

ATTACHMENT C

Minnesota Department of Natural Resources

Marsh Lake Ecosystem Restoration Project

Marsh Lake Draft Operation and Management Plan

(April, 2016)



Operation and Management Plan – Marsh Lake

DOW# 06000100

April 2016

Special Consideration: This Operation and Management Plan will be used to guide management activities on Marsh Lake within the framework of the U.S. Army Corps of Engineers Standing Instructions (see addendum, USACE Standing Instructions).

Location: The Marsh Lake Dam is located on the Minnesota River in western Minnesota. Lac qui Parle and Marsh Lake Reservoirs form boundaries for Lac qui Parle and Swift Counties.

Datum: All elevations use the 1929 National Geodetic Vertical Datum (1929 NGVD). To convert to NAVD88 add 0.67 feet to Marsh Lake.

Background

Marsh Lake is an approximately 5,000-acre shallow reservoir. The fixed-crest Marsh Lake Dam was constructed to hold a conservation pool in the upper part of the Lac qui Parle. The Works Progress Administration constructed the Marsh Lake Dam and rerouted the Pomme de Terre River into Marsh Lake between 1936 and 1939. The reservoir was first filled in the spring of 1939. The Corps of Engineers improved the dam between 1941 and 1951 as part of the Lac qui Parle Project. The project was operated by the State of Minnesota until 1950, when operation and maintenance responsibilities were transferred to the Corps of Engineers.

The average annual water level on Marsh Lake is 938.3 ft. The crest elevation of the fixed crest spillway on the Marsh Lake Dam is 937.6 ft. Approximately 3,000 acres of Marsh Lake is less than 3 feet deep when the lake is at the level of the fixed crest spillway.

The Marsh Lake Dam is currently an earth-fill structure 11,800 feet long with an average top elevation of 950.0 feet. The service spillway is a concrete fixed-crest overflow section 112 feet wide with a crest elevation of 937.6 feet. A grouted riprap emergency spillway immediately southwest of the service spillway is 90 feet wide with a crest elevation of 940.0 feet. The dam also has a 2-foot-square gated low flow outlet conduit with a sill elevation of 932.6. The current dam does not allow active water level management.

Marsh Lake has a history of providing good quality fish and wildlife habitat. Marsh Lake could once be considered one of Minnesota's top five waterfowl hunting destinations. Unfortunately, habitat conditions have deteriorated due to excessive nutrient inputs, sustained high water levels, and undesirable fish species. The "Marsh Lake Ecosystem Restoration Project" is a collaborative effort among government agencies and partners to restore ecosystem function within Marsh Lake by restoring the Pomme de Terre River to its historic channel and by modifying the Marsh Lake dam infrastructure.

These modifications will:

1. Allow for greater fluctuations in water levels more characteristic of natural hydrographs;
2. Help control undesirable fish species by removing winter fish refuges and by restoring native fish passage and spawning areas;

3. Help promote healthy and diverse aquatic plant growth;
4. Help reduce sediment and nutrient transport and resuspension;
5. Provide options for active water level management to enhance habitat conditions.

General Project Information

The implementation of the Marsh Lake Restoration Project is anticipated to occur from 2016 to 2018. The Project area includes Marsh Lake, the Pomme de Terre River outlet, the Marsh Lake Dam, and the upper portion of the Lac qui Parle reservoir. Ecosystem restoration features of the project include:

- Restore the Pomme de Terre River to its historic channel
 - ✓ Which will remove a major winter refuge area for common carp within Marsh Lake
 - ✓ Which will reconnect traditional spawning areas for native fishes from Lac qui Parle Lake/Reservoir
 - ✓ Which will help trap sediments and nutrients in the natural floodplain
- Modify the Marsh Lake Dam, construct fishway and notched weir structure
 - ✓ Which will restore connectivity for native fishes between Marsh Lake and Lac qui Parle Lake/Reservoir
 - ✓ Which will restore a more natural hydrologic regime within the Marsh Lake pool and promote aquatic plant growth and overall lake health
- Include an alternative drawdown water control structure feature
 - ✓ To provide the option for active water level management as needed to supplement enhancing habitat and water quality conditions

Historical and Present Habitat Conditions

Current conditions on Marsh Lake are characterized as a shallow, turbid, and hyper-eutrophic lake system (about 3,000 of 5,000 acres are less than 3 feet deep). Because the Marsh Lake Dam has an elevated fixed crest, the continuous minimum water surface has disrupted natural period drying events. As a result, emergent aquatic plants that require exposed mudflat conditions to germinate from seed have declined in the lake. Loss of emergent and submersed aquatic plants has resulted in increased wind fetch. Wind induced wave action and nonnative carp re-suspend sediments and nutrients, blocking sunlight and reducing opportunity for submersed aquatic plant growth. Increased wave action has severely eroded the shoreline, islands and points of Marsh Lake.

