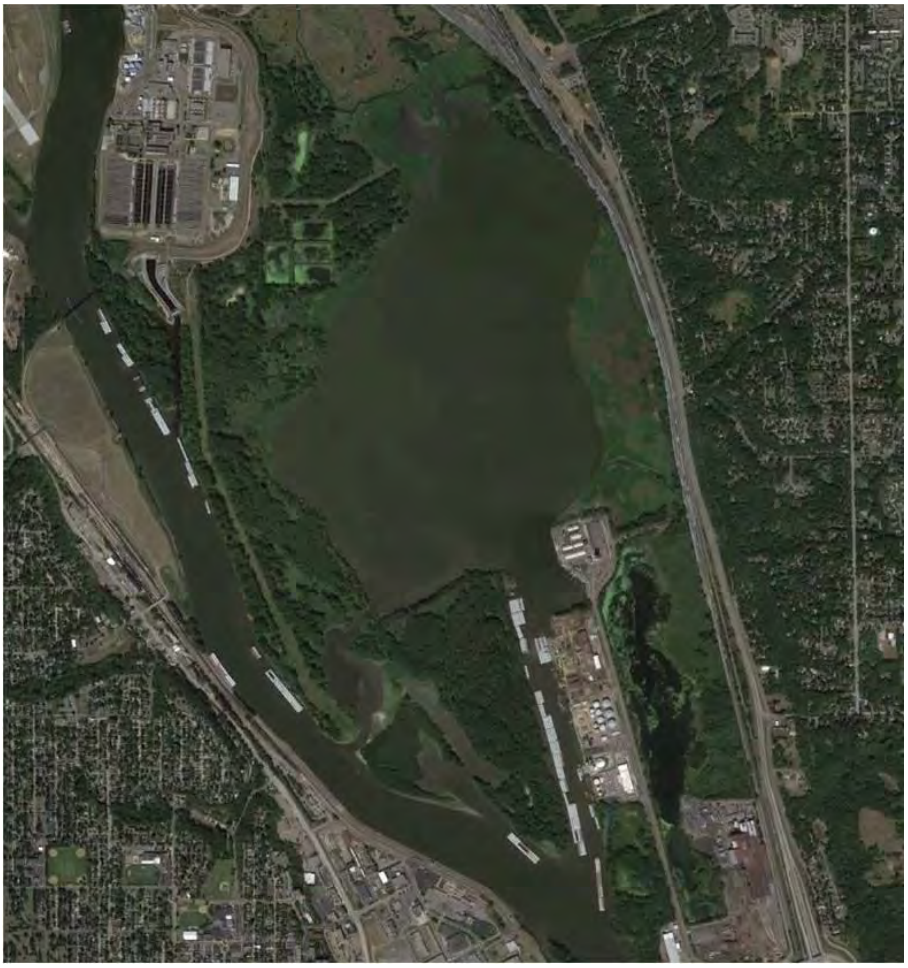
US Army Corps of Engineers®
St. Paul District

Pigs Eye Lake Ramsey County, MN Section 204

Feasibility Study Report with Integrated Environmental Assessment



U.S. Army Corps of Engineers, St. Paul District
Ramsey County, Local Sponsor
May 2018

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EXECUTIVE SUMMARY

This Feasibility Study Report with Integrated Environmental Assessment investigates the feasibility of alternative measures to address problems and opportunities associated with the Pigs Eye Lake Continuing Authorities Program Section 204 beneficial use of dredged material project. Pigs Eye Lake is a 628-acre, shallow backwater lake, situated southeast of St. Paul, Minnesota, within Pool 2 of the Mississippi River.

The project lies within the Mississippi National River and Recreation Area, established by Congress to protect, preserve, and enhance the nationally significant resources of this reach of the Mississippi River. The project area is directly adjacent to one of the largest nesting sites for colonial water birds within the state. Several species of herons, egrets, and cormorants nest in the rookery. In addition, the project area is located within the Pigs Eye Lake section of Battle Creek Regional Park, and Battle Creek flows into the north end of Pigs Eye Lake.

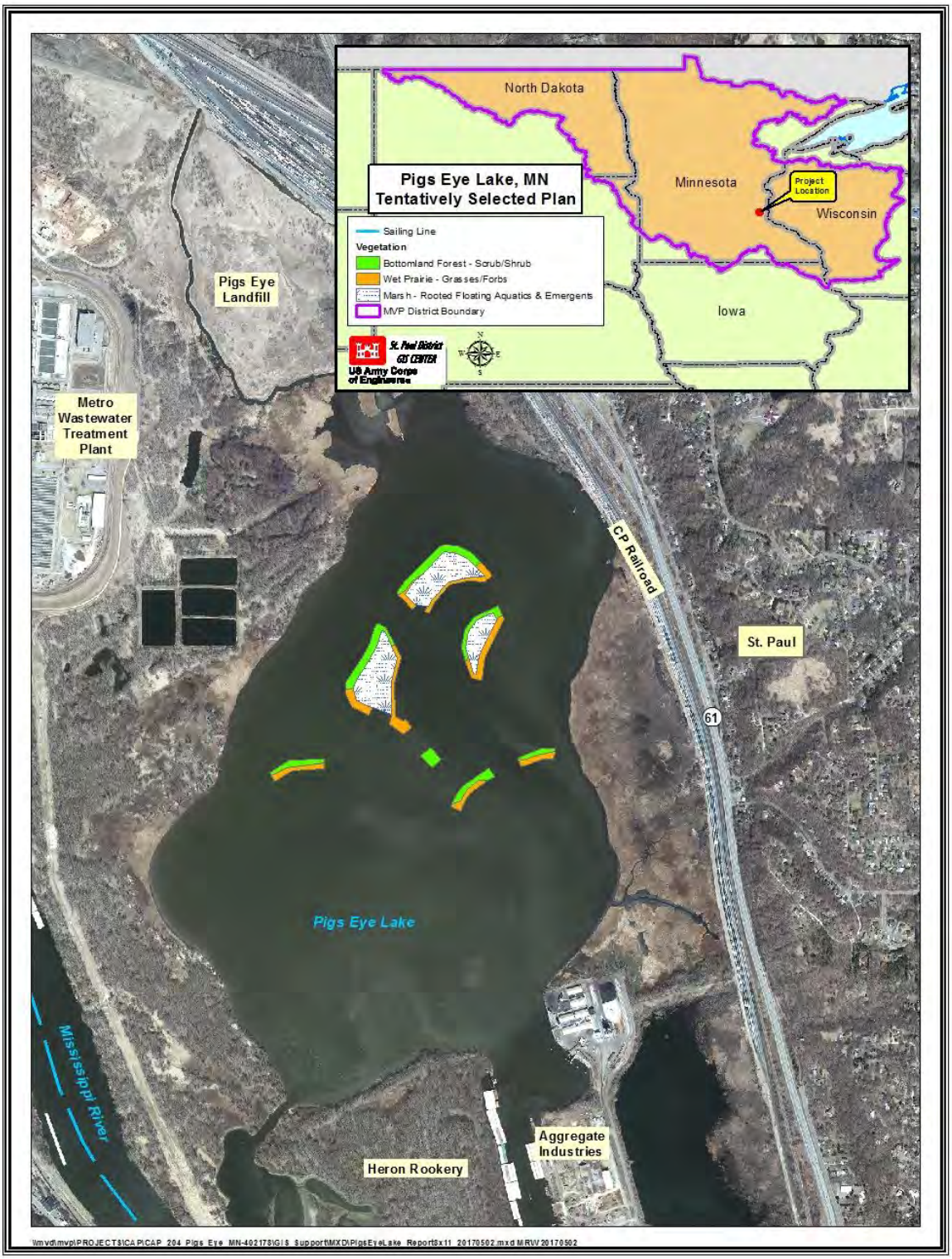
The habitat concerns within the project area primarily include high levels of turbidity, wind-induced shoreline erosion, lack of depth diversity, and lack of shoreline habitat for birds and aquatic plants.

The objectives of the project are to:

1. *Improve aquatic habitat* – Create depth and habitat diversity in Pigs Eye Lake. Increase acreage of aquatic vegetation. Incorporate structural habitat features to promote fisheries.
2. *Improve the quantity and quality of habitat for migratory bird species* – Create suitable habitat for migratory birds such as dabbling ducks within Pigs Eye Lake.
3. *Maintain or enhance the quantity of shoreline habitat* – Protect existing floodplain forest and marsh habitat along the shoreline of Pigs Eye Lake from wind and wave erosion.

The study team identified a variety of measures that could be taken to achieve project objectives, including full and split island designs, sand benches, and creation of wetland (marsh) habitat. The measures were combined in various logical combinations to form alternative project plans.

The Tentatively Selected Plan, shown in Executive Figure 1, would restore backwater habitat by creating seven islands with sand benches. Three of the islands would utilize a “split” design that would establish a sheltered area in the center, allowing for the inclusion of approximately 17.6 acres of marsh plantings. The recommended plan addresses all project objectives. Based on the certified cost estimate the plan would cost approximately $16.5 million to complete. Operations and Maintenance will pay approximately $3.2 million as part of the base plan for permanently placing dredged material. Thus, the certified cost for the Eco-system project is approximately $13.3 million. This would be the cost share portion that is applicable to the project and is used to determine per average annual habitat.



Executive Figure 1: Pigs Eye Lake Tentatively Selected Plan

Table of Contents

Figures

Tables

Appendices

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1 Study Background

1.1 Purpose and Scope of the Investigation

The U.S. Army Corps of Engineers (Corps, USACE), St. Paul District (District) is proposing to restore, protect, and create aquatic and wetland habitats in connection with construction or maintenance dredging of an authorized project under Continuing Authorities Program (CAP) Section 204 at Pigs Eye Lake, Ramsey County, MN.

This Feasibility Study Report with integrated Environmental Assessment (EA) provides a concise study overview of the plan formulation process that has been followed to create viable alternatives and ultimately identify the recommended plan for the Pigs Eye Lake Section 204 Feasibility Study. This report was prepared to comply with the National Environmental Policy Act (NEPA) of 1969. Upon completion, this report will provide planning, engineering, and construction details of the recommended restoration plan to allow final design and construction to proceed subsequent to the approval of the plan.

The project scope includes habitat within and immediately around Pigs Eye Lake. Implementation of a restoration plan in this area will directly benefit the entire Pigs Eye Lake ecosystem; restoration efforts are essential to restoring aquatic habitat in the lake.

On October 17, 2012 the Corps received a letter of interest from Ramsey County Parks & Recreation expressing interest in acting as a sponsor and requesting that the Corps perform a study to determine the feasibility of restoring aquatic habitat through the creation of islands in Pigs Eye Lake. Funding for the study under the authority of the Beneficial Use of Dredged Material Program (Section 204 of the Water Resources Development Act [WRDA] of 1992, as amended) was made available in 2015. The study was initiated in January 2015 and the Federal Interest Determination was approved by the Mississippi Valley Division on May 14, 2015. The Feasibility phase of the effort began immediately.

1.2 Authority

This study is authorized under Section 204 of the WRDA of 1992, as amended. Section 204 provides authority for the Corps to restore, protect, and create aquatic and wetland habitats in connection with construction or maintenance dredging of an authorized federal navigation project. Section 204 is one of a number of existing authorities in the CAP, which gives USACE authority to plan, design, and construct a project without specific project authorization by Congress. The federal cost for individual Section 204 projects is limited by statute to $10 million.

The general purpose of this program is for:

"(1) Sediment Use – For sediment obtained through the construction, operation, or maintenance of an authorized federal water resources project, the Secretary shall develop, at federal expense, regional sediment management plans and carry out projects at locations identified in plans developed under this section, or identified jointly by the non-federal interest and the Secretary, for use in the construction, repair, modification, or rehabilitation of projects associated with federal water resources projects for

purposes …(A) to reduce storm damage to property; (B) to protect, restore, and create aquatic and ecologically related habitats, including wetlands; and (C) to transport and place suitable sediment."

In accordance with the 2007 WRDA authority, the Planning Phase of the project is developed at 100 percent federal expense. The Design and Implementation Phase of the project is cost-shared 65 percent federal and 35 percent non-federal. The Sponsor must provide all lands required for the project and is responsible for 100 percent of the operation and maintenance, repairs, replacements, and rehabilitations (OMRR&R) of the completed project. If needed, the non-federal sponsor is 100 percent responsible for any costs associated with testing, handling, and treatment of HTRW. The non-federal sponsor must meet requirements of Section 221 of Flood Control Act of 1970 as amended.

1.3 Project Area

Pigs Eye Lake is a 628-acre, shallow backwater lake, situated southeast of St. Paul, Minnesota, within Pool 2 of the Mississippi River (Figure 1). Pigs Eye is the largest lake in St. Paul and is located in Pool 2, which extends approximately 33 miles upstream from Lock and Dam 2 at Hastings, Minnesota (river mile 815.2) to Lock and Dam 1 (Ford Dam) at Minneapolis, Minnesota (river mile 847.9). The Minnesota River joins the Mississippi River at the upper end of Pool 2. The project lies within the Mississippi National River and Recreation Area, established by Congress to protect, preserve, and enhance the nationally significant resources of this reach of the Mississippi River. The project area is directly adjacent to one of the largest nesting sites for colonial water birds within the state. Several species of herons, egrets, and cormorants nest in the rookery. In addition, the project area is located within the Pigs Eye Lake section of Battle Creek Regional Park, and Battle Creek flows into the north end of Pigs Eye Lake.

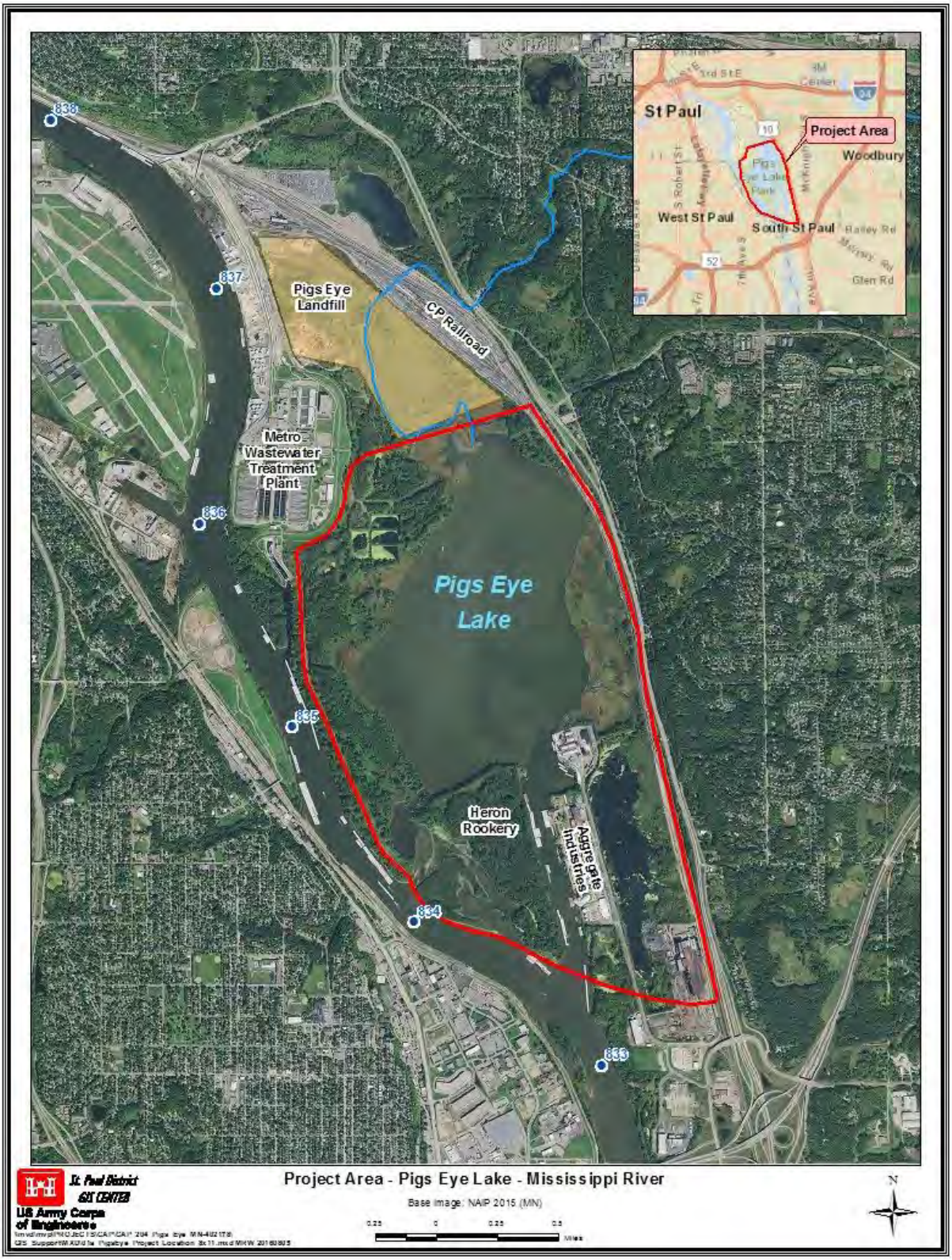

Figure 1: Project Area

1.4 Prior Studies, Reports, and Existing Water Resources Projects

This section contains a summary of relevant past and current projects

Upper Mississippi River Environmental Design Handbook, August 2006. This document provides design guidance for habitat projects involving items such as water level management, floodplain restoration and other features. It is a documentation of lessons learned and innovations in the Environmental Management Program (EMP).

Identifying, Planning and Financing Beneficial Use Projects using Dredged Material is a guidance document that was published jointly by the Corps and the U.S. Environmental Protection Agency (USEPA) in October 2007. In this document Habitat Development is identified as one of the most common and most important beneficial uses of dredged material.

Pool 2 Dredged Material Management Plan. This draft report is under development in 2018. Long term planning for dredged material placement has been ongoing since the mid-1970's to maximize opportunities for beneficial use, starting with the Great River Environmental Action Team (GREAT) study from 1974 -1980. As a result of the GREAT recommendations, seventeen reconnaissance reports were developed in the mid-1980's assessing specific dredging locations and subsequent management of the material. These documents have reached the end of their planning period and are being updated on a pool-by-pool basis. Issues to be addressed in the Pool 2 Dredged Material Management Plan (DMMP) include increased sedimentation throughout Pool 2 and the lack of long-term upland dredged material placement sites available for use.

Lock and Dam 2 Embankment Repair. This effort is in plan formulation and the project design will be initiated and completed in 2018, with construction award scheduled for 2019. Lock and Dam 2 is located at approximately river mile 815, near Hastings, Minnesota, between Dakota and Washington Counties. This site consists of the main lock, and one auxiliary lock on the Washington County side, and the embankment on the Dakota County side. The Lock and Dam 2 embankment will undergo an embankment repair and improvement project to ensure it is protected from potential erosion due to high waters, ice action, and wind fetch.

Lower Pool 2 Channel Management Study. The Boulanger Bend to Lock & Dam 2 study is located on the Mississippi River in Lower Pool 2 between river miles 815.2 and 821.0. This segment of the nine foot navigation channel has experienced changing sedimentation patterns that have exceeded the Corps' ability to maintain the channel. The degraded channel has adversely affected commercial navigation and strained the U.S. Coast Guard's ability to delineate safe conditions for all users. The Lower Pool 2 Channel Management Study recommended plan is to excavate/maintain a wider channel that is still within authorized dimensions and place two new training structures (rock sills) one on the right descending bank and one on the left descending bank. These minor changes would improve navigability and safety.

2 Affected Environment and Future without Project conditions

The following paragraphs describe the current conditions and the anticipated future without project conditions within and around the project area.

2.1 Physical Setting

Pigs Eye Lake is located in Ramsey County, MN; the shallow backwater is 628 acres in size, with depths averaging only 3-4 feet deep in the deepest areas (Figure 2). Pigs Eye is located southeast of St. Paul, Minnesota, within Pool 2 of the Mississippi River. Pigs Eye is one of the three largest lakes in St. Paul, MN. Although Pigs Eye is called a lake, it is actually a large riverine open-water floodplain. The area is managed as part of the Ramsey-Washington Metro Watershed District. Pigs Eye Lake was named after an early European settler named Pierre "Pigs Eye" Parrant, who was blind in one eye.

The north end of the lake and adjacent riparian land is owned by the City of St. Paul (Figure 3). The majority of the lake and riparian area is owned by Ramsey County. The land area northwest of the lake contains inactive waste water treatment ponds and is owned by the Metropolitan Waste Control. The Port Authority owns portions of the lake and riparian land on the southern tip of the lake around the outlet of Pigs Eye Lake into the Mississippi River. The Port Authority land is currently being utilized for barge loading/off loading, and this area is dredged to maintain suitable depths for barge traffic.

The existing land use in and around the project area is predominantly floodplain forest and shallow marsh (Figure 4).

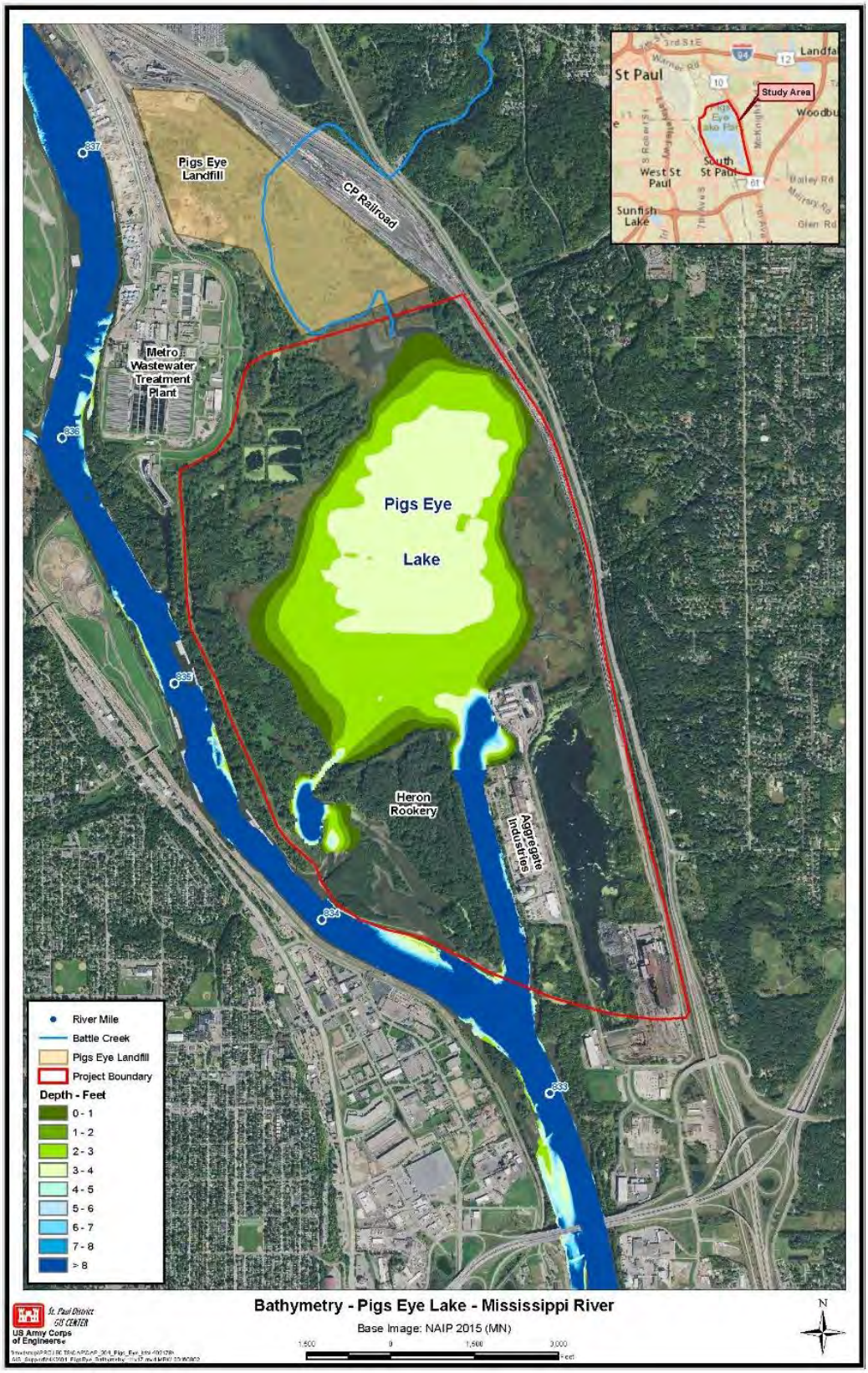

Figure 2: Pigs Eye Lake Bathymetry

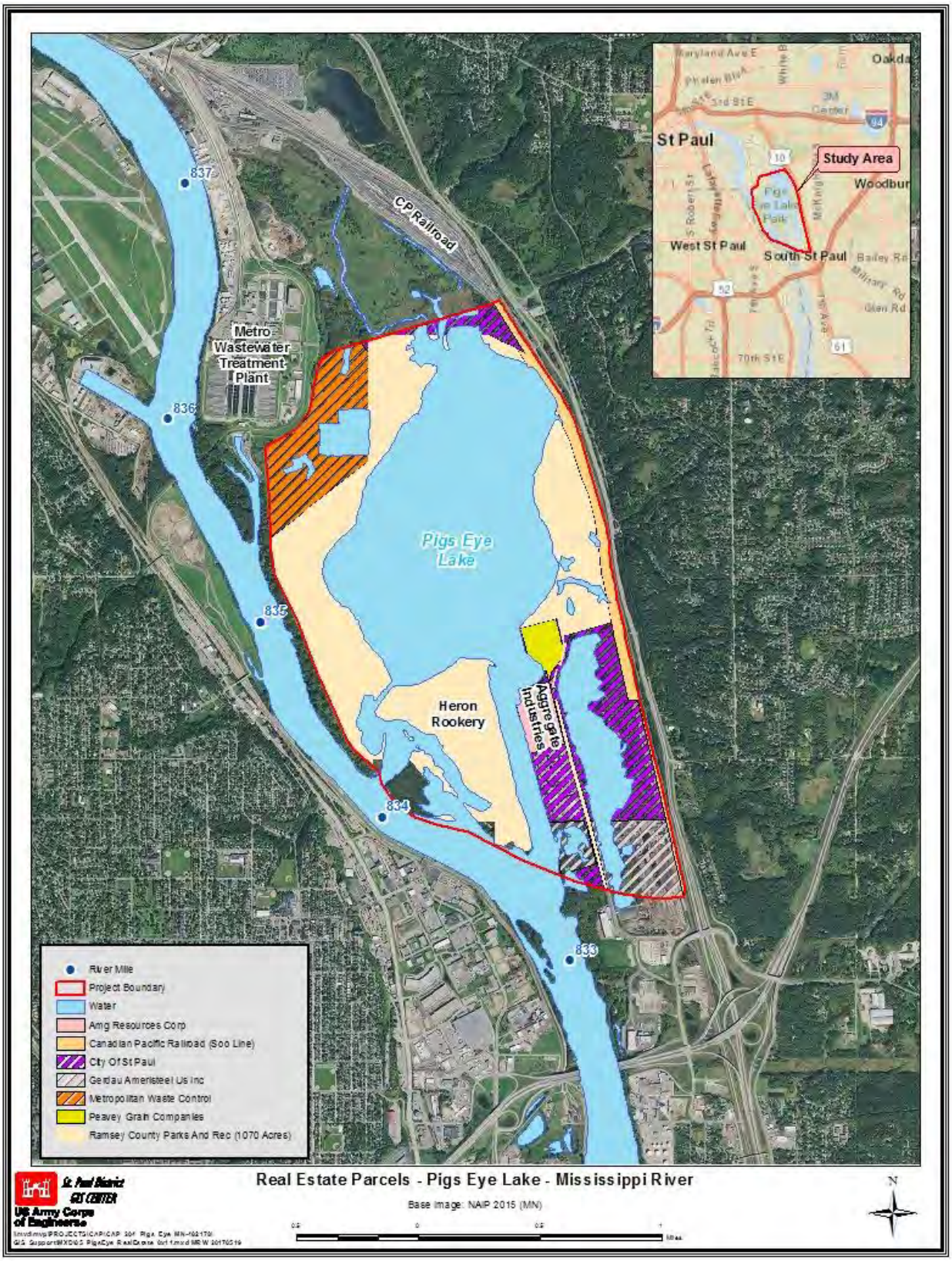

Figure 3: Pigs Eye Lake Real Estate

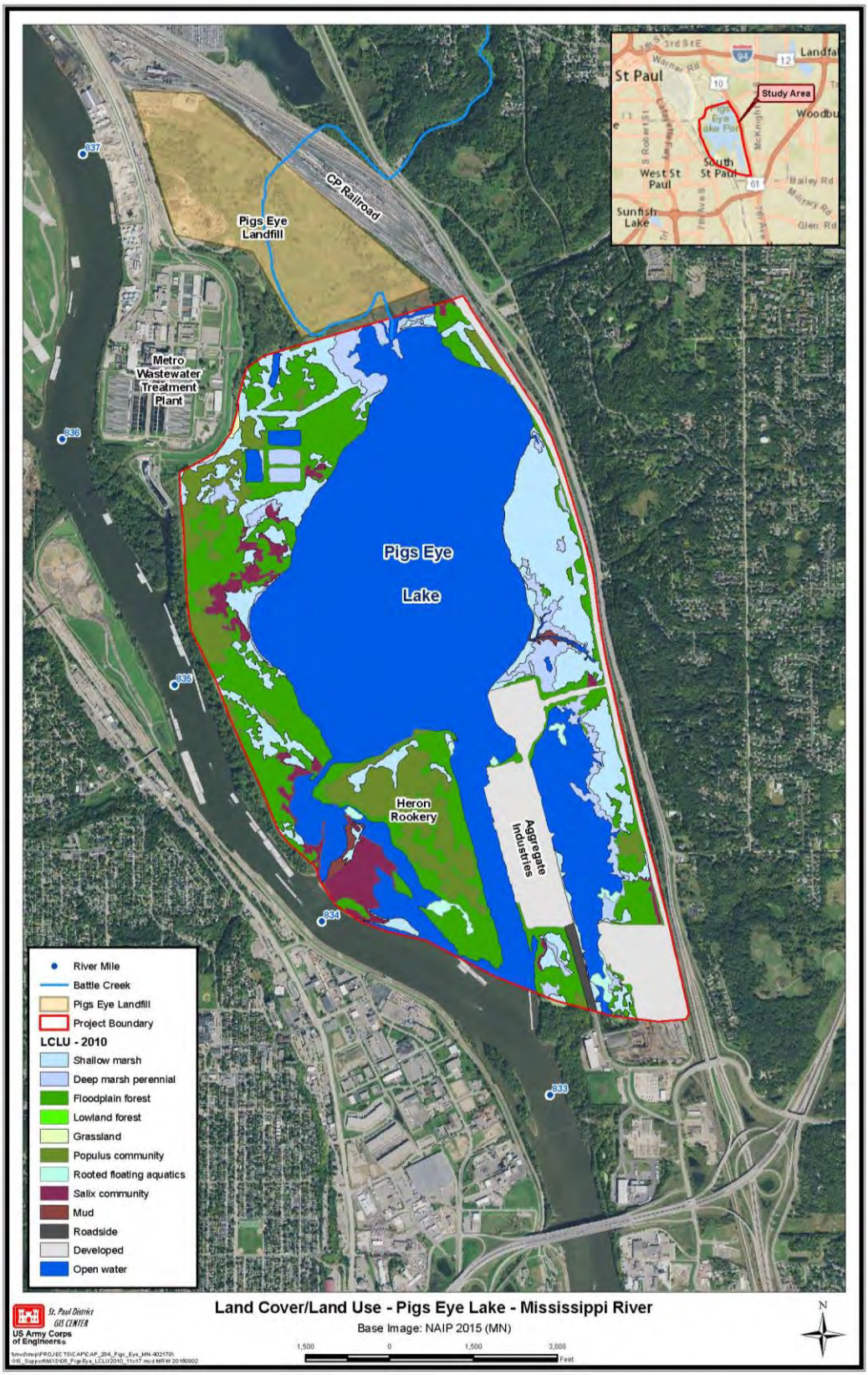

Figure 4: Land Use and Land Cover

2.1.1 Pigs Eye Lake Heron Rookery

To the south of Pigs Eye Lake, on Pigs Eye Island, is the Pigs Eye Heron Rookery Scientific and Natural Area. This floodplain forest supports nesting colonies of a number of colonial waterbirds, including the great blue heron, great egret, black-crowned night-heron, double-crested cormorant and yellow-crowned night-heron. This is one of only four locations within Minnesota where yellow-crowned night-herons are known to nest. Many other birds also utilize the site, and a total of 89 bird species have been documented on the island.

