Phase II Report
Dredged Material Management Plan Study
January 2008

Milwaukee Harbor, Wisconsin

US Army Corps of Engineers®

Detroit District

EXECUTIVE SUMMARY

The Milwaukee Harbor long-term disposal study was initiated in 1993 under the Authority of Section 123, P.L.91-611. Policy and procedures regarding development, review, approval, and implementation of Dredged Material Management Plans (DMMP) were subsequently established in July 1994. To conform to the new policy, this Phase II Final DMMP Document has been prepared and phases the study into the new procedures. This document identifies specific measures necessary to manage the volume of material likely to be dredged over a 20 - year period.

The Milwaukee Harbor Federal Navigation Project is located on the west shore of Lake Michigan at the city of Milwaukee, Wisconsin which is about 85 miles north of Chicago, Illinois, and approximately 83 miles west of Grand Haven, Michigan. The project is a commercial harbor at the confluence of the Milwaukee, Menomonee, and Kinnickinnic Rivers. With the current dredging cycle the Jones Island Confined Disposal Facility (CDF), utilized for disposal of maintenance material, would be at full capacity in 2011. Due to an anticipated event of disposal of 176,000 cubic yards of permittee dredged material, the CDF could be at capacity in 2008. This permittee action would place material dredged from the Kinnickinnic River, as part of an effort sponsored by the Environmental Protection Agency, Wisconsin Department of Natural Resources and the Milwaukee Port Authority. A tipping fee will be assessed to cover the cost of the permittee dredging capacity. A disposal plan to accommodate, at a minimum, 20-years of future dredged material (510,000 cubic yards of material), is needed. Maintenance dredging of Milwaukee Harbor would allow continued economic benefits associated with navigation of this commercial harbor. Accommodating the permittee dredging while providing DMDF capacity for navigation will have positive economic and environmental effects in providing a synergistic and cost-reducing approach in comparison to the implementation of a single-purpose project for either purpose, and is determined to be in the public interest.

Numerous alternatives for dredged material disposal at the Harbor have been investigated to date. These range from new upland dredged material disposal facilities, in-water placement, beneficial use of material such as beach nourishment, and no action. This study seeks a disposal solution that is the least costly, engineeringly, economically and environmentally feasible project alternative.

Based upon the investigation presented in this Phase II Dredged Material Management Plan document, the alternative plan to construct a DMDF (Dredged Material Disposal Facility) on top of the existing Milwaukee Jones Island CDF, is designated as the “Base Plan”. This Base Plan forms the basis for future actions leading toward implementation of a disposal facility to adequately handle dredged material disposal for a minimum of 20 years for Milwaukee Harbor.

Please note that any references in this report regarding elevations refer to International Great Lakes Datum (IGLD), 1955. To convert to IGLD 1985, add 0.7 feet.

PHASE II REPORT
DREDGED MATERIAL MANAGEMENT PLAN
MILWAUKEE HARBOR, WISCONSIN

January 2008

U.S. ARMY CORPS OF ENGINEERS
DETROIT DISTRICT

PHASE II REPORT
FINAL DREDGED MATERIAL MANAGEMENT PLAN
MILWAUKEE HARBOR, WISCONSIN

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MILWAUKEE HARBOR, WISCONSIN
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)

1. PROJECT DESCRIPTION

Milwaukee Harbor is located in the city of Milwaukee, Milwaukee County, Wisconsin, which is located about 85 miles north of Chicago, Illinois (See Figure 1). Milwaukee Harbor is a deep draft harbor at the confluence of the Milwaukee, Menomonee, and Kinnickinnic Rivers. The authorized project at Milwaukee Harbor has two segments which consist of an outer and inner harbor (See Figure 2). The outer harbor is situated between the harbor's breakwaters located approximately 3,000 feet offshore and the shoreline, over a length of about 3.5 miles. The north and south breakwaters in the outer harbor have lengths of 9,954 feet and 9,646 feet, respectively, and are separated by a 500 foot entrance channel into Lake Michigan. The inner harbor extends the commercial navigation channel to portions of the Milwaukee, Menomonee, and Kinnickinnic Rivers, as well as the South Menomonee and Burnham Canals. The entrance channel into the inner harbor is formed by piers on the north and south sides of the channel which are 1,656 feet and 1,621 feet in length, respectively. The width between the piers is 358 feet at the outer harbor and 552 feet at the entrance to the Milwaukee and Kinnickinnic Rivers.

2. SCOPE OF THE STUDY

This study is conducted under the guidance of the Planning Guidance Notebook (ER 1105-02-100), Appendix E, paragraph 15, dated 22 April, 2000. The purpose of this Dredged Material Management Plan (DMMP) study is to determine if additional suitable dredged material placement sites are located in the vicinity of Milwaukee County that will satisfy future dredge disposal needs of a 20-year capacity associated with the Milwaukee Harbor. The decision to recommend implementing the final Management Plan is based upon a preliminary appraisal that at least one potential solution would be engineeringly, economically and environmentally feasible, will be in accord with current Federal policies and budgetary priorities, and will be supported by the project's sponsor, the Milwaukee Port Authority.

The purpose of this DMMP document is to: (a) present studies that have been conducted to date; (b) provide an economic assessment to justify continued maintenance dredging; (c) discuss potential options that appear viable for disposal of dredged material; and (d) select a Base Plan for Milwaukee Harbor dredged material disposal.

The level of detail in this Phase II DMMP document is limited by the extent of information available in the study time frame. In the Phase II DMMP document phase of the study process, problems and opportunities of the project are defined and potential alternatives

are formulated and analyzed to identify a plan (or plans) that would handle the dredging volume for a 20-year period.

3. AUTHORIZATION AND DEVELOPMENT HISTORY

3.1 General

Authorizing legislation for the dredging Milwaukee Harbor has evolved over the years. Legislation specific to Milwaukee Harbor is shown on Table 2.

Prior to 1976, dredged material for the Milwaukee Harbor was generally open water placed. In 1976 the Jones Island Confined Disposal Facility (CDF), constructed by the Corps, began accepting dredged material from Milwaukee Harbor and has been the primary placement site of dredged material A summary of disposal locations for annual maintenance dredging is displayed below in Table 1.

3.2 Permittee Disposal at Jones Island CDF

With the current dredging cycle the Jones Island Confined Disposal Facility (CDF), utilized for disposal of maintenance material, would be at full capacity in 2011. Due to an anticipated event of placement of 176,000 cubic yards of permittee dredged material, the CDF could be at capacity in 2008. This permittee material would be dredged from the Kinnickinnic River in an area upstream of the navigation channel and placed at a designed cell within the CDF. The Great Lakes Legacy Act material would be placed within the capacity of the existing Milwaukee Confined Disposal Facility and is not part of the new Dredged Material Disposal Facility being proposed. Dredging of the Kinnickinnic River is being pursued by the Environmental Protection Agency (EPA), Wisconsin Department of Natural Resources (DNR) and Milwaukee Port Authority as a Great Lakes Legacy Act action. As a condition of using the remaining capacity, a tipping fee will be assessed for the permittee dredging.

The large amount of material associated with dredging of the Knninckinnic River hastens the filling of the Jones Island CDF. To facilitate accommodating future disposal needs the Port of Milwaukee has indicated a willingness to share the future cost of material disposal and act as the local sponsor for the base plan developed under this study. The Port of Milwaukee has received a 1.8 million dollar grant from the Wisconsin Department of Transportation to expand their disposal capability.

Table 1 Channel Maintenance History					
FY	Total Cost[1]	Cubic Yards	Cost/CY[1]	Placement Site	Contractor or Government
1957	N/A	190,000	N/A	N/A	Contractor
1960	N/A	169,495	N/A	N/A	Government
1962	N/A	150,454	N/A	N/A	Government
1963	$234,564	26,119	$8.95	N/A	Government
1964	$131,666	29,866	$4.39	N/A	Government
1965	$48,758	56,220	$0.81	N/A	Contractor
1965	N/A	214,057	N/A	N/A	Government
1965	$266,203	34,747	$7.65	N/A	Government
1965	N/A	2,750,166	N/A	N/A	Government
1966	$2,226,583		N/A	N/A	Government
1966	$9,658,420		N/A	N/A	Government
1966	N/A	387,426	N/A	N/A	Government
1966	N/A	1,207,856	N/A	N/A	Government
1967	$3,194,320	197,300	$16.19	N/A	Government
1967	$550,002	50,650	$10.89	N/A	Government
1968	N/A	80,075	N/A	N/A	Government
1969	N/A	59,333	N/A	N/A	Government
1976	$4,575,274	465,833	$9.83	Jones Island CDF	Government/ Contractor
1977	$445,040	125,000	$3.55	Jones Island CDF	Government
1978	$2,602,168	208,389	$12.50	Jones Island CDF	Contractor
1981	$1,270,606	92,500	$13.74	Jones Island CDF	Contractor
1982	$874,536	83,016	$10.54	Jones Island CDF	Contractor
1987	$2,687,226	307,656	$8.73	Jones Island CDF	Contractor
1990	$315,650	28,033	$11.25	Jones Island CDF	Contractor
1990	$211,026	10,757	$19.62	Jones Island CDF	Contractor
1991	$913,138	95,597	$9.55	Jones Island CDF	Contractor
1993	$756,982	108,067	$7.01	Jones Island CDF	Contractor
1995	$280,016	18,934	$14.79	Jones Island CDF	Contractor
1999	$720,525	54,259	$13.28	Jones Island CDF	Contractor
2001	$26,426	1,218	$21.69	Jones Island CDF	Contractor
2007	765,600	72,000	$10.63	Jones Island CDF	Contractor
Totals	$32,725,302	7,287,908			

[1] All values in FY07 dollars. Years 1963 through 1967 updated using Engineering News Record (ENR) cost index, subsequent years updated using Civil Works Construction Cost Index System.

Section 123 of the 1970 River and Harbor Act (Public Law 91-611) authorized the Corps of Engineers to construct, operate, and maintain contained placement areas for contaminated dredged material in the Great Lakes area. This law provided for the construction of CDFs specific to the region, with local interests supplying lands, easements and right-of-ways. Construction of the existing CDF at Milwaukee Harbor under Section 123 was at 100% Federal cost. A 25% non-Federal cost share was waived in cases that the sponsor was participating in a wastewater treatment program and was not violating water quality standards. However, construction of a new CDF under Section 123 is no longer possible due to a change in policy.

Until passage of the Water Resources Development Act (WRDA) of 1996, there was no specific administrative policy for cost sharing the construction of a new CDF. Administration policy had followed criteria per a 23 July 93 Assistant Secretary of the Army, Civil Works (ASA-CW) memorandum that the Army could accept contributions from non-Federal interests for the pre-1986 projects for all expenses associated with a CDF, unless precluded by authorizing legislation. If a project's authorization was vague regarding responsibility for CDF construction, it was not to be 100% Federal.

Cost sharing for construction of Dredged Material Disposal Facilities (DMDF) associated with the construction and operations and maintenance of Federal navigation projects for harbors and inland waters was established by WRDA '96. It specifies that land-based and aquatic dredged material disposal facilities shall be considered as general navigation features of the project. Section 101 of WRDA '86, as amended by Section 201 of WRDA '96, that pertain to cost sharing for maintenance dredging are as follows;

SEC. 101 HARBORS.
(a) Construction.-

(1) PAYMENTS DURING CONSTRUCTION. - The non-Federal interests for a navigation project for a harbor or inland harbor, or any separable element thereof, on which a contract for physical construction has not been awarded before the date of enactment of this Act shall pay, during the period of construction of the project, the following costs associated with general navigation features:

(A) 10 percent of the cost of construction of the portion of the project which has a depth not in excess of 20 feet; plus

(B) 25 percent of the cost of construction of the portion of the project which has a depth in excess of 20 feet but not in excess of 45 feet; plus

(C) 50 percent of the cost of construction of the portion of the project, which has a depth in excess of 45 feet.

(2) ADDITIONAL 10 PERCENT PAYMENT OVER 30 YEARS. - The non-Federal interests for a project to which paragraph (1) applies shall pay an additional 10 percent of the cost of the general navigation features of the project in cash over a period not to exceed 30 years, at an interest rate determined pursuant to section 106. The value of lands, easements, rights-of-way, and relocations (LERRDs) provided under paragraph (3), and the costs of relocations borne by the non-Federal interests under paragraph (4) shall be credited toward the payment required under this paragraph.

(3) LANDS, EASEMENTS, AND RIGHTS-OF-WAY. -The non-Federal interests for a project to which paragraph (1) applies shall provide the lands, easements, rights-of-way, and relocations (other than utility relocations, under paragraph (4)) necessary for the project including lands, easements, rights-of-way, and relocations (other than utility relocations accomplished under paragraph (4) that are necessary for dredged material disposal facilities.

(4) UTILITY RELOCATIONS. - The non-Federal interests for a project to which paragraph (1) applies shall perform or assure the performance of all relocations of utilities necessary to carry our the project, except that in the case of a project for a deep draft harbor and in the case of a project constructed by non-Federal interests under Section 204, one-half of the cost of each such relocation shall be borne by the owner of the facility being relocated and one-half of the cost of each such relocation shall be borne by the non-Federal interests.

(5) DREDGED MATERIAL DISPOSAL FACILITIES FOR PROJECT CONSTRUCTION. - In this subsection, the term “ general navigation features” includes constructed land-based and aquatic dredged material disposal facilities that are necessary for the disposal of dredged material required for project construction and for which a contract for construction has not been awarded on or before the date of enactment of this paragraph.

TABLE 2
AUTHORIZING LEGISLATION

ACT	WORK AUTHORIZED	DOCUMENTS
Aug 30, 1852	North Pier[1]	S. Doc 175, 25th Cong., 2nd Sess.
Mar 3, 1883	Inner 7,600 feet of breakwater[12]	Annual Report, 1881, p 2122
Mar 2, 1907	South Pier. Extending north breakwater.1,000 feet	Annual Report, 1906, p. 1752 (No prior survey or estimate affecting breakwater extensions)
Sep 22, 1922	Extend north breakwater; a south breakwater; Present dimensions of inner entrance channel.	H. Doc 804, 66th Cong., 2nd Sess.
Aug 30, 1935[2]	Dredging a portion of outer harbor to 21-foot depth	H. Doc. 289, 72d Cong., 1st Sess.
Mar 2, 1945[3]	Dredging river channels to 21-foot depth	S. Doc. 29, 76th Cong., 1st Sess.
Jul 14, 1960	Deepen South Menominee and Burnham Canals to 21 feet	H. Doc. 285, 86th Cong., 2nd Sess.
Oct 23, 1962	Deepen an approach channel to 30 feet by 800 feet wide and 300 feet wide through breakwater, deepen entrance channel 28 feet through piers, outer harbor to 28 feet south of entrance channel, and a channel 27 feet in Milwaukee River to Buffalo Street, and in Kinnickinnic River to Chicago & North Western R.R. bridges.	H. Doc. 134, 87th Cong., 1st Sess[4].

1. Completed under previous project
2. Uncompleted portion was de-authorized December 31, 1989 under section 1001, P.L. 99-662.
3. Uncompleted portion was de-authorized 1977 (dredging Milwaukee River from Buffalo Street to north Humboldt Ave Bridge.
4. Contains the latest published map

3.3 Milwaukee Harbor

The Milwaukee Harbor is located on the west side of Lake Michigan approximately 85 miles north of Chicago, Illinois. The River and Harbor Acts of 30 Aug 1935, 2 Mar 1945, 14 July 1960, and 23 October 1962 authorized the construction of breakwaters and dredging of the harbor to accommodate robust commercial shipping activity. See Figure 2 for project map of the harbor.

3.4 Milwaukee (Jones Island) CDF

The existing 44 acre Jones Island CDF was completed in 1975 at a cost of $5,962,806 and is located in the south side of the outer harbor. This facility was authorized by the Chief of Engineers, U.S. Army Corps of Engineers, under Section 123 of the River and Harbor Act of 1970 (Title I of Public Law 91-611). Section 123 of this act provided for the construction of CDFs which have a capacity to hold 10 years of dredged material placement needs specific to the Great Lakes Region, with local interests supplying lands, easements, and rights-of-way. Construction of the CDF at Milwaukee Harbor was accomplished at 100 percent Federal cost. Its purpose is to receive dredged material that is unsuitable for open lake placement from both Milwaukee Harbor and Port Washington Harbor, which is located approximately 25 miles north of Milwaukee Harbor. This placement facility was designed to use both mechanical and hydraulic dredging operations. The facility contains filter cells. The design capacity of the facility was to hold 1,600,000 cubic yards of contaminated dredged material. See Figure 3 for aerial photo of the harbor.

3.5 Previous Studies

U.S. EPA formally selected the site as a Great Lakes Legacy Act project and provided funds to finalize the Milwaukee Harbor Concept Design in 2005.

Wisconsin Department of Natural Resources formally requested use of the Milwaukee CDF, June 2004.

Milwaukee Harbor Concept Design Document, Under Section 401(a) of the Water Resources Development Act (WRDA) 1990 (as amended) the Wisconsin Department of Natural Resources requested that the Corps provide assistance for the planning and engineering portion of a project to remove sediments from the Kinnickinnic River. An agreement to provide the assistance was executed 13 August 2002.

Milwaukee Harbor, Wisconsin Phase I Scoping Document- Summary Report,Dredged Material Management Plan (December 1997). Five sites were evaluated for potential CDF locations under the authority of PL 91-611.

Repair of North Detached, South Detached and South Shore Connector Breakwaters, *Milwaukee Harbor, Environmental Assessment & 404(b)(1) evaluation (February 1995).*

Rehabilitation of Sections of the North Breakwater and North Entrance Pier at Milwaukee Harbor, Revised Environmental Assessment & 404(b)(1) evaluation (February 1985).

General Design Memorandum, Rehabilitation of the North Breakwater and North Pier, Milwaukee Harbor, (October 1984).

Rehabilitation of the North Breakwater and Entrance Pier at Milwaukee Harbor, Environmental Assessment & 404(b)(1) evaluation (July 1984).

Milwaukee Harbor South Breakwater Head Repair, Environmental Assessment (March 1982).

Review Report, Milwaukee Harbor, (March 1974)

Maintenance Dredging at Milwaukee Harbor, Wisconsin, Final Environmental Statement (November 1974).

Navigation Improvements at Milwaukee Harbor, Wisconsin Draft Environmental Impact Statement (November 1973)

Milwaukee Diked Disposal Area, Final Environmental Statement (April 1972). The report evaluates the impacts for the Jones Island disposal site.

4. DESCRIPTION OF EXISTING CONDITION

4.1 General

Evaluation of Milwaukee Harbor channel sediments was completed (2002) in accordance with the Great Lakes Dredged Material Testing and Evaluation Manual USEPA/USACE, 1998). The Manual presents guidance on testing and evaluation for proposed discharges of dredged material into U.S. waters of the Great Lakes Basin. The physical and chemical testing conducted indicated that the sediments in the outer and inner harbor areas may have deleterious impacts to water quality and benthic organisms. Therefore the material is not suitable for unrestricted in water disposal.

The channel limits identified in the Milwaukee Harbor Dredged Material Management Plan (DMMP) study are all Federal channels generally from the harbor entrance to approximately 1.75 miles to the upstream limit of the Menominee River. Results from 2002 sampling and analysis of channel sediments indicate 85% fine material (silt with clay). Levels of metals were moderately high, with above background conditions for arsenic, barium, cadmium, chromium, and lead. Semi-volatile organic compounds were moderately high. PCB levels were mostly non-detectable, with a few stations just above 1.0 ppm. Pesticides were non-detectable. Appropriate disposal would isolate the material preventing impacts to water

quality and benthic organisms including the lower reaches of the Milwaukee and Kinnickinnic Rivers.

4.2 Outer Harbor

Extending from Lake Michigan, the project depth and width in the lake approach channel are 30 feet and 800 feet, respectively. At the entry into the outer harbor, the width reduces to 300 feet and then expands to 600 feet inside the outer harbor breakwaters. From this point, the width varies in the outer harbor. The project depth is 28 feet in the south outer harbor and at the entrance channel, and 21 feet northward.

Most of the north breakwater was rehabilitated from 1957 to 1964. Major rehabilitation of the navigation structures, including 4,240 linear feet of the north breakwater and 1,656 linear feet of the north entrance, is complete. Additional major rehabilitation work completed includes removal of an existing barrier on the outer 754 feet of the north shore connected breakwater.

4.3 Inner Harbor

In the entrance channel to the inner harbor, the width is 280 feet at the outer harbor and 452 feet at the entrance to the Milwaukee and Kinnickinnic Rivers. The width of the Federal channel varies from approximately 200 feet at the downstream end to approximately 80 feet at the upstream end.

Following is a brief description of major public channels and cannels that comprise the inner Milwaukee Harbor;

- Milwaukee River; The project depth is 27 feet to the Chicago and Northwestern Railway Swing Bridge at mile 0.2 and 21 feet to the East Buffalo Street Bridge.

- Kinnickinnic River; The project depth is 27 feet from the inner harbor entrance, extending to the Chicago and Northwestern Railway Swing Bridge at mile 1.0, then decreasing the depth to 21 feet, extending to the upstream project limit at South Kinnickinnic Avenue Bridge (State Highway 32).

- Menomonee River; The project depth is 21 feet, from the confluence between the Milwaukee River and the Menominee River, extending to the upstream limit of the Federal navigation channel, which is approximately 1,500 feet downstream of the US 41 bridge.

- South Menomonee Canal; The project depth is 21 feet, from the confluence between the Menominee River and the South Menominee canal, extending to the upstream project limit of the Federal navigation channel, which is approximately 1,100 feet upstream of I 94 bridge.

- Burnham Canal; The project depth is 21 feet, from the confluence between the South Menominee canal and the Burnham cannel, extending to the upstream limit of the Federal

navigation Channel, which is approximately 400 feet upstream of I-94 bridge.

4.4 Jones Island CDF

Currently, the dredged material from Milwaukee Harbor (defined above) is placed in the Jones Island Confined Disposal Facility (CDF), also referred to as the Milwaukee Harbor CDF. The Jones Island CDF is located adjacent to the shoreline at the southern extremity of the outer harbor. In 1998, a portion of the south end of the Jones Island CDF was converted to a docking facility for car ferry service. Jones Island continues to receive dredged material that is unsuitable for open lake placement from Milwaukee Harbor. Although in the past dredged material from Port Washington Harbor was placed in the CDF, there are no longer commercial users in Port Washington and therefore it is not anticipated to be dredged in the future. The original design of the CDF included a filter cell, which allows for hydraulic or mechanical method of dredging, but since the WI DNR does not allow a discharge, only mechanical method is used. See Table 3 below with the channel maintenance history of Port Washington.

Table 3
Port Washington Channel Maintenance History

FY	Total Cost[1]	Cubic Yards	Cost/CY[1]	Placement Site	Contractor or Government
1977	$980,002	14,372	$68.18	Jones Island CDF	Government
1978	$139,173	0	$0.00	Jones Island CDF	Government
1981	$857,666	16,484	$52.02	Jones Island CDF	Contractor
2003	$224,520	11,204	$20.05	Jones Island CDF	Contractor
Totals	$2,201,361	42,060			

[1] All values in FY07 dollars.

The future DMDF must be able to contain at a minimum, a 20-year dredged material capacity (including backlog), which in this case is 350,000 cubic yards (cy). Permittee dredging is calculated at 160,000 cubic yards (cy). The 20-year maintenance dredging capacity is based on a dredge cycle of 4 years and an average quantity of 70,000 cy.

The dredging volume for the Milwaukee Harbor has been considerably reduced with the construction of the "Big Tunnel" storm water retention basin under the City of Milwaukee (See Chart 1 on page 11). In addition there is a large backlog of approximately 270,000 cubic yards in the Navigation Channel due to a lack of funds available to completely maintain the channel. The backlog volume was not included in future dredging calculations. The 17,500 cy/year figure was based on reviewing dredging volumes for the last 20 years. Those figures were annualized to spread the volume over a per year basis (See Chart 2 on page 11). As can be seen, the 17,500 cy/year figure allows an ample quantity of volume. The 70,000 figure was based on an estimate of 17,500 cubic yards per year of dredging and dredging cycles of

approximately 4 years. Capacity figures include the volume of the dikes so excavating material from the CDF or DMDF to construct on-site berms does not create any additional capacity.

Chart 1. Dredging Volumes expressed on a per year basis for Milwaukee Harbor.

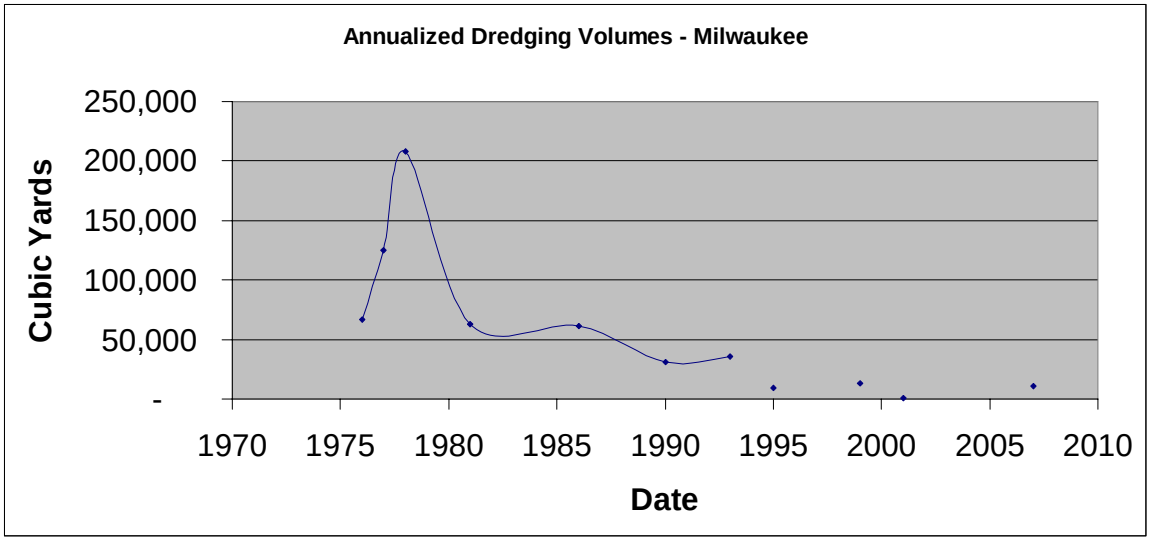
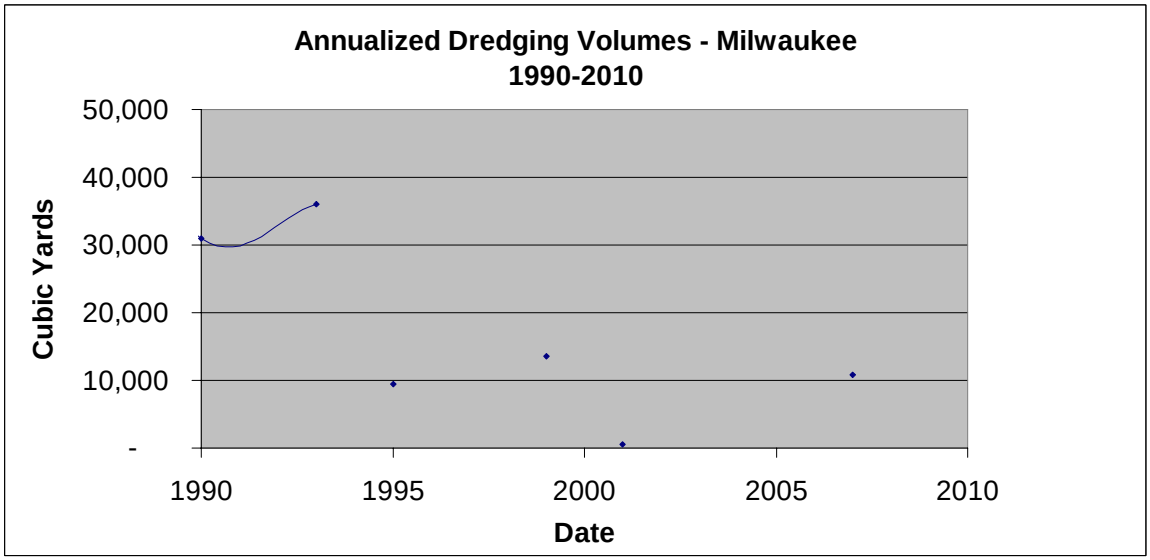


Chart 2. Dredging Volumes in Milwaukee over the period 1990-2010.



5. PROJECTION OF FUTURE CONDITIONS IN THE ABSENCE OF A MANAGEMENT PLAN

In the absence of a Management Plan, there is approximately enough remaining capacity for 5 years. After that, the lack of dredging would result in shoal buildup, which reduces channel depth, forcing ships to light load (partially load) or discontinue transit into the Milwaukee Harbor. Also, shoaled channels cause more sediment re-suspension from ship hulls and prop wash. Light loading reduces draft, which allows the vessels to clear the shoals, but increases per-unit shipping costs, which consequently increases costs to industry and the consumer.

Without project conditions remaining dredged cycles

Calendar Year	Project Year	Sediment Placed In existing CDF	
2007	1	72,000	
2008	2	30,000	Scheduled
2009	3		
2010	4		
2011	5	70,000	* CDF will be essentially full
2012	6		
2013	7		
2014	8		
2015	9	70,000	New site required
2016	10		
2017	11		
2018	12		
2019	13	70,000	New site required
2020	14		
2021	15		
2022	16		
2023	17	70,000	New site required
2024	18		
2025	19		
2026	20		
2027	21	70,000	New site required
2028	22		
2029	23		
2030	24		
2031	25	70,000	New site required

Milwaukee Harbor was last dredged in 2001. Approximately 1,218 cubic yards was dredged and placed in Milwaukee's current CDF. After dredging in 2001, the Milwaukee CDF has an estimated maximum of 176,000 cubic yards of capacity remaining out of its 1,600,000 cubic yard design capacity. It is anticipated that between 70,000 and 162,000 cubic yards will be dredged by 2011. The 2011 dredging cycle will essentially fill the current Milwaukee CDF to its design capacity. There would be insufficient storage space in the current CDF for another dredging cycle. Therefore, after the 2011 dredging cycle, a new DMDF will have to be found for all future sediments.

Below is a brief discussion of future economic trends. For a detailed discussion, see Appendix C, entitled "Economic Assessment" presents support for continued Operation & Maintenance (O&M) dredging.

Aggregate commodity traffic shipped through Milwaukee Harbor has experienced a 4.8% average annual growth rate since 1993. In more recent history, traffic at the Harbor since 2001 has experienced a 2.4% growth rate. Based on increasing rail costs, congestion, and capacity limitations, and an analysis of the most recent trends, traffic at Milwaukee Harbor can reasonably be expected to increase by approximately 2% annually for the foreseeable future.

The National Economic Development (NED) benefit of dredging a project is the reduction of commodity transportation costs. A transportation rate analysis of Milwaukee Harbor performed in 2005 indicated that, at the authorized depth, the cost of alternative land transportation for commodities shipped through Milwaukee Harbor exceeded the waterborne transportation cost by 179.6%. Maintaining the harbor to the authorized depth clearly yields NED benefits.

The fleet servicing the Harbor demonstrates to the economic rationale for decreasing the number of shallow-depth loadings and maximizing vessel draft to the authorized channel depth. Doing so reduces the number of needed trips, thereby increasing shippers' savings, a NED benefit. In 2006, the U.S. Army Corps of Engineers, Buffalo District performed an analysis to ascertain the increased cost to shippers resulting from increased depth. Corps personnel utilized a model called GLLAPOM (Great Lake Level Analysis of Port Operation and Maintenance). Results from the model indicate that at one foot above the authorized depth at Milwaukee Harbor, indicating one foot of shoaling, transportation costs per ton increase by approximately $0.24. At two feet above authorized depth, per ton costs increase by approximately $0.57. Using 3.3 million tons, the average of the last 12 years of commodity traffic, such shoaling would cause total cost increases of $792,000 and $1.88 million, respectively. However it should be noted that GLLAPOM assumes that the originators and receivers of cargo will bring in the same amount of cargo regardless of the increased costs. In many cases, originators or receivers ship less when costs exceed a certain point. Therefore, these cost increase estimates are likely biased upward. Yet, the model does indicate that NED benefits are reduced by lack of maintenance dredging. For more information regarding the methodology used in this analysis, please see the Economic Assessment in Appendix C.

6. PROBLEMS AND OPPORTUNITIES

This section summarizes problems (current) and opportunities that were developed during the evaluation for placement of dredged material from Milwaukee Harbor.

6.1 Problems and Current Status

There is approximately 5 years of dredged material capacity remaining in the Jones Island CDF under its current design. Presently, commercial navigation use of the harbor will maintain near present tonnage levels but if continued dredging does not take place, significant shoaling within the navigation channel will result. Coal is shipped to the harbor for fueling the three local electric generating plants, which if restricted, would increase utility costs significantly.

6.2 Opportunities

The opportunity statements presented in this section evolved from evaluating the area resources and problems evident in the development of the Dredged Material Management Plan (DMMP) for Milwaukee Harbor:

(a) Provide additional use of the existing CDF property;

(b) Locate upland site(s) for future (long-term) consideration to place dredged material;

(c) Evaluate beneficial uses for dredged material.

7. ALTERNATIVE PLANS

The alternatives that are presented in the following paragraphs are those that remain as potential options for consideration in handling future maintenance dredging needs of Milwaukee Harbor navigation channels. The Milwaukee Harbor management plan considers a full range of measures, which includes; open water disposal, development of a new disposal site, and beneficial use of the dredged material. A summary of alternative placement options for the annual maintenance-dredging program is displayed at the end of Section 8 in Table 4.

7.1 Alternative 1 - Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF.

This alternative proposes to continue using the existing Milwaukee Harbor (Jones Island) site by constructing a raised perimeter dike offset from the existing dikes around the CDF to create a new DMDF on top of it. The DMDF will be located within Milwaukee Harbor (See Figure 4 for general location, Figure 5 for Plan view and Figure 6 for cross section view).

The EPA and Wisconsin DNR are proposing to use the existing Jones Island CDF for placement of contaminated dredged material from the Kinnickinnic River in a specially designed cell within the CDF. The dredging of the Kinnickinnic River and construction of the special cell within a cell would be funded through the Legacy Act. This is not a confinement cell as much as a segregation cell and will be constructed from mounded dredged material. The dikes will not be constructed using the segregated Kinnickinnic River dredged material. No special liners or clay/bentonite are required. The purpose of constructing a special cell within a cell is to separate the Kinnickinnic River dredged material, because the Great Lakes Legacy Act material is at a level of contamination that is comparable to historic dredging within the harbor, while current Operation and Maintenance (O&M) dredged material placed in the CDF is cleaner and has potential for beneficial reuse. The District indicated to the local sponsor (Milwaukee Port Authority) that the Legacy Act dredging (approximately 176,000 cubic yards) would effectively fill the CDF to 100% capacity under existing conditions.

As a result, the Milwaukee Port Authority requested and received a state grant to cost share building a DMDF over the existing Jones Island CDF and has requested the Corps to design and construct the DMDF through International & Interagency Services (IIS) agreement (previously SFO). Creating the DMDF would provide 20-year dredged material capacity.

The existing Milwaukee CDF was constructed under 91-611 authority. Under the provisions of 91-611 the Corps set aside capacity for non-Federal Navigation Channel dredging. This capacity was typically about 20% of the Federal Navigation capacity. The Legacy Act material would be placed under this authority. The proposed modification would involve using dredged material already deposited within the existing Jones Island CDF. This configuration would allow for more efficient use of the site and expand its usefulness.

7.2 Alternative 2 - Construct a DMDF adjacent to the existing Milwaukee Harbor (Jones Island) CDF.

This alternative provides for the construction of a new DMDF which would extend north of the existing Jones Island CDF. The dredged material capacity of this expansion facility would be similar to that of the future 20-year capacity. Construction work would involve adding on to the existing facility and would involve the construction of new dikes. The new dikes would be constructed as a rubble mound structure. However, the north dike of the existing Jones Island CDF would serve as a connecting structure between the existing CDF and the northward expansion structure. This alternative would also use the Jones Island CDF for placement of the contaminated Kinnickinnic River material, which would essentially fill it. Plan views showing the location of this alternative are shown on Figure 7.

7.3 Alternative 3 – Open Water placement.

This alternative proposes to place dredged material in an Open Water Disposal site, with a 3 - foot thick cap, approximately 8 miles southeast from Milwaukee Harbor entrance, Lake Michigan. The character of the dredged material is classified as silty, therefore, it can easily

disperse with wave currents. The purpose of the Cap is to prevent the dredged material from dispersing. The parameters to conduct a stability analysis include; determining the location for placement of the dredged material, the grain size of the Capping material and the current velocities. The analysis results determine the placement depth which would cause minimal particle movement of the dredged material.

7.4 Alternative 4 - Beach Nourishment

Alternative 4 considers the placement of the dredged material on the beaches within Lake Michigan shoreline, which would serve a beneficial use.

Beach nourishment is becoming a more utilized option where local conditions warrant. Beach nourishment is ideal in shoreline areas that are classified as "erosional", where more material is lost through natural erosion than is deposited via littoral drift. Also, beach nourishment helps to expand recreational beaches at local or state parks, if near by. Lastly, sandy material can be placed on shorelines in preserve areas to enhance shoreline habitat.

7.5 Alternative 5 - No Action

With the Milwaukee Harbor (Jones Island) CDF at approximately 94% capacity, it is anticipated that by the year 2011, the CDF will be at full capacity and dredging of material from Federal navigation channels will not occur without identifying a new dredged material disposal facility.

8. EVALUATION OF ALTERNATIVE PLANS

8.1 Alternative 1 - Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF.

This alternative would create future capacity by constructing a DMDF over an existing CDF. Funding for the construction of the 20-year dredged material capacity would be cost shared with the Milwaukee Port Authority (65% Fed / 35% non-Fed) and the betterment (additional capacity) would be 100% non- Federal funded.

The Corps would benefit from supporting the EPA/DNR's project to remove the higher level contaminated Kinnikinnic River material, which is located upstream of our O&M dredging. If the Kinnikinnic River material is not removed, it may migrate downstream and impact our channels. By constructing a cell within a cell, it will isolate the higher level contaminated dredged material from the O&M dredging. (Under the Remedial Action Plan (Sect 401a, WRDA 1990) Program the Detroit District studied the Kinnickinnic River and recommended placement of the material in the Milwaukee CDF) The EPA and the State of Wisconsin have continued pursuing this alternative under the Legacy Act and have worked with the Detroit District to develop this alternative.

The top elevation of the existing Jones Island CDF is +10 feet above the Low Water Datum (LWD) elevation of 576.8 feet International Great Lakes Datum (IGLD), 1955. It will also be the final elevation of the segregated cell for placement of the Kinnikinnic River dredged material. Building the new offset dikes to + 18 feet to elevation 594.8 feet above LWD will provide the 20-year dredged material capacity in the amount of 510,000 cy. Figure 6 shows a typical cross section. The cost estimate for constructing the new DMDF is approximately $ 2,865,313. Conceptual costs for this alternative are shown in Appendix B.

8.2 Alternative 2 - Construct a DMDF adjacent to the existing Milwaukee Harbor (Jones Island) CDF.

This alternative could provide additional placement capacity, at approximately 510,000 cubic yards. The cost to construct the rubble mound design disposal site to accommodate 510,000 cy capacity in Milwaukee harbor site was determined through extrapolation of the costs from the Draft *Phase I Scoping Document, Dredged Material Management Plan Study, Milwaukee Harbor* (Dec 1997) report. Using the CIVIL WORKS CONSTRUCTION COST INDEX SYSTEM, CWBS Feature Code 12: Navigation Ports and Harbors, (EM 110-2-1304), the projected dollars in 2007 dollar worth for construction of a 510,000 cy capacity DMDF would cost approximately $ 12,307,141. In order to compare equivalent costs and capacity, the Rubblemound design from the Phase I document with a capacity of 829,427 cy and a cost of $13, 236,000 (1997 dollars) was reduced to an equivalent 510,000, cy capacity and $8,138,582 (1997 dollars). The $8,138,582 cost was then extrapolated to current costs. By extending northward from the north dike of the existing Jones Island CDF, construction costs would be less compared to a structure requiring new dikes on all four sides. This alternative would provide capacity for 20-years of dredged material placement at Milwaukee Harbor. However, in comparing construction cost and Federal cost sharing, to Alternative 1 - Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF, this alternative is not the least costly alternative.
As discussed above the Corps would benefit from the EPA/DNR's project.

8.3 Alternative 3 – Open Water placement.

The use of open water sites would result in the burial of bottom habitat, releases of turbidity and associated contaminants into the water column, and will require a clean cap to isolate the material from local benthos (bottom dwelling organisms).

Sediments are contaminated with metals, polychlorinated biphenyls (PCBs), and **polycyclic aromatic hydrocarbons** (PAHs). Due to the nature of the physical character (fine grain) and contaminants in the dredged material, a cap would be difficult to place. The fine grain material contains mainly silts and fine sand. The dispersion of the exceptionally "fine grain" material would require a large cover area (approx. 1,800 feet x 1,420 feet x 3 feet) to confine the dredged material for the 20 year period in order to prevent it from becoming exposed and contaminating the waters of Lake Michigan. A sand cap of approx. 284,000 cubic yards would be barged to the site. (Reference; The draft "Phase I Scoping Document,

Dredged Material Management Plan, Milwaukee Harbor, December 1997", Appendix C, Hydrology & Hydraulic Analysis for Alternative I – Open Water Disposal.) The analysis determined a site approximately 8 miles southeast of the harbor entrance with depths approximately 75-100 feet. Note; the Milwaukee's municipal water intake was a factor in the location. The cost for open water placement over a 20-year period is $8,251,440.

Current Wisconsin Department of Natural Resources water quality standards do not permit open water placement of dredged material; therefore, it is not likely that the State would issue a 401 Water Quality Certification for this alternative. Costs to transport dredged material and a sand cap (by barge) to this open water location (8 miles) would be higher than the costs to transport dredged material to the Milwaukee Harbor (Jones Island) CDF located in the harbor.

8.4 Alternative 4 - Beach Nourishment

This alternative considers the feasibility of using the material to enhance area beaches or return the material into the natural system from which it came.

The District has been very proactive in attempting to develop beneficial uses for the dredged material from the Milwaukee Harbor. Unfortunately the dredged material is fine-grained organic silts with low but detectable levels of PCBs, PAHs, and metals. The State of Wisconsin regulates dredged material as a solid waste and has stringent limits with regard to the beneficial use of solid waste. These limits are often so low as to be below laboratory detection limits. Therefore the District and the local sponsor cannot ensure that the dredged material complies with State regulations. This issue has been broached with the State on more than one occasion and the District continues to follow developments in this regard.

The "fine grain" nature of this material makes it physically unsuitable for beach nourishment. In addition, the contaminate nature of the sediment makes it unsuitable for beneficial reuse. Current Wisconsin Department of Natural Resources water quality standards do not permit open water placement of dredged material; therefore, it is not likely that the State would issue a 401 Water Quality Certification for this alternative.

8.5 Alternative 5 - No Action

Unless additional disposal areas are developed, dredging of material from designated navigation channels could not occur which would threaten the viability of the channel as a means to efficiently move goods and commodities. Under the "No Action" option, a backlog of maintenance dredging would grow, which will limit full utilization of the channel, resulting in increased transportation costs. Therefore, this alternative is not acceptable as a solution.

TABLE 4 - Summary of Alternatives					
Alternative	Placement	Capacity cubic yards	Construction Costs ($)	Annualized Average cost	Recommend to Phase II
Construct DMDF on top of CDF	Upland	350,000[1] 160,000[2]	1,977,066[3] 888,247[4]	156,968 70,522	Y
Construct DMDF adjacent to CDF	Upland	350,000[1] 160,000[2]	8,491,927[3] 3,815,213[4]	674,211 302,906	N
Open Water	Open Water	350,000[1] 160,000[2]	5,693,494[7] 2,557,946[7]	320,208 143,855	N
Beach Nourishment	Beach Nourishment	Unlimited	------[5]		N
No Action	N/A	N/A	-----		N

1. 20- year Navigation Capacity
2. Additional Permittee Capacity (betterment)
3. Cost for 20- year Capacity (including 20% contingency)
4. Cost for Additional Capacity (betterment) including 20% contingency
5. The dredged material that was determined to be environmentally unacceptable.
6. Construction will occur in one construction season.
7. Amounts are discounted to FY07 dollar values.
8. The Federal cost does not include Great Lakes Legacy Act funds.

9. TRADE-OFF ANALYSIS

Each of the following alternatives is compared in the following paragraphs as to their advantages and disadvantages if implemented.

9.1 Alternative 1 - Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF.

Advantages: The CDF is located the nearest to the Federal navigation channels compared to open water or beach nourishment alternatives. No additional Real Estate is required. The Port Authority is willing to cost share the base plan and fund the additional capacity. The site is adequate in size to meet the 20 - year capacity, is engineeringly feasible, environmentally acceptable and least costly.

As such, this alternative has been determined to be the least costly and engineeringly feasible, and environmentally advantageous and therefore is the “recommended alternative”, which will be carried forward for implementation. Milwaukee Port Authority has agreed to sponsor the project and is willing to cost share the project.

Disadvantages: Temporary disturbance to wildlife habitat during construction, additional height on structure.

9.2 Alternative 2 - Construct a DMDF adjacent to the existing Milwaukee Harbor (Jones Island) CDF.

Advantages: The site is adequate in size to meet the 20 - year capacity, engineeringly feasible and environmentally acceptable. The CDF is also located the nearest to the Federal navigation channels compared to open water or beach nourishment alternatives.

Disadvantages: This alternative is not the least costly, occupation of additional estuary bottomland. Therefore, Alternative 2 will not be considered further.

9.3 Alternative 3 – Open Water Placement.

Advantages: It has an unlimited space; therefore it will meet the 20–year capacity requirement.

Disadvantages: Sediments are contaminated with metals, PCB, and PAHs, costly capping would be required, long haul distance. The Wisconsin Department of Natural Resources regulations do not permit open water placement of dredged material; therefore, it is highly unlikely that the State would issue a 401 Water Quality Certification for this alternative. Considering the contaminate levels in the dredged material, and the cost of transportation, this alternative will not be considered further.

9.4 Alternative 4 - Beach Nourishment

Advantages: This alternative could meet the 20 - year capacity.

Disadvantages: The dredged material is not suitable for beach nourishment. Sediments are contaminated with metals, PCB, and PAHs. The Wisconsin Department of Natural Resources regulations do not permit open water placement of dredged material; therefore, it is highly unlikely that the State would issue a 401 Water Quality Certification for this alternative. As such, Alternative 4 is not engineeringly feasible or environmentally acceptable and will not be considered as a candidate for implementation.

9.5 Alternative 5 - No Action

Advantages: None

Disadvantages: The backlog of maintenance dredging would continue to accrue, which will continue to limit full utilization of the channel, resulting in increased transportation costs.

10. SELECTION OF FINAL PLAN

10.1 Base Plan

Original studies to investigate disposal options for dredged material in the Milwaukee Harbor were initiated prior to the establishment of DMMP guidelines. This document has been prepared in accordance with recent procedures established for development, review and implementation of DMMP's. Based on current information in this Phase II DMMP Document, *Alternative 1 - Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF* meets the criteria as engineeringly feasible, environmentally acceptable and least costly. Accordingly, information that follows is presented on the basis that reflects this option as the Base Plan.

The south end of the existing Jones Island CDF will continue to be used by the Port Authority for Car Ferry service. New dikes offset from the perimeter of the CDF will be constructed to + 18 which will include the 20-year dredged material capacity and the additional capacity (betterment). See figure 5 & 6, which shows a plan view and typical dike cross section. The DMDF dikes will be constructed with onsite dredged material, and will be wider at the base and higher in elevation than the existing dikes to meet the 20-year capacity requirements. The positioning of the offset dike is based on obtaining maximum volume and bearing capacity to support the dike within the existing Jones Island CDF. The entire dike construction may be accomplished in the initial construction.

The DMDF will continue to allow for placement by mechanical dredging since the WDNR will not issue a discharge permit. With regards to effluent, when needed, the Port Authority will connect to the wastewater treatment plant, therefore a new filter cell will not be needed. All rainfall that lands on the outside of the new dikes will flow to a central sump and then to the Waste Water Treatment Plant. The EPA will also use that method to pump water levels down in the existing Jones Island CDF, so that they can construct the Legacy Act cell more easily.

10.2 Project Advantages

Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF alternative was chosen over the other sites because of the following major advantages: it is least costly, while being both engineeringly feasible and environmentally acceptable. Other advantages include that the site is sufficient enough in size

to meet the required 20 - year capacity while being situated where a mechanical offloading is easily accessed. This site is much closer to the dredging operation areas compared to the much greater distance of hauling dredged material to open water. Onsite dredged material could be used to construct dikes, which contributes to making this alternative less costly than other alternatives.

This alternative would create additional capacity. Funding for the construction of the 20-year dredged material capacity would be cost shared with the Milwaukee Port Authority (65% Fed / 35% non-Fed) and the betterment (additional capacity) would be 100% non-Federal funded.

10.3 Real Estate

The local sponsor already acquired the necessary real estate interests when the Milwaukee Harbor (Jones Island) CDF was constructed. The construction of the offset dikes will not necessitate additional LERRD acquisition. For more detailed analysis, see Appendix D, "Real Estate Plan".

10.4 Project Design

The Design Report (see Appendix A) includes a brief narrative, location map, plan view, cross sections, detail, and quantitative calculations for developing the alternative, *Construct the Milwaukee Harbor(Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF.*

10.5 Project Construction

The project construction would consist of building offset perimeter dikes on top of the existing CDF for the DMDF. On-site sub-grade material would be excavated from the CDF to be used to construct the offset perimeter dikes. The rich soil would quickly vegetate, which would provide for a natural appearance to the placement site.

The construction sequence is such that the entire perimeter dike will be constructed in one construction season. A typical construction operation would consist of (a) stripping the topsoil, (b) compacting the surface area immediately under the proposed perimeter dike, (b) excavating and stockpiling the dredged material for dike construction, and, (c) shaping and compacting the dikes (See appendix A for details) If a specific dredging operation requires a cordoned off area, then the contractor could use temporary push up berms to isolate such areas.

10.6 Project Cost

Table 5[1] Cost Estimate for Alternative 1 - Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF. (2007 price level)					
	Feature – Capital Costs	**Quantity**	**Unit**	**Unit Price[(4)]**	**Estimated Cost ($)**
1	Mob & Demob	1	L.S.	$145,000	$ 145,000
2	Compacted fill	71,000	C.Y.	$ 11.47	$814,370
3	Riprap – Armor Stone	10,500	TN	$ 69.64	$ 731,220
4	Crushed Aggregate	5,000	C.Y.	$ 36.28	$ 181,400
5	Geotextile	20,000	S.Y.	$ 4.11	$ 82,200
6	Portland Cement	703	TN	$178.61	$125,563
7	Site Restoration	1	LS	$14,500	$14,500
9	Load & Transport Material in Cell	71,000	CY	$10.86	$ 771,060
	Total Construction				$ 2,865,313
	Escalate Total Const. to FY09 -1.021%				$ 2,925,484
	Feature – Indirect Costs	**Quantity**	**Unit**	**Unit Price**	**Estimated Cost ($)**
	Engineering & Design pre. Const. (6% of capital costs)	1	LS	$ 717,900	$ 171,900
	Construction Management S&A (9%)	1	LS	$257,900	$ 257,900
	E & D During Const.	1	LS	$ 28,700	$ 28,700
	Contract Award	1	LS	$10,000	$10,000
	Real Estate				0.00
	Subtotal, Non-Construction				$ 468,500
	Contingency (15%)				$ 70,300
	Total Non-Construction				$ 538,800
	Escalate Total Non-Construction to FY09 - 1.021%				$ 550,115
	Total Project Cost Escalate to FY09				$ 3,475,599[2]
	Annualized Average Cost				$ 275,917[3]
	Annual O&M Cost				$ 12,000
	Total Annualized Average Cost				$ 287,917

1 See detailed cost estimate provided in Appendix B.
2 As construction will occur during a single season, no interest during construction was estimated.
3 Amortized over the 20-year project life using the FY07 discount rate of 4.875%.
4 Construction Contingency of 20% was added to the unit price.

The Cost Engineering Appendix shows the costs with contingencies for the project (See Appendix B). The appendix includes a brief narrative, cost summary table, and a detailed cost estimate. Table 5 shows a cost summary for Alternative 1 - *Construct the Milwaukee Harbor (Jones Island) DMDF on top of the existing Milwaukee Harbor (Jones Island) CDF.*

11. DESCRIPTION OF SELECTED MANAGEMENT PLAN

11.1 General

The plan is intended to provide a means to manage the dredged material from the Milwaukee Harbor for a period of 20 years. The design capacity of the proposed DMDF for the selected site must achieve a 20 - year capacity, be the least costly and engineeringly feasible, while meeting all Federal environmental standards.

11.2 Cost Apportionment

Project implementation will be cost shared in accordance with Sections 101 and 214 of WRDA 86 as amended and Section 217 of WRDA 96 and per Policy Guidance Letter No 47, *Cost Sharing for Dredged Material Disposal Facilities and Dredged Material Disposal Facilities Partnerships* dated, 3 April 1998. TITLE I of WRDA '96 (see discussion on Page 3, Paragraph 3) which states that, "Dredged Material Disposal Facilities for O&M will now be considered a general navigation feature (GNF) and cost shared in accordance with Title I of WRDA '86. According to WRDA '86, SEC 101 HARBORS, subsection (a)(1) PAYMENTS DURING CONSTRUCTION, the cost to the non-Federal interest is based on the authorized depth of the channel. The authorized channel depth for the Milwaukee Harbor varies between 28 feet below IGLD at the harbor entrance and to 21 feet at the upstream limit on the Menominee River; therefore it meets the criteria within the 20 to 45 ft range, which has a non-Federal cost share of 35% :25% during the construction of the DMDF and 10% in cash over a period not to exceed 30 years.

The sponsor will also be responsible for 100% of the construction costs associated with additional DMDF capacity beyond that required for maintenance of the Federal Navigation Channel.

12. ENVIRONMENTAL CONSIDERATIONS

12.1 General

An Environmental Assessment (EA), Dredged Material Disposal Facility at Jones Island CDF, Milwaukee Harbor, Wisconsin was prepared in accordance with the National Environmental Policy Act of 1969. This EA along with The Milwaukee Harbor Draft Dredged Material Management Plan Study document were made available for agency and public review November 25, 2007.

Review of the proposed Dredged Material Disposal Facility at Jones Island CDF project plan and a single positive public review comment indicate that the proposed base plan action does not constitute a major Federal action significantly affecting the human environment; therefore, an environmental Impact Statement will not be prepared and a Finding of No Significant Impact has been signed and is attached.

13. RESULTS OF COORDINATION WITH LOCAL, STATE AND FEDERAL AGENCIES

On June 28, 2004 the State of Wisconsin requested the use of the CDF in Milwaukee Harbor to use as a disposal site for Kinnickinnic River contaminated material located outside the Federal navigation channel. We informed the State that the remaining capacity in the CDF was limited and construction of a new DMDF would be required, which included cost sharing. As a result, the Governor recognizing the need for the new facility requested and received State funds in the amount of $1.8 million for Milwaukee Harbor. EPA then provided funding to the Corps to design a segregated cell for the contaminated Kinnickinnic River material under its Great Lakes Legacy Act Program. The Corps provided a design to the Port of Milwaukee for review on July 30, 2007. Numerous coordination meetings were held between the Corps, EPA, Milwaukee Port Authority and the Wisconsin Department of Natural Resources with the goal of obtaining efficiencies and saving in an approach to a joint project that will provide savings over the implementation of any single purpose economic or environmental project. Some of the correspondence is included in Appendix E – "Correspondence".

14. COST SHARING AND FINANCING

14.1 Management Plan Studies

The cost associated with Management Plan studies for continued maintenance of existing Federal navigation projects are O&M costs and are 100% Federally funded. Project sponsors, port authorities, and other project users, are partners in dredged material management and must pay the costs of their own participation in the dredged material management studies including participation in meetings, providing information and other coordination activities.

Budgeting priorities for the navigation purpose is limited to the Base Plan. Therefore, the cost for any component of a management plan study attributable to meeting local or state requirements of Federal laws and regulations shall be a non-Federal cost. The COE does not anticipate any additional costs will be incurred beyond those associated with the execution of the base plan related to compliance with any required local or state laws and regulations. Study activities related to dredged material management for the Federal project but not required for continued maintenance dredging and dredged material disposal, will not be funded by the Federal Government and will not be included in the dredged material management studies unless funded by others.

