UPPER MISSISSIPPI RIVER RESTORATION FEASIBILITY REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

GREEN ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 13, UPPER MISSISSIPPI RIVER
RIVER MILES 545.9 THROUGH 548.7
JACKSON COUNTY, IOWA

APPENDIX E
ENGINEERING

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ENGINEERING

1. PURPOSE

In accordance with Engineering Regulation (ER) 111-2-1150, this Appendix documents the engineering and design effort during project formulation by the U.S. Army Corps of Engineers (Corps), Rock Island District (District). Engineering data and analyses in the feasibility phase shall be sufficient to develop the complete Project schedule and baseline cost estimate with reasonable contingency factors for each cost item or group of cost items. Engineering analysis shall integrate sound environmental engineering principles.

2. PROJECT DESCRIPTION

The Green Island project is located in Pool 13 of the Upper Mississippi River (UMR) between river miles (RMs) 545.9and 548.7 just south of the confluence with the Maquoketa River (Figure 1 & 2 and Table 1). The study area is located in Jackson County, IA, approximately 3 miles upstream of Clinton, IA. The project features would be located entirely in the Green Island Wildlife Management Area (GIWMA), managed by the Iowa Department of Natural Resources (IADNR). The GIWMA is bordered by the Green Island Levee which consists of approximately 10.8 miles of levees protecting nearly 4,500 acres of land. Roughly 3,000 acres of this land are contained within the Green Island WMA. The Green Island WMA consists of a managed wetland complex including shallow lakes, emergent vegetation and managed moist soil areas, and braided channels surrounded by floodplain timber stands. The wetland complex includes a pump station and a series of water control structures to manage water levels in the GIWMA.

The existing pump station pumps water into Pool A. Water travels through Pool A by a series of conveyance channels to the 4th Ditch (Pump Station Rd), where there is a conveyance channel running parallel for access to the water control structures. Water can be drained into Pool B using the water control structures located along the 4th Ditch. Water can be gravity drained from Pool B into the Mississippi River from a water control structure when water levels on the Mississippi River are low enough to allow for drainage. See Figure 1.

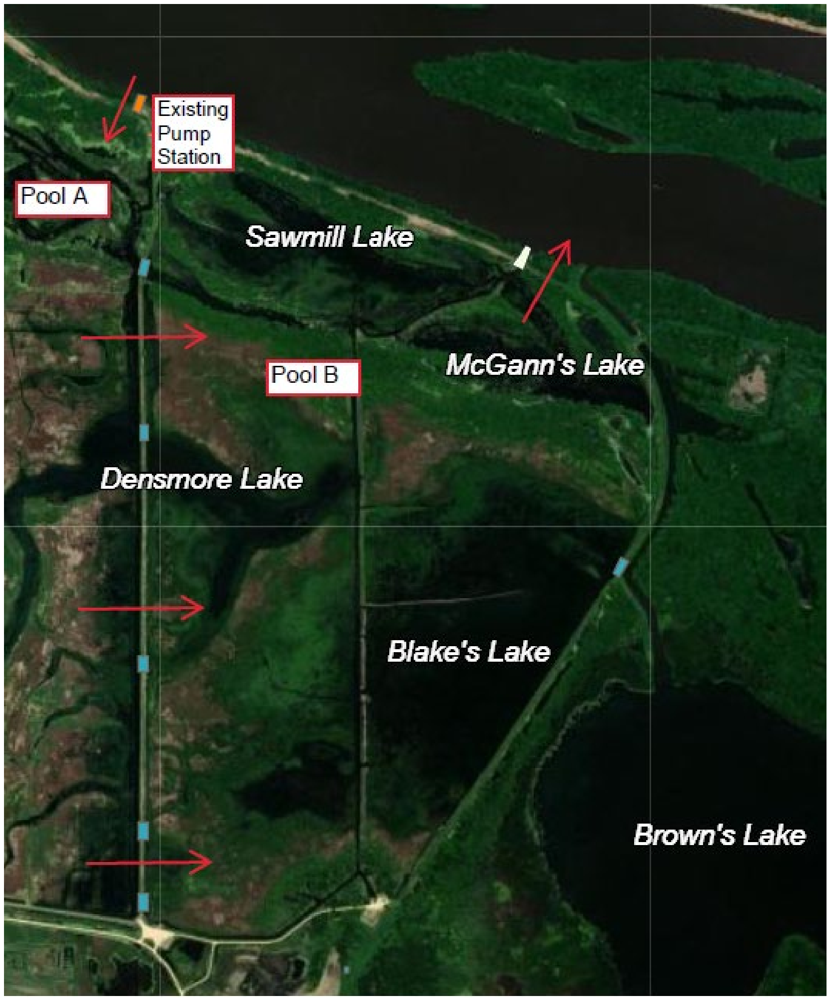


Figure 1 Existing Water Level Management

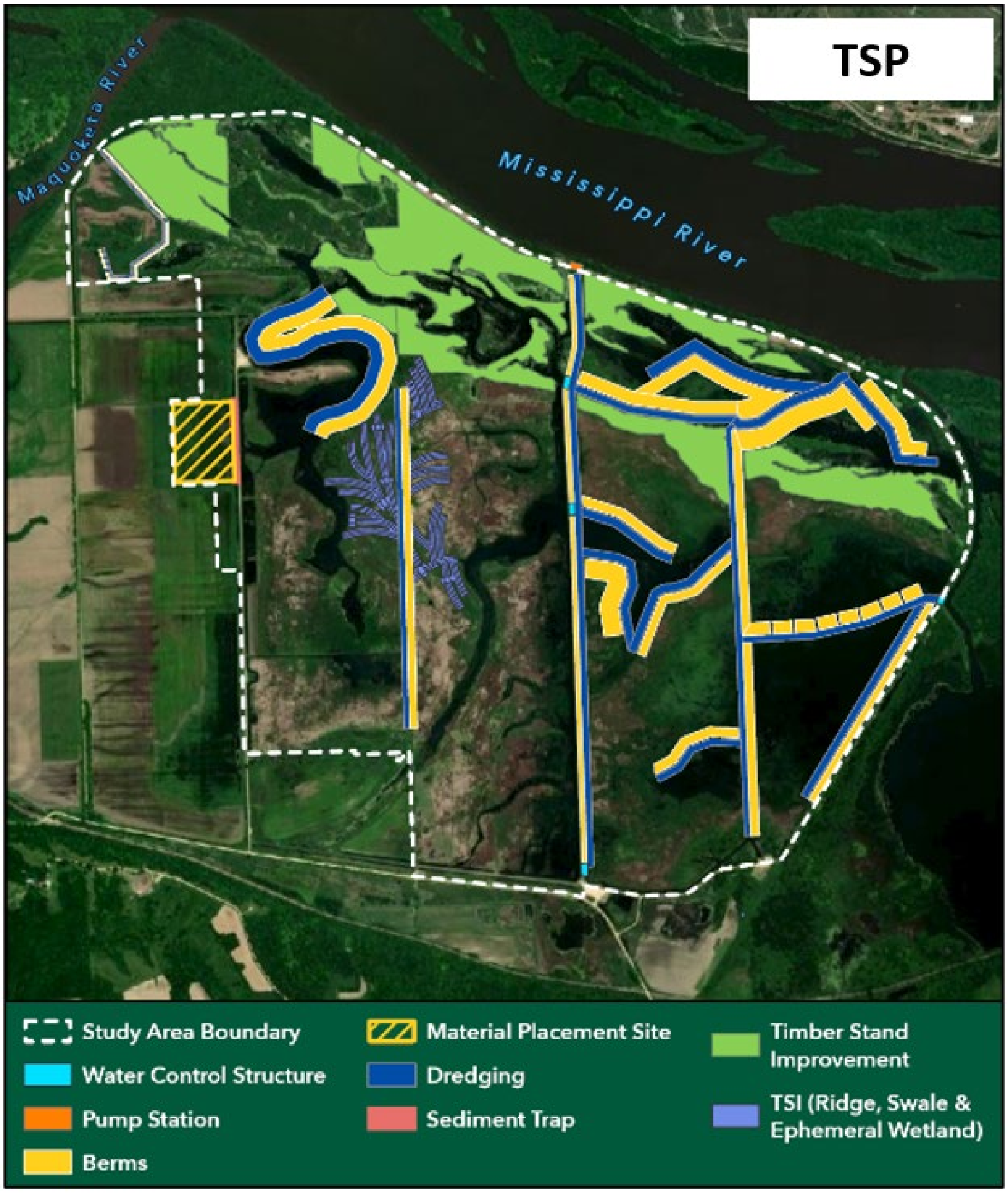


Figure 2. Site Location and Features

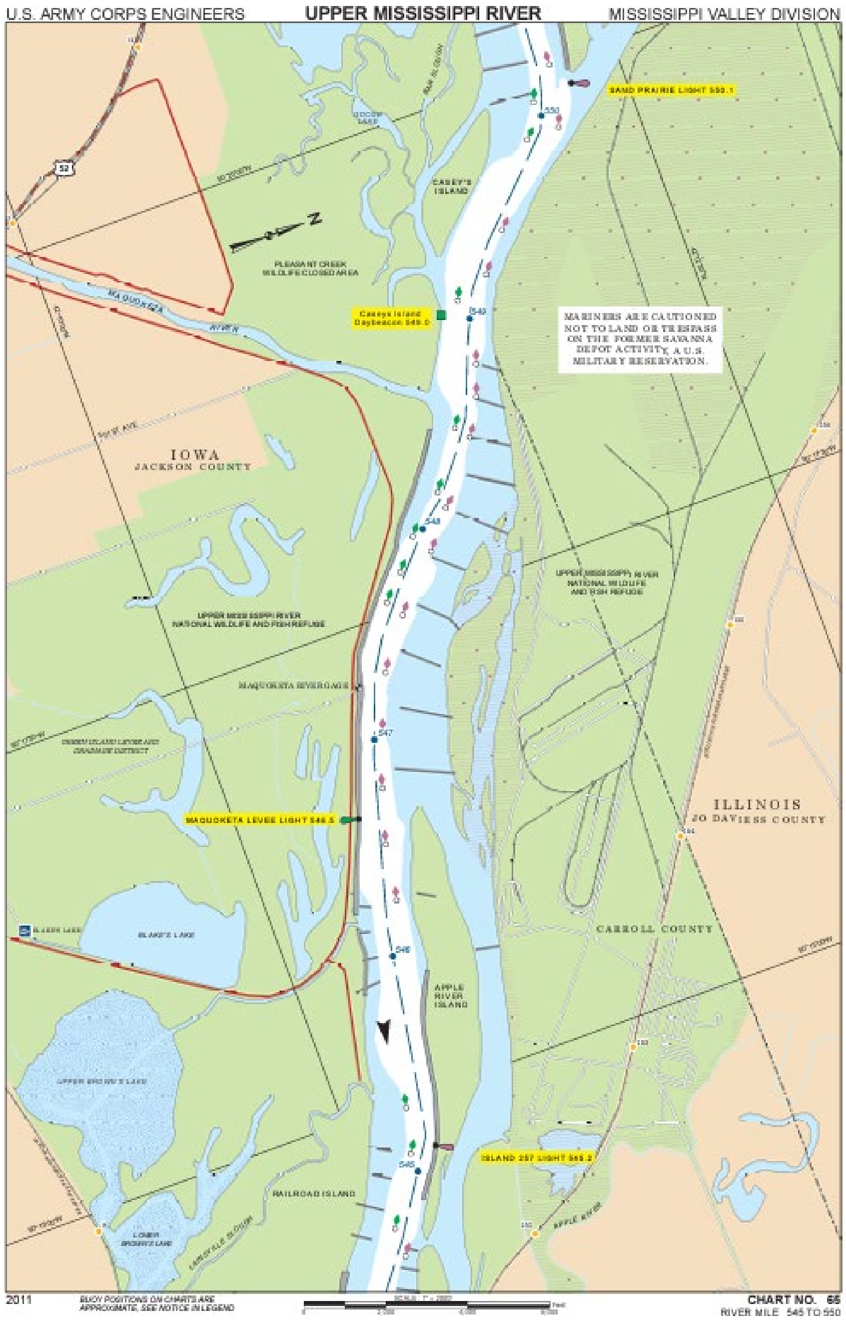


Figure 3. Navigation Chart 65
Source: http://www.mvr.usace.army.mil/Portals/48/docs/Nav/NavigationCharts/UMR/CHART_65.pdf

Table 1. Project Information

ProjectWise Link	B5GILDD1202001 - FEASIBILITY
Solicitation/Contract Number	N/A at this time
P2 Project Name and Number	472045 – Green Island, IA
Technical Lead	Chandra Dowda
Project Name	Green Island Habitat Rehabilitation and Enhancement Project
Project Feature Type	Dredged channels, dredged material placement berms, Timber stand improvement (TSI), water level management to include a new pump station and water control structures, Ridge and Swale Ephemeral Wetland, sediment trap and aquatic habitat restoration.
Project Location	Jackson County, Iowa Between River Miles 545.9 and 548.7
Project Map Location	See Figure 1
Project Description	The work includes, but is not limited to, dredging for conveyance and overwintering, placing dredged material for topographic diversity and berm creation, TSI to include tree clearing and tree plantings, sediment trap, water control structures and a new bidirectional pump station.

