CONFINED DISPOSAL FACILITIES
ON THE
GREAT LAKES

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1. Purpose

This report will provide an overview of the confined disposal facilities for dredged materials on the Great Lakes. The report will discuss the purpose and authority for these facilities, the regulation of dredge and fill activities, the process by which these facilities are planned and constructed, and summarize the design, operation and monitoring of confined disposal facilities. This report is a compilation of existing information on confined disposal facilities and is intended to be used for information and reference by Federal, state, and local agencies and concerned citizens. This report has been updated periodically to provide the most current information.

2. History of Dredged Material Management on the Great Lakes

The U.S. Army Corps of Engineers (Corps) is authorized to maintain some 137 navigation projects around the Great Lakes, of which 70 are deep-draft (18 feet or greater). These projects include harbors and channels for commercial and recreational navigation users. Maintenance requires the repair and rehabilitation of navigation structures, such as breakwaters, piers and locks, and the periodic dredging of sediments from navigation channels. The Corps dredges approximately 3-5 million cubic yards of sediments annually from navigation projects around the Great Lakes. The amount of sediments dredged, depths and frequency of dredging are project specific.

Up until the mid 1960's, dredged material was disposed with economics as the key concern. This meant unconfined, open-water disposal in most cases. In the mid 1960's, environmental concerns were raised about the degradation of water quality in the Great Lakes. These concerns primarily focused on the eutrophication of the lakes, and controls on the pollutional loadings of nutrients such as phosphorus and nitrogen. The practice of open water disposal of dredgings from polluted harbors and waterways was criticized and called into question.

In 1966, the Corps began investigating the feasibility of using alternate disposal areas at a number of harbors. In 1967, the Corps, in cooperation with the Federal Water Pollution Control Administration (the predecessor of USEPA) initiated a 2-year pilot investigation on alternate methods for dredged material disposal. This investigation examined the pollutional status of the Great Lakes, provided a detailed look at existing dredging and disposal practices, described the effects of these operations on water quality, and examined potential modifications and control measures to abate environmental impacts. A variety of disposal alternatives were investigated, including several innovative treatment technologies. Pilot projects conducted included the construction and operation of the first confined disposal facilities on the Great Lakes.

The final report of this pilot program, <u>Dredging and Water Quality Problems in the Great Lakes</u> (Buffalo District, 1969) could not document substantial impacts on water quality or benthic communities resulting from open water disposal of dredged materials. Impacts were of a transient nature. The report concluded, though, that open water disposal of polluted dredged material is "presumptively" undesirable. Recommendations of this report included additional research on the environmental effects of dredging and disposal and the development of a program for the confinement of polluted dredged material around the Great Lakes.

In 1970, Congress authorized two programs which were to have a major impact on the dredging and disposal practices of the Corps through the passage of Public Law 91-611. The Diked Disposal Program was initiated to provide funding for construction of diked disposal facilities to contain polluted dredged materials on the Great Lakes. The same law authorized the Dredged Material Research Program (DMRP), a five year research program to examine the environmental effects of dredging and disposal. The Corps' Waterways Experiment Station (WES) was tasked to manage this research program.

3. Research on Dredged Material Management

The DMRP was conducted between 1973-1978 at a cost of $33 million. In all, some 270 individual studies were conducted. About two-thirds were completed by universities, private research laboratories, and other Federal agencies. About one-third of the studies were completed by the Corps. The major conclusions of the DMRP as summarized in the Executive Overview and Detailed Summary report (USACE, 1978) are as follows:

"The first is that there is no single disposal alternative that presumptively is suitable for a region or group of projects. Correspondingly, there is no single disposal alternative that presumptively results in impacts of such a nature that it can be categorically dismissed from consideration."

"The second basic conclusion is that environmental considerations are acting more strongly than possibly any force to necessitate long-range regional planning as a lasting, effective solution to disposal problems. No longer can disposal alternatives be planned independently for each dredging operation for multiple projects in a given area."

"Turning to inland and coastal waters, the DMRP achieved definite results that soundly substantiate that the most widely held fears over the short-term release of contaminants to disposal site waters are unfounded. As long as the geochemical environment is not basically changed, most contaminants are not released from the sediment particles to the water. However, in contrast, upland disposal often result in a change in the geochemical environment that can lead to contaminant release. Some nutrients, such as ammonium and manganese and iron are released in open-water disposal, but in most cases enough mixing is present to rapidly dilute these to harmless concentrations."

"If a confined disposal site is to be effective from an environmental protection standpoint, it must be efficient in retaining a high percentage of the finer soil particles, for it is these clays and silts that carry the contaminants. These are, admittedly the materials most difficult to retain in an area, but if they can be, the effluents should be essentially nontoxic except for occasional situations where nutrient levels and oxygen depletion may be excessive."

The results of the studies conducted under the DMRP were condensed into a series of Engineer Manuals for use by Corps districts in the planning, design and operation of dredged material management projects. Since the completion of the DMRP a number of other research programs dealing with dredging and dredged material management have been conducted by the Corps:

- Field Verification Program (FVP)
- Dredging Operations Technical Support Program (DOTS)
- Dredging Research Program (DRP)
- Long-Term Effects of Dredging Operations Program (LEDO)
- Dredging Operations and Environmental Research (DOER)

Dredged material research studies continue to be conducted under the LEDO and DOER programs. Numerous technical reports and newsletters have been distributed from these programs. Many of the products from these research programs are available online through the homepage of the DOTS program (www.wes.army.mil/el/dots/dots.html). In addition, proceedings from seminars and meetings sponsored by a variety of groups dealing with dredged material management have been published, such as:

- American Society of Civil Engineers (ASCE) Conference on Dredging and its Environmental Effects (ASCE, 1976);
- U.S.-Japan Experts Meeting on Management of Bottom Sediments Containing Toxic Substances (USACE, biennial); and,
- ASCE Conference on Dredging and Dredged Material Disposal (ASCE, 1984).

