Engineer's Report

Turtle Connection and Cross Lakes

Flood Damage Reduction Project

Prepared For:
Red Lake Watershed District

July 23, 2024

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TURTLE CONNECTION AND CROSS LAKES FLOOD DAMAGE REDUCTION PROJECT

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I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Nathan P. Dalager, P.E.

License Number 25309

HDR Engineering, Inc.

213 LaBree Ave N, Suite 203

Thief River Falls, Minnesota 56701-2022

Contents

Tables

Figures

Appendices

Acronyms

BFE	Base Flood Elevation
BWSR	Minnesota Board of Water and Soil Resources
CD	County ditch
CFS	Cubic Feet per Second
CLOMR	Conditional Letter of Map Revision
CN	Curve Number
CRP	Conservation Reserve Program
CSAH	County State Aid Highway
CSP	Corrugated Steel Pipe
DEM	Digital Elevation Model
EAW	Environmental Assessment Worksheet
FDR	Flood Damage Reduction
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
JD	Judicial Ditch
LiDAR	Light Detection and Ranging (survey technology)
LTFS	Long Term Flood Solutions
MNDNR	Minnesota Department of Natural Resources
MnDOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
NAVD 88	North American Vertical Datum of 1988
NEH	National Engineering Handbook
NLCD	National Landcover Dataset
NOAA	National Oceanic and Atmospheric Administration
OHW	Ordinary Highwater
P&N	Purpose & Need Statement
PMP	Probable Maximum Precipitation
R	SCS Storage Coefficient
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
RCPA	Reinforced Concrete Pipe Arch
Red River	Red River of the North
ROW	Right-of-Way
RRBWMA	Red River Basin-Wide Modeling Approach

RRFDRWG	Red River Flood Damage Reduction Work Group
RRWMB	Red River Watershed Management Board
SWPPP	Stormwater Pollution Prevention Plan
T_C	Time of Concentration
TP 11	Technical Paper 11
TSAC	Technical and Scientific Advisory Committee
USACE	United States Army Corp of Engineers
USGS	U.S. Geological Survey
WCA	Wetland Conservation Act
WSE	Water Surface Elevation

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1 Executive Summary

The Red Lake Watershed District (RLWD) is developing a Flood Damage Reduction (FDR) project of significance. The intent of the Turtle Connection and Cross Lakes Flood Damage Reduction Project (Project) is a design that provides a FDR component, improved fish passage, and establishes preferred normal lake levels by adjusting the outlet dams at Cross, Turtle, and Connection lakes.

The proposed Project consists of a rock arch rapids and removal of the existing dam at Cross Lake, abandonment and removal of the Turtle Lake dam, and a rock arch rapids and water control structure at South Connection Lake, which will establish preferred long-term lake levels and provide fish passage. The proposal provides a gated/stop log outlet structure at South Connection Lake to provide the ability to manage water levels in Turtle and Connection Lakes for FDR.

The structure layouts consider statutory requirements affecting landowners, changes to lake levels, water quality considerations, cost, and flood reduction impacts.

All elevations in this report are in the North American Vertical Datum of 1988 (NAVD 88).

This Engineer's Report complies with Sec. 103D.711 MN Statutes, and is part of the design process defining the layout and hydraulic impacts of the project.

The recommended option is Alternative 5, which provides a 0.5 foot drawdown of Connection Lake and Turtle Lake in the Fall, creating 340 acre-feet of drawdown storage. This option also provides a 0.5 foot bounce in 100-year water levels creating an additional 440 acre-feet of temporary storage. This results in a total of 780 acre-feet of FDR storage in a 100-year frequency flood event. Alternative 5 also results in a 40 cubic feet per second (cfs) (38.3%) decrease in the 100-year flow downstream of the Connection Lake outlet and a 41 cfs (30.0%) decrease in the 100-year flow downstream of the Cross Lake outlet while the 100-year outlet velocity remains essentially unchanged between existing and proposed conditions at approximately 3 feet per second (fps). For Cross Lake, Alternative 5 proposes raising the normal water runout elevation 0.5 feet above the existing court-ordered runout elevation. The cost for this Alternative is estimated at approximately $1.5 million.

