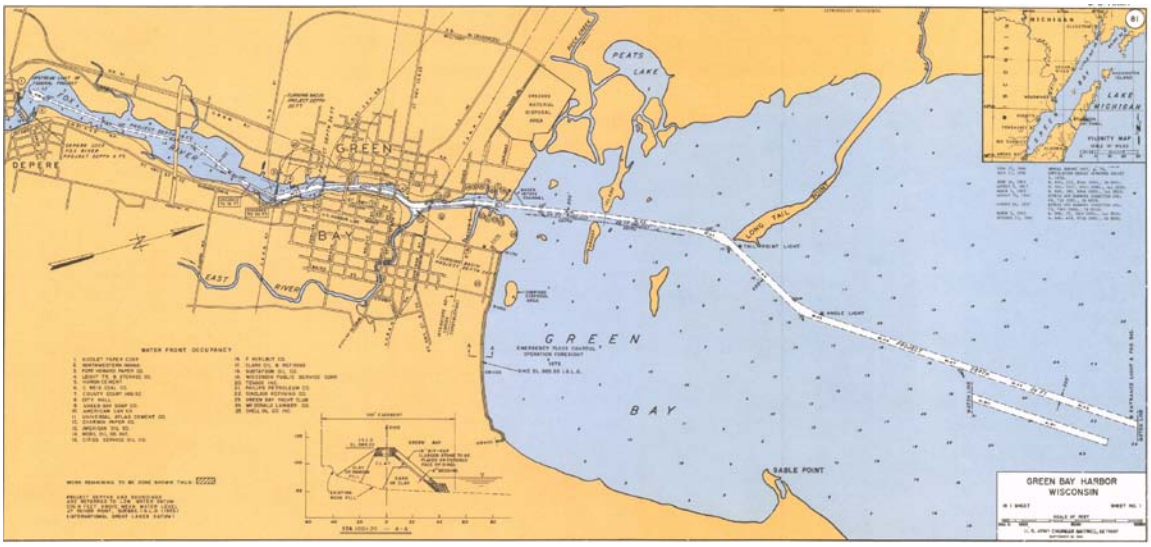
Appendix E

Study of Offshore Disposal of Dredged Material Green Bay



Prepared For:

Planning, Programs, and Project Management

Prepared By:

Great Lakes Hydraulics and Hydrology Office

US Army Corps
of Engineers
Detroit District

Introduction

This study was undertaken as a joint effort between the US Army Corps of Engineers Detroit District and Engineering Research and Development Center. The purpose was to examine offshore disposal of dredged material from the Green Bay navigation channel.

Model

LTFATE is a numerical modeling system for systematically estimating the long-term response of an open-water dredged material disposal site to local environmental forcings. The methodology is based on the development of databases of wave and current time series and the application of these boundary conditions to coupled hydrodynamic, sediment transport, and bathymetry change models. The approach was developed to provide an estimate of long-term material fate over periods of time on the order of months to years.

Waves

The best wave data available within Green Bay was that found by Baird and Associates in the "Cat Island Chain Restoration Design Development Report" (April 2005). Baird used wind data from Green Bay Airport and pressure transducers to create and calibrate a 2D WAVAD model. WAVAD is a second generation, two-dimensional wave generation and propagation model, similar to the WISWAVE model used by the U.S. Army Corps of Engineers. From the WAVAD model, storms were extracted at the boundary of the STWAVE model. STWAVE was used to transform the waves from deeper water into shallower depths around the Cat Islands. The storms at this boundary were the furthest offshore that were available in Green Bay. Therefore, they were chosen to use in the LTFATE model. It was also important to examine wind effects, which also can create currents. Typically when measured wave data or hindcast data are not available, a 30-40 mph sustained wind is used over a subject fetch. It was assumed that strong winds would be present during the subject storms so wind was also applied in LTFATE. The subject storms are shown in Table 1.

Table 1 – Storms Modeled

Storm H_s (ft)	Storm T_p (sec)	Storm Duration (hrs)	Wind Speed (mph)
12.1	7.41	24	30
12.1	7.41	24	40

Sediment

The most recent soil samples gathered in the dredged channel by the Detroit District were from 2006. This report showed that most of the sediment ranged from fine sand to silt. 17 samples were gathered in 2006 and three were selected to model. The three selected are shown in Table 2. The samples ranged from the most coarse to the most fine with one being in between.

Table 2 – Sediments Modeled

Sample	Silt (%)	Sand (%)	D_{50} (mm)	D_{85} (mm)
3	0	100	0.2	0.31
6	35	65	0.07	0.13
16	65	35	-	0.08

Analysis

Several iterations were performed to determine the depth at which sediment does not move. Depths were modeled from 30 feet to 140 feet. In addition to depth, it was important to examine whether wind stress had a significant impact on erosion. A representative depth of 50 feet was examined and the results are shown in Table 4.

Table 3 – Various Shear Stresses for 24 hr storm, 30 mph wind, 50 ft depth

Sediment Grab Sample No.	Bed Shear Stress Current-induced Shear Stress (0.3 ft/s surface current) (Pa)	Current and Wind-induced Shear Stress (Pa)	Current, Wind and Wave-induced Shear Stress (Pa)
3	0.10746	0.10752	3.45

From the results in Table 3, it was evident that wind induced shear stress had less than a 4% impact on the total shear stress. Therefore, it seemed unimportant whether a 30 mph or 40 mph wind was used. For the shallower depths where wind would have more of an effect, a 40 mph wind was used. For depths 100 feet and greater a 30 mph wind was used. In terms of sediment, all 3 samples were modeled for depths up to 100 feet. However, these runs showed very little difference in results so for the final runs, only sample 3 was used. All of the modeling results are shown in Table 4.

Table 4 – Modeling Results

Storm Duration (hr)	Wind Speed (mph)	Water Depths (ft)	Sediment Grab Sample No.	Erosion Thickness caused by Current, Wind and Wave-induced Shear Stress (in)
24	40	30	3	> 20
24	40	30	6	> 20
24	40	30	16	> 20

Table 4 - Continued

Storm Duration (hr)	Wind Speed (mph)	Water Depths (ft)	Sediment Grab Sample No.	Erosion Thickness caused by Current, Wind and Wave-induced Shear Stress (in)
24	40	40	3	> 20
24	40	40	6	> 20
24	40	40	16	> 20
24	40	50	3	> 20
24	40	50	6	> 20
24	40	50	16	> 20
24	40	60	3	> 20
24	40	60	6	> 20
24	40	60	16	> 20
24	40	70	3	> 20
24	40	70	6	> 20
24	40	70	16	> 20
24	40	80	3	> 20
24	40	80	6	> 20
24	40	80	16	> 20
24	40	90	3	> 20
24	40	90	6	> 20
24	40	90	16	> 20
24	40	100	3	> 20
24	40	100	6	> 20
24	40	100	16	> 20
24	30	50	3	> 20
24	30	100	3	> 20
24	30	110	3	> 20
24	30	120	3	> 20
24	30	130	3	14
24	30	140	3	0

Conclusions

From these results, it was evident that if it was determined to be necessary for the sediment to remain at rest, it would need to be placed at a depth of 140 feet or deeper. It is important to note that these model results were developed using the most available data. It is possible that the results could change if resources were available to determine more accurate wave heights, periods and currents at the subject depth. In addition, migration of the sediment was not examined, only at what shear stress the sediment would mobilize.