3. ENGINEERING.

3.1. Hydrology and Hydraulics. Hydrologic analysis to support design of the measures described herein and additional data collection and analysis in support of this study are documented in the following Attachments:

Attachment A Hydrology and Hydraulics (including Climate Change Analysis)
GreenIsland_APP E ATT A HYDROLOGY AND HYDRAULICS_20230626_DQC2.docx

Attachment D Water Quality
Appendix - Water Quality_DRAFT.docx

Water level information is available at Rivergages.com and in Attachment A Hydrology and Hydraulics.

Water quality sampling may be required during dredging and excavation activities. Turbidity curtains may be required during aquatic excavations, reference Photo 1 below for an example.

Photograph 1. Turbidity Curtain (Huron Island HREP Stage I)

3.2. Surveying, Mapping, and Other Geospatial Data Requirements.

Project datum information is summarized below:

- Horizontal: NAD 83 State Plane Iowa North
- Vertical: NAVD88
- Geoid 18 (CONUS)
- Units: US Survey Feet
- Conversion: MSL12-0.68 feet = NAVD88

EC-TS Performed Topographic and Hydrographic Survey and provided precise data for a local elevation conversion of the feasibility area. EGIS supplemented the topographic data with Lidar Imagery from publicly available data. More details on method of survey and control points are included in Attachment E, Survey, Mapping, and Geospatial Data. B5GILDD1202001-RPT_FEAS-2023-06-07-APP E ATT E Survey_Mapping_Geospatial Data.docx

3.3. Geotechnical.

Project measures include mechanical dredge cuts and deflection berms to provide access to project features and to improve wildlife habitat for plant, animal, and fish species. Hand auger borings and vane shear tests were conducted at Green Island with the overall objective to define site geology and engineering properties of the soil. The collected sample locations for geotechnical lab testing are shown in Figure 3. The geotechnical lab testing provided a baseline for determination of side slopes on dredge cut locations and dredge placement sites.

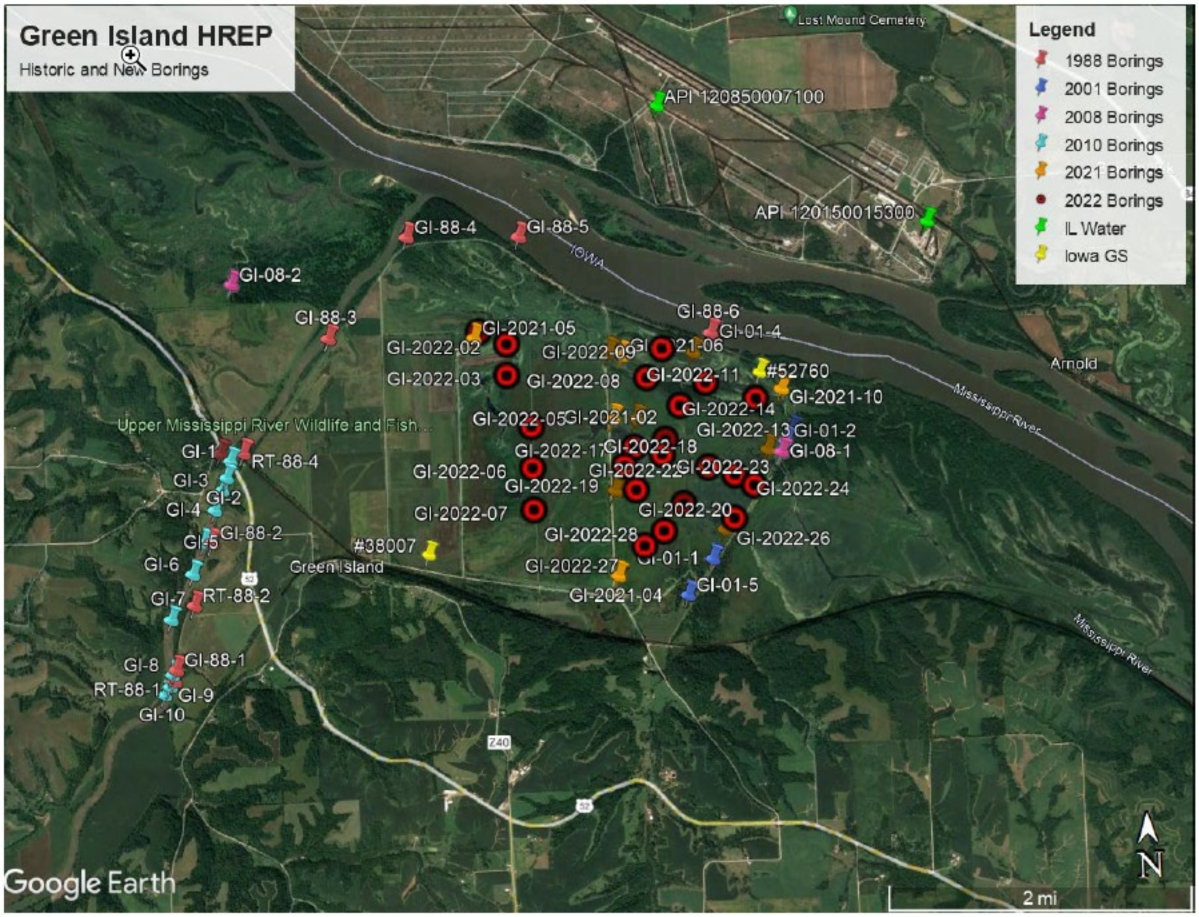


Figure 4. Locations of Historic and New Borings

Geotechnical analyses to support design of the measures and data collection and analysis in support of this study are documented in Attachment C - *Geotechnical Engineering Design.*

3.4. Environmental Engineering.

This project is being constructed under the Upper Mississippi River Restoration program authority. Environmental Engineering considerations are included in Attachment B Civil and Environmental Engineering. Hazardous Toxic and Radioactive Waste is discussed in Attachment H HTRW.

Environmental considerations are included in the main report, including discussion on permit requirements, cultural resources, and NEPA considerations.

The project will be covered under Nationwide Permit 27 Environmental restoration. A Refuge Special Use Permit is not required for this project. NPDES Storm Water permits, if required, will be the responsibility of the construction Contractor.

3.5. Civil Design.

Feature Layouts and feature selection is described in Attachment B Civil and Environmental Engineering. Utility relocations are not required for this Project. There are no existing utilities onsite.

3.6. Structural Requirements.

The reinforced concrete hydraulic structures in the Project will be designed following the current ACI *Building Code Requirements for Structural Concrete* (ACI 318-14) dated 2014 and Engineering Manual (EM) 1110-2-2104, *Strength Design for Reinforced Concrete Hydraulic Structures* dated 30 November 2016. The structural steel components in the Project will be designed following the current AISC *Steel Construction Manual 14th Edition* dated 2011. Additional analyses will require EM 1110-2-2100 *Stability Analysis of Concrete Structures* dated 01 December 2005, EM 1110-2-2502 *Retaining and Flood Walls* dated 29 September 1989, EM 1110-2-2902 *Conduits Culverts and Pipes* dated 31 December 2020, EM 1110-2-2906 *Design of Pile Foundations* dated 15 January 1991, and EM 1110-2-3104 *Structural and Architectural Design of Pumping Stations* dated 30 June 1989.

Concrete structures will be designed for 28-day compressive strength of 4,500 psi. Concrete reinforcement will be deformed billet-steel bars conforming to ACI 615, grade 60 requirements.

The downstream gated structure and pump station will be located downstream of the existing diesel-powered pump station, immediately upstream of Mississippi River mile 547.25. The existing pump station will remain in place so the old diesel pumps can be used as a backup if needed. The pump station will be a bi-directional system designed to transfer water both to and from the Mississippi River, from either Pool A or Pool B, when free flow water elevations are not desirable; it will have a gate on either side of the pump. A single 5-foot by 5-foot gated free-flow culvert opening will be provided adjacent to the pump station as an integral concrete structure. The two openings—the pump station and one gated free flow culvert—will be located on the protected side and channel into a single 10-foot by 6-foot box culvert to span the width of the berm. The pump station gates will be utilized as system redundancy during a surge event. The gates will be cast iron. The pump station will be designed such that the maximum elevation at which the pumps can operate is the 500-yr flood elevation (601.60-feet MSL 1912 ADJ). The pumps will be located at a design invert elevation of 576.00-feet (MSL 1912 ADJ), a depth that will allow them to remain submersed during a low water condition. As a system redundancy, the pump station will house two 27,000-GPM electric submersible pumps capable of providing two-thirds of the requested 40,000-GPM design capacity, as stipulated by the sponsor to match the existing pump station capacity.

Channels leading to the downstream gate and pump station will be excavated to elevation 576.82 (MSL 1912 ADJ). This difference in elevations from the interior bottom to the invert introduces a siltation concern for both the free flow culvert and the pumps. Silt mitigation is not yet included in the design. Trash racks will be provided on both the river side and protected side to shield the structure from debris. The structure was designed to allow for a minimum interior managed water elevation level of 582.80-feet (MSL 1912 ADJ) and a maximum interior managed water elevation level of 587.70-feet (MSL 1912 ADJ). The minimum water level management cycle elevation was set at 582.80-feet; however, this design will allow for lower drawdowns if deemed necessary by the sponsor. The river side of the culvert will have a stoplog structure for water management and dewatering capabilities. The sluice gates will be operated by mechanically driven motors, and the stoplog structures will be manually installed. The pump station and outlet structure will be designed for heavy machinery, such as an excavator, in order to clean the trash racks and operate the stoplogs. The design of the pump station will be similar to the design used for the Ventura Marsh Aquatic Ecosystem Restoration Project in Clear Lake, Iowa (Contract No. W912EK-10-B-0008).

The upstream gated structure will be located downstream of the existing diesel-powered pump station, immediately upstream of Mississippi River mile 547.25. Two culvert openings will be provided on the upstream side as an integral concrete structure. The two openings will channel into one 10-foot by 6-foot box culvert spanning the width of the berm. The sluice gates will be operated by mechanically driven motors, and the stoplog structures will be manually installed. Two culvert openings are provided for system redundancy and to reduce the size of stoplog and trash rack structures. Channels leading to the upstream gate and pump station will be excavated to Elevation 576.82 (MSL 1912 ADJ). This difference in elevations from interior bottom to invert introduces a siltation concern for the gated free flow culverts. Silt mitigation is not yet included in the design. Trash racks will be provided on both the river side and protected side to protect the structure from debris. Stoplog closures will be provided on the river side. The structure will be designed to allow for a minimum interior managed water elevation level of 582.80-feet (MSL 1912 ADJ) and a maximum interior managed water elevation level of 587.70-feet (MSL 1912 ADJ). The river side of the culvert will have a stoplog structure for water management and dewatering capabilities. The gated culvert structure will be designed for heavy machinery, such as an excavator, in order to clean the trash racks and operate the stoplogs.

3.7. Electrical and Mechanical Requirements.

Mechanical Requirements

The existing Green Island pump station currently utilizes two 150 hp 20,000 gpm diesel powered vertical propeller pumps. The diesel equipment and pumps are located in a covered pump house. The current configuration only allows for one-way river to marsh pumping capability. The pump station is operated by the Iowa DNR.

The Iowa DNR Bureau of Construction Services prepared the engineering plans for the pump station in 1990. The original design allowed for bi-directional pumping capability utilizing valving. The original design was not followed, and one-way pumping capability was installed. Allied Systems Inc. supplied and installed the pump station pumps. The pumps are housed in a covered pump station. Diesel drivers power each pump.

On site assessment indicated that the pumps are in operable condition. Parts for the pumps are readily available. The pumps are able to be overhauled to like-new condition, if required. Per on-site personnel, the pumps have sufficient pumping capacity. The pumps are not subject to flooding conditions.

