PDHonline Course C274 (4 PDH)

Beneficial Use of Dredged Material – Habitat

Instructor: John Huang, Ph.D., PE and John Poullain, PE

2020

PDH Online | PDH Center

5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088
www.PDHonline.com

An Approved Continuing Education Provider

CHAPTER 3

LOGISTICAL CONSIDERATIONS

3-1. General. With the huge quantities of dredged material created during dredging operations, site utilization, economic transport handling, and storage plans become critical to the overall life and use of a project. This section will discuss procedures for dewatering, transporting, handling and storage, and cost analyses of these activities in determining beneficial use of dredged material. It should be remembered that dewatering is not applicable for some types of beneficial uses such as wetland and aquatic habitat development and aquaculture. However, dewatering is critical to nesting islands, upland habitat development, most kinds of recreational use, agriculture, forestry, horticulture, and other types of beneficial uses.

3-2. Dewatering. Dredged material is usually placed hydraulically into confined disposal areas in a slurry state. Although a significant amount of water is removed from it through the overflow weirs of the disposal area, the confined fine-grained dredged material usually consolidates to a semifluid consistency that still contains large amounts of water. The volume occupied by the liquid portion of the dredged material greatly reduces available future disposal volume. The extremely high water content also may make the dredged material unsuitable or undesirable for commercial or beneficial use. Two dewatering methods, fully described and discussed in items 24, 28, 29, 31, 57, and 84, are generally used. The first method is allowing evaporative forces to dry fine-grained dredged material into a crust while gradually lowering the internal water table. This has been the least expensive and most widely applicable dewatering method identified through dredging research. Good surface drainage, which rapidly removes precipitation and prevents ponding of surface water, accelerates evaporative drying. Shrinkage forces developed during drying return the material to a more stable form, and lowering of the internal water table results in further consolidation. The second method of promoting good surface drainage is by constructing drainage trenches in the disposal area using heavy equipment. Use of a Riverine Utility Craft to make trenches proved successful on disposal sites with fine-grained material. A site must be dewatered sufficiently to accept heavy equipment, which limits the second method in its application as long as 2 years after a disposal site has been filled, depending upon the soil characteristics of the dredged material. A less frequently used method, rarely applied to disposal sites, includes installation of underground drainage tiles or sand layers prior to filling the site.

3-3. Transport, Handling, and Storage. Fundamental features of transport systems and general guidance for analysis of technical and economic feasibility are provided in item 74. They are presented to acquaint planners with the magnitude and scope of the transport system and provide some cost-effective analysis information for five transport modes: hydraulic pipeline, rail haul, barge movement, truck haul, and belt conveyor movement. Hydraulic pipeline and truck haul have been the primary transportation methods used for most existing beneficial use sites. Since the transport of dredged material can be a major cost item in determining the economic feasibility of a project, the transport system should be evaluated early in the site selection stage, of the planning process. Legal, political, sociological, environmental, physical, technical, and economic aspects should be examined in relation to availability of transport routes, A sequence of five steps must be followed when selecting a transport route:

Step	Information Source
1. Identify available routes	Maps, ground reconnaissance
2. Classify nature (wet/dry) of dredged material	Beneficial use needs and sources of dredged material
3. Determine annual volume of dredged material and duration of project	Dredged material sources
4. Estimate cost of available transport modes	Item 74
5. Identify and evaluate technical, environmental, legal, and institutional requirements	Item 74 Specific sources: local, state, and Federal agency regulations

a. Elements of Transport Systems. Transport systems involve three major operations: loading, transporting, and unloading. The loading and unloading activities are situation dependent and are the major cost items for short distance transport. The hydraulic pipeline is the only mode which requires a unique rehandling activity; all other transport modes may interchange loading and unloading operations to suit the specific site needs. Loading, unloading, and transporting operations can be separated into detailed components (i.e., backhoes, service roads, rail spurs, cranes, conveyors, etc.) and each component examined for capacity, operational schedule and cycle, and costs of equipment and operation and maintenance.

b. Transport Modes.

(1) Hydraulic pipeline. The hydraulic pipeline is the only transport system recommended for movement of dredged material in slurry form. Assuming government construction of the disposal site, contractor operations of the dredging work, and no easement costs, this system can be economically competitive for distances up to several miles. The conditioning step requires a rehandling dredge and fluidizing system. Control of density and flow to minimize operational problems is an essential conditioning process unique to the hydraulic pipeline mode. Suggested criteria to be used in selecting a rehandling (or secondary) dredge for operation within a containment area include: unit cost of dredging; ease of transportation; minimum downtime; small size to allow maneuverability in a small basin; capability to dredge in

shallow water to minimize dike height; and maximum cutter width to reduce the number of passes. Numerous dredges fitting these criteria are on the market. Some have additional features, such as cutterheads capable of following natural contours of the basin bottom without damage to natural or man-made seals, wheel attachments for the cutterhead to allow dredging operations in plastic or rubber-lined basins, and capability of dredging forward and backward. The fluidizing system is needed to supply water from the closest source to maintain flotation of the dredge. Unloading facilities are unnecessary since the dredged material slurry is usually pumped out of the pipeline into a containment area. A schematic of rehandling operations for hydraulic pipeline transport is presented in Figure 3-1. The pipeline to the land improvement site would include a pneumatic or centrifugal hydraulic pump booster system and would be automated to the maximum extent possible.. The following items should be taken into consideration in any planning for pipeline transport:

(a) Slurry movement of saline dredged material to a freshwater environment is not recommended.

(b) Dewatering requirements before a beneficial use application may be a cost burden and may require treatment of decanted water.

(c) Building codes, easement acquisition, utility relocation, climatological factors, and urban area disruption from construction may be obstacles.

(d) Confining dikes must be provided and could be a significant cost item.

(e) Right-of-way acquisition.

(f) Federal, state, and local regulations and requirements.

Real estate and right-of-wayÆ easements are very site-specific items of political as well as economic concern. These items can impact greatly on the cost of hydraulic pipeline system and therefore should be given due consideration in any cost-benefit analysis and in the final cost evaluation. Cost guidelines do not take into account expenses due to the uniqueness of each situation.

(2) Rail haul. Rail haul using the unit train concept is technically feasible and economically competitive with other transport modes for hauling dredged material distances of 50 to 300 miles. A unit train is one reserved to carry one commodity (dredged material) from specific points on a tightly regulated schedule. Facilities are required for rapid loading and unloading to make the unit train concept work and to enable benefits from reduced rates on large volumes of bulk movement. Bottom dump cars or rotary car dumpers are needed to meet the rapid loading and unloading requirement. Economic feasibility demands the utilization of existing railroad tracks; however, the building of short intermediate spurs may be required to reach disposal areas.

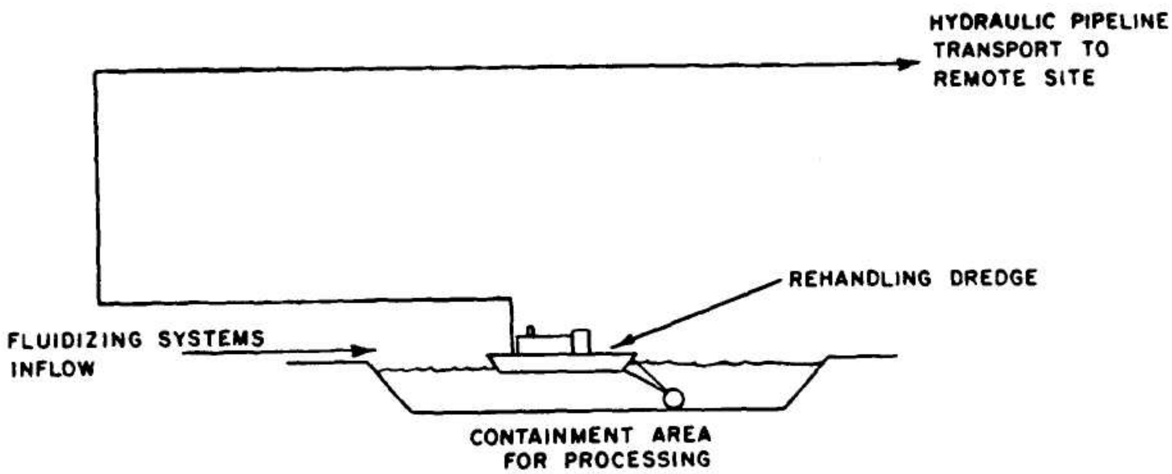

Figure 3-1. Schematic of rehandling system for hydraulic pipeline

Figure 3-2. Tugboat and barge transporting dredged material

The following items should be taken into consideration in any planning for rail haul transport to a beneficial use site:

(a) Dredged material must be dry enough to free-fall from cars.

(b) Scheduling and length of unit trains are often strictly regulated.

(c) State regulations may require open hopper cars to be covered.

(d) Dual use of hopper cars may require washing of cars between use and treatment of wash water to prevent contaminant transfer.

(3) Barge movement. Depending upon the volume of material to be moved, barge movement can be an economically competitive transport mode for the movement of dredged material up to 300 miles. Barge haul was used in the Sacramento District to remove 7 million cubic yards (yd^3) of dredged material from Grand Isle (Figure 3-2). To ensure reasonable costs, a barge unit should consist of familiar and available equipment. In addition, loading and unloading mooring docks capable of accommodating the two cargo scows simultaneously must exist with roadways between the docks and disposal areas to make barge transport practical. The following items should also be taken into consideration:

(a) Thorough information must be obtained about the waterway: navigation depth, allowable speed, lock size, traffic density and patterns, etc.

(b) Often, regulations exist concerning cleanup responsibilities with associated fines for spills in inland waters.

(c) Climatic conditions may affect operational schedules.

(d) A user charge for waterways may become a reality in the future.

(4) Truck haul. Truck haul of dredged material can be economically competitive for distances up to 50 miles. At greater distances, transport by truck is labor- and fuel-intensive and not economically justifiable. The simplicity of loading and unloading requirements and the relative abundance of available roadways make truck hauling technically the most attractive transport mode, and it has wide District application (Figure 3-3). Costs analyses are based on utilizing 25-ton dump trucks with 8.5-yd^3 capacities and assume that routes exist which are adequately upgraded and maintained. Economic feasibility of truck hauling is based on rates established by negotiation with trucking companies and include all associated driver and fuel costs. The following items should also be taken into consideration:

(a) State highway and safety regulations cover a variety of elements (gross weights of trucks, weight per axle, etc.).

(b) Emission and noise standards.

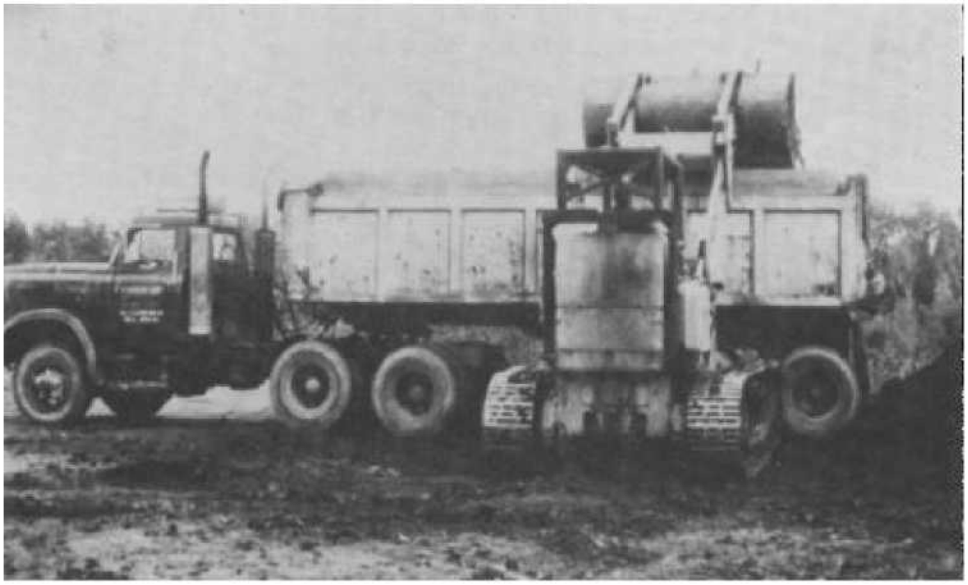

Figure 3-3. Truck haul utilized by the Chicago District

Figure 3-4. A 36-inch belt conveyer loading operation

(c) Local ordinances designating truck routes.

(d) Traffic control of truck operations during winter months in northern climates.

(e) Weight limits on bridges and roadways.

(5) Belt conveyor movement. Belt conveyor systems are employed on a limited basis to transport relatively dry dredged material for short distances. They are technically feasible and cost competitive. Belt specifications vary in width (30 to 70 inches), flight length (900 to 2,600 feet), and speed (7 to 90 miles per hour). Systems can be designed to suit project needs excluding certain terrain difficulties. Because of system flexibility, belt conveyors fit neatly into many loading and unloading operations. The California Highway Department, under an agreement with the Sacramento District, uses dozers and conveyors to load dredged material onto barges (Figure 3-4). The following items should be taken into consideration in any planning for belt conveyor transport:

(a) Building codes, easement acquisition, utility relocation, climatological factors, and urban area disruption for construction may be obstacles.

(b) Material pileup due to system failure.

(c) Malfunctions of sequential belt systems resulting in entire system stoppage.

c. Loading and Unloading Elements. Loading and unloading elements may incur high costs which can restrict project viability. Item 74 presents several examples of loading and unloading options and schematics of scenarios associated with various dry material transport modes; two examples are shown in Figures 3-5 and 3-6. Two other examples include a pair of backhoe excavators and a series of conveyor belts providing rapid loading of unit trains, and a barge haul scheme using backhoes for excavation and loading directly into dump trucks which make the intermediate haul to the scows. In this EM, cost comparisons are based on the loading and unloading component scenarios presented in Item 74. The truck haul loading element components are similar to the rail loading components which include excavation backhoes and a series of belt conveyors. The unloading system is simple back-dumping at the beneficial use site. Placement methods are important, and are discussed in Chapter 5 and other chapters where critical elevations are needed for beneficial use applications.