2 Introduction

2.1 Purpose

An analysis has been prepared for an FDR and fish passage project at Turtle, Connection, and Cross Lakes within the Hill River Subwatershed approximately 6 miles northeast of the City of Fosston, MN. This Flood Damage Reduction Project evaluates alternatives that provide an FDR component, maintain fish passage, and establish preferred and permittable lake levels.

2.2 Location

The Hill River has a drainage area of approximately 177 square miles and is 32 miles long, with most of the Hill River Subwatershed in Polk County; see **Figure 1**. The Hill River Subwatershed is located in northwestern Minnesota and is a tributary of the Clearwater River, which flows into the Red Lake River at Red Lake Falls, MN. The Red Lake River then flows west and enters the Red River of the North at East Grand Forks, MN.

2.3 Background

2.3.1 Red River Basin Peak Flow Reduction Initiative

There is a region-wide goal to reduce peak flows along the Red River of the North (Red River) mainstem by 20 percent during a flooding event similar to the 1997 flood. In order to reach this goal each tributary of the Red River has been provided with both peak flow and volume reduction goals as set forth in the Red River Basin Commission's (RRBC) Long Term Flood Solutions (LTFS) Basin Wide Flood Flow Reduction Strategy Report. The goals set forth for the RLWD are 35 percent peak flow reduction and 13 percent volume reduction at the United States Geological Survey (USGS) Gage on the Red Lake River at Crookston and 12 percent peak flow reduction and 10 percent volume reduction in ungaged areas. The RLWD is continually looking to build additional strategies that contribute to the flood damage reduction goals.

2.3.2 MNDNR and Watershed Collaboration

The Minnesota Legislature mandated creation of the Red River Basin Flood Damage Reduction Work Group (FDRWG) to resolve gridlock over state permitting of flood damage reduction projects in the Red River Basin. The FDRWG is co-chaired by the Minnesota Department of Natural Resources (MNDNR) and Red River Watershed Management Board (RRWMB), and continues to meet to administer a 1998 Mediation Agreement on flood damage reduction and natural resource enhancement; see **Figure 2** for RLWD priority flood damage reduction subwatersheds. FDRWG | RRWMB

The 1998 Flood Hazard Mediation agreement promoted the project work team process, which fostered trust between the MNDNR and local units of government, resulting in various multi-purpose projects.

In 2022 the MNDNR contacted the RLWD to discuss the Turtle-Connection-Cross chain of lakes and develop a multi-purpose project, which led to the current project.

