specifications required to produce a product of equal or better quality than the present product and at a cost equal or cheaper than present materials. New products will require testing to meet specific standards.

Most existing standards have developed from existing materials for existing uses. Therefore, any beneficial use products from decontaminated dredged material will have to meet existing specifications and standards before they will be accepted by the commercial community.

TECHNICAL SESSION 14: Policy and Planning B

John Goodin, Chair

PARTNERSHIPS, PLANNING, AND POLICY: AN INTERAGENCY APPROACH TO BENEFICIAL RE-USE OF DREDGED MATERIAL

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The interagency approach developed under the PSDDA program focused its attention on clean dredged material designated for open-water disposal. In cases where the material was to be re-used, there has been no clear mechanism for handling issues such as permitting, characterization and prioritization of use.

Washington state has several factors which complicate the designation of material for re-use. First, the volume of clean sediment dredged in the region is relatively small compared to other areas of the country. This leads to increased competition for what material is available. Second, the state has strict regulations regarding sediment quality, the parameters of which differ slightly from those required for sediment destined for open-water disposal. Third, over 2.1 million acres of aquatic lands are state-owned and managed, including 60 percent of the intertidal habitat in the state. Public ownership of aquatic lands (and therefore dredged material from those lands) affects the dredging as well as placement of the material.

In May 1995 the directors of the four agencies with regulatory jurisdiction over dredging and disposal of sediments (EPA, Corps, Washington Department of Ecology and Washington Department of Natural Resources) signed an interagency agreement. One of the several items that this agreement addressed was the beneficial re-use of dredged material. The directors convened a workgroup, which included representatives from local jurisdictions, ports, Indian tribes and other resource agencies in addition to the agency representatives. The goal of the workgroup was to promote beneficial uses of dredged material and to identify and resolve agency conflict regarding the use of dredged material.

The workgroup met from August 1995 to December 1996. They compiled an inventory of the dredged material that is available on a routine basis, providing volume, sediment characteristics and points of contact. The group also compiled each agencies regulations and policies, and outlined areas of conflict and confusion. Some of these issues could be resolved within the group: others need changes in regulation or director approval. The group also prepared flow charts of the regulatory process and identified places in which beneficial uses could be considered and reviewed.

The workgroup produced two products. One is a Users Manual that is designed to be a guide to the process for potential project proponents, including local jurisdictions and public interest groups. The second product is an executive summary for the agency directors, outlining the roadblocks to increased use of dredged material for beneficial use, and providing recommendations for simplifying and streamlining the process.

MANAGING DREDGED MATERIAL PLACEMENT OPTIONS AND THEIR TRENDS

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This country as well as most other countries must now obtain the maximum practicable environmental benefits when dredging and disposing of dredged material, or so it seems. Even though studies worldwide have shown that the vast majority of the dredged material is classified as clean and therefore available for beneficial use, there is a reluctance to use the material because the predominant mind-set is to treat it as a waste product due to the contaminated nature of less than five percent of the material dredged.

This presentation will address not only several of the 1300 plus current beneficial uses of dredged material but discuss and give examples of some other innovative methods for dealing with dredged material. It will focus on the potential for using all sediment benefically.

Innovative approaches include:

(1) *Restoring abandoned coal mine lands.* The single biggest water pollution problem facing the Commonwealth of Pennsylvania is polluted water draining from abandoned coal mining operations. Using dredged material mixed with ash from coal-fired power plants to form a cement-like material would fill mining tunnels and seal openings to keep water out.

(2) *Combining fly ash, lime, and lagooned sludge with dredged material to produce inert soil.* This material could be used for disposal dike construction and highway rights-of-way, as well as a number of other uses.

(3) *Placing clean dredged material into strategically selected flow-lane disposal areas.* This can prevent erosion to banklines, islands, and the river bed itself, and not have an adverse environmental impact.

(4) *Forming regional beneficial use partnerships.* Involving public and private entities as partners to recommend, plan, design, build, maintain, monitor, and fund beneficial use projects can contribute to a successful project. Likewise, Congress can provide extra funding for a wide variety of beneficial use projects when such projects include local cost-sharing. Several of these financial opportunities will be discussed.

(5) *Available disposal or utilization options for dredged material are being restricted and this can be overcome.* Options are becoming more limited each year as restrictions on in-water placement increases and currently available sites become exhausted. Recognizing the acute shortage of adequate disposal areas and the increasing difficulty of acquiring them, several sections of the Water Resources Act of 1996 were enacted to address this situation. Among other things, Secretary of the Army policy allows for public-private partnerships that may enable private entrepreneurs to provide disposal/containment capacity to the government on a contractual arrangement. The Secretary may reimburse the private entity, subject to appropriations, for the disposal of dredged material into the facility through the payment of a disposal fee. The disposal or user fee would be sufficient to repay funds contributed by the private entity plus a reasonable return on investment.

(6) *Under certain conditions, dredged material can be used as sand berms.* Sand berm construction can be used to corral and control oil spill damage, as well as used in a number of other ways. Examples of berm utilization to contain oil spillage during the Persian Gulf War were quite effective.

Consideration of some of these innovative approaches will result in more environmentally sound dredging operations, and perhaps more cost effective operations.

THE TAMPA BAY INITIATIVE

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Tampa Bay, Florida, is one of the largest estuaries in North America. Tampa Harbor, Manatee Harbor, and St. Petersburg Harbor are three Federal navigation projects located within

Tampa Bay. Tampa Bay is also designated by the Environmental Protection Agency as a National Estuary Program (NEP) site.

The NEP in conjunction with the Tampa Bay Regional Planning Councils' Agency on Bay Management (ABM) is developing a Comprehensive Conservation Management Plan (CCMP) for Tampa Bay. The Corps has provided input into the CCMP through its participation in the ABM and NEP programs. The CCMP has identified the Corps with a dredging leadership role in this plan by having the Corps facilitate the Dredged Material Advisory Committee whose primary responsibilities include dredged material management with regard to the ports, development of a dredged material management plan (DMMP) for the Bay and to look at new technologies for management.

The District is currently under contract with EPA to develop the DMMP. Numerous opportunities are being looked at within Tampa Bay as far as Beneficial Uses of Dredged material. A report has been forwarded to higher authority for the use of dredged material from Manatee Harbor to be used in the wetland habitat creation project at Cockroach Bay. This project is also a Coastal America Project. It involves the filling of areas formerly mined for sea shells (pits), then revegetated with emergents and mangroves and finally connected to the Bay.

Another project we are pursuing is the Harbor Isles Lake Restoration which involves the filling of a lake created during residential housing development. The lake is deep and has water quality problems due to the lack of vegetation within the photic zone. The material will be dredged from St. Petersburg Harbor and placed within the lake to raise the bottom elevation. We are currently looking for a local sponsor. We are also looking at filling a formerly dredged hole adjacent to McDill Air Force Base. The material was removed and used for the creation of the runway at McDill. The material will be dredged from the Tampa Harbor Navigation project and placed in the hole to bring the bottom elevation back to a level where seagrasses would recolonize it.

Other possibilities include expansion of a bird nesting colony island adjacent to the Alafia Channel. This project is being looked at as part of the Tampa Harbor - Alafia River Feasibility Study. Another effort is the filling of former dredged holes in the Bay bottom as part of the Tampa Harbor Big Bend Feasibility Study.

ENVIRONMENTAL RESTORATION
FROM CONCEPT TO CONSTRUCTION

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The Water Resources Development Acts (WRDA) of 1986-1996 greatly affected the US Army Corps of Engineers ability to perform an increasing number of environmental restoration projects and provided for cost-sharing with local sponsors. Continued implementation of environmental laws and regulations resulted in major improvements in our Nation's surface and ground water, air, and soils. Benefits include improvements in fish and wildlife habitat and in human health. Much remains to be done in the realm of environmental restoration and opportunities abound for further work.

However, environmental restoration projects with real potential may be unable to be funded due to timing, lack of proper authority, mismatch of project size and maximum funding under a particular authorization, or other similar challenges. In this time of shrinking Corps and other federal agency dollars, there are still opportunities for environmental restoration including wetland and aquatic habitat restoration as well as alternative uses of dredged material such as managed soils and restoration of former brownfield and Superfund sites. By managing the budget process and using new authorities as well as state and local interests, these can be realized.

This paper will discuss some of the authorities available under WRDA and elsewhere and how together with appropriations and Partnerships, both federal and non-federal dollars can be used to maximize benefits for environmental restoration. Among the techniques and methods which the Corps can use to maximize federal funds are: cost-sharing, creating opportunities for harbor/port-wide environmental benefits, provide customer satisfaction, National Economic and Environmental Benefits, Interstate/Intra-agency sponsorship, Partnering and Public Awareness for our ports, harbors, estuaries, and ecosystems.

TECHNICAL SESSION 15: Agricultural Applications

Richard A. Price, Chair

USE OF DREDGED MATERIAL AS A SOIL AMENDMENT

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Navigable waterways play a vital role in the economy of this nation. River dredging is a necessary activity to maintain open transportation channels for river traffic. River dredging is a process where various machines equipped with scooping or suction devices are used to deepen waterways. The US Army Corps of Engineers is currently responsible for removing about 300 million cubic yards of sediments from these waterways by dredging to maintain navigable waters in the United States (Bartos 1977). Environmental problems of disposal of dredged material in open water associated with production of sediments which can be damaging to riverine habitat for various aquatic life. Thus, there is a need to find an environmentally optimal place to deposit this material. About 70 percent of dredged sediments are presently placed in open water. However, there is an increasing desire to investigate alternative disposal practices including land application. One possible alternative is to use the dredged material as an amendment to agricultural cropland.

About 16 million hectares of cropland in the United States could benefit from a greater depth of good soil (USDA 1967). Several million hectares of these soils with lower productivity are associated with flooding, high water or periodic wetness, and are conveniently located near US waterways. Coarse-textured dredged material can improve these fine-textured heavy clay soils by increasing soil aeration, water infiltration, and decreasing soil compaction. It also could help with costs through lowered horsepower requirement of tillage, less chemical needed for weed control, and faster warming of soil in early spring, and thereby increasing yields of crops.

Bartos, Michael J. Jr. 1977. Containment area management to promote natural dewatering of fine-grained dredged material. TR D-77-19. US Army Engineer Waterways Experiment Station, Vicksburg, MS.

USDA. 1967. Statistical Bulletin No. 461. US Government Printing Office, Washington, DC.

AGRICULTURAL USE OF YAZOO RIVER DREDGED MATERIAL

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The use of Yazoo River dredged material for improving marginal farmland was considered as an alternative to thick-layer confined disposal facilities (CDF). Large, thin-layer CDF's can be placed on marginal farmland making it more suitable to cotton (*Gossypium hirsutum* L.) production.

A study was conducted to demonstrate cotton production on Yazoo River dredged material. Dredged material was collected from an existing thick-layer CDF and cotton was grown in the greenhouse under various fertilizer treatments. Lint yields equivalent to 594 kg/ha ginned lint were obtained with an N rate of 168 kg/ha. After the greenhouse study, cotton was planted on the CDF using normal agricultural practices and N was applied at 78 kg/ha preplant and 78 kg/ha sidedress. The thick-layer CDF produced an average yield of 883 kg/ha of ginned lint.

Sediment core samples collected from a 1.6 km stretch of river, scheduled for dredging, were mixed with soil from the proposed site of a thin-layer CDF at 1:3 and 3:2 soil to sediment ratios. These sediment/soil mixes were subjected to the greenhouse test along with soil from a nearby productive cotton field.

Fertilizer rates recommended by soil tests produced 319 kg/ha in the 1:3 mix, 178 kg/ha in the 3:2 mix and 244 kg/ha in the cotton field soil. Results of this study indicate that Yazoo river dredged material can produce cotton yields comparable to yields in area cotton fields.

BENEFICIAL USES OF DREDGED MATERIAL: AGRICULTURE USE

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Beneficial uses of dredged material are being investigated by local, State, and Federal resource and regulatory agencies as a long-term, viable alternative for dredged material

placement. In the Chesapeake Bay region, beneficial uses of dredged material are crucial given the necessary maintenance dredging and the limited number of placement options. This presentation focuses on two areas. The first topic is the placement of dredged material on agricultural land and selected beneficial use projects. The second topic is a summary of research conducted in the United States on the use of dredged material as an amendment for agricultural soils.

Though the case studies presented are small-scale projects, the potential exists for larger-scale application of this technology. Given the availability of suitable placement sites and the institutional and public support, agricultural applications are a very feasible and economically practical application.

CURRENT AGRICULTURAL APPLICATIONS OF DREDGED MATERIAL IN WASHINGTON, NEW JERSEY, SOUTH CAROLINA, AND MISSISSIPPI

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During the Dredged Material Research Program in the 1970s, a number of productive and agricultural applications of dredged material were studied. These findings were published in Corps reports and have been encouraged as beneficial use applications since that time. The actual "count" on agricultural applications is uncertain; however, there are several states in which this is practiced on a wider scale than in other locations. The primary reasons that agricultural practices using dredged material as soil supplements are carried out now are varied, but generally involve private landowners who gave an easement to the Corps to allow dredged material to be placed on their property, then they farmed the disposal site. The other most common reason is a public or private conservation or natural resources office growing food crops in disposal sites for wildlife utilization in winter months and during migration, especially for waterfowl, turkey, and deer.

Washington. Along the Columbia River, dredged material is either placed in open water in the River, placed on natural or manmade islands such as Miller Sands, or placed upland above natural bank. This material is primarily sand, with some fines and some pumice and other small rock. When the material is placed in upland situations, it provides a different substrate for planting, and when placed in thin layers, can be readily mixed with clayey soils. Along the north bank of the Columbia between Longview and Portland, there are numerous fields of truck and field crops planted on dredged material. In addition, some of these areas with thicker deposits of sand are used as livestock feed lots because sand material is well-drained and provides a much healthier situation for growing out cattle for market. In addition to these uses of maintenance material, when Lake Vancouver (a silted-in ox-bow lake of the Columbia) at Vancouver, WA, was restored, the dredged material taken from the lake bottom was used for agricultural enhancement as well as for beach nourishment, island creation, a recreation park, and spillway construction.

New Jersey. The Philadelphia Corps District has 17 confined disposal facilities (CDF) along the east bank of the Delaware River near and south of the City of Philadelphia on the New Jersey banks. These sites are mostly privately owned, and the Corps had easements to place dredged material. Several sites that are more infrequently used have been farmed by landowners between dredging cycles. Crops grown include corn, soybeans, and hay for cattle. Crops appear to be thriving each year. At one CDF, the farmer bales *Phragmites australis* for his cattle to eat during dry summer months. At another, an oil company has purchased part of the CDF to develop it into a forested wetland mitigation bank. While these activities are occurring, wildlife utilization of these sites is both diverse and abundant, with pheasants, deer, songbirds, raptors, and waterfowl all observed on the CDFs.

South Carolina. Several of the largest CDFs in the Charleston, SC, area are privately owned, with easements granted to the Charleston Corps District. Between dredging cycles, some of the larger CDFs are planted in soybeans and corn after dewatering. It should be noted that these CDFs also contain waterbird nesting colonies and have other wildlife utilization as well.

Mississippi. In addition to the study conducted in the Yazoo Basin with thin layer disposal, there are a number of other disposal sites in Mississippi being farmed. These are primarily located in two areas. The first and least used as older disposal sites in the Upper Yazoo Basin, where landowners have breached Corps dikes between dredging cycles and grow winter wheat and soybeans in the CDFs. The second and much more abundant use is in the Tennessee-Tombigbee Waterway, where Mobile Corps District annually plants some of its CDFs in wildlife food crops for overwintering waterfowl, as well as for deer, turkey, quail, and other game and non-game wildlife.

Other States. Texas farmers and ranchers regularly pasture livestock in CDFs along the Gulf Intracoastal Waterway. In Minnesota, Maryland, Louisiana, Alabama, and Mississippi, CDFs have been planted in trees for development as pine or pulpwood plantations. In California's Delta leading from the Central Valley (American, San Joaquin, and Sacramento Rivers), farmers vie for rights to dredged material because they use it for either dike regrading and repair or for agricultural enhancement of their peaty soils. Competition is so keen there for the material that it is difficult to put it to other beneficial use such as wetland restoration.

TECHNICAL SESSION 16: Aquatic and Marine Habitats A

Jan Brooke, Chair

THE RESPONSE OF BENTHOS TO OPEN WATER DISPOSAL

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Macrobenthos quickly recolonized an area 1 by 5 k following the spring 1987 open water disposal of approximately 3.7x106 cy of sediments dredged from the Rappahannock Shoals section of the Baltimore navigation channel, during the deepening of the channel to 50 feet. The disposal site was located west of the channel at about 13 m depth in the mesohaline-polyhaline transition zone of Chesapeake Bay. Sediments at the disposal site were initially mud (median phi of 6.5) with the dredged material being slightly sandier (median phi of 6.0).

The success of the macrobenthos in recolonizing the disposal site was related to the flexible life histories of the species that allowed a rapid recovery of populations that was independent of the timing of disposal (Spring or Summer) and the slightly sandier grain size of the dredged material. While the macrobenthos that dominate this area of Chesapeake Bay are primarily estuarine opportunists there was a progression through time in the recolonization relative to size of organisms and sediment reworking.

Over a period of four years the dredged material disturbed areas maintained a higher secondary productivity relative to nearby reference sites.

DESIGN OF A SUBMERGED DREDGED MATERIAL ISLAND AS HABITAT MITIGATION IN DRAYTON HARBOR, WASHINGTON

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Port of Blaine, Washington was created in the early 1950's to support a commercial fishing interest on the Pacific Northwest and Alaskan Waters. The Harbor was initially dredged from a broad tidal flat, and enclosed with a rubble mound breakwater. To accommodate future growth of the harbor, the breakwater was aligned to capture and protect some additional virgin intertidal area.

As a consequence of the sheltering by the breakwater, the now protected tidal flat became higher biologically active. Although always intended as an area for future expansion, the permitting agencies were very reluctant to permit dredging and loss of the mud flat without significant mitigation. Adjacent shoreline areas were already classified as highest quality, so loss mitigation and disposal of dredge material in the immediate area was precluded.

A twofold strategy was devised to maximize the value of the dredging from an environmental perspective and to use the dredged material for project benefit. First, the behavior of the local ecosystem was described. The biological value of the site was determined, not as mere acreage to be removed, but rather as linear feet of "edges", or all the small rivulets in the intertidal zones which supported biological activity. A dredge plan was then developed which created terraces to support various intertidal communities, and fingers of land intended to maximize the total amount of edges that could occur.

The residual dredged material was used to construct a submerged disposal island in the biologically less active center of the bay. The material was used to raise the bottom elevation to a depth of greater biological activity. The island was shaped to conform with prevailing tidal currents, and armored at strategic points to ensure island stability without totally encasing the disposal mound. Poor quality material was placed inside berms of competent material, and then capped. Select substrate was used in the capping material to promote certain types of biological recolonization. The long term value of the disposal island is to have created new habitat with commercial harvest value.

EXPERIMENTAL DISPOSAL OF DREDGED MATERIAL IN THE SNAKE RIVER, IDAHO/WASHINGTON

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Completion of the Lower Granite Lock and Dam Project on the Snake River in 1975 provided electrical power production, flood control, navigation, and recreation to eastern Washington and west-central Idaho. Several of those uses are being threatened by annual inflows of about 2.3 million cubic yards (2.1×10^6 m^3) of fine sediment to the upstream end of Lower

Granite Reservoir. Dredging was conducted in 1986 with land disposal on dedicated wildlife habitat.

Because of limited land disposal options, experimental in-water disposal was initiated in 1988. Three in-water disposal options were evaluated: in 1988, a mid-depth site, originally 6.1 to 12.1 m (20 - 40 ft) deep was modified to a depth of 1.8 to 3.6 m (6-12 ft), thereby creating an underwater plateau; an island was created in 1989 immediately downstream of the underwater plateau; and in 1992, the third type of in-water disposal alternative, a deep (> 60 ft) water disposal site was built.

Monitoring of fish and benthic communities began in 1988 and continued annually through 1993. We compared fish and benthic invertebrate metrics between disposal and reference sites with similar habitat characteristics (depth, velocity, macrophytes, etc.). Shallow, low gradient shorelines with sandy substrate were created along the island with dredged material. This habitat is preferred rearing habitat for subyearling chinook salmon *(Oncorhynchus tshawytscha)* and became a significant rearing area in the middle reservoir. One concern expressed at the inception of the project was that the created habitat could be overly attractive to downstream juvenile salmonid fishes. We saw no evidence that residualization of chinook salmon and steelhead *(Oncorhynchus mykiss)* occurred as a result of the in-water disposal.

The second major concern was the potential to attract salmonid fish predators such as smallmouth bass *(Micropterus dolomieu)* and northern squawfish *(Ptychocheilus oregonensis)*. Generally, numbers of juvenile anadromous fish predators in shallow waters were higher at reference stations than at disposal stations. Fish community composition at disposal stations was similar to that at reference stations and did not exhibit significant variability in species abundance and composition during 1989 through 1993. We found no evidence that species richness and the percent tolerant species were different between disposal and reference stations.