The existing pumps are driven by diesel drivers. The diesel drivers may be replaced with electric motors with no modifications. The future pumping arrangement may be powered using either diesel or electric power. Electrically powered equipment would require substantial electrical infrastructure construction work and investment since no electrical infrastructure is currently in place.

The current pump house could potentially be reworked to provide river to marsh and marsh to river pumping capability utilizing the original plans as a baseline. New underground piping would need to be installed. Substantial cost avoidance would be realized through re-use of the pump station structure, foundation, and graded conditions. It appears feasible to rotate the discharge of the pumps 90 degrees and install piping as shown on the original design. The existing pumps could also easily be overhauled and relocated to a new pump station. USACE has observed pumps dating back to the early 1900's that are currently still in service with routine maintenance.

The existing two 150 hp 20,000 gpm pumps represent a good starting design capacity baseline for a new or reconfigured pump station. New pumps ideally would be selected to match the existing pump performance characteristics since the existing pumps meet the DNR's needs and operate well. Hydraulic analyses and recommendations may dictate that the size of the pumps be adjusted up or down. Pump size may need to be increased if pumping conditions such as operation elevations, pumping distances, etc. are modified substantially from the existing conditions. Final pump style would be determined during design phase.

A new pump station could potentially be constructed. Valving similar to the original pump station design could be utilized to allow for two-way flow. A covered or uncovered pump station could be constructed. An uncovered pump station would cost substantially less than a covered pump station since no building and associated infrastructure would be required. Factors driving the final configuration would include exact pump style, budget, and maintainability.

Electrical Requirements

USACE engineering met with Matt Kurt of Maquoketa Valley Electric Cooperative (MVEC) (319-820-0368) to discuss the feasibility of providing power to the pump station. MVEC proposed installing an underground (UG) power cable along the North-South roadway which leads directly to the existing pump station. The UG power cable would require an aboveground maintenance/pull box every 600 feet. MVEC also proposed installing an aboveground utility box adjacent to each gate structure along the road for future use to provide power to the gates if this were ever desired. In addition, MVEC will install a transformer adjacent to the new pump station. The transformer will have a revenue meter socket built into it for the utility to use for their meter installation. Our construction contractor will be responsible for installing the new transformer pad and UG conduit for the UG power cable, as well as the secondary conductors and conduit to feed the new pump station. It's recommended that the new transformer pad be constructed so that the transformer will be at or above the 500-year flood elevation or flood of record, whichever is highest at this location. The new UG power cable, pull boxes, transformer, and meter will be owned and maintained by MVEC.

A proposal was made by the DNR to run power a longer way around and approach the pump station from the east so that power can be supplied to gate structures along the river. If this were done, it will cost more, and power cannot be supplied to all of the gate structures since one or more are on the Aliant Energy side of the utility boundary line.

The power cable will consist of 3 phase conductors, 1 neutral conductor, and a fiberoptic (FO) cable. The FO cable may be used for future use if future communication for monitoring and control is desired with the new pump station.

The existing pump station does have electrical power supplied by a 16KW belt driven generator which runs off the east diesel engine.

The boundary line between MVEC and Aliant Energy Company runs NS and roughly splits the existing pump station down the middle. The new pump station must be constructed to the east of the existing pump station to be under MVECs jurisdiction. If the new pump station is constructed along the boundary line between the 2 utilities, or if the existing pump station is rehabbed by replacing the existing diesel pumps with electric pumps, the majority of the electrical loads must be on the MVEC side of the line.

MVEC will be bringing power to the DNR office and from there to the GI HREP site. The route from the DNR office to GI HREP site will cross a railroad. This will require coordination between MVEC and railroad, which takes time. A permit may be required to cross underneath the railroad tracks. The electrical cost for underground installation of service is estimated to be $800,000 in construction costs with operational monthly costs of $15,000 for a usage month and $70 for a no usage month.

Electrical Engineering recommendations are as follows and must be sanctioned by Mechanical Engineering:

1. Recommend the new pump station have vertical turbine pumps. There are extra control and monitoring for submersible pumps, such as leak detection. Also, roof hatches are highly recommended above each pump in case a motor or pump has to be pulled.

2. Recommend the existing pump station remain operational during the construction of the new pump station just in case the DNR has a requirement to pump during construction of the new pump station. Otherwise, temporary pumping will have to be provided by the construction contractor as needed.

3. If it were decided to rehab the existing pump station and replace the 2 diesel engines with electric motors, Engineering believes it will be easy to construct an adaptor and place the new horizontal shaft electric motor to the existing diesel foundations. Engineering doesn’t recommend a vertical shaft motor to replace the diesels since the existing pump drive mount plate is not constructed to take the weight of a vertical shaft motor. Of course, if this is done, the existing pumps will have to be inspected for wear and probably refurbished.

4. Engineering recommends using directional boring to install the UG conduit for the new UG cable.

5. It may be recommended to install parallel UG conduits so there is a spare conduit in case there is a failure of the UG cable, and a portion of the cable will have to be replaced. The spare conduits will also run into each of the above ground pull boxes.

3.8. Hazardous, Toxic and Radioactive Waste.

A Phase I Environmental Site Assessment (ESA) was completed in March of 2023 for the Study Area and adjacent area. The Phase I ESA documented the Study Area history, reviewed state and Federal environmental databases, and reviewed potential Recognized Environmental Conditions (RECs). Information is provided in Attachment H, Hazardous Toxic and Radioactive Waste (HTRW) Documentation report.
<u>Green Island HREP Attachment HTRW DRAFT.docx</u>

As required for all earth working Projects in the District, it is also recommended that the Environmental Protection specification section include requirements for HTRW testing of any material to be brought onto the site or removed from the site to ensure the material is not contaminated. If contaminated material is identified, the District would stop work and follow the steps outlined in ER 1165-2-132.

Ensure all construction equipment is cleaned and free of soil residues, plant, pests, noxious weeds and seeds. No soils can be removed from site unless tested. Material dredged and placed on the placement sites shown do not require HTRW testing, but any soil material removed from the project site will require testing of the parameters listed in the following table.

Table 2. Soil and Materials Analytical Parameters

SOIL AND MATERIALS ANALYTICAL PARAMETERS

Volatiles Testing Requirements	
Item	**Method**
Volatiles	SW-8260B

Semi-Volatiles Testing Requirements	
Item	**Method**
Base/Neutrals Extractable Organics	SW-8270C
Acid Extractable Organics	SW-8270C

PCB Testing Requirements	
Item	**Method**
PCBs	SW-8082

Pesticides Testing Requirements	
Item	**Method**
Pesticides	8081A

Herbicides Testing Requirements	
Item	**Method**
Herbicides	8151

Metals Testing Requirements	
Item	**Method**
Antimony	6010 B
Arsenic	6010 B
Barium	6010 B
Beryllium	6010 B
Cadmium	6010 B
Chromium, total	6010 B
Chromium, hexavalent	6010 B
Cobalt	6010 B
Copper	6010 B
Lead, total	6010 B
Manganese	6010 B
Mercury	7471A
Nickel	6010 B
Selenium	6010 B
Silver	6010 B
Thallium	6010 B
Vanadium	6010 B
Zinc	6010 B
Boron	6010 B
Molybdenum	6010 B
Strontium	6010 B

TCLP Testing Requirements	
Item	**Method**
Arsenic	6010B
Barium	6010B
Benzene	8021
Cadmium	6010B
Chlordane	8081A
Chlorobenzene	8260B
Chloroform	8260B
Chromium	6010B
o-Cresol	8270C
m-Cresol	8270C
p-Cresol	8270C
2,4,D	8151A
1,4-Dichlorobenzene	8260B
1,2-Dichloroethane	8260B
1,1-Dichloroethylene	8260B
2,4 Dinitrotoluene	8270C
Endrin	8081A
Heptachlor	8081A
Hexachlorobenzene	8270C
Nitrobenzene	8270C
Pentachlorophenol	8270C
Pyridine	8270C
Trichloroethylene	8270C
2,4,5-Trichlorophenol	8270C
Methoxychlor	8081A
Methyl ethyl ketone	8260B
Mercury	7471A
Lindane	8081A
Lead	6010B
Hexachlorethane	8270C
Hexachlorobutadine	8270C
Tetrachloroethylene	8260B
Toxaphene	8081A
Silver	6010B
Selenium	6010B
2,4,6-Trichlorophenol	8270C
2,4,5-TP	8151A
Vinyl Chloride	8260B

3.9. Construction Procedures and Water Control Plan.

Detailed construction procedures will be developed in the design stage. Water control plans required during construction will need to address high water action plans and construction methods in variable river stages.

3.10. Initial Reservoir Filling and Surveillance Plan.

Not applicable to this Project.

3.11. Flood Emergency Plans for Areas Downstream of Corps Dams.

Not applicable to this Project.

3.12. Environmental Objectives and Requirements.

Project Objectives (which are environmental objectives) are outlined in the Main Report in Section II, Paragraph D.

3.13. Reservoir Clearing.

Not applicable to this Project.

3.14. Operation and Maintenance.

This project was developed to reduce the overall operation and maintenance for the project sponsor. Reference Attachment F OMRRR for more details.
B5GILDD1202001-RPT_FEAS-2023-06-15-APP E ATT F - OPERATIONS AND MAINTENANCE.docx

3.15. Access Roads.

The study area of interest is best accessed by land. The project site can be accessed either from the Southwest or the Southeast direction via HWY 52 and then by turning onto Green Island Road at either lower corner of the project boundary, as seen in Figure 4 below.

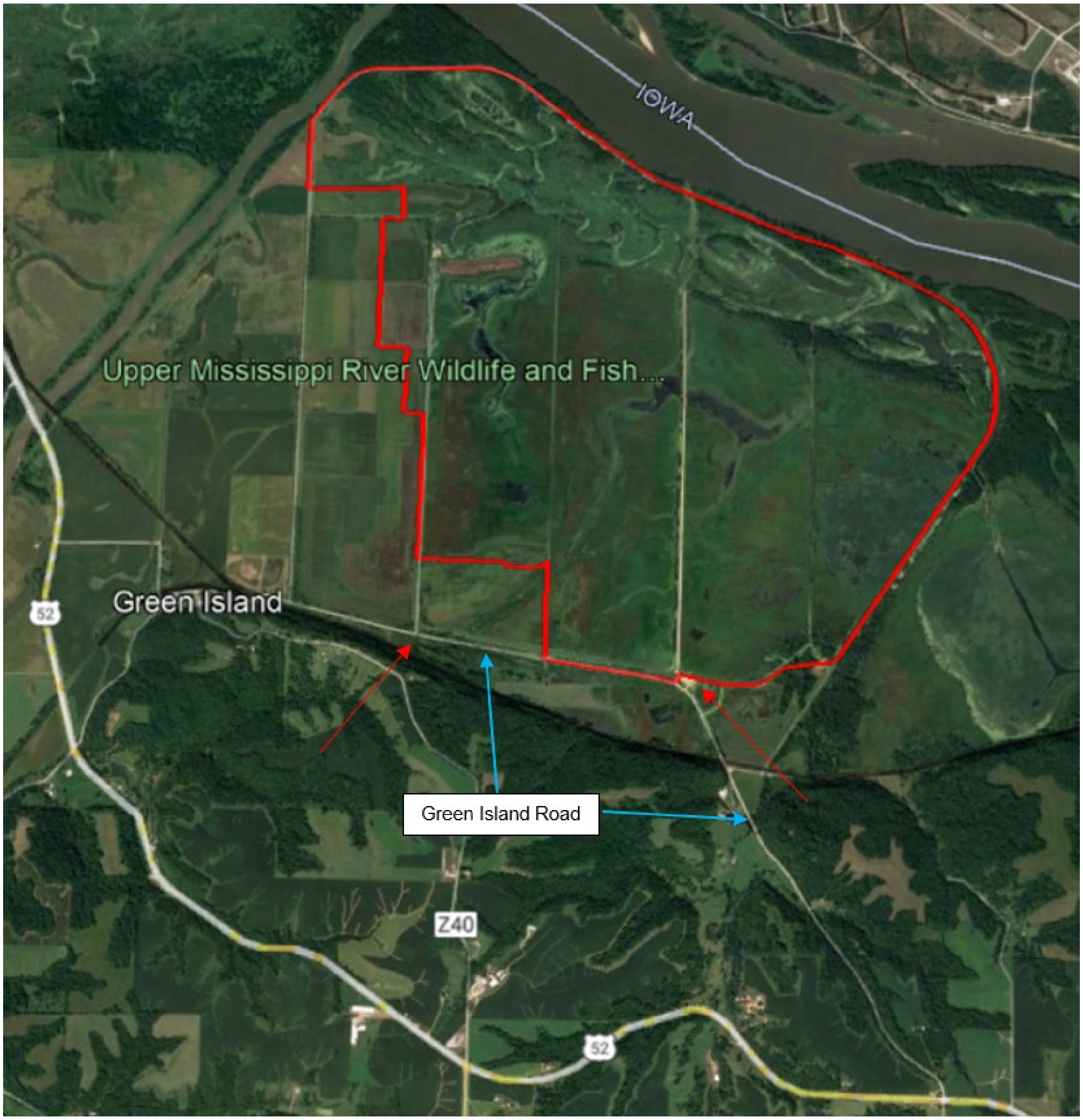


Figure 5. Project Land Access

3.16. Corrosion Mitigation.

Not applicable to this Project.