In addition, reports from many authors have been presented in scientific and engineering journals dealing with dredging, disposal, and sediment-water-biological interactions.

A number of efforts have been initiated regarding sediment contamination on the Great Lakes. These include studies and symposia conducted by the International Joint Commission (IJC) on CDFs, in-place pollutants, and remedial action plans (RAPs) for areas of concern (AOCs). Some of these reports from these IJC sponsored studies/symposia are available online at the IJC's homepage (www.ijc.org).

In the 1987 amendments to the Clean Water Act (Section 118), Congress directed the USEPA to conduct a five-year study and demonstration program on the remediation of contaminated sediments at Great Lakes AOCs. Because of its considerable expertise with the management of contaminated sediments, the Corps of Engineers has provided technical support to state, Federal and international agencies in many of these studies. In 1989, Environment Canada initiated a number of programs under the Cleanup Fund directed at contaminated sediments.

The ARCS program and Cleanup Fund evaluated a variety of remediation technologies which may be applicable to contaminated sediments within the Great Lakes (Averett et al., 1990; USEPA 1994). The costs of these treatment technologies are very high, and the decision to treat sediment should be considered carefully. It is also worth noting that none of the advanced technologies are capable of treating all sediment contaminants, and that almost every treatment process would require a confined disposal facility, or equivalent, for storage, pretreatment, and residue disposal. Most of the products of the ARCS program are available online through the USEPA's home page (www.epa.gov/glnpo/sediment/arcs/).

4. Regulation of Dredged Material Management

The disposal of dredged or fill materials to waters of the U.S. is regulated under sections of the Clean Water Act of 1972, as amended (CWA). Section 404 designates the Corps as the lead federal agency in the regulation of dredge and fill activities using guidelines developed by the USEPA in conjunction with the Corps. A detailed description of the decision making process for dredged material management has been developed by the Great Lakes Dredging Team, and is available at their web site (www.glc.org/projects/dredge/)

The Corps of Engineers performs the majority of the dredging within the Great Lakes as part of its navigation maintenance mission. However, approximately 1-3 million cubic yards are dredged annually by others (industry, municipalities, states, etc.) for a variety of purposes including maintenance of marinas and private slips, clearing water supply intakes, placement of utilities across rivers, bridge repairs, waterfront development and environmental remediation. The Corps regulates the disposal of these dredged or fill materials as part of its permit authority under Section 404. Federal regulations on these Corps activities are contained in 33 CFR Parts 209, 335-338 (Discharge of Dredged Material into Waters of the U.S. or Ocean Waters; Operation and Maintenance; Final Rule), and 33 CFR Parts 320-330 (Regulatory Programs of the Corps of Engineers).

Permits for the disposal of dredge or fill materials into waters of the United States are issued through Corps district offices. The Corps has cooperative permitting programs with many states. Only one state (Michigan) has been transferred 404 permitting responsibilities as provided under 404(g). For the disposal of maintenance dredgings conducted by the Corps, the Corps does not issue itself a permit. The Corps prepares a 404(b)(1) evaluation and must comply with the substantive and procedural requirements of state environmental regulations.

Section 401 of the CWA provides the state authority to issue certification of dredge and fill disposal activities. This certification indicates that the proposed fill or dredged disposal will not violate State water quality standards or criteria. The Corps obtains 401 certification from state agencies for the disposal of dredged materials to the open lake and for the discharge (effluent) from a confined disposal facility.

5. Dredged Material Management Guidelines

Prior to 1970, decisionmaking about the management of dredged materials was primarily based on economic considerations. With the development of water quality criteria and standards, concerns over the discharge of dredged materials necessitated procedures for evaluating and classifying sediments. Numerical criteria (known as the Jensen criteria) were used nationally in the early 1970's, prior to the national 404(b)(1) Guidelines. These criteria consisted of seven physical and chemical parameters for determining the acceptability of dredged material disposal into the nation's waters.

The CWA amendments of 1972 directed that decisionmaking about proposed disposal of dredged or fill materials be made using the Section 404(b)(1) evaluation procedure. Section 404(b)(1) directs the application of guidelines "developed by the Administrator (USEPA) in conjunction with the Secretary (Corps)", and that these guidelines be based on criteria comparable to those developed for ocean dumping under Section 403(c).

National 404(b)(1) Guidelines were developed by the USEPA in conjunction with the Corps in 1975 (40 CFR 230). Interim guidance on implementation of these 404(b)(1) Guidelines was published as part of the Dredged Material Research Program (USACE, 1976). In 1980, final 404(b)(1) Guidelines were published in the Federal Register. In addition, proposed testing requirements were published, but were never finalized.

Over the past ten years, the Corps and USEPA have worked together to develop a series of guidance documents related to dredged material management. In 1990, the USEPA and Corps published an updated testing manual for dredged material disposal into the ocean (USEPA/USACE, 1990). In 1992, the Corps and USEPA published a technical framework for evaluating the environmental effects of dredged material management alternatives (USACE/USEPA, 1992). In 1998, the Corps and USEPA finalized a dredged material testing and evaluation manual for inland waters (USEPA/USACE 1998a).