Fish community abundance and composition were more variable among shallow disposal and reference stations than mid-depth and deep stations, possibly reflecting the susceptibility of shallow water fishes to environmental disturbances. Disposal of in-water sediments to create shallow water habitat in Lower Granite Reservoir has potential for increasing localized fish diversity. Creating more shallow water habitat could increase fish species richness, increase availability of food items to outmigrating yearling salmonids, and increase available rearing habitat for subyearling chinook.

If managers have concerns for increased species richness, dredged material can be disposed in mid-depth to deep habitats with no apparent adverse ecosystem effects. These disposal stations were represented by few fish species and low overall abundances.

PARTNERED FEASIBILITY AND DESIGN FOR AQUATIC AND WETLAND HABITAT RESTORATION IN THE INTERTIDAL HUDSON RIVER, NEW YORK

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The Hudson River Habitat Restoration Project (HRHR) is an extensive, partnered, and cost-shared (with the State of New York) restoration effort to bring back emergent freshwater tidal wetlands, improve native aquatic plant communities, control exotic vegetation, enhance fisheries, and manage the existing 11 million cubic yards of dredged material and maintenance dredging as the need arises in an environmentally-acceptable, beneficially useful manner. This work is occurring in more than 100 miles of the Hudson River between New York City and the lock and dam at Troy, NY.

The Hudson was historically intertidal upriver of Troy, and had numerous meandering shallow channels and braided-stream wetlands, small islands, and widely fluctuating water levels. By the mid-1700's, the river was being trained and managed for boat traffic and commerce, and locks and dams were built in its upper reaches to stabilize water levels. The City of Albany and other towns along the banks were built in or adjacent to wetlands and river bank forest. By the mid-1800's, the river had been constrained on both sides by railroad corridors, and within the River by training dikes and rock/timber cribs constructed by the US Army Corps of Engineers. In addition, the Corps dredged approximately 11 million cubic yards of primarily sandy material from the navigation channel and placed it on and between river islands behind the rock/timber cribs. In recent years, dredged material has been placed on island uplands which are authorized disposal sites. This early dredged material placement, coupled with the training constraints on the channel, caused many of the river islands to merge into higher and larger islands, to disappear entirely, and/or to attach themselves to the river banks.

Resulting cumulative impacts of all of the above activities include loss of most islands and wetlands as they once existed, a more stable (and navigable) river level, loss of migratory fish passages, introduction of exotic species, proliferation of native pest species, and increased industrialization and urbanization along the entire river. Since little historic biological data exist except maps, sketches, and figures of islands, wetlands, and river topography and hydrology from more than 150 years ago to the present, it is difficult to assess impacts quantitatively; however, all agencies and private organizations involved in the HRHR acknowledge that significant impacts have occurred and are currently working to gather any existing data and fill the gaps.

The Corps completed a 3-year reconnaissance study in the HRHR in 1995, in which it identified willing partners and assessed the potential for restoration work in the Hudson River floodplain. The Corps and the State of New York are currently working on a 3-year cost-shared feasibility and design study, in which prioritized wetland sites on dredged material islands and/or other impacted areas are being evaluated from both engineering and environmental standpoints. Preliminary designs are being made for restoration at Schodack-Houghtling Island Complex, Manitou Marsh, and Hudson Bay South. Site-specific data sets and designs are being completed, and will be implemented in the next phase of the HRHR. In addition, a Hudson River hydrogeomorphology (HGM) model compatible with the Corps' HGM research is being developed.

TECHNICAL SESSION 17: Confined Disposal Facilities

Donald F. Hayes, PhD, PE, Chair

THE LONG-TERM STUDY OF POINTE MOUILLEE CDF AND ITS WETLAND AND AQUATIC HABITATS

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Pointe Mouillee is a major restoration project funded and constructed in the late 1970's by the US Army Corps of Engineers (Corps), and is part of a Michigan wildlife management area. The site was jointly designed and sponsored by the Corps and the State of Michigan. The Corps Waterways Experiment Station participated in the interagency design and long-term management plan development, and has conducted long-term environmental monitoring on the site since 1979. The 900-acre confined disposal facility (CDF) was built in the configuration and location of an eroded barrier island in western Lake Erie that had protected the 3700-acre management area which had been rapidly eroding after the loss of the protective barrier island. The total site size is 4600 acres.

The CDF was designed to hold contaminated dredged material from the Lake, protect the overall site, and provide upland and wetland habitats and recreational facilities. The long-term management plan signed by partnering agencies in 1979 includes wetland restoration and creation, waterfowl nesting islands, beneficial uses of dredged material, a marina, a visitors center, hiking and jogging trails, bike paths, fishing piers and year-round fishing, hunting in season, nature education, and a number of natural resource recreational activities such as duck decoy contests and fishing rodeos.

After construction was completed in 1983, Pointe Mouillee was initially monitored without a comparison natural wetland site because there was no other wetland left in that part of Lake Erie (the rest had eroded away or been filled). Vegetation and wildlife were the major parameters measured due to the low level of funding from 1979-1989. In addition, informal surveys of fishermen and other site users were made to determine how and why they used the site. The five cells of the CDF are still being filled, in a 50-year project life. The first cell filled with dredged material colonized in *Phragmites australis*, a native pest plant, but due to continued filling and water level manipulation, this species has since been replaced by a diverse mixture of young cottonwoods, willows, and other woody species, and fresh water marsh. Other cells are colonizing with submerged aquatic vegetation fringed by *Typha*, *Scirpus*, and a number of other desirable wetland species as they are being filled. The projected conclusion of the CDF island in 50 years is to be a mixture of upland habitat interspersed with wetlands and shallow water ponds. It was originally intended to be capped with two feet of clean sediment to prevent any biomagnification by contaminants in the sediment. However, due to the large quantities of sand in the dredged material, this capping will probably not be necessary.

The 3700-acre management area protected by the CDF is being actively managed by the Michigan Department of Natural Resources for multiple habitat purposes, recreation, and education. The recovery of vegetation inside the protected area was initially slowed by lake level rises in the 1980's, but is now revegetating with emergents and floating marsh species. The colonization in the 1990's by zebra mussels and purple loosestrife, and a very high carp population inside the management area is being controlled by manipulating water levels on a seasonal basis. The shallow open water areas in the management area receive very high fish nursery utilization.

In 1990, during the Corps Wetlands Research Program, a comparison wetland was located in Ontario, Canada, at Pointe Pelee National Park, and an arrangement was made with the Canadian Park Service for cooperation and data sharing. Since vegetation and wildlife had been the primary data collected in past years, it was decided to concentrate available resources and research on fisheries and aquatic invertebrates, with continued wildlife observations. Light traps were used to measure abundance and diversity of larval fishes and macroinvertebrates, and seines were used to quantify juvenile fishes. Fish assemblages differed significantly between the two wetlands. At Pointe Mouillee, both larval and juvenile fishes were more abundant, speciose, and diverse than at Pointe Pelee, the natural wetland. Assemblages at Pointe Mouillee were dominated by common carp, yellow perch, sunfishes, and gizzard shad, while Pointe Pelee was dominated by sunfishes, large-mouth bass, black bullhead, and golden shiners. Black bullhead, large-mouth bass, sunfishes, and yellow perch also constituted a recreational fishery at Pointe Mouillee, but were not the dominant larval or juvenile species.

Macroinvertebrate species richness and diversity were comparable between the two wetlands, but abundance was lower at Pointe Mouillee. Assemblages at Pointe Mouillee were dominated by water boatmen, while assemblages at Pointe Pelee were dominated by water fleas, seed shrimp, and scuds. All of these species are prey items for fishes and waterfowl.

In addition to the comparable fisheries and macroinvertebrate communities, Pointe Mouillee is attracting large populations of birds and other animals. The large site is a major migratory stopover point for shorebirds, waterbirds, raptors, waterfowl, and songbirds, and provides nesting habitat for several waterbird colonies, numerous songbirds, mute swans, Canada geese, black ducks, and mallards. Over 200 species of birds have been recorded since the CDF was completed. Birders from Canada and a six-state area frequent the site, especially during migration. Bird migratory use at Pointe Mouillee is greater for shorebirds, waterbirds, and waterfowl than at Pointe Pelee.

Pointe Mouillee is less than 20 years old---a very young wetland system, dynamic and changing. Pointe Pelee is a documented 4500 years old. When the comparison studies began, it was not anticipated that results would be so similar due to the great age differences. Rather, it was intended that Pointe Pelee would serve as a guide for further natural resource refinement at

Pointe Mouillee, and it is continuing to do so. In addition, due to its location in a urban area sandwiched between Detroit, MI, and Toledo, OH, it has become a prime destination place for natural resource recreation. Long-term information will continue to be gathered at Pointe Mouillee as funds become available, and data information exchange will continue with the Canadian Park Service and Environment Canada.

MANAGEMENT OF THE TIMES BEACH CONFINED DISPOSAL FACILITY FOR BENEFICIAL USE

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The Times Beach Confined Disposal Facility (CDF) located in Buffalo, New York was left partially filled 20 years ago, in response to the presence of avian wildlife at the site. The material placed in the site was dredged from the Buffalo River. This dredged material had significantly high concentrations of PAHs, PCBs, and metals. The site has been primarily unmanaged for the last 20 years.

Over this time period a significant data base of contaminant mobility has developed. This collective 20 year study consists of surveys and collections of the vegetation, invertebrate, earthworm, and avian species present. There is also a data base of chemical analyses addressing the change in soil and water contaminant concentrations over this time period.

This presentation will address the observed changes in contaminant mobility and the species at the site, and how accurate the predicted ecological risk assessment was on the site. Current work at the site involves: (1) addressing the need for active management plans involving management with native American plant species, and the role of contaminant mobility changes in a native ecosystem, and (2) development of a model to predict and manage relevant environmental impacts and risks inherent in using similar areas as nature preserves.

BENEFICIAL USE OF A CONFINED DISPOSAL FACILITY AS A COMMERCIAL RACETRACK

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Once a confined disposal site was filled and returned to the sponsor, the concept of the development of a commercial racetrack evolved. The sponsor coordinated with all the appropriate interested parties and all agreed to move forward with the concept. After much discussions and considerations, a plan was prepared and proposed. Sufficient dredged material was removed from the site and a sandier dredged material was brought in from a second disposal site to provide the proper soil properties to compact into the racetrack road base. The participating interested parties successfully coordinated the construction and final completion of the project. The first ever commercial NASCAR race in Savannah occurred in May 1997 on the confined disposal facility.

MANAGEMENT OF CONFINED DISPOSAL FACILITIES FOR BENEFICIAL USES

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Confined dredged material disposal facilities (CDFs) can be managed for beneficial uses. Although CDFs generally contain contaminated dredged material, the transient aquatic and wetland ecosystems as well as the ultimate upland ecosystem can be valuable wildlife habitat if a risk-based management plan is applied. The ecosystems that sequentially occur on the CDF must be accurately predicted and/or established to limit contaminant mobility while providing stable, conservative and diverse plant and animal communities. Ecosystem management for beneficial uses at CDFs is not limited to post-operational phases. During the operational stages management for beneficial uses may include establishment of vegetative types that exclude sensitive species during periods when colonization is inappropriate, while habitat is provided for species at low risk. The application of beneficial uses of CDFs such as production of manufactured soil may also depend on ecosystem management to limit plant and animal colonization in reuse areas.

TECHNICAL SESSION 18: Aquatic and Marine Habitats B

William Muir, Chair

BENEFICIAL USE INTEGRATED WITHIN AN ECOSYSTEM APPROACH TO FISHERIES HABITAT RESTORATION AT THE HOBOKEN RAIL TERMINAL, HOBOKEN, NEW JERSEY

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New Jersey Transit's need to expand rail facilities at the Hoboken Terminal in Hoboken/Jersey City, NJ provided an opportunity to create over 20 acres of interpier finfish habitat and to effect improvements that benefit the entire estuary. To create fish habitat, a system-oriented approach designed to produce sustainable improvements in water quality, circulation, and opportunities for shelter and food was developed. The key component of this effort is the development of a confined disposal facility (CDF) within an existing canal. Several measures to improve local water quality, particularly summer levels of dissolved oxygen (DO), comprise the other components. Species such as striped bass, tomcod, white perch, tautog, cunner and other species are expected to utilize this interpier habitat.

Long Slip canal is an abandoned 100 by 2,000-foot long waterway separated from the main channel of the Hudson River by a 1,500-foot wide interpier area that contains nearly ten acres of piles, the abandoned remnants of two former commercial piers. The canal bulkheads are highly deteriotated. Two combined sewer overflows (CSO) discharge into the canal, depositing organic debris and sediments. Summer canal waters are characterized by chronic extreme anoxia, high salinity, density stratification, and methane blooms. Tidal circulation within the canal is poor. Canal waters reaching the interpier area degrade those waters because circulation is restricted by a shoal along the main river channel. Field studies determined that plant and animal life are absent from the canal in the summer and depauperate during other seasons. The low DO levels in the interpier area preclude otherwise valuable habitat for several juvenile and adult species.

To correct these problems, about 100,000 cy will be dredged from the entrance basin shoal and placed in the CDF. This will create 4.5 new acres for rail yard expansion and make available an additional 4 acres that are currently isolated by the canal. There is additional capacity in the CDF to accept off-site dredged materials not suitable for ocean disposal, partially offsetting construction costs. The CDF will eliminate the oxygen demand of canal waters and canal and entrance basin sediments. Numerical modeling found that the dredging and realigned shoreline eliminated stagnation and stratification, raising DO levels within the entire inlet. The CSO's can not be eliminated, but will be improved and extended into areas of better circulation. Rip rap armor fronting the containment dike will diversify available shelter for juveniles and substrate for food species to attach. Finally, a walkway along the containment berm crest will introduce public access and may yield revenue-generating opportunities that could further offset the costs to sustain the habitat area.

The project is a model of isolating areas of pollution, reducing chronic pollutant loading, realigning the shoreline and bottom topography to improve circulation, and diversifying the habitat structural components applicable to many situations. It provides the preponderance of long-term benefits essential to the approval process.

LONG-TERM EFFECTS OF DREDGING ON FISH COMMUNITIES: A CASE STUDY OF THE LYNNHAVEN ESTUARY

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A comparative study was made of the structure of demersal fish and benthic communities in two sections of a back bay in the lower Chesapeake Bay. This study was an attempt to assess the possible impacts that might occur due to changes in the benthic communities caused by dredging and how that would effect the long-term changes in fisheries populations. Over the past ten years there has been a significant increase in dredging of small channels for non-commercial boating due to the massive increase in development in the coastal zone.

The Chesapeake Bay has been subjected to this type of growth while at the same time there seems to be ever dwindling fisheries resources. While reviewing a request to dredge a small channel in the Lynnhaven Bay, it became evident that there was not sufficient literature relating the effects of dredging. Specifically, we were concerned with the changes that occur to benthic communities and the subsequent changes in fisheries that rely on benthic infauna and epifauna.

This study was designed to compare the changes that have occurred in the Lynnhaven estuary where there are two similar channels, one dredged only five years ago and one dredged over twenty years ago. The assumption being that both channels would have recolonized to similar benthic populations and would have similar fisheries communities within the five year period.

The study was conducted during the winter and spring of 1997 using otter trawl samples for fisheries and a Young benthic grab sampler for the benthic infaunal and epifaunal communities. In comparing the differences in the two areas, the area that had been dredged only five years ago showed a marked decrease in the total number of fish and the diversity of fish species. Further, the benthic community showed a significant decrease in diversity but had a comparable overall biomass to the channel dredged twenty years ago.

The ability of both the fish and benthic communities to recover would appear to take significantly more than five years to recover. This is evidenced by the differences that are shown to occur in diversity and abundance of the fish communities present in the two comparative dredged areas. It is therefore concluded that there are significant long-term effects caused by dredging to the fisheries communities in Lynnhaven Estuary.

DAN-NY: A MANAGER-FRIENDLY GIS FOR VIEWING MARINE ENVIRONMENTAL DATA AND MANAGING DREDGED MATERIAL DISPOSAL IN COASTAL WATERS

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The US Army Corps of Engineers, New York District (NAN) is responsible for management and monitoring of the regional dredged material ocean disposal site known as the Mud Dump Site located 6 miles offshore New Jersey. The Site's proximity to commercial and recreational fishing areas, historic disposal sites, and heavy shipping within the approaches to New York Harbor create a unique set of circumstances in terms of disposal site management.

Information, in the form of project-specific details, sediment testing, and environmental monitoring data have been collected for numerous dredged material projects over the past ten years. This vast database currently exists at NAN in a non-electronic, report-style format which has been the typical means/mode of data storage. Access to the information is both limited and a labor intensive process. Recently, the NAN and the US Environmental Protection Agency, Region II have conducted marine environmental surveys in the New York Bight to acquire additional, site-specific data to assess environmental conditions within a broad area termed the Historic Area Remediation Site, which encompasses the Mud Dump Site. Management of these recent data and developing a capability for accessing both new and historic data from the region will be critical for designation and subsequent management of the expanded disposal area in the years to come. A system designed with the user/project manager in mind which incorporates elements of relational databases and geographic information systems (GISs) would, at both staff and management levels, improve the efficiency of dredged material disposal site management.

NYD funded SAIC for the development and implementation of the Disposal Analysis Network for the New York District (DAN-NY) which shall provide the NYD with the following capabilities to aid disposal site management:

(1) User-friendly access to and display of multi-disciplinary marine environmental data (seafloor photographs, bathymetric surveys, sidescan sonar images, tabular results from chemical, biological, and geological analyses of seafloor samples, etc.)

(2) Archiving of data from individual dredged material disposal events (from NYDISS units, as described in another paper of this workshop)

(3) Information-based siting of disposal projects in the New York Bight

(4) Numerical modeling to simulate dredged material disposal, mound creation, and potential consolidation and/or erosion (as described in second paper of this session)

(5) Real-time management of disposal projects (access to scow logs, disposal marker buoys, monitoring results, etc.)

Although not intended to be an exclusive system for dredged material management in the New York region, DAN-NY is initially being tailored for the NYD ocean disposal site manager. In later iterations and once the system has been utilized by the NYD and the U.S. Army Engineer Waterways Experiment Station (WES), the goal is to broaden the capabilities of DAN-NY for use in other applications and within other Corps Districts.

WILMINGTON HARBOR OCEAN BAR CHANNEL DEEPENING PROJECT: WILMINGTON OFFSHORE FISHERIES ENHANCEMENT STRUCTURE

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The dredging of substantial quantities of rock from the Wilmington Harbor Ocean Bar Channel in southeastern North Carolina provided a unique opportunity to use dredged material beneficially, that is, used in a way that is economically and environmentally acceptable and accrues natural resource benefits to society. Approximately 1.6 million yds^3 of dredged material has been used to construct a marine structure offshore in the Atlantic Ocean to the southeast of the Wilmington ocean dredged material disposal site. The new structure was designed to be a bathymetric anomaly which provides habitat diversity and attracts fish.

About 1.0 million yds^3 of the material to be dredged was rock, while the remainder was a mixture of sand, silt, clay, and shell fragments. Samples of the rock indicated four different fossiliferous limestones. Dredging was accomplished by a hydraulic pipeline dredge with a rock cutterhead. The rock cutterhead broke and ground the rock into pieces that were lifted hydraulically into a scow moored alongside the dredge. The resulting dredged material was predominantly golf ball to softball sized rock pieces mixed with sands and smaller pieces. Some rock pieces were as big as volleyballs. The scow transported the dredged material to the placement location about 3 nautical miles from the dredging location.

Factors considered in the design of the structure included type of material used, shape, orientation to currents, vertical relief, side slopes, and general size. The rock dredged material provided excellent marine habitat material because of its durability and stability, rugosity, the habitat complexity it provides, and its availability. This presentation will the project planning process, construction issues and environmental monitoring conducted to date.

TECHNICAL SESSION 19: Coastal Case Studies A

Ram K. Mohan, PhD, PE, Chair

MODELING WITH DREDGED MATERIAL AND EXPERIMENTING WITH DIFFERENT TECHNIQUES IN THE NETHERLANDS

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The Lake IJsselmeer area consists of a series of smaller and larger lakes (totally 2000 sq km) with an artificial origin. The whole area used to be an estuary called the Zuiderzee. With the building of the Afsluitdijk (barrierdam) in 1932, a large freshwater basin was created. The purpose of this ambitious project was, amongst others to enable the reclamation of land. At this moment about 150.000 ha of land is reclaimed. The construction of the dam and the reclamation of the land deprived the area of its natural morphological dynamics that characterize a natural delta area. The remaining water is characterized as fairly shallow (1 to 4 meters) with dikes at its shores, leaving little space for the swamp areas one should expect at the shores of natural lowland lakes. Water levels are strictly managed, preventing any natural wetland development.