3.17. Project Security.

Safety and security are important parameters which would be detailed during the design phase. Of specific concern will be the coordination of regional hunting seasons during construction. There is a waterfowl refuge area (shown in red in Figure 5.) on the West side of the project area that is not open for hunting during fall/winter hunting season dates. As a waterfowl refuge, during that period it is important to allow the waterfowl a place to rest.

Staging areas would be in generally remote locations, to include existing parking lots within the GIWMA, and equipment would need to be secured when there is no oversight in these locations. These parking areas would be closed to public access when construction is in process in their respected pools. Only one Pool at a time will have closed parking areas for construction, always leaving public access to parking open to one Pool.

Figure 6. Waterfowl Refuge at GIWMA

3.18. Cost Estimates.

Cost estimates are provided in Appendix F, *Cost Engineering*.
B5GILDD1202001-APPX-2023-05-26-COST.docx

3.19. Schedule for Design and Construction.

Design work would be completed in general 18 to 24 months prior to construction award. Table 3 below is the estimated construction stages for the TSP. These schedules are broken out for a typical HREP funding scenario.

Table 3. Green Island Construction Schedule

Stage	Pool	Item	Measure Name
I	A/B	**Start Date: 2027**	**End Date: 2029**
		Build Pump Station	WCS-01
		Water Control Structures	WCS-02, WCS-03, WCS-06, WCS-07, WCS-08, WCS-09
II	A	**Start Date: 2029**	**End Date: 2031**
		Dredging – Over Wintering	CHN-A-01
		Dredging - Conveyance	CHN-A-02
		Construct Topographic Diversity Berms	BRM-A-01, BRM-A-02
		Construct Ridge and Swale	RS-01
		Create Sediment Trap	ST-01
		Timber Stand Improvement (TSI)	TSI-01, TSI-02, TSI-09
III	B	**Start Date: 2031**	**End Date: 2033**
		Dredging – Over Wintering	CHN-B-01, CHN-B-02
		Dredging - Conveyance	CHN-B-03, CHN-B-04, CHN-B-06, CHN-B-07, CHN-B-08, CHN-B-09, CHN-B-10, CHN-B-11, CHN-B-12, CHN-B-13
		Construct Topographic Diversity Berms	BRM-B-03 thru BRM-B-13 (excluding #5)
		Timber Stand Improvement (TSI)	TSI-03, TSI-04, TSI-06
IV	A/B	**Start Date: 2033**	**End Date: 2035**
		Timber Stand Improvement (TSI)	TSI-08(Ridge and Swale), TSI (All Berms)

3.20. Special Studies.

No special studies were performed.

3.21. Plates, Figures and Drawings.

Refer to Appendix L, *Plates.*
B5GILDD1202001-RPT_FEAS-2023-08-30-APP L PLATES.pdf

3.22. Data Management.

Data will be managed using the District's Bentley ProjectWise Explorer data management system. For more details refer to Appendix E, *Engineering*, Attachment G, *Data Management.* B5GILDD1202001-RPT_FEAS-2023-06-08-APP E ATT G Data_Management.docx

3.23. Use of Metric System Measurements.

Metric units are used for water quality measurements, all other measurements utilize the English system.

4. DESIGN CONSIDERATIONS

4.1. Design Criteria.

Reference Attachment B Civil and Environmental Engineering for design criteria, including submerged aquatic vegetation, wind driven wave reduction, and overwintering habitat. B5GILDD1202001-RPT_FEAS-2023-06-06-APP E ATT B CIVIL AND ENVIRONMENTAL.docx

4.2. Feature Site Location.

Feature Site Locations are described in Attachment B Civil and Environmental Engineering. Information that led to feature locations is included in the following:

- Sponsor Recommendations
- Site visits
- Water Depths
- Water Quality Monitoring Data
- Sediment Sources
- Habitat Suitability Index
- Velocity
- Wind Wave Modeling
- Sediment Evaluations
- Aerial Photography and Mapping
- Recreational Boating Impacts
- Floodplain Impacts
- Hazardous, Toxic and Radioactive Waste (HTRW)
- Real Estate Boundaries

4.3. Dredge Material Topographic Diversity Berms.

All placement sites were identified as desirable locations for dredge material placement. This material provides benefits such as habitat for nesting birds, restoring waterfowl habitat, while also contributing to the ability to plant additional forest vegetation. Berms were designed to heights for tree planting survivability and to provide sufficient capacity for dredge material placement.

The dredge material will be placed on the disposal sites to a top elevation of 589.72 in Pool A and 586.82 in Pool B NAVD88. Water management pools are shown in Figure 6 below. During the feasibility design, a conservative slope recommendation was provided by Geotech due to a lack of boring data at the site. Dredged channel side slopes were set at 8H:1V for stability and to prevent sloughing for all features. Based on the nature of the Ridge and Swale and Murphy's Cell features being a slightly different construction using a dozer to push up material, those slopes were set at 3H :1V. Dredged material placement site design will be revised if further Geotechnical borings and seepage analyses indicate that slope recommendation changes are required. The slope designs will help ensure that once the material is placed it will not migrate off site. Changing of slopes and/or protection of slopes may be required based on further Geotechnical analysis. Dredge disposal site capacity is 1,095,969 CY. Total anticipated dredging quantity for the TSP is 1,095,969 CY. The site footprints, as identified in early iterations, were designed to match historic footprints and will be refined during design. The potential dredged material placement sites and proposed quantities are summarized in Figure 6 and Table 4.

Where possible, dredge channels and topographic diversity berm layouts were designed adjacently to allow for side casting of dredged material.

4.3.1.1. BRM-A-01 Berm: Fish Lake Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.2. BRM-A-02 Berm: Murphy's Cell

The intent of this proposed feature was to control the Murphy's cell in the northwest section of the project.

4.3.1.3. BRM-B-01 Berm: Sawmill Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.4. BRM-B-02 Berm: McGann's Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.5. BRM-B-03 Berm: Densmore Upper Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.6. BRM-B-04 Berm: Densmore Lower Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.7. BRM-B-06 Berm: Blake's Lake to Browns Berm

The intent of this proposed feature was to plant vegetation and to break up waves, with a 50' break every 300'.

4.3.1.8. BRM-B-07 Berm: Blake's Lake Lower Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.9. BRM-B-08 Berm: 5th Ditch Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.10. BRM-B-09 Berm: Southeast Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.11. BRM-B-10 Berm: 4th Ditch Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.12. BRM-B-11 Berm: McGann's to Miss Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.13. BRM-B-12 Berm: Snag Slough Berm

The intent of this proposed feature was to plant vegetation and to break up waves.

4.3.1.14. BRM-B-13 Berm: Densmore Horseshoe

The intent of this proposed feature was to plant vegetation and to break up waves.

Figure 7. Water Management Pools

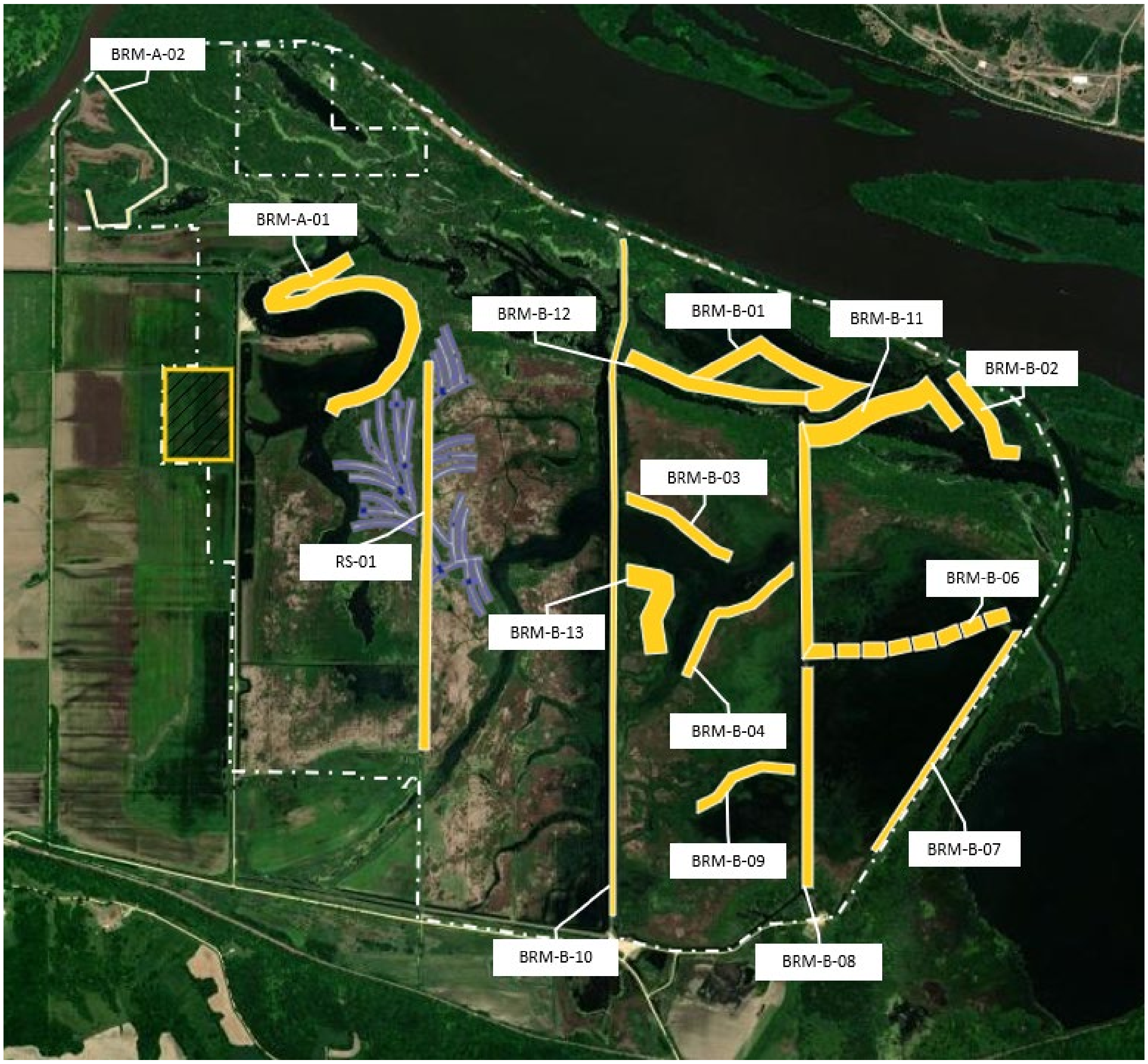


Figure 8. Dredge Material Placement Location Map

Table 4. Summary of Dredged Material Placement Site Capacities

Measure Name	Description	Quantities	Units
Berm			
BRM-A-01	Fish Lake Berm	107,352	CY
BRM-A-02	Murphy's Cell Berm	44,694	CY
BRM-B-01	Sawmill Berm	57,910	CY
BRM-B-02	McGann's Berm	28,596	CY
BRM-B-03	Densmore Lake Upper Berm	32,483	CY
BRM-B-04	Densmore Lake Lower Berm	53,562	CY
BRM-B-06	Blake's Lake to Browns Berm	45,527	CY
BRM-B-07	Blake's Lake Lower Berm	56,812	CY
BRM-B-08	5th Ditch Berm	123,877	CY
BRM-B-09	Southeast Berm	29,908	CY

BRM-B-10	4th Ditch Berm	252,198	CY
BRM-B-11	McGann's to Miss Berm	40,397	CY
BRM-B-12	Snag Slough	39,760	CY
BRM-B-13	Densmore Horseshoe	43,859	CY
RS01	Ridge & Swale	128,906	CY
	5 Potholes - 60' length	1,701	CY
	10 Potholes - 100' length	8,426	CY
	Total	**1,095,969**	CY

4.4. Timber Stand Improvement (TSI).

TSI measures would address the identified floodplain forest problems and restoration objectives related to lack of diversity and loss of spatial extent by enhancing the age, composition, and structure of the existing forest. The forest inventory results and more details on the TSI prescriptions are included in Appendix A, *Environmental.* The PDT used the Floodplain Forest model, to evaluate the following measures. The TSI locations can be seen in Figure 7 below.