14.2 Implementation

Costs for implementing Management Plans for existing projects are O&M costs and shall be shared in accordance with navigation O&M cost sharing provisions applicable to the project as authorized. The cost for any component of a Management Plan attributable solely to meeting state water quality standards (which are generally more restrictive than those satisfying the Base Plan) will be a non-Federal cost.

Table 6
Federal / Non Federal Cost

	Total Cost	Federal Cost	Non- Federal Cost
Construction of DMDF 350,000 cy capacity (1)	$ 2,018,584 (3)	$ 1,312,080	$ 706,504
E&D, S&A, Contract Award, Contingency for 350,000 CY(4)	$ 379,580 (3)	$ 246,727	$ 132,853
Construction of DMDF 160,000 cy capacity (2)	$ 906,900	$ 0.00	$ 906,900
E&D, S&A, Contract Award, Contingency for 160,000 CY(4)	$ 170,535	$ 0.00	$ 170,535
	$ 3,475,599	$ 1,558,807	$ 1,916,792

1 350,000 cy is for navigation capacity
2 160,000 cy is for permittee capacity
3 Cost share , 65Fed /35 Non Fed. The Federal cost does not include Great Lakes Legacy Act funds.
4 See Table 5 for details.
5 Estimated costs are escalated to FY 2009.

15. CONCLUSION/RECOMMENDATION

The Milwaukee Harbor is in need of additional dredged material placement capacity as the existing Jones Island CDF is reaching its capacity. Lack of additional capacity would result in dredging of the Milwaukee Harbor being curtailed, or not taking place. With the increased shoaling, the navigation capability would be adversely affected.

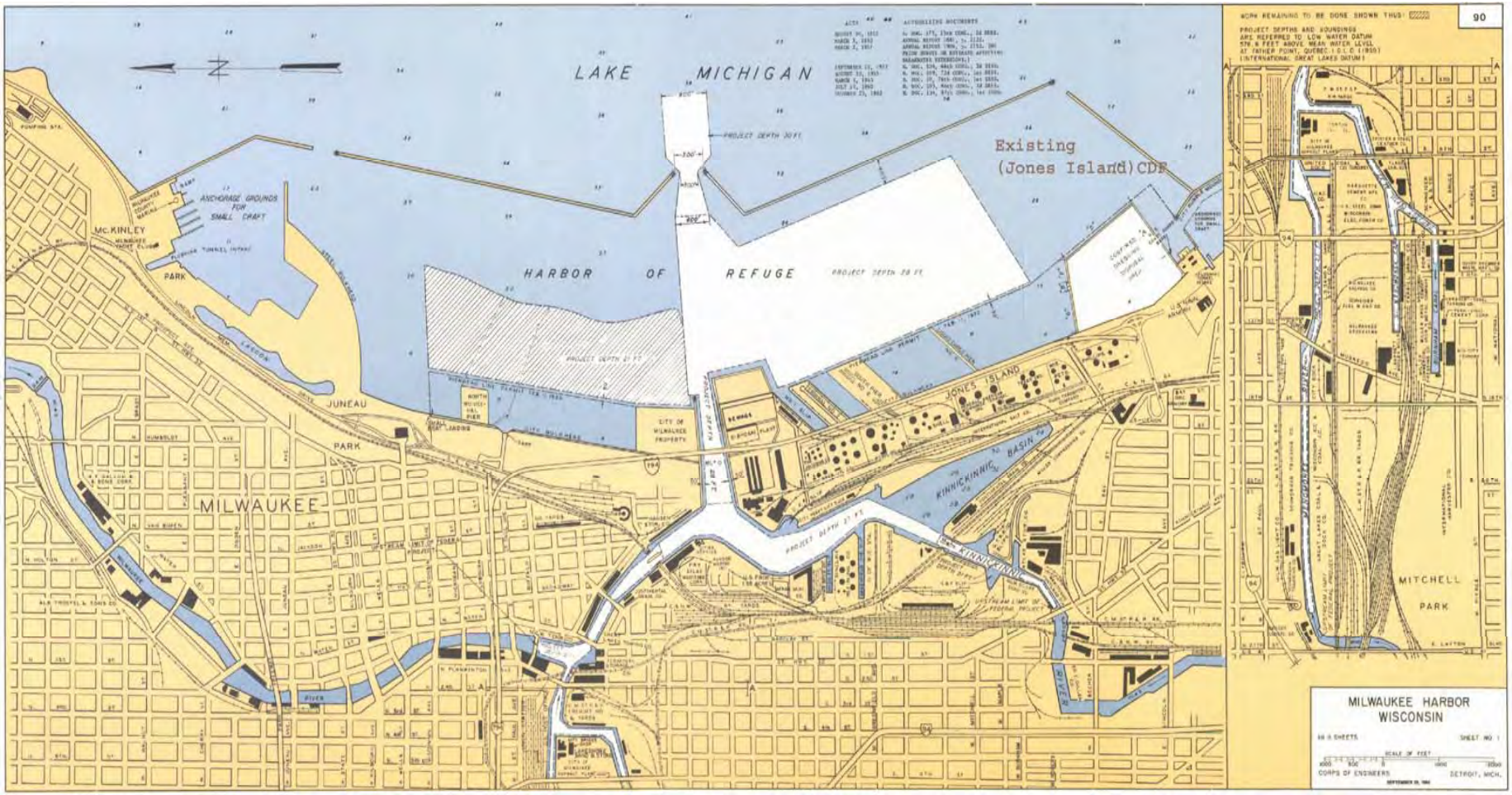
Approval of the project assumes and is predicated upon the Corps of Engineers granting of permit authority for use of most remaining CDF capacity for the Great Lakes Legacy Act project, since concurrent approval and implementation of actions serving both environmental and navigation purposes would best serve the public interest.

Accordingly, it is recommended that the Detroit District proceed with detailed design and plans and specifications to construct the Base Plan presented in the Phase II Final Dredged Material Management Plan document to provide management of dredged material for a 20-year period for Milwaukee Harbor.

WILLIAM J. LEADY
LTC, EN
Commanding

Regional Map for Milwaukee Harbor

Figure 1



Milwaukee HBR DMMP

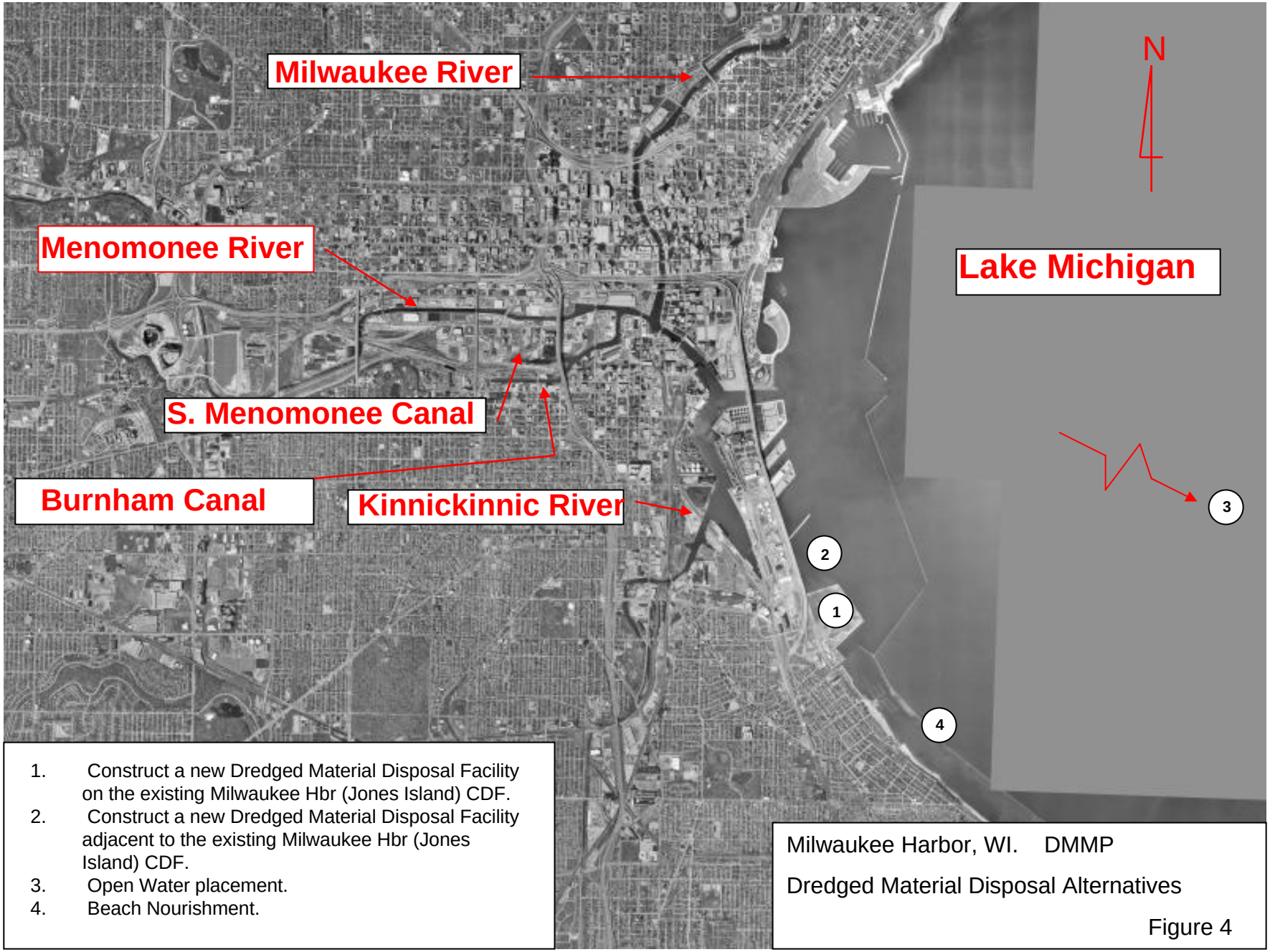
Project Map

Figure 2

Milwaukee Harbor, WI. DMMP

Jones Island CDF

Figure 3

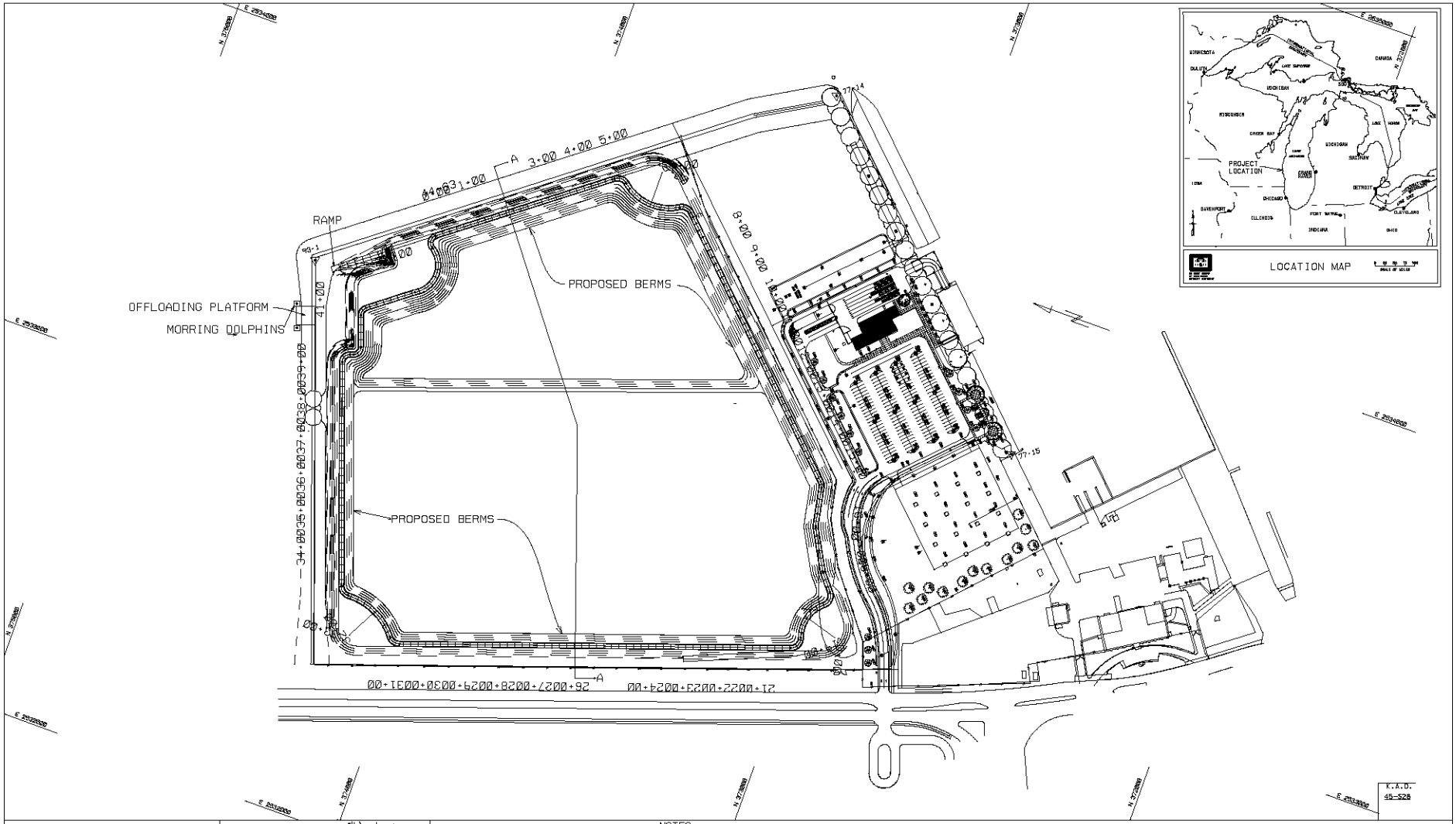


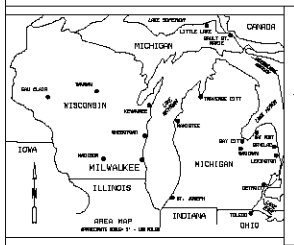
1. Construct a new Dredged Material Disposal Facility on the existing Milwaukee Hbr (Jones Island) CDF.
2. Construct a new Dredged Material Disposal Facility adjacent to the existing Milwaukee Hbr (Jones Island) CDF.
3. Open Water placement.
4. Beach Nourishment.

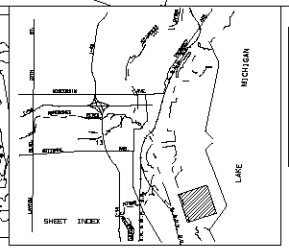
Milwaukee Harbor, WI. DMMP

Dredged Material Disposal Alternatives

Figure 4







LEGEND

- GPS CONTROL MONUMENT
- BRONZE OR BRASS DISC
- CHANNEL LINE TURNING POINT

NOTES:

SURVEY CONTROL AND BENCH MARK DATA IS AVAILABLE FROM THE DETROIT DISTRICT, ENGINEERING & TECHNICAL SERVICES, OPERATIONS TECHNICAL SUPPORT BRANCH, KEWAUNEE AREA OFFICE.

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ALL ELEVATIONS ARE IN FEET AND ARE REFERENCED TO LOW WATER DATUM ELEVATION, 577.8 FEET ABOVE MEAN SEA LEVEL, I.G.L.D. 1985.

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.

COMBINED GRID SCALE FACTOR - 0.99995590
GRID DIST. DIVIDED BY COMBINED GRID SCALE FACTOR - GROUND DIST.

100 0 100 200 300
1" = 100'

THIS PROJECT WAS DESIGNED BY THE DETROIT DISTRICT OF THE U.S. ARMY CORPS OF ENGINEERS. THE INITIALS OR SIGNATURES AND REGISTRATION DESIGNATIONS OF INDIVIDUALS APPEAR ON THESE PROJECT DOCUMENTS WITHIN THE SCOPE OF THEIR EMPLOYMENT AS REQUIRED BY ER 1110-1-8152.

NO.	DATE	REVISION	BY

U.S. ARMY ENGINEER DISTRICT, DETROIT
CORPS OF ENGINEERS
DETROIT, MICHIGAN

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDEXED ON THIS SHEET.

MILWAUKEE HARBOR,
WISCONSIN

PROPOSED DREDGED MATERIAL DISPOSAL FACILITY PLAN VIEW

SUBMITTED BY: _____ P.E.
CHIEF, CEASE BRANCH

APPROVED: _____ P.E.
CHIEF, ENGINEERING & TECHNICAL SERVICES DIVISION

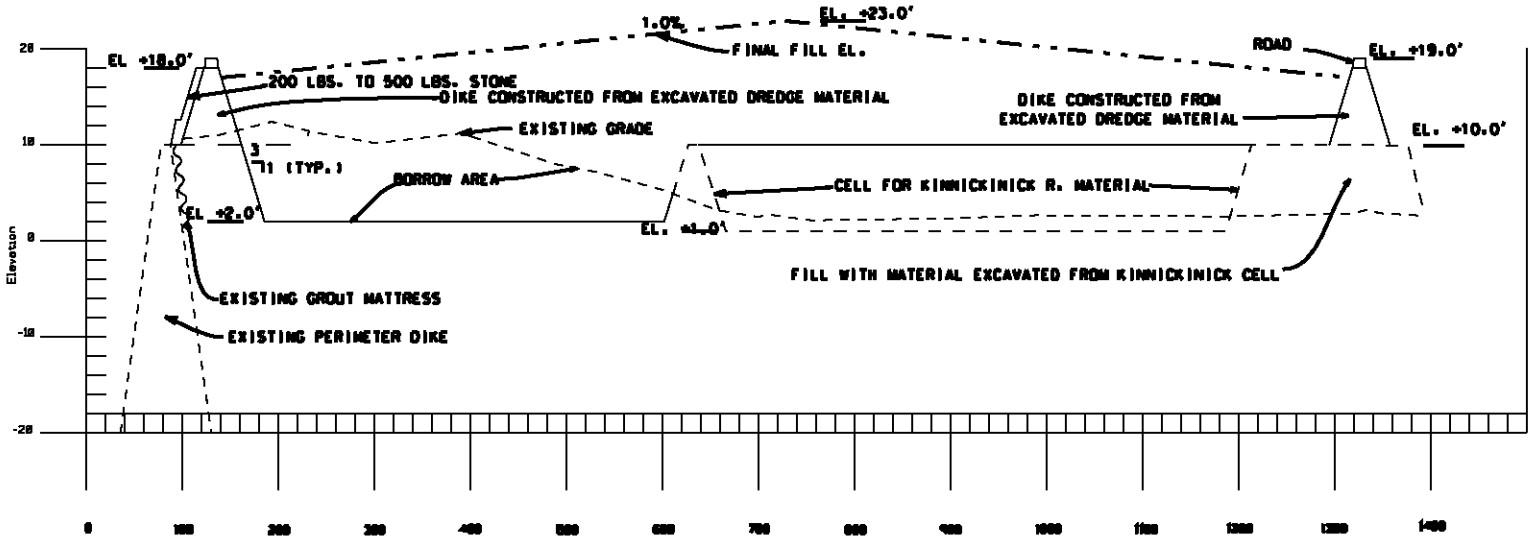
APPROVAL RECOMMENDED: _____ P.E.
CHIEF, ENGINEERING & CONSTRUCTION OFFICE

SCALE AS SHOWN

DRAWING NUMBER

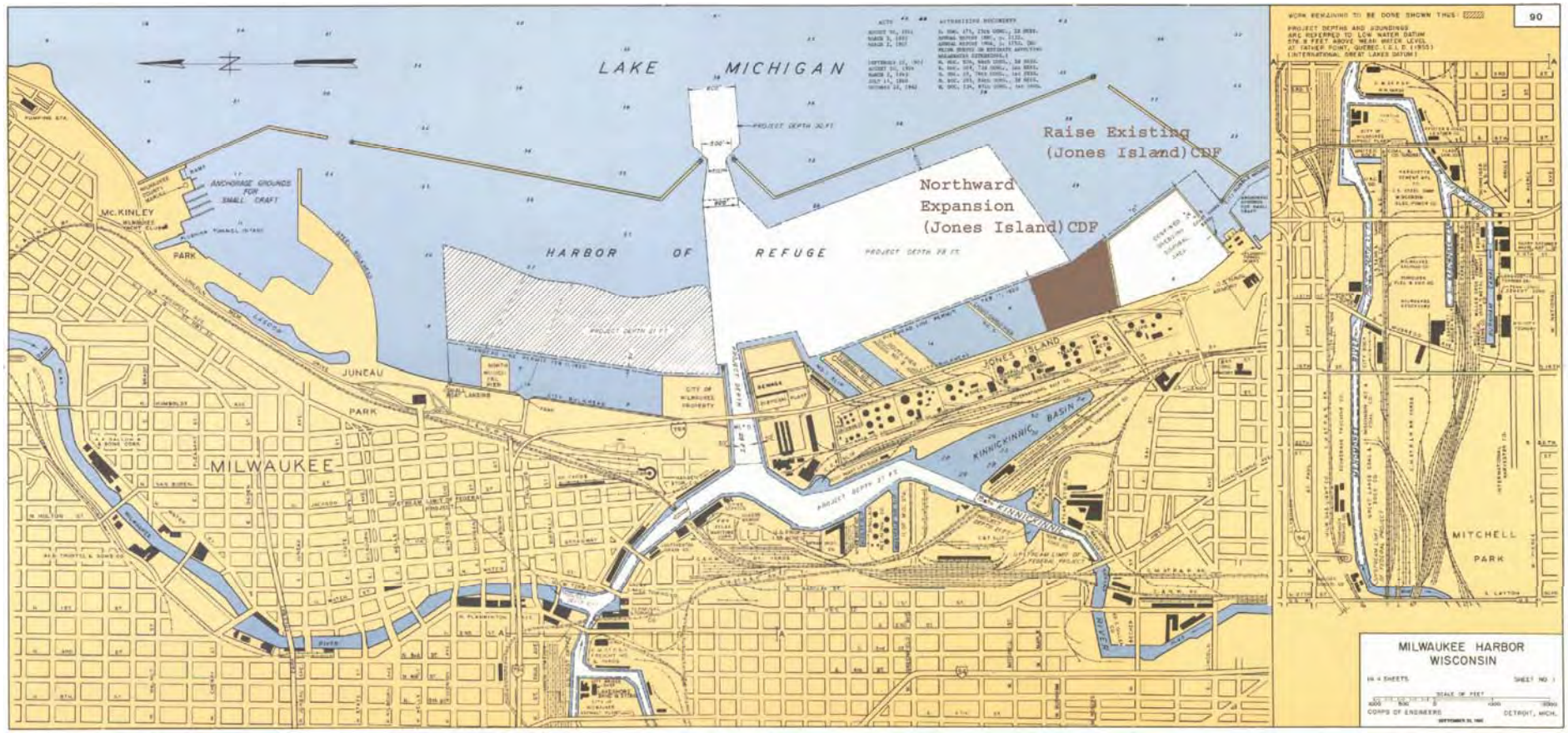
SHEET 1 OF 2

FIGURE 5



U.S. ARMY ENGINEER DISTRICT, DETROIT CORPS OF ENGINEERS DETROIT, MICHIGAN	
MILWAUKEE HARBOR, WI. DREDGE MATERIAL DISPOSAL FACILITY SECTION A-A	
DRAWN BY: KJW	CHECKED BY: XXX
DATE: 25 JUL 07	PLATE #2/ID

FIGURE 6



Milwaukee Hbr DMMP

Construct a DMDF north of Jones Island CDF

Figure 7

APPENDIX A

DESIGN APPENDIX
MILWAUKEE, WISCONSIN
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)

U.S. ARMY CORPS OF ENGINEERS
DETROIT DISTRICT

APPENDIX A
DESIGN APPENDIX
MILWAUKE E, WISCONSIN
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)

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FIGURES

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ATTACHMENTS

ATTACHMENT A GEOTECHNICAL DATA

APPENDIX A

DESIGN APPENDIX
MILWAUKEE, WISCONSIN
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)

1. INTRODUCTION

1.1. PURPOSE AND SCOPE OF STUDY. The purpose of this appendix is to present detailed engineering and design data for the Milwaukee, Wisconsin Dredged Material Disposal Facility (DMDF) project. This appendix provides the basis for the preparation of plans and specifications for construction of the DMDF. Description of procedures and basic supporting data related to investigations made in connection with the preparation of this appendix are presented in the paragraphs and figures to follow. This engineering and design is being accomplished under the National Harbors Program: Dredged Materials Management Plan (DMMP).

1.2. BACKGROUND. The existing Milwaukee Confined Disposal Facility (CDF) was constructed in 1973. The north and east sides are stone rubble mound dikes with a grout filled mattress on the interior slope extending from the top to 1.0' above Low Water Datum. The south wall consists of steel sheet pile cells and the west side is a steel sheet pile bulkhead. Two circular filter cells are located in the north dike. The area enclosed is approximately 54 acres.

In 2003 the southern portion, approximately 14 acres, of the CDF was returned to the local sponsor for development. The remaining 40 acre site is near capacity with 70,000 cubic yards (cy) of maintenance dredging in 2007 and an expected 176,000 cubic yards (cy) of permit dredging disposal in 2008.

To continue maintenance of the harbor additional capacity is required. Three alternatives were considered including expansion of the facility to the north, open water disposal and upward expansion by construction of interior dikes. Economic and environmental factors and the input of the local stakeholders determined the upward expansion is the preferred alternative. This appendix details the upward expansion of the facility.

1.3. DATA COLLECTION. The design data collected during the course of this study has included the following:

a. CADD drawings developed from topographic surveys provided by the Technical Support Section, Detroit District Corps of Engineers used for the plan layout and volume computations.
b. Soil boring investigations by STS Consultants in August 2006 and soil boring investigations by Coleman Engineering Company in July 1995 and October 1997 used to provide data for a stability analysis of the proposed dikes and estimate the long term settlement.
c. All soundings and elevations are referenced to Low Water Datum (L.W.D.) for Lake Michigan, 577.5 feet above Mean Sea Level at Rimouski, Quebec. International Great Lakes Datum (I.G.L.D.) 1985.

2. DESIGN

2.1. DESIGN CRITERIA. The design rationale used in this study provides for an efficient least cost plan based on sound engineering practice with proper consideration given to environmental and social aspects. The following parameters were assumed:

- Estimates of the 20 year capacity requirements of the DMDF include 350,000cy of maintenance dredging and 70,000cy of permit dredging. In addition approximately 130,000cy of backlog dredging currently exist.
- Capacity will be attained by constructing new interior dikes from on-site materials.
- Dredging and conveyance into the site will be performed by mechanical equipment. The limited area available for containment will not permit the storage of the high volume of water associated with the hydraulic transport of dredged material. The Corps does not have a permit to discharge from the existing Confined Disposal Facility (CDF). Discharge from the existing filter cells would require water quality certification from the Wisconsin Department of Natural Resources (WDNR). Access to the filter cells from the DMDF is not included in the design.
- The water in the DMDF will be controlled by evaporative dewatering. Trenching and spreading will speed the evaporative process. This method has proved effective with the existing CDF.
- The local stakeholders have limited the top elevation of the interior dikes to +18 feet above L.W.D.
- It is assumed that bulking and consolidation will be the same.

2.2. PROJECT FEATURES. Milwaukee Harbor is located on the west shore of Lake Michigan in the City of Milwaukee, Wisconsin which is about 85 miles north of Chicago, Illinois, and approximately 83 miles west of Grand Haven, Michigan.

Milwaukee Harbor is a deep draft harbor at the confluence of the Milwaukee River and the Kinnickinnic River.

The Milwaukee Dredged Material Disposal Facility (DMDF) is located in the outer harbor 6500 feet south of the entrance channel. The site is bounded by water on the north and east sides and access by land on the west side. A ferry terminal occupies the southern portion of the site. The Site Plan is shown on Figure 1.

The total area available for construction of additional dikes for dredged material placement is approximately 40 acres. The plan includes construction of dikes with a road on the crest inside the existing perimeter dikes, a Section A-A is shown on Figure 2. An off loading platform and mooring piles will be installed at the northeast corner for use in off loading activities, shown on Figure 4. A road and gate along the west side will provide land access to the off loading site.

The volume of materials to be dredged and placed in the DMDF during a particular dredging season will depend upon the degree of critical shoaling and the availability of dredging funds, however, it is estimated that average bi-annual maintenance dredging activities would be 35,000 cubic yards

The top elevation of new dikes would be 8 feet above the top elevation of existing perimeter dikes. Materials for new dike construction would be obtained from borrow areas located within the site. Drainage within the cell would be maintained by construction of new ditches or improvements to existing ditches.

The interior dikes will be constructed to a slope of 1V:3H. All interior dikes will have a minimum fifteen foot (15.0 ft.) top width to accommodate a crushed aggregate road. Typical sections are shown on Figure 3. Radius will be constructed at the corner of the cell to allow for vehicle turn around and dumping. It is envisioned that material will be off loaded from scows into trucks with excavation equipment, transported and dumped into the cell. Chutes or conveyors could also be used to transport and distribute the material into the cell. Low ground pressure equipment would be needed to spread the dredged material to facilitate drying. Placement into the confined area would be controlled so as to preclude erosion of the interior dike slope.

2.3. SITE DESIGN. The design of the DMDF is limited by the relatively small area available for confinement. The construction of the dikes will be completed in phases. The permit dredging scheduled for 2008 will be required to construct a cell for placement. The cell will be constructed by excavating the west portion of the existing CDF to +1.0 feet above L.W.D. The excavated material will be placed in 1.0 foot lifts around the perimeter of the site to an elevation of +10.0 feet above L.W.D. and compacted to 90% of the maximum dry density.

The footprint of the new interior dike will be graded to an elevation of +10.0 feet. The marginal quality of the material within the existing CDF requires foundation reinforcement for the new interior dikes. Portland cement, at 5% volume dry weight, will be mixed with the top one foot of the foundation material

and compacted. This will be sufficient to reduce plasticity and improve bearing strength.

The interior dikes will be constructed from material excavated from the CDF. The material will be placed in 1.0 foot lifts and compacted to 90% maximum dry density. The interior and exterior slopes will be constructed to 1V: 3H. The volume of material required to construct the dikes is based on the assumption the construction of the permit dredging cell will precede the dike construction. The excavation of the cell will provide sufficient material to fill the footprint of the dike to an elevation of +10 feet. The volume of material shown in Figure 5 was calculated using Microstation Inroads software for fill above +10 feet.

The distance from the outside of the existing perimeter dikes to inside the new cell, approximately 100', precludes direct deposition into the cell. A 1 foot thick crushed aggregate road with a geotextile underlayment will be constructed on top of the new dikes. The quantities calculated used the Inroads software to determine the square footage of the top surface of the berms including the radius. The exterior of the berms on the north and east sides will be protected by 200lb – 500lb splash stone. A woven geotextile will be placed underneath the splash stone for filtration and drainage.

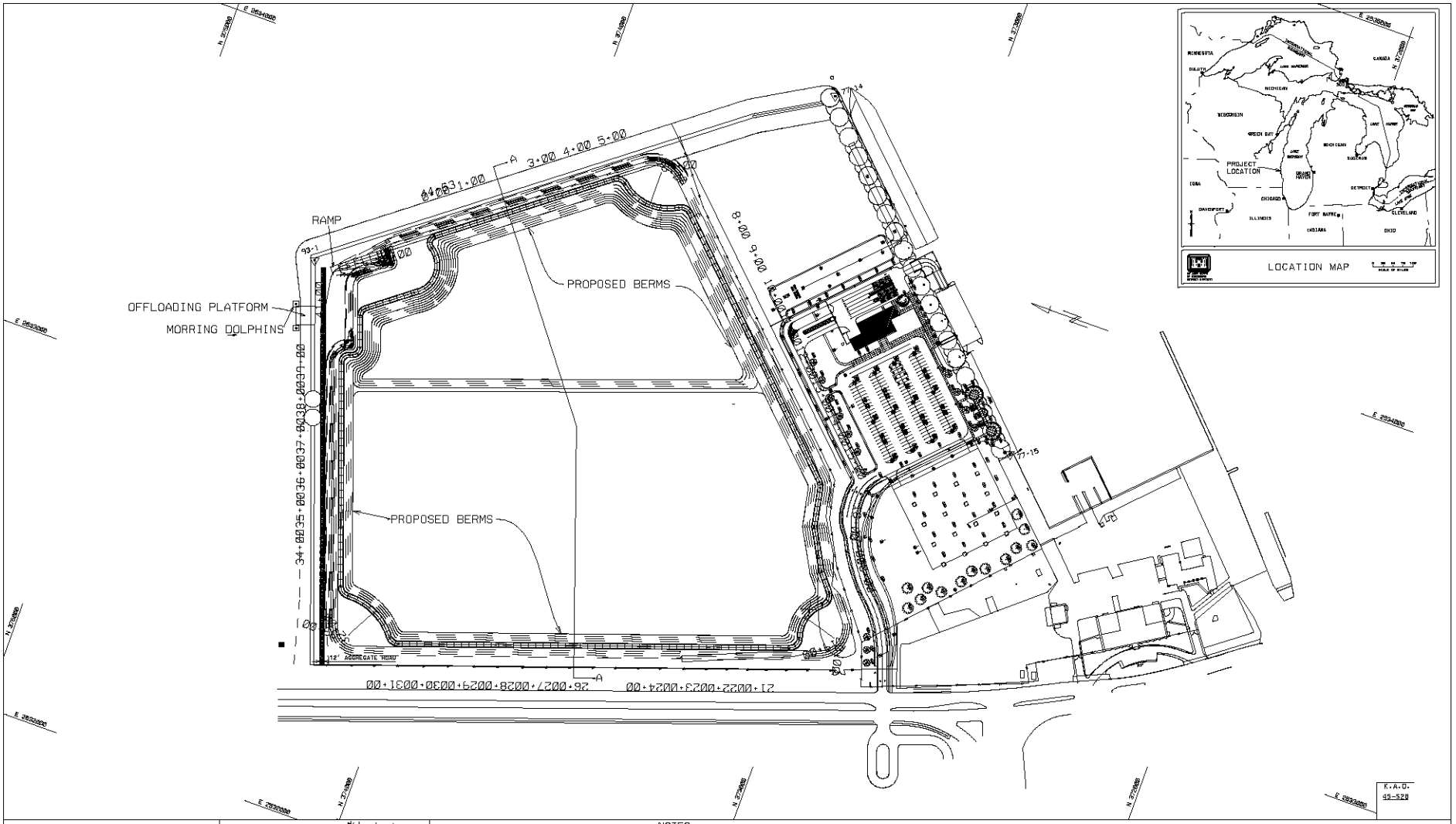
In the dredging and disposal cycle, assuming 35,000 cubic yards of materials are removed will result in a 1' thick layer of material spread throughout the placement area to facilitate drying and consolidation. The total area available for fill was calculated using Inroads. A digital terrain model was created assuming the entire area designated for permit dredging is filled to +10 feet. The borrow area was modeled excavated to +2 feet providing sufficient material to construct the berms. A top surface was created intersecting the dikes at +17 feet with a 1% grade to the middle of the new cell. A volume of approximately 500,000cy was calculated between the two surfaces, shown in figure 6. A settlement analysis is included in the Geotechnical Data Attachment A. Settlement was not included in the available volume assuming this volume will be used for a final cover and landscaping when the site is filled.

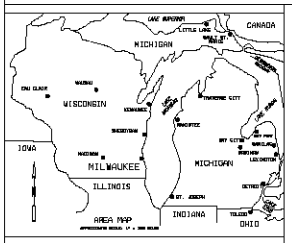
A stability analysis of the proposed new berm configuration was undertaken in order to assure its integrity under conditions of deposition into the site. Data for the analyses was derived from soil borings taken within the proposed placement area as shown in the Geotechnical Data Attachment A. The borings indicate that the soils in the CDF are primarily high and low plasticity silty/sandy clays (CL and CH) with trace organics. A soil profile of the placement area is shown in the Geotechnical Data Attachment A.

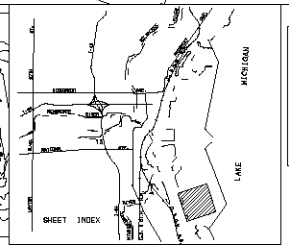
The stability analysis as detailed in the Geotechnical Data Attachment A provides a check to determine the stability of the dikes against sliding. The results of the analysis verify that the proposed dimensions for side slopes of 1V:3H will provide a sound structure.

REFERENCES

1. U.S. Army, Waterways Experiment Station. January 1976. Mathematical Model for Predicting the Consolidation of Dredged Material in Confined Disposal Areas. Technical Report DS-76-1. Vicksburg, Mississippi.
2. U.S Army Engineer District, Savannah. November 1977. Design and Construction of Retaining Dikes for Dredged Material Containment Facilities. Technical Report DS-77-9. Savannah, Georgia.
3. U.S. Army, Waterways Experiment Station. December 1978. Guidelines for Designing, Operating and Managing Dredged Material Containment Areas. Technical Report DS-78-10. Vicksburg, Mississippi.
4. U.S. Army, Office, Chief, of Engineers, 30 September 1987, Confined Disposal of Dredged Material, EM 1110-2-5027.







LEGEND

- GPS CONTROL MONUMENT
- BRONZE OR BRASS DISC
- CHANNEL LINE TURNING POINT

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COMBINED GRID SCALE FACTOR = 0.99999570
GRID DIST. DIVIDED BY COMBINED GRID SCALE FACTOR = GROUND DIST.

100 0 100 200 300
1" = 100'

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NO.	DATE	REVISION	BY

U.S. ARMY ENGINEER DISTRICT, DETROIT
CORPS OF ENGINEERS
DETROIT, MICHIGAN

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS ON THIS SET AS INDEXED ON THIS SHEET.

MILWAUKEE HARBOR, WISCONSIN

PROPOSED DREDGED MATERIAL DISPOSAL FACILITY PLAN VIEW

SUBMITTED BY: P.E.
CHIEF, DESIGN BRANCH

APPROVED:
CHIEF, ENGINEERING & TECHNICAL SERVICES DIVISION

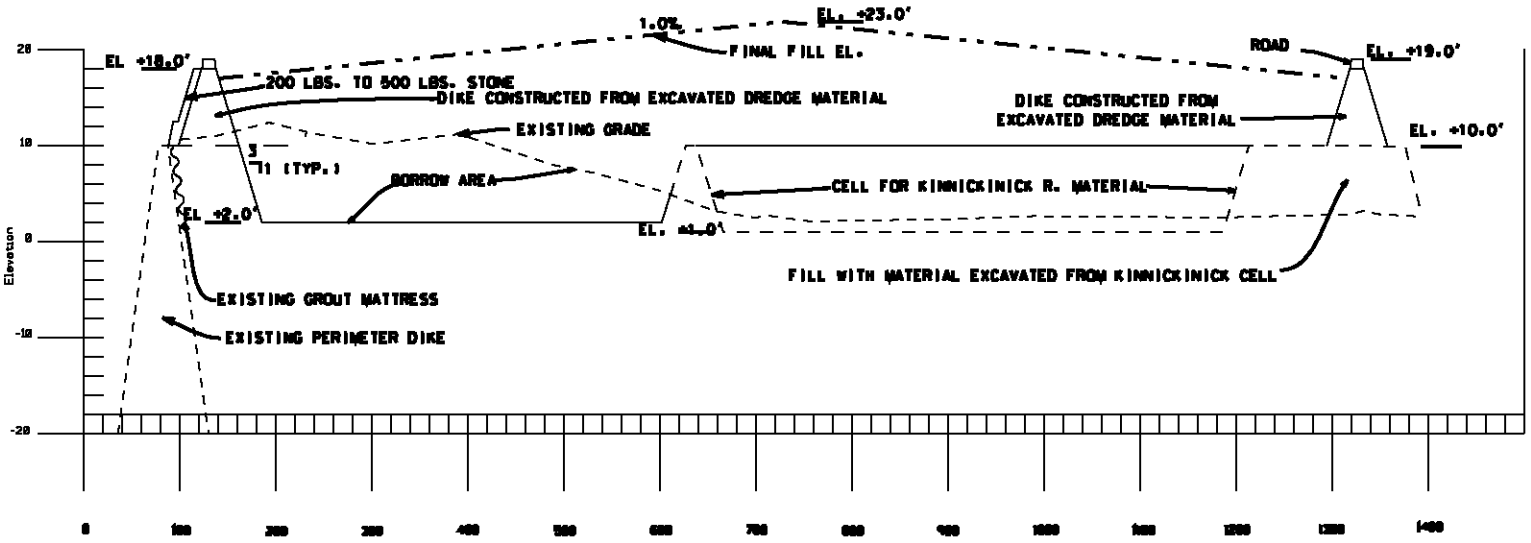
APPROVAL RECOMMENDED: P.E.
CHIEF, ENGINEERING & CONSTRUCTION OFFICE

SCALE AS SHOWN

DRAWING NUMBER

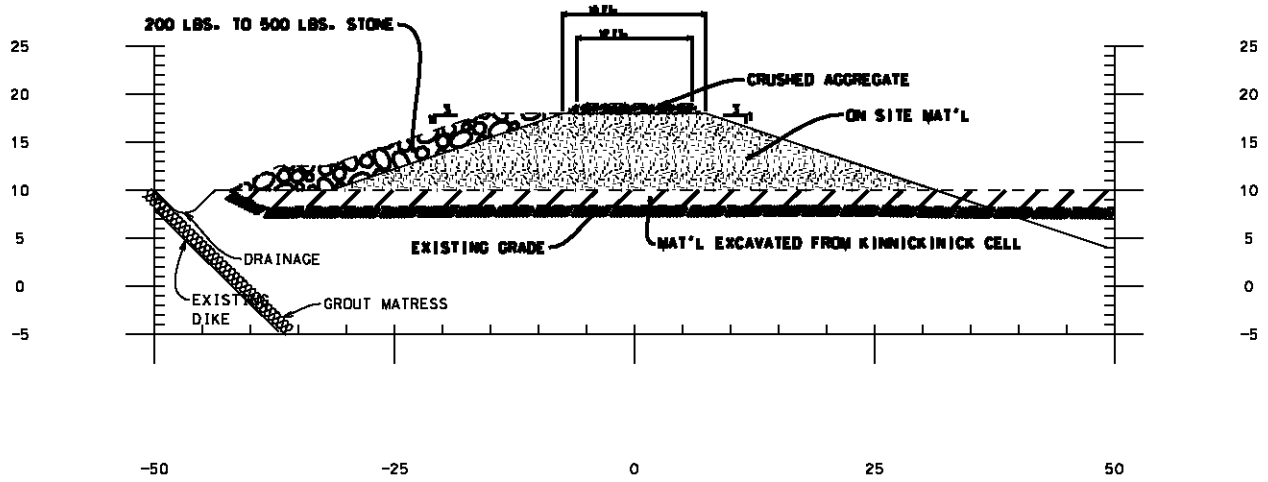
SHEET 1 OF 2

Figure 1, Page A-6

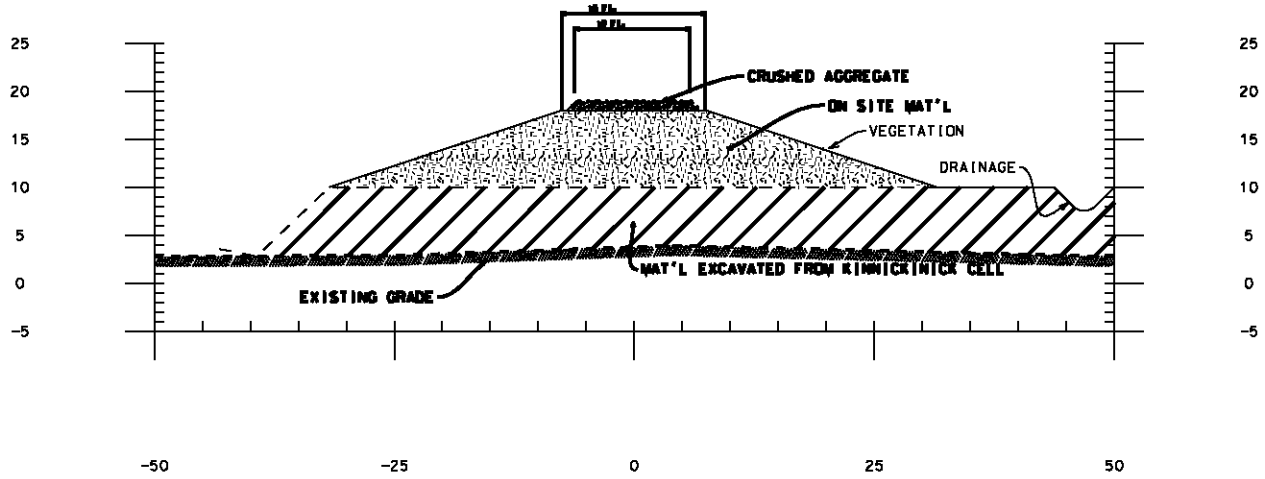


U.S. ARMY ENGINEER DISTRICT, DETROIT CORPS OF ENGINEERS DETROIT, MICHIGAN	
MILWAUKEE HARBOR, WI. DREDGE MATERIAL DISPOSAL FACILITY SECTION A-A	
DRAWN BY: KJW	CHECKED BY: XXX
DATE: 25 JUL 07	PLATE #2/ID

Figure 2, Page A-7



TYPICAL SECTION EAST SIDE



TYPICAL SECTION SOUTH & WEST SIDES

U.S. ARMY ENGINEER DISTRICT, DETROIT
CORPS OF ENGINEERS
DETROIT, MICHIGAN

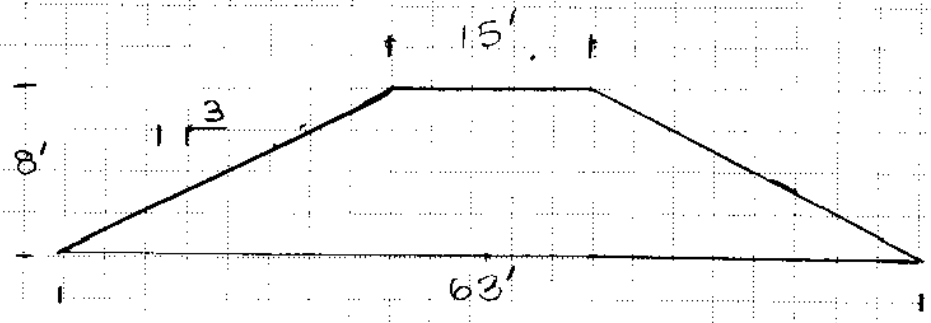
MILWAUKEE HARBOR, WI.
DREDGE MATERIAL DISPOSAL FACILITY

TYPICAL SECTIONS

DRAWN BY: KJW	CHECKED BY: XXX
DATE: 25 JUL 07	PLATE #3/ID

COMPUTATION SHEET

PROJECT	Milwaukee DMMP	DATE	7/26/07
SUBJECT		PAGE	1 OF 2
ITEM		PAGE	OF
COMPUTED BY	KJW	CHECKED BY	REF



Armour stone 160 lbs/cf
clay 100 lbs/cf
cerrient 94 lbs/cf
berm lengh 4463 lf

east side lengh 980'
north side lengh 1075'
Surface area
top of berms 125,550 sf

Geotextile
under armour stone
$(24')^2 + (8')^2 = 640\ ft^2$ $\sqrt{640} = 25.30\ ft$

$25.30' \times (980 + 1075) = 51991\ sf$
under road and radius 125,550 sf

total geotextile = 177541 sf ÷ 9 = 19727 sy

Armour stone

$51991\ sf \times 2.5\ ft = 129978\ cf \times \frac{160\#}{cf} \times \frac{1\ ton}{2000\#} = 10398\ ton$

crushed aggregate

$125550\ sf \times 1' = 125550\ cf \div 27 = 4650\ cy$

Cement

$63' \times 1.0' \times 4463 = 281169\ cf \times \frac{100\ lbs}{cf} = 28116900\ lbs$

$28116900\ lbs \times 0.05 = 1405845\ lbs \times \frac{1\ ton}{2000\ lbs} = 703\ tons$

COMPUTATION SHEET

PROJECT	Milwaukee DMMP	DATE	7/26/07
SUBJECT		PAGE	2 OF 2
ITEM		PAGE	OF
COMPUTED BY	KJW	CHECKED BY	REF

Steel Sheet Pile

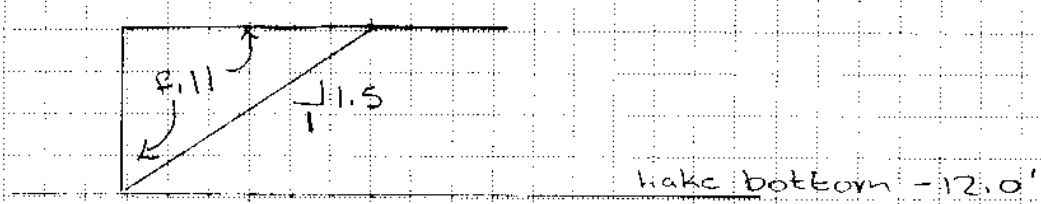
150 lf × 60' deep = 9000 sf × $\frac{24.2 \text{ lb}}{\text{sf}}$ × $\frac{1 \text{ ton}}{2000 \text{ lbs}}$ = 109 tons

PZC19 $\frac{24.2 \text{ lbs}}{\text{ft}^2}$

timber piles for mooring dolphins

37 piles/dolphin × 2 = 74 piles × 60' lengh = 4440 lf

riprap



$\frac{12' \times 18'}{2}$ = 108 sf × 50' = 5400 cf

5400 cf × $\frac{85 \text{ lbs}}{\text{cf}}$ = 459000 lbs × $\frac{1 \text{ ton}}{2000 \text{ lbs}}$ = 230 tons

Quantities

Geotextile	20,000 sy	SSP	109 tons
armour stone	10,500 ton	timber piles	4440 lf
crushed aggregate	5000 cy	riprap	230 tons
cement	562 tons		

Triangle Volume

Triangle Volume Report

Original Surface: 10'
Design Surface: berms

Mode: Entire Surface
Cut Factor: 1.0
Fill Factor: 1.0

Cut: 0.0 cu ft
Fill: 1899807.5 cu ft
Net: -1899807.5 cu ft

Cut: 0.0 cu yd
Fill: 70363.2 cu yd
Net: -70363.2 cu yd

Triangle Volume

Triangle Volume Report

Original Surface: cdf7
Design Surface: fill w/1% Slope

Mode: Entire Surface
Cut Factor: 1.0
Fill Factor: 1.0

Cut: 24205.6 cu ft
Fill: 13254109.3 cu ft
Net: -13229903.7 cu ft

Cut: 896.5 cu yd
Fill: 490892.9 cu yd
Net: -489996.4 cu yd

US Army Corps
of Engineers
Detroit District

Attachment A

Milwaukee CDF DMMP

Milwaukee, Wisconsin

GEOTECHNICAL DATA

July 2007

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1995 Boring Logs	A-26
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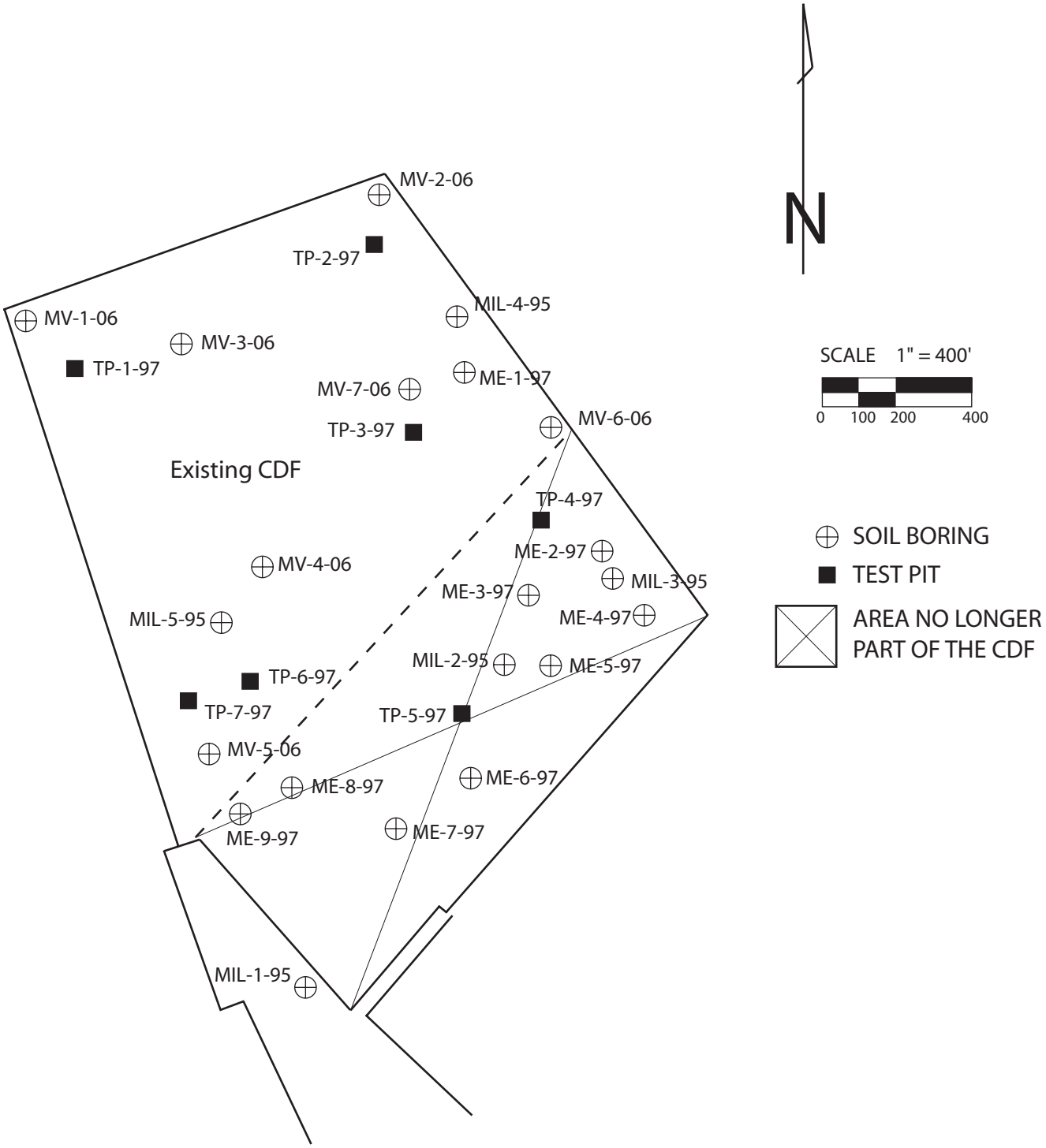
Stability Analysis Report	A-37
Settlement Calculations	A-64

Milwaukee CDF - Approximate Soil Boring Locations



DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 374,153.42 E 2,532,492.27
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-1-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 17 / UNDISTURBED 3
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	574.0
16. DATE HOLE	STARTED 8/30/2006 / COMPLETED 8/30/2006
17. ELEVATION TOP OF HOLE	+583.1
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+583.1	0.0		Fill: ML, Light brown to brown very loose to medium dense silt, little clay, trace organic matter, aluminum can fragment was observed in Sample No. 1	42	1 0.0 2.0	Blows = WOH,1,2,4 Qp = 2.0 TSF
				63	2 2.0 4.0	Blows = 10,6,6,7 Qp = 1.5 TSF
+579.1	4.0		CL-ML, Brown to dark brown very soft to medium (firm) clayey silt, trace organic matter and shells	100	3 4.0 6.0	Blows = 2,1,2,1 Qp = .75 TSF
				83	4 6.0 8.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
+575.1	8.0		CL, Brownish gray to gray medium (firm) to stiff silty clay, trace to some fine to coarse sand, trace fine gravel 1" Brownish gray silty fine sand seams with shell fragments observed at 9', 10.5' and 11.5' 2" Dark gray to black sandy silt seam observed at 12'	63	5 8.0 10.0	Blows = 3,2,1,9 Qp = 1.25 TSF
				71	6 10.0 12.0	Blows = 3,2,2,3 Qp = 1.5 TSF
				33	7 12.0 14.0	Blows = WOH, WOH, 2,1 Qp = 1.0 TSF
				33	8 14.0 16.0	Blows = 2,2,2,2 Qp = .5 TSF
+567.1	16.0		GP, Brown to gray medium dense to dense fine to medium gravel, little fine to coarse sand Note: Both rounded gravel of various rock types and angular dolomite fragments observed	8	9 16.0 18.0	Blows = 3,2,13,23
				46	10 18.0 20.0	Blows = 18,23,17,10
+563.1	20.0					