In order to create a more complete ecosystem nature development is carried out, focusing on the construction of the basic morphology of the missing swamp areas. *Phragmites australis* is the plant species used as a major structurizer in the so created areas. It consolidates the newly built shores, defending it against wave exposure. It serves as shelter and spawning area for fish and it's used for feeding by several species of waterfowl if growing in water. The use of *Phragmites* is not without risk. In areas that are too dry, it easily becomes a monoculture with little ecological value. On the other hand, it needs to have root connection with an area that is (at least temporary) not inundated and it will not expand much into areas that are permanently inundated.

Above mentioned characteristics of *Phragmites* demand specific features of the created basis for ecologically interesting wetlands. The most favorable situation is one in which there is lots of relief in the terrain, varying between 20 cm above to ca. 1 meter below water level. Most of the terrain must be under water.

The techniques for modeling dredging material into such an area vary with the characteristics of the material. Lately, three projects were prepared, experimenting with different techniques for different kinds of material.

Sandy Material: The Abbert Project. In a small area of ca 15 ha. One hundred small isles with a diameter of ca 10 meters were created using sandy soils coming from the dredging of the adjacent fairway. The material was transported from the dredged fairway, as a sand-and-water-slurry in a 12 inch flexible pipeline attached to a caterpillar. With its broad tracks it could ride on the shallow lake bottom, replacing the mouth of the pipeline every few hours. Modeling with sand is fairly easy and we didn't encounter many difficulties with the implementation. However, the lakebottom was not always trustworthy and it was grace to the skills of the caterpillar driver that the machine didn't go under into a unexpected peat layer. It must be noted that since we were in no hurry with the dredging job, we could afford to shut down the pump in order to move the pipe. If ships are waiting to become unloaded or there is time pressure on the dredging job for other reasons this technique might cause a capacity problem. In ecological sense the technique is not very favorable.

Sand is naturally low in nutrients and with the pumping water most of the nutrients are washed out. So vegetation development is slow. This forced us into planting Phragmites whereas we preferred a natural development of *Phragmites*.

Dry Clay: The Lake Vossmeer Project. In order to create a more rich environment we developed a project over about 150 ha, making use of dry clay, coming from the digging of canals. In the shallow water (80 cm.) 120.000 m3 was transformed into about 450 little heaps, just above water level. The area is protected from the heavy wave influence by a broad sand dam. When starting the implementation we thought we would be able to drive into the lake with large dumpers with wide tires. The bottom of the lake was to silty however. Walking goes fine but as soon as the dumpers drive twice over the same place, the structure of the soil is disturbed and it becomes almost fluid. So we decided to close the protection dam all around the project and pumped out most of the water. We made pathways of sand over the lake bottom, transporting the clay into the field with ordinary transport means. The heaps are constructed by long-arm-caterpillars taking up the clay from the pathways. Modeling with this method is easy. One can almost literary mold the wanted structure. Due to the richness of the soil we do expect quick development.

The method is very costly and unfit for larger areas. It was also risky. The protection dam was constructed as a temporary wavebreaker, not as a polder dike. On several occasions it broke through with all the surrounding water flushing into the working area.

Wet Clay and Peat: The Ijsselmonding Project. In waters too deep to drive but to shallow to go by boat, materials can best be brought in as a slurry by pipes. At this moment we are preparing a 500 ha project making use of large quantities of clay and peat originating from large dredging jobs. The slurry is brought in between dams in several compartments, together shaping an artificial delta area. A pilot is yet under construction. Modeling with clay slurry is impossible. The -at best-yogurt-thick material takes years for consolidation and will always float out into one layer of equal levels. In order to create the wanted relief, the underground is first manipulated. By creating structures with sand, somewhat the same as in the Abbert project, we try to manipulate the consolidation. In the end we expect the clay layer to follow the shapes of the underground.

This can be reinforced by pumping out water at certain places, thereby stimulating the consolidation process. We hope to find a economically and ecologically viable way to deal with the large amounts of dredging materials that will come available in the coming years.

AN OVERVIEW OF BENEFICIAL USES OF DREDGED MATERIAL IN A HIGHLY URBAN ENVIRONMENT

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As part of the US Army Corps of Engineers New York District's Dredged Material Management Plan (DMMP) and harbor expansion and restoration projects, the beneficial use of clean and contaminated dredged material is being examined in some detail. These uses include:

(1) Creation and enhancement of habitat (wetland, upland, and aquatic);

(2) Capping of landfills;

(3) Improvement of water quality through wetland construction at the base of landfills and combined sewer outfalls;

(4) Creation and enhancement of artificial reefs through addition of blast rock from new work dredging;

(5) The restoration (capping) of the New York ocean "Mud Dump" site which is scheduled to be closed in Autumn 1997;

(6) The creation and enhancement of shellfish beds and submerged aquatic vegetation habitat with appropriate dredged material; and

(7) The "recontouring" of certain areas of the harbor, primarily by the deposition of dredged material in manmade depressions to restore approximate ambient bathymetric conditions.

Potential markets in the New York\New Jersey Metro region will also be explored for processed or treated dredged material from New York\New Jersey Harbor. Most likely beneficial uses would include landfill cover, construction fill, mine and quarry reclamation, and capping of brownfields. Promising end-products include blended cement and manufactured soil.

THE BENEFICIAL USE OF DREDGED MATERIAL IN NEW JERSEY

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Dredged material can be considered a resource, and the New Jersey Department of Environmental Protection strongly supports its beneficial use. It is also essential to develop and evaluate emerging beneficial use strategies to ensure a multi-faceted and integrated dredged material management program.

The Department's guidance manual "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" (in draft, March 1996) discusses its approach to evaluating and regulating proposed beneficial use alternatives. In general, these alternatives are evaluated by the Department on a case-by-case basis, in a process similar to that used to evaluate proposed beneficial uses of non-hazardous solid waste. This evaluation includes an analysis of contaminant levels present in the dredged material *vis-a-vis* thresholds for environmental and human exposure at the proposed use site.

The Department is also currently developing criteria to establish categorical regulatory thresholds for contaminants and any associated beneficial use criteria or limitations. At the present time, potential beneficial use options in New Jersey include beach nourishment, habitat development, construction material/fill, landfill cover, agricultural uses, and capping open water dredged material disposal sites. A number of approved beneficial use projects will be discussed, including the use of (1) a stabilized dredged material product for landfill closure/brownfield development at the OENJ site in Elizabeth, and (2) dredged material from Strawbridge Lake (Moorestown, Burlington County) for landfill cover.

THE DELAWARE RIVER DEEPENING PROJECT: MANAGEMENT OF UPLAND CONFINED DISPOSAL FACILITIES AS WETLAND/WILDLIFE HABITATS

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The proposed Delaware River Deepening project provides for a full width channel deepened from -40.0 to -45.0 feet MLW. from the Delaware Bay to the Philadelphia/Camden waterfront, a distance of about 102.5 miles. Approximately 33 million cubic yards of dredged material would be removed for initial construction over a four year period. Over the 50 year project life approximately 300 million cubic yards of maintenance dredging will occur. Dredged material from the river would be placed in confined upland disposal areas. Material excavated from the Delaware Bay would be primarily sand and would be used for beneficial purposes including wetland environmental restoration and underwater sand stockpiling.

In order to provide capacity for the dredged material from the Delaware River, four new upland disposal areas ranging in size from 275 to 350 acres, will be constructed. Each area will be divided into two cells which will enable the District to manage the areas to provide wetland and wildlife habitat. By rotating the disposal of dredged material between the cells, in addition to rotation of the new areas with existing sites, individual cells will be maintained as undisturbed wetland habitat for four to five years. After the initial construction of dikes and installation of drainage structures both cells will initially receive approximately 3 to 6 feet of predominantly fine grained, nutrient rich dredged material. One cell will continue to receive dredged material over a 7 to 8 year period; the other cell will be managed for wetland/wildlife values over a 3-4 year period.

Desirable wetland vegetation will not become established unless the water in the wetland cell is drawn down to bare substrate. After the initial filling the active cell would be dewatered and managed in a conventional manner. The water in the wetland cell would be drawn down after dredging is completed, and the area would be seeded from a helicopter with a combination of desirable wetland species. After the plants have become established (i.e.,. after one growing season), water would be diverted from the active dredged material disposal cell into the wetland cell, to levels of 1 to 2 feet deep . These species should become established during the first growing season and remain during the 3 to 4 year period until more dredged material is placed on the cell, when this procedure would be repeated to establish wetland vegetation on the other cell.

An important aspect of this wetland creation is Phragmites control. There is a risk that Phragmites would become established during the drawdown of the cells for planting by invading rhizomes from adjacent plants. To minimize this risk, impoundment berms would be sprayed with herbicide in the late summer, prior to the drawdown. After the area is reflooded, an appropriate fish species would be introduced to the flooded cell to control mosquitos. If due to climatic reasons additional water is needed in the wetland cell, it will be diverted from the active dredged material disposal cell during future dredging activities.

By utilizing a combination of conventional management measures combined with careful environmental control it is envisioned that these new upland areas can serve the Corps dredging needs and provide beneficial wetland habitat for the life of the project.

TECHNICAL SESSION 20: DREDGED MATERIAL MANAGEMENT AND RE-USE A

Richard Della, Chair

RE-USING DREDGED MATERIAL IN THE SACRAMENTO-SAN JOAQUIN DELTA

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The California Senate passed the Delta Flood Protection Act (SB34) in March 1988. The bill legislated the appropriation of $12 million annually for special flood protection projects on the Sacramento-San Joaquin Delta islands for ten years, beginning in July 1988. SB34 directed the California Department of Water Resources (CADWR) to develop and implement flood protection projects on eight western Delta islands to protect public infrastructure, urban areas, water quality, and other public benefits. SB34 also directed CADWR to seek partnering opportunities with owners and operators of island levees; Federal agencies with flood protection missions; and other potential beneficiaries.

Coincidentally, environmental agencies and organizations in the San Francisco Bay region had been calling for beneficial re-use of dredged material, rather than continuing in-bay disposal practices. So cooperative efforts were made by the CADWR, the US Army Corps of Engineers San Francisco District, and local reclamation districts to demonstrate safe re-use of dredged material in the Delta. The Corps would be able to use the project as a case study for the Long-Term Management Strategy (LTMS) program. The CADWR would be able to further its efforts to streamline the permit process for future projects in the Delta, with the California Environmental Protection Agency.

A pilot project was first completed at Sherman Island in 1990, using 2500 cy of dredged material. In February 1993, the CADWR wanted to implement a larger-scale project. The Corps identified the Suisun Bay Channel dredging project as a source of material. The CADWR identified Jersey Island, owned by Oakley Sanitation District, as the levee site. A work plan was developed, dividing activities and costs among the project participants.

In Fall 1994, 50,000 cy of dredged material from Suisun Bay and New York Slough were placed at the Jersey Island site. The Corps provided funding, and services to dredge and transport the material to Jersey Island. The Oakley Sanitation District assisted with costs for offloading, rehandling, and placing the material onto the levees. The CADWR also provided funding and obtained the necessary permits. The project demonstrated that the Delta island levees are suitable for re-using dredged material, having a long-term capacity of 3.5 million cubic yards.

In-situ PROCESSING OF DREDGE SEDIMENTS FROM THE PORT OF NEW YORK AND NEW JERSEY: CASE STUDIES OF LARGE VOLUME UPLAND PLACEMENT FOR USE AS STRUCTURAL FILL AND BROWNFIELD REMEDIATION

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A joint project of ECDC Environmental and ITEX has established a fully operational Dredge Sediments Recovery and Recycling Facility at Port Newark, New Jersey. The facility treats dredged sediments at dockside before removing them from the barge. Proprietary mixing equipment mixes specially prepared cement-based additives to improve the material's compressive and supportive strengths. The process also reduces leachability of any contaminants that may be present in the dredged material.

The facility is currently processing 4000 cubic yards per day of material from dredging projects in the New York Harbor area and has capacity to expand to 12,000 cubic yards per day production. Processed material is being used for structural fill at a local shopping mall development site and a second beneficial use location will open in August or September 1997.

TECHNICAL SESSION 21: Capping

Michael R. Palermo, PhD, PE, Chair

BENEFICIAL USE OF DREDGED MATERIAL FOR SUBAQUEOUS CAPPING

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Subaqueous capping is the placement of a subaqueous covering or cap of clean isolating material over contaminated sediment. Capping is an option for dredged material placement and for in-situ remediation of contaminated sediments. Beneficial use of dredged material as capping material is a common component of many capping projects. Both sandy and fine-grained material can be suitable for use as capping material, depending on site conditions and other factors. This paper briefly describes the technical requirements for capping, beneficial use of dredged material for capping, and a summary of recent case studies.

SUBAQUEOUS CAPPING IN NEW ENGLAND: WISE USE OF DREDGED MATERIALS

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Disposal of dredged materials at selected ocean disposal sites has been carefully monitored and managed in New England as part of the Disposal Area Monitoring System (DAMOS) for twenty years. Throughout this history, the goals of the program have been to minimize adverse impacts on the marine environment and to wisely manage the disposal of dredged materials. As part of the management approach, dredged materials deemed suitable for open water disposal (determined through testing and comparative evaluation) have been used as a resource.

Through the evolution of the program, level-bottom capping was initiated to manage the disposal of sediments deemed unsuitable for open water disposal. These sediments have been

successfully isolated from New England waters through the placement of cleaner dredged materials.

As our knowledge of capping as a management tool has increased, several important factors have emerged: managers need evaluative tools for determining what dredged materials are suitable for use in capping finer-grained sediments; the careful placement of disposal mounds at a site can create confined depressions that substantially reduce cap volume requirements; consolidation of capped material, caps and underlying sediments needs to be factored in to design and monitoring requirements; accurate, verified placement of materials is critical to project success; self armoring of cap surfaces from erosion can be enhanced by selection of the cap materials and the sequence of disposal.

The DAMOS program has continued to test and evaluate the use of a variety of dredged materials for use in capping projects at a range of depths from 10-90 m. As yet, no material or depth has proven unsuitable but each project has been evaluated individually. An empirical effort to define geotechnical requirements for cap materials has provided promising results and may lead to more general guidelines.

The use of dredged materials to build confined mounds on the seafloor, provides an important management option for disposal of large volumes of contaminated sediments. The materials suitable for open ocean disposal effectively constitute the raw materials to engineer containment structures. Placing a series of disposal mounds (capped or not) in a ring can create a topographic depression to contain project materials that require capping. These mounds need not be constructed of a homogeneous material such as sand, but can themselves contain capped sediments. When sediments are precisely disposed at a taut-wire moored buoy, distinct mounds are formed in water depths to at least 90 m. The gravitational forces on falling sediments are, however translated into lateral density flows when loose material hits the bottom or slopes of the mound. By confining the lateral spread of disposed project material the need for cap material can be cut in half in some cases.

Even slight changes in slope can restrict the fine sediment apron of mounds sufficiently to require substantial reductions in cap requirements. While the use of dredged materials for capping has not been seen traditionally as a beneficial use, it is one of the wisest options available to resource managers.

USE OF DREDGED MATERIAL FOR CAPPING SOLID WASTE LANDFILLS

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Increased environmental awareness of the public, coupled with the enactment of stricter state and federal regulations, has resulted in the requirement that solid waste disposal facilities be capped with clean uncontaminated material upon closure. The capping of landfill disposal areas restricts potential upward contaminant migration from within the site and provides for a zone of clean material at the surface. Typically, compacted clays have been used for such applications due to their inherent low permeability, thus reducing surface water infiltration and contaminant transport, while maximizing the surface run-off. In many cases, clean maintenance dredged sediments from rivers and harbors can usually meet the physical requirements of such caps and offer several advantages: (1) *economic:* this provides a placement site for maintenance dredged material, (2) *environmental:* the low permeability of the silty and clayey dredged material minimizes surface infiltration and potential upward transport of contaminants, and (3) *beneficial:* this provides a beneficial use of clean dredged material from maintenance dredging.

Effective capping of solid waste landfills requires careful and well-planned geo-environmental design and subsequent monitoring to evaluate performance. In general, solid waste landfills can be classified as follows, based on the nature of the waste product: (1) *hazardous and toxic waste landfills:* are those that contain wastes defined by the Code of Federal Regulations, paragraph 40, (2) *Class I Waste Landfills:* are landfills which accommodate solid wastes, which after defined testing, contain specific constituents which equal or exceed listed levels or are ignitable or corrosive, (3) *Class II Waste Landfills:* are those that contain non-hazardous solid wastes which cannot be classified as Class I or III, and (4) *Class III Waste Landfills:* are landfills that contain inert and essentially insoluble wastes that are not readily decomposable. Depending on the classification of landfills and applicable environmental regulations, they may require closure by specific capping layers and thicknesses. However, such caps typically consist of one or more layers of the following: barrier soil liner (low permeability layer, clay or equivalent), geomembrane liner, lateral drainage layer (sand), and vertical percolation barrier (topsoil for vegetation).

Design requirements of various caps and potential use of various fractions of dredged material as part of such capping layers will be described in the presentation. Desired dredged material for such use (including water content, consistency, permeability, texture, pH, organic content, and soluble salt content) and potential techniques that will aid in such use (including direct placement and dewatering, dredged material rehandling/reuse facilities, particle separation techniques, and treatment chains for contaminated sediments), will be identified. In addition, experimental, analytical, and field simulation techniques for evaluating the effectiveness of maintenance dredged material for use in such caps will also be discussed. Finally, case studies of pilot-scale and full-scale projects where dredged material has been used for capping solid waste landfills (or is being planned for such use) will be presented.

THE 1997 CAPPING PROJECT IN THE MUD DUMP SITE

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Based on an agreement between the White House, EPA, and the Army during the summer of 1996, the Mud Dump Site (6 miles east of Sandy Hook, NJ) will be closed to Category II (mildly contaminated) dredged material on 1 September 1997. Thus, the summer of 1997 will be the last opportunity to place Category II dredged material in the Mud Dump site, at present the only open water site available to New York Harbor. The New York District (NAN) requested that the U.S. Army Engineer Waterways Experiment Station (WES) design a Category II mound and cap that will be placed during the spring and summer of 1997 (hereafter referred as the 1997 mound or 1997 capped mound).

During this effort, an estimated 960,000 cy (barge log) of Category II dredged material from 5 projects (1 federal and 4 permit), will be placed in the Mud Dump site followed by capping with in excess of 3,000,000 cy of sand. Part of the capping material may be sand removed from Sandy Hook channel as part of the normal maintenance dredging, i.e., a beneficial use.

WES work on this project has consisted of computing site capacity, predicting mound stability, consolidation, and Category II mound placement and cap placement. The presentation will provide an overview of the entire project, and focus on the design of the contaminated sediment mound placement using the MDFATE model. Also, we are using NY District's site management software - Disposal Analysis Network for New York (DAN-NY), as part of the design, and would include some information on that in the talk.

TECHNICAL SESSION 22: Coastal Case Studies B

Scott P. Miner, Chair

BENEFICIAL USE OF DREDGED MATERIAL: SECTION 204 PROJECTS IMPLEMENTED IN THE NEW ORLEANS DISTRICT

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Louisiana's coastal wetlands comprise approximately 40 percent of coastal wetlands in the continental United States. However, as a result of both natural and human-induced causes, these wetlands are undergoing land loss at a rate of 25 to 35 square miles annually. Since the 1970s the US Army Corps of Engineers, New Orleans District (MVN) has beneficially utilized a portion of shoal material removed during maintenance dredging of Federal navigational channels for wetlands enhancement, development or creation. Factors that limit beneficial use of shoal material for wetlands development include cost and Corps of Engineers policy. Corps of Engineers regulations and policy, which specify the manner in which dredged material disposal operations are conducted, state the selected disposal alternative should be the least costly alternative consistent with engineering and environmental requirements. Beneficial use of dredged material for wetlands development is seldom the least costly disposal alternative. The passage of Section 204 of the Water Resources and Development Act (WRDA) in 1992 provided supplemental funding and authority for the implementation of beneficial use of dredged material generated during maintenance of Federal navigational projects.

Specifically, Section 204 of WRDA 1992 provides funding and authority to the Secretary of the Army to carry out projects for the protection, restoration or creation of aquatic or related habitats in association with construction, operation, or maintenance of authorized navigation projects. Projects can be implemented if environmental, economic and social benefits justify the project cost. Project approval is granted regionally through Corps of Engineers Division Offices. Funds are allocated by Army Headquarters and Corps of Engineers Districts's compete nationwide for Section 204 funds. Section 204 requires the Federal sponsor, typically a Corps of Engineers District, provide 75 percent of the funding for the construction of the protection, restoration or creation component of a particular activity and a non-Federal local sponsor provide the remaining 25 percent of the construction costs and 100 percent of the maintenance costs.