2.1.2 Pigs Eye Landfill

To the north is the 300 acre site of the former Pigs Eye Landfill, which was used for the disposal of mixed municipal, commercial, and industrial waste beginning in the mid-1950s until 1972, and for disposal of incinerated sludge ash from 1977 to 1985. According to the Minnesota Department of Health, "although commonly referred to as a landfill, the site did not operate according to Minnesota Pollution Control Agency's (MPCA) landfill rules, which were not yet in place when the site was in operation. Therefore, the site is more accurately described as a dump where refuse of various types were disposed of with minimal control" (Minnesota Department of Health, 2000).

As a result of the various types of waste dumped at the site over the years, it is currently listed on U.S. Environmental Protection Agency's (EPA) Comprehensive Response, Compensation, and Liability Information System (CERCLIS) and is a Minnesota Superfund site addressed by the MPCA Superfund Program.

Currently, the MPCA is coordinating cleanup activities at the dump site, as required by the Minnesota Superfund program.

2.1.3 Canadian Pacific Railway

The Canadian Pacific Railway, or CP Rail System, is near highway 61 and the east edge of Pigs Eye Lake. The rail yard was built in 1950s, and currently more than 110 trains pass through this area per day.

2.1.4 Metropolitan Wastewater Treatment Plant

To the west of Pigs Eye Lake is an upland area with a moderate degree of development, including the Metropolitan Wastewater Treatment Plant.

2.1.5 Aggregate Industries

The main access to Pigs Eye Lake is through a slip maintained by Aggregate Industries, a manufacturer and supplier of asphalt, concrete, and other aggregates. Barges from the main channel of the Mississippi River travel through the slip to access Aggregate Industries, and can load and unload on the northern most end of the property at the Red Rock Terminal.

2.2 Climate

The project area has a continental climate typical of the upper Midwestern United States. Winters are cold and snowy while summers are hot and humid. The average annual temperature of the area is

47.05° F (56.6° F/37.5° F) with an average annual precipitation of 32.04 inches. As a result of the continental climate, the area experiences a great range of temperatures and the full range of precipitation and related weather events including snow, sleet, rain, ice, thunderstorms, tornadoes, and fog. Further climate change analysis for the region and potential effects on flow has been conducted and is available in Appendix G.

2.3 Geology and Soil Substrate

2.3.1 Geology

Pigs Eye Lake is located within a historic river channel cut into Paleozoic sedimentary rock formations during the Pleistocene glacial period 40,000 to 10,000 years ago. The valley was subsequently filled with glacial sediment. The current Mississippi River channel adjacent to Pigs Eye Lake was cut during the draining of Glacial Lake Agassiz via Glacial River Warren 11,700 and 9,400 years ago. During glacial waning periods large amounts of sediments deposited by Mississippi tributaries acted as natural dams, creating a series of lakes upstream and likely leading to the deposition of glacio-lacustrine clays on the western portion of Pigs Eye Lake. Since glacial time the Mississippi River has been a braided stream affecting Pigs Eye Lake only in times of flood.

The construction of the locks and dams upstream and downstream along the Mississippi is not believed to have had a significant effect on the sedimentation patterns of Pigs Eye Lake, which was already a backwater area. On the other hand, development to the north and west of the lake likely did have an impact on sedimentation. Development immediately upstream of the lake, including the adjacent waste water treatment plant, resulted in the abandonment of an upstream channel connecting the lake to the main channel. Additionally, as a result of the rail yard development north of Pigs Eye Lake, Battle Creek channel was re-routed and its flow conditions were likely altered. By further isolating the lake from the main channel, these changes likely resulted in an increased rate of fine particle sedimentation within the lake.

2.3.2 Subsurface Conditions

Four soil borings were performed during late October 2015 by USACE personnel. The boring locations were selected in order to characterize conditions throughout the lake, and generally corresponded with the locations of conceptual project features. Results on the borings are further detailed in Appendix E, Section 5.1.

Borings generally indicated very soft soils for a depth between 10 ft and 22 ft. The bottom of Pigs Eye Lake is primarily composed of unconsolidated silts and clays (with 90 percent of material passing through a #200 sieve) and a high concentration of organic carbon. The soils were dominated by silty clay with organics (CH) but also included clayey organic silt (OH), clayey peat (Pt), clayey sand (SC), and wood fragments mixed with clay (Pt).

The very soft soils are underlain by either bedrock, indicated by the trace levels of the St. Peter sandstone in boring 15-3M, or dense sandy and/or gravelly alluvium.

2.3.3 Hazardous, Toxic, and Radioactive Waste (HTRW)

Environmental studies by several agencies, including the Corps, have been conducted in the project vicinity of Pigs Eye Lake. Because there are known sources of hazardous, toxic, and radioactive wastes (HTRW) in the project area, a Phase I HTRW analysis was conducted in June 2016, in accordance with ER-1165-2-132, Water Resource Policies and Authorities HTRW Guidance for Civil Works Projects. The Phase I analysis identified the primary sites with the highest potential for soil and water contamination, which are the Pigs Eye Landfill, a 350 acre site immediately north of the lake, and the Pigs Eye Wastewater Treatment Plant, 1 mile northwest of the lake (see Appendix K – HTRW, for the full report).

As a result of the Phase I report, a Phase II investigation with additional sampling at the proposed project locations was conducted in order to better quantify any potential chemical or environmental contamination that may exist and thereby impact the proposed Project. The results of the tests conducted are summarized below in Section 2.3.4, while full results are included in Appendix E - Sediment Report. Section 7.1.6 presents a discussion and conclusion about the results in regards to the proposed alternative.

2.3.4 Sediment Contaminant Testing Summary

The Corps collected sediment samples throughout Pigs Eye Lake and analyzed them for a suite of routinely-tested physical and chemical parameters. The Corps also collected and incorporated results of tests previously conducted by other entities in Pigs Eye Lake. Contaminant levels found in the tests were compared with several sets of reference values developed by the Minnesota Pollution Control Agency (MPCA) to evaluate the acceptability of constructing potential project measures within the lake. The results were coordinated and discussed with local and regional resource agencies. The analysis and coordination led to the conclusions that: (1) The northernmost portion of the lake near the former Pigs Eye Landfill should be avoided as part of this project (incorporated as a planning constraint, see Section 4.2 and Figure 15), and (2) Construction of habitat features in the remainder of the lake are not expected to pose an unacceptable risk to wildlife and therefore, overall project planning should continue.

Targets used to interpret the degree of contamination are divided into SQTs and SRVs. The Sediment Quality Targets (SQTs) consist of level I guidance for a high level of protection for benthic invertebrates and level II guidance for the moderate level of protection for benthic invertebrates. The MPCA's Residential Soil Reference Values (SRVs) were also compared to the results to determine if the material is suitable for upland placement.

The MPCA oversaw and/or conducted sediment sampling in the northernmost portion of Pigs Eye Lake between 1992 and 2007. Results of the various investigations conducted in the lake indicate that cadmium, copper, lead, zinc, and polychlorinated biphenyls (PCBs) are present in the Pigs Eye Lake sediments at concentrations that exceed respective level I and level II sediment quality targets (SQTs). Additionally, perfluorinated chemicals (PFCs), including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been detected in lake sediments. However, PFCs are ubiquitous throughout Mississippi River Pool 2, and with the exception of the area directly around the landfill, PFC

levels within Pigs Eye Lake do not appear to be significantly elevated compared to the general region (see Appendix E – Sediment Report, Attachment 1, PFC Summary).

The Corps conducted two sediment surveys; 3 boreholes were tested in 2015 and 10 boreholes were tested in 2016. The samples were analyzed for grain size, metals, PCBs, pesticides, PAHs, cyanide, total organic carbon, percent moisture, percent solids and percent total volatile solids. In addition, PFCs were analyzed for 6 of the 10 2016 boreholes. Under MPCA's current SQT and SRV levels, the only exceedances detected in the 2015 sampling were for SQTs and only for the borehole closest to the former landfill (15-1M), except for cadmium which exceeded the SQT I in all three boreholes. Under the proposed changes to the SRVs, cadmium levels from boreholes 15-1M and 15-2M and benzo(a)pyrene from 15-1M exceeded the Residential/Recreational limit, but were below the Commercial/Industrial SRVs.

The 2016 results showed similar results as the 2015 survey, with a large number of SQT exceedances, but again there were no SRV exceedances under the current MPCA guidance. Similar to the 2015 results, however, several boreholes showed recreational/residential use exceedances for cadmium and benzo(a)pyrene under the proposed MPCA SRV values.

As an outcome of the USACE surveys, it is believed that the highest levels of contamination are limited to the area adjacent to the landfill. The rest of the lake shows contamination of PFCs, widespread low level (SQT I) exceedances for heavy metals and PAHs, limited locations with higher exceedances for cadmium and PAHS (SQT II and proposed Recreational/Residential SRVs) and no recent detection of PCBs. A detailed discussion of the sediment analysis conducted for the project is presented in Appendix E – Sediment Report.

2.4 Hydrologic and Hydraulic Conditions

2.4.1 River Discharge and Stages

Mississippi River annual chance exceedance of discharge is shown in Appendix G - Hydrology and Hydraulics; the tables in the appendix can be used to relate discharge with frequency. Annual Chance Exceedance (ACE) discharges that could be useful in this study are:

50% ACE (2-year)	38,500 cfs
20% ACE (5-year)	63,400 cfs
10% ACE (10-year)	81,800 cfs
5% ACE (20-year)	101,000 cfs
2% ACE (50-year)	127,000 cfs
1% ACE (100-year)	148,000 cfs
0.5% ACE (200-year)	169,000 cfs
0.2% ACE (500-year)	200,000 cfs

This data is taken from a discharge frequency analysis of the Saint Paul Gage (USGS) on the Mississippi River. These discharges are used in the most recent Flood Insurance Study models (HEC-RAS). A more detailed figure which includes additional technical information can be seen as Figure 1 in Appendix G.

2.4.1.1 Dam Operation

Pool 2 is regulated in a manner typical for navigation pools in the St. Paul District. Figure 5 shows the operating curves for Lock and Dam 2 on the Mississippi River. All elevations stated are NAVD 1988. The curve for the South Saint Paul Control Point (CP) can be used to estimate water elevations in Pigs Eye Lake. When river discharges are greater than 62,500 cfs, the gates are removed from the water at Lock and Dam 2 and the pool is unregulated. When discharges are between 12,500 and 62,500 cfs the pool is in "secondary control," i.e., a pool elevation of 686.1 ft is maintained at the dam. The water surface elevation upstream of the dam rises and falls with river discharge. Due to the slope on the pool, the range of fluctuation under secondary control is greater the farther upstream from the dam one progresses.

Figure 5: Operating Curves for Dam 2 (Note Elevations are in NAVD88 Datum)

When river discharges decline to 12,500 cfs, regulation of the pool shifts to "primary control," whereby a water surface elevation of 686.8 is maintained at the primary control point at the South Saint Paul Gage (which happens to be adjacent to the Pigs Eye Lake area). As discharges decline below 12,500 cfs, the water surface elevation at Lock and Dam 2 is increased from 686.1 to 686.8. If river discharges were to decline to zero, the pool water surface would (in theory) be flat at elevation 686.1. The mapped floodway and ineffective flow areas were also identified in order to avoid inducing flood stage impacts (see Figure 15).

2.5 Water Quality

Historical water quality data for Pigs Eye Lake is limited, as the lake is not monitored by the local watershed district or Ramsey County Parks & Recreation. However, the lake does have a long

documented history of high turbidity. As just one example, an account in a local newspaper from September of 1973 describes a canoe tour of Pigs Eye Lake: "The muddy bottom is so close to the surface during these waning summer days that large carp barely have room to jump over canoe paddles. But the water is so murky you can't see them."

According to the MPCA website, the mean concentration for total phosphorus in Pigs Eye Lake is 0.365 mg/L and the mean Secchi disk transparency for Pigs Eye Lake is 1.3 feet, giving the lake a hypereutrophic classification. These average conditions are based on a summary of lake water quality data available on the MPCA website (www.pca.state.mn.us), which indicates that the data is old (collected between 1970 and 1988), but does not indicate the origin of the data. Satellite imagery acquired between 1999 and 2000 indicated that the lake's transparency depth is less than 1.5 feet (Minnesota Lake Finder, www.dnr.state.mn.us). In general, these data are indicators of poor water quality and suggest that the lake is very nutrient-rich and has low visibility and light penetration.

2.6 Air Quality

The EPA is required by the Clean Air Act to establish air quality standards that primarily protect human health. These National Ambient Air Quality Standards (NAAQS) regulate six major air contaminants across the United States. When an area meets criteria for each of the six contaminants, it is called an 'attainment area' for that contaminant; those areas that do not meet the criteria are called 'nonattainment areas.' Ramsey County is classified as an attainment area for each of the six contaminants and is therefore not a region of impaired ambient air quality (EPA 2017). This designation means that the project area has relatively few air pollution sources of concern.

2.7 Habitat

2.7.1 Aquatic Habitat

Pigs Eye Lake is a contiguous backwater floodplain lake, situated in the middle portion of Navigation Pool 2 of the Mississippi River. The upper and middle portions of Pool 2 are constricted by tall bluffs, and consist predominantly of main channel and main channel border habitats. The main channel is the part of the river that conveys the majority of river discharge. The main channel in Pool 2 is managed for commercial navigation (i.e., barge) traffic and is maintained at a depth of at least nine-feet-deep by dredging in areas where sediment accumulates. Main channel border habitat includes the areas between the deep channel and the riverbank. Pigs Eye Lake is somewhat unique as one of the few backwater areas in this upper portion of the Pool. No comparable backwater areas exist upstream of Pigs Eye Lake in Pool 2, and the next nearest backwater lake is more than six miles downstream. Unfortunately, Pigs Eye Lake's loose, mucky bottom, wind-swept surface, and shallow depths limit the biological productivity of the lake. Re-suspension of sediments from wind and rough-fish activity limit light penetration and rooting capability of submersed vegetation. The lack of stable substrate and high nutrient levels limit the establishment of macroinvertebrate communities.

2.7.2 Wetlands

The Corps' definition of wetlands are, "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a

prevalence of vegetation typically adapted for life in saturated soil conditions." While a full, detailed wetland delineation has not been conducted for the project area, it is apparent from aerial imagery dating as far back as 1951 that the majority of the lake does not support aquatic vegetation. Wetland vegetation is prevalent around the outside edge of the lake and the surrounding floodplain habitat, and includes species such as bulrush, bur-reed, arrowhead, and cutgrass. However, the extent of the wetland vegetation has slowly been receding due to de-stabilization and erosion of the shoreline. It is estimated that 111 acres of wetland have been lost in this manner since 1951. Approximately 131 acres of shallow marsh wetland and 18.6 acres of bottomland scrub/shrub forest are estimated to remain in the shoreline area surrounding Pigs Eye Lake.

2.7.3 Terrestrial Habitat

The riparian area surrounding Pigs Eye Lake is low-lying marsh. Areas of emergent aquatic vegetation, represented by sedges, rushes, cutgrass, smartweeds, arrowhead, and water plantains are interspersed with woody terrestrial communities represented by species such as silver maple, green ash, American elm, cottonwood, box elder, and sandbar willow. Most of the immediate shoreline is undeveloped, but is bordered by a network of railroad tracks to the northeast, a wastewater treatment facility to the west, and a former dump site to the north. The island on the south side of the lake is a valuable Heron Rookery, and is more densely forested than the areas on the north and west sides of the lake

2.8 Fish and Wildlife

2.8.1 Fish

In comparison to other Upper Mississippi River pools, Pool 2 supports a moderate fishery. Upper Pool 2 provides mostly main channel and main channel border habitat because the floodplain is restricted by bluffs throughout the upper portion. Water quality also influences the fish community in Pool 2 – high turbidity and high nutrient levels downstream of where the Minnesota River enters Pool 2 decrease the suitability of this habitat for some fish. Trapnet surveys of Pigs Eye Lake were conducted five times between 1972 and 1999. The most recent survey in 1999 found gizzard shad to be the most abundant (319 of 605 fish sampled), while common carp made up the majority of biomass (164 of 334 pounds of fish sampled). Other species found include black crappie, bluegill, bowfin, channel catfish, freshwater drum, quillback, and white bass. Twenty species were sampled in total.

The UMR on a whole supports a diverse assemblage of freshwater fish. Approximately 100 species of fish representing as many as 25 families have been recently sampled from the UMR between Minneapolis and Lock and Dam 10 (Schmidt & Proulx, 2009). Most of the fish present are native warmwater species. Common game species include walleye, sauger, northern pike, channel catfish, largemouth bass, bluegill, and white and black crappie. Common non-game fish include freshwater drum, carp, redhorses, buffaloes, and a wide variety of minnows. Exotic species currently residing in the UMR include common carp, grass carp, bighead carp, goldfish, and rainbow and brown trout.

2.8.2 Wildlife

The Mississippi River is a part of a major bird migration route, termed the Mississippi Flyway. At least 300 species of birds, about 60 percent of the total number of species in the conterminous United States,

are known to nest along the Upper Mississippi River and within the river valley. Waterfowl are considered particularly important due to their large numbers and visibility. Approximately 30 species of waterfowl use the UMR. Waterbird surveys were conducted by the National Park Service during the fall migration, from October-December of 2015. Surveyors observed 17 species of waterbirds on Pigs Eye Lake. Species included mallard, gadwall, widgeon, common merganser, ring-billed gull, and ruddy duck. Between 4 and 8 bald eagles were observed during each of the five site visits as well (Holdhusen, 2016).

A variety of mammals and birds inhabit the floodplain forests and wetlands adjacent to Pigs Eye Lake. River otters and beavers were observed during National Park Service waterbird surveys (Holdhusen, 2016), and an active beaver lodge and several otter dens have been documented. White-tailed deer, red fox, raccoon, woodchuck, striped skunk, Eastern cottontail, and a variety of squirrels all inhabit the floodplain, and also likely make use of the shoreline habitat surrounding Pigs Eye Lake.

2.8.3 Aquatic Invertebrates

The unconsolidated, flocculent, and organically-enriched substrate present throughout Pigs Eye Lake is not well suited to a diverse macroinvertebrate community. A 2007 report describing the results of a survey of the benthic community in Pigs Eye Lake characterized the area as having extremely low diversity and noted that the lake was “dominated by two groups – Chironomidae (midges) and Oligochaeta (aquatic worms) – that are normally considered tolerant of pollution and organic enrichment” (Montz 2007).

2.8.4 Threatened and Endangered Species

2.8.4.1 Federally-Listed Species

A review of the FWS Information for Planning and Conservation (IPaC) website (https://ecos.fws.gov/ipac/), was conducted on February 20, 2018 to determine whether any federally-listed threatened and endangered species may occur within or near the project area. The search area used for the IPaC report is shown in Figure 6 below.

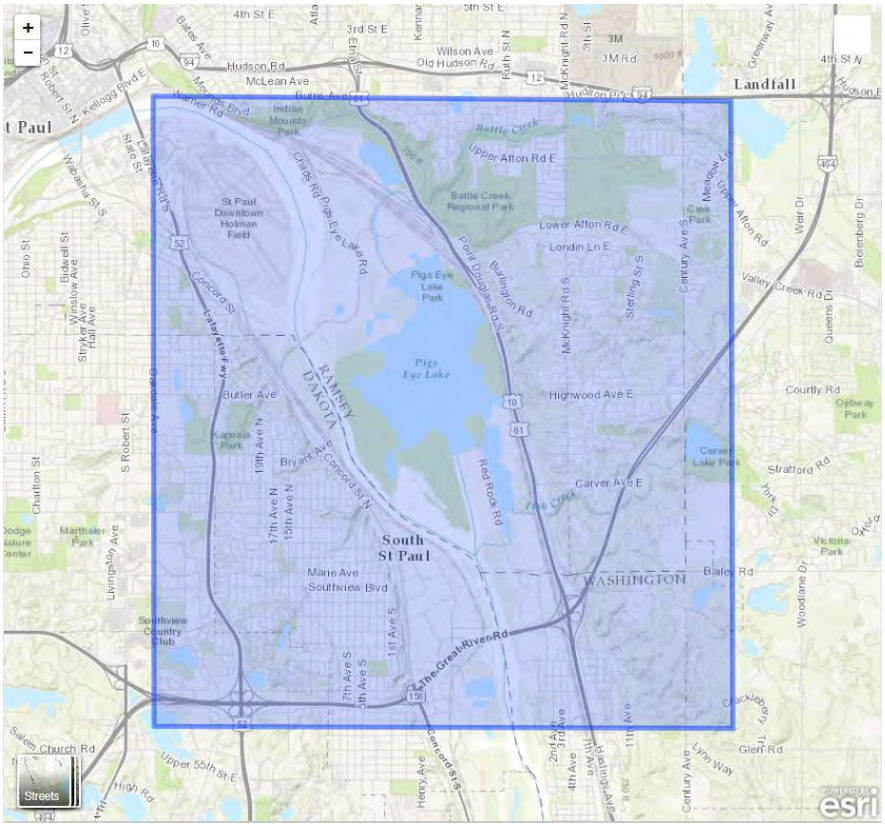

Figure 6: Search Area for IPaC Trust Report, February 20, 2018

The IPaC database search indicated the potential occurrence of four federally-listed species: one endangered mussel - the Higgins eye (*Lampsilis higginsii*); one endangered insect – the rusty patched bumble bee (*Bombus affinis*); one threatened prairie plant – the prairie bush clover (*Lespedeza leptostachya*); and one threatened mammal – the Northern long-eared bat (*Myopis septentrionalis*). These species are listed in Table 1.

Table 1: Federally-Listed Threatened and Endangered Species That May Occur In the Project Area

Scientific Name	Common Name	Federal Status
Mussels		
Lampsilis higginsii	Higgins eye	E
Insects		
Bombus affinis	Rusty patched bumble bee	E
Mammals		
Myotis septentrionalis	Northern long-eared bat	T
Plants		
Lespedeza leptostachya	Prairie bush-clover	T

Status: E = endangered, T= threatened

Suitable habitat for the Higgins eye consists of areas of various stable substrates in large streams and rivers (U.S. Fish and Wildlife Service [USFWS] 2004, Ohio River Valley Ecosystem Team 2002). The Higgins eye has been reintroduced to Pool 2 on a larger scale since 2000, and the population is now naturally reproducing.

The rusty patched bumble bee occupies grasslands and tallgrass prairies of the Upper Midwest and Northeast. This bumble bee needs areas that provide food (nectar and pollen from flowers), nesting sites (underground and abandoned rodent cavities or clumps of grasses above ground), and overwintering sites for hibernating queens (undisturbed soil) (USFWS 2016).

The northern long-eared bat's spring and summer habitat includes live and dead standing trees and the bat feeds on insects while flying through the understory of forested hillsides and ridges. The bat hibernates in caves and mines during the winter, and swarms in surrounding wooded areas in autumn.

The prairie bush-clover is an upland prairie plant, and a member of the pea family. The species only occurs within high-quality, dry to mesic, native tallgrass prairie habitats in the upper Mississippi River Valley.

2.8.4.2 State-Listed Species

A number of species that are listed by the State of Minnesota as endangered, threatened, or special concern have been historically documented in the vicinity of the project area. A review of the Minnesota DNR's State Natural Heritage Information System (NHIS) database was conducted on February 20, 2018. Natural Heritage Database information was obtained from the Division of Ecological and Water Resources, Minnesota Department of Natural Resources (DNR) through an inter-agency cooperative licensing agreement and includes the most recent July 14, 2017 update. The search included a one-mile buffer around the project area to ensure that any listed species, sensitive communities, or critical habitats adjacent to the proposed project area would be included. There are a total of nine species listed by the state of Minnesota as endangered, threatened, or of special concern that may occur within or near the project area: six freshwater mussels, two fishes, and one plant. These species are listed in Table 2.

Table 2: State-Listed Threatened and Endangered Species With Historic Records Near the Project Area

Scientific Name	Common Name	Minnesota Status
Mussels		
Fusconaia ebena	Ebonyshell	E
Arcidens confragosus	Rock pocketbook	E
Truncilla donaciformis	Fawnsfoot	T
Quadrula metanevra	Monkeyface	T
Quadrula nodulata	Wartyback	T
Pleurobema sintoxia	Round pigtoe	SC
Fish		
Ictiobus niger	Black Buffalo	T
Cycleptus elongates	Blue Sucker	SC
Plants		
Besseya bullii	Kitten-tails	T
Crocanthemum canadense	Canada frostweed	SC

Status: E = endangered, T= threatened, SC = special concern

All accounts of the nine state-listed species occur outside of Pigs Eye Lake. The six species of freshwater mussels listed in Minnesota occur in nearby main channel locations with more consistent flow. There are no known recent collections of freshwater mussels from within Pigs Eye Lake. It is unlikely that freshwater mussels would exist in the substrate conditions present within the lake. The accounts of the fish are also outside of the project area, but due to the highly mobile nature of fish, it is assumed that individuals of these species may use the project area. Accounts of the plant, kitten-tails, are from upland areas surrounding the project area. The proposed project does not include any activities expected to take place within the vicinity of these occurrences.