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 583.1

Hole No. MV-1-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			CL, Brown very stiff silty clay, trace fine to coarse sand and fine gravel	71	11 20.0 22.0	Blows = 5,7,9,14 Qp = 3.0 TSF
				100	12 22.0 24.0	3" diameter shelby tube sample from 22.0' - 24.0' Qp = 2.5 TSF
+559.1	24.0					
			ML, Grayish brown to gray medium dense silt, little clay, trace to little fine sand 6" silty clay seam at 28.8'	79	13 24.0 26.0	Blows = 6,7,11,14 Qp = 1.5 TSF
				100	14 26.0 28.0	3" diameter shelby tube sample from 26.0' - 28.0' Qp = 3.5 TSF
				92	15 28.0 30.0	Blows = 9,8,8,17 Qp = 2.25 TSF
+553.1	30.0					
			CL, Brown and slightly reddish brown very stiff silty clay, trace to little fine to coarse sand and fine gravel	100	16 30.0 32.0	Blows = 6,7,12,14 Qp = 2.5 TSF
				50	17 32.0 34.0	3" diameter shelby tube sample from 32.0' - 34.0' Qp = 3.0 TSF
				100	18 34.0 36.0	Blows = 6,7,10,13 Qp = 3.0 TSF
				100	19 36.0 38.0	Blows = 8,8,10,14 Qp = 2.0 TSF
				100	20 38.0 40.0	Blows = 7,9,11,14 Qp = 2.0 TSF
+543.1	40.0					
			END OF BORING - 40.0' Borehole advanced to 12' with with solid stem augers. Borehole advanced from 12' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 10' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 9.1' while drilling and before casing installation.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 374,526.90 E 2,533,430.66
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-2-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 8/29/2006 / COMPLETED 8/30/2006
17. ELEVATION TOP OF HOLE	+586.2
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+586.2	0.0		Fill: ML and OH, Light brown, brown and dark brown loose to medium dense silt and organic silt, trace to little clay, fine to coarse sand and fine gravel Note: Gravel encountered while drilling from 6'-8'	38	1 0.0 2.0	Blows = 3,5,5,5
				79	2 2.0 4.0	Blows = 4,6,8,7 Qp = 2.0 TSF
				58	3 4.0 6.0	Blows = 6,4,5,5 Qp = 2.0 TSF
				42	4 6.0 8.0	Blows = 12,15,13,21
+578.2	8.0		OH and OL, Dark brown to gray very soft to medium (firm) organic silt and organic clay, trace to little fine sand and shell fragments	67	5 8.0 10.0	Blows = 8,4,3,5 Qp = .25 TSF
				33	6 10.0 12.0	Blows = WOH,2,2,4 Qp = .25 TSF
				33	7 12.0 14.0	Blows = 3,2,2,2 Qp = .5 TSF
				100	8 14.0 16.0	Blows = WOH,WOH,WOH,WOH Qp = .5 TSF
				33	9 16.0 18.0	3" diameter shelby tube sample from 16.0' - 18.0' No recovery, pushed spoon for disturbed sample
+568.2	18.0		GC, Light gray to tan medium dense sandy gravel, trace to some silt and clay Note: Gravel consisted of angular dolomite fragments		10 18.0 20.0	3" diameter shelby tube sample from 18.0' - 20.0' Poor sample; tube damaged/dented while sampling

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 586.2

Hole No. MV-2-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			GC, Light gray to tan medium dense sandy gravel, trace to some silt and clay Note: Gravel consisted of angular dolomite fragments *(continued)*	25	11 20.0 22.0	Blows = 12,10,9,9
				17	12 22.0 24.0	Blows = 15,10,14,13
				4	13 24.0 26.0	Blows = 1,6,5,3
					14 26.0 28.0	No sample taken - pounded casing due to gravel
+558.2	28.0					
			GP, Brown to gray loose to medium dense gravel, little fine to coarse sand Note: Gravel consisted of various rounded to subrounded rock types	25	15 28.0 30.0	Blows = 7,7,6,17
				17	16 30.0 32.0	Blows = 3,3,4,4
				21	17 32.0 34.0	Blows = 4,4,5,4
				17	18 34.0 36.0	Blows = 5,4,4,6
+549.7	36.5			67	19 36.0 38.0	Blows = 6,6,5,6
			SM, Brown medium dense silty fine to medium sand with mm-scale varves/bedding, trace to little fine gravel	17	20 38.0 40.0	Blows = 8,6,7,9
+546.2	40.0					
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 28' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Boring dry while drilling and prior to casing installation and introduction of drilling fluids. No groundwater levels were recorded.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 374,063.22 E 2,532,974.50
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-3-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 17 / UNDISTURBED 3
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	577.4
16. DATE HOLE	STARTED 8/30/2006 / COMPLETED 8/30/2006
17. ELEVATION TOP OF HOLE	+579.6
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+579.6	0.0		Fill: OH, Dark brown to black very soft organic silt, little shell fragments, trace organic matter and plastic	8	1 0.0 2.0	Blows = WOH,2,1,1 Very little recovery; sample disturbed
				29	2 2.0 4.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				100	3 4.0 6.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				75	4 6.0 8.0	3" diameter shelby tube sample from 6.0' - 8.0' Qp = 0.0 TSF
+571.6	8.0		OH, Dark brown to black very soft organic silt and clay, trace to little fine sand 1" fine sand seam observed at 13'	75	5 8.0 10.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				71	6 10.0 12.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				58	7 12.0 14.0	Blows = WOH,1,2,WOH Qp = 0.0 TSF
+565.6	14.0		CH, Gray very soft silty clay, some fine to coarse sand	75	8 14.0 16.0	3" diameter shelby tube sample from 14.0' - 16.0' Poor sample; disturbed due to wood in tube
+563.6	16.0		SM, Dark gray to gray medium dense silty fine sand, trace fine gravel	50	9 16.0 18.0	Blows = 1,3,10,10
				83	10 18.0 20.0	Blows = 7,13,13,12

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 579.6

Hole No. MV-3-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+557.6	22.0		SM, Dark gray to gray medium dense silty fine sand, trace fine gravel *(continued)*		11 20.0 22.0	No sample recovered
			ML and CL-ML, Gray to brownish gray loose silt and very soft clayey silt, trace to little fine sand	42	12 22.0 24.0	3" diameter shelby tube sample from 22.0' - 24.0' Qp = 0.0 TSF Poor sample; tube damaged/dented while sampling
				100	13 24.0 26.0	Blows = 7,2,2,1 Qp = 0.0-0.5 TSF
				100	14 26.0 28.0	3" diameter shelby tube sample from 26.0' - 28.0' Qp = .5 TSF No recovery; pushed spoon for disturbed sample
+550.6	29.0			75	15 28.0 30.0	3" diameter shelby tube sample from 28.0' - 30.0' Poor sample (started falling out of tube)
			SM, Brown to gray medium dense silty fine to medium sand, trace to little fine gravel			
				46	16 30.0 32.0	Blows = 7,6,9,9
				29	17 32.0 34.0	Blows = 9,10,15,13
+543.6	36.0			42	18 34.0 36.0	Blows = 11,10,10,9
			CL, Brown to gray stiff to very stiff silty clay, trace to little fine to medium sand, trace fine gravel	54	19 36.0 38.0	Blows = 10,9,13,17 Qp = 2.0 TSF
+539.6	40.0			38	20 38.0 40.0	Blows = 5,8,7,9 Qp = 1.0 TSF
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 10' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 2.2' while drilling and before casing installation.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,576.82 E 2,553,142.05
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-4-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 17 / UNDISTURBED 3
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	577.4
16. DATE HOLE	STARTED 8/31/2006 / COMPLETED 8/31/2006
17. ELEVATION TOP OF HOLE	+581.1
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+581.1	0.0		Fill: OH, Dark brown to black very soft to stiff organic silt, trace to little fine to coarse sand, trace to little organic matter	83	1 0.0 2.0	Blows = 1,2,1,2, Qp = 1.0 TSF
				58	2 2.0 4.0	Blows = WOH,1,1,1 Qp = 0.0 TSF
				83	3 4.0 6.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				100	4 6.0 8.0	3" diameter shelby tube sample from 6.0' - 8.0' Qp = 0.0 TSF
				50	5 8.0 10.0	Blows = WOH,WOH,WOH,6 Qp = 0.0 TSF
+571.1	10.0		GP, Brown to gray loose to dense gravel, trace to little fine to coarse sand Note: Gravel consisted of various rounded to subrounded rock types	29	6 10.0 12.0	Blows = 4,4,4,6
				13	7 12.0 14.0	Blows = 6,5,7,5
				25	8 14.0 16.0	Blows = 2,4,4,3
				13	9 16.0 18.0	Blows = 13,15,16,10
+563.1	18.0		GP, Tan medium dense gravel Note: Gravel consisted of angular dolomite fragments	8	10 18.0 20.0	Blows = 3,1,15,17
+561.1	20.0					

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 581.1

Hole No. MV-4-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			SM, Gray medium dense silty fine to coarse sand, trace to some fine gravel	79	11 20.0 22.0	Blows = 9,9,15,14
+558.1	23.0			67	12 22.0 24.0	Blows = 8,9,11,8 Qp = 2.5 TSF
			CL, Brownish gray to gray very stiff silty clay, trace to little fine to coarse sand, trace fine gravel Note: Fine sandy silt seam observed from 39.2' to 39.8'	54	13 24.0 26.0	Blows = 7,7,6,7 Qp = 2.5 TSF
					14 26.0 28.0	3" diameter shelby tube sample from 26.0' - 28.0' No recovery, pushed spoon for disturbed sample
				100	15 28.0 30.0	3" diameter shelby tube sample from 28.0' - 30.0' Qp = 2.5 TSF
				88	16 30.0 32.0	Blows = 3,3,5,8 Qp = 1.75 TSF
				100	17 32.0 34.0	Blows = 5,6,8,11 Qp = 2.25 TSF
				100	18 34.0 36.0	3" diameter shelby tube sample from 34.0' - 36.0' Qp = 2.75 TSF
				100	19 36.0 38.0	Blows = 5,7,9,13 Qp = 2.25 TSF
+541.1	40.0			100	20 38.0 40.0	Blows = 6,8,10,14 Qp = 2.5 TSF
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 28' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 3.7' while drilling and before casing installation.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,002.36 E 2,532,972.15
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-5-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 18 / UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 8/28/2006 / COMPLETED 8/28/2006
17. ELEVATION TOP OF HOLE	+584.3
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+584.3	0.0		Fill: ML and CL-ML, Dark brown to brown loose silt and stiff to hard clayey silt, trace fine sand and organic matter	100	1 0.0 2.0	Blows = 2,5,6,9 Qp = 4.0 TSF
				63	2 2.0 4.0	Blows = 13,3,4,4 Qp = 1.0 TSF
+580.3	4.0					
			Fill: OH, Dark gray very soft to soft organic silt, trace fine sand and organic matter	83	3 4.0 6.0	Blows = 3,3,3,4 Qp = .75 TSF
				100	4 6.0 8.0	Blows = WOH,WOH,2,WOH Qp = .5 TSF
				100	5 8.0 10.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0-.25 TSF
+573.3	11.0			100	6 10.0 12.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
			CL, Gray very soft silty clay, trace fine sand			
+571.3	13.0			79	7 12.0 14.0	Blows = 12,9,30,39 Qp = 0.0 TSF
			SM, Black to brownish gray medium dense to dense silty fine to coarse sand, trace to little fine gravel			
				46	8 14.0 16.0	Blows = 7,4,21,50/0.2
				67	9 16.0 18.0	Blows = 20,25,31,36
				46	10 18.0 20.0	Blows = 13,10,9.8
+564.3	20.0					

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 584.3

Hole No. MV-5-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			CL and CL-ML, Brown to gray soft to stiff silty clay and clayey silt, trace to little fine to medium sand Note: Silty fine to coarse sand seam encountered in Sample No. 11; 1/4" to 1/2" sand seams observed between 24' - 28'	63	11 20.0 22.0	3" diameter shelby tube sample from 20.0' - 22.0'
				25	12 22.0 24.0	Blows = 6,3,4,8 Qp = 1.5 TSF
				63	13 24.0 26.0	Blows = 6,4,7,7 Qp = 1.25 TSF
				100	14 26.0 28.0	Blows = 3,5,5,6 Qp = .75 TSF
				100	15 28.0 30.0	Blows = 4,6,6,7 Qp = 1.5 TSF
				100	16 30.0 32.0	3" diameter shelby tube sample from 30.0' - 32.0' Qp = 1.0 TSF
				100	17 32.0 34.0	Blows = 5,4,5,6 Qp = 1.0 TSF
				83	18 34.0 36.0	Blows = 2,3,3,3 Qp = .5 TSF
				100	19 36.0 38.0	Blows = 2,2,3,4 Qp = .25 TSF
				100	20 38.0 40.0	Blows = 5,8,8,16 Qp = 1.5 TSF
+544.3	40.0					
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 10' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Boring was dry while drilling and prior to casing installation and introduction of drilling fluids. No groundwater levels were recorded.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,748.68 E 2,534,031.15
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-6-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	579.0
16. DATE HOLE	STARTED 8/29/2006 / COMPLETED 8/29/2006
17. ELEVATION TOP OF HOLE	+586.0
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+586.0	0.0		Fill: ML and CL-ML, Light brown, brown and dark brown very loose to medium dense silt and soft to stiff clayey silt, trace to little fine to medium sand, trace asphalt and slag in Sample No. 2, trace shell fragments and organic matter in Sample Nos. 3 and 4	100	1 0.0 2.0	Blows = 4,5,8,9 Qp = 1.0 TSF
				100	2 2.0 4.0	Blows = 7,6,8,7 Qp = 1.5 TSF
				83	3 4.0 6.0	Blows = 4,5,5,5 Qp = 1.5 TSF
+580.0	6.0					
			Fill: OH, Dark brownish gray soft to medium (firm) organic clayey silt, trace to little fine sand and organic matter	92	4 6.0 8.0	Blows = 1,1,2,2 Qp = .5 TSF
				100	5 8.0 10.0	Blows = 1,1,1,2 Qp = .25-.75 TSF
				100	6 10.0 12.0	Blows = 4,2,1,3 Qp = .5 TSF
+574.0	12.0					
			OL and OH, Dark gray to black soft to medium (firm) organic clay and silt, trace to little shell fragments and organic matter, trace fine sand	100	7 12.0 14.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				100	8 14.0 16.0	Blows = WOH,WOH,WOH,WOH Qp = .5 TSF
				63	9 16.0 18.0	3" diameter shelby tube sample from 16.0' - 18.0' Qp = .25 TSF
+568.0	18.0					
				4	10 18.0 20.0	Blows = 5,2,1,6

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 586.0

Hole No. MV-6-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			GP, Tan loose to extremely dense gravel, trace to little fine to coarse sand Note: Gravel consisted of angular dolomite fragments; 100% loss of drilling fluid from 18'-20' and from 20'-22' *(continued)*	8	11 20.0 22.0	Blows = 5,6,4,9
					12 22.0 24.0	Blows = 50/0.1 No recovery
				29	13 24.0 26.0	Blows = 5,30,12,10
					14 26.0 28.0	Blows = 50/0.1 No recovery
					15 28.0 30.0	Blows = 9,4,4,5 No recovery - 2 attempts
+556.0	30.0					
			GP, Brown to gray loose to medium dense fine to coarse sand and fine gravel Note: Gravel consisted of various rounded to subrounded rock types; 100% fluid loss from 36'-38'	8	16 30.0 32.0	Blows = 4,2,4,3
				8	17 32.0 34.0	Blows = 4,4,4,3
				29	18 34.0 36.0	Blows = 3,2,2,2
				13	19 36.0 38.0	Blows = 4,3,2,3
				42	20 38.0 40.0	Blows 6,7,6,5
+546.0	40.0					
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 33' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Groundwater was encountered at 7' while drilling and prior to introduction of drilling fluids.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

DRILLING LOG

DIVISION	USACE
INSTALLATION	Chicago District
SHEET	1 OF 2 SHEETS
1. PROJECT	Milwaukee CDF Geotech Inv.
2. LOCATION (Coordinates or Station)	Milwaukee, Wisconsin N 373,965.30 E 2,533,439.44
3. DRILLING AGENCY	STS Exploration
4. HOLE NO. *(As shown on drawing title and file number)*	MV-7-06
5. NAME OF DRILLER	Randy/Matt
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED --- DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	NA
8. DEPTH DRILLED INTO ROCK	NA
9. TOTAL DEPTH OF HOLE	40.0
10. SIZE AND TYPE OF BIT	4" Solid Stem/3 7/8" Rock Bit
11. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*	IGLD 85
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50 ATV
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN	DISTURBED 15 / UNDISTURBED 5
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 8/31/2006 / COMPLETED 8/31/2006
17. ELEVATION TOP OF HOLE	+583.9
18. TOTAL CORE RECOVERY FOR BORING	NA %
19. GEOLOGIST	Bryan Bergmann

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS *(Drilling time, water loss, depth weathering, etc., if significant)* g
+583.9	0.0		Fill: SC-SM, Black medium dense organic fine to coarse sand, some silt, little clay, trace shell fragments	63	1 0.0 2.0	Blows = 4,4,6,7 Qp = 2.0 TSF
				100	2 2.0 4.0	Blows = 5,6,7,8 Qp = 1.5 TSF
+579.9	4.0		Fill: OH, Black very soft to stiff organic silt, little to some fine sand, trace fine gravel, shell fragments and organic matter	79	3 4.0 6.0	Blows =5,4,3,3 Qp = .25-1.5 TSF
				83	4 6.0 8.0	Blows = 1,1,1,2 Qp = .25 TSF
				100	5 8.0 10.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				100	6 10.0 12.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
				17	7 12.0 14.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				71	8 14.0 16.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF
				100	9 16.0 18.0	3" diameter shelby tube sample from 16.0' - 18.0' Qp = 0.0 TSF
				50	10 18.0 20.0	Blows = WOH,WOH,WOH,WOH Qp = 0.0 TSF

DRILLING LOG (Cont Sheet)

ELEVATION TOP OF HOLE 583.9

Hole No. MV-7-06

PROJECT: Milwaukee CDF Geotech Inv.

INSTALLATION: Chicago District

SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
+561.9	22.0		Fill: OH, Black very soft to stiff organic silt, little to some fine sand, trace fine gravel, shell fragments and organic matter *(continued)*	100	11 20.0 22.0	3" diameter shelby tube sample from 20.0' - 22.0' Qp = 0.0 TSF
			OH, Black very soft to medium (firm) organic silt, trace fine sand and organic matter	75	12 22.0 24.0	Blows = WOH,WOH,WOH,WOH Qp = .25 TSF
+557.9	26.0			75	13 24.0 26.0	3" diameter shelby tube sample from 24.0' - 26.0' Qp = .5 TSF
			CL, Brown to dark brown stiff to very stiff silty clay, trace to little fine to coarse sand Note: 4" Sandy silt seam observed in Sample No. 14; Dark gray fine to medium sand seam observed in Sample No. 15	75	14 26.0 28.0	Blows = WOH,WOH,WOH,1 Qp = .25 TSF
				42	15 28.0 30.0	3" diameter shelby tube sample from 28.0' - 30.0' Qp = 3.5 TSF
				100	16 30.0 32.0	Blows = 5,5,6,7 Qp = 1.5 TSF
				100	17 32.0 34.0	3" diameter shelby tube sample from 32.0' - 34.0' Qp = 1.25 TSF
				100	18 34.0 36.0	Blows = 5,4,8,9 Qp = 1.5 TSF
				75	19 36.0 38.0	Blows = WOH,3,4,8 Qp = 1.25 TSF
+543.9	40.0			100	20 38.0 40.0	Blows = 4,5,6,10 Qp = 1.25 TSF
			END OF BORING - 40.0' Borehole advanced to 10' with with solid stem augers. Borehole advanced from 10' to 38' using a 3 7/8" rock bit and mud rotary drilling methods. 12' of temporary 4" steel casing was installed. Boring was backfilled with bentonite grout and 3/8" bentonite chips. Note: Boring was dry while drilling and prior to casing installation and introduction of drilling fluids. No groundwater levels were recorded.			All samples collected with 2" diameter split-spoon sampler; driven with a 140 pound hammer dropped 30", unless otherwise noted. Note: Individual laboratory test results are included on separate data sheets and summarized in the Appendix. STS Project No. 200605402

Hole No. -ME-1-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-1-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 7 97 — COMPLETED OCT 7 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 584.8
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Medium stiff, brown, organic SILT, occasional garbage (consisting of plastic wrappings), rootlets, dry, slightly plastic 0.8'	80%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 2-3-4-4 field pen. 2.0 tsf (brown silt) field torvane 0.29 tsf (gray silt) field pen. 1.25 tsf (gray silt)
584.0	0.8		Medium stiff, dark gray, organic SILT, with shells, dry, plastic, occasional garbage (consisting of aluminum foil and plastic wrap) 2.0'			
582.8	2.0		Soft, dark gray, clayey, organic SILT, plastic, moist, occasional garbage (consisting of clear and black plastic wrap), light gray, clayey silt seam 1.3' - 1.5' 4.0'	95%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 1-1-1-2 field torvane 0.22 tsf field pen. 0.5 tsf
580.8	4.0		Soft, dark gray, clayey, organic SILT, occasional garbage (consisting of blue plastic fragments), moist, plastic, thin seam with sand at 0.6' 6.0'	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 1-1-2-2 field torvane 0.13 tsf field pen. 0.5 tsf
578.8	6.0		Soft, dark gray, clayey, organic SILT, occasional garbage (consisting of plastic wrap), moist, plastic 6.4'	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 1/12"-2-1 field torvane 0.19 tsf (gray, clayey silt) field pen 0.5 tsf (gray, clayey silt)
578.4	6.4		Soft, gray, clayey, organic SILT, moist, medium plastic, trace of sand seam at 1.4' - 1.6' 8.0'			
576.8	8.0		Soft, gray, clayey, organic SILT, moist, plastic, with traces of gravel and sand in last 0.2' 10.0'	70%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1-1-1-1 field torvane 0.11 tsf field pen. 0.5 tsf water at bottom of boring after 10 minutes
574.8	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by OCA 1/94) PROJECT Milwaukee CDF, Milwaukee, WI HOLE NO. -ME-1-97

Hole No. -ME-2-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
3. DRILLING AGENCY Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number) -ME-2-97	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER Scott Strigel	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER 579.4
7. THICKNESS OF OVERBURDEN N/A	16. DATE HOLE: STARTED OCT 1 97; COMPLETED OCT 1 97
8. DEPTH DRILLED INTO ROCK N/A	17. ELEVATION TOP OF HOLE 586.8
9. TOTAL DEPTH OF HOLE 10.0	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Medium stiff, dark brown, fine, organic SILT, trace of gravel, friable, dry, some plant matter 2.0'	50%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop boring backfilled 60-40 cement-bentonite mix 10' - SS sample 0' - 2.0' blows 3-4-4-3 2', upper 2'
584.8	2.0		Stiff, dark brown, fine, organic SILT, trace of gravel becoming moist in lower 0.5', with plant material slightly plastic 4.0'	80%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 3-7-4-6
582.8	4.0		Soft, dark brown, fine, organic SILT, trace of gravel, moist, slight to moderately plastic 6.0'	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 2-2-1-2 field torvane 0.19 tsf field pen. 0.5 tsf
580.8	6.0		Soft, dark brown, fine, organic SILT, moist, moderately plastic, trace of gravel at 0.9' down 7.0'	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 1-2-2-2 field torvane 0.75 tsf field pen 0.33 tsf
579.8	7.0		changes to black, organic SILT, with plant material 8.0'			
578.8	8.0		Soft, dark brown, fine, organic SILT, moderately plastic, moist, at 1.1' down silt becomes black 9.1'	100%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 2-1-2-3 field torvane 0.10 tsf (brown silt) field pen. 0.25 tsf field torvane 0.2 tsf (black silt) field pen. 0.5 tsf (black silt)
577.7	9.1		Soft, black, fine, organic SILT, trace of sand, occasional garbage (consisting of aluminum foil), with plant material, moderately plastic 10.0'			
576.8	10.0		End of Boring			water 7.7' after drilling, 7.4', 10 and 20 minutes later backfilled with native material

DRILLING LOG

DIVISION	North Central
INSTALLATION	Detroit
SHEET	1 OF 1 SHEETS
1. PROJECT	Milwaukee CDF, Milwaukee, WI
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	-ME-3-97
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	N/A
8. DEPTH DRILLED INTO ROCK	N/A
9. TOTAL DEPTH OF HOLE	10.0
10. SIZE AND TYPE OF BIT	N/A
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD 55
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	579.3
16. DATE HOLE	STARTED OCT 1 97; COMPLETED OCT 1 97
17. ELEVATION TOP OF HOLE	585.8
18. TOTAL CORE RECOVERY FOR BORING	N/A %
19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
583.8	2.0		Medium stiff, brown, fine, organic SILT, shell fragments, friable, dry, charcoal and plant bits, slightly plastic (2.0')	40%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 2-3-4-5 1st spoon had 0.7' recovery, 2nd spoon taken 1' away
581.8	4.0		Stiff, brown, fine, organic SILT, friable, dry, slightly plastic, with plant matter (4.0')	75%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 3-4-5-6 field torvane 0.3 tsf field pen. 1.75 - 2.0 tsf
579.8	6.0		Stiff, brown, fine, organic SILT, with plant material, shell fragments, cinders, charcoal, slightly plastic, dry (6.0')	80%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 3-4-5-4 field torvane 0.4 tsf field pen. 1.5 tsf
579.6	6.2		Medium stiff, brown, fine, organic SILT, with cinders (6.2') at 0.2' down becomes medium stiff, gray, fine, organic SILT, trace of gravel, plus shell fragments, slightly plastic (8.0')	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 2-3-2-4 field torvane 0.21 tsf field pen 0.75 tsf
577.8	8.0		Soft, gray, fine, organic SILT, plastic, becoming clayey at bottom 0.8', occasional garbage (consisting of plastic wrap) (10.0')	95%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1-1-2-2 field torvane 0.25 tsf field pen. 0.5 - 0.75 tsf 40 minutes after drilling, water at 6.5'
575.8	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94)

PROJECT Milwaukee CDF, Milwaukee, WI

HOLE NO. -ME-3-97

Hole No. -ME-4-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-4-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 1 97 — COMPLETED OCT 1 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 588.4
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Medium, brown, fine to medium SANDY SILT, some gravel, dry (0.7')	65%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop
587.7	0.7		Medium, dark brown, organic SILT, with gravel, dry, friable (2.0')			SS sample 0' - 2.0' blows 7-11-13-14
586.4	2.0		Very stiff, dark brown, fine, organic SILT, friable, dry, with wood pieces, becoming dark brown to black 0.6' down (4.0')	80%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 5-8-9-14 field tarvane 0.43 tsf field pen. 2.8 tsf
584.4	4.0		Stiff, dark brown, fine, organic SILT, with cinders, trace of gravel, friable, dry, slightly plastic (6.0')	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 7-7-8-11 field tarvane 0.40 tsf, 0.55 tsf field pen. 1.75 tsf
582.4	6.0		Stiff, black, fine, organic SILT, with trace of garbage (consisting of cinders, possible small metal fragments), slightly plastic, friable, dry (8.0')	100%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 5-4-5-6 field tarvane 0.49 tsf, 0.45 tsf field pen 1.25 tsf
580.4	8.0		Medium stiff, fine, organic SILT, with plant parts and cinders, plastic, dry (9.5')	100%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 3-2-4-5 field tarvane 0.35 tsf, 0.36 tsf field pen. 1.0 tsf
578.9	9.5		Loose, gray, fine SILTY SAND, dry (10.0')			
578.4	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94) — PROJECT Milwaukee CDF, Milwaukee, WI — HOLE NO. -ME-4-97

Hole No. -ME-5-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-5-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 6 97 — COMPLETED OCT 6 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 587.9
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Very stiff, dark brown, organic SILT, crumbly, dry, some gravel, trace of sand, slightly plastic, dry, with cinders	50%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 6-8-17-16
585.9	2.0		2.0'			
			Very stiff, dark brown, organic SILT, crumbly, dry, with glass, metal debris, brick pieces	40%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 9-20-10-7 pocket pen. 2.0 tsf
583.9	4.0		4.0'			
			no recovery, refer to boring ME-5A-97	0%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 4-3-4-5
581.9	6.0		6.0'			
			no recovery, refer to boring ME-5A-97	0%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 3-4-5-5 material was within the auger
579.9	8.0		8.0'			
			Medium stiff, gray, organic SILT, moist, plastic, with shell fragments and organic material	100%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 3-2-3-4 field torvane 0.31 tsf field pen. 0.75 tsf
577.9	10.0		10.0'			
			End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94) PROJECT Milwaukee CDF, Milwaukee, WI HOLE NO. -ME-5-97

Hole No. -ME-5A-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-5A-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 6 97 — COMPLETED OCT 6 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 587.8
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 8.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			No sampling conducted 0.0' to 4.0'			4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop relocated 6.0' +/- west of boring ME-5-97 to attempt recovery of the 4.0' - 8.0' zone boring augered to 4.0' deep prior to sampling
583.8	4.0		4.0'			
583.6	4.2		Soft, brown, organic SILT, with gravel 4.2'	85%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 2-2-2-2 field torvane 0.19 tsf field pen. 0.75 tsf
			Soft, dark gray to black, organic, clayey SILT, with shells, plastic, moist			
581.8	6.0		6.0'			
			Medium stiff to stiff, dark gray, organic, clayey SILT, moist, plastic, with shell fragments, occasional garbage (consisting of rubber band fragments)	40%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 4-4-4-5 field torvane 0.19 tsf field pen. 0.41 tsf
579.8	8.0		8.0'			
			End of Boring			boring backfilled 60-40 cement-bentonite mix 8' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94) PROJECT Milwaukee CDF, Milwaukee, WI HOLE NO. -ME-5A-97

Hole No. -ME-6-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
3. DRILLING AGENCY Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number) -ME-6-97	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED N/A; UNDISTURBED N/A
5. NAME OF DRILLER Scott Strigel	14. TOTAL NUMBER CORE BOXES N/A
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN N/A	16. DATE HOLE: STARTED OCT 6 97; COMPLETED OCT 6 97
8. DEPTH DRILLED INTO ROCK N/A	17. ELEVATION TOP OF HOLE 589.0
9. TOTAL DEPTH OF HOLE 10.0	18. TOTAL CORE RECOVERY FOR BORING N/A %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Hard, dark brown, organic SILT, with gravel, dry, crumbly, many rootlets — 2.0'	80%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 9-13-19-20
587.0	2.0		Very stiff, dark brown, organic SILT, with woody material and some gravel, dry, crumbly, slightly plastic, between 0.6' - 0.7' large light gray, stone sampled (road gravel) — 4.0'	60%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 7-8-10-11
585.0	4.0					
584.8	4.2		Medium stiff, dark brown, organic SILT, dry, crumbly, with gravel, broken glass — 4.2' Stiff, gray, organic SILTY CLAY, moist, plastic, with wood debris — 6.0'	75%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 4-5-5-5 field torvane 0.29 tsf field pen. 1.5 tsf
583.0	6.0					
582.5	6.5		Medium stiff, brown, organic SILT, with cinders — 6.5' Medium stiff, gray, organic SILT, with organic material and shells, moist, plastic — 8.0'	65%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 3-2-3-3 field torvane 0.39 tsf (brown silt) field pen. 1.5 tsf (brown silt)
581.0	8.0					
579.0	10.0		Medium stiff, gray, clayey, organic SILT, with gravel, moist, plastic — 10.0'	60%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 2-3-2-5 field torvane 0.13 tsf field pen. 0.25 tsf
			End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (modified by CCA 1/94) — PROJECT Milwaukee CDF, Milwaukee, WI — HOLE NO. -ME-6-97

Hole No. -ME-7-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT Milwaukee CDF, Milwaukee, WI	10. SIZE AND TYPE OF BIT N/A
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) IGLD 55
	12. MANUFACTURES'S DESIGNATION OF DRILL Diedrich D-50
3. DRILLING AGENCY Coleman Engineering Company	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED N/A — UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number) -ME-7-97	14. TOTAL NUMBER CORE BOXES N/A
5. NAME OF DRILLER Scott Strigel	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	16. DATE HOLE — STARTED OCT 6 97 — COMPLETED OCT 6 97
7. THICKNESS OF OVERBURDEN N/A	17. ELEVATION TOP OF HOLE 587.8
8. DEPTH DRILLED INTO ROCK N/A	18. TOTAL CORE RECOVERY FOR BORING N/A %
9. TOTAL DEPTH OF HOLE 10.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Very stiff, dark brown, organic SILT, with cinders, friable, dry, slightly plastic, occasional garbage (consisting of cinders, plastic wrap fragments and glass shards) 2.0'	70%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 7-9-8-8 field pen. 2.75 - 3.0 tsf
585.8	2.0					
			Stiff, dark brown, organic SILT, with wood material, slight to medium plastic, dry, with black organic silt inclusions in last 0.3' of sample 4.0'	50%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 5-5-7-7 field torvane 1.0 tsf field pen. 0.45 tsf
583.8	4.0					
583.6	4.2		Medium stiff, dark brown, organic SILT, friable, dry 4.2' Soft, dark gray, clayey, organic SILT, moist, plastic, with woody pieces 6.0'	45%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 4-4-3-3 field torvane 0.15 tsf (gray silt layers) field pen. 0.25 tsf (gray silt layers)
581.8	6.0					
			Medium stiff, dark gray, clayey organic SILT, moist, plastic 8.0'	35%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 2-2-3-3 field torvane 0.15 tsf field pen. 0.25 tsf
579.8	8.0					
			Soft, dark gray to black, clayey, organic SILT, moist, plastic, with wood debris, occasional garbage (consisting of aluminum foil fragments) 10.0'	70%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 2-1-2-1 field torvane 0.9 tsf field pen. 0.25 tsf
577.8	10.0					
			End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. (modified by OCA 1/94) — PROJECT Milwaukee CDF, Milwaukee, WI — HOLE NO. -ME-7-97

Hole No. -ME-8-97

DRILLING LOG	DIVISION North Central	INSTALLATION Detroit	SHEET 1 OF 1 SHEETS

1. PROJECT	Milwaukee CDF, Milwaukee, WI
2. LOCATION (Coordinates or Station)	
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	-ME-8-97
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	N/A
8. DEPTH DRILLED INTO ROCK	N/A
9. TOTAL DEPTH OF HOLE	10.0
10. SIZE AND TYPE OF BIT	N/A
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD 55
12. MANUFACTURER'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED N/A; UNDISTURBED N/A
14. TOTAL NUMBER CORE BOXES	N/A
15. ELEVATION GROUND WATER	579.4
16. DATE HOLE	STARTED OCT 7 97; COMPLETED OCT 7 97
17. ELEVATION TOP OF HOLE	586.1
18. TOTAL CORE RECOVERY FOR BORING	N/A %
19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
585.5	0.6		Stiff, brown, organic SILT, with rootlets, cinders 0.6'	90%	1 0.0 2.0	4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 5-5-5-6
			Medium, brown SILTY SAND at 1.2' and 1.4', thin, gray silt seams each about 0.1' Loose, brown SAND, with silt 2.2'			
583.9	2.2			75%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 3-2-3-2
583.6	2.5		Soft, gray SILTY SAND, moist, slightly plastic 2.5'			
			Loose, dark gray SILTY SAND, with organics, cinders, siltier from 0.9' to 1.1' down 4.0'			
582.1	4.0		Very soft, dark gray to black, organic SILT, lower 0.4' wet, rest moist, top 0.3' with sand 6.0'	100%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 1/12"-1/12" field torvane 0.12 tsf field pen. 0.25 tsf
580.1	6.0		Very soft, black, organic SILT, wet, plastic, with sand 6.6'	0%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 1/12"-1-3 field torvane 0.04 tsf field pen. 0.5 tsf
579.5	6.6		Very soft, gray, organic SILT, wet, plastic, last 0.2' with silt and shell material 8.0'			
578.1	8.0		Very soft, gray to black SILT, wet, plastic 8.4'	90%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1-2-2-2
577.7	8.4		Loose, gray SILTY SAND, fine, saturated 10.0'			water at 6.8, 5 minutes after boring
576.1	10.0		End of Boring			boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94) PROJECT Milwaukee CDF, Milwaukee, WI HOLE NO. -ME-8-97

DRILLING LOG

DIVISION	North Central
INSTALLATION	Detroit
SHEET	1 OF 1 SHEETS
1. PROJECT	Milwaukee CDF, Milwaukee, WI
10. SIZE AND TYPE OF BIT	N/A
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD 55
2. LOCATION (Coordinates or Station)	
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
3. DRILLING AGENCY	Coleman Engineering Company
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED N/A; UNDISTURBED N/A
4. HOLE NO. (As shown on drawing title and file number)	-ME-9-97
14. TOTAL NUMBER CORE BOXES	N/A
5. NAME OF DRILLER	Scott Strigel
15. ELEVATION GROUND WATER	
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
16. DATE HOLE	STARTED OCT 7 97; COMPLETED OCT 7 97
17. ELEVATION TOP OF HOLE	584.6
7. THICKNESS OF OVERBURDEN	N/A
18. TOTAL CORE RECOVERY FOR BORING	N/A %
8. DEPTH DRILLED INTO ROCK	N/A
19. SIGNATURE OF INSPECTOR	
9. TOTAL DEPTH OF HOLE	10.0

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			Stiff, brown, organic SILT, many rootlets, dry, slightly plastic, with gravel (2.0')	70%	1 0.0 2.0	boring relocated 20' west of staked locating due to ditch and large concrete debris 4-1/2" HSA, 3" Split Spoon 140# hammer, 30" drop SS sample 0' - 2.0' blows 5-6-7-8 field pen. 3.0 tsf
582.6	2.0		Stiff, brown, organic SILT, with fine sand in lower 0.5' (2.5')	100%	2 2.0 4.0	SS sample 2.0' - 4.0' blows 4-7-7-8 field torvane 0.4 tsf (brown silt) field pen. 2.0 tsf (brown silt) field torvane 0.25 tsf (gray silt) field pen. 2.5 tsf (gray silt)
582.1	2.5		Stiff, dark gray, organic SILT, moist, plastic, with gravel (4.0')			
580.6	4.0		Medium stiff, brown, organic SILT, dry, slightly plastic (4.3')	95%	3 4.0 6.0	SS sample 4.0' - 6.0' blows 3-2-3-3 field torvane 0.3 tsf field pen. 0.75 tsf - 1.0 tsf
580.3	4.3		Medium stiff, gray, organic SILT, organics, occasional garbage (consisting of aluminum foil fragments), mottled with black organic inclusions (6.0')			
578.6	6.0		Soft, gray, clayey SILT, trace of gravel, moist, plastic, trace of fine sand (8.0')	105%	4 6.0 8.0	SS sample 6.0' - 8.0' blows 2-1-2-2 field torvane 0.15 tsf field pen. 0.25 tsf
576.6	8.0		Soft, gray, clayey SILT, moist, plastic (8.9')	90%	5 8.0 10.0	SS sample 8.0' - 10.0' blows 1/12"-1-1 field torvane 0.07 tsf (clayey silt) field pen. 0.25 tsf (clayey silt)
575.7	8.9		Very soft, light gray, SILTY CLAY, wet, plastic (10.0')			
574.6	10.0		End of Boring			muddy bottom, no water boring backfilled 60-40 cement-bentonite mix 10' - 2', upper 2' backfilled with native material

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (modified by GCA 1/94)

PROJECT Milwaukee CDF, Milwaukee, WI | HOLE NO. -ME-9-97

Hole No. MIL-1-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 3 SHEETS

1. PROJECT: Milwaukee CDF	10. SIZE AND TYPE OF BIT: 3-1/4" x 6-1/2" HSA
2. LOCATION (Coordinates or Station): N 372,500.000 E 2,564,800.000	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): IGLD (LWD 576.8)
3. DRILLING AGENCY: Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL: Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number): MIL-1-95	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 19; UNDISTURBED 0
5. NAME OF DRILLER: Scott Strigel	14. TOTAL NUMBER CORE BOXES: -
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER: 11.8
7. THICKNESS OF OVERBURDEN: Unknown	16. DATE HOLE: STARTED JUL 20 95; COMPLETED JUL 20 95
8. DEPTH DRILLED INTO ROCK: 0.0	17. ELEVATION TOP OF HOLE: 13.3' +/-
9. TOTAL DEPTH OF HOLE: 50.0	18. TOTAL CORE RECOVERY FOR BORING: 0 %
	19. SIGNATURE OF INSPECTOR: David R. Ellsbeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 0.6' +/- 7" Topsoil	78%	SS-1 0.0 1.5	3/9/19 N=28 14/18"
	0.6					
	0.9		0.6' to 1.0' +/- SAND, fine to coarse, medium dense, brown, silty, moist, with gravel			
			1.0' to 3.5' +/- SAND, fine to medium grained, medium dense, brown, silty, moist, with gravel	67%	SS-2 1.5 3.0	21/12/10 N=22 12/18"
			SAND, fine to medium grained, medium dense, brown, silty, moist, with gravel	67%	SS-3 3.0 4.5	11/10/4 N=14 12/18"
	3.5		3.5' to 6.0' +/- CLAY, plastic, soft, sandy, silty, gray, moist			
				67%	SS-4 4.5 6.0	4/3/4 N=7 Penetrometer = 1.5 TSF 12/18" Torvane = 0.70 TSF
	6.0		6.0' to 7.5' +/- SILT, non-plastic, moist, gray, sandy	78%	SS-5 6.0 7.5	2/2/5 14/18" Torvane = 0.75 TSF
	7.5		7.5' to 8.8' +/- CLAY, plastic, medium dense, sandy, moist, brown	89%	SS-6 7.5 9.0	10/15/27 Penetrometer = 3.0 TSF Cobbles and Boulders at 8.2' - 9.7' and 9.7' - 11.8' 16/18" Torvane = 1.05 TSF
	8.8		8.8' to 14.0' +/- GRAVEL, fine to coarse grained, sub-rounded to sub-angular, light brown, sandy, moist	100%	SS-7 9.0 10.0	60/44/50-0" Bouncing 12/12"
						50-0" Bouncing No Sample Recovery
				33%	SS-8 12.0 13.5	12/14/12 6/18"
	14.0		14.0' to 18.5' +/- SAND, fine to coarse grained, very dense, black, silty, gravelly, wet	56%	SS-9 13.5 14.7	40/92/100-3" 10/18"
			SAND, fine to coarse grained, very dense, black, silty, gravelly, wet	56%	SS-10 15.0 16.5	17/42/88 10/18"
			SAND, fine to coarse grained, very dense, black, silty, gravelly, with cinders, slag, wet	67%	SS-11 16.5 18.0	74/85/88 12/18"
	18.5		18.5' to 25.0' +/- SAND, fine to medium grained, dense, black, wet, with gravel, cinders and slag	58%	SS-12 18.0 20.0	24/33/36/33 14/24"

DRILLING LOG

DIVISION	
INSTALLATION	
SHEET 2 OF 3 SHEETS	
1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 372,500.000 E 2,564,800.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-1-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	50.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	-
15. ELEVATION GROUND WATER	11.8
16. DATE HOLE	STARTED JUL 20 95 / COMPLETED JUL 20 95
17. ELEVATION TOP OF HOLE	13.3' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Edlebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			SAND, fine to medium grained, dense, black, with gravel, cinders, slag, pieces of metal, wet	100%	SS-13 20.0 21.5	35/50/29 18/18"
	25.0		25.0' to 50.0' +/- CLAY, medium plastic, medium stiff, silty, light grayish brown, wet	100%	SS-14 25.0 26.5	3/9/10 Penetrometer = 1.75 TSF 18/18" Torvane = 0.90 TSF
			CLAY, medium plastic, medium stiff, silty, light grayish brown, wet	100%	SS-15 30.0 31.5	8/10/14 Penetrometer = 1.50 TSF 18/18" Torvane = 0.90 TSF
			CLAY, medium plastic, medium stiff, sandy, silty, light grayish brown, wet	100%	SS-16 35.0 36.5	5/8/9 Penetrometer = 0.75 TSF 18/18" Torvane = 0.55 TSF

DRILLING LOG

DIVISION

INSTALLATION

SHEET 3 OF 3 SHEETS

1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 372,500.000 E 2,564,800.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-1-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0.0
9. TOTAL DEPTH OF HOLE	50.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 19 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES	-
15. ELEVATION GROUND WATER	11.8
16. DATE HOLE	STARTED JUL 20 95 / COMPLETED JUL 20 95
17. ELEVATION TOP OF HOLE	13.3' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Ellebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			CLAY, medium plastic, stiff, sandy, silty, some gravel, wet, light grayish brown	100%	SS-17 40.0 41.5	14/14/22 Penetrometer = 2.0 TSF 18/18" Torvane = 1.45 TSF
			CLAY, medium plastic, stiff, sandy, silty, some gravel, wet, light grayish brown	100%	SS-18 45.0 46.5	18/21/26 N=47 Penetrometer = 2.0 TSF 18/18" Torvane = 0.90 TSF
			CLAY, medium plastic, stiff, sandy, silty, some gravel, wet, light grayish brown	100%	SS-19 48.5 50.0	14/20/24 N=44 Penetrometer = 2.0 TSF 18/18" Torvane = 0.90 TSF
	50.0		End of Boring			Borehole Backfilled With Chipped Bentonite 50.0' - 0.0'

Hole No. MIL-2-95

DRILLING LOG

DIVISION	
INSTALLATION	
SHEET 1 OF 1 SHEETS	
1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 373,238.000 E 2,565,281.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-2-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED 2
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	17.0
16. DATE HOLE	STARTED JUL 19 95 / COMPLETED JUL 19 95
17. ELEVATION TOP OF HOLE	8.5' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Edlebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 20.0' +/- CLAY, plastic, soft, moist, sandy, dark brown, with organics	17%	SS-1 0.0 1.5	Took Auger Sample Due To Low Recovery 4/2/2 3/18"
			CLAY, plastic, very soft, sandy, wet, with organics	11%	SS-2 5.0 6.6	Took Auger Sample Due To Low Recovery 1-12"/1 2/18" Torvane = 0.40 TSF
			CLAY, plastic, soft, sandy, wet, with organics, dark brown	50%	ST-3 8.0 10.0	Pushed Shelby Tube From 8.0' - 10.0' Penetrometer = 1.25 TSF 12/24"
			CLAY, plastic, very soft, sandy, wet, with organics, dark brown	78%	SS-4 10.0 11.5	WH/1-12" 14/18"
			CLAY, plastic, very soft, sandy, dark brown to black, wet, with organics	50%	ST-5 13.0 15.0	Pushed Shelby Tube From 13.0' - 15.0' Penetrometer = 0.0 TSF 12/24"
			CLAY, plastic, very soft, sandy, dark brown to black, wet, occasional sand seams, with organics and plastic	100%	SS-6 15.0 16.5	WH-12"/1 18/18"
			CLAY, plastic, very soft, sandy, dark brown to black, wet, occasional sand seams, with organics	100%	SS-7 18.5 20.0	1-12"/1 Hole Was Backfilled With Chipped Bentonite From 20.0' - 0.0' 18/18"
	20.0		End of Boring			

Hole No. MIL-3-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 1 SHEETS

1. PROJECT: Milwaukee CDF	10. SIZE AND TYPE OF BIT: 3-1/4' x 6-1/2" HSA
2. LOCATION (Coordinates or Station): N 373,538.000 E 2,565,469.000	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): IGLD (LWD 576.8)
3. DRILLING AGENCY: Coleman Engineering Company	12. MANUFACTURES'S DESIGNATION OF DRILL: Diedrich D-50
4. HOLE NO. (As shown on drawing title and file number): MIL-3-95	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 9; UNDISTURBED 0
5. NAME OF DRILLER: Scott Strigel	14. TOTAL NUMBER CORE BOXES: 0
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.	15. ELEVATION GROUND WATER: 6.7
7. THICKNESS OF OVERBURDEN: Unknown	16. DATE HOLE: STARTED JUL 18 95; COMPLETED JUL 18 95
8. DEPTH DRILLED INTO ROCK: -	17. ELEVATION TOP OF HOLE: 9.0' +/- LWD
9. TOTAL DEPTH OF HOLE: 20.0	18. TOTAL CORE RECOVERY FOR BORING: 0 %
	19. SIGNATURE OF INSPECTOR: Wayne R. Ellebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 2.5' +/- SAND, fine grained, moist, silty, dark brown, with organics, loose	11%	SS-1 0.0 1.5	Took Auger Sample Due To Low Recovery 2/2/2 N=4 2/18"
	2.5		2.5' to 7.0' +/- CLAY, soft, wet, silty, dark brown to gray, with organics, loose	67%	SS-2 5.0 6.5	2/1/2 N=3 12/18"
	7.0		7.0' to 20.0' +/- SAND, fine to medium grained, silty, dark grayish brown, with organics, wet, loose	67%	SS-3 10.0 11.5	2/2/2 N=4 12/18"
			SAND, fine to medium grained, silty, dark gray, with organics, wet, loose	89%	SS-4 11.5 13.0	3/2/2 N=4 16/18" Torvane = 0.30 TSF
			SAND, fine to medium grained, silty, dark gray, with organics, wet, loose	100%	SS-5 13.0 14.5	3/3/2 N=5 18/18"
			SAND, fine to medium grained, silty, dark gray, with organics, wet, loose	100%	SS-6 14.5 16.0	2/2/2 N=4 18/18"
			SAND, fine to medium grained, silty, dark gray, wet, with organics and shells, loose	100%	SS-7 16.0 17.5	1/2/2 N=4 18/18"
			SAND, fine to medium grained, silty, dark gray, wet, with organics and shells, loose	100%	SS-8 17.5 19.0	2/1/2 N=3 18/18"
			SAND, fine to medium grained, silty, dark gray, wet, with organics and shells, loose	100%	SS-9 19.0 20.0	1/2 12/12"
	20.0		End of Boring			1-1/4" PVC Well Installed to 20.0' With 10' Screen and 13' of Riser. Borehole Allowed to Cave-in Around Well and Backfilled From 10.0' - 0.0' With Auger Cuttings

Hole No. MIL-4-95

DRILLING LOG

DIVISION

INSTALLATION

SHEET 1 OF 1 SHEETS

1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 374,194.000 E 2,565,150.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-4-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6'1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 2; UNDISTURBED 5
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	16.3
16. DATE HOLE	STARTED JUL 18 95; COMPLETED JUL 18 95
17. ELEVATION TOP OF HOLE	6.5' +/- LWD
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Edlebeck

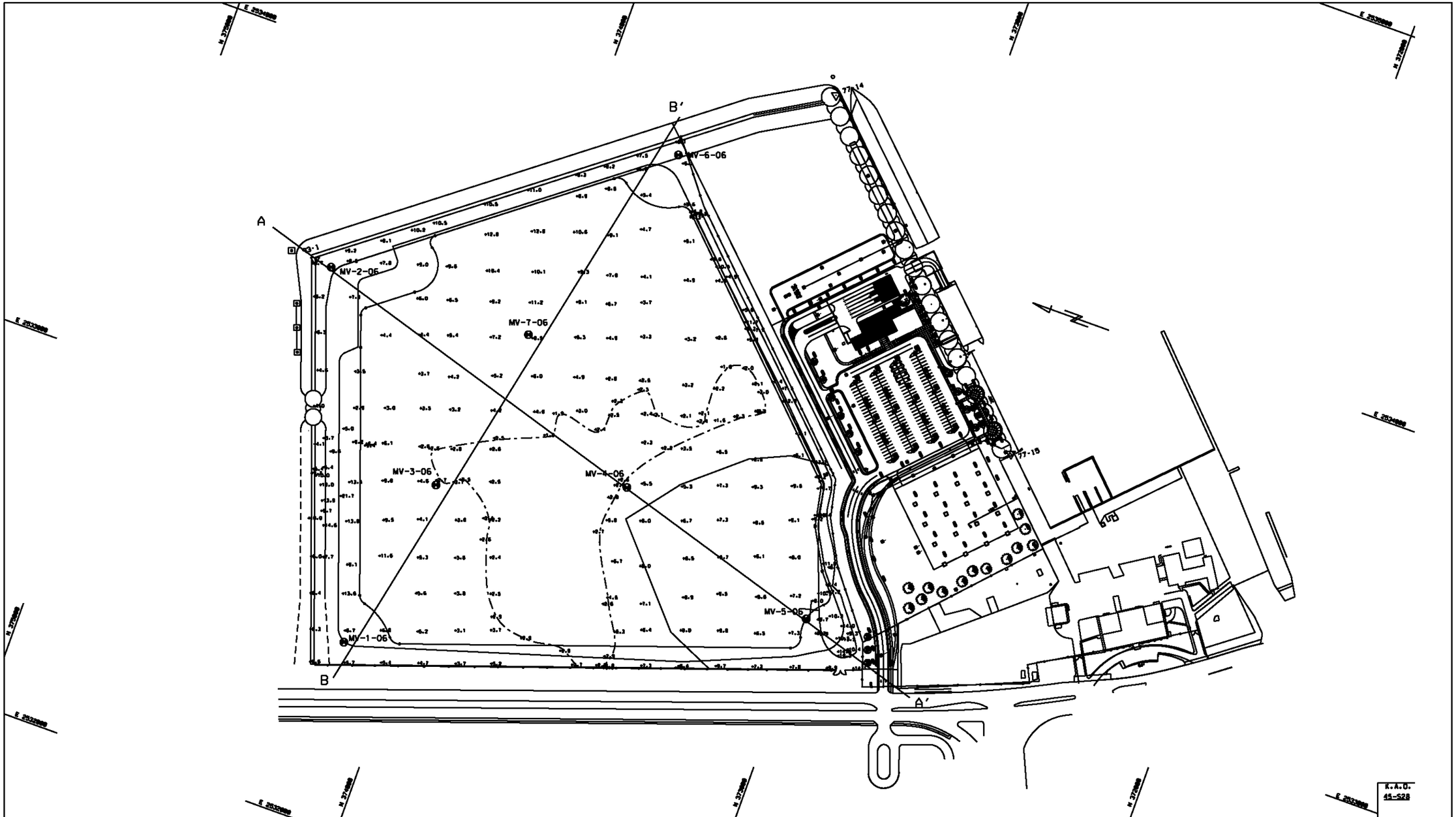
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 3.0' +/- SAND, fine grained, dry, silty, dark brown, with organics	17%	SS-1 0.0 1.5	1/12" N=1 3/18"
	3.0		3.0' to 11.5' +/- CLAY, plastic, very soft, wet, with organics, sandy			
				92%	ST-2 5.0 7.0	Pushed Shelby Tube From 5.0' - 7.0' 22/24"
			CLAY, plastic, very soft, wet, sandy, with organics, dark gray	89%	SS-3 7.0 8.5	1/12" 16/18" Torvane = 0.35 TSF
				75%	ST-4 10.0 12.0	Pushed Shelby Tube From 10.0' - 12.0' Penetrometer = 0.0 TSF 18/24"
	11.5		CLAY, plastic, very soft, wet, with organics, dark gray			
			11.5' to 14.5' +/- SAND, fine to medium grained, wet, dark gray, with organics, silty	100%	SS-5 12.0 13.5	1/WH/WH 18/18" Torvane = 0.30 TSF
	14.5		14.5' to 20.0' +/- CLAY, slightly plastic, very soft, wet, sandy, dark gray, with organics	78%	SS-6 15.0 16.5	1/WH/1 Penetrometer = 0.25 TSF 14/18" Torvane = 0.25 TSF
			CLAY, slightly plastic, very soft, wet, sandy, dark gray, with organics	78%	SS-7 18.5 20.0	1/2/1 Penetrometer = 0.50 TSF 14/18" Borehole Collapsed to 17.0', Then Backfilled With Chipped Bentonite to the Surface Torvane = 0.50 TSF
	20.0		End of Boring			

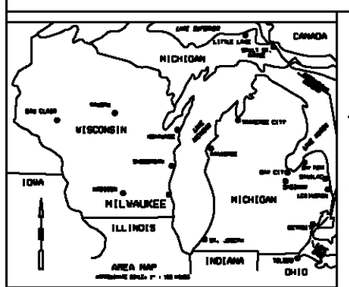
Hole No. MIL-5-95

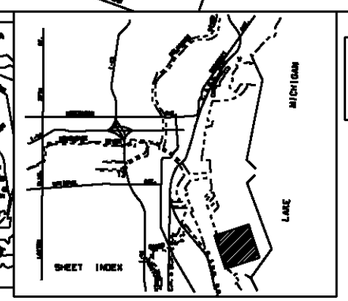
DRILLING LOG

DIVISION	
INSTALLATION	
SHEET 1 OF 1 SHEETS	
1. PROJECT	Milwaukee CDF
2. LOCATION (Coordinates or Station)	N 373,375.000 E 2,565,650.000
3. DRILLING AGENCY	Coleman Engineering Company
4. HOLE NO. (As shown on drawing title and file number)	MIL-5-95
5. NAME OF DRILLER	Scott Strigel
6. DIRECTION OF HOLE	[X] VERTICAL [ ] INCLINED 0.0 DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	Unknown
8. DEPTH DRILLED INTO ROCK	0
9. TOTAL DEPTH OF HOLE	20.0
10. SIZE AND TYPE OF BIT	3-1/4" x 6-1/2" HSA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	IGLD (LWD 576.8)
12. MANUFACTURES'S DESIGNATION OF DRILL	Diedrich D-50
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 5 / UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	0
15. ELEVATION GROUND WATER	3.1
16. DATE HOLE	STARTED JUL 19 95 / COMPLETED JUL 19 95
17. ELEVATION TOP OF HOLE	6.7' +/-
18. TOTAL CORE RECOVERY FOR BORING	0 %
19. SIGNATURE OF INSPECTOR	David R. Edlebeck

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth weathering, etc., if significant) g
			0.0' to 1.2' +/- SAND, fine to coarse, with silt, with gravel, light brown, moist	67%	SS-1 0.0 1.5	8/11/10 12/18"
	1.2		1.2' to 4.5' +/- SILT, non-plastic, hard sandy, moist			
	4.5		4.5' to 9.5' +/- CLAY, fine grained, sandy, loose, wet, dark gray, with organics	33%	SS-2 5.0 6.5	2/2/1 6/18" Torvane = 0.075 TSF
				0%	ST 7.5 9.0	Unable to Push Shelby Tube (No Recovery) 0/24"
	9.5		9.5' to 16.0' +/- GRAVEL, fine to medium grained, sub-angular to sub-rounded, sandy, wet, light brown	33%	SS-3 10.0 11.5	4/3/4 6/18"
			GRAVEL, fine to medium grained, sub-angular to sub-rounded, sandy, silty, wet	56%	SS-4 15.0 16.5	10/3/1 10/18"
	16.0		16.0' to 17.5' +/- SAND, fine to medium, silty, loose, dark gray, wet, with organics	75%	ST-5 16.5 18.5	Pushed Shelby Tube From 16.5' - 18.5' 18/24"
	17.5		17.5' to 18.5' +/- CLAY, fine to medium grained, silty, dark gray, wet			
	18.5		18.5' to 20.0' +/- SAND, fine grained, silty, gray, wet, dense, with gravel	100%	SS-6 18.5 20.0	14/16/16 18/18" Borehole Collapsed to 7.4', Then Backfilled With Chipped Bentonite to the Surface
	20.0		End of Boring			







LEGEND

- OPS CONTROL MONUMENT
- BRONZE OR BRASS DISC
- CHANNEL LINE TURNING POINT
- SOIL BORING LOCATION

NOTES:

SURVEY CONTROL AND BENCH MARK DATA IS AVAILABLE FROM THE DETROIT DISTRICT. ENGINEERING & TECHNICAL SERVICES. OPERATIONS TECHNICAL SUPPORT BRANCH. KEWAUNEE AREA OFFICE.