In 1996, the MVN with the Louisiana Department of Natural Resources, a strong proponent of beneficial use of dredged material for wetlands development, constructed two Section 204 projects in which dredged material was used beneficially for wetlands and barrier island development and restoration. The wetlands development project involved the placement of dredged material into shallow open water areas to restore degraded brackish marsh. The island restoration project utilized dredged material to increase the elevation of portions of a barrier island that had undergone severe storm induced erosion. For both of the Section 204 projects constructed, beneficial use of dredged material disposal costs exceeded the least costly disposal alternative that was consistent with engineering and environmental requirements.

BENEFICIAL USES OF DREDGED MATERIAL IN THE GALVESTON DISTRICT

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The US Army Engineer District, Galveston is responsible for 1000 miles of deep and shallow draft channels along the Texas Gulf Coast. Maintenance requires relocating approximately 35 to 40 million cubic yards of dredged materials annually. The dredged material has been put to work within the district boundaries to create wetlands, build beaches, bird island and industrial fill. One of the first and best examples of beneficial uses of dredged material within Galveston was the raising of Galveston Island.

After the devastating hurricane of 1900, dredges pumped fill material behind the newly built seawall to raise the island. Much of the fill operation looked like a modern day confined disposal area, levees, berms and a big discharge pipe. One of the major differences was that the material was being pumped under homes, businesses, and schools, while they were being occupied. Often a beneficial use of the dredged material has been derived without prior intent.

Many islands have been created within the Galveston District in practically every bay within the state. Most support some type of colonial waterbird and islands in Aransas National Wildlife Refuge, Laguna Madre and Matagorda Bay support endangered species such as the piping plover, whooping crane and brown pelican. Brown pelicans currently nest in 3 locations within the state, all active placement areas. Recent studies by the Galveston Bay National Estuary Program identified submerged benefits as well. Over 2,500 acres of oyster reef have been created along the Houston Ship Channel. The reefs developed exclusively on the side of the channel were materials were placed.

The Galveston District has continually embarked on other marsh creation projects, creating over 350 acres of new intertidal marsh. Recent examples include the approximately 50 acres of marsh created in the Aransas National Wildlife Refuge (ANWR) in 1993. The marsh was designed and built to emulate habitat for the endangered Whooping Crane. Beach nourishment within the Galveston District includes both direct beach placement and nearshore berms. Over 20 million cubic yards have been used for direct beach nourishment, as well as over 2 million cubic yards in nearshore berms. The district recently completed its first cost shared beach nourishment job in South Padre Island placing 500,000 cubic yards of sand on eroding beaches. Currently 25 to 30 percent of the material is used beneficially and efforts continue to improve those percentages. Construction on the widening and deepening of the Houston-Galveston Ship Channel will utilize 100 percent of the material beneficially to create over 4200 acres of new marsh, bird island and boater destination over the next 50 years. Plans for the Gulf Intracoastal Waterway in the ANWR call for the construction of 1200 acres of new marsh over the next 50 years.

SAND-FILLED GEOTEXTILE CONTAINERS

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The Baltimore District Operations Division utilized geotextile tubes during 1994-1995, in conjunction with a dredged material management plan which endeavors to beneficially place dredged material. To the extent that almost the entirety of the Eastern Shore of Maryland is considered a wetland, the availability of acceptable upland sites is decreasing. Each of three projects placed in excess of 30,000 cy of sandy material along an eroding shoreline on the leeward side of the installed geotextile tubes. Each project resulted in the creation of an emergent marsh following the planting of *Spartina patens* and *Spartina alterniflora*. The typical project used a tube with a 37.5 foot circumference, 250 feet long, and a tensile strength of 400 pounds/inch. Each tube was filled with dredged material to create an offshore breakwater to absorb wave energy, and to protect dredged material placed behind them and along the eroding shoreline.

Geotextile tubes have a place in dredged material management plans for two reasons. First, the tubes are economical when compared to options such as stone containment. Geotextile tubes do not have the same life expectancy of rubble mound structures, but should be considered as permanent structures for planning purposes. As estimated life expectancy exceeds ten years. Second, they can be deployed in locations very difficult to access with conventional methods of shoreline protection construction methods incorporating bulkheading or rubble mound structures. The tubes not only result in a net savings in construction dollars, but are also more sensitive to the environment, in that heavy construction equipment is not necessary. The tubes are fabricated of polyethylene and will float in a foot of water, whereas the polyester tubes (higher strength) will sink. It is recommended that polyester material be used on dredging projects when the pumping distance is less than one mile, and the horsepower on the dredge exceeds 400. The polyester cloth exhibits a tensile strength of 1000 pounds/inch.

Each tube attained a maximum effective height of four feet, contrary to manufacturer's theoretical projections of six feet. It appears that irregardless of the circumference of the tube, that four feet is the maximum attainable effective height when placed in water. Circumferences varied from a high of 445 feet to a low of 30 feet.

One of the most important lessons learned focuses on pressure control during filling of the tubes. This may be more important when the tube is placed in water than on land. Two techniques for controlling pressure are currently being incorporated in future specifications. One, a Y-valve is required during filling, to allow a maximum of 50 percent of the flow into the tube. The remaining flow is diverted either into a second tube, or along the shoreline on the leeward edge of the tube. Second, a control port is sewn into the tube to allow pressure control/release during the filling operation.

We believe that geotextile tubes will continue to provide a cost-effective means for containing dredged material, and for providing a means of beneficially using the material. In projects currently under development where height in excess of four feet is required, tubes may be stacked to achieve the desired height.

LOSS OF SEDIMENT CONTAMINANTS FROM SAN FRANCISCO BAY THROUGH A CONTAINED DREDGED DISPOSAL FACILITY

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Maintaining the navigable waters of the San Francisco Bay is essential to both the commercial and recreational marine industries of California. Dredging operations, required to keep these marine waters open to ship traffic, often result in large amounts of material that need to be disposed in a way that is both economical and safe for the environment. Innovative new disposal techniques have been employed in a recent dredge operation at the Port of Oakland. The US Army Corps of Engineers (Corps) and Port of Oakland (Port) are operating a disposal facility for the containment of dredged material generated through the Port's 42-foot deepening project.

Approximately 6.6 million cubic yards of dredged material will be disposed at the Galbraith disposal facility located in San Leandro, CA. Sediments dredged from the Port waterways are dewatered at the Galbraith site. Water is discharged over weirs and through a series of vegetated control channels designed to slow water flow, decrease suspended solids, and facilitate uptake of contaminants by associated vegetation planted throughout the channels. Water is ultimately discharged back to the Bay. Even though a large amount (>5.6 x 104 Kg) of sediment was released to the Bay, water and sediment quality data shows that over 99% of all sediment contaminants are retained within the facility. This project shows the feasibility to utilize large-scale disposal facilities for upland beneficial use of dredged materials generated within San Francisco Bay.

TECHNICAL SESSION 23: Aquatic and Marine Habitats C

Richard Worthington, Chair

UTILIZATION OF SOLIDIFIED ORGANIC SLUDGE SEDIMENTS FOR MARINE ENVIRONMENT CONSERVATION AND HABITAT CREATION

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In many fish-cultivating grounds within enclosed sea areas, large amounts of dregs and organic matter accumulate as sludge. This sludge is a major cause of anoxia and other troubles in water quality maintenance in the fish-cultivating grounds.

As one of the countermeasures against these troubles, eliminating the sludge by dredging has been planned and examined many times. However, dredging itself cannot deal with the sludge, and this is an obstacle to employment of dredging for water quality improvement. On the other hand, organic sludge has a potentiality as a useful material if appropriately treated and recycled.

The authors have developed a new system of solidifying the organic sludge with a non-toxic chemical agent (CTG method patented) which is composed of gypsum, cement and pozzolanic material and formed into a block to create an artificial fish-reef. Thus, it is expected that the sludge will be utilized for restoration of the damaged environment in the fish-cultivating grounds. Our former studies showed good results that the solidified sludge is a suitable material for growth of marine animals and plants.

Based on the results, the authors constructed a block (unit size : 90 cm x 90cm x 170 cm) with the solidified sludge, and installed 86 blocks in Kusuura Bay (Hondo City, Kumamoto Pref., Kyushu, Japan) as components of an artificial reef in a large-scale fishing ground construction.

Through the monitoring of eight years since 1987, we confirmed that the damaged environment of the area has been steadily restored, especially around the reefs.

Additionally, the block reef of solidified sludge gathers many fish and is functioning as a habitat for attached and boring animals. The authors also confirmed that the blocks were destroyed into pieces by the feeding activities of these animals and sediment of these pieces also has created a new habitat for infaunal benthic organisms. These results show that the block reefs of the solidified sludge can create sandy sediment as an appropriate habitat for bivalves, bate worms and sea grass, and will contribute to conservation and creation of good environments in fishing grounds.

BENTHIC RECOLONIZATION FOLLOWING CESSATION OF DREDGED MATERIAL DISPOSAL IN MIRS BAY, HONG KONG

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Disposal of dredged material at a specially-designated open water site in Mirs Bay, Hong Kong ceased in 1993. A sidescan sonar survey performed at the end of 1995 confirmed the presence of disposed material on the seabed near the southwestern corner of the Mirs Bay Disposal Site (MBDS), both within and outside the site boundaries.

A survey involving REMOTS sediment-profile imaging in conjunction with benthic grab sampling and taxonomic analysis subsequently was conducted to assess the physical characteristics of the disposed material on the seafloor and the degree, if any, to which it had become colonized by benthic organisms. The REMOTS images showed that a poorly-sorted mixture of rocks, pebbles, sand, mud and shell fragments comprised the disposed material, while homogenous mud characterized three reference sites located in nearby areas unaffected by disposal.

Benthic organisms were found to be inhabiting both the disposal and reference sites. A higher total number of individuals in each of the major taxonomic groups (polychaetes, crustaceans, echinoderms, molluscs, and sipunculans) was found in grab samples from disposal site stations compared to the reference stations. Two multivariate statistical techniques (clustering and non-metric multidimensional scaling) and the ANOSIM significance test confirmed that the benthic community at the disposal site was significantly different from that at the reference sites, due to the higher abundance and diversity of benthic organisms inhabiting the disposed material.

Higher sand content, greater sediment stability and increased habitat variety were seen as the main factors accounting for the apparent stimulation of the benthic community on the disposed material. This beneficial aspect of dredged material disposal at MBDS, while unintended, has implications for the management of other disposal sites in Hong Kong.

TIDAL-FLAT CREATION FOR BIRD HABITAT AT HIROSHIMA PORT, JAPAN

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Project Description

Hiroshima Port is located at the inner bottom of calm Hiroshima Bay. In the western district, reclamation of 150ha at the river mouth was planned for the urban renewal and port development. Most of the existing tidal-flat, which provided bird habitat of 24ha, was to be lost due to the reclamation. During 7 months of autumn and winter, over 4000 individuals of 80 avian species (2000-3000 ind./day, 30-40 species/day) were observed before the implementation. Compensating the habitat loss, the project tried to create a new tidal-flat of similar area outside the seawall of the reclaimed land. The following topics were examined for the habitat creation: (1) morphological stability, (2) material availability, and (3) bird recovery/utilization.

Beneficial Use and Designing

Existing flat was made of fine sand (d50=0.4mm) with 15 percent silt and clay, discharged by the river. Similar sediment was expected suitable for the bird habitat and benthos supply. As the ground was too soft for the seawall construction, there needed improvement by replacing silty sand by coarse one. Utilization was planned of the removed soft sediment there. The balanced slope and the critical depth of the sediment move were estimated by the Swart or Lector Formula for the incidental waves. The cross-section was designed with a submerged gravel bank. Sand was planned to place over the soft sediment with 1m thick.

Implementation and Monitoring

Small scale experiments were first conducted for the disturbed soft sediment. Consolidation, strength and expansion were checked. Sediment and sand were placed by the direct dumping from barges up to C.D.L.-2m depth, followed by the placing through the floating-conveyer system and finished by clamshell vessels. Three years were required to finish placing of 1.4 mil. m3 soft sediment and 0.4 mil. m3 of sand. Recovery of benthos and birds were monitored. Settlement of polichaeta and bivalves was smooth especially at lower area below L.W.L. Invasion of birds was gradually developed from the neighbor flats. Over 4000 ind. with 30 species could be observed in the first December after the completion in February 1991.

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TECHNICAL SESSION 24: Dredged Material Management and Re-Use B

Richard Della, Chair

USING ADDAMS TO DESIGN BENEFICIAL USE PROJECTS

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The Automated Dredging and Disposal Alternatives Management System (ADDAMS) consists of a variety of computer programs (called "modules") for designing and analyzing dredging and dredged material disposal projects. Many ADDAMS modules apply to designing and analyzing beneficial use projects.

This presentation will focus on applying several ADDAMS modules to the design and analysis of an intertidal marsh restoration project. The use of ADDAMS modules to determine the necessary sediment volume, estimate effluent water quality, and predict long-term surface elevations will be described in detail. Particular attention will be placed on data needs, how specific ADDAMS modules relate to one-another, and how to interpret the ADDAMS results.

Additionally, each current ADDAMS module and its potential application to beneficial use projects will be described. A brief overview of the general operation of ADDAMS modules including key commands, help messages, etc. will be provided. Future plans for ADDAMS will also be discussed.

ADDAMS was developed and is distributed by the Environmental Laboratory at the USAE Waterways Experiment Station. More information can be obtained by contacting Dr. Paul R. Schroeder, Environmental Laboratory, WES, at 601/634-3709.

SOIL WASHING POTENTIAL AT CONFINED DISPOSAL FACILITIES

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The diminishing capacity of existing confined disposal facilities (CDFs) is a significant operational concern, as land development and acquisition costs continue to rise. Alternatives such as capacity expansion and restricted use (that is, storage of only the most contaminated sediments or sediment fractions) have been considered for extending the life of CDFs. Some U.S. Army Corps of Engineers' facilities are evaluating the reclamation of clean dredged material fractions from existing CDFs to recover storage capacity. This clean material has potential market value as fill, soil amendment, landfill cover and other beneficial uses.

Because contaminants often associate with a particular sediment fraction, volume reduction can be achieved using physical separation. Physical separation technologies have long been employed in the mining industry for selective mineral separation, which is effected by taking advantage of differences in the size, density or surface chemistry of the particles being separated.

Demonstration projects have been conducted at Erie Pier and Saginaw Bay. The Erie Pier CDF is a 332,000 square meter facility in Duluth receiving mechanically dredged material from the Duluth-Superior Harbor. Erie Pier sediments contain low levels of PCBs, low to moderate levels of metals, and other organics. A simple soil washing technology has been employed there since 1988 to recover the clean coarse materials as construction fill. Approximately 20-25 percent of the Erie Pier dredged material is removed annually.

Saginaw Bay has been identified as an Area of Concern, and sediments from this area are also contaminated with PCBs, organics and metals. A demonstration project was conducted at the Saginaw Bay CDF employing various pieces of physical separation equipment. Approximately 80 percent of the dredged material was recoverable as a washed product. Research is currently underway to develop standardized procedures for conducting physical separation feasibility evaluations on sediments and to evaluate the potential for capacity recovery at existing CDFs.

INSIGHTS FROM DUTCH EXPERIENCE IN PREPARING DREDGED SEDIMENTS FOR BENEFICIAL RE-USE

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Due to its proximity to the sea, high population density and need to reclaim land; the Netherlands began to grapple with dredged material management long before the US. Heidemij is one of the largest environment and infrastructure engineering firms in the Netherlands and has been extensively involved in sediment dredging, storage, treatment and beneficial reuse projects. The purpose of this presentation is to summarize the insights gained through these years of experience and to apply them to the somewhat different circumstances that prevail in the US.

Topics to be covered include:
(1) Specialized dredging techniques for small rivers and shallow waters
(2) Dredged material storage and ripening
(3) Land reclamation (Polders)
(4) Size and density separation techniques for contaminated sediments (including the patented Fingerprint process and newly developed TDG test)
(5) *Ex-situ* biological treatment of sediment
(6) Beneficial reuse of contaminated material

Numerous specific project examples will be discussed including:
(1) Petroleum Port in Amsterdam
(2) Harbor of Stein
(3) Malburger Harbor, Arnhem
(4) Oosterchelde Harbor, Zierikzee

Particular attention will be paid to the practical, materials handling expertise acquired in the execution of these projects.

BRICK MANUFACTURE FROM DREDGED MATERIAL, A REALITY!

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Fine clay size dredged material was collected from the confined disposal site at Savannah, GA. Pilot studies indicated a high quality brick could be manufactured from certain dredged material types. A sorting process was established on the CDF and appropriate size material was collected and removed for the manufacture of brick. This material replaced expensive raw clay material that had been transported from long distances to Savannah.

TECHNICAL SESSION 25: Inland Case Studies

Trudy J. Olin, PE, Chair

ASHTABULA RIVER AND HARBOR, ASHTABULA COUNTY, OHIO: THE ASHTABULA RIVER PARTNERSHIP FOR DREDGING/DISPOSAL OF CONTAMINATED SEDIMENTS, A UNIQUE AND NON-TRADITIONAL APPROACH FOR A PROJECT PARTNERSHIP AND FUNDING

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Industrial sources within the Ashtabula area adjacent to Fields Brook have contaminated the sediments in the Brook and Ashtabula River with polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), heavy metals, etc. The Fields Brook watershed, which drains into the Ashtabula River, poses a potential health risk to people who may be exposed to the contaminated sediments and has been placed on the US Environmental Protection Agency National Priorities List of uncontrolled hazardous waste sites and is being remediated under Superfund.

The lower Ashtabula River has been identified as a Great Lakes Area of Concern. The Area of Concern has been designated as the lower 2 miles of the Ashtabula River, including Fields Brook and the nearshore areas of Lake Erie.

In order to maintain navigable depths in the Ashtabula Harbor and River at Ashtabula, Ohio, it is necessary to dredge the harbor and river on a periodic basis due to natural shoaling processes. Sediments from portions of the river considered unsuitable for unrestricted open-lake disposal require placement in a confined disposal facility or alternative disposal/remediation.

To date, the Buffalo District does not have an environmentally acceptable disposal facility for the polluted sediments that need to be dredged from the Federal navigation channel to maintain the required depths. The restrictions on dredged material disposal have prevented the District from maintaining adequate river navigation depths and, more significantly, is anticipated to restrict the commercial operations in the lower river, and possibly, the Outer Harbor, as the polluted sediments are anticipated to migrate and move downstream.

The Ashtabula River Partnership (ARP) has entered into an unique and non-traditional partnership with local citizens, private industries and local, State and Federal governments/agencies in order to formulate the remedial cleanup/feasibility study of the river. The partnership includes the U.S. Army Corps of Engineers, Buffalo District, U.S. Environmental

Protection Agency and Ohio Environmental Protection Agency including industries involved in the Fields Brook Superfund Site.

The feasibility report was recommended based on findings in an Initial Appraisal Report which concluded that the combination of toxic and non-toxic sediments located in/adjacent to the Federal channel could not be addressed by existing authorities. The feasibility report will address the different concerns of O&M and environmental dredging and is funded from separate authorities/sources at a cost of $1,800,000. Funding sources include the Corps O&M, General, to address commercial navigation needs, Support For Others (SFO)/USEPA to address overall environmental concerns and technical assistance to the Ashtabula RAP Group/OEPA to address its overall environmental concerns/area.

The ARP has determined the extent and volume of PCB-contaminated sediments in the Ashtabula River using resources provided from the USEPA, OEPA and USACE and has investigated several upland sites and recommended the development of a disposal facility at a site approximately 3 miles east of the Ashtabula River/Harbor area.

The feasibility study will address alternatives and investigate problems and needs pertaining to contaminated sediments in the lower river including full environmental, economic, and social use and development of the harbor. Approximately 1,210,000 cubic yards of contaminated material is situated in the lower river, about 150,000 cubic yards is regulated under the Toxic Substance Control Act (TSCA). The ARP considered a wide array of Alternatives and/or Component (Options) pertaining to sediment dredging, dewatering/transport and disposal. Alternative Components (Options) were assessed/evaluated for environmental and social acceptability, and engineering and economic feasibility, and/or for best meeting the project planning objectives. The recommended plan involves: dredging (environmentally), developing and utilizing a dewatering/transfer facility, transporting the dewatered dredged material to and disposing of the material in an upland TSCA/non-TSCA disposal facility. Environmental protection measures have been incorporated into the project design, construction, operation, and maintenance plans.

The primary purpose of the Corps' Dredged Material Management Plan (DMMP) program is to exercise sound management practices to promote full beneficial uses of dredged materials to sustain and further enhance project area economic and environmental development. The ARP's study is considered an alternative DMMP.

The ARP has established a GOAL to "RESTORE FULL BENEFICIAL USES TO THE ASHTABULA RIVER." The end products of the ARP's efforts will result in the removal of contaminated sediments to allow for future open lake disposal of dredged sediments and development of future navigation infrastructure and enhance overall environmental quality.