3-4. <u>Cost Analysis for Dewatering and Transport</u>.

a. Dewatering Costs. Costs associated with dewatering of dredged containment areas are directly related to the degree of trenching effort required and the type of heavy equipment necessary to accomplish dewatering. Thus, the program costs for progressive trenching are highly site-specific depending

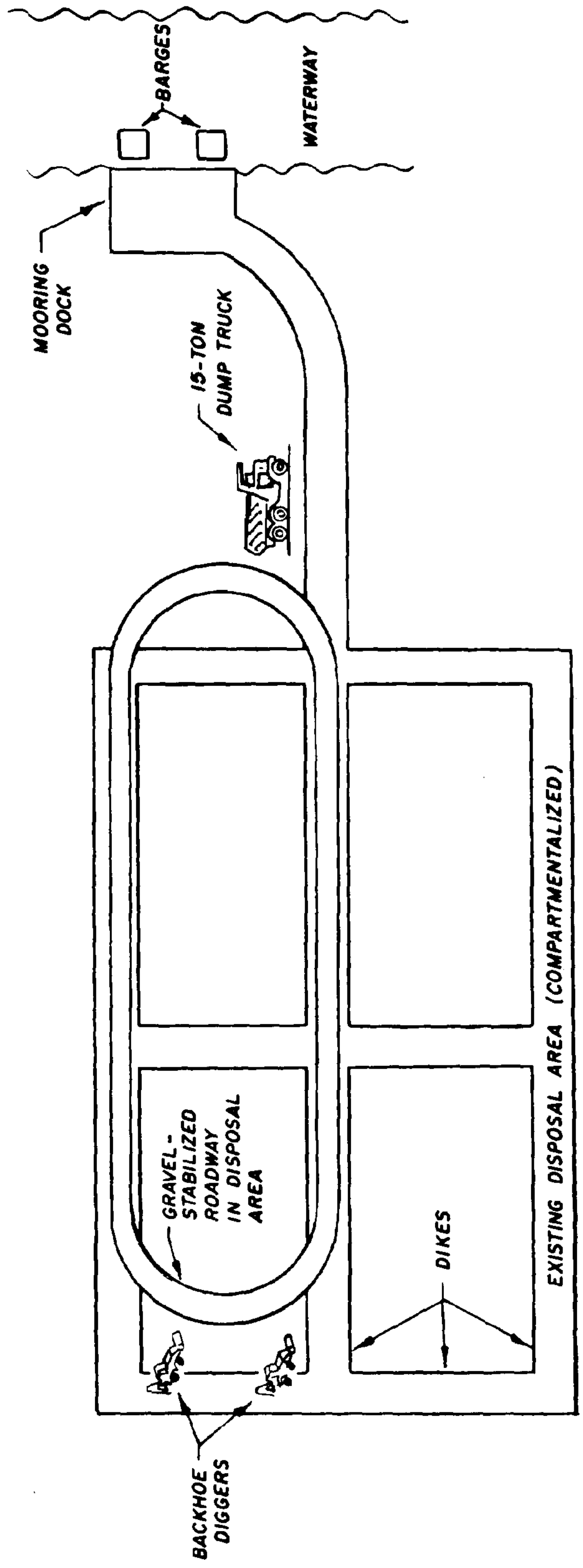

Figure 3-5. Barge loading operation

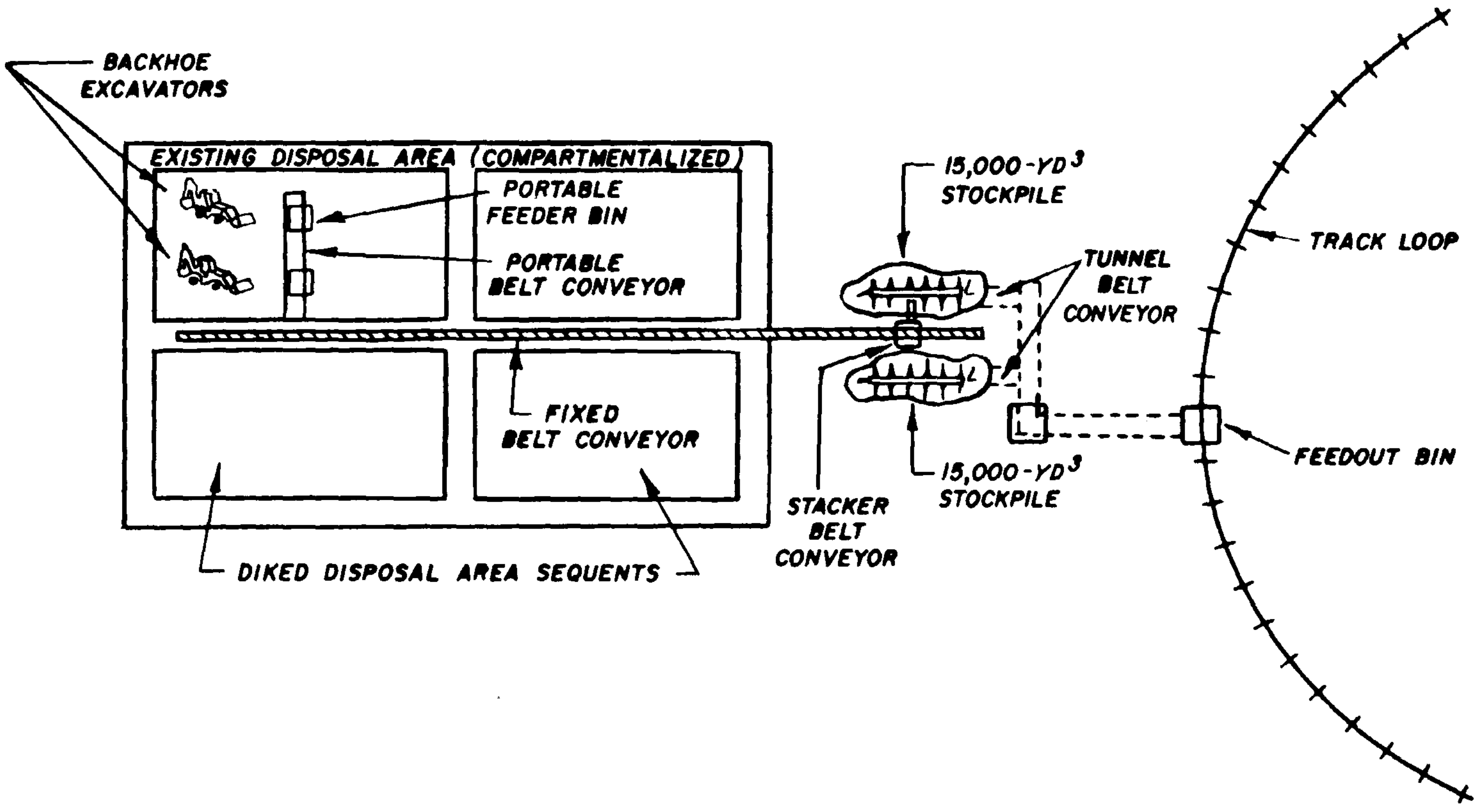

Figure 3-6. Unit train rail loading facility

upon disposal area size, equipment selected, type of access available, and frequency of trenching operations. A preliminary trenching program is developed from crust formation estimates, equipment operational characteristics (from Table 3-1), and trenching cycle intervals (from Table 3-2). Total cost may be estimated from computing equipment operating hours plus factors for nonproductive activities (30 percent is a good estimate), mobilization/demobilization, and administrative costs.

b. Transport costs. Transport cost can account for 90 percent or more of total land improvement and beneficial use budget costs. The cost figures presented in this section are meant to serve as examples for planning and do not represent definitive cost estimates. Table 3-3 is included to provide insight into the cost relationships for various modes of transport. The table provides total system costs for all five transport modes. Transport costs are reported in dollars per cubic yard of dredged material moved. This breakdown shows that economic feasibility is limited by distance for most transport modes. This table also shows the economies of scale for larger annual volumes of material shipped. Real estate and right-of-way costs for the hydraulic pipeline system are not included in the cost-estimating procedure.

Table 3-1

Operational Characteristics of Trenching Equipment

Equipment	Crust Thickness, in., for Effective Operation: Minimum	Crust Thickness, in., for Effective Operation: Maximum	Maximum Trench Depth, in.	Approximate Trenching Rate, lin ft/hour	Approximate Rental Cost* $/hour
RUC	0	12	18	2,000+	75-100
Low-ground-pressure tracked vehicle + rotary trenchers	4	24	24	2,000+	35-45
Small dredge	4	10	30	25	50-75
Amphibious dragline	6	18**	Crust + 18	40	50-70
Small dragline on double mats	12	18	Crust + 18	30	35-50
Medium dragline on double mats	12	18	Crust + 18	40	40-50
Small dragline on single mats	18	24+	Crust + 18-24	50	35-45
Medium dragline on single mats	18	30+	Crust + 18-24	60	40-50
Large dragline on single mats	24	36	Crust + 24	80	45-55

Note: a. Vehicle or mat ground pressure must also satisfy critical layer RCI mobility criteria.
b. Low-ground-pressure tracked vehicle assumed to pull drag plow with point set only 1 or 2 in. below existing crust.
c. More exact definitions of dragline equipment given in text.

* Southeastern United States, 1977.

** Above this crust thickness, conventional dragline is usually more efficient.

\+ Between 24- and 30-in, crust thickness, use single mats.
Increase rates 10 lin ft/hour if dragline is working from perimeter dike.

Table 3-2

Estimated Interval Between Trenching Cycles for Various Equipment Items in Fine-Grained Dredged Material

Equipment Item	Equipment Location in Disposal Area	Initial Condition of Disposal Area Surface	Estimated Trenching Interval
RUC	Interior	Decant point	Each 2 weeks for first month, monthly thereafter
RUC	Interior	Crust ≥ 2 in.	Monthly
Low-ground-pressure tracked vehicle + rotary trencher	Interior	Crust ≥ 4 in.	Monthly
Small dredge	Interior	4 in. < crust – 10 in.	4 months
Amphibious dragline	Interior	Crust ≥ 6 in.	4 months
Conventional dragline	Interior	Crust ≥ 12 in.	4 months
Conventional dragline	Perimeter	Decant point	Monthly for first 3 months, bimonthly for next 3 months, 4 months thereafter
Conventional dragline	Perimeter	2 in. < crust < 6 in.	Bimonthly for first 4 months, 4 months thereafter
Conventional dragline	Perimeter	Crust ≥ 6 in.	4 months

Table 3-3

Comparison of Costs of Various Transport Systems, Quantities, and Distances**

Annual Quantity yd^3	Transport Distance miles	Cost, $\$/yd^3$, for Cited Transport System				
		Pipeline	Rail	Barge	Belt	Truck
500,000	10	2.47	*	2.47	8.98	4.57
	20	3.14	*	3.14	15.15	6.61
	100	9.54	7.18	4.71	*	13.69
	250	*	9.32	7.41	*	*
1,000,000	10	1.46	*	2.92	5.39	3.73
	20	1.91	*	3.14	13.47	4.19
	100	6.45	5.39	4.49	*	12.91
	250	*	7.58	7.18	*	*
3,000,000	10	0.79	*	2.70	2.25	3.17
	20	1.12	*	2.92	3.93	3.56
	100	4.10	4.21	4.49	*	12.35
	250	*	5.34	7.35	*	*
5,000,000	10	0.67	*	2.81	1.68	3.05
	20	0.90	*	2.92	3.14	3.42
	100	3.48	4.04	4.38	13.58	12.07
	250	*	6.06	7.07	*	*

* Indicates not competitive economically.
** These costs were taken from item 57 and are adjusted to March 1978 dollars.

CHAPTER 4

HABITAT DEVELOPMENT

4-1. Definition and Application. Habitat development refers to the establishment and management of relatively permanent and biologically productive plant and animal habitats. The use of dredged material for habitat development offers a disposal technique that is an attractive and feasible alternative to more conventional disposal options. Various habitat development alternatives and their applicability to disposal operations and sites will be discussed in this section. Within any habitat, several distinct biological communities may occur. For example, the development of a dredged material island may involve a wide variety of habitats (Figure 4-1). Four general habitats are suitable for establishment on dredged material:

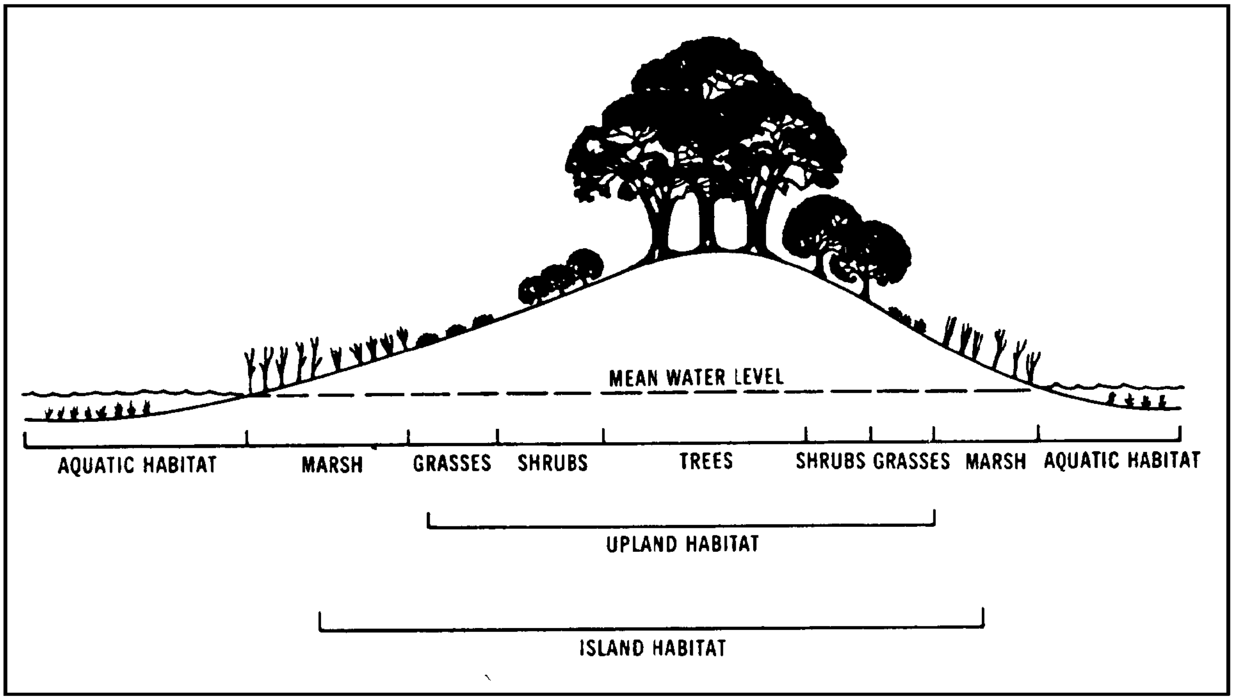

Figure 4-1. Hypothetical site illustrating the diversity of habitat types that may be developed at a disposal site

a. Wetland. Wetland habitat is a very broad category of periodically inundated communities, characterized by vegetation which survives in wet soils. These are most commonly tidal freshwater and saltwater marshes, relatively permanently inundated freshwater marshes, bottomland hardwoods, freshwater swamps, and freshwater riverine and lake habitats.

b. Upland. Upland habitat includes a very broad category of terrestrial communities, characterized by vegetation which is not normally subject to inundation. Types may range from bare ground to mature forest.

c. Aquatic. Aquatic habitats are typical submerged habitats extending from near sea, river, or lake level down several feet. Examples are tidal flats, oyster beds, seagrass meadows, fishing reefs, clam flats, and freshwater aquatic plant beds.

d. Island. Islands are upland and/or high zone wetland habitats distinguished by their isolation and particular uses, and completely surrounded by water or wetlands.

These concepts and their implementation are discussed in detail in items 19, 32, 51, and 72 and in Chapters 5-8 of item 73.