2.9 Historic and Cultural Resources

The Pool 2 locality contains numerous historic properties indicating continual human occupation over approximately the last 12,000 years. Historic properties include a variety of precontact and historic archaeological sites. Precontact sites include lithic and artifact scatters, village sites, petroglyphs, and burial mounds. Historic sites include Dakota villages, trading posts and forts, early town sites, standing structures, shipwrecks, transportation corridors, bridges and river training structures. Several historic properties within this locality are listed on the National Register of Historic Places (NRHP) or are eligible for listing on the NRHP. In addition, the pool contains several historic districts.

Previous investigations proximal to the Project Area include exploration of burial mounds, identification of military roads, transportation features and standing structures and studies associated with the Metropolitan Council Environmental Services sewerage plant. Twenty-six recorded historic properties exist within two and half miles of the Project Area. Several of these sites are listed on or are eligible for listing on the NRHP.

None of the historic properties are situated along the lake's shoreline (most of the shoreline is wetlands or udorthents). Only higher landforms, such as a natural levee running along the peninsula west of the lake and a terrace along the east side of the lake, contain or afford a high probability to harbor intact historic properties.

The nearest historic properties include two burial mounds, a historic road and railroad corridor situated northeast of the lake and a historic road and two historic artifact scatters on the peninsula west of the lake. In addition, possible precontact components were recovered in geologic cores located along the natural levee/peninsula west of the lake. Charred fish bone fragments were identified from two deeply buried soil horizons residing five and eight meters below the modern ground surface. It is not certain if these materials represent human activities or are the product of natural processes, such as a marsh fire. Consequently, these finds have not been assigned a site number.

Pigs Eye Lake proper appears to be a relatively recent body of water. Historical accounts and maps depict the area as marsh, wetland or hay meadow with several streams running through it. The French called the area the Grand Marais. The lake may have formed after the construction of river training structures in the late 19th century and subsequently Lock and Dam 2.

Historic Dakota villages were located along the peninsula west of the lake during the 18th and 19th centuries. Europeans began to occupy the Pigs Eye peninsula in the 1830s and continued through the 1950s. A variety of structures, including a tavern, sawmill, rest house, residences, agricultural fields and a railroad bridge and corridor are depicted on a series of maps and aerial photographs. The community was known by several names, most recently denoted as Pigs Eye. By the 1920s the wastewater treatment plant along the peninsula was installed and the mid-20th century witnessed the construction of barge terminals for elevators and other facilities along the lakes southern outlet. Beginning in the 1950s the area immediately north of the lake was utilized as a dump.

A total of 18 river training structures (e.g., wing dams) are situated along the main channel along the peninsula west of the lake. In the larger context of Upper Mississippi River constriction works, wing dams appear to be eligible for listing on the NRHP (Pearson 2003). As navigation features, they have been periodically modified as dictated by river conditions and navigation needs, especially after the 9-foot channel project began operation in the 1930s. In some cases, they were reduced or extended in length and height or removed. Under the current operations, the wing dams are submerged, although portions of some of the wing dams may be visible during low water events. No historic shipwrecks or river training structures are recorded along the main channel or within Pigs Eye Lake.

Aside from geomorphological investigations along the peninsula and sub-surface investigations in areas within the sewerage plant, no comprehensive cultural resources surveys have been conducted in the Project Area. Because most of the lake's shoreline is wetlands or udorthents (urban or disturbed soil), only the higher ground formed by natural levees, point bars and crevasse splays afford a high probability to harbor intact cultural resources.

2.10 Socioeconomic Resources

Ramsey County is located in the State of Minnesota. The county is named for Alexander Ramsey, the first governor of the Minnesota Territory.

As of 2014, the population of Ramsey County was 532,655. Ramsey County is the 2nd most populated county in the state of Minnesota out of 87 counties and it is one of the most densely populated counties in the United States. The largest Ramsey County racial/ethnic groups are White (64.0 percent) followed by Asian (13.7 percent) and Black (11.1 percent). In 2014, the median household income of Ramsey County residents was $55,101, however, 16.3 percent of Ramsey County residents live in poverty.

St. Paul, the county seat of Ramsey County, is the capital and second-most populous city in Minnesota. The city hosts the Capitol building and the House and Senate office buildings, numerous state departments, federal buildings, and other services are also headquartered in St. Paul. Several major corporations are also headquartered in St. Paul. The city lies mostly on the east bank of the Mississippi River in the area surrounding its point of confluence with the Minnesota River. St. Paul adjoins Minneapolis, and together the "Twin Cities" form the Minneapolis-St. Paul Metropolitan area, with a population of about 3.5 million residents.

2.10.1 Recreation/Aesthetic Resources

The Ramsey County Parks & Recreation system is a natural resource base park system which, encompasses over 6,500 acres consisting of 6 regional parks including a family aquatic center and nature center, 6 regional trail corridors, 9 county parks, 9 protection open space sites, 11 indoor ice arenas and 5 golf courses. The park system is comprised of a variety of land types ranging from urbanized lake fronts, natural lake fronts, and low-land and upland natural areas. Due to the wide range of differing land types a variety of recreational activities consist mainly of boating, fishing, picnicking, play areas, swimming, biking, walking, running, mountain biking, cross country skiing, archery, bird watching, hiking, off-leash dog areas, golf, hockey, and many more.

The project area lies within Pigs Eye Lake section of Battle Creek Regional Park. Battle Creek Regional Park is jointly owned and maintained by Ramsey County and the City of St. Paul and is a is comprised of four segments, Fish Hatchery, Indian Mounds, Pigs Eye Lake, and Battle Creek. The Battle Creek and Pigs Eye Lake segment is owned and maintained by Ramsey County.

2.10.2 Commercial Navigation

Pool 2 serves as a link between the upstream ports of Minneapolis, St. Paul, the Minnesota River, and the remaining Mississippi River navigation system downstream. Between 2006 and 2015 barge freight through Lock and Dam 2 ranged from 4.7 to 7.4 million tons (average of 6.8 million tons). The most important commodities hauled are farm products moving from local terminals in St. Paul and on the Minnesota River to the Gulf for export. Other important commodities include fertilizer, crude materials (sand/gravel/stone, road salt, scrap metal, etc.), cement, and petroleum products.

2.10.3 Airport Wildlife Hazards

The St. Paul Downtown Airport (Holman Field) is located approximately 5,500 feet west/northwest of Pigs Eye Lake. The airport has three runways and services more than 64,000 takeoffs and landings

annually. Aircraft collisions with birds and other wildlife can pose a threat to aircraft safety. Because the proposed project is relatively close to the St. Paul Downtown Airport, the project's potential effects to airport operations were evaluated and coordinated with relevant agencies including the Federal Aviation Administration (FAA), U.S. Department of Agriculture-Wildlife Services (USDA-WS), and Minneapolis Saint Paul Metropolitan Airports Commission.

2.10.4 Environmental Justice

The U.S. Environmental Protection Agency (USEPA) on-line EJScreen mapping tool (Version 2017) was used to characterize existing conditions for minority and low-income groups. A 2-mile buffer around the center of Pigs Eye Lake was created as the study area (a 1-mile buffer was initially selected, but included mostly the lake itself). The EJScreen tool estimated an approximate population of 21,063 in the area. The EJScreen tool identified several Demographic Indicators that had relatively high percentile values compared to the state and regional percentiles, but were not as high when compared to the national averages. For example, the minority population living in the area surrounding the project area is 39%, compared to a state average of 18%, and an EPA regional value of 25%, but a national average of 38%.

2.11 Resource Significance

The criteria for determining the significance of resources are provided in the *Federal Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (Water Resources Council 1983)* (P&G) and USACE planning guidance ER 1105-2-100. Protecting and restoring significant resources is in the national interest. The significance and the relative scarcity of the resources helps determine the federal interest in the project. Significant resources in the project area include natural and cultural resources that are recognized as significant by institutions and the public. For ecosystem restoration projects, the significance of resources is based on both monetary and non-monetary values. Monetary value is based on the contribution of the resources to the Nation's economy. Non-monetary value is based on technical, institutional or public recognition of the ecological, cultural, and aesthetic attributes of resources in the project area. The scientific community and natural resources management agencies recognize the technical significance of resources.

2.11.1 Institutional Recognition

Tangible support for the restoration of the lake ecosystem has been demonstrated at the federal, state, and local level. Backwater habitats on the Upper Mississippi River are a significant resource. In 1986, U.S. Congress designated the Upper Mississippi River System as both a "…nationally significant ecosystem and a nationally significant navigation system…" in Section 1103 of the WRDA 1986. The National Research Council's Committee on Restoration of Aquatic Ecosystems targeted the Upper Mississippi River for restoration as one of only three large river-floodplain ecosystems so designated. The Upper Mississippi River Basin Association is an advocate for restoration on habitat on the Upper Mississippi River. In addition, the Upper Mississippi River Conservation Committee recognized the importance of the floodplain forest to the fish and wildlife of the river.

Specific recognition of Pigs Eye Lake's value to wildlife and goals to preserve the area have been ongoing for well over 40 years. For example, an environmental impact report published by the Corps in 1973 noted that, "64 species of birds, including 2,500 herons nest there," and related correspondence from

the USFWS in 1974 reiterated that, “The Pigs Eye Lake area has diverse environmental characteristics which make it imperative that it should be preserved as a natural area.”

2.11.2 Public Recognition

Ramsey County is proud of the history of their lake and watershed as a fully-functioning ecosystem and wish to see the habitat restored such that the wildlife there will again be abundant and diverse. The public recognizes the Upper Mississippi River, including Pool 2, as a nationally, regionally, and locally significant resource. Some of the public services the Mississippi River provides include aesthetics, recreation, science, education, raw materials, and flood regulation. In general, these services identified show the wide range of uses from the river, which extend beyond the ecological health of the Upper Mississippi River, and directly relate to public welfare and long-term ecological health of the region.

2.11.3 Technical Recognition

Numerous scientific analyses and long-term evaluations of the Upper Mississippi River have documented its significant ecological resources. Since the early 20th century, researchers, government agencies, and private groups have studied the large river floodplain system. The UMR ecosystem consists of hundreds of thousands of acres of bottomland forest, islands, backwaters, side channels, and wetlands, all of which support more than 300 species of birds; 57 species of mammals; 45 species of amphibians and reptiles; 150 species of fish; and nearly 50 species of mussels. More than 40 percent of North America’s migratory waterfowl and shorebirds depend on the food resources and other life requisites (shelter, nesting habitats, etc.) that the ecosystem provides.

3 Problem Identification

Based on the information discussed in Chapter 2, the existing conditions for a variety of fish and wildlife species expected to occur in the type of habitat in Pigs Eye Lake would be considered poor. High turbidity, a lack of habitat diversity, and poor sediment quality are some of the problems that have been identified within the lake that influence the value of the existing habitat. This chapter documents what is known about the problems such as when they may have arisen, stressors that currently contribute to the problems, and how they interact with one another to create the conditions observed in Pigs Eye Lake today. This understanding of the problems is used to predict the future conditions in the project area in the absence of a project.

3.1 Historically Documented Landscape Changes

Historic maps and aerial imagery reveal substantial changes in the landscape and around Pigs Eye Lake. The 1890 Mississippi River Commission map portrays conditions prior to impoundment of the river, and reveals that the majority of Pigs Eye Lake prior was a large, shallow marsh, connected to the main channel of the Mississippi River by small side channels on both the upstream and downstream ends (Figure 7). As mentioned in the Cultural Resources section, French explorers called the area the Grand Marais, meaning “great marsh”.

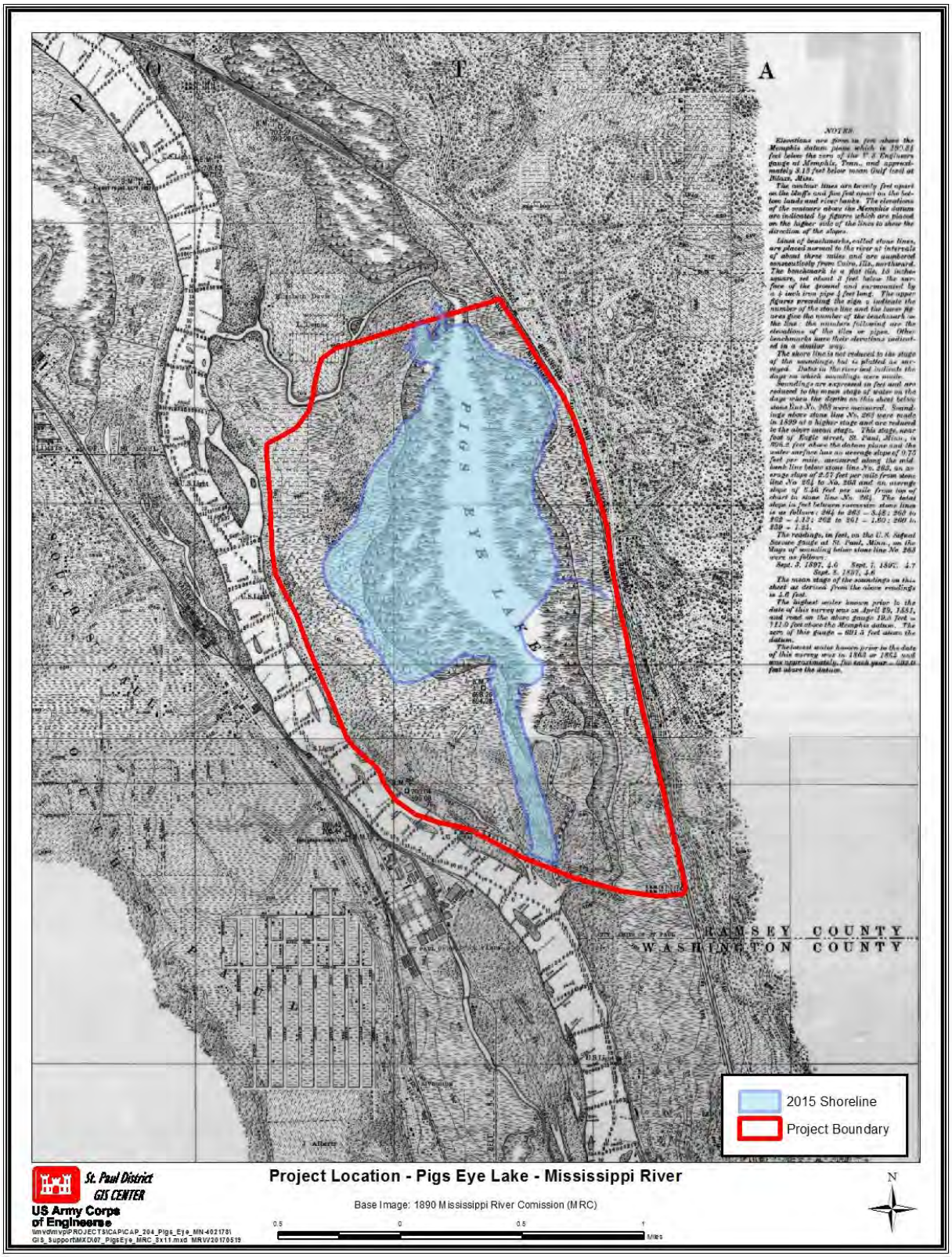

Figure 7: 1890 Mississippi River Commission Map

An aerial photo taken in July of 1951 (Figure 8) shows the impacts of construction of Lock and Dam 2 in inundating much of the marsh area within Pigs Eye Lake. The image also shows the beginning of significant development around the perimeter of the lake. To the northwest, a wastewater treatment plant has been constructed. Railroads, roads, and residential developments are prevalent along the east side of the lake. Compared to modern-day images, the southern end of the lake is significantly less developed and a mosaic of channels and islands is present. The lake itself has more shoreline variability, as well as marsh, wetland, and wooded habitat. The presence of aquatic vegetation can be seen within the lake, as well as shallow areas around the modern-day Heron Rookery.

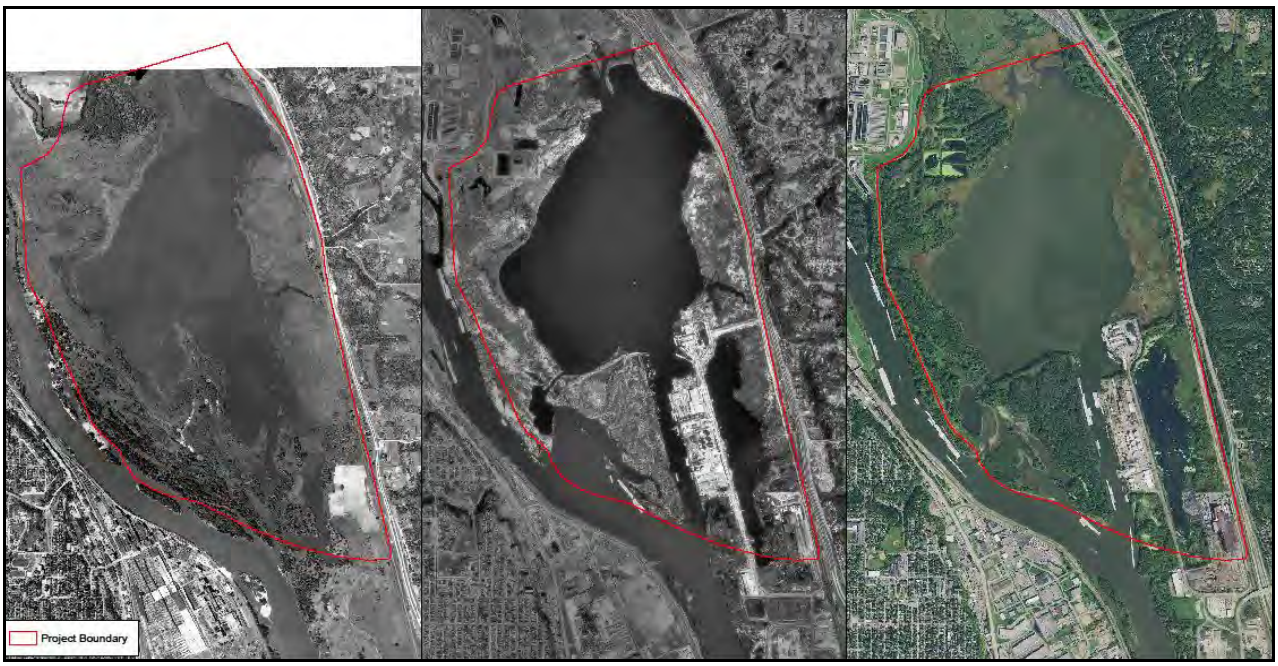

Figure 8: Aerial Photographs From Left to Right: 1951, 1991, and 2015

The 1991 aerial photograph, taken in April, shows much more industrial development around the lake. The Metropolitan Wastewater Treatment Plant has expanded and the associated ash ponds are now visible. Although it is not clear on the map, it should be noted that the Pigs Eye Landfill that was located a little north of the lake was opened and closed in this time period between these two photos. The Red Rock Terminal to the southeast of the lake was constructed, with a prominent dredged channel leading north from the main channel into the lake. The peninsula at the southern end of the lake has disappeared, and the shoreline has eroded, widening the lake. The Canadian Pacific Railroad has expanded into former open water habitat on the northeast side. A channel is apparent at the southeast corner of the lake that leads into the modern-day Hog Lake and the area that connects Hog Lake to the main navigation channel also appears to have been dredged. The dredged area was used as a barge fleeting area, though no barges are visible at the time of the photo.

By 2015, the size of the lake does not appear to have increased dramatically, but a comparison using GIS software suggest that shoreline has indeed continued to erode (see Figure 12). Development has continued in more localized areas to the north, east, and south. The barge fleeting area that had been

dredged to the southwest of the heron rookery has received significant sedimentation and began to revegetate. The 2015 photo was taken in September.

3.2 Factors Influencing Habitat Change

3.2.1 Lock and Dam 2 and Pool Regulation

Prior to river modification projects, this stretch of the UMR contained numerous islands, natural levees, point bars, and secondary channels. At that time, Pigs Eye Lake contained a significant amount of marsh, especially on its east and west sides (Figure 7). When Lock and Dam No. 2 was completed and began operating in 1930, many areas of the floodplain were permanently inundated, including Pigs Eye Lake. The consistent increase in water elevations within the marsh that is now Pigs Eye Lake likely caused the vegetation to slowly die off and become unsuitable for the growth of marsh vegetation.

3.2.2 Wind and Wave Action

Wind blowing across Pigs Eye Lake generates waves that cause shoreline erosion and greatly increase the suspension of the very fine lake bottom sediments. Typical wind direction and magnitude for the area are shown in Figure 9. The wind data that is nearest to Pigs Eye Lake is at the Holman Field Airport which is about two to three miles northwest of Pigs Eye Lake. Figure 10 shows the dominant wind directions overlaid on an image of Pigs Eye Lake, illustrating the most affected shorelines. The primary wind direction is indicated by yellow arrows, whereas the secondary wind direction is shown by black arrows.

Water depths and wind data from Pigs Eye Lake were used to model the 'wind fetch' of the existing conditions for comparison with proposed project. Wind fetch is a measure of the distance wind can travel in a constant direction across water without encountering an obstacle (e.g., shoreline, an island, reef, etc.). Wind data is incorporated into the model to account for the likelihood of wind blowing in any particular direction. The wind fetch of the existing conditions is greater than 900 meters in most parts of Pigs Eye Lake. The strongest wind fetch is in the open water of the lake (Figure 11). Areas with longer wind fetch produce larger wind-generated waves, which can subsequently increase turbidity and erode shorelines. The shallow nature of Pigs Eye Lake makes this particularly problematic because waves have a greater effect on mobilizing sediment when they occur in shallower areas.

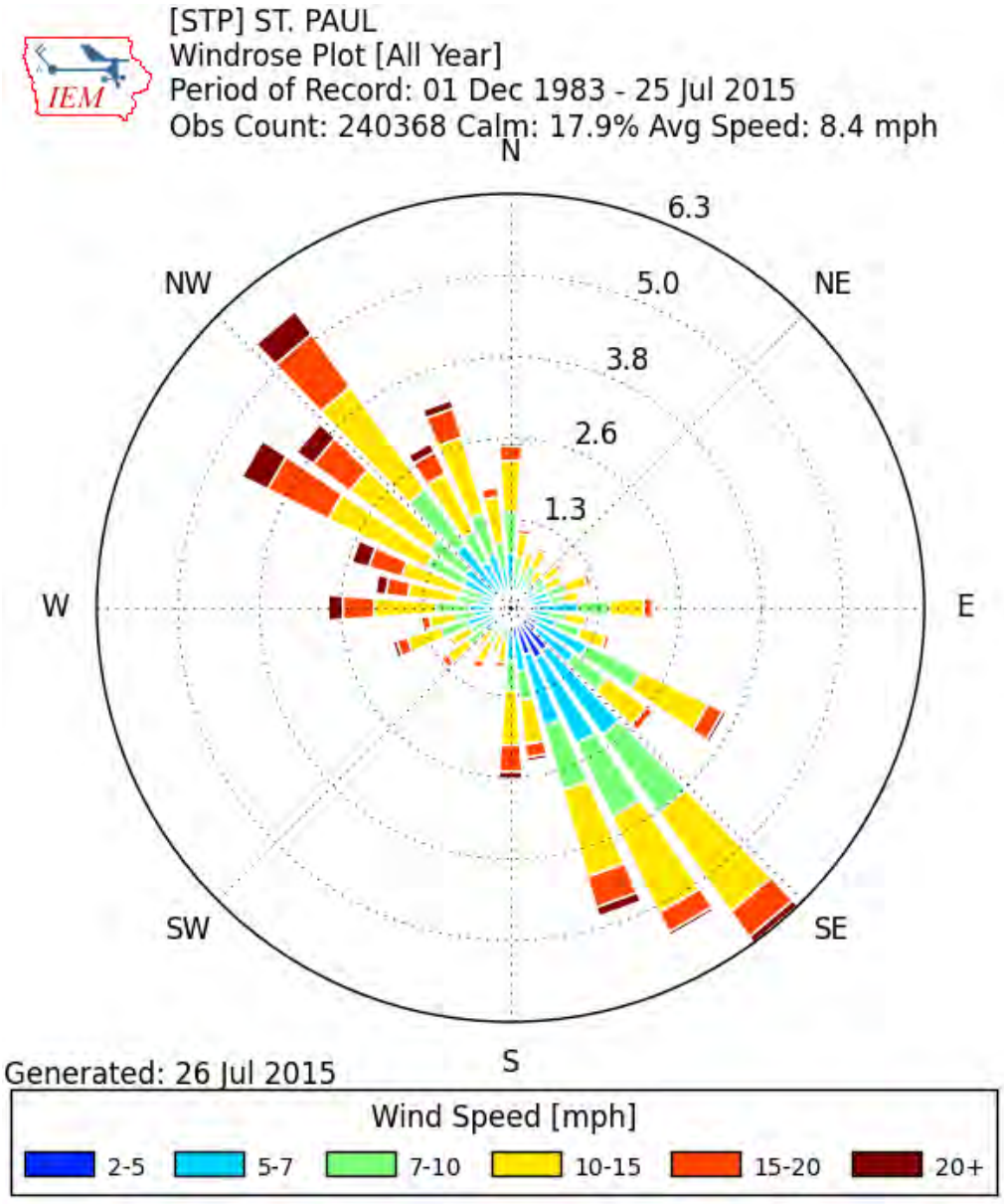

Figure 9: Wind Rose at Holman Field Saint Paul MN (Graphics from IEM/Iowa State University)