A key to restoring freshwater aquatic ecosystems within Marsh Lake is restoring a more natural hydrologic regime. On a river floodplain lake like Marsh Lake, a more natural hydrologic regime includes lower lake levels in some years to enable aquatic vegetation to re-establish. Elsewhere (namely, the pools in the Upper Mississippi River), variability in water levels has resulted in increased extent, diversity, and abundance of aquatic vegetation, increased food for waterfowl, and improved water quality conditions. A clear water system with more aquatic plants would favor native fishes over the non-native common carp.

Overall habitat and water quality conditions within Marsh Lake continue to decline. Habitat and water quality conditions will not improve in the lake without improved water level management.

Management Objective

The primary goal of the Marsh Lake Ecosystem Restoration Project was developed as part of a coordinated effort by several resource agencies.

“To return the Marsh Lake area ecosystem to a less degraded and more natural condition by restoring ecosystem structure and functions.”

Based on this goal, project objectives were established and are summarized below:

1. Reduced sediment loading to Marsh Lake;
2. Restored natural fluctuations to the hydrologic regime of Marsh Lake;
3. Restored geomorphic and floodplain processes to the Pomme de Terre River;
4. Reduced sediment resuspension within Marsh Lake;
5. Increased abundance of emergent and submersed aquatic plants within Marsh Lake;
6. Increased availability of waterfowl habitat within Marsh Lake;
7. Restored aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River and Lac qui Parle;
8. Reduced abundance of aquatic invasive fish species within Marsh Lake;
9. Increased diversity and abundance of native fish within Marsh Lake and the Pomme de Terre River.

These objectives are being pursued in coordination with project partners using an adaptive management approach. This approach will help optimize opportunities for success and will require extensive coordination and communication amongst the parties involved.

Adaptive Management Strategy and Rationale for Adaptive Management

Fischenich et al. 2012, describes the rationale for Adaptive Management as based in the following summary statement:

Because of the changing conditions and uncertainties, ecosystem stability can only be viewed as a short-term objective. Long-term restoration must be an ongoing process whereby restoration implementation becomes a continuing series of management decisions. Each decision should be based upon a growing pool of research information, updated measurements of ecosystem responses, and evaluations of degrees of progress in reaching a set of goals or targets that have been identified as indicative of ecosystem vitality (Davis and Ogden 1994).

Specifically, the benefits of Adaptive Management include:

- Built-in flexibility will improve the likelihood of success across a broad range of future conditions.
- Use of the best available science to help plan, design, construct, and operate the project.
- New information gathered during monitoring is considered through an iterative process.
- Providing a forum for discussions between scientists, managers, and stakeholders.
- Promoting long-term cost savings by incorporating flexibility and robustness into planning and implementation.

Monitoring/Adaptive Management Project Team

The project partnership consists of staff from USACE, MNDNR, and UMRWD. The partnership will establish a structure whereby clear lines of communication and information exchange between all

parties can occur effectively to implement and manage the project. Successful systemic and project-specific adaptive management implementation will require the right resources being coupled at the right time to support the framework components. Please note that USACE involvement in terms of ecosystem project monitoring will expire 5 years after project implementation. A list of Project Partners included as the Adaptive Management Team will need to be kept up to date accordingly.

**Project Partners
-Adaptive Management Team-**

Agency	Personnel	Title	Contact Info
MVP Corps	Shahin Khazrajafari	Project Manager	Shahin.khazrajafari@usace.army.mil Tel: 651.290.5219
MVP Corps	David Potter	Fishery Biologist	David.f.potter@usace.army.mil Tel: 651.290.5713
MVP Corps	Corby Lewis	Hydraulic Engineer	Corby.R.Lewis@usace.army.mil Tel: 651.290.5806
MNDNR	David Trauba	Regional Wildlife Manager	David.trauba@state.mn.us Tel: 507.359.6030
MNDNR	Vacant	Area Wildlife Manager	Walt.Gessler@state.mn.us Tel: 320.752.4394
MNDNR	Chris Domeier	Area Fisheries Supervisor	Chris.Domeier@state.mn.us Tel: 320.839.2656
MNDNR	Mike Davis	Malacologist	Mike.davis@state.mn.us Tel: 507.251.4116
MNDNR	Luther Aadland	River Scientist	Luther.Aadland@state.mn.us Tel: 218.739.7576
MNDNR	Ricky Lien	Wetland Habitat Team Supervisor	Ricky.lien@state.mn.us Tel: 651.259.5227
MNDNR	Nicole Hansel-Welch	Shallow Lakes Program Supervisor	Nicole.hansel-welch@state.mn.us Tel: 218.833.8626
MNDNR	Josh Kavanagh	Wildlife Lake Specialist	Joshua.kavanagh@state.mn.us Tel: 320.354.5530
MNDNR	Ryan Bjerke	Area Hydrologist	Ryan.Bjerke@sate.mn.us Tel: 320-839-3823
MNDNR	Jesse Roberts	Wildlife Operations and Development Consultant	jesse.f.roberts@state.mn.us Tel: 651.259.5175
UMRWD	Dianne Radermacher	Administrator	dianne.radermacher@midconetwork.com Tel: 320. 839.3411
USFWS	Scott Simmons	Big Stone Refuge Manager	Scott_simmons@fws.gov Tel: 320.273.2191

