# Platte River, Sleeping Bear Dunes

## Conceptual Solutions for Platte River Dredged Material

## Contract No. W911K-10-D-002, Task Order 0016

**December 16, 2011**

**11602.117**

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*Prepared for*


*Prepared by*

**U.S. Army Corps of Engineers**
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## TABLE OF CONTENTS

## 1.0 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) - Detroit District is assisting the National Park Service (NPS) with several projects requiring conceptual designs and cost estimates for ways of addressing various issues occurring at five locations around the Great Lakes, including the Platte River site in the Sleeping Bear Dunes National Lakeshore. Reference is provided to contract No. W911XK-10-D-0002, IDIQ for Planning, Engineering and Design Services.

Two issues exist at the Platte River site:

- The requirement for annual dredging needed to keep the river mouth open to boat traffic
- The existence of an unnatural and unsightly mound of stockpiled dredge material that has been built up by depositing the material, from annual dredging campaigns, on the east side of the river.

An underlying goal of the NPS is to restore, *to the fullest extent practical*, the river and its adjacent shorelines to their natural condition, while at the same time allowing boat launching for access to Lake Michigan. Toward that end, it is the intent of the NPS to lessen the negative impacts of annual dredging operations and to remove the mound of stockpiled dredge material.

In accordance with the scope of work required by the contract referenced above, several tasks have been completed, including:

- data collection and review;
- performance of a site visit;
- photogrammetric analysis;
- preliminary review of Piping Plover habitat;
- development of conceptual level designs addressing the removal of stockpiled dredge materials and accommodation of boat access to Lake Michigan; and
- cost estimating.

The remainder of the report is dedicated to describing the work performed for the study, and includes a final recommendation for a preferred solution.

## 2.0 EXISTING CONDITIONS

Existing conditions have been determined from a review of available information (aerial photos, maps, discussions with NPS representatives, sediment samples). Additionally, a site visit was performed on May 3, 2011. The purpose of the visit was to take field measurements, sediment samples, observe processes and learn about site constraints.

Referring to Figures 2.1 and 2.2, the Platte River is located in the southern portion of Sleeping Bear Dunes National Lakeshore, approximately seven miles southwest of the Village of Empire. After flowing through a series of lakes, the river continues for three miles to Platte River Point where it discharges into Lake Michigan. A county-owned boat launch is located at Platte River Point, approximately 900 ft from the river mouth at the end of Lake Michigan Road.


**Figure 2.1 Sleeping Bear Dunes National Lakeshore**


**Figure 2.2 Platte River Point**

## 2.1 Boat Launch

The boat launch is a public facility on the county road right-of-way and maintained by the Benzie County Road Commission. It is used heavily in the autumn by salmon fishermen working to get their boats out into Platte Bay and greater Lake Michigan. Discussions with NPS staff in October 2010 indicated the following statistics and dimensions:

- Approximately 300 boaters use the boat launch and dredged channel during a typical salmon fishing season
- Approximate dimensions:
  - Typical boat length is 16 ft, maximum 22 ft
  - Required water depth is 2.5 ft
  - Dredged channel width is 30-35 ft

## 2.2 Annual Dredging

Dredging between the boat launch and river mouth has been performed since 1968 and was initially done by the State of Michigan. Dredging currently occurs after Labor Day, extending from the boat launch through the sand bars until open water is reached. This results in water depths

deep enough to allow boats, particularly motor craft, access to Lake Michigan without having to raise their motors and walk their boats to the river mouth, as was the practice prior to 1968.

Removal of material from the river is done with a tracked excavator, operating in the water and on shore. In the early years of dredging, approximately 2,600 cubic yards of the dredged material was placed along a 1,200 ft stretch of the west side of the river for the dual purpose of stabilizing the bank and to keep the river mouth from wandering. The existing practice is to dispose of the material on the east bank of the Platte River, in the reach between the boat launch and the river mouth. From discussions with NPS officials, it is understood that approximately 900 cy/yr needs to be removed annually and stockpiled on the east bank to enable reliable boat access between the boat launch and Lake Michigan.

## 2.3 Dredged Material Mound on East Bank

Pranger (2005) estimated that the total volume of dredged material deposited on the east bank to be approximately 17,600 cubic yards. From discussions with NPS, less than 6,000 cubic yards have been dredged and deposited on the east side of the river since the 2005 estimate was made.

Rough measurements of the stockpile indicate dimensions of 500 ft in length, a width of 160 ft and a height of 13 ft. Based on these figures, it is estimated that the volume of the material is approaching 40,000 cubic yards. It is understood that accurate records of the exact quantities of material that have been dredged were not maintained and the difference in the estimates cannot be explained.

The current Michigan Department of Environmental Quality (MDEQ) permit contains rough cross-sections of the mound, which have been used to calculate a total mound volume of approximately 32,000 cubic yards. The MDEQ permit, entitled "Notice of Authorization," issued on August 31, 2009 expires on August 31, 2014. A copy is included in this report as Appendix C.

For purposes of this study, a quantity of 32,000 cubic yards will be used to analyze the various conceptual designs discussed.

The surface of the mound is covered mostly with gravel and medium sized sand. A test pit dug into the stockpile indicated a much larger percentage of sand and less gravel and pebbles than at the surface, indicating that sand has likely been winnowed from the surface by wind, leaving a lag of gravel.

## 2.4 Platte River and Shoreline

**Platte River Upstream** – The upstream portion of the Platte River was investigated via a canoe in order to observe river bank and river bed conditions. The river has a mild slope and occasional evidence of river bank erosion, but nothing severe to result in significant volumes of sediment. The river bed was either sandy or covered with a gravel/cobble lag, with boulders in some areas.

**West Side of Platte River** - Sand dunes up to 20 ft high were present at Platte River Point, west of the river. The beach at Platte River Point was approximately 80 ft wide. Material in this area consisted mostly of sand with areas of scattered gravel and pebbles. A beach berm was near the water line with a swale (i.e. a lower area) behind it. Sand was wet through the back of the beach, although it was very far from the waterline. Two pits dug on the beach showed uniform sand without any particular layers. A thin surface layer of black sand was observed on the berm near the waterline.

**Platte River Point** - A bypassing shoal in the form of a bar existed offshore of the river mouth, and sediment is likely being transported around Platte River Point by the action of diffracted waves. Sediment begins heading to the east along the northern shoreline of this section of the park into Platte Bay, and this process has formed a large bypass shoal off the mouth of the river. Sediments bypassing the river mouth continue east along the north shoreline of the park and are being deposited upon the beaches.

The lakebed was mostly covered with cobbles and boulders, just east of the river mouth to the extent visible from the shore. The lakebed around the waterline was covered mostly with cobbles near the river mouth and became more sandy (ripples) towards the east.

**East Side of Platte River** - The beach east of the river mouth was mostly sand with scattered pebbles in some areas. It was up to 80 ft wide and featured a berm near the water line with a swale behind the beach. It is likely that this beach is recently accreted and at least partly made from material eroded from the exposed edge of the dredged material. The beach material was sand, and test pits indicated no significant layering.

Vegetated bluffs, about 20 ft in height (from LiDAR data), were observed at the east end of the site. Examination of the material showed sand stained with brownish organic material.

## 2.5 Piping Plover

Steve Yancho, Chief of Natural Resources for the Sleeping Bear Dunes National Park, and Alice Van Zoern, a Piping Plover researcher for the University of Minnesota, were interviewed during the site visit to collect information concerning Piping Plover habitat use and nesting behavior at Platte River Point. Information critical to the planning, timing and design of the project gathered from the site visit and interviews include:

1. Plovers arrive and nest from early April until early August when the juveniles leave the nest and become mobile. Sound disturbances from project activities will be a concern during this time period.
2. During most years, Plovers nest on dredged material, usually along the west side of the river and the mound of dredged material. It seems that they prefer nesting on the cobbles deposited by dredging activities and actively seek out this substrate. The cobbles camouflage the birds and their nests.

3. In 2011, there were eight nesting pairs in the Platte River area with three nests being near the project area. One nest is located directly on the mound of dredged material and two nests are west of the mouth of the river along the beach. Usually, most Plover nests are along the west bank of the river on the dredged material.
4. Plover nests are usually identified and marked by mid-May.
5. Plovers have been nesting on the mound of dredged material since 2004 as it provides a good habitat.
6. Due to the ever-changing nature of the beach and lakeshore environment, Piping Plover are highly adaptive to a changing habitat.
7. The biggest concerns for project planning will be timing around the Plover nesting season and the loss of cobble substrate. If these two issues are properly mitigated, the impact on Piping Plover should be minimal.

## 2.6 Sediment Sampling

Sediment samples were obtained along the beaches to the west and east of the Platte River mouth and from the Platte River bottom. Grain size analyses were run on each of the samples by Coleman Engineering of Ironwood, Michigan. Refer to Figure 2.3 showing the locations (waypoints) at which sediment samples were obtained. Samples obtained at points 1, 2, 8 and 9 have been characterized as fine to medium sand. The remaining samples have been characterized as fine to course sand and containing various percentages of gravel, dependent upon where the samples were obtained. The grain size analyses performed are included in Appendix A.

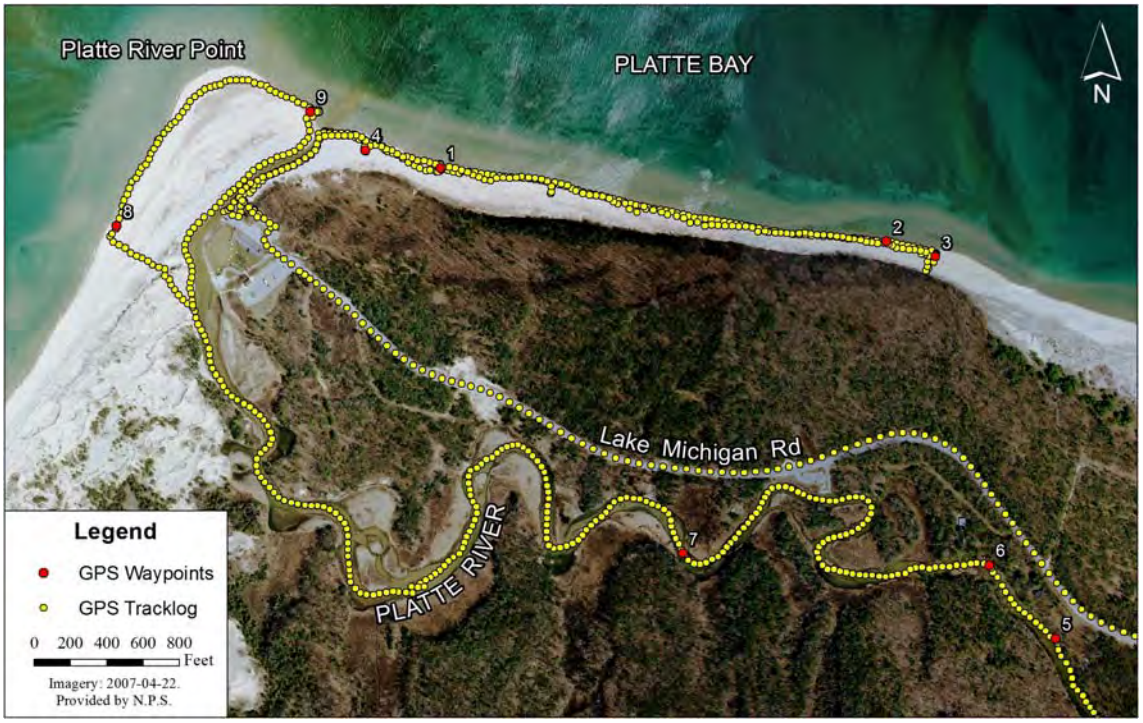


**Figure 2.3 Sediment Sampling Locations**

# 3.0 SHORELINE CHANGE ANALYSIS

A comprehensive series of historic aerial photographs from 1954, 1974, 1977, 1983, 1993, 1998, 2005, 2006, 2007, 2009, and 2010 were used for shoreline comparisons in GIS. Figure 3.1 provides a summary of the above historic aerial photos. The sand spit at Platte River Point and the Platte River mouth area have undergone noticeable changes since 1954. Note that the beach width in individual aerial photos is partly a function of the lake level at the time of photography. Figure 3.2 provides the monthly average lake level at the time of each image. General observations and a summary of major changes in the shoreline are provided in this section. A complete archive of the digitized shorelines on various background aerial photos is provided in Appendix B.

## 3.1 Software and Method

The software used for delineating the shoreline and georeferencing aerial photos was Environmental Systems Research Institute, Inc. (ESRI)® ArcMap™ 10.0, part of the ArcGIS Desktop 10 suite. Shorelines were captured using heads-up digitizing and saved in ESRI Shapefile format (ESRI, 1998). Heads-up digitizing is the manual delineation of features observed on a computer screen, often from digital imagery or maps (ESRI, 2009). This approach is commonly used for delineation of features from digital imagery for GIS analysis (Moore et al., 2003; Zuzek et al., 2003; Wozencraft et al., 2001). Aerial photos lacking spatial reference were georeferenced using the Georeferencing Tools in ArcMap.

## 3.2 Data Sources

The shoreline delineations were based on digital aerial photographs provided by NPS and other sources (Table 3.1).

**Table 3.1 Data Sources**

| Year | Date | Digital Image Format | Photo Scale | Geo-referenced | Provider |
|---|---|---|---|---|---|
| 2010 | 03/07/2010 | Ortho Mosaic | 12,000 | Yes | USDA Geospatial Data Gateway |
| 2009 | 13/07/2009 | Ortho Mosaic | 12,000 | Yes | USDA Geospatial Data Gateway |
| 2007 | 22/04/2007 | 2007-04-22 Orthophoto Mosaic, | 12,000 | Yes | National Parks Service |
| 2007 | 20/10/2007 | 2007-10-20 Orthophoto Mosaic, | 12,000 | Yes | National Parks Service |
| 2006 | 12/06/2006 | Ortho Mosaic | 12,000 | Yes | USDA Geospatial Data Gateway |
| 2005 | 20/06/2005 | Ortho Mosaic | 12,000 | Yes | USDA Geospatial Data Gateway |
| 1998 | 27/04/1998 | DOQQ | 40,000 | Yes | Michigan Geographic Data Library |
| 1993 | 22/04/1993 | DOQQ | 40,000 | Yes | Michigan Geographic Data Library |
| 1983 | 01/07/1983 | Airphoto (Scan) | 26,000 | No | USGS Earth Explorer |
| 1977 | 29/04/1977 | Airphoto (Scan) | 18,000 | No | USGS Earth Explorer |
| 1974 | 01/05/1974 | Airphoto (Scan) | 13,000 | No | USGS Earth Explorer |
| 1954 | 13/05/1954 | Airphoto (Scan) | 17000 | No | USGS Earth Explorer |

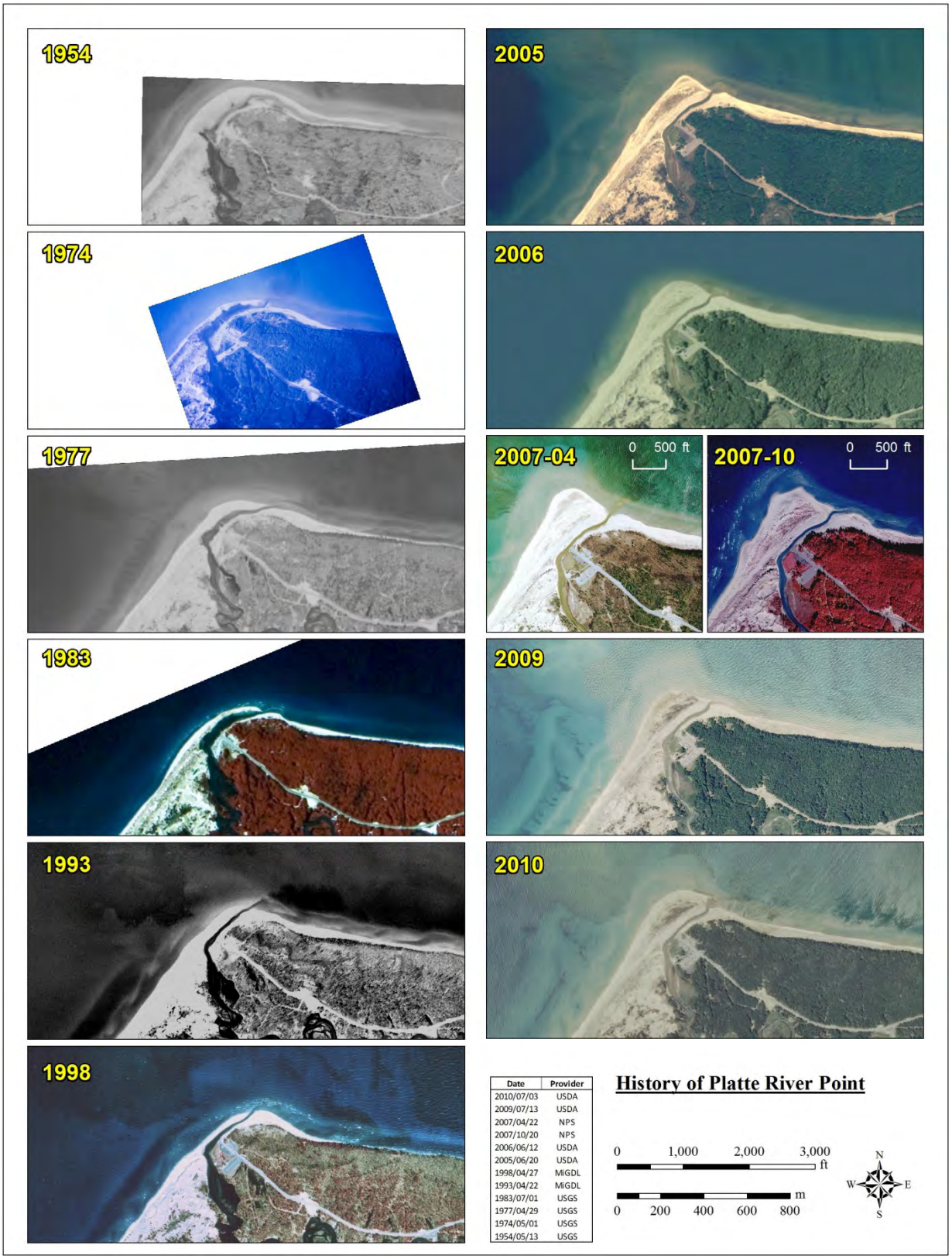


**Figure 3.1 Platte River Mouth Area 1954 - 2010**

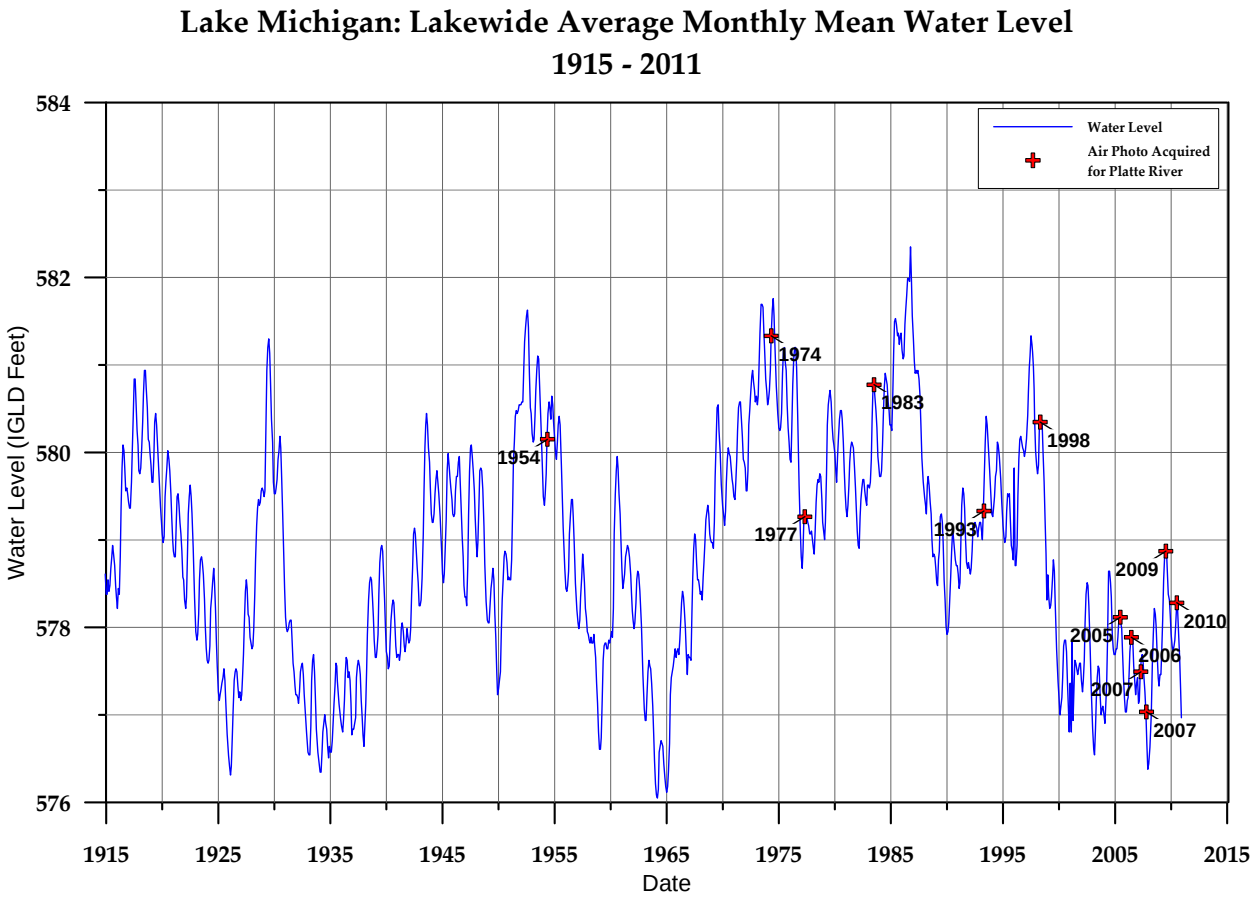


**Figure 3.2 Lake Michigan Monthly Mean Water Levels for the Aerial Photos**

## 3.3 General Observations

Detailed examination of historic aerials indicates that in 1954 the river mouth was located approximately 2,100 ft east of its present (2011) location. A narrow sand spit had extended across the mouth towards the east as a result of local eastward alongshore sand transport. In general, the Platte River mouth location is influenced by lake levels and frequency/intensity of storm events (both waves and river floods). Under natural conditions, dramatic river mouth switches (back to the west) are more likely to occur under high lake level and river flood conditions. After each switch however, the river mouth will start to migrate to the east once the water levels are back to average or low levels.

Figure 3.3 shows conditions around the Platte River mouth in 1974. Lake levels steadily trended upward since their historic low in March of 1964 and had reached above 581 ft in 1974. As a result, the river section inshore of the river mouth was very wide in 1974. Several jetties are visible in this photo, indicative of active usage of the area for boating. Of particular interest is a 100 ft long groin constructed on the east bank of the river mouth, likely intended to stop its migration towards the east (Figure 3.3).

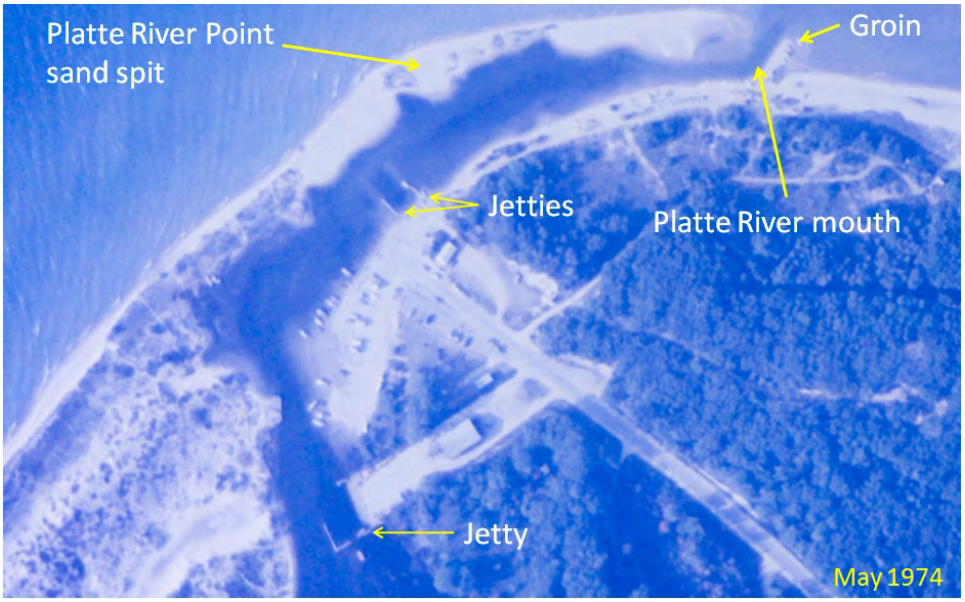


**Figure 3.3 Conditions around Platte River Point in May 1974**

Figure 3.4 shows conditions around the Platte River mouth in 1998. The boat launch and car parking areas represent their present (2010) conditions. Details of river mouth location and beach conditions during historic high lake levels of 1986 to 1988 are not available. The groin observed near the river mouth in the 1974 photo had likely been buried under the sandy beach in 1998. The area in which the groin was located corresponds to the location of the existing mound of dredged material, which suggests that the practice of placing dredged material at the present mound location may have started prior to 1998.