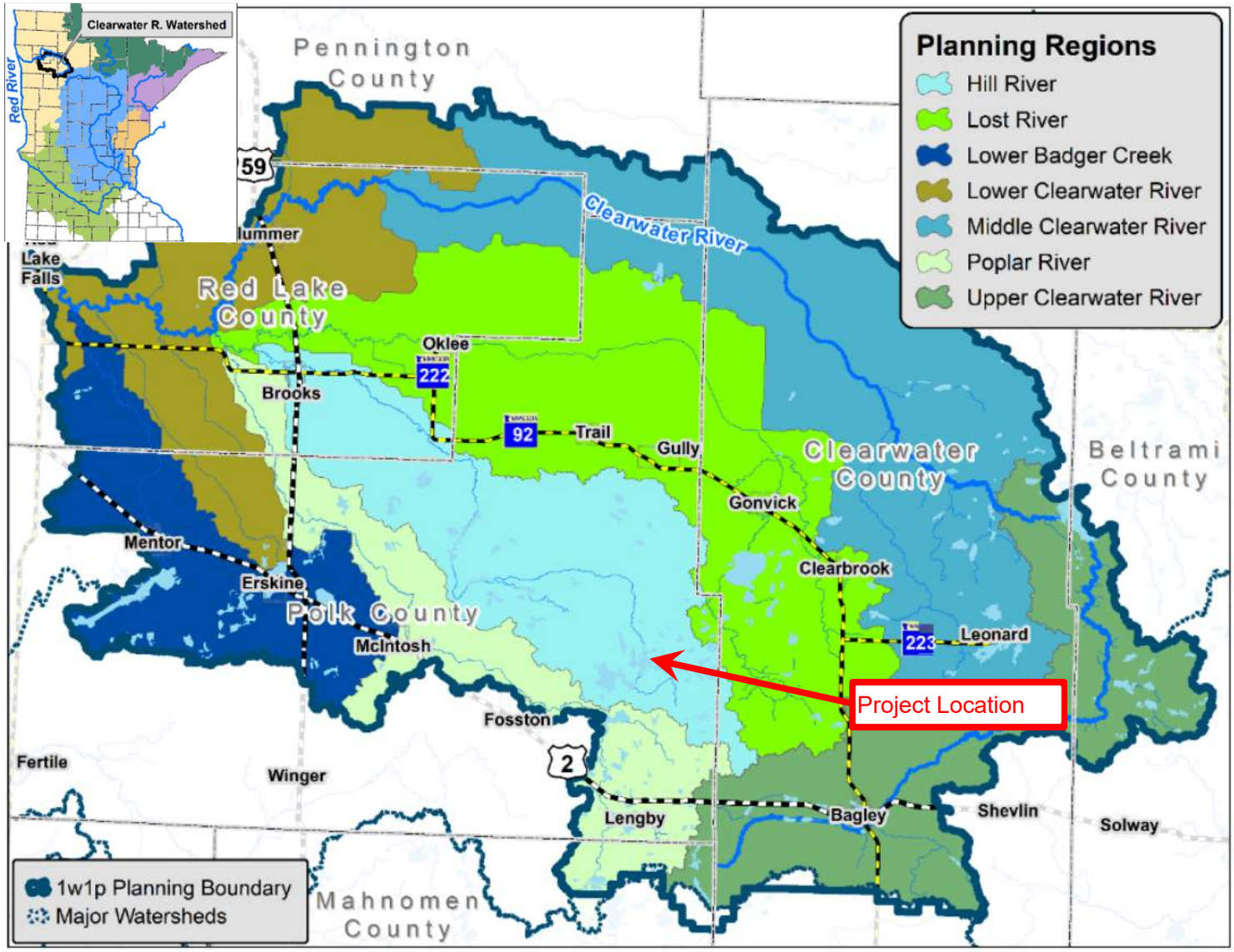

Figure 1: Clearwater River Subwatershed from [ClearwaterCWMP_FINAL.pdf (redlakewatershed.org)]