The Corps and USEPA have adopted a tiered approach for the evaluation of dredged material. This approach begins with a reason-to-believe evaluation. Historic information about the dredging site and potential sources of contamination are evaluated to determine if there is a reason to believe the sediments are contaminated. Dredged material testing is conducted only as needed to determine if the material will have unacceptable adverse impacts on water quality and aquatic biota. Analysis may include physical, chemical, and effects-based biological testing for toxicity and bioaccumulation.

The national 404(b)(1) Guidelines and the national testing manuals are general in nature, and lack many of the specifics necessary for a local or regional application. In 1990, the Corps and USEPA Regions 2, 3, and 5 formed a task group to develop dredged material testing and evaluation guidance specifically for the Great Lakes. The draft Great Lakes Dredged Material Testing and Evaluation Manual was released for public review and comment in 1994. It contains recommended procedures for dredged material testing specifically for the Great Lakes. The regional manual (USEPA/USACE 1998b) was finalized in 1998 is available on the hompage of the USEPA (www.epa.gov/glnpo/sediment/gltem).

6. Dredged Material Management Alternatives

The options for managing dredged material might be divided into the following categories:

- open water placement
- beach/littoral nourishment
- capping (level bottom or CAD)
- beneficial use (upland)
- confined disposal
- treatment

The Corps of Engineers has developed technical guidance in the form of Engineer Manuals for districts to use in evaluating the feasibility of dredged material management options and in design and construction management. In addition, the Corps has developed a number of computer models specifically for the analysis of dredged material management options.


Figure 1. Bottom-dump scow

Open water placement involves the discharge of dredged material directly to the lake or river. Hydraulically dredged material may be discharged by pipeline a short distance offshore. Mechanically dredged material may be placed in bottom-dump barges or scows and towed to disposal sites several miles away. Discharged dredged material settles through the water column and deposits on the bottom at the disposal site. The dredged material may remain in a mound at the site or disperse depending on the material's physical properties and the hydrodynamics of the disposal site. Open water placement is used with approximately 32% of Great Lakes dredged material (1993-1996). Most open water disposal sites in the Great Lakes are dispersive in nature. USACE guidance on the selection of open water disposal sites is available (USACE 1976) and computer models have been developed to simulate the development of mounds and movement of dredged material at open water disposal sites (Scheffner et al. 1995).


Figure 2. Beach nourishment

Beach/littoral nourishment involves the placement of dredged material directly onto a beach or into the shallow water. Beach nourishment is typically discharged by pipeline from a hydraulic dredge. Suitable dredged material is typically a fine sand, and may only stay on the beach for a limited time before being eroded into the littoral drift. Littoral nourishment involves a discharge to near shore, shallow areas, and is typically done with bottom dump scows when a mechanical dredge is used. Beach and littoral nourishment are used with approximately 12% of Great Lakes dredged material (1993-1996). USACE technical guidance on beach nourishment is available (USACE 1987a).

Capping is the placement of a contaminated dredged material in a subaqueous disposal site and covering the material with a layer of clean material. Level bottom capping is the placement of dredged material onto a level bottom surface, as shown on figure 3. Confined aquatic disposal (CAD) involves the use of a depression or excavated subaqueous pit for disposal to provide lateral containment, as shown on figure 3. Cap materials are typically a clean, sandy dredged material. Capping has been used extensively for management of dredged material in the ocean in New York and New England, but has not been used in the Great Lakes. USACE technical guidance on dredged material capping and computer models of cap placement are in development (Palermo et al., 1998)

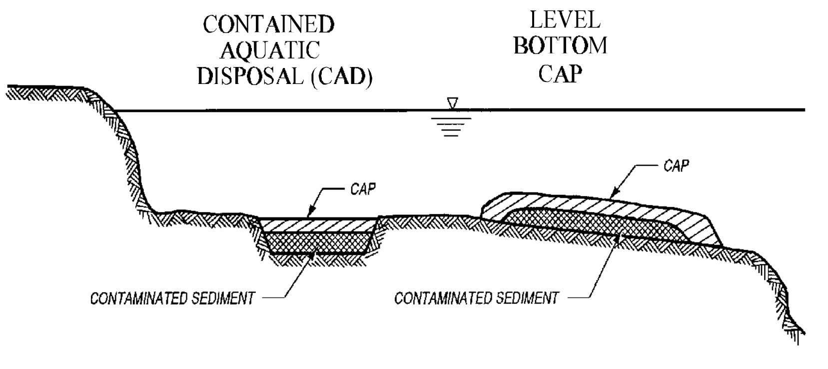

Figure 3. Level bottom capping and contained aquatic disposal (CAD)

Beneficial use of dredged material includes beach and littoral nourishment (as discussed above) and a variety of upland applications, described here. Upland beneficial uses for dredged material include construction fill, landscaping, agricultural applications and wetland/habitat enhancement. Dredged material from Great Lakes harbors has been used for these and other beneficial uses. For upland uses, dredged material is typically placed into a storage area or CDF for dewatering, and then transported by truck for use. The development of islands for wildlife habitat with dredged material is typically done by direct placement from a pipeline. The USACE has continuing authorities to provide federal funding (cost-shared) for the additional cost associated with beneficial use of dredged material for the protection, preservation and enhancement of wetlands and aquatic habitat. Technical guidance on beneficial use (USACE 1987a) has been developed and the promotion of beneficial use is a priority of the Great Lakes Dredging Team.