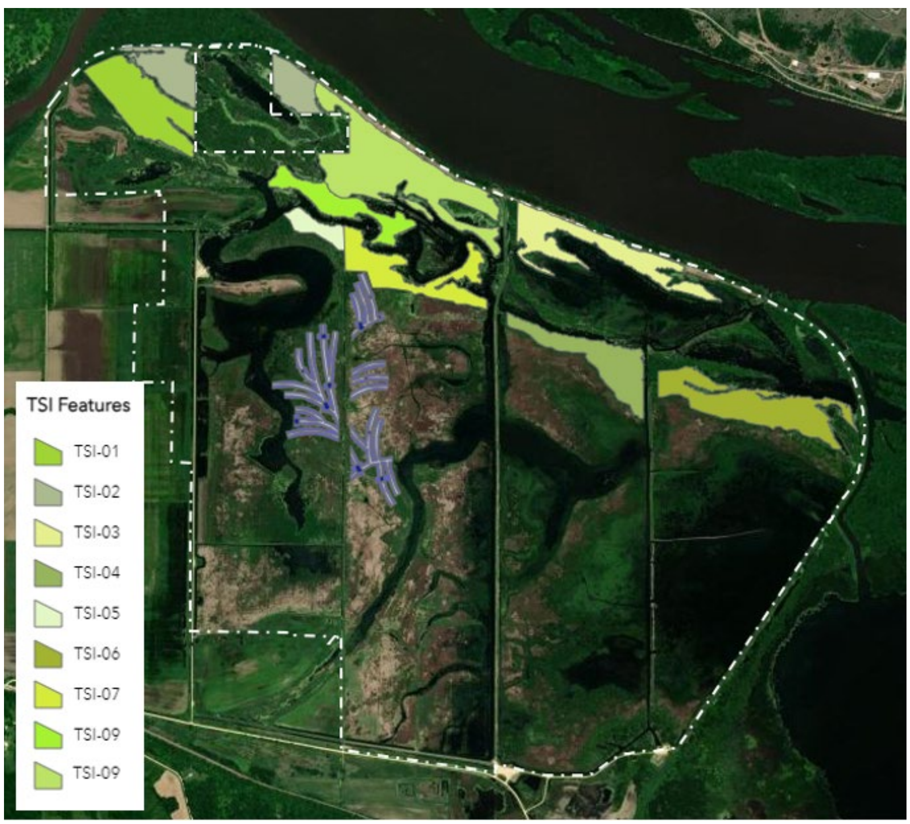


Figure 9. TSI Locations

4.4.1. TSI-01 Snider Lake West Timber Stand Improvement

TSI-01 identified approximately 34 acres to receive timber stand improvement. Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment. The target for tree thinning is to release good form understory trees and increase light by cutting stressed and poor in growth form understory and midstory trees. Thinning will be uneven; some areas require no thinning due to open canopy conditions. Tree plantings will focus on increasing species and age diversity in areas where gaps in the canopy exist. Shrub plantings target positive impacts to pollinator species and migratory bird use during fall migration. Tree and/or shrub planting efforts are primarily intended to be conducted using containerized stock. Invasive species treatment will include fall and spring season herbicide application to reed canary grass in canopy gaps.

4.4.2. TSI-02 Snider Lake East Timber Stand Improvement

TSI-02 identified approximately 27 acres to receive timber stand improvement. Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment, similar to TSI-01.

4.4.3. TSI-03 Sawmill Lake Upper Timber Stand Improvement

TSI-03 identified approximately 25 acres to receive timber stand improvement. Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment, similar to TSI-01.

4.4.4. TSI-04 Sawmill Lake Lower Timber Stand Improvement

TSI-04 identified approximately 26 acres to receive timber stand improvement. Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment, similar to TSI-01.

4.4.5. TSI-06 McGann's Lake Timber Stand Improvement

TSI-06 identified approximately 36 acres to receive timber stand improvement. Timber stand improvement will include tree thinning, tree and shrub plantings, and invasive species treatment, similar to TSI-01.

4.4.6. TSI-08 Fish Lake East, R&S North Timber Stand Improvement

TSI-08 identified approximately 24 acres to receive timber stand improvement. Timber stand improvement will include tree thinning where necessary, and tree and shrub plantings. Living trees to remain will be marked for protection.

4.4.7. TSI-09 North Central 3rd-4th Ditch Timber Stand Improvement

TSI-09 identified approximately 40 acres to receive timber stand improvement. Timber stand improvement will include tree thinning where necessary, and tree and shrub plantings.

4.4.8. TSI-09 Lower North Central 3rd-4th Ditch Timber Stand Improvement

TSI-09 Lower identified approximately 20 acres to receive timber stand improvement. Timber stand improvement will include tree thinning where necessary, and tree and shrub plantings.

Photograph 2. Thinning treatment at Beaver Island HREP, March 2021

4.5. Ephemeral Wetland.

Ephemeral wetland features that were considered included ridge and swale features.

4.5.1. RS-01 Ridge and Swale

The intent of this proposed feature was to increase topographic diversity for native plants and animals. Creating the approximately 140 acres of ridge and swale feature will consist of clear cutting, planting trees, mulching, and excavation of approximately 15 Ephemeral Wetland (potholes). The potholes are of varying depths, typical section details can be found in Appendix L, Plates. Five of the potholes are 54’ wide by 60’ long. The other 10 potholes are 86’ feet wide by 100’ long.

4.6. Aquatic Habitat Restoration.

Aquatic habitat restoration features that were considered included channel excavation for overwintering habitat, water control structures, sediment trap, and berm construction. Significant factors contributing to the value of winter bluegill habitat on the UMRS include water depth, dissolved oxygen (DO), water temperature, and current velocity. The features mentioned would create desirable habitat by ensuring adequate depth for fish and other aquatic species to survive during the winter, reducing velocities, and sedimentation to ensure the longevity of the overwintering dredge cuts.

4.6.1. Excavation/Dredge Channels

Excavation has been proposed as a potential measure to provide suitable year-round habitat for fish, provide conveyance for interior supply and drainage, as well as provide material to increase topographic diversity within the floodplain forest. Mechanical dredging was the excavation method used for feasibility design assuming a Marsh buggy (also known as a marsh excavator or a swamp buggy), which is a type of amphibious vehicle designed to be used in both aquatic and terrestrial areas. These tracked vehicles can float when in the water. Marsh buggies are used to navigate rough wetland terrain. Several potential areas in the study area were evaluated for channel excavation. During the feasibility design, a conservative slope recommendation was provided by Geotechnical Engineering due to a lack of boring data at the site. Dredge cut slopes were set at 8H:1V for all features except the Ridge and Swale and Murphy's Cell features, which were set at 3H:1V. Based on the nature of the Ridge and Swale feature being a slightly different construction using a dozer to excavate material, those slopes were set at 3H :1V. Dredge channels will be designed further during PED once further Geotechnical borings and seepage analyses are completed. Slopes may be changed and/or protection of slopes may be required based on further analysis. The potential dredge channel capacities are summarized in Figure 9 and Table 5.