4-2. <u>Case Studies of Selected Habitat Development Sites</u>. Numerous examples of habitat development using dredged material substrates exist; nearly 1,000 are listed in Appendix C and four are presented here to show the diversity of such sites.

a. Buttermilk Sound Salt Marsh.

(1) Buttermilk Sound, a 5-acre intertidal island marsh located in the Altamaha River, Georgia, was created by plantings during 1975-76 on a sandy, infertile dredged material island which had not revegetated since deposition of material a number of years ago. Success of the original plantings was related to the period of tidal inundation and type of propagule. Sprigs were more successful than seeds, and smooth cordgrass was the most successful species planted (item 19).

(2) From the outset, this marsh site has been very successful (Figure 4-2). Since 1979 it has been visually indistinguishable from natural reference marshes. Although tidal scouring initially washed out plantings and eroded the lower part of the intertidal zone, the site quickly stabilized. The established plant community has trapped large amounts of fine material, resulting in a thick layer of silt that now covers the original substrate. Smooth cordgrass dominates the entire lower two-thirds of the intertidal zone. Swards of big cordgrass and saltmeadow cordgrass remain at the middle elevations where they had been planted. The Buttermilk Sound site differs from nearby natural marshes by possessing greater plant species diversity at lower elevations. This is probably due to plant species that were introduced in zones lower than those at which they would naturally occur. Aboveground biomass is similar to natural marshes, but belowground biomass is less. Wildlife use of the marsh is greater than in the natural marshes in all respects, including white-tailed deer, alligators, clapper rails, tern nesting, and migratory shorebird and waterbird use (item 59).

Figure 4-2. Buttermilk Sound habitat development field site, Altamaha River, Georgia, after 6 years of development

Figure 4-3. Salt Pond 3 habitat development field site, South San Francisco Bay, California, after 5 years of development

(3) In 1985, the Buttermilk Sound site continues to represent one of the most successful marshes built by the CE. It appears to be very stable and the marsh area, especially in the upper marsh zone, continues to increase coverage and density to the extent that only one bare sandy spot remains on the entire island. This spot was not shaved down from the original elevation to an intertidal zone, and therefore has been very slow to vegetate.

b. Salt Pond 3 Salt Marsh.

(1) Salt Pond 3, a marsh site is South San Francisco Bay, California, was established on a portion of a 100 acre saltwater evaporation pond that was partially filled hydraulically with clayey dredged material in 1974. It is the only nonisland habitat development site that has been built by the CE. Plantings of Pacific cordgrass and pickleweeds were established during 1976-77. Cordgrass sprigs successfully colonized the lower two thirds of the intertidal zone, and pickleweeds rapidly and naturally colonized the upper one-third (item 59) (Figure 4-3).

(2) The plantings maintained themselves and have spread slowly into adjacent unvegetated areas. Production is somewhat less than in nearby natural marshes, perhaps due to the relatively early stage of site succession. The lower cordgrass zone appears visually equivalent to natural marshes, and the entire 100 acres with the exception of an occasional small mudflat and the tidal channel have become densely vegetated (item 59).

(3) Wildlife use is predominantly by birds, especially shorebirds which feed along the channel, and terns and other waterbirds. Peregrine falcons and other raptors frequent the area and feed on songbirds and rodents in the upper marsh zone. This site appears to be stable and has survived the excessive rainfall and severe storms that pounded the west coast in 1983 without apparent damage. The rainfall actually seemed to improve appearance of the marsh by increasing growth in the upper marsh zone.

c. Gaillard Island Confined Disposal Facility.

(1) Gaillard Island, a new diked disposal island in lower Mobile Bay, Alabama, was built in 1981 by the Mobile District (Figure 4-4). The large, triangular-shaped island is being filled with material from the main shipping channel, and its gently sloped dike is primarily silty clay. Waves come into the island dike from all three sides, and erosion is a continuing problem. In 1981, smooth cordgrass was planted on the northwest dike behind temporary breakwaters made of floating and fixed tire breakwaters. Surviving plantings from 1981 grew and spread behind the breakwater, and more plants were set in 1982 with more breakwater designs and tests. Many of these were thriving in 1983 in spite of severe storms in the area over 1982-83 (item 2). Plantings in 1983 and 1984 were primarily coupled with tests of several filter materials and tire configurations, as well as burlap rolls, different size propagules, and various placements in the intertidal zone.

Figure 4-4. Gaillard Island habitat development field site, Lower Mobile Bay, Alabama, after 3 years of development

Figure 4-5. Bolivar Peninsula habitat development field site, Galveston Bay, Texas, after 6 years of development

(2) On the upland portion of the dike, aerially seeded Bermuda grass now dominates, and it has effectively stabilized large portions of the dike. Diversity of invading plant species is increasing, and this colonization process is expected to accelerate over time. Plant succession is already progressing, as areas that were weedy annuals in 1982 are now perennial grasses. Species diversity and populations of both plants and animals increase with each seasonal data collection period; these have been documented since 1981 and will continue to be noted, at least through 1987 (item 2).

(3) Twenty bird species are now nesting on the island; in 1984, 1985, and 1986 the birds numbered approximately 16,000 each year. Laughing gulls dominated the nesting areas; however, large numbers of seven tern species, black-necked stilts, and black skimmers nested with apparent success. Muskrats colonized the island in late 1985; land birds nested there for the first time in 1984. Brown pelicans are nesting on Gaillard Island, and 1983 marked the first recorded nesting for the species in Alabama in this century. In 1983, two chicks fledged from a single successful nest. In the 1984 summer survey, nests had increased to eight; 133 active nests were observed in 1985. In 1986, there were over 200 active nests by May, with more being built. In addition, large numbers of nonbreeding white and brown pelicans are living year-round at Gaillard Island (item 42).

d. Bolivar Peninsula Upland and Marsh Site.

(1) The Bolivar Peninsula field site is located on Goat Island in eastern Galveston Bay, Texas, and includes both marsh and upland planted areas. The original site is 20 acres of sandy dredged material, protected by a sandbag dike and a fence. It was built by the CE and planted in 1976-77. Both smooth and saltmeadow cordgrasses established well on this site (Figure 4-5). In the upland area, shrubs, trees, and upland grasses initially established well, but invasion by other species eventually crowded them out (item 2). Since initial establishment, smooth cordgrass has spread throughout the lower tidal zone and dominates the site. The saltmeadow cordgrass has spread throughout the upper intertidal zone, and has also spread into the upland section of the site. Saltgrass and pickleweeds have invaded the same zone (item 2).

(2) Oysters had densely colonized the dike area by 1982 and now help serve as a breakwater for the marsh. The site has also been heavily colonized by fiddler and blue crabs and has much fish use during high tide. Wildlife use is quite good; large numbers of sea and wading birds use the site. Small mammals live inside the fence that was once built to exclude them, and a number of ground nesting birds use the site. By 1983, conversion of the upland zone from prairie grasses and woody plants to high marsh plants was complete. Cover on the site is dense, and unless it becomes heavily grazed by ranging feral goats on the island, should remain in that condition (item 59). Clapper rail use is also quite heavy (item 42).

(3) Four adjacent dredged material sites are now being compared on Goat Island: the old site planted in 1976-77; a new deposit (1982) to the west of the old site being planted to test two breakwater designs built of low-cost materials; a second new deposit (1982) on the east side of the old site that is serving as a control; and a part of the old site that was covered with a new application of sandy dredged material in January 1986. Part of the original planting was deliberately covered with dredged material to determine the impacts of smothering, and to determine how rapidly a salt marsh could recover from such disturbance. It will also be compared to a site in East Matagarda Bay where silty dredged material was placed in August 1986 over existing high marsh. Data will be collected on these four areas at least through 1987 (item 42).

(4) The Bolivar Peninsula site survived a direct hit by two hurricanes in 1983 and 1986. The only noticeable change was the washing away of the protective fence in the bay in front of the site. All of the natural marshes with which it was compared were changed by washouts of pockets of marsh that created open-water pockets. These types of washouts did not occur on the field site (item 42).

4-3. Habitat Development Selection Process. The diversity of biological communities indicates the potential diversity of alternatives available under habitat development. This wide range of options will usually make using quantitative measures for selecting specific alternatives impractical, and consequently, selecting a given habitat development alternative is likely to be highly judgmental. The best determination will be made by a combination of local biological and engineering expertise and public opinion. Guidelines for the evaluation of individual habitat development situations are summarized below.

a. Conditions Favoring Habitat Development.

(1) The selection of habitat development as a disposal alternative will be competitive with other disposal options and types of beneficial uses when one or more of the following conditions exists:

(a) Public/agency opinion strongly opposes other alternatives.

(b) Recognized habitat needs exist.

(c) Enhancement measures on existing disposal sites are identified.

(d) Feasibility has been demonstrated locally.

(e) Stability of dredged material deposits is desired.

(f) Habitat development is economically feasible.

(g) Extensive quantities of dredged material are available.

Since disposal alternatives are often severely limited and constrained by public opinion and/or agency regulations, with constraints on open-water and other sites, disposal habitat development will be an attractive alternative, and in many cases will have strong public appeal. The need for restoration or mitigation or the need for additional habitat may strongly influence the selection of the habitat development alternative. This is particularly applicable in areas where similar habitat of considerable value or of public concern has been lost through natural processes or construction activities, such as at Pointe Mouillee in Lake Erie. Habitat development may be used as an enhancement measure to improve the acceptance of a disposal technique. For example, seagrass may be planted on submerged dredged material, or wildlife food plant established on upland confined disposal sites. Habitat development has considerable potential as a low-cost mitigation procedure and may be used to offset environmental impacts incurred in disposal.

(2) The concept of habitat development is more apt to be viewed as a feasible alternative if it has been successfully demonstrated locally. Even the existence of a pilot-scale project in a given locale will offset the uncertainties often present in the public and in resource agencies' perception of an experimental or unproven technique. The vegetation cover provided by most undiked habitat alternatives will generally stabilize dredged material and prevent its return to the waterway. In many instances this aspect will reduce the amount of future maintenance dredging necessary at a given site and result in a positive environmental and economic impact.

(3) The economic feasibility of habitat development should be considered in the context of long-term benefits. Biologically productive habitats have varied but unquestionable value (i.e., sport and commercial fisheries) and are relatively permanent features. Consequently, habitat development may be considered a disposal option with long-term economic benefits that can be applied against additional costs that may be incurred in its implementation. Habitat development may be particularly economically competitive in situations where it is possible to take advantage of natural conditions or where minor modifications to existing methods would produce desirable biological communities. For example, the existence of a low-energy, shallow-water site adjacent to an area to be dredged may provide an ideal marsh development site and require almost no expenditure beyond that associated with open-water disposal. Actual dollar values assigned to habitat development has been a controversial topic of discussion among scientists for a number of years. All agree that it has to be done, and that such sites are highly valuable; none agree on valuation estimates.

b. Guidelines. Habitat development presents several options ranging from establishment of upland communities to the development of seagrass meadows. A broad procedural guide to the selection of the habitat development alternative is given in Figure 4-6. The beneficial use planner should ignore categories unrelated to the particular problem, and may wish to add key site specifications.

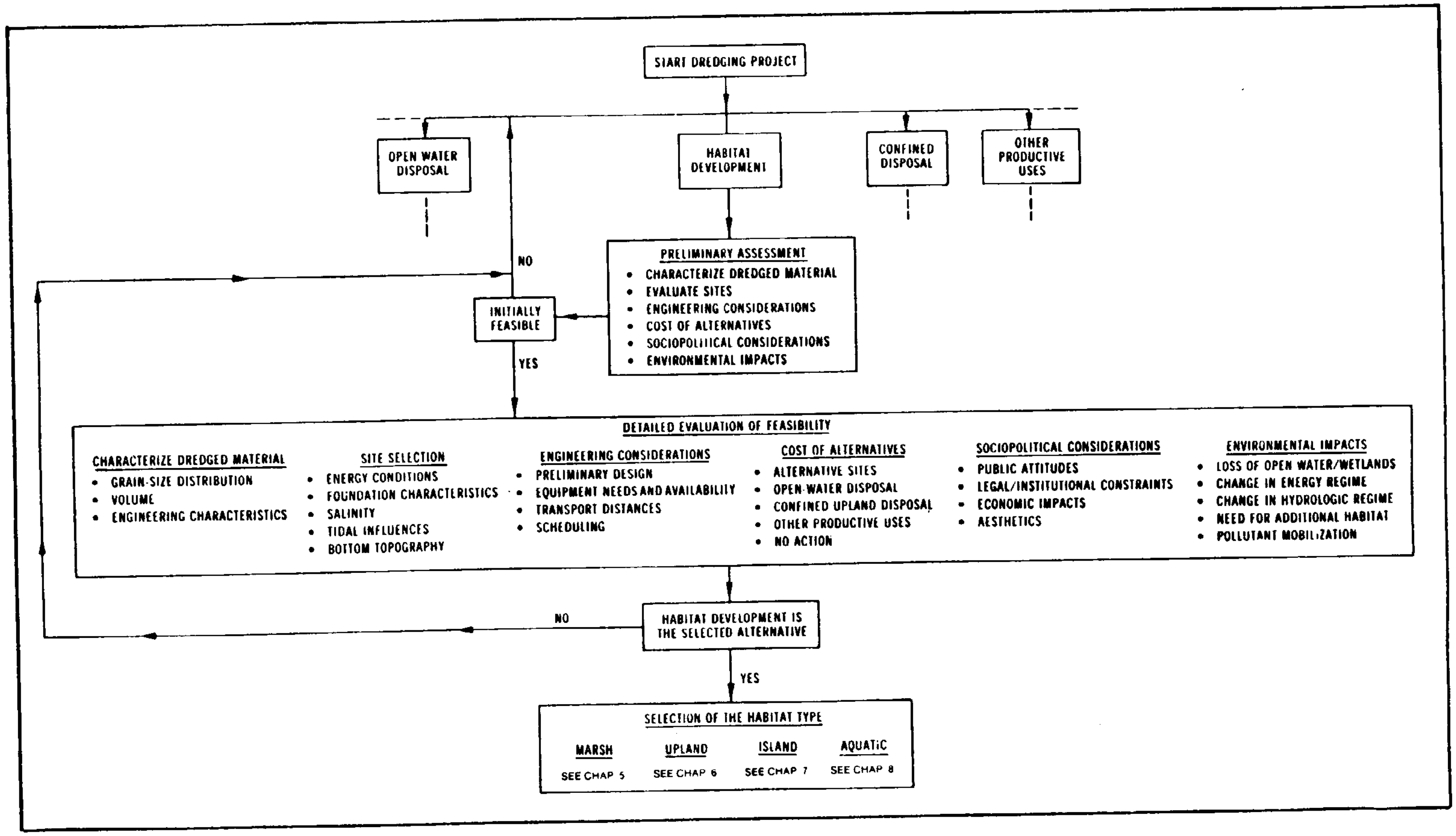

Figure 4-6. Procedural guidelines for selection of habitat development alternatives

(1) Preliminary assessment. The initial consideration of habitat development as a disposal alternative should include a preliminary assessment of feasibility, which involves judgment based on available data. A determination that habitat development is not initially feasible should be based on compelling negative evidence and not merely on a lack of information or specific precedents. In the absence of such negative evidence, one should proceed to the detailed evaluation of feasibility. Factors may arise at several stages in the evaluation that would lead to a determination of infeasibility. Should that occur, other disposal alternatives would be reconsidered.