Confined disposal is the placement of a dredged material into a secure area where the sediment is physically contained. Confined disposal facilities (CDFs) are diked structures that have been built for the disposal of dredged material where in-water placement and beneficial use are not feasible or environmentally unacceptable. The size, shape, design and level of complexity of these facilities has varied widely depending on dredging quantities, methods of disposal, sediment contamination levels, state and local requirements and site characteristics. In addition to CDFs, contaminated dredged material have also been placed in commercial landfills, although this has been done more frequently with environmental cleanup dredging than with navigation dredging. Confined disposal is the most commonly used management practice for contaminated sediments dredged for navigation and environmental remediation (IJC 1997, USEPA 1998). USACE technical guidance on confined disposal is available (USACE 1987b) and several computer models have been developed to support CDF design and operation (Schroeder and Palermo 1990; Stark 1991; Myers and Brannon 1991).


Fig.4 ARCS Physical separation technology demonstration at Saginaw, MI

Treatment technologies are available to destroy, extract, or immobilize sediment contaminants. A number of treatment technologies were evaluated by the USACE as part of a Great Lakes study conducted 30 years ago (Buffalo District 1969). The USEPA Great Lakes National Program Office conducted a comprehensive analysis of sediment treatment technologies under the Assessment and Remediation of Contaminated Sediments (ARCS) Program (Averett et al. 1990; Allen 1994; USEPA 1994). Treatment technologies are in varying stages of development, with relatively few available "off-the-shelf" at a full-scale. Because of their costs, state of development, and inability to address the entire suite of contaminants present in most sediments, treatment technologies have been used at a limited number of sediment remediation projects around the Great Lakes.

7. CDF Planning

Confined disposal, as the name implies, involves the placement of dredged materials into a site or facility prepared to contain the dredged materials. In contrast to other areas of the country, CDFs were constructed at Great Lakes sites only for dredged material determined to be unsuitable for open water disposal or beneficial use because of contamination. In other areas, CDFs may have been used because they were less costly than transport to an open water disposal site or because open water disposal would have resulted in the sediments depositing in the navigation channel downstream (and necessitated their dredging again).

A confined disposal facility (CDF) may be an upland or in-water structure. The Corps of Engineers has constructed 44 confined disposal facilities around the Great Lakes since the late 60's for the disposal of contaminated dredged materials from navigation projects. The locations of these CDFs are shown on figure 6 and pertinent facts about these facilities are provided on table 1. Additional CDFs (not shown) have been constructed in Canada. About one-third of the CDFs were constructed at upland sites and two-thirds constructed in water.


Figure 5. Milwaukee CDF

Upland confined disposal facilities may be formed by the construction of earthen dikes or use existing pits or depressions. In-water CDFs are generally formed by stone-filled dikes similar in appearance to a breakwater. The size and shape of a CDF are determined by the required storage capacity and local site conditions.

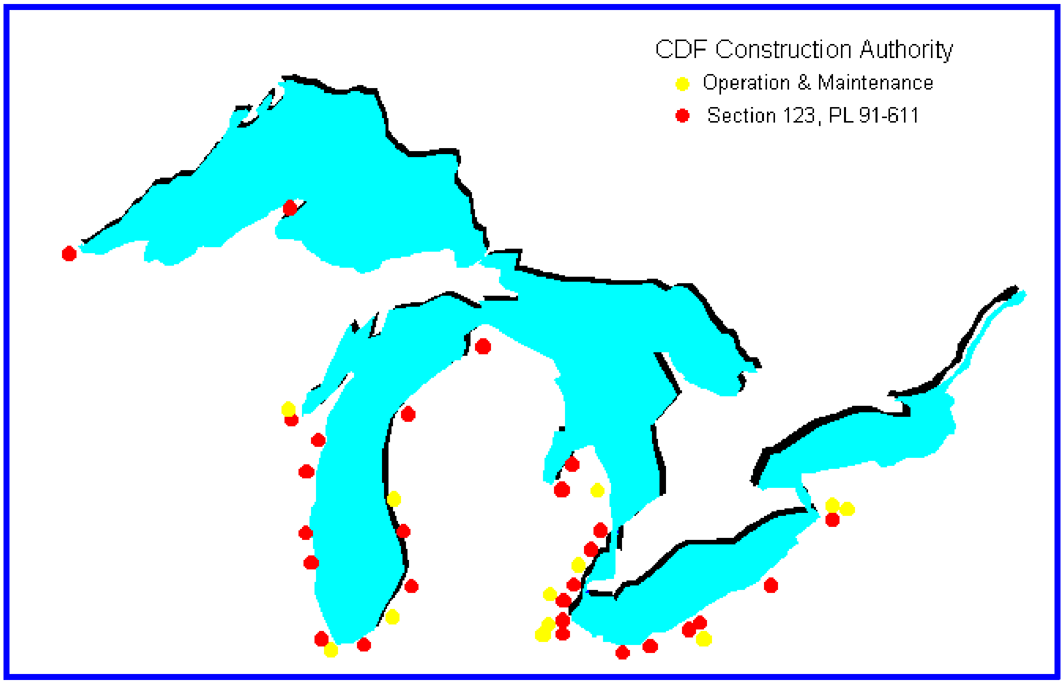

Figure 6. Locations of Great Lakes CDFs

Of the CDFs built by the Corps around the Great Lakes, 27 were constructed under the authority of Section 123, River and Harbor Act of 1970 (PL 91-611) (those listed on table 1a). The remainder (listed on table 1b) were constructed under the Operation and Maintenance (O&M) authority of the specific navigation project. Section 123 had specific requirements for the funding of a CDF. Under this law, the Corps was authorized to construct facilities for the disposal of 10-years volume of maintenance dredgings from Federal navigation project(s).