4.6.1.1. CHN-A-01
CHN-A-01, also known as Fish Lake Channel, was intended to provide overwintering habitat.

4.6.1.2. CHN-A-02
CHN-A-02, also known as Murphy's Cell, was intended to provide drainage.

4.6.1.3. CHN-B-01
CHN-B-01, also known as Sawmill Lake Channel, was intended to provide overwintering habitat.

4.6.1.4. CHN-B-02
CHN-B-02, also known as McGann's Lake Channel, was intended to provide overwintering habitat.

4.6.1.5. CHN-B-03
CHN-B-03, also known as Densmore Lake Upper Channel, was intended to provide drainage.

4.6.1.6. CHN-B-04
CHN-B-04, also known as Densmore Lake Lower Channel, was intended to provide drainage.

4.6.1.7. CHN-B-06
CHN-B-06, also known as Blake's Lake to Browns Channel, was intended to provide drainage.

4.6.1.8. CHN-B-07
CHN-B-07, also known as Blake's Lake Lower Channel, was intended to provide drainage.

4.6.1.9. CHN-B-08
CHN-B-08, also known as 5th Ditch Channel, was intended to provide drainage.

4.6.1.10. CHN-B-09
CHN-B-09, also known as Southeast Channel, was intended to provide drainage.

4.6.1.11. CHN-B-10
CHN-B-10, also known as 4th Ditch Channel, was intended to provide drainage.

4.6.1.12. CHN-B-11
CHN-B-11, also known as McGann's to Miss Channel, was intended to provide drainage.

4.6.1.13. CHN-B-12
CHN-B-12, also known as Snag Slough Channel, was intended to provide drainage.

4.6.1.14. CHN-B-13
CHN-B-13, also known as Densmore Horseshoe, was intended to provide drainage.

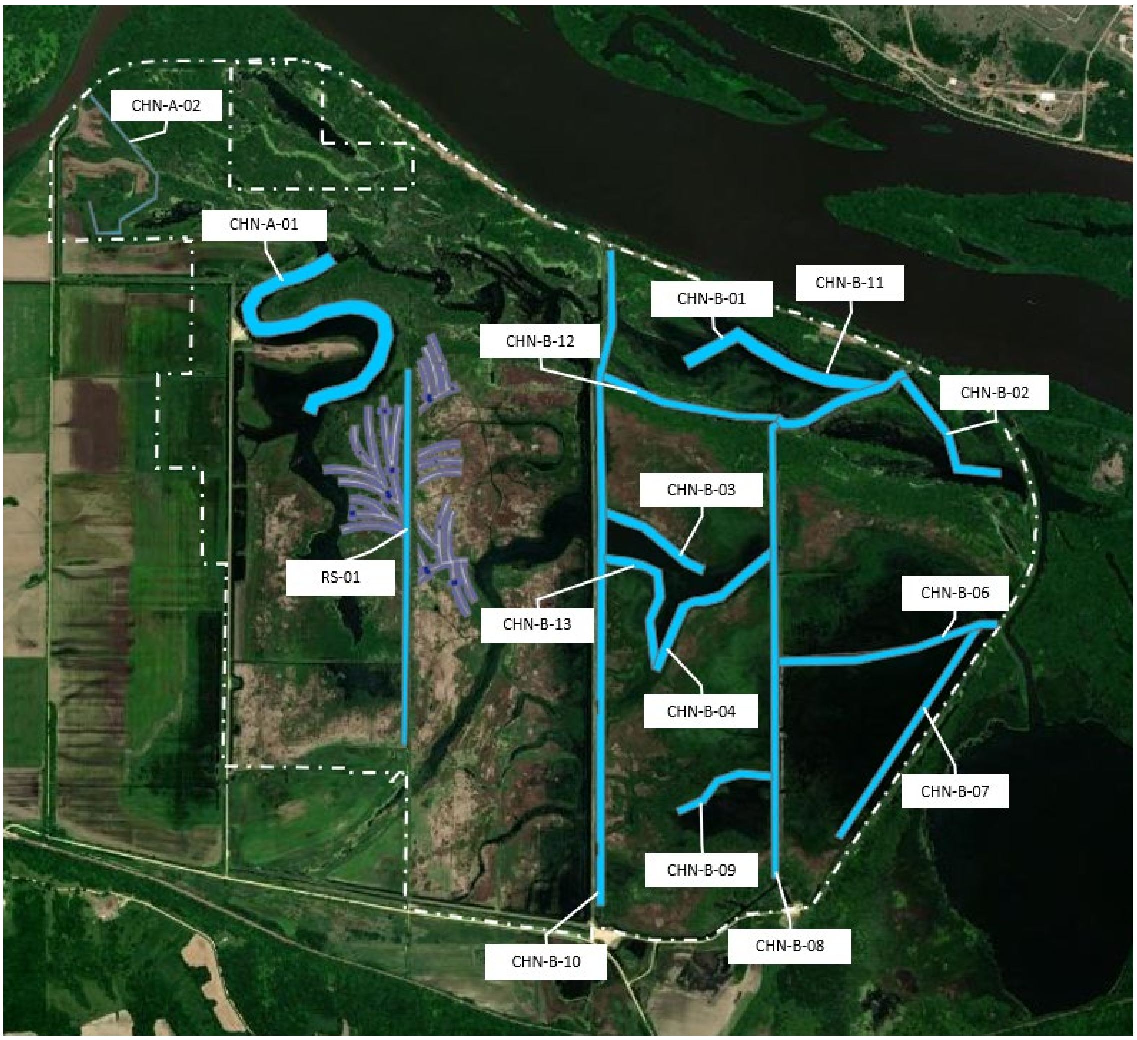


Figure 10. Dredge Channels Location Map

Photograph 3. Marsh Buggy operation Huron Island HREP

Photograph 4. Marsh Buggy operation Lake Odessa HREP

Table 5. Summary of Dredge Channel Capacities

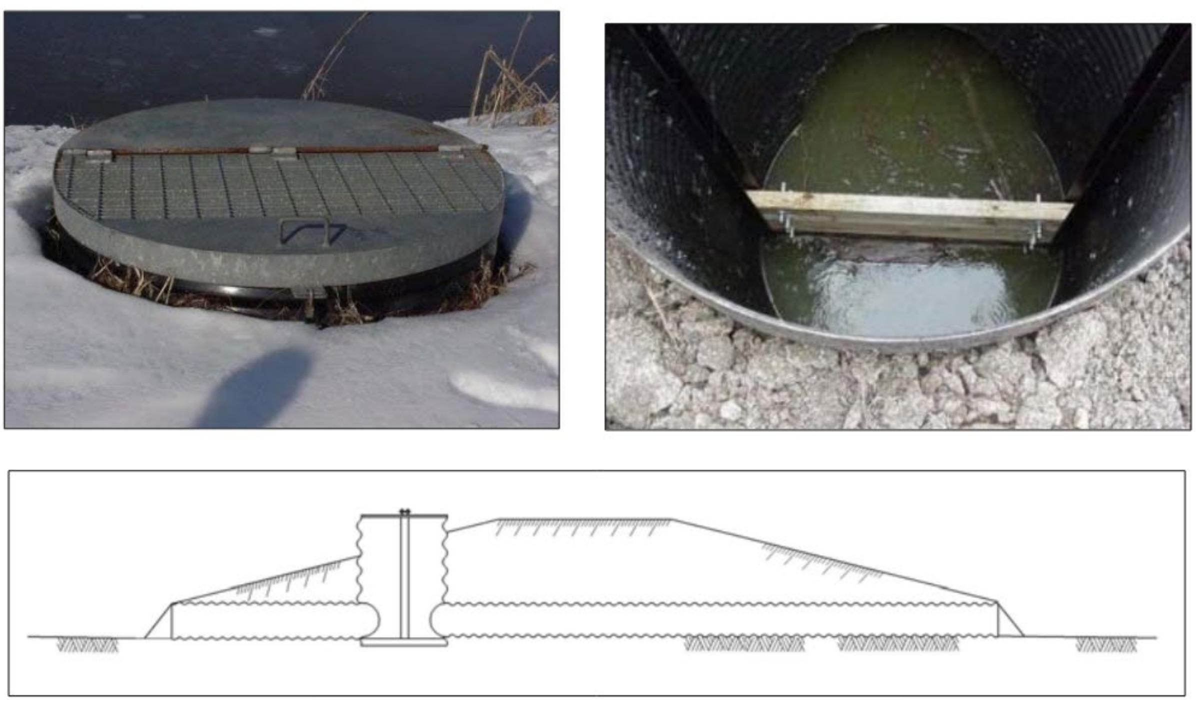
Measure Name	Description	Quantities	Units
Channel			
CHN-A-01 Alt-6	Fish Lake Channel (mod)	107,352	CY
CHN-A-02	Murphy's Cell Channel	44,694	CY
CHN-B-01	Sawmill Lake Channel	57,910	CY
CHN-B-02	McGann's Lake Channel	28,596	CY
CHN-B-03 Alt-6	Densmore Lake Upper Channel (mod)	32,483	CY
CHN-B-04 Alt-6	Densmore Lake Lower Channel (mod)	53,562	CY
CHN-B-06 Alt-6	Blake's Lake to Browns Channel (mod)	45,527	CY
CHN-B-07	Blake's Lake Lower Channel	56,812	CY
CHN-B-08	5th Ditch Channel	123,877	CY
CHN-B-09 Alt-6	Southeast Channel (mod)	29,908	CY
CHN-B-10	4th Ditch Channel	252,198	CY
CHN-B-11	McGann's to Miss Channel	40,397	CY
CHN-B-12	Snag Slough Channel	39,760	CY
CHN-B-13	Densmore Horseshoe Channel	43,859	CY
RS01	Ridge & Swale	128,906	CY
	5 Potholes - 60' length	1,701	CY
	10 Potholes - 100' length	8,426	CY
	Total	**1,095,969**	CY

4.6.2. Water Control Structures

Water control structures are proposed with an invert elevation to match the proposed channel bottom elevation. The dimensions and material type of the control structures can be found in Table 6.

Table 6. List of Proposed Water Control Structures for TSP Plan

Water Control Structure No.	**Type**	**Pool**	**Cell/Lake**	**Structure Diameter / Dimensions (FT)**	**Conduit Diameter / Dimensions (FT)**	**Conduit Length (FT)**
WCS-01	Pump Station	A/B	-		14 x 14	400
WCS-02	CMP w/ Stoplog	A/B	4th Ditch Upper	6(ID) x 10H	3	85
WCS-03	CMP w/ Stoplog	A/B	Densmore Upper	6(ID) x 10H	3	85
WCS-04	CMP w/ Stoplog	A/B	Densmore Lower	6(ID) x 10H	3	85 (Assumed)
WCS-05	CMP w/ Stoplog	A/B	4th Ditch Lower	6(ID) x 10H	3	85 (Assumed)
WCS-06		B	Brown's			200 (Assumed)
WCS-07	CMP w/ Stoplog	A/B	4th Ditch Parking Lot	6(ID) x 8H	3	65
WCS-08	CMP Wisconsin Tube	A	Murphy's	2(ID) x 4H	1	100 (Assumed)
WCS-09	CMP Wisconsin Tube	A	Murphy's	2(ID) x 4H	1	100 (Assumed)



Photograph 5. Stoplog Water Control Structures, Banner Marsh HREP

Photographs 6a and 6b. Pump Station, Andalusia Refuge HREP

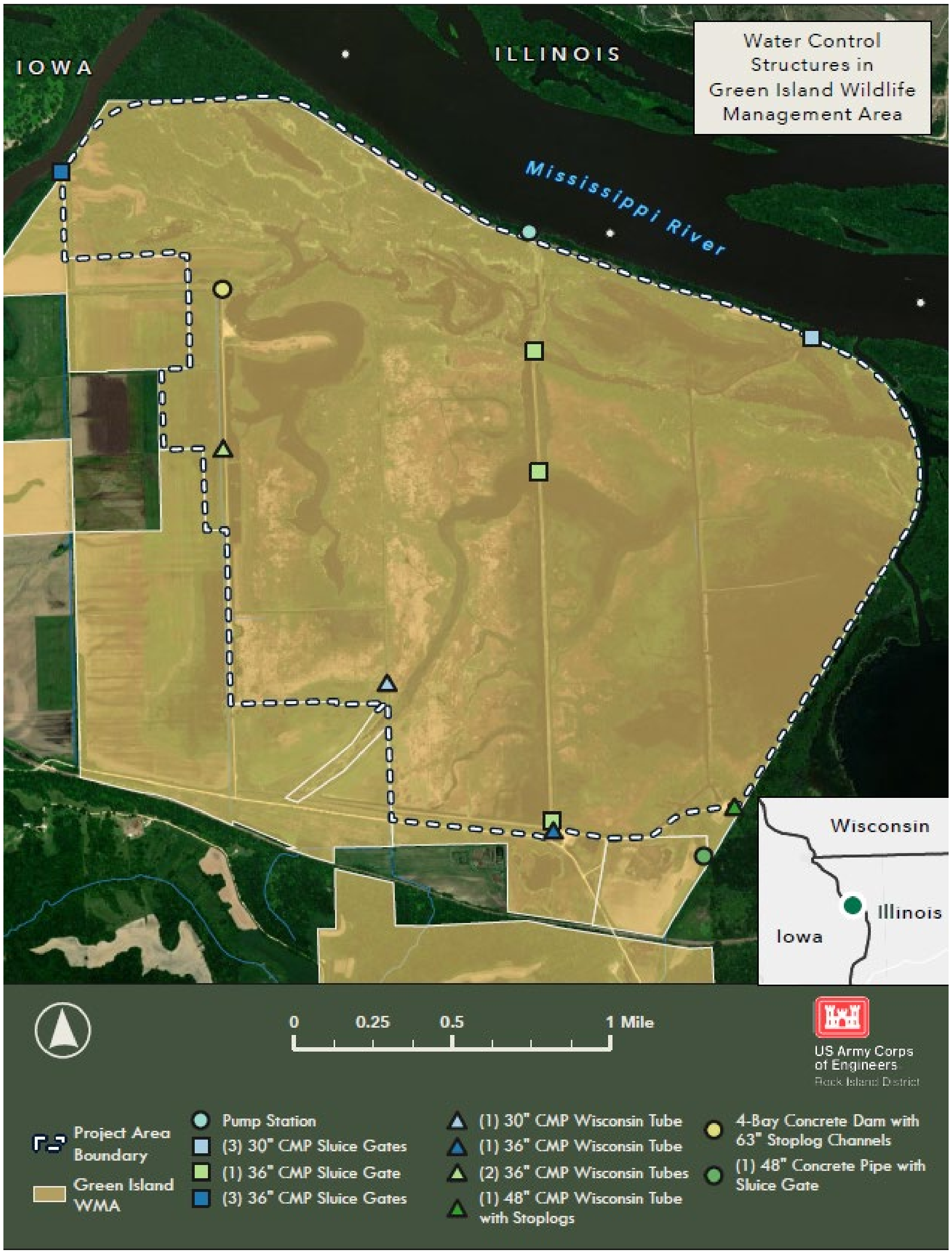


Figure 11. Existing Water Control Structures GIWMA

Figure 12. Proposed Water Control Structures GIWMA

4.6.2.1. WCS-01

WCS-01, also known as Pump Station, was considered to have a culvert invert elevation to match channel bottom elevation.

4.6.2.2. WCS-02

WCS-02, also known as 4th Ditch (Pumphouse Road) North Structure, was considered to invert elevation to match channel bottom elevation.

4.6.2.3. WCS-03

WCS-03, also known as 4th Ditch (Pumphouse Road) Densmore Upper, was considered to invert elevation to match channel bottom elevation.

4.6.2.4. WCS-04

WCS-04, also known as 4th Ditch (Pumphouse Road) Densmore Lower, was considered to invert elevation to match channel bottom elevation. This feature while evaluated, was not included in the TSP.

4.6.2.5. WCS-05

WCS-05, also known as 4th Ditch (Pumphouse Road) South Structure, was considered to invert elevation to match channel bottom elevation. This feature while evaluated, was not included in the TSP.

4.6.2.6. WCS-06

WCS-06, also known as Browns Lake Structure, was considered to invert elevation to match channel bottom elevation.

4.6.2.7. WCS-07

WCS-07, also known as 4th Ditch (Pumphouse Road) Parking Lot, was considered to invert elevation to match channel bottom elevation.

4.6.2.8. WCS-08

WCS-08, also known as Murphy's Cell North, was considered to invert elevation to match channel bottom elevation.

4.6.2.9. WCS-09

WCS-09, also known as Murphy's Cell South, was considered to invert elevation to match channel bottom elevation.

4.6.3. Sediment Trap

4.6.3.1. ST Sediment Trap

A sediment trap was considered in order to better capture and control the sedimentation of the study area. A sediment placement site was also evaluated in the project features and included in APP E, Attachment F – Operation and Maintenance costs.

4.7. Alternatives.

See Section V Evaluation and Comparison of Alternatives in the main report for the list of alternatives that were evaluated for the CE-ICA comparison. The features that were carried forward as part of one or multiple alternatives are included in Table 6. All the alternatives can be seen in Figures 11-16 below.