Riparian ownership

The Minnesota Department of Natural Resources owns the land surrounding Marsh Lake up to the 945.0 contour elevation. This property is managed as part of Lac qui Parle WMA. See project map attached. MNDNR will be responsible for all active water level management on Marsh Lake and will coordinate those activities as/when necessary including proper notification to USACE and EWR Staff.

Active Management Activities, Management Coordination, and Maintenance

The fishway has been designed as a notched weir passive water control structure to allow for natural water level fluctuation and variability. It is anticipated that this new dam structure will serve to meet primary management goals for Marsh Lake. In the event goals in the Marsh Lake Ecosystem Restoration Plan are not attained with the fishway, an alternative drawdown structure has been integrated into the project allowing water levels to be actively manipulated as per recommendations by the adaptive management team. The Minnesota Department of Natural Resources will be responsible for all active water level management with consultation provided by other project partners. Full winter drawdowns may be considered to restructure fish populations within Marsh Lake. If a full winter drawdown is to be pursued, water levels would be lowered after the pelican nesting season, but early enough to allow other species of wildlife such as reptiles and amphibians an opportunity to evacuate the system prior to freeze up. Alternatively, growing season drawdowns or partial drawdowns may be considered to stimulate the growth of submersed and emergent vegetation or provide additional food resources for migrating waterfowl. Full summer drawdowns would currently be avoided since they would be detrimental to the Pelican nesting islands on Marsh Lake.

Growing Season or Partial Drawdowns (April to September) – water level target of 938.0 - 936.0 ft. A maximum growing season drawdown to elevation 936.0 ft would result in exposing approximately 2,625 acres of lake bed.

Winter Drawdowns (September to February) - water level target of 935.0 ft, leaving 2,425 acres of water in Marsh Lake, most of which would freeze to the bottom.

Overall operation of the Hwy. 75 and Lac qui Parle Dams will not be modified though coordination of activities is anticipated.

Management Goals

1. Reduce sediment loading to Marsh Lake by restoring Pomme de Terre river to its original channel;
2. Restore a more natural hydrologic regime to Marsh Lake via notched weir structure;
3. Restore geomorphic and floodplain processes on Pomme de Terre River;
4. Reduce sediment resuspension and improve water clarity in Marsh Lake with a goal of 0.7 meters transparency per MPCA impairment standards for Western Cornbelt Plains;
5. Increase emergent vegetation coverage within Marsh Lake to 1,500 acres or ~30% of the basin;
6. Increase submersed aquatic vegetation within Marsh Lake to 3,000 acres or ~60% of the basin;
7. Improve fish and wildlife habitat through passive and active water level management. Initiate active management activities at the discretion of the adaptive management team or when Marsh Lake conditions fall below 50% of the numeric vegetation and water clarity goals listed here;
8. Restore aquatic habitat connectivity between Marsh Lake, Pomme de Terre River, and Lac qui Parle Lake;
9. Reduce abundance of aquatic invasive fish species in Marsh Lake to <40% by weight;
10. Increase diversity and abundance of native fish in Marsh Lake and Pomme de Terre River.

Monitoring

When habitat conditions decline within Marsh Lake, the proposed active management actions will be considered and implemented. Vegetation will be monitored when degradation is suspected by conducting shallow lake surveys, using systematic point sampling, calculating aquatic plant distribution, diversity and frequency of occurrence. Water clarity and water quality parameters will be monitored

periodically using an approved water quality sampling regime and fish population composition will be verified by periodic test netting. In addition to pre-drawdown sampling, these efforts will be duplicated and tracked following all drawdowns to determine success.

Please also see the Marsh Lake Ecosystem Restoration Project “Performance Monitoring and Adaptive Management Plan” for additional information.

Water levels may be monitored in real-time on the [USACE Water Resources Link](#).