The law also required that there must be a local sponsor for the CDF, except for disposal of dredged materials from the Great Lakes connecting channels in Michigan. Local sponsors were typically a city, county or state governmental agency. The local sponsor was required to provide all lands, easements, and rights of way to the Corps for the CDF site. The local sponsor was also required to provide 25% of the funds for the construction of the CDF. This local cost share could, however, be waived if the USEPA certified that the area was in compliance with an approved water quality program. The local sponsor would receive title to the CDF after it was filled and be responsible for its maintenance.

Table 1a. Great Lakes Confined Disposal Facilities Constructed under Section 123, PL 91-611

Name/Location	State	Type[1]	Year Built	Size (acres)	Capacity (yd^3)	Percent Filled	Existing or Planned Uses after Filling	Construction Cost[4]
Cleveland Harbor Dike 12	OH	L	1974	56	2,760,000	100	Waterfront Dev.	$6,800,000
Huron Harbor	OH	L	1975	63	2,600,000	65	Small Boat Harbor	$6,400,000
Toledo Harbor Site 3	OH	L	1976	242	11,100,000	93	Port Development	$18,400,000
Buffalo Harbor Dike 4	NY	L	1977	107	6,900,000	52	Wildlife Area	$15,400,000
Lorain Harbor	OH	L	1977	58	1,850,000	56	Small Boat Harbor	$7,900,000
Erie Harbor	PA	L	1979	23	420,000	10	Industrial Dev.	$400,000
Cleveland Harbor Dike 14	OH	L	1979	88	6,130,000	87	Recreation/Park	$28,300,000
Michigan City	IN	U	1978	3	50,000	100	Recreation/Park	$300,000
Chicago Area	IL	L	1984	42	1,300,000	30	Marina Expansion	$7,800,000
Grand Haven Harbor	MI	U	1974	36	310,000	100	Public Use	$433,000
Milwaukee Harbor	WI	L	1975	44	1,600,000	87	Expansion	$5,963,000
Dickinson Island	MI	I	1975	174	2,000,000	67	Wildlife Area	$5,072,000
Manitowoc Harbor	WI	L	1975	24	800,000	45	Land Use Dev.	$4,147,000
Kenosha Harbor	WI	L	1975	32	750,000	100	Public Use	$8,270,000
Bolles Harbor	MI	L	1978	25	335,000	44	Marina Expansion	$972,000
Saginaw Bay	MI	I	1978	283	10,000,000	87	Wildlife Area	$14,844,000
Holland Hbr-Riverview Site[2]	MI	L	1978	11	120,000	100	Recreation/Park	$1,583,000
Holland Hbr-Windmill Site[2]	MI	I	1978	17	160,000	100	Recreation/Park	$1,654,000
Sebewaing Harbor	MI	U	1979	9	84,000	100	Airport Extension	$1,300,000
Duluth Harbor Erie Pier	MN	L	1979	82	1,000,000	65	Recreational	$1,558,000
Pte Mouille	MI	I	1981	700	18,000,000	45	Wildlife Area/Marsh	$55,856,000
Green Bay Harbor	WI	I	1979	60	1,200,000	99	Recreational	$5,565,000
Kewaunee Harbor	WI	L	1982	28	500,000	74	Recreational	$2,017,000
Frankfort Harbor	MI	U	1982	80	74,000	[3]		$800,000
Inland Route	MI	U	1982	9	19,500	38	Wildlife Area	$176,000
Monroe Harbor	MI	L	1983	89	4,300,000	66	State Park	$38,380,000
Keweenaw Waterway	MI	U	1987	21	308,000	79		$941,000
Clinton River	MI	U	1989	30	370,000	26	Recreational Area	$2,618,000

Table 1b. Great Lakes Confined Disposal Facilities Constructed under Authorities Other Than PL 91-611

Name/Location	State	Type[1]	Year Built	Size (acres)	Capacity (yd^3)	Percent Filled	Existing or Planned Uses after Filling	Construction Cost
Cleveland Harbor Dike 10	OH	L	1970	--	1,000,000	100	Waterfront Dev.	
Cleveland Harbor Dike 10B	OH	L	in prep	68	3,840,000	0	Airport	$32,900,000
Small Boat Harbor/Buffalo	NY	L	1968	33	1,500,000	100	Small Boat Harbor	$500,000
Times Beach/Buffalo	NY	L	1972	45	1,500,000	20	Wildlife Area	$500,000
Grassy Island (Isl 18)/Toledo	OH	I	1977	150	5,000,000	92	None	$5,000,000
Toledo Harbor Site 3 Ext	OH	L	1994	155	5,300,000	0		$4,800,000
Bayport/Green Bay	WI	L	1965	400	650,000		City Landfill	City Owned
Clinton River/Fisheries Site	MI	L	1979	4	21,000	100	Recreational Area	Unknown
Grassy Island/Detroit Riv.	MI	I	1960	80	4,320,000	100	Wildlife Area	$747,150
Harsen's Island/St Clair Riv.	MI	U	1975	17	100,000	100	Wildlife Area	Unknown
Kawkawlin River	MI	U	--	--	--	--		Private
Monroe Edison	MI	U	--	43	--	100	Detroit Edison	Private
Port Sanilac	MI	U	1979	13	143,300	100	Municipal Landfill	Used Once
Verplank/Grand Haven Harbor	MI	U	1974	19	134,000	100	Parking Lot	City Property
Whirlpool/St. Joseph Harbor	MI	U	1978	14	25,000	100	Transfer Site	$638,076
Malleable/St. Joseph Harbor	MI	U	1978	--	35,000	100		Unknown
Middleground/Saginaw River	MI	L	1978	13	150,000	100	Recreation Area	Unknown