LOWER MONONGAHELA RIVER PROJECT LOCKS AND DAMS 2, 3, AND 4: BENEFICIAL USES ASSOCIATED WITH THE DISPOSAL OF DREDGED AND EXCAVATED MATERIAL

Carmen Rozzi, PE
US Army Engineer District, Pittsburgh
Pittsburgh, Pennsylvania USA

This paper will discuss the Pittsburgh District's comprehensive review of alternative measures to place dredged and excavated materials generated by construction of the Monongahela River, Locks and Dams 2, 3, and 4 project. These alternatives explore a broad range of alternative disposal measures rather than narrowly focusing on a single recommended plan. This flexible approach to considering various disposal actions will enable the District to more effectively respond as circumstances, requirements and opportunities change over time.

This paper considers the environmental, economic, and social benefits of various disposal options. These options include providing disposal material to help local corporate development restoration efforts concerning a "brownfield site" and reclamation of an existing upland stripmined area. Allegheny and Monongahela in-river disposal options have been explored. Water quality improvements associated with the disposal of material in deep anaerobic holes produced from years of commercial dredging operations within the Allegheny River would help in reestablishing aquatic biota. Monongahela River disposal would provide much needed shallow water habitat. Several commercial and recycled material uses have been identified and will be outlined within the body of the paper.

Each one of these alternative disposal measures will have its own unique benefit enhancing the quality of the environment in which it will be placed. Further information can be obtained from the author.

MANAGEMENT OF PEAT BOTTOM SEDIMENTS FOR WATER QUALITY AND RECREATIONAL NAVIGATION IMPROVEMENT IN CHAIN O LAKES, ILLINOIS

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Engineers have been trying to determine a cost-effective and acceptable way to rebuild wetland islands lost over time in the Chain O Lakes. Using technology pioneered in Europe and under development by the US Army Corps of Engineers Waterways Experiment Station (WES), the Fox Waterway Agency (FWA) has found a means of achieving this goal.

The FWA is testing the concept of building breakwaters and berms through the use of geotextile tubes filled with dredged material. The tubes are placed in location and pumped full of peat and silt. While the fine-grained material is not as easily filled nor height as easily gained as with tubes filled with sand, the tubes are holding and functioning adequately.

WES is developing project design, and the first effort is a test to determine how well the technique will work using fine-grained material. The Illinois Department of Natural Resources are funding all of the design costs and part of the construction costs. A lot of volunteer effort went into the project by Chain O Lakes Agency members, and if this test continues to function well, a number of other geotextile tube projects in Chain O Lakes will be undertaken.

100 PERCENT BENEFICIAL USE?

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St. Paul, Minnesota, USA

Can the St. Paul District Army Corps of Engineers (District) reach a goal of 100 percent beneficial use of dredged material? Placing dredged material at locations where it can be used productively, either directly at the location placed or by removal and beneficial use elsewhere is a major objective. The District has had significant success in achieving beneficial use of dredged material. Records show that in the past 10 years, beneficial use of annual dredging quantities ranged from 56 percent to 100 percent and averaged 80 percent.

The District has provided dredged material for a variety of uses to other federal agencies, state agencies, counties, municipalities, contractors, private organizations and landowners. Dredged material has been used as landfill for residential and commercial development including airport expansion, retail stores, sanitary landfill cover, and wastewater treatment plants. It has been used to implement environmental enhancement projects such as Weaver Bottoms and Environmental Management Program habitat rehabilitation projects like the Pool 8 Islands. Recreational use of dredged material has included beach enhancement and park development such as the District's Blackhawk Park and other county and municipal parks. Sand and gravel pits have been filled with dredged material making them suitable for future development. Dredged material has been used for ice control on roads, road construction fill, as an ingredient in molded products, and as an aggregate in concrete.

The District actively promotes beneficial use at federally owned sites in a number of ways and encourages it at non-federal sites whenever possible. Partnerships with other federal, state, and local agencies has increased the awareness of dredged material placement site locations. This has increased the chances of mutually beneficial projects. The District works closely with municipalities, developers, and contractors to take advantage of new beneficial use opportunities as they surface. Opportunities are unpredictable, making flexibility in the site selection and approval process necessary. Partnerships have opened more lines of communications and flexible state regulatory agreements have been negotiated to assure that opportunities can be implemented on a timely basis.

The District encourages other agencies to assist in locating new beneficial use opportunities and being responsive to taking advantage of them. Through partnerships and the continued development of new uses for the dredged material, a goal of 100 percent beneficial use is possible.

Material placed at federally owned stockpile sites is made available at no cost to anyone on a first come basis. However, if there are competing demands for the material and cost considerations are comparable, the District's policy is to provide material to the governmental entity that represents the largest public constituency.

Notices and questionnaires are periodically distributed to potential users to make them aware of material availability and to gather information on demand and site suitability. At federally owned sites the District has established material removal guidelines to promote fair, safe, and efficient use of this resource.

TECHNICAL SESSION 26: Geotextile Tube Applications

Jack E. Davis, PE, Chair

DREDGED MATERIAL FILLED GEOTEXTILE TUBES AND CONTAINERS: CASE HISTORIES

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Beneficial uses of fine-grained dredged material have been limited because of its high water content, low strength, low angle of repose, and lack of control as to where these materials migrate.

Very large geotextile containers filled with dredged material have re-gained popularity in the past few years because of their simple placement and construction, cost effectiveness and minimum impact on the environment. These containers are hydraulically or mechanically filled with a variety of dredged material types, including fine-grained materials.

Containment of dredged material in geotextile tubes, bags or other large containers, filled in place or filled in large bottom dump hopper barges and dumped below water has helped solve several difficult construction problems. Dike construction using long, sometimes continuous, tubes in wetlands, subdivision and perimeter dikes in dredged material disposal areas, under water stability berms, containment of contaminated materials, island construction, barrier island breach repair and structural scour protection are examples of projects that could not have been completed without use of geotextile containment systems.

This presentation recaps 30+ years of case histories demonstrating the use of geotextile containers of various forms and serving various functions. A listing, along with important project details, of documented large bag/tube/container projects constructed over the past 30+ years is given to demonstrate the significant track record of these systems.

OVERVIEW OF GEOCONTAINER PROJECTS IN THE UNITED STATES

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A number of geocontainers have been successfully filled with sandy dredged material and placed in water depths up to 70 feet using split hull bottom dump barges in Europe, Malaysia, Japan, and the United States. Two US projects which have been very successful will be discussed in the presentation. They are Red Eye Crossing in the Lower Mississippi River below Baton Rouge, partnered with the US Army Engineer District, New Orleans, and the Marina Del Rey project in California partnered with the US Army Engineer District, Los Angeles. Two other projects in which fine-grained highly plastic maintenance dredged material was contained in geocontainers in New York Harbor will also be discussed.

At Red Eye Crossing, six underwater bendway weir dikes, 7000 feet long, were constructed using Geobags placed on flat top barge, and Geocontainers placed with split hull bottom dump barges. These training dikes were more cost effective than riprap, and do not pose a threat to navigation or present underwater hazards. More work is planned for the Lower Mississippi River using these tubes.

At Marina Del Rey, 44 geocontainers, each containing an average of 1300 cubic yards of contaminated dredged material, were filled and dumped into an approved underwater area out of harm's way. These tubes were lined with non-woven polyester geotextile that kept the material contaminated with lead, zinc, and copper from escaping.

In New York Harbor, tubes filled with fine-grained sediment had seam problems when dropped into 57 feet of water. They also tended to twist and were subject to strain in sliding out of the hopper barge and free-falling through the water. More work is being done to work out the problems and perfect this technique.

Conclusions of the various tests run are: (1) geocontainers cannot be overfilled or they will fail; (2) fabric strength is of critical importance; (3) contaminated material can be removed from the system for prices ranging from $16 to $79 per cubic yard; (4) hopper barges must be clean and in good repair to deploy correctly; and (5) bulking factors of the material is of critical importance to successful deployment of tubes.

RAISING MISSISSIPPI RIVER LEVEES USING GEOTEXTILE TUBE TECHNOLOGY

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This presentation will describe a technical, feasible, and expedient concept for raising levees using geotextile tubes filled with dredged material pumped directly from the Mississippi River. This method of construction was developed using new, innovative geotextile tube technology developed by the Corps Waterways Experiment Station (WES) under the Construction Productivity Research Program (CPAR).

The use of tubes to raise levees is an economical and environmentally sensitive alternative for dike construction and repair, and will not destroy sensitive forested wetlands on the riverside of the levee while preventing the need to have to borrow high quality soils from farmland on the land side of the levee.

No field tests have been conducted using this method in the Mississippi River levee system. However, dike upgrading using dredged material-filled geotextile tubes was conducted in the Mobile Corps District, and was successful in providing additional elevation to dike heights on Gaillard Island, a 1300-acre dredged material island in Mobile Bay where over 25,000 seabirds nest annually. Use of tubes greatly lessened disturbance to the nesting bird colonies, and proved to be feasible.

DEWATERING SEWAGE SLUDGE WITH GEOTEXTILE TUBES

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Municipal sewage was placed in geotextile bags for the purpose of evaluating the dewatering and consolidation capabilities of large geotextile tubes and effluent water quality. A proposed ASTM test method for determining the flow rate of suspended solids from a geotextile containment system for dredged material was used to conduct tests to determine the efficiency of different combinations of geotextile filters.

As water passed through the geotextile bag, samples were collected during, immediately after, and for several days following to determine the total percent suspended solids (TSS), heavy metals, and bacterial count seeping from the bags. The quality of pore water or effluent passing through the geotextile container systems proved to be environmentally acceptable for discharge into the Mississippi River and/or return to the plant. The test results indicated a significant reduction in the sludge volume in the geotextile tube.

This same technique is being explored for use with contaminated dredged material, and should work in similar fashion. In a test in New York Harbor, material was contained in a demonstration test in 67 feet of water that included dioxins, PCBs, PAHs, pesticides, and heavy metals. Research using this process for dewatering hog and dairy farming wastes, paper mill wastes, fly ash, mining wastes, chemical sludge from lagoons, and material from waste streams is being carried out by WES and the University of Illinois.

TECHNICAL SESSION 27: Sediment Management and Erosion Control

T. Neil McLellan, PhD, PE, Chair

MASSACHUSETTS DREDGED MATERIAL MANAGEMENT PLAN: TWENTY-YEAR FORECAST OF DREDGING NEEDS, SEDIMENT CHARACTERIZATION, AND RE-USE/DISPOSAL OPTIONS

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Bob Wardwell, Dave Westcott, and Steve Lecco
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The Massachusetts Office of Coastal Zone Management has embarked on a far reaching investigation of dredging and dredged sediment disposal in the Commonwealth. The long term plan identifies dredging needs, sediment characteristics and disposal/reuse options for four Designated Port Areas (DPAs) in the Commonwealth over the next twenty years. The four DPAs are Fall River, New Bedford, Salem and Gloucester. Approximately 3.5 million cubic yards of maintenance and improvement dredging will be needed in these ports to sustain navigational access and to support diverse maritime/marine uses. A critical issue in dredging in Massachusetts, which is evident in each of the DPAs, is the limited availability of cost effective and environmental sound disposal/reuse options.

A unique aspect of the MA Dredged Material Management Plan (DMMP) is that it involves the coordination of three complimentary planning/regulatory efforts. First, as opposed to a traditional, "top-down" process, the DMMP is composed of individual Environmental Impact Reports (EIRs)specific to each of the four ports. Second, these documents are being developed in conjunction with a concurrent state-funded port development effort. Third, the state is simultaneously developing new dredging and disposal regulations that will address all potential disposal alternatives. Over a two year period, then, the state's DMMP will evolve as the sum of its parts, informed by a dredged material management policy that evolves from a balance of port development and environmental protection considerations.

Dredging and disposal policy in Massachusetts has, since the mid 1970's, been extremely conservative and disposal of any dredged sediment in state waters, regardless of sediment quality, has typically been prohibited. Central to the state's development of the DMMP will be an evolution of policy regarding the disposal of dredged material in general, and of unsuitable material in particular. Because each port area has a markedly different character, the coordinated

EIR/port plan process has been designed to allows each port to be flexible in determining where and how disposal should occur.

This presentation will highlight aspects of the Dredged Material Management Plan (DMMP) which relate to beneficial uses of dredged sediment. The siting process for identifying new aquatic disposal locations in each of the DPAs will be examined. Our discussion will include the methods to preliminarily characterize dredge sediment; its suitability for in-water disposal and beneficial use; siting criteria for aquatic disposal locations; and candidate sites in each of the DPAs for confined disposal facilities (CDFs), confined aquatic disposal (CADs) and beach nourishment/habitat creation. Since these urban harbors have not been dredged in decades, our paper will discuss management of contaminated sediment as well as use of clean sediment for subaqueous capping.

BENEFICIAL USE OF DREDGED MATERIAL IN NEARSHORE PLACEMENT AREAS IN NORTH CAROLINA

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The Wilmington District has been active in the use and monitoring of nearshore placement of navigation maintenance material removed from ocean entrance channels. Beach quality material removed from the entrance channels is routinely deposited within the active littoral system, thereby maintaining the overall littoral sediment budget of the area. The District has designated and employed two major nearshore dredged material placement sites, one in connection with the Morehead City Harbor project and the other at Oregon Inlet.

The Morehead City Nearshore Placement Area (MCNPA) is located on the west side of Beaufort Inlet generally along the 25- foot MLW contour. Planning and design of the MHCNPA was initiated in 1991 with placement starting in 1995. Annual deposal has occurred each year thereafter. Approximately 1.5 million cubic yards of beach quality material has been placed in the MCNPA. This material would have otherwise been placed in the Morehead City ocean dredged material disposal site which lies seaward of the active littoral zone. The primary purpose of the MCNPA is to prevent channel maintenance related deflation of the Beaufort Inlet ebb tide delta which has been documented over the last 45 to 50 years. Both physical and biological monitoring are performed over this site to evaluate movement of material and effects of material placement on fisheries and benthic resources.

The Oregon Inlet Nearshore Placement is located on the south or Pea Island side of Oregon Inlet generally between the 12 and 15-foot MLW contours. Physical monitoring is performed at this site. Approximately 300,000 cubic yards of dredged material has been placed in this site.

Monitoring results show that material placed in both sites are moving as predicted. Environmental monitoring has not documented any adverse effects of placing dredged material in these sites. Factors critical to getting these sites operational include: employing a systematic approach utilizing multi disciplinary backgrounds in engineering, environmental, social and interpersonal learning techniques; open interagency coordination and collaborative planning; and flexibility in technical design and operation of each nearshore placement site.

HISTORY AND FUTURE OF DREDGED MATERIAL MANAGEMENT AT SHIRLEY PLANTATION, CHARLES CITY COUNTY, VIRGINIA: A PRIVATE PERSPECTIVE

Charles H. Carter III and George Junkin
Shirley Plantation and Weanack Land, Limited Partners
Charles City County, Virginia USA

The primary objective of dredging operations is the maintenance of navigable shipping channels. Materials generated from such operations must be stored in an appropriate manner. The volume of materials removed from a river and the capacity limitation of placement sites encourage development of beneficial uses. Further, beneficial uses should be balanced with environmental considerations.

Considering dredged material as a resource minimizes any environmental impacts, ameliorates notions from the public that placement is merely dumping, and provides a benefit which can be extracted. Markets for this material are often limited, but are developing. For example, fly ash was once a marketable by-product that is now widely used in the construction industry. As these markets develop, dredge maintenance costs may be reduced or replaced.

The immediate advantage of such use of dredged material is the extension of the life of the materials management area. Knowledge that such a site is being developed for a resource and a benefit to the environment also improves public acceptance.

Channel maintenance has been required for ship navigation of the James River for over 150 years. The area of interest for this paper is the site on the James known as Turkey Island Cut-Off. Chronic shoaling formation at the cut-off stems from several sources. The current rate of shoaling activities at Turkey Island is 73,700 cubic yards a year.

Over the past half century at Shirley Plantation, dredged material has been used to create upland habitats. Upland habitat creation usually added little to the cost of the disposal operation. These former disposal sites, however, are full and can no longer be used because of permitting restrictions.

The Shirley Plantation Tidal Borrow Pit is an ideal location for implementing a comprehensive and long-term dredge management area. It encompasses a total of 90 acres and has capacity of up to 1.8 million cubic yards of deposition. The site is directly across the river from Turkey Island Shoals.

The Shirley Plantation Tidal Borrow Pit meets the criteria for placement and has a 25-year capacity at current shoaling rates. How can this site extend its capacity, generate habitat resources, and provide an economic support to the landowner? One possible avenue is to "harvest" the deposited materials for sand and gravel to be used as an aggregate material for mortar, concrete, and asphalt. Another possible avenue is to use the material to form topsoil, which also could be "harvested" for agricultural applications, mined land reclamation, and wetland creation or restoration. Thus, the depositional material is essentially recycled in the placement area. The economics and markets for beneficial uses are not easily apparent. However, the Shirley Plantation Tidal Borrow Pit is clearly a solution to the Turkey Island Cut-Off placement problem.

USES OF DREDGED MATERIAL TO COMBAT EROSION AT WESTPORT, WASHINGTON

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The two rubble mound jetties at the mouth of Grays Harbor (Figure 1) have accomplished their design purpose well of deepening the entrance for navigation since their construction near the turn of the century. However, erosion attributed to the South Jetty near the Town of Westport has become an increasing concern in recent years. The ocean beach to the south of South Jetty and Half Moon Bay located landward of South Jetty are continuing to erode. Since 1986, the erosion rates at South Beach and at Half Moon Bay have increased dramatically. The erosion threatens a sewer line, a water aquifer, and roads in Westport. Also threatened are the loss of a state park and the land spit attached to the South Jetty (separating South Beach and Half Moon Bay). Breaching of the land spit threatens the South Jetty and the entrance channel.

US Army Engineer Waterways Experiment Station (WES) was asked by Seattle District to examine the problem, and WES conclusions were:

(1) Erosion of the South Beach shoreline had increased from 15-20 feet per year between 1967 and 1986, to 60 feet/year since 1986.

(2) Continued erosion trends would breach the land spit, isolating South Jerry in 5-10 years unless corrective action was taken.

(3) Should a breach open, it would widen through erosion by waves and tidal currents causing continued land loss and possibly capturing some of the tidal prism. The impact of such an event to the channel, project maintenance, navigation, and local lands could be significant.

(4) Causes of the erosion were undertermined.

(5) Corrective actions could not be determined without further investigation.

(6) One proposed alternative was the construction of an off-shore underwater feeder berm with dredged maintenance sand even though this technology was still considered experimental.

A 1991 Seattle District O&M study concluded that due to the fine gradation of the dredged sand from the Bar Channel, an offshore berm placed offshore of South Beach would not accrete onto the adjacent beach, but that if a large amount of Bar Channel material were placed in 30-40 feet of water over an extended period of time, the rate at which this beach profile is lowered could be reduced. The study also concluded that construction of a nearshore berm was better suited for Half Moon Bay, where there are relatively low, long period waves and coarse-grained dredged material which would result in transport and accretion at the shoreline.

Lacking Section 111 funding for studying remediation of the project-caused erosion, Seattle District coordinated the use of operations and maintenance dredged material to construct two offshore berms. Seattle District placed an offshore berm in Half Moon Bay with a medium size contract hopper dredge in May and June 1992, using 200,000 cubic yards (cy) of maintenance material. In May 1994, an additional 146,000 cy was placed at this berm. Placement of a berm offshore of South Beach in 1992 was resisted by crab fishermen and 637,000 cy of maintenance material for the Bay Channel w as placed at an existing deep water disposal site. In September and October 1993, 373,000 cy was finally placed offshore of South Beach along the -40 foot contour by medium size government hopper dredge. In September and October 1994, another 264,000 cy of maintenance material from the Bar Channel was placed offshore of South Beach along the -30 foot contour by contract hopper dredge. Survey cross-sections of the Half Moon Bay berm show material is being transported towards shore. Surveys of the South Beach berms show no long-lasting features. The original objective for placing material off South Beach was to nourish the nearshore area. The berm shape was used only to facilitate tracking of the material by hydrographic surveys.

Between May 1993 and December 1994, erosion in Half Moon Bay increased from an average long-term erosion rate of 5-10 feet/year to an average of 70 feet, with localized erosion as much as 150 feet, causing damage to Westport's sewer outfall line. The rock revetment protecting Westport was also being overtopped in winter storms and flooding parts of Westport. Between October and December 1995, Seattle District under the authority of Section 111 placing 300,000 cy of maintenance material directly on the beach to nourish the Half Moon Bay shoreline by contract hopper dredge and booster pump. Placement was hampered by high tides and storm waves. A January 1996 comparison survey showed most of the material had eroded from the fill site and deposited in a layer up to six feet deep in the area immediately offshore. Local entities attribute the lack of winter flooding of Westport to this deposit of nearshore material.