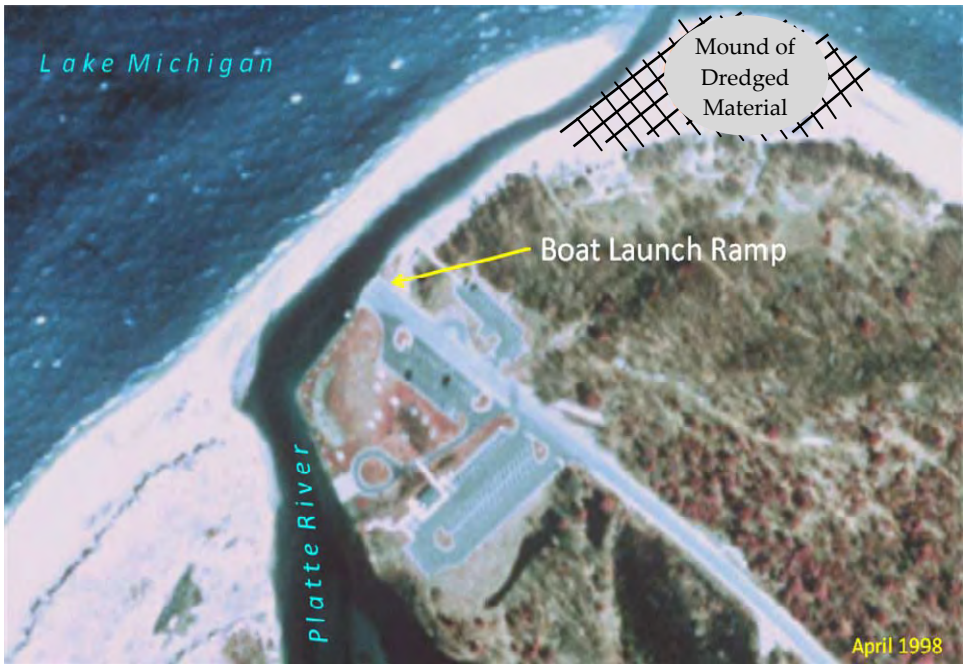


**Figure 3.4 Conditions around Platte River Point in April 1998**

## 3.4 Shoreline Change Analysis Around Platte River Point

A complete archive of the digitized shorelines on various background aerial photos is provided in Appendix B. Figure 3.5 shows the 1954 and 2010 historic shorelines on the 1954 image. Note that Lake Michigan level in 1954 was close to two feet higher in 1954 than in 2010. The Platte River mouth in 1954 was about 2,100 ft east of its position in 2010. The long and narrow sand spit that extended from Platte River Point towards the east, separating the river from Lake Michigan, indicates that the direction of net longshore sand transport is from west to east. As discussed earlier, under natural conditions, the river mouth migrates slowly eastward and then abruptly switches back to a westerly position during storms at high lake levels (and/or floods), and the process then repeats.

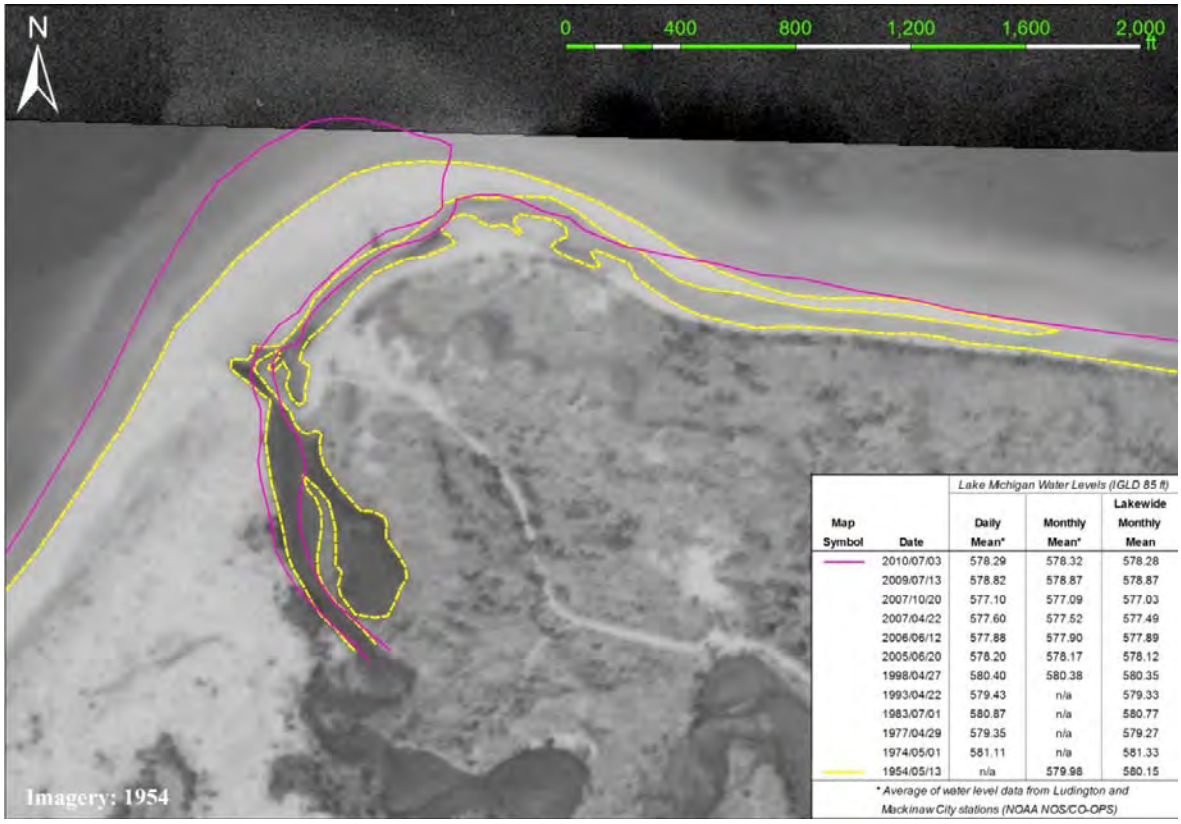


**Figure 3.5 Selected Historic Shorelines showing Platte River Mouth Location and Adjacent Beach Conditions in 1954 and 2010**

Figure 3.6 shows selected historic shorelines between 1974 and 1993, superimposed on the 1993 image. Lake Michigan levels were mostly between their historic average and high in this period (Figure 3.2). Figure 3.6 indicates that the river mouth did not change its position between 1974 and 1983. This was likely the result of construction of the groin on the east side of the river mouth, as shown in Figure 3.3. The river mouth in 1993, however, was positioned about 200 ft to the west of its 1983 position. This was likely due to the placement of dredged material on the east side of the river mouth (i.e. on the existing dredged mound) or other construction activities during this period.

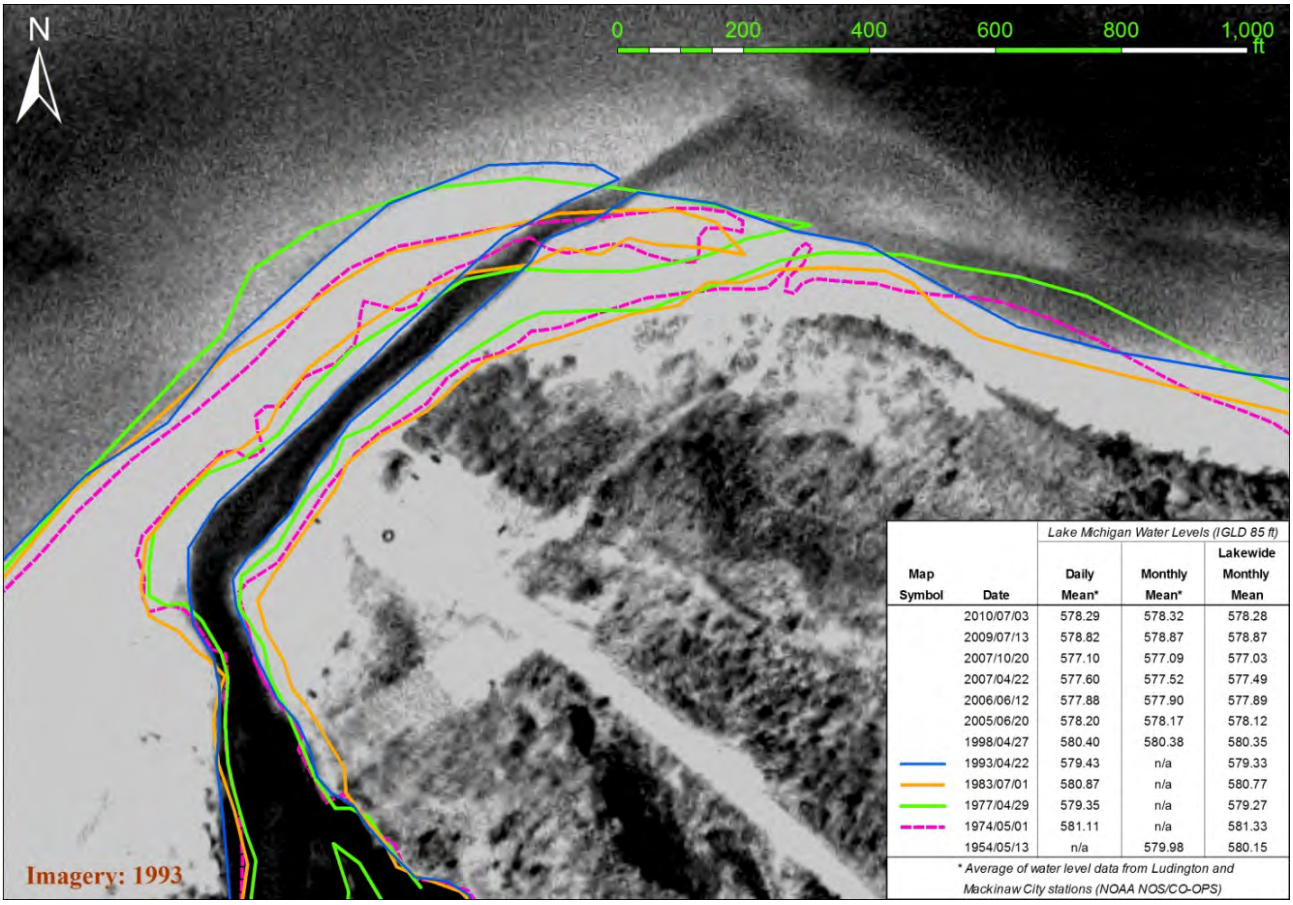


**Figure 3.6 Selected historic shorelines shown on the 1993 Aerial Photo showing Platte River Point and Adjacent Beach Conditions**

Figure 3.7 shows a comparison of historic shorelines since 1998 on the 2010 aerial photo. With the exception of 1998, the remaining shorelines correspond to recent low lake level conditions and feature relatively wide beaches. Figure 3.7 indicates that the river mouth has not changed its position since 1998, likely resulting from the placement of the material along the west bank of the river and on the mound of dredged material east of the river mouth.

Note that the apparent change in size of the spit between the river and Lake Michigan, in different years, is due to the fluctuation in lake levels more than other factors. In periods of high water, the spit will appear narrower, and in periods of low water, it will appear wider.

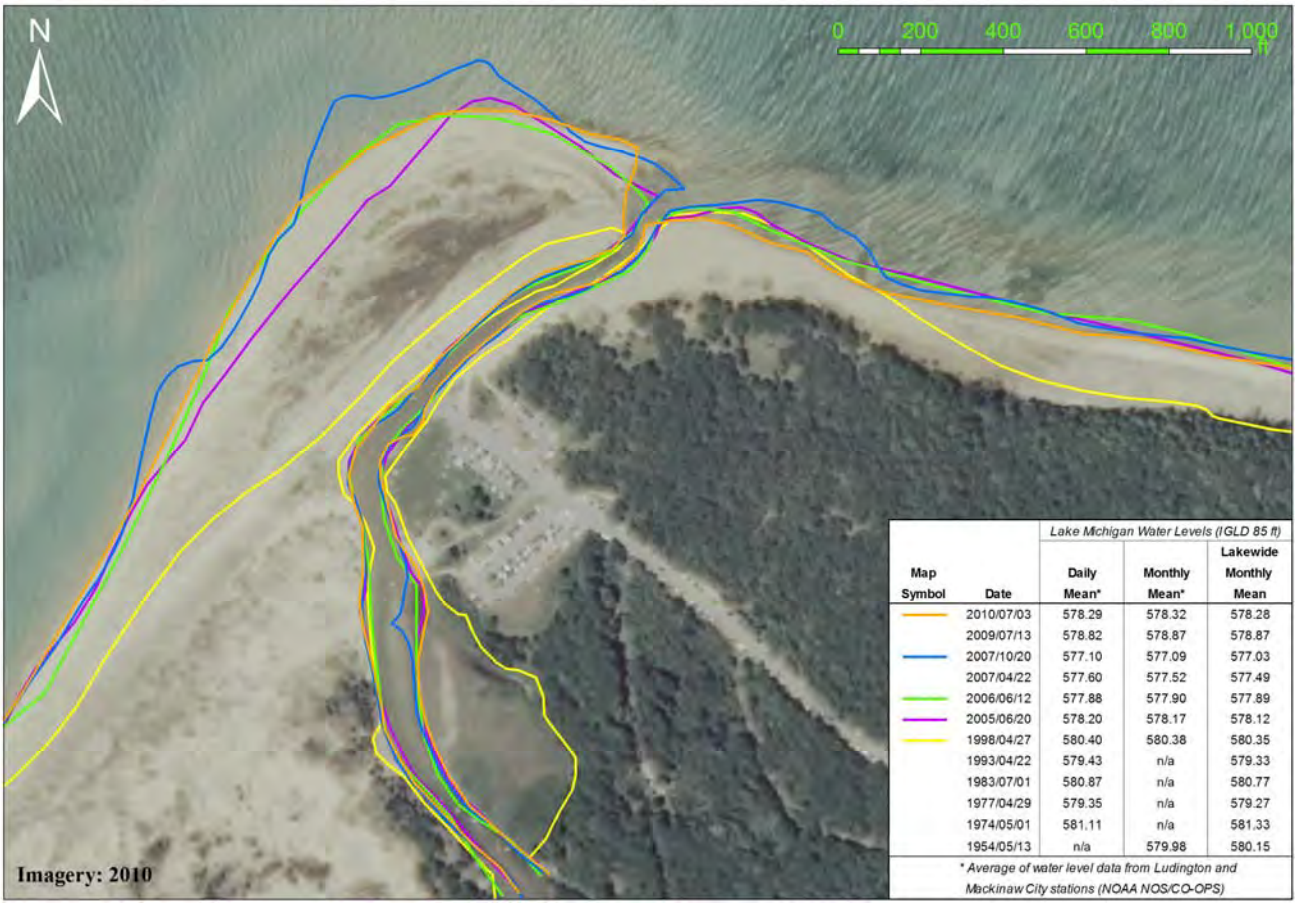


**Figure 3.7 Selected Historic Shorelines shown on the 2010 Aerial Photo showing Platte River Point and Adjacent Beach Conditions**

## 3.5 Overall Shoreline Change

A direct comparison of shorelines cannot be made from the imagery due to the fact that the position of the shoreline is a function of lake level at the time the aerial photograph is taken. Among the historic images used in this study, Lake Michigan monthly mean water levels at the time of 1954 and 1998 imagery were relatively identical (i.e. 580.15 ft in 1954 and 580.35 ft in 1998). A comparison of 1954 and 1998 shoreline on a regional scale was thus completed to provide an idea of sediment sources and sinks in the study area. Figure 3.8 shows the results.

The entire area east of Platte River Point (i.e. Zone 4 and Zone 5) is a large sediment sink where sediment has been continuously deposited. This area represents a transport convergence zone that accommodates sediments arriving from both north and west shores. Average shoreline accretion between 1954 and 1998 was 2.5 ft/year. Zone 4 is approximately 1.9 miles long, resulting in a total accumulation area of 120,000 square yards over 44 years. Assuming that the sediment in Zone 4 arrives mainly from Platte River Point area, and further assuming a profile height of 14.8 ft (i.e. from -9.9 ft to +4.9 ft CD), this would translate to an estimated eastward annual average longshore sand transport rate of 13,100 cubic yards per year at Platte River Point. Figure 3.8 indicates that this

material has been supplied mainly through erosion of the shoreline/bluffs in Zone 1, south of Platte River Point.

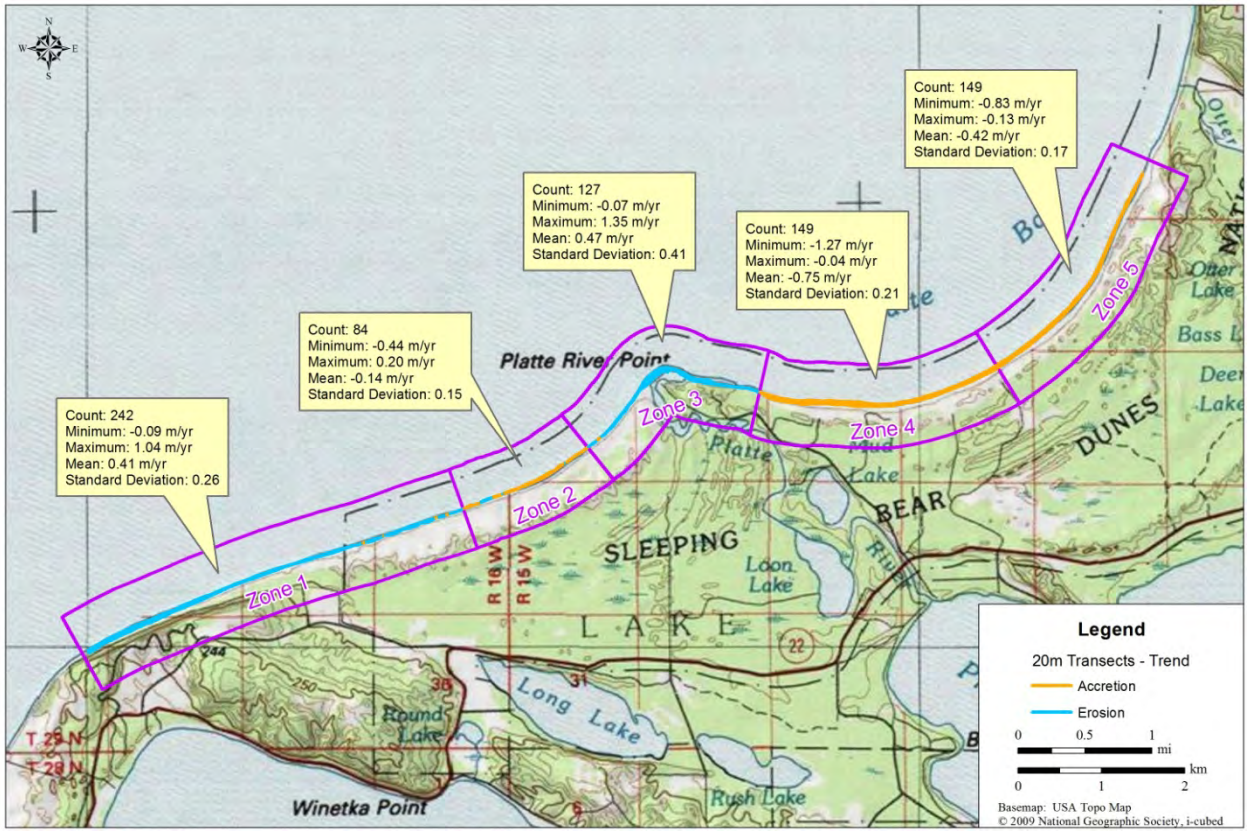


**Figure 3.8 Regional Erosion and Accretion Rates between 1954 and 1998 on both sides of Platte River Point**

# 4.0 MEASURES

Prior to this report, several preliminary measures for improvements to the conditions at the site were prepared and presented to NPS management and staff for discussion. A key outcome from these discussions is that NPS requires the final solution to accommodate boat access to Lake Michigan at the site. The idea of closing the boat launch was not to be considered. Therefore, the criteria to be met by the preferred solution are as follows:

1. Recreational boat access to Lake Michigan shall continue.
2. Impacts due to dredging should be reduced.
3. The existing mound of dredged material on the east side of the Platte River mouth shall be removed.
4. Addressing Piping Plover impacts.

Various measures for addressing each of the above criteria are described in this section. In Section 5, concepts are presented based on a combination of the various measures described.

Cost estimates have been prepared for the measures discussed below. The cost estimates are in present (2011) dollars and include a 20% contingency. Details of the cost estimates are contained in spreadsheet form in Appendix D.

For the purpose of comparison of the methods and potential concepts, the costs estimates have been prepared under the assumption that the work will be performed by commercial contractors. Work presently performed by NPS staff, should it continue, would likely lower the cost. It has also been assumed that if annual dredging of the river mouth would continue, the mound of dredged material would be disposed of in-water.

## 4.1 Continuing Recreational Boat Access to Lake Michigan

Recreational boat access, particularly for small power boats, to Lake Michigan from within Sleeping Bear Dunes National Lakeshore may be accomplished by any of following means:

1. the continuation of present dredging practices;
2. the installation of an alternative means of launching recreational boats at Platte River Point;
3. closing the existing boat launch and constructing another one nearby; or
4. installing coastal structures to fix the river mouth location.

### *4.1.1 Continuing Present Dredging Practices*

The continuation of present dredging practices from the existing boat launch through the mouth of the Platte River will allow access to Lake Michigan by boats.

Originally performed by the State of Michigan, dredging began and continues due to the strong influence of the area's boating community. Approximately 900 cubic yards of material is currently being dredged annually. Continuation of the present dredging practices is estimated to cost approximately $10,000 per year, the amount presently being budgeted by NPS.

### *4.1.2 Installing an Alternative Means of Launching Recreational Boats*

Recreational boat access to Lake Michigan could also be gained by utilizing a system of gratings laid across the beach and into the water, allowing car, trailer and boat to be backed across the beach and the boat to be launched. The towns of Empire and Glen Arbor, Michigan both use such a system. Each has installed a system manufactured by ACE Welding in Traverse City, Michigan.

The Town of Empire was contacted to discuss the system used to launch boats in that community. The system consists of a system of steel grates placed directly upon the beach, running from a concrete pad located adjacent to the parking lot across approximately 40 ft of beach to the water. The steel grates are 10 ft x 12 ft in size and connected to one another by two, 2-inch diameter steel pipes run on each side of the grates. A minimum of one grate extends fully into the water.

The system is installed in the spring and removed in the fall. Village staff (DPW Superintendent, Len Shalda) estimate that the cost of installation and removal, using a small crane, costs the Village a very reasonable $400 per activity. The one-year old system at Empire had a total cost, including initial installation, of $28,000.

If incorporated into a solution at Sleeping Bear Dunes National Lakeshore, such a system would preferably extend from the existing launch area to the mouth of the Platte River along the east bank, covering a length of about 900 ft. No new parking facility will be needed as the existing lot can be used for cars and trailers.

One significant and important difference exists between its application in Glen Arbor and Empire and its application at Platte River Point. The length over which boaters must back their boats and trailers in each of the two communities is much shorter than the distance needing to be covered at Platte River Point. Using the Village of Empire's experience as a basis, the system at Platte River is estimated to have an initial cost of approximately $605,000 (includes 20% contingency).

Seasonal installation and removal would come at additional annual cost. The cost of seasonal maintenance to install and remove the system is expected to exceed that of Empire's experience. It is understood that the Village is receiving pro bono service for the installation and removal, explaining the very low cost of the service to them. Estimating that it will take a commercial contractor approximately three days to install or remove the system, the cost of seasonal maintenance is estimated to cost $5,000 per activity, or about $10,000 per year. It is noted that this amount is very close to the current NPS annual budget for maintenance dredging at this site.