(a) The detailed evaluation of feasibility includes six major categories beginning with a characterization of the dredged material and arranged generally in the order of need for acquisition of information. In characterizing the dredged material, the physical, chemical, and engineering characteristics of the material to be dredged should be determined. These properties will help define the general considerations of site selection.

(b) Site selection should be based on an adequate knowledge of energy conditions, foundation characteristics, salinity, tidal influences, and bottom topography. Energy conditions will largely influence the feasibility of establishing a stable substrate, or the necessity of protection structures. Foundation characteristics will determine the ability of a given site to support construction activities or structures. Salinity and tidal influences will dictate the plant species composition. A more detailed analysis of these factors will be necessary later for detailed design purposes if the habitat development alternative is selected, but even in this early phase, some field sampling may be necessary if general information is not available.

(c) Engineering considerations at this stage are largely confined to preliminary designs and an assessment of equipment needs and availability. Details such as scheduling to meet critical environmental dates (e.g., spring or summer planting times) and the identification of dredged material transport distances will provide useful planning data. In many projects, the pivotal determination of engineering feasibility or infeasibility can be made at this stage.

(d) Evaluation of the cost of alternative disposal methods is the next essential step. In a number of CE Districts, this is the first step in assessment. Detailed economic analyses must await the further development of design criteria; however, a general cost comparison of the various alternative sites should be possible at the completion of the preliminary assessment of feasibility. This is another critical step because considerable time and effort can be spared by defining the economic limits that the project must satisfy to remain competitive with other alternatives.

(e) Of the sociopolitical considerations, public attitudes and legal and institutional constraints are most likely to prove limiting. Negative public attitudes generally occur when the community views the proposed habitat as a threat to established values. Legal and institutional constraints frequently arise when there are unanswered questions of ownership and access or when local interests have designated the site for an alternative future use. Direct economic impacts may be identified if the habitat to be developed may alter important shellfishing or recreational areas or block a water view.

(f) The environmental impact of most habitat development projects may be expressed as a loss of open-water habitat or wetland systems and changes in hydraulic and energy regimes. The impacts of these factors tend to be cumulative and are directly related to the perceived need for additional habitat. In general, the need for more habitat is considered more critical in areas that have lost or are losing considerable habitat of that type. Pollutant mobilization by plants growing on contaminated dredged material might be of concern, and its potential should be determined prior to habitat development.

(2) Selection of habitat development as an alternative. Upon completion of the preliminary assessment of feasibility, a determination can be made whether habitat development is applicable. If habitat development is a selected alternative, a decision regarding the type or types of habitats to be developed must be made. This decision will be largely judgmental, but in general, site peculiarities will not present more than one or two logical options. Specific advantages and disadvantages likely to be encountered are evaluated, and items of particular concern during early feasibility determinations are highlighted in Chapters 5, 6, 7, and 8.

CHAPTER 6

UPLAND HABITATS

6-1. General. Upland habitats encompass a variety of terrestrial communities ranging from bare soil to dense forest. In the broadest interpretation, upland habitat occurs on all but the most disturbed disposal sites. For example, a gravelly and bare disposal site may provide nest sites for killdeer or tern species; weedy growth may provide cover for raccoons or a food source for seed-eating birds; and water collected in desiccation cracks may provide breeding habitat for mosquitoes. The essential fact is that man-made habitats will develop regardless of their management; however, the application of sound management techniques will greatly improve the quality of those habitats (item 72)

6-2. Upland Habitat Development Considerations. Upland habitat development has potential at hundreds of disposal sites throughout the United States. Its implementation is largely a matter of the application of well-established agricultural and wildlife management techniques.

a. Advantages. Upland habitat development as a disposal alternative has several distinct advantages:

(1) Adaptability.

(2) Improved public acceptance.

(3) Creation of biologically desirable habitats.

(4) Elimination of problem areas.

(5) Low-cost enhancement or mitigation.

(6) Compatibility with subsequent disposal.

The principles and applications of this alternative are adaptable to virtually any upland disposal situation. Regardless of the condition or location of a disposal area, considerable potential exists to convert it into a more productive habitat. Small sites in densely populated areas may be keyed to small animals adapted to urban life, such as seed-eating birds and squirrels. Larger tracts may be managed for a variety of wildlife including waterfowl, game mammals, and rare or endangered species. The knowledge that a site will ultimately be developed into a useful area, be it a residential area, a park, or wildlife habitat, improves public acceptance. Many idle and undeveloped disposal areas that are now sources of local irritation or neglect would directly benefit from upland development, and such development may well result in more ready acceptance of future disposal projects. Upland habitat development will usually add little to the cost of disposal operations. Standard procedures may involve liming, fertilizing, seeding, and mowing. A typical level of effort would be similar to that applied for erosion control at most construction sites and considerably less than that encountered in levee maintenance. Unless the target habitat is forest, this type of habitat will generally be compatible with subsequent disposal operations. In most situations, a desirable vegetative cover can be produced in one growing season. Subsequent disposal would simply require recovery of the lost habitat. Indeed, the maintenance of a particular vegetation stage may require periodic disposal to retard or set back succession (item 73).

b. Disadvantages. The disadvantages of upland habitat development are potential public opposition to subsequent disposal and possible necessity of long-term management. The development of a biologically productive area at a given site may discourage subsequent disposal or modification of land use at that site. This problem could be avoided by the clear identification of future plans prior to habitat development, or by the establishment and maintenance of biological communities recognized as being most productive in the earlier stages of succession. In the latter case, subsequent disposal may be a necessary management tool. Some habitat types will require management. For example, if annual plants such as corn are selected for establishment, then yearly planting will be necessary. If the intent is to maintain a grassland or open-field habitat, it may be necessary to mow the area every 2 to 5 years to retard woody vegetation. In most cases, it will be possible to establish very low maintenance habitats, but if the intent is to establish and perpetuate a given habitat type, long-term management will be essential and may be expensive.

6-3. Guidelines for Upland Development.

a. Upland Habitat Needs and Assessments. Those upland habitats in limited supply should be identified and the opportunity for additional habitat assessed. Public attitudes are of particular consequence in the implementation of this alternative, and public opinion should be actively sought. Site selection should be made with a particular target habitat in mind as the importance of other habitats will be greatly influenced by the needs and attributes of the surrounding area. The chemical and physical properties and the relative quantities of different types of dredged material should be evaluated to determine the characteristics of the soil to be used in the habitat development. Several remedial treatments are possible. For example, it may be possible to improve the agricultural characteristics of the surface layer by top dressing the site with material selected for its agronomic characteristics. It may also be possible to bury a problem soil by capping it with a layer of clean material.

b. Planning and Design.

(1) Assuming that upland habitat development has been selected as a disposal alternative or as an enhancement measure, habitat planning and design guidelines are indicated in Figure 6-1. The criteria discussed under site

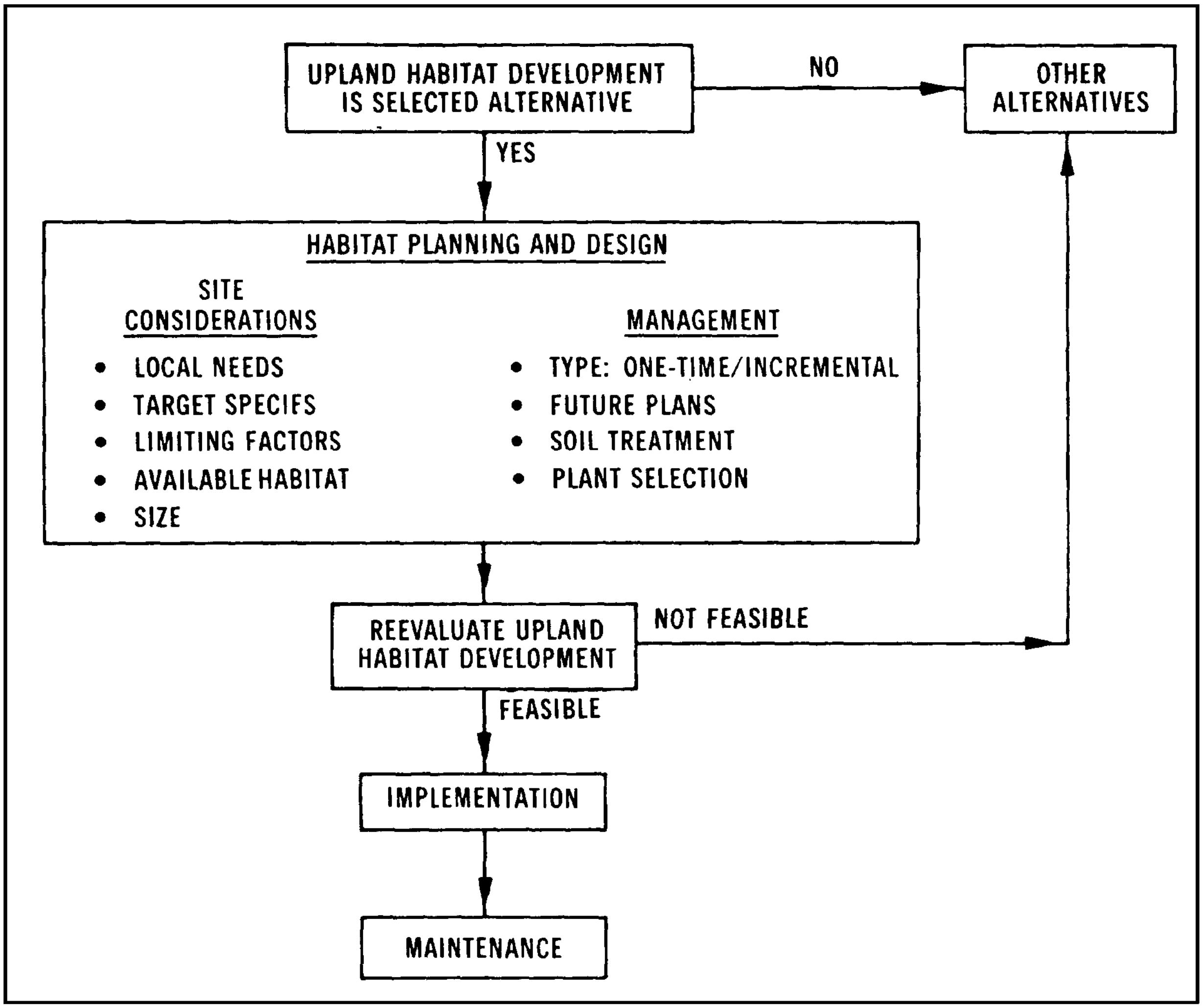

Figure 6-1. Procedural guidelines for selection of upland habitat development

considerations are applicable regardless of whether the site is a new or previously used disposal area. Local needs and thereby target wildlife species will be determined primarily by the desires of state wildlife agencies and those of the public. These needs are likely to reflect local perception of the value of wildlife. If the area has a strong hunting tradition, the emphasis may be on game animals. If there is strong agency concern for an endangered species, that may be the emphasis. In many cases, a target species per se will not be identified. Rather, a grouping such as "songbirds" or "small game" will be designated. The list of target species must be evaluated in light of the available habitat surrounding the site and the size of the disposal site. The size of a disposal area will seldom be large enough to exert a significant impact on regional animal populations if it only duplicates existing habitat types. Therefore, the success of the site will usually be determined by its ability to enhance surrounding habitats or remedy limiting environmental factors.

(2) Basic management decisions will depend on the type of disposal and future plans at the site. If one-time disposal with periodic maintenance is planned, the management plan may be quite flexible. One-time disposal without management indicates the need to establish a plant community that is relatively self-sustaining. If periodic disposal is planned, plant communities that are rapidly functional are advised. Properly planned, periodic disposal could be considered a wildlife management option used to control succession or diversify the habitat and avoid confrontation regarding subsequent activities. Future plans for any habitat development site should be well documented and understood by interested agencies and the public prior to implementation.

(3) Soil treatment and plant selection are closely related and can proceed after determination of the type of disposal, identification of the characteristics of the dredged material, and determination of target species have been completed. Soil treatment may include a variety of activities such as burying problem materials, dewatering, mixing materials to obtain improved soil characteristics, leaching, fertilization, and liming (Figure 6-2). Plant selection will be dictated by soil conditions and habitat preferences. In many situations it will be possible to identify highly desirable natural plant communities near the disposal area. Development of site conditions (soil, elevation, diversity) on dredged material that are similar to those of desirable plant communities will encourage natural invasion and natural development of similar communities. When this is possible, a considerable savings in planting and maintenance costs may be realized.

c. Reevaluation and Implementation. If, upon reevaluation, the upland habitat development alternative remains feasible, the project may be implemented and subsequently maintained. Implementation will be highly site specific but should present few difficulties beyond the problems typically encountered in contracting new or unusual work. Advice from local wildlife biologists and soil scientists may prove invaluable in this stage.