1 U - Upland, I - In water, Island, L - In water, Adjacent to land or breakwater
2 Both facilities considered as one
3 Frankfort CDF was not used for permanent disposal and has been filled in with gravel.
4 Actual construction costs, not adjusted for inflation

For CDFs constructed under O&M authorities, the local sponsor requirements were determined in the original authorizing legislation for the navigation project. Generally, harbors authorized in the 19th century had little or no sponsor requirements, while projects authorized after World War II had significant sponsor requirements. In many cases, local sponsors have planned or implemented productive and beneficial uses for CDFs. These uses have included the development of recreational areas, new or expanded marinas, wildlife refuges, etc. An example is the marina development incorporated into the Manitowoc CDF design (figure 7). Such development must be compatible with the environmental integrity of the facility and the CDF lands cannot be transferred from the local sponsor without the approval of the Corps.

Figure 7. Manitowoc CDF

In 1996, Congress established uniform requirements for local cooperation for all new CDFs. Section 201 of the Water Resources Development Act (WRDA) of 1996 established a cost sharing formula based on the harbor depth. For most Great Lakes harbors, a new CDF will require a non-Federal sponsor to provide at least 25 percent of construction costs plus all lands, easements, rights-of-way and relocations. Section 217 of WRDA 1996 established procedures for a partnership between the Corps and a non-Federal governmental agency or private entity to collaborate on a CDF for multiple users.

The process by which most of the existing CDFs on the Great Lakes were planned and constructed can be divided into several key steps:

- Site Selection
- Identification of Local Sponsor
- Environmental Impact Statement
- Detailed Design
- Local Cooperation Agreement
- Obtain Appropriate Permits
- Construction

Fig. 8 Bolles Harbor CDF

This is an open, public process with a number of opportunities for input and comment. It is generally a very slow process. Site selection alone has taken ten years or longer in a few cases. It is fair to state that the decisions made during site selection are the most difficult and controversial. The responsibilities and priorities of Federal and state regulatory agencies must be balanced with the needs of the prospective local sponsors.

8. CDF Design and Operation

There is no single, best CDF design. The structural and environmental design is very site specific. The configuration of a CDF in a particular locale often reflects the intended use of the facility by the local sponsor after filling. CDFs are generally formed by the construction of dikes: upland facilities typically have earthen dikes; in-lake CDFs typically have stone dikes. The purpose of a CDF design is to retain as high a percentage of the sediment particles as practical (basic conclusion of the DMRP).

The EPA/Corps Technical Framework (USACE/USEPA 1992) is based on an evaluation of potential pathways by which contaminants associated with dredged material in a CDF might impact surface water, ground water, air, plant and animals. Laboratory tests are available to determine the mobility of contaminants along these pathways (i.e. leachate, effluent, runoff, plant/animal uptake). Using these tests, the significance of a contaminant migration pathway can be determined and appropriate controls (i.e. liners, water treatment, caps, etc.) designed. The Corps has also developed computer models to estimate contaminant losses and aid in CDF design (Brannon et al, 1990; Schroeder and Palermo, 1990; Stark, 1991).

In terms of wastewater treatment technology, CDFs function as settling basins. Existing CDFs were designed to retain greater than 99.9% of the sediment particles disposed. This is quite comparable with the efficiencies of advanced municipal wastewater treatment facilities. The dredged sediments are placed into the facility either mechanically (by a clamshell and crane or trucks) or hydraulically (by pipeline). Most of the coarse sediments (sands and gravel) settle rapidly near the point of disposal. Fine grained sediments (silts and clays) may require more time to settle out. Water (effluent) is drained or discharged from the CDF during dredged disposal operations. During non-dredging periods, limited amounts of water may be released from rainfall runoff or seepage.

Figure 9. Hydraulic dredge discharge to Chicago Area CDF

Most in-lake facilities have stone dikes constructed with layers of stone of increasing size. The center of the dike (core) typically contains sand or gravel. The outer layers of the dike have stone with sizes increasing from several pounds to several tons to protect the facility from wave energy. Most existing, in-lake CDFs have no liners. The stone dikes are permeable upon construction. The in-lake CDF has ponded water in hydrostatic equilibrium with the adjacent harbor, river, or lake.

As dredged material are placed into the CDF, water is moved passively through the dike. The sand or gravel in the core of the dike functions as a filter and retains much of the suspended sediments. As the in-lake CDF becomes filled, portions of the dike become clogged as the sediments are mounded against it. The stone dike becomes progressively less and less permeable. At some point, the stone dike becomes clogged to the stage where water cannot exit as fast as dredgings are disposed. The water level within the CDF will now rise during disposal. In order to control the water level within the CDF a variety of release mechanisms have been used. These include fixed or adjustable overflow weirs and filter cells.

Many variations on the above design have been employed at existing CDFs. Some dikes have liners, including clay, plastic fabrics, and grouted mattresses. Some dikes have steel sheet pile in portions of the design. The design intent is the same; to retain the sediment particles to which the contaminants are tightly bound.