THE COORDINATE GRID SYSTEM SHOWN IS REFERENCED TO THE WISCONSIN STATE PLANE COORDINATE SYSTEM. LAMBERT PROJECTION. SOUTH ZONE (4803). NORTH AMERICAN DATUM 1983 (NAD83). US FOOT.

ALL ELEVATIONS ARE IN FEET AND ARE REFERENCED TO LOW WATER DATUM ELEVATION. 576.8 FEET ABOVE MEAN SEA LEVEL. I.G.L.D. 1955.

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.

THE SURVEY SHOWN WAS CONDUCTED BY THE LAKE MICHIGAN AREA OFFICE - KEWAUNEE SURVEY PARTY ON 24 JANUARY AND 07 FEBRUARY 2006 USING A NIKON TOTAL STATION AND A RANGE POLE WITH A REFLECTOR.

COMBINED GRID SCALE FACTOR = 0.99996870
GRID DIST. DIVIDED BY COMBINED GRID SCALE FACTOR = GROUND DIST.

100 0 100 200 300

1" = 100'

THIS PROJECT WAS DESIGNED BY THE DETROIT DISTRICT OF THE U.S. ARMY CORPS OF ENGINEERS. THE INITIALS OR SIGNATURES AND REGISTRATION DESIGNATIONS OF INDIVIDUALS APPEAR ON THESE PROJECT DOCUMENTS WITHIN THE SCOPE OF THEIR EMPLOYMENT AS REQUIRED BY ER 1110-1-8152.

NO.	DATE	REVISION	BY

U.S. ARMY ENGINEER DISTRICT, DETROIT
CORPS OF ENGINEERS
DETROIT, MICHIGAN

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET AS INDEXED ON THIS SHEET.

MILWAUKEE HARBOR, WISCONSIN

CONFINED DISPOSAL AREA

DMMP SOIL PROFILE

SUBMITTED BY: _____ P.E.
CHIEF, CEGBE BRANCH

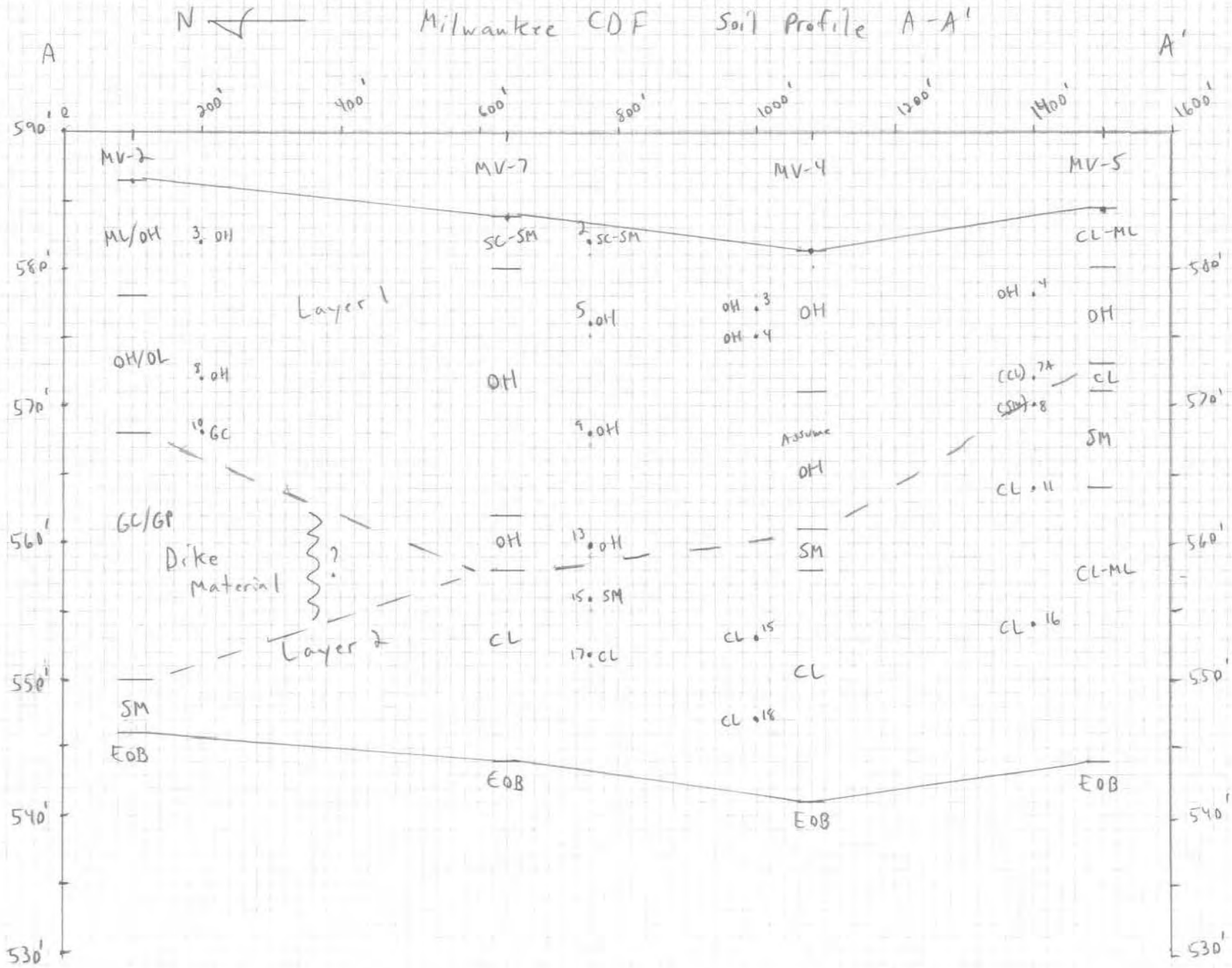
APPROVED: _____
CHIEF, ENGINEERING & TECHNICAL SERVICES DIVISION

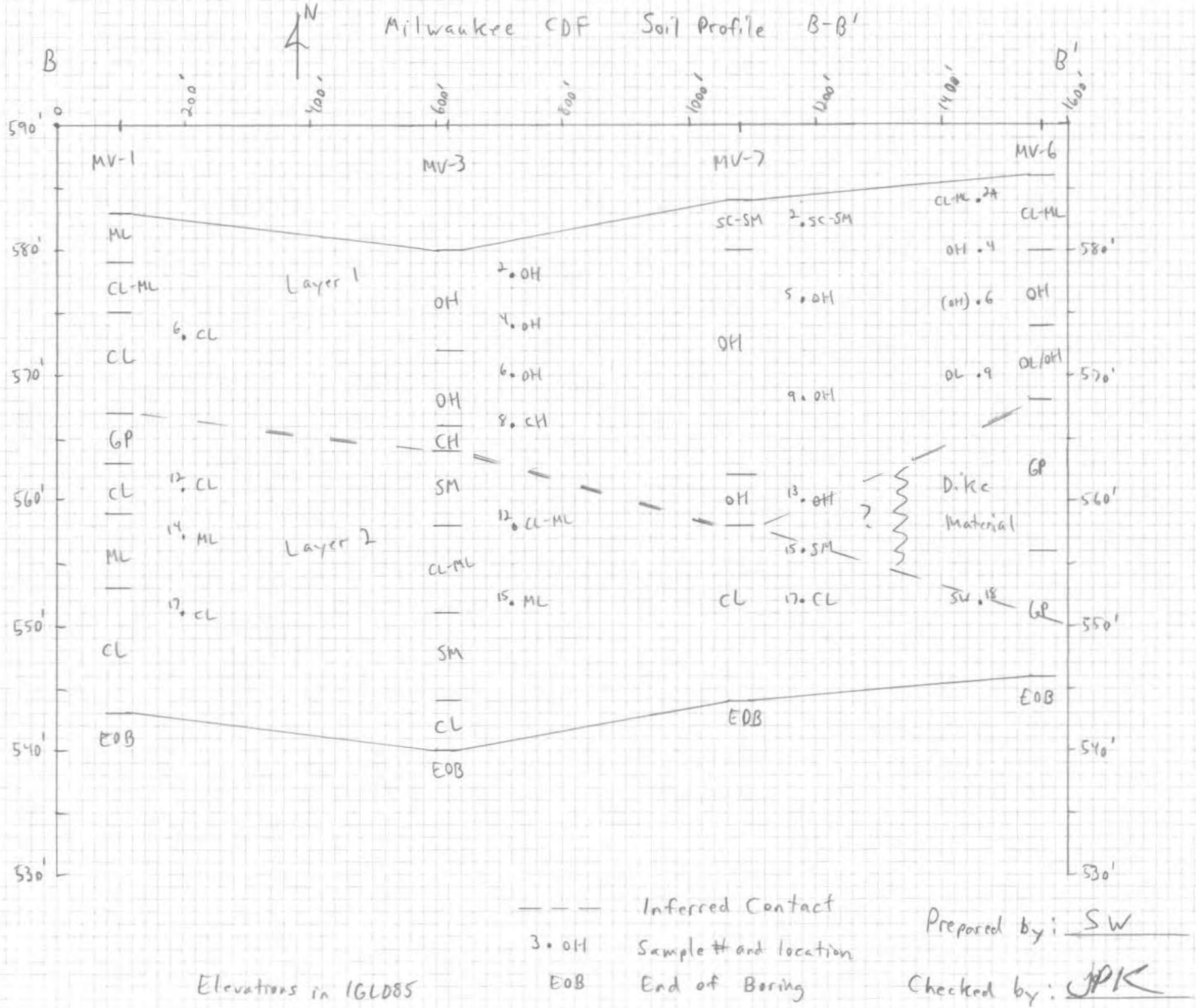
APPROVAL RECOMMENDED: _____ P.E.
CHIEF, ENGINEERING & CONSTRUCTION OFFICE

SCALE AS SHOWN

DRAWING NUMBER

SHEET 1 OF 1


N
Milwaukee CDF Soil Profile A-A'
A
A'
0
200'
400'
600'
800'
1000'
1200'
1400'
1600'
590'
580'
570'
560'
550'
540'
530'
MV-2
MV-7
MV-4
MV-5
ML/OH
3. OH
SC-SM
2. SC-SM
CL-ML
Layer 1
5. OH
OH .3
OH .4
OH
OH .4
OH/OL
1. OH
OH
(CL) .7A
(SM) .8
CL
10. GC
9. OH
Assume
OH
SM
CL .11
GC/GP
Dike Material
?
OH
13. OH
SM
CL-ML
15. SM
CL .16
Layer 2
CL
17. CL
CL .15
CL
SM
CL .18
EOB
EOB
EOB
EOB
Inferred Contact
3 • OH Sample # and location
EOB End of Boring
Elevations in IGLD85
Prepared by: SW
Checked by: JPR


Milwaukee CDF Soil Profile B-B'
N
B
B'
0
200'
400'
600'
800'
1000'
1200'
1400'
1600'
590'
580'
570'
560'
550'
540'
530'
MV-1
MV-3
MV-7
MV-6
ML
CL-ML
CL
GP
CL
ML
CL
EOB
Layer 1
Layer 2
OH
CH
SM
CL-ML
CL
EOB
2. OH
4. OH
6. OH
8. CH
12. CL-ML
15. ML
6. CL
12. CL
14. ML
17. CL
SC-SM
OH
CL
EOB
2. SC-SM
5. OH
9. OH
13. OH
15. SM
17. CL
CL-ML .2A
OH .4
(OH) .6
OL .9
SW .18
CL-ML
OH
OL/OH
GP
GP
EOB
Dike Material
?
Inferred Contact
3. OH Sample # and location
EOB End of Boring
Elevations in IGLD85
Prepared by: SW
Checked by: JPK

Lab Results for Milwaukee CDF (2006)

Layer 1 values are shaded

									Standard Proctor		Est. St. Proctor	Compacted @ 90% St. Proctor*									Terzaghi	Skempton
Boring	Spl #	Depth	Soil Type	Clay (%)	PI	SG	w (%)	yd (pcf)	yd_{max} (pcf)	w_{opt} (%)	yd_{max} (pcf)	90% w_{opt}	$yd_{90\%}$ (pcf)	y_{moist} (pcf)	Qu (psf)	phi (deg)	c (psf)	org (%)	Cc	LL	Est Cc	Est Cc
MV-1-06	bulk	2-7				2.69			98	21		0.189	96.0	114.1								
583.1	6	10-12	CL	37.5	10		19				115.7							0.66		21	0.099	0.098
Sect B-B'	12	22-24	CL	61.6	16	2.783	17.9	115.1			109.6					23.5	0		0.146	30	0.18	0.161
	14	26-28	ML	15.2	3		15.8	122.8			116.7					0	2560			18	0.072	0.077
	17	32-34	CL	39.5	11	2.707	15.2	121.6			114.3								0.12	23	0.117	0.112
MV-2-06	bulk	2-6.5				2.7			98.5	17		0.153	96.8	111.6								
586.2	3	4-6	OH	43.2	23						89.7									56	0.414	0.343
Sect A-A'	6	10-12																				
	8	14-16	OH	55.3	23		53.4	74.1			92.2							3.78		53	0.387	0.322
	10	18-20	GC	24.5	10						109.9									28	0.162	0.147
MV-3-06	bulk	2-6.5				2.7			88.5	24		0.216	86.5	105.2								
579.6	2	2-4	OH	39.1	20						88.3									57	0.423	0.35
Sect B-B'	4	6-8	OH	34.1	17		66.7	58.2			93.4					0	88	7.36		50	0.36	0.301
	6	10-12	OH	46.5	25						91.8									54	0.396	0.329
	8	14-16	CH	48.8	30						90.4									57	0.423	0.35
	12	22-24	CL-ML	23.8	6						117.3									18	0.072	0.077
	15	28-30	ML	14.6	NP	2.679					121.0					0	3140		0.075	12	0.018	0.035
MV-4-06	bulk	2-9				2.72			92.5	23.5		0.212	90.8	110.0								
581.1	3	4-6	OH	38.4	22		71.5				87.0							8.05		59	0.441	0.364
Sect A-A'	4	6-8	OH	40	19	2.501	69.5	54.8			87.2								0.55	58	0.432	0.357
	15	28-30	CL	39.1	10	2.728	15.6	119.8			114.9								0.126	22	0.108	0.105
	18	34-36	CL	51.9	15	2.721	19.4	110.6			111.0								0.292	28	0.162	0.147
MV-5-06	bulk	2-6				2.72			101.5	19		0.171	100.5	117.7								
584.3	4	6-8	OH	50.8	19		68.4				88.1							7.68		57	0.423	0.35
Sect A-A'	7A	12-13	(CL)		32						97.3									49	0.351	0.294
	8	14-16	(SM)	2.2																		
	11	20-22	CL	72.2	14						110.8									28	0.162	0.147
	16	30-32	CL	48.1	11	2.749	21.6	108.7			113.4								0.125	24	0.126	0.119
MV-6-06	bulk	2-6.5				2.72			104	15		0.135	103.0	116.9								
586	2A	2-3.5	CL-ML	30.1	6						114.8									21	0.099	0.098
Sect B-B'	4	6-8	OH		17						93.4									50	0.36	0.301
	6	10-12	(OH)		14						92.7									50	0.36	0.301
	7	12-14					78.4											8.39				
	9	16-18	OL	23.3	21	2.549	50.2	66.9			95.0					19	0		0.45	49	0.351	0.294
	18	34-36	SW	0.9																		
MV-7-06	bulk	2-8.5				2.72			105	17		0.153	104.0	119.9								
583.9	2	2-4	SC-SM	19.4	7						109.3									28	0.162	0.147
Sect A-A'	5	8-10	OH	39.6	23		67.2				86.4							7.93		60	0.45	0.371
Sect B-B'	9	16-18	OH	45.9	25	2.549	63.2	61.3			84.4					0	140		0.452	63	0.477	0.392
	11	20-22					59.1	59.4							513	0	256					
	13	24-26	OH	41	22	2.532	75	52.4			82.1								0.71	65	0.495	0.406
	15	28-30	SM	4.7		2.649													0.117			
	17	32-34	CL	42.4	14	2.728	18.2	112.1			112.4								0.163	26	0.144	0.133
				35.8	17	2.6761	45.5	88.4	98.29	19.5	101.01			**113.6**					0.277	40	0.274	0.234

* used for compacted dike

Correlations used:

Est. Standard Proctor yd = 130.8 - (0.82*LL) + (0.21*PI)

Terzaghi estimate of Cc = 0.009*(LL-10)

Skempton estimate of Cc = 0.007*(LL-7)

Moist unit wt. = yd*(1+w)

Milwaukee Confined Disposal Facility DMMP
Stability Analysis for the Raising of Existing Dikes

Introduction

A Stability Analysis was conducted for placing inner dikes to construct a Dredge Material Disposal Facility (DMDF) in Milwaukee, Wisconsin (Figure 1). The concept plan is to excavate the existing CDF material above low water datum (LWD) and use that material to construct an inner dike adjacent to the existing outer dikes to a top elevation of 18 feet above LWD. The elevation of LWD at the site is 577.5 ft International Great Lakes Datum 1985 (IGLD85). In addition, a one foot thick gravel road on top of the dike will be included, therefore bringing the total elevation of the new inner dikes to 19 feet above LWD (596.5 ft IGLD85).

The exterior slopes on the North and East sides of the inner dikes would be protected with a ~2.5 ft thick layer of splash stone. For the planned gravel road on top of the dikes, a design road distributed load of 750 psf (approximately equivalent to a 62.5 lb/ft line load over 12 ft) acting on the top of the structure will be used for the analysis. This design loading was provided by the Design Engineer, Kerry Williams. Two cross-sections, one at 5+00 and one at 26+00, were chosen as the most critical, or "worst case", sections and were examined in this stability analysis. An interior dike that will be constructed to create a cell on the west side of the CDF to contain the Kinnickinnic River dredge material was not analyzed because it is not part of the DMMP project.

Two design cross-sections were selected and analyzed for slope stability on the inner (right) and outer (left) sides. Bearing capacity of the dike foundation was also estimated due to the additional loading from truck traffic on the gravel road. Settlement calculations and results are provided in a separate section of the Geotechnical Appendix.

Material Properties

Soil strength parameters were selected from field and lab test data, several references, and from engineering judgment. Soils in the CDF are primarily high and low plasticity silty/sandy clays (CL and CH) with trace organics. From lab test data, optimum moisture contents range from 15 to 24.0%, and maximum dry densities range from 88.5 to 105 pcf. Analysis parameters chosen for the specific materials are shown in Table 1. Refer to the Soil Profile in the Geotechnical Appendix for additional field and lab test data.

Analysis Assumptions

The computer software SLOPE/W was used to create the cross-sections and determine the factors of safety of the sections for an end of construction (short-term)

condition, and a full capacity (long-term) condition using Spencer's Method. Spencer's Method was utilized because it satisfies all conditions of static equilibrium and provides a factor of safety based on both force and moment equilibrium. For verification of the SLOPE/W results, spreadsheets utilizing the Modified Swedish Method were used as recommended in EM1110-2-1902 to verify the results of the right side, end of construction, analysis of section 26+00 (See attached calculations). Bearing capacity results for sections 5+00 and 26+00 are provided along with the results of the Slope Stability Analysis in Table 2. The bearing capacity cross-section and calculations are also attached.

The assumptions used for this stability analysis are listed below:

1) Layer 1 soil properties were used for the dike and foundation (see Soil Profile for data used to estimate the soil properties). Proctor test data was also used to estimate properties for the dike because it is expected to be compacted.

2) Additional dike foundation material will be placed and graded to ~10 ft above LWD prior to dike construction. Because minimal compaction is assumed, the same soil parameters as the underlying dike foundation (Layer 1) will be used.

3) Dike material will be assumed to be compacted to not less than 90 percent of the maximum Standard Proctor density (ASTM D 698).

4) Full capacity condition is considered the long-term condition for this analysis.

5) For full capacity condition, the average saturated unit weight of Layer 1 was used for dike fill. Cohesion was assumed to be half of what was used for the dike because the material will be initially more loosely consolidated.

6) The firm base (deep foundation) layer of sandy clay ranges from approximately 5 feet to 27 feet below LWD. This depth of this layer increases lake ward. Assuming a worst case condition, the top of the deep foundation will be assumed to be 27 feet below LWD throughout the CDF. See also Layer 2 details in the Soil Profile.

7) Splash stone protection used is assumed to be limestone, γ = 160 pcf.

8) Surcharge load on road on top of slope from truck and excavator traffic is 750 psf. Will also assume this includes any surcharge due to ice loads.

9) Rapid drawdown condition is not anticipated and will not be evaluated in this analysis.

10) Steel sheet pile bulkhead along west end is assumed to be an unyielding structure. The embedment depth of this bulkhead is at least 24 ft below LWD as shown in the CDF as-built drawings.

11) The existing filter cell is no longer used; however, additional site preparation may be necessary at this location.

Results and Conclusions

Analyzed cross-sections from the SLOPE/W software are attached along with slope stability verification and bearing capacity calculations. A summary table of the results of the stability analysis is shown in Table 2. All values shown in Table 2 assume there is no reinforcement of the slope and that a line load of 62.5 lb/ft exists due to road and ice loads. It is assumed that stability of the inner slopes will improve as additional dredge material is placed into the CDF so this side (right side) was not analyzed for the full capacity condition.

All slopes, except for one, are stable under current conditions and design. The end of construction and the full capacity condition for Section 26+00 (left side) did not meet stability criteria for sliding. However, a recommended configuration is shown that meets the criteria for this section for both conditions.

Furthermore, both cross-sections did not meet the recommended bearing capacity factor of safety. Additional reinforcement will be necessary to prevent bearing capacity failure of the dike due to road loads and the weaker foundation material. This will increase project costs, but will provide better long term support of the structure and foundation. The concept alternatives that were evaluated are shown in the following section Foundation Reinforcement.

Foundation Reinforcement

Alternative 1 – Staged Construction

This alternative allows the foundation to gain strength due to dissipation of pore water pressure in the foundation soils. It is expected that the foundation will gain strength as time progresses; however, the gain of strength may not be uniform due to the nature of the in-place soils. Furthermore, the time needed for this strength gain may be excessive therefore increasing costs and schedule duration; so therefore, this alternative will likely be rejected.

Alternative 2 – Excavation and Replacement

This alternative would require that a portion of the weak foundation materials would be replaced with stronger materials. A significant quantity to excavate and replace would be required which reduces available capacity of the CDF and increases construction cost. This alternative is rejected because of the increased costs due to bringing in offsite material, and also the replaced material will have to be disposed of off site or relocated within the CDF.

Alternative 3 – Geogrid System

This alternative provides installation of biaxial geogrid layers within the dike foundation for improved bearing capacity. Due to the nature of the existing foundation soils, multiple layers would most likely be needed. Although this alternative would

require less excavation and replacement of foundation soils, additional costs will be incurred due to the design and installation of the geogrid system. This alternative is considered feasible depending on results of a concept design and cost analysis.

Alternative 4 – Cement Modified Soil

This alternative would require mixing water and Portland cement with existing soil to strengthen the foundation. The use of Portland cement is recommended over lime because of the additional strength requirements and reduced curing time. A small cement content, <5% volume dry weight, would be sufficient to reduce plasticity of the soil and improve bearing strength. Additional costs would be incurred due to addition and mixing of soil cement, and compaction. Also there will be some effect on dike construction schedule because the foundation will have to be prepared prior to dike construction. Like alternative 3, this alternative is considered feasible depending on results of a concept design and cost analysis.

Recommendations

It will be recommended that the top 1 foot of material should be cleared and grubbed and not be used for dike construction because of probable higher organic content and debris. The current design calls for 3 on 1 side slopes but some of the slopes can be changed to 2.5 on 1 side slopes (See Table 2 and cross sections). This is not a requirement but may save some additional quantity of material used for dike construction. Because of the assumed material properties, a 2 on 1 side slope is not recommended for any slope in this CDF.

Woven geotextile (AASHTO Class 2 or equivalent) should be carefully placed on the North and East outer slopes (underneath the splash stone) for filtration and drainage. Also the loading on the dike due to vehicular traffic should be restricted to 750 psf or less. Furthermore, this analysis assumes that the CDF dike material can be placed and compacted as specified. Construction of the dikes in lifts of 8 to 12 inches of loose thickness is also recommended to allow for proper moisture control and compaction.

In order to determine the most feasible foundation reinforcement alternatives, additional evaluation to determine more exact quantities and cost for implementation will be required. If it is determined that other alternatives not discussed in this report may be feasible, additional analysis of these alternatives would also be required. Furthermore, the results of this stability analysis are based on the provided design. Any significant structural changes or additional loads must be re-evaluated to verify that all stability criteria are maintained for the proposed design.

References

1) EM1110-1-1905, Bearing Capacity of Soils, 30 Oct 1992.

2) EM1110-2-1902, Slope Stability, 31 Oct 2003.

3) EM1110-2-5027, Confined Disposal of Dredged Material, 30 Sept 1987.

4) Milwaukee Confined Disposal Facility DMMP Geotechnical Investigation Report, prepared by STS Consultants, Dec 2006.

5) Study Report - Milwaukee Harbor, WI, Increasing Disposal Capacity by Dike Raising, May 1996.

6) Report of Subsurface Investigation for Milwaukee Confined Disposal Facility, Milwaukee, WI, prepared by Coleman Engineering, Nov 1995.

7) Duncan, J. Michael, and Wright, Stephen G., Soil Strength and Slope Stability, John Wiley and Sons, Inc., 2005.

8) "Properties and Uses of Cement-Modified Soil", Portland Cement Association, 2003.

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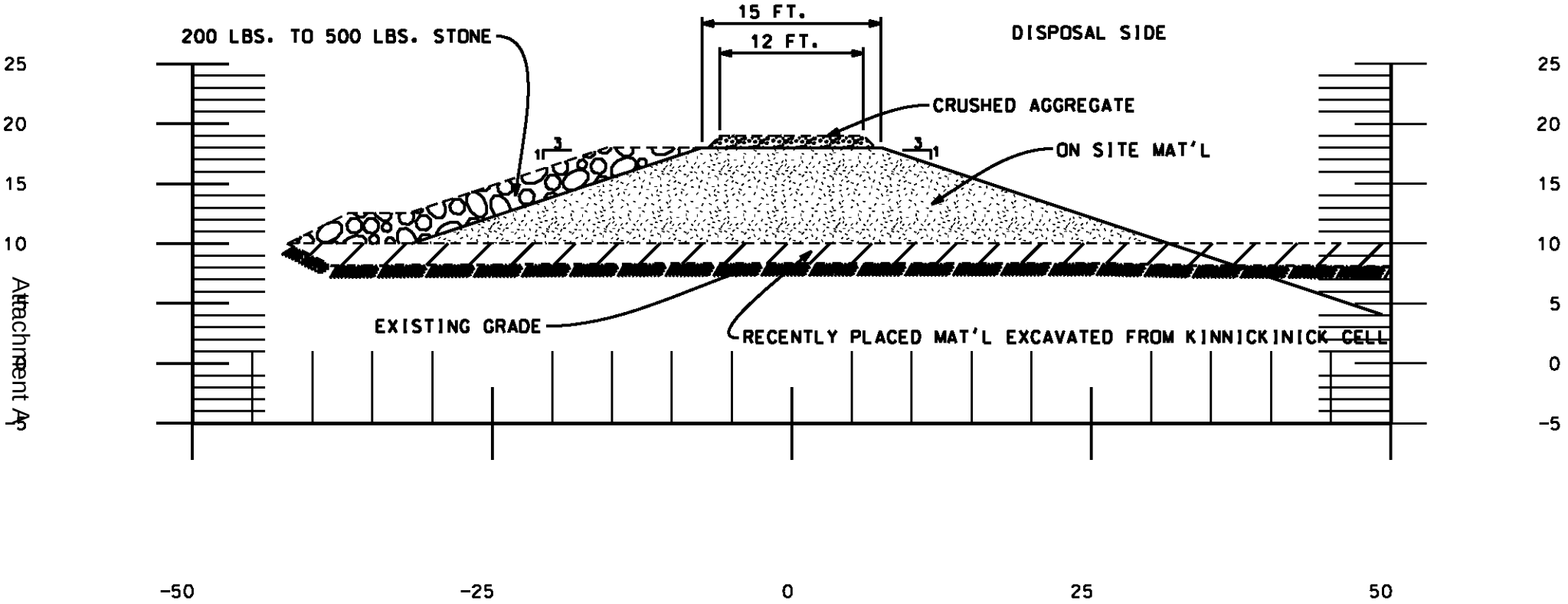
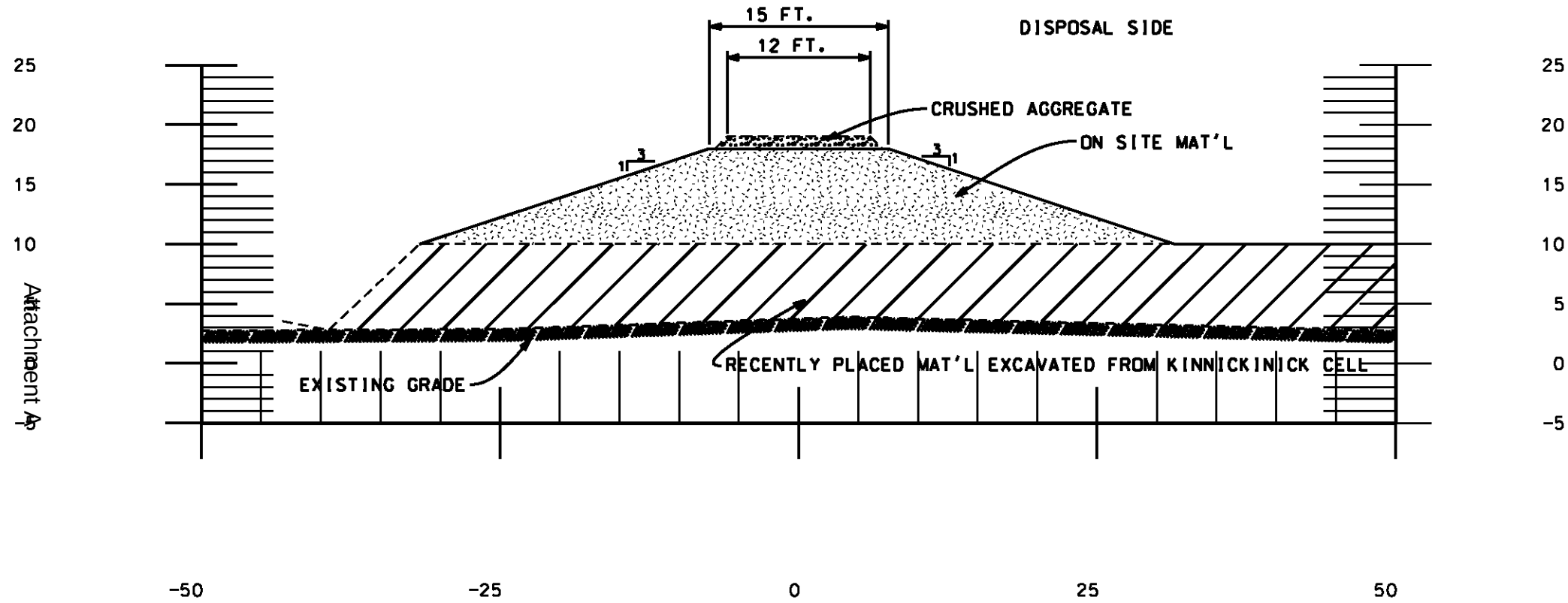
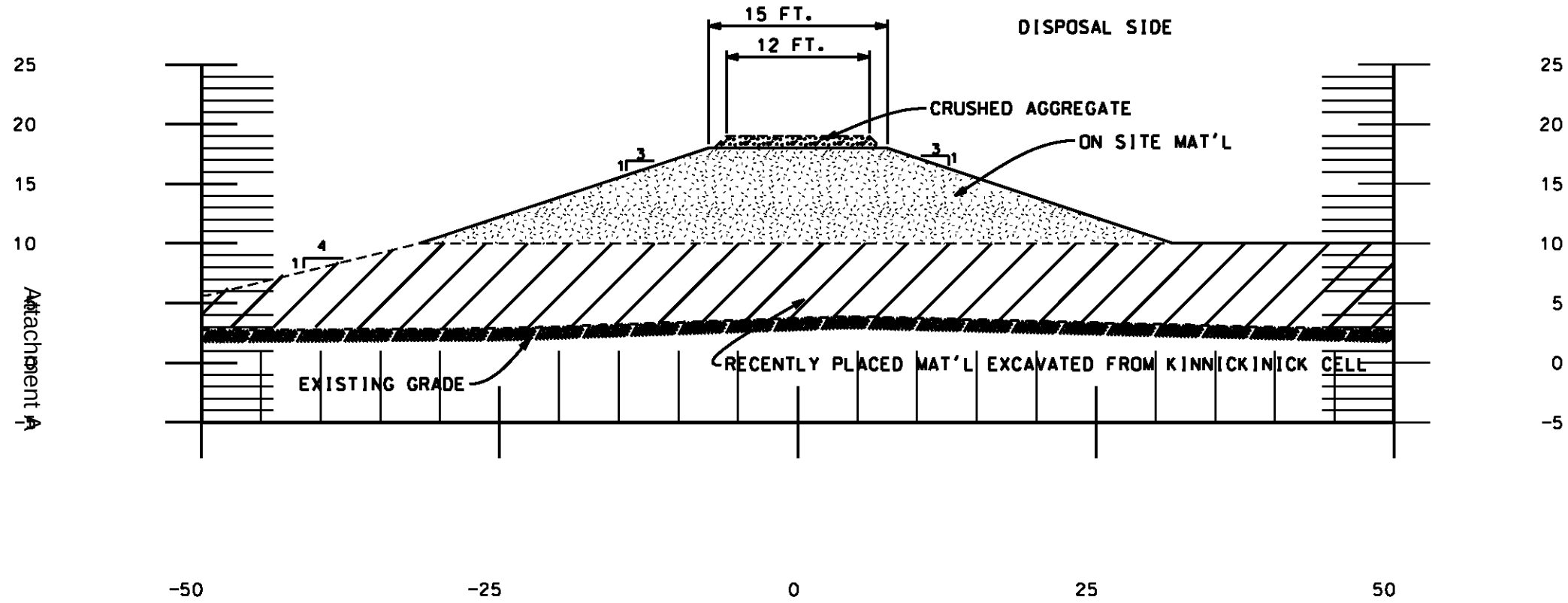


PROPOSED CROSS-SECTION 5+00



PROPOSED CROSS-SECTION 26+00



RECOMMENDED CROSS-SECTION 26+00

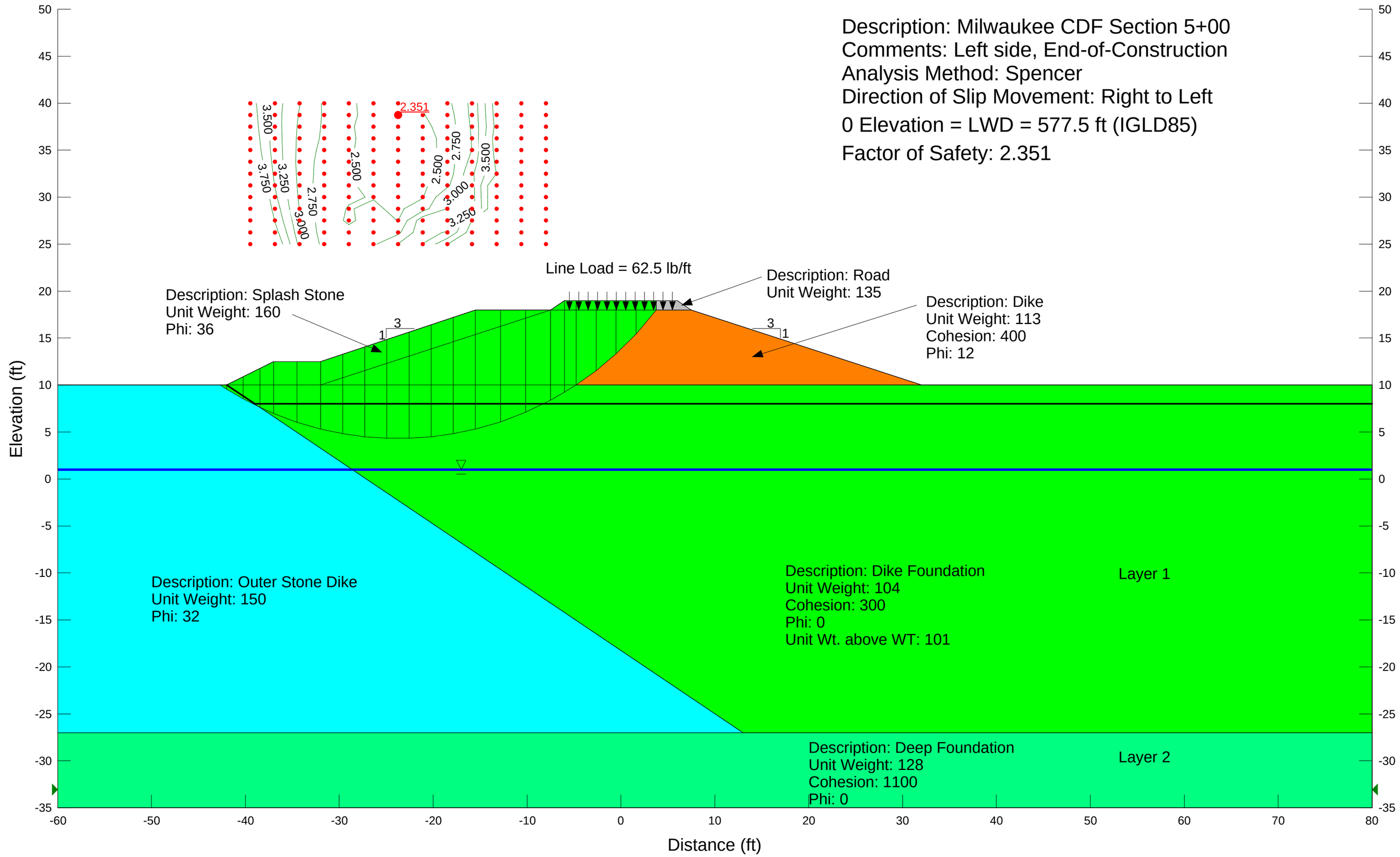
Table 1. Soil Parameters for Milwaukee CDF Dike Raising Stability Analysis
(Refer to Geotech Appendix for Field and Lab Data)

Section 5+00 - Short-term condition (Undrained)			
Material	Unit Weight ‘γ’ (pcf)	Strength ‘Φ’ (degrees)	Cohesion ‘c’ (psf)
Road	135	no strength	
Dike	113	12	400
Foundation (moist)	101	0	300
Foundation (sat.)	104	0	300
Splash Stone	160	36	0
Deep Foundation	128	0	1100
Outer Dike Stone	150	32	0
Section 5+00 - Full capacity condition (outer side only)			
Material	Unit Weight ‘γ’ (pcf)	Strength ‘Φ’ (degrees)	Cohesion ‘c’ (psf)
Road	135	no strength	
CDF Fill (sat.)	104	0	200
Dike	113	25	0
Foundation (moist)	101	27	0
Foundation (sat.)	104	27	0
Splash Stone	160	36	0
Deep Foundation	128	0	1200
Outer Dike Stone	150	32	0
Section 26+00 - Short-term condition (Undrained)			
Material	Unit Weight ‘γ’ (pcf)	Strength ‘Φ’ (degrees)	Cohesion ‘c’ (psf)
Road	135	no strength	
Dike	113	12	400
Foundation (moist)	101	0	300
Foundation (sat.)	104	0	300
Deep Foundation	128	0	1100
Section 26+00 - Full capacity condition (outer side only)			
Material	Unit Weight ‘γ’ (pcf)	Strength ‘Φ’ (degrees)	Cohesion ‘c’ (psf)
Road	135	no strength	
CDF Fill (sat.)	104	0	200
Dike	113	25	0
Foundation (moist)	101	27	0
Foundation (sat.)	104	27	0
Deep Foundation	128	0	1200

Table 2. Summary Results for Milwaukee CDF Dike Raising Stability Analysis

Section 5+00 - Short-term condition (Undrained)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.3	**2.35**	**Yes**
3 on 1 slope - right side	1.3	**1.78**	**Yes**
2.5 on 1 slope - left side	1.3	**2.10**	**Yes**
2.5 on 1 slope - right side	1.3	**1.74**	**Yes**
Section 5+00 - Full capacity condition (Effective)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.5	**2.70**	**Yes**
3 on 1 slope - right side	NA	NA	NA
2.5 on 1 slope - left side	1.5	**2.38**	**Yes**
2.5 on 1 slope - right side	NA	NA	NA
Section 26+00 - Short-term condition (Undrained)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.3	**1.06**	**No**
3 on 1 slope - left, revised	1.3	**1.34**	**Yes**
3 on 1 slope - right side	1.3	**1.84**	**Yes**
2.5 on 1 slope - left side	Not Recommended		NA
2.5 on 1 slope - right side	1.3	**1.80**	**Yes**
Section 26+00 - Full capacity condition (Effective)			
Scenario	Req. FS (Sliding)	FS (Sliding)	Meets Stability Criteria?
3 on 1 slope - left side	1.5	**1.22**	**No**
3 on 1 slope - left, revised	1.5	**1.84**	**Yes**
3 on 1 slope - right side	NA	NA	NA
2.5 on 1 slope - left side	Not Recommended		NA
2.5 on 1 slope - left, revised	Not Recommended		NA
2.5 on 1 slope - right side	NA	NA	NA
Bearing Capacity Results			
Scenario	Req. FS (Bearing)	FS (Bearing)*	Meets Stability Criteria?
Section 5+00	2.5	**1.8**	**No**
Section 26+00	2.5	**1.8**	**No**