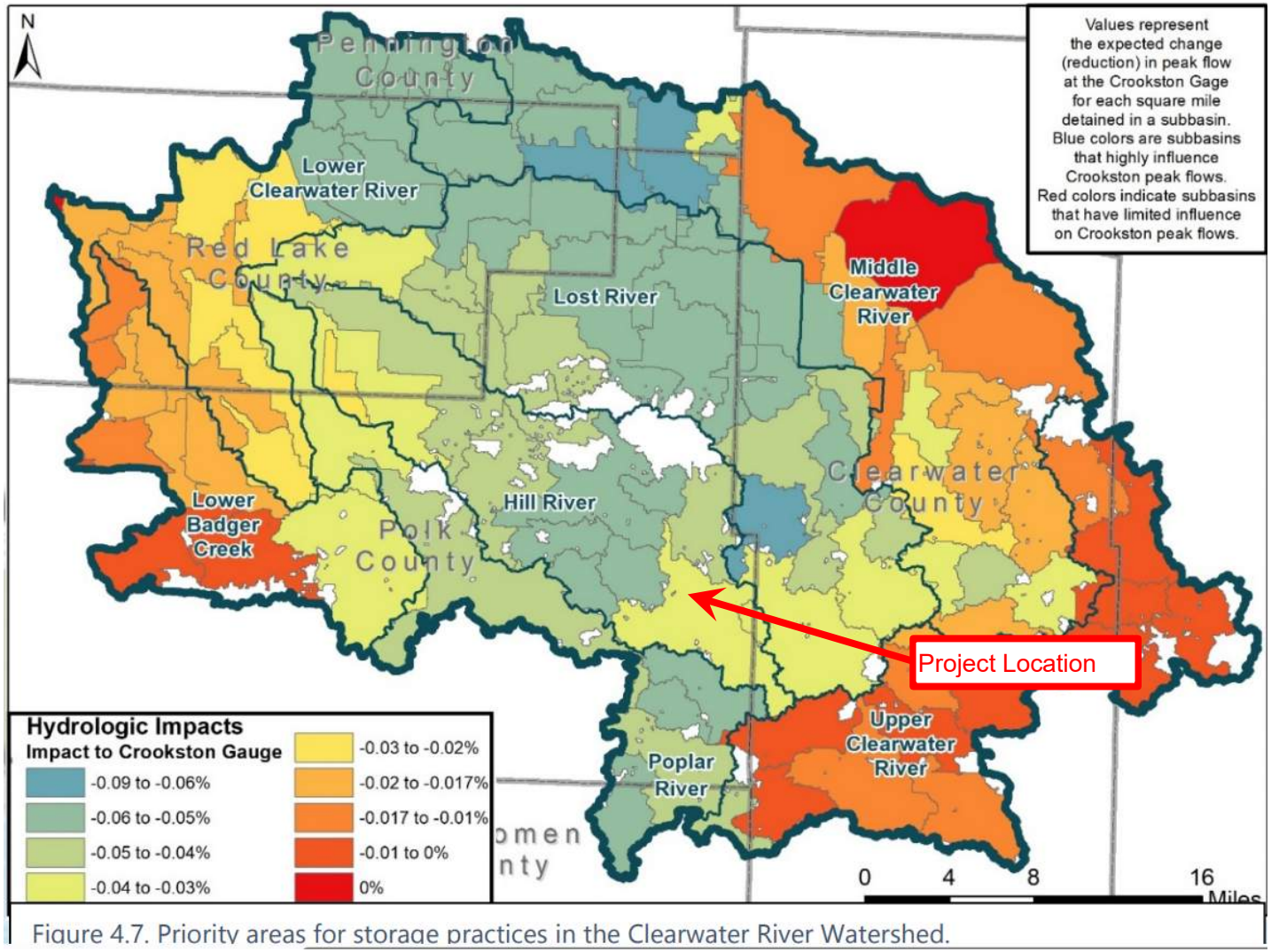

Figure 4.7. Priority areas for storage practices in the Clearwater River Watershed.

Figure 2: Clearwater River Subwatershed Priority Areas from [ClearwaterCWMP_FINAL.pdf (redlakewatershed.org)]

2.3.3 Project Work Team Goals

The Project Work Team consists of local landowners, the RLWD, and Local, State, and Federal Agencies. A few of the work team goals include FDR, water quality improvements, natural resource enhancements, and raising pool levels to provide additional recreational benefits. **Table 1** outlines strategies supported by the FDRWG.

Table 1: Red River Basin Flood Damage Reduction Measures

Reduction Measure Types	Potential Applications	Appropriateness / Ranking
Reduction of Flood Volumes	Manage water levels with a gated structure to provide storage during events.	Positive effects on downstream flooding
Increase Crossing Capacity	Increase the flow capacity between lakes	Reduce chance of road washouts
Protection / Avoidance	Evacuation of structures in the floodplain or flood proofing of structures and farmable land	Reduce structure impacts and improve farmable land
Temporary Flood Storage	Allow for a bounce in water levels by adjusting outlet geometry.	Positive effects on downstream flooding

2.3.4 Lake Levels

Homesteaders settled the area around 1883 and began efforts to drain the Turtle-Connection-Cross Lakes. County Ditch 68 was constructed in 1918 to increase tillable land by further draining the lakes. Concrete dams were constructed in 1933 at Turtle, Connection, and Cross lakes to establish the current lake levels.