9. CDF Monitoring and Management

Monitoring procedures at CDFs are as individual as the designs. There is no single, systematic monitoring program applicable to all facilities. The monitoring program for a CDF is typically the result of comments and coordination with state and Federal regulatory agencies. The final monitoring program may be included in the Section 401 water quality certification issued by the state. When the CDF has been constructed, an Operation & Maintenance Manual prepared by the Corps is used to outline monitoring activities to be performed by the Corps during the CDFs operating life, and by the local sponsor after the CDF has been filled.

The integrity of CDF dikes and other design features are inspected at least annually. If there is a severe meteorolgical event (e.g., high waves or especially heavy rain), additional inspections of CDF dikes are typically performed. Special monitoring studies have been conducted at existing CDFs for a variety of purposes. Dye tracer tests have been conducted at seven in-water facilities to test the integrity of liners and dike walls. CDF repairs and/or modifications were made as needed. Stone dikes at in-water CDFs require routine maintenance every few years (stone replacement or repositioning). Earthen dikes at upland CDFs are inspected for erosion and undesirable plants (with roots that might compromise dike integrity).

Plants grow quickly on contaminated dredged material inside CDFs and many types of animals are attracted to the upland/aquatic habitats inside CDFs. This can present a real management dilemna:

Figure 10. Vegetation inside Green Bay CDF

> Is it better to allow plant and animal utilization of the CDF since it may represent the only suitable habitat within a largely urbanized area, or

> Is it better to prevent plant and animal utilization of the CDF because of the contaminated nature of the dredged material?

Figure 11. Times Beach CDF

The Times Beach CDF in Buffalo (figure 11) has been used extensively for scientific investigations on the effects of contaminated dredged materials on flora and fauna at the site (Stafford et al, 1991).

These, and other studies are used to formulate management plans for native vegetation and animal life which inhabit CDFs. Plants in CDFs have been controlled by cutting, burning or herbicides because of concerns about contaminant uptake, attraction of animals, and the loss of CDF capacity. Animals have been controlled by removing plants, trapping, fences, and even pesticides (rotenone). Spotting and removing dead animal carcasses is very important in CDFs because of the potential for botulism poisoning of waterfowl.

CDF water quality monitoring is generally conducted during the dredging operation and consists of monitoring the effluent at the weir overflow or filter cells, the mixing zone, dredge discharge, and open water sites near the discharge or around the CDF. Twelve facilities have monitoring wells installed in the dike walls. The type of chemical analysis conducted on water quality samples collected has varied, depending on the type and level of pollutants in the dredged sediments and local or regional water quality priorities.

The results of water quality monitoring has confirmed that CDFs are highly efficient at retaining the sediment solids and attached contaminants. CDF effluents typically have suspended solids levels between 10 and 150 mg/l. As CDFs become filled, the detention time for particle setting is reduced. In some cases, mechanical dredging and disposal to the CDF are required to maintain effluent water quality compliance.

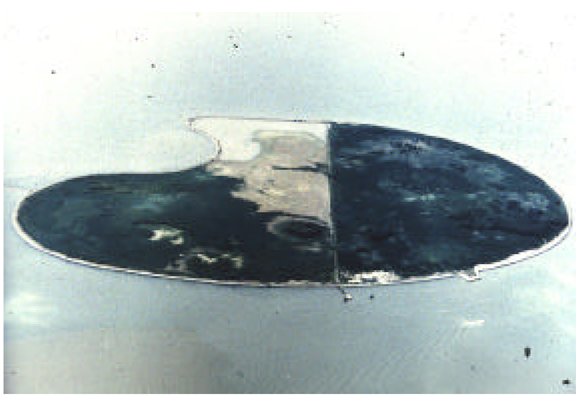

Figure 12. Saginaw Bay CDF

The environmental significance of contaminant losses from in-lake CDFs was the focus of detailed studies at the Saginaw Bay and Chicago Area CDFs. The USEPA and Corps worked together to evaluate the losses of PCBs from the Saginaw Bay CDF (figure 12) through biomonitoring techniques and computer modeling. The results of computer modeling suggested that the Saginaw CDF was between 99.82 and 99.93 percent efficient in retaining PCB's (Myers, 1991). The PCB loss predicted by a simulation of 5,000 days was only 0.25 Kg (Velleux et al, 1993). Biomonitoring could not detect any contaminant losses from the CDF (Velleux et al, 1993).

In a separate study, biological organisms were collected in and around the Chicago Area CDF to detect evidence of PCB losses (Dorkin et al, 1989). While the fish and invertebrates collected from within the CDF had higher levels in their tissues than in surrounding waters, organisms from immediately outside the CDF were not significantly different from remote stations, indicating no discernable loss of PCBs from the CDF. Another study conducted at the Chicago Area CDF have attempted to measure the volatile loss of PCBs (REFERENCE?).

10. Future Trends

Over the past 30 years, twenty-three of the 44 Great Lakes CDFs have been filled or have less than ten percent of their capacity remaining (table 1). In that time, the volume of sediments dredged annually from Great Lakes harbors and channels has reduced slightly, owing to Federal funding limitations. Superfund and other enforcement programs have enabled the removal of significant volumes of contaminated sediments from rivers and harbors for environmental remediation. Environmental regulatory programs, improvements in wastewater treatment technology, sediment remediation and pollution prevention have reduced the levels of contamination in “new” sediments depositing in navigation channels. The regulations on the management of dredged material have become more rigorous and the non-Federal cost-sharing requirements for new CDFs have increased with the Water Resources Development Act of 1996. The combination of these factors has produced the following impacts:

- continued demand for CDFs to manage contaminated dredged material for navigation
- increased demand for CDFs to manage contaminated sediments dredged for remediation
- more stringent environmental requirements for new CDFs
- costs of new CDFs are increased beyond that due to inflation
- fewer ports and local governments are capable of sponsoring a new CDF

The above conditions have begun to change the way in which CDFs are perceived in the Great Lakes. The cost-sharing requirements have placed a substantial incentive on ports and local governments to prolong the useful life of existing CDFs. Agencies and industries responsible for sediment remediation have recognized the financial and political advantages of partnering with the Corps and navigation interests in the development of a multi-user CDF. Congress has recognized the importance of soil conservation and other preventative measures in the long-term solution of Great Lakes dredged material management needs.