*Includes Additional Road Load of 750 psf.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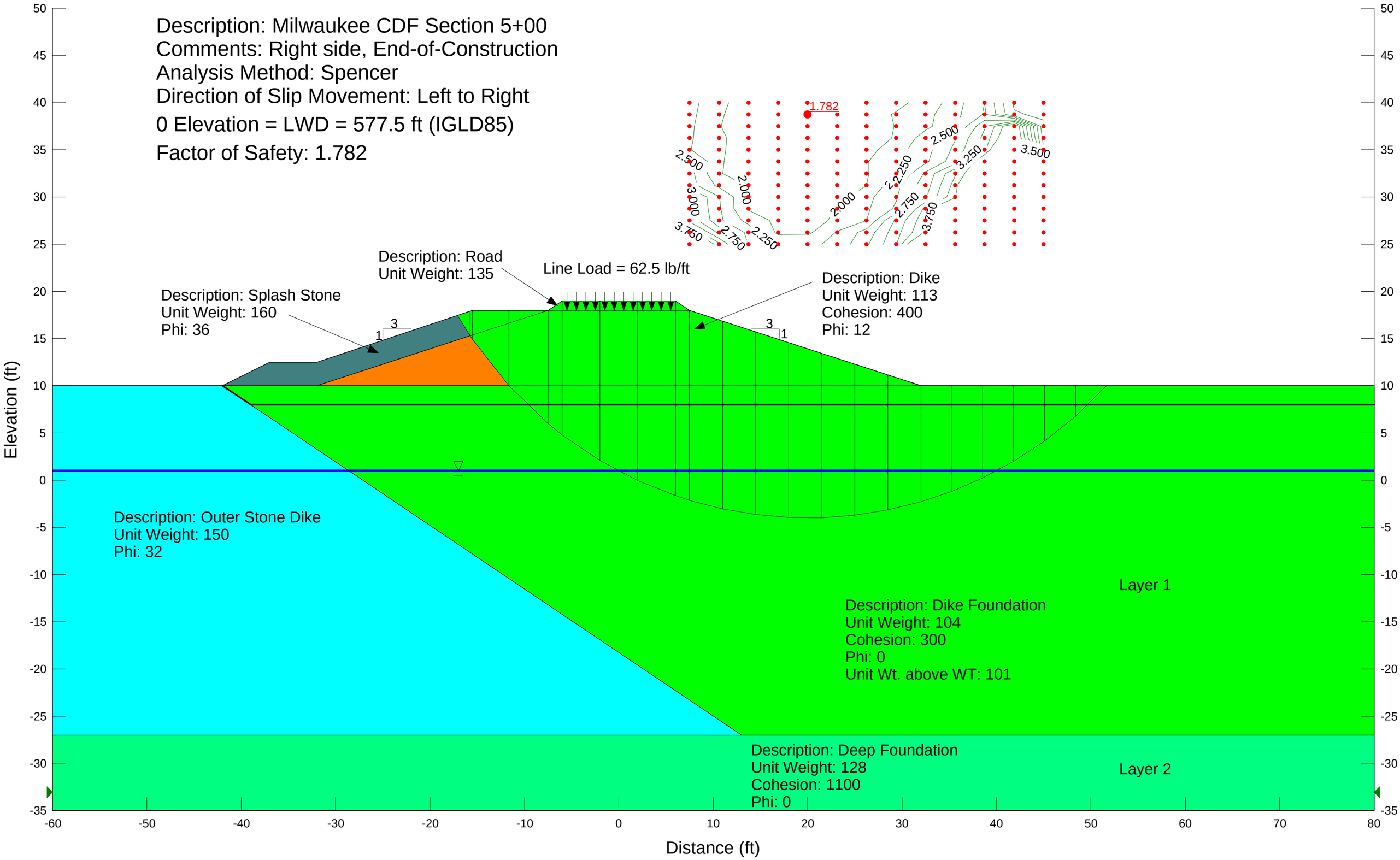
Comments: Left side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
Factor of Safety: 2.351
2.351
3.500
3.750
3.250
2.750
3.000
2.500
2.500
2.750
3.000
3.250
3.500
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
3
1
3
1
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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Direction of Slip Movement: Left to Right
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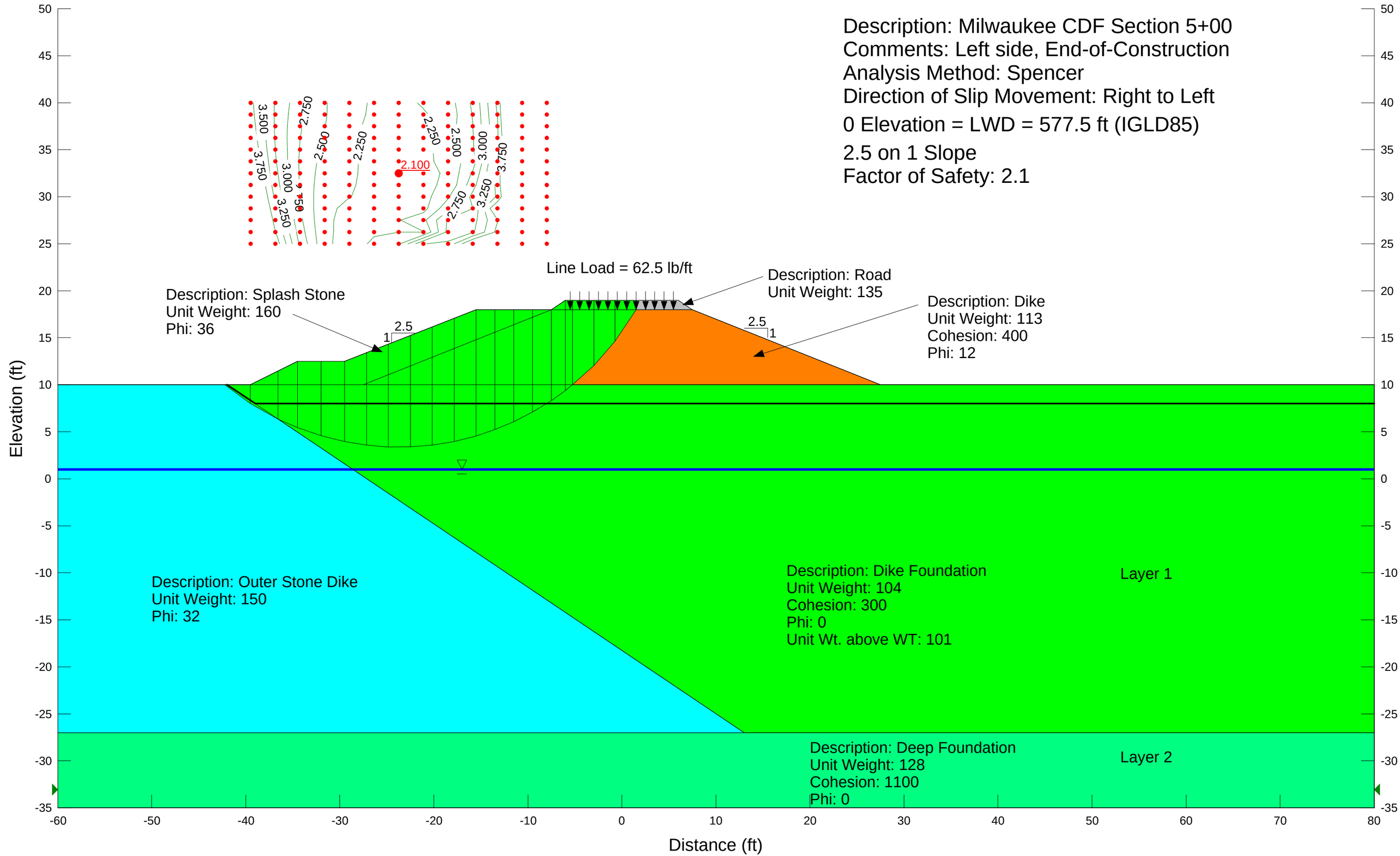
Factor of Safety: 1.782
1.782
2.500
3.000
3.750
2.750
2.250
2.000
2.000
2.2250
2.750
3.750
2.500
3.250
3.500
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
3
1
3
1
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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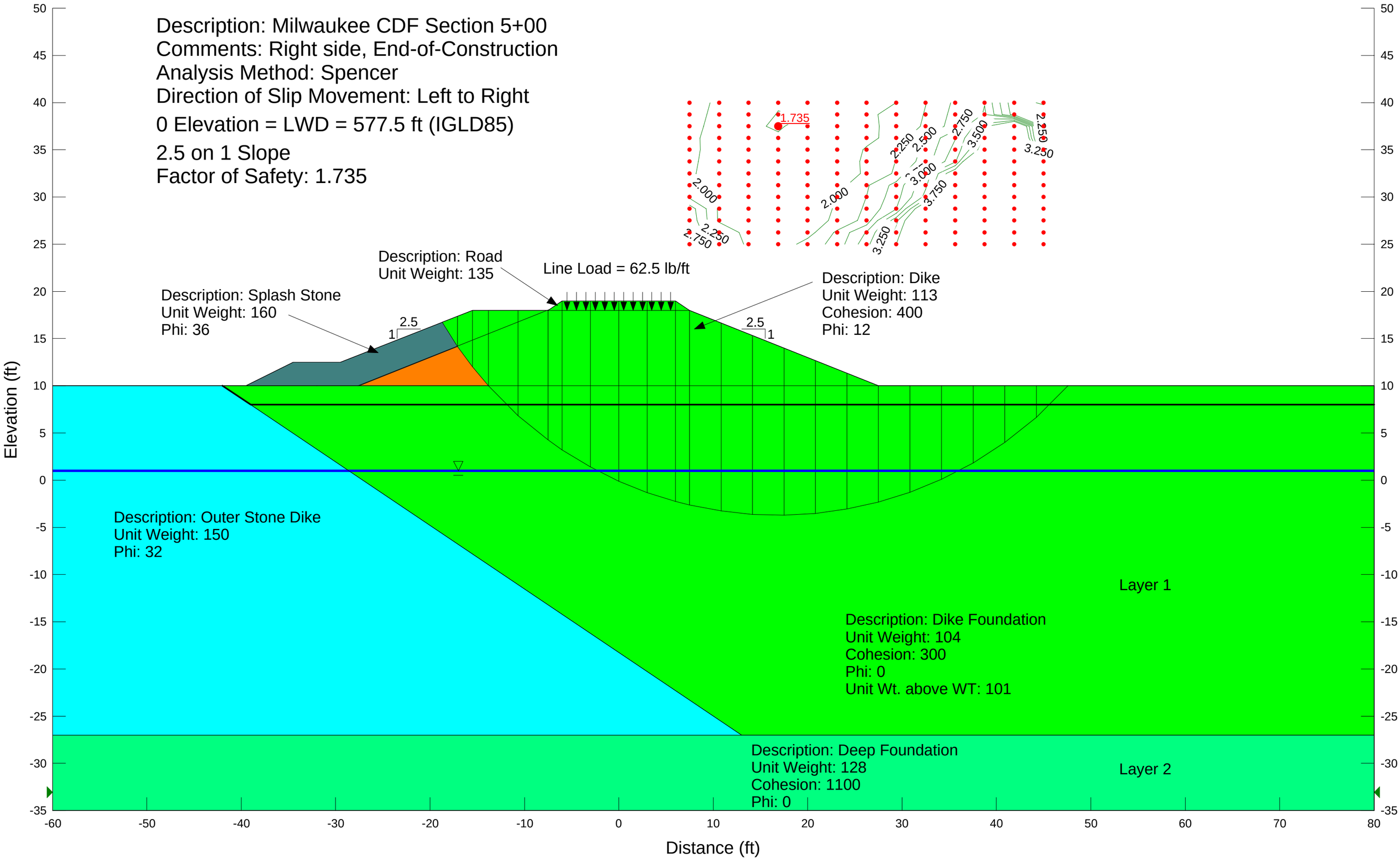
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 2.1
2.100
3.500
3.750
3.000
3.250
2.750
2.500
2.250
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
2.5
1
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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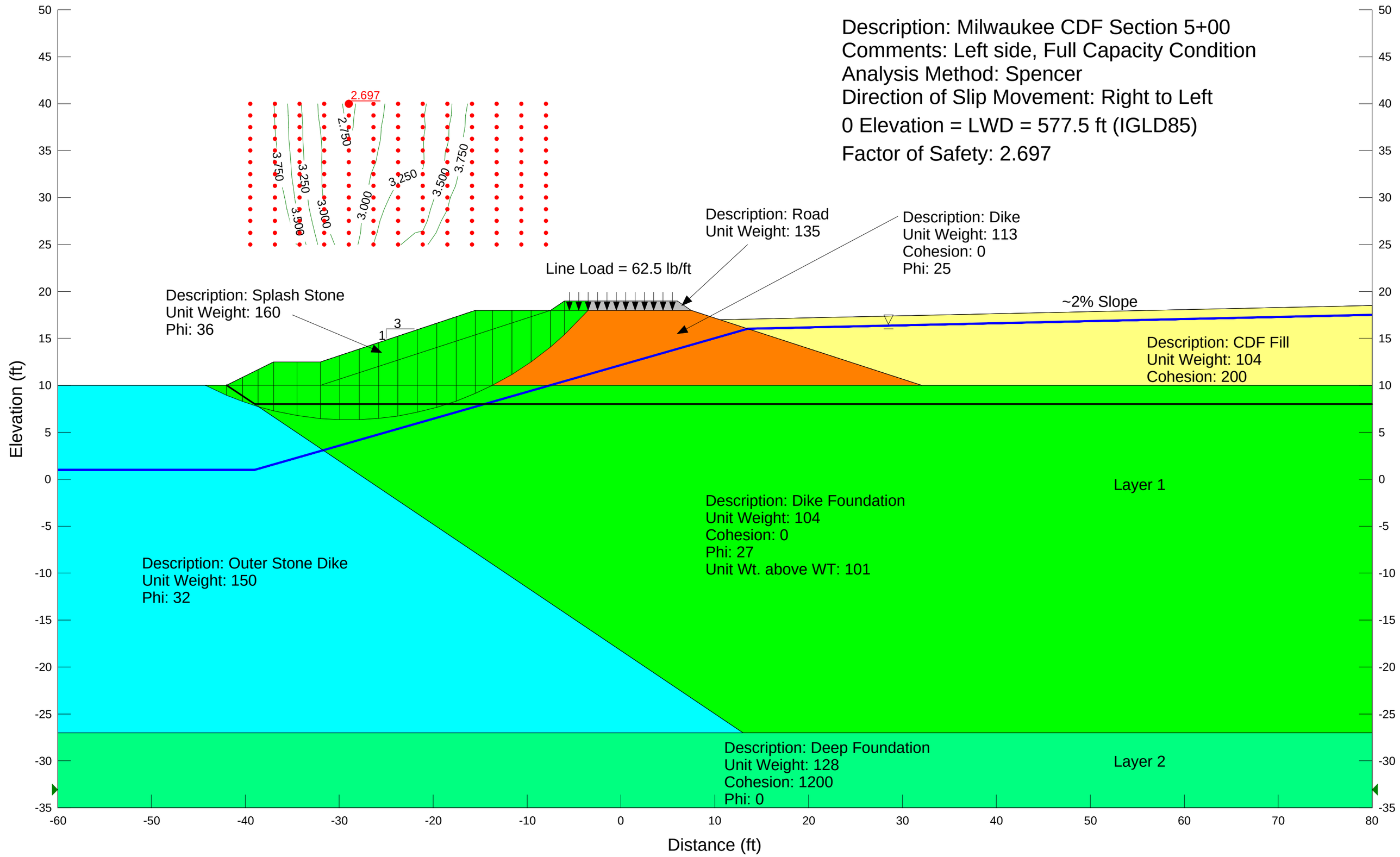
Direction of Slip Movement: Left to Right
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 1.735
1.735
2.000
2.250
2.750
3.250
3.500
3.750
3.000
2.500
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Splash Stone
Unit Weight: 160
Phi: 36
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
2.5
1
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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Analysis Method: Spencer
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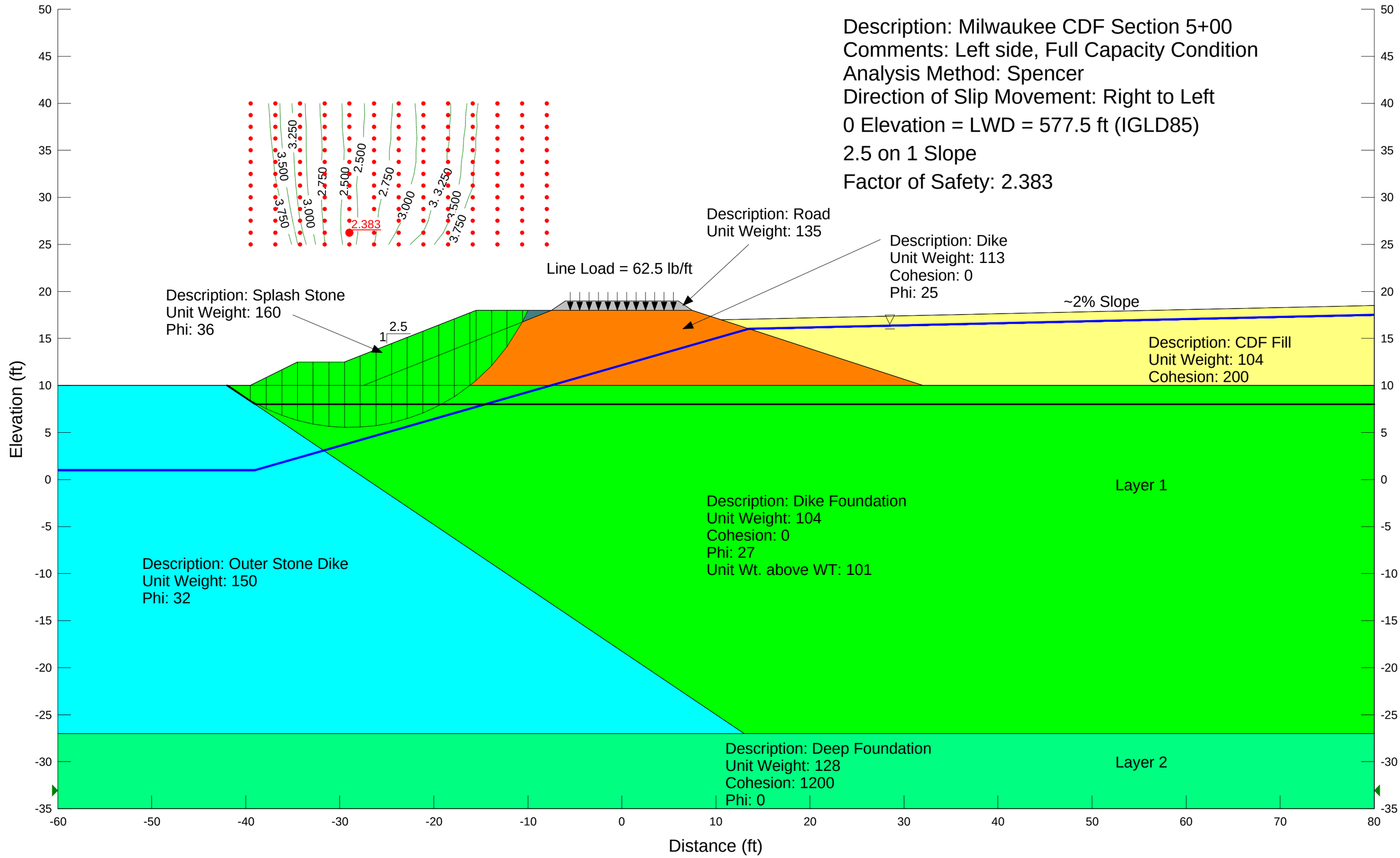
Factor of Safety: 2.697
2.697
2.750
3.000
3.250
3.500
3.750
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
Line Load = 62.5 lb/ft
Description: Splash Stone
Unit Weight: 160
Phi: 36
3
1
~2% Slope
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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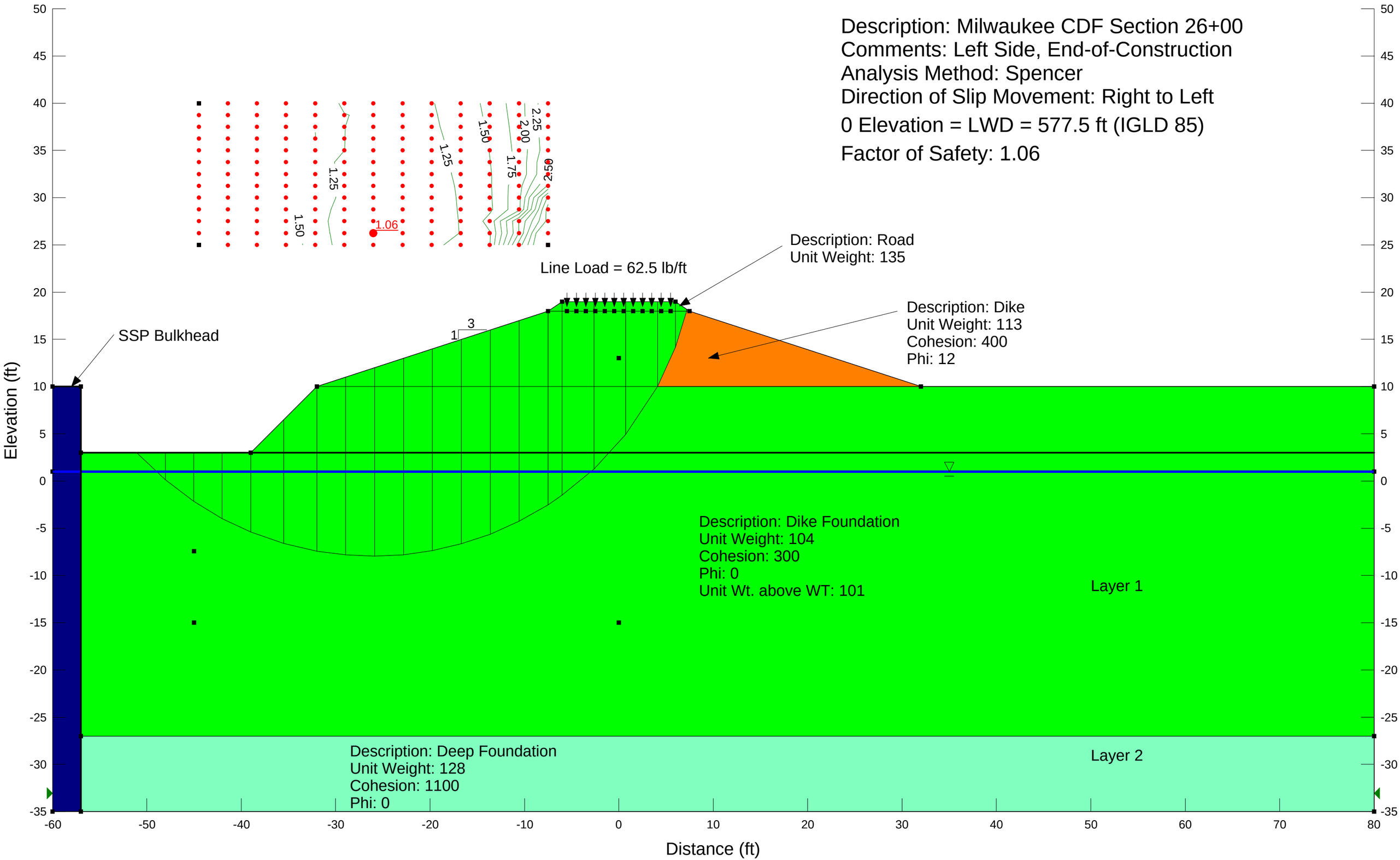
Comments: Left side, Full Capacity Condition
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 2.383
2.383
3.250
3.500
3.750
3.000
2.750
2.500
2.500
2.750
3.000
3.250
3.500
3.750
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
~2% Slope
Description: Splash Stone
Unit Weight: 160
Phi: 36
2.5
1
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Outer Stone Dike
Unit Weight: 150
Phi: 32
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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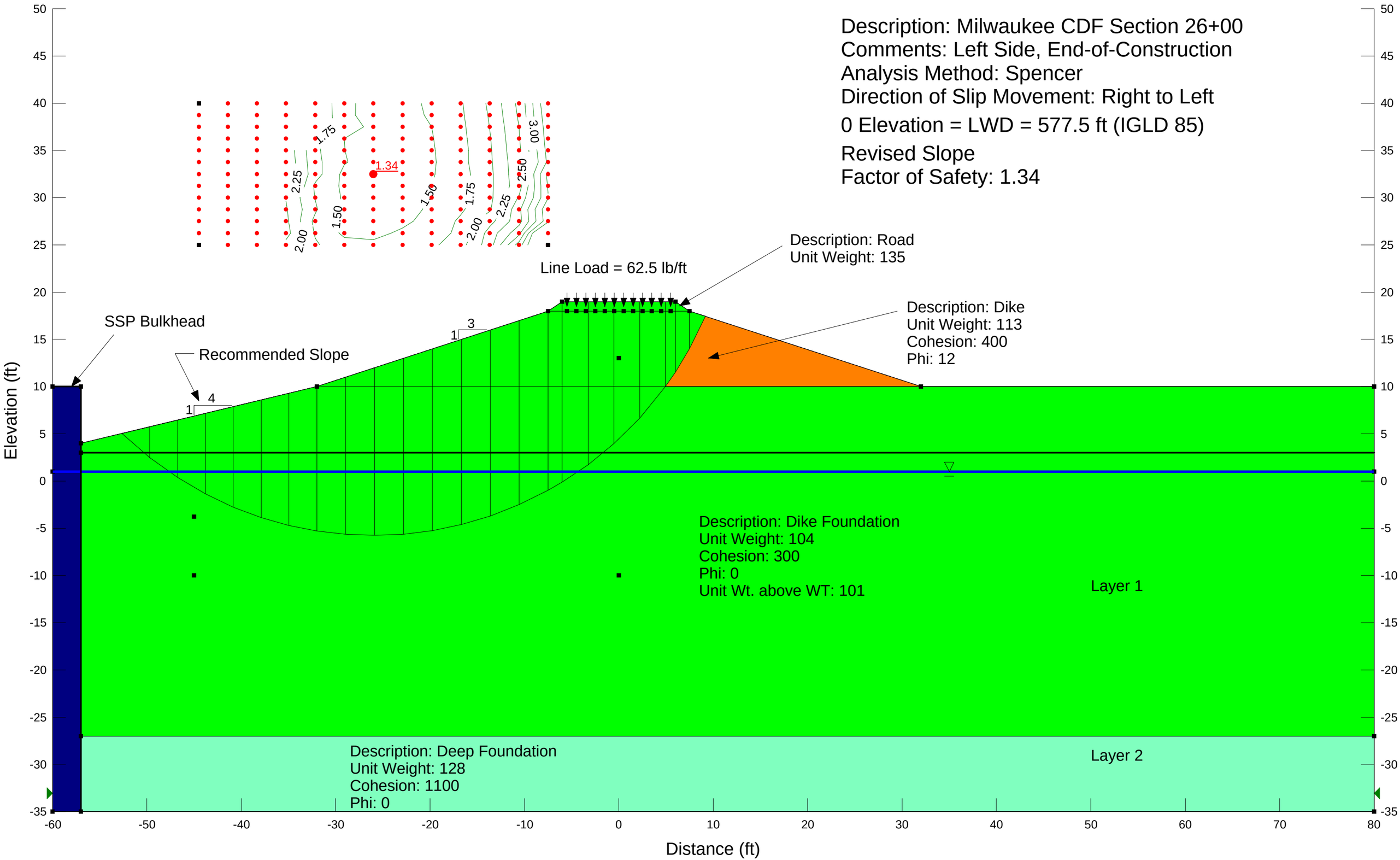
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD 85)
Factor of Safety: 1.06
1.06
1.50
1.25
1.25
1.50
1.75
2.00
2.25
2.50
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
3
1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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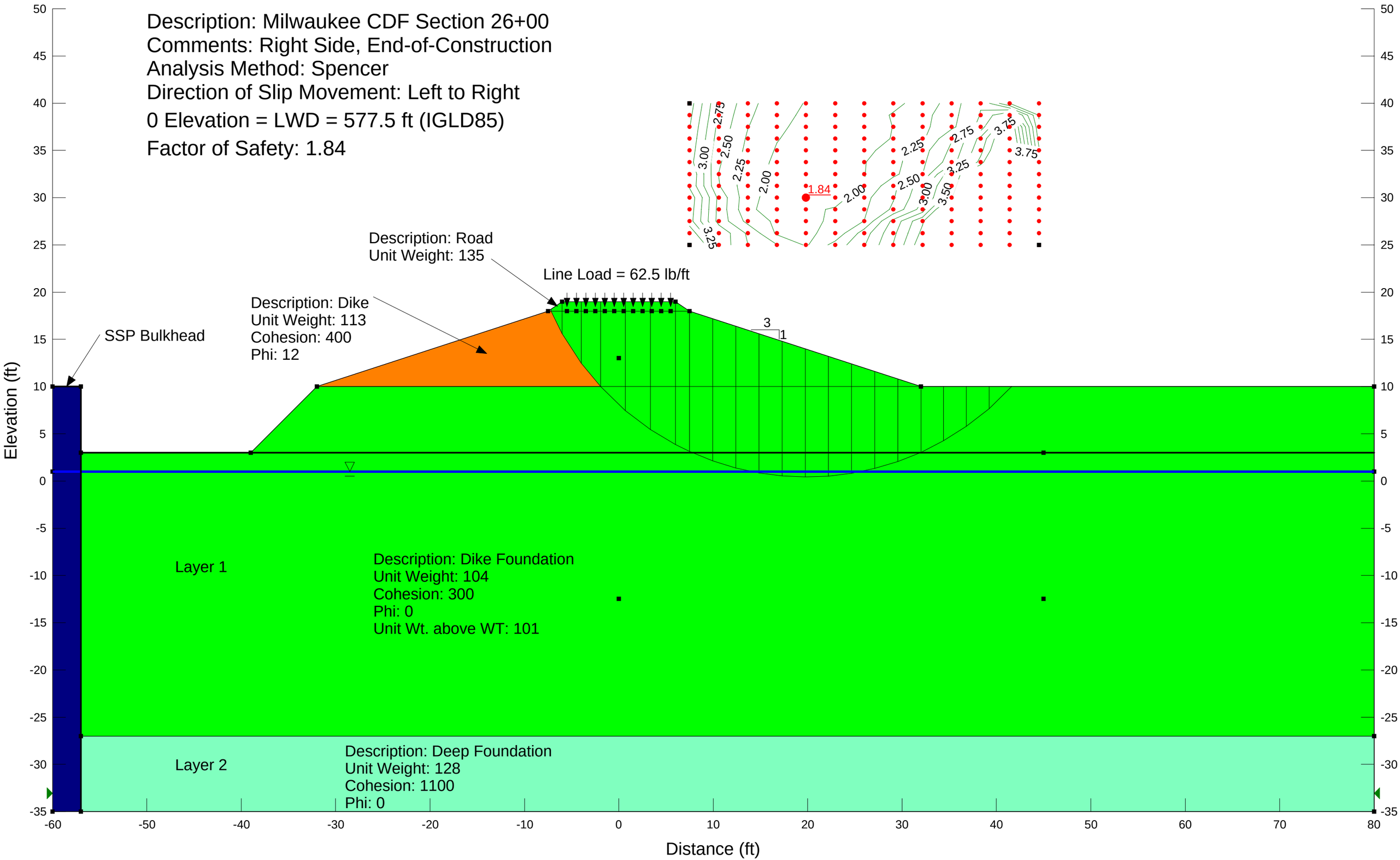
Comments: Left Side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD 85)
Revised Slope
Factor of Safety: 1.34
1.34
2.25
2.00
1.75
1.50
1.50
1.75
2.00
2.25
2.50
3.00
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
Recommended Slope
4
1
3
1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 1
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)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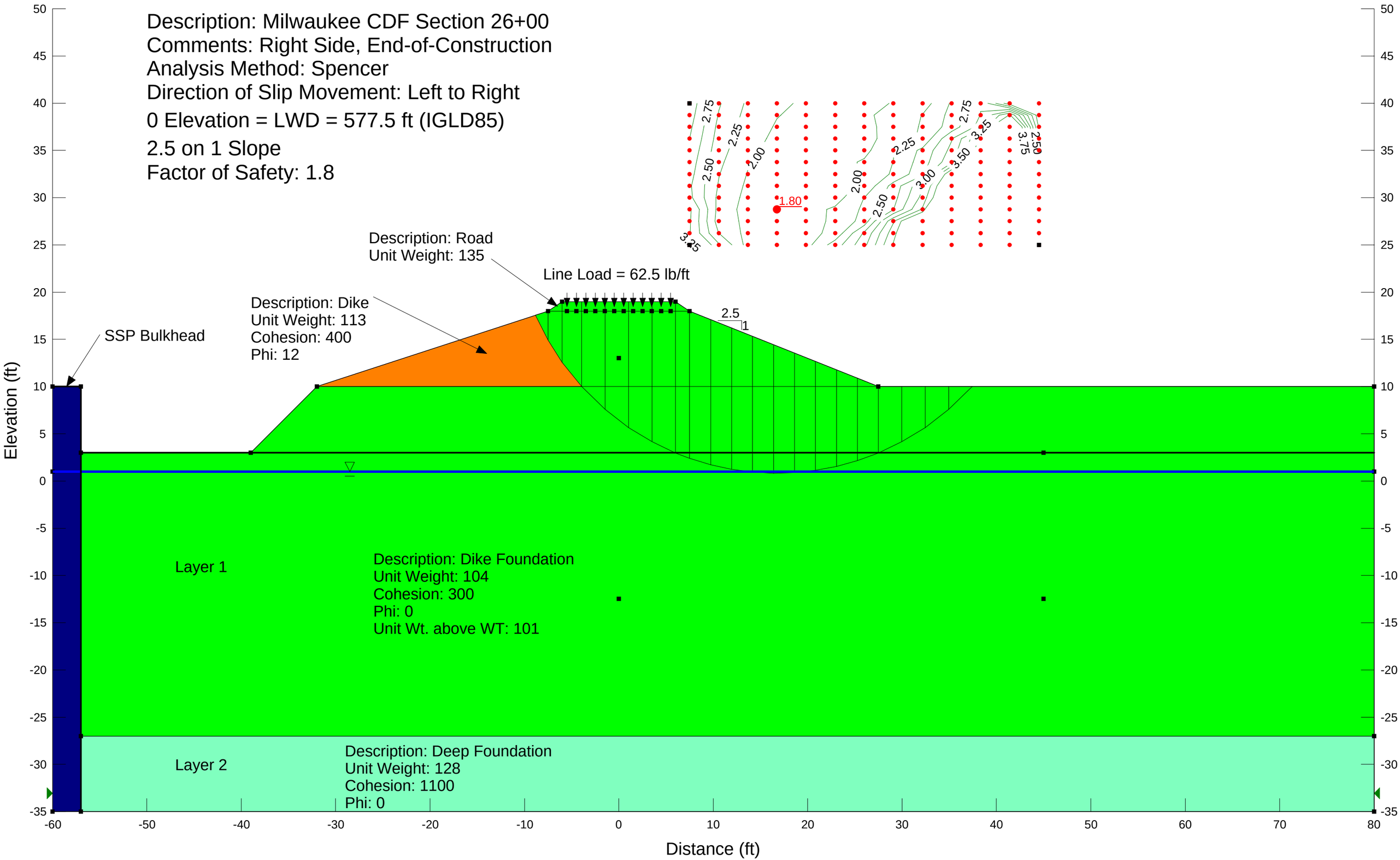
Factor of Safety: 1.84
1.84
3.00
2.75
2.50
2.25
2.00
3.25
3.50
3.75
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
3
1
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 2
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Elevation (ft)
Distance (ft)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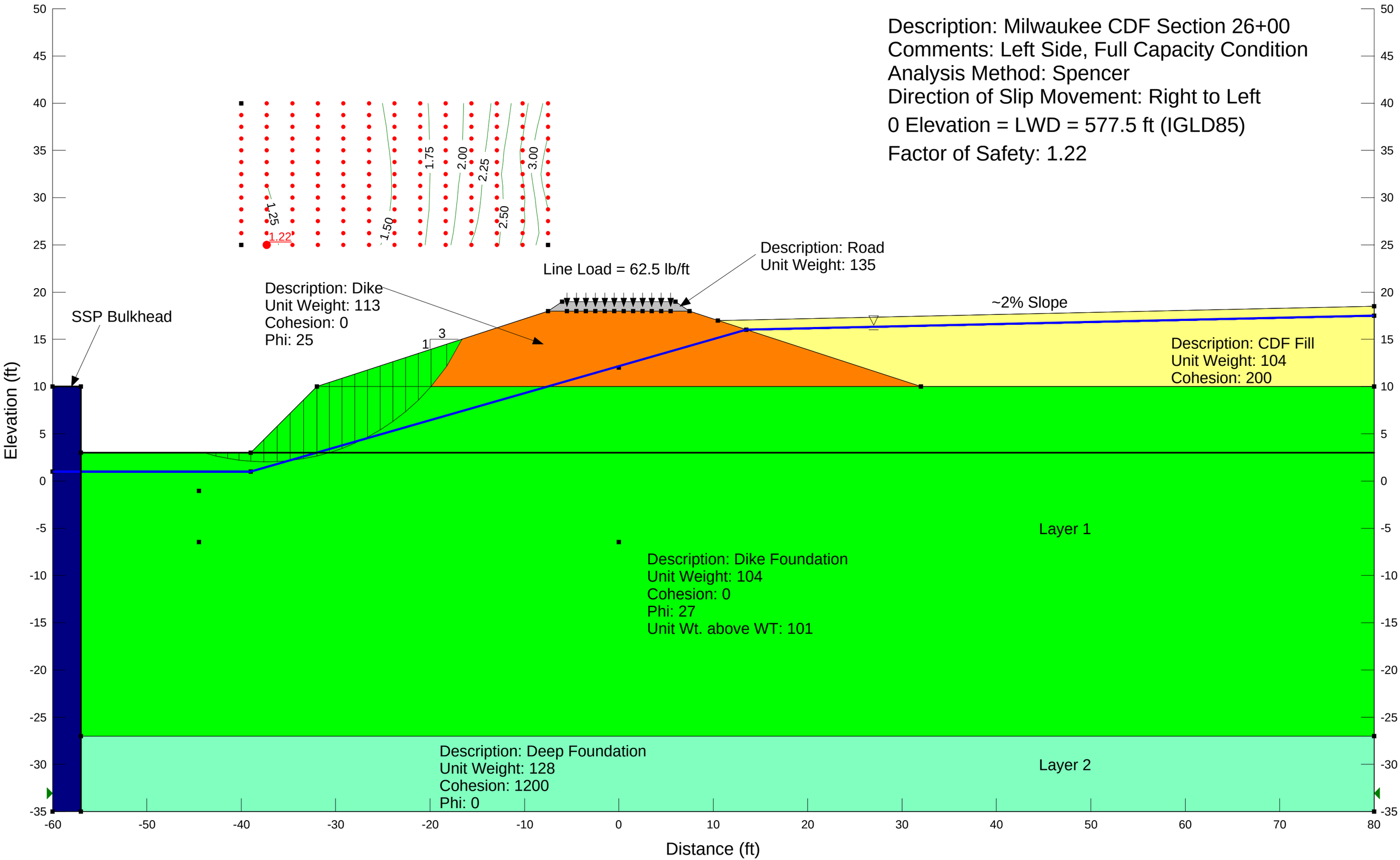
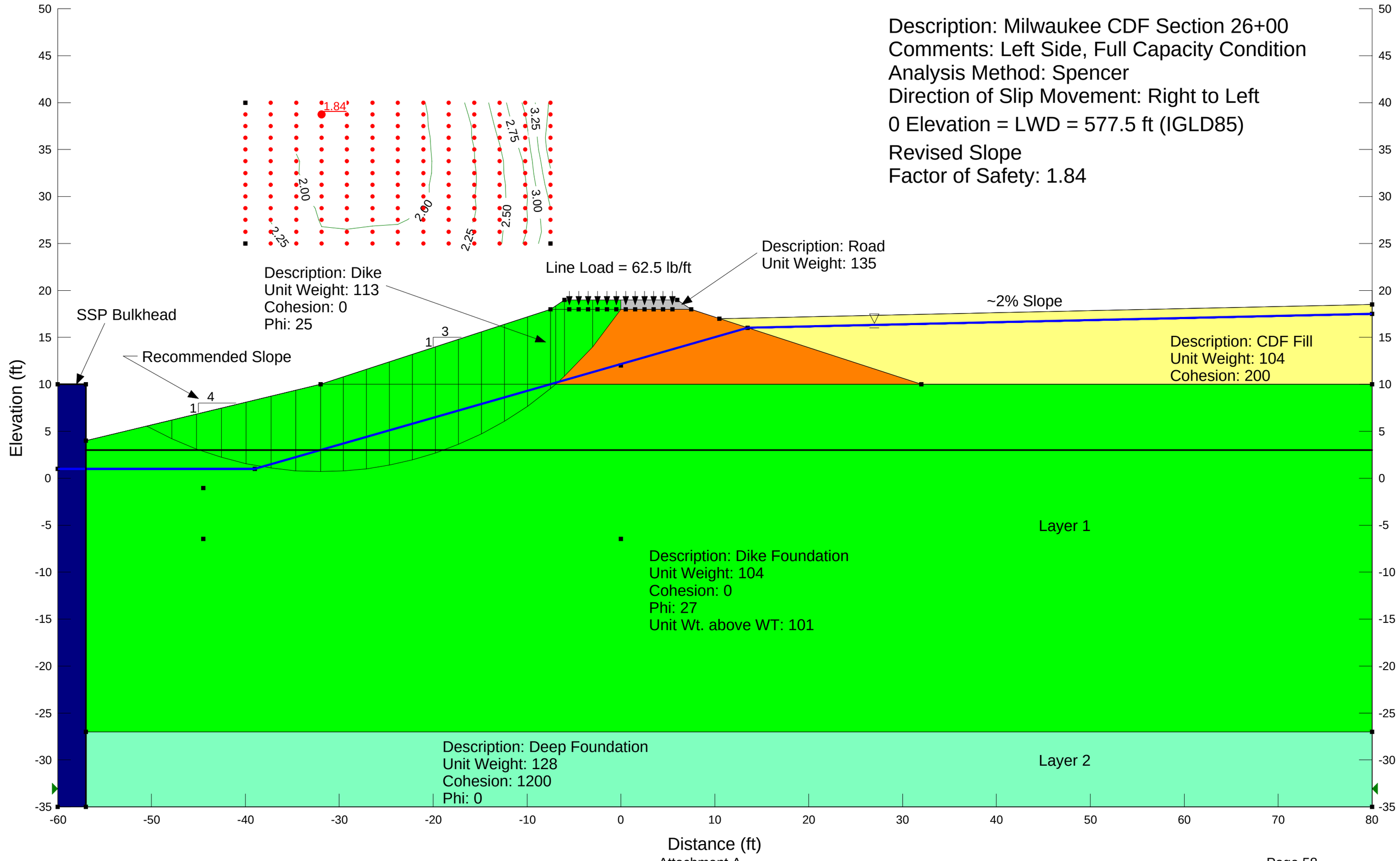
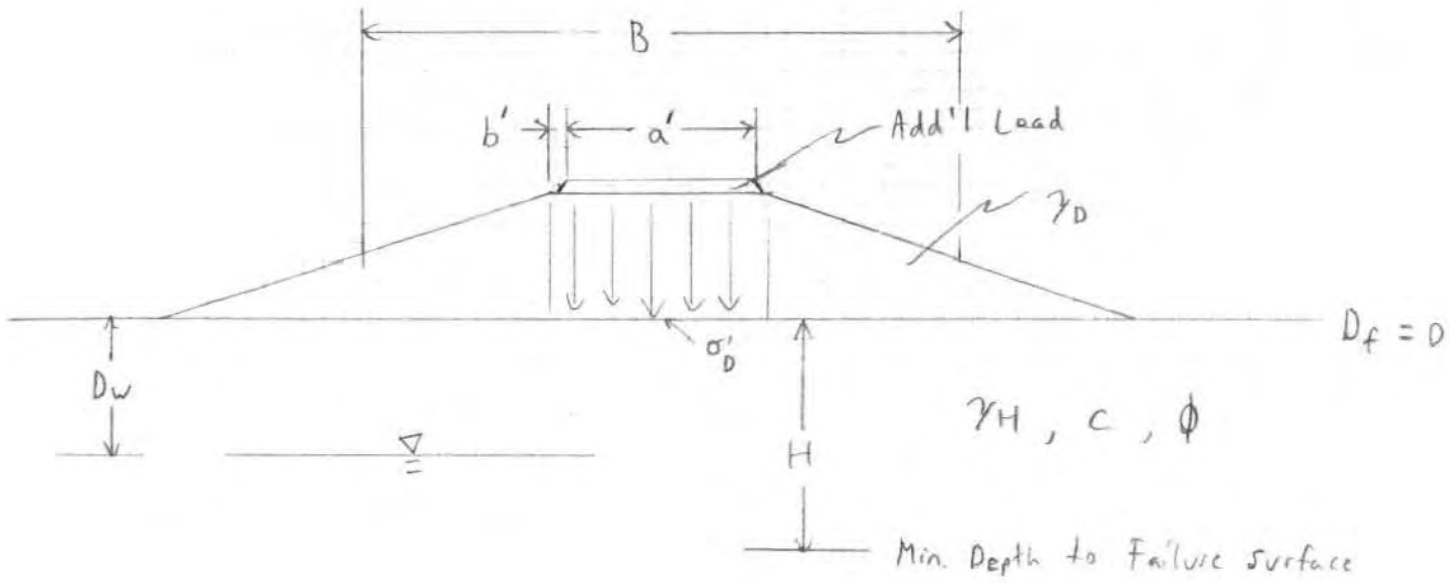
Comments: Right Side, End-of-Construction
Analysis Method: Spencer
Direction of Slip Movement: Left to Right
0 Elevation = LWD = 577.5 ft (IGLD85)
2.5 on 1 Slope
Factor of Safety: 1.8
1.80
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Dike
Unit Weight: 113
Cohesion: 400
Phi: 12
SSP Bulkhead
2.5
1
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 300
Phi: 0
Unit Wt. above WT: 101
Layer 2
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1100
Phi: 0
Elevation (ft)
Distance (ft)


Description: Milwaukee CDF Section 26+00
Comments: Left Side, Full Capacity Condition
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
Factor of Safety: 1.22
1.25
1.22
1.50
1.75
2.00
2.25
2.50
3.00
Line Load = 62.5 lb/ft
Description: Road
Unit Weight: 135
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
SSP Bulkhead
~2% Slope
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)


Description: Milwaukee CDF Section 26+00
Comments: Left Side, Full Capacity Condition
Analysis Method: Spencer
Direction of Slip Movement: Right to Left
0 Elevation = LWD = 577.5 ft (IGLD85)
Revised Slope
Factor of Safety: 1.84
1.84
2.00
2.25
2.50
2.75
3.00
3.25
Description: Road
Unit Weight: 135
Line Load = 62.5 lb/ft
Description: Dike
Unit Weight: 113
Cohesion: 0
Phi: 25
SSP Bulkhead
Recommended Slope
4
1
3
1
~2% Slope
Description: CDF Fill
Unit Weight: 104
Cohesion: 200
Layer 1
Description: Dike Foundation
Unit Weight: 104
Cohesion: 0
Phi: 27
Unit Wt. above WT: 101
Description: Deep Foundation
Unit Weight: 128
Cohesion: 1200
Phi: 0
Layer 2
Elevation (ft)
Distance (ft)

Generalized Cross-Section for Bearing Capacity Calculations



US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Bearing Capacity Calculations

Typical Section, End-of-Construction

Computed by: SW **Date:** 17-Apr-07
Checked by: JPK **Date:** 17 Apr-07

*Refer to attached cross-section for more detail on inputs

Inputs

Height (ft)	9.0	*embankment height*
c (psf)	300	*fdn soil cohesion*
γ_D (pcf)	113	*soil unit weight above foundation*
γ_H (pcf)	104	*soil unit weight below foundation*
γw (pcf)	62.4	*water unit weight*
Φ (deg)	0	*fdn soil friction angle*
Foundation type	strip	*strip, square, or circular*
Df (ft)	0.0	*foundation depth*
Dw (ft)	9.0	*depth to water table*
B (ft)	39.5	*foundation width*
q (psf)	750	*any external loads*

Assumptions

1) Shallow Foundation
2) Strip Footing
3) 750 psf road load
4) Allowable load = Effective surcharge

Bearing Capacity Factors (see table)

Nq	1.00
Nγ	0.00
Nc	5.70

a'	12	*external dist. load width*
b'	1.5	*distance from edge of load to slope edge*

Results

ζq	1.0	*correction factor*
ζγ	1.0	"
ζc	1.0	"
$\sigma_{v(2)}$ (psf)	500	*Add'l surcharge effect*
ψ (deg)	45	
H (ft)	39.50	*approx depth of shear failure beneath fdn base*
L_{sh} (ft)	39.50	*approx horizontal length of failure*
γ_D' (pcf)	113.0	*eff. soil unit weight*
γ_H' or (pcf)	55.8	*eff. soil unit weight below foundation*
σ_D' (psf)	1017.0	*eff. surcharge pressure @ fdn depth*
qa (psf)	1517.0	*eff. surcharge pressure @ fdn depth + load(s)*
qu (psf)	2727.0	*ultimate bearing capacity* $(\sigma_{v(z)})$
Factor of Safety	**1.80**	*recommended FS = 2.5*
Meets Criteria?	**No**	

Eq. 3.15 from Das, 1990
if 0≤d≤B, where d = Dw

$$\bar{\gamma} = \gamma' + \frac{d}{B}(\gamma - \gamma')$$

Eq. 11.4 from Das, 1990
where z = height = q'

$$\sigma_{v(z)} = \frac{qa'}{a' + \frac{z}{2} + b'}$$

Equations from EM1110-1-1905 -> $q_a = \frac{q_u}{FS}$ $\quad q_u = cN_c\zeta_c + \frac{1}{2}B'\gamma_H'N_\gamma\zeta_\gamma + \sigma_D'N_q\zeta_q$

Terzaghi Dimensionless Bearing Capacity Factors (after Bowles 1988)

φ'	N_q	N_c	N_γ
28	17.81	31.61	15.7
30	22.46	37.16	19.7
32	28.52	44.04	27.9
34	36.50	52.64	36.0
35	41.44	57.75	42.4
36	47.16	63.53	52.0
38	61.55	77.50	80.0
40	81.27	95.66	100.4
42	108.75	119.67	180.0
44	147.74	151.95	257.0
45	173.29	172.29	297.5
46	204.19	196.22	420.0
48	287.85	258.29	780.1
50	415.15	347.51	1153.2

φ'	N_q	N_c	N_γ
0	1.00	5.70	0.0
2	1.22	6.30	0.2
4	1.49	6.97	0.4
6	1.81	7.73	0.6
8	2.21	8.60	0.9
10	2.69	9.60	1.2
12	3.29	10.76	1.7
14	4.02	12.11	2.3
16	4.92	13.68	3.0
18	6.04	15.52	3.9
20	7.44	17.69	4.9
22	9.19	20.27	5.8
24	11.40	23.36	7.8
26	14.21	27.09	11.7

Milwaukee CDF Stability Analysis Verification
Section 26+00, Right Side, End-of-Construction, 3 on 1 Slope

Computed by: SW
Checked by: JPK

			unit wt.	113				F.S. ->	1.8300	1.8350	1.8351
Slice	Horiz. width "b" (ft)	Ave. Height "h" (ft)	Area "A" (sqft)	Weight "W" (lbs)	Base Inclin. "α" (deg)	Base Length "Δl" (ft)	Cohesion "c" (psf)	Fric. Angle "Φ" (deg)	z_{i+1} (Trial FS 1)	z_{i+1} (Trial FS 2)	z_{i+1} (Trial FS 3)
1	1.20	1.87	2.23	252.55	63.5	2.68	400	12	-676.94	-674.33	-674.30
2	2.02	5.08	10.28	1161.35	57.2	3.74	400	12	-542.00	-535.53	-535.46
3	2.02	7.84	15.86	1792.40	50.5	3.18	400	12	223.92	233.76	233.86
4	2.65	10.35	27.45	3101.56	43.9	3.68	300	0	2370.30	2382.43	2382.55
5	2.65	12.61	33.43	3777.35	37.1	3.32	300	0	4543.61	4557.59	4557.73
6	2.65	14.39	38.16	4311.75	30.9	3.09	300	0	6532.28	6547.87	6548.03
7	1.50	15.02	22.53	2546.40	26.3	1.67	300	0	7483.22	7499.65	7499.81
8	2.45	15.01	36.77	4155.24	22.1	2.64	300	0	8701.46	8719.16	8719.34
9	2.45	15.08	36.94	4174.34	17.0	2.56	300	0	9541.51	9560.40	9560.59
10	2.45	14.92	36.54	4129.22	12.1	2.51	300	0	10008.73	10028.77	10028.97
11	2.45	14.53	35.61	4023.74	7.3	2.47	300	0	10116.47	10137.62	10137.83
12	2.45	13.95	34.17	3860.67	2.5	2.45	300	0	9885.14	9907.39	9907.62
13	2.45	13.15	32.22	3641.13	2.2	2.45	300	0	9623.69	9647.04	9647.27
14	2.45	12.16	29.78	3365.11	-7.0	2.47	300	0	8803.94	8828.39	8828.64
15	2.45	10.95	26.83	3031.78	-11.8	2.50	300	0	7751.45	7777.05	7777.31
16	2.45	9.53	23.35	2638.08	-16.7	2.56	300	0	6522.09	6548.89	6549.15
17	2.45	7.88	19.30	2180.39	-21.7	2.64	300	0	5187.30	5215.36	5215.64
18	2.40	6.38	15.34	1733.79	-26.9	2.70	300	0	3811.70	3841.11	3841.40
19	2.40	5.02	12.06	1363.20	-32.3	2.84	300	0	2399.25	2430.17	2430.47
20	2.40	3.33	8.00	904.21	-38.0	3.05	300	0	1058.38	1091.03	1091.35
21	2.40	1.24	2.97	335.75	-44.2	3.35	300	0	**-35.08**	**-0.35**	**0.00**

Side Force Inclination (θ) ->	**0.0**
SLOPE/W calculated FS ->	**1.844**
FS that satisfies equilibrium ->	**1.835**

Verified? **Yes**

Notes:

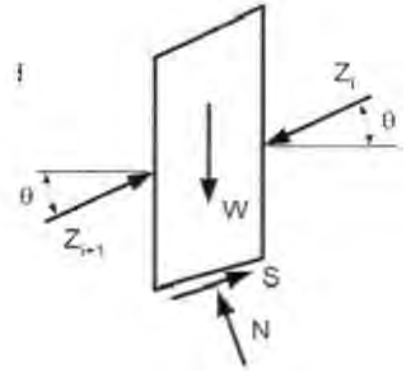
1) Input cells are light yellow.
2) Modified Swedish Method used to check Spencer's Method (per EM1110-2-1902).
3) Side Force Inclination is assumed to be equal to that used in SLOPE/W.
4) Verification is for end-of-construction condition.

5) Line loads are not considered.

6) Allowable difference between factors of safety is 2%.

Equation F-7 from EM1110-2-1902

$$Z_{i+1} = Z_i + \frac{W\left[\sin\alpha - \frac{\tan\phi\cos\alpha}{F}\right] - \frac{c\cdot\Delta l}{F}}{\cos(\alpha-\theta) + \frac{\tan\phi\sin(\alpha-\theta)}{F}}$$



Slice Data used for Stability Analysis Verification

Slice	1	2	3	4	5	6	7	8	9	10	11
Factor of Safety	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844
Phi Angle	12	12	12	0	0	0	0	0	0	0	0
C (Strength)	400	400	400	300	300	300	300	300	300	300	300
C (Force)	1071.7	1496	1273.4	1103.4	997.06	926.65	501.82	793.2	768.75	751.78	741.02
Pore Water Pressure	0	0	0	0	0	0	0	0	0	0	20.876
Pore Water Force	0	0	0	0	0	0	0	0	0	0	51.564
Pore Air Pressure	0	0	0	0	0	0	0	0	0	0	0
Pore Air Force	0	0	0	0	0	0	0	0	0	0	0
Slice Width	1.1969	2.0236	2.0236	2.6509	2.6509	2.6509	1.5	2.45	2.45	2.45	2.45
Mid-Height	1.8673	5.0788	7.8385	10.354	12.61	14.394	15.023	15.009	15.078	14.915	14.534
Base Length	2.6792	3.74	3.1836	3.6779	3.3235	3.0888	1.6727	2.644	2.5625	2.5059	2.4701
Base Angle	63.465	57.244	50.533	43.883	37.096	30.882	26.268	22.085	17.04	12.129	7.3074
Polygon Closure	8.9299	6.0295	9.509	19.164	21.301	46.792	12.685	20.033	0	38.672	37.519
Weight	268.39	1205.9	1836.9	3116.9	3721	4198.5	2445.5	3937.4	3931.1	3867.2	3751.9
Base Shear Force	535.69	925.59	910.15	598.76	541	502.76	272.18	430.3	417.03	407.82	401.98
Base Normal Force	396.4	986.78	1901.8	3832.9	4260.1	4679.2	2537	4006.6	3938.9	3844.1	3726.9
Left Side Normal Force	2.7557	592.57	266.84	618.76	2841.1	4976.1	6943.3	7820.3	8925.3	9678.1	10084
Left Side Shear Force	592.57	33.777	15.21	35.27	161.95	283.64	395.77	445.76	508.75	551.66	574.82
Right Side Normal Force	33.777	266.84	618.76	2841.1	4976.1	6943.3	7820.3	8925.3	9678.1	10084	10157
Right Side Shear Force		15.21	35.27	161.95	283.64	395.77	445.76	508.75	551.66	574.82	578.96
Line Load		125	125	187.5	125	187.5					

Slice	12	13	14	15	16	17	18	19	20	21
Factor of Safety	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844	1.844
Phi Angle	0	0	0	0	0	0	0	0	0	0
C (Strength)	300	300	300	300	300	300	300	300	300	300
C (Force)	735.72	735.55	740.49	750.86	767.37	791.26	809.03	853.3	915.4	1006.3
Pore Water Pressure	34.035	34.466	22.178	0	0	0	0	0	0	0
Pore Water Force	83.467	84.504	54.743	0	0	0	0	0	0	0
Pore Air Pressure	0	0	0	0	0	0	0	0	0	0
Pore Air Force	0	0	0	0	0	0	0	0	0	0
Slice Width	2.45	2.45	2.45	2.45	2.45	2.45	2.4049	2.4049	2.4049	2.4049
Mid-Height	13.945	13.152	12.155	10.951	9.5289	7.8757	6.38	5.0163	3.3273	1.2355
Base Length	2.4524	2.4518	2.4683	2.5029	2.5579	2.6375	2.6968	2.8443	3.0513	3.3543
Base Angle	2.5377	2.2143	6.9817	11.799	16.702	21.737	26.906	32.275	37.989	44.197
Polygon Closure	35.841	34.128	16.052	14.861	26.935	11.8	20.448	18.257	7.545	16.774
Weight	3584.1	3364.4	3092.8	2768.5	2393.2	1960.6	1549.6	1218.4	808.18	300.09
Base Shear Force	399.1	399.01	401.69	407.32	416.28	429.25	438.9	462.93	496.65	546.01
Base Normal Force	3583.8	3412.8	3210.5	2972.1	2693.5	2360.1	2044.8	1825.7	1509	1038.4
Left Side Normal Force	10157	9914.3	9381.1	8589.5	7580.5	6405	5129.6	3810.2	2441.2	1118.3
Left Side Shear Force	578.96	565.13	534.73	489.61	432.09	365.09	292.39	217.19	139.15	63.742
Right Side Normal Force	9914.3	9381.1	8589.5	7580.5	6405	5129.6	3810.2	2441.2	1118.3	
Right Side Shear Force	565.13	534.73	489.61	432.09	365.09	292.39	217.19	139.15	63.742	
Line Load										

Milwaukee Confined Disposal Facility DMMP
Settlement Calculations

Introduction

Estimates of soil settlement were performed for two areas of the proposed CDF dike construction. The first area involves a maximum thickness of dredge material over the compressible foundation (Figure 1). The second area involves calculating settlement at specified points in the foundation of the proposed dikes (Figure 2). Table 1 lists the lab data used for this analysis, further details on the lab data can be found in the Soil Profile. Table 2 lists the soil properties used for the dredge material settlement analysis. Table 3 lists the soil properties used for the dike foundation settlement analysis. Calculation tables for the dredge material and CDF foundation are shown in Tables 4 and 5 respectively. Separate calculation sheets are attached for the specified depths in the dike foundation settlement analysis. Hand calculations, graphs and correlations are also attached.

Analysis Assumptions

The assumptions used for this settlement analysis for each case are listed below:

Dredge Material and CDF Foundation

1) Uniform dredge material with properties similar to existing fill. Average lab data values will be used for dredge material and foundation.

2) Maximum settlement is determined. Layer thickness used is maximum thickness assuming 1 ft freeboard from top of dike. Height due to road is not included. The top surface of the placed dredge material is assumed to be flat.

3) Foundation is normally consolidated. This may yield higher settlements than actual.

5) Pre consolidation pressure assumed to be equal to initial effective stress for CDF foundation sub layers.

6) Water will not be continuously pumped out, and analysis assumes material settlement. Amount of water displaced due to additional material placement will have to be factored in the available capacity calculations.

7) Void ratios are approximate and were determined from graphical means using existing lab data (see Graph 1).

8) Assume double drainage for dredge material and foundation layers.

9) Graph 2 used to approximate percent consolidation at 20 years.

10) Assume no modification to foundation soil.

Dike Foundation

1) Lab data corresponding to specified depth will be used for this analysis.

2) Minimum coefficient of consolidation used for time rate calculation (realistic, but more conservative).

3) External loads are neglected because they are temporary. Long term effect assumed to be minimal.

4) Graph 2 used to approximate percent consolidation at 20 years.

5) Assume double drainage for dike foundation layers.

6) Assume no modification to dike foundation soil.

Results and Conclusions

Table 6 shows the results for the dredge material settlement calculations and Table 7 shows the results for the dike foundation settlement calculations. The results show the expected settlement for each case using the above assumptions. The difference in total settlement between the CDF foundation and dike foundation is due to differing layer thicknesses, and selected parameters. Actual settlement may be more or less depending on soil type, location in CDF, thickness of layers, method of placement, frequency and quantity of material placement, drainage, etc. As stated in the assumptions, water displacement due to adding dredge material needs to be accounted for in quantity calculations. Estimated settlement will also be reduced due to any foundation treatment for the dikes but this will also reduce long term maintenance of the dikes.

Recommendations

To maximize available capacity of the CDF over the 20 year design life, it is recommended that a long term pump system be considered. Maximum settlement due to consolidation of material in the CDF may be increased by maintaining a low water level before and after placement of dredge material. The removal of water increases the effective vertical pressure on the underlying soil thereby increasing consolidation. Additional analysis would be required to develop an effective long term system. Furthermore, funding would need to be provided throughout the life of the CDF on an annual or as-needed basis to maintain the pump system. A cost analysis should also be conducted to estimate the savings due to the additional available capacity versus the cost of maintaining a pump system.

References

1) EM1110-1-1904, Settlement Analysis, 30 Sept 1990.

2) EM1110-2-5027, Confined Disposal of Dredged Material, 30 Sept 1987.

3) Milwaukee Confined Disposal Facility DMMP Geotechnical Investigation Report, prepared by STS Consultants, Dec 2006.

4) Study Report - Milwaukee Harbor, WI, Increasing Disposal Capacity by Dike Raising, May 1996.

5) Das, Braja M., Principles of Foundation Engineering, 2nd Edition, PWS Publishing division of Wadsworth, Inc., 1990.

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Checked by: _____
Tina Kowitz, P.E.
Geotechnical and Structural Eng. Branch

Figure 1. Cross-Section for Dredge Material Settlement Analysis

(Not to scale)

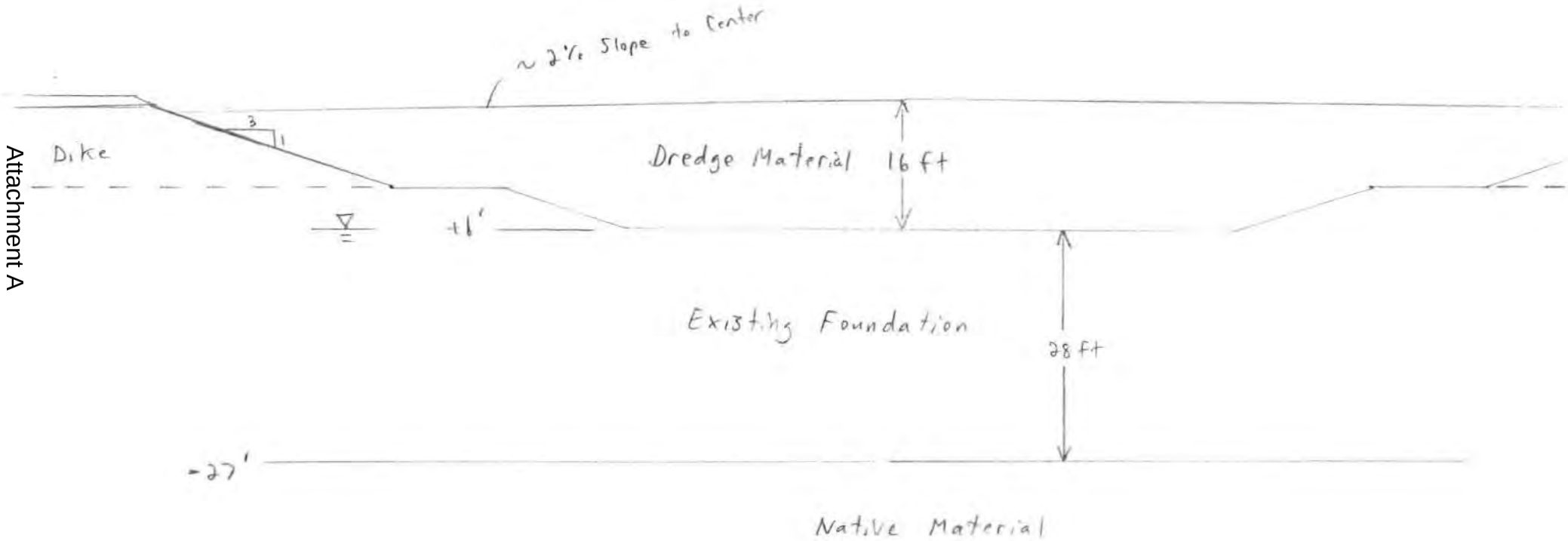
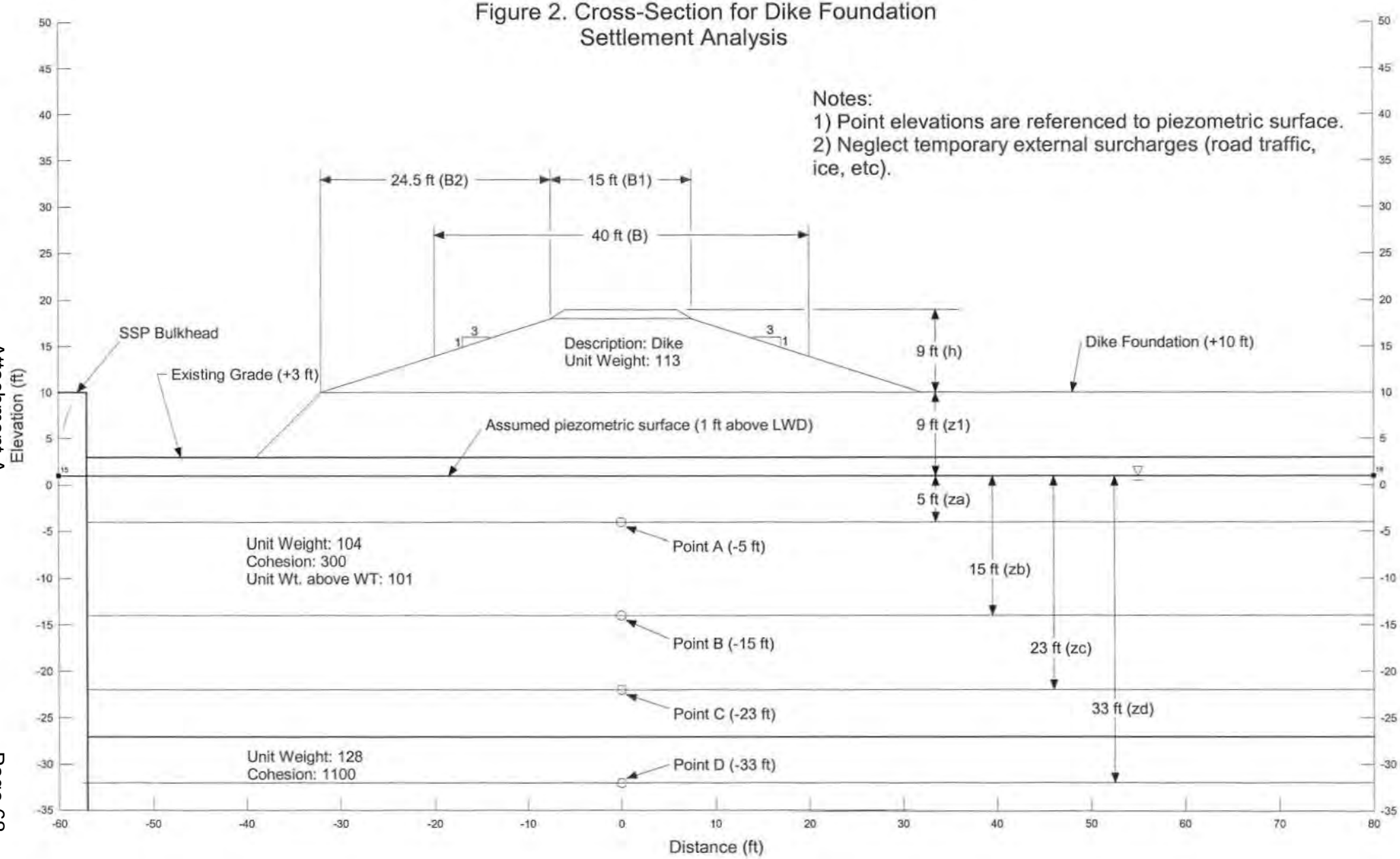


Figure 2. Cross-Section for Dike Foundation Settlement Analysis



Milwaukee CDF Settlement Analysis

Table 1. Summary Lab Test Data*

Water line is assumed to be 1 ft above LWD (577.5 ft), data depths corrected to water line.