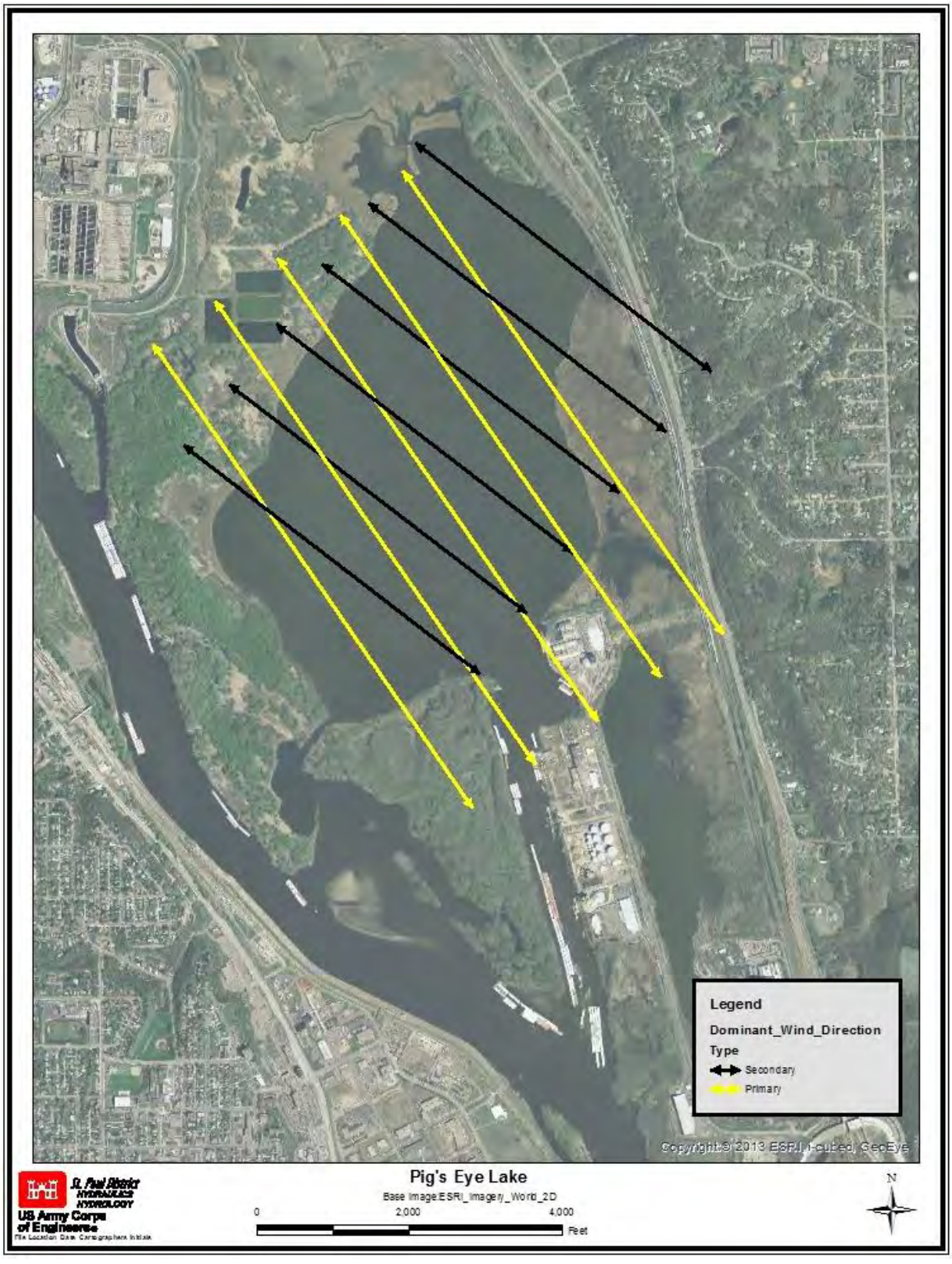

Figure 10: Map Showing Primary and Secondary Wind Direction Over Pigs Eye Lake

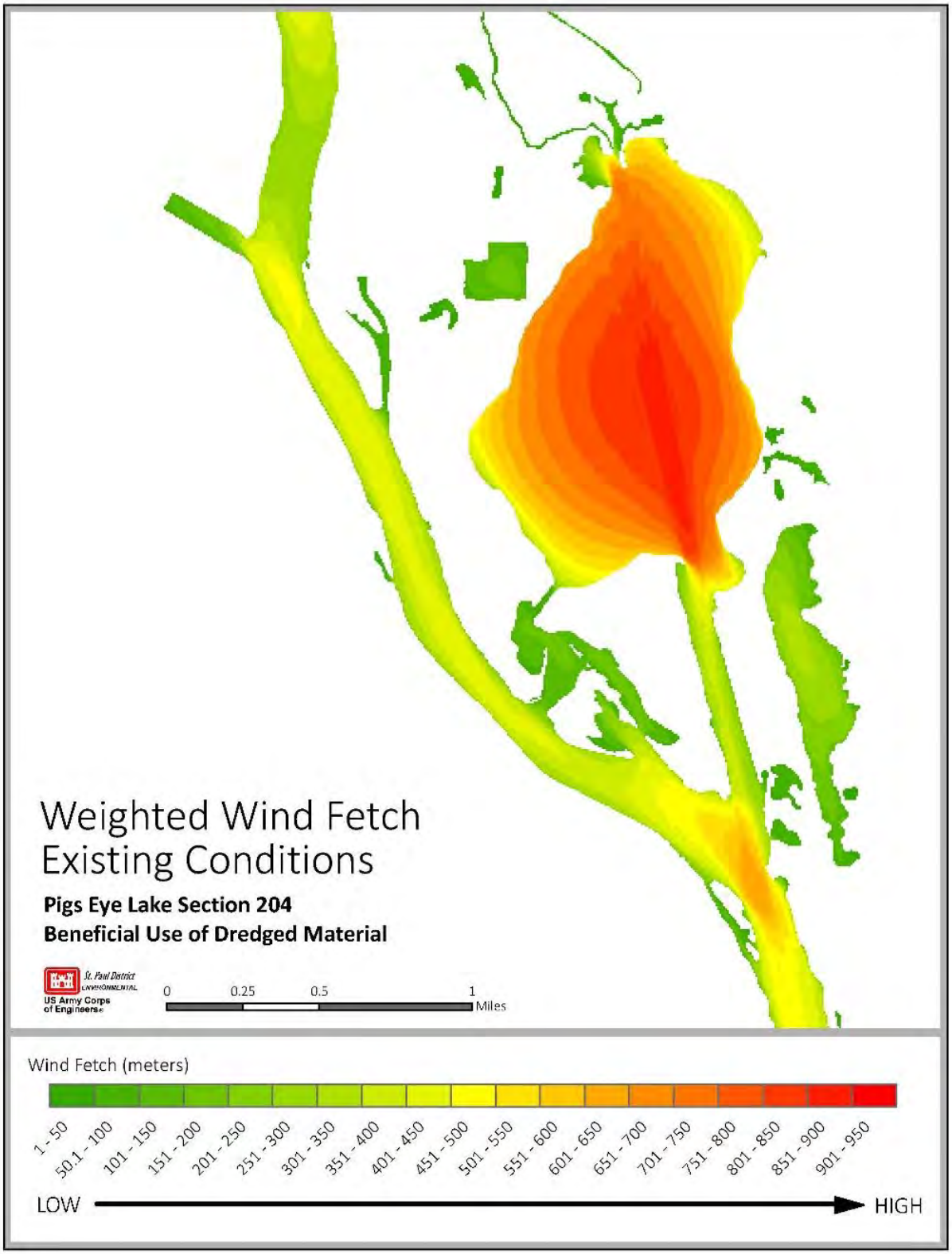

Figure 11: Existing Wind Fetch Conditions in Pigs Eye Lake

3.2.3 Shoreline Erosion

One of the most significant changes in Pigs Eye Lake is the progression of receding vegetation around the shoreline of the lake, giving way to open water. An examination of aerial imagery in Figure 12 highlights the areas that have eroded. In the forty years between 1951 and 1991, approximately 93 acres of vegetated shoreline area was converted to open water. Between 1991 and 2015, an additional 18 acres was lost, particularly along the northwest and eastern shorelines. It is likely that the exposure of the vegetation to wave energy weakened the vegetation over time, destabilizing the substrate, and allowing the shoreline substrate to erode. As the amount of open water in the lake increased, wind fetch also increased, allowing larger, unbroken waves to further erode the vegetation and substrate of the shorelines. The areas where erosion is worst correspond with the predominant wind directions, further suggesting that wind-generated waves are likely causing the ongoing erosion.

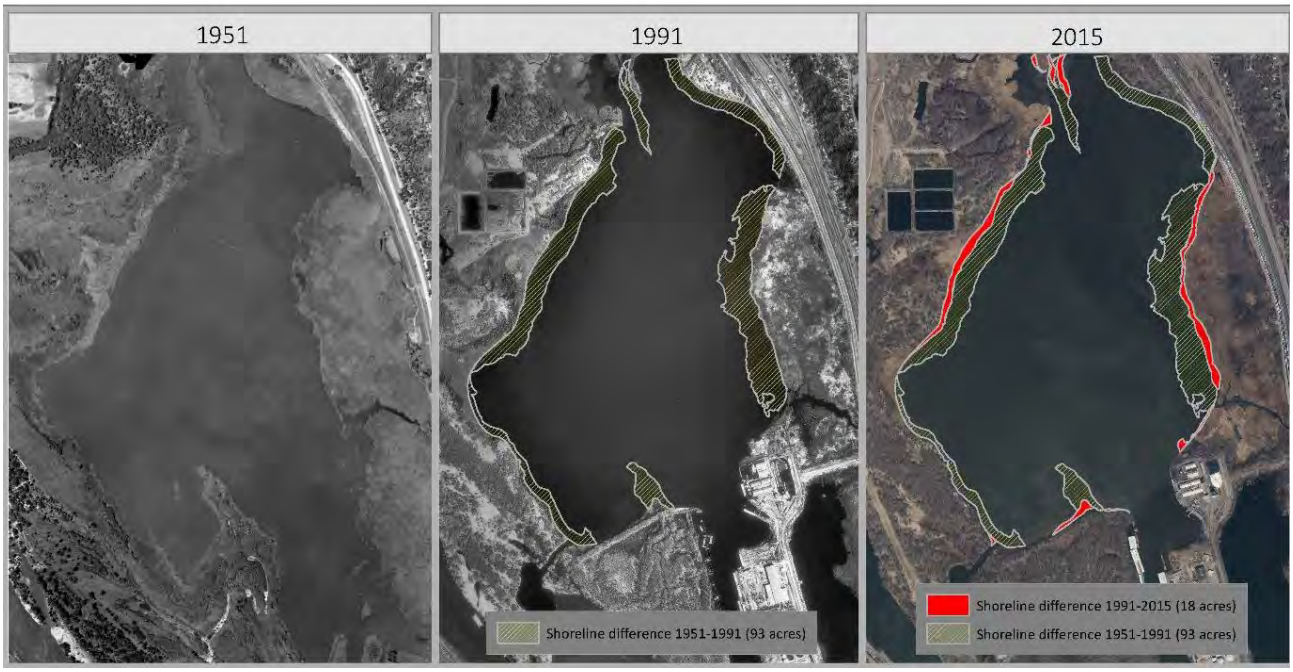

Figure 12: Shoreline Erosion in Pigs Eye Lake From 1951–2015

3.3 Problem Summary and Interactions

Each of the historic changes and problems identified above have influenced the resulting habitat conditions present today in Pigs Eye Lake. The problems were combined and summarized in a conceptual model to show how they are believed to be interacting with one another (Figure 13).

Altered Hydrology - The construction and operation of Lock and Dam No. 2, and the subsequent development around the lake, including the wastewater treatment plant, landfill, Red Rock Terminal, Hog Lake, and railroads have contributed to the alteration of the hydrology of Pigs Eye Lake.

Problems – The altered hydrology of the lake has led to the problem of increased wind fetch within the lake, which has subsequently led to shoreline erosion and loss of aquatic vegetation. As the shoreline erodes further, more vegetation is lost, and the wind fetch is further increased.

Poor Existing Habitat Conditions – The problems have led to the poor habitat conditions present in Pigs Eye Lake today. The high wind fetch results in constant re-suspension of the sediments within the lake, which causes high turbidity. The constant shifting of sediment and unstable substrate reduces the ability of vegetation to stay rooted. As vegetation decreases and open water increases, even more sediment is disturbed. The problems and resulting poor conditions create a negative feedback loop with no foreseeable improvements without intervention.

Risk to Infrastructure and Human Health – As the shoreline erosion continues to progress, it will soon threaten adjacent infrastructure. Of particular concern are the 4 ash ponds belonging to the Metropolitan Wastewater Treatment Plant to the northwest of the lake.

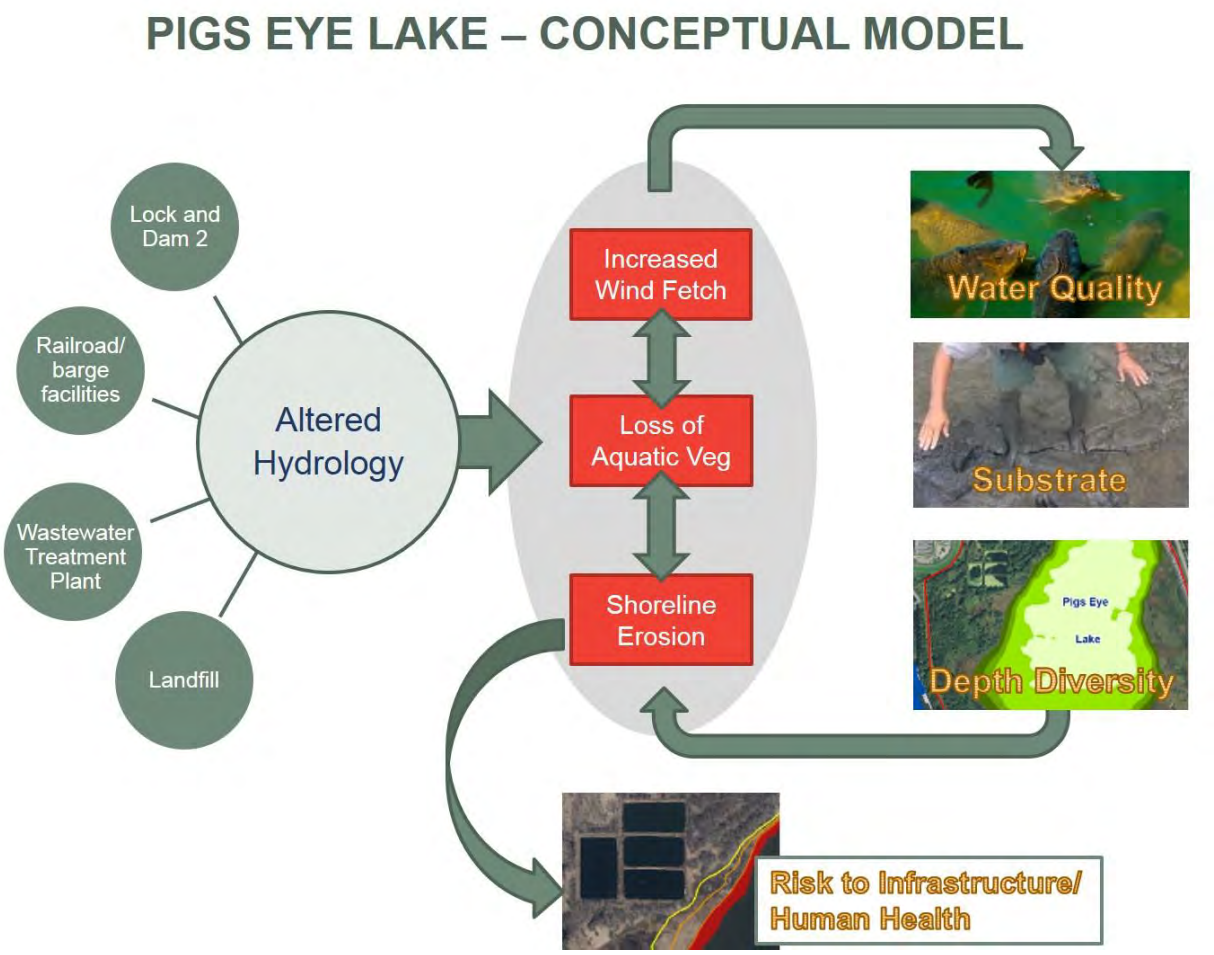

Figure 13: Conceptual Model of Pigs Eye Lake Problems

3.4 Estimated Future Without Project Conditions

The Future Without Project (FWOP) condition is the forecasted condition of the project area for the next 50 years, assuming that no significant action is taken to address the resource problems identified.

Based on the information discussed above, baseline conditions for a variety of fish and wildlife species expected to occur in the type of habitat in Pigs Eye Lake would generally be considered marginal at best,

and poor in many areas. The lake's lack of depth diversity and overall shallow average depth combined with wind and wave activity subject the environment to continual re-suspension of fine sediments and result in very limited aquatic plant growth.

Without construction of a project within Pigs Eye Lake, little change in the lake geomorphology is anticipated during the next 50 years. Continued deposition of fine-grained materials will occur along with occasional flooding that washes some sediments downstream.

In the absence of a project, the current rate of erosion is expected to continue. The 18 acres of erosion over the last 24 years equates to a loss of 0.75 acres per year. This rate of erosion was used to estimate the additional erosion expected over the period of evaluation of 50 years (years 2019-2069). This amounts to 18.75 acres within the next 25 years, and 37.5 acres over the 50-year evaluation period. A visual representation of the predicted area where erosion and loss of vegetation would be expected to occur is presented on the FWOP 25-Year and FWOP 50-Year (Figure 14).

Figure 14: Predicted Shoreline Erosion in Pigs Eye Lake 2018–2068

Over the 50 year period, the erosion predicted in Pigs Eye Lake threatens several pieces of infrastructure including the Wastewater Treatment Facility's ash ponds that hold toxic material on the western shoreline, as well as the Canadian Pacific Railway on the northeast shoreline.

3.4.1 Climate Change

ECB No. 2016-25 (USACE 2016) provides guidance for incorporating climate change information in hydrologic analyses in accordance with the Corps overarching climate change adaption policy. It calls for a qualitative analysis and provides links to online tools that can be used in this qualitative analysis. The goal of a qualitative analysis of potential climate threats and impacts to Corps hydrology-related projects and operations is to describe the observed present and possible future climate threats, vulnerabilities, and impacts specific to the study goals or engineering designs. This includes consideration of both past (observed) changes as well as potential future (projected) changes to relevant climatic and hydrologic variables.

The U.S. Global Research Program's Third National Climate Assessment was completed in 2014. It states that:

> "in the Upper Midwest extreme heat, heavy downpours, and flooding will affect infrastructure, health, agriculture, forestry, transportation, air and water quality, and more. Climate change will tend to amplify existing risks climate poses to people, ecosystems, and infrastructure. Climate change also alters pests and disease prevalence, competition from non-native or opportunistic native species, ecosystem disturbances, land-use change, landscape fragmentation, atmospheric and watershed pollutants, and economic shocks such as crop failures, reduced yields, or toxic blooms of algae due to extreme weather events."

Important driving climate variables include seasonal precipitation and air temperature and both variables are expected to increase in the future. In the Pigs Eye Lake project area this could alter hydrologic characteristics such as the magnitude, duration, and timing of river flows; water quality variables such as temperature, dissolved oxygen, and turbidity; and geomorphic processes like sediment deposition and secondary channel erosion.

While climate change modeling and assessment at the project scale relies on qualitative information at this point in time, the existing hydrologic record can provide some insight on recent changes. An analysis of the Mississippi River discharge record at the nearby USGS gage at Prescott, Wisconsin indicates that the average annual discharge and the number of days of overbank flows per year have increased over the last 3 or 4 decades. Most of the increase is occurring during the spring and early summer months with smaller increases in the fall. During the winter months of December, January, and February overbank flooding has not occurred. Given that climate modeling indicates a wetter climate in the future, the increased flows indicated in the recent hydrologic record are likely to persist and potentially get worse. These changes will be considered during project planning and design. Additional information can be found in Appendix G – Hydrology and Hydraulics.

In addition, a study was done looking at climate change and trends to river flows on the Mississippi and Minnesota Rivers (see the Climate Change Effects on Pool 2 Attachment in Appendix G).

4 Plan Formulation

Plan formulation for Pigs Eye Lake Section 204 has been conducted in accordance with the six-step planning process described in *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983) and the *Planning Guidance Notebook* (ER 1105-2-100, dated April 2000). The six steps in the iterative plan formulation process are:

1. Specify the water and related land resources problems and opportunities of the project area;
2. Inventory and forecast existing conditions;
3. Formulate alternative plans;
4. Evaluate alternative plans;
5. Compare alternative plans; and
6. Select the recommended plan.

The basis for selection of the recommended plan is fully documented below, including the logic used in the plan formulation and selection process (Appendix N – Plan Formulation).

4.1 Problems and Opportunities

One of the critical steps in the initial planning process is the identification of problems and opportunities associated within the geographic scope of the project area. Problem statements are concise characterizations of the broad issue that will be addressed with the project. Opportunity statements follow each problem and consist of an array of opportunities presented by the virtue of planning and construction activities occurring at the site of the problem. Opportunities can be directly related to solving the problem at hand, but can also be ancillary to the identified problem. From the list of problems and opportunities, objectives for the project are drafted. The success of the project planning is determined by the fulfillment of the objectives through identified measures.

Problem Statements

- Loss of emergent aquatic vegetation
- Loss of submergent aquatic vegetation
- Lack of habitat diversity in Pigs Eye Lake and within Pool 2
- Degradation & loss of shoreline habitat
- Lack of depth diversity
- Exotic fish (common carp) present in lake and throughout Mississippi River

Opportunities

- Increase beneficial use of dredged material
- Increase fish spawning habitat

- Increase bird feeding and nesting habitat
- Increase recreational opportunities where compatible with overall project goals and objectives

4.2 Objectives and Constraints

Based on the project's problems and opportunities, specific objectives were established and are listed below. The guidance for developing objectives is provided in USACE planning guidance ER 1105-2-100 and specifies that objectives must be clearly defined, must provide information on the effect desired, the subject of the objective, the location where the effect will occur and the timing and duration of the effect. For the purpose of this report, the timing or duration of the objectives is assumed to be the 50 year period of analysis (years 2019-2069).

Objectives:

1. *Improve aquatic habitat* – Create depth and habitat diversity in Pigs Eye Lake. Increase acreage of aquatic vegetation. Incorporate structural habitat features to promote fisheries.

2. *Improve the quantity and quality of habitat for migratory bird species* – Create suitable habitat for migratory birds such as dabbling ducks within Pigs Eye Lake.

3. *Maintain or enhance the quantity of shoreline habitat* – Protect existing floodplain forest and marsh habitat along the shoreline of Pigs Eye Lake from wind and wave erosion.

Planning constraints are temporary or permanent limits imposed on the scope of the planning process and the choice of solutions. These limits can be related to the ecological, economic, engineering, legal, and administrative aspects of a project. Some constraints are states of nature, whereas others are based on the design of built structures and other engineering considerations. Legislation and decision makers can impose other constraints; such human-imposed constraints are possible to change. The following planning constraints were established to guide and set boundaries on the formulation and evaluation of alternatives.

The following constraints were considered in plan formulation:

- Institutional constraints: Avoid or minimize impacts to flood stages and navigation.
    - Ensure measures do not negatively impact the 9-foot navigation channel.
    - Restoration measures should not increase flood heights or adversely affect private property or infrastructure.
    - Avoid or minimize impacts on aviation (i.e., aircraft wildlife strikes).
- Engineering constraints: Construction access must be feasible. Material quantities for the project must be available from the navigation dredge cuts or temporary dredged material placement sites in Pool 2.
- Environmental constraints: Construct measures consistent with federal, state, and local laws. Compliance and coordination under NEPA emphasizes the importance of environmental impacts to be minimized and avoided, as much as possible. Therefore, the following constraints are considered when analyzing alternatives:

- Avoid disturbance of contaminated area adjacent to the Pigs Eye Landfill
- Minimize disturbance of sediments within the lake
- Avoid adverse impacts to endangered species
- Minimize waterbird and migratory bird impacts (e.g., Heron Rookery SNA)
- Avoid adverse impacts to cultural resources

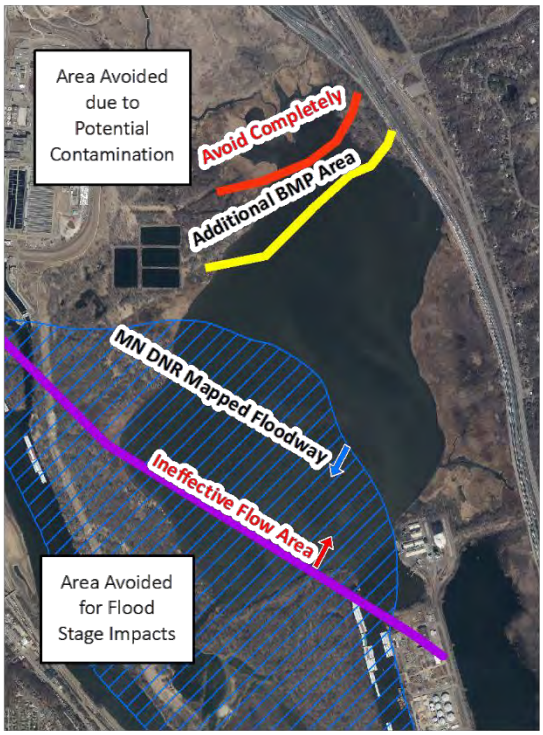

Figure 15: Contamination and Flood Stage Constraints

4.3 Identification and Evaluation of Available Measures

A management measure is a feature (a structural element that requires construction or assembly on-site) or an activity (a nonstructural action) that can be combined with other management measures to form alternative plans. Management measures were developed to address project area problems and to capitalize upon project area opportunities. Management measures were derived from a variety of sources including prior studies, the NEPA public scoping process, and the multidisciplinary, interagency project delivery team.

Before alternative plans were formulated, the first step taken was to identify general locations and categories of potential improvements that would satisfy the objectives established previously. The process began with several discussions concerning the management goals and objectives discussed in the previous section. This generated an array of *general measures* from which *alternative plans* were developed. The formulation of these alternative plans involved an assessment of the measures as to whether they met the goals and objectives of the study and how likely they were to produce measurable habitat benefits. This is a subjective process requiring further trade-off analysis and habitat evaluation

procedures of alternative plans; however, the depth of professional experience and first-hand management knowledge by many members of the team was invaluable in defining specific measures.

Finally, during this process, several measures were screened for a variety of reasons and are described in the screening section below, along with the necessary justification for their elimination from consideration. Alternative plans were developed through combinations of the measures carried forward.

4.3.1 No Action

The no action measure is defined as no implementation of a project to modify habitat conditions in the project area. This measure is carried forward for further consideration.

4.3.2 Sand Blanket

A sand blanket could be implemented in Pigs Eye Lake by placing coarse sand material over the entire existing lake substrate. The current substrate is very soft flocculent material, and a sand blanket may provide a more stable substrate and reduce sediment resuspension. There are several disadvantages of this measure. First, is the relatively high cost; a rough estimate to lay a sand blanket 6–12 inches deep would cost $10 million to $20 million. Second, a sand blanket would require a large amount of material (more sand may be required for an effective sand blanket than is available from maintenance dredging in Pool 2 or even from temporary dredged material placement sites in Pool 2). Finally, the team determined that this measure would have a low likelihood of addressing the project objective of reducing shoreline erosion. The high cost and relatively low habitat benefits would result in a poor cost-benefit ratio. Therefore a sand blanket would not be effective or efficient and this measure was screened from further consideration.

4.3.3 Islands

Island creation could serve a variety of habitat purposes in Pigs Eye Lake. Islands protect shallow areas from wind and wave action and erosion, which in turn protects existing aquatic vegetation and improves conditions for the growth of aquatic vegetation in other shallow areas. Islands provide floodplain habitat, and their creation increases habitat diversity and provides habitat niches that have been lost in Pool 2. This measure was carried forward for further consideration in alternative plans.

4.3.4 Sand Benches

Sand benches are in essence a smaller-scale version of a sand blanket that would be constructed adjacent to islands to extend the shallower, limnetic habitat surrounding islands. Sand benches would be established by extending sand placement below the water surface adjacent to project island features. Sand benches could be constructed at varying elevations, but would be submerged at normal pool elevation. Sand benches would provide seasonal sandbar habitat under low water level conditions; sand benches would also improve substrate conditions through stabilization, and reduce turbidity in Pigs Eye Lake by reducing sediment resuspension. Like the sand blankets, the potential disadvantages are cost and availability of sand material for construction. Sand benches may be more effective and efficient than sand blankets, especially when combined with other measures such as islands. Sand benches were carried forward for further consideration.

4.3.5 Marsh Creation/ Enhancement

Wetlands could be created in Pigs Eye Lake. This would be accomplished by a combination of creating areas protected from wind, stabilizing substrate, and planting wetland vegetation. Wetlands would be constructed to an elevation near normal lake elevation. This would increase the amount of emergent vegetation or wetland habitat in the project area; establishment of emergent marsh and isolated wetlands is important for fish and wildlife. This measure was carried forward for further consideration in alternative plan development.

4.3.6 Shoreline Stabilization

Shoreline stabilization could be accomplished by several types of features: Placement of coarse sand material on top of existing shoreline areas; Constructing groins, vanes, or berms; Bio-stabilization measures; or combinations of these features. The progression of erosion despite current vegetation makes it unlikely that bio-stabilization measures would be effective on their own. Rock groins, vanes, and berms would be feasible, but are not preferable as they would reduce the aesthetic value of the area. Placing sand along the shorelines would be expected to provide only a short-term solution. None of these features would contribute to the project objective of protecting shoreline habitat from wind and waves. Therefore, this measure was screened from further consideration.

4.3.7 Water Level Management

Management of the water elevation within Pigs Eye Lake – either on a one-time or recurring basis – could enhance aquatic habitat. A full-lake or partial drawdown would consolidate the flocculent substrate, and could allow construction of island or other features in the dry, de-watered conditions.

A full-lake or smaller-scale growing season drawdown could enhance aquatic vegetation and consolidate sediment in the dewatered areas. Exposure of the substrate within the lake may allow sediments to consolidate, reducing turbidity within the lake. If seeds are present within the sediments, drying and exposure to light could cause plants to germinate and increase vegetation. A drawdown could be conducted during the growing season (approximately June through September) to best promote aquatic plant growth. Additional drawdowns could be done in the following growing seasons to enhance growth of perennial vegetation established with the initial drawdown.

A temporary drawdown of water levels performed during the winter season may be effective as a rough fish management tool. Lowered lake levels reduce oxygen and increase the likelihood of a winter fish kill; this tool can be implemented to reduce the population of nuisance fish such as carp.