In order to increase the capacity of existing CDFs, there are at least three options available. One is to raise the elevation of the surrounding dikes. A second is to increase consolidation of dredged material in the CDF through aggressive dewatering. A third option is to remove material from the CDF. The first and last of these options have been implemented at Great Lakes CDFs, while the second is still being considered (Miller 1997).

Raising the dikes of an existing CDF can provide additional capacity with limited capital cost and minimal environmental controversy. One approach is to build low berms or “push-up” dikes interior to the main structural dikes using dredged material excavated from within the CDF. Dike raising is most attractive in CDFs with a large surface area. In smaller facilities, this option may only provide capacity for a few dredging cycles. In addition, the increased height of the CDF may not be consistent with the uses planned by local sponsors. The Cleveland CDF dikes were raised in 1995 to provide enough capacity for four years of dredging, while a new CDF was completing design and construction. This timing was negotiated with the sponsor, who was anxious to use the filled CDF for park and recreational development.

Another means for enhancing the capacity of existing CDFs is by increasing the consolidation of dredged material through active dewatering practices. Experience at Great Lakes CDFs has shown that self weight consolidation of dredged material can provide approximately 25-30 percent additional capacity over the filling life (10-15 years). In order to improve the consolidation, districts are currently looking into a number of dewatering technologies, including wick drains and subsurface drains.


Figure 13. Washed sand at Erie Pier CDF in Duluth

As the levels of contaminants found in dredged material at many Great Lakes harbors have declined, some of the sediments being placed into CDFs may be suitable for beneficial use, like construction fill or landfill cover (Miller et al. 1997). At several existing CDFs which are nearly filled, local port authorities have taken the lead in identifying potential uses for dredged material excavated from CDFs. The Brown County Port Authority has received a grant from the USEPA to modify the Bayport CDF in Green Bay, Wisconsin to prepare dredged material for use as a fill in road construction projects. The Milwaukee Port Authority is investigating the feasibility of using dredged material from the Milwaukee CDF to cap an abandoned waste dump. The Toledo Port Authority is exploring the development of a manufactured (bagged) soil product with dredged material, biosolids and other "waste" materials. At the Erie Pier CDF in Duluth, Minnesota, dredged material is treated in a crude soil washing operation to separate clean sand from the silt and clay. The sand is removed with earthmoving equipment, stockpiled and transported away from the CDF by truck for use as construction fill, landscaping and other applications (Olin and Bowman 1996) .

Sediment remediation has been completed or initiated at over 30 sites in the Great Lakes (USEPA 1998). At many sites, sediment remediation has become stalled because of limited funds, lack of corporate involvement, regulatory complexities and lack of public support (IJC 1997). In some of these same areas, the ports, navigation users and Corps have also become stalled in their search for a CDF for many of the same reasons. The common needs of navigation and environmental remediation for a CDF have forged several innovative partnerships. At the Ashtabula River in Ohio and Indiana Harbor, Indiana, CDFs are being planned and designed for contaminated sediments dredged from navigation channels and as part of environmental restoration. The U.S. Fish & Wildlife Service and State of Michigan are working with the Corps to use the existing CDF at Saginaw Bay for management of contaminated sediments removed as part of a Natural Resources Damage Assessment settlement.

In 1993 and 1996, Congress directed the Corps to evaluate measures that might reduce the amount of sediments dredged at Great Lakes harbors and channels through prevention.

Working through the Department of Agriculture, Natural Resource Conservation Service (NRCS) a program was implemented to provide incentives to farmers in the Maumee River watershed to convert to no-till farming. This program, in conjunction with other soil conservation programs of the NRCS has shown the ability to reduce sediment loadings from the Maumee River by about 10-15 percent (REFERENCE). An economic evaluation conducted for the National Oceanic & Atmospheric Administration (NOAA) and the Northeast Midwest Institute indicates that the potential savings to dredging and dredged material management appear to outweigh the costs of soil conservation measures in the Maumee River Basin (REFERENCE). In 1998, the Corps initiated a program to develop sediment transport models for Great Lakes tributaries in order to identify areas where soil conservation and non-point source pollution controls might yield reductions to dredging and dredged material management costs. Information on the program is available at its web site (www.glc.org/projects/sediment).

11. Summary

The Corps of Engineers has designed, constructed, and operated confined disposal facilities (CDFs) for the management of contaminated sediments dredged in order to maintain navigation projects on the Great Lakes. This report has provided a broad overview on CDFs on the Great Lakes. The CDF program has provided an environmentally responsible alternative to open-water disposal of polluted sediments. CDF designs have been quite varied, but have all been based on scientific and engineering principles developed from extensive research and validated by field experience and monitoring.

Though not authorized as an environmental clean-up program, the construction and operation of CDFs has enabled the Corps to remove over 60 million cubic yards of contaminated sediments from Great Lakes harbors and waterways. So long as contaminated sediments are removed to maintain safe navigation channels or for environmental remediation, there will be a continued need for CDFs.

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