Disposal of dredged material in Half Moon Bay has been revised from placement as offshore berms to maximization of the amount of sandy maintenance material that can be placed in the near shore area as close to shore as possible. The object is to raise the offshore bottom 5-15 feet to elevation -10 feet. In 1996, a government hopper dredge placed 274,780 cy in Half Moon Bay by bottom dumping as close to shore as feasible. Maintenance material from contract dredging in 1996 could not be placed in Half Moon Bay due to the presence of too many crabs. During 1997, maintenance dredged material placement in Half Moon Bay is foreseen over a larger area. No additional maintenance dredged material has been placed beyond that previously mentioned offshore of South Beach due to its unavailability in the Bar Channel. Reduced maintenance is expected in the outer harbor as channel slopes stabilize.

The recommended solution to the erosion in the vicinity of Westport includes a 2000-foot landward extension of the South Jerry and a less heavily constructed jetty arcing 2300 feet northward to connect with the existing Westport revetment. Part of the recommended plan is continued placement of dredged material offshore of the jetty extension in Half Moon Bay. Over a 50-year project, annual placement is anticipated to dispose a total 4,000,000 cy in the nearshore and direct placement on the north toe of the jetty extension every four years is expected to total 1,800,800 cy. The South Beach shoreline is to be allowed to continue to erode without intervention.

The benefical use of a large portion of the approximately two million cy of Grays Harbor annual maintenance material has played a major role in fighting erosion at the harbor entrance and will continue to do so in the future.

STUDY AREA

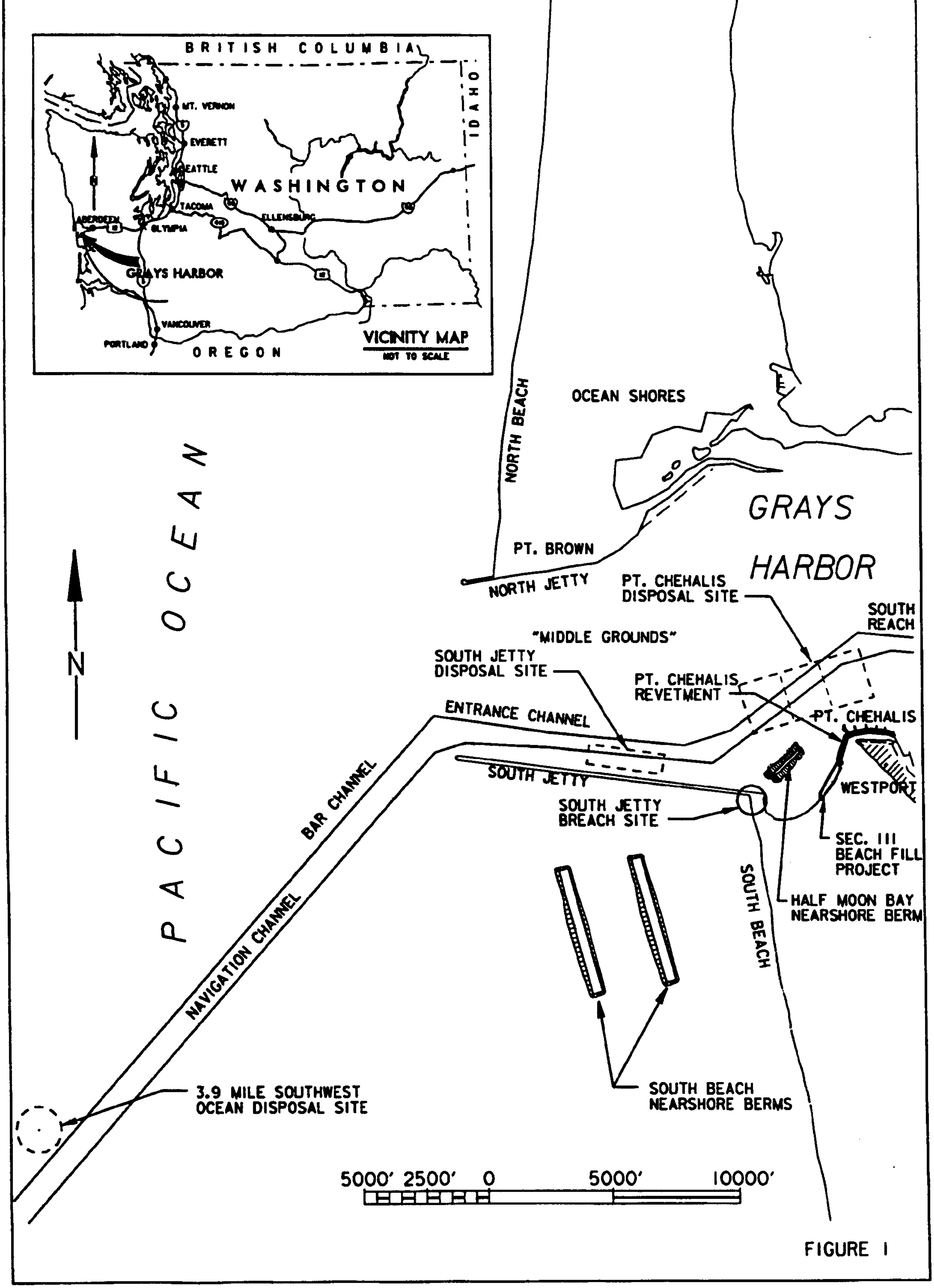

FIGURE 1

TECHNICAL SESSION 28: Case Studies

Mary C. Landin, PhD, and Thomas R. Patin, PE, Co-Chairs

This session is set aside for an open forum discussion of projects and case studies using dredged material benefically that may not have been presented in the course of this workshop. Initial discussion and visuals will include:

Batiquitos Lagoon, Carlsbad, California USA
Galliard Island, Mobile, Alabama, USA
Tennessee-Tombigbee Waterway, Mississipp/Alabama USA
Weaver Bottoms, Wisconsin/Minnesota USA
Riverlands, Illinois River, Illinois USA

These are large Corps and port beneficial uses projects. The floor will be open to discuss any case study the audience brings to the attention of the session chairs.

Attached as an appendix to this proceedings are fact sheets on more than 50 individual and/or groups of Corps beneficial use projects (bird islands are grouped into regions). This list is by no means exhaustive, as there are more than 3000 beneficial use projects in existence at the current time.

INDEX OF AUTHORS IN ALPHABETICAL ORDER

APPENDIX A: FACT SHEETS ON EXAMPLE BENEFICIAL USES OF DREDGED MATERIAL PROJECTS

Bolivar Peninsula Marsh Creation Site

Corps Division: Southwestern, Galveston District
Project Type: salt marsh creation using a previously-placed dredged material deposit
Project Size: old Bolivar, 10 acres; new Bolivar, 10 acres; control Bolivar, 10 acres; 3 natural reference sites, varying sizes
Project Location: Goat Island, Bolivar Peninsula, Galveston Bay, Texas
Substrate Type: fine-grained sand dredged material
Energy Sources: 26 mile northerly wind fetch across Galveston Bay
Protection Provided: temporary 10 x 4-ft sandbags filled with dredged material to form a dike at old Bolivar site in 1975; floating tire breakwater, plant rolls, and erosion control mat at new Bolivar site in 1980's
Vegetation Used: Smooth cordgrass in the low marsh zone and saltmeadow cordgrass in the high marsh zone were planted behind temporary breakwaters, although several minor upland plant species were tested in the upper zone at the old Bolivar site in the 1970's. Much natural colonization occurred, especially in the high marsh and upland areas.
Project Constructed: first dredged material placed in 1960s, marsh project initiated in 1975 on old Bolivar, marsh project initiated in 1980 on new Bolivar
Monitoring: Monitoring has occurred since 1974 on old Bolivar. Old Bolivar was compared to 3 natural reference marshes. New Bolivar and control Bolivar (where no planting occurred) monitoring initiated in 1980 (6 marsh sites in all).
Success or Failure: short-term success of marsh: good; long-term success: looking okay but still being monitored
Costs: less than $1 per CY, approximately $2500 per acre to plant, geotextile dike was additional expense
POC(s): Dr. Mary Landin or Hollis Allen, WES; Dr. Jim Webb, TAMU;
Rob Hauch, Dolan Dunn, and Rick Medina, Galveston District

Apalachicola Bay Marsh Creation Site

Corps Division: South Atlantic, Mobile District
Project Type: salt marsh creation using new dredged material placed inside the dike of an older dredged material island
Project Size: less than 10 acres
Project Location: Apalachicola Bay, Florida
Substrate Type: silty dredged material placed within and over a sand dredged material island substrate
Energy Sources: long southerly wind fetch from the Gulf of Mexico

Protection Provided: the south dike of the island was used as a breakwater, with a breach provided for intertidal flow
Vegetation Used: planted with smooth cordgrass in low marsh zone and saltmeadow cordgrass in higher marsh zone. Island upland was planted in pines and grasses. Much natural colonization occurred in the marsh and in the upland.
Project Constructed: Island built prior to 1974. Dredged material placed inside island in 1975, site planted in 1976.
Monitoring: Site has been monitored since 1974-75,and had 3 natural reference marshes for comparisons.
Success or Failure: short-term: highly successful; long-term: some of the marsh is washing out near the dike breach, which has widened
Costs: approximately $1.25 per CY for maintenance material; island was constructed to have several dredging cycles' life expectancy
POC(s): Dr. Sue Rees or Patrick Langan, Mobile District, or Dr. Mary Landin, WES

Gaillard Island Confined Disposal Facility (CDF)

Corps Division: South Atlantic, Mobile District
Project Type: a confined disposal facility built of dredged material in Mobile Bay; marsh was planted along the northwest dike
Project Size: the CDF is a triangular-shaped island 1300 acres in size; the planted marsh, a demonstration project, is 35 acres
Project Location: two miles out in the Bay from Theodore, Alabama
Substrate Type: silty sand dredged material
Energy Sources: wave and wind energies buffet all three sides of the island, with long wind fetches and with ship/barge wakes hitting the south and east dikes
Protection Provided: the east and part of the south dikes were riprapped; planting occurred behind floating tire breakwaters on the northwest dike, and using plant rolls and erosion control matting
Vegetation Used: smooth cordgrass was planted. Natural colonization behind berms which formed from trapped sediments included saltmeadow cordgrass, saltmarsh bulrush, saltmarsh cattail, American three-square, and a number of other minor species in the marsh zones. The upland was aerially seeded with grasses, then planted with a variety of both exotic and native tree species (District's choice--only the native species survived).
Project Constructed: island built in 1980-81; marsh tests in 981-82; monitoring begun 1981.
Monitoring: Island was created over bay bottom, but no baseline data were collected on fishes or benthos; seagrasses not present. Island monitoring included vegetation, wildlife, some fisheries, physical changes. Seabird use of the island has been spectacular, with thousands of pairs of over 20 species of terns, gulls, skimmers, pelicans, stilts, and others nesting on the island in increasing numbers since its construction. Wading bird began occurring in 1988, when vegetation reached successional stages that would support their nests.
Success or Failure: short-term: success of planted marsh mixed, success of colonized marsh very high, success of wildlife use of island habitats, excellent.

Costs: approximately $1.25 per CY; CDF was constructed to have life of expectancy of approximately 40 years
POC(s): Dr. Sue Rees, Mobile District, or Dr. Mary Landin, WES, Tom Olds, FWS Atlanta, Dr. Jim Webb, TAMU

Coffee Island Marsh Creation Site

Corps Division: South Atlantic, Mobile District
Project Type: marsh creation on old dredged material island
Project Size: less than 5 acres
Project Location: adjacent to the Gulf Intracoastal Waterway (GIWW) in Mississippi Sound, AL, near Bayou le Batre
Substrate Type: sandy dredged material
Energy Sources: wind and wave fetches within the Sound and from the GIWW
Protection Provided: bioengineering (plant rolls and erosion control matting)
Vegetation Used: smooth cordgrass was planted on bare sandy shoreline
Project Constructed: planting occurred in 1985
Monitoring: monitoring included only vegetation
Success or Failure: short-term mixed success; long-term data not being collected
Costs: $1.25 per CY
POC(s): Hollis Allen, WES, or Paul Bradley, Mobile District

Southwest Pass Marsh Nourishment Site(s)

Corps Division: Mississippi Valley, New Orleans District
Project Type: restoration of subsided and eroded intertidal marsh on the western side of the Southwest Pass using unconfined dredged material placed at sub-tidal elevations
Project Size: approximately 10,000 acres of new marsh since 1974
Project Location: below Head of Passes, on the western side of Southwest Pass
Substrate Type: silty sand dredged material
Energy Sources: several miles of westerly wind fetch
Protection Provided: none
Vegetation Used: No plantings. Sites colonized in variety of plants within 3-5 years, including smooth cordgrass, big cordgrass, saltmeadow cordgrass, other common Louisiana coastal plants, including on a couple of high spots, common reed (which will be displaced by succession and subsidence).
Project Constructed: marsh restoration begun in 1974 and continued every year during maintenance dredging operations
Monitoring: monitoring using remote sensing and older aerial photos, backed up by ground truthing data collected along permanent transect lines in various age marshes
Success or Failure: generally very successful; some spots were allowed to build too high, but these will become marsh over time as the land continues to subside. Dredged material placement technique refinement being evaluated at WES under the Wetlands Research Program.

Costs: in 1970s, an additional $.50 per CY; costs are increasing to an addition $1 to $2 per CY as placement areas are further and further away from channel
POC(s): Dr. Mary Landin or Joe Letter, WES, Sue Hawes and Dr. Linda G. Mathies, New Orleans District, Dr. Jim Webb, TAMU

Atchafalaya River Delta Marsh Nourishment Sites

Corps Division: Mississippi Valley, New Orleans District
Project Type: marsh and bird island nourishment using GIWW maintenance dredged material
Project Size: several sites of several acres each
Project Location: mouth of the Atchafalaya River, Louisiana
Substrate Type: silty dredged material
Energy Sources: river currents, some barge wakes within the GIWW, some wave energy from the Gulf
Protection Provided: none
Vegetation Used: allowed to colonize naturally (in case of bird islands, vegetation is not encouraged)
Project Constructed: at different times in the 1970s and 1980s
Monitoring: very limited, general observations by New Orleans District and Louisiana DNR personnel
Success or Failure: short-term: successful for marsh, high successful for birds, long-term: islands and marsh will required continued nourishment to remain in place
Costs: estimated $2.00/cy
POC(s): Ms. Sue Hawes, New Orleans District, Dr. Bill Good or Greg Ducote, Louisiana DNR, Dr. Mary Landin, WES

Mississippi River Gulf Outlet Marsh Nourishment

Corps Division: Mississippi Valley, New Orleans District
Project Type: use of maintenance dredged material to restore subsided marsh on one side of the channel
Project Size: approximately 100 acres (may be larger)
Project Location: adjacent to the MRGO, which connects the Mississippi Sound and the Mississippi River, Louisiana
Substrate Type: silt and sand
Energy Sources: barge wakes in the MRGO
Protection Provided: none
Vegetation Used: No planting. Natural colonization occurred within 3-5 years.
Project Constructed: in the 1980s
Monitoring: very limited, basically just observational data
Success or Failure: Quite successful; a controversy exists in the area because of the lack of dredged material to continue the process. It has become less expensive to take MRGO material

to the Gulf rather than to build marsh, and limited dredging budgets made the New Orleans District recently choose this option.
Costs: estimated $2.00/cy
POC(s): Dr. Linda G. Mathies or Sue Hawes, New Orleans District, Dr. Mary Landin, WES, Dr. Bill Good or Greg Ducote, LA DNR

Fina la Terre Marsh Management Site

Corps Division: Mississippi Valley, New Orleans District
Project Type: restoration and management of existing marsh being impacted by salt water intrusion, subsidence, and erosion using structures and some dredged material
Project Size: management unit is several hundred acres, dredging area is smaller
Project Location: Terrebonne Parish, LA
Substrate Type: silt and sand
Energy Sources: negligible except in storm events
Protection Provided: structures put in place to keep out salt water that killed existing marsh vegetation, and to allow water level manipulation
Vegetation Used: No plantings. Natural colonization and succession. Project is privately owned, and is being used as a mitigation bank.
Project Constructed: 1980's
Monitoring: Environmental monitoring is an interagency arrangement between La. DNR, LSU, EPA, New Orleans District, and Minerals Management Service. Engineering monitoring will be conducted beginning FY 92 by WES.
Success or Failure: questionable--some agencies like the project, others don't -- seems to mostly depends upon whether you subscribe to intensive marsh management activities vs. passive management of natural wetlands.
Costs: unknown
POC(s): Ms. Sue Hawes, New Orleans District, Dr. Mary Landin or Joe Letter, WES, Dr. Bill Good or Greg Ducote, LA DNR

Hillsborough Bay CDF Marsh Creation Sites

Corps Division: South Atlantic, Jacksonville District
Project Type: Two CDF islands built to hold new work and maintenance dredged material from Tampa and Hillsborough Bays, Florida, where marshes were created along shorelines and nesting habitat provided on island surfaces.
Project Size: Total of the two islands: several hundred acres.
Project Location: Hillsborough Bay, Florida, near Tampa
Substrate Type: sand dredged material
Energy Sources: wave energies and wind fetches from all sides of both islands
Protection Provided: marsh plantings and limited bioengineering (some riprap may now be in place that I am unaware of)
Vegetation Used: smooth cordgrass sprigs, with mangrove seed pods in the marsh stand

Project Constructed: 1978-1979
Monitoring: State of Florida and local consulting firm are monitoring.
Success or Failure: Islands are stable, habitats are successful. Islands are being filled with maintenance material.
Costs: $11.25 per CY, with 25-year design life of the two islands
POC(s): Roy R. Lewis, Lewis Environmental Services Inc., Tampa, FL; Dr. H. K. Smith, Jacksonville District; Dr. Mary Landin, WES

West Bay Shoreline Stabilization Project

Corps Division: Southwestern, Galveston District
Project Type: stabilization of eroding shoreline using maintenance dredged material, and engineering and bioengineering techniques coupled with marsh plantings
Project Size: currently approximately 40 acres in a test project, could expand considerably with maintenance dredged material
Project Location: West Bay, GIWW, Texas
Substrate Type: silty sand and silt dredged material (depends upon where in the GIWW dredged material is obtained)
Energy Sources: barge wakes, some wind fetch and natural wave energies
Protection Provided: use of combinations of geotextiles, stone/concrete, erosion control mat, plant rolls
Vegetation Used: smooth cordgrass was planted behind and in protective material
Project Constructed: FY 92
Monitoring: pre-construction data collected by WES and TAMU; construction monitoring by WES and Galveston District; post-construction data collected by WES, TAMU, and Galveston District
Success or Failure: partial success; some erosion taking place, but marsh has become well established; geotextile tubes did not achieve desired height for wave protection
Costs: estimated $1.00/cy, geotextiles were additional expense at estimated $10.00/linear foot installed
POC(s): Rob Hauch and Dr. Neil McLellan, Galveston District, Jack Davis, Bill Curtis, and Dr. Mary Landin WES; Dr. Jim Webb, TAMU

Aransas National Wildlife Refuge Shoreline Stabilization and Wetland Restoration Project

Corps Division: Southwestern, Galveston District
Project Type: stabilization of eroded marsh shoreline using maintenance dredged material, and engineering and bioengineering techniques coupled with marsh plantings
Project Size: several miles of refuge shoreline protected
Project Location: Aransas NWR, Texas, north of Corpus Christi, along the GIWW
Substrate Type: silty sand and silt dredged material, depending upon where within the GIWW the dredged material is obtained

Energy Sources: barge and boat wakes, some wind fetch and natural wave energies from San Antonio Bay
Protection Provided: combinations of geotextiles, concrete/ stones, and bioengineering structures
Vegetation Used: smooth cordgrass planted in and around the protective material
Project Constructed: FY 93
Monitoring: pre-construction data collected by WES and FWS; construction monitored by WES and Galveston District; post-construction data collected by WES, Galveston District, and FWS
Success or Failure: Small pilot project put in place by volunteer labor using saltwater-tolerant concrete bags in 1989 are still in place, but overwash is causing continued impact on marshes along parts of shoreline. Large project geotextile tubes are holding well, and marsh behind them is rapidly spreading; considerable fish and wildlife use of the marsh and shallow water areas.
Costs: estimated $1.00/cy; geotextiles and other soft structures were additional costs (inexpensive)
POC(s): Rob Hauch and Dr. Neil McLellan, Galveston District; Jack Davis, Bill Curtis, Dr. Mary Landin, WES