Proposed Restoration/Construction Activities

Proposed project features include:

1. Fishway - The fishway would be constructed from the current spillway and extend about 300 feet downstream at a 3% slope. Boulder weirs would be spaced 20 feet apart with each achieving individual 10-inch drops. The ramp would range in width from 150 feet at the dam, to 200 feet wide at the downstream edge. It would be approximately 300 feet long. The downstream invert would tie into the river bed at elevation 926.0 ft. The designed dam structure would have a 30 ft-wide notch at the top of the fishway with a bottom elevation of 935.5 ft and a top elevation of 937.6 ft. The ramp would tie into the existing bank on the east side. On the west side, the ramp would tie into a partially rip-rapped earthen embankment or containment embankment, 20 feet wide and with 1H:4V side slopes. 1,579 cubic yards of large (1.6 ft diameter and larger boulders for weirs) rock would be used in the fishway channel. Rip-rap and gravel bedding would be used to armor the fishway channel. Impervious fill would also be used as bedding and fill material. Concrete footings for a future bridge crossing would also be incorporated into construction. Lastly, an emergency spillway would be built between the fishway and active water level control structure at an elevation of 940.0 ft.
2. Active Water Control Structure and Access Ramp - The active water level control structure would be constructed west of the emergency spillway. Excavation for the structure’s outflow channel/tailrace would extend about 650 feet long, downstream of the embankment. The intake for the structure would require excavation to deepen the approach and placement of new rip-rap to protect the structure. The approach and tailrace sections to the structure would be lined with a 33-inch layer of rip-rap over 12-inch bedding. Sheetpile would be buried under the concrete structure to minimize seepage.

The sill of the intake would have an invert elevation of 934.0 feet. A 60-ft long section of the channel bed immediately downstream of the concrete spillway would also be lined with a 33-inch layer of rip-rap over 12-inch bedding.

Associated with the water control structure, a 100-ft long dredge maintenance access ramp would extend from the top of the west embankment into Marsh Lake. Rock would be placed in a 33-inch thick layer on top of 12 inches of bedding material. The top 8 inches of the rip-rap would be chinked. The ramp would have a 15% slope and would extend from the top of the embankment (950.0 ft) into the Marsh Lake bottom (935.0 ft).

3. Embankment / Dam Access Road - One mile of the new embankment/dam access road would be constructed to an approximate elevation of 954.0 ft. Rock rip-rap against wave action would be necessary for the lake side of the new embankments. Rock rip-rap would be placed to a top

elevation equal to rock rip-rap on the existing embankment (~942.0 feet). Impervious clay fill material for the new embankments would be borrowed from a nearby upland site and/or from the abandoned road.

4. Pomme de Terre River Restoration - Two in-channel erosion control structures would be necessary to prevent head-cutting in the PdT River channel above the embankment. Riffle structures would be constructed to control grade, thus preventing the river from headcutting. Riffles would be tied into each bank and would traverse the entire river channel. Riffle materials would be boulders, rip-rap, and gravels. Riffles would be sloped on the upstream side at 1H:4V and on the downstream side of the crest at 1H:20V. This would provide a drop in the water surface elevation of about 7/10 of a foot (8 inches).

Bank stabilization would be constructed along 2,000 linear feet of the PdT River. Toe wood sod mats would be used. For this, about 20 feet of excavation into the bank along PdT River would be needed to anchor the materials. Large trees (coarse woods) would be placed in an interlocking matrix and anchored with boulders. Topsoil or soil mats would be placed to fill the void between trees. Branches, shrubs, and live willow cuttings (fine wood) would be integrated into the matrix. Seven plugs would be used to keep the river from flowing down remnant channels during high flow events. Plugs would also be used and would be based on the toe-wood sod mat design.

Construction Timing and Duration

Subject to approval and permits construction could begin as early as fall 2016 beginning with the drawdown structure and followed by other dam features (phase 1). The Pomme de Terre re-route would be considered the second phase of the construction project. This project could take up to 1-3 years to complete, depending on when construction is initiated. The active draw down structure, fishway, and new road/embankment can be constructed any time during the open water season when site conditions and water levels allow. Water levels may be artificially drawn down to help facilitate construction.

Additional Information

Additional information concerning the Marsh Lake Ecosystem Restoration Project can be obtained from contacting individuals listed as part of the adaptive management project team or by reviewing the following materials:

1. Marsh Lake Ecosystem Restoration Project – USACE Standing Instructions
2. Marsh Lake Ecosystem Restoration Project - Federal Environmental Assessment dated July 2011
3. Marsh Lake Ecosystem Restoration Project - Federal Environmental Supplement
4. Marsh Lake Ecosystem Restoration Project - USACE Marsh Lake Dam Engineering Design Plan
5. Marsh Lake Ecosystem Restoration Project - Environmental Assessment Worksheet
6. Marsh Lake Ecosystem Restoration Project - Performance Monitoring & Adaptive Management Plan