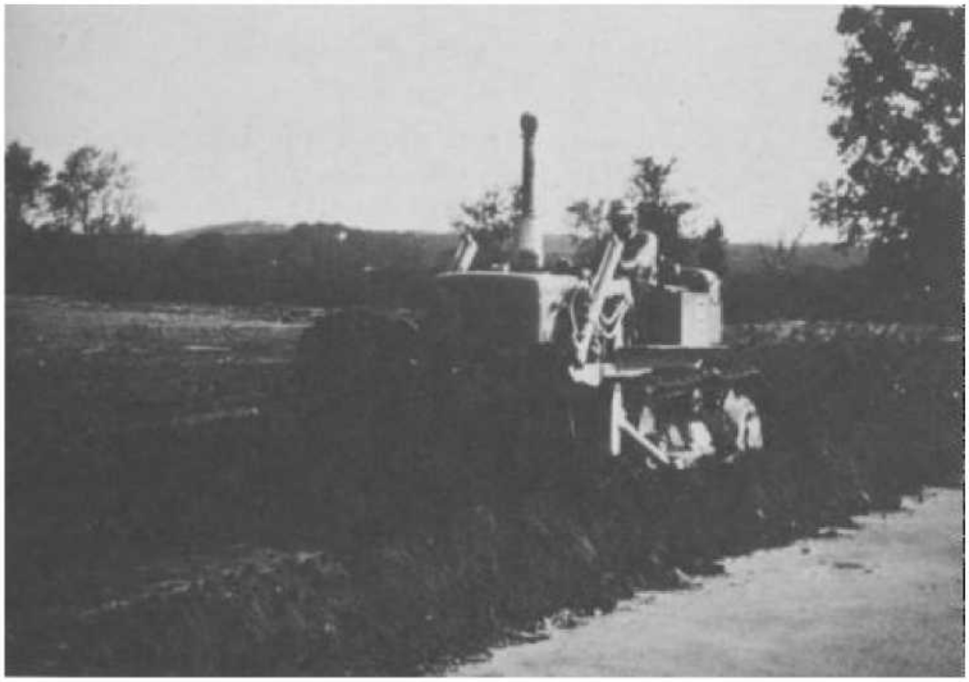

Figure 6-2. Mixing layers of silty and sandy dredged material at Nott Island upland site, Connecticut River, Connecticut

6-4. Upland Site Development.

a. Site selection. Two types of upland habitat development sites have potential beneficial use: older, existing sites where habitat development and enhancement occurred, and planned sites where upland habitat development is part of the project goal. In both cases, several factors determine selection of the best possible site: availability, disposal need capacity, proximity to dredging area, physical and engineering characteristics, environmental and social acceptability, tidal and current considerations, and habitat development feasibility.

b. Site characterization. After the upland disposal site has been selected for development, field and laboratory investigations of the site and related areas should be initiated. If the site is an older disposal area to be reclaimed, it and the surrounding area should be evaluated physically and biologically to assess its potential for habitat development and determine necessary action. If dredging and disposal operations are involved, it will be necessary to add information related to the site's capacity, need for and design of a protective or retention structure, and construction details. This information should be collected in conjunction with characterization of the sediments to be dredged. Physical, biological, socioeconomic, and engineering tests should be made to determine site suitability (items 32 and 62) and acceptance. Target wildlife species should be identified, and other potential upland objectives such as site stability and multiple habitat use should be considered.

c. Vegetation establishment. Since upland habitat is developed primarily for wildlife and less often for erosion control, it is important to key in on target species that will use the disposal site. An excellent example is the Nott Island site in the Connecticut River, Connecticut, where a mixture of grasses and legumes was planted as a nesting and grazing meadow for waterfowl, deer, and small mammals (Figure 6-3). Although an animal's habitat consists of a wide variety of components, vegetation is by far the most important. Vegetation growth form, height, density, placement, diversity or uniformity, seasonal changes, biomass, and hardiness strongly influence species composition, abundance, and well-being of wildlife. Secondary objectives of recreation, aesthetics, erosion control, and soil quality also depend in part on

Figure 6-3. Nott Island habitat development site, showing the planted nesting and grazing meadow after 5 years of development

vegetation. These relationships make it necessary to begin consideration of the ultimate vegetation of the site early in the planning process. Three methods of upland vegetation establishment exist: allowing natural plant invasion and establishment, planting selected species, and combining natural establishment with planned propagation.

(1) Natural invasion and establishment. The ability of propagules to reach the upland site is the most important factor in describing the potential for natural colonization on dredged material. This ability increases as the distance from a propagule source decreases and as the size of the site and ease with which the propagule can be transported increase. Propagules may be transported over a distance by wind or water; by attaching themselves to an animal's fur, feathers, or feet; by being ingested and excreted by an animal; or by attaching to a human. Secondary factors in the potential for natural colonization include physical and biological features of the site itself. Plants growing and reproducing on the site will reestablish after deposition of dredged material if the deposit was not too thick and if new substrate conditions are not prohibitive. Plants growing and reproducing near the area will establish only if seeds blow or are carried onto the site, if rhizomes or other vegetative reproduction forms extend onto the site, and if the new substrate conditions are not prohibitive.

(2) Planting selected species. Standard practices in agronomy are usually sufficient to handle plant propagation on upland sites. With appropriate planning and management, any site can be vegetated within a few years and most sites within a year. Planting upland sites ensures that desirable vegetation grows there, that substrates stabilize rapidly, and that aesthetic appearances of disposal sites improve faster. The chief disadvantage over natural invasion is the cost involved with site preparation and plant propagation and establishment.

(3) Combining natural establishment and planting. A combination of the two methods of vegetation establishment may be beneficial. Allow invasion to stabilize the substrate and start modifying the sediments, then plant a different type of vegetation when the season or timing or soil conditions are more suitable. The reverse also is possible: to get immediate benefits of selected plantings, plant the site, then allow the site to proceed in natural successional stages. Also, use subsequent deposits of dredged material to set back vegetation succession to a more desirable stage.

d. Selecting Plant Species and Propagule Type.

(1) Selecting plant species.

(a) If the site is to be planted, advance consideration must be given to the plant species that will create the desired habitat for the target wildlife species. An initial selection of species should be made during the planning phase, even though once the site is established, alternate species may prove to be more acceptable and be substituted for those originally selected (item 32). Numerous species are suitable for planting upland dredged material sites (item 39). Item 13 identifies, by state, 250 species or species groups that are of benefit to wildlife and adapted to grow on dredged material and presents species growth characteristics, habitat requirements, ranges, and tolerances of 100 of these. Item 45 identifies 50 species generally useful for dewatering and decontaminating dredged material. Item 54 gives growth characteristics of many tree and shrub species suitable for confined upland disposal areas. Items 12, 39, and 73 summarize data on plants known to grow on dredged material sites.

(b) Other species of more local character are available, and many species with unknown tolerances and adaptability may prove useful after field testing. Local soil conservation service personnel and agronomists will be able to provide updated information on species and new varieties. Selection of species or species mixtures to be planted at a particular disposal site must include consideration of project goals, climate, substrate characteristics, plant species characteristics, plant species availability, ease of propagation, management requirements, and costs. Certain species mixtures are commonly planted, such as a clover and a grass species, to take advantage of the different properties of each. Occasionally the mixture will not be successful because of interactions among the species and because the soil is too acidic, infertile, or compacted.

(2) Selecting propagule type. Items 32 and 39 give the best propagule types for selected plant species, based on criteria of availability and cost, ease of collection and handling, ease of storage, ease of planting, occurrence of disease, and need for rapid vegetation establishment. In general, seeds are cheaper and easier to work with than vegetative propagules such as cuttings, sprigs, or seeding in upland habitats. However, some plant species and planting situations require vegetative propagules, e.g., to rapidly stabilize the exterior of a sand dike.

(3) Handling plant material. If commercial seed sources are not available, collection and storage of wild seeds should follow the guidelines in item 32. Some desirable species are available as transplants (potted, balled and burlapped, or bare-rooted nursery stock). However, many upland plants that are desirable as long-term cover and food sources, such as trees and shrubs, are not commercially available.

e. Preparing and Planting the Site.

(1) Substrate modification. Once the dredged material has been placed and dewatered sufficiently to allow equipment access, it can be modified as necessary. Modifications will usually be directed toward preparing the substrate for vegetation establishment, and will depend on the condition of the substrate and the exact design of the project. In upland habitats, these activities are largely agronomic.

(a) Mechanical modification. The site may require grading to change the topography that resulted from disposal, e.g., to make the slope uniform by removing depressions or mounds, increase relief by making depressions or mounds or altering the slope, make islands, or raise low spots. Variation in texture of the sediments results either intentionally by disposal of more than one type of material or naturally through hydraulic sorting during disposal. This variation may need to be reduced to a more uniform soil for ease of seedbed preparation. This can be done by repeated passes with a blade or deep plowing followed by disking. If possible, grading should be done at the time of year when precipitation is lowest to reduce erosion of the bare soil. Seedbed preparation includes plowing or disking one or more times to break up clumps and aerate the soil, fill or cover desiccation cracks, even out moisture content, destroy unwanted vegetation that may have invaded, turn under green manure, incorporate soil amendments, and in general improve the quality of the substrate. Preparation is best done several months prior to planting and again just before planting, if labor and equipment are available. Success of the site may depend especially on this process.

(b) Chemical modification. Prior to final mechanical seedbed preparation (preferably several weeks to months ahead), the substrate at the site should be sampled and the soils analyzed chemically in the same fashion as for site characterization. Their properties may have been altered by dredging and dewatering from what they were in the initial tests. Some of the common problems that may be found include high salinity levels, soil acidity or alkalinity, or lack of one or more of the essential plant nutrients at levels sufficient to support good plant growth. These can be corrected with soil amendments, leaching, or other techniques (item 32).

(c) Biological modification. Biological modification of the substrate may also aid in the success of the project. This could include such things as removal of existing and competitive vegetation by cutting, short-lived herbicide application, or cultivation; growth of a preliminary green fertilizer crop; or addition of farmyard manure, sewage sludge, etc., on light-textured sands to improve their nutrient- and moisture-holding capacity. If legumes are to be grown on the site, the seed should be inoculated with the proper strain of <u>Rhizombium</u> bacterium to improve chances of fixing adequate amounts of atmospheric nitrogen.

(2) Timing. Timing of all factors related to plant establishment is an important consideration in habitat development. Adequate planning will have allowed lead time to locate, obtain, and prepare sufficient amounts of viable seeds or vegetative propagules, including any period of seed dormancy. Timing of planting will strongly influence plant success. For example, seeding warm weather annuals before the last cool period in spring will result in heavy crop damage, and seeding the same seeds in midsummer will result in heat and drought stress during sprouting. Seeding of cold weather species too early in the autumn will result in sporadic germination, increased chances of insect infestations such as army worms, and heat and drought stress. Optimum seeding times vary with climatic regions and photoperiods, and local agronomic authorities should be consulted before planting. Refer to items 32 and 39 for species-specific details on timing.

(3) Planting.

(a) Temperature. Vegetative propagules may be planted any time the ground is not frozen and any time the day temperatures average less than 68°F.

In general, March to May is best for warm weather plants and September to November for cold weather plants over most of the United States. In the Deep South, transplanting is usually done successfully from October through May, with June through September being too hot. Dormant propagules may be more readily transplanted in winter months. Propagules held in storage inside a nursery or greenhouse should not be planted until temperatures at the field site are at least as warm as the storage area, to lessen shock. Propagules held in a shady area should be gradually acclimated to sunny conditions if the site is in the sun, to prevent blistering and death of leaves and plant shock. General planting methods are given in Items 32 and 39; specific recommendations for local conditions can be obtained from the Soil Conservation Service or county extension service agents.

(b) Methods. Methods of planting vary with the propagule type. Seeds should be sowed in a well-prepared seedbed that has been plowed and/or disked to a depth of at least 6 inches. It is important to consider planting techniques and equipment, seeding rates and depths, and seed and soil treatments when using seed propagules. For transplants, types of propagules, planting techniques and equipment, transplant spacings, timing of planting, plant growth habits, and long-range project goals are all important factors in determining site success (item 32).

6-5. Engineering Design of Upland Sites. Guidelines for substrate design and sediment protection and retention apply to both a new disposal area or one that may already have a retention structure and some material placed. Design should be based on information gathered during the site description, on results of field and laboratory tests, and on the requirements for the planned habitat development. The majority of the information in this section was compiled from items 17, 32, and 62. Dredged material may be placed by either hydraulic or mechanical methods. The hydraulic pipeline dredge is the most commonly used and will continue to be the major source of dredged material to be used for upland habitat development. Hydraulic transport of material assumes additional prominence when one considers that the newer concepts for dredged material handling systems, involving direct pumpout of hopper dredges, temporary containment basins, or bucket-loaded scows, usually involve final disposition by pipeline. The pipeline dredge can dispose of material in upland areas through the use of shore lines or shallow-draft floating pipelines.

a. Substrate Design.

(1) Elevation. Substrate design for upland habitat development includes determination of site elevations, slope, orientation, configuration, and size (area and volume). The design must provide for placement of dredged material to a stable elevation within the desired elevation limits, allowing for settlement due to consolidation of both the sediments and foundation material. For fine-grained sediments, the substrate must be designed to provide adequate surface area and retention time for sedimentation of suspended solids. Procedures for substrate design generally follow those established by

items 56 and 62 for the design of conventional containment areas. The determination of substrate elevation is governed by two limitations: the project requires placement of a given channel sediment volume, and the size to handle this volume within elevation limits must be determined; or the project requires a substrate to be constructed within given size limits, and the volume of channel sediment to construct this substrate must be determined. In either of these cases, a correlation between in situ sediment volumes and volumes occupied by the dredged material must be determined. The first step is to calculate void ratios by determining water content of samples of the sediments to be dredged. The second is to compute the void ratio of the dredged material after dredging and deposition (items 56 and 62).

(2) Sedimentation of solids. Confined disposal areas with primarily fine-grained dredged material should be designed to retain solids by gravity sedimentation during the dredging operation. Solids retention is directly affected by the size of the confinement area (particularly length and depth), inflow rate (dependent on dredge size and operation), physical properties of the sediment, and salinity of the water and sediments. Items 56 and 62 detailed separate design procedures for determining sediment retention time requirements for fresh and saline sediments with continuous disposal. In addition, these procedures include factors influencing efficiency of the substrate containment, effects of short-circuiting, ponding depth, weir placement, and shapes of containment. In the event that substrate containment does not provide an adequate gravity sedimentation basin, then one of the following alternatives must be exercised:

(a) The size of the site must be increased.

(b) A smaller dredge must be used.

(c) Intermittent dredging and/or disposal operations must be initiated.

(3) Weir design. Retention structures used to confine dredged material must provide a means of releasing carrier water back into the waterway, which is best accomplished by placing a weir within the containment area. Effluent quality can be strongly affected by the design and operation of the discharge weir, with the weir length and ponding depth having the greatest control on this quality. Item 82 developed a design procedure for defining weir length and ponding depth to minimize the discharge of solid particles into the waterway.

(4) Dredged material settlement. Settlement will occur following completion of the dredging operation because of the self-weight consolidation of the dredged material layer and/or the consolidation of compressible foundation soils. Estimated settlements may be determined by procedures presented by item 62. Once loading conditions are determined, ultimate settlements that occur after the completion of 100-percent primary consolidation can be estimated from laboratory consolidation data. This settlement is not as critical as for wetland habitats, but is important because of the ponding effect it

causes. Time rates of consolidation for both the dredged material and foundation soils are required to determine the relationship between the desired final substrate elevation and time. If the data from the laboratory tests reveal that settlement will not meet desired elevation requirements, an adjustment to the substrate configuration must be made to raise or lower the initial substrate elevation as required.

b. Substrate Protection and Retention.

(1) Requirements for a structure. Data gathered for the site description should be used to determine if a protective or retention structure will be needed for the upland site. Engineering data collected at a specific site should determine: amount and character of material to be protected or retained, maximum height of dredged material retained above the firm bottom, degree of protection from waves and currents required, duration of the structure, foundation conditions at the site, and availability of construction material. All habitat development sites may require a structure for protection of the perimeter from erosion caused by currents, waves, or tidal action. Particular concern should be given to the effects of any proposed structure on existing current or wave patterns. A structure positioned so that it constricts the water flow will increase local current velocities or reflect wave energies, and thus may encourage erosion. All habitat development sites may require structures for retention of the dredged material to allow it to consolidate, to control the suspended solids content of the effluent, or to protect surrounding habitat or adjacent structures. Site hydraulics, the properties of the sediment to be dredged, the time over which disposal will occur, and the existing site characteristics are closely interrelated in determining the need for such structures.