Texas City Dike Marsh Creation Site

Corps Division: Southwestern, Galveston District
Project Type: marsh creation
Project Size: less than 5 acres
Project Location: on the northeast side of Texas City Dike in Galveston Bay, Texas City, Texas
Substrate Type: silty sand dredged material
Energy Sources: long wind fetch from north, both natural and boat-generated wave energies
Protection Provided: rubble breakwater put into place after the marsh was planted and established but was beginning to fail; breakwater stabilized marsh
Vegetation Used: smooth cordgrass
Project Constructed: 1978-1979
Monitoring: initial monitoring, Galveston District; long-term observations, WES. Fish and shellfish, and clapper rail and other bird, use of the little marsh recorded. Public reaction favorable, with use of the marsh fringes as fishing spots.
Success or Failure: initial plantings successful; over time, combination of waves and wind began taking out the marsh. District placed a rubble breakwater along the northeast outer edge, and the marsh stabilized. This is a very small marsh pilot project. The concept could be expanded considerably along the Texas City Dike.
Costs: approximately $1.25/cy (less than other placement options)
POC(s): Rob Hauch, Dolan Dunn, or Rick Medina, Galveston District; Dr. Mary Landin, WES; Dr. Jim Webb, TAMU

Buttermilk Sound Marsh Restoration Sites

Corps Division: South Atlantic, Savannah District

Project Type: salt marsh restoration on old maintenance dredged material sand which smothered existing salt marsh; project shaved down mound to intertidal elevation and planted as experiment
Project Size: entire island positively influenced by project was over 20 acres; initial project was 7 acres
Project Location: Atlantic Intracoastal Waterway, Buttermilk Sound, mouth of Altamaha River, Georgia, north of Brunswick
Substrate Type: sand maintenance dredged material
Energy Sources: minimal
Protection Provided: none
Vegetation Used: 8 high and low marsh species, including smooth cordgrass, saltmeadow cordgrass, big cordgrass, marsh elder, sea oxeye, saltgrass, other minor species in test plots. Over time, site was dominated by smooth, big, and saltmeadow cordgrasses typical of surrounding marshes.
Project Constructed: island mound formed in 1960's; marsh creation project begun in 1974
Monitoring: long-term data collected by University of Georgia and WES (pre-, during, and post-construction intensive monitoring)
Success or Failure: Revegetation highly successful, wildlife and fisheries use more abundant than 3 nearby natural reference marshes to which it was compared. Remaining upland mound that was not shaved down received high seabird use, including nesting terns and skimmers. From a "marsh" perspective, project highly successful; from a "displacement of one of two potential seabird nesting areas for miles around" standpoint, project probably should not have happened.
Costs: $0.98 per CY; with approximately $2500 per acre for planting experimental area; site preparation costs were $2000
POC(s): Dr. Bob Reimold, Metcalf and Eddy (formerly of University of Georgia); Dr. H. K. Smith, Jacksonville District; Dr. Mary Landin, WES, Paul Knutson, private consultant, Gloucester Point, VA

St. Johns River Marsh Creation/Management Site

Corps Division: South Atlantic, Jacksonville District
Project Type: intertidal marsh creation, marsh management using dredged material
Project Size: several hundred acres
Project Location: along the St. Johns River, near Jacksonville, Florida
Substrate Type: silt and silty sand dredged maintenance dredged material
Energy Sources: river traffic wakes, river currents, minimal wind fetch, minimal tidal impacts
Protection Provided: unknown
Vegetation Used: none; natural colonization
Project Constructed: early 1980's
Monitoring: extremely limited data collected by local and state agencies
Success or Failure: from all observations, very successful and site is stable, but project success criteria not established and monitoring not carried out.
Costs: unknown

POC(s): St. Johns Water Management District; Sandy Lemlich, Seattle District (formerly of Jacksonville District); Dr. H. K. Smith, Jacksonville District

Winyah Bay Marsh Creation Site

Corps Division: South Atlantic, Charleston District
Project Type: marsh creation using maintenance dredged material placed adjacent to 60-year-old dredged material island
Project Size: in 1996, more than 150 acres
Project Location: off Middle Ground Island in Winyah Bay, near Georgetown, SC
Substrate Type: silt dredged material
Energy Sources: river currents, several mile wind fetch, close to a very strong tidal area (the Gorge) that provides the inlet to Winyah Bay
Protection Provided: none
Vegetation Used: none, natural colonization by smooth cordgrass and saltmarsh bulrush
Project Constructed: dredged material placement for marsh begun in 1974. A number of older naturally-vegetated dredged material islands from channel construction already in Bay that are primarily used for recreation by boaters.
Monitoring: Limited monitoring begun by WES in 1989. Using remote sensing, different ages of marsh determined and studied. Each deposit of dredged material appeared to colonize with smooth cordgrass within 3 years of being deposited; some areas remain large very productive mudflats. Different age "new marsh" compared to a much older natural marsh across the channel (no new marshes in SC available for comparison). Marsh and mudflat macrobenthos, fisheries, vegetation, wildlife, insects, and soils data collected and analyzed.
Success or Failure: based on monitoring that began 15 years after project begun, marsh formation is successful once sediment stabilization occurs. New marsh is forming on a annual basis, mudflats are relatively stable. Problem is much of the newly-placed dredged material is washed out of the Bay through a deep gorge that connects it with the Atlantic before stabilization can occur.
Costs: $1.25 per CY
POC(s): Jim Woody, Charleston District; Dr. Doug Clarke and Dr. Mary Landin, WES; Dr. Mark LaSalle, Marine Extension Service, USDA; Dr. Courtney Hackney, University of North Carolina-Wilmington

Harkers Island Marsh Creation Sites

Corps Division: South Atlantic, Wilmington District
Project Type: salt marsh and seagrass creation on older dredged material deposits shaved down to intertidal and sub-tidal elevations as test plots for NMFS/USACE MOA studies.
Project Size: three sites of less than 5 acres each
Project Location: along the AIWW, near Beaufort, NC
Substrate Type: sand dredged material
Energy Sources: several mile wind fetch, limited wave energy problems

Protection Provided: steep banks on each side of the shaved down areas left in place for side slope protection
Project Constructed: 1987
Monitoring: Monitoring by NMFS with limited assistance by WES.
Vegetation Used: smooth cordgrass and eelgrass
Success or Failure: Initial data and site observations by WES indicate sites are tracking along exactly as new marshes and seagrass beds on sand substrate along the Atlantic Coast are expected to grow in spite of poor project design. NMFS disagrees that sites are working but has never released data.
Costs: unknown
POC(s): Paul Knutson, private consultant, Gloucester Point, VA (for WES); Dr. Doug Clarke and Dr. Mary Landin, WES; Mark Fonseca, NMFS; Frank Yelverton, Wilmington District; Dr. Pace Wilbur, NOAA

Bodkin Island Marsh Restoration Site

Corps Division: North Atlantic, Baltimore District
Project Type: island and marsh restoration using maintenance dredged material
Project Size: 7 acres
Project Location: approximately 2 miles off mainland, near Kent Narrows and Chester River, in Queen Annes County, Maryland
Substrate Type: sand dredged material
Energy Sources: long wind fetch and moderate to high wave energies from the southeast/southwest; 2-mile wind fetch and lower wave energies from the northeast/northwest.
Protection Provided: soft structures, primarily geotextile tubes
Vegetation Used: Island to be planted with smooth cordgrass, saltmeadow cordgrass, saltmarsh bulrush, Olney's threesquare, and marsh elder in marsh zone; Japanese honeysuckle, poison ivy, saltmeadow cordgrass, and black cherry on black duck nesting area (upland); and widgeongrass, horned pondweed, and sago pondweed in protected tidal pools. (island designed by WES with input from other agencies)
Project Constructed: will begin in October 1997
Monitoring: Baseline data collection by WES, Baltimore District, Maryland DNR, and FWS (Annapolis office). Island construction monitoring by WES and Baltimore District. Post-construction monitoring will be by District, Maryland DNR, FWS, and Vern Stotts (retired FWS).
Success or Failure: high level of success predicted by interagency working group
Costs: estimated cost is $1,000,000 for entire island construction (7 acres)
POC(s): Bob Blama and Dan Bierly, Baltimore District; John Gill and John Wolflin, FWS; Bill Carter and Jonathan McKnight, Maryland DNR; Dr. Steve Maynord, Jack Davis, Dr. Mary Landin, WES.

Kenilworth Marsh Restoration Project

Corps Division: North Atlantic, Baltimore District
Project Type: wetland restoration
Project Size: estimated 40 acres
Project Location: in National Aquatic Gardens, off the Anacostia River, a tributary of the Potomac River, in downtown Washington, DC
Substrate Type: silt and sand dredged material
Energy Sources: minimal
Protection Provided: temporary water-filled geotextile tubes were used to hold back the dredged material until consolidation, and hold back the freshwater tide until the project was planted
Vegetation Used: 16 different fresh marsh species with wildlife food vaue were planted; none were able to out-compete the seed bank within the dredged material, and the site is now dominated by the seed bank species, especially broadleafed cattail. It is also starting to colonize with small willows, cottonwoods, and other woody species, and will ultimately become a floodplain forest. It was once a forest, and will become so again.
Project Constructed: 1993
Monitoring: Pre-, during, and post-monitoring conducted either by Baltimore District or by one of its contractors. Some data collection by National Park Service, owner of the site.
Success or Failure: highly successful
Costs: unknown
POC(s): Steve Garbarino and Bob Blama, Baltimore District; National Park Service Aquatic Gardens Office; Dr. Mary Landin, WES

Eastern Neck National Wildlife Refuge Wetland Project

Corps Division: North Atlantic Division, Baltimore District
Project Type: wetland restoration
Project Size: approximately 5-10 acres
Project Location: on Eastern Neck National Wildlife Refuge shoreline, near Kent Narrows in Chesapeake Bay, MD
Substrate Type: sand dredged material
Energy Sources: long northwesterly wind fetch
Protection Provided: detached riprap breakwaters and geotextile tubes
Vegetation Used: backfilled sand dredged material was planted with smooth cordgrass and saltmeadow cordgrass in 1993 and 1994
Project Constructed: 1993
Monitoring: engineering by WES and Baltimore District; biological monitoring contracted by WES to US Fish and Wildlife Service Annapolis Field Office
Success or Failure: successful, but breakwaters were spaced too far apart, and dredged material is eroding from between them. The site needs closure between breakwaters and nourishment.
Costs: unknown
POC(s): Bob Blama, Baltimore District; John Gill, US FWS; Dr. Mary Landin and Dr. Steve Maynord, WES

Barren Island Marsh Creation/Nesting Island

Corps Division: North Atlantic, Baltimore District
Project Type: marsh and seabird nesting island creation using maintenance dredged material
Project Size: approximately 100 acres
Project Location: Chesapeake Bay, Maryland
Substrate Type: sand dredged material
Energy Sources: low to moderate wind fetch and wave energies
Protection Provided: earlier marsh planting used to protect marsh shoreline and nesting areas; later protection provided by geotextile tubes placed several hundred feet from Barren Island shoreline
Vegetation Used: Earlier smooth cordgrass planted on island fringes. Oyster shell material placed on island crest for nesting terns. Later plantings on dredged material deposited behind geotextile tubes.
Project Constructed: 1984-1996
Monitoring: data collected by Baltimore District, WES, and Environmental Concern Inc., general observations by FWS, engineering data by WES and Nicolon Corporation
Success or Failure: short-term indications from nesting use and marsh stability are success; long-term information on first work indicate site continuing to erode. Long-term information on latest work not yet in. Site has been added to more than one time by maintenance dredged material at much cost savings to the District, and has potential for being used again.
Costs: cost savings of $63,000 during last dredging cycle Barren Island was used, even with additional planting and nesting substrate costs
POC(s): Bob Blama, Baltimore District; John Gill, US Fish and Wildlife Service, Annapolis, MD; Jack Davis and Dr. Mary Landin, WES; Edward Trainer, Nicolon Corporation

Windmill Point Marsh Creation Site

Corps Division: North Atlantic, Norfolk District
Project Type: fresh intertidal marsh creation using maintenance dredged material
Project Size: 15 acres
Project Location: at Windmill Point in the James River, east of Hopewell, VA
Substrate Type: both sand dredged from a borrow area and silt maintenance dredged material were used
Energy Sources: strong river and flood currents, 3-ft tides, several mile wind fetch from west
Protection Provided: temporary sand dike served as breakwater
Vegetation Used: on dike, grasses and forbs; in island interior, natural colonization occurred before site could be planted.
Project Constructed: In 1973-74; first marsh purposely designed and built by the USACE. Site agreed upon by interagency state and federal working group.
Monitoring: Pre-, during, and post-construction monitoring by WES and its contractors (UVa, VIMS, Old Dominion University, Environmental Concern Inc., others).

Success or Failure: Island broke in half when sand dike failed, and interior marsh mostly washed out in 1983. As a stable marsh, a failure. As a protected shallow water habitat for fish spawning and use by wildlife on remnant island, successful. Many lessons learned in early effort.
Costs: approximately $1.00 per CY for construction
POC(s): Craig Selzer, Tom Yancy, Sam McGee, and Ronnie Vann, Norfolk District; Dr. Bob Diaz and Dr. Gene Silberhorn, VIMS; Dr. Ed Garbisch, Environmental Concern Inc., Dr. Mary Landin, WES, Charles Newling, Wetland Science Associates (formerly of WES)

Miller Sands Island Marsh Creation Site

Corps Division: North Pacific, Portland District
Project Type: intertidal marsh creation, upland restoration, and dune stabilization using maintenance dredged material
Project Size: 150 acres (upland island), 3-mile-long sand spit, and 23 acre planted marsh
Project Location: Lewis and Clark National Wildlife Refuge, lower Columbia River, near Astoria, Oregon
Substrate Type: sand and volcanic dredged material
Energy Sources: 8-ft tides, very strong northwest 6-10-mile wind fetch, strong river and flood currents, and high wave energies
Protection Provided: no structures; marsh is protected behind the sand spit, which was stabilized with dune plantings
Vegetation Used: In intertidal marsh, 8 species tested. Dominant plantings were tufted hairgrass, slough sedge, and Lyngbye's sedge. On sand spit, American beachgrass was used. On upland (old sand dredged material island) seed mixture of grasses and legumes were used on prepared, limed, and fertilized, disked site.
Project Constructed: 1974-1976
Monitoring: Pre-, during, and post-construction monitoring conducted by WES, with assistance from Portland District, and their contractors (NMFS, Univ. of Washington, Oregon State University, others).
Success or Failure: All three habitats very successful. Upland only remains successful because FWS refuge personnel continue to apply fertilizer every few years to maintain growth of grasses. Legumes did not survive on long-term, and intense grazing by nutria and muskrats keep island vegetation under stress. Dune grass has spread from original plantings over 2 miles, and is holding sand spit; used by nesting seabirds. Marsh remains stable through management using dredged material by Portland District; they apply new dredged material to eroded spots along the channel side of the sand spit with every maintenance cycle. Three nearby marsh reference sites compared to planted marsh; no comparisons made of upland and dunes. Fisheries and benthos comparable on all sites; wildlife use spectacularly greater on Miller Sands.
Costs: $1.37 per CY
POC(s): Geoff Dorsey, Steve Stevens, Mark Smith, Steve Martin, Portland District; Jake Redlinger, North Pacific Division; Dr. Mary Landin, WES; Dr. Mike Schiewe, NOAA National Marine Fisheries Service

Mott Island and Other Islands in Columbia River

Corps Division: North Pacific, Portland District

Project Type: habitat development using dredged material
Project Size: several islands of varying sizes
Project Location: Mott, Sand, Rice, and other dredged material islands are located in and around Lewis and Clark and Columbia White-tailed Deer National Wildlife Refuges in the lower Columbia River, Oregon.
Substrate Type: primarily sand
Energy Sources: strong wind and wave energies, 8-ft tides
Protection Provided: none
Vegetation Used: natural colonization
Project Constructed: in the 1950s, and some are added to on a regular basis using maintenance dredged material
Monitoring: Primarily limited to the 1970's. Extensive studies done on Mott, Sand, and Rice Islands during the USACE Dredged Material Research Program to document vegetation and soil successional changes on manmade islands and their use as habitats. Continued eagle and other wildlife observations made on islands on a regular basis.
Success or Failure: Stable and successful, although the islands with maintenance dredged material need to be expanded or new islands built due to (1) heights of presently mounded dredged material and (2) the loss of habitat due to having to put material in such confined locations over and over again. Much songbird, small mammal, and goose use of islands.
Costs: islands are so old that this information is probably no longer available
POC(s): Dr. Mary Landin and Jean O'Neil, WES; Geoff Dorsey and Steve Stevens, Portland District; Jake Redlinger, North Pacific Division

Jetty Island Salt Marsh/Seagrasses Creation Site

Corps Division: North Pacific, Seattle District
Project Type: island, marsh, and seagrass habitat development using dredged material
Project Size: over 50 acres
Project Location: adjacent to the Shohomish River mouth and harbor channel in Puget Sound, at Everett, Washington
Substrate Type: sand dredged material
Energy Sources: several mile westerly wind fetch, 8+-ft tides, river currents, current movement within Puget Sound
Protection Provided: none on main energy side; bulkhead on channel side receiving river currents
Vegetation Used: Original island built in 1891 had natural colonization; new marsh, mudflat, and upland planted with tufted hairgrass, slough sedge, dune grasses, eelgrass, and other species.
Project Constructed: Original dredged material island over 100 years old. Has been added to in maintenance dredging many times. New marsh built 1989.

Monitoring: Intensive study during DMRP (1970's). Low-level observations and data collection until 1985, then intensive again prior to island addition and marsh planting. Detailed monitoring plan agreed upon by interagency working group, and being carried out for Seattle District, Port of Everett, and State of Washington by Pentec Corporation.
Success or Failure: Highly successful site. Island upland used for day visits, with park rangers, nature tours. First Arctic tern nests in contiguous states on Jetty Island; much wildlife use. New marsh and seagrass bed sites are thriving; natural colonization has occurred with additional species. Long-term monitoring program will continue.
Costs: estimated $4.00/cy
POC(s): Dennis Gregoire, Port of Everett; Jon Houghton, Pentec Corporation; Hiram Arden and Ken Brunner, Seattle District; Justine Smith Bartion and Dr. Fred Weinmann, EPA; Dr. Mike Schiewe, NMFS; Dr. Mary Landin, WES; Dr. Ron Thom, University of Washington.