### 4.1.3 Constructing a Boat Launch Nearby

Other launch locations, such as a site located in the vicinity of Isle View Drive (commonly known as Tiesma Road), 7,500 ft to the east of the river mouth, may shorten the distance over which grates would need to be placed, but would incur significant additional costs to provide car/trailer parking and other amenities. Relocation to other areas of the park may also likely have negative impacts to native vegetation, including listed threatened and endangered species and existing infrastructure.

The relocation of the boat launch to any other location on the Lake Michigan or Platte Bay shorelines, without the installation of a launch system similar to that just described, is not considered to be a viable option. Regardless of its location, any boat launch and channel capable of serving small power craft will have a negative impact upon the littoral system and could experience sediment accretion problems. Therefore, this measure will not be given further consideration.

### 4.1.4 Coastal Structures

The fourth measure considered the construction of man-made structures, such as steel sheet pile jetties or rubblemound extensions of the existing spit northward. These are not considered to be practical or cost-effective means of reducing the negative impacts of dredging upon the natural system and of maintaining recreational boat access to Lake Michigan. Their construction would incur significant additional cost and would only serve to delay the time at which dredging would once again be required. The net effect of the structures would simply be to push the river mouth further northward into Platte Bay. Eventually, sediments moving from south to north along the Lake Michigan shoreline would once again begin to bypass the end of the structure and fill the river mouth. Therefore, this measure will not be given further consideration.

## 4.2 Reduction of Impacts Due to Dredging

Reduction of the impacts due to dredging may be accomplished by two means: the cessation of dredging altogether and disposing of dredged material at an in-water site within the littoral system.

### 4.2.1 Cessation of Dredging

The cessation of dredging operations would contribute to a reduction in the negative impacts to the river since material would not be removed from the natural littoral system. It would eliminate the cost of annual or periodic dredging, saving NPS approximately $10,000 per year.

### 4.2.2 In-water Disposal of Dredged Material

If dredging is still required, the impacts may be reduced by making sure the material is deposited downdrift of the Platte River mouth within the littoral system. Under this scenario, the net balance of material is maintained within the overall system.

The intent of this disposal option is to place the material back into the littoral system, east of the Platte River mouth. Disposal of the dredged material in the water, in a manner allowing its return to the littoral system, provides yet another means of reducing the negative impacts of dredging.

To place the material in and below water so that it responds naturally to the littoral system will require that the material be placed in shallow water. The bathymetry along the shoreline east of the river mouth is very irregular. Referring to Figure 4.1, the underwater slope in the nearshore is quite steep in some areas and flatter in others. Between transects A and B, the underwater slopes are relatively steep. In contrast, the nearshore underwater slopes in the area of transect C, located approximately 3,200 ft east of the Platte River mouth, are flatter. Note that the -10 ft contour extends further out into Platte Bay in the vicinity of transect C than it does in the area between transects A and B. Placement of the material in areas having steep underwater slopes may not be the most suitable for the desired response to the littoral system. Further study is required to determine just how the placement of material would respond to the system. Placement of the material in the shallower areas around transect C is more likely to have greater success in achieving the purpose of disposing of it in-water.

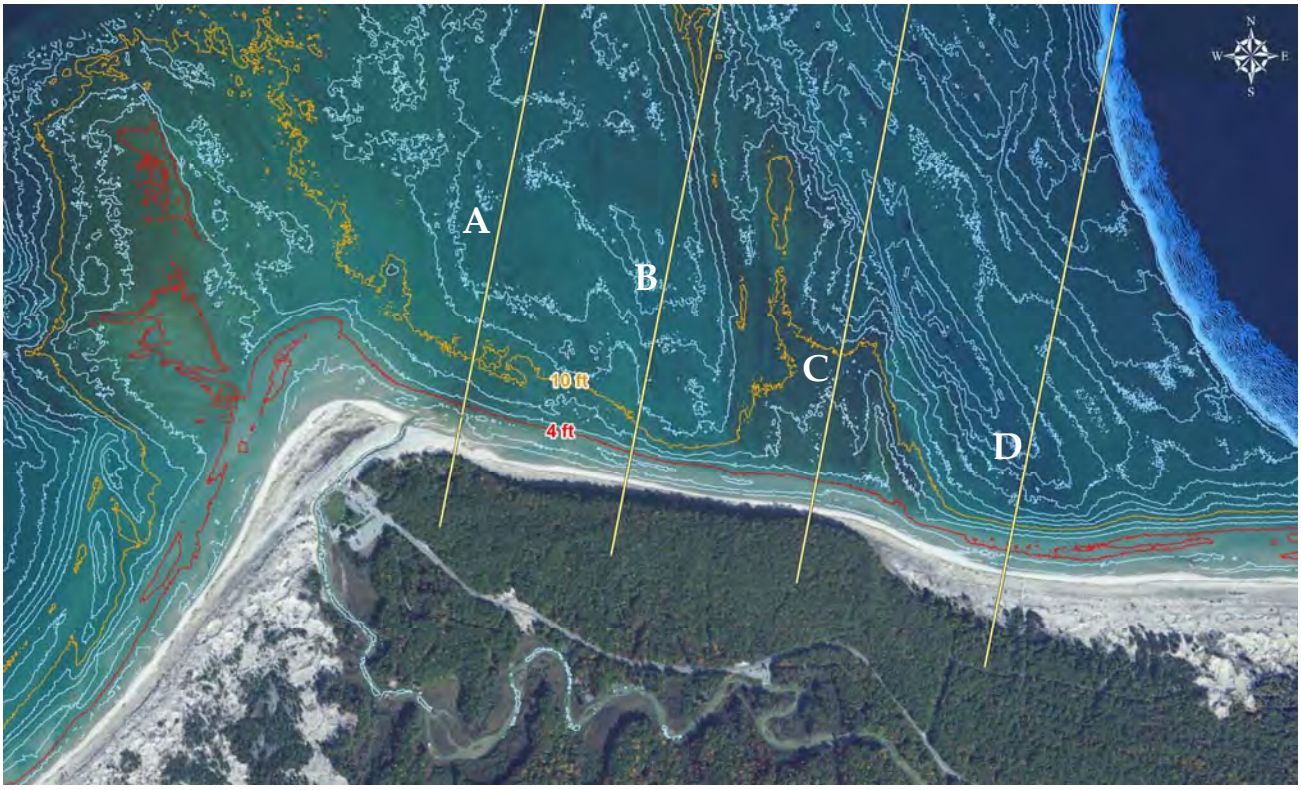


**Figure 4.1 Platte Bay Bathymetry**

For purposes of this study, two alternative means of transporting the material to the in-water disposal site near transect C have been considered.

**Dump Trucks** - Placement of the material in the area of transect C will require transportation, via dump trucks, of the material over a greater distance than the dredged materials are being

transported presently and will, therefore, incur greater disposal costs than are presently experienced. The cost of dredging and in-water disposal of materials dredged from the river is estimated to be $25,700 per dredging event.

**Pumping -** Transporting the dredged material to the proposed in-water disposal site by hydraulic methods has also been considered. Assuming that the material would be moved from the mound into the water using land-based equipment such as an excavator or dozer, the dredged material would be pushed or discharged into at least three feet of water, immediately adjacent to the mound of dredged material. The material would then be pumped down the beach, requiring a minimum of one booster pump to maintain the critical velocity needed to transport the material to the disposal site. The material would then be pumped directly into shallow water at the site. The estimate for the cost of in-water disposal for the pumping system has not been quantified. The reason for this is that the mobilization cost alone to establish a system onsite would be much greater than the cost of a system using dump trucks. Therefore, this alternative will no longer be considered.

### *4.2.3 Upland Disposal*

An alternative to in-water disposal is upland disposal, where the material is taken to a designated site and placed. Upland disposal costs are heavily dependent upon the cost of trucking the material to the disposal site and, as a result, will also be greater than disposal costs presently being experienced at Platte River Point.

The identification of an upland disposal site is beyond the scope of this study. The physical and chemical characteristic of the dredged material, and the site at which it will be disposed, will be subject to the scrutiny of State and Federal regulatory agencies. However, for purposes of this study, a round trip haul distance of eight miles has been assumed.

Upland disposal of the materials dredged from the river is estimated to cost $29,000 per dredging event. The cost is based on the assumption that the material is clean and does not contain contaminants. If contaminants were found in the material, upland disposal costs would be greater.

Dredging of any kind and the disposal of the dredged material will be subject to the scrutiny of State and Federal regulatory agencies. A precedent has been set for the in-water disposal of clean dredged material in shallow water (South Manitou Island). Both the means of disposal and the disposal site will likely require approvals from the State of Michigan Departments of Natural Resources and Environmental Quality, as well as the USACE and the several Federal Agencies with whom they will coordinate the approval process.

Since it appears that in-water disposal offers the best means of reintroducing the dredged material to the natural system, and based upon the significant cost differential between that of in-water disposal and upland disposal, in-water disposal using dump trucks has been assumed to be the preferred method of dredged material disposal.

## 4.3 Removal and Disposal of Dredged Material Mound

The removal and disposal of the mound will benefit the littoral system if the material is disposed of at an in-water site. The benefit occurs because there will be no net loss of material from the system.

The estimated cost of removal and in-water disposal, near transect C, of the existing mound of dredged material is provided below.

1. Dump trucks – the estimated cost is $385,000
2. Pumping – the estimated cost is $772,000

## 4.4 Consideration of the Piping Plover

Consideration of the four criteria to be met by the preferred solution also addressed the Piping Plover. While the precise impacts to the Piping Plover are not known, NPS considers that removal of the existing mound of dredged material will have only a short-term impact upon the Plover and that the Plover will return once the dredged material is removed. Consideration must be given, however, to the timing of construction activities. The nesting season of the Plover at the Platte River site generally begins in early April and runs through mid-August. It is recommended that dredging and sediment removal activities be performed after the Piping Plover have vacated their nests.

Given that the Piping Plover is an endangered species, a detailed investigation will be required in subsequent stages of the project, prior to design or construction. From previous experience on other sites around the Great Lakes, it is likely that the US Fish & Wildlife Service will be involved with this process. The purpose of the investigation is to confirm whether or not remaining habitat is suitable for the Piping Plover and identify impacts to the Piping Plover.

## 5.0 CONCEPT REVIEW

Several basic concepts have been discussed with NPS management and staff. Five concepts have been given further consideration:

- Concept 1: No Action - continue annual dredging and disposal on the existing mound of dredged material on the east side of the river.
- Concept 2: Cease dredging operations and remove the existing mound of dredged material.
- Concept 3: Cease dredging operations, remove the existing mound of dredged material, and install and maintain an alternative means of launching recreational craft.
- Concept 4: Continue annual dredging of the river and dispose of dredged material at an in-water site. Leave the existing mound of dredged material.
- Concept 5: Continue annual dredging of the river and dispose of dredged material at an in-water site. Remove the existing mound of dredged material.

An additional concept was also considered in which all dredging operations would cease, no alternative means of launching recreational craft would be provided and the mound of dredged material would remain. This scenario would reduce the impacts due to dredging and eliminate the cost of annual or periodic dredging. It would not remove the unsightly and unnatural mound of dredged material. Additionally, in a relatively short period of time, it would eliminate the ability to launch recreational craft, particularly power boats, as they are being launched presently. For these reasons, this concept was not given further consideration.

## 5.1 Concept 1 - No Action

Under a "no action" approach, no changes would be made to the current NPS practice of annual dredging and disposal. Additionally, the mound of existing dredged material on the east and west banks of the Platte River would remain, i.e. the quantities of dredged material deposited on both the west side of the river (approx. 2,660 cubic yards) and east side of the river (approx. 32,000 cubic yards) would remain.

Annual dredging of the river mouth, and the presence of the existing dredged material on both sides of the river, interfere with the natural processes. By taking a course of "no action," the impacts on the natural system due to dredging will not be reduced and the desire to remove the existing mound of dredged material on the east side of the river mouth will not be satisfied. A no action approach, however, would maintain recreational boat access to Lake Michigan.

**Advantages**:

- Maintains recreational boat access to Lake Michigan.
- Does not incur additional cost beyond that already budgeted.

**Disadvantages:**

- Does not reduce the impacts of dredging upon the littoral system.
- Leaves the unsightly and unnatural mound of dredged material on the east side of the river mouth.

**Cost:**

- $10,000 per year (based upon present dredging costs).

## 5.2 Concept 2 - Cease Dredging Operations and Remove the Mound of Dredged Material

In this scenario, the cost of annual dredging would be eliminated, but a onetime cost to remove the existing mound of dredged material on the east side would be incurred. NPS would save the approximately $10,000 presently being budgeted for annual or periodic dredging. Assuming that the least-cost method of in-water disposal previously discussed is utilized, the cost of removal of the existing mound of dredged material would be approximately $385,000.

**Advantages:**

- Reduces the impacts of ongoing dredging operations upon the littoral system.
- Saves the cost of annual or periodic dredging.
- Removes the existing mound of dredged material from the east side of the river.

**Disadvantages:**

- Eliminates the ability of recreational craft to access Lake Michigan.
- May degrade Piping Plover habitat.

**Cost:**

- Removal of the mound of dredged material: $385,000.

## 5.3 Concept 3 - Cease Dredging Operations, Remove the Mound of Dredged Material and Install and Maintain an Alternative Means of Launching Recreational Craft

This concept is similar to Concept 2, but also includes the ability to launch recreational craft, particularly power boats. The launch would be created by installing a series of steel grates, as described above in Section 4.

**Advantages:**

- Reduces the impacts of ongoing dredging operations upon the littoral system.
- Saves the cost of annual or periodic dredging.
- Removes the existing mound of dredged material from the east side of the river.
- Includes the ability to launch recreational craft.

**Disadvantages:**

- Incurs additional costs.
- May degrade Piping Plover habitat.

**Cost:**

- Removal of the mound of dredged material: $385,000.
- Alternative means of launching craft: $605,000.
- Seasonal launch maintenance of $10,000 per year.

## 5.4 Concept 4 - Continue Dredging Operations, In-water Disposal and Leave Mound of Dredged Material

To maintain continued access to Lake Michigan by recreational craft, Concept 4 would involve the performance of annual dredging and disposal of the material at an in-water site. Additionally, the mound of existing dredged material on the east and west banks would remain. The criteria for removing the mound of dredged material would not be met.

**Advantages:**

- Retains the ability to launch recreational craft.
- Saves the cost of removing the mound of dredged material.

**Disadvantages:**

- Does not reduce the impacts of dredging upon the littoral system.
- Leaves the unsightly and unnatural mound of dredged material on the east side of the river mouth.

**Cost:**

- Continued annual maintenance cost: $25,700 (In-water disposal)

## 5.5 Concept 5 - Continue Dredging Operations, In-water Disposal and Remove Mound of Dredged Material

Concept 5 satisfies the NPS criteria of removing the existing mound of dredged material and allows continued access to Lake Michigan by recreational craft.

Removal of the existing mound of dredged material only partially reduces the negative impacts of dredging upon the natural system, by making it possible for the river mouth to move toward the east. However, continued dredging at the present location of the river mouth will prevent the river mouth from migrating.

**Advantages:**

- Removes the unnatural and unsightly mound of dredged material from the east side of the river.
- Retains the ability to launch recreational craft.

**Disadvantages**:

- Incurs additional costs.
- May degrade the habitat for Piping Plover.

**Cost:**

- Removal of the mound of dredged material: $385,000.
- Continued annual maintenance dredging cost: $25,700, assuming in-water disposal.

## 6.0 CONCLUSIONS AND RECOMMENDATION

The criteria of the preferred solution are:

1. Recreational boat access to Lake Michigan shall continue.
2. Impacts due to dredging should be reduced.
3. The existing unnatural and unsightly mound of dredged material on the east side of the Platte River mouth shall be removed.
4. Addressing Piping Plover impacts.

Several concepts for the addressing the above criteria have been described and advantages and disadvantages of each one identified. Given the desire of the NPS to continue service to the boating community, there are no easy solutions by which the need for dredging at the Platte River site can be diminished. Continuation of annual dredging appears to be the most practical and least costly way of doing so, but does present significant site impacts.

The final conclusions drawn from the study are as follows:

1. That the cost of the alternative steel grate boat launch system would be greater than the current practice of annual dredging.
2. That continued annual dredging is the most cost-effective means of providing access to Lake Michigan for recreational craft.
3. That it is most cost-effective to dispose of the existing mound of dredged material and future dredged material in-water using land-based methods of transporting the material to the disposal site.
4. Removal of the existing mound of dredged material on the east bank will require further investigation related to how this may impact the Piping Plover and its habitat.

Based upon the analyses performed and consideration of the cost of each potential concept, Concept 5 is recommended, in which annual dredging of the river mouth would continue, the mound of dredged material would be removed, and material from annual dredging and the existing mound would be disposed of in-water.

The initial cost of Concept 5 is estimated to be $410,700, including dredging of the Platte River mouth. Annual or periodic maintenance dredging is estimated to cost $25,700 per year.

Prior to completing designs or proceeding to construction we recommend the following studies:

- Impacts to Piping Plover and its habitat due to removal of the existing mound of dredged material on the east side of the Platte River.
- Further investigation of the disposal site to determine the limits of the disposal area and to determine how the placement of material would respond to the system.
- Detailed examination and testing of the material to confirm whether or not contaminants are present.

## 7.0 REFERENCES

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# APPENDIX A

## SEDIMENT SAMPLING RESULTS
*COLEMAN ENGINEERING*

**COLEMAN ENGINEERING COMPANY**
200 East Ayer Street
Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (SP) SAND, brown, fine to medium Boring No.

Shape: Hardness: Sample No. 1

Remarks: Platte River pt. 1 Depth:

Date Rec'd: 6/2/2011

MECHANICAL ANALYSIS PORTION OF HYDROMETER ANALYSIS

| Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|
| **3"** | 76.2 | | | |
| **2"** | 50.8 | | | |
| **1 1/2"** | 37.5 | | | |
| **1** | 25.4 | | | |
| **3/4** | 19.1 | | | |
| **3/8** | 9.5 | | | |
| **4M** | 4.76 | | | |
| **10M** | 2.00 | 0.00 | 0.0 | 100.0 |
| **40M** | 0.42 | 29.90 | 10.9 | /* 89.1 |
| **100M** | 0.149 | 245.30 | 89.1 | /* 0.0 |
| **200M** | 0.074 | 0.10 | 0.0 | /* 0.0 |
| **Pan** | | 0.00 | 0.0 | /* 0.0 |

***Percent Based on Total Sample**

Original Sample:

Material retained on No. 10 mesh: weight = 0 gm = 0.0 %

Material passing No. 10 mesh: weight = 275.3 gm = 100.0 %

Weight of Total Sample = 275.3 gm

Tested By: Denise Lotzer Date: 6/3/2011

Submitted By: Date: 6/30/2011

Form: D422A Revision Date: 1/17/05

**COLEMAN ENGINEERING COMPANY**
200 East Ayer Street
Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (SP) SAND, brown, fine to medium Boring No.

Shape: Hardness: Sample No. 2

Remarks: Platte River pt. 3 Depth:

Date Rec'd: 6/2/2011

MECHANICAL ANALYSIS PORTION OF HYDROMETER ANALYSIS

| Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|
| **3"** | 76.2 | | | |
| **2"** | 50.8 | | | |
| **1 1/2"** | 37.5 | | | |
| **1** | 25.4 | | | |
| **3/4** | 19.1 | | | |
| **3/8** | 9.5 | | | |
| **4M** | 4.76 | | | |
| **10M** | 2.00 | 0.00 | 0.0 | 100.0 |
| **40M** | 0.42 | 24.60 | 10.5 | /* 89.5 |
| **100M** | 0.149 | 210.40 | 89.5 | /* 0.0 |
| **200M** | 0.074 | 0.00 | 0.0 | /* 0.0 |
| **Pan** | | 0.00 | 0.0 | /* 0.0 |

***Percent Based on Total Sample**

Original Sample:

Material retained on No. 10 mesh: weight = 0 gm = 0.0% %

Material passing No. 10 mesh: weight = 235 gm = 100.0% %

Weight of Total Sample = 235 gm

Tested By: Denise Lotzer Date: 6/3/2011

Submitted By: Date: 6/30/2011

Form: D422A Revision Date: 1/17/05

**COLEMAN ENGINEERING COMPANY**
200 East Ayer Street
Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (SP) SAND, brown, fine to coarse, some fine gravel Boring No.

Shape: Hardness: Sample No. 3

Remarks: Platte River pt. 4 Depth:

Date Rec'd: 6/2/2011

MECHANICAL ANALYSIS
PORTION OF HYDROMETER
ANALYSIS

| Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|
| **3"** | 76.2 | | | |
| **2"** | 50.8 | | | |
| **1 1/2"** | 37.5 | | | |
| **1** | 25.4 | | | |
| **3/4** | 19.1 | | | |
| **3/8** | 9.5 | 0.00 | 0.0 | 100.0 |
| **4M** | 4.76 | 23.70 | 7.7 | 92.3 |
| **10M** | 2.00 | 3.40 | 1.1 | 91.2 |
| **40M** | 0.42 | 87.70 | 28.4 | **/*** 62.8 |
| **100M** | 0.149 | 193.30 | 62.7 | **/*** 0.1 |
| **200M** | 0.074 | 0.10 | 0.0 | **/*** 0.1 |
| **Pan** | | 0.30 | 0.1 | **/*** 0.0 |

***Percent Based on Total Sample**

Original Sample:

Material retained on No. 10 mesh: weight = 27.1 gm = 8.8 %

Material passing No. 10 mesh: weight = 281.4 gm = 91.2% %

Weight of Total Sample = 308.5 gm

Tested By: Denise Lotzer Date: 6/3/2011

Submitted By: Date: 6/30/2011

**COLEMAN ENGINEERING COMPANY**
200 East Ayer Street
Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (SP) SAND, brown, fine to coarse, with fine gravel Boring No.

Shape: Hardness: Sample No. 4

Remarks: Platte River pt. 5 Depth:

Date Rec'd: 6/2/2011

MECHANICAL ANALYSIS PORTION OF HYDROMETER ANALYSIS

| Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|
| **3"** | 76.2 | | | |
| **2"** | 50.8 | | | |
| **1 1/2"** | 37.5 | | | |
| **1** | 25.4 | | | |
| **3/4** | 19.1 | | | |
| **3/8** | 9.5 | 0.00 | 0.0 | 100.0 |
| **4M** | 4.76 | 50.70 | 13.2 | 86.8 |
| **10M** | 2.00 | 7.00 | 1.8 | 85.0 |
| **40M** | 0.42 | 69.70 | 18.2 | **/*** 66.8 |
| **100M** | 0.149 | 251.80 | 65.6 | **/*** 1.2 |
| **200M** | 0.074 | 0.80 | 0.2 | **/*** 1.0 |
| **Pan** | | 4.00 | 1.0 | **/*** 0.0 |

***Percent Based on Total Sample**

Original Sample:

Material retained on No. 10 mesh: weight = 57.7 gm = 15.0% %

Material passing No. 10 mesh: weight = 326.3 gm = 85.0% %

Weight of Total Sample = 384 gm

Tested By: Denise Lotzer Date: 6/3/2011

Submitted By: Date: 6/30/2011

**COLEMAN ENGINEERING COMPANY**
200 East Ayer Street
Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (GP) SANDY GRAVEL, brown, fine,sand f-c Boring No.

Shape: Hardness: Sample No. 5

Remarks: Platte River pt. 6 Depth:

Date Rec'd: 6/2/2011

MECHANICAL ANALYSIS PORTION OF HYDROMETER ANALYSIS

| Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|
| **3"** | 76.2 | | | |
| **2"** | 50.8 | | | |
| **1 1/2"** | 37.5 | | | |
| **1** | 25.4 | | | |
| **3/4** | 19.1 | | | |
| **3/8** | 9.5 | 0.00 | 0.0 | 100.0 |
| **4M** | 4.76 | 242.90 | 63.1 | 36.9 |
| **10M** | 2.00 | 47.10 | 12.2 | 24.7 |
| **40M** | 0.42 | 51.40 | 13.3 | /* 11.4 |
| **100M** | 0.149 | 42.60 | 11.0 | /* 0.4 |
| **200M** | 0.074 | 0.50 | 0.1 | /* 0.3 |
| **Pan** | | 1.10 | 0.3 | /* 0.0 |

***Percent Based on Total Sample**

Original Sample:

Material retained on No. 10 mesh: weight = 290 gm = 75.2% %

Material passing No. 10 mesh: weight = 95.6 gm = 24.8% %

Weight of Total Sample = 385.6 gm

Tested By: Denise Lotzer Date: 6/6/2011

Submitted By: Date: 6/30/2011

Form: D422A Revision Date: 1/17/05

**COLEMAN ENGINEERING COMPANY**
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Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (SP) SAND, brown, fine to coarse, trace fine gravel Boring No.