(2) Selection of structure. The protective or retention structure should meet four conditions:

(a) Suitability to the project goals of dredged material disposal and habitat development.

(b) Practicality and ease of construction.

(c) Ease of maintenance.

(d) Reasonableness of cost.

Item 17 evaluates several protective and retention structures considered technically feasible for use in terrestrial habitat development and presents information on structure selection, applicability to specific site conditions, and conceptual procedures for design and construction. The most feasible structures are often dikes constructed from filled fabric bags or from sand in moderate to low wave-energies in temperate climates (item 17). The term "fabric bag" covers products from several producers of sacklike containers that can be filled with sand, sand-cement, or concrete and used as building blocks for breakwaters, groins, revetments, or containment dikes. Rock and rubble from new work dredging can also be used.

(3) Design of structure. EM 1110-2-1902 and EM 1110-2-2300 provide proven methods for design and construction of earth- and rock-filled structures. Those procedures should be used to supplement engineering considerations of elevation requirements and earth and water pressure forces. Internal structures may be advisable. Cross and spur dikes are used to control circulation within a disposal area, with the cross dike commonly employed to divide large disposal areas into smaller cells, and spur dikes employed to interrupt direct slurry routes between the inlet and outlet. The cross dike is the more significant of the two structures for habitat development purposes, since use of a cross dike allows flexibility in disposal including incremental filling and separation of dredged material by grain size. (See Figure 15-2, Chapter 15, for riprapped structures and cross dikes used at an upland habitat site.)

(4) Construction of structure. Site-specific factors affecting construction techniques are: equipment accessibility, wave and current conditions, tidal range, water depth, bottom conditions, and distance from the dredging site (item 17). The construction material used and method of construction are significant factors. In addition to the fabric bags previously discussed, three basic types of retention structure construction exist: hauled dikes, cast dikes, and hydraulically placed dikes (item 30). Construction techniques for retaining walls, sills, breakwaters, gabions, and other structures are highly site specific and should be determined on a case-by-case basis (item 30).

6-6. Ecological Design of the Upland Sites. Planning for a habitat development site should be based on sound ecological principles and should attempt to make efficient use of available resources in reaching the goal. The two major resources that can be manipulated for habitat development are substrate (in this case, dredged material) and vegetation. All previous aspects of planning should be united in the ecological design of the site for proper placement of dredged material and vegetation.

a. Placement of Dredged Material. Many aspects of the engineering design of an upland disposal site are directly related to the site's potential biological characteristics. Physical appearance of the site is particularly important, and structures, configuration, size, elevation, topography, timing, and site interaction with surrounding habitats must be considered for ecological integrity of the upland site.

b. Placement of Vegetation. Presence or absence and patterns of vegetation are critical factors in habitat development. Such ecological concepts as structural diversity, community size, species patterns of abundance, and biotic succession are pertinent. Specific concepts that should be applied to upland habitat design are diversity, ecological succession, habitat patterning, and vegetation structure and function.

6-7. Dredging and Disposal Operations.

a. Construction. The first step in construction of an upland habitat development site is to build a protective or retention structure, if called for in the project design, or to modify an existing structure or site (e.g., raise a dike or add drainage). Some site preparation may be necessary, perhaps construction of an access route or removal of vegetation. Access for equipment and pipes should be built to minimize damage, especially to wetlands. Unless the project calls for shallow disposal and recovery of plants present on the site, vegetation to be covered should be mowed or cut to prevent recovery after disposal or to prevent dead branches and shrubs from protruding. Clearing and grading are required along the dike alignment to allow construction.

b. Dredged Material Placement. A significant amount of material rehandling is sometimes required in developing upland habitat because the final distribution of material at the site is important. This handling can be reduced if the initial location and distribution of the coarse- and fine-grained fractions of the dredged material are controlled. One means of control is to take advantage of the differential settling characteristics of the various sized particles in the dredged slurry. Another means is to operate the dredging plant and peripheral equipment in a manner that will produce the desired substrate (item 4). For the majority of disposal operations, the criteria for locating the discharge pipeline in the disposal area have been to maintain an adequate flow distance relative to the weir, keep the discharge end of the pipeline a safe distance away from the interior slope of the dike, and minimize the pumping distance from the dredge. The criteria are directed at preventing short-circuiting or channelization of the flow through the containment area, avoiding scouring damage to dikes, and minimizing pumping costs. Some modifications of these pipe location criteria may be required if advantage is to be taken of particle size differential settling characteristics for habitat development. Coarse-grained material encountered during dredging operations can be taken advantage of with end-of-pipe operations. If the character of the sediment-water slurry being transported is known beforehand or can be determined by monitoring at the dredge or at the end of the pipe, then the coarse material can be diverted by use of a wye connection without interrupting the dredging operations or the dredging sequence. The diverted material can be placed directly in the desired location hydraulically or stockpiled for later use in habitat development. Stockpiling and subsequent rehandling of the material are roughly equivalent to obtaining the material from a source outside the disposal area and involve the use of additional or supplementary equipment.

c. Containment Area Operation. Activities during substrate material placement are aimed at the retention of solids and production of an effluent that will meet criteria for release into the waterway. Operational difficulties, such as channelization of the dredged slurry and insufficient ponding depth, may result in excessive amounts of solids leaving the disposal area through the weir. This is counterproductive and usually violates laws and regulations. Therefore, it is recommended that during and after the disposal operation a well-planned monitoring program be implemented to ensure that suspended solids in the effluent remain within acceptable environmental limits. Suspended solids retention can sometimes be increased by increasing ponding depths through efficient operation of the weir. Concepts of containment area management instituted immediately following the completion of a disposal operation are also important to successful implementation of a habitat project. The most important aspect of dredged material disposal area management was to remove all surface water as fast as possible to enhance surface drying (item 4). This conclusion can be extended to include terrestrial habitat development since extensive site activity must usually wait until the substrate is trafficable. In addition, working the area to a gentle slope toward the effluent point allows efficient drainage of surface water, and evaporative dewatering can be supplemented by transpiration by vegetation.

d. Quality Control. Specifications for all phases of construction should be detailed and clear. Thorough inspection of all operations will ensure that the work is in compliance with plans and specifications for upland habitat development and any mitigation requirements, and will mean fewer post-dredging operations and lower project cost.

CHAPTER 7

ISLAND HABITATS

7-1. General.

a. One hundred years of active dredging operations by the CE, state agencies, and private industry has resulted in the creation, by placement of dredged material, of over 2,000 man-made islands throughout U.S. coastal, Great Lakes, and riverine waterways (item 40) (Figure 7-1). These islands are of varying sizes and characteristics and presently range in age from newly formed ones to those estimated to be 50 years old, Although the majority of the islands were made by the CE, many are owned or managed by other Federal agencies, state governments, conservation organizations, or private citizens. The CE continues to maintain an interest in these man-made islands because of its responsibility in using environmentally acceptable disposal methods and sites, the continuing need for disposal sites, the need for wildlife habitats in waterway areas, and the islands' recreation potential (item 51). The rapid increase in the U.S. population and the corresponding demand on natural resources have helped to cause a gradual change in the use of the islands by wildlife and a need for reassessment of their role as habitats. Natural sites have been altered and occupied by man through industrial, housing, and recreational development to such a large extent that some areas of the United States no longer have coastal islands that are still suitable wildlife habitat. Dredged material islands have provided this vital habitat in many areas.

b. The primary wildlife species needing dredged material islands as part of their life requirements are 37 species of colonial-nesting waterbirds: pelicans, cormorants, anhingas, herons, egrets, ibises, spoonbills, gulls, terns, and skimmers. Several of these species are rare, threatened, or endangered throughout large parts of their ranges (Figure 7-2). An estimated 2 million are nesting on over 700 of these dredged material islands in U.S. waterways, especially along the Atlantic and Gulf coasts from Long Island to Mexico. Islands can offer these birds protection from ground predators, seclusion from man, and nesting substrates similar to those found in traditional nesting sites. The birds are especially vulnerable during the nesting season when they concentrate for several months in colonies and remain in them until their chicks have fledged. These waterbirds are protected by Federal laws since they are migratory species. These laws make destruction, harassment, or disruption of nesting colonies of birds illegal, including those on dredged material sites. State laws often back up these Federal regulations in offering protection to nongame species.

c. In general, the correlation between increases in human populations and decreases in waterbird populations holds true. The only exceptions exist when alternate habitats such as dredged material islands become available. Huge declines in waterbird numbers have stabilized somewhat, partly as a result of the creation of islands, and without which waterbird populations

Figure 7-1. A dredged material island in Florida typical of those built in the U.S. Intracoastal Waterway

Figure 7-2. Endangered brown pelicans nesting on Gaillard Island CDF, their first nesting in Alabama in over 80 years

would be 50 percent or less of present levels (item 73). Detailed research and discussion on islands built of dredged material are presented in items 40 and 73. Guidance for selection of island development as a disposal alternative is presented in Figure 7-3, and details for the selection process are presented in item 72.

7-2. Island Development and Management. Although many colonies of birds presently are nesting on dredged material islands, there are numerous characteristics of these islands that could be improved by management to enhance the available habitat, and there are several ways dredging operations can be altered to benefit the numerous sea and wading birds and other wildlife on dredged material islands. Development and management of dredged material islands for avian wildlife will also usually provide essential habitat for smaller mammals and rodents that use the islands, and covers a broad spectrum of techniques. In some cases, small mammals may act as bird predators, so their colonization should not be encouraged.

a. Habitat Changes.

(1) Basically, development/management of an island for colonial sea and wading birds is concerned with habitat manipulation, habitat establishment, and habitat protection. Manipulation of habitats, by far the most likely technique to be used by engineers, would include proper placement of dredged material to maintain or reestablish habitats, increase the size of existing islands, and/or change configuration, elevation, vegetation, and other features for more desirable habitats. Manipulation of habitats would include, for the biologist, establishment of new vegetation and management of existing vegetation on islands through various agronomic and horticultural techniques.

(2) Establishment of new habitats is desirable when nesting habitat is lacking and new islands must be created, with the resulting need for vegetation establishment; when nesting habitat is expanded by an addition to an existing island which must be established with vegetation; or when undesirable nesting habitats (vegetation) occurring on islands must be cleared out and desirable habitats established in their place.

(3) Habitat protection may be accomplished by island posting or fencing for isolation. Most bird species are already protected by law, but their habitats are not protected except during the time they are occupied by the nesting birds. Year-round protection to prevent destruction of habitat from year to year and seasonal protection to prevent nesting colony disruption by humans and predators are necessary.

(4) Management of existing islands has been demonstrated to be an effective disposal technique and wildlife management practice. Considerable potential exists for the disposal of dredged material and the creation or improvement of avian habitat. Management of existing dredged material islands is most desirable because the potential environmental impacts of disposing on an existing site are less than those of developing new islands.

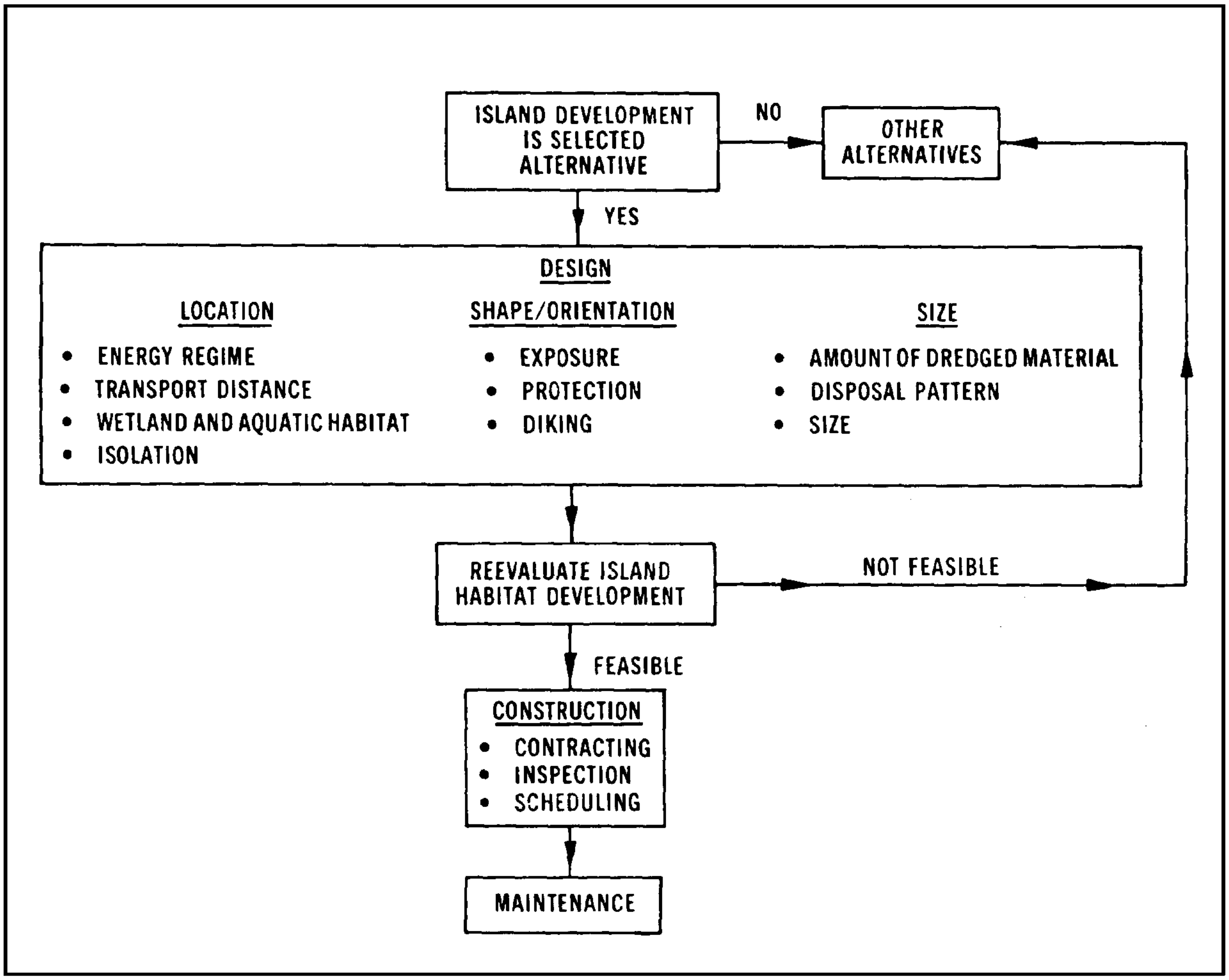

Figure 7-3. Procedural guidelines for selection of island habitat development

b. Use of Dredging Operations on Existing Islands.