A temporary reduction of water levels within Pigs Eye Lake was considered for portions of the lake and the complete lake. There are numerous issues and disadvantages associated with this measure. The measure is not efficient in terms of cost; constructing structures for water exclosure and pumping water out of lake would be very expensive. Additionally, the hydraulic conditions in the lake are not favorable for a drawdown because Battle Creek flows into the lake, and these flows would also need to be redirected. Finally, the conditions in the lake substrate may not be suitable for an effective drawdown because the thick layer of soft and mucky substrate may not consolidate as expected during a drawdown. This measure was screened from further consideration.

4.3.8 Hydraulic Modifications

Hydraulic modifications considered consisted of manipulating water quality characteristics by designing project features specifically to influence flow direction, rate, timing, and other hydraulic conditions in Pigs Eye Lake. Upon evaluation of existing hydraulic conditions in the area, the study team determined it would not be effective in terms of meeting project objectives. Water movement in Pigs Eye Lake is highly variable and dependent on Pool 2 dynamics. No opportunities for improving water quality were identified that could be influenced by hydraulic manipulations. This measure was screened from further consideration.

4.3.9 Carp Exclosures

Nuisance fish contribute to the resource problems in Pigs Eye Lake. Nuisance fish, including carp, contribute to sediment re-suspension and turbidity and their rooting behavior disturbs beneficial aquatic plants. The study team evaluated carp exclosures or structures to keep common carp out of the lake. If carp could be excluded from the lake, this would likely decrease turbidity within the lake and could increase water clarity and overall conditions for aquatic vegetation.

It is unlikely this measure could be effectively implemented at Pigs Eye Lake. The lake itself is large, and part of a larger system connected hydraulically to Battle Creek and the Mississippi River. In a lake the size of Pigs Eye, with the extensive connectivity to the larger Pool 2 river system, it would be very difficult to remove all existing carp. Additionally, from a feasibility standpoint, it would be quite difficult to construct and maintain a rough fish exclosure. This measure could not be effectively implemented to meet study objectives and was screened from further consideration.

4.3.10 Habitat Dredging

The lack of depth diversity and aquatic structure in Pigs Eye Lake limits the value of the lake for some types of fish. Pothole dredging would involve dredging various sized “pothole” areas in Pigs Eye Lake to a depth consistent with healthy aquatic ecosystem function at this location. Pothole dredging could be implemented at critical locations for restored and expanded depth diversity, aquatic structure, deepwater habitat and improved water quality. Increased availability of deeper water would improve habitat conditions. However, it was determined that there would be a very high risk that a dredge cut in the lake would not be sustainable. This is because the deep layer of unconsolidated substrate throughout Pigs Eye Lake would likely lead to sloughing, causing the sides of the dredge cut to fall into the cut and fail. Therefore, this measure was screened from further consideration.

Table 3 outlines the resource problems; the objectives; the chemical, physical, and biological stressors that need to be addressed to reach the objectives; and the potential management measures to address these stressors.

Table 3: Summary of the Problems, Opportunities, Objectives and Measures

Resource Problems	Stressors	Objectives	Restoration Measures
Loss of emergent aquatic vegetation	Wind fetch, wave action, erosion, rough fish, turbidity, sediment resuspension, plant breakage.	Objectives 1 & 3	Sand blanket, high & low islands, wetland creation, water level management, hydraulic modification, carp exclosures.
Loss of submersed aquatic vegetation	Wind fetch, wave action, erosion, rough fish, turbidity, sediment resuspension, plant breakage.	Objectives 1 & 3	Sand blanket, sand bench, high & low islands, wetland creation, water level management, hydraulic modification, carp exclosures.
Lack of habitat diversity in Pigs Eye Lake and within Pool 2	Wind fetch, erosion, lack of habitat diversity.	Objectives 1, 2, & 3	High & low islands, sand bench.
Degradation & loss of of shoreline habitat	Wind fetch, wave action, erosion, rough fish, turbidity, sediment resuspension, invasive species, altered hydrologic regime, poor water quality.	Objectives 1, 2, & 3	Sand blanket, sand bench, high & low islands, wetland creation, shoreline stabilization, water level management, hydraulic modification, carp exclosures, habitat dredging.
Lack of water bird habitat	Lack of habitat diversity, lack of aquatic vegetation, sediment resuspension, invasive species, poor water quality.	Objectives 1 & 3	Sand benches, high & low islands, wetland creation, shoreline stabilization.

4.4 Screening of Measures

Screening of measures (Table 4) is a process whereby various criteria are evaluated to better characterize a specific measure and the likelihood that it can achieve cost effective restoration. The evaluation criteria identified in the P&G were used to identify the alternative management measures retained for further consideration. The purpose of this preliminary screening is to narrow down the number of alternatives to be subjected to detailed further analysis; however, it will not preclude resurrecting a measure at a future date if it becomes apparent that a measure was screened out based on incomplete data or an invalid assumption. The measures that are retained for further consideration must derive from the planning objectives for the project, must be feasible within the project constraints, and must be considered to best meet the screening criteria within the range of alternatives considered. Alternative plans are developed from the measures carried forward; if a measure is not justified and not carried forward, the measure would not be further developed into an alternative plan. Alternative plans are different combinations of various sizes and scales of measures that would contribute to attaining the planning objectives. A measure may stand alone as an alternative plan that can be implemented independently of other measures, resulting in some achievement of the planning objectives. Measures are screened against selected criteria in the first iteration of the planning process and alternative plans are developed and screened against the same criteria in a later iteration of the planning process. Review of the four formulation criteria suggested by the P&G (completeness, effectiveness, efficiency,

and acceptability, defined below) and resource significance (institutional, public, and technical) were used to aide in the selection of the TSP.

- **Completeness -** Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planned effects.
- **Effectiveness -** Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified objectives.
- **Efficiency -** Efficiency refers to cost-effectiveness and the most efficient allocation of other resources. Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and achieving the specified objectives.
- **Acceptability -** Acceptability refers to the workability and viability of the alternative with respect to acceptance by state and local entities and the public compatibility with existing laws.
- **Institutional Recognition** - The importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups.
- **Public Recognition -** Some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource.
- **Technical Recognition** - The resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity.

Table 4: Screening of Measures (Shaded Measures Are Screened From Further Analysis)

Measure	Complete	Effective	Efficient	Acceptable	Justification for Elimination from Further Consideration
No Action					No action will be carried forward. All alternative plans must be compared against the No Action alternative.
Sand Blanket	Yes	No	No	Yes	The sand blanket is not effective in meeting all project objectives; it is also a high cost measure and may exceed available quantities of dredged material for project use. This measure is not cost efficient if the entire lake bottom is capped. This measure is screened from further consideration.
Sand Benches	Yes	Yes	No	Yes	Sand benches may be effective when combined with islands, and could be scaled to be cost effective. This measure is retained.
Islands	Yes	Yes	No	Yes	Islands would improve habitat quality in a variety of ways and would benefit aquatic vegetation, provide floodplain habitat, and reduce the impacts of wind fetch and wave action. In these site conditions, islands may not be efficient on their own however when combined with sand benches and marsh creation the efficiency would be gained. In addition, this measure could be more cost effective based on island design and island size. This measure is retained.
Marsh Creation/ Enhancement	Yes	Yes	No	No	Marsh creation and/or enhancement may be complete and effective, however the cost and acceptability are of concern. Wetland enhancement near Battle Creek is directly adjacent to the Pigs Eye Landfill and superfund site. Disturbing or re-suspending HTRW is not in line with Corps policy. However, marsh wetlands could be created in combination with islands, or split island designs, and could be scaled to be cost effective. This measure is retained.
Shoreline Stabilization	Yes	No	No	Yes	Shoreline stabilization would be accomplished by placement of dredged material over existing shoreline. The coarse sand material would reduce erosion and stabilize the shoreline. This measure may be partially effective at meeting objectives, but it would not be efficient in terms of cost. This measure was screened from further consideration.

Measure	Complete	Effective	Efficient	Acceptable	Justification for Elimination from Further Consideration
Water Level Management	No	No	No	Yes	A partial or complete drawdown of Pigs Eye Lake would be very costly and only partially meet study objectives. The measures is not effective or efficient and it is screened from further consideration.
Hydraulic Modifications	Yes	No	No	Yes	Hydraulic modification is intended to improve flow direction, rates, and more for the purpose of improved water quality or ecosystem function. However, no opportunities to use this measure to improve water quality were identified and it was determined that this measure would not be effective or efficient and is screened from further consideration
Carp Exclosures	No	No	No	Yes	Due to the size of Pigs Eye Lake and the hydraulic connectivity with Battle Creek and the Mississippi River, carp exclosures would not be feasible. This measure is not effective or efficient, and it is not complete as it would require additional actions outside the project area. This measure is screened from further consideration.
Habitat Dredging	No	Yes	Yes	No	Habitat dredging would be effective in meeting some project objectives. This measure is not complete as it would require additional actions outside the project area, such as land acquisition for upland disposal of fine material from Pigs Eye Lake. It is also questionable whether the increased depths would be maintainable due to the instability of the substrate. This measure is screened from further consideration.

The measures retained for further consideration (islands, sand benches, and marsh creation/enhancement) were derived from the planning objectives for the project, and are considered to be the most complete, effective, efficient, and acceptable within the range of measures considered. Increments and scales of the retained measures were developed and combinations of the different scales and increments of the measures will be used to formulate alternative plans.

4.5 Formulation of Alternative Plans

Alternative plans are combinations of measures that would contribute to attaining the planning objectives. A measure may stand alone as an alternative plan that can be implemented independently of other measures, resulting in some achievement of the planning objectives. Measures can also be combined to form an alternative plan. Measures identified and described in Section 4.4 that were deemed feasible were carried forward for consideration in the development of alternatives. The measures carried forward were: islands, sand benches, and marsh creation/enhancement.

Some of the important factors that led to the development of the final array of alternatives for this project are described below. Alternative development is a complex, iterative process with many inputs. Several of the constraints and objectives can be identified as the most influential in producing the alternatives that were considered, and are therefore the focus of the discussion.

Constraints – Two of the project constraints highly limited the acceptable geographical placement of measures. First was avoiding disturbance to the contamination in the northern part of the lake, adjacent to the former landfill. Available contaminant testing data was collected, reviewed, and assessed, and additional sampling needs were identified and collected (as described in Section 2.3.4 and Appendix E – Sediment Report). The data and analysis were coordinated with internal and external stakeholders through a specially-formed group of members of the interagency project team, formed to analyze contaminant concerns related to the project. The consensus of the group was to avoid disturbance to the area in the northernmost part of the lake (shown in Figure 15). Appendix A – Correspondence & Coordination presents documentation related to the discussions and conclusions of the Pigs Eye Lake Contaminants Sub-Group. The final array of alternative plans also avoided the area that would have required additional BMPs.

A second factor that limited the geographical placement of measures is the constraint to avoid impacting flood stages. Hydraulic modeling was used to identify the effective flow limit boundary within the lake, as shown in Figure 15. By keeping project features to the north of this boundary, they are kept within the ineffective flow area and do not have an effect on flood stages. The Minnesota DNR's regulatory floodway boundary (also shown in Figure 15) extends further into the lake, so islands within this zone were aligned roughly parallel to the expected flowlines in order to ensure that stage impacts would be negligible if flood waters were to move through this region.

Project Objectives – Meeting objective number 3 - *Maintain or enhance the quantity of shoreline habitat* - had a significant influence on alternative design. The future of the shoreline habitat around the lake was determined to be heavily affected by wind fetch and related wave action. Therefore, in order to meet this objective, measures needed to be used in a way that would maximize the reduction of wind

fetch across Pigs Eye Lake. Islands are the primary measure carried forward that would reduce wind fetch, and initial island concepts did not meet this objective well. The hydraulic engineer working on the project designed a group of islands specifically aimed at reducing wind fetch.

Preliminary dredged material quantity estimates for constructing the initial alternative plans exceeded the amount of available sand material on placement sites. In addition, the cost estimate for initial iterations of alternatives significantly exceeded the non-federal cost share threshold and some alternatives exceeded the federal cost limit for a Section 204 study of $10 million. (More information on the initial formulation of alternatives that included Alternatives 1-3m can be found in Appendix N – Plan Formulation.) These alternatives were then screened from further consideration, and the PDT reformulated to design smaller alternatives aimed to reduce the quantity of dredged material needed for construction, while attempting to maintain wind fetch reduction benefits. This resulted in retaining the overall shape of the 9-island concept but reducing the overall sand quantity required (Alternative 4). Islands in this concept were spaced far enough apart that the shoreline habitat around the islands wouldn't necessarily be sheltered. The 'split island' design better addresses Objectives 1 and 2 to *improve aquatic habitat* and *Improve the quantity and quality of habitat for migratory bird species* (Alternative 5). Split islands would create pockets of very sheltered aquatic habitat, while minimizing the additional sand needed for construction. The concept was that if one of the berms was split off of the island and separated from it by a short distance, the island should still have little risk of erosion along the split since the fetch would be very small. This gap between the two sides would create a very sheltered pocket that would provide protection for birds and animals and increased stability for aquatic vegetation.

The sheltered areas within the split island interiors in Alternative 5 provides areas where aquatic vegetation may be able to grow, but it was felt that the existing substrate may still be too loose for aquatic plants to take root. To improve the likelihood of these areas to support aquatic vegetation, the team designed a marsh component which would include a layer of sand placed over the existing substrate in these split island centers. The addition of sand would be expected to consolidate the existing sediments and incorporating some wetland plantings in these areas would increase the habitat value immediately (Alternative 5m).

The final iteration of alternatives were designed to further reduce the quantity of material for construction to reduce project costs while also maximizing habitat benefits. The final iterations of design reduced the number of islands to 7 (Alternative 6m) and to 4 (Alternative 7m). Both Alternative 6m and Alternative 7m maintained 3 split islands, and retained the marsh feature. More information on determination of the island size and layout can be found in Appendix C - Habitat Evaluation and Quantification and Appendix G - Hydrology and Hydraulics.

4.6 Final Array of Alternative Plans

4.6.1 No Action Alternative

The No Action Alternative is the plan in which none of the measures or combinations thereof would be constructed. There would be no cost to the No Action Alternative.

Under future without-project conditions, habitat conditions in the project area would generally stay about the same or decline at a slow rate. Pigs Eye Lake would continue to provide marginal habitat for birds, fish, and other aquatic biota, and in general it is expected that conditions there will not change markedly over the project life. Pigs Eye Lake will continue to be affected by wind and wave action and turbidity, and aquatic vegetation will continue to be limited. Wind-induced waves would continue to erode the shoreline and further widen the lake. The HEP analysis for Pigs Eye Lake (Appendix C - Habitat Evaluation and Quantification) resulted in an estimated 231.7 Average Annual Habitat Units (AAHUs) for the project area over the next 50 years.

4.6.2 Alternatives 4-7m

The alternative plans all contain the retained measures of islands and sand benches. The difference across alternatives is primarily the island size (quantity of dredged material required) and inclusion of marsh creation. Three plans contain modified islands which allow for marsh habitat to be placed within areas further sheltered from wind and wave action, and are referred to as "split islands" as compared to the other "full" islands. Only the split island designs provide areas that are protected enough to allow for marsh habitat to be established (Alternatives 5m, 6m, and 7m). A summary of each alternative can be found in Table 5 and

Figure 16 (No Action Alternative and Alternative 4), Figure 17 (Alternative 5 and 5m), and Figure 18 (Alternative 6m and 7m).

Table 5: Summary of Pigs Eye Lake Alternatives

Alternative	Island Design	Marsh	Total Fill (cy)
No Action	-	-	-
4	Full	No	419,748
5	Split	No	470,859
5m	Split	Yes	502,121
6m	Split	Yes	413,329
7m	Split	Yes	345,959

Figure 16: No Action Alternative and Alternative 4

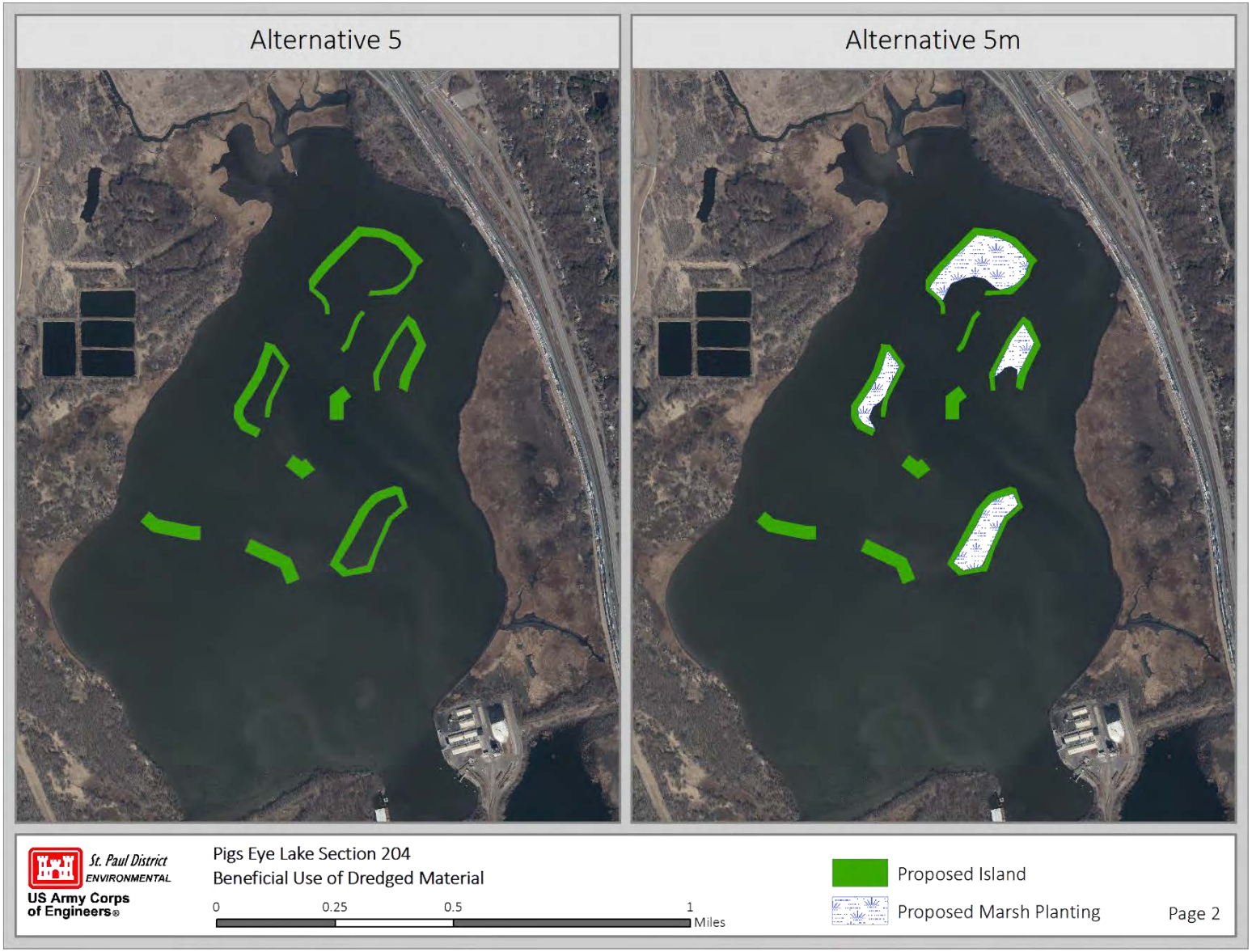

Figure 17: Alternative 5 and 5m

Figure 18: Alternative 6m and 7m

5 Evaluation and Comparison of Alternatives

This section describes the final array of feature groups and alternatives that were evaluated. It also documents the process used to determine the potential costs and habitat benefits of each alternative.

5.1 Environmental Benefits

The USFWS's 1980 version of Habitat Evaluation Procedures (HEP) was used to quantify and evaluate the potential project effects and benefits. The HEP methodology utilizes a Habitat Suitability Index (HSI) to rate habitat quality on a scale of 0 to 1 (1 being optimum). The HSI is multiplied by the number of acres of available habitat to obtain Habitat Units (HU's). One HU is defined as one acre of optimum habitat. By comparing the projected HU's available without a proposed action to projected HU's with a proposed action or alternative, the benefits of different alternatives can be quantified. HSIs and HUs were calculated for the baseline conditions and for Future Without-Project and Future With-Project conditions.

The Migratory Habitat Model for Dabbling Ducks (Devendorf 2001) HSI was selected to evaluate potential benefits of the proposed project based on the existing habitat and habitat enhancement strategies proposed for this project. The objectives developed for the project are to (1) Improve aquatic habitat, (2) Improve the quantity and quality of habitat for migratory bird species, and (3) Maintain or enhance the quantity of shoreline habitat. Meeting these objectives would result in an increase of nesting and resting areas, improved visual and wind barriers, and increased aquatic vegetation, all of which would result in greater suitability of the area for waterbirds such as ducks, geese, and swans. The Migratory Habitat Model for Dabbling Ducks reflects success of meeting objectives (1) and (2) well.

A 37.5 acre subset of the project area is being evaluated using the marsh wren HSI model to reflect success in meeting Objective (3). In the absence of a project, this subset of the project area is predicted to be entirely converted from marsh to open water over the course of the 50-year planning period due to the effects of wind-generated waves. The dabbling duck migration model is not sensitive enough to capture the total loss of this area in the context of the much larger 741 acre project area. The use of the marsh wren model for this subset emphasizes the importance of this predicted habitat loss, and incorporates a quantitative measure of benefits obtained by reducing wind fetch. The resulting Average Annual Habitat Units (AAHUs) for each alternative are included in

Table 8. For a more detailed description of the habitat analysis as well as the detailed net AAHUs generated for feasible feature combinations see Appendix C – Habitat Evaluation and Quantification.

5.2 Base Plan Costs

The Federal Standard, or "Base Plan" for the disposal of dredged material associated with construction or maintenance dredging of navigation projects is the least costly, environmentally acceptable plan. The Base Plan costs for this project assume normal excavation and transportation costs based on the current practices in Lower Pool 2. The Base Plan costs were estimated based on excavation of dredged material from the nearest temporary placement sites in Pool 2 (Upper Boulanger, Lower Boulanger, and Pine Bend), transportation to the nearest prospective permanent placement site, and the cost to acquire real

estate for permanent placement. Real estate costs were estimated based on obtaining a one-time dredged material placement easement at the closest identified potential placement location. The total Base Plan costs associated with the amount of dredged material needed for each alternative is presented in Table 6.

If a beneficial use is selected for a project and the costs exceed those of the Base Plan, the costs borne by the Section 204 project are those incremental costs above the Base Plan cost (Appendix E of ER 1105-2-100). The incremental costs above the Base Plan include transportation the additional distance up river to Pigs Eye Lake, unloading and placement of the dredged material, stabilizing with rock, capping the islands with fines, and seeding with willows. The incremental portion (Section 204 Costs) are the costs that are used to compare the alternatives in the Cost Effectiveness and Incremental Cost Analyses. For funding purposes, these incremental costs are then split between the Section 204 funding (65 percent) and the non-federal sponsor (35 percent).

Table 6: Base Plan Costs for Each Alternative

Alternative	Total Fill (cy)	Base Plan Costs
4	419,748	$ 3,243,000
5	470,859	$ 3,636,000
5m	502,121	$ 3,886,000
6m	413,329	$ 3,178,000
7m	345,959	$ 2,706,000

5.3 Cost Effectiveness and Incremental Cost Analysis

Corps guidance requires a cost effectiveness analysis and an incremental cost analysis (CE/ICA) for determining what project features and design alternatives should be built based on comparison of quantified habitat benefits (outputs) and estimated costs of alternative features designs. This process identifies alternative features or combinations of features that fully or partially meet the objectives of the project and at the same time are the most cost effective. A cost effectiveness analysis is conducted to ensure that the least cost alternatives have been established, subsequent incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

CE/ICA is a three step procedure: (1) calculate the environmental outputs of each feature; (2) determine a cost estimate for each feature; and (3) combine the features to evaluate the best overall project alternative based on habitat benefits and cost.

Costs were annualized by applying the interest and amortization factor of 0.03795 (50 year period of analysis at 2.875 percent interest rate) to the construction cost (Table 7) over a period of 50 years. The incremental analysis of alternatives was accomplished following guidance by Corps' Institute of Water Resources and using methodology described in Robinson *et al*. (1995). Refer to Appendix D – Incremental Cost Analysis, for the detailed results of the analysis.

Section 204 construction costs for features and subsequently for project alternatives were computed (

Table 8), assuming a 50-year project period of analysis and a FY2017 project discount rate of 2.875 percent. All plans assume 1 year of construction and reflect October 2017 price levels. Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) and Interest During Construction (IDC) costs were quantified and considered in the analysis but not applied; both were found to be minimal and inclusion would not change the outcome of the CE/ICA analysis. OMRR&R is estimated to be $2,000 annually (see Section 6.4) and IDC is estimated to be $4,000-6,000 annually.

Table 7: Section 204 Project Costs and Annualized Costs

Alternative	Total Fill (cy)	Total Project Cost	Base Plan Cost	Section 204 Cost	Annualized Cost (Section 204)
Alt4	419,748	$ 15,710,000	$ 3,243,000	$ 12,467,000	$ 473,000
Alt5	470,859	$ 17,664,000	$ 3,636,000	$ 14,028,000	$ 532,000
Alt5m	502,121	$ 18,781,000	$ 3,886,000	$ 14,895,000	$ 565,000
Alt6m	413,329	$ 15,569,000	$ 3,178,000	$ 12,392,000	$ 470,000
Alt7m	345,959	$ 13,102,000	$ 2,706,000	$ 10,396,000	$ 395,000

*The annualized cost was determined using the FY17 discount rate of 2.875 percent

Primary assumptions and constraints used in conducting CE/ICA are as follows:

1) AAHUs for all analyzed fish and wildlife species were assumed to have equal value in comparing alternative plans.
2) Alternatives analysis was limited to combinations that at least partially met the project's objectives listed in section 4.2.

From the process, 6 plans were generated. The CE/ICA process resulted in 1 cost effective plan and 3 "Best Buy" plans (including the No Action plan). The full array of alternatives and results of the CE/ICA analysis is displayed in Figure 19 and

Table 8. The Best Buy alternatives are displayed in Figure 20.