The following existing court ordered lake levels were established July 18, 1932 by the Fourteenth Judicial District, Polk County:

- Cross Lake – 1304.40 feet
- Connection Lake – 1307.60 feet
- Turtle Lake – 1307.54 feet

Note the original court order elevations were in the 1912 datum and have been converted to NAVD 88 for this report. All elevations in this report are in the North American Vertical Datum of 1988 (NAVD 88).

There are long-term stage gages at Cross and Turtle Lakes maintained by the MNDNR at Cross and Turtle lakes readings in the 1940's and from the 1990's to present. Information is available at Lake Water Level Report: Cross (60002700) | LakeFinder | Minnesota DNR (state.mn.us). See **Figure 3, Figure 4,** and **Table 2** for a summary of the lake stage information:

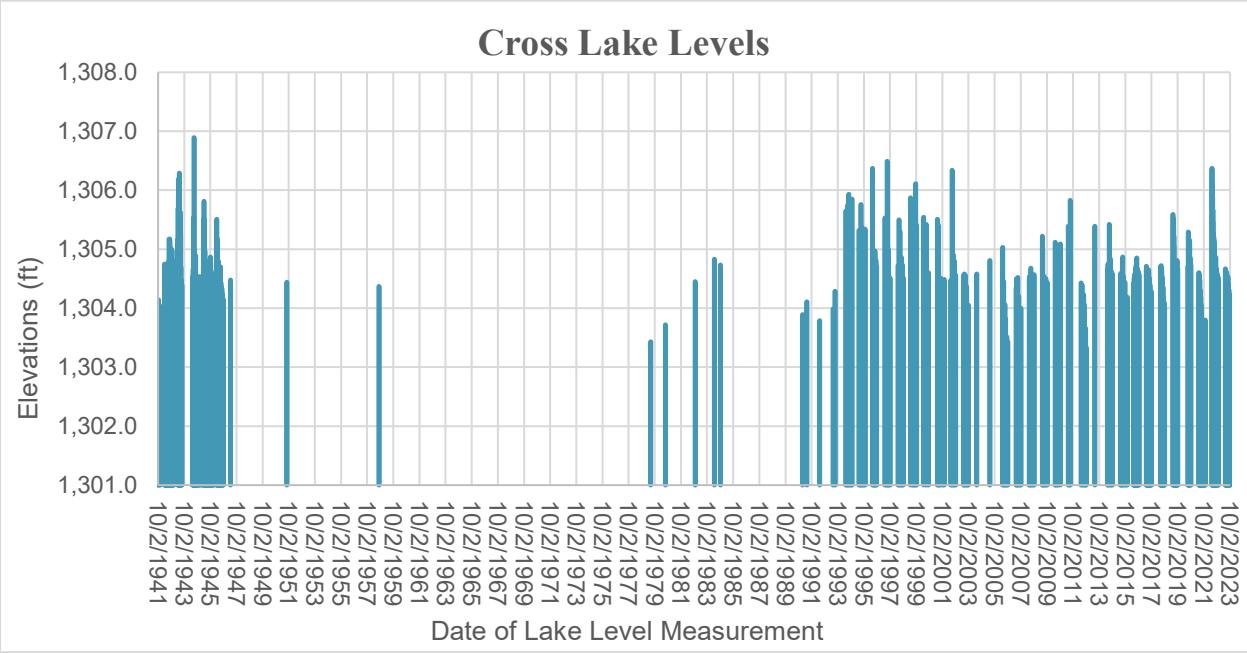

Figure 3: Cross Lake MNDNR Measured Water Levels (NAVD 88 datum)

