COASTAL ENGINEERING APPENDIX

For

Public Beach Protection in Four Illinois Coastal Communities

Beneficial Use of Dredged Material Pilot Project Program

July 2020
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ATTACHMENT D-1 – Wave Roses from WIS Hindcast Stations
1.0 Background

The proposed pilot application of dredged material from Waukegan Harbor would involve placing sand onshore at six sites immediately north of Chicago. At this stage in the program TS-EH has not yet been tasked with the development of construction profiles at each of the sites. Instead, the information necessary to develop these has been collected.

2.0 Design Parameters

2.1 Lake Bed Elevation

Pre-placement conditions of the proposed sites will be developed using the most recently collected bathymetric data. Should such datasets not be available for a specific location, JALBTCX bathymetric data will be used.

2.2 Wave Climate

Design wave conditions are developed using hindcast data made available through the Wave Information Studies (WIS) project, administered through the Coastal and Hydraulics Laboratory at ERDC. The nearest hindcast computational point for each of the six sites is as follows:

<table>
<thead>
<tr>
<th>Site</th>
<th>Station ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunset Park and Beach in Lake Bluff</td>
<td>94029</td>
</tr>
<tr>
<td>Foss Park in North Chicago</td>
<td>94030</td>
</tr>
<tr>
<td>Glencoe Beach in Glencoe</td>
<td>94025</td>
</tr>
<tr>
<td>Dog Beach in Evanston</td>
<td>94020</td>
</tr>
<tr>
<td>Greenwood Street Beach in Evanston</td>
<td>94020</td>
</tr>
<tr>
<td>Lee Street Beach in Evanston</td>
<td>94020</td>
</tr>
</tbody>
</table>

The most frequent, and largest, waves were Angle Class III, typically approaching from the NNE direction (~22.5 degrees). For the purpose of this feasibility study, only Angle Class III waves will be considered for this analysis. Wave roses for the aforementioned stations are included in Attachment 1.

The meteorological direction convention used in the analysis is illustrated in Figure 1. Waves from the north come from 0-degrees while waves from the east come from 90-degrees. For the purposes of design, it is assumed that an approach angle of 90 degrees is perpendicular to the design section. Therefore, a wave approaching from a 22.5 degree angle from a meteorological convention would translate to a 67.5 degree angle from a wave transformation convention.
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- Angle Class I: Mean wave approach angle greater than 30-degrees to right of normal to shore (90- to 150-degrees)
- Angle Class II: Mean wave approach angle within 30-degrees to either side of normal to shore (30- to 90-degrees)
- Angle Class III: Mean wave approach angle greater than 30-degrees to left of normal to shore (330- to 30-degrees)

Figure 1: WIS Hindcast Station 94029 Wave Rose
2.3 Lake Level

An analysis of the Calumet Harbor, Illinois and Milwaukee, Wisconsin lake level gages was completed by Baird and Associates in 2013 in support of the Rosewood Beach Park Project in Highland Park, Illinois. The results of this work included extraction of still-water levels and surge heights for a range of return periods. Using the total lake level value for each return period, a regression equation was developed to estimate the 20-year return period which had not been included in the analysis. It is assumed that the differences in lake levels between the considered sites and Highland Park, Illinois are negligible.

Using the total lake level value for each return period, a regression equation was developed to estimate the 20-year return period which had not been included in the analysis. This equation is as follows:

\[ \text{[Total Water Level]} = 581.47 + 0.7366 \cdot \ln \text{[Return Period]} \]

<table>
<thead>
<tr>
<th>Return Period</th>
<th>Elevation (ft, LWD) SWL + Surge</th>
<th>Elevation (ft, IGLD85) SWL + Surge</th>
<th>Elevation (ft, NAVD88) SWL + Surge</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-year</td>
<td>6.7</td>
<td>584.2</td>
<td>584.7</td>
</tr>
<tr>
<td>25-year</td>
<td>6.4</td>
<td>583.9</td>
<td>584.4</td>
</tr>
<tr>
<td>20-year</td>
<td>6.2</td>
<td>583.7</td>
<td>584.1</td>
</tr>
<tr>
<td>10-year</td>
<td>5.8</td>
<td>583.3</td>
<td>583.8</td>
</tr>
<tr>
<td>5-year</td>
<td>5.3</td>
<td>582.8</td>
<td>583.3</td>
</tr>
<tr>
<td>2-year</td>
<td>4.3</td>
<td>581.8</td>
<td>582.3</td>
</tr>
</tbody>
</table>