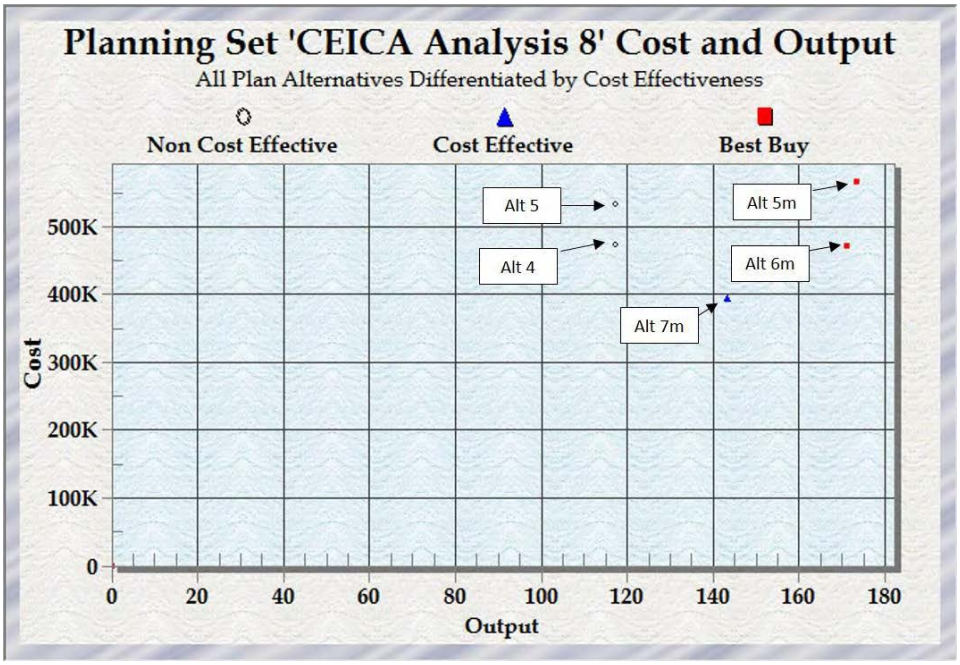

Figure 19: CE/ICA Results – Full Array of Alternatives

Table 8: Results of CE/ICA for Alternative Plans

Alternative	Total Fill (cy)	Section 204 Cost	Annualized Cost (2.875% Discount Rate)	AAHU Gain	AACost/ AAHU	Cost Effectiveness
No Action	-	$ -	$ -	0	$ -	Best Buy
Alt4	419,748	$ 12,467,000	$ 473,100	117.2	$ 4,000	No
Alt5	470,859	$ 14,028,000	$ 532,300	117.2	$ 4,500	No
Alt5m	502,121	$ 14,895,000	$ 565,200	173.4	$ 3,300	Best Buy
Alt6m	413,329	$ 12,392,000	$ 470,200	171.1	$ 2,700	Best Buy
Alt7m	345,959	$ 10,396,000	$ 395,500	143.4	$ 2,800	Yes

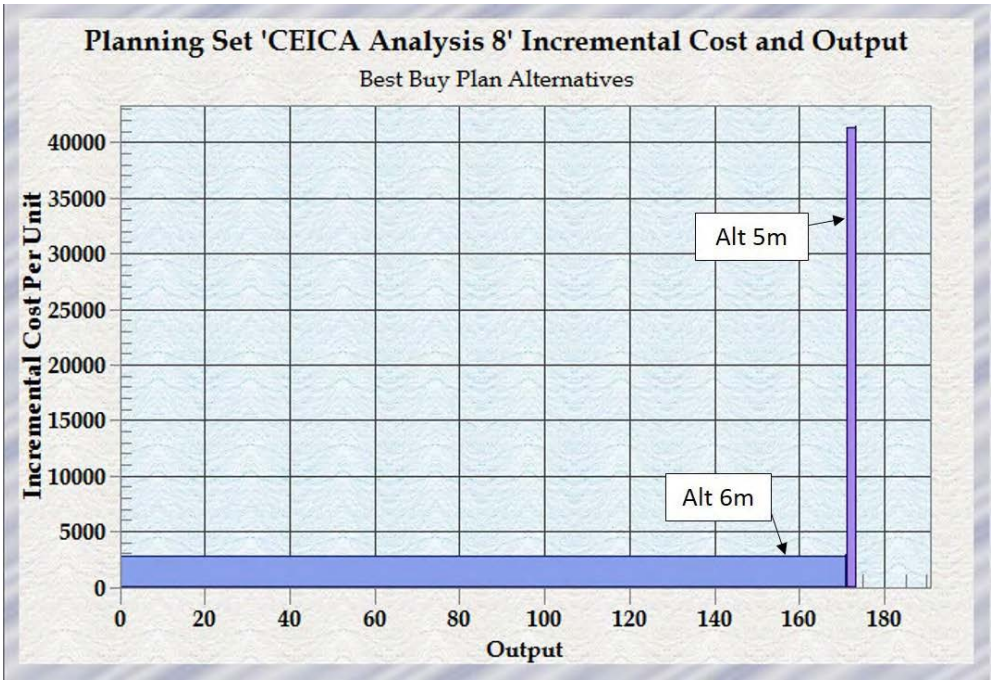

Figure 20: CE/ICA Results – Incremental Cost Per Unit of Best Buy Plans

The Best Buy plans presented provide the information necessary to make well-informed decisions regarding desired project scale and features. Progressing through the increasing levels of output for the alternatives in Table 9 helps determine whether the increase in output is worth the additional cost. As long as decision makers consider a level of output to be "worth it", subsequent levels of output are considered. When a level of output is determined to be "not worth it", then subsequent levels of output will also likely be "not worth it", and the final decision regarding desired project scale and features for environmental restoration will be reached.

Table 9: Incremental Cost Per Output (Net AAHUs) for Pigs Eye Lake Best Buy Plans

Alternative	Net AAHUs	Annualized Cost	AACost/ AAHU	Incremental AACost	Incremental Output (HUs)	Incremental AACost/AAHU
No Action	0	$ -	$ -	$ -	0	$ -
Alt6m	171.1	$ 470,200	$ 2,700	$ 470,200	171.1	$ 2,700
Alt5m	173.4	$ 565,200	$ 3,300	$ 95,000	2.3	$ 41,300

Typically in the evaluation of Best Buy plans, "break points" are identified in either the last column in Table 9, or in the stair-step progression from left to right in Figure 20. Break points are defined as significant increases or jumps in incremental cost per output, such that subsequent levels of output may not be considered "worth it". Identification of such break points can be subjective. For Pigs Eye Lake, break points were identified between each of the three Best Buy plans (No Action, Alternative 5m, and Alternative 6m). The Cost Effective Plan, Alternative 7m, was also evaluated.

No Action (Best Buy) - This alternative was not chosen because it does not improve or maintain the ecosystem resources within the project area. This alternative would cost $0. The continued shoreline erosion due to wind and wave activity would reduce the habitat value provided in the project area. The existing project area provides 217.9 AAHUs. Although conditions in the project area would decline under the FWOP, no model variables would be expected to change because existing conditions already reflect the lowest possible score for a majority of the variables. This alternative does not meet any of the project objectives.

Alternative 7m (Cost Effective) – This is the smallest alternative formulated, which would only create 4 islands, and significantly less acreage of floodplain forest and marsh habitat compared to Alternatives 5m and 6m. This results in lower habitat benefits (143 habitat units compared to over 170 in the subsequent Best Buy 5m and 6m plans). This alternative also does not meet the project objective of reducing shoreline erosion, as 3-5 fewer islands respectively, exposes more shoreline to wind and wave erosion. This alternative would not even reduce the current rate of erosion (almost 1 acre per year) by 50%. The Best Buy plans both would reduce rate of erosion by over 70%. For these reasons, Alternative 7m was deemed as not worth it and this alternative was eliminated.

Alternative 5m (Best Buy) –This alternative improves the aquatic ecosystem in Pigs Eye Lake by creating new floodplain forest habitat, reducing wind-wave action, and creating new wetland habitat. This alternative has all the same features as Alternative 6m, with the main difference being 3 additional islands (100,000 additional cy). This alternative would cost approximately $14.9 million and net 173.4 AAHUs, at an average annual cost per average annual habitat unit of $3,300. This larger alternative meets the project objectives and provides slightly more AAHUs, however, the incremental average annual cost per average annual habitat unit is $41,300 and only generates an incremental output of 2.3 additional habitat units. This small increase in habitat units, without providing additional features, and at a much larger cost, was deemed not worth it, and this alternative was eliminated.

Alternative 6m (Best Buy) - This alternative improves the aquatic ecosystem in Pigs Eye Lake by creating new floodplain forest habitat, reducing wind-wave action, and creating new wetland habitat. This alternative would cost approximately $12.4 million and would result in a net gain of 171.1 AAHUs, at an average annual cost per average annual habitat unit of $2,748. The incremental output is 171.1 habitat units and the incremental average annual cost per average annual habitat unit is $2,700. Alternative 6m was considered worth the investment as it met all project objectives and maximizes habitat benefits at a reasonable cost.

5.4 Plan Selection

Selecting the National Ecosystem Restoration (NER) plan requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, completeness, effectiveness, efficiency, and acceptability.

5.4.1 National Ecosystem Restoration Plan

The alternative plan that reasonably maximizes the benefits in relation to cost and meets the overall planning objectives is Alternative 6m, tentatively selected as the National Ecosystem Restoration Plan (NER Plan). This is the first CAP Section 204 study in the District, but in comparison to similar island building projects in the District's Habitat Rehabilitation and Enhancement Project (HREP) program, the $2,700 per AAHU created by Alternative 6m is efficient in achieving the ecosystem restoration objectives and has been considered reasonable. For reference, HREPs yielding an average annual cost per AAHU of $2,000 have generally been accepted as justified, with $3,000 per AAHU accepted in some circumstances. These numbers have not been adjusted for inflation since they were developed in the early 1990s. These criteria have been used to justify construction of over $59 million in habitat projects within the St. Paul District since the program began. The Tentatively Selected Plan – Alternative 6m is consistent with regional and State planning for the area.

The federal objective for water and related land resources planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable Executive Orders, and other federal planning requirements. Achievement of the federal objective is measured in terms of contribution to federal accounts intended to track the overall benefits of a given project.

5.4.2 Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made with some knowledge of the degree of reliability of the estimated benefits and costs of alternative plans. Risk is a measure of the probability and consequence of uncertain future events. Uncertainty refers to a lack of knowledge about critical elements or processes contributing to risk or natural variability in the same elements or processes.

The team worked to manage risk in developing measures. The team used experience from past projects to identify potential risks and reduce uncertainty during plan formulation. The team developed measures by expanding on and referencing successful similar island building work in the Upper Mississippi River (UMRR HREPs), referencing the *UMRR Design Handbook* (USACE, 2012), and best professional judgment.

The primary risks identified for Pigs Eye Lake included risk of disturbing contaminants, constructability risks, and risks associated with climate change impacts to flow discharges. The risk of disturbing contaminants was significantly minimized following extensive HTRW and sediment sampling. The outcome of these surveys was that contamination was not a project risk as construction would avoid the former landfill and sediment samples were within acceptable limits, as described in Appendix E – Sediment Report and Appendix K - HTRW. The potential consequence identified from construction risks was largely the risk of island settlement. The team discussed the MPCA's work in the St. Louis River Interlake Duluth Tar Site, which has similar unconsolidated substrate characteristics to Pigs Eye Lake and was successfully implemented. The team also held numerous constructability meetings aimed at proper island design that incorporated additional material for settlement and lateral spread. Risks associated with increases in flow discharges as a result of climate change are also present. The primary effect of

generally increasing discharges will be the increased duration of inundation on the constructed project features which would affect the success of the project. As outlined in great detail in Appendix G, rising stages would increase the potential for erosion to the islands. Higher stages could increase erosion on the lower island areas in particular. Vegetation is an important component of erosion protection and increased flooding could impact vegetative quality and species.

Furthermore, the team had several meetings to conduct an Abbreviated Risk Analysis during which project risks were factored into project costs (Attachment 2 of Appendix I – Cost Engineering). The adjacent Mississippi river is a dynamic system, and post-construction monitoring and adaptive management would be used to address any unplanned outcomes of the Tentatively Selected Plan. Therefore, none of the project measures (islands, sand benches, marsh habitat) are believed to be burdened by significant risk or uncertainty regarding the eventual success of the proposed habitat.

5.4.3 Consistency with Corps Campaign Plan

The Corps has developed a Campaign Plan with a mission to "provide vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and reduce risk from disasters." This study is consistent with the Corps Campaign Plan by producing lasting benefits for the nation, by optimizing agency coordination, and by using innovative solutions in pursuit of a sustainable, environmentally beneficial, and cost-effective ecosystem restoration design.

5.4.4 Consistency with Corps Environmental Operating Principles

The Corps has reaffirmed its commitment to the environment by formalizing a set of Environmental Operating Principles (EOP) applicable to all of its decision-making and programs. The EOPs are: foster sustainability as a way of life throughout the organization; proactively consider environmental consequences of all USACE activities and act accordingly; create mutually supporting economic and environmentally sustainable solutions; continue to meet our corporate responsibility and accountability under the law for activities undertaken by USACE, which may impact human and natural environments; consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs; leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner; and employ an open, transparent process that respects views of individuals and groups interested in USACE activities. The EOPs were considered during the plan formulation, and the TSP is consistent with the EOPs. The TSP promotes sustainability and economically sound measures by incorporating the most natural and least cost methods for restoring Pigs Eye Lake, floodplain forest, and wetland habitat for fish and wildlife species.

6 Recommended Plan

The results of the NEPA analysis, incremental cost analysis, P&G criteria evaluation, and habitat evaluation in this chapter were considered in the decision-making process along with other factors, including physical features on the site, management objectives, critical needs of the region, and ecosystem needs. The Pigs Eye Lake team concluded that the alternative plan that best meets the goals and objectives is Alternative 6m. This alternative is cost-effective and justified as a "Best Buy" plan.

Alternative 6m was identified by the PDT as the NER Plan and is the recommended or Tentatively Selected Plan (TSP), and is currently being coordinated for concurrence with the Project Sponsor, Ramsey County (Appendix A – Correspondence & Coordination). The plan would create a complex of 7 islands with approximately 16.3 acres of floodplain forest and wet prairie habitat and 17.6 acres of marsh habitat in Pigs Eye Lake (Figure 21).

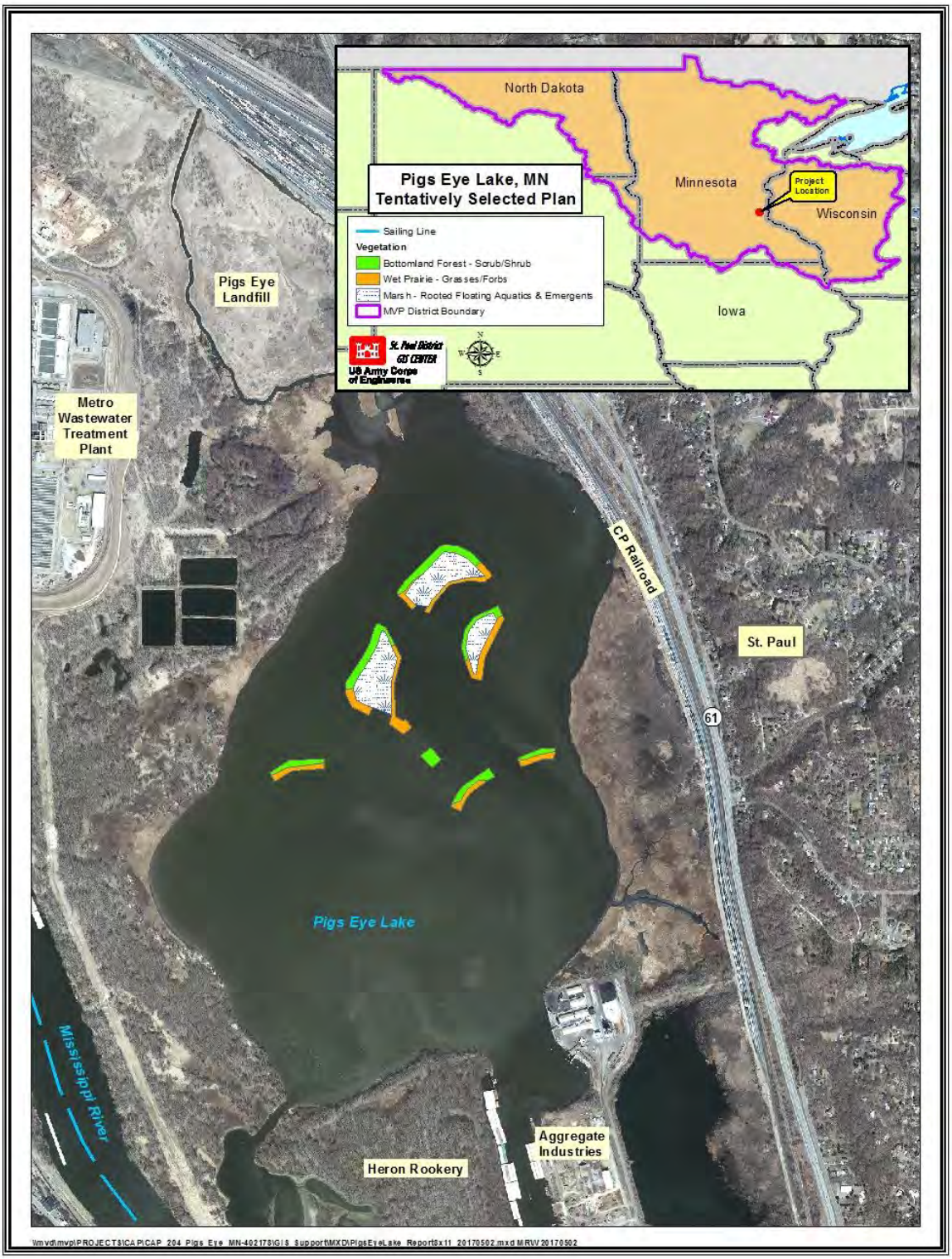

Figure 21: Map of the Tentatively Selected Plan (Alternative 6m)

6.1 Plan Features

The recommended plan for beneficial use of dredged material in Pigs Eye Lake (Alternative 6m) includes construction of 7 islands (3 of which are split island designs), 17.6 acres of marsh habitat (associated with the 3 split islands), and 16.3 acres of island habitat for floodplain forest or wet prairie plantings. The features of the recommended plan are designed to address study objectives (Table 10). Some features of the recommended plan address multiple objectives.

Table 10: Plan Features and Project Objectives

Features	Objectives	Description
Islands	Improve aquatic habitat Improve the quantity and quality of habitat for migratory bird species Maintain or enhance the quantity of shoreline habitat	The islands improve habitat conditions by increasing habitat diversity, increasing the amount of protected areas, and protect the existing shoreline vegetation by reducing wind and wave action.
Marsh Habitat	Improve aquatic habitat Improve the quantity and quality of habitat for migratory bird species	The marsh feature would provide the added benefit of promoting emergent and floating leaf aquatic vegetation.
Floodplain Forest/ Wet Prairie Habitat	Improve the quantity and quality of habitat for migratory bird species Maintain or enhance the quantity of shoreline habitat	Floodplain forest plantings would provide habitat for shoreline species while also acting as an obstacle to wind blowing across the lake.

The Corps has constructed many islands to improve habitat on the Upper Mississippi over the past few decades. Many of the features and recommendations have been denoted in the Corps' *Upper Mississippi River Restoration Program - Environmental Design Handbook, December 2012*. This document was used to insure island dimensions and design criteria were in general agreement with currently accepted design characteristics. Figure 22 is an aerial image taken in Pool 8 that shows some islands constructed by the Corps as part of a habitat improvement project. Islands constructed in different years are shown and identified to demonstrate the progression and growth of island vegetation.

The proposed islands for Pigs Eye Lake would vary somewhat from these typical sections. This has been done in part to provide a better design for construction on very soft sediments. Changes have also been proposed to improve the habitat value. However, the proposed island designs retain the general linear form of the islands shown in Figure 22. See Appendix L – Civil Drawings, for details.

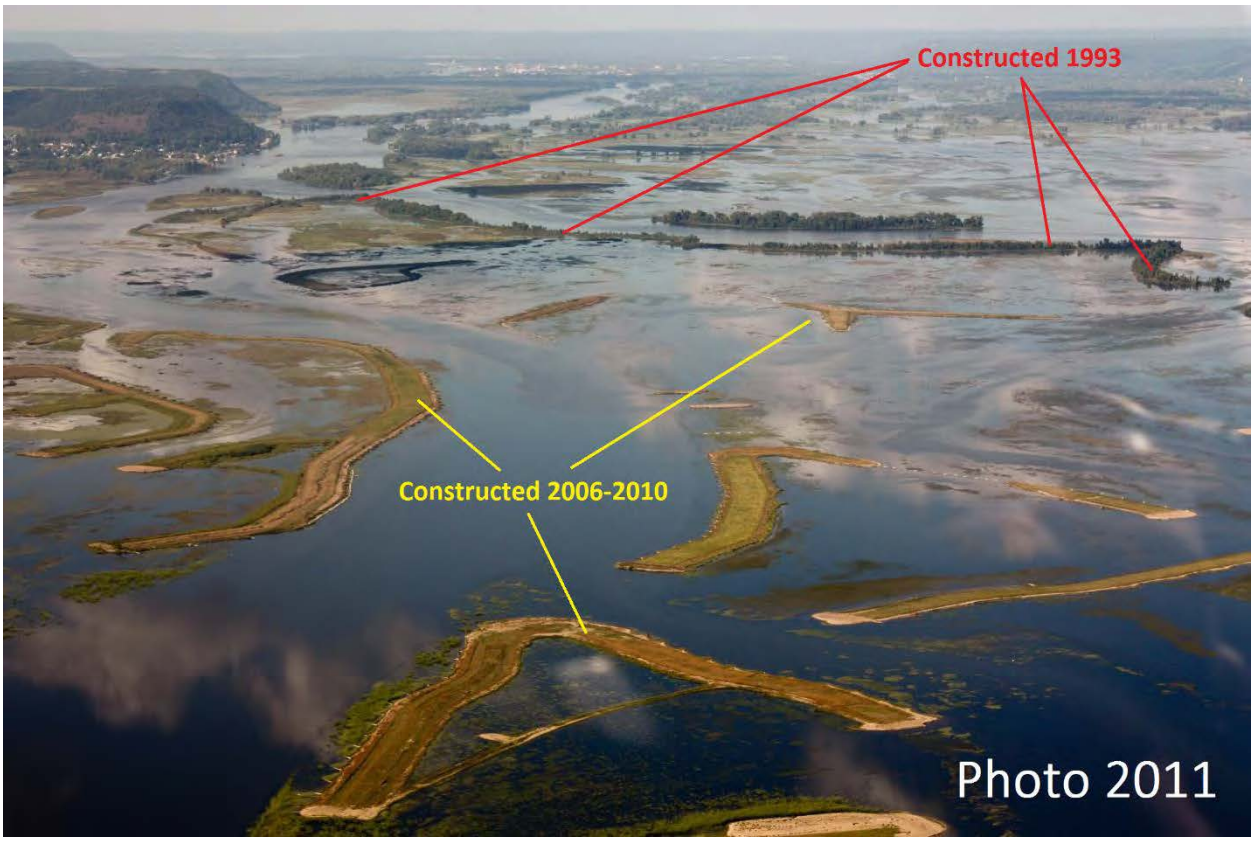

Figure 22: Example of Islands constructed by Corps for Habitat in Pool 8

6.2 Design Considerations

The Project has been developed to a feasibility level of design (Table 11). Design details are included in Appendix L – Civil Drawings. As with all feasibility level studies, these details will be refined in the Plans and Specifications (P&S) Stage.

Assumptions:

Settlement: Assumptions for settlement were 2.5 ft where design grade was 1 ft above low control pool (LCP, 686.8), or 687.8. Conversely, 1.5 ft of settlement was assumed where design grade was lower than 1 ft above LCP, or 687.8.

Lateral Displacement: A 10 percent increase in sand fill material was assumed to account for lateral displacement of the foundation.

Observation of test fill sections prior to construction of the project can be utilized to inform settlement and lateral displacement specifics.

Design quantities: Design quantities are based on a bathymetry survey performed by the Corps, dated October, 22, 2015. The survey was performed for River Miles 834.4-836.3 and adjusted to Low Control Pool (L.C.P.) elevation 687.2. The water surface elevation at the time of the survey was elevation 687.4. The Vertical Control is NAVD 88 and Horizontal Control DGPS NAD 83-State plane MN-South.

Table 11: Design Quantities for the Tentatively Selected Plan

Topsoil (Fine Material)	Volume	Settlement	Lateral Spread	Rock Groins	Marsh Plantings	Willows
Topsoil total volume [cu.yd.]	Total sand + settlement + lateral fill volume [cu.yd.]	Total Settlement [cu.yd.]	10% in sand fill quantity [cu.yd.]	Rock total volume [cu.yd.]	Marsh Volume [cu.yd.]	2 rows spaced at 2' apart [ln.ft.]
14,579	369,867	115,735	23,103	2,100	28,883	17,294

6.3 Construction Implementation

The sand and topsoil needed to construct the islands would be sourced from material dredged for maintenance of the 9 foot navigation channel project on the Upper Mississippi River. Most likely, sand would be obtained by mechanically offloading temporary placement sites in Lower Pool 2 (Pine Bend, Upper Boulanger, and Lower Boulanger). To transport dredged material from temporary placements sites, barges could travel from the main channel through the access channel for the Red Rock Terminal to a staging location at the southern end of Pigs Eye Lake. Preliminary analysis has concluded that the southern end of the lake can be reached through the access channel for the Red Rock Barge Terminal (8-9+ ft draft). Coordination will continue with businesses utilizing the Red Rock Terminal with regard to project construction.

How islands are constructed is generally left to the discretion of the contractor. The contractor is responsible for providing the finished product (the islands as designed) in a manner best suited to their operation, and without causing environmental damage. Experience with construction of other island projects within the St. Paul District (28 islands in 6 different locations) has shown that there is a general pattern to cost effective construction of islands.

The sand base for an island is placed using hydraulic or mechanical dredging equipment. Because of the large quantities involved, it is usually much more cost effective to use hydraulic dredging equipment than mechanical dredging equipment.

Fine material is placed on islands by a variety of methods. Placement of fine material using mechanical equipment is slower and more costly in terms of actual placement. By comparison, placement of fine material using hydraulic dredging equipment is faster.

The contractor would be allowed to use available technologies, so long as they are able to meet all the other conditions, including any necessary State permits and/or water quality certifications.

Rock, utilized for groin construction along island shorelines, can be barged to the islands and placed using mechanical equipment (hydraulic excavators) from either the new island base or from barges.

Front end loaders can be used for unloading rock form material barges for direct placement, or for loading on to haul trucks. Soft conditions expected on the islands, however, may reduce the amount of work performed with tire mounted equipment on this project. A primary factor limiting production for rock placement is usually water depths for the rock barges and push boats. To reduce the amount of access dredging or double handling of rock along the islands, contractors may elect to place rock protection during periods of high water.

Generally, a balance must be struck to provide reasonable access for the construction while minimizing the environmental disturbances associated with the dredging and construction. Contractors are allowed to request alternate access routes. These requests would be evaluated on a case-by-case basis for approval and may require additional environmental review.

6.3.1 Construction Restrictions

Construction restrictions could be applied for any number of reasons. Restrictions are generally applied in the construction of habitat projects to minimize the adverse effects of construction and to protect valuable habitats. The following are the basic construction restrictions that would likely be applied in the construction of the island measures.

Access Dredging – Preliminary analysis has indicated that the southern part of the lake can be reached without access dredging.

Bald Eagles – In general, project activities will not be allowed within 660 feet of a bald eagle nest during the nesting season. If construction activities would involve loud noises, a ½ mile buffer zone would be required during this period.

Pigs Eye Island Heron Rookery SNA – Disturbance to the SNA due to construction activities would need to be minimized. Staging on or directly adjacent to the Pigs Eye Island Heron Rookery SNA would not be allowed without special precautions to avoid disturbance. Additional restrictions may be necessary during the sensitive nesting period of April 1 – July 15 depending on the proposed method of construction.

Mud Waves – Due to the soft substrate conditions in the project area, lateral displacement of substrate (i.e., “mud waves”) could be caused by construction. Construction techniques to reduce this risk should be used. For example, lateral displacement could be reduced by construction methods such as placing the material in staggered “lifts.”

6.3.2 Construction Schedule

Because of the location and nature of the construction, nearly all the work would require use of marine equipment. Construction of this type is limited to the open water season on the Upper Mississippi River. Construction in certain years can begin in April, but May is a more typical for beginning construction due to the constraints associated with spring high water. At the other end of the spectrum, late November is the end of the construction season due to winter freeze-up. The construction schedule for the project would depend on the funds available for construction and other factors such as the potential for combining construction with District operation and maintenance activities or the need to accommodate

other habitat measures such as pool drawdown. Based on current and expected CAP and O&M budgets and project priorities within the St. Paul District, it is estimated that construction of the project would begin in 2019 and be completed in 2020. The optimum approach would be to construct the project under one construction contract.

6.3.3 Permits

This document will be distributed for public review and comment in compliance with NEPA. Ramsey County – the state-designated Responsible Governmental Unit (RGU) – will concurrently ensure compliance with the Minnesota Environmental Protection Act. This will be accomplished by distributing the report for review as an Environmental Assessment Worksheet. An application for a Public Waters Work Permit from the state of Minnesota will be submitted. Clean Water Act Section 401 water quality certification from the State of Minnesota will be requested by the Environmental Compliance Branch of the Corps, based upon the Finding of Compliance of the 404(b)(1) evaluation in Appendix B – Clean Water Act. The proposed fill activity would comply with State water quality standards and it is not anticipated that the proposed project would violate Minnesota water quality standards for toxicity. Water quality certification would be obtained from Minnesota prior to project construction. The St. Paul District has determined that the proposed activity is in compliance with all environmental laws and regulations, including the Endangered Species Act, Clean Water Act, NEPA, and Bald and Golden Eagle Protection Act.

6.4 Operation and Maintenance Considerations

The purpose of assigning Operations, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) costs is to ensure commitment and accountability by the project partner. The project features are dynamic and intended to emulate natural backwater processes, therefore, operation and maintenance will be minimal. Dynamic features are those where river and lake forces will be allowed to shape the measures with no future maintenance anticipated. The present value and estimated average annual OMRR&R costs for Ramsey County are estimated to be minimal ($2,000 annually). Ramsey County Parks & Recreation, if a project partnership agreement is executed, would be responsible for 100 percent of the operation and maintenance of the project features.

Operation and maintenance would be similar to that undertaken by the project partner for day-to-day management of wildlife areas and other public use areas. The only potential maintenance actions anticipated would be wildlife management activities such as inspections and monitoring and management of nuisance or invasive species. The project sponsor may need to coordinate proposed maintenance activities with nearby stakeholders such as the St. Paul Downtown Airport, Metropolitan Council, and MPCA.