Shape: Hardness: Sample No. 6

Remarks: Platte River pt. 7 Depth:

Date Rec'd: 6/2/2011

| | Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|---|
| | **3"** | 76.2 | | | |
| | **2"** | 50.8 | | | |
| | **1 1/2"** | 37.5 | | | |
| | **1** | 25.4 | | | |
| | **3/4** | 19.1 | | | |
| | **3/8** | 9.5 | 0.0 | 0.0 | 100.0 |
| | **4M** | 4.76 | 0.5 | 0.2 | 99.8 |
| | **10M** | 2.00 | 0.3 | 0.1 | 99.7 |
| MECHANICAL ANALYSIS | **40M** | 0.42 | 50.7 | 15.9 | /* 83.8 |
| PORTION OF HYDROMETER ANALYSIS | **100M** | 0.149 | 265.4 | 83.1 | /* 0.7 |
| | **200M** | 0.074 | 1.5 | 0.5 | /* 0.2 |
| | **Pan** | | 0.7 | 0.2 | /* 0.0 |

***Percent Based on Total Sample**

Original Sample:

Material retained on No. 10 mesh: weight = 0.8 gm = 0.3% %

Material passing No. 10 mesh: weight = 318.3 gm = 99.7% %

Weight of Total Sample = 319.1 gm

Tested By: Denise Lotzer Date: 6/6/2011

Submitted By: Date: 6/30/2011

**COLEMAN ENGINEERING COMPANY**
200 East Ayer Street
Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (SP) SAND, brown, fine to medium Boring No.

Shape: Hardness: Sample No. 7

Remarks: Platte River pt. 8 Depth:

Date Rec'd: 6/2/2011

MECHANICAL ANALYSIS
PORTION OF HYDROMETER
ANALYSIS

| Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|
| **3"** | 76.2 | | | |
| **2"** | 50.8 | | | |
| **1 1/2"** | 37.5 | | | |
| **1** | 25.4 | | | |
| **3/4** | 19.1 | | | |
| **3/8** | 9.5 | | | |
| **4M** | 4.76 | | | |
| **10M** | 2.00 | 0.00 | 0.0 | 100.0 |
| **40M** | 0.42 | 11.60 | 4.7 | /* 95.3 |
| **100M** | 0.149 | 232.90 | 95.3 | /* 0.0 |
| **200M** | 0.074 | 0.10 | 0.0 | /* 0.0 |
| **Pan** | | 0.10 | 0.0 | /* 0.0 |

***Percent Based on Total Sample**

Original Sample:

Material retained on No. 10 mesh: weight = 0 gm = 0.0% %

Material passing No. 10 mesh: weight = 244.6 gm = 100.0% %

Weight of Total Sample = 244.6 gm

Tested By: Denise Lotzer Date: 6/6/2011

Submitted By: Date: 6/30/2011

Form: D422A Revision Date: 1/17/05

**COLEMAN ENGINEERING COMPANY**
200 East Ayer Street
Ironwood, Michigan 49938
Telephone: (906)-932-5048 Fax: (906)-932-3213

# PARTICLE-SIZE ANALYSIS OF SOILS - MECHANICAL

(ASTM D422)

Project Name: 2011 Laboratory Testing C.E.C. Job #: GL-11153

Client: W.F. Baird and Associates LTD.

Address: 2981 Yarnouth Greenway Drive Madison, Wisconsin 53711

Soil Description: (SP) SAND, brown, fine to medium Boring No.

Shape: Hardness: Sample No. 8

Remarks: Platte South Pit pt. 9 Depth:

Date Rec'd: 6/2/2011

MECHANICAL ANALYSIS PORTION OF HYDROMETER ANALYSIS

| Sieve Size | Grain Diameter (mm) | Weight Retained | Percent Retained | Percent Finer |
|---|---|---|---|---|
| **3"** | 76.2 | | | |
| **2"** | 50.8 | | | |
| **1 1/2"** | 37.5 | | | |
| **1** | 25.4 | | | |
| **3/4** | 19.1 | | | |
| **3/8** | 9.5 | | | |
| **4M** | 4.76 | | | |
| **10M** | 2.00 | 0.00 | 0.0 | 100.0 |
| **40M** | 0.42 | 2.10 | 0.9 | /* 99.1 |
| **100M** | 0.149 | 238.10 | 99.1 | /* 0.0 |
| **200M** | 0.074 | 0.10 | 0.0 | /* 0.0 |
| **Pan** | | 0.10 | 0.0 | /* 0.0 |

***Percent Based on Total Sample**

Original Sample:

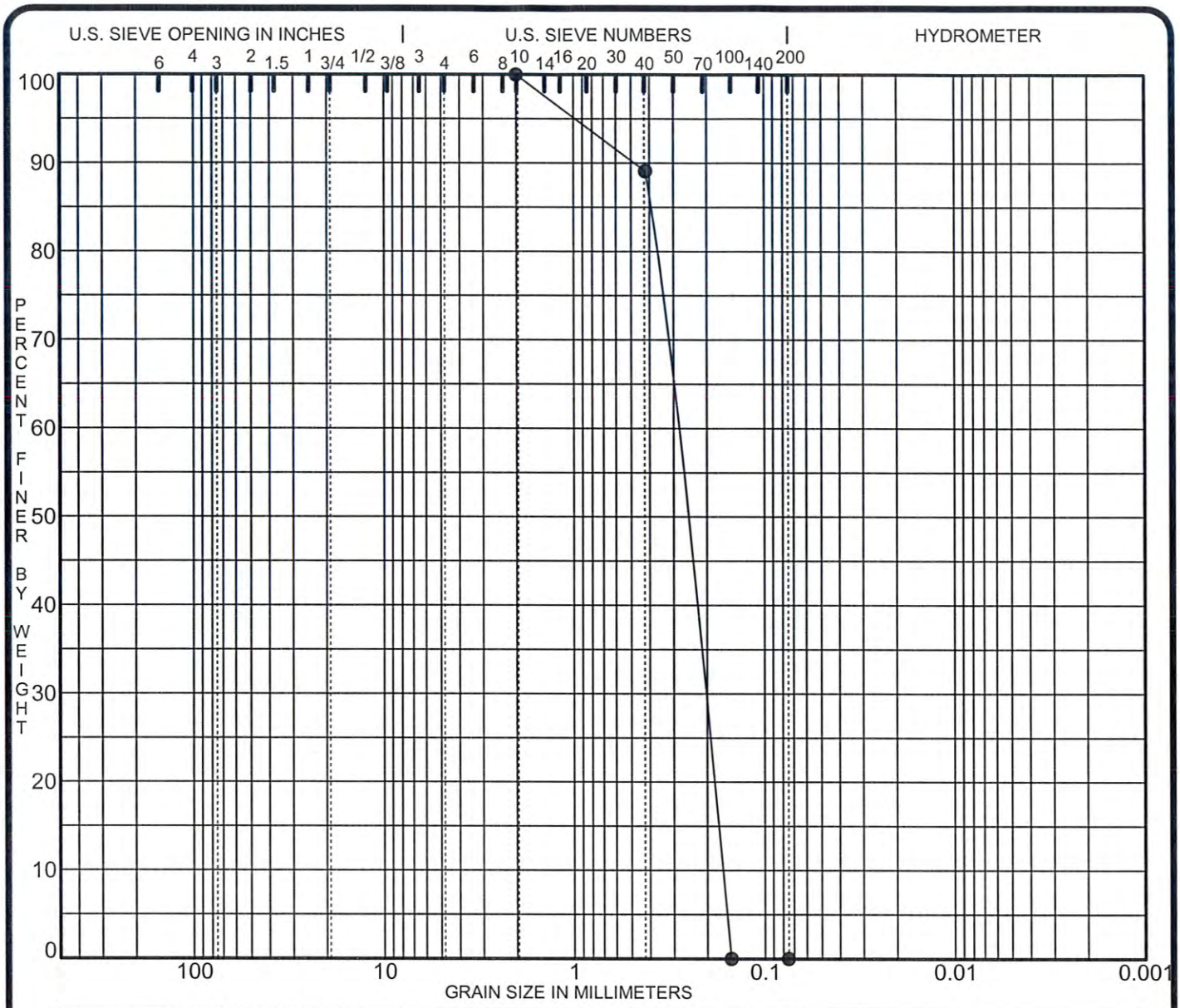
Material retained on No. 10 mesh: weight = 0 gm = 0.0% %

Material passing No. 10 mesh: weight = 240.4 gm = 100.0% %

Weight of Total Sample = 240.4 gm

Tested By: Denise Lotzer Date: 6/6/2011

Submitted By: Date: 6/30/2011




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● **Platte River Pt. 1 - #1** | **(SP) SAND, brown, fine to medium** | | | | | **0.89** | **1.8** |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● **Platte River Pt. 1 - #1** | **2.00** | **0.30** | **0.267** | **0.212** | **0.1684** | **0.0** | **100.0** | **0.0** | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

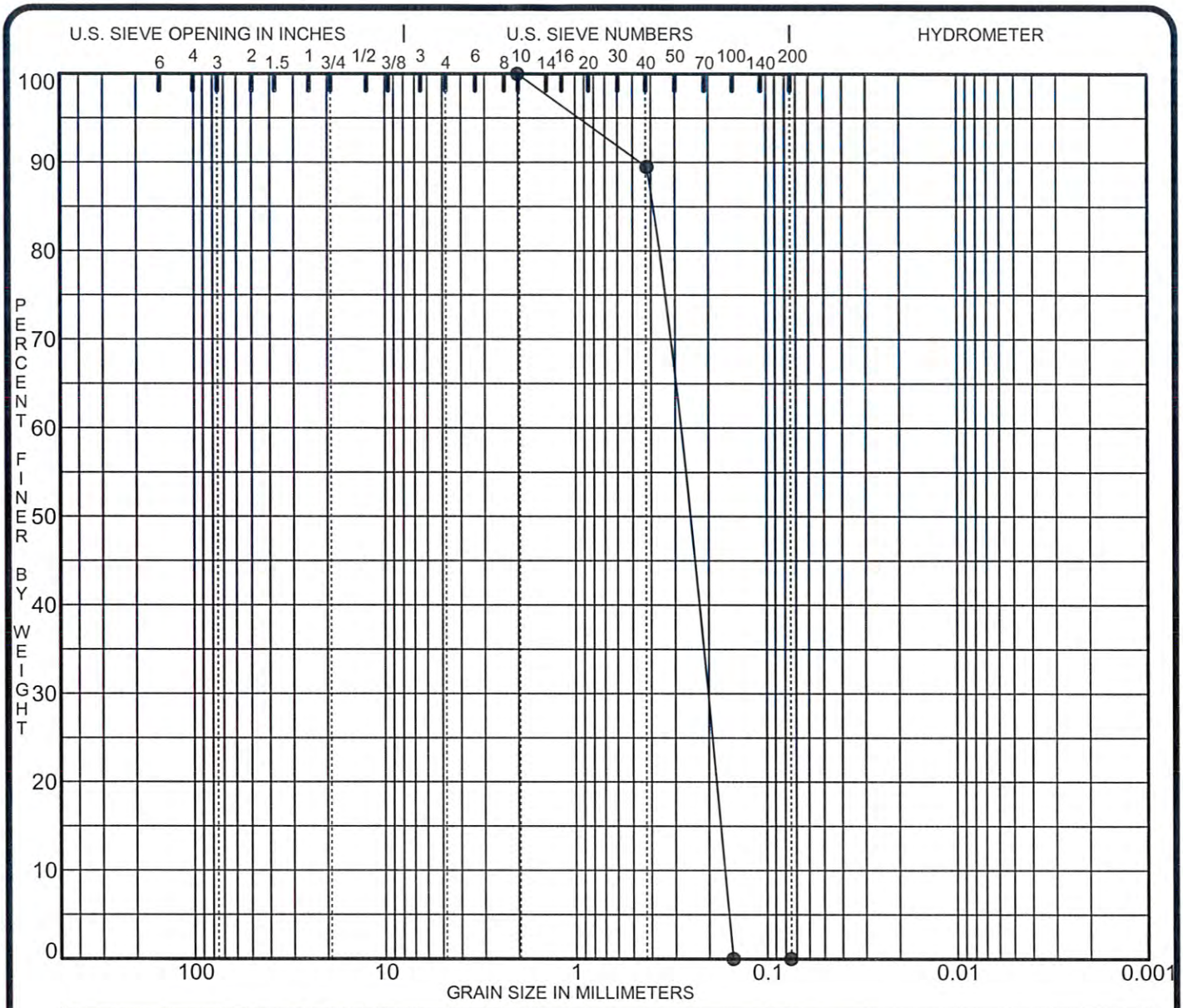
JOB NO. **11153**

DATE **6/30/11**

# GRADATION CURVES

**COLEMAN ENGINEERING COMPANY**
635 CIRCLE DRIVE
IRON MOUNTAIN, MICHIGAN 49801
Telephone: (906) 774-3440 Fax: (906) 774-7776

WMR 6/30/11




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 3 - #2 | (SP) SAND, brown, fine to medium | | | | | 0.89 | 1.8 |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 3 - #2 | 2.00 | 0.30 | 0.267 | 0.212 | 0.1683 | 0.0 | 100.0 | 0.0 | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

JOB NO. **11153**

DATE **6/30/11**

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IRON MOUNTAIN, MICHIGAN 49801
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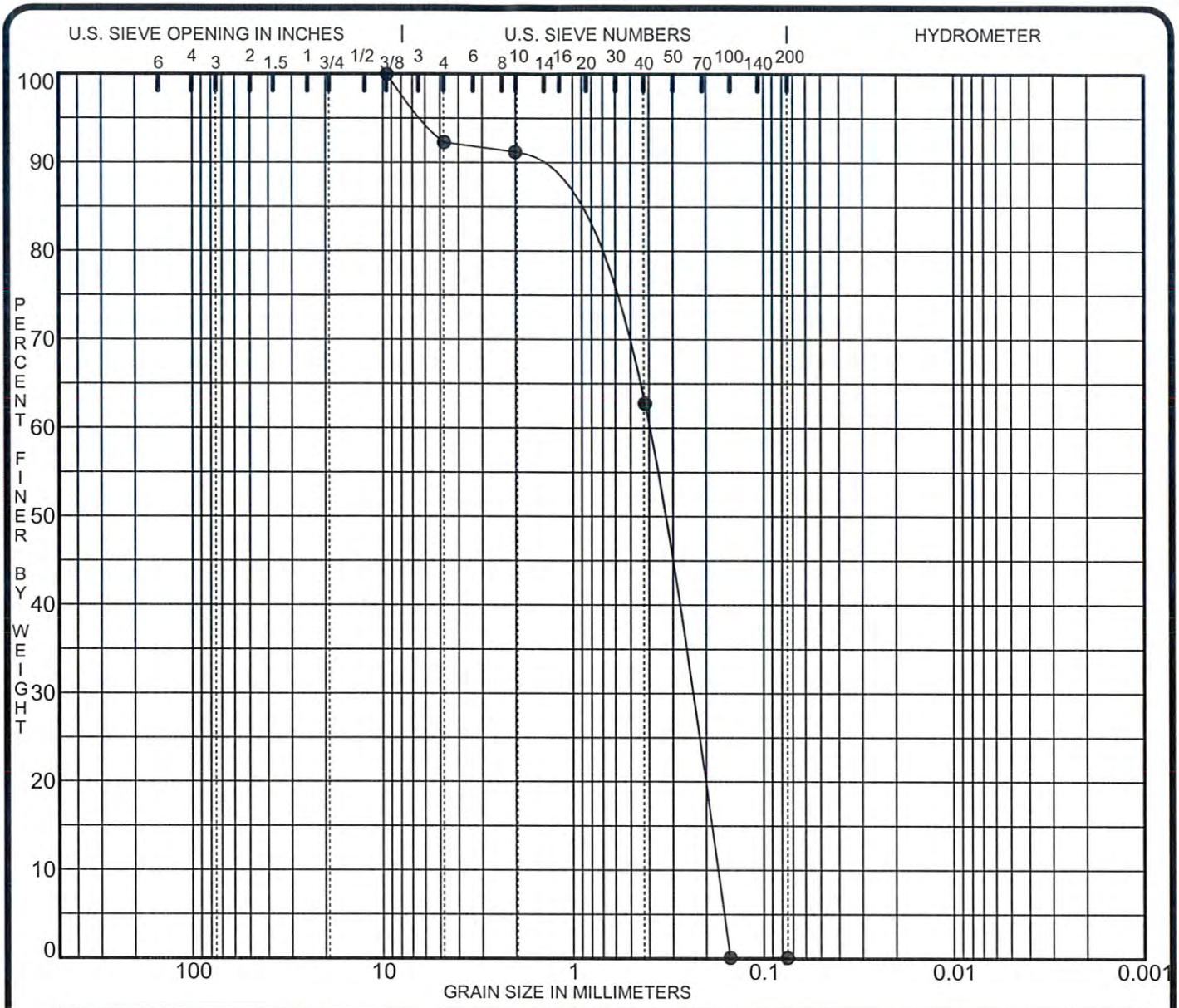
LWBR 6/30/11




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 4 - #3 | (SP) SAND, brown, fine to coarse, some fine gravel | | | | | 0.85 | 2.3 |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 4 - #3 | 9.50 | 0.40 | 0.340 | 0.245 | 0.1765 | 7.7 | 92.2 | 0.1 | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

JOB NO. **11153**

DATE **6/30/11**

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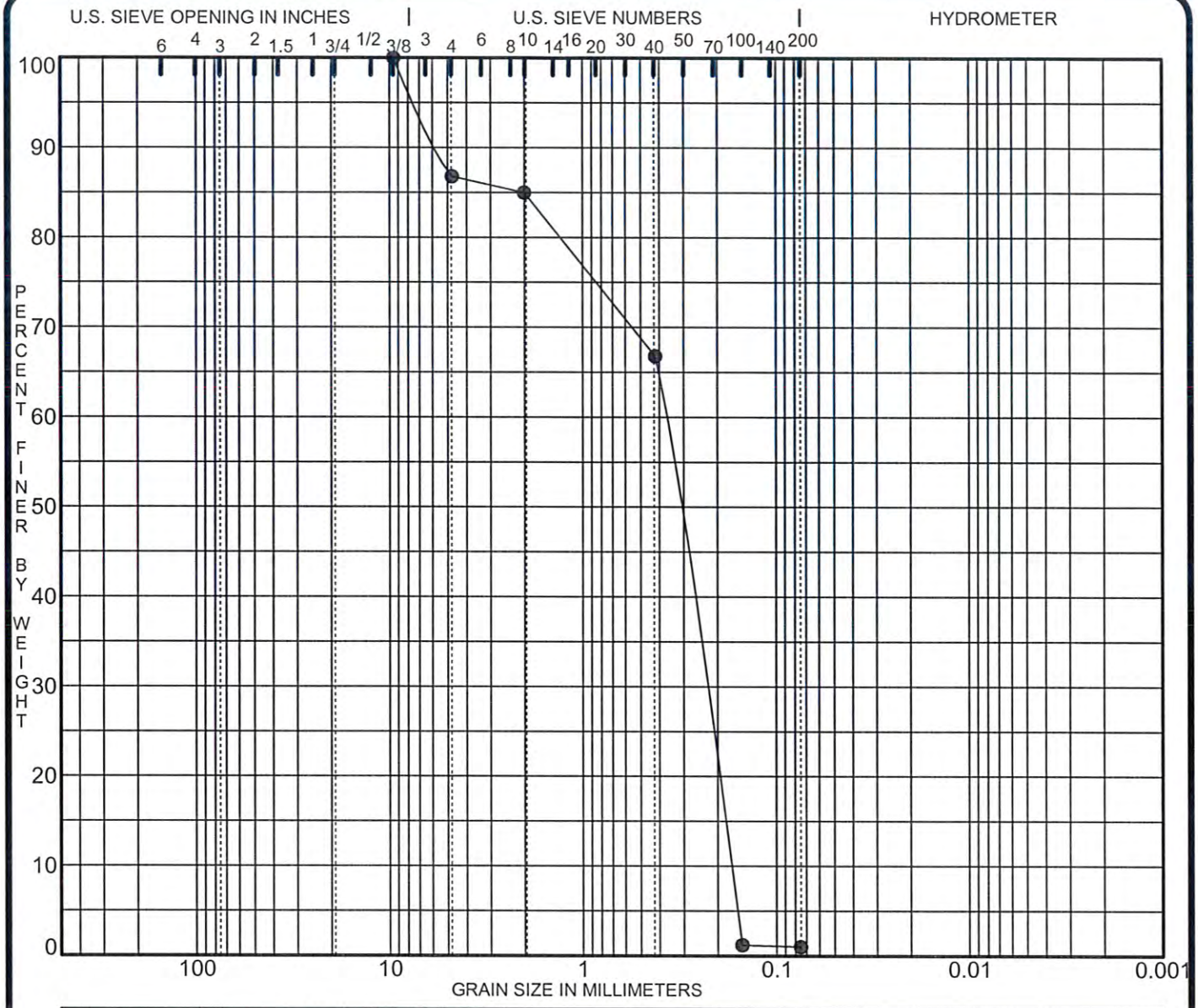
IRON MOUNTAIN, MICHIGAN 49801
Telephone: (906) 774-3440 Fax: (906) 774-7776

WDR 6/30/11




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 5 - #4 | (SP) SAND, brown, fine to coarse, with fine gravel | | | | | 0.85 | 2.2 |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 5 - #4 | 9.50 | 0.38 | 0.323 | 0.236 | 0.1722 | 13.2 | 85.8 | 1.0 | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

JOB NO. **11153**

DATE **6/30/11**

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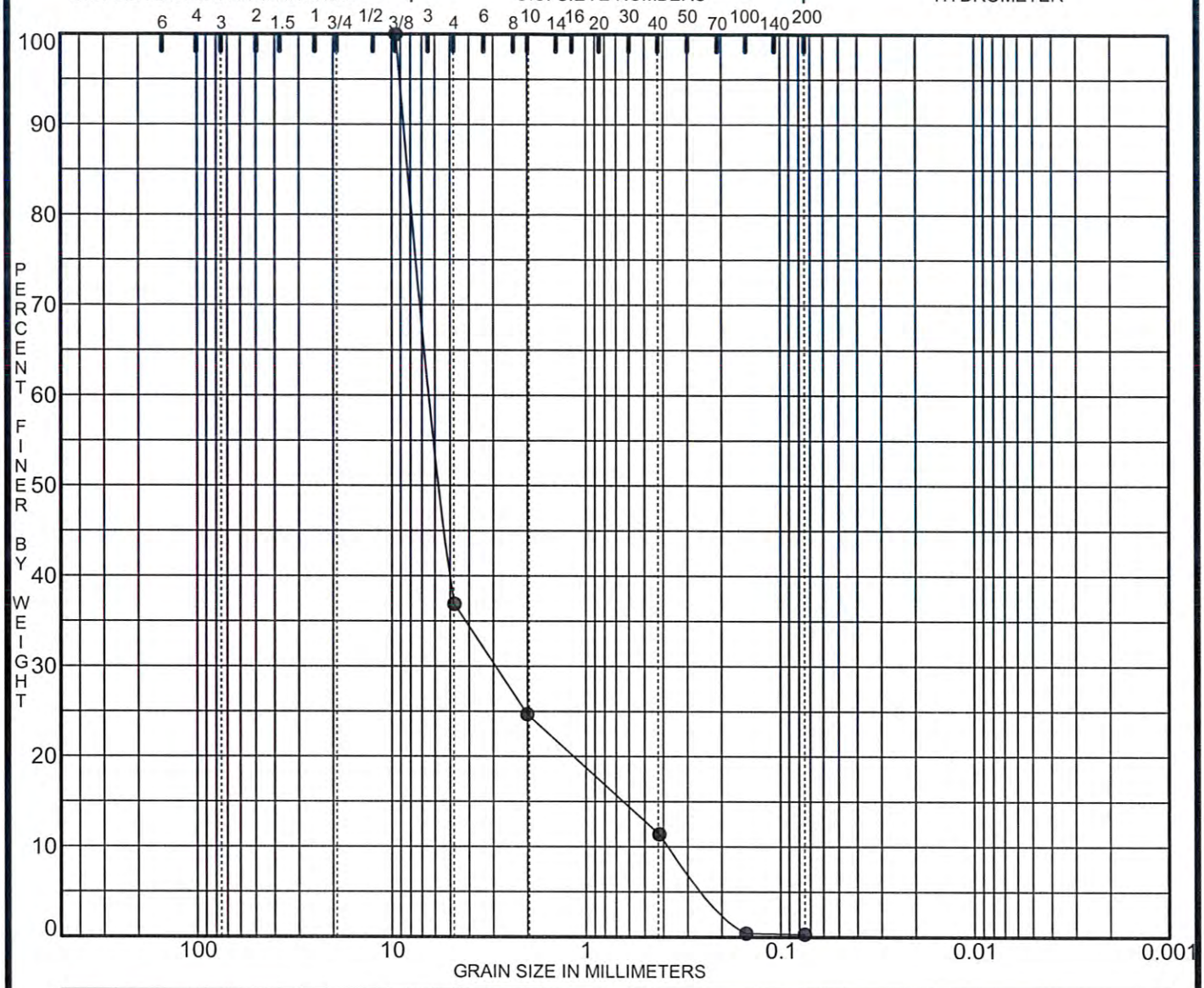
WDR 6/30/11