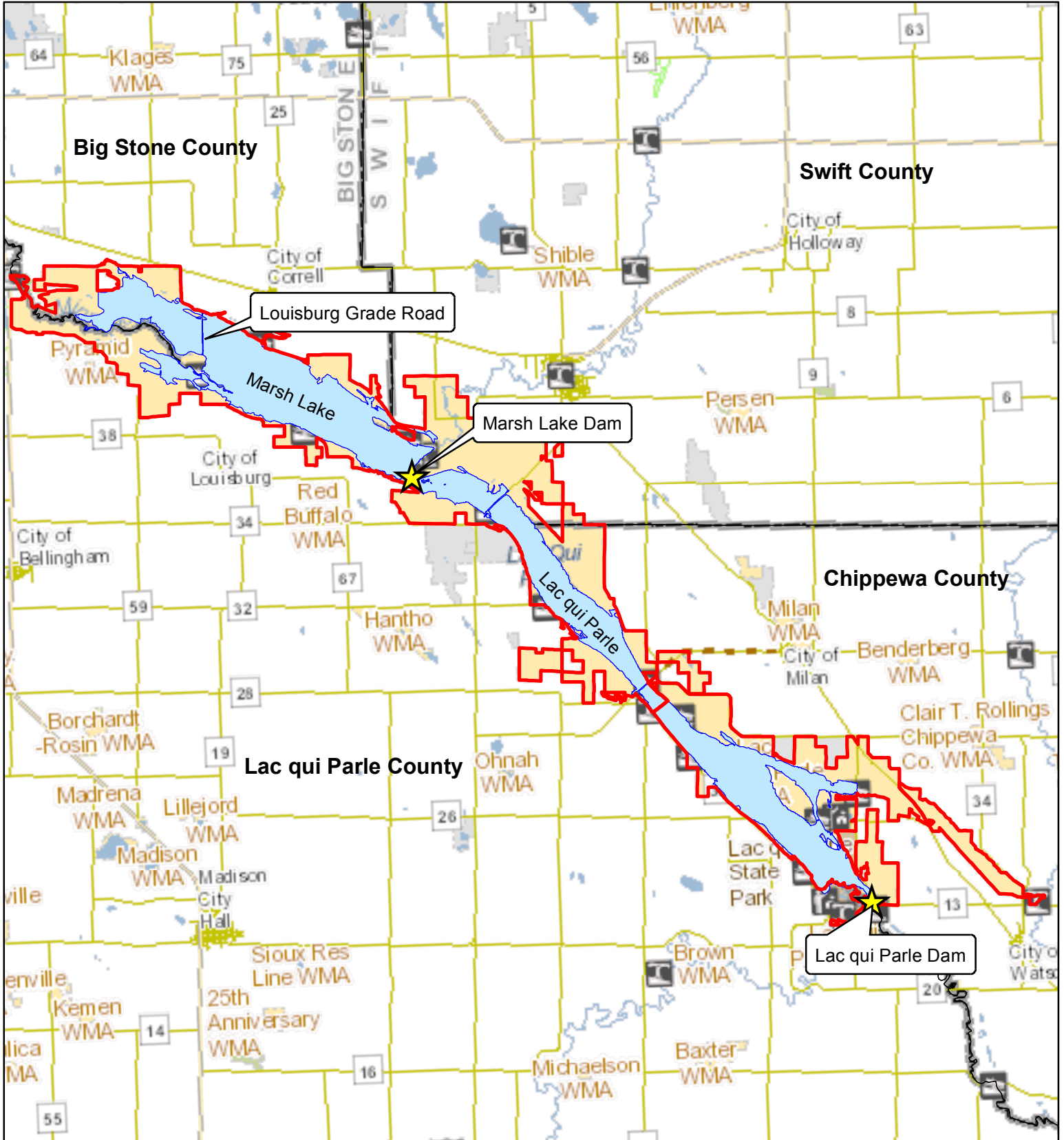
Information can also be found on the [USACE Marsh Lake Ecosystem Restoration Project Page](#).