6.5 Real Estate Considerations

The majority of the lake and riparian area is owned by the non-federal sponsor, Ramsey County (see Figure 3). The north end of the lake and adjacent riparian land is owned by the City of St. Paul. The land area northwest of the lake contains inactive waste water treatment ponds and is owned by the Metropolitan Waste Control. The Port Authority owns portions of the lake and riparian land on the

southern tip of the lake around the outlet of Pigs Eye Lake into the Mississippi River. The Port Authority land is currently being utilized for barge loading/offloading.

No additional land interest is required for the project. The project will be constructed in waters owned and managed by the non-federal sponsor, with the underlying land owned by the sponsor as well. The exact staging area for construction will be determined during development of plans and specifications. No additional real estate or relocations are deemed necessary.

6.6 Project Cost Summary

After a recommended plan was identified using preliminary costs, a more detailed cost estimate was completed for the recommended plan. Table 12 shows the estimated cost by account. Total project costs are separated by base plan costs and the CAP Section 204 costs (as described in Section 5). The costs are expressed as Project First Costs and include construction, contingencies, engineering, planning, design, and construction management. The Project First Costs are the project costs at the effective price level of October 2017. The more refined cost estimate also involved updated quantities, an updated Abbreviated Risk Analysis to determine contingencies, Micro-Computer Aided Cost Estimating System (MCACES), and Total Project Cost System (TPCS) to determine Present Value costs. The detailed estimate of the project design and construction costs are provided in Appendix I – Cost Estimate; however due to the sensitivity of providing this detailed cost information which could bias construction contract bidding, this material has been omitted in the public document. Quantities and costs may vary during final design.

Table 12: Tentatively Selected Plan Preliminary Cost

Account	Feature	Cost Plus Contingency
01	LANDS AND DAMAGES	$100,000
06	WILDLIFE FACILITIES AND SANCTUARIES	$13,371,000
31	ADAPTIVE MANAGEMENT AND MONITORING	$281,000
30	PLANNING, ENGINEERING, AND DESIGN	$932,000
31	CONSTRUCTION MANAGEMENT	$885,000
TOTALS	BASE PLAN	$3,178,000
	SECTION 204	**$12,392,000**

6.7 Project Performance (Monitoring and Adaptive Management)

The project performance assessment will allow measurement of differences from baseline conditions for key physical and biological factors. This should allow a quantitative determination of improvement and assessment of whether features are functioning as intended (see Table 13). Additional information can be found in Appendix J – Monitoring and Adaptive Management.

Table 13 Monitoring and Adaptive Management Summary

Performance Indicator	Activity	Monitoring Target
Migratory Bird Use Rates	Fall Waterbird Counts	10% increase in total bird numbers or increase in species richness by year 5 following construction
Vegetation Monitoring	1-yr planted seedling survival & growth	75% planted seedling survival & positive production & survivorship
	Long-term planted seedling survival & growth	Year 3: >75% survival Year 6: >60% survival Year 10: >50% survival
	Marsh and wet prairie establishment success	Density, Species Richness, and Quality targets detailed in Appx. J.
Island Settlement	Island Elevation Surveys	Islands at or very close to design elevation
Water Quality	Pre- and post- project Turbidity and TSS monitoring	Consistent and measurable reduction from baseline
Shoreline Protection	Shoreline Erosion Analysis	Retreat of overall shoreline less than predicted 0.75 acres per year

7 Environmental Effects

An environmental evaluation in accordance with NEPA (42 U.S.S 4331) has been conducted for the recommended action, and a discussion of the impacts follows. This discussion also examines the no action alternative.

The important natural resources of the project area and its surroundings are described in Chapter 2 (Existing Resources) of this Feasibility Study Report with Integrated EA. Table 14 shows the comparison of benefits (i.e. habitat value increase) among all alternatives to floodplain forest habitat and aquatic resources. The types of effects to Alternatives 4, 5, 5m and 7m are similar to the TSP, but the degree of increase in habitat value varied by alternative. Additional descriptions of the ecological effects and benefits associated with the no action, recommended plan, and alternative plans can be found in Chapters 3, 4, and Appendix C - Habitat Evaluation and Quantification.

Table 14: Comparison of Environmental Benefits and Habitat Acreages

Alternative	AAHU Gain	Marsh Habitat (acres)	Floodplain Forest & Wet Prairie (acres)
No Action	0	0	0
Alt4	117.2	0	23.3
Alt5	117.2	0	21.4
Alt5m	173.4	20.0	21.4
Alt6m	171.1	17.6	16.3
Alt7m	143.4	17.6	14.9

In addition, Alternatives 4, 5, 5m and 7m involve the same restoration measures, and the type and degree of adverse impacts, if any, to noise, aesthetics, recreation, commercial navigation, HTRW, environmental justice, air quality, water quality and threatened and endangered species, and cumulative effects would not be appreciably different from those associated with the TSP. Therefore, only the effects of the TSP and the No-Action Alternative are discussed in detail below. To maintain brevity, the discussion does not include those parameters where there are “no effects,” but this information is included in the Table 15.

Table 15: Environmental Assessment Matrix

	No Action Alternative							Proposed Alternative						
	BENEFICIAL				ADVERSE			BENEFICIAL				ADVERSE		
PARAMETER	SIGNIFICANT	SUBSTANTIAL	MINOR	NO EFFECT	MINOR	SUBSTANTIAL	SIGNIFICANT	SIGNIFICANT	SUBSTANTIAL	MINOR	NO EFFECT	MINOR	SUBSTANTIAL	SIGNIFICANT
A. Social Effects														
1. Noise Levels				X								T		
2. Aesthetic Values					X					X		T		
3. Recreational Opportunities					X					X		T		
4. Transportation				X							X			
5. Public Health and Safety				X							X			
6. Community Cohesion (Sense of Unity)				X							X			
7. Community Growth and Development				X							X			
8. Business and Home Relocations				X							X			
9. Existing/Potential Land Use				X							X			
10. Controversy				X							X			
B. Economic Effects														
1. Property Values				X							X			
2. Tax Revenue				X							X			
3. Public Facilities and Services				X							X			
4. Regional Growth				X							X			
5. Employment				X						T				
6. Business Activity				X							X			
7. Farmland/Food Supply				X							X			
8. Commercial Navigation				X						X				
9. Flooding Effects				X							X			
10. Energy Needs and Resources				X							X			
C. Natural Resource Effects														
1. Air Quality				X								T		
2. Terrestrial Habitat					X				X			T		
3. Wetlands						X			X					
4. Aquatic Habitat					X				X			T		
5. Habitat Diversity and Interspersion					X				X					
6. Biological Productivity					X					X		T		
7. Surface Water Quality					X					X		T		
8. Water Supply				X							X			
9. Groundwater				X							X			
10. Soils				X							X			
11. Threatened or Endangered Species				X							X			
D. Cultural Resource Effects														
1. Historic Architectural Values				X							X			
2. Prehistoric & Historic Archeological Values				X							X			

T= Temporary Effect

7.1 Socioeconomic Effects

7.1.1 Noise

The no-action alternative would have no impact on noise in the project area.

The proposed project would cause temporary, minor, adverse impacts on local noise levels during construction. The project area is relatively isolated, and any nearby noise receptors already experience noise generated by the adjacent railroad tracks, Highway 10/61, a barge shipping facility, and wastewater treatment plant. The increased noise levels would be temporary and would disappear upon project completion.

7.1.2 Aesthetics

The no-action alternative would have minor, adverse effects on aesthetics in the project area. Without intervention, the shoreline would be expected to continue to erode and lead to additional loss of shoreline vegetation and further decline in the area's aesthetic value.

The proposed project would cause temporary, minor, adverse impacts on aesthetics during construction. The aesthetic value of the areas would be reduced as a result of the activity and disturbance associated with construction and the presence of construction equipment.

The proposed project would also have long-term minor beneficial impacts. Impacted entities would be residences on the bluffs to the east of Pigs Eye Lake that currently overlook the project area and recreationists. Construction of the proposed project would change some views of the area from vast expanse of open water to interspersed, vegetated islands. Although aesthetic values are somewhat subjective, the islands would likely be considered aesthetically pleasing to most.

7.1.3 Recreation

The no-action alternative would have minor adverse effects on recreation. The project area would continue to degrade due to further loss of shoreline and the turbidity exacerbated throughout the lake by wind-generated waves.

The proposed project would result in a short-term adverse impact to recreation and a long-term beneficial effect on recreation. During construction, project activities would preclude recreational access and use of some of the lake. These adverse effects would be temporary and would disappear upon project completion. In the long-term, the improvement to the habitat in Pigs Eye Lake as a result of project construction would lead to more and enhanced recreational opportunities, including fishing, paddling, and bird-watching.

7.1.4 Commercial Navigation

The no-action alternative would have no effect on commercial navigation.

The proposed project would have a minor beneficial impact on commercial navigation. The project would provide a location to place sediments dredged in the maintenance of the 9-Foot Navigation Channel, which would otherwise occupy space in designated placement sites.

7.1.5 Airport Wildlife Hazards

The proposed project is located approximately 6,000 feet southeast of the St. Paul Downtown Airport. Because certain types of wildlife may interact with airport operations, the proposed project was evaluated for potential impacts.

The no-action alternative would have no impact on aviation in the project area.

The proposed alternative is not expected to adversely impact local aviation operations or cause an increase in wildlife strikes. This conclusion is based on (1) Comparison of existing and proposed habitat conditions and wildlife use, (2) Analysis of reported airport strikes at St. Paul Downtown Airport, and (3) Results of coordination with representatives from the local airport authorities, USDA Wildlife Services, and wildlife management experts from local resource agencies. The evaluation and coordination resulted in the Minneapolis Saint Paul Metropolitan Airports Commission stating that they were "Not Opposed" to the project. These factors are discussed in the following sections.

7.1.5.1 Existing and Proposed Project Conditions

The proposed project would improve habitat and increase wildlife use of the area. However, there is already significant wildlife use in and around the Pigs Eye Lake area such that the change would not lead to significantly different overall hazards for the airport.

Although habitat conditions in Pigs Eye Lake are degraded, it remains a high-use area for many types of birds. Surveys conducted in 2015 by the National Park Service recorded 17 waterbird species using Pigs Eye Lake, with 2,384 total birds counted in only five days over the course of the fall migration season. The most commonly identified bird was the mallard, followed closely by Canada geese. Eighty-five percent of mallards counted were seen on a single observation day on November 24, while the Canada geese were observed in similar numbers throughout the survey with an average of 144 individual geese counted per day. At least four eagle nests have been identified around the perimeter of the lake, and surveyors noted between four and eight eagles present each day. The Pigs Eye Lake Heron Rookery – a Minnesota-recognized Scientific Natural Area – supports populations of herons, egrets, cormorants; in total, 89 species of birds have been documented at the rookery. The heavy use of Pigs Eye Lake by birds, despite the degraded conditions, is likely due in part to the fact that the area represents one of the larger tracts of undeveloped land along the Mississippi River within the Twin Cities area, and the River is the central feature of the largest migration route in North America. This would suggest that birds would also likely be expected to continue using the site into the future, regardless of project construction.

One of the primary objectives of the proposed project is to improve the habitat in Pigs Eye Lake for migratory birds. The proposed islands would improve the existing habitat by reducing wind-induced waves, protecting existing shoreline habitats, and increasing habitat diversity. As discussed previously, the lake already receives significant use by birds. In addition to the lake itself, there are thousands of acres of valuable bird habitat adjacent to Pigs Eye Lake (i.e., Pigs Eye Lake Heron Rookery, Red Rock Lake, Hog Lake, Little Pigs Eye Lake, etc.). Of the nearly 3,000 acres of water and undeveloped floodplain area including and surrounding Pigs Eye Lake, the project would directly affect only 60 acres. Specifically, the project would convert approximately 20 acres of open water to islands and 20 acres of open water

to marsh. The project would reduce wind-driven waves on approximately 681 acres of open water and the direct surrounding shoreline. However, the project would not change the total acreage of wildlife habitat near the St. Paul Downtown Airport – it would improve and protect a portion of it.

Large-scale population fluctuations could further influence the numbers of birds using the area at a greater rate and regardless of project completion. For example, the most recent FAA National Wildlife Strike Database Serial Report (Number 22) cites a study by Dolbeer and Begier (2013) that concluded, "Of the 21 species of birds in North America with mean body masses >4 lbs and with at least 10 reported air strikes with civil aircraft from 1990-2012, 17 species' populations increased with a net gain of 17 million birds" (Dolbeer et al. 2016).

7.1.5.2 Wildlife-Aircraft Strikes at Downtown St. Paul Airport

Despite the significant wildlife use presently occurring in Pigs Eye Lake and the surrounding area, the Downtown St. Paul Airport has experienced a lower incidence of wildlife-aircraft strikes than the U.S. average.

The FAA maintains and publishes strike data online. Strike reporting by airports and pilots is voluntary, but research suggests that over 90 percent of strikes with commercial aircraft are now reported (Dolbeer 2015). Between 1990 and 2015, the total number of reported Bird Strikes by U.S. Aircraft (including strikes by U.S. planes occurring in other countries) was 164,444. The total number of commercial and general aviation aircraft movements during this time period was 2.7 billion. This equates to approximately 6.1 strikes per 100,000 flights. Approximately eight percent of all strikes (13,558 strikes) were reported as causing some level of damage to the plane. During the same 26-year period, 365 human injuries were attributed to bird strikes (205 strikes) and eleven of these bird strikes caused a total of 25 human fatalities.

Wildlife strikes have occurred in the airspace near the St. Paul Downtown Airport, and data about the strikes has been collected since 1990. The Wildlife Strike Database was searched on February 10, 2017 for records from the St. Paul Downtown Airport. The data ranges from January 1990 to present, and includes reports of a total of 68 bird strikes in this 27-year period, averaging 2.5 strikes per year. Based on a reported 64,000 flights annually from the airport, this equates to approximately 3.9 strikes per 100,000 flights. The number of strikes per year has increased since 1990, but it is difficult to interpret this without corresponding data for the number of flights each year in order to standardize the measure. Increased reporting may also play a role.

The type of birds most frequently struck at St. Paul Downtown Airport were hawks, eagles, and falcons, which accounted for 19 of the 68 total strikes (~28 percent). The species struck most was the Bald Eagle (8 strikes). Geese, ducks, and swans accounted for 12 strikes total. The data is summarized in Table 15. Nearly 60 percent of all strikes occurred during the months of July through October, likely coinciding with the period when young birds fledge from nests (Figure 23). Of note, this appears to be prior to the main migratory season as represented by bird count data collected in Pigs Eye Lake by the National Park Service, which reported the highest bird counts at the end of November and early December.

The strike database also allows those reporting incidents to enter a qualitative assessment of the level of damage, if any, which was sustained by the aircraft from each strike. Categories of damage include "None," "Minor," Substantial," "Destroyed," and "Uncertain." Table 16 provides a summary of the damage levels reported for the 68 bird strikes from St. Paul Downtown Airport. Of those reported, most strikes caused No damage or Minor damage (n=42). Approximately nine percent of strikes were reported as causing Substantial damage (n=6). None were categorized as Destroyed.

Table 16: Bird Species Struck at St. Paul Downtown Airport, 1990–2016

Species	Number
Hawks/Eagles/Falcons	**19**
American kestrel	4
Bald eagle	8
Hawks	3
Peregrine falcon	3
Red-tailed hawk	1
Geese, ducks, swans	**12**
Canada goose	7
Ducks	2
Unidentified Geese	1
Mallard	1
Snow goose	1
Gulls	**7**
Gulls	7
"Songbirds" (*Passeriformes*)	**5**
American crow	1
Eastern meadowlark	1
European starling	1
Red-winged blackbird	1
Western meadowlark	1
Other	**4**
Common loon	1
Hairy woodpecker	1
Rock pigeon	2
Unknown Birds	**21**
Unknown bird	2
Unknown bird - large	2
Unknown bird - medium	6
Unknown bird - small	11
Mammals	**2**
Striped skunk	1
White-tailed deer	1
Total	**70**

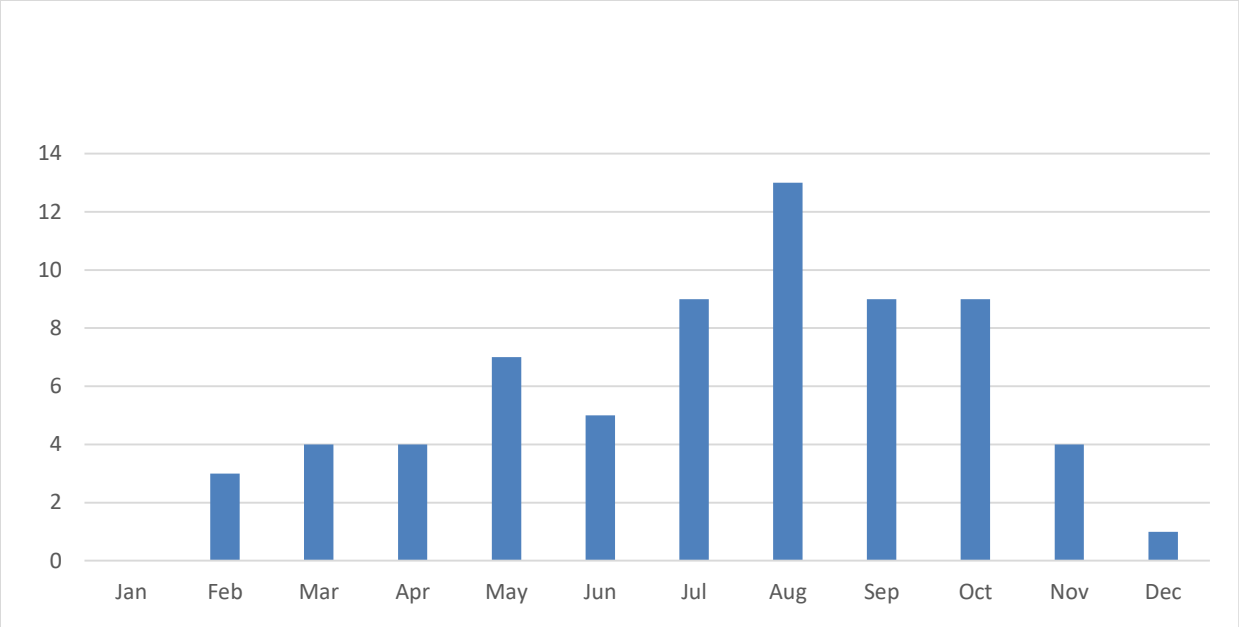

Figure 23: Number of Reported Bird Strikes by Month

7.1.5.3 Aircraft-Wildlife Hazard Coordination

Coordination in regards to airport safety has been ongoing with the FAA, USDA-WS, and Minneapolis Saint Paul Metropolitan Airports Commission (see Appendix A - Correspondence & Coordination). Together with the FAA, the USDA-WS provided four recommendations that might reduce the chance for the project to attract wildlife hazards based on their review of the project. The recommendations have been taken into consideration during project planning and incorporated to the extent practicable, as discussed below.

Table 17: Reported Damage from Bird Strikes Occurring at St. Paul Downtown Airport, 1990–2016

Damage	Number
None	29
Minor	13
Substantial	6
Destroyed	0
Uncertain/Unreported	20
Total	68

First, the USDA-WS recommended planting thick, woody, scrub-brush vegetation species, especially near the water's edge, in order to minimize open areas where waterfowl nesting occurs. Two rows of willows are incorporated in most of the island perimeters in order to stabilize the island edges, and should serve well in partially fulfilling this suggestion. However, some open sandy areas are desirable as a project feature to allow for turtle nesting and are therefore being incorporated into the project design. Additionally, there are concerns that planting entirely woody and shrubby species would have a high potential for being foraged by resident beavers, whereas it is believed that planting a more diverse cover would likely have greater success. The Corps believes this would meet the intended goal of this suggestion. Detailed planting plans will be developed following the feasibility stage, which will be coordinated for additional comments.

Second, the USDA-WS recommended minimizing shallow-water emergent vegetation (i.e., cattails) to prevent muskrats from building huts, which could provide nesting platforms for Canada geese. A focus

of the wetland plantings will be rooted floating aquatic vegetation such as lotus, but some emergent vegetation would also be incorporated into the project. Softstem and hardstem bulrush are already prevalent along much of the Pigs Eye Lake shoreline. These species provide important fish habitat for cover and spawning. Emergent vegetation like bulrush can actually discourage birds like geese from accessing the land. Muskrats, beavers, and mink already make use of Pigs Eye Lake and the bulrush, with a number of huts observable along the shoreline. However, resource managers that frequent the lake have not noted use of these huts by nesting geese. Therefore, the Corps will partially implement this recommendation, and will remain cognizant of the concern as detailed planting plans are developed.

The third recommendation by the USDA-WS is to avoid incorporating sand benches above or below the water's surface, due to concerns that fluctuating water levels could lead to exposing the sand and creating nesting areas. Although sand benches (i.e., sandbars, sand flats, etc.) were considered during planning, none were incorporated into the TSP. The water levels in Pigs Eye Lake are highly connected to the navigation channel. During dry periods, minimum water levels are maintained by manipulating the Lock and Dam system in order to facilitate navigation in the main channel. The Corps used this minimum low water level elevation in order to design the islands such that there would be minimal areas of frequently exposed, barren sand. The only areas expected to be shallow and sandy would be the transitional areas between the water and the shoreline, and any areas set aside for turtle nesting habitat.

Finally, the fourth USDA-WS recommendation is to reduce the overall number of islands and steepening the slopes of the island banks to decrease the shoreline available to nesting waterfowl. Unfortunately, because of the unconsolidated nature of the substrate in Pigs Eye Lake, the islands require relatively gentle slopes to increase stability. Even still, the slopes were designed to be as steep as possible in order to minimize the quantity of sand needed to construct them. The number of islands in the TSP was reduced from 9 islands to 7 islands during planning following this suggestion. Concerning shoreline length, the TSP would have among the shortest total length of shoreline of all the island configurations considered during planning. Although reducing wildlife hazards was not the main reason for doing so, shoreline length in the TSP was in fact reduced by 32 percent (~17,000 feet) since this recommendation was made.

7.1.6 Hazardous, Toxic, and Radioactive Waste

Under the no-action alternative, continued wind-wave action could mobilize contaminated sediments near the Pigs Eye Landfill and move them throughout the lake. Waste from the Pigs Eye Landfill has contributed to known contaminated land on the former landfill site as well as heavy metals found in borings taken from the far northern portions of the lake, as discussed in Section 2.3.

The proposed alternative would have a short-term risk of disturbing sediments during construction, but would have a long-term positive effect on the project area by capping existing flocculent sediments and reducing the likelihood of redistributing contaminated sediment due to wind-generated waves. The existing lake substrate conditions and the proposed fill material were considered in this determination, as discussed in the following sections.

This project would not involve Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) related activities or costs. The project would not involve clean-up or management of materials regulated by the CERCLA, and would not interfere with any ongoing or future cleanup actions associated with the nearby Pigs Eye dump site. Analysis and coordination of HTRW testing results indicate that: (1) CERCLA materials in the project area are at acceptable levels for construction of the proposed project features, and (2) Constructing the proposed ecosystem restoration features within the lake would have positive incidental benefits to the lake and surrounding areas.

7.1.6.1 Existing Sediment and Substrate

Sediment sampling and testing of the substrate throughout the lake has indicated that contaminants are not a major concern in the proposed project location. The test results revealed the highest levels of contamination are limited to the area adjacent to the landfill, which is outside of the footprint of the proposed islands. For the rest of the lake that would be affected by the island construction, sediment testing showed that the lake has ubiquitous contamination of PFCs, widespread low level (SQT I) exceedances for heavy metals and PAHs, limited locations with higher exceedances for cadmium and PAHS (SQT II and proposed Recreational/Residential SRVs) and no recent detection of PCBs. The relatively low levels of contamination (SQT I exceedances) present in the existing substrate would not pose a large risk of bioavailability or uptake of contaminants, and placing clean sand on top of the existing sediments to construct the proposed islands would probably benefit the aquatic and benthic environment by capping serving as an additional barrier to contaminant mobility. Local and regional resource agencies have been coordinated with and are supportive of this determination, and coordination will continue into the next project phase to develop strategies for further minimizing risks.

Construction activities may cause short-term disturbance and redistribution of the sediment adjacent to the islands during construction. The contractor would be required to utilize BMPs during construction to minimize these effects.

7.1.6.2 Proposed Fill Material

The proposed fill material would include rock, sand, and topsoil. The rock would be clean and sourced from a quarry. The sand and topsoil fill would consist primarily of material generated from dredging in the lower portion of Pool 2. Historically, sediment testing in Pool 2 has shown that some of the siltier dredge cuts in Lower Pool 2 have had issues with contamination. The levels of Pool 2 contamination appear to increase downstream, likely due to decreased granular size seen downstream where the pool becomes more lake-like. However, all of the dredged material currently available on the temporary placement islands where sand would be sourced for the project was dredged after 1999-2000. Sediment testing since 2000 has revealed fewer types and decreased levels of contamination. The only hits noted have been exceedances of SQT Level 1 limits for several PAHs (e.g., acenaphthylene and pyrene), and two pesticides (DDD and DDT). These contaminants were found at relatively low levels that would not have negative impacts if used to construct wildlife habitat (based on MN SQT guidelines), or if used as topsoil (based on MN SRV Guidelines). If preparation of project plans and specifications leads to a proposal to utilize material from Pigs Eye Lake for topsoil, existing contaminant data would be examined and additional testing may be required to ensure the material is acceptable for this use. Data and

conclusions would be coordinated with the Contaminants Sub-Group and any other relevant agencies for concurrence.

7.1.7 Environmental Justice

Environmental Justice is a national goal and is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Project goals and objectives were established to provide environmental restoration and enhance the quality of the environment for all people. Public involvement, via public meetings and distribution of information concerning the proposed project, has and will continue to be an integral part of planning for this project to ensure that concerns of all people will be fully considered in the decision-making process. Minority groups were identified in communities surrounding the project area; however, the project itself would not have any adverse effects on surrounding communities. Therefore, neither the no action alternative nor the proposed action would cause a disproportionate impact on any population.

7.2 Natural Resource Effects

7.2.1 Air Quality and Climate Change

The proposed project has been assessed for air quality effects on several levels: compliance with the rules provided by the Federal Clean Air Act, analysis of greenhouse gas emissions and potential effects on climate change, and impacts to sensitive local receptors (e.g., schools, parks, residences, hospitals, etc.).

The 1990 Federal Clean Air Act Amendments directed the Environmental Protection Agency (EPA) to develop federal conformity rules. Those rules (promulgated as 40 CFR parts 51 and 93) are designed to ensure that federal actions do not cause, or contribute to, air quality violations in areas that do not meet the National Ambient Air Quality Standards (NAAQS). The EPA has developed NAAQS for six principal air quality pollutants: carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter, and sulfur dioxide. The final rule dictates that a conformity review be performed when a federal action generates air pollutants in a region that has been designated a non-attainment area for one or more of the six NAAQS criteria pollutants. Ramsey County is in “attainment” of the NAAQS for each of the criteria pollutants, so no conformity analysis is required for the proposed project.

Greenhouse gas (GHG) emissions and their effect on climate change are global issues resulting from numerous and varied sources, with each source making a relatively small addition to global atmospheric GHG concentrations, but which collectively have a large impact on a global scale. Although climate changes in the past have been caused by natural factors, human activities are now the dominant agents of change. Human activities are affecting climate through increasing atmospheric levels of heat-trapping gasses, including those emitted by the combustion of fossil fuels (e.g., Mellilo et al. 2014).

The proposed project would have both short-term adverse impacts from GHG emissions and long-term beneficial impacts from providing carbon sequestration. The proposed project would be expected to produce greenhouse gasses during construction in the form of exhaust from various types of machinery used for material transport and material placement. This particular project involves an alternative end

use of material that is already dredged in order to maintain another federally-authorized project. Therefore, the impact of this project would be the difference in emissions that would result from the proposed use of dredged material to construct islands in Pigs Eye Lake, rather than the typical placement of this material at a nearby upland placement site. In particular, the main difference would be transporting the previously-dredged material, by barge, approximately 13 miles upstream to Pigs Eye Lake. On the other hand, the proposed project would also provide carbon sequestration benefits by increasing carbon storage potential in standing riparian biomass and eventually by cycling the carbon through the floodplain river system and into the sediment. Quantifying these benefits would be difficult and outside of the scope of this analysis, but are well-documented throughout scientific literature (e.g., Sutfin, Wohl, and Dwire 2015). These benefits would be long-term and would continue for the life of the project.