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● **Platte River Pt. 6 - #5** | (GP) SANDY GRAVEL, brown, fine, sand fine to coarse | | | | | **3.76** | **16.6** |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● **Platte River Pt. 6 - #5** | **9.50** | **6.12** | **5.485** | **2.912** | **0.3684** | **63.1** | **36.6** | **0.3** | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

JOB NO. **11153**

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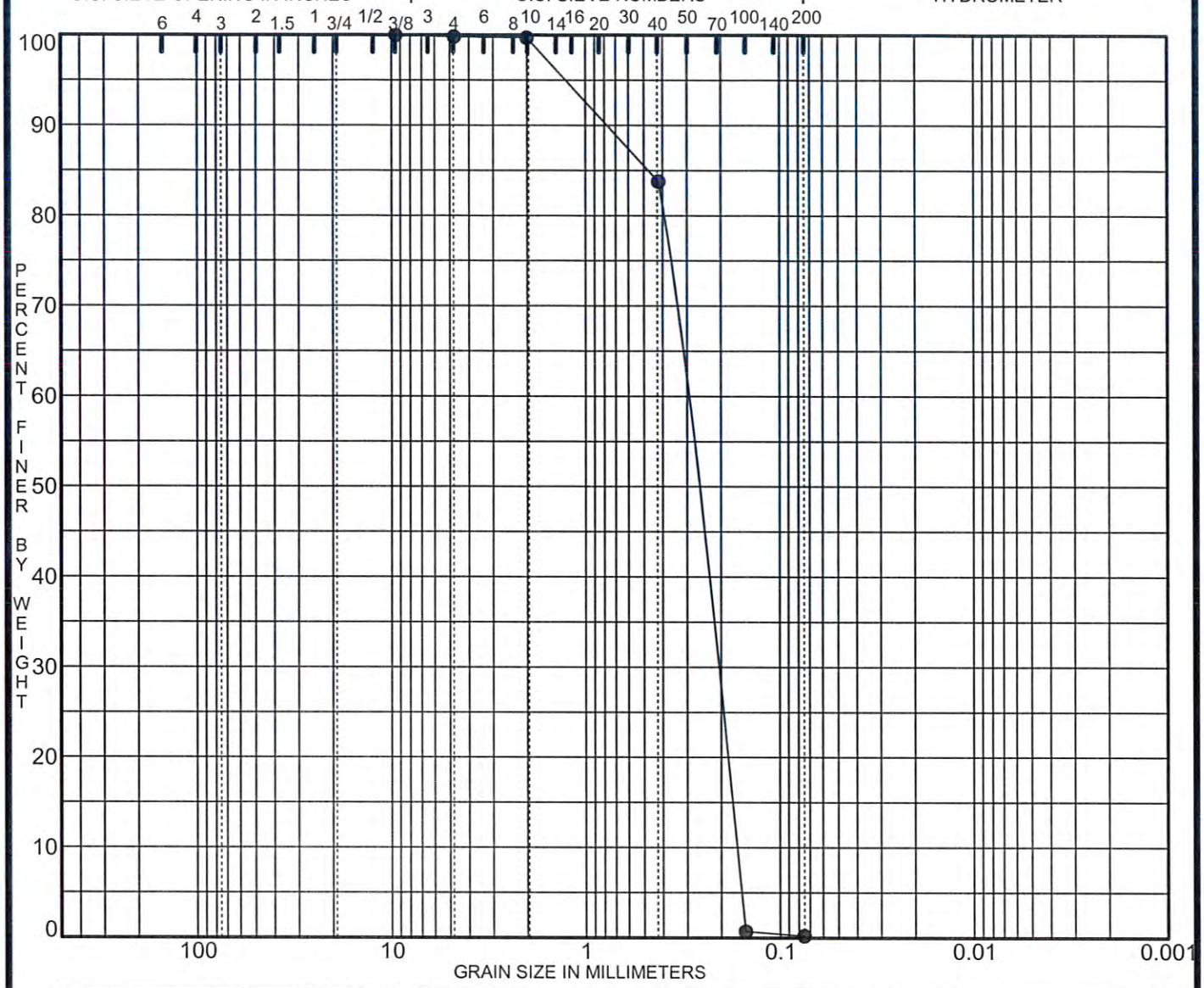
WMR 6/30/11




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 7 - #6 | (SP) SAND, brown, fine to coarse, trace fine gravel | | | | | 0.88 | 1.9 |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● Platte River Pt. 7 - #6 | 9.50 | 0.31 | 0.276 | 0.216 | 0.1683 | 0.2 | 99.6 | 0.2 | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

JOB NO. **11153**

DATE **6/30/11**

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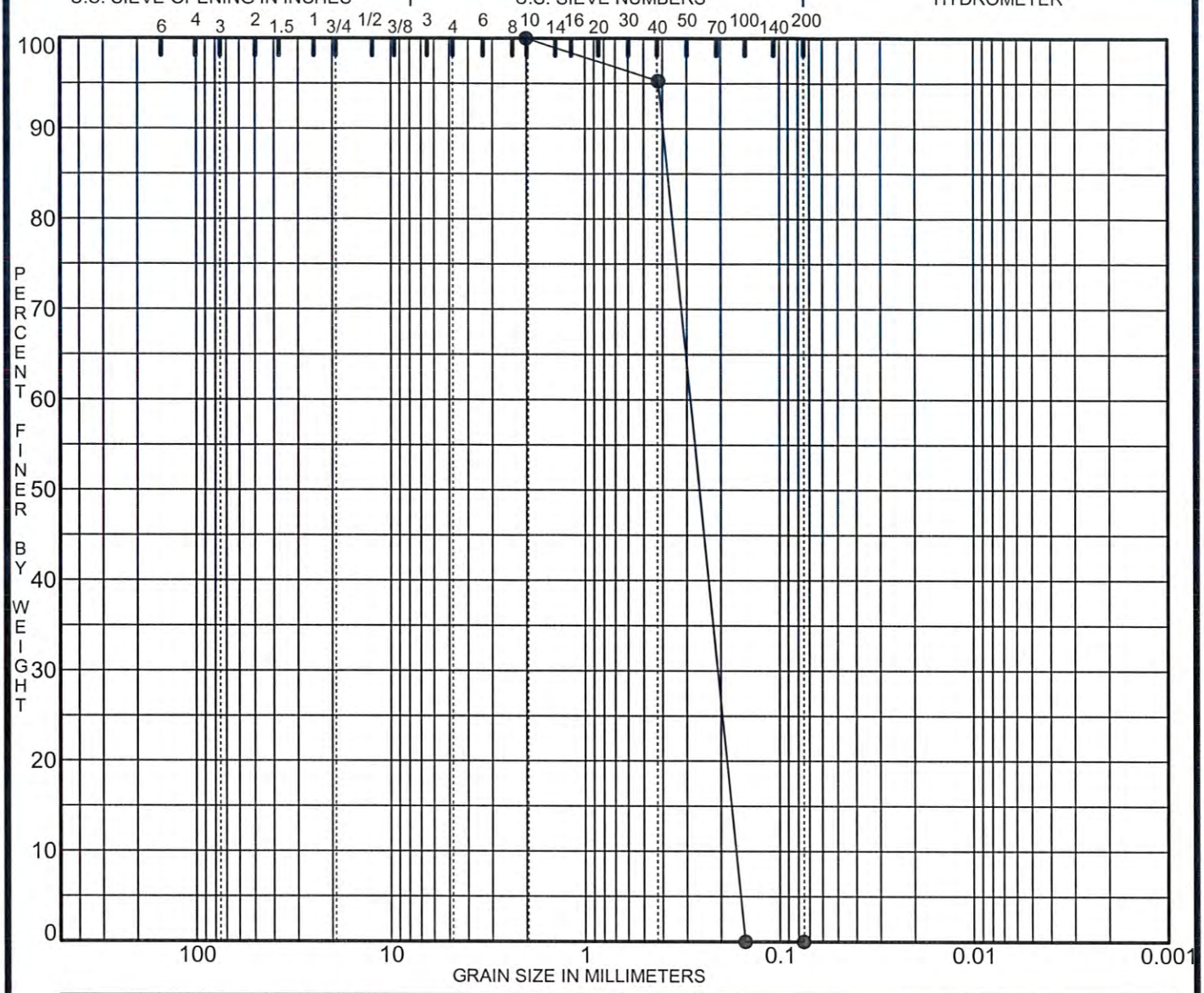
Telephone: (906) 774-3440 Fax: (906) 774-7776

LODER 6/30/11




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● **Platte River Pt. 8 - #7** | **(SP) SAND, brown, fine to medium** | | | | | **0.90** | **1.7** |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● **Platte River Pt. 8 - #7** | **2.00** | **0.29** | **0.257** | **0.207** | **0.1671** | **0.0** | **100.0** | **0.0** | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

JOB NO. **11153**

DATE **6/30/11**

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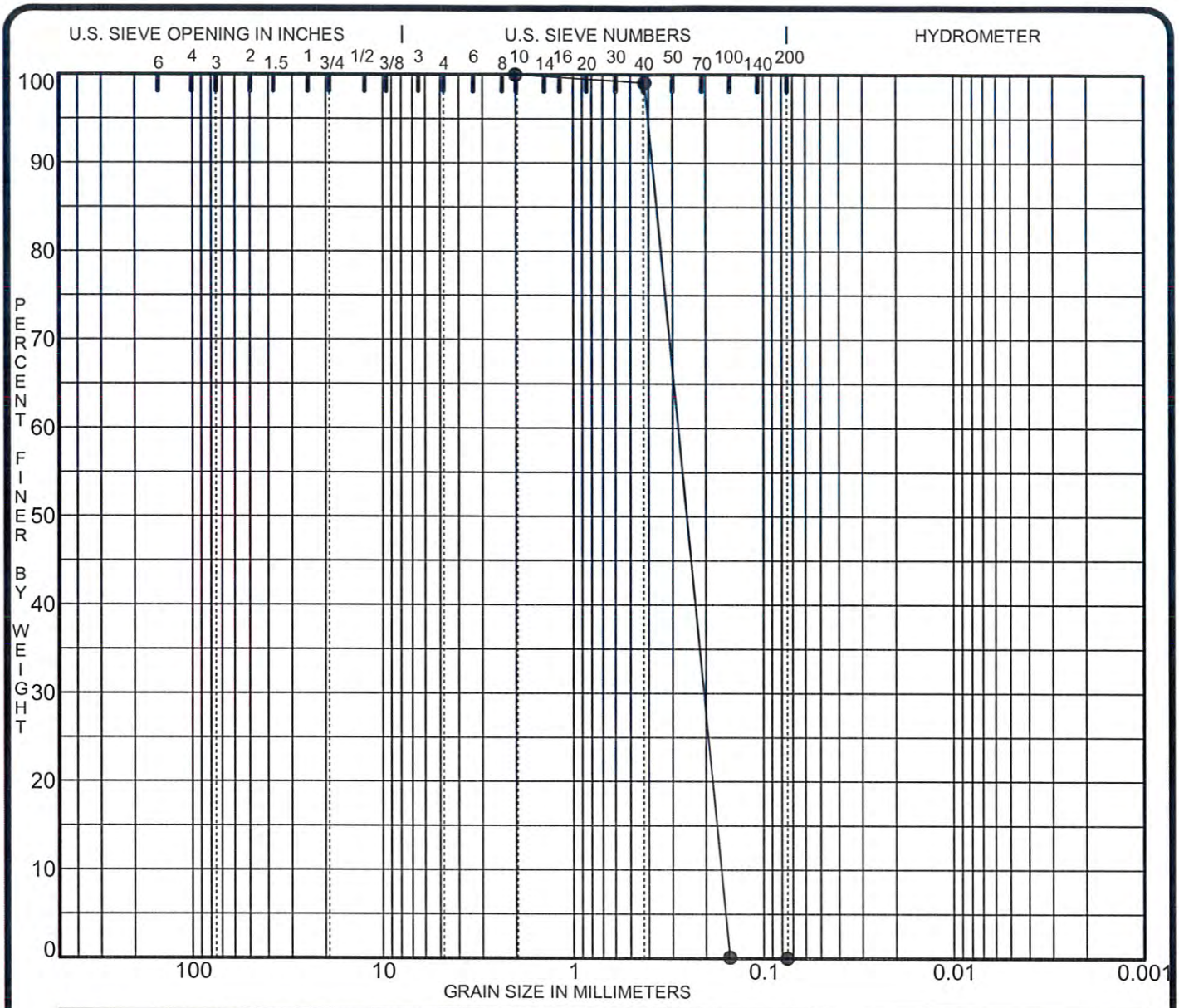
IRON MOUNTAIN, MICHIGAN 49801
Telephone: (906) 774-3440 Fax: (906) 774-7776

WDR 6/30/11




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen I.D. | Classification | MC% | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● **Platte** | **(SP) SAND, brown, fine to medium** | | | | | **0.90** | **1.7** |
| **South Pit** | | | | | | | |
| **Pt. 9 - #8** | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| Specimen I.D. | D100 | D60 | D50 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● **Platte** | **2.00** | **0.28** | **0.252** | **0.205** | **0.1663** | **0.0** | **100.0** | **0.0** | |
| **South Pit** | | | | | | | | | |
| **Pt. 9 - #8** | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

PROJECT **Platte River, Michigan Island & Pictured Rocks - Michigan**

JOB NO. **11153**

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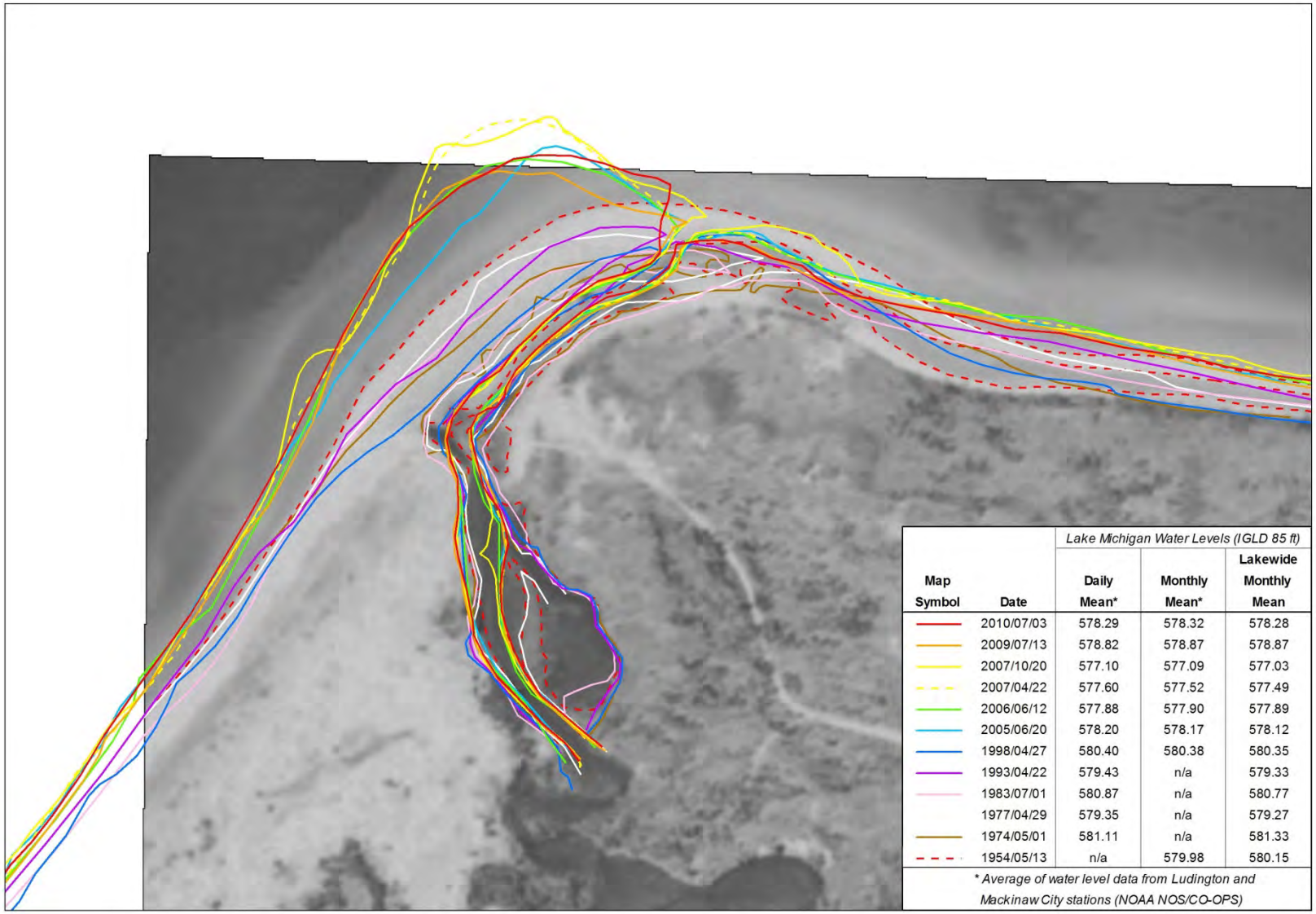
Telephone: (906) 774-3440 Fax: (906) 774-7776

WDR 6/30/11

# APPENDIX B

# ARCHIVE OF DIGITIZED SHORELINES



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

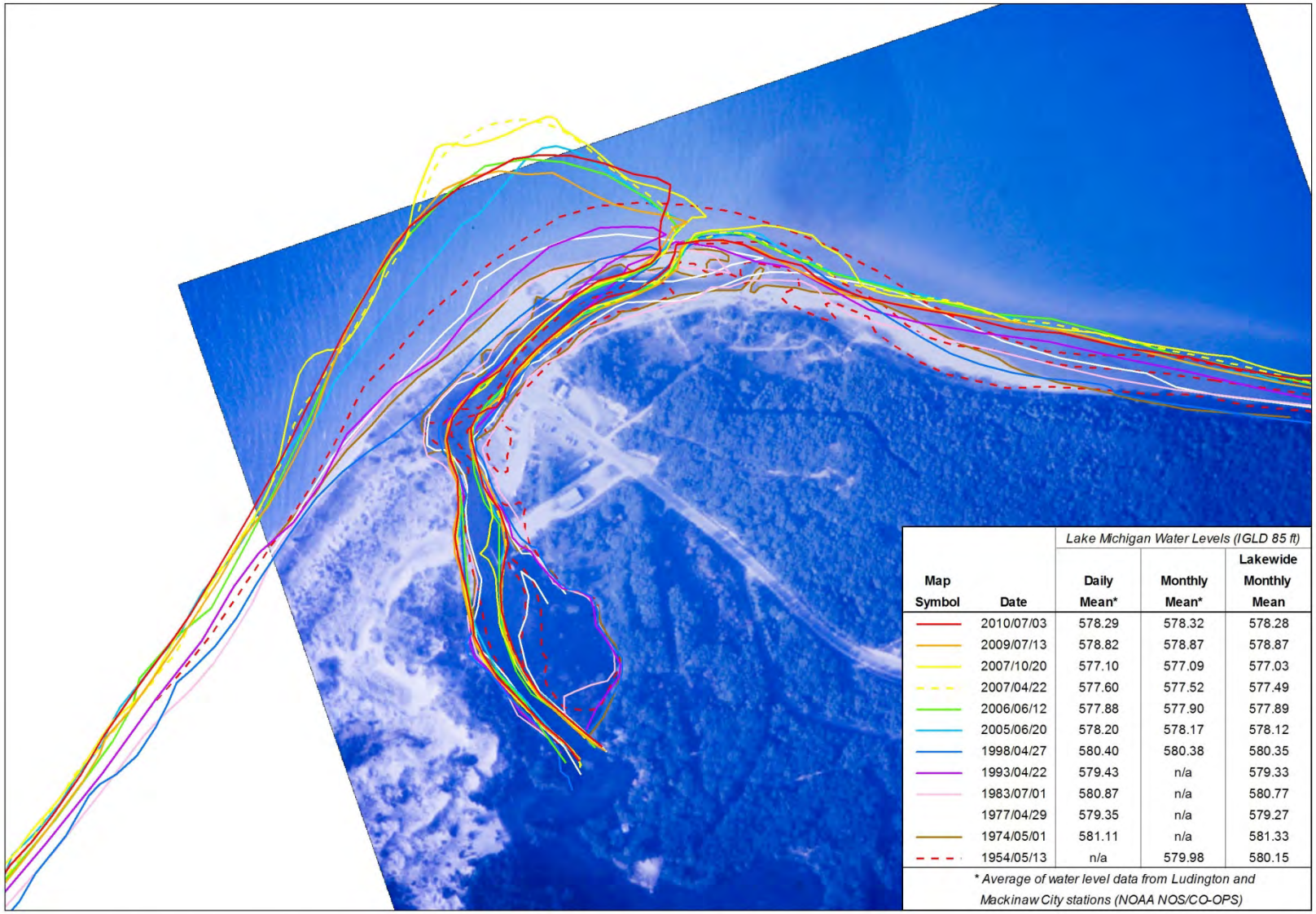
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 1954-05-13 (USGS)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

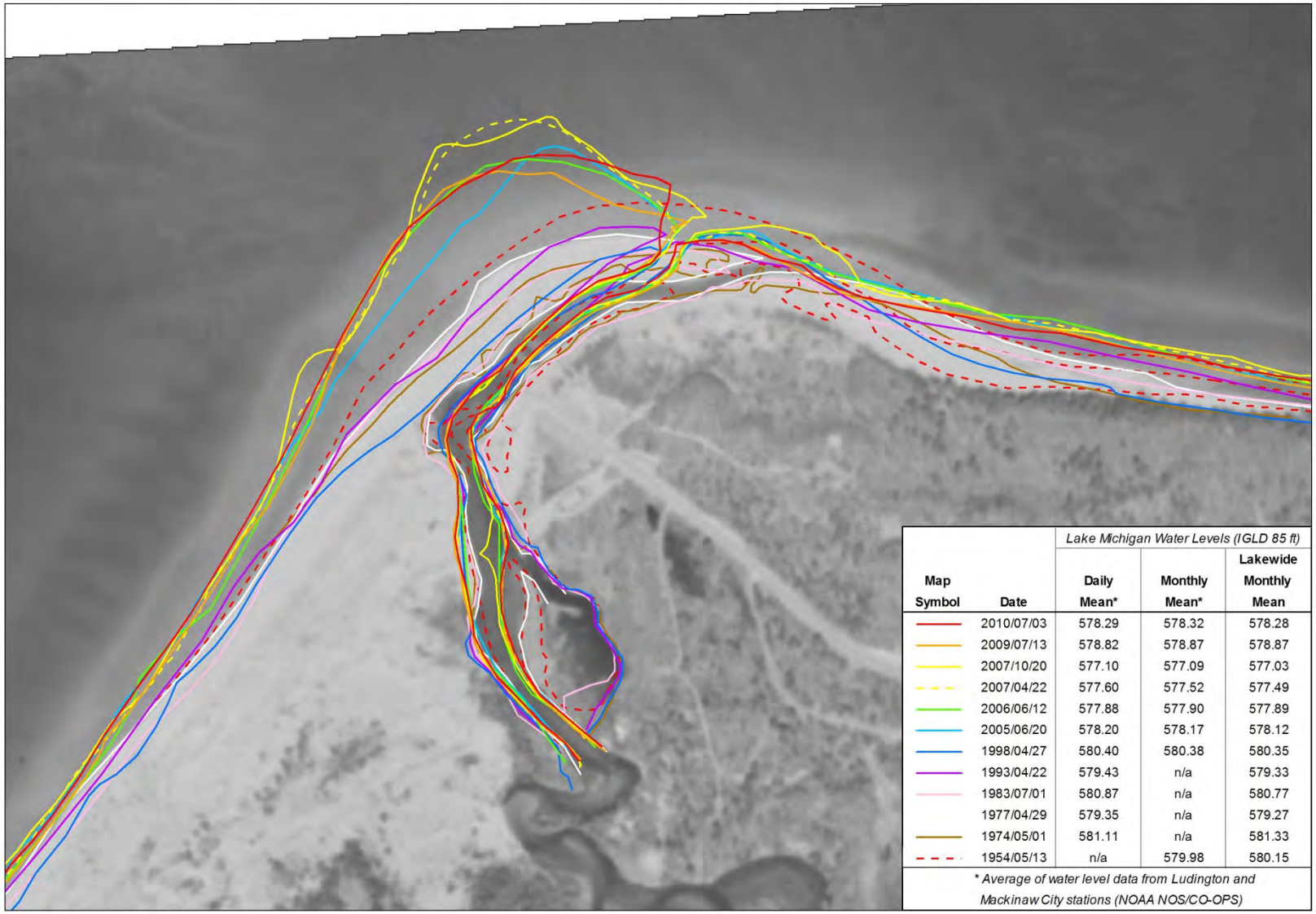
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 1974-05-01 (USGS)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