Table 7. Project Features Evaluated for CE-ICA

Measure Name	Description	Quantities	Units	Alternative
Berm Embankment				
BRM-A-01	Fish Lake Berm	78,514	CY	2,3,5
BRM-A-01 Alt-6	Fish Lake Berm (mod)	107,352	CY	6
BRM-A-02	Murphy's Cell Berm	44,694	CY	2,6
BRM-A-03	3rd Ditch Berm	142,914	CY	3,5
BRM-B-01	Sawmill Berm	57,910	CY	2,5,6
BRM-B-02	McGann's Berm	28,596	CY	2,3,5,6
BRM-B-03	Densmore Lake Upper Berm	57,874	CY	2,3,5
BRM-B-03 Alt-6	Densmore Lake Upper Berm (mod)	32,483	CY	6
BRM-B-04	Densmore Lake Lower Berm	82,983	CY	2,3,5
BRM-B-04 Alt-6	Densmore Lake Lower Berm (mod)	53,562	CY	6

BRM-B-05	Blake's Lake Spur Berm	31,114	CY	2
BRM-B-06	Blake's Lake to Browns Berm	45,527	CY	2,3
BRM-B-06 Alt-6	Blake's Lake to Browns Berm (mod)	45,527	CY	6
BRM-B-07	Blake's Lake Lower Berm	56,812	CY	2,6
BRM-B-08	5th Ditch Berm	123,877	CY	2,3,5,6
BRM-B-09	Southeast Berm	63,284	CY	2,5
BRM-B-09 Alt-6	Southeast Berm (mod)	29,908	CY	6
BRM-B-10	4th Ditch Berm	252,198	CY	2,3,6
BRM-B-11	McGann's to Miss Berm	40,397	CY	2,3,5,6
BRM-B-12	Snag Slough	39,760	CY	2,6
BRM-B-13	Densmore Horseshoe	43,859	CY	2,6
RS01	Ridge & Swale	128,906	CY	2,6
	5 Potholes - 60' length	1,701	CY	2,6
	10 Potholes - 100' length	8,426	CY	2,6
Channel Excavation				
CHN-A-01	Fish Lake Channel	78,514	CY	2,3,5
CHN-A-01 Alt-6	Fish Lake Channel (mod)	107,352	CY	6
CHN-A-02	Murphy's Cell Channel	44,694	CY	2,6
CHN-A-03	3rd Ditch Channel	142,914	CY	3,5
CHN-B-01	Sawmill Lake Channel	57,910	CY	2,5,6
CHN-B-02	McGann's Lake Channel	28,596	CY	2,3,5,6
CHN-B-03	Densmore Lake Upper Channel	57,874	CY	2,3,5
CHN-B-03 Alt-6	Densmore Lake Upper Channel (mod)	32,483	CY	6
CHN-B-04	Densmore Lake Lower Channel	82,983	CY	2,3,5
CHN-B-04 Alt-6	Densmore Lake Lower Channel (mod)	53,562	CY	6
CHN-B-05	Blake's Lake Spur Channel	31,114	CY	2
CHN-B-06	Blake's Lake to Browns Channel	45,527	CY	2,3
CHN-B-06 Alt-6	Blake's Lake to Browns Channel (mod)	45,527	CY	6
CHN-B-07	Blake's Lake Lower Channel	56,812	CY	2,6
CHN-B-08	5th Ditch Channel	123,877	CY	2,3,5,6
CHN-B-09	Southeast Channel	63,284	CY	2,5
CHN-B-09 Alt-6	Southeast Channel (mod)	29,908	CY	6
CHN-B-10	4th Ditch Channel	252,198	CY	2,3,6
CHN-B-11	McGann's to Miss Channel	40,397	CY	2,3,5,6
CHN-B-12	Snag Slough Channel	39,760	CY	2,6
CHN-B-13	Densmore Horseshoe Channel	43,859	CY	2,6
RS01	Ridge & Swale	128,906	CY	2,6
	5 Potholes - 60' length	1,701	CY	2,6
	10 Potholes - 100' length	8,426	CY	2,6
Sediment Trap				
ST-01	Sediment Trap	3,146	CY	2,5,6

Timber Stand Improvement (TSI)				
TSI-01	Snider Lake West	34	AC	2,3,6
TSI-02	Snider Lake East	27	AC	2,3,6
TSI-03	Sawmill Lake Upper	25	AC	2,3,6
TSI-04	Sawmill Lake Lower	26	AC	2,3,6
TSI-06	McGann's Lake Channel	36	AC	2,3,6
TSI-08	Fish Lake East, R&S North	4	AC	2,6
TSI-08	Fish Lake East, R&S North	20	AC	2,6
TSI-09	North Central 3rd-4th Ditch	40	AC	2,3,6
TSI-09 Lower	North Central 3rd-4th Ditch	20	AC	2,3,6
RS's	Ridge & Swale	25	AC	2,6
BRM's	Berms	62	AC	2,3,6
Water Control Structures				
WCS-01	Pump Station	1	EA	2,3,6
WCS-02	4th Ditch Replacement North	1	EA	2,3,5,6
WCS-03	4th Ditch Replacement Densmore Upper	1	EA	2,3,5,6
WCS-04	4th Ditch Replacement Densmore Lower	1	EA	2,3,5
WCS-05	4th Ditch Replacement South	1	EA	2,3,5
WCS-06	Brown's Lake Outlet	1	EA	2,3,6
WCS-07	4th Ditch Replacement Parking Lot	1	EA	2,6
WCS-08	Murphy's Cell North	1	EA	2,6
WCS-09	Murphy's Cell South	1	EA	2,6
Pump Station				
PS-01	Pump Station	1	LS	2,3,6