Marsh Lake Ecosystem Restoration Project

Project Location Map

Marsh Lake Division of Waters# 06000100



UPPER MINNESOTA RIVER
WATERSHED DISTRICT

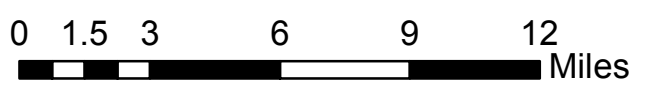


US Army Corps
of Engineers®



MNDNR

 Lac qui Parle WMA

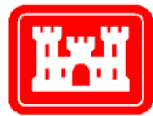
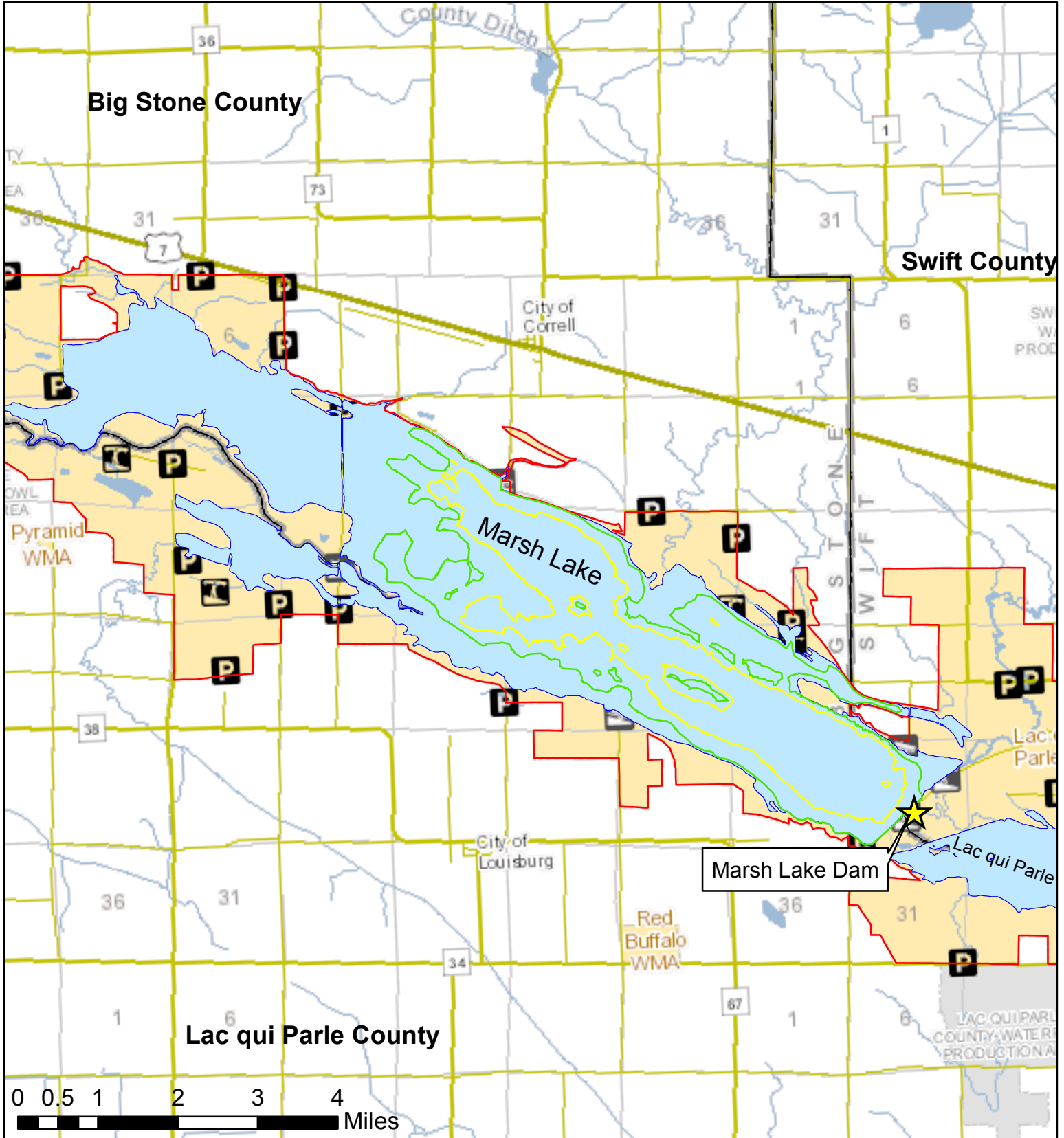