3.0 Climate Change Impacts

USACE is undertaking its climate change preparedness and resilience planning and implementation in consultation with internal and external experts using the best available and actionable climate science. As part of this effort, USACE has developed concise reports summarizing observed and projected climate and hydrologic patterns, at a HUC2 watershed scale cited in reputable peer-reviewed literature and authoritative national and regional reports. Trends are characterized in terms of climate threats to USACE business lines. The reports also provide context and linkage to other agency resources for climate resilience planning, such as downscaled climate data for sub-regions and watershed vulnerability assessment tools.

The USACE literature review report focused on the Great Lakes Region was finalized in April 2015 (USACE, April 2015). Waukegan Harbor is located in the Great Lakes Region. The USACE literature review document summarizes several studies which have attempted to project future changes in conditions on Lake Michigan. Based on a review of two studies, while temperature scenarios show consistent warming, precipitation scenarios show a wide range of both wetter and drier conditions. One such study, which utilized multiple Global Climate Models (GCMs) representing three emissions scenarios were employed to estimate possible future levels of Lake Michigan-Huron using the lake-level model developed by the Great Lakes Environmental Research Laboratory (GLERL). A wide range of possible resulting lake levels was indicated, varying from -9.8 feet to +4.9 feet, as shown in Figure 3. The years represent the first year of a 15-year averaging period. The line in the box represents the median of all cases. The top and bottom of each box represent the 25th and 75th percentile values. The plus signs represent outlines. There is also a large range of uncertainty regarding potential future lake levels, although a majority of the projections would indicate a decrease in lake levels with time.
Figure 2: Lake Michigan-Huron level departure (m) distributions based on the GCM/GLERL simulations for three averaging periods for three emission scenarios.

When considering a single placement through this pilot program, it is unlikely that the placed material will still be in place to be impacted by climate change impacts. Subsequent placements and their construction profiles will have to be evaluated based on the amount of shoreline available for the placement of dredged materials.

4.0 References


ATTACHMENT D-1 – Wave Roses from WIS Hindcast Stations
WIS Hindcast Station 94020 Wave Rose

Lake Michigan WIS Station 94020
ANNUAL 2014
Long: -87.6° Lat: 42.04° Depth: 10 m
Total Obs / Total Ice: 8759 / 1319

WAVE ROSE

SIG WAVE HEIGHT (m)

0.0-0.5 0.5-1.1 1.1-1.5 1.5-2.0 2.0-2.5 2.5-3.0 3.0-3.5 3.5-4.0

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WIS Hindcast Station 94025 Wave Rose

Lake Michigan WIS Station 94025
ANNUAL 2014
Long: -87.88°  Lat: 42.16°  Depth: 16 m
Total Obs / Total Ice : 8759 / 1295
WAVE ROSE

frequency of occurrence

SIG WAVE HEIGHT (m)

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WIS Hindcast Station 94029 Wave Rose

Lake Michigan WIS Station 94029
ANNUAL 2014
Long: -87.76° Lat: 42.28° Depth: 16 m
Total Obs / Total Ice : 8759 / 1248
WAVE ROSE

frequency of occurrence

SIG WAVE HEIGHT (m)

0.1 1.2 2.3 3.4 4.5

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WIS Hindcast Station 94030 Wave Rose

Lake Michigan WIS Station 94030
ANNUAL 2014
Long: -87.76°  Lat: 42.32°  Depth: 19 m
Total Obs / Total Ice : 8759 / 1272
WAVE ROSE

SIG WAVE HEIGHT (m)

US Army Engineer Research & Development Center  STS4030