Figure 13. Alternative 1 No action

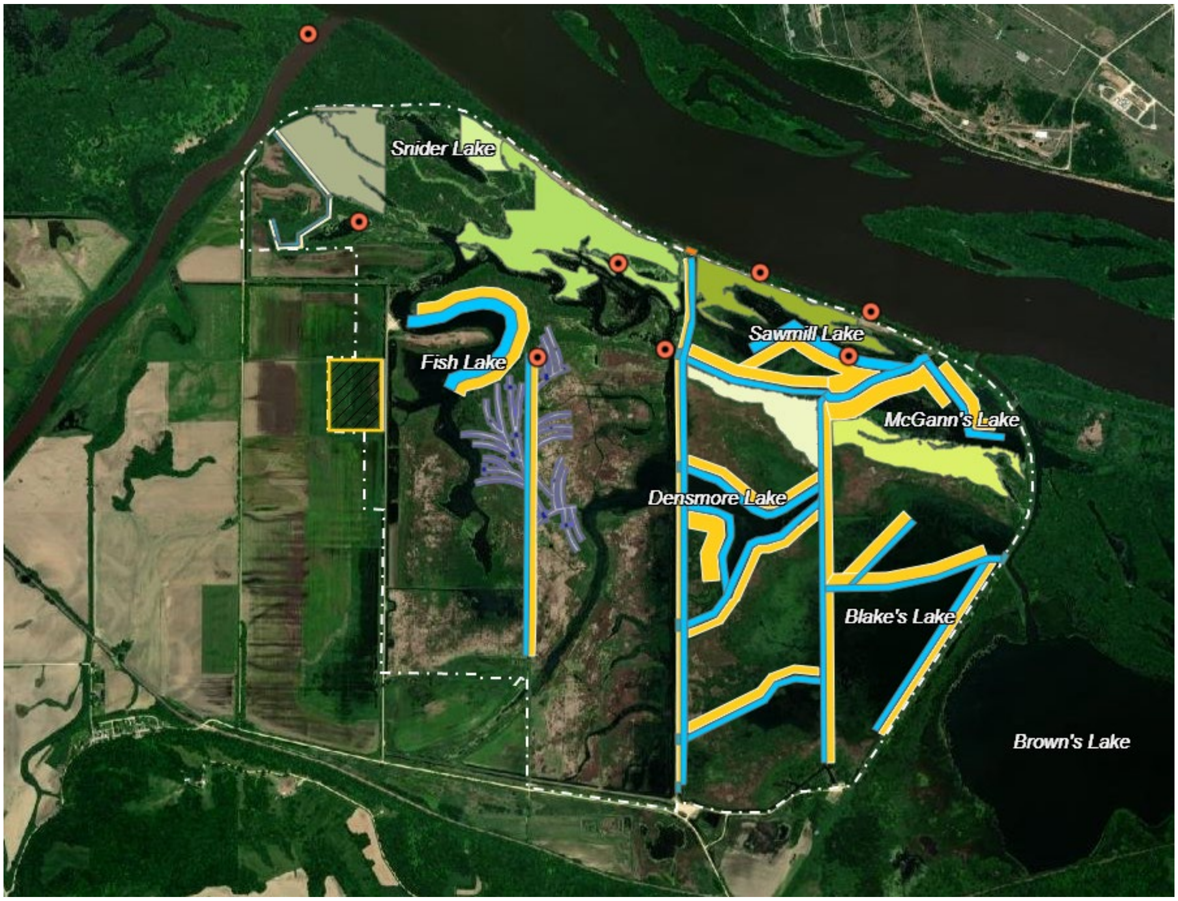


Figure 14. Alternative 2 Cadillac Plan

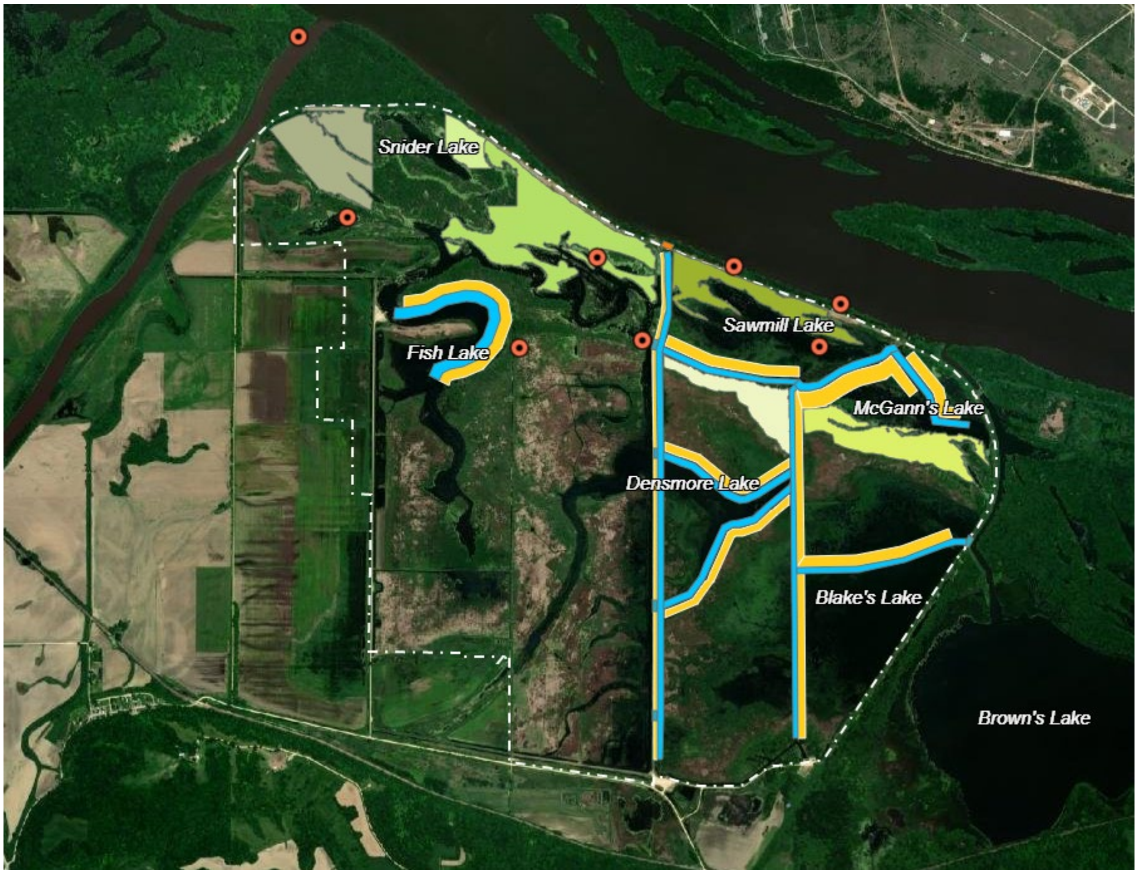


Figure 15. Alternative 3 Critical Plan Small

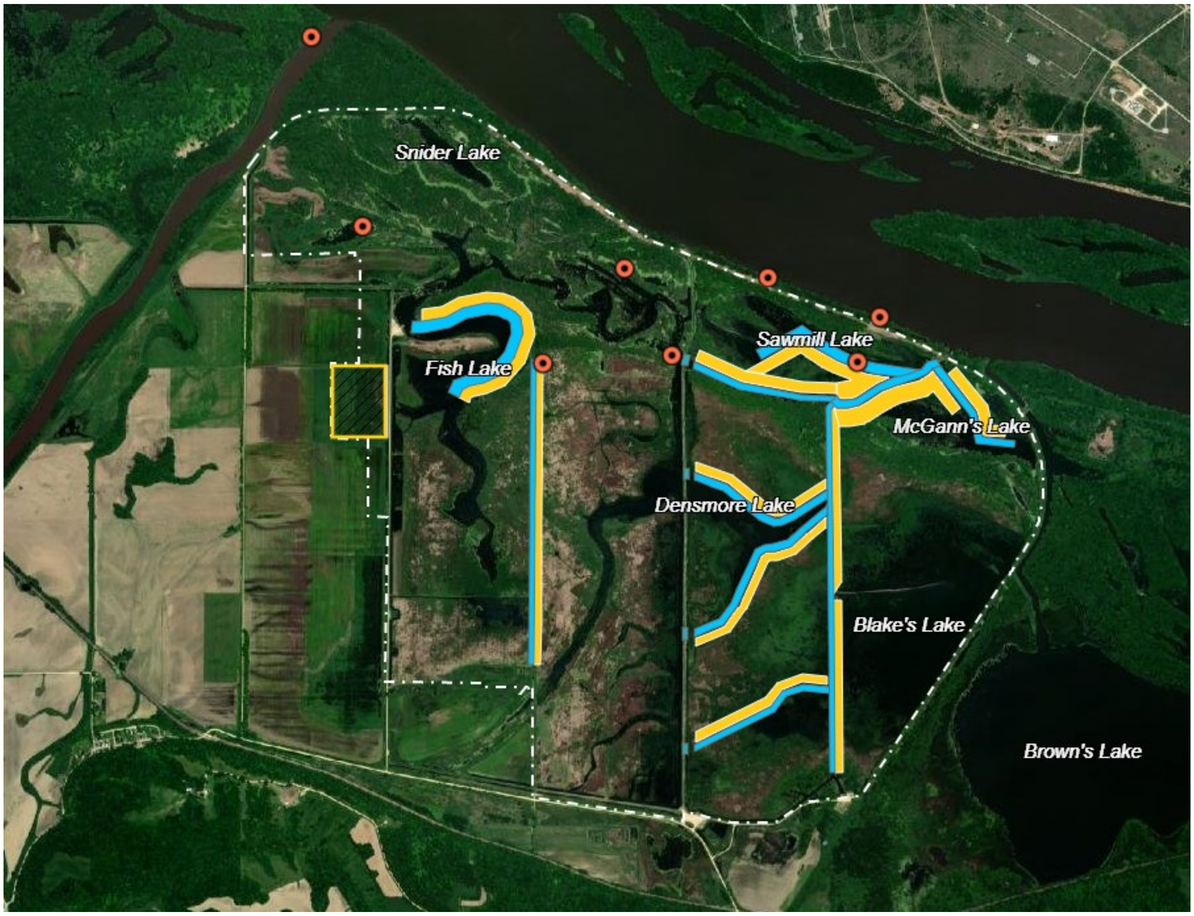


Figure 16. Alternative 5 No Pump/No Brown's Lake Outlet

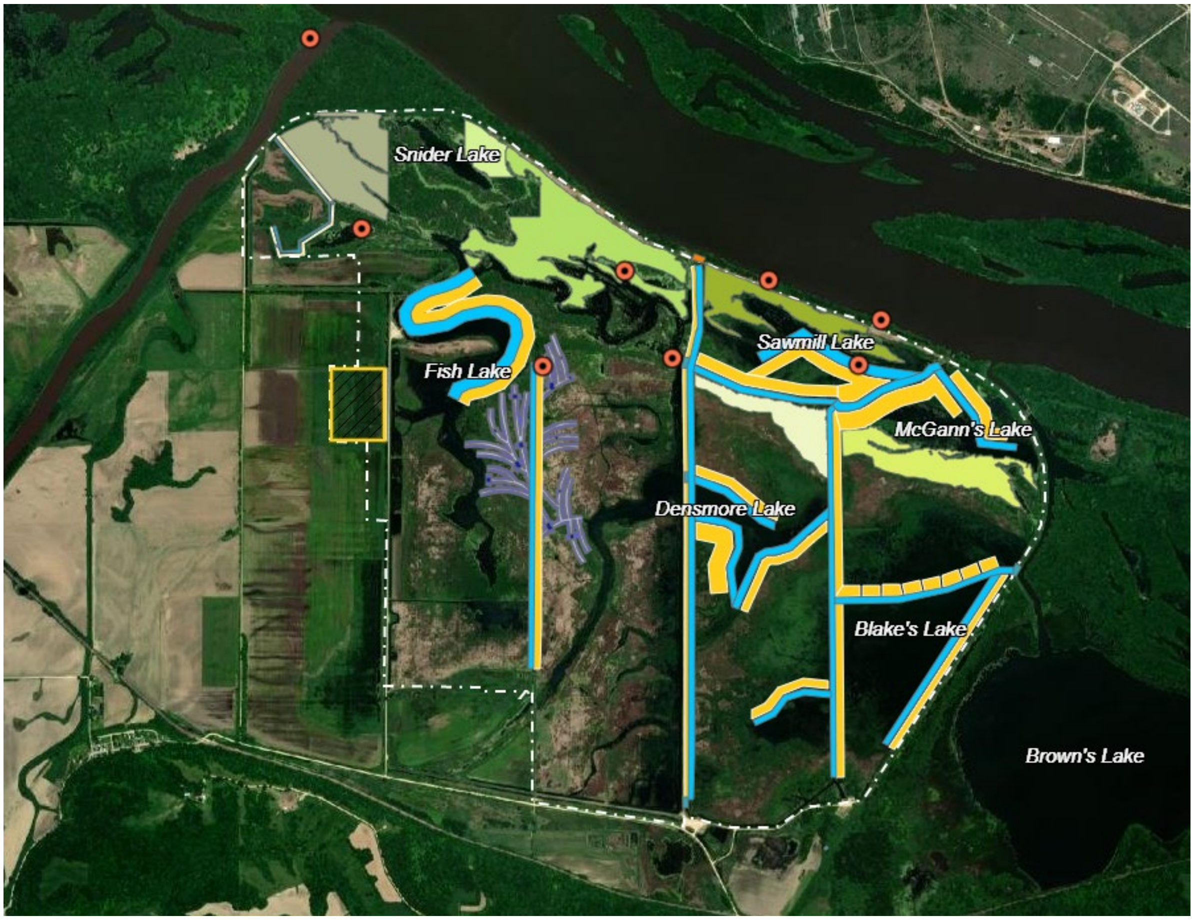


Figure 17. Alternative 6 Balanced Water Level Management Plan

5. TENTATIVELY SELECTED PLAN

The tentatively selected plan is the Balanced Water Level Management Plan and is described in detail in the main report in section VI.

Table 8. Tentatively Selected Plan

Measure Name	Description	Quantities	Units
Berm Embankment			
BRM-A-01	Fish Lake Berm	107,352	CY
BRM-A-02	Murphy's Cell Berm	44,694	CY
BRM-B-01	Sawmill Berm	57,910	CY
BRM-B-02	McGann's Berm	28,596	CY
BRM-B-03	Densmore Lake Upper Berm	32,483	CY
BRM-B-04	Densmore Lake Lower Berm	53,562	CY
BRM-B-06	Blake's Lake to Browns Berm	45,527	CY
BRM-B-07	Blake's Lake Lower Berm	56,812	CY
BRM-B-08	5th Ditch Berm	123,877	CY
BRM-B-09	Southeast Berm	29,908	CY

BRM-B-10	4th Ditch Berm	252,198	CY
BRM-B-11	McGann's to Miss Berm	40,397	CY
BRM-B-12	Snag Slough	39,760	CY
BRM-B-13	Densmore Horseshoe	43,859	CY
RS01	Ridge & Swale	128,906	CY
	5 Potholes - 60' length	1,701	CY
	10 Potholes - 100' length	8,426	CY
	Total	**1,095,969**	CY
Channel Excavation			
CHN-A-01	Fish Lake Channel	107,352	CY
CHN-A-02	Murphy's Cell Channel	44,694	CY
CHN-B-01	Sawmill Lake Channel	57,910	CY
CHN-B-02	McGann's Lake Channel	28,596	CY
CHN-B-03	Densmore Lake Upper Channel	32,483	CY
CHN-B-04	Densmore Lake Lower Channel	53,562	CY
CHN-B-06	Blake's Lake to Browns Channel	45,527	CY
CHN-B-07	Blake's Lake Lower Channel	56,812	CY
CHN-B-08	5th Ditch Channel	123,877	CY
CHN-B-09	Southeast Channel	29,908	CY
CHN-B-10	4th Ditch Channel	252,198	CY
CHN-B-11	McGann's to Miss Channel	40,397	CY
CHN-B-12	Snag Slough Channel	39,760	CY
CHN-B-13	Densmore Horseshoe Channel	43,859	CY
RS01	Ridge & Swale	128,906	CY
	5 Potholes - 60' length	1,701	CY
	10 Potholes - 100' length	8,426	CY
	Total	**1,095,969**	CY
Sediment Trap			
ST-01	Sediment Trap	3,146	CY
	Total	**3,146**	CY
Timber Stand Improvement (TSI)			
TSI-01	Snider Lake West	34	AC
TSI-02	Snider Lake East	27	AC
TSI-03	Sawmill Lake Upper	25	AC
TSI-04	Sawmill Lake Lower	26	AC
TSI-06	McGann's Lake Channel	36	AC
TSI-08	Fish Lake East, R&S North	4	AC
TSI-08	Fish Lake East, R&S North	20	AC
TSI-09	North Central 3rd-4th Ditch	40	AC
TSI-09 Lower	North Central 3rd-4th Ditch	20	AC

RS's	Ridge & Swale	25	AC
BRM's	Berms	62	AC
	Total	**319**	AC
Water Control Structures			
WCS-01	Pump Station	1	EA
WCS-02	4th Ditch Structures Replacement North Structure	1	EA
WCS-03	4th Ditch Structures Replacement Densmore Upper	1	EA
WCS-06	Brown's Lake Outlet	1	EA
WCS-07	4th Ditch Structure Replacement Parking Lot	1	EA
WCS-08	Murphy's Cell North	1	EA
WCS-09	Murphy's Cell South	1	EA
	Total	**7**	EA
Pump Station			
PS-01	Pump Station	1	LS
	Total	**1**	LS

The new Pump Station will allow for a bidirectional flow into and out of Pool A and Pool B, either separately or simultaneously. This will allow the GIMWA water levels to be better managed and allow the pools to be drawn down more effectively. The system would no longer have to rely on the river levels to be low in order to gravity drain the pools. See Figure 18. The existing pump station will remain as a backup to bring water into the system, if needed. Additional channels will be dredged for conveyance to allow the water levels to travel through Pool B where they were not able to before and in both pools, the water levels will be able to be raised or lowered faster and more efficiently.

Figure 18. New Water Level Management Plan

6. VALUE ENGINEERING STUDY

The VE study shall be completed in compliance with ER 11-1-321. The VE study will be conducted during the design stage.

7. REFERENCES

2004 Report to Congress, Upper Mississippi River System Environmental Management Program. Corps, Rock Island District, Rock Island, IL. This report is the first formal evaluation of the UMRR-EMP. This report evaluates the program; describes its accomplishments, including development of a systemic habitat needs assessment; and identifies certain program adjustments.

2010 Report to Congress, Upper Mississippi River System Environmental Management Program. Corps, Rock Island District, Rock Island, IL. This report is the most recent formal evaluation of the UMRR-EMP that evaluates the program; describes its accomplishments, including development of a systemic habitat needs assessment; and identifies certain program adjustments.

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R.P. Richards, Measures of flow variability and a new flow-based classification of Great Lakes tributaries, 1990

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Upper Mississippi River Restoration Environmental Management Program Environmental Design Handbook. Corps, Rock Island District, Rock Island, IL, December 2012. This Design Handbook of the UMRR-EMP evaluates project features and incorporates lessons learned throughout the lifetime of the program.

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Upper Mississippi River System-Environmental Management Program, Pool 13, Potters Marsh Habitat Rehabilitation and Enhancement Project. This HREP is located in Carroll and Whiteside Counties, Illinois upstream of Beaver Island Project at RMs 522.5 through 526.0. The Definite Project Report was completed in 1992. The operation and maintenance report was completed in 1997. PERs were completed in 1998, 2002, and 2003.

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