Goglihite (Lincoln Avenue) Salt Marsh/Seagrasses Mitigation Site

Corps Division: North Pacific, Seattle District
Project Type: salt marsh creation for mitigation (Port of Tacoma)
Project Size: less than 5 acres
Project Location: in Seattle, WA
Substrate Type: primarily sand dredged material
Energy Sources: low to moderate wind and wave energies
Protection Provided: none
Vegetation Used: eelgrass, sedges
Project Constructed: 1987-1988
Monitoring: Active mitigation monitoring program being conducted by University of Washington. Coordinated with Seattle District, EPA, state agencies, NMFS, FWS.
Success or Failure: short-term: very successful, long-term: site has silted in, negating any refuge use at low tide by young salmonids as called for in goals and objectives
Costs: unknown
POC(s): Ken Brunner and Kathy Kunz, Seattle District; Dr. Fred Weinmann, EPA; Dr. Mike Schiewe, NMFS; Dr. Charles Simenstad, University of Washington, Dr. Doug Clarke amd Dr. Bill Brostoff, WES

Donlin Island/Venice Cut, Sacramento Delta, CA Wetland Restoration

Corps Division: South Pacific, Sacramento District
Project Type: intertidal fresh and brackish marsh restoration on subsided land using maintenance dredged material
Project Size: 35 acres (both islands)
Project Location: San Joaquin River, near Stockton, CA
Substrate Type: silt and sand dredged material
Energy Sources: river currents primarily, minimal barge and boat wakes, weak intertidal influence (Donlin Island is brackish intertidal, Venice Cut is fresh intertidal)

Protection Provided: none
Vegetation Used: natural colonization
Project Constructed: 1983
Monitoring: Long-term monitoring program set up by Sacramento District and University of California-Davis, with assistance from WES. Monitoring was a doctoral dissertation project, and included vegetation, wildlife, fisheries, other parameters.
Success or Failure: Both projects successful and relatively stable; both have room for additional dredged material to expand the marshes, although demand for dredged material for levee repair is strong and continuous, and probably will preclude any additions to the sites.
Costs: approximately $1.50 per CY with 1,000,000 CY placed at the two sites (much less cost than other placement options)
POC(s): Dr. Sid England, Sacramento District; Dr. Mary Landin, WES; Fred Nikaji, FWS (retired, but living in area)

Salt Pond #3 Marsh Restoration Site

Corps Division: South Pacific, San Francisco District
Project Type: salt marsh restoration and salt pond rehabilitation using dredged material
Project Size: 111 acres
Project Location: south of Hayward, CA, in South San Francisco Bay, at the mouth of the Alameda Flood Control Channel
Substrate Type: silt dredged material
Energy Sources: long fierce northwesterly wind fetch across the Bay, and 4-5 ft tides
Protection Provided: existing dike at site was breached to provide intertidal flow to the marsh
Vegetation Used: Pacific cordgrass, 2 species of pickleweed
Project Constructed: salt pond had been in existence for decades; marsh project carried out 1973-1976
Monitoring: Site was considered a demonstration under the DMRP, and was not subject to the intensity level of monitoring other DMRP sites were. Initial monitoring under local contract included only vegetation and birds. Long-term monitoring by WES included soils, vegetation, wildlife, physical changes (no fisheries or benthos), and is still on-going. Although less than 10 acres of the site was planted, the entire site colonized in pickleweed. Succession has been rapid, and the site now resembles older typical salt marshes of the Bay -- it no longer supports Pacific cordgrass, but is almost entirely pickleweed. The nearby channel has silted in, and has colonized with cordgrass.
Success or Failure: Successful, although some people think the site is too high to be a good marsh because intertidal flow does not reach the upper 1/3 of the site.
Costs: $1.68 per CY (1973 cost including material transport, site preparation, and planting)
POC(s): Dr. Mary Landin, WES; Scott Miner, San Francisco District

Muzzi Marsh Salt Marsh Restoration Project

Corps Division: South Pacific, San Francisco District

Project Type: salt marsh restoration using dredged material
Project Size: over 50 acres
Project Location: north of Tiburon, in Marin County, on the western side of San Francisco Bay, California
Substrate Type: mixture silt and sand dredged material
Energy Sources: easterly wind fetch, sometimes has strong wave energies against shoreline
Protection Provided: existing dike from dredged material confinement was breached to provide intertidal flow
Vegetation Used: natural colonization with Pacific cordgrass and pickleweed
Project Constructed: 1980's
Monitoring: Most monitoring has been by California Coastal Commission; San Francisco District has kept track of this site because it is a mitigation site. The site was an old disposal site that was opened up to intertidal flow. At a later date a tidal channel was dug around the site to introduce water throughout the site. Parts were left as upland and the rest became wetland. Has nature trails, passive recreation opportunities throughout the site--excellent bird watching spot.
Success or Failure: successful
Costs: approximately $2.00 per CY (does not include mitigation costs per permit applicant)
POC(s): Phyllis Faber, California Coastal Commission; Scott Miner, San Francisco District; Dr. Mary Landin, WES

Warm Springs Intertidal Marsh Restoration

Corps Division: South Pacific, San Francisco District
Project Type: marsh restoration coupling dredged material and structures to provide water stability and intertidal elevations
Project Size: over 100 acres
Project Location: adjacent to South San Francisco Bay just north of San Jose, California
Substrate Type: silt dredged material
Energy Sources: long fierce northerly wind fetch and strong wave energies
Protection Provided: dikes and culverts
Vegetation Used: natural colonization
Project Constructed: in 1980's
Monitoring: Pre-construction baseline data collected by State and private consultant who built the project (Phil Williams and Associates). Long-term monitoring data limited, but being collected by state agencies to some extent. Project consists of several wetland areas connected to the Bay by tidal culverts, but protected from wave energy by dikes. Nature trails, bird watching, etc. part of project design; site receives considerable recreational use.
Success or Failure: successful
Costs: unknown
POC(s): Phil Williams, private consultant, San Francisco, CA; Scott Miner, San Francisco District

Sonoma Baylands Wetland Restoration Project

Corps Division: South Pacific, San Francisco District
Project Type: marsh restoration coupling dredged material and structures to provide water stability and intertidal elevations
Project Size: over 100 acres
Project Location: adjacent to north San Francisco Bay at the mouth of the Petaluma River, CA
Substrate Type: silt dredged material
Energy Sources: minimal
Protection Provided: dikes and culverts
Vegetation Used: some plantings of Pacific cordgrass and Salicornia, rest of area by natural colonization
Project Constructed: in 1996-97
Monitoring: Pre-construction baseline data collected by State and Corps contractors; Corps design and placement of dredged material; short-term and long-term data being collected by State and Corps.
Success or Failure: early stage--successful
Costs: unknown
POC(s): Scott Miner, Project Manager of Sonoma Baylands, San Francisco District

Pointe Mouillee CDF Wetland Restoration

Corps Division: North Central, Detroit District
Project Type: wetland restoration and shoreline stabilization combining structures and dredged material
Project Size: 4600 acres, 900 of which is a confined disposal facility built on and configured to an eroded barrier island
Project Location: in western Lake Erie on the Pointe Mouillee Waterfowl Management Area, near Flat Rock, Michigan
Substrate Type: silt and sand maintenance dredged material (both occur, depending upon where the dredge is working
Energy Sources: strong easterly wind fetch across Lake Erie
Protection Provided: riprap dike, reinforced inside and outside, and cross dikes for side protection
Vegetation Used: natural colonization
Project Constructed: 1976-1983 engineering; habitat development still occurring
Monitoring: Initial monitoring State of Michigan, Detroit District, EPA, WES. Long-term monitoring, WES. Site has a long-term management plan that includes visitors center, nature trails, hiking/biking/jogging, fishing piers, marina, and in-season waterfowl and small game hunting. Heavily used by locals, and by regional birding clubs. Wildlife use of site is spectacular; marsh is recovering from decades of erosion. Wetlands are intensively managed by Michigan DNR.
Success or Failure: highly successful; being compared to 4500-yr-old Pointe Pelee, Ontario, wetland at Pointe Pelee Canadian National Park

Costs: $9.43 per CY; construction costs of CDF with regard to total area protected/restored is $10,500 per acre
POC(s): Les Weigum, Detroit District; Dr. Mary Landin and Dr. Jan Hoover, WES; Bob Johnson and others, Michigan DNR

Times Beach CDF Marsh Restoration Site

Corps Division: North Central, Buffalo District
Project Type: wetland creation using dredged material
Project Size: over 25 acres
Project Location: in Lake Ontario, near Buffalo, NY
Substrate Type: silty sand dredged material
Energy Sources: wind fetch and some wave energies broken by the confined disposal facility dike
Protection Provided: CDF dike
Vegetation Used: natural colonization
Project Constructed: Project was originally constructed to hold dredged material from the nearby channel, but after one maintenance dredging cycle, Buffalo District built a new CDF due to the high level of wildlife use on the site and a request from the Audubon Society to have the site made into a bird sanctuary.
Monitoring: Pre-project monitoring was minimal; post-project monitoring conducted by the local Audubon Society chapter, and by WES.
Success or Failure: successful
Costs: unknown (only costs were site acquisition and dikes)
POC(s): Don Borkowski, Buffalo District; Dr. John Simmers , Jeannie M. Roper, and Dr. Mary Landin, WES

Craney Island CDF

Corps Division: North Atlantic, Norfolk District
Project Type: confined disposal facility to hold Norfolk Harbor dredged material
Project Size: several hundred acres
Project Location: adjacent to the channel and attached to the mainland, in the city of Norfolk, VA
Substrate Type: silt dredged material
Energy Sources: river currents from the James River, 3-4 ft tidal range
Protection Provided: riprap dike
Vegetation Used: natural colonization
Project Constructed: 1980's
Monitoring: Pre-project engineering monitoring done by WES and Norfolk District. No pre-project environmental monitoring. Post-project monitoring has been almost exclusively engineering; however, wildlife use is occurring on the site, and natural marsh and upland vegetation is growing inside the CDF.

Success or Failure: Successful in that it holds dredged material from the Harbor. Unsuccessful in that it displaced river bottom and has no long-term environmental plan. Proposed plans for the CDF include development of a plan, development of the site as a local recreational park, development as an industrial site, additions of marsh -- some of these uses are not compatible, and choices will have to be made.
Costs: unknown
POC(s): Jim Melchor, Sam McGee, and Ronnie Vann, Norfolk District; Dr. Mike Palermo, WES

Hart-Miller Island CDF

Corps Division: North Atlantic, Baltimore District
Project Type: confined disposal facility scheduled to be a recreational site when completed
Project Size: 1100 acres
Project Location: at Hart and Miller Islands, in Chesapeake Bay, near the Baltimore Channel, Maryland
Substrate Type: silty sand maintenance dredged material
Energy Sources: long wind fetch across Chesapeake Bay, strong wave energies
Protection Provided: riprap dike
Vegetation Used: natural colonization
Project Constructed: 1980's
Monitoring: Intensive pre-, during, and post-project monitoring has been conducted by the State of Maryland on water quality, soils, and other parameters. Site has progressed from connection of the two islands, to two cells being filled, to fresh marsh vegetation colonizing the cells. Considerable wildlife use occurring, including nesting by gulls. A long-term management plan has been agreed upon by all agencies, and is part of a state law. Use cannot change from recreation and habitat. South Cell is filled, and concept plan approved. North Cell dikes were raised to 44 feet to hold dredged material until Poplar Island site is completed.
Success or Failure: Mixed reactions; site filled much quicker than anticipated because material was placed from other projects. Recreational development is slower than locals would like, but site is not completely full. Recreational beach has been built using dredged material.
Costs: unknown
POC(s): Jeff McKee, Baltimore District; Frank Hamons, Maryland Port Administration; Wayne Young, Maryland Environmental Service; John Wilson, Maryland Department of Natural Resources; Tom Patin and Dr. Mary Landin, WES

Core Sound Islands

Corps Division: South Atlantic, Wilmington District
Project Type: seabird nesting islands constructed of maintenance dredged material
Project Size: over 15 acres
Project Location: Core Sound, near AIWW, North Carolina
Substrate Type: sand dredged material
Energy Sources: both wind fetch and wave energies affect all sides of islands

Protection Provided: 10 x 4 ft nylon sandbags built to form kidney-shaped configuration (to offer protected cove for feeding seabirds and wading birds)
Vegetation Used: smooth cordgrass and saltmeadow cordgrass planted along outer edges of shoreline, where sand was allowed to overtop the sandbags after islands were filled. Crest of islands purposely kept bare for best nesting substrate.
Project Constructed: 1978-1979
Monitoring: University of North Carolina at Wilmington, North Carolina State University, and Wilmington District monitored wildlife, vegetation, site stability, and other parameters. Local fishermen (or vandals) cut the sandbags on one island right after filling, and the island washed away. The other island is stable and thriving.
Success or Failure: One island failed due to vandalism. One island very successful.
Costs: estimated $1.50/cy
POC(s): Dr. Jim Parnell, UNC-Wilmington; Dr. Steve Broome, NCSU; Trudy Wilder, Wilmington District; Barry Holliday, HQUSACE; Dr. Mary Landin, WES

645 Gulf Coast Dredged Material Waterbird Nesting Islands

Corps Division: South Atlantic, Southwestern, Lower Mississippi Valley
Project Type: wildlife islands using dredged material
Project Size: sizes of islands range from 0.5 acres to over 100 acres
Project Location: islands located throughout the Gulf Intracoastal Waterway system and in major harbors such as Mobile, Tampa, and Galveston
Substrate Type: most are built of sandy dredged material; some have silty sand or silt bases, especially in parts of Texas
Energy Sources: depends upon location within the waterway; most have some wave and wind actions; all are affected by barge and boat wakes
Protection Provided: for older islands, none; for CDF's, riprap or well-engineered dikes
Vegetation Used: all older islands colonized naturally; some additions or newer islands were partially planted
Project Constructed: most islands built in the 1930-1950s
Monitoring: Most islands have not had any monitoring, although over 50 percent in any given year will have 1 or more waterbird colonies on them. In Texas, the Fish-eating Bird Survey collected annual data on all colonies, but does not distinguish dredged material or natural islands. Periodic data have been collected in Louisiana, Alabama, Mississippi, and Florida. Extensive DMRP data exists on these bird islands, including vegetation in and out of colonies, feeding information, and nesting populations and relationships.
Success or Failure: Although most were not built purposely as nesting islands, their utilization as such has been highly successful.
Costs: less than $1 per CY; most islands are so old that records have been lost
POC(s): Dr. Mary Landin, WES; Sue Hawes, New Orleans District; Dr. H. K. Smith, Jacksonville District; Dr. Sue Rees, Mobile District; Bob Bass, Galveston District; Dr. Rich Paul, National Audubon Society, Tavanier, FL; Dr. Elizabeth Smith, TAMU-Corpus Christi; Roy R. Lewis, Lewis Environmental Services Inc., Tampa, FL; others

More than 400 Atlantic Coast Dredged Material Wildlife Nesting Islands

Corps Division: South Atlantic, North Atlantic, and New England
Project Type: wildlife islands built using dredged material
Project Size: varies from 0.5 acres to over 100 acres
Project Location: most islands are located in the Atlantic Intracoastal Waterway adjacent to the channel from Florida to Long Island, in Chesapeake Bay, or in major harbor areas (Savannah, Charleston, Norfolk, Philadelphia, New York
Substrate Type: most are sand or silty sand, although those in harbors contain more silt
Energy Sources: wind fetches and wave energies vary; all are affected to some extent by barge and boat wakes
Protection Provided: most older islands, none; newer islands and CDFs, riprap or some other protective structure
Vegetation Used: all AIWW islands colonized naturally with the exceptions of Core Sound and Barren Island, which had shorelines planted with cordgrass
Project Constructed: most constructed when AIWW was built in 1930-1940s
Monitoring: Islands in New Jersey, North Carolina, and Florida were intensively monitored for vegetation and wildlife during the DMRP. Other islands periodically surveyed for waterbird colonies by state agencies, local birding groups, and in a FWS nationwide survey in the early 1980s. National Park Service and Rutgers University has monitored islands in Long Island Sound and vicinities.
Success or Failure: Most of the islands were found to have some type of wildlife/waterbird nesting use. Most were relatively stable, although some were suffering erosion along channel sides. As a whole, most islands viewed as very successful, with locals and some agency people not even realizing they are manmade islands.
Costs: less than $1 per CY; most islands are so old that records have been lost
POC(s): Dr. Jim Parnell, University of North Carolina - Wilmington; Dr. Robert Soots, USACE-BERH, Fort Belvoir, VA; Roy R. Lewis, Lewis Environmental Services, Tampa, FL; Dr. Mike Erwin, FWS, Patuxent, MD; Dr. Johanna Burger, Rutgers University; Dr. Mary Landin, WES; Trudy Wilder, Wilmington District; Betty Gray Waring, Norfolk District; Bob Blama, Baltimore District; Jim Woody, Charleston District; Dr. H. K. Smith, Jacksonville District

76 Pacific Coast Dredged Material Islands and Sites with Waterbird Colonies

Corps Division: South Pacific, North Pacific
Project Type: wildlife islands using dredged material
Project Size: varies from 2.0 acres to over 200 acres
Project Location: from San Diego Harbor, California, to Everett Harbor, Washington, along major navigation channels (especially the Columbia and Snake Rivers system and the Sacramento/San Joaquin Rivers system)
Substrate Type: sand and aggregate (and volcanic material)
Energy Sources: very long wind fetches and strong wave energies against almost all islands, river currents, up to 10 ft tides

Protection Provided: none
Vegetation Used: natural colonization in all cases except Miller Sands Island and Jetty Island
Project Constructed: most constructed either in the 1930s or in the 1950s when channels/harbors were deepened and widened
Monitoring: Islands in Oregon and Washington identified, researched, and evaluated during DMRP; those with waterbird colonies intensively monitored for vegetation utilization and bird populations. Other monitoring of islands incidental and local.
Success or Failure: some very successful, others never receive wildlife use or have too much human recreational pressures
Costs: less than $1 per CY; most islands are so old that records have been lost
POC(s): Jake Redlinger, North Pacific Division; Dr. Sid England, Sacramento District; Scott Miner, San Francisco District; Geoff Dorsey, Portland District; Ken Brunner, Seattle District; Teri Berila, Walla Walla District; Dr. David Manuwal, University of Washington; Dennis Gregoire, Port of Everett; others

Great Lakes Waterbird Nesting Islands and Sites

Corps Division: North Central
Project Type: wildlife habitat development using dredged material
Project Size: varies from 1.0 acres to over 100 acres
Project Location: Islands located primarily where shipping channels were cut through connecting rivers and in harbors: Detroit River, Sault Saint Marie, Lake St. Clair, and Duluth are some of the locations.
Substrate Type: primarily sand and cobble
Energy Sources: river and lake currents, ship and barge wakes, sometimes strong wind fetches that are causing entire islands to disappear
Protection Provided: in some cases, none; in others such as in the Detroit River, islands are riprapped
Vegetation Used: natural colonization
Project Constructed: most were built in the 1950s
Monitoring: All of the islands have been monitored at least twice, in 1976-1977 during the DMRP and again in 1985, for waterbird colony locations and sizes. Vegetation that provides nesting substrate has also been documented. Beyond those data, monitoring has not occurred.
Success or Failure: mixed: a number of these islands are eroding severely, especially in the St. Mary's River area, and their value as nesting islands is all but lost. Where islands are stable, continued use by large tern and gull populations occurs. Islands offer havens for endangered species in the US Great Lakes.
Costs: estimated $1.00 per CY; most islands are so old that records have been lost
POC(s): Dr. Mary Landin, WES; Dr. Bill Scharf, Northwestern Michigan University; Les Weigum, Detroit District; Dr. Jim Ludwig, private consultant; others

Twitch Cover Seagrass Plantings

Corps Division: North Atlantic, Baltimore District
Project Type: seagrass bed restoration using maintenance dredged material
Project Size: less than 5 acres
Project Location: Twitch Cove, Chesapeake Bay, Maryland
Substrate Type: sand dredged material
Energy Sources: long wind fetch, and wave energies from all sides
Protection Provided: longard (geotextiles) tubes surrounding the site
Vegetation Used: eelgrass
Project Constructed: 1989
Monitoring: Pre-, during, and post-planting monitoring by Baltimore District, WES, and NMFS. Eelgrass bed planted behind protection of longard tubes
Success or Failure: grass bed appears to be failing
Costs: estimated $1.50/cy
POC(s): Robert N. Blama, Baltimore District; Mark Fonseca, NMFS; Dr. Doug Clarke, WES

Slaughter Creek Oyster Reef Restoration

Corps Division: North Atlantic, Baltimore District
Project Type: oyster reef development using dredged material capped with old oyster cultch
Project Size: less than 5 acres
Project Location: Slaughter Creek, Chesapeake Bay, Maryland
Substrate Type: silty sand dredged material
Energy Sources: long wind fetch and wave energies from all sides
Protection Provided: oyster shell capping
Vegetation Used: none (not applicable)
Project Constructed: 1989
Monitoring: Pre-, during, and post-project monitoring conducted by Baltimore District, WES, and NMFS.
Success or Failure: successful, and a similar project will be carried out in another location in 1991
Costs: estimated $1.50/cy
POC(s): Robert N. Blama, Baltimore District; Dr. Doug Clarke, WES; Mark Fonseca, NMFS

Mission Bay Seagrass Restoration Plantings

Corps Division: South Pacific, Los Angeles District
Project Type: seagrass restoration using dredged material substrates
Project Size: more than 200 acres
Project Location: in Mission Bay Park, San Diego, California
Substrate Type: sand dredged material
Energy Sources: minimal wind and wave energies, limited impacts by local boaters and recreationalists
Protection Provided: none
Vegetation Used: eelgrass

Project Constructed: 1980s-1997
Monitoring: Pre-, during, and post-planting monitoring conducted by the contractor hired to plant the site. Monitoring is continuing to document spread of the original planting of several acres that is now covering most of 200 acres of protected coves and lakes within the Mission Bay Park, which was constructed entirely of dredged material.
Success or Failure: success
Costs: costs of dredging part of project; costs of planting eelgrass was less than $5000 per acre
POC(s): Dr. Keith Merkel, Merkel Associates, National City, CA; Mission Bay Park office; Dr. Mary Landin and Dr. Doug Clarke, WES

Mobile Thin Layer Dredged Material Placement

Corps Division: South Atlantic, Mobile District
Project Type: thin layer (not more than 12 inches) of dredged material placed over large bay bottom area as pilot demonstration
Project Size: less than 10 acres
Project Location: lower Mobile Bay, Alabama
Substrate Type: silt maintenance dredged material
Energy Sources: long wind fetch across Mobile Bay, and surface wave energies from boats and natural conditions
Protection Provided: none
Vegetation Used: none, not applicable
Project Constructed: 1988
Monitoring: Pre-, during, and post-project monitoring conducted by Mobile District, WES, and EPA. Dredged material was placed using a small dredge that could be manipulated to spread the material as it fell from the pipe in thin layers. Motile and non-motile organism impacts and recolonization and water quality were monitored. Minimal impacts resulted, and organism levels were at pre-project levels in 6 months.
Success or Failure: success
Costs: estimated $1.00/cy
POC(s): Dr. Sue Rees and Doug Nester, Mobile District; Dr. Doug Clarke and Bob Lazor, WES

Mobile Underwater Berm Project

Corps Division: South Atlantic, Mobile District
Project Type: construction of deepwater and nearshore berms using dredged material
Project Size: berms several acres each in size; stable berm is 2 miles long and contains several million cubic yards of material
Project Location: Gulf of Mexico off entrance to Mobile Bay, Alabama
Substrate Type: silt and sand dredged material
Energy Sources: full wind and wave energies of the Gulf of Mexico
Protection Provided: none
Vegetation Used: none, not applicable