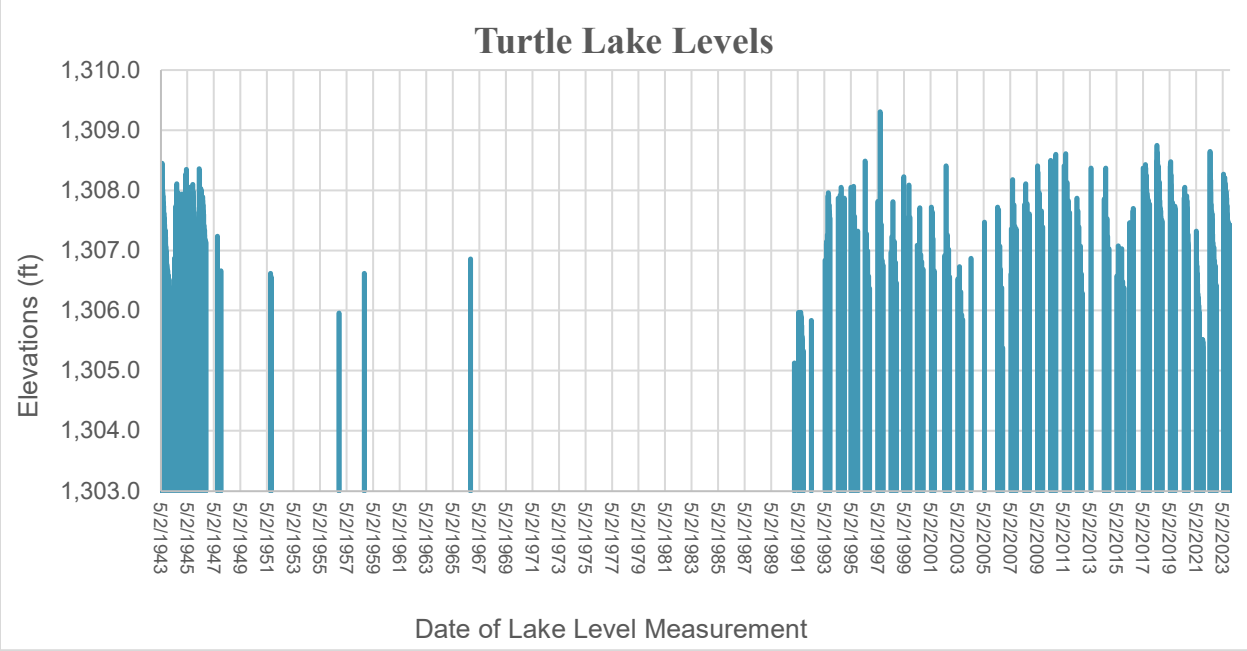

Figure 4: Turtle Lake MNDNR Measured Water Levels (NAVD 88 datum)

Table 2: Turtle and Cross Lake Water Level Summary

Drainage Basin	Turtle Lake Water Levels (Feet)	Cross Lake Water Levels (Feet)
Court Ordered Runout Elevation	1307.54	1304.40
Ordinary Highwater	1308.30	1306.00
Historic Low	1305. 71	1303. 37
Historic High	1309.35	1306.93
2022 Low	1306.31	1304.52
2022 High	1308.70	1306.45

2.3.5 Project Area History

The notes below are a summary of notes taken from a February 2023 landowner meeting, Paul Stolen notes dated April 18, 1994, and Orrin Torgerson notes dated January 1989. These notes provide background information on the lakes as remembered by people in the area. The information has not been confirmed but provides general information which was considered when laying out options.