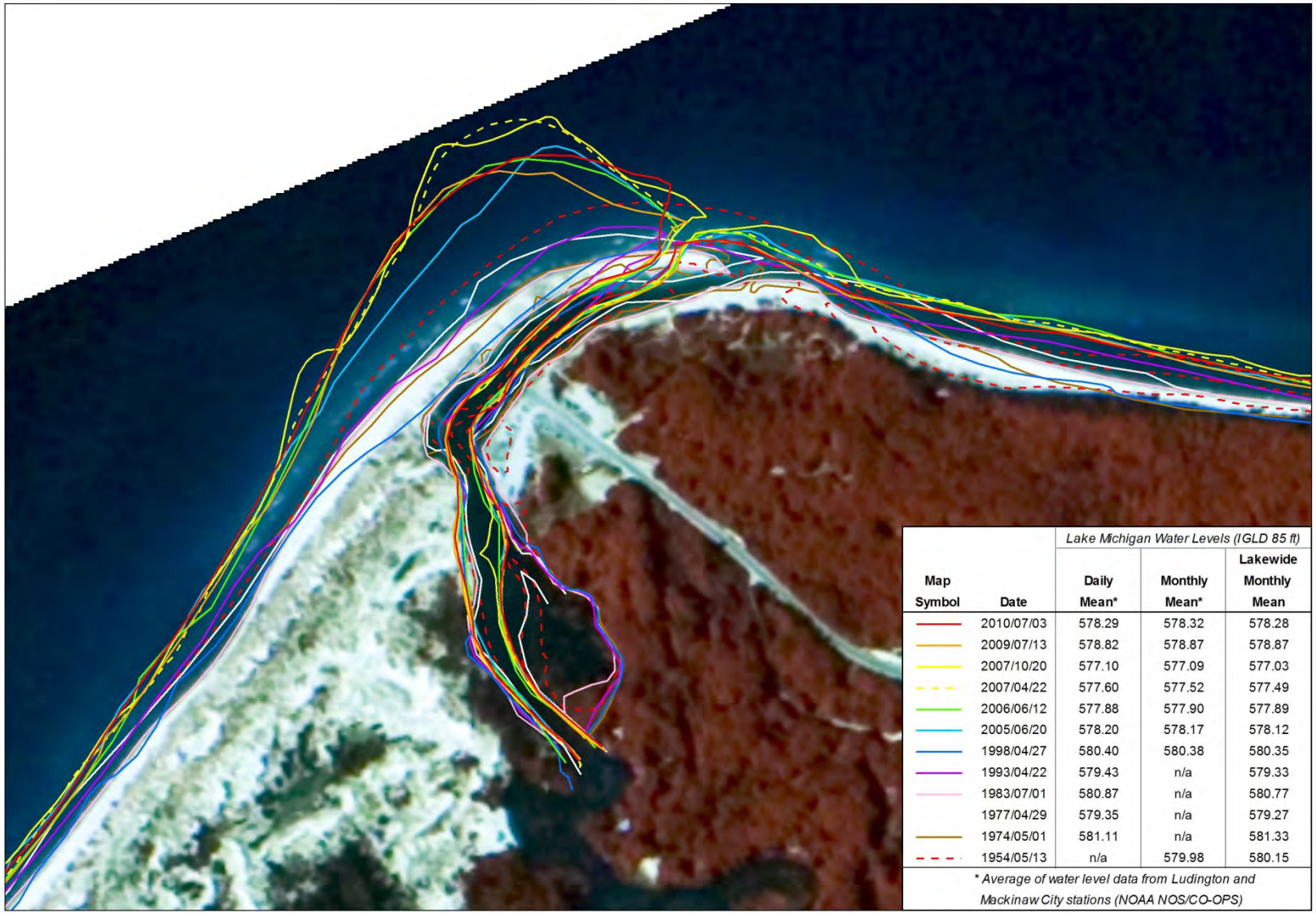
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 1977-04-29 (USGS)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

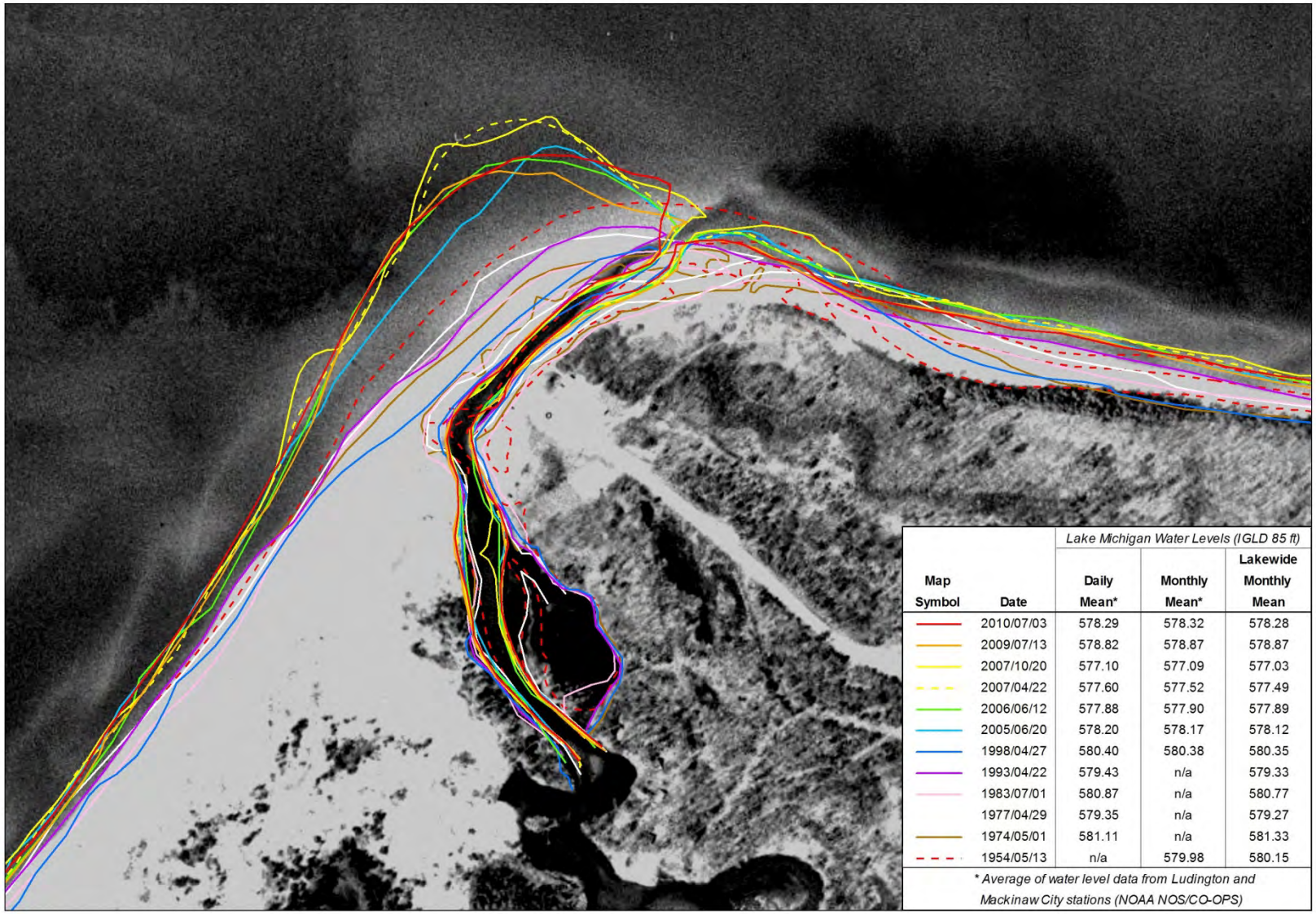
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 1983-07-01 (USGS)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

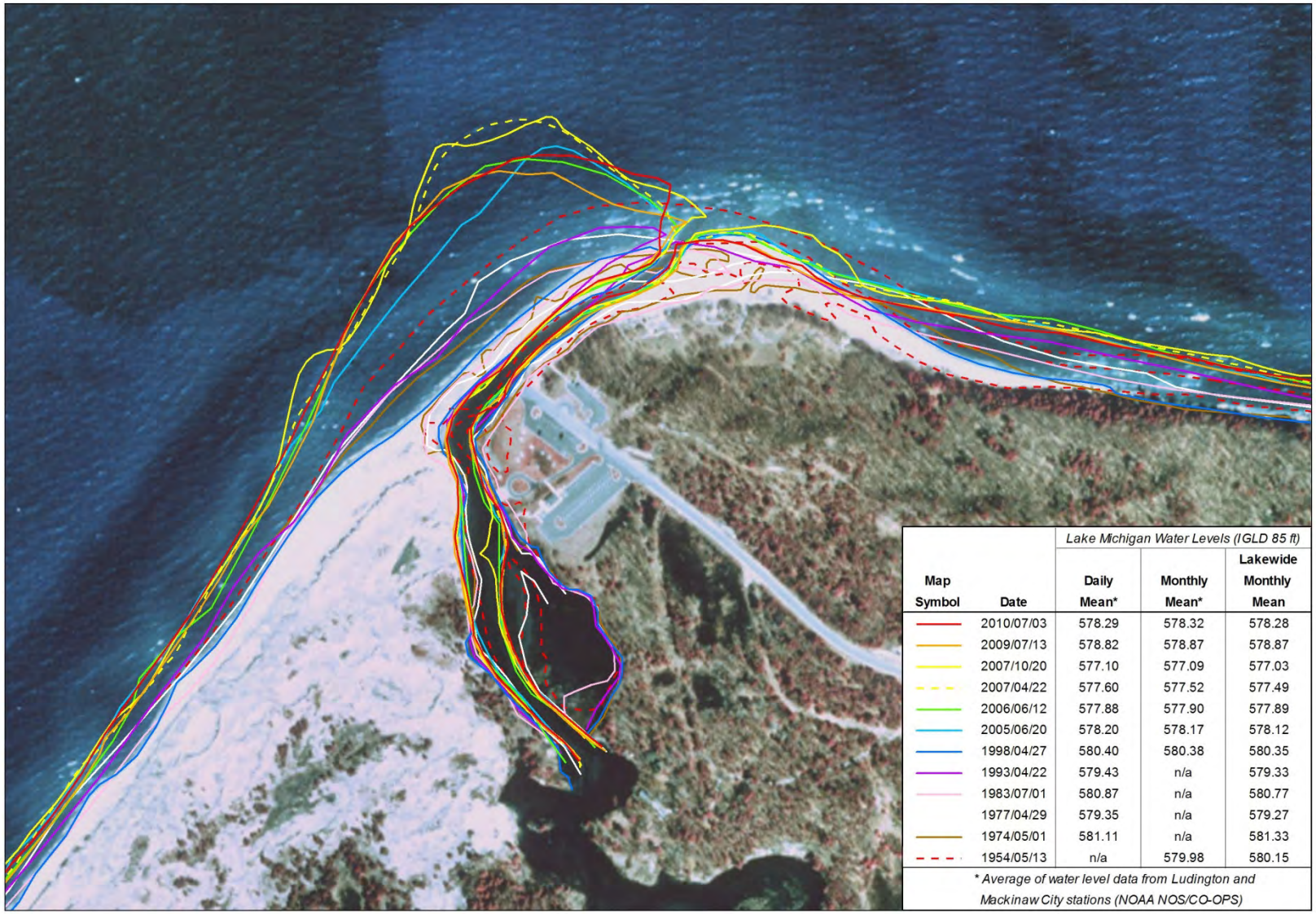
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 1993-04-22 (MiGDL)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

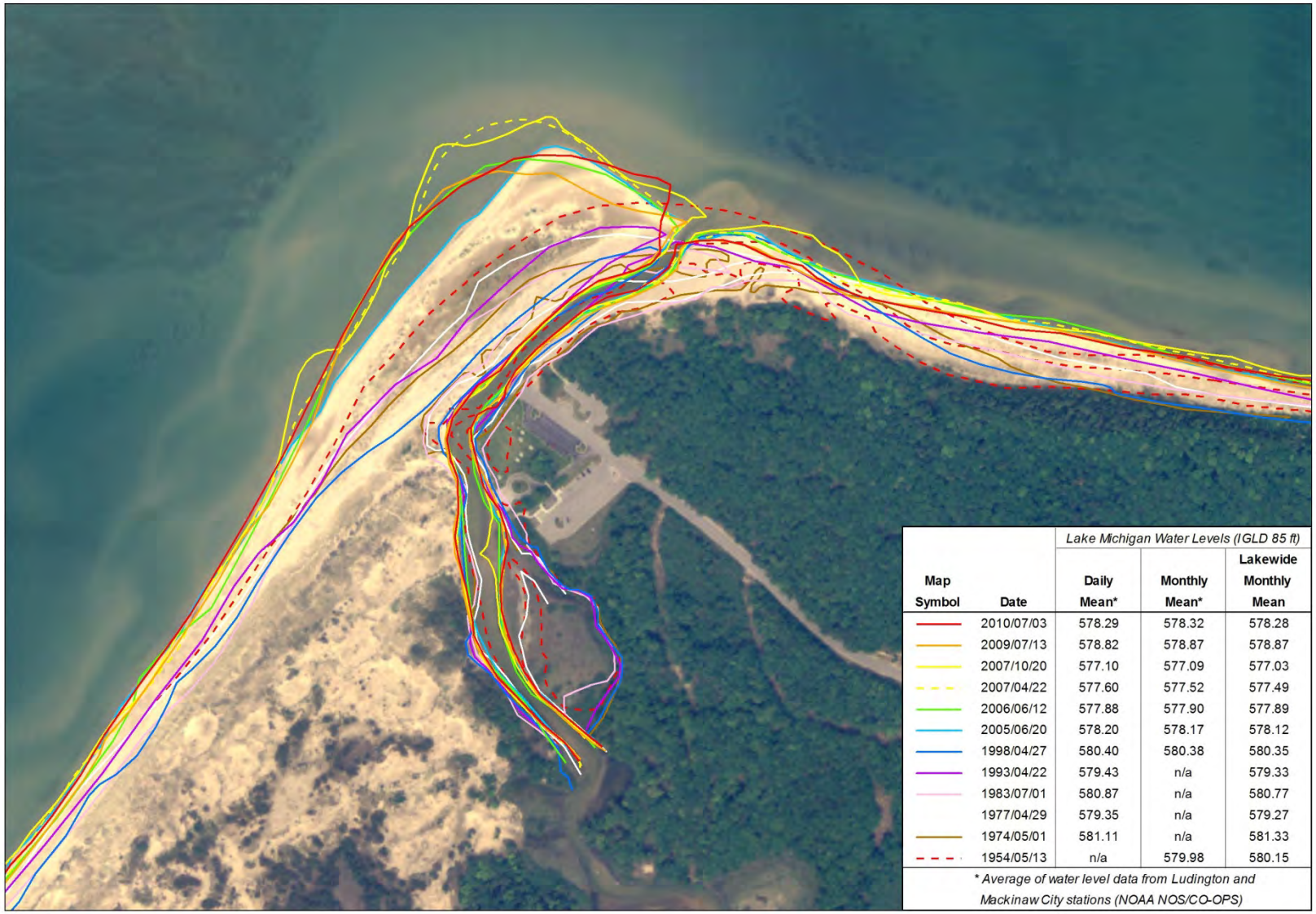
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 1998-04-27 (MiGDL)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

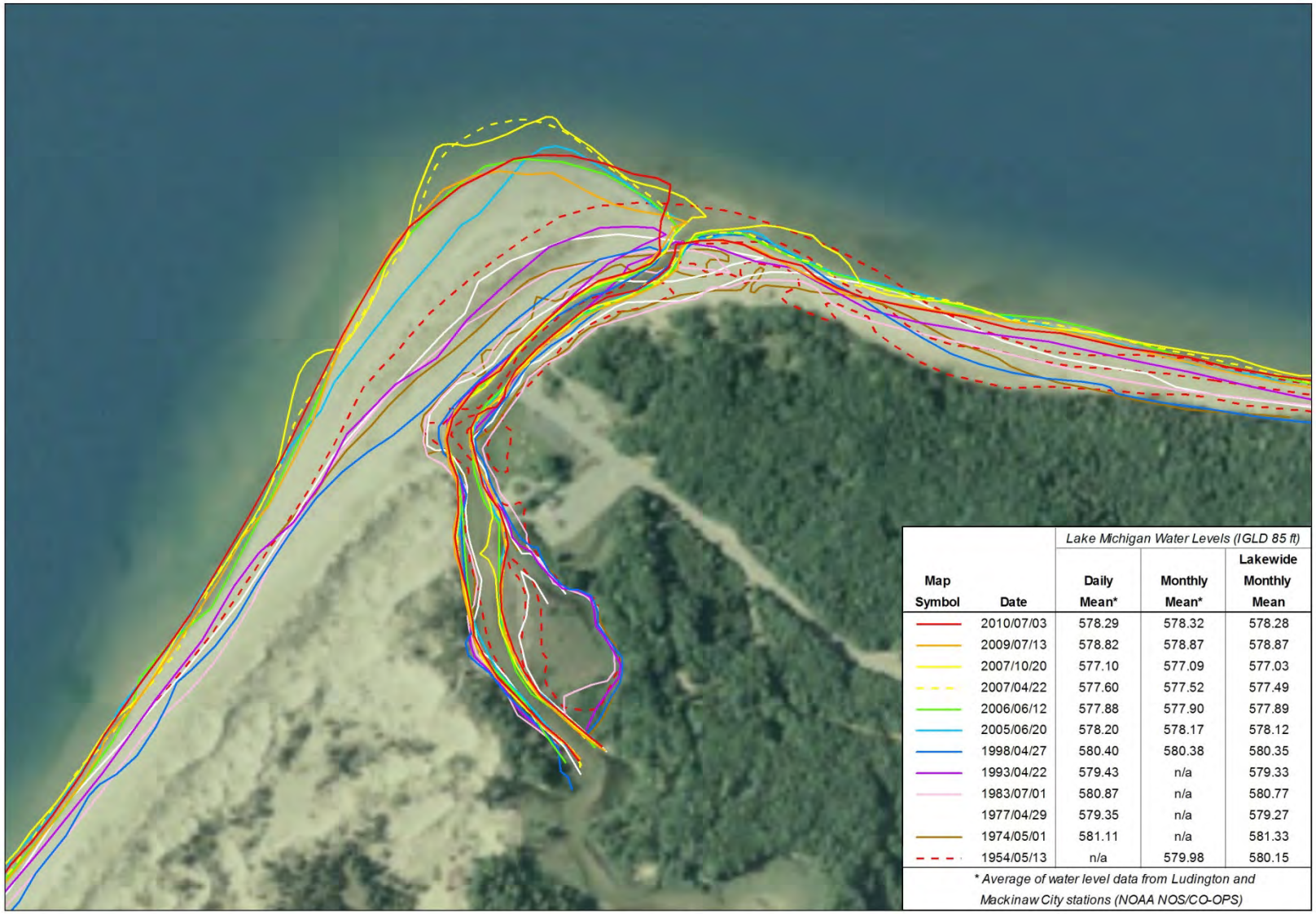
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 2005-06-20 (USDA)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

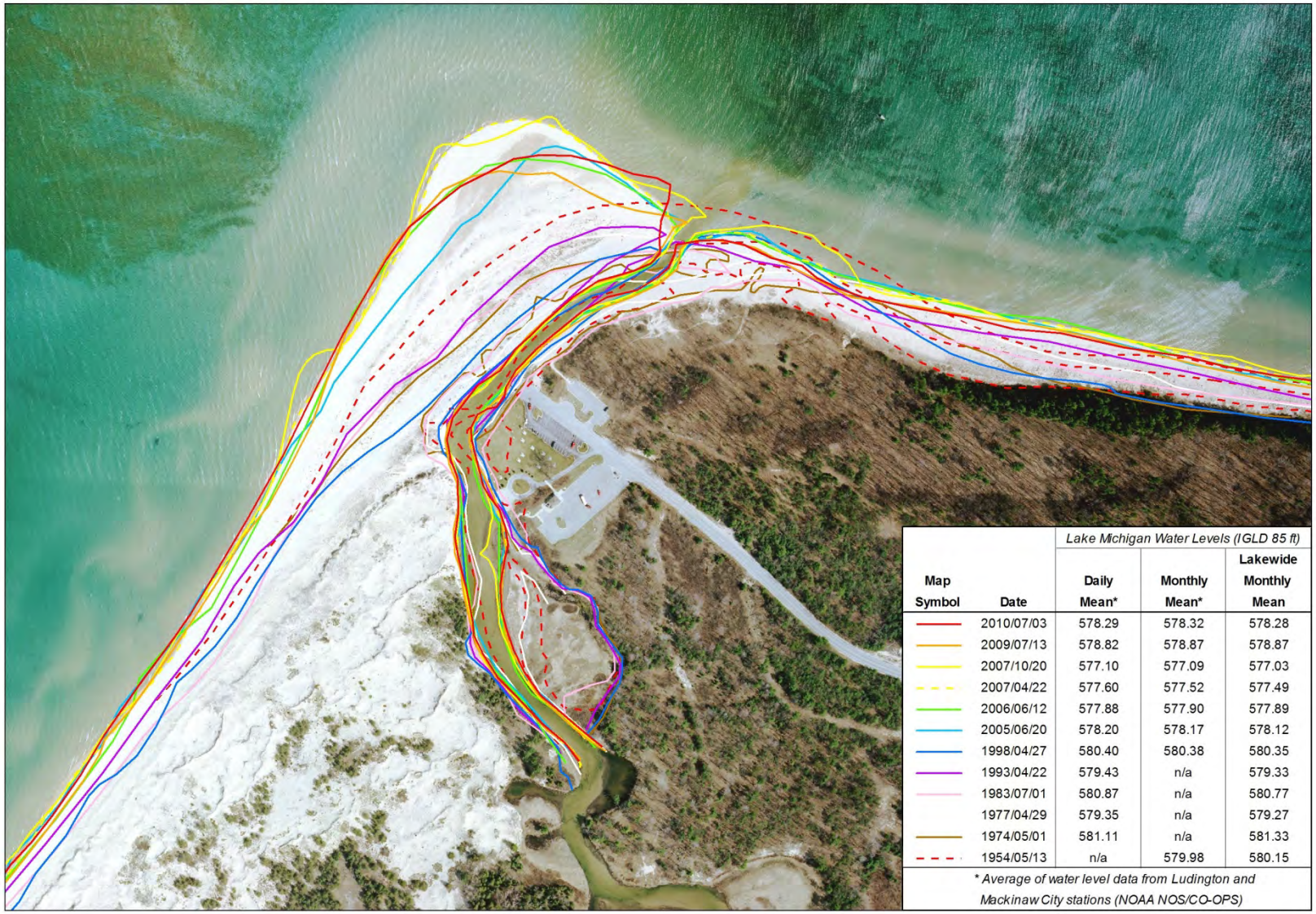
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 2006-06-12 (USDA)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