At a local scale, the nearest sensitive receptor is a residential community of St. Paul, which is located on top of the bluff, approximately 2,000 feet east of the proposed project. During project construction, the project would have a temporary, minor, and localized adverse effect on air quality due to emissions produced by construction equipment. Air quality impacts generated by the project would be indistinguishable from the adjacent railroad tracks, Highway 10/61, a barge shipping facility, and wastewater treatment plant, and would not be expected to individually or cumulatively significantly change air quality in the area. This would be short-lived and would disappear upon project completion. Construction activities are expected to produce very little dust because the materials to be handled would be either wet (dredged material) or larger materials than are generally mobilized by wind (large rocks for training structure construction).

7.2.2 Terrestrial Habitat

The no action alternative would have minor adverse effects on terrestrial habitat. Under the no action alternative, the shoreline surrounding Pigs Eye Lake would be expected to continue eroding, reducing both the quantity and quality of terrestrial habitat.

The proposed project would have substantial beneficial effects to terrestrial habitat by preserving existing terrestrial habitat along shoreline of Pigs Eye Lake from erosion.

An estimated 111 acres of habitat around the perimeter of Pigs Eye Lake has eroded over the last 64 years, including low-elevation terrestrial habitat. Erosion that would be expected to continue in the absence of a project threatens an estimated 37.5 acres of additional shoreline habitat over the next 50 years. The proposed project would provide protection for some of this terrestrial habitat by reducing wind-generated waves within the lake.

7.2.3 Wetlands

The no action alternative would have substantial adverse effects on wetlands. Several areas along the shallow shoreline of Pigs Eye Lake currently support stands of aquatic vegetation. Under the no action alternative, many of these areas would be degraded due to the continued wind-generated waves and consequent shoreline erosion.

The proposed project would have substantial beneficial effects to wetlands both by preserving existing wetlands and by creating additional wetlands.

An estimated 111 acres of habitat around the perimeter of Pigs Eye Lake has eroded over the last 64 years, most of which was wetland. Erosion that would be expected to continue in the absence of a project threatens an estimated 37.5 acres of additional shoreline habitat over the next 50 years. The proposed project would provide protection for some of this terrestrial habitat by reducing wind-generated waves within the lake.

The proposed project would also create an estimated 33.9 acres of additional wetland habitat. This would include approximately 16.3 acres of bottomland forest and/or wet prairie and approximately 17.6 acres of marsh. Other areas within the island complex or newly-protected shoreline areas may re-vegetate over time as well.

7.2.4 Aquatic Habitat

The no action alternative would have a minor adverse effect on aquatic habitat. The stressors reducing the quality of aquatic habitat in Pigs Eye Lake would continue to act on the habitat and further declines in quantity and quality of aquatic habitat would occur if no action is taken to protect or improve the area.

The proposed project would have substantial beneficial effects on the aquatic habitat within the lake. Reducing wind-generated waves throughout the lake would lead to reduced turbidity and would help preserve the existing vulnerable wetlands around the perimeter of the lake. In inundated areas where sand would be placed - such as the bases of the islands and in some of the island interiors - the substrate would be significantly more stable than existing, allowing macroinvertebrates and plants to colonize. The increased habitat diversity (substrate elevation, near-shore shallow areas, substrate type) and increased vegetation would provide additional habitat for fish and aquatic organisms.

7.2.5 Habitat Diversity & Interspersion

The no action alternative would have a minor adverse effect on habitat diversity and interspersion, as the Pigs Eye ecosystem will continue to degrade over time.

The proposed project would have a substantial beneficial effect on habitat diversity and interspersion by creating more varied and higher-quality habitat within the lake. The existing habitat within the lake is very uniform, consisting of a vast expanse of shallow water (2-4 feet deep) with a soft and silty substrate. The proposed project would introduce additional habitat types within the area including shallow sandy areas, shallow marsh, low and frequently inundated floodplain forest. The proposed project would increase the availability of littoral habitat near each of the new islands.

7.2.6 Biological Productivity

The no action alternative would have a minor adverse effect on biological productivity. The continued degradation of the area that would occur in the absence of a project would further reduce the quantity and quality of habitat available within Pigs Eye Lake.

The proposed project would have temporary, minor adverse effects on biological productivity resulting from disturbance caused by construction activities. Birds, fish, and other mobile animals that might normally utilize the immediate project area would likely avoid the area during construction. The construction disturbance would be expected to be localized, and areas of the lake would remain relatively undisturbed during construction.

The project is in close proximity to the Pigs Eye Island Heron Rookery Scientific and Natural Area (SNA), shown in Figure 24. This was taken into account during project planning in order to avoid and minimize impacts to biological productivity within the SNA. No project work, including staging, is currently proposed on or directly connected to the SNA. However, the main location for accessing Pigs Eye Lake – especially by barge – is the channel maintained for use by the Red Rock Terminal which runs directly adjacent to the eastern shore of the SNA. Pigs Eye Lake itself borders the north part of the SNA. It is likely that barges would use the channel for project construction in order to transport construction materials into the area, such as sand, rock, topsoil, or plantings. The project would therefore likely cause an increase in barge traffic frequency. However, because of how common barge traffic is through the channel already, no additional impacts to the rookery would be expected from the use of the channel. Additionally, special attention will be given to the time period from April 1 through July 15 to ensure project activities are compatible. This time has been designated as a sensitive nesting period for the Pigs Eye Heron Rookery SNA, and the area is closed during that time. Contractor-proposed activities would be evaluated to ensure they would have no or negligible impacts to the SNA.

The proposed project would also have a long-term minor positive effect by improving and maintaining existing habitat and by creating additional habitat that would provide forage and spawning opportunities for a variety of fish and wildlife.

Figure 24: Pigs Eye Island Heron Rookery SNA and surrounding project areas

7.2.7 Surface Water Quality

The no-action alternative would have no effect on surface water quality.

There would be a temporary, minor adverse effect on water quality in the project area during construction. Localized increases in suspended sediment and turbidity are likely. However, a number of best management practices would be incorporated into the project construction in order to minimize these effects, such as spreading thin layers of material and allowing settlement and utilizing silt curtains to reduce the movement of suspended sediments out of the project area.

In the long term, the project would have a minor beneficial effect to local water quality in Pigs Eye Lake due to reduction in wind-generated waves and establishment of additional aquatic vegetation.

7.2.8 Aquatic and Terrestrial Organisms

The no-action alternative would have no effect on aquatic and terrestrial organisms.

Under the proposed alternative, there would be a temporary, minor adverse effect to fish and wildlife during project construction that may have otherwise used the project area. These would most likely include fish, ducks and other waterbirds, muskrat, mink, and beavers. These mobile organisms would be displaced due to avoidance of the area during construction. The few invertebrates inhabiting the proposed island footprints would be covered and killed.

There would be a long-term, substantial positive effect on fish and wildlife utilizing the area in the future, as the project area would provide significantly improved habitat conditions. The Habitat Evaluation Appendix C discusses some of these benefits in greater detail.

7.2.9 Threatened and Endangered Species

7.2.9.1 Federally-listed Species

The Higgins eye (*Lampsilis higginsii*), rusty patched bumble bee (*Bombus affinis*), prairie bush-clover (*Lespedeza leptostachya*) and the northern long-eared bat (*Myotis septentrionalis*) are the only federally-listed species known to possibly exist in the project area (FWS IPaC website, accessed on 20 February 2018). No critical habitat is found in the project area.

No past surveys have reported freshwater mussels living in Pigs Eye Lake, and the habitat in the lake is not conducive to supporting these species or any other mussel species in high abundance.

No trees are planned to be cut at a result of any of the project features and no bat roosting or maternity trees are known in the project area.

The prairie bush-clover has not been found in the project area and is typically not found in any of the types of habitats affected by the proposed project.

The USFWS has compiled recent survey data and conducted habitat modeling to identify the potential for occurrence of the rusty patched bumble bee (USFWS 2017). The area surrounding the proposed project has been identified as having a high potential for supporting the rusty patched bumble bee. However, the proposed project construction activities would be limited to permanently inundated and open water areas, where the rusty patched bumble bee is unlikely to be present. If project construction activities are identified that would potentially impact upland areas, they would require further review.

For these reasons, the St. Paul District has determined that both the No Action and the Tentatively Selected Plan would have no effect on federally-listed threatened and endangered species.

7.2.9.2 State-listed Species

Fish – There is a potential to impact fish during project construction. Any listed fish using the project area would likely be temporarily displaced during project construction, but would benefit from the improvement in habitat following construction.

Mussels – No past surveys have reported freshwater mussels living in Pigs Eye Lake, and habitat in the lake is not conducive to supporting these species or any other mussel species in high abundance.

Plants – Kitten-tails have been documented in the upland areas near the proposed project site. Although no construction activities would occur directly in these areas, a survey of any upland areas that would be disturbed would be conducted to ensure that resources of concern, such as listed plants, are not disturbed by project construction.

7.2.9.3 Bald Eagles

Bald eagles exist throughout Pool 2 and have been documented using Pigs Eye Lake during numerous studies (i.e. Holdhusen 2016). A large part of their life cycle (breeding, fledging, and feeding) is dependent upon use of the Mississippi River and surrounding shallow water areas.

It is possible the proposed project could have some adverse effects to eagles, though such effects would likely be limited to disturbance during construction. The primary concern would be the disturbance of eagles during the nesting season, which generally occurs from mid-January to mid-June. Eagles generally return to the same nest or group of nests each year, but often build new nests in different locations. Because of this, existing nest data can help in the assessment of potential effects, though a nest survey conducted in the nesting season just prior to construction would be needed to ensure impacts to eagles are avoided or minimized. In cases where some impacts to eagles are possible, a permit may be requested from the FWS to ensure compliance with the Bald and Golden Eagle Protection Act. While it is unlikely that such a permit would be needed for this project after the application of minimization and avoidance measures, the Corps would coordinate with the FWS in seeking a permit if needed for any given project component.

7.3 Cultural Resource Effects

Pigs Eye Lake has historically been an extensive wetland (Grand Marias of the Mississippi) that has become more lacustrine during the 20th century. Creating isolated islands in this normally saturated setting would not affect significant cultural resources. As the construction will take place entirely from river-borne barges, no landward access roads or storage yards will be used. The Corps has determined that the Project has no potential to effect historic properties.

7.4 Cumulative Effects

7.4.1 Scope of Cumulative Effects Analysis

Cumulative effects are defined by the Council on Environmental Quality as, "[T]he impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

The time frame considered for the scoping of potential future cumulative impacts was bounded by the project life considered during other analyses, which was 50 years, which is the time frame used for project planning and analysis of the project benefits. Although this life-span is somewhat arbitrary, no reasonably foreseeable future actions were identified beyond this time scale.

The geographic scale analyzed for cumulative impacts was limited to potential actions that have or would have effects in the immediate and adjacent project area. However, this does not mean that only activities with footprints overlapping the proposed project were considered - this is because the proposed project is a part of a large river system, which necessitates considering if actions upstream or downstream could also impact this particular reach of the river.

7.4.2 Actions Identified within the Project Area

The following past, present, and reasonably foreseeable future actions were identified as having the potential to interact with or have impacts related to those of the proposed project.

7.4.2.1 Past actions

7.4.2.1.1 Modifications to UMR for Navigation

The floodplain geomorphology, stream hydraulics, and water levels of the Upper Mississippi River have been modified by impoundment and other navigation features since the 1820s. The most relevant navigation improvement actions within the project impact area are likely the construction of hundreds of channel training structures placed between 1866 and 1907 as part of the 4-foot, 4.5-foot, and 6-foot navigation channel projects. Following the construction of these structures was the construction of Lock and Dam Number 2 in 1930, which raised water levels by several feet in the immediate project area and allowed for a 9-foot-deep navigation channel adjacent to Pigs Eye Lake. The cumulative effect of these actions has played a large role in the development of the habitat that currently exists in the project area.

7.4.2.1.2 Pigs Eye Landfill

Directly to the north of the lake is the site of Pigs Eye Landfill, operated from the mid-1950s until 1972 for the disposal of mixed municipal and commercial waste. Some remediation has been completed at the dump site, but monitoring and further remediation is ongoing.

7.4.2.2 Concurrent and Ongoing Actions

7.4.2.2.1 Navigation on the UMR

The operation, maintenance, and navigation use of the main channel of the UMR at its current authorized level is expected to continue into the future.

7.4.2.2.2 Wastewater Treatment Plant

The St. Paul Metropolitan Council's Metro Wastewater Treatment Plant is located directly northwest of Pigs Eye Lake. It is the largest wastewater treatment plant in Minnesota and has a capacity of 251 million gallons per day. The plant serves 1.8 million residents. The plant utilizes advanced secondary treatment with chlorination/dechlorination and discharges directly to the Mississippi River approximately one mile upstream of where Pigs Eye Lake is connected to the main stem of the river. A series of excavated ponds exist to the direct northwest of Pigs Eye Lake shoreline. Previously the ponds were filled with incinerator ash. However, due to contaminant concerns by the MPCA the contents of the ponds were removed to an offsite locations. The remnant level of contamination in the ponds is unknown.

7.4.2.2.3 Industrial, Commercial, and Transportation Facility Development

A number of industrial, commercial, and transportation developments surround Pigs Eye Lake. A railroad and major highway (MN 10/61) border Pigs Eye to the northeast. The railroad facilities include a recently-expanded 8 track rail system with an adjacent railyard that covers approximately 40 acres. The Red Rock Barge Terminal is a barge loading facility that has been constructed at the southern end of Pigs Eye Lake, and includes a maintained, 9-foot channel from the main channel of the UMR into the lake.

The terminal encompasses 272 acres. Eight lessees utilize the site for both inbound and outbound shipping of steel scrap, asphalt, grain, fertilizer, and coal.

7.4.2.2.4 Residential Development

The area on top of the bluff to the east of Pigs Eye Lake is generally developed residential land.

7.4.2.2.5 Lake Pepin Eutrophication Total Maximum Daily Load (TMDL) Study and South Metro Mississippi River Total Suspended Solids TMDL Study

The Minnesota Pollution Control Agency has identified the Mississippi River from Lock and Dam 1 to the head of Lake Pepin to be impaired for phosphorus and total suspended solids (TSS). Ongoing TMDL studies are being undertaken to identify the maximum quantities of these pollutants that can be allowed to enter the water body without exceeding water quality standards. The proposed project would have an effect on TSS and turbidity levels. Turbidity in this reach of the river began increasing in the early 1920s as the Twin Cities metropolitan area grew and agricultural use of the Minnesota River Basin increased. Sediment cores from Lake Pepin have shown that the sediment load to Lake Pepin doubled between the 1930s and the 1960s and has stabilized at that level, although the source of the sediment has shifted from farm fields to increased erosion of stream banks and bluffs.

7.4.2.2.6 Minnesota River Watershed Study

The Corps is currently working on an integrated watershed study of the Minnesota River, with the intent to produce a watershed management plan. The results of the study will enable examination of existing conditions, forecasting of future conditions, and simulation of alternatives to identify management actions that are ecologically sustainable, economically sound, and socially desirable.

7.4.2.3 Reasonably Foreseeable Actions

7.4.2.3.1 Additional Remediation to Pigs Eye Landfill

Studies of the Pigs Eye Landfill site are ongoing. It is anticipated that these studies could lead to additional remediation of the site, if necessary.

7.4.2.3.2 Expansion of Barge Fleeting

Proposals have been made to expand or construct additional barge fleeting or unloading in and near Pigs Eye Lake. No official steps have been taken to begin evaluating or permitting these actions to the knowledge of the Corps.

7.4.2.3.3 Battle Creek Regional Park Master Plan

Ramsey County proposes to begin the process of updating the 1981 Master Plan for Battle Creek Regional Park in 2018. This parkland generally includes the area owned by Ramsey County in and around Pigs Eye Lake. Ramsey County plans to consider potential actions for developing the Pigs Eye Lake area as parkland during this process.

7.4.2.3.4 Mississippi River Paddle Share

The Mississippi Park Connection and the Mississippi National River and Recreation Area coordinated to create a first-of-its-kind recreational opportunity wherein users can rent a kayak and necessary paddling equipment at an unmanned station. Several stations are provided so that users can drop the kayak off at

a downstream location and ride a rented bike to the point of origin. In 2016, the first four stations were installed in Minneapolis. There are plans to continue developing these stations downstream in St. Paul, including one near Pigs Eye Lake itself.

7.4.3 Environmental Consequences of Cumulative Effects

The environmental consequences outlined below are organized by resource categories, in the same order as resources are discussed for the project in Chapter 7. For brevity, only those resources where cumulative effects are expected are discussed.

7.4.3.1 Recreation

The proposed project would be expected to have a long-term, minor beneficial impact on recreation. Many of the past, present, and reasonably foreseeable actions identified above have effects on recreation. The project is located in an urban setting with a relatively high population density. The water quality improvements that have followed the implementation of the Federal Clean Water Act of 1972 have increased the public's interest in recreating on this stretch of the river. Water quality impairments still exist, but the success of programs such as the Mississippi River Paddle Share described above highlight the fact that the public has a desire to experience the river in a recreational capacity. The ongoing Lake Pepin TMDL and Minnesota River Watershed Study demonstrate that the public is interested in further improving water quality in this reach. The reasonably foreseeable actions of further developing the area for recreation in connection with the upcoming Battle Creek Regional Park Master Planning effort further emphasizes the desire to create additional recreational opportunities along the Mississippi River near the Twin Cities Metro area. The expected improvements to water quality, reduction in wind and waves, and improvement of the area for wildlife use would all lead to an improvement in the recreational experience of future users of the lake. If other reasonably foreseeable actions are taken to improve recreation as predicted, the overall effect of these actions would likely provide substantial benefits to recreation.

7.4.3.2 Terrestrial Habitat, Aquatic Habitat, and Habitat Diversity/Interspersion

The proposed project would be expected to have a long-term, substantial beneficial impact on terrestrial habitat, aquatic habitat, and habitat diversity and interspersion. The proposed project was designed to improve the habitat in and around the lake, and to protect the existing resources. The modification of the river for navigation purposes and the development around Pigs Eye Lake has undoubtedly had an impact on the terrestrial and aquatic habitat resources surrounding the project area. Many of these actions have contributed to the problems identified as a part of this project. Further expansion of these developments could have additional adverse impacts on the habitat quantity and quality present within Pigs Eye Lake, and on the UMR as a whole.

7.4.3.3 Bird Populations and Aircraft-wildlife Interactions

As described in the previous section, the proposed project would improve the habitat in the project area for wildlife, including migratory birds. Many of the past, present, and reasonably foreseeable actions identified above would also likely have some level of effect on migratory birds in the Upper Mississippi River. Further, since migratory birds spend portions of their lives across extremely vast areas, many additional actions throughout the United States and beyond our national borders would also affect

habitat that these birds use. All of these actions, combined with the uncertainty of other drivers of bird populations make any real analysis of the issue unrealistic. However, from the standpoint of a cumulative effects analysis, the magnitude of the proposed project and its impacts to bird populations would not contribute to any identifiable threshold of cumulative significant impact to either bird populations or subsequently, aircraft-wildlife interactions.

7.4.3.4 Surface Water Quality

The proposed project would be expected to have a minor beneficial effect on surface water quality due to the reduction in suspended sediments. Several of the other ongoing efforts are attempting to address water quality issues in the watershed – the Lake Pepin TMDL and the Minnesota River Watershed Study. These actions, considered together, would be expected to further benefit water quality. Due to the massive scale of actions that may impact water quality, other unknown factors such as the effects of climate change on future watershed hydrology or due to unknown developments throughout the watershed have potential to impact water quality in both positive and negative ways. Overall, the identified ongoing efforts would be expected to have a net positive effect on water quality.

8 Plan Implementation

The schedule for the feasibility study is documented in Table 18. After the feasibility report is approved, and a Project Partnership Agreement is executed with the non-Federal Sponsor, the PDT will initiate Plans & Specifications. The Preconstruction Engineering and Design phase is pending funding and will include refinements to the design of the Recommended Plan. This schedule assumes that availability of funds to prepare plans and specifications and undertake construction will not be limiting.

The project has been broken out into two construction phases. The first phase of construction could begin Fall 2019 with the unloading and transport of sand to Pigs Eye Lake and be complete in Fall 2020. The first phase includes dewatering of fines needed to cap the islands.

The second phase of construction focuses placement of fines to cap the islands and plantings for marsh species and floodplain forest seedlings. This phase includes planting and weed control to ensure quality tree establishment. Capping and seeding islands could begin around Spring 2021, and be complete in Fall 2021.

Table 18: Estimated Project Schedule

Requirement	Scheduled Date
Submit final Feasibility Report and Environmental Assessment to Mississippi Valley Division, U.S. Army Corps of Engineers	November 2017
Execute Project Partnership Agreement with Ramsey County Parks & Recreation	May 2018
Obtain construction approval by Mississippi Valley Division U.S. Army Corps of Engineers	July 2018
Begin Plans and Specifications	August 2018
Complete Plans and Specifications	January 2019
Advertise for Bids	May 2019
Award Contract (FY19)	July 2019
Complete island construction	November 2020
Complete capping islands and floodplain forest plantings	November 2021

9 Summary of Environmental Compliance and Public Involvement

The planning for Pigs Eye Lake Project has been an interagency effort involving the St. Paul District, Ramsey County, the USFWS, the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, National Park Service, local airport authorities, and others. Interagency meetings and site visits were held on a periodic basis throughout the study. In addition to the meetings, information coordination took place on an as-needed basis to address specific problems, issues, and ideas.

The draft Feasibility Report and Environmental Assessment was sent to congressional interests, federal, state, and local agencies; Native American groups; special interest groups; interested citizens; and others listed in Appendix A– Correspondence & Coordination.

9.1 Environmental Laws and Regulations

This Feasibility Study Report with Integrated EA was prepared and the proposed work designed to comply with all applicable environmental laws and regulations. A highlight of compliance with the major environmental laws and regulations follows and is summarized in Table 19.

Discussions with permitting agencies have not indicated any major obstacles with the issuance of permits that would be critical for construction of the project at this time.

9.1.1 Clean Water Act

The proposed project would involve discharges of fill into waters of the United States. A Clean Water Act Section 404(b)(1) Evaluation has been prepared for the project and is included as Appendix B. Section 401 water quality certification from the State of Minnesota will be requested by the Environmental Compliance Branch of the Corps.

9.1.2 Fish and Wildlife Coordination Act

In compliance with the FWCA, project plans have been coordinated with the USFWS and the Minnesota DNR. Correspondence is documented in Appendix A: Correspondence & Coordination.

9.1.3 Cultural Resources and Tribal Coordination

In accordance with 36 CFR 800.3(a)(1), the Corps has determined the proposed project to have no potential to cause effects and has no further obligations under Section 106. Tribal letters were sent out in accordance with Executive Orders 13007 and 13175.

9.1.4 State Permits

The Corps will submit an application to the Minnesota DNR for a Public Waters Work Permit, out of comity. Some additional permits and environmental planning may fall under the responsibility of the contractor conducting the proposed work. The contractor would be responsible for obtaining construction permits as necessary, such as a National Pollutant Discharge Elimination System permit. These responsibilities would be detailed in the Specifications provided to the Contractor.

Table 19: Compliance Review with Applicable Environmental Regulations and Guidelines

Environmental Requirement	Compliance[1]
Federal Statutes	
Archaeological and Historic Preservation Act	Full
Bald and Golden Eagle Protection Act of 1940, as amended	Partial
Clean Air Act, as amended	Full
Clean Water Act, as amended	Partial[2]
Endangered Species Act of 1973, as amended	Full
Federal Water Project Recreation Act, as amended	Full
Fish and Wildlife Coordination Act, as amended	Full
Land and Water Conservation Fund Act of 1965, as amended	Full
Migratory Bird Treaty Act of 1918, as amended	Full
National Environmental Policy Act of 1969, as amended	Partial[3]
National Historic Preservation Act of 1966, as amended	Full
National Wildlife Refuge Administration Act of 1966	Full
Noise Pollution and Abatement Act of 1972	Full
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic Rivers Act of 1968, as amended	N/A
Farmland Protection Policy Act of 1981	N/A
Executive Orders, Memoranda	
Floodplain Management (EO.. 11988)	Full
Protection and Enhancement of Environmental Quality (E.O. 11514)	Full
Protection and Enhancement of the Cultural Environment (E.O. 11593)	Full
Protection of Wetlands (E.O. 11990)	Full
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 30 August 1976)	Full

[1] The compliance categories used in this table were assigned according to the following definitions:

a. Full - All requirements of the statute, E.O., or other policy and related regulations have been met for the current stage of planning.

b. Partial - Some requirements of the statute, E.O., or other policy and related regulations remain to be met for the current stage of planning.

c. Noncompliance (NC) - Violation of a requirement of the statute, E.O., or other policy and related regulations.

d. Not Applicable (N/A) - Statute, E.O., or other policy and related regulations not applicable for the current stage of planning.

[2] Full compliance to be achieved with the District Commander's signing of the 404(b)(1) Evaluation and receipt or waiver of Section 401 Water Quality Certification from the State of Minnesota.

[3] Full compliance to be achieved with the District Commander's signing of the Finding of No Significant Impact.

9.2 Summary of Coordination, Public Views, and Comments

Interagency meetings were held on a periodic basis throughout the study phase. Two subgroups were also formed to evaluate contaminants and discuss habitat impacts during the planning phase. In addition to the meetings, coordination took place on an as-needed basis to address specific problems, issues, and ideas. Documentation of these interactions can be found in Appendix A – Correspondence & Coordination.

A public notice of availability of the draft Report was published on March 12, 2018 on the Corps website. The draft Feasibility Report and Environmental Assessment was sent to congressional interests, federal, state, and local agencies; special interest groups; interested citizens; and others.

A summary of comments received and responses to the comments is presented in Appendix A, along with copies of each of the comment letters. All comments received were considered. No comments led to substantive report revisions; several minor typographical corrections were made to the report based on comments received.

The majority of commenters expressed general support for the project. Comments were received from the MnDNR and MPCA reiterating that construction activities should adhere to local noise regulations, minimize impacts to nearby natural resources (e.g., heron rookery and sensitive nesting periods), and that additional permitting may be required if dredging is incorporated into the project. One entity – the Metropolitan Council – indicated concerns about project assumptions related to project objectives, construction and long-term project performance uncertainties, and contaminated sediments assumed to be located within the project footprint. Responses were provided for each of these comments, but did not lead to any changes in the report or in the recommended plan because the topics of concerns raised (e.g., contaminants, water quality, wildlife, airport bird strikes) were coordinated with the appropriate regulatory or implementing agencies throughout the planning process (e.g., MPCA, MnDNR, MAC/FAA). The data, technical opinions, and correspondence received from each of the agency experts were used in planning the project and contradict the concerns presented in the comments. Data collected by the Corps along with data provided by other resource agencies indicated that sediment contamination levels in the project area were below thresholds for CERCLA requirements as well as more stringent state requirements. The risks and uncertainties associated with the project constructability and success were considered and incorporated into project quantities, construction considerations, and monitoring and adaptive management strategies.

10 Recommendation

The recommended plan is Alternative 6m, which includes 7 Islands, floodplain forest (16.3 acres) and marsh habitat (17.6 acres).

The estimated cost of the project at current price levels is $12.4 million (including sunk general design costs). Upon completion, Ramsey County would be responsible for Operation, Maintenance, Repair, Rehabilitation, and Replacement at an estimated average annual cost at current price levels of $2,000. The recommended plan also includes a monitoring program at an estimated total cost at current price levels of $139,000.

The project area covers over 1700 acres. The expected outputs include the enhancement and creation of 7 islands, 16.3 acres of floodplain forest, and 17.6 acres of marsh. This plan would reduce wind and wave action and create conditions more suitable for floodplain forest and shoreline species, while preserving the existing shoreline from further erosion. The recommended plan will contribute 171.1 average annual habitat units over the 50-year period of analysis to the National Environmental Quality Account at an average annual cost of $2,700 per average annual habitat unit.

I have weighed the accomplishments to be obtained from the Pigs Eye Lake project against the cost and have considered the alternatives, impacts, and scope of the proposed project. Therefore, I recommend that the Pigs Eye Lake project for the beneficial use of dredged material in Pool 2 of the Upper Mississippi River be approved for construction.

The recommendations contained herein reflect the information available at this time and current department policies governing formulation of individual projects under the continuing authorities Environmental Management Program. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works continuing authorities program nor the perspective of higher review levels within the Executive Branch.

Samuel L. Calkins
Colonel, Corps of Engineers
District Commander

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