The following notes are from a landowner meeting at the Fosston Civic Center on February 14, 2023:

- Efforts to drain the lakes occurred when homesteaders first settled the lakes in 1883.
- County Ditch 68 was constructed in 1918 to further drain the lakes to increase agricultural land, see **Figure 5**.
- Dams were constructed in 1933 to restore lake levels, but the drought prevented the lakes from filling until the fall of 1941.
- Cross Lake was a reliable fishing lake in the 1950s and 1960s, with Turtle Lake being a good walleye lake in the 1970s.
- The Turtle Lake outlet structure washed out prior to 1984.
- The South Connection Lake outlet structure washed out in 2019.
- Landowners thought the water levels currently are about 2 feet lower than in the 1970s prior to structure washouts.
- There used to be an abundance of ducks in Turtle Lake due to lots of freshwater shrimp.
- Turtle Lake winter killed in 2018 and 2022.
- Cattle are watered at the small lakes to the east of Cross Lake.

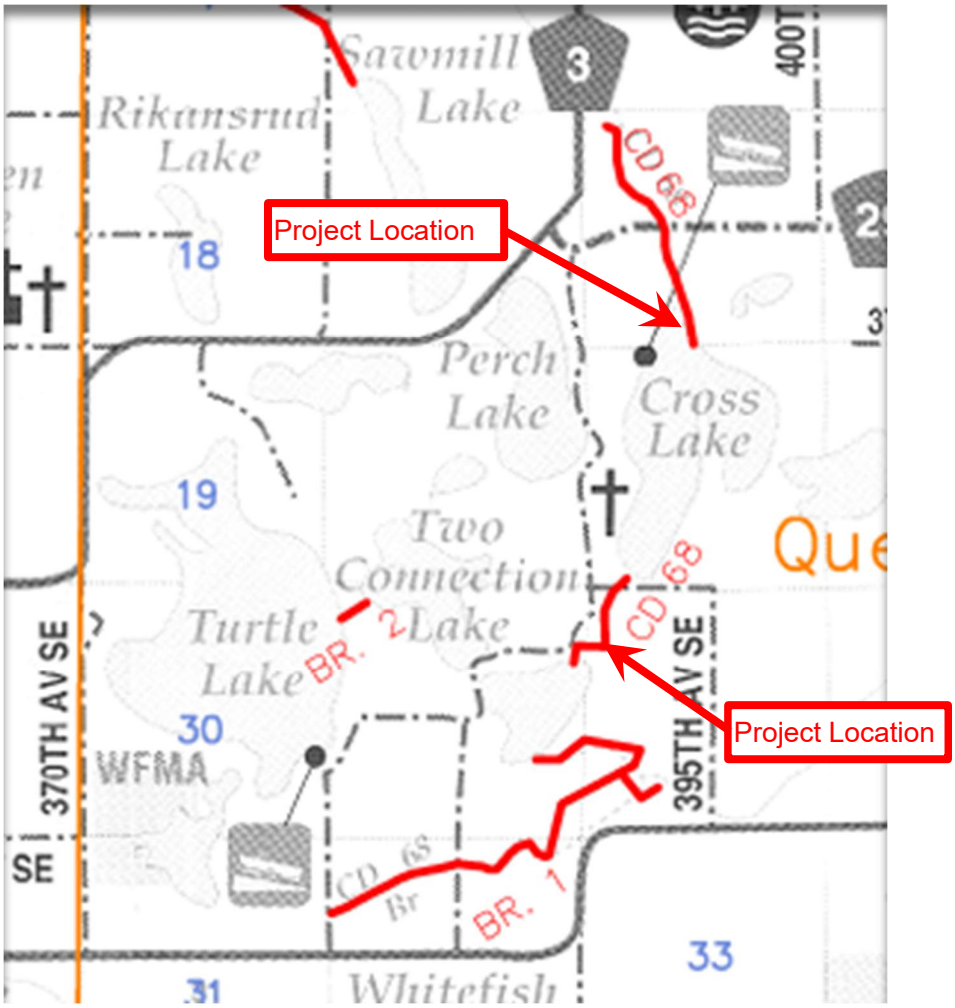

Figure 5: County Ditch #68 Built Circa 1918 to Drain