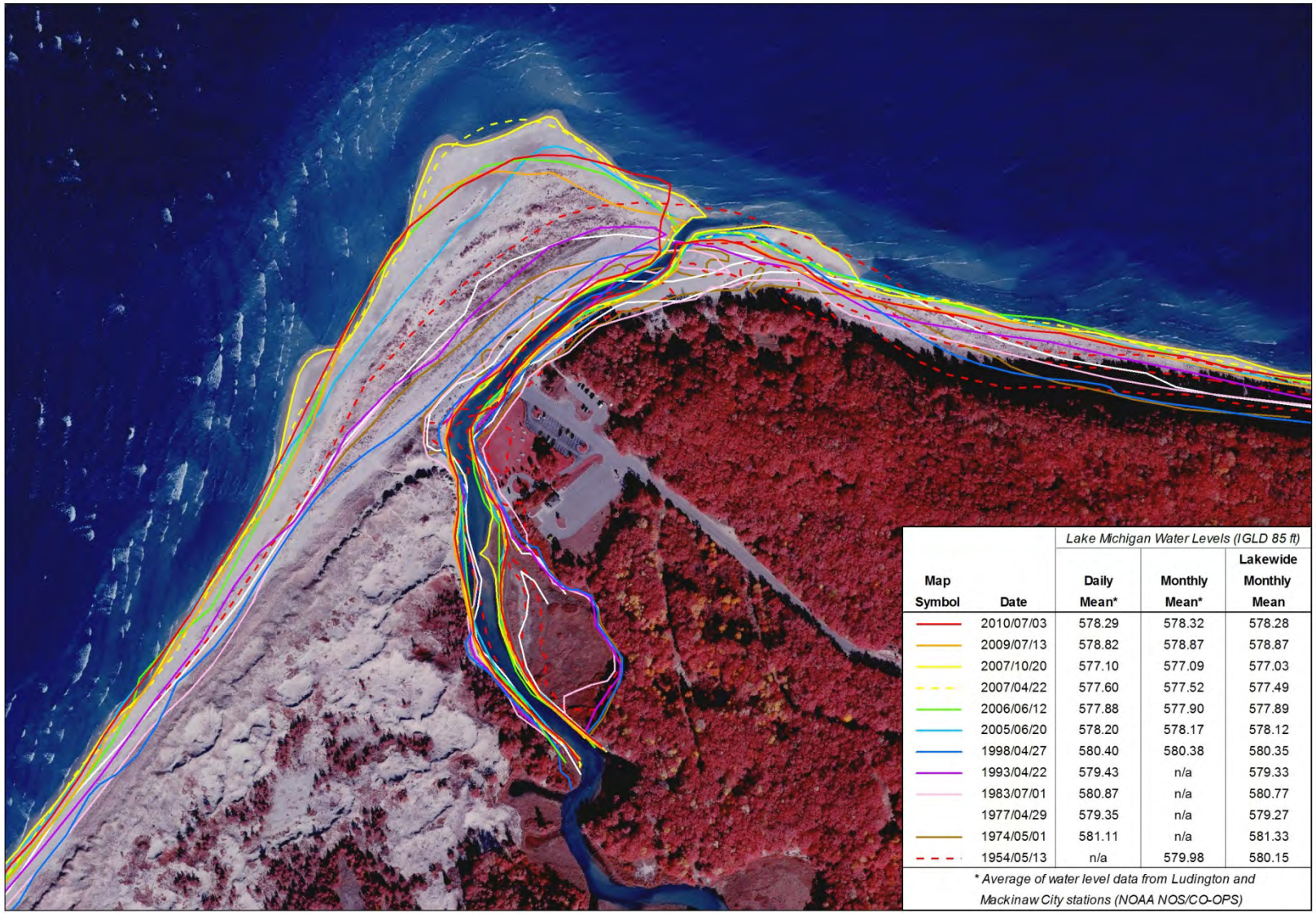
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 2007-04-22 (NPS)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

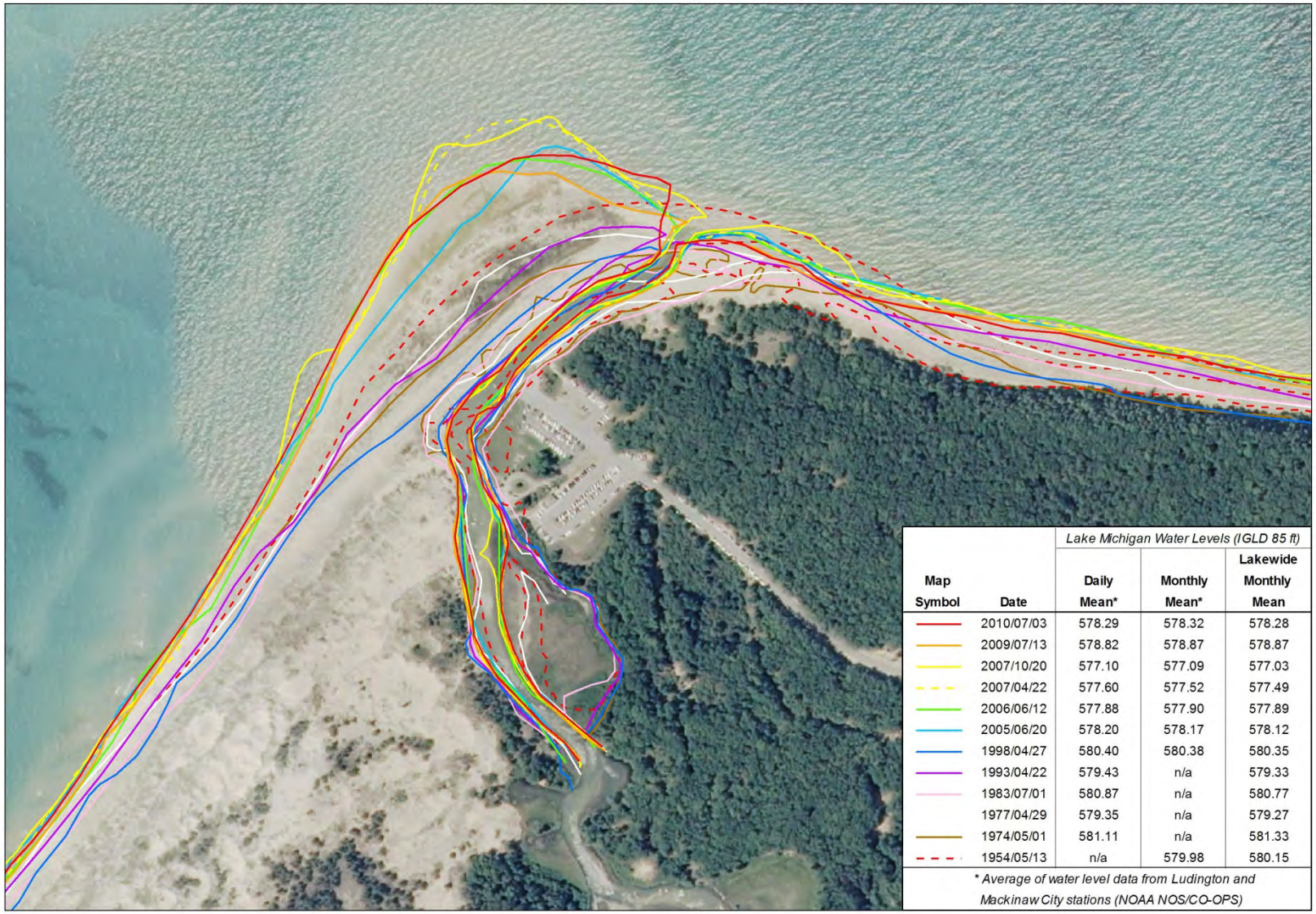
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 2007-10-20 (NPS)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
| | 2007/04/22 | 577.60 | 577.52 | 577.49 |
| | 2006/06/12 | 577.88 | 577.90 | 577.89 |
| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

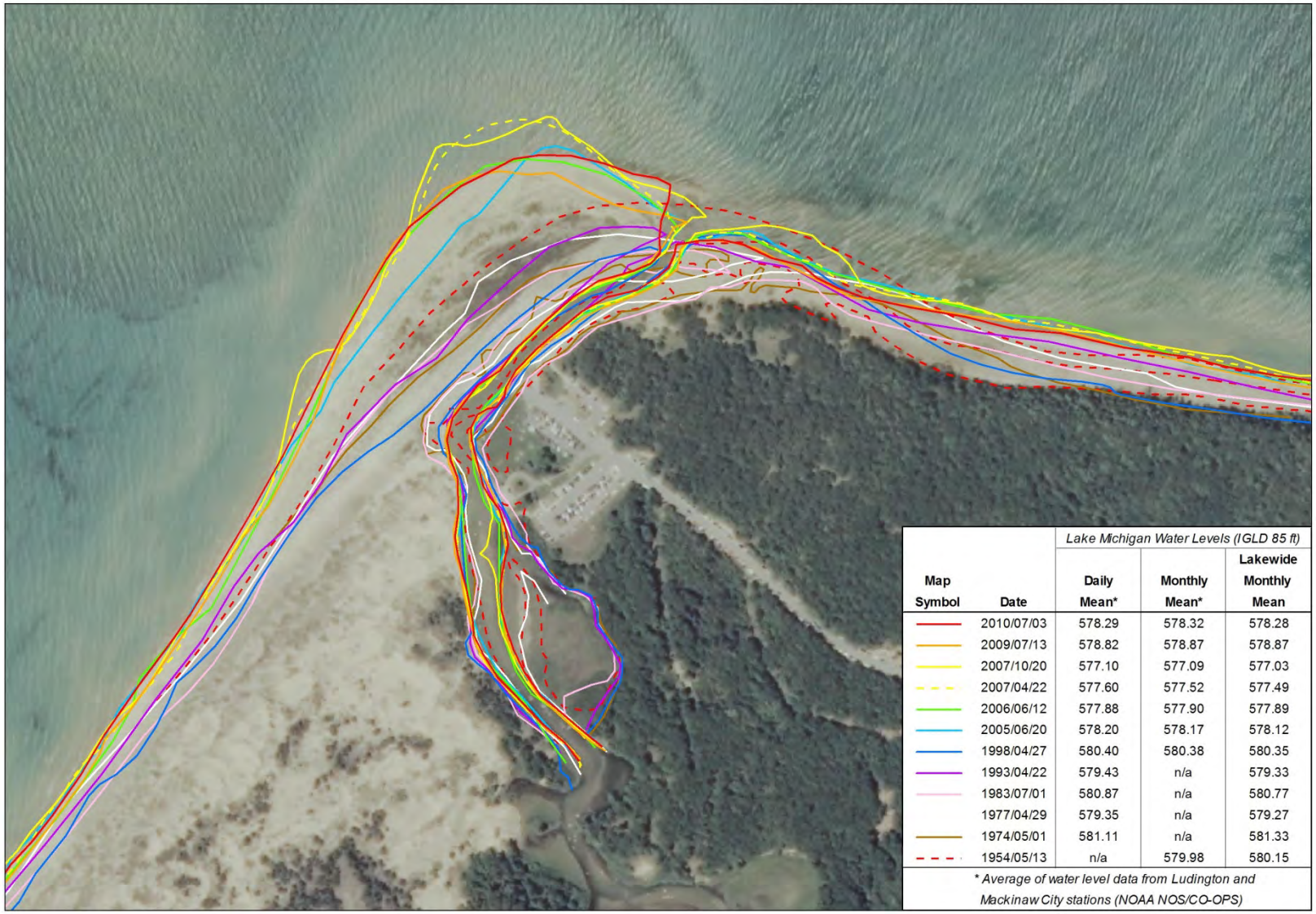
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 2009-07-13 (USDA)

Baird



| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
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| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
| | 2007/10/20 | 577.10 | 577.09 | 577.03 |
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| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
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| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

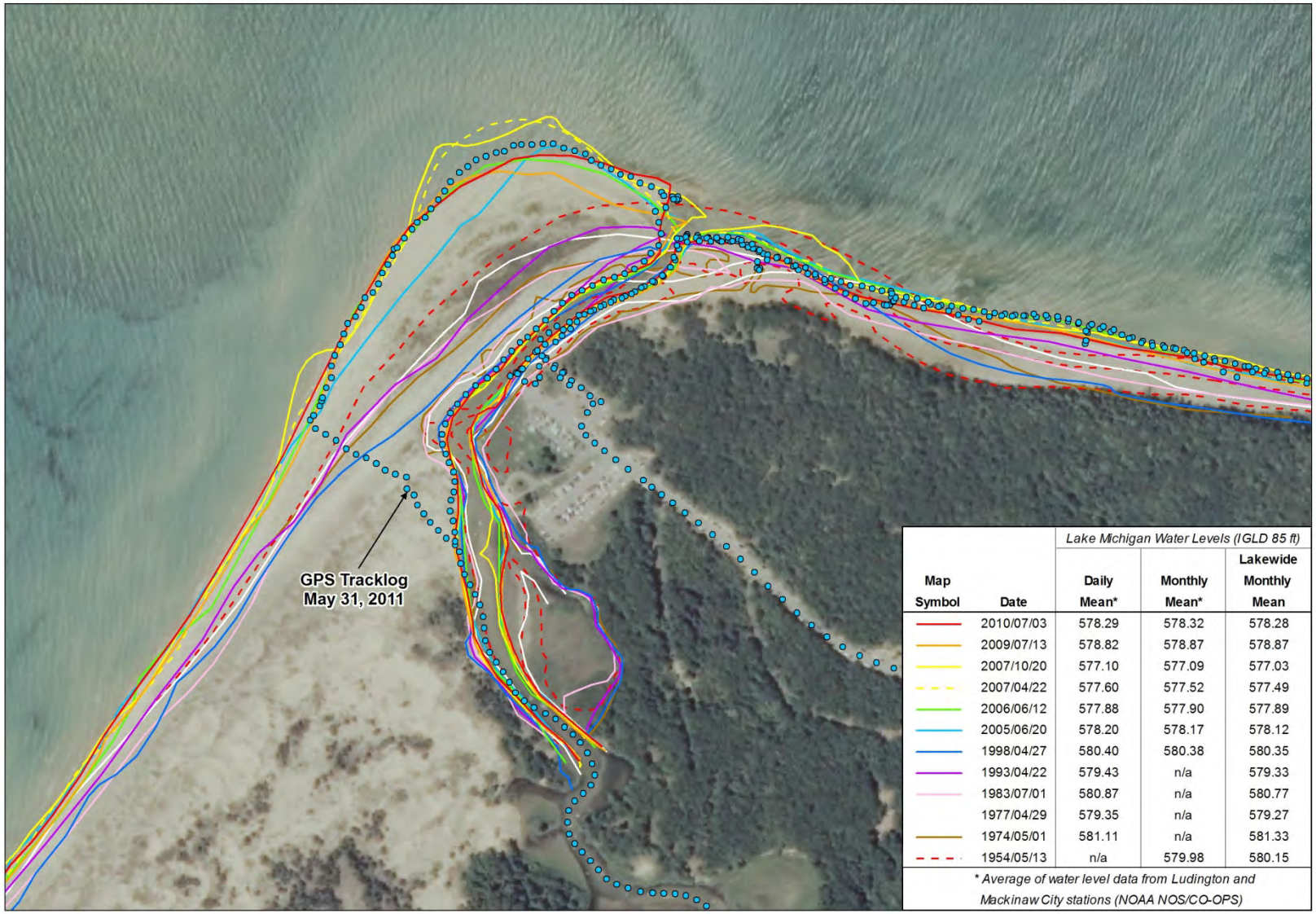
0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 2010-07-03 (USDA)

Baird




| Map Symbol | Date | Lake Michigan Water Levels (IGLD 85 ft) Daily Mean* | Monthly Mean* | Lakewide Monthly Mean |
|---|---|---|---|---|
| | 2010/07/03 | 578.29 | 578.32 | 578.28 |
| | 2009/07/13 | 578.82 | 578.87 | 578.87 |
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| | 2005/06/20 | 578.20 | 578.17 | 578.12 |
| | 1998/04/27 | 580.40 | 580.38 | 580.35 |
| | 1993/04/22 | 579.43 | n/a | 579.33 |
| | 1983/07/01 | 580.87 | n/a | 580.77 |
| | 1977/04/29 | 579.35 | n/a | 579.27 |
| | 1974/05/01 | 581.11 | n/a | 581.33 |
| | 1954/05/13 | n/a | 579.98 | 580.15 |

** Average of water level data from Ludington and Mackinaw City stations (NOAA NOS/CO-OPS)*

0 100 200 300 400 500 ft

N

**Shoreline Comparison at Sleeping Bear Dunes National Lakeshore**

Imagery: 2010-07-03 (USDA)

Baird

# APPENDIX C

## NOTICE OF AUTHORIZATION

*MDEQ Permit*

# Notice of Authorization

## Permit Number 09-10-0008-P

Issued: 8/31/2009
Expiration Date: 8/31/2014

The State of Michigan, Department of Environmental Quality, Land and Water Management Division, 120 West Chapin St., Cadillac, Michigan, 49601-2158, 231-775-3960, under provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and specifically:

☒ Part 301 Inland Lakes and Streams

Authorized activity:

**5-Year Maintenance Permit**

Dredge approximately 900 cubic yards of material from the mouth of the Platte River and dispose of that material on-site. All work shall be done according to the plans dated August 31, 2009 on file at the Cadillac District Office.

To be conducted at property located: Benzie County
Waterbody: Platte River
Lake Township: Town 27N, Range 15W, Section 20

Permittee: Sleeping Bear Dunes National Lake
9922 Front Street
Empire, MI 49630

Steven E. Chester, Director
Department of Environmental Quality

Robyn L. Schmidt
District Representative

*This notice must be displayed at the site of work.*
*Laminating this notice or utilizing sheet protectors is recommended.*

Please refer to the above Permit Number with any questions or concerns.

# MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
# PERMIT

**ISSUED TO:**

Sleeping Bear Dunes National Lake
9922 Front Street
Empire, MI 49630

| | |
|---|---|
| **Permit No.** | 09-10-0008-P |
| **Issued** | August 31, 2009 |
| **Extended** | |
| **Revised** | |
| **Expires** | August 31, 2014 |

**This permit is being issued by the Michigan Department of Environmental Quality (MDEQ) under the provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) and specifically:**

- ☒ **Part 301 Inland Lakes and Streams**
- ☐ **Part 315 Dam Safety**
- ☐ **Part 325 Great Lakes Submerged Lands**
- ☐ **Part 323 Shorelands Protection and Management**
- ☐ **Part 303 Wetlands Protection**
- ☐ **Part 353 Sand Dune Protection and Management**
- ☐ **Part 31 Floodplain/Water Resources Protection**

**Permission is hereby granted, based on permittee assurance of adherence to State requirements and permit conditions to:**

****5-Year Maintenance Permit****

**Dredge approximately 900 cubic yards of material from the mouth of the Platte River and dispose of that material on-site. All work shall be done according to the attached plans dated August 31, 2009.**

****A U.S. Army Corps of Engineers permit is required before this work can be conducted.****

**Water Course Affected:** Platte River
**Property Location:** Benzie County, Lake Township
Town/Range 27N, 15W, Section 20

**Authority granted by this permit is subject to the following limitations:**

A. Initiation of any work on the permitted project confirms the permittee's acceptance and agreement to comply with all terms and conditions of this permit.
B. The permittee in exercising the authority granted by this permit shall not cause unlawful pollution as defined by Part 31, Floodplain/Water Resources Protection of the NREPA.
C. This permit shall be kept at the site of the work and available for inspection at all times during the duration of the project or until its date of expiration.
D. All work shall be completed in accordance with the plans and the specifications submitted with the application and/or plans and specifications attached hereto.
E. No attempt shall be made by the permittee to forbid the full and free use by the public of public waters at or adjacent to the structure or work approved herein.
F. It is made a requirement of this permit that the permittee give notice to public utilities in accordance with Act 53 of the Public Act of 1974 and comply with each of the requirements of that act.
G. This permit does not convey property rights in either real estate or material, nor does it authorize any injury to private property or invasion of public or private rights, nor does it waive the necessity of seeking federal assent, all local permits or complying with other state statutes.
H. This permit does not prejudice or limit the right of a riparian owner or other person to institute proceedings in any circuit court of this state when necessary to protect his rights.
I. Permittee shall notify the MDEQ within one week after the completion of the activity authorized by this permit, by completing and forwarding the attached, preaddressed post card to the office addressed thereon.
J. This permit shall not be assigned or transferred without the written approval of the MDEQ.
K. Failure to comply with conditions of this permit may subject the permittee to revocation of permit and criminal and/or civil action as cited by the specific State Act, Federal Act and/or Rule under which this permit is granted.
L. Work to be done under authority of this permit is further subject to the following special instructions and specifications:

1. All work shall be completed in accordance with the attached plans dated August 31, 2009.

2. Authority granted by this permit does not waive permit requirements under the Natural Resource and Environmental Protection Act, Part 91 - Soil Erosion and Sedimentation Control- Dave Neiger at 231-882-9674.

3. The authority to conduct the activity as authorized by this permit is granted solely under provisions of the governing act as identified above. This permit does not convey, provide, or otherwise imply approval of any other governing act, ordinance, or regulation, nor does it waive the permittee's obligation to acquire any local, county, or federal approval or authorizations necessary to conduct the activity.

4. Authority granted by this permit does not waive any jurisdiction of the U.S. Army Corps of Engineers 616-842-5510 or the need for a federal permit, if required.

5. Initiation of any work on the permitted project confirms the permittee's acceptance and agreement to comply with all terms and conditions of this permit. Noncompliance with these terms and conditions, and/or the initiation of other regulated activities not specifically authorized by this permit shall be cause for the modification suspension, or revocation of this permit, in whole or in part. Further, the DEQ may initiate criminal and/or civil proceedings as may be deemed necessary to correct project deficiencies to protect natural resources values and secure compliance with statutes.

6. The following threatened or endangered species are known to occur on or near this project site and may be impacted by your activities: Piping Plover. Please coordinate all activities on-site, PRIOR to commencement of those activities, with Jack Dingledine, USFWS, East Lansing Field Office, 2651 Coolidge Road, East Lansing, MI 48823, 517-351-6320, Jack_Dingledine@fws.gov

7. Construction pads, haul roads, temporary structures, or other structural appurtenances to be placed on or over bottomlands and /or wetlands are not authorized by this permit and shall not be constructed unless authorized by separate permit or permit revision granted in accordance with applicable law.

8. All dredge spoils including organic and inorganic soils, vegetation, and debris shall be placed above the ordinary high water mark, leveled, and stabilized with sod and/or seed, and mulched, in such a manner as not to erode into any waterbody, wetland, or floodplain, see attached plans.

9. All machinery shall access the project via the existing access drive.

10. This permit shall be kept at the site of the work and available for inspection for the duration of the project or until its date of expiration and authorizes representatives of the DEQ to enter upon the subject property in order to inspect project progress and compliance.

11. This permit is being issued for the maximum time allowed under Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, including all permit extensions allowed under the administrative rules R 281.813. Therefore, no extensions of this permit will be granted. Initiation of the construction work authorized by this permit indicates the permittee's acceptance of this condition. The permit, when signed by the DEQ, will be for a five-year period beginning at the date of issuance. This permit expires on August 31, 2014.