Test location	Sample #	Data Depth below water (ft)	Pc (tsf)	Cc	e_o	Cv (in^2/sec)	SG	LL	w	γ_d (pcf)	γ_s (pcf)
MV-1-06	12	18.4	2.6	0.146	0.51	4.37E-05	2.783	30	0.179	115.1	135.7
MV-1-06	17	28.4	2.5	0.12	0.4	2.80E-05	2.707	23	0.152	121.6	140.1
MV-3-06	15	27.9	4	0.075	0.32	2.33E-06	2.679	12	NA	NA	NA
MV-4-06	4	6.4	0.67	0.55	1.82	2.47E-06	2.501	58	0.695	54.8	92.9
MV-4-06	15	26.4	2.9	0.126	0.42	1.73E-05	2.728	22	0.156	119.8	138.5
MV-4-06	18	32.4	4.1	0.292	0.54	1.05E-05	2.721	28	0.194	110.6	132.1
MV-5-06	16	25.2	3.8	0.125	0.58	8.02E-07	2.749	24	0.216	108.7	132.2
MV-6-06	9	9.5	0.63	0.45	1.38	3.19E-06	2.549	49	0.502	66.9	100.5
MV-7-06	9	11.6	1.4	0.452	1.43	4.58E-06	2.549	63	0.632	61.3	100.0
MV-7-06	13	19.6	0.5	0.71	2.01	6.57E-07	2.532	65	0.75	52.4	91.7
MV-7-06	15	23.6	4.1	0.117	0.75	6.06E-07	2.649	NA	NA	NA	NA
MV-7-06	17	27.6	3	0.163	0.52	2.53E-05	2.728	26	0.182	112.1	132.5
					Ave ->	1.16E-05	2.656				

*Refer to Soil Profile for additional details

Table 2. Selected CDF Parameters for Analysis

	Thickness (ft)	Ave Cv (in^2/sec)	SG	γ_t (pcf)*
Dredge Mat'l	16	1.16E-05	2.656	165.8
Foundation	28	1.16E-05	2.656	165.8

*Where γ_t = SG * γ_w and (γ_w = 62.4 pcf)

Table 3. Selected Dike Foundation Parameters for Analysis

Water line is assumed to be 1 ft above LWD, data depths corrected to water line.

	Depth below water (ft)	Data Depth Used	Pc (tsf)	Cc	e_o	Cv (in^2/sec)	SG	LL#	γ_s (pcf)*
Point A	5	6.4	0.67	0.55	1.82	2.47E-06	2.501	58	92.9
Point B	15	11.6	1.4	0.452	1.43	4.58E-06	2.549	63	100.0
	15	18.4	2.6	0.146	0.51	4.37E-05	2.783	30	135.7
	use ->	ave	2.0	0.299	0.97	2.41E-05	2.666	47	118
Point C	23	23.6	4.1	0.117	0.75	6.06E-07	2.649	24	132.2
Point D	33	32.4	4.1	0.292	0.54	1.05E-05	2.721	28	132.1

#LL @ Point C taken from data depth 25.2

*γ_s @ Point C taken from data depth 25.2

Table 4. Dredge Material Ultimate Settlement Calculations

$\gamma_t = \gamma_s$ = 165.8 pcf

i	h_i (ft)	l_i (ft)	σ_i' (psf)	e_i	σ_f' (psf)	e_f	h_f (ft)	δ (ft)
1	1.00	0.131	0	6.65	6.8	5.33	0.83	0.17
2	1.00	0.131	0	6.65	20.3	4.56	0.73	0.27
3	1.00	0.131	0	6.65	33.8	4.21	0.68	0.32
4	1.00	0.131	0	6.65	47.3	3.97	0.65	0.35
5	1.00	0.131	0	6.65	60.8	3.80	0.63	0.37
6	1.00	0.131	0	6.65	74.3	3.66	0.61	0.39
7	1.00	0.131	0	6.65	87.9	3.54	0.59	0.41
8	1.00	0.131	0	6.65	101.4	3.44	0.58	0.42
9	1.00	0.131	0	6.65	114.9	3.36	0.57	0.43
10	1.00	0.131	0	6.65	128.4	3.28	0.56	0.44
11	1.00	0.131	0	6.65	141.9	3.21	0.55	0.45
12	1.00	0.131	0	6.65	155.4	3.15	0.54	0.46
13	1.00	0.131	0	6.65	169.0	3.09	0.53	0.47
14	1.00	0.131	0	6.65	182.5	3.04	0.53	0.47
15	1.00	0.131	0	6.65	196.0	2.99	0.52	0.48
16	1.00	0.131	0	6.65	209.5	2.94	0.52	0.48
	16.00	2.092					9.62	6.38

Where:

i = sublayer number
h_i = initial layer thickness
l_i = initial reduced thickness
σ_i' = initial ave effective stress
γ_s = saturated unit weight
e_i = initial void ratio
σ_f' = final ave effective stress
e_f = final void ratio
h_f = final layer thickness
δ = ultimate settlement

Equations from EM1110-2-5027

F-3

$$\ell_i = \frac{h_{i,o}}{1 + e_{i,o}}$$

F-5

$$\sigma_f' = \sigma'_{1,\infty} = \frac{1}{2}\ell_1 (\gamma_s - \gamma_w)$$

F-2

$$h_f = h_{1,\infty} = \ell_1 (1 + e_{1,\infty})$$

F-4

$$\delta(\infty) = \sum_{i=1}^{m} (e_{i,o} - e_{i,\infty})\, \ell_i$$

where:

$e_i = e_{i,o}$ $\qquad$ $e_f = e_{i,\infty}$

Table 5. CDF Foundation Ultimate Settlement Calculations

$\gamma_t = \gamma_s$ = 165.8 pcf

i	h_i (ft)	l_i (ft)	σ_i' (psf)*	e_i	σ_f' (psf)	e_f	h_f (ft)	δ (ft)
1	10.00	3.771	1340.0	1.65	1556.3	1.55	9.61	0.39
2	10.00	5.283	4000.0	0.89	4216.3	0.86	9.81	0.19
3	8.00	5.738	8200.0	0.39	8416.3	0.38	7.90	0.10
	28.00	14.79					27.31	0.69

*Pc from consolidation tests (see also Table 3)

Milwaukee CDF Settlement Analysis

Table 6. Results of Settlement Calculations for Dredge Material and Foundation

	Dredge Mat'l	Foundation
Ultimate Settlement (ft)	6.38	0.69
Estimated Time for 90% Consolidation (yrs)	21.4	65.6
Time factor at 20 yrs	0.794	0.259
Estimated % Consolidated at 20 years	88	58

Total estimated ultimate settlement of dredge material (ft)	**7.07**
Approx settlement of dredge material @ 20 yrs (ft)	**6.01**

Table 7. Results of Settlement Calculations for Dike Foundation

	Point A	Point B	Point C	Point D
Depth below water (ft)	5	15	23	33
Initial Settlement (in)	0.22	0.43	0.63	0.76
Initial Settlement (ft)	0.02	0.04	0.05	0.06
Consolidation Settlement (in)	5.66	1.28	0.60	0.98
Consolidation Settlement (ft)	0.47	0.11	0.05	0.08
Total Settlement (ft)	0.49	0.15	0.10	0.14
Estimated Time for 90% Consolidation (yrs)	76.8	23.1	1635.8	162.6
Estimated % Consolidated at 20 years	53	86	9	36

Total estimated settlement under center of structure (ft)	**0.88**
Approx settlement under center of structure @ 20 yrs (ft)	**0.55**

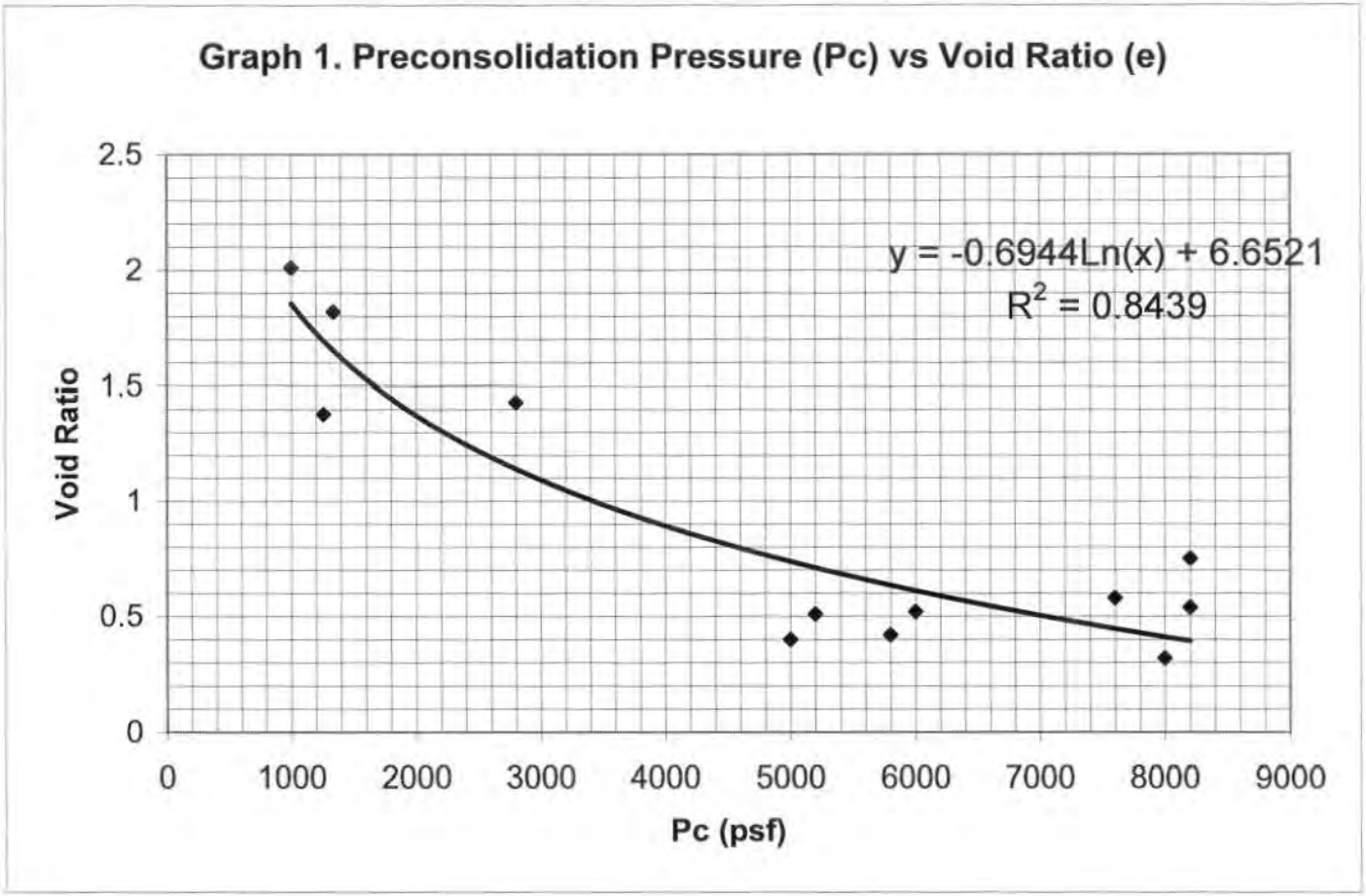
Data from lab tests

Pc (tsf)	Pc (psf)	e_o
2.6	5200	0.51
2.5	5000	0.4
4	8000	0.32
0.67	1340	1.82
2.9	5800	0.42
4.1	8200	0.54
3.8	7600	0.58
0.63	1260	1.38
1.4	2800	1.43
0.5	1000	2.01
4.1	8200	0.75
3	6000	0.52

Equation to determine e:

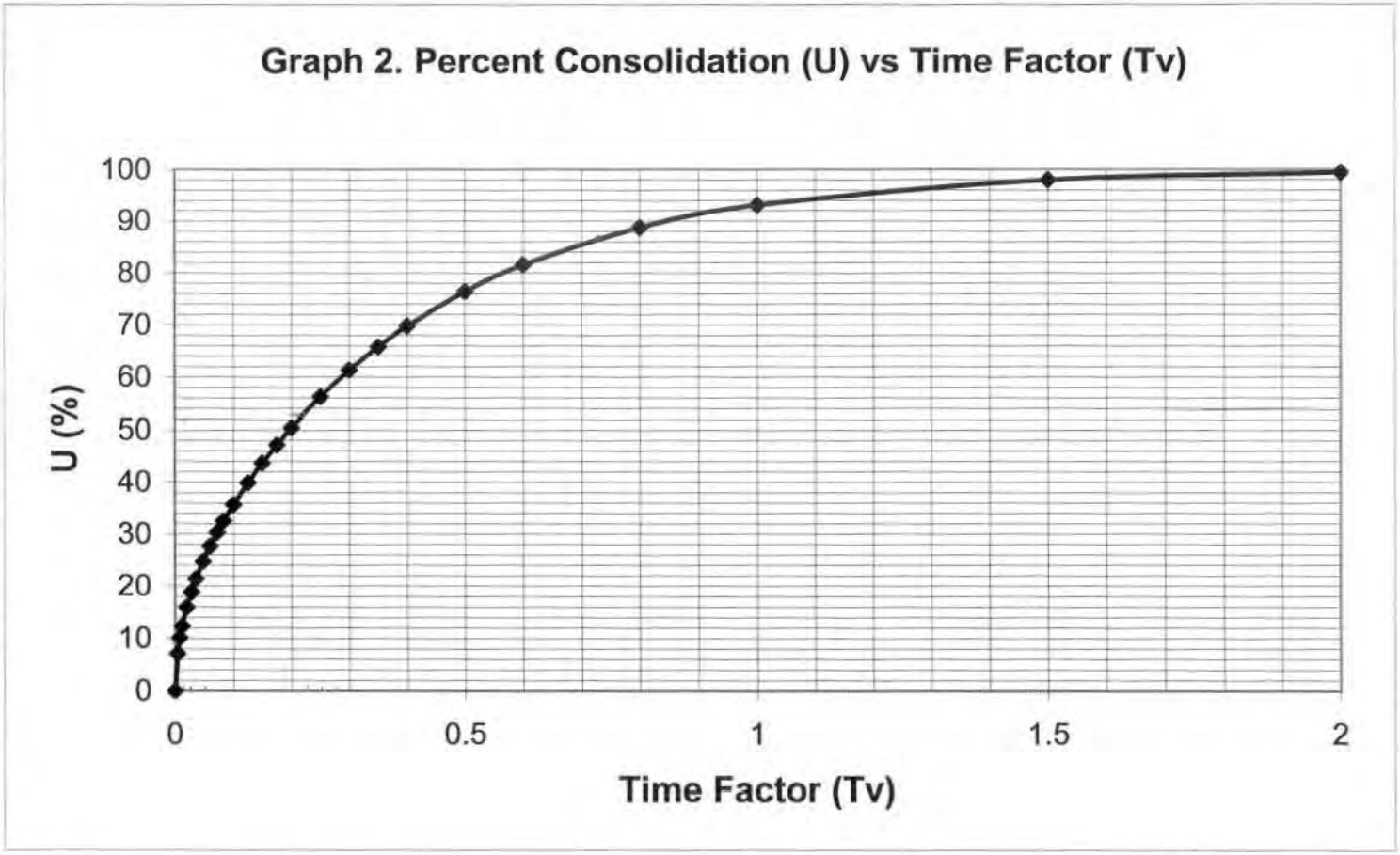
y = -0.6944Ln(x) + 6.6521

where:
x = e, void ratio
y = pressure



From EM1110-1-1904
Table 3-10, Case 1

Tv	U (%)
0	0
0.004	7.14
0.008	10.09
0.012	12.36
0.02	15.96
0.028	18.88
0.036	21.4
0.048	24.72
0.06	27.64
0.072	30.28
0.083	32.51
0.1	35.68
0.125	39.89
0.15	43.7
0.175	47.18
0.2	50.41
0.25	56.22
0.3	61.32
0.35	65.82
0.4	69.79
0.5	76.4
0.6	81.56
0.8	88.74
1	93.13
1.5	98
2	99.42



US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPK **Date:** 9 May 07

Point A

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	5
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	93
Estimated cohesion (psf)	300
LL at point	58
Specific Gravity at point	2.50
Initial void ratio (eo) at point	1.82
pc at point (psf)	1340
Cc at point	0.550
Calculated Δp (psf)	876.7
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.10
Cv (in^2/sec)	2.47E-06
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	14.0
po (psf)	1061.5
OCR	1.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	1.48E-03
Fdn layer thickness (ft)	14.0
Swell index Cs	0.067
Sc Equation used	1.69
ρ_i (feet)	0.02
ρ_i (inches)	0.22
Sc (feet)	0.47
Sc (inches)	5.66
Total Settlement (inches)	**5.87**
Ave time 90% consolid (yrs)	**76.82**
Time factor at 20 yrs	**0.221**
Approx % Consolid at 20 yrs	**53.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463 \left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPK **Date:** 9 May 07

Point B

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	15
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	118
Estimated cohesion (psf)	300
LL at point	47
Specific Gravity at point	2.67
Initial void ratio (eo) at point	0.97
pc at point (psf)	4000
Cc at point	0.299
Calculated Δp (psf)	722.1
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.20
Cv (in^2/sec)	2.41E-05
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	24.0
po (psf)	1743.0
OCR	2.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	1.45E-02
Fdn layer thickness (ft)	24.0
Swell index Cs	0.058
Sc Equation used	1.67
ρ_i (feet)	0.04
ρ_i (inches)	0.43
Sc (feet)	0.11
Sc (inches)	1.28
Total Settlement (inches)	**1.71**
Ave time 90% consolid (yrs)	**23.14**
Time factor at 20 yrs	**0.733**
Approx % Consolid at 20 yrs	**86.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463 \left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPR **Date:** 9 May 07

Point C

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	23
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	132
Estimated cohesion (psf)	300
LL at point	24
Specific Gravity at point	2.65
Initial void ratio (eo) at point	0.75
pc at point (psf)	8200
Cc at point	0.117
Calculated Δp (psf)	602.1
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.29
Cv (in^2/sec)	6.06E-07
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	32.0
po (psf)	2514.4
OCR	3.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	3.64E-04
Fdn layer thickness (ft)	32.0
Swell index Cs	0.029
Sc Equation used	1.67
ρ_i (feet)	0.05
ρ_i (inches)	0.63
Sc (feet)	0.05
Sc (inches)	0.60
Total Settlement (inches)	**1.23**
Ave time 90% consolid (yrs)	**1635.76**
Time factor at 20 yrs	**0.010**
Approx % Consolid at 20 yrs	**9.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463 \left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

US Army Corps of Engineers
Detroit District

Milwaukee CDF (DMMP)

Soil Foundation Settlement Calculations
Typical Section, End-of-Construction

Computed by: SW **Date:** 23-Apr-07
Checked by: JPR **Date:** 9 May 07

Point D

Inputs

Dike height (ft)	9.0
Dike base eff. length (ft)	40
Dike unit wt. (pcf)	113
Fdn layer above water (ft)	9
Depth to point from water (ft)	33
Fdn unit wt. above water (pcf)	101
Fdn unit wt. above point (pcf)	104
Unit wt. at point (pcf)	132
Estimated cohesion (psf)	300
LL at point	28
Specific Gravity at point	2.72
Initial void ratio (eo) at point	0.54
pc at point (psf)	8200
Cc at point	0.292
Calculated Δp (psf)	528.8
Janbu influence factor μ0	1.0
Janbu influence factor μ1	0.35
Cv (in^2/sec)	1.05E-05
Double drainage?	yes

Results

q (psf)	1017.0
Hc (ft)	42.0
po (psf)	2450.4
OCR	3.3
Overconsolidated?	yes
Young's Modulus (psf)	2.25E+05
Cv (ft^2/day)	6.30E-03
Fdn layer thickness (ft)	42.0
Swell index Cs	0.035
Sc Equation used	1.67
ρ_i (feet)	0.06
ρ_i (inches)	0.76
Sc (feet)	0.08
Sc (inches)	0.98
Total Settlement (inches)	**1.74**
Ave time 90% consolid (yrs)	**162.63**
Time factor at 20 yrs	**0.104**
Approx % Consolid at 20 yrs	**36.0** *

*From Graph 2

Assumptions

1) Water unit wt. of 62.4 pcf
2) Dike length, L, is infinite
3) Point/layer locations and data based on consolidation test results

Equations used:

Immediate Settlement
(EM1110-1-1904, eq 3-17)

$$\rho_i = \mu_0 \cdot \mu_1 \cdot \frac{q \cdot B}{E_s}$$

Consolidation
(Das, 1990, eq 1.65)
(for normally consolidated clays)

$$S_c = \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.67)
(for overconsolidated clays with $p_o + \Delta p_{av} < p_c$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_o}$$

(Das, 1990, eq 1.69)
(for overconsolidated clays with $p_o < p_c < p_o + \Delta p_{av}$)

$$S_c = \frac{C_s H_c}{1 + e_o} \log \frac{p_c}{p_o} + \frac{C_c H_c}{1 + e_o} \log \frac{p_o + \Delta p_{av}}{p_c}$$

(Das, 1990, eq 1.62)

$$C_s = 0.0463 e_L = 0.0463 \left(\frac{LL}{100}\right) G_s$$

(EM1110-1-1904, eq 3-27b)
Taylor square root of time method

$$c_v = \frac{0.848 h_e^2}{t_{90}}$$

COMPUTATION SHEET

PROJECT Milwaukee CDF (DMMP) SHEET NO. 1 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPL 9 May 07 REF DRAWING NO.

Assumptions

- Soil layers are uniform, so average values are used
- Disregard external loads (not constant)
- Settlement point/layer locations are based on consolidation test results
- No effect due to dewatering site prior to construction
- Dike foundation @ +10 ft prior to dike construction

References

1) EM 1110-1-1904, Settlement Analysis, 30 Sept 1990.
2) Das, Braja, Principles of Foundation Engineering, Second edition (1990), PWS Publishing Company, Boston.
3) Milwaukee CDF DMMP Geotechnical Investigation Report, prepared by STS Consultants, Dec 2006.

Parameters (Refer to Table 1 and Cross-Section)

Point A Settlement $\gamma_A = 101$ pcf $\gamma_{sat} = 104$ pcf

surcharge from dike $= q = \gamma_{dike} \cdot h = 113$ pcf $\cdot$ 9 ft $q = 1017$ psf

present eff. stress: $p_o = \gamma_A z_1 + \gamma_{sat} z_a - \gamma_w z_a$

$p_o = \underbrace{(101\text{ pcf})(9\text{ ft})}_{909} + \underbrace{(93\text{ pcf})(5\text{ ft})}_{465} - \underbrace{(62.4\text{ pcf})(5\text{ ft})}_{312}$

$p_o = 1061.5$ psf

COMPUTATION SHEET

PROJECT Milwaukee CDF (DMMP) SHEET NO. 2 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPK 9 May 07 REF DRAWING NO.

Determine OCR $OCR = \frac{p_c}{p_o} = \frac{1340 \text{ psf}}{1067.5 \text{ psf}} = 1.26$ > 1 overconsolidated

Estimate Young's Modulus $E_s = 250\,c$ to $1000\,c$ for overconsolidated clay (Das, p 161)

use conservative value $E_s = 250\,c$ $c = 300$ psf

$E_s = (250)(300 \text{ psf})$ $E_s = 225{,}000$ psf

Immediate Settlement

$S_i = \mu_0 \cdot \mu_1 \cdot \frac{q B}{E_s}$ (eq 3-17 EM 1110-1-1904)

$B = 40$ ft $q = 1017$ psf $E_s = 225{,}000$ psf $H = z_1 + z_2$

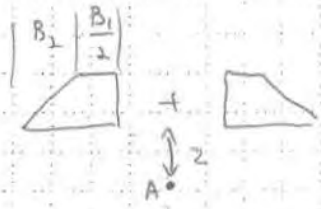
estimate μ_0 and μ_1 from attached Fig 3-8 $H = 14'$, assume $L = \infty$

$\mu_1 = 0.10$ $\mu_0 = 1$ ($D = 0$) $H/B = 14'/40' = 0.35$

$S_i = 1.0 \cdot 0.10 \cdot \left(\frac{1017 \text{ psf} \cdot 40 \text{ ft}}{225{,}000 \text{ psf}}\right)$ $S_i = 0.018$ ft or 0.22 inches

Consolidation Settlement

$\Delta p = 2 I q$ (2 symmetrical areas)



determine I from attached Fig 3.40

$B_1 = \frac{15'}{2} = 7.5'$ $B_2 = 24.5'$ $z = H = 14'$ $\frac{B_1}{z} = \frac{7.5'}{14'} = 0.535$

$\frac{B_2}{z} = \frac{24.5'}{14'} = 1.75$ $I = 0.431$

COMPUTATION SHEET

PROJECT Milwaukee CDF (DMMP) SHEET NO. 3 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPV 9May07 REF DRAWING NO.

$\Delta p = 2 \cdot (0.431)(1017\ psf)$ $\Delta p = 876.7\ psf$

determine consolidation settlement equation (Das, pg. 168)

$p_o = 1061.5\ psf$ $p_c = 1340\ psf$ $\Delta p = 876.7\ psf$

$p_o < p_c < p_o + \Delta p$ use eq. 1.69

$$S_c = \frac{C_s H}{1+e_o} \log \frac{p_c}{p_o} + \frac{C_c H}{1+e_o} \log \frac{p_o + \Delta p}{p_c}$$

Swelling index $= C_s = 0.0463 \left(\frac{LL}{100}\right) S.G.$ (Das, eq 1.62)

$C_s = 0.0463 \left(\frac{58}{100}\right) 2.50$ $C_s = 0.067$

$$S_c = \frac{(0.067)(14\ ft)}{1+1.82} \log \frac{1340}{1061.5} + \frac{(0.55)(14\ ft)}{1+1.82} \log \frac{1061.5 + 876.7}{1340}$$

$S_c = 0.333 \log 1.262 + 2.730 \log 1.446$

$S_c = 0.47\ ft$ or 5.65 inches

Total estimated Settlement @ Point A

$S_T = S_i + S_c$ $S_T = 0.22\ in + 5.65\ in.$

$S_T = 5.87$ inches

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 4 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPK 9May07 REF DRAWING NO.

Estimated time rate of consolidation for Dike Foundation

from EM 1110-1-1904 eq 3.22b @ 90% consolidation $t = \frac{0.848 H_e^2}{C_v}$

Assume double drainage $H_e = \frac{H}{2} = \frac{14}{2} = 7.0' \rightarrow 84$ inches

C_v from consolidation test data (MV-4-06, #S-4)

$$t_{90} = \frac{0.848 (84 \text{ in})^2}{2.47 \times 10^{-6} \text{ in}^2/\text{sec}} \cdot \left(1.16 \times 10^{-5} \frac{\text{day}}{\text{sec}} \cdot \frac{1 \text{ yr}}{365 \text{ day}}\right)$$

$t_{90} = 26.8$ yrs

Time factor @ 20 years (T_v)

$t = 20$ yrs $T_v = \frac{t \cdot C_v}{(H_e)^2} = \frac{20 \text{ yr} \cdot 2.47 \times 10^{-6} \frac{\text{in}^2}{\text{sec}} \cdot 86400 \frac{\text{sec}}{\text{day}} \cdot \frac{365 \text{ day}}{\text{yr}}}{(84 \text{ in})^2}$

$T_v = 0.221$

Approx % consolidation @ 20 years

From Graph 2

% Consolidated at time factor (T_v) = 0.221

U = 53 % consolidated at 20 years

COMPUTATION SHEET

PROJECT Milwaukee CDF (DMMP) SHEET NO. 5 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPK 9May07 REF DRAWING NO.

Additional point calculations for Pts B, C, and D inputs

Point B

$H = 24'$ $H/B = 24'/40' = 0.6$, $\mu_1 = 0.2$

$z = H = 24'$ $\frac{B_1}{2} = \frac{7.5}{24} = 0.313$ $\frac{B_2}{2} = \frac{24.5}{24} = 1.02$ $I = 0.355$

$\Delta p = (2)(0.355)(1017\ psf)$ $\Delta p = 722.07\ psf$

Point C

$H = 32'$ $H/B = 32'/40' = 0.8$ $\mu_1 = 0.29$

$z = H = 32'$ $\frac{B_1}{2} = \frac{7.5}{32} = 0.234$ $\frac{B_2}{2} = \frac{24.5}{32} = 0.766$ $I = 0.296$

$\Delta p = (2)(0.296)(1017\ psf)$ $\Delta p = 602.06\ psf$

Point D

$H = 42'$ $H/B = 42'/40 = 1.05$ $\mu_1 = 0.35$

$z = H = 42'$ $\frac{B_1}{2} = \frac{7.5}{42} = 0.179$ $\frac{B_2}{2} = \frac{24.5}{42} = 0.583$ $I = 0.26$

$\Delta p = (2)(0.26)(1017\ psf)$ $\Delta p = 528.84\ psf$

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 6 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPK 9 May 07 REF DRAWING NO.

Estimated time rate of consolidation for Dredge Material & Foundation

$t_{90} = \frac{0.848\ h^2}{c_v}$ Assume double drainage $H_e = \frac{H}{2} = \frac{16'}{2} = 8' \rightarrow 96$ inches

$c_v = 1.16 \times 10^{-5}\ in^2/sec$ $t_{90} = \frac{0.848 \cdot (96\ in)^2}{1.16 \times 10^{-5}\ \frac{in^2}{sec}} \cdot \left(1.16 \times 10^{-5}\ \frac{day}{sec} \cdot \frac{1\ yr}{365\ day}\right)$

$t_{90} = 21.4$ yrs dredge material

Foundation $H_e = \frac{28}{2} = 14' \rightarrow 168$ inches $c_v = 1.16 \times 10^{-5}\ in^2/sec$

$t_{90} = \frac{0.848\ (168\ in)^2}{1.16 \times 10^{-5}\ in^2/sec} \left(1.16 \times 10^{-5}\ \frac{day}{sec} \cdot \frac{1\ yr}{365\ day}\right)$ $t_{90} = 65.6$ yrs foundation

Time factor @ 20 years

$t = 20$ yrs $T_v = \frac{t \cdot c_v}{(H_e)^2} = \frac{20\ yr \cdot 1.16 \times 10^{-5}\ \frac{in^2}{sec} \cdot 86400\ \frac{sec}{day} \cdot \frac{365\ day}{1\ yr}}{(96\ in)^2} = \frac{7316.4\ in}{(96\ in)^2}$

$T_v = 0.794$ dredge material

$T_v = \frac{7316.4\ in^2}{(168\ in)^2} = 0.259$ foundation

Approximate % consolidation @ 20 yrs From Graph 2

dredge material % consolidated at time factor $(T_v) = 0.794$

COMPUTATION SHEET

PROJECT Milwaukee COF (DMMP) SHEET NO. 7 OF 7 SHEETS

ITEM Estimated Settlement Calculations DATE

SUBJECT FILE

COMPUTED BY SAW CHECKED BY JPK 9May07 REF DRAWING NO.

U = 88 % dredge material

foundation % consolidated at time factor (T_v) = 0.259

U = 58 % foundation

Approximate settlement of material @ 20 yrs

ultimate settlement dredge material = 6.38 ft

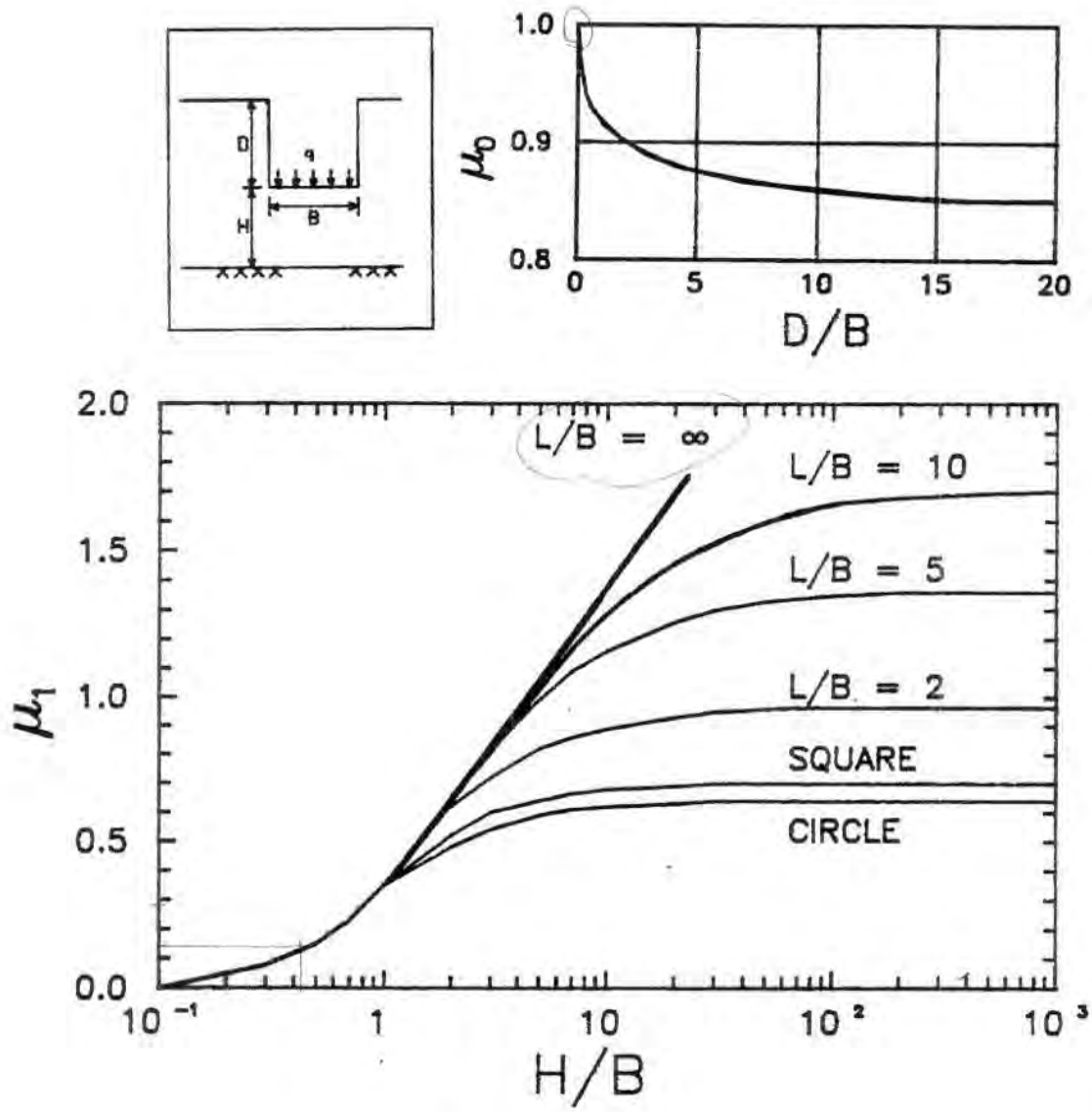
" " foundation = 0.69 ft

Approx. settlement (@ 20 yrs) = $\left(6.38' \cdot \frac{88}{100}\right) + \left(0.69' \cdot \frac{58}{100}\right)$

= 6.01 ft

Total settlement of dredge material + fdn

= 6.38' + 0.69' = 7.07 ft



$$\rho_i = \mu_o \cdot \mu_1 \cdot \frac{q \cdot B}{E_s^*}$$

L = LENGTH, FT
B = WIDTH, FT
E_s^* = EQUIVALENT YOUNG'S SOIL MODULUS, TSF
ν_s = POISSON'S RATIO, 0.5

Figure 3-8. Chart for estimating immediate settlement in cohesive soil. Reprinted by permission of the National Research Council of Canada from Canadian Geotechnical Journal, Vol 15, 1978, "Janbu, Bjerrum, and Kjaernsli's Chart Reinterpreted", by J. T. Christian and W. D. Carrier III, p 127.

APPENDIX B
COST ENGINEERING REPORT
FOR THE
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)
MILWAUKEE HARBOR, WISCONSIN

APPENDIX B
COST ENGINEERING REPORT
FOR THE
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)
MILWAUKEE HARBOR, WISCONSIN

1. Introduction

1.1 Milwaukee Harbor is located on the west shore of Lake Michigan in the City of Milwaukee, Wisconsin which is about 85 miles north of Chicago, Illinois, and approximately 83 miles west of Grand Haven, Michigan. Milwaukee Harbor is a deep draft harbor at the confluence of the Milwaukee River and the Kinnickinnic River. The Milwaukee Harbor has two segments which consists of an outer and inner harbor. The existing 44 acre Jones Island Confined Disposal Facility (CDF) was completed in 1975. This facility was authorized by the Chief of Engineers, U.S. Army Corps of Engineers, under Section 123 of the River and Harbor Act of 1970 (Title I of Public Law 91-611). Under the Dredged Material Management Plan (DMMP) program for which this project is being proposed, the new facility will be referred to as the Dredged Material Disposal Facility (DMDF)

1.2. DMMP Alternatives In the final development of dredged material management plans for material dredged from the Milwaukee Harbor, two alternative plans identified are:

a. **Alternative 1 – Construct a new DMDF on top of the Jones Island (Milwaukee Harbor) CDF.**

This alternative consists of the existing dredged material within the DMDF being excavated and used in the construction of the new dikes at the facility. The excavated material will be placed along the entire perimeter of the Milwaukee DMDF (excluding the area previously developed and being used as a ferry docking facility by the Port of Milwaukee) for construction of the inner perimeter dikes to an elevation of 618.00 as referred to L.W.D. for Lake Michigan. The new inner perimeter dikes will be offset approximately 50 -75 feet from the existing perimeter dikes and SSP wall on the west side of the facility. The dikes will have side slopes of 3H:1V with a top width of 15 feet, and the north and east lake side perimeter dikes will be faced with 200-500 pound stone for wave-erosion protection. A one foot thick layer of crushed aggregate will be placed on top of the ramp located on the Southwest corner and the dikes to facilitate truck traffic on the dikes. The additional capacity created by construction of the new dikes will be approximately 510,000 CYDs.

b. Alternative 2 – Open Water Placement.

This alternative consists of an open water disposal site which is approximately 8 miles southeast from the Milwaukee Harbor entrance. Approximately 510,000 CYDs of dredged material will be transported by barges. The range of depths at the proposed open water site are approximately 75-100 feet. A cover is required due to the character of material "fine grain" with contaminates (PCB's, PAH's & Metals). A cover area of 1800 ft x 1420 ft x 3 ft cap thickness is required. Approximately 284,000 CY of capping material will be required. This alternative would include double handling, transport of cap matetial from the quarry to the dock and then placing on barge, and bottom scow dumping at the site.

2. Purpose and Scope of Cost Engineering Appendix

2.1. The purpose of this appendix is to present the cost estimates associated with the two alternative plans identified in the preceding paragraphs. It is prepared in accordance with National Harbors Program: Dredged Material Management Plan, "EC 1165-2-200", policy, dated 21 July 1994.

Excel is used to present the alternative cost estimates in this appendix.

3. Alternative Cost Estimates

3.1. Construction quantities in the technical appendix are used in the cost estimates presented in this appendix. Additional quantities and features that should be considered for each alternative have been computed by the cost engineering personnel and included in the cost estimate. The quantities are, therefore, substantially complete from the standpoint of biddability, constructibility, and operability of each alternative. (See Table 1)

3.2. As part of the risk analysis (range estimating), contingencies are included to identify the high range of each line item in the estimates. These contingencies are based on a percentage of the total estimated cost for each line item. A 15 percent contingency is used for items in the estimate based on the nature of the engineering and design details and quantity take-offs currently available and experience in implementing these specific line items. Other contingency percent rates used for specific items reflect the reliability of specific engineering, design, and other details available at this time.

Cost Tracking System

DMMP Current Working Estimate

Harbor/River: Milwaukee DMDF Expansion
State: Wisconsin
Project Name: Milwaukee DMDF Expansion
(Describe) : Construct new interior perimiter berms

Date of Estimate: 5 November 2007
EPD:September 2010

CWBS No.	Bid Item No.	Description of Features/Sub-Features	ALT 1 DMDF Expansion Quantity	UOM	U.P.	Estimate	ALT 2 Open Lake Placement w/Cap Quantity	UOM	U.P.	Estimate
		Construction								
		Mobilization & Demobilization	1	LS	$145,000	$145,000	1	LS	$145,000	$145,000
		Compacted Fill	71,000	CY	$11.47	$814,370				
		Riprap - Armor Stone	10,500	TN	$69.64	$731,220				
		Crushed Aggregate	5,000	CY	$36.28	$181,400				
		Geotextile	20,000	SY	$4.11	$82,200				
		Portland Cement	703	TN	$178.61	$125,563				
		Site Restoration	1	LS	$14,500	$14,500				
		Load &Transport Material in Cell	71,000	CY	$10.86	$771,060				
		Transport Dredged Material by Barge					500,000	CY	$2.49	$1,245,000
		Buy & Truck Cap Sand Pit to Dock					284,000	CY	$21.67	$6,154,280
		Barge Cap Sand, Dock to Placement Site					284,000	CY	$2.49	$707,160
		Total Construction				$2,865,313				$8,251,440
		Escalation to FY2009 (QTR1) - 1.021%				$2,925,484				$8,424,720
		Escalation to FY2010 (QTR1) - 1.021%				$2,986,920				$8,601,639
		Escalation to FY2011 (QTR1) - 1.021%				$3,049,645				$8,782,274
		Engineering & Design	6	%		$171,900	6	%		$495,100
		S&A	9	%		$257,900	9	%		$742,600
		Contracting & Award	1	LS	$10,000	$10,000	1	LS	$10,000	$10,000
		EDDC	1	%		$28,700	1	%		$82,500
		Subtotal Non-Construction				$468,500				$1,330,200
		Contigency	15	%		$70,300	15	%		$199,500
		Total Non-Construction				$538,800				$1,529,700
		Annual O & M	20	YR	$12,000	$240,000	20	YR	$12,000	$240,000
		TOTAL PROJECT				$3,644,113				$10,021,140

1. Contingency and other markups are included in the unit cost.
2. Non Construction Cost are for the first year only and not escalated
3. Transport Dredged Material by Barge is the cost difference between placement in CDF and Open Water placement.

See below for additional description.

Recommended Program Amount

Prepared By: Sheetal Malhotra
Civil Engineer

Coordinated W/ Kerry Williams
Civil Engineer

Recommended Program Amount

Approval Recommended By:
William D. Merte, P.E.
Chief, Const., Cost & General Branch

Approved By:
David L. Schweiger, P.E.
Chief, Engineering Design & Const. Office

Estimated by	Kerry Williams
Designed by	Kerry Williams
Prepared by	Sheetal Malhotra
Preparation Date	11/5/2007
Effective Date of Pricing	11/5/2007
Estimated Construction Time	Days

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Right click here and select "Update Field" to build the Table of Contents for this report.

Date	Author	Note
11/5/2007	Sheetal Malhotra	Alternative 1 – Construct new interior perimeter berms. Materials for new berm construction would be obtained from suitable borrow areas located within the site. It is assumed that material will be excavated with backhoes from the interior borrow areas, loaded into trucks, transported, stabilized with Portland cement if necessary, and compacted along the perimeter of the DMDF. The exterior of the berms on the north and east sides will be protected by 200 lb – 500 lb stone. A woven geotextile will be placed underneath the stone for filtration and drainage. Crushed aggregate road with a geotextile underlayment will be constructed on top of the new berms. The placement of dredged materials into the expanded DMDF would be by mechanical methods, anticipated to be dredged materials transported by barges and offloaded by a clamshell bucket crane. Alternative 2 – Open Water Placement. Approximately 510,000 CYs of dredged material will be transported by barges to an open water disposal site approximately 8 miles southeast of the Milwaukee Harbor. After open water placement, a sand cover approximately 3 foot thick is required due to the character of material “fine grain” with contaminates (PCB’s PAH’s & Metals). Approximately 284,000 CY of capping material will be required. Material from a local source would involve trucking it from a local gravel pit to a transfer dock facility, and then barging the material out to the open-lake placement site for placement over the dredged material. This would include double handling, transport of cap material from the quarry to the dock and then placing on barge, and bottom scow dumping at the site. 20% Contingency is applied.

Direct Cost Markups	Category	Method
Productivity	Productivity	Productivity
Overtime	Overtime	Overtime

	Days/Week	Hours/Shift	Shifts/Day	1st Shift	2nd Shift	3rd Shift
Standard	*5.00*	*8.00*	*1.00*	*8.00*	*0.00*	*0.00*
Actual	*5.00*	*8.00*	*1.00*	*8.00*	*0.00*	*0.00*

Day	*OT Factor*	*Working*	*OT Percent*	*FCCM Percent*
Monday	*1.50*	*Yes*	*0.00*	*0.00*
Tuesday	*1.50*	*Yes*		
Wednesday	*1.50*	*Yes*		
Thursday	*1.50*	*Yes*		
Friday	*1.50*	*Yes*		
Saturday	*1.50*	*No*		
Sunday	*2.00*	*No*		

Sales Tax	TaxAdj	Running % on Selected Costs
MatlCost		

Contractor Markups	Category	Method
JOOH	JOOH	Running %
HOOH	HOOH	Running %
Profit	Profit	Running %
Bond	Bond	Running %
Excise Tax	Excise	Running %

Owner Markups	Category	Method
Escalation	Escalation	Escalation

StartDate	StartIndex	EndDate	EndIndex	Escalation
10/11/2007	*0.00*	*10/11/2007*	*0.00*	*0.00*

Contingency	Contingency	Running %
SIOH	SIOH	Running %

Description	Quantity	UOM	LaborCost	MatlCost	EQCost	DirectCost	SubCMU	CostToPrime	ProjectCost
Direct Costs			**1,830,257.13**	**2,504,111.36**	**2,658,158.35**	**7,665,831.56**	**0.00**	**7,665,831.56**	**11,117,545.47**
			1,830,257.13	*2,504,111.36*	*2,658,158.35*	*7,665,831.56*		*7,665,831.56*	*11,117,545.47*
12 Navigation Ports & Harbors	**1.0**	**EA**	**1,830,257.13**	**2,504,111.36**	**2,658,158.35**	**7,665,831.56**	**0.00**	**7,665,831.56**	**11,117,545.47**
			1,830,257.13	*2,504,111.36*	*2,658,158.35*	*7,665,831.56*		*7,665,831.56*	*11,117,545.47*
1202 Harbors	**1.0**	**EA**	**1,830,257.13**	**2,504,111.36**	**2,658,158.35**	**7,665,831.56**	**0.00**	**7,665,831.56**	**11,117,545.47**
			541,451.78	*516,111.36*	*682,983.47*	*1,975,928.88*		*1,975,928.88*	*2,865,635.52*
Alternative 1 - DMDF Expansion	**1.0**	**EA**	**541,451.78**	**516,111.36**	**682,983.47**	**1,975,928.88**	**0.00**	**1,975,928.88**	**2,865,635.52**
			0.00	*0.00*	*0.00*	*100,000.00*		*100,000.00*	*145,027.26*
120201 Mob, Demob & Preparatory Work	**1.0**	**EA**	**0.00**	**0.00**	**0.00**	**100,000.00**	**0.00**	**100,000.00**	**145,027.26**
RSM 023252500100 Mobilization and demobilization, add to below, maximum	1.0	LS	0.00	0.00	0.00	100,000.00	0.00	100,000.00	145,027.26
			541,451.78	*516,111.36*	*682,983.47*	*1,875,928.88*		*1,875,928.88*	*2,720,608.26*
120220 Disposal Areas	**1.0**	**EA**	**541,451.78**	**516,111.36**	**682,983.47**	**1,875,928.88**	**0.00**	**1,875,928.88**	**2,720,608.26**
			541,451.78	*516,111.36*	*682,983.47*	*1,875,928.88*		*1,875,928.88*	*2,720,608.26*
12022002 Site Work	**1.0**	**EA**	**541,451.78**	**516,111.36**	**682,983.47**	**1,875,928.88**	**0.00**	**1,875,928.88**	**2,720,608.26**
			541,451.78	*516,111.36*	*682,983.47*	*1,865,928.88*		*1,865,928.88*	*2,706,105.53*
12022002 01 Dike Construction	**1.0**	**EA**	**541,451.78**	**516,111.36**	**682,983.47**	**1,865,928.88**	**0.00**	**1,865,928.88**	**2,706,105.53**
			0.49	*0.00*	*0.66*	*1.24*		*1.24*	*1.80*
HNC 023153105900 Compaction, of backfill, structural, 6" lifts, self propelled roller	71,000.0	ECY	34,971.28	0.00	46,599.04	88,057.82	0.00	88,057.82	127,707.84
			1.00	*31.45*	*1.46*	*35.66*		*35.66*	*51.71*
RSM 023704500370 Rip-rap, random, broken stone, 300 lb. average, dumped (Note: Riprap price used from FY07 Milwaukee Stone Purchase project. Material only.)	10,500.0	TON	10,448.20	330,225.00	15,281.80	374,406.14	0.00	374,406.14	542,990.97
			0.49	*0.00*	*0.66*	*1.24*		*1.24*	*1.80*
HNC 023153105900 Compaction, of gravel, structural, 6" lifts, self propelled roller	5,000.0	ECY	2,462.77	0.00	3,281.62	6,201.25	0.00	6,201.25	8,993.51
			0.90	*1.65*	*0.03*	*2.83*		*2.83*	*4.11*
HTW 026203000114 Geotextile Fabric, 170 Mil Thick Non-Woven Polypropylene	20,000.0	SY	18,049.78	33,000.00	629.21	56,693.31	0.00	56,693.31	82,220.76
			1.79	*0.00*	*2.59*	*4.72*		*4.72*	*6.84*
RSM 020551500200 Common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	71,000.0	CY	127,340.87	0.00	184,176.18	334,923.14	0.00	334,923.14	485,729.85
			1.79	*18.15*	*2.59*	*23.77*		*23.77*	*34.48*
RSM 020601500100 Bank run gravel, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	5,000.0	CY	8,967.67	90,750.00	12,970.15	118,873.64	0.00	118,873.64	172,399.18
			0.00	*4.42*	*0.00*	*4.64*		*4.64*	*6.73*
RSM 030602000300 Cement, portland, type I, bulk, includes material only	14,058.0	CWT	0.00	62,136.36	0.00	65,243.18	0.00	65,243.18	94,620.39
			0.37	*0.00*	*0.83*	*1.27*		*1.27*	*1.84*

Description	Quantity	UOM	LaborCost	MatlCost	EQCost	DirectCost	SubCMU	CostToPrime	ProjectCost
HNC 023154260185 Excavate and load, bank measure, wet material, 5 C.Y. bucket, hydraulic excavator	71,000.0	BCY	26,269.18	0.00	59,201.39	90,322.32	0.00	90,322.32	130,991.99
			1.73	*0.00*	*0.00*	*2.05*		*2.05*	*2.97*
USR 033107002901 Mixing , placing portland cement, direct chute, over 20 C.Y., includes vibrating, excludes material	10,414.0	CY	18,000.15	0.00	0.00	21,337.16	0.00	21,337.16	30,944.69
			0.43	*0.00*	*1.44*	*1.95*		*1.95*	*2.83*
USR 023402001390 Soil stabilization, includes scarifying	71,000.0	ECY	30,770.75	0.00	102,092.07	138,579.30	0.00	138,579.30	200,977.76
			9.69	*0.00*	*15.55*	*27.04*		*27.04*	*39.21*
USR 023704500101 Rip-rap, random, machine placed for slope protection (Note: Armor Stone = 129978 cf / 27 = 4800 cy)	4,800.0	LCY	46,513.55	0.00	74,620.34	129,775.35	0.00	129,775.35	188,209.63
			3.07	*0.00*	*2.59*	*6.22*		*6.22*	*9.02*
RSM 023154900100 Hauling, excavated or borrow material, loose cubic yards, 2 mile round trip, 2.6 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading	71,000.0	LCY	217,657.60	0.00	184,131.67	441,516.28	0.00	441,516.28	640,318.96
			0.00	*0.00*	*0.00*	*10,000.00*		*10,000.00*	*14,502.73*
12022002 02 Restoration	**1.0**	**EA**	**0.00**	**0.00**	**0.00**	**10,000.00**	**0.00**	**10,000.00**	**14,502.73**
USR 023252500101 Site Restoration	1.0	LS	0.00	0.00	0.00	10,000.00	0.00	10,000.00	14,502.73
			1,288,805.35	*1,988,000.00*	*1,975,174.88*	*5,689,902.68*		*5,689,902.68*	*8,251,909.95*
Alternative 2 - Open Lake Placement W/Cap	**1.0**	**EA**	**1,288,805.35**	**1,988,000.00**	**1,975,174.88**	**5,689,902.68**	**0.00**	**5,689,902.68**	**8,251,909.95**
			0.00	*0.00*	*0.00*	*100,000.00*		*100,000.00*	*145,027.26*
120201 Mob, Demob & Preparatory Work	**1.0**	**EA**	**0.00**	**0.00**	**0.00**	**100,000.00**	**0.00**	**100,000.00**	**145,027.26**
RSM 023252500100 Mobilization and demobilization, add to below, maximum	1.0	LS	0.00	0.00	0.00	100,000.00	0.00	100,000.00	145,027.26
			1,288,805.35	*1,988,000.00*	*1,975,174.88*	*5,589,902.68*		*5,589,902.68*	*8,106,882.69*
120215 Mechanical Dredging	**1.0**	**EA**	**1,288,805.35**	**1,988,000.00**	**1,975,174.88**	**5,589,902.68**	**0.00**	**5,589,902.68**	**8,106,882.69**
			1,288,805.35	*1,988,000.00*	*1,975,174.88*	*5,589,902.68*		*5,589,902.68*	*8,106,882.69*
12021502 Site Work	**1.0**	**EA**	**1,288,805.35**	**1,988,000.00**	**1,975,174.88**	**5,589,902.68**	**0.00**	**5,589,902.68**	**8,106,882.69**
			1,288,805.35	*1,988,000.00*	*1,975,174.88*	*5,589,902.68*		*5,589,902.68*	*8,106,882.69*
12021502 01 Excavation and Disposal	**1.0**	**EA**	**1,288,805.35**	**1,988,000.00**	**1,975,174.88**	**5,589,902.68**	**0.00**	**5,589,902.68**	**8,106,882.69**
			2.69	*7.00*	*3.89*	*14.43*		*14.43*	*20.92*
USR 020551500201 Sand, stockpiling with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction (Note: Fill sand quote from Michaels Materials is $3/cy for material and $4/cy for trucking to dock. Michaels Materials is located in Waterloo, WI (Contact Steve Hollis (920) 478-2084)))	284,000.0	CY	764,045.20	1,988,000.00	1,105,057.07	4,096,938.83	0.00	4,096,938.83	5,941,678.13
			0.18	*0.00*	*0.31*	*0.52*		*0.52*	*0.75*
USR 023152104080 Loading Material on barge	284,000.0	BCY	50,573.85	0.00	86,945.57	146,901.35	0.00	146,901.35	213,047.00
			0.60	*0.00*	*1.00*	*1.72*		*1.72*	*2.49*
Transport Dredged Material by barge	**500,000.0**	**CY**	**302,310.75**	**0.00**	**499,300.35**	**858,163.05**	**0.00**	**858,163.05**	**1,244,570.36**
			135.87	*0.00*	*224.40*	*385.69*		*385.69*	*559.36*
USR Marine Crew Barge Material to site (Note: assume 75 % full 1500 cy * 0.75 = 1125 cy 500000 cy / 1125 cy = 445 trips assume 3 miles per hour, site is approximately 8 miles away, round trip 16 miles (16 miles/3 miles per hour = 5 hrs per trip) 445 trips * 5 hrs per trip = 2225 hours)	2,225.0	HR	302,310.75	0.00	499,300.35	858,163.05	0.00	858,163.05	1,244,570.36
			0.61	*0.00*	*1.00*	*1.72*		*1.72*	*2.49*