(1) The CE has provided habitat incidental to project purpose since the agency first created dredged material islands. Since that time, islands have been kept in various stages of plant succession through dredged material deposition from channel maintenance operations. These operations can have a significant positive impact on waterbird breeding populations (Figure 7-4). Through proper planning the positive impact of regular maintenance dredging could be increased. Since past dredging operations have been carried out with little or no regard for nesting birds, many areas do not have adequate diversity of nesting habitats. Some areas lack ground nesting habitats while others lack woody habitats. Item 73 reports habitat needs that could be satisfied by dredging operations in all the regions studied. Needs for bare ground nesting areas and more tree/shrub habitats exist on almost every part of the U.S. coast. The rate at which various habitats appear on an island after receiving dredged material and an estimate of their longevity have been determined (items 40 and 73).

(2) Once site-specific needs are known, nesting habitat management can easily become a part of the regular maintenance dredging process. To maintain target habitat diversity for certain bird species, islands in any given area would have to be selected to receive periodic depositions of dredged material. Restrictions against dredged material deposition on all or parts of some islands may be necessary in order to allow habitats for tree nesting birds to develop or to preserve existing tree habitats (Figure 7-5). The feasibility of these management recommendations has already been demonstrated by the Wilmington District. They have been practicing such management on a local, annual basis for several years and have developed a long-range colonial sea and wading bird management plan for the lower Cape Fear River estuary which includes maintenance dredging and placement and timing of dredged material depositions on existing islands.

c. Building New Islands.

(1) Construction of new islands would be desirable under some conditions. If it has been demonstrated that there is a need for nesting habitat in an area lacking suitable islands, and if the benefits for the birds will exceed any negative effects of construction of an island to benthic organisms and current flow, then an island could be built. However, islands should not be placed in areas where they would be used for recreational purposes during the breeding season, thus eliminating or severely reducing their wildlife value.

(2) In most areas there is no need for more islands for colonial nesting birds or other forms of wildlife. Management of existing islands should be given first priority. There are areas, however, where additional nesting habitats would be beneficial and existing dredged material and natural islands are not available to fulfill that need. Establishment of need should be

Figure 7-4. Royal and sandwich terns nesting on dredged material islands in North Carolina, where successional vegetation stages are deliberately set back with disposal operations to maintain tern nesting habitat

Figure 7-5. Woody habitat on Little Pelican Island, a dredged material island in Galveston Bay, Texas, which is not often disturbed by disposal, and continues as a heron, egret, spoonbill and ibis nesting colony

determined by consultation with knowledgeable wildlife biologists or by field studies. Generally, construction of new islands for wildlife will not be feasible unless it can be demonstrated that the anticipated positive impacts on the target species will outweigh any negative impacts on the environment. However, it would be desirable to construct a limited number of new islands in various regions of the United States for study purposes and to obtain baseline data. As more natural sites are taken over by man, strategic placement of new sites may become more valuable as a management tool. The present knowledge of bird utilization is based primarily on empirical observations of existing dredged material islands, and more baseline data are needed.

(3) In addition to establishment of need, the feasibility of new island construction will be dependent on the concerns of Federal and state agencies and the private sector. These concerns vary considerably among the regions of the country. However, it has been proven that construction of new islands for birds and other forms of wildlife is feasible. The Wilmington District constructed two islands in Core Sound, North Carolina (Figure 7-6), and the US Army Engineer Waterways Experiment Station (WES) has built or modified several islands for habitat development. The two North Carolina islands were unique in that they were the first to be constructed and placed in a manner to deliberately create habitat for colonial sea birds and aquatic life, and they were retained by the use of large nylon sand-filled bags. The sites were designed so that during future maintenance dredging of the nearby navigation channel, material could be added to them within the existing sandbag retainers, and more sandbags may be added to create higher retention dikes. The kidney shape of the islands formed a small cove where it is expected that a marsh will develop and benthic organisms will thrive. Marsh around the island was given a boost by the planting of smooth cordgrass and saltmeadow cordgrass around the perimeter. The islands were placed in an area with adequate shallow water and food resources but with a scarcity of bare ground nesting habitat. Gull-billed terns, common terns, least terns, and black skimmers nested on the islands during the first breeding season after construction. A number of islands have now been built in Florida, Alabama, Texas, Louisiana, and the Great Lakes with waterbird habitat development as a secondary project goal.

(4) Site location of an island should be worked out with knowledgeable wildlife biologists and concerned agencies to establish the best location. Building an island in an area that does not conform to the biological and engineering specifications outlined herein would fail to produce the desired wildlife habitat. The islands must be placed where the birds will be isolated from predators and human disturbances, unless the islands are going to be actively protected by wardens. With active protection, colonies of sea and wading birds have been successful close to human activities and have provided tourist attractions that could be observed from outside the colony (item 40).

(5) Timing of island development is important. Ideally, an island should be built during the fall or winter preceding the initiation of the next breeding season. The birds generally do not use a site until after the

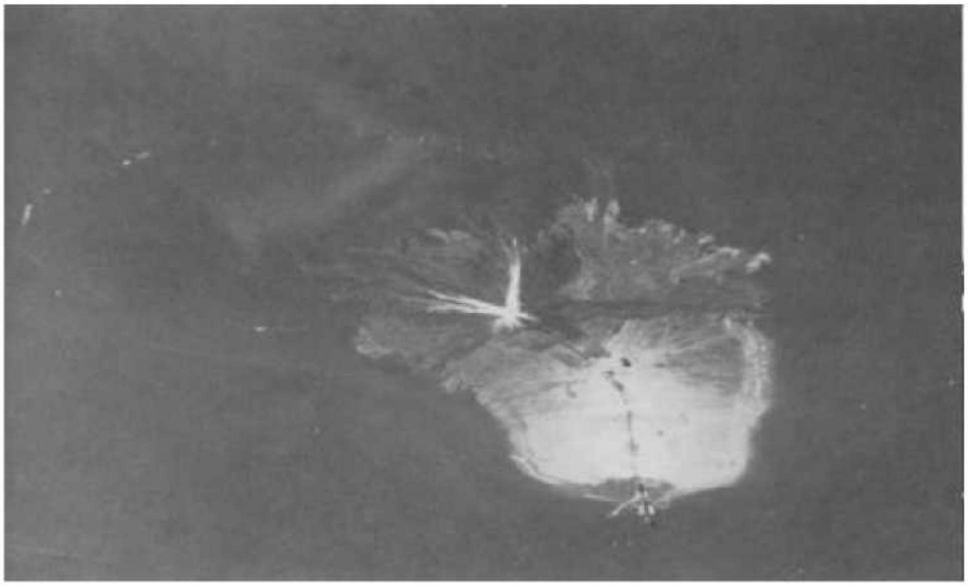

Figure 7-6. A new dredged material island built by Wilmington District in Core Sound in 1977 for seabird nesting habitat. The island is still being used for disposal, and is also a very successful nesting site.

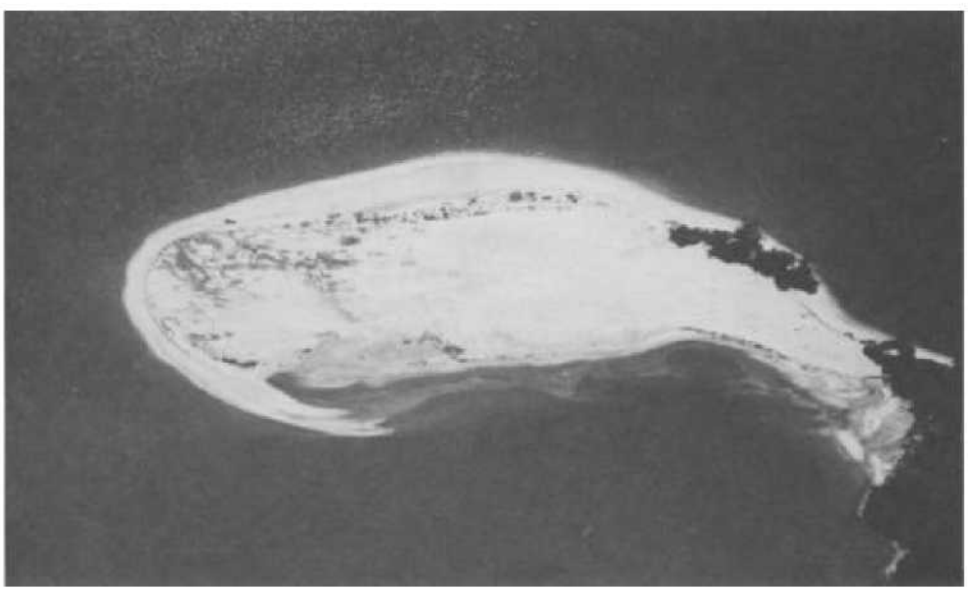

Figure 7-7. An addition built by Jacksonville District to Sunken Island in Hillsborough Bay, Florida, during maintenance dredging operations. It was built as seabird nesting habitat in cooperation with the National Audubon Society.

initial sorting of fine materials by wind and water. If it is built in the spring, this sorting will not have had time to take place, and any colony of birds trying to nest there may not be successful. Their eggs may be covered by drifting fine material. In addition, they cannot use a site until it has had adequate time to dewater.

(6) The physical design of an island is important. In general, islands must be permanently emergent at high water levels; birds have been found nesting on all sizes and shapes of islands as long as they met this crucial breeding requirement. However, observations of hundreds of bird colonies on dredged material islands and the kinds of islands they select has led to four categories of recommendations: size, configuration, substrate, and elevation (item 40). Whether an island is diked or undiked can make a significant difference in bird use.

(a) Ideally, new islands should be no smaller than 5 acres and no larger than 50 acres; however, birds have been found nesting on both smaller and larger islands, and this is a highly site- and species-specific feature. Islands larger than 50 acres would generally be difficult to manage and would also be more likely to support predator populations such as coyotes, snakes, foxes, feral cats and dogs, rats, and raccoons. Islands between the two extremes can be more easily managed, and considerable habitat diversity could be achieved on them. Generally, the greater the amount of habitat diversity to be maintained for wildlife populations, the larger the island should be.

(b) The configuration of an island will depend on the target wildlife species. Steep slopes such as those found on dikes should be avoided for all species. A slope no greater than a 3-foot rise per 100 feet has been recommended (item 73). Substrate configurations for the ground nesting species are given in item 73. Many bare ground nesters must have gentle slopes to prevent their eggs from rolling from nest scrapes. There is also evidence that the formation of a bay or pond with the island makes it more attractive to nesting birds (item 40).

(c) The general nesting substrate requirements of colonial bird species are given in item 73. Generally, coarser materials such as sand or cobble make better nesting substrates due to greater stability. Fine materials such as silts and clays are subject to wind and rain erosion, and usually have desiccation cracks, settling, and ponding. A mixture of sand and shell material makes good nesting substrate for most of the ground nesting birds which prefer sandy beach areas. These bird species historically nested on sandy beaches before being forced off by human use. Fine, unstable dredged material may be stabilized to form suitable nesting substrate by adding coarse materials such as shells over its surface or by planting a ground cover on the material to provide vegetation for those species which prefer that kind of habitat, such as the Forster's tern or laughing gull. Tree nesting species obviously prefer woody vegetation, and these trees and shrubs often colonize best on silty, more fertile substrates. Selected plant species of shrubs and trees which are discussed in item 73 may be planted on the sites since there are several plant species which seem to be preferred over others by tree nesting birds. If plant propagation is to be a part of a management scheme, these species should be given first consideration.

(d) Elevations of constructed islands should be high enough to prevent flooding of the areas that could be used by waterbirds for nesting. However, elevations do not need to be so high that the substrate will not become stabilized due to wind erosion. Generally, the optimal elevation for an island is between 3 and 10 feet above mean high water. The desirable elevation to be achieved will depend on texture of the exposed dredged material, wind exposure, and the habitat objectives or target species. Coarser materials may stabilize at higher elevations than finer materials. If islands could be constructed of coarser material for ground nesting birds, then it would be acceptable in some cases to exceed the recommended elevation. In general, the higher the elevation, the slower the island will be colonized by plants. Therefore, lower elevations to achieve plant cover for some ground nesting species and all tree nesting species should be considered where those are the target wildlife species and where substrates are of fine-textured material. It should be remembered that given the proper substrates and vegetation for nesting, none of the species using dredged material islands for nesting choose one elevation over another as long as they are above the tide or flood lines.

d. Dredged Material Island Additions, Additions to islands may be a useful management tool if valuable nesting sites are altered by erosion until they have to be eventually abandoned. Additions to such islands will prolong their usefulness as nesting habitats. Additions to islands which are covered with vegetation will increase habitat diversity by providing some bare ground habitat, at least temporarily, for those forms of wildlife requiring bare ground (Figure 7-7). In south Florida, additions may be done in such a manner that encourages growth of mangroves, an excellent nesting substrate for tree nesting birds. Colonies have responded favorably to island additions, especially bare ground nesting species along the gulf and Atlantic coasts.

e. Confined Disposal Facilities (CDFs). In the Great Lakes and a number of ports along the eastern and gulf coasts, CE Districts have constructed large, permanent, diked islands for maintenance dredging. These islands are sometimes over 1,000 acres in size, often well-armored, and in most cases designed for permanent containment of contaminated sediments, especially along the mid-Atlantic to New York coast and in the Great Lakes. These islands are located up to 3 miles from shorelines and are relatively isolated. From the time of their construction, they have been used more and more by nesting and loafing seabirds. Jacksonville, Mobile, Detroit, Wilmington, and other CE Districts considered seabird use in design and management on newer CDFs, and the seabird colonization has been spectacular in several cases. Management on CDFs generally consists of continued protective isolation, wildlife monitoring, and posting. Vegetation management has not yet become a problem on any of these relatively new islands.

f. Protection of Bird Colonies.

(1) Since the primary users of dredged material islands are the sea and wading birds which nest in colonies, and the lack of isolation and protection is one of the primary problems these birds face, this species group would be greatly benefited by the provision of protection of colonies and nesting areas. They are already protected by Federal law and regulation as migratory species. Since this does not protect habitat unless the migratory animal is present, it can sometimes be detrimental for long-term protection purposes. In addition, some states have laws and regulations designed to give protection. A number of endangered or threatened species nest in colonies on dredged material islands. It has been shown repeatedly throughout North America that, in general, protected colonies are successful and unprotected colonies are not. Every Federal and state agency and individual has the responsibility to see that its actions are not in violation of laws which protect wildlife. To ensure compliance with the law, maintenance operations involving placement of dredged material should be conducted in a manner which will not disturb the bird colonies. Management should include proper care during placement of dredged material, surveying, and dike construction.

(2) Public education concerning the vulnerability of colonial-nesting birds has the potential of being a valuable management tool. Through various public affairs channels, the general public could be made aware of the value of dredged material islands to colonial birds. At the same time they could be informed that the continued disposal of dredged material may be a viable management option.

(3) Other protective measures for colonies which are valuable management tools include posting of colonies with signs such as those used by Mobile and Portland Districts, fencing, designation of certain colonies as sanctuaries, limiting of scientific study (and thus disturbance of the birds by constant observation and measurements), and control of wildlife predators such as raccoons, foxes, and feral animals.

g. Vegetation on Dredged Material Islands.