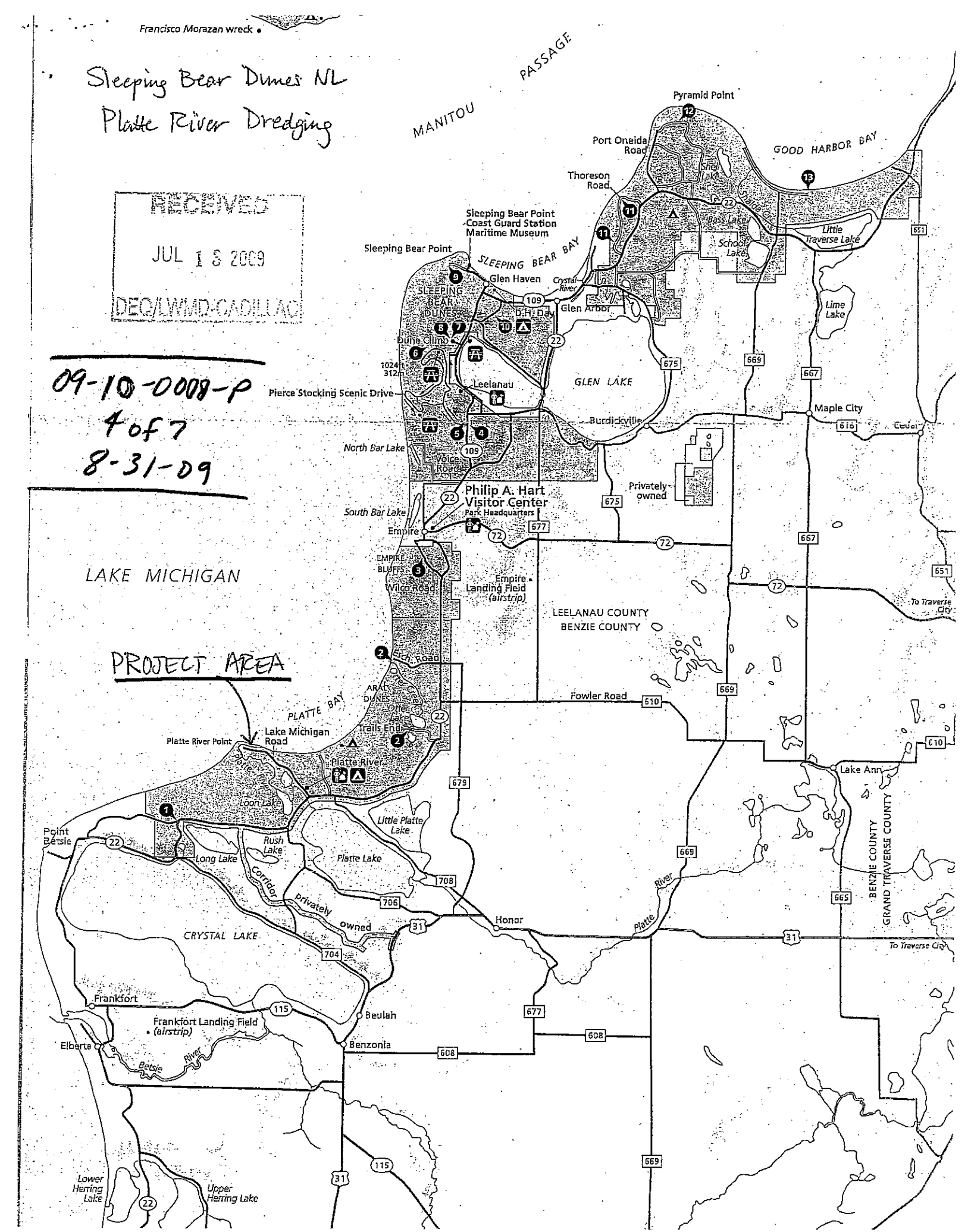
12. The permittee shall indemnify and hold harmless the State of Michigan and its departments, agencies, officials, employees, agents and representatives for any and all claims or causes of action arising from acts or omissions of the permittee, or employees, agents, or representatives of the permittee, undertaken in connection with this permit. This permit shall not be construed as an indemnity by the State of Michigan for the benefit of the permittee or any other person.

13. Any modification or revision to the approved design plans and/or specifications must be approved in writing by the Department of Environmental Quality.

Steven E. Chester, Director
Department of Environmental Quality

By Robyn L. Schmidt
Robyn L. Schmidt
District Representative
Land and Water Management Division

cc: Benzie CEA
Lake Township
Jack Dingledine, USFWS, East Lansing Field Office
USACE, Detroit (88-056-153-2)


Francisco Morazan wreck
Sleeping Bear Dunes NL
Platte River Dredging
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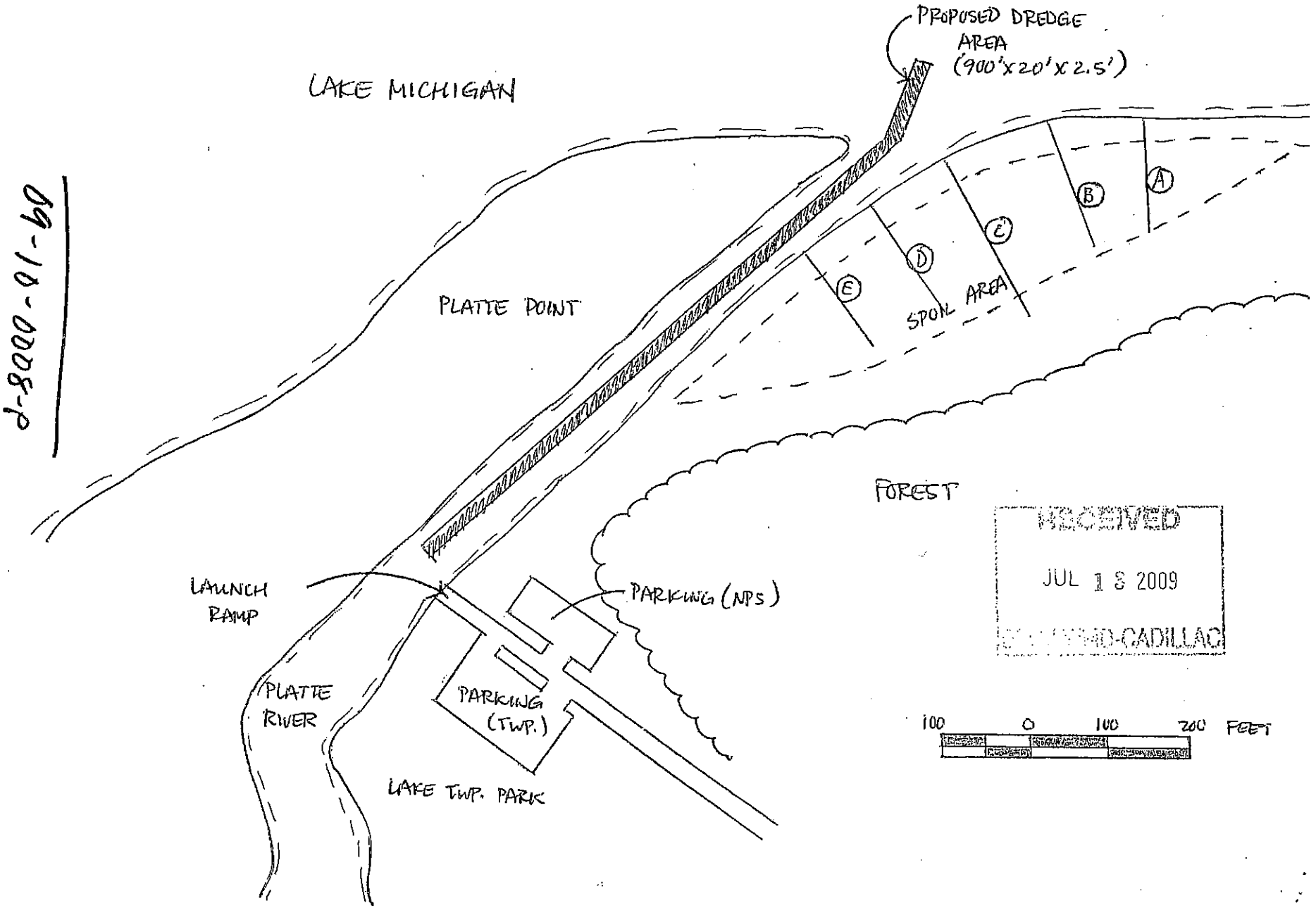
DEQ/LWMD-CADILLAC
09-10-0008-P
4 of 7
8-31-09
MANITOU PASSAGE
Pyramid Point
Port Oneida Road
GOOD HARBOR BAY
Thoreson Road
Shell Lake
Bass Lake
Shalda Lake
Little Traverse Lake
School Lake
Sleeping Bear Point Coast Guard Station Maritime Museum
Sleeping Bear Point
SLEEPING BEAR BAY
Glen Haven
Crystal River
SLEEPING BEAR DUNES
D.H. Day
Glen Arbor
Lime Lake
Dune Climb
GLEN LAKE
Pierce Stocking Scenic Drive
Leelanau
Maple City
Burdickville
Cedar
North Bar Lake
Voice Road
Philip A. Hart Visitor Center
Park Headquarters
South Bar Lake
Empire
Privately owned
LAKE MICHIGAN
EMPIRE BLUFFS
Wilco Road
Empire Landing Field (airstrip)
LEELANAU COUNTY
BENZIE COUNTY
To Traverse City
PROJECT AREA
Esch Road
ARAL DUNES
Otter Creek
Otter Lake
PLATTE BAY
Fowler Road
Platte River Point
Lake Michigan Road
Trails End
Platte River
Lake Ann
Point Betsie
Loon Lake
Little Platte Lake
Rush Lake
Long Lake
Platte Lake
Corridor
privately owned
CRYSTAL LAKE
Honor
Platte River
BENZIE COUNTY
GRAND TRAVERSE COUNTY
Frankfort
Frankfort Landing Field (airstrip)
Beulah
Elberta
Benzonia
Betsie River
Lower Herring Lake
Upper Herring Lake

SLEEPING BEAR DUNES NATIONAL LAKESHORE

PLATTE RIVER DREDGING

7/9/09

NORTH

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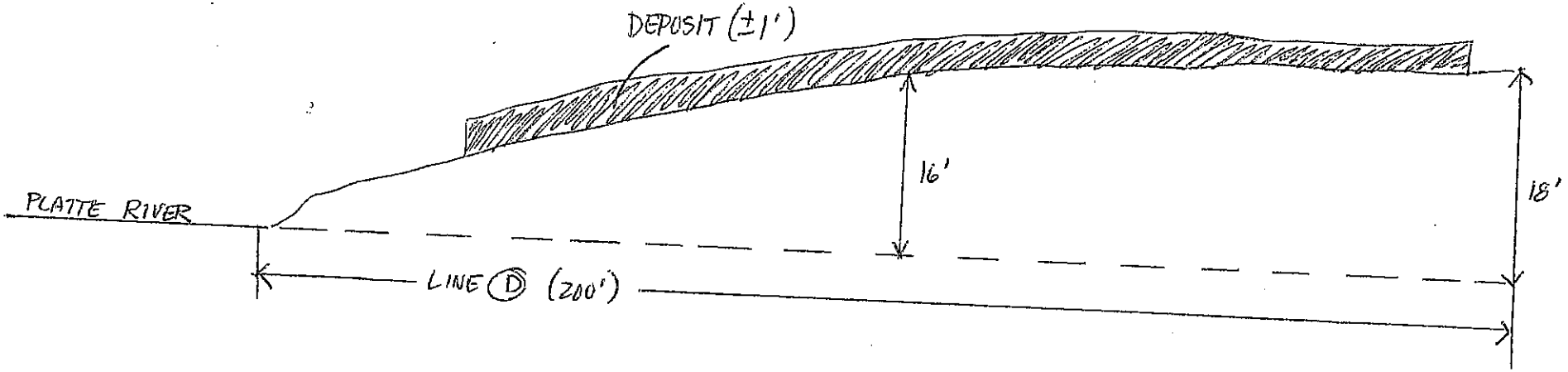
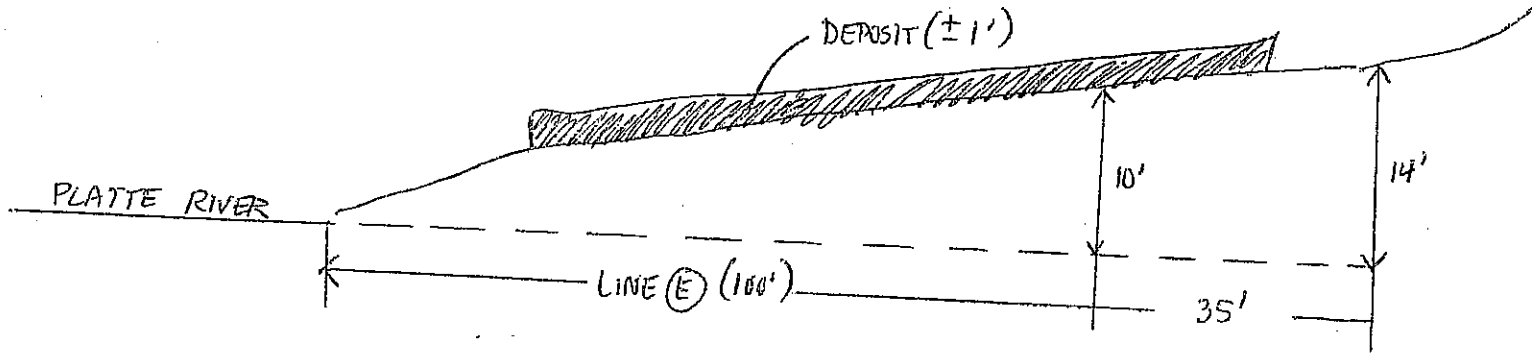
5 of 7
8-31-09

SLEEPING BEAR DUNES NL
PLATTE RIVER DREDGING
PROPOSED SPOIL AREA

7/9/09

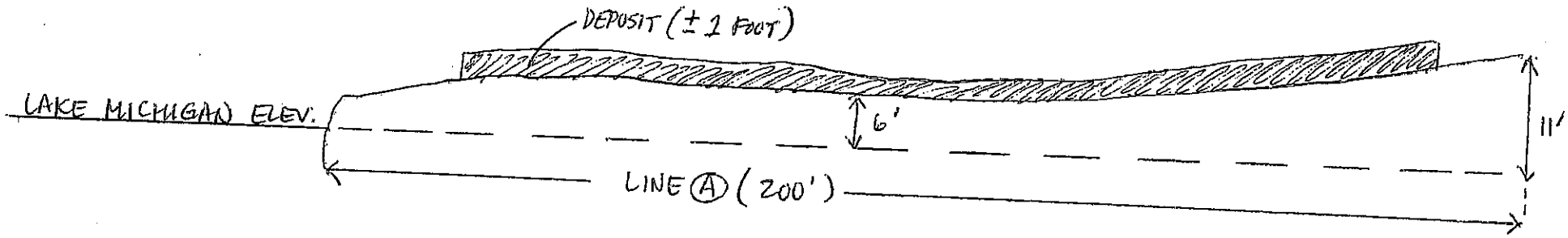


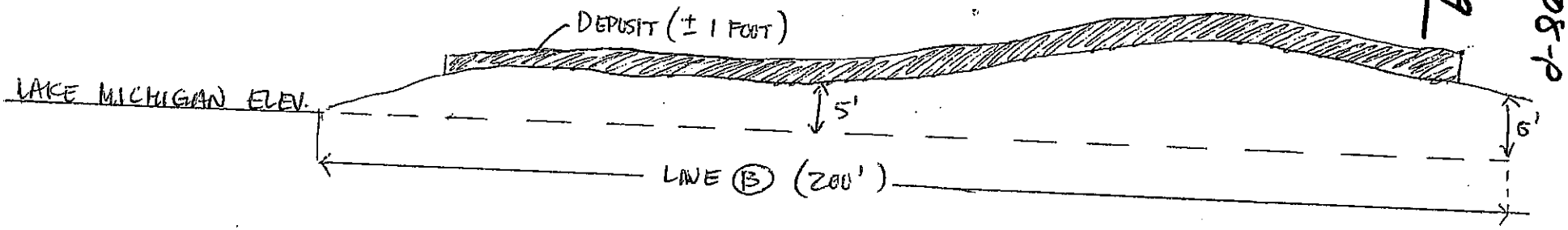




04-10-0008-P
6 of 7
8-31-09

SLEEPING BEAR DUNES NL
PLATTE RIVER DREDGING
PROPOSED SPOIL AREA

7/9/09

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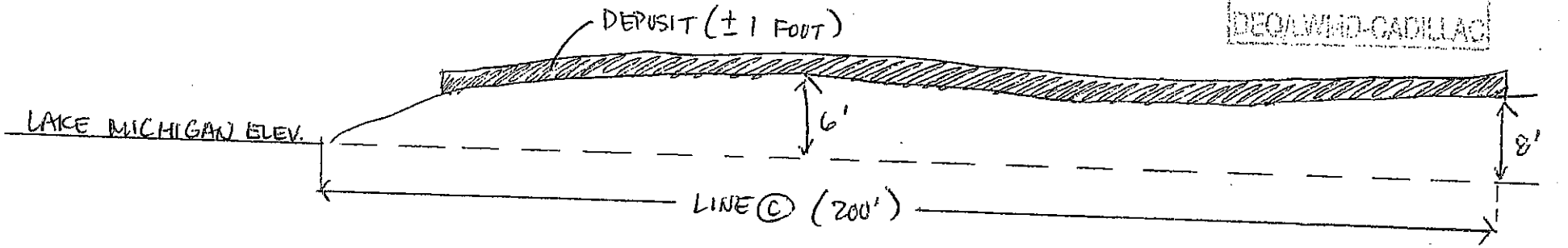
09-10-0006-P





# APPENDIX D

# COST ESTIMATES

**Platte River, Sleeping Bear Dunes**

**Opinion of Probable Construction Costs**

***Cease Dredging Operations and Remove Existing Mound of Dredged Material*** **Concept 2 - With Dump Truck System**

**Conceptual Solutions**

| Item | Unit | Est. Quantity | Unit Cost | Extension | Subtotal |
|---|---|---|---|---|---|
| 1 General | | | | | |
| 1.1 Mobilization & demobilization | LS | 1 | $24,400 | $ 24,400 | $ 24,400 |
| 2 Excavation | | | | | |
| 2.1 Excavate and load trucks. | CY | 32,000 | $2.60 | $ 83,200 | $ 83,200 |
| 3 Trucking | | | | | |
| 3.1 Haul material 3,200 ft east. | CY | 32,000 | $4.41 | $ 141,120 | $ 141,120 |
| 4 Disposal | | | | | |
| 4.1 Place material at disposal site. | CY | 32,000 | $2.25 | $ 72,000 | $ 72,000 |
| | | | | Subtotal | $320,720 |
| | | | | Construction Contingency 20% | $64,100 |
| | | | | **Total** | **$384,820** |

General Notes

1 Values shown are determined through engineering judgment on conceptual designs and are subject to change based on site and project-specific data and criteria.

**Platte River, Sleeping Bear Dunes**

**Opinion of Probable Construction Costs**

***Cease Dredging Operations and Remove Existing Mound of Dredged Material*** **Concept 2 - With Pumping System**

**Conceptual Solutions**

| Item | Unit | Est. Quantity | Unit Cost | Extension | Subtotal |
|---|---|---|---|---|---|
| 1 General | | | | | |
| 1.1 Mobilization & demobilization | LS | 1 | $80,000 | $ 80,000 | $ 80,000 |
| 2 Excavation | | | | | |
| 2.1 Excavate existing mound. | CY | 32,000 | $2.60 | $ 83,200 | $ 83,200 |
| 3 Pumping and Placement of Dredged Material | | | | | |
| 3.1 Pump material 3,200 ft east. | CY | 32,000 | $15.00 | $ 480,000 | $ 480,000 |
| | | | | Subtotal | $643,200 |
| | | | | Construction Contingency 20% | $128,600 |
| | | | | **Total** | **$771,800** |

General Notes

1 Values shown are determined through engineering judgment on conceptual designs and are subject to change based on site and project-specific data and criteria.

**Platte River, Sleeping Bear Dunes**

**Opinion of Probable Construction Costs**

***Cease Dredging Operations, Remove Existing Mound, and Provide Alternative Means of Launching Craft*** **Concept 3**

**Conceptual Solutions**

| Item | Unit | Est. Quantity | Unit Cost | Extension | Subtotal |
|---|---|---|---|---|---|
| 1 General | | | | | |
| 1.1 Mobilization & demobilization | LS | 1 | $24,400 | $ 24,400 | |
| | | | | | $ 24,400 |
| 2 Excavation | | | | | |
| 2.1 Excavate and load trucks. | CY | 32,000 | $2.60 | $ 83,200 | |
| | | | | | $ 83,200 |
| 3 Trucking | | | | | |
| 3.1 Haul material 3,200 ft east. | CY | 32,000 | $4.41 | $ 141,120 | |
| | | | | | $ 141,120 |
| 4 Disposal | | | | | |
| 4.1 Place material at disposal site. | CY | 32,000 | $2.25 | $ 72,000 | |
| | | | | | $ 72,000 |
| 5 Provide and Install Alternate Means of Launching Craft | | | | | |
| 5.1 Metal grate launch similar to Town of Empire | LF | 900 | $560 | $ 504,000 | |
| | | | | | $ 504,000 |
| 6 (Seasonal Maintenance Cost) | | | | | |
| 6.1 Install or remove grating system | Allow | 2 | $5,000 | $10,000 | |
| | | | | | (not tabulated) |
| | | | | Subtotal | $824,720 |
| | | | | Construction Contingency 20% | $164,900 |
| | | | | **Total** | **$989,620** |

General Notes

1 Values shown are determined through engineering judgment on conceptual designs and are subject to change based on site and project-specific data and criteria.

**Platte River, Sleeping Bear Dunes**

**Opinion of Probable Construction Costs**

***Continue Maintenance Dredging and Leave Existing Mound of Dredged Material*** **Concept 4 - In-Water Disposal**

**Conceptual Solutions**

| Item | Unit | Est. Quantity | Unit Cost | Extension | Subtotal |
|---|---|---|---|---|---|
| 1 General | | | | | |
| 1.1 Mobilization & demobilization | LS | 1 | $12,100 | $ 12,100 | |
| | | | | | $ 12,100 |
| 2 Excavation | | | | | |
| 2.1 Excavate and load trucks. | CY | 1,000 | $2.60 | $ 2,600 | |
| | | | | | $ 2,600 |
| 3 Trucking | | | | | |
| 3.1 Haul material 3,200 ft east. | CY | 1,000 | $4.41 | $ 4,410 | |
| | | | | | $ 4,410 |
| 4 Disposal | | | | | |
| 4.1 Place material at disposal site. | CY | 1,000 | $2.25 | $ 2,250 | |
| | | | | | $ 2,250 |
| | | | | Subtotal | $21,360 |
| | | | | Construction Contingency 20% | $4,300 |
| | | | | **Total** | **$25,660** |

General Notes

1 Values shown are determined through engineering judgment on conceptual designs and are subject to change based on site and project-specific data and criteria.

**Platte River, Sleeping Bear Dunes**

**Opinion of Probable Construction Costs**

***Continue Maintenance Dredging and Leave Existing Mound of Dredged Material*** **Concept 4 - Upland Disposal**

**Conceptual Solutions**

| Item | Unit | Est. Quantity | Unit Cost | Extension | Subtotal |
|---|---|---|---|---|---|
| 1 General | | | | | |
| 1.1 Mobilization & demobilization | LS | 1 | $12,100 | $ 12,100 | |
| | | | | | $ 12,100 |
| 2 Excavation | | | | | |
| 2.1 Excavate and load trucks. | CY | 1,000 | $2.60 | $ 2,600 | |
| | | | | | $ 2,600 |
| 3 Trucking | | | | | |
| 3.1 Haul material 4 miles upland. | CY | 1,000 | $7.20 | $ 7,200 | |
| | | | | | $ 7,200 |
| 4 Disposal | | | | | |
| 4.1 Place material at disposal site. | CY | 1,000 | $2.25 | $ 2,250 | |
| | | | | | $ 2,250 |
| | | | | Subtotal | $24,150 |
| | | | | Construction Contingency 20% | $4,800 |
| | | | | **Total** | **$28,950** |

General Notes

1 Values shown are determined through engineering judgment on conceptual designs and are subject to change based on site and project-specific data and criteria.

**Platte River, Sleeping Bear Dunes**

**Opinion of Probable Construction Costs**

***Continue Maintenance Dredging and Remove Existing Mound of Dredged Material*** **Concept 5 - In-Water Disposal**

**Conceptual Solutions**

| Item | Unit | Est. Quantity | Unit Cost | Extension | Subtotal |
|---|---|---|---|---|---|
| 1 General (Year 1) | | | | | |
| 1.1 Mobilization & demobilization | LS | 1 | $24,400 | $ 24,400 | |
| | | | | | $ 24,400 |
| 2 Excavation (Year 1) | | | | | |
| 2.1 Excavate and load trucks. | CY | 32,000 | $2.60 | $ 83,200 | |
| | | | | | $ 83,200 |
| 3 Trucking (Year 1) | | | | | |
| 3.1 Haul material 3,200 ft east. | CY | 32,000 | $4.41 | $ 141,120 | |
| | | | | | $ 141,120 |
| 4 Disposal (Year 1) | | | | | |
| 4.1 Place material at disposal site. | CY | 32,000 | $2.25 | $ 72,000 | |
| | | | | | $ 72,000 |
| 5 Seaonal Dredging and Disposal (Year 2) | | | | | |
| 5.1 Dredge and In-water Disposal | Allow | 1 | $21,360.00 | $ 21,360 | |
| | | | | | $ 21,360 |
| | | | | Subtotal | $342,080 |
| | | | | Construction Contingency 20% | $68,400 |
| | | | | **Total** | **$410,480** |

General Notes

1 Values shown are determined through engineering judgment on conceptual designs and are subject to change based on site and project-specific data and criteria.