Description	Quantity	UOM	LaborCost	MatlCost	EQCost	DirectCost	SubCMU	CostToPrime	ProjectCost
Barge Cap Sand, dock to placement site	**284,000.0**	**CY**	**171,875.55**	**0.00**	**283,871.88**	**487,899.44**	**0.00**	**487,899.44**	**707,587.19**
			135.87	*0.00*	*224.40*	*385.69*		*385.69*	*559.36*
USR Marine Crew Barge Material to site	1,265.0	HR	171,875.55	0.00	283,871.88	487,899.44	0.00	487,899.44	707,587.19

(Note: assume 75 % full 1500 cy * 0.75 = 1125 cy 284000 cy / 1125 cy = 253 trips assume 3 miles per hour, site is approximately 8 miles away, round trip 16 miles (16 miles/3 miles per hour = 5 hrs per trip) 253 trips * 5 hrs per trip = 1265 hours)

Description	UOM	Quantity	Overtime	Profit	JOOH	HOOH	Bond	SmallTools	SubCMU	PrimeCMU
Overhead			**0.00**	**676,126.34**	**383,291.58**	**402,456.16**	**136,915.58**	**0.00**	**0.00**	**1,598,789.66**
			0.00%							
12 Navigation Ports & Harbors	**EA**	**1.0**	**0.00**	**676,126.34**	**383,291.58**	**402,456.16**	**136,915.58**	**0.00**	**0.00**	**1,598,789.66**
			0.00%							
1202 Harbors	**EA**	**1.0**	**0.00**	**676,126.34**	**383,291.58**	**402,456.16**	**136,915.58**	**0.00**	**0.00**	**1,598,789.66**
			0.00%							
Alternative 1 - DMDF Expansion	**EA**	**1.0**	**0.00**	**174,276.93**	**98,796.44**	**103,736.27**	**35,291.08**	**0.00**	**0.00**	**412,100.72**
			0.00%							
120201 Mob, Demob & Preparatory Work	**EA**	**1.0**	**0.00**	**8,820.00**	**5,000.00**	**5,250.00**	**1,786.05**	**0.00**	**0.00**	**20,856.05**
RSM 023252500100 Mobilization and demobilization, add to below, maximum	LS	1.0	0.00	8,820.00	5,000.00	5,250.00	1,786.05	0.00	0.00	20,856.05
			0.00%							
120220 Disposal Areas	**EA**	**1.0**	**0.00**	**165,456.93**	**93,796.44**	**98,486.27**	**33,505.03**	**0.00**	**0.00**	**391,244.67**
			0.00%							
12022002 Site Work	**EA**	**1.0**	**0.00**	**165,456.93**	**93,796.44**	**98,486.27**	**33,505.03**	**0.00**	**0.00**	**391,244.67**
			0.00%							
12022002 01 Dike Construction	**EA**	**1.0**	**0.00**	**164,574.93**	**93,296.44**	**97,961.27**	**33,326.42**	**0.00**	**0.00**	**389,159.06**
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
HNC 023153105900 Compaction, of backfill, structural, 6" lifts, self propelled roller	ECY	71,000.0	0.00	7,766.70	4,402.89	4,623.04	1,572.76	0.00	0.00	18,365.38
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
RSM 023704500370 Rip-rap, random, broken stone, 300 lb. average, dumped (Note: Riprap price used from FY07 Milwaukee Stone Purchase project. Material only.)	TON	10,500.0	0.00	33,022.62	18,720.31	19,656.32	6,687.08	0.00	0.00	78,086.33
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
HNC 023153105900 Compaction, of gravel, structural, 6" lifts, self propelled roller	ECY	5,000.0	0.00	546.95	310.06	325.57	110.76	0.00	0.00	1,293.34
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
HTW 026203000114 Geotextile Fabric, 170 Mil Thick Non-Woven Polypropylene	SY	20,000.0	0.00	5,000.35	2,834.67	2,976.40	1,012.57	0.00	0.00	11,823.99
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
RSM 020551500200 Common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	CY	71,000.0	0.00	29,540.22	16,746.16	17,583.46	5,981.89	0.00	0.00	69,851.74
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
RSM 020601500100 Bank run gravel, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	CY	5,000.0	0.00	10,484.65	5,943.68	6,240.87	2,123.14	0.00	0.00	24,792.35
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
RSM 030602000300 Cement, portland, type I, bulk, includes material only	CWT	14,058.0	0.00	5,754.45	3,262.16	3,425.27	1,165.28	0.00	0.00	13,607.15
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		

Description	UOM	Quantity	Overtime	Profit	JOOH	HOOH	Bond	SmallTools	SubCMU	PrimeCMU
HNC 023154260185 Excavate and load, bank measure, wet material, 5 C.Y. bucket, hydraulic excavator	BCY	71,000.0	0.00	7,966.43	4,516.12	4,741.92	1,613.20	0.00	0.00	18,837.67
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
USR 033107002901 Mixing , placing portland cement, direct chute, over 20 C.Y., includes vibrating, excludes material	CY	10,414.0	0.00	1,881.94	1,066.86	1,120.20	381.09	0.00	0.00	4,450.09
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
USR 023402001390 Soil stabilization, includes scarifying	ECY	71,000.0	0.00	12,222.69	6,928.97	7,275.41	2,475.10	0.00	0.00	28,902.17
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
USR 023704500101 Rip-rap, random, machine placed for slope protection (Note: Armor Stone = 129978 cf / 27 = 4800 cy)	LCY	4,800.0	0.00	11,446.19	6,488.77	6,813.21	2,317.85	0.00	0.00	27,066.01
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
RSM 023154900100 Hauling, excavated or borrow material, loose cubic yards, 2 mile round trip, 2.6 loads/hour, 6 C.Y. dump truck, highway haulers, excludes loading	LCY	71,000.0	0.00	38,941.74	22,075.81	23,179.60	7,885.70	0.00	0.00	92,082.86
			0.00%							
12022002 02 Restoration	**EA**	**1.0**	**0.00**	**882.00**	**500.00**	**525.00**	**178.61**	**0.00**	**0.00**	**2,085.61**
USR 023252500101 Site Restoration	LS	1.0	0.00	882.00	500.00	525.00	178.61	0.00	0.00	2,085.61
			0.00%							
Alternative 2 - Open Lake Placement W/Cap	**EA**	**1.0**	**0.00**	**501,849.42**	**284,495.13**	**298,719.89**	**101,624.51**	**0.00**	**0.00**	**1,186,688.95**
			0.00%							
120201 Mob, Demob & Preparatory Work	**EA**	**1.0**	**0.00**	**8,820.00**	**5,000.00**	**5,250.00**	**1,786.05**	**0.00**	**0.00**	**20,856.05**
RSM 023252500100 Mobilization and demobilization, add to below, maximum	LS	1.0	0.00	8,820.00	5,000.00	5,250.00	1,786.05	0.00	0.00	20,856.05
			0.00%							
120215 Mechanical Dredging	**EA**	**1.0**	**0.00**	**493,029.42**	**279,495.13**	**293,469.89**	**99,838.46**	**0.00**	**0.00**	**1,165,832.90**
			0.00%							
12021502 Site Work	**EA**	**1.0**	**0.00**	**493,029.42**	**279,495.13**	**293,469.89**	**99,838.46**	**0.00**	**0.00**	**1,165,832.90**
			0.00%							
12021502 01 Excavation and Disposal	**EA**	**1.0**	**0.00**	**493,029.42**	**279,495.13**	**293,469.89**	**99,838.46**	**0.00**	**0.00**	**1,165,832.90**
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
USR 020551500201 Sand, stockpiling with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction (Note: Fill sand quote from Michaels Materials is $3/cy for material and $4/cy for trucking to dock. Michaels Materials is located in Waterloo, WI (Contact Steve Hollis (920) 478-2084)))	CY	284,000.0	0.00	361,350.01	204,846.94	215,089.29	73,173.38	0.00	0.00	854,459.61
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
USR 023152104080 Loading Material on barge	BCY	284,000.0	0.00	12,956.70	7,345.07	7,712.32	2,623.73	0.00	0.00	30,637.82
			0.00%							
Transport Dredged Material by barge	**CY**	**500,000.0**	**0.00**	**75,689.98**	**42,908.15**	**45,053.56**	**15,327.22**	**0.00**	**0.00**	**178,978.92**
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
USR Marine Crew Barge Material to site (Note: assume 75 % full 1500 cy * 0.75 = 1125 cy 500000 cy / 1125 cy = 445 trips assume 3 miles per hour, site is approximately 8 miles away, round trip 16 miles (16 miles/3 miles per hour = 5 hrs per trip) 445 trips * 5 hrs per trip = 2225 hours)	HR	2,225.0	0.00	75,689.98	42,908.15	45,053.56	15,327.22	0.00	0.00	178,978.92

Description	UOM	Quantity	Overtime	Profit	JOOH	HOOH	Bond	SmallTools	SubCMU	PrimeCMU
			0.00%							
Barge Cap Sand, dock to placement site	**CY**	**284,000.0**	**0.00**	**43,032.73**	**24,394.97**	**25,614.72**	**8,714.13**	**0.00**	**0.00**	**101,756.55**
			0.00%	*8.00%*	*5.00%*	*5.00%*	*1.50%*	*0.00%*		
USR Marine Crew Barge Material to site	HR	1,265.0	0.00	43,032.73	24,394.97	25,614.72	8,714.13	0.00	0.00	101,756.55

(Note: assume 75 % full 1500 cy * 0.75 = 1125 cy 284000 cy / 1125 cy = 253 trips assume 3 miles per hour, site is approximately 8 miles away, round trip 16 miles (16 miles/3 miles per hour = 5 hrs per trip) 253 trips * 5 hrs per trip = 1265 hours)

Description	ManHours	BaseWage	TaxableFringe	WCI	NonTaxFringe	Total
Labor Rates	**49,266.9**	**1,325,868.56**	**458,611.68**	**75,959.01**	**45,776.89**	**2,168,356.28**
12 Navigation Ports & Harbors	**49,266.9**	**1,325,868.56**	**458,611.68**	**75,959.01**	**45,776.89**	**2,168,356.28**
1202 Harbors	**49,266.9**	**1,325,868.56**	**458,611.68**	**75,959.01**	**45,776.89**	**2,168,356.28**
Alternative 1 - DMDF Expansion	**14,116.1**	**385,950.35**	**141,385.31**	**22,111.09**	**14,116.12**	**641,028.48**
120220 Disposal Areas	**14,116.1**	**385,950.35**	**141,385.31**	**22,111.09**	**14,116.12**	**641,028.48**
12022002 Site Work	**14,116.1**	**385,950.35**	**141,385.31**	**22,111.09**	**14,116.12**	**641,028.48**
12022002 01 Dike Construction	**14,116.1**	**385,950.35**	**141,385.31**	**22,111.09**	**14,116.12**	**641,028.48**
		29.37	*10.74*		*1.00*	*48.68*
RSM B-CEMTFINR Cement Finishers	238.0	6,991.07	2,556.49	400.52	238.03	11,588.64
		30.54	*10.05*		*1.00*	*49.30*
RSM B-EQOPRCRN Equip. Operators, Crane/Shovel	947.7	28,942.10	9,524.17	1,658.09	947.68	46,722.74
		39.66	*10.05*		*1.00*	*60.28*
RSM B-EQOPRLT Equip. Operators, Light	163.2	6,473.24	1,640.34	370.85	163.22	9,839.54
		30.07	*10.05*		*1.00*	*48.74*
RSM B-EQOPRMED Equip. Operators, Medium	2,126.6	63,946.22	21,372.12	3,663.48	2,126.58	103,641.66
		27.37	*10.05*		*1.00*	*45.49*
RSM B-EQOPROIL Equip. Operators, Oilers	328.3	8,986.22	3,299.65	514.82	328.32	14,933.81
		25.56	*6.95*		*1.00*	*39.75*
RSM B-LABORER Laborers, (Semi-Skilled)	1,945.0	49,713.72	13,517.62	2,848.10	1,944.98	77,313.11
		26.56	*6.95*		*1.00*	*40.95*
RSM B-LABORER Laborers, (Semi-Skilled)	497.4	13,211.51	3,457.08	756.89	497.42	20,371.51
		26.39	*10.93*		*1.00*	*45.31*
RSM B-TRKDVRHV Truck Drivers, Heavy	7,869.9	207,686.27	86,017.84	11,898.35	7,869.89	356,617.48
Alternative 2 - Open Lake Placement W/Cap	**35,150.8**	**939,918.21**	**317,226.37**	**53,847.91**	**31,660.77**	**1,527,327.80**
120215 Mechanical Dredging	**35,150.8**	**939,918.21**	**317,226.37**	**53,847.91**	**31,660.77**	**1,527,327.80**
12021502 Site Work	**35,150.8**	**939,918.21**	**317,226.37**	**53,847.91**	**31,660.77**	**1,527,327.80**
12021502 01 Excavation and Disposal	**35,150.8**	**939,918.21**	**317,226.37**	**53,847.91**	**31,660.77**	**1,527,327.80**
		30.07	*10.05*		*1.00*	*48.74*
RSM B-EQOPRMED Equip. Operators, Medium	6,553.8	197,074.15	65,866.15	11,290.38	6,553.85	319,410.46
		25.56	*6.95*		*1.00*	*39.75*
RSM B-LABORER Laborers, (Semi-Skilled)	3,276.9	83,758.15	22,774.62	4,798.50	3,276.92	130,257.86
		26.39	*10.93*		*1.00*	*45.31*
RSM B-TRKDVRHV Truck Drivers, Heavy	11,360.0	299,790.40	124,164.80	17,174.99	11,360.00	514,769.21
Transport Dredged Material by barge	**8,900.0**	**229,063.75**	**66,572.00**	**13,123.06**	**6,675.00**	**358,862.70**
		19.95	*2.87*		*0.00*	*27.32*
HNC FC-ENGQC Engineers, Quality Control (Note: Assumed a Occupation Code of #29086 Engineer Technician III)	2,225.0	44,388.75	6,385.75	2,543.03	0.00	60,776.31
		30.07	*10.05*		*1.00*	*48.74*
RSM X-EQOPRMED Outside Equip. Operators, Medium	2,225.0	66,905.75	22,361.25	3,833.03	2,225.00	108,438.35
		27.37	*10.05*		*1.00*	*45.49*
RSM X-EQOPROIL Outside Equip. Oilers	2,225.0	60,898.25	22,361.25	3,488.86	2,225.00	101,204.18
		25.56	*6.95*		*1.00*	*39.75*
RSM X-LABORER Outside Laborers, (Semi-Skilled)	2,225.0	56,871.00	15,463.75	3,258.14	2,225.00	88,443.86

Description	ManHours	BaseWage	TaxableFringe	WCI	NonTaxFringe	Total
Barge Cap Sand, dock to placement site	**5,060.0**	**130,231.75**	**37,848.80**	**7,460.98**	**3,795.00**	**204,027.56**
		19.95	*2.87*		*0.00*	*27.32*
HNC FC-ENGQC Engineers, Quality Control (Note: Assumed a Occupation Code of #29086 Engineer Technician III)	1,265.0	25,236.75	3,630.55	1,445.81	0.00	34,553.72
		30.07	*10.05*		*1.00*	*48.74*
RSM X-EQOPRMED Outside Equip. Operators, Medium	1,265.0	38,038.55	12,713.25	2,179.23	1,265.00	61,651.47
		27.37	*10.05*		*1.00*	*45.49*
RSM X-EQOPROIL Outside Equip. Oilers	1,265.0	34,623.05	12,713.25	1,983.55	1,265.00	57,538.56
		25.56	*6.95*		*1.00*	*39.75*
RSM X-LABORER Outside Laborers, (Semi-Skilled)	1,265.0	32,333.40	8,791.75	1,852.38	1,265.00	50,283.82

Description	MatlCost	Output	ManHours	TotalCost
Material Rates	**0.00**	**2.0**	**8.0**	**720.55**
12 Navigation Ports & Harbors	**0.00**	**2.0**	**8.0**	**720.55**
1202 Harbors	**0.00**	**2.0**	**8.0**	**720.55**
Alternative 2 - Open Lake Placement W/Cap	**0.00**	**2.0**	**8.0**	**720.55**
120215 Mechanical Dredging	**0.00**	**2.0**	**8.0**	**720.55**
12021502 Site Work	**0.00**	**2.0**	**8.0**	**720.55**
12021502 01 Excavation and Disposal	**0.00**	**2.0**	**8.0**	**720.55**
Transport Dredged Material by barge	**0.00**	**1.0**	**4.0**	**360.27**
	0.00			*0.16*
USR Marine Crew Barge Material to site	0.00	1.0	4.0	360.27
Barge Cap Sand, dock to placement site	**0.00**	**1.0**	**4.0**	**360.27**
	0.00			*0.28*
USR Marine Crew Barge Material to site	0.00	1.0	4.0	360.27

Description	ListPrice	PurchaseYear	EQHours	Depr/Rntl	Operating	Total
Equipment Rates	**6,367,856.36**		**38,079.0**	**515,561.83**	**1,962,271.14**	**2,658,158.35**
12 Navigation Ports & Harbors	**6,367,856.36**		**38,079.0**	**515,561.83**	**1,962,271.14**	**2,658,158.35**
1202 Harbors	**6,367,856.36**		**38,079.0**	**515,561.83**	**1,962,271.14**	**2,658,158.35**
Alternative 1 - DMDF Expansion	**3,613,234.81**		**13,185.2**	**148,084.58**	**493,626.22**	**682,983.47**
120220 Disposal Areas	**3,613,234.81**		**13,185.2**	**148,084.58**	**493,626.22**	**682,983.47**
12022002 Site Work	**3,613,234.81**		**13,185.2**	**148,084.58**	**493,626.22**	**682,983.47**
12022002 01 Dike Construction	**3,613,234.81**		**13,185.2**	**148,084.58**	**493,626.22**	**682,983.47**
				12.90	*54.34*	*69.65*
EP B10CC010 BATCH PLANT, CONCRETE DISPENSER, 60 CY/HR MAX, W/TWO AGGREGATE BINS, 9.6 CY/ 3.1 CY CEMENT BIN/ 9' LONG SLOPING 12" DIA SCREW WET MIXER/DELIVERER/ 250 GAL WATER TANK/ & METERING PUMP, 8 CY LOAD, TRUCK MTD	137,871.15	2003	0.0	0.00	0.00	0.00
				1.75	*1.60*	*3.61*
GEN B25Z1040 BUCKET, CLAMSHELL, 0.6 CY (0.5 M3) GENERAL PURPOSE, SQUARE NOSE (ADD TEETH WEAR COST)	15,945.67	2003	619.4	1,084.49	989.18	2,235.17
				34.17	*71.06*	*116.87*
GEN C85Z2370 CRANE, MECHANICAL, LATTICE BOOM, CRAWLER, DRAGLINE/CLAMSHELL, 0.50 CY (0.4 M3), 17 TON (15 MT), 100' (30.5 M) BOOM (ADD BUCKET)	697,836.44	2003	619.4	21,160.63	44,012.80	72,385.17
				10.35	*29.71*	*43.67*
GEN G15Z3080 GRADER, MOTOR, ARTICULATED, 135 HP (101 KW), 12' (3.6 M) BLADE WIDTH	207,938.01	2003	272.0	2,816.46	8,083.39	11,879.94
				36.78	*130.51*	*180.31*
GEN H25Z3210 HYDRAULIC EXCAVATOR, CRAWLER, 140,000 LB (63,503 KG), 3.50 CY (2.7 M3) BUCKET, 31.4' (9.6 M) MAX DIGGING DEPTH	751,203.65	2003	328.3	12,074.86	42,848.39	59,201.39
				12.70	*29.44*	*44.28*
GEN R30Z5650 ROLLER, STATIC, SELF-PROPELLED, PNEUMATIC, 30 TON (27.2 MT), 78" (2.0 M) WIDE, 8 TIRES	126,389.06	2003	272.0	3,455.96	8,007.86	12,045.78
				14.67	*59.82*	*77.12*
GEN R45Z5690 ROLLER, VIBRATORY, SELF-PROPELLED, DOUBLE DRUM, SMOOTH, 12 TON (10.9 MT), 67" (1.7 M) WIDE, ASPHALT COMPACTOR	150,383.66	2003	646.8	9,491.82	38,690.70	49,880.66
				18.87	*55.10*	*77.73*
GEN R50Z5820 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, SMOOTH, 22 TON (20.0 MT), 84" (1.2 M) WIDE, SOIL COMPACTOR	207,553.76	2003	272.0	5,134.26	14,988.28	21,144.95
				13.91	*46.57*	*64.21*
GEN T15Z6500 TRACTOR, CRAWLER (DOZER), 136-180 HP (101-134 KW), POWERSHIFT, W/UNIVERSAL BLADE	203,523.30	2003	272.0	3,785.29	12,667.94	17,466.05
				13.18	*34.57*	*49.90*
GEN T40Z6870 TRUCK OPTION, TRANSIT MIXER, 8 CY (6.1 M3) (ADD 65,000 LB (29,484 KG) GVW TRUCK)	127,000.00	2003	272.0	3,585.59	9,405.17	13,575.32
				1.85	*6.65*	*8.85*
GEN T50Z7320 TRUCK, HIGHWAY, CONVENTIONAL, 8,800 LB (3,992 KG) GVW, 4X4, 2 AXLE, 3/4 TON (0.68 MT) - PICKUP	21,355.83	2003	207.1	384.20	1,377.45	1,832.70
				5.49	*26.28*	*33.28*

Description	ListPrice	PurchaseYear	EQHours	Depr/Rntl	Operating	Total
GEN T50Z7520 TRUCK, HIGHWAY, 55,000 LB (24,948 KG) GVW, 6X4, 3 AXLE (ADD ACCESSORIES)	96,691.16	2003	272.0	1,494.28	7,150.06	9,052.81
				6.60	*24.05*	*32.42*
GEN T50Z7700 DUMP TRUCK, HIGHWAY, 10 - 13 CY (7.6 - 9.9 M3) DUMP BODY, 35,000 LBS (15,900 KG) GVW, 2 AXLE, 4X2	113,695.91	2003	5,680.0	37,506.10	136,598.39	184,131.67
				7.15	*33.62*	*42.70*
GEN T50Z7710 DUMP TRUCK, HIGHWAY, 16 - 20 CY (12.2 - 15.3 M3) DUMP BODY, 75,000 LBS (34,000 KG) GVW, 2 AXLE, 6X4	124,080.34	2003	2,026.7	14,484.40	68,141.49	86,535.22
				13.73	*40.35*	*57.80*
GEN T60Z7910 TRUCK, WATER, OFF-HIGHWAY, 5,000 GAL (18,927 L), W/175 HP (130 KW) TRACTOR	219,866.99	2003	272.0	3,736.18	10,975.89	15,723.72
				24.18	*77.77*	*109.16*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	411,899.90	2003	1,153.3	27,890.08	89,689.24	125,892.92
Alternative 2 - Open Lake Placement W/Cap	**2,754,621.55**		**24,893.8**	**367,477.24**	**1,468,644.92**	**1,975,174.88**
120215 Mechanical Dredging	**2,754,621.55**		**24,893.8**	**367,477.24**	**1,468,644.92**	**1,975,174.88**
12021502 Site Work	**2,754,621.55**		**24,893.8**	**367,477.24**	**1,468,644.92**	**1,975,174.88**
12021502 01 Excavation and Disposal	**2,754,621.55**		**24,893.8**	**367,477.24**	**1,468,644.92**	**1,975,174.88**
				7.15	*33.62*	*42.70*
GEN T50Z7710 DUMP TRUCK, HIGHWAY, 16 - 20 CY (12.2 - 15.3 M3) DUMP BODY, 75,000 LBS (34,000 KG) GVW, 2 AXLE, 6X4	124,080.34	2003	11,360.0	81,188.86	381,951.00	485,052.66
				23.31	*69.16*	*99.50*
MAP L40CA007 LOADER, FRONT END, WHEEL, 6.00 CY BUCKET, ARTICULATED, 4X4	416,718.19	2003	873.8	20,370.48	60,438.17	86,945.57
				24.18	*77.77*	*109.16*
MAP T15CA014 TRACTOR, CRAWLER (DOZER), 240 HP, LOW GROUND PRESSURE, W/7.70 CY STRAIGHT BLADE (ADD ATTACHMENTS)	411,899.90	2003	5,680.0	137,354.60	441,706.52	620,004.42
Transport Dredged Material by barge	**900,961.56**		**4,450.0**	**81,963.71**	**372,671.06**	**499,300.35**
				19.71	*132.20*	*165.24*
EP M10XX032 MARINE EQUIPMENT, TUGS, 65 FT LENGTH, 22 FT BEAM, 7'6" DRAFT, 80 TON, TOW BOAT	900,961.56	2003	2,225.0	43,849.46	294,150.81	367,669.35
				17.13	*35.29*	*59.16*
NON XX0XX800 DUMP SCOW BARGE, 1,500 CY APPROX. 200'x 50' x 15'	0.00	2003	2,225.0	38,114.25	78,520.25	131,631.00
Barge Cap Sand, dock to placement site	**900,961.56**		**2,530.0**	**46,599.59**	**211,878.16**	**283,871.88**
				19.71	*132.20*	*165.24*
EP M10XX032 MARINE EQUIPMENT, TUGS, 65 FT LENGTH, 22 FT BEAM, 7'6" DRAFT, 80 TON, TOW BOAT	900,961.56	2003	1,265.0	24,930.14	167,236.31	209,034.48
				17.13	*35.29*	*59.16*
NON XX0XX800 DUMP SCOW BARGE, 1,500 CY APPROX. 200'x 50' x 15'	0.00	2003	1,265.0	21,669.45	44,641.85	74,837.40

Description	ManHours	LaborCost	EQHours	EQCost	CrewHours	CrewCost
Crew Rates						
Navigation Ports & Harbors						
Harbors						
Alternative 1 - DMDF Expansion						
Disposal Areas						
Site Work						
Dike Construction						
1 eqoprcrn + 1 hydr excavator, crawler, 3.70 CY (severe)	656.6474	26,269.18	328.3237	59,201.39	328.3237	85,470.57
1 eqoprmed + 1 dozer, crawler, 136-180 HP	734.4828	30,770.75	2,040.2299	102,092.07	272.0307	132,862.82
1 eqoprmed + 1 roller, vib, tandem, S/P, 12 ton	970.2128	37,434.04	646.8085	49,880.66	646.8085	87,314.70
3 laborers + 1 pickup truck, 8,8000 GVW	533.3333	18,049.78	71.1111	629.21	177.7778	18,678.98
B11A	280.0000	10,448.20	140.0000	15,281.80	140.0000	25,730.00
B12G	1,238.7097	46,513.55	1,238.7097	74,620.34	619.3548	121,133.89
B15	3,546.6667	136,308.53	3,040.0000	197,146.33	1,013.3333	333,454.87
B34A	5,680.0000	217,657.60	5,680.0000	184,131.67	5,680.0000	401,789.27
C6	476.0686	18,000.15	0.0000	0.00	238.0343	18,000.15
Alternative 2 - Open Lake Placement W/Cap						
Mechanical Dredging						
Site Work						
Excavation and Disposal						
B10U	1,310.7692	50,573.85	873.8462	86,945.57	873.8462	137,519.42
B15	19,880.0000	764,045.20	17,040.0000	1,105,057.07	5,680.0000	1,869,102.27

APPENDIX C
ECONOMIC ASSESSMENT
FOR THE
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)
MILWAUKEE HARBOR, WISCONSIN

Appendix C
Economic Assessment

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Introduction

The Milwaukee Harbor long-term disposal study was initiated in 1993 under the Authority of Section 123, P.L.91-611. Policy and procedures regarding development, review, approval and implementation of Dredged Material Management Plans (DMMP) are established in Appendix E, paragraph 15 of the Planning Guidance Notebook (ER 1105-02-100). Unfortunately, this ER gives little guidance on performing an economic assessment. In subsection b of said paragraph, this ER states:

> For many projects with readily available maintenance and usage information, a preliminary assessment, based on indicators such as annual O&M costs per ton of cargo, volume and frequency of traffic, and vessel dimensions, may establish the Base Plan and confirm that continued maintenance appears to be warranted[1].

The purpose of a typical DMMP economic assessment is to compare the economic indicators used to originally justify the Project with the current estimates of said indicators. This comparison is done to determine the effects of changes in maintenance dredging of the Project. Ultimately, the economic assessment is used to justify, or to not justify, continued maintenance dredging.

However, cases occur in which the authorizing document was completed so long ago that it either lacks discussion of economic indicators, or said discussion bares little resemblance to current economic conditions. In such cases, the DMMP economic assessment is forced to evaluate the effects of changes in maintenance dredging using the best available data.

As ER 1105-02-100 does not identify required outlines or table formats for an economic assessment, this analysis mostly follows those found in the draft EC 1165-2-200 (National Harbors Program: Dredged Material Management Plan) dated July 21, 1994.

Project Description

The following is a brief description of Milwaukee Harbor and its facilities. For a more detailed Project description, including maps, see section 1 of the Main Report. Milwaukee Harbor is located on the west shore of Lake Michigan in the city of Milwaukee, Wisconsin, about 85 miles north of Chicago, Illinois. Milwaukee Harbor is a deep draft harbor at the confluence of the Milwaukee, Menomonee, and Kinnickinnic Rivers. The authorized project at Milwaukee Harbor has two segments, consisting of an outer and inner harbor. The outer harbor stretches approximately 3.5

[1] Found on page E-71 of ER 1105-02-100.

miles and is situated between the Harbor's breakwaters, located approximately 3,000 feet offshore, and the shoreline. The inner harbor extends the commercial navigation channel to portions of the Milwaukee, Menomonee, and Kinnickinnic Rivers, as well as the South Menomonee and Burnham Canals. The entrance channel into the inner harbor is formed by piers on the north and south sides of the channel.

Milwaukee Harbor has approximately 16 deep-draft facilities currently operated by private firms and the Port Authority. Thirteen facilities are located in the outer and inner harbor, while the others are situated on the Kinnickinnic, Milwaukee and Menomonee Rivers. Each facility has access to rail lines operated by the Union Pacific Railroad and the Canadian Pacific Railway.

Benefit Indicators

The authorizing legislation for the construction of navigation features and dredging at Milwaukee Harbor spans from August of 1852 to October of 1962. Considering the lack of reliable commodity and vessel data for the majority of this 100-year-plus time span, a typical comparison of economic indicators will not be performed. Instead, this assessment will describe past and current trends in commodity and vessel traffic for Milwaukee Harbor, comparison of these trends with those experienced across the Great Lakes region, and future traffic projections.

Commodity Traffic - Milwaukee Harbor is primarily a receiving port; 87.2% of traffic is inbound. The outbound commodities are primarily farm products (wheat, corn and soybeans), sand and gravel. The primary inbound commodities are non-metallic minerals, coal lignite, cement, concrete, asphalt, tar and pitch.

Table C-1 details the shipped tonnage of each of these commodities groups as found in the Corps' *Waterborne Commerce of the United States, Part* 3- *Waterways and Harbors Great Lakes*. The table covers years 2001 through 2005, the latest year for which the Corps has released data. Table C-1 also details the percentage of total tonnage each commodity represents.

Taken together, these six commodities groups make up roughly 95% of traffic through Milwaukee Harbor. Over the five-year period, non-metallic minerals have decreased in relative importance while coal lignite, cement and concrete have increased. The particular non-metallic mineral in this case is road and other de-icing salts. Approximately 60-70% of the State of Wisconsin's roadways use salt brought in through the Harbor. Salt traffic dipped sharply in 2002, but has been rising since. The inbound coal is barged inland to three area power plant. This commodity has fluctuated over the period but remained essentially stable until 2005 when it experienced a sharp increase. Concrete and cement are used in southeastern Wisconsin's construction industry and have risen steadily over the period. Taken together, these three commodity classifications account for approximately 75% of the cargo shipped through Milwaukee Harbor. Although of relatively less importance,

asphalt, tar and pitch have increased slightly. This commodity group is used in various construction and industrial applications. The two outbound commodity groups, farm products and sand and gravel have decreased slightly.

Table C-1
Commodity Classification
Milwaukee Harbor
2001-2005
(in thousands of short tons)

	Non-Metallic Minerals	Coal Lignite	Cement & Concrete	Farm Products	Asphalt, Tar & Pitch	Sand & Gravel	All Comm-odities
2001	1,147	770	661	365	164	97	3,373
Percent	*34.0%*	*22.8%*	*19.6%*	*10.8%*	*4.9%*	*2.9%*	
2002	680	787	816	474	209	60	3,127
Percent	*21.7%*	*25.2%*	*26.1%*	*15.2%*	*6.7%*	*1.9%*	
2003	742	674	867	277	143	106	3,002
Percent	*24.7%*	*22.5%*	*28.9%*	*9.2%*	*4.8%*	*3.5%*	
2004	812	733	904	238	174	92	3,156
Percent	*25.7%*	*23.2%*	*28.6%*	*7.5%*	*5.5%*	*2.9%*	
2005	911	1,156	963	317	189	79	3,805
Percent	*23.9%*	*30.4%*	*25.3%*	*8.3%*	*5.0%*	*2.1%*	
Average	*26.0%*	*24.8%*	*25.7%*	*10.2%*	*5.4%*	*2.7%*	

Source: Waterborne Commerce of the United States

Aggregate commodity traffic at Milwaukee Harbor is presented in Table C-2. Data for years 1985 through 2005 are found in the Corps' *Waterborne Commerce of the United States, Part* 3- *Waterways and Harbors Great Lakes*. Data for 2006 was reported by Milwaukee Harbor in April, 2007.

One characteristic of the presented data is that commodity traffic in 1993 is relatively equal to that in 1985 and represents a change in traffic trends at the Harbor. From 1985 through 1992, traffic generally exhibited a downward trend, decreasing by roughly 330,000 tons (-13.5%). From 1993 through 2006, traffic generally exhibited an upward trend, increasing by roughly 1.3 million tons (52.2%).

The years 2005 and 2006 represent a large increase in commodity traffic at the Harbor. These years are either short-term increases from the average trend or long-term increases. If these years are short-term increases, the resulting analysis will be biased in favor of justifying maintenance dredging. Subtracting the years 2005 and 2006, traffic from 1993 through 2004 increased 660,000 tons (26.4%), so even if these years are short-term increases, commodity traffic at Milwaukee Harbor is clearly rising,

In a further attempt to examine the data without possible biasing from years 2005 and 2006, Table C-2 also shows three-year traffic averages from 1993 through 2004. Note that three years is an arbitrary choice and is not meant to represent any economic or technological situation. Excluding years 2005 and 2006, the data show that the three-year average has increased approximately 336,000 tons (12.2%).

Table C-2
Aggregate Commodity Traffic
Milwaukee Harbor 1985-2005

Year	Traffic	3-Yr Averages
1985	2,490	
1986	1,823	
1987	2,161	
1988	2,289	
1989	2,379	
1990	2,128	
1991	2,076	
1992	2,153	
1993	2,496	
1994	2,641	
1995	3,140	**2,759**
1996	2,858	
1997	3,265	
1998	3,108	**3,077**
1999	3,531	
2000	3,539	
2001	3,373	**3,481**
2002	3,127	
2003	3,002	
2004	3,156	**3,095**
2005	3,805	
2006	3,800	

Source: Waterborne Commerce of the United States

Operations and Maintenance Cost per Ton - As stated in paragraph E-15 of ER 1105-02-100, the operations and maintenance cost (O&M) of the Project per ton of commodity shipped can be used to justify continued maintenance of the Project.

A more detailed discussion of historic O&M costs is presented later in this analysis. For the immediate purpose, it is noted that Milwaukee Harbor is not dredged every year, but rather every three to five years on average. Dredging has not occurred at the Harbor since 2001 and the amount dredged in that year was abnormally small. For

these reasons, it appears that using the average of O&M costs over several years for calculating the ratio of costs per ton is more appropriate. Table C-3 presents the costs of dredging and environmental sampling which have occurred at the Harbor since 1995. The table also lists total commodity tons shipped through the Harbor in those same years. Finally, an average O&M cost per commodity ton is derived.

Table C-3
Operation and Maintenance
Cost per Commodity Ton
1995 – 2006

Year	Dredging Cost[1]	Environ. Samp. Cost[1]	Total Cost	Tonnage Shipped[2]	O&M Cost per Ton
1995	$ 355,717	$ 0	$ 355,717	3,140,000	
1996	$ 0	$ 0	$ 0	2,858,000	
1997	$ 0	$ 0	$ 0	3,265,000	
1998	$ 0	$ 0	$ 0	3,108,000	
1999	$ 829,728	$ 0	$ 829,728	3,531,000	
2000	$ 0	$ 0	$ 0	3,539,000	
2001	$ 28,736	$ 0	$ 28,736	3,373,000	
2002	$ 0	$ 47,934	$ 47,934	3,127,000	
2003	$ 0	$ 0	$ 0	3,002,000	
2004	$ 0	$ 0	$ 0	3,156,000	
2005	$ 0	$ 0	$ 0	3,805,000	
2006	$ 0	$ 0	$ 0	3,800,000	
12-year Average			**$ 105,176**	**3,308,666**	**$ 0.32**

[1] Costs in FY07 dollar values.
[2] Measured in short tons.

Great Lakes Commodity Comparison - As many more types of commodities are shipped throughout the Great Lakes than are shipped through Milwaukee Harbor, a simple comparison of traffic tonnage will not yield any important information. Table C-4 details the increase/decrease in Great Lakes tonnage for the same commodity groups discussed in Table C-1.

Two points regarding these commodity groupings need to be noted. First, because non-metallic minerals is a NEC category (Not Otherwise Classified), it is somewhat of a "catch-all" category. At the port of Milwaukee, this category is almost, if not absolutely, exclusively road and other de-icing salts. Across the Great Lakes region, this category would also include other unclassified minerals. Secondly, as the major farm products shipped through Milwaukee Harbor are wheat, corn and soybeans, only these products are used in comprising farm produce for the Great Lakes region.

Table C-4
Great Lakes
Select Commodity Groups
2001-2005

	Non-Metallic Minerals	Coal lignite	Cement & Concrete	Farm products	Asphalt, Tar & Pitch	Sand & Gravel	**Total**
2001	6,323	42,475	6,740	6,299	1,248	7,550	**72,636**
2002	4,854	40,165	6,874	5,526	1,345	5,267	**66,033**
2003	5,544	39,982	7,102	4,511	1,171	6,253	**66,566**
2004	6,044	40,413	7,179	4,562	1,061	5,511	**66,774**
2005	5,771	42,365	7,140	4,607	1,011	4,696	**67,595**
Change in Tonnage over the Period	**-552**	**-110**	**400**	**-1,692**	**-237**	**-2,854**	**-5,041**
Percent Change	-8.7%	-0.3%	5.9%	-26.9%	-19.0%	-37.8%	-6.9%

Source: Waterborne Commerce of the United States

Table C-5 then compares the changes in Great Lakes traffic for these selected commodities to Milwaukee Harbor's.

Table C-5
Changes in Traffic Compared
Milwaukee Harbor and Great Lakes

	Milwaukee Harbor	Great Lakes
Non-Metallic Minerals	-20.6%	-8.7%
Coal lignite	50.1%	-0.3%
Cement & Concrete	45.7%	5.9%
Farm products	-13.2%	-26.9%
Asphalt, Tar & Pitch	15.2%	-19.0%
Sand & Gravel	-18.6%	-37.8%
Group Total	**12.8%**	**-6.9%**

Across the Great Lakes region, five of the six commodity groups in question have decreased, causing the total of these commodity groups to decline by 6.9%. For the same period, Milwaukee Harbor traffic has increased 12.8%. For four of these commodity groups, traffic at the Harbor and for the Lakes mirrors each other. The largest decreases across the Great Lakes region occur in the two commodity groups that Milwaukee Harbor exports, namely farm products and sand and gravel. Non-metallic

minerals decreases across both the Great Lakes and Milwaukee, while cement and concrete both increase.

The most striking result of the comparison is that while across the Great Lakes, coal lignite is relatively static, Milwaukee Harbor has experienced an increase of 50.1% (386,000 tons). This implies that Milwaukee Harbor is becoming a more prominent shipper of Great Lakes coal, primarily due to increased cost of transporting coal by rail.

Future Traffic Projections - A search of available Corps reports reveals that no evaluations regarding traffic projections for Milwaukee Harbor have been performed. Yet, an argument for increasing traffic at Milwaukee Harbor can be made based on current traffic trends at the Harbor. This analysis has detailed that commodity traffic at Milwaukee Harbor has increased by 1.3 million tons over the last 14 years. This increase is caused by the supply and demand conditions in each of the commodities markets. An evaluation of these markets is beyond the scope of this analysis. At best, some generalizations can be made about these markets.

Several supply factors have lead to increasing traffic at Milwaukee Harbor, but only one is pertinent to this discussion, the advantage of waterborne transportation over rail transportation. For users that have access to both water and rail transportation in the Greta Lakes basin, waterborne transportation is relatively cheaper due to the economies of scale inherent to transporting greater amounts of cargo.

In 2005, the Tennessee Valley Authority (TVA) undertook an analysis for the U.S. Army Corps of Engineers to determine the costs of rail, trucking and water transportation for commodities shipped throughout the Great Lakes basin. TVA conducted interviews with ports, shippers and rail authorities to determine the origin and destination of commodities traveling on the Great Lakes. A specific commodity having a unique origin and destination was defined as a movement. TVA also surveyed port and shipping officials to estimate fuel, handling, storage, etc costs associated with cargo transportation. These costs were then modeled to obtain an average cost per ton for each movement. TVA then used an existing rail-costing model to determine the cost of shipping that same movement via rail. The result of this analysis was that waterborne transportation throughout the Great Lakes, and specifically at Milwaukee Harbor, is relatively cheaper than rail transportation. However, it should be noted this analysis assumed that the various industries will continue to utilize the same origin and destination in the event of a port closure. In certain cases, industries might engage in different actions, e.g. halting manufacturing, moving facilities, utilizing different suppliers, etc in the event of a port closure. Because the cost differential between waterborne and rail transportation assumes the same origin and destination, any such actions would bias the estimated cost differential upward. See the Works Cited page for more information on this study.

Also, in many cases, waterborne transportation is more available, due to increased rail congestion and capacity limitations[2]. It is safe to assume that these factors will not be easily ameliorated, causing water transportation to become relatively more appealing in the future.

For example, as transporting coal by rail has become more expensive, power plants in the Milwaukee area have increased the amount of coal shipped by water through the Harbor. From 2000 to 2005, the bulk of Milwaukee Harbor's inbound coal, roughly 672,000 tons on average, was shipped from Chicago Harbor, IL. In 2005, Milwaukee Harbor began receiving additional shipments of coal, approximately 290,000 tons, from Duluth Harbor, MN and Superior Harbor, WI. Table C-4 previously showed that coal shipments at Milwaukee Harbor increased by 50.1%, a direct result of increasing rail transportation costs[3].

Based on increasing railroad costs, railroad constraints and the increasing traffic trend of the last five years, it is safe to assume that commodity traffic at Milwaukee Harbor will experience moderate increases in future years.

Vessel Traffic – Based on data compiled by the US Army Corps of Engineers, the composition of the fleet servicing the harbor has changed slightly over the last ten years. *The Phase I Summary Report – Dredged Material Management Plan Study-Milwaukee Harbor Wisconsin*, dated December 1997 and prepared by the Detroit District US Army Corps of Engineers, detailed that most commodities were shipped by Class 5 vessels (600 feet to 649 feet in length). An examination of similar data for 2005 reveals that Class 8 vessels (731 to 849 feet) have gained equal prominence. Based on the 2005 data, Class 3 vessels (500-549 feet) are the smallest class utilizing the Harbor, while the previously mentioned Class 8 are the largest.

The drafts of the vessels servicing Milwaukee Harbor are displayed for the years 1991, 1995, 2001 and 2005 in Table C-6. These numbers represent the aggregate of inbound, outbound, foreign and domestic vessels.

The number of vessels reporting drafts of 26 feet or more increased from 39 in 1991 to 76 in 2005. Note that the authorized depth of Milwaukee's outer harbor and the entrance to the inner harbor is 28 feet and 27 feet at the mouth of the Kinnickinnic River (in the inner harbor). This indicates that shippers tend to load to the deepest draft possible to maximize cargoes and minimize transportation costs. The fact that in 1995, shippers used 5 vessels of 28-foot draft and 8 vessels of 29-foot draft, underscores that shippers seek to maximize vessel draft to reduce costs. Certainly, if the depth of the channels had permitted, shippers would have loaded to these deeper drafts in subsequent years.

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[2] Great Lakes – St. Lawrence Seaway New Cargoes/ New Vessels Market Assessment Report, January 2007. Prepared by TEMS, inc and Rand Corporation for the U.S. Department of Transportation and Transport Canada. Section 5.4.

[3] The coal shipment information came from the U.S. Corps of Engineers Inland Navigation Planning Center. That the impetus of this shift was due to increased rail costs came from a conversation with TVA.

Table C-6
Vessel Traffic
Milwaukee Harbor
1991 - 2005

Draft	1991	%	1995	%	2001	%	2005	%
29	0	0.0%	8	0.1%	0	0.0%	0	0.0%
28	0	0.0%	5	0.1%	1	0.0%	0	0.0%
27	23	0.8%	11	0.2%	0	0.0%	37	2.2%
26	16	0.6%	14	0.2%	18	0.7%	39	2.3%
25	11	0.4%	14	0.2%	56	2.2%	11	0.7%
24	41	1.5%	55	0.8%	53	2.1%	68	4.1%
23	59	2.1%	23	0.4%	82	3.3%	91	5.4%
22	32	1.2%	47	0.7%	78	3.1%	59	3.5%
21	45	1.6%	59	0.9%	32	1.3%	42	2.5%
20	20	0.7%	22	0.3%	48	1.9%	57	3.4%
19	12	0.4%	51	0.8%	94	3.8%	37	2.2%
18	49	1.8%	47	0.7%	97	3.9%	73	4.4%
17	30	1.1%	29	0.4%	21	0.8%	39	2.3%
16	21	0.8%	67	1.0%	47	1.9%	132	7.9%
15	9	0.3%	21	0.3%	23	0.9%	48	2.9%
14	19	0.7%	24	0.4%	35	1.4%	3	0.2%
13	127	4.6%	45	0.7%	10	0.4%	72	4.3%
>12	2,245	81.4%	5,938	91.6%	1,795	72.1%	865	51.7%
Total	**2,759**		**6,480**		**2,490**		**1,673**	

Source: Waterborne Commerce of the United States

As it currently stands, many of the vessels reporting drafts of 26 feet or more are light-loaded because their mid-summer drafts exceed the authorized channel depth.

The most significant change over the 15-year period is the decrease in the number of vessels reporting drafts of 12 feet or less, 2,245 in 1991 compared to 865 in 2005. This represents a 61.5% decrease. Barges of 12-foot draft or less are used to transfer cargo from the deeper-draft vessels in the inner harbor to dock facilities in the upstream, shallower depth portions (21 feet) of the Project. A decrease in the use of these shallower-draft barges during a time period that has experienced growth in tonnage traffic indicates that shippers prefer to forgo transferring cargo when possible to lower transportation costs. Over the 15-year period, the number of vessels recording drafts of 16 to 21 feet has increased from 177 to 380, emphasizing this preference for deeper-draft vessels. However, this is only possible when the drafts of the inner harbor and upstream portions of the Project are sufficiently maintained.

Benefit Indicator Summary -

The benefit indicators for continued maintenance dredging are summarized in

Table C-7 on the following page. Based on the information and trends discussed above, it is expected that coal, concrete, cement, asphalt, tar, pitch and possibly non-metallic minerals will make up a larger percentage of aggregate traffic while farm products, sand and gravel will comprise a smaller percentage. Tonnage traffic is expected to increase moderately. Class 5 and 8 vessels will most likely continue to be the most common used at Milwaukee Harbor in the future. Also, it is expected that shippers in the inner harbor will continue to maximize draft whenever possible, resulting in fewer shallow barges used for transfer.

Note that the table only lists commercial navigation benefit indicators. Listings for recreation and commercial fishing benefit indicators are not presented in the table since this analysis does not attempt to quantify any such benefit.

Table C-7
Benefit Indicators

Benefit Indicators[1]	Current Operations[2]	Trend[3]	Summary/Remarks
Commodity Types			Although the absolute tonnage of asphalt, tar and pitch shipped through the Harbor has increased, its relative size of total traffic, as measured by percentage, has remained relatively static.
Coal	30.4%	Increasing	
Concrete & Cement	25.3%	Increasing	
Non-Metallic Minerals	23.9%	Decreasing	
Farm Products	8.3%	Decreasing	
Asphalt, Tar & Pitch	5.0%	Static	
Sand & Gravel	2.1%	Decreasing	
Tonnage			Although down from 2001 levels, Non-Metallic Minerals has experienced growth in each of the last four reported years.
Coal	1,156	Increasing	
Concrete & Cement	963	Increasing	
Non-Metallic Minerals	911	Increasing	
Farm Products	311	Decreasing	
Asphalt, Tar & Pitch	189	Increasing	
Sand & Gravel	79	Decreasing	
All Commodities	3,805	Increasing	
O&M Cost per Ton		$ 0.32[4]	
Growth Rates			Although not specifically forecasted, tonnage traffic at Milwaukee Harbor is expected to increase.
Coal		50.1%	
Concrete & Cement		45.7%	
Non-Metallic Minerals		-20.6%	
Farm Products		-13.2%	
Asphalt, Tar & Pitch		15.2%	
Sand & Gravel		-18.6%	
All Commodities		12.8%	
Vessel Types	Bulk	Bulk	No change.
Vessel Sizes	Class 3-8, mainly class 5 & 8.	Increased use of Class 8s, decreased use of shallow barges.	No change.
Vessel Operations	Utilizing maximum channel depth, continued use of light loading.	No change.	No change.

[1] Includes only pertinent indicators.
[2] Based on vessel traffic from *Waterborne Commerce of the United States. Part 3-Great Lakes*. Calendar Year 2005. Reported in thousands of tons.
[3] Period considered is 2001 through 2005.
[4] Period considered is 1995 through 2006.

Cost Indicators

Maintenance Cost History- Dredging records report quantities dredged at Milwaukee Harbor beginning in 1957, however the records for many of the years prior to 1976 are missing dredging costs. 1976 is also a prominent year in these records because that

was the first year in which the existing Confined Disposal Site (CDF) was first used for disposal of dredged material. Therefore, Table C-8 reports the dredging quantities and costs beginning in 1976 to the latest year in which Milwaukee Harbor was dredged, 2001. Note that the cost of dredging includes transportation to and placement in the CDF.

Table C-8
CDF Construction and
Maintenance Dredging Costs
1975 – 2001
(in FY07 dollars[1])

CONSTRUCTION HISTORY			
1975	CDF Construction	$ 22,062,256	
DREDGING HISTORY[2]			
	Cubic Yard	**Cost**	**Cost per CY**
1976	465,833	$ 4,575,274	$ 9.83
1977	125,000	$ 445,040	$ 3.55
1978	208,389	$ 2,602,168	$ 12.50
1981	188,401	$ 1,270,606	$ 13.74
1987	307,656	$ 2,687,226	$ 8.73
1990	134,387	$ 526,676	$ NA
1993	108,067	$ 756,982	$ 7.01
1995	18,934	$ 280,016	$ 14.79
1999	54,259	$ 720,525	$ 13.28
2001	1,218	$ 26,426	$ 21.69
TOTAL	1,612,144	$ 13,890,939	

[1] Updated using Civil Works Constuction Cost Index System
[2] Source: USACE Detroit District Website http://www.lre.usace.army.mil

Table C-9 presents the maintenance cost history across several cost categories for the last six years. Several shortcomings exist with the reported data. No Operations and Maintenance (O&M) has been needed at the CDF in approximately 15 years. Dredging at the Project last took place 6 years ago. This was an unusual dredging situation in that an abnormally small amount of material was removed, therefore the cost is not truly representative of normal dredging. Also, as with the above table, the cost of dredging includes transportation to and placement in the CDF. Separable costs for each of these activities were not available. Finally, an environmental study has only been performed once at the Harbor during the last 5 years. Combined, all these factors lead to an abnormally low average maintenance cost over the last 5 to 6 years.

Table C-9
Maintenance Cost History
(in FY07 dollars[1])

Reach or Segment	Construction/ Acquisition		Dredging Costs (dollars per year)							
	Year	Cost		2001	2002	03	04	05	06	Average
Whole Project	1975	$27,349,780	Dredg	$ 28,736	-0-	-0-	-0-	-0-	-0-	
			Transpo r-tation	Included Above.	-0-	-0-	-0-	-0-	-0-	
			Placeme nt	Included Above.	-0-	-0-	-0-	-0-	-0-	
			Env. Studies	-0-	$ 47,934	-0-	-0-	-0-	-0-	
			Disposa l Site O&M	-0-	-0-	-0-	-0-	-0-	-0-	-0-
			Total	$ 28,736	$ 47,934	-0-	-0-	-0-	-0-	$12,778

[1] Updated using Civil Works Constuction Cost Index System

Maintenance Cost Projections - The existing CDF has remaining capacity of approximately 200,000 CY. Maintenance dredging of roughly 50,000 CY is scheduled for the summer of FY07. Also, the Environmental Protection Agency (EPA) plans to dispose of approximately 176,000 CY in FY08. By the end of FY08, the existing CDF will have zero capacity.

The estimated cost for the construction of the Dredged Material Disposal Facility (DMDF) is detailed in Table C-10. All amounts are presented in FY09 dollar levels. As construction would occur within a single construction season, no interest during construction was estimated. Finally, the annualized average cost of constructing the DMDF is calculated by amortizing the Total Construction Costs over the 20-year life of the Project utilizing the FY08 Federal Discount rate of 4.875%.