Marsh Lake Ecosystem Restoration Project

Marsh Lake Contours

Marsh Lake Division of Waters# 06000100



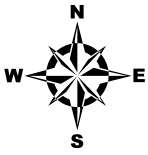
US Army Corps of Engineers®



Marsh_935_line

Marsh_938_line

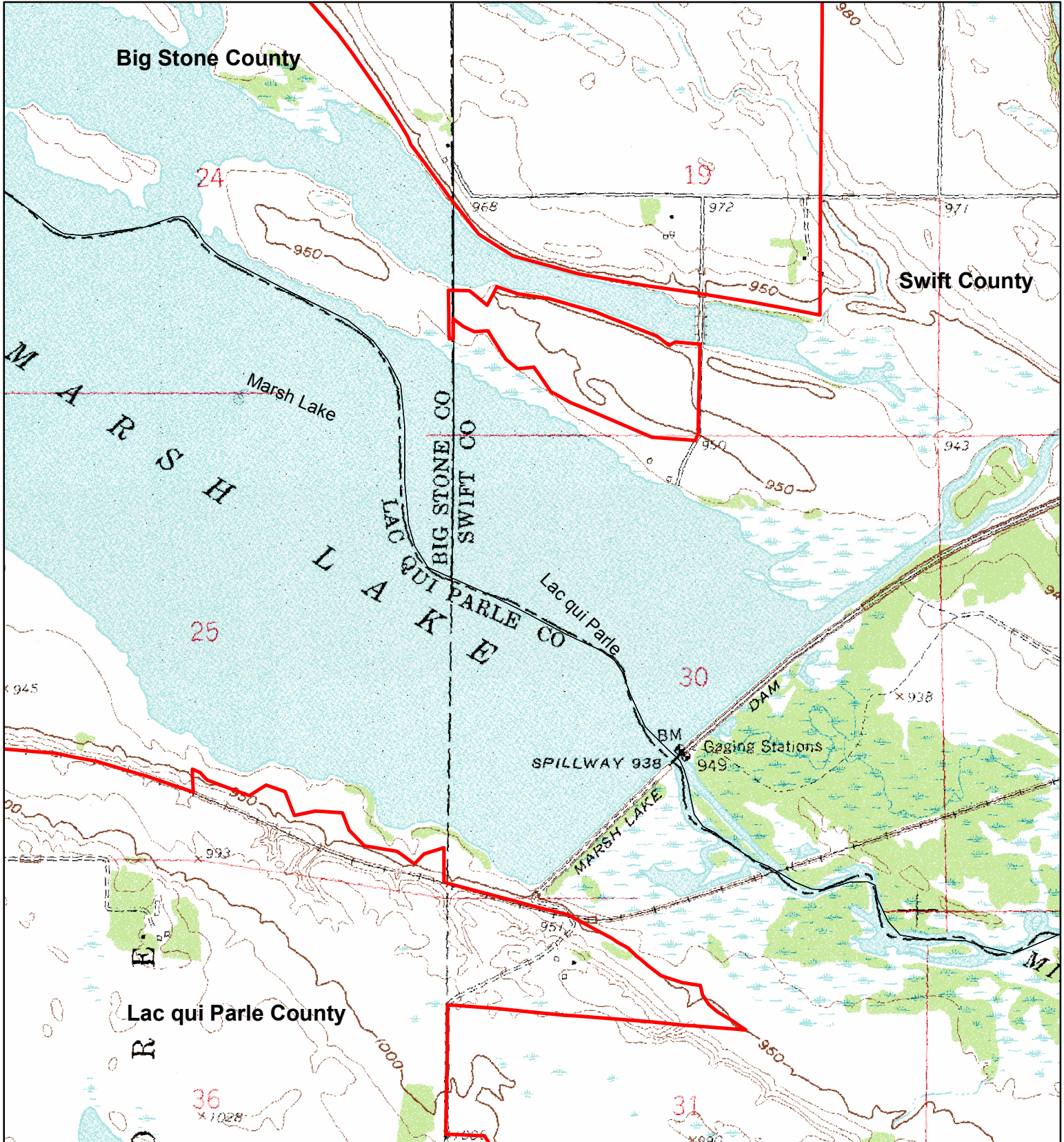
Lac qui Parle WMA



Marsh Lake Ecosystem Restoration Project

Marsh Lake U.S. Geological Survey 1:24,000

Marsh Lake Division of Waters# 06000100



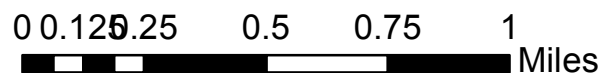
UPPER MINNESOTA RIVER
WATERSHED DISTRICT



US Army Corps
of Engineers®



 Lac qui Parle WMA



1

2

3

4

5

D

C

B

A



MARSH LAKE

255TH AVE SW

250TH AVE SW

95th ST SW

BRW 1

BORROW AREA

BRW 4

BRW 2

PROPOSED EMBANKMENT ALIGNMENT (PHASE 2)

BRW 3

EXISTING EMERGENCY SPILLWAY

EXISTING DAM / NEW FISH PASSAGE

STAGING AREA

DRAWDOWN STRUCTURE

PARKING AND STAGING

DRAWDOWN STRUCTURE OUTLET CHANNEL

MINNESOTA RIVER

POMME DE TERRE RIVER

100th ST SW

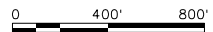
EXISTING DAM/EMBANKMENT CONTROL LINE

EAGLE NEST X=2086617 Y=1126491

660' EAGLE NEST EXCLUSION ZONE

240TH AVE SW

GENERAL PLAN VIEW



BORROW PIT BOUNDRY COORDINATES		
NAME	NORTHING	EASTING
BRW 1	1130283.31	2086359.78
BRW 2	1130269.31	2087012.88
BRW 3	1129698.76	2087069.48
BRW 4	1129908.65	2086367.18