(1) A number of suitable plant species could be planted on islands that would increase the islands' attractiveness to wildlife and especially to colonies of nesting sea and wading birds (items 39 and 73). Depending upon the wildlife species specific requirements, a variety of suitable plants could be used in a management plan for islands. No plantings would be necessary for ground nesting species in most cases, although some of these species use sparse herbs and grasses for nesting. Since tree nesting species require tree/shrub habitat, planting of this vegetation type on islands would hasten wildlife use by more quickly providing suitable habitat. Woody habitat will require 5 to 30 years to develop, depending upon the region and climatic conditions.

(2) Another aspect of vegetation on islands is that sometimes it must be controlled in order to provide the proper or desired habitat for target wildlife species. Vegetation control would be necessary if habitat for ground nesting species was scarce and there was an abundance of other habitats or if the wrong species of trees were growing on an island that precluded nesting or other wildlife use. Some of the control methods that have been successfully tried on dredged material islands are mechanical removal (tractors, tillers, chain saws, axes), hand removal (pulling up plants by their roots), controlled burning, and applications of herbicides. Controlled burning is not very successful because new growth will begin immediately. Herbicides should be carefully applied according to directions; they have been found to be extremely effective on islands in North Carolina.

7-3. Development and Management Problems.

a. Numerous potential problems may be encountered in building and/or managing dredged material islands. A key to success in the early planning stages is cooperation and coordination with Federal, state, and local agencies with regulatory authorities. Many obstacles to project success could be removed by correct planning and public awareness efforts before the project actually begins.

b. The development of specifications for dredged material disposal to develop islands for habitat and simultaneously satisfy the need to dispose of a given amount of dredged material requires considerable care. Specifications should include: exact locations, time of disposal, size of deposit, elevation of deposit, and movement of disposal pipes to ensure that habitat plans are carried out. Onsite monitoring is highly desirable and is necessary when disposal is onto an island with an existing bird colony or population of vulnerable wildlife.

c. Silt curtains (effective only in certain parts of United States under certain soil conditions) or temporary dikes sometimes may be required in disposal activities, and if a dike is built on an existing island and filled, the dike should usually be at least partially removed or breached to allow ground access to water by young birds. This will require return to the site by earth-moving equipment. Dikes do not need to be erected until just prior to disposal use for best use by wildlife. Periodic monitoring to determine aftereffects of disposal will provide useful information for future disposal efforts.

d. The public is seldom aware of wildlife needs. Severe damage can be inflicted on a colony by simply fishing or boating adjacent to an island during the nesting season through disturbance of young and adults. Surveying and dike construction activities could also disrupt nesting birds. Education of both the general public and dredging personnel is needed. An information program should be a part of every ongoing or planned dredging operation. Positive public opinion regarding disposal operations of dredged material in North America may improve public acceptance and understanding of dredged material disposal operations, and allow more of this resource to be developed for the benefit of North American wildlife.

CHAPTER 8

AQUATIC HABITATS

8-1. General.

a. Aquatic habitat development is the establishment of biological communities on dredged material at or below mean tide in coastal areas, and in permanent water in lakes and rivers. Potential developments include such communities as tidal flats, seagrass meadows, oyster beds, clam flats, fishing reefs, and freshwater aquatic plant establishment. This habitat development alternative has great potential that is just now beginning to be realized through various District projects. The bottom of many water bodies potentially could be altered using dredged material; this could simultaneously improve the characteristics of the site for selected aquatic species and permit the disposal of significant quantities of material (item 72).

b. A number of applications of this alternative have been made by CE Districts in recent years, including development of razorshell clam sites in Portland District, creation of gravel riffles in the Tennessee-Tombigbee Waterway in Mobile and Nashville Districts, razor clam and mussel habitat in St. Paul District, and establishment of artificial fishing reefs in a number of Districts. Unsuccessful attempts to establish seagrasses on dredged material have been made, and is a concept to be reattempted using the newest techniques and very careful site selection.

c. The recent creation of an underwater berm using coarse-grained dredged material has been tested at Virginia Beach, Virginia, in Norfolk District. This will not only provide aquatic habitat, but will serve to protect the shoreline through storm wave dissipation, sand stockpiling for beach nourishment, and allowing a reduction in maintenance dredging in some tidal inlets. Three smaller sites have also been developed as underwater berms for aquatic habitat: Thimble Shoal, Virginia, in Norfolk District; Kings Bay, Georgia, in Jacksonville District; and Charleston Harbor, South Carolina, in Charleston District.

8-2. Aquatic Habitat Development. Limited aquatic habitat development has been tested in Florida (items 72 and 77), the Great Lakes, and several west, east, and Gulf coast Districts. It is a still-developing concept, with much still unknown about what is likely to be encountered or considered at any site. Each aquatic habitat site should be approached as a unique situation until further guidelines are made available.

a. Advantages. Several advantages to aquatic habitat development are recognized. It provides high biological production, has a potential for wide application, complements other habitats, and provides habitat where none previously existed or had been destroyed. Aquatic habitats may be highly productive biological units. Seagrass beds are recognized as exceptionally valuable habitat features providing both food and cover for many fish and shellfish. Oyster beds and clam flats have high recreational and commercial importance. Fishing reefs built on flat, relatively sterile lake, river, or bay bottoms provide habitat diversity, food, and cover, as well as recreation for fishermen. Dredging material disposal projects impacting aquatic communities predictably incur strong criticism, and in these cases reestablishment of similar communities may be feasible as a mitigation or enhancement technique. In many instances it may be possible to establish aquatic habitats as part of a wetland habitat development project. This concept potentially has very wide application, as most dredging projects are flanked by open water. Often, the selective subaquatic placement of material will both enhance the disposal site and accommodate large amounts of dredged material. In the case of fishing reefs built of dredged material, the material is usually bedrock or rubble from new work dredging operations suitable for reef formation. This kind of dredged material is also well suited for oyster and clam bed development since it gives oysters and clams places to attach.

b. Disadvantages. The primary and overriding disadvantage of aquatic habitat development is an inadequate understanding of techniques for applying this alternative. Careful site-by-site determination combined with local biological and engineering expertise is necessary. Seagrass establishment to date has largely been on disturbed sites that did not involve dredging (items 76 and 77), and its application to disposal sites thus far has been very limited. Development of freshwater aquatic habitat has been limited to providing protective structures via barge-transported coarse-grained material to allow natural plant development, in the case studies listed in para 8-1b.

8-3. Guidelines for Aquatic Habitat Development. The lack of more specific engineering and environmental guidance on aquatic habitat development should not eliminate the consideration of this alternative. References which provide guidance by experts in coastal areas include items 64 and 76-78. Most aspects of habitat development presented in the preliminary assessment and the detailed evaluation of feasibility (Figure 4-6) will be applicable to aquatic habitat development. Of particular significance will be hydraulic energies along the bottom and circulation patterns. The interaction of the texture of the material with the hydraulic energies of the site will be significant, as the material must provide a stable surface substrate. The possibility that alteration of the bottom configuration of a waterway could adversely affect current patterns should be carefully considered, especially with fishing reefs and protective structures for freshwater aquatic plants. In large projects or in those projects where some question exists regarding the impact, it may be advisable to develop physical, chemical, and biological models of the aquatic system prior to project implementation.

8-4. Design of Seagrass Habitat. There are few well-documented examples of seagrass habitat development on dredged material, though a few successful transplants have been made in southern California and on one site in Florida. Revegetation of reclaimed subtidal bottom has been successfully accomplished (item 76), and results from these projects can be applied to dredged material.

Transplanting techniques are described in item 76. Figures 8-1 and 8-2 show the coring method of transplanting plugs, in this case, of shoal grass at Port St. Joe, Florida. Figure 8-3 shows a bareroot propagule of eel grass. Figure 8-4 shows turtle grass being transplanted into sand. Seagrass development will help stabilize dredged material through the binding action of roots and rhizomes, and in the dissipation of wave and current energy, thereby reducing erosion processes.

a. Location. Seagrasses normally occur along shorelines with low wave and current energies. Development of seagrass habitat in higher energy areas will require permanent protection with breakwaters or planting within lagoons created within dredged material islands.

b. Depth. Bottom elevations within seagrass beds extend from mean low water to -2 m in estuaries and -10 m in coastal environments.

c. Water Quality. Surveys to predict expected annual fluctuations in water quality at a site will be needed to assess suitability. Data should be collected as frequently as possible so that the site can be adequately characterized. Presence of natural seagrass beds in the vicinity of a proposed site will also be a strong indicator of general water quality suitability.

(1) Light. The foremost need of seagrasses is sufficient light penetration through the water column to support growth. High water column turbidity is an indication that a site is not suitable for habitat development.

(2) Salinity. Most of the common species of seagrasses require salinities greater than 20 ppt, though some local variations may exist where plants tolerate salinities as low as 10 to 15 ppt.

(3) Temperature. Though seagrasses require relatively low-energy environments, the area needs to be well flushed and currents must circulate to prevent lethal temperature extremes from occurring.

d. Sediment Type. Sediment grain size is not usually a limiting factor, as most seagrasses can tolerate a wide range in sediment from coarse sand to mud.

e. Vegetative Establishment.

(1) Plant selection. In most geographic regions, species selection will be based on salinity, though along the southeast Atlantic and Gulf coasts where two or three seagrass species occur, other considerations need to be made. In this area, environmental tolerances or species growth rate may be a prime factor in species selection (item 48).

(2) Propagule selection. Seagrass habitat development is almost exclusively restricted to transplanting mature plants from a donor bed, as nursery

Figure 8-1. Removing plugs of shoal grass from an existing bed near Port St. Joe, Florida. They were transplanted on a nearby dredged material site.

Figure 8-2. Temporary storage for the shoal grass plugs was provided by containers of seawater, which were transported to the dredged material site by skiff.

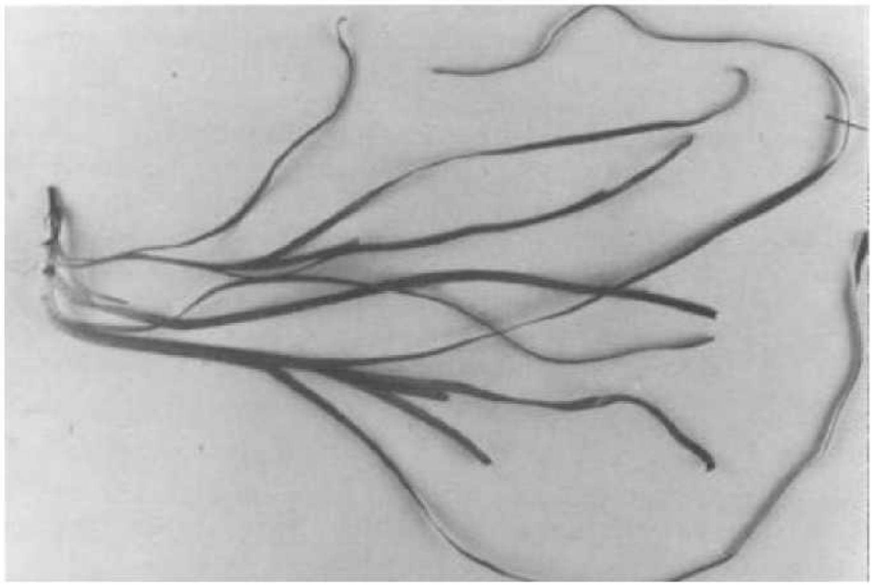

Figure 8-3. A bareroot propagule of eel grass ready for transplantation. This is the most efficiently handled and cost effective type of propagule.

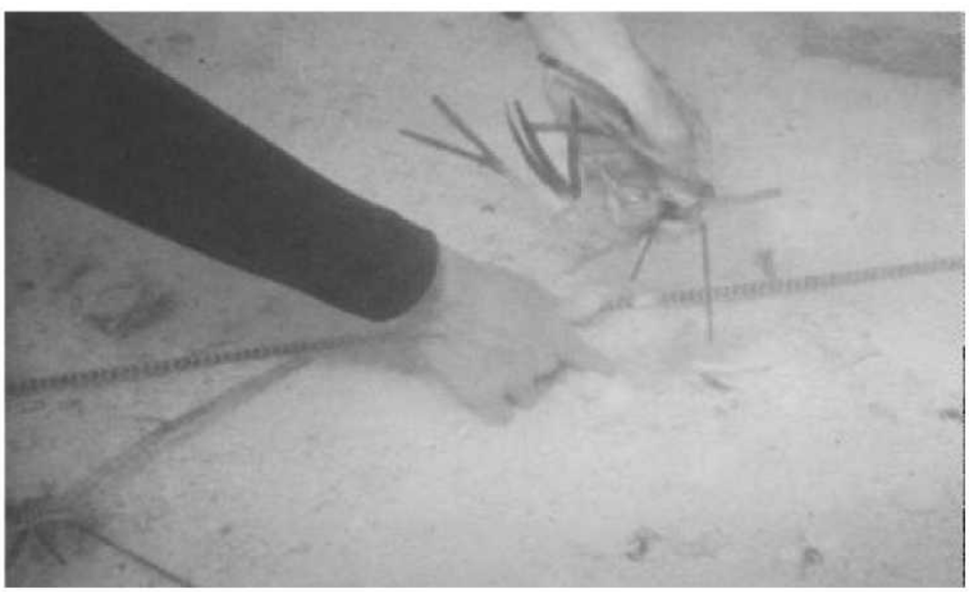

Figure 8-4. Transplanting a bareroot propagule of turtle grass on a sandy site. The transplant is held in place with a long staple, which prevents waves and currents from washing it out.

stock is currently unavailable. Mature plants reproduce by branching. Methods using seeds or seedlings have not been adequately developed.

(3) Plant spacing. The rate at which seagrass will cover the bottom is dependent on species growth rate and spacing of transplants. Some species are much faster growing than others. Spacing guidelines can be found in item 76.

(4) Handling plant material. Plants need to be handled as carefully as possible to avoid damage to roots and shoots. Turtle grass meristematic tissue protection is critical for that species' reproduction. Short-term plant storage (hours) can be in well-aerated containers, while longer term storage (days, weeks) should be in floating pens or flowing seawater tables. Plants should never be directly exposed to sun and air for more than a minute or two.

(5) Pilot propagation study. In a seagrass development project where there are unknown factors such as water quality, rate of plant spread, or lack of experience in similar projects, it is prudent to conduct a pilot study. A pilot project is particularly advisable if the project is a large and costly one. A pilot study's main purpose is to determine whether or not the propagules will grow under conditions found on the site. The study can be conducted in less than a year, but the test species should be allowed to grow for one full season before conclusions are drawn. Such a project should be of sufficient size that it will accurately reflect future operational difficulties. The size of the pilot study is limited only by the desired tests, the time available for such testing, and funding. A simple statistical design will permit quantitative evaluation of the study where prediction of degree of success or failure can be made. The success of these plants can generally be evaluated by observation of survival. Test plots established should be evaluated on a regular basis to determine survival and growth.

(6) Time of planting. Almost without exception, spring is the best time for planting seagrasses. Transplanting can be successful in other seasons, but with less overall survival.