Table C-10
Dredged Material Disposal Facility
Construction Costs [1]

Features	Quantity	Unit Amount	Total Amount
Construction			
Mobilization & Demobilization			$ 148,045
Compacted Fill	71,000 cy	$ 11.47	$ 831,472
Riprap - Armor Stone	10,500 tn	$ 69.64	$ 746,576
Crushed Aggregate	5,000 cy	$ 36.28	$ 185,209
Geotextile	20,000 sy	$ 4.11	$ 83,926
Portland Cement	703 tn	$ 178.61	$ 128,200
Site Restoration			$ 14,804
Load/Transport Material	71,000 cy	$ 10.86	$ 787,252
Subtotal Construction			**$ 2,925,484**
Engineering & Design	6%		$ 175,529
S&A	9%		$ 263,294
Contracting & Award			$ 10,000
EDDC	1%		$ 29,255
Subtotal Non-Construction			$ 478,078
Contingency	15%		$ 71,712
Subtotal Non-Construction			**$ 549,790**
Total First Costs [2]			**$ 3,475,274**
Annualized Average Cost [3]			**$ 275,917**
Annual O&M Cost			**$ 12,000**
Total Annualized Average Cost			**$ 287,917**

[1] Presented in FY 2009 dollars.
[2] As construction will occur during a single season, no interest during construction was estimated.
[3] Amortized over the 20-year project life using the FY08 discount rate of 4.875%.

Table C-11 presents the projected dredging maintenance costs for Milwaukee Harbor over the next 20 years. According to the Detroit District's 5-year Plan, Milwaukee Harbor will be dredged in FY07 and again in FY11. After FY11, Detroit District will dredge the Harbor approximately every four years. The costs of each dredging occurrence after FY11 was derived by averaging the estimated costs of dredging in

FY07 and FY11. As above, the cost of transportation and placement of the dredged material is included in the dredging costs. Environmental sampling and assessment will be performed in FY07 and again in FY11.

This analysis assumes that sampling will occur every four years as well and that the cost remain constant throughout the 20-year period of analysis. Dredging and environmental sampling costs are presented in FY07 dollar values. As the proposed DMDF will have a pump to aid in dewatering the dredged material, there will be an annual O&M cost of $12,000.

Table C-11
Maintenance Cost Projections
(in thousands of FY07 dollar)

Year	Construction	Dredging	Envir. Samp.	Total	Total Plus O&M
2007		$750	$50	$800	$800
2008				$0	$0
2009	$3,314[1]			$3,314	$3,326
2010				$0	$12
2011		$661	$41	$703	$715
2012				$0	$12
2013				$0	$12
2014				$0	$12
2015		$530	$34	$564	$576
2016				$0	$12
2017				$0	$12
2018				$0	$12
2019		$438	$28	$466	$478
2020				$0	$12
2021				$0	$12
2022				$0	$12
2023		$362	$23	$385	$397
2024				$0	$12
2025				$0	$12
2026				$0	$12
Total	$3,314	$2,741	$176	$6,232	$6,448
Annualized Average	**$263**	**$218**	**$14**	**$495**	**$512**

[1] DMDF project costs discounted to 2007 dollar values.

Economic Justification

Milwaukee Harbor currently ships and receives approximately 3.8 million tons of commodities annually. The Harbor has experienced an increasing trend, 1.3 million

tons or 52.2%, in commodity traffic over the past 14 years. Increasing rail congestion suggests that commodity traffic can be expected to increase moderately in future years.

The fleet servicing the Harbor demonstrates a desire to decrease the number of shallow-depth vessels and maximize vessel draft to the authorized channel depth. Doing so, reduces the number of needed trips, thereby increasing shippers' savings, a NED benefit. In 2006, the U.S. Army Corps of Engineers, Buffalo District performed an analysis to ascertain the increased cost to shippers resulting from increased depth. Corps personnel utilized a model called GLLAPOM (Great Lake Level Analysis of Port Operation and Maintenance). This model is designed to simulate the shipping costs associated with the most recent yearly waterborne shipments at varying hypothetical constrained port channel depths. GLLAPOM simulates each vessel movement for a given historical shipment list at a port of interest and determines the maximum tons the vessel can carry given water column constraints. Decreases in available water column lead to light loading and the need to make more round trips to carry the same yearly tonnage levels. The increased time necessary to move all of the historical cargo tonnages needed results in higher transportation costs.

Results from the model indicate that at one foot above the authorized depth at Milwaukee Harbor, indicating one foot of shoaling, transportation costs per ton increase by approximately $0.24. At two feet above authorized depth, per ton costs increase by approximately $0.57. Using 3.3 million tons, the average of the last 12 years of commodity traffic, such shoaling would cause total cost increases of $792,000 and $1.88 million, respectively. However it should be noted that GLLAPOM assumes that the originators and receivers of cargo will bring in the same amount of cargo regardless of the increased costs. In many cases, originators or receivers ship less when costs exceed a certain point. Therefore, these cost increase estimates are likely biased upward. Yet, the model does indicate that NED benefits are reduced by lack of maintenance dredging.

The TVA analysis previously mentioned supports another justification for continued maintenance at Milwaukee Harbor. Results specific to the Harbor indicate that transporting one ton of a commodity via water is approximately $23.26 cheaper than land transportation. As previously noted, assumptions regarding static origin and destination points biases this estimate upward. However, when compared to the average O&M cost per ton, estimated in Table 3, of $0.32, it is clear that the benefit of continued maintenance outweighs the costs.

The current CDF will have zero remaining capacity at the end of FY08. In absence of this facility, the only other options are to either haul the contaminated material to the nearest CDF, located approximately 100 miles away in Green Bay, or to cease dredging. The former would dramatically increase costs, so the most likely scenario is that dredging at Milwaukee Harbor would cease. This would lead to shoaling that would force vessels to light load, eroding NED benefits i.e. increasing transportation costs.

An examination of the available evidence yields the conclusion that continued maintenance dredging at Milwaukee Harbor is justified.

Works Cited

Great Lakes – St. Lawrence Seaway New Cargoes/ New Vessels Market Assessment Report, January 2007. Prepared by TEMS, inc and Rand Corporation for the U.S. Department of Transportation and Transport Canada.

Transportation Rate Analysis: Great Lakes and St Lawrence Seaway 2005. August 2005. Prepared by The Tennessee Valley Authority Navigation and Hydraulic Engineering Knoxville, Tennessee for U.S. Army Corps of Engineers Huntington District Inland Navigation Planning Center

APPENDIX D
REAL ESTATE PLAN
FOR THE
DREDGED MATERIAL MANAGEMENT PLAN (DMMP)
MILWAUKEE HARBOR, WISCONSIN

APPENDIX D

REAL ESTATE PLAN

MILWAUKEE HARBOR, WISCONSIN
DREDGED MATERIAL MANAGEMENT PLAN
FOR A NEW DREDGED MATERIAL DISPOSAL FACILITY

AUTHORITIES

The Milwaukee Harbor Dredged Material Disposal Facility (DMDF) is conducted under the guidance of the **National Harbors Program: Dredged Material Management Plan dated July 21, 1994 (EC1165-2-200).**

The Federal Navigation Project at Milwaukee Harbor, Wisconsin was initially authorized by the **River and Harbor Act of 1852**. The authorization was modified by the **River and Harbor Acts of 30 August 1935; 2 March 1945; 14 July 1960; and 23 October 1962**. The project provides for two breakwaters enclosing a 1200 acre outer basin and two inner piers protecting the river mouth. The project also provides for Federal Navigation approach channel and basin area within Lake Michigan; and navigational channels in the Kinnickinnic, Milwaukee and Menominee Rivers. Under Section 123 of the rivers and Harbor Act of 1970, a Confined Disposal Facility (CDF) was constructed and completed at Milwaukee Harbor (1975) for the purpose of containing dredged material that is unsuitable for open lake disposal. The CDF project was in cooperation with the City of Milwaukee acting through its Board of Harbor Commissioners and is operated by the Milwaukee Harbor Commission.

The Water Resources Development Act of 1986, as amended (33 U.S.C. 2211) defined cost sharing between the Federal Government and the local sponsor. The Act was amended in Sec. 201 of WARDA 1996; section Sec. 101(a) of WARDA 1986. (b) Operation and Maintenance.--Section 101(b) of such Act (33 U.S.C. 2211(b); 100 Stat. 4083) adding "dredged material disposal facilities." The Federal share of the cost of constructing land-based and aquatic dredged material disposal facilities that are necessary for the disposal of dredged material required for the operation and maintenance of a project

Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended (42 U.S.C. 1962d-5b), and Section 101 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2211), provide, *inter alia*, that the Secretary of the Army shall not commence construction of any water resources project, or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

LOCATION

The harbor is located within the City of Milwaukee, on the west shore of Lake Michigan about 85 miles north of Chicago. It is the major port on the Wisconsin shore of Lake Michigan and is served by

numerous domestic and foreign commercial vessels The harbor extends four miles along the shore and has numerous deep-draft and recreational navigation facilities. South of Milwaukee Harbor to the Milwaukee-Racine County line, shoreline development consists of industrial developments, utility works and public parks as the Milwaukee County Park Commission owns the much of this shoreline. There is also residential development, including some undeveloped lands along the shoreline. The inner portion of Milwaukee Harbor is formed by the confluence of the Milwaukee, Menominee and Kinnickinnic Rivers. The banks of these rivers, within the harbor, are lined by many industrial, commercial and municipal facilities including coal yards, foundries, cement plants, sand and gravel yards, marine terminals, recreational boat sales and service centers, a municipal solid waste incinerator, and a municipal sewage treatment plant. The outer harbor is formed by the breakwaters which define the harbor-of-refuge. Development of the outer harbor is directed toward marine commerce and recreational boating. Terminals and piers are present for bulk general cargo and petroleum products. Other facilities include yacht clubs, public launching ramps and the U.S. Coast Guard Station. The mission and purpose of the Milwaukee Harbor Project is commercial navigation on the Great Lakes and connecting channels. The project also provides a harbor of refuge for commercial vessels and recreational pleasure craft.

NON-FEDERAL SPONSOR IDENTIFICATION

As was performed with the original CDF project, the local sponsor for the is the Milwaukee Port Authority, which Acts through the Board of Harbor Commission, created in 1920, and is a department of the City of Milwaukee. The Commission, through the resources of the city, will provide all easements and rights-of-way necessary for the construction, operation and maintenance of the new DMDF project.

The Commission has provided local cooperation in the original project and will provide local cooperation for this project, as required by the Project Cooperation Agreement (PCA) and participate in project design.

The Commission has the full power, authority and capability to provide the items of local cooperation it has the legal status to obtain additional property if required for the construction and/or operation of the project. It also has the legal capability to provide its share of total project costs. Accordingly, the city has the capability to complete its portion of the project within the designated time frames. The Commission is capable of providing all required LERRDs necessary for project construction, operation and maintenance. The Commission is a legally constituted public body with the full power, authority, and capability to perform of the terms of the PCA. It has the power of eminent domain. Its legal department is fully capable of handling acquisitions and condemnations. Requirements of PL 91-646, acquisition policies and procedures, LERRDs crediting procedures, and the requirements for land acquisition have been discussed with the sponsor.

ESTATES (including Project Lands)

The original Section 123 CDF was constructed under the Corps of Engineers rights of Navigational Servitude. In addition, the local sponsor, the Board of Harbor Commission acquired a land grant from the State of Wisconsin (who owns the bottomlands of Lake Michigan) for the construction of the disposal facility.

For access from the City roadway to the CDF, a standard road easement was the estate utilized for the original Section 123 Project. No additional estates are necessary for this project as the disposal area and access easements will lie within the same footprint of the previous project

PROJECT DESCRIPTION

There is a need to develop additional dredged material disposal at Milwaukee Harbor. Originally, there were several alternatives, including open water disposal, expanding the existing facility to the north, upland disposal and raising the height of the facility at the site. The alternative which has been given priority is to construct a new DMDF on top of the existing CDF.

The existing CDF will be filled when the EPA's Legacy Act material and the Corp's FY08 O&M dredging is completed. At that time, the District would provide a letter to the Port Authority indicating the Section 123 CDF is filled per the Local Cooperation Agreement. The existing O&M Manual states that the Corps would dewater, grade and level all dredged materials contained within the CDF, and would place a ground cover consisting of clean material. The letter to the Port Authority will have to explain that these items have not been completed because the Corps is proposing to construct a new DMDF at the site.

SCOPE AND CONTENT

1) Purpose - This Real Estate Plan (REP) addresses real estate matters associated with several levels of governments including the Detroit District Corps of Engineers, the Environmental Protection Agency and the Wisconsin Department of Natural Resources in development of an additional dredged material disposal at Milwaukee Harbor.

2) Description of LERRDs -The project consists of the construction of a new DMDF within a raised perimeter dike offset from the existing dikes around the previously authorized CDF for placement of dredged material.

3) The land needed for the project is owned by the local sponsor, the Board of Harbor Commission, and was acquired from a land grant from the State of Wisconsin for the construction of the original Section 123 CDF. The site is subject to Navigational Servitude. The Commission also owns the land on which the road easements are located. The Commission has the legal authority to acquire and hold title to real property for project purposes and, through the City of Milwaukee, has the power of eminent domain for this project. There is no lands or interests in land required for the project located outside the sponsor's political boundaries or lands required for the project owned by an entity whose property the sponsor cannot condemn.

4) The project does not include the requirement to acquire non-standard estates. The previous land grant from the State had already been acquired for the former Section 123 project.

5) The Federal 123 project lies fully or partially within the LERRDs required for the project.

6) There is Federally owned land included within the LERRDs required for the project.

7) A portion of the LERRDs required for the original project did lie below the Ordinary High Water Mark. Navigational servitude does apply to this project.

8) Drawings depicting the project area are attached.

9) It is not expected that flooding would occur as a result of the project.

10) A baseline cost estimate is provided in this Real Estate Plan (refer to "Real Estate Cost Estimate"

section of this plan).

11) Relocation assistance - There are no known Public Law 91-646 relocations necessary for the project. The Project will not require displacement of persons or businesses.

12) No present or anticipated mineral activity is within the Project area.

13) The sponsor is fully capable to perform the duties required for any acquisition associated with this project and management of the site (see previous section "Non-Federal Sponsor Identification").

14) The enactment of zoning ordinances will not be required for this project.

15) A schedule of the land acquisition milestones and LERRDs certification will be completed per the Project Schedule (see milestones in the section "Real Estate Management Plan").

16) No facility or utility relocations will be performed as a result of the project construction.

17) Environmental impacts relative to contamination (refer to "Environmental" section of this plan).

18) There is no known opposition from the public to this project

19) If applicable, the non-Federal sponsor will be notified in writing about the risks associated with acquiring land before the execution of the PCA. (Refer to narrative in "Real Estate Management Plan").

20) Other factors:

a. There are no special aquatic sites, including wetlands impacted by the acquisition.
b. There are no historical properties within the proposed Project area.
c. There are no cemeteries or public facilities within the Project area requiring relocation.
d. Plans and specifications do not identify any relocation of public utilities or roadways.

VALUE OF LANDS, EASEMENTS, RIGHTS-OF-WAYS, RELOCATIONS AND DISPOSAL AREAS:

Since the LERRDs have already been acquired in the previous Section 123 Project, it is not necessary to determine a value for this project.

ENVIRONMENTAL

As required by the National Environmental Policy Act of 1969 (NEPA), the Corps of Engineers will provide environmental documentation. An EA will be prepared for the recommended project and a Finding of No Significant Impact (FONSI) will be signed prior to contract advertising.

Coordination efforts with the State Historic Preservation Office (SHPO) for a prior project at the site was made. A determination was found that no properties eligible for or listed on the National Register of

Historic Places were located within the area of potential Project impact.

The Project was evaluated under the following acts, as amended: Fish and Wildlife Act of 1956, Fish and Wildlife Coordination Act of 1958, National Historic Preservation Act (NHPA), Michigan Coastal Zone Management Act of 1972, Endangered Species Act of 1973, Water Resources Development Act of 1976, Clean Water Act of 1977, and Clean Air Act, as well as, Executive Orders 11988 and 11990. The evaluation concluded the proposed Project would not cause significant adverse impacts on the human environment or environmental resources in the Project area.

REAL ESTATE MANAGEMENT PLAN

Real Estate Division will further assess real estate requirements for the recommended plan, as well as, provide detailed information regarding LERRDs identified as necessary for the Project. In addition, the Real Estate Division will coordinate, monitor, and assist with all acquisition activities undertaken by the Non-Federal Sponsor. This will assure that the acquisition process complies with Federal and State laws specifically the requirements under the Federal Uniform Relocation and Acquisition Act (P.L. 91-646). The Real Estate Division will also attend District team meetings, review and provide input into draft and final reports prepared by the team, and participate in the internal technical review.

The Non-Federal Sponsor has been given detailed information regarding the requirements for LERRDs necessary for completion of the Project and fully anticipates meeting the current District schedule. The Real Estate Division will monitor and assist the Sponsor with all acquisition activities which will assure that the acquisition process complies with Federal and State laws.

Subsequent to execution of the PCA, the non-federal sponsor will be advised in writing to proceed with acquisition of the required interests in real estate. The schedule for land acquisition was coordinated with the project PM and the non-federal sponsor.

The Board of Harbor Commission will certify in writing to the Government, with appropriate documentation, that all LERRDs have been acquired after they review the PCA by 26 July 2007. This date for Real Estate Certification is reasonable, since the Board of Harbor Commission owns the lands needed for the project

REAL ESTATE COST ESTIMATE

Federal Administrative costs		$16,000.00
Non-Federal Sponsor costs		
a. LERRDs value	$0.00	
b. Administrative	$0.00	
Total		$16,000.00

EXHIBIT "A"

DETROIT DISTRICT REAL ESTATE
ASSESSMENT OF NON-FEDERAL SPONSOR
REAL ESTATE ACQUISITION CAPABILITY

PROJECT: Dredged Material Disposal Facility (DMDF) Plan Milwaukee, Wisconsin

I. LEGAL AUTHORITY

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes?

(X) Yes
( ) No.
Initials RJ Date: 10 July 2006

b. Does the sponsor have the power of eminent domain for this project?

(X) Yes
( ) No.
Initials RJ Date: 10 July 2006

c. Does the sponsor have "quicktake" authority for this project?

(X) Yes
( ) No.

Initials RJ Date: 10 July 2006

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary?

( ) Yes
(X) No

Initials RJ Date: 10 July 2006

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn?

(X) Yes. State of Wisconsin
( ) No
Initials RJ Date: 10 July 2006

II. HUMAN RESOURCE REQUIREMENTS

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended?

( ) Yes
(X) No

Initials RJ Date 10 July 2006

b. If the answer to II.a. is "yes", has a reasonable plan been developed to provide such training?

(X) N/A

Initials RJ Date: 10 July 2006

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project?

(X) N/A.
Initials RJ Date: 10 July 2006

d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule?

(X) Yes See a. above.
( )
Initials RJ Date: 10 July 2006

e. Can the sponsor obtain contractor support, if required in a timely fashion?

(X) Yes
( ) No

Initials RJ Date: 10 July 2006
f. Will the sponsor likely request USACE assistance in acquiring real estate?

( ) Yes
(X) No

Initials RJ Date: 10 July 2006

III. OTHER PROJECT VARIABLES

a. Will the sponsor's staff be located within reasonable proximity to the project site?

(X) Yes
( ) No

Initials RJ Date: 10 July 2006

b. Has the sponsor approved the project/real estate schedule/milestones?

(X) Yes
( ) No

Initials RJ Date: 10 July 2006

c. Has the sponsor performed satisfactorily on other USACE projects?

(X) Yes
( ) No

Initials RJ Date : 10 July 2006

d. With regard to this project, the sponsor is anticipated to be: highly capable / capable/moderately capable/marginally capable/insufficiently capable

(X) Yes The sponsor has performed successfully on other Corps of Engineers projects and has a full Real Estate Staff from the City of Milwaukee performing Real Estate functions.
( ) No

Initials RJ Date: 1 September 2006

Prepared by:

/S/ ROBERT JAMESON
Signature

Realty Specialist
Title

Reviewed and approved by:

/S/ DON C. ERWIN
Signature

Assistant District Counsel

Title

APPENDIX E

CORRESPONDENCE

FOR THE

DREDGED MATERIAL MANAGEMENT PLAN
MILWAUKEE HARBOR, WISCONSIN

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

WISCONSIN
DEPT. OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary

101 S. Webster St.
Box 7921
Madison, Wisconsin 53707-7921
Telephone 608-266-2621
FAX 608-267-3579
TTY 608-267-6897

June 28, 2004

Mr. William O'Donoghue
USAED-Detroit
Chief, Technical Services Branch
P.O. Box 1027
Detroit, MI 48231-1027

Subject: Request for CDF Use

Dear Mr. O'Donoghue:

The purpose of this letter is to request use of the U.S. Army Corps of Engineers CDF in Milwaukee, Wisconsin, to dispose up to 170,000 cubic yards of dredged material from the Kinnickinnic River between Becher Street and Kinnickinnic Avenue. The purpose of the project is to restore the river for improvement of local navigation conditions and remove contaminated sediments.

The project is located within the Milwaukee Estuary immediately upstream from the Federal Channel as shown in Figure 1 as well as in the attached information sheet. This stretch of the river was dredged to 21 feet deep between 1915 and 1936 according the available historic nautical charts. Sometime in the 1940s, dredging ceased after designation of the Federal Channel. Subsequently, sediment accumulated and resulted in a shallow condition in the area with the water levels ranging from 0-10 ft below the Lake Michigan chart datum water level (577.5 feet) as referenced to the International Great Lakes Datum 1985.

As a typical urban stream the sediment in the project area is contaminated with various pollutants, but mainly PCBs and PAHs. Multiple studies were conducted between 1980 and 1995 by different investigators to define the sediment contamination, and more recently, new navigation needs. A 2002 effort, conducted by the U.S. Army Corps of Engineers (USACE) and funded jointly by the USACE, U.S. Environmental Protection Agency (USEPA) and Wisconsin DNR (WDNR), assessed and defined sediment contamination in the study area. For your information I have enclosed the 2002 assessment data on a CD.

The 2002 sediment assessment data was used in the development of a Concept Design Documentation Report (CDDR) recently completed by the USACE to assist WDNR in determining the best alternative to meet navigation needs in the study area and remove and dispose of contaminated sediments. The alternatives were developed using an interagency team and input from local land and business owners. There is significant interest in this project at the local, state and federal level. As you can see from the letters received to date [Attachment 1], local government and businesses groups are very supportive of the project. However, they have been patient through the planning process and now want to see the project completed quickly.

To this end, WDNR is working with various government agencies and business groups to complete a final engineering design for the site. We plan to apply for a WDNR and USACE dredging permit in August 2004, finish the engineering design work by December 2004 and dredge in 2005, assuming the project is selected for USEPA funding under the Great Lakes Legacy Act. Subsequently, to avoid delays in our project schedule, we would like to initiate coordination now regarding use of the CDF so that any USACE requirements, special conditions or capacity issues can be addressed and, as necessary, be incorporated into the project design.

I look forward to working with you to complete another step toward implementation of the project. Thank you in advance for your prompt attention to our request. If you have any questions or need further information about the project please contact Xiaochun Zhang at 608-264-8888 or by e-mail ZHANGX@DNR.STATE.WI.US.

Sincerely,

Gregory Hill, Chief
Water Quality Modeling Section
Wisconsin Department of Natural Resources
101 S. Webster St., Box 7921
Madison, WI 53707-7921

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Governor Doyle announces $1.5 million Harbor Assistance award for Port of Milwaukee

April 12, 2006

Governor Jim Doyle today announced a $1,488,000 award through the state's Harbor Assistance Program (HAP) that will expand the dredged-material disposal facility at the Port of Milwaukee.

"The Port of Milwaukee is a hub of economic activity that handles a variety of agricultural products and other bulk materials, supporting job growth in Wisconsin and throughout the Midwest," Governor Doyle said. "This award will help the port continue to fulfill its important economic role."

To encourage economic development, Governor Doyle's 2005 - 2007 state budget included $13.9 million to fund the HAP - a $9.7 million increase over the previous two-year state budget. Governor Doyle's "Grow Wisconsin" plan calls for strategic investments in the statewide transportation network to support job growth. In addition to the Port of Milwaukee project, Governor Doyle recently announced two other HAP awards totaling nearly $3 million in Superior and Manitowoc.

The HAP award to the city of Milwaukee will expand the capacity of the Port of Milwaukee's confined disposal facility (CDF) that holds dredged materials. The project is expected to extend the life of the CDF for at least another 10 years. Grant recipients must provide a 20% local match.

Created in 1979, the HAP assists harbor communities to maintain and improve waterborne commerce. Port projects typically involve dock reconstruction, mooring structure replacement, dredging and the construction of facilities to hold dredged material. Since the program began, the Wisconsin Department of Transportation (WisDOT) has administered some $50.2 million in matching funds for 56 port preservation and improvement projects. Successful projects must pass a rigorous cost/benefit analysis and must receive favorable recommendations from the state Harbor Advisory Council and the WisDOT Secretary. Wisconsin's harbors move some 40 million tons of goods worth over $7 billion each year and support some 11,400 jobs.

For more information contact:
Larry Kieck, WisDOT Bureau of Transit, Local Roads, Rails and Harbors

Other news releases:

Law of the month

News release archives

Public hearings and meetings

WisDOT media contacts

(608) 267-9319 lawrence.kieck@dot.state.wi.us

Return to top

Questions about the content of this page:
Office of Public Affairs, opa.exec@dot.state.wi.us
Last modified: April 12, 2006

Bowman, David W LRE

From:	Bowman, David W LRE
Sent:	Wednesday, May 10, 2006 10:05 AM
To:	White, Michael B LRDOR; Hempfling, Thomas E LRDGL; Brown, Theodore A LRDOR; Pawlus, Larry LRE; Fulford, Mike B LRE; O'Bryan, Michael K LRE; Schloop, Wayne LRE; Mundell, Angela R LRE; Miller, Jan A LRDGL; O'Keefe, Gary A LRE; Long, Terry A LRE; Foster, David L LRE; Johnson, Thomas R LRE; Malaikal, Jan C MAJ LRE
Subject:	Milwaukee Site Visit - DMMP

1. Attendees:

Dave Bowman - PM
Tom Johnson - LMAO
Mike White - LRD
Jan Miller - LRD
Eric Reinelt - Port Director
Larry Sullivan - Port Engineer
Jim Clausner - ERDC-WES

2. Meeting convened on 4 May 2006. Attendees met for a brief discussion of the Port of Milwaukee. The Port Director outlined some of the long-term plans of the Port. The Port of Milwaukee appears to be a vital concern with steady growth in the market. One of the areas where they see a lot of growth is in barge traffic. Barges are floated up the Mississippi and then through Chicago into Lake Michigan to Milwaukee. They reported that this type of transport costs only about $20/ton. (Later, on a tour of the Port we saw one of those barges being unloaded (Attached photos)).

After the meeting the Port Director took Mr. White on a tour of the Port of Milwaukee, including the Milwaukee CDF, the old car ferry slip that the Port Authority proposes to fill in with 80,000 cubic yards of dredged material from the CDF, and the proposed dredging area for the Kinnickinnic River. A portion of the Milwaukee CDF was leased back to the Port and they constructed a ferry terminal on that portion of the CDF. Mr. White was very impressed with this beneficial use of a CDF and recommended that the District and the Port work together to write up the story for publication. The Port and the Corps discussed the DMMP process. The Port asked the Corps to focus on two alternatives - raising the CDF dikes and northward expansion. Each alternative presents some potential environmental and engineering issues. Mr. White indicated that LRD strongly supported the link with the KK River project and the win-win nature of the project with the Port, the EPA, the Wisconsin DNR, and the Corps all benefiting from the project. He emphasized that the District needed to maintain close coordination with the Port to ensure that we meet the schedule imposed by the State grant that the Port has received. Scheduling is also critical to meet Federal funding cycles.

On Friday the PM met with the EPA, DNR, Port and stakeholders to provide the status of soil borings and stability analysis work being done by the Corps. The PM also met separately with the Port to outline design parameters for the DMMP. The Port provided

additional information about dredge quantities and that information will be reviewed.

Pictures of the first of several barges the Port of Milwaukee's tenant, Advance Boiler and Tank, located at the Ports inner harbor mooring basin, will receive for a local power plant project. Advance will fabricate these pieces and then barge them to the power plant later this summer. The first barge arrived on May 3rd, 2006; others are expected in June, October, November, December and next March.

The barge and tug used to transport these stainless steel structures to Chicago was Volunteer Barge & Transport of Nashville, TN. The pieces manufactured by PSP Industries of Mississippi were loaded in Utica, Mississippi. Once in Chicago, Calumet River Fleeting towed the barge to Milwaukee along the Lake Michigan coastline. The river barge service to/from Milwaukee is connected to the Mississippi River through the Illinois River, and is available year round.

IMG_0513.JPGIMG_0521.JPG

KINNICKINNIC RIVER RESTORATION PROJECT
FINAL ENGINEERING DESIGN -SHORELINE STABILIZATION
MEETING, May 16, 2007
MEMORANDUM OF MINUTES

Logistics: The meeting began at 1:00 p.m. at the Port of Milwaukee office
Attendees: Larry Sullivan – Port of Milwaukee
Yisheng Lan – Port of Milwaukee
Todd Brachman – Lincoln Warehouse
Richard and Tom Gold – Lincoln Warehouse
Dave Ferron – Paul Davis
Gorge Marek – Quarles and Brady for Raitt Corporation
Lloyd Stephien – Commercial Heat Treating
Kevin Connell – Commercial Heat Treating
Chris Svoboda – Pier Milwaukee
Jerry Starr – B+E 53207
John Klement – Icon Development
Dan Druml – Paul Davis
Gregory F. Bird – Citizen
Sharon Gayan – Wisconsin DNR
Greg Hill – Wisconsin DNR (via teleconference)
Marsha Burzynski – Wisconsin DNR
Xiaochun Zhang – Wisconsin DNR

Key Issues discussed at the meeting:

❖ Project Update

- Barr Engineering will provide a preliminary final engineering design report on May 18, 2007
- The budget item proposed by the Governor for sediment remediation to match federal fund has been adopted by the Joint Committee on Finance of the Wisconsin Legislature. Then the budget proposal will be taken up by the Senate and Assembly.
- USACE is preparing a final design of a cell on Jones Island CDF for disposal of dredged materials from the KK River project area.
- USEPA and WDNR will soon enter a project agreement for supplemental design and remedial planning work for the project.

❖ Shoreline Protection Options

The primary purpose of this meeting was to get feedback from BID members on shoreline protection options. Our goal was to identify the preferred protection option for each riparian property parcel. After going through a discussion session, some of the riparian property owners reached a final decision. Table 1 summarizes the current status for each parcel.

Follow-up action: To those property owners/manager who have not made a final decision, it will be greatly appreciated if you could provide your decision to Xiaochun Zhang by May 25, 2007.

This step affects the overall project such as final engineering design, dredging permits application and approval and project funding. If you still have questions, please feel free to ask.

- **Input to dredging design elements (Attachment A for March-23-07 meeting)**

  - There might be confusions about the attachment A. Each property owner may provide his/her concerns and recommendations (if there is any) regarding the design elements listed in Attachment A. You could submit yours either to WDNR individually or as part of BID's collective comments. WDNR plans to complete the final engineering design report for dredging by the end of July. We will appreciate your comments no later than June 30, 2007. However, the sooner the better.

If anyone finds mistakes and/or missing main items in the above, please let Xiaochun Zhang know. Thank you for your participation in the meeting and support to the project.

Shoreline Protection -KK River Sediment Remediation Project

Parcel Number	Existing shoreline features	Business Owners/ Operation managers	Preferred shoreline protection option	Design for the preferred option		Comments
				Cost/ firm	Timeline	
425	Timber wall/	Commercial Heating/Fishing	Steel Sheet Piling (SSP)			
426A & 426B	Timber wall w/ concrete cap	Icon Development/ Milwaukee Marine	Unknown			considering SSP?
427	Timber wall (analyzed as not protected)	Paul Davis	SSP			
428	Timber wall (analyzed as not protected)	Paul Davis	SSP			
429	**Steel sheet piles (SSP)**	Pier Milwaukee	Baseline option			
432&433	**SSP**	Gillen Comp.	Additional SSP/or a waiver			Followed up after meeting
436	Apparently not protected	RAITT Company/ Gillen Comp.	Unknown/.			owner was absent at the meeting (absent)
437	Timber wall/concrete	Pump House Marina	Unknown /			absent
439	Apparently not protected	Lincoln Warehouse	Baseline option			considering other options
440	**SSP**	RDAR Corp.	Baseline option?			absent
441	Timber wall	B & E 53207 Corp, South wing marine	SSP			
442	Railroad crossing		Not applicable			
443	Not affected	Jon R Curro	Not applicable			

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
BOX 1027
DETROIT, MICHIGAN 48231-1027

July 30, 2007

IN REPLY REFER TO:

Planning, Programs, & Project Management

Mr. Larry Sullivan
Harbor Engineer
2323 S. Lincoln Memorial Dr.
Milwaukee, WI 53207

Dear Mr. Sullivan;

This will provide for your review, technical information regarding the development of the design for a cell within the Milwaukee Harbor Confined Disposal Facility in Milwaukee, Wisconsin. The U.S. Environmental Protection Agency's Great Lakes National Program Office (GLNPO) and the Wisconsin Department of Natural Resources (WDNR) are proposing to conduct a sediment remediation project on the Kinnickinnic River in Milwaukee under authority of the Great Lakes Legacy Act. The U.S. Army Corps of Engineers, Detroit District (Corps) is designing a cell ("KK cell") to contain dredged material proposed to be placed in the Milwaukee Confined Disposal Facility (CDF) as part of a Support for Others Agreement with GLNPO. The proposed configuration of the KK cell is provided as Figures 1 and 2. This design is currently undergoing review by the U.S. Environmental Protection Agency and may undergo minor modifications.

In addition, Cell Design and Operation information (Attachment 1) is being provided in response to an e-mail dated March 23, 2007 from Mr. Bizhan Sheikholeslami (WDNR Waste and Materials Management Program) and subsequent conference calls. Participants in the calls included the WDNR Bureau of Watershed Management, the Milwaukee Port Authority, and the U.S. Environmental Protection Agency's Great Lakes National Program Office (GLNPO). The e-mail expressed concern about the elevation distance between the bottom of the proposed cell and the Low Water Datum for Lake Michigan and indicated that State regulations require that there shall be a separation distance of 10 feet between the lake elevation (Low Water Datum (LWD) =577.5 – IGLD 1985) and the bottom of the KK cell. The proposed design calls for a cell with a bottom elevation 1 foot above LWD. Wisconsin Statutes state that the WDNR can exempt certain solid waste facilities from the licensed landfill requirements on a case by case basis. Mr. Sheikholeslami suggested that the Corps should provide information which explains why the site should be exempted from the licensed landfill requirements. Mr. Sheikholeslami's memo further suggested that the request for exemption should come from the Port Authority as the owner of the site.

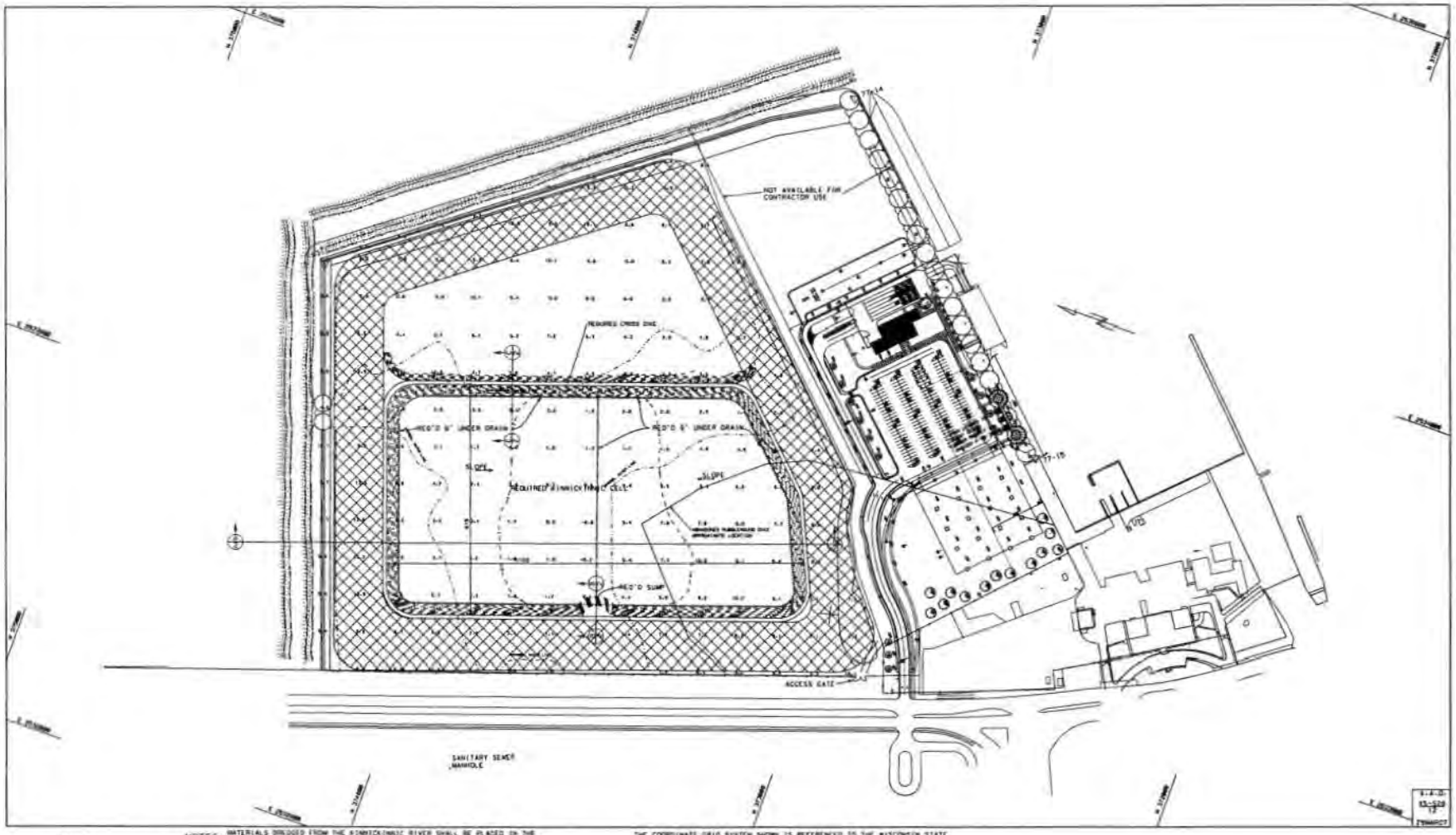
We would propose that you provide that information to the WDNR at your earliest convenience so that we can complete design of the KK cell. Please contact myself or Mr. David Bowman at (313) 226-2223 if you have any questions about the project.

Sincerely,

for Mike B.K. Fulford, P.E., REM
Chief, Planning, Programs, &
Project Management Division

Copy Furnished:

Ajit Vaidya, U.S. Environmental Protection Agency – Great Lakes National Program Office, 77 W. Jackson Blvd., Chicago, IL 60604



LEGEND:

- GPS CONTROL MONUMENT
- BRONZE OR BRASS DISC
- CHANNEL LINE TURNING POINT
- FILL AREA
- 1.0' CONTOURS
- 6" UNDER DRAIN
- WATER LINE

NOTES:

MATERIALS DREDGED FROM THE KINNICKINNIC RIVER SHALL BE PLACED IN THE KINNICKINNIC CELL CONSTRUCTED BY THE CONTRACTOR. ANY MATERIAL THAT IS DEPOSITED ELSEWHERE THAN THE KINNICKINNIC CELL SHALL BE REQUIRED TO BE REMOVED AND PLACED IN THE KINNICKINNIC CELL AT THE CONTRACTOR'S EXPENSE.

ALL ROCK, BOULDERS, SCRAP MATERIALS, STUMPS, DEBRIS ENCOUNTERED IN THE EXCAVATION AREA SHALL BE DISPOSED OFFSITE. THE ABANDONED RUBBLEMOUND DIKE, IF ENCOUNTERED, IS NOT REQUIRED TO BE REMOVED.

ALL STANDING WATER SHALL BE PUMPED TO THE MMSD PRIOR TO CONSTRUCTION.

THE CROSS DIKE SHALL BE CONSTRUCTED PRIOR TO THE PLACEMENT OF DREDGED MATERIAL.

THE ENTIRE FILL AREA SHALL BE FILLED TO A MINIMUM OF +10.0 FEET ABOVE LWD. MATERIAL PLACED IN THE FILL AREA AND CROSS DIKE SHALL BE PLACED IN 1.0' LIFTS AND COMPACTED TO 90% OF THE MAXIMUM STANDARD PROCTOR DENSITY (ASTM D 698). THE FILL AREA SHALL BE GRADED TO A LEVEL SURFACE UPON COMPLETION.

MOORING, OFFLOADING, AND TRANSPORT FACILITIES ARE NOT AVAILABLE FOR CONTRACTOR USE. THE CONTRACTOR SHALL USE IT'S OWN FACILITIES FOR CONVEYING MATERIALS FOR THE DISPOSAL OPERATION AND SHALL BE REMOVED UPON COMPLETION OF WORK UNLESS APPROVED BY THE U.S. ARMY CORPS OF ENGINEERS.

THE CONTRACTOR SHALL PREVENT EROSION OR DAMAGE OF THE CDF DIKES BY IT'S OPERATIONS. ANY DAMAGE SHALL BE REPAIRED BY THE CONTRACTOR AT IT'S OWN EXPENSE. ALL REPAIRS SHALL BE APPROVED BY THE U.S. ARMY CORPS OF ENGINEERS.

THE COORDINATE GRID SYSTEM SHOWN IS REFERENCED TO THE WISCONSIN STATE PLANE COORDINATE SYSTEM, LAMBERT PROJECTION: SOUTH ZONE (4803). NORTH AMERICAN DATUM 1983, U.S. FOOT.

ALL ELEVATIONS AND DEPTHS ARE IN FEET AND ARE REFERENCED TO LOW WATER DATUM (LWD). 577.5 FEET ABOVE MEAN SEA LEVEL AT REVOUSKI, QUEBEC, I.G.L.D. 1985.

THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES INDICATED AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME.

THE SURVEY SHOWN WAS CONDUCTED ON 26-28 MAY 2007.

THE SOUNDINGS SHOWN WAS CONDUCTED ON 20 MAY 1996. SOUNDINGS SHOWN AS THUS -10.2

NUMBER	DATE	REVISION	BY

U.S. ARMY CORPS OF ENGINEERS, DETROIT DISTRICT
CONSTRUCTION, COST, & GENERAL ENGINEERING BRANCH

ESTIMATED BY: K.W.
DRAWN BY: K.W.
CHECKED BY: K.W.
REVIEWED BY: MGR.
APPROVED BY: CHF.

MILWAUKEE HARBOR, WI.

KINNICKINNIC CELL

SITE PLAN

PLOT SCALE: FULL
DATE: 13 JUN 07
SHEET: 1 OF 1
FILE NAME:
SOLICITATION NUMBER:
CONTRACT NUMBER:

Figure 1

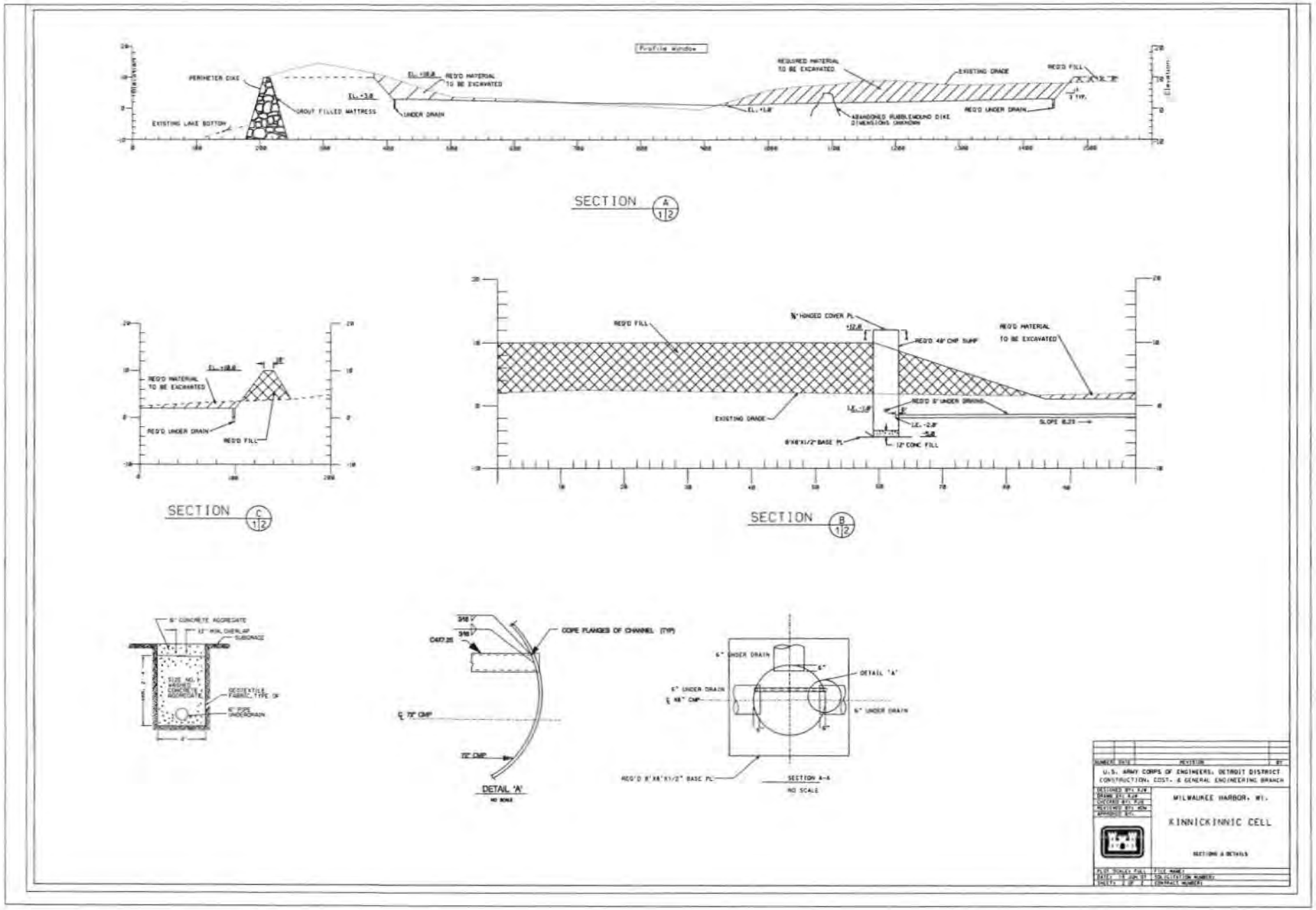

PERIMETER DIKE
GROUT FILLED MATTRESS
EXISTING LAKE BOTTOM
UNDER DRAIN
REQ'D MATERIAL TO BE EXCAVATED
EXISTING GRADE
REQ'D FILL
REQ'D UNDER DRAIN
ABANDONED RUBBLEMOUND DIKE DIMENSIONS UNKNOWN
SECTION A 1/2
REQ'D MATERIAL TO BE EXCAVATED
REQ'D UNDER DRAIN
REQ'D FILL
SECTION C 1/2
REQ'D FILL
HINGED COVER PL
REQ'D 48" CMP SLIP
REQ'D MATERIAL TO BE EXCAVATED
EXISTING GRADE
REQ'D 6" UNDER DRAIN
12" CONC FILL
SLOPE 0.25
SECTION B 1/2
6" CONCRETE AGGREGATE
SUBGRADE
GEOTEXTILE FABRIC, TYPE IV
6" PVC UNDERDRAIN
COPE FLANGES OF CHANNEL (TYP)
DETAIL 'A'
NO SCALE
6" UNDER DRAIN
DETAIL 'A'
REQ'D 8'X8'X1/2" BASE PL
SECTION A-A
NO SCALE
U.S. ARMY CORPS OF ENGINEERS, DETROIT DISTRICT
CONSTRUCTION, COST, & GENERAL ENGINEERING BRANCH
MILWAUKEE HARBOR, WI.
KINNICKINNIC CELL
SECTIONS & DETAILS

Figure 2.

Attachment 1.

Cell Design and Operation Information for the Proposed Great Lakes Legacy Act Project at the Kinnickinnic River in Milwaukee, Wisconsin

Prepared by the U.S. Army Engineer District, Detroit
for the
U.S. Environmental Protection Agency – Great Lakes National Program Office

NR 504.06(2)(b) The separation distance between the seasonal high groundwater table and the bottom of the clay component of a composite liner or a clay liner shall be at least 10 feet except for zone-of-saturation landfills.

The existing dredged material in the Milwaukee CDF shows characteristics that have created an efficient barrier against the migration of any water or contaminants from within the CDF. Soil borings (previously provided) indicate that the dredged material present meets both the fine grain soil definition of WDNR [NR 500.03 (86)] as well as the soil requirements for clay liner material cited in WDNR [NR 504.06 (2) (a)]. Underneath the proposed bottom elevation of the cell throughout the entire CDF is consolidated dredged material ranging anywhere from 6-14 feet deep near shore to approximately 20-24 feet at the most lakeward side of the CDF. Extensive geotechnical data for permeability of fine-grained dredged material in CDFs show that they are capable of achieving field hydraulic conductivities low enough to equal that of constructed clay liners ($<10^{-7}$ cm/sec) (Krizek and Salem 1974). Guidance in USEPA/USACE (2004) states that fine-grained dredged material tends to form its own disposal-area liner as particles consolidate. Similar guidance is provided in USACE (1987) and USACE (2003). Guidance in Richardson et al. (1996) also notes the self-sealing property of fine-grained dredged material. Due to the low permeability of the dredged material beneath the bottom of the proposed KK cell (starting at elevation 577.5) which overlays an impermeable clay stratum, it is reasonable to conclude that no hydraulic connectivity will be present from which contaminants can migrate from the site to the lake (Richardson 1996).

There would be a minimum of 100 feet of this impermeable dredged material between Lake Michigan and the proposed cell (Figure 1). Currently the Milwaukee CDF has an upland area on the west side and a car ferry operation bordering the south side which provides a 300 foot buffer between the lake and the CDF. The east side of the cell is also at least 300 feet from the lake. The northernmost portion of the cell is approximately 100 feet from the lake however both the north and east perimeter dikes have an existing grout mattress liner within the CDF.

Potential migration will be further reduced as leachate is pumped from the cell to minimize any lateral flows or downward migration from the site. Prior to construction, any ponded water

in the CDF would be removed. Leachate would be collected in the KK cell during dredging operations and until a suitable cover is placed. Since the dredging and disposal operation involves mechanical (rather than hydraulic) methods, the addition of water will be minimal. Placing perimeter trenches in the cell eliminates the need for an extensive leachate collection system. The design calls for a temporary leachate collection system that is low to zero maintenance and will insure proper collection of surface runoff as well as perched water within the cell. A trench will be dug around the cell perimeter and filter cloth will be installed along with 6-inch perforated pipe and then filled with crushed stone. The trench will drain to a stand pipe with a sump where any leachate would then be discharged to the Milwaukee Metropolitan Sewerage District wastewater treatment system. We understand that approval to discharge this liquid into the wastewater treatment system has been obtained by the Port of Milwaukee. Leachate collection systems not only remove unwanted liquid in the cell, but they increase consolidation in fine grained sediments while decreasing permeability. The type of leachate collection described above has been shown to decrease permeability by 2 orders of magnitude in fine grain dredged material (USACE 1978). Again, a leachate collection system will reduce the hydraulic head in the cell, further eliminating the probability of migration of the contaminants out of the site.

In summary, after analysis of WDNR Solid Waste and Landfill regulations in reference to the KK cell, it is apparent that impermeable soil and a properly designed leachate collection systems are key attributes of a well designed dredged material containment cell. Existing data has shown that development of an impermeable layer in the bottom of the new cell has occurred over time as the dredged material has consolidated. The favorable characteristics of the existing soil material combined with controls such as the leachate collection system described ensures a secure environment will continue to exist for the materials that will be placed in the KK cell.

> The interim and final cover cap. The cover needs to be placed within 30 days of the completion of dredging [NR 506.08(3)]. If the cap is not impervious then a leachate collection system needs to continue to operate until an impervious cap is placed. The Department will accept the future dredging as the final cover if it exceeds three feet in depth with minimum 2% slope on the top. The leachate collection will continue until such requirement is met.

Up to 170,000 cubic yards of dredged sediment from the Kinnickinnic River is expected to be placed into the KK cell constructed in the western half of the CDF. The placement of this Kinnickinnic River material would bring the top elevation of the cell back up to +10.0 feet above LWD. The top of the existing SSP walls on the west side of the CDF are at elevation +10.5 above LWD, the outer dike rubblemound structures on the north and east side of the CDF are at elevation +10 above LWD. Immediate capping of this material would be difficult due to the unconsolidated nature of the dredged material. The dredging and disposal operation would need to be modified to add a solidification agent. We would propose instead to allow the leachate collection system to operate for at least six months after the dredging operation has been completed. The Corps is preparing a Dredged Material Management Plan for the Milwaukee Harbor. One alternative under consideration would construct a new dredged

material disposal facility on top of the existing CDF. This new facility would eventually provide 8 feet of impermeable dredged material above the proposed CDF cell. However, due to the size of the KK cell a 3- foot cover would likely not be obtained for several dredging cycles. A minimum two percent slope at the final grade will be completed if determined necessary by the WDNR after analysis of the final closure conditions (USACE 2007).

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Xiaochun Zhang (WDNR) Email (March 28, 2007). "Summary of conference call Re: cell design for the KK River Project 3-28-07"

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

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December 21, 2007

File Ref: 1600

U.S. Army Corps of Engineers - Detroit District
ATTN: CELRE-PL
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Detroit, MI 48231-1027

Dear Mr. Gary A. O'Keffe:

Thank you for the opportunity to comment on the *November 2007 Phase II Report, Draft Dredged Material Management Plan (DMMP) and Environmental Assessment* for Milwaukee Harbor, Milwaukee. The Department concurs with the report's recommendation to construct a new Dredge Material Disposal Facility on top of the existing Jones Island Confined Disposal Facility. The new facility would have a minimum 20-year (510,000 cubic yard) capacity for management of dredged material.

Frank Schultz, Waste& Materials Management Program supervisor (414) 263-8694, is our liaison for the project. He will facilitate Department endangered resources, waste management, and water quality regulatory activities on this project as the Detroit District proceeds with detailed design.

Sincerely,

Gloria L. McCutcheon

Gloria L. McCutcheon, P.E.
Regional Director

cc. Marsha Burzynski – SER/Milwaukee
Sharon Gayan – SER/ Milwaukee
Mike Thompson – SER/Milwaukee
Bizhan Sheikholeslami - SER/Waukesha
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DEPARTMENT OF THE ARMY
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IN REPLY REFER TO
Executive Office

FINDING OF NO SIGNIFICANT IMPACT

DREDGED MATERIAL DISPOSAL FACILITY AT JONES ISLAND CDF MILWAUKEE HARBOR, WISCONSIN

The Corps of Engineers is proposing to construct a Dredged Material Disposal Facility (DMDF) for disposal of sediments from maintenance of the Milwaukee Harbor Federal Navigation Project. The selected alternative proposes the continued use of the Milwaukee Harbor (Jones Island) Confined Disposal Facility (CDF) site, tiering a DMDF on top of it. The facility would accommodate, at a minimum, 20-years of dredged material, which is approximately 510,000 cubic yards. The DMDF would consist of a raised perimeter dike offset from the existing dikes of the CDF. Alternatives to the proposed DMDF include constructing a DMDF adjacent to the Jones Island facility, open water placement, beach nourishment and the no action alternative.

The proposed project would not result in any significant cumulative or long-term adverse environmental effects. The DMDF has been designed to adequately isolate and contain contaminated dredged material. There would be a permanent increase in the height of the Jones Island facility profile. Construction of the facility would be localized and confined to the immediate vicinity within an area that is remote and currently operated as a disposal facility. Environmental consequences of periodic disposal activity would be local in scope, of minor magnitude and a continuation of ongoing harbor operation and maintenance practices. Project benefits include continued maintenance of Milwaukee Harbor and the continued economic benefits associated with it. An Environmental Assessment (EA), *Dredged Material Disposal Facility at Jones Island CDF, Milwaukee Harbor, Wisconsin* was prepared in accordance with the National Environmental Policy Act of 1969. This EA along with The *Milwaukee Harbor Draft Dredged Material Management Plan* Study document were made available for agency and public review November 25, 2007.

Review of the proposed Dredged Material Disposal Facility at Jones Island CDF project plan and a single positive public review comment indicate that the proposed base plan action does not constitute a major Federal action significantly affecting the human environment; therefore, an environmental Impact Statement will not be prepared.

17 JAN 2008
DATE

William J. Leady
Lieutenant Colonel, U.S. Army
District Commander