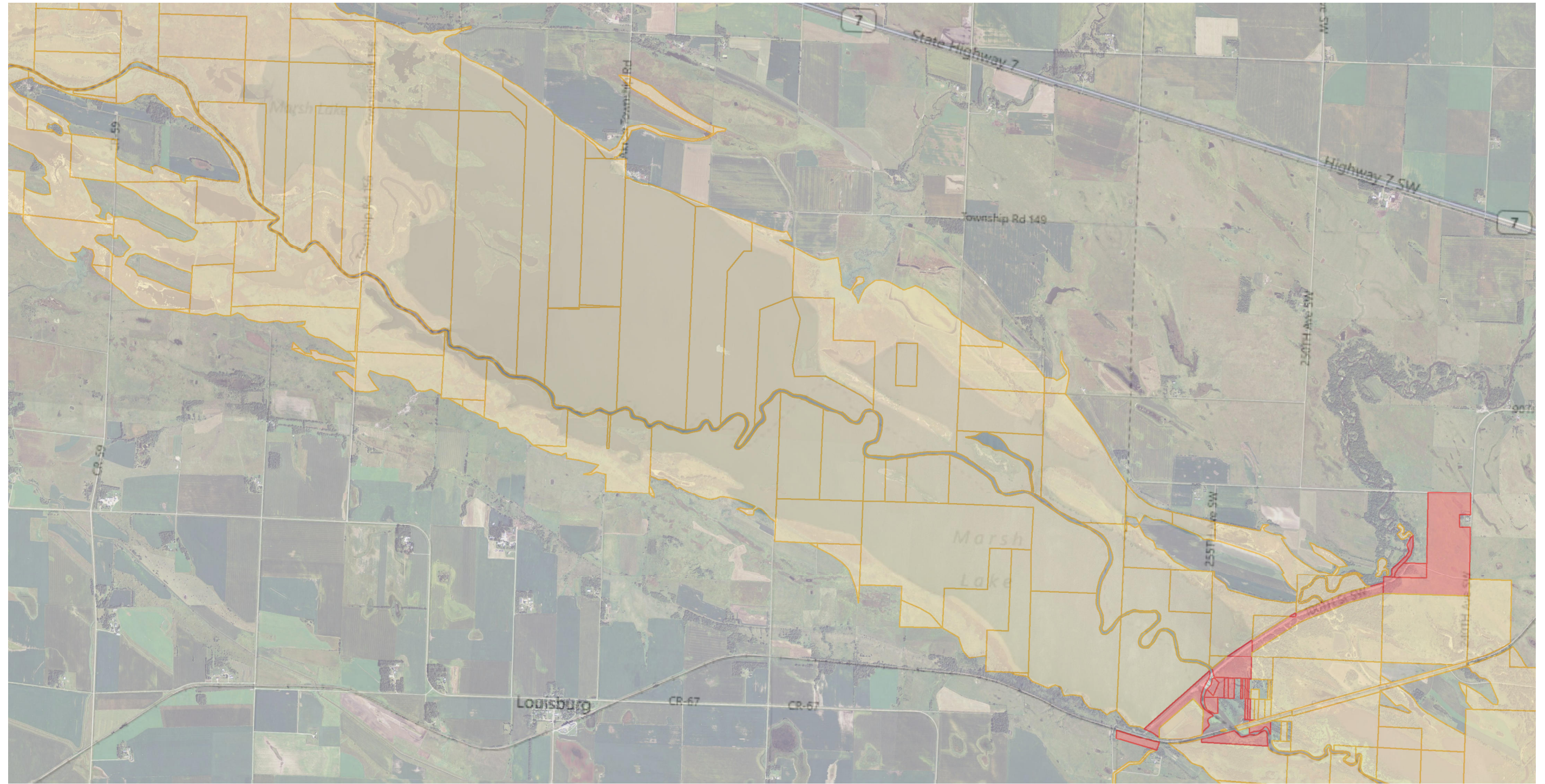
MARK	DESCRIPTION	DATE	APPR. MARK	DATE	APPR. DATE

DESIGNED BY: U.S. ARMY CORPS OF ENGINEERS	DATE:
DRAWN BY: RFP	SUBMITTED BY: M. MOSE
CHECKED BY: GCW	APPROVED BY: GCW
ST. PAUL DISTRICT	ST. PAUL, MINNESOTA
SOLICITATION NO.:	CONTRACT NO.:
FILE NUMBER:	FILE NUMBER:
ANSI D:	ANSI D:

MARSH LAKE ECOSYSTEM RESTORATION - PHASE 1
 MINNESOTA RIVER
 MARSHLAKE DAM
 APPLETON, MN
 GENERAL PLAN
 EMBANKMENT AND CHANNEL
 RESTORATION

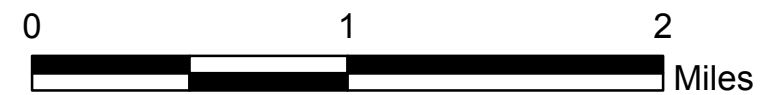
Sheet ID
C-101

ELEVATION DATUM (VERTICAL CONTROL):
 HORIZONTAL DATUM (HORIZONTAL CONTROL):
 MARSH LAKE ECOSYSTEM RESTORATION - PHASE 1
 MINNESOTA RIVER
 MARSHLAKE DAM
 APPLETON, MN
 GENERAL PLAN
 EMBANKMENT AND CHANNEL
 RESTORATION
 U.S. SURVEY FEET
 GEOD 12A
 COMBINED FACTOR (CF): 0.9999546418



Marsh Lake, MN

Base Image: Bing Maps Road with 2010 USDA NAIP Imagery



USACE ACQUIRED ESTATE

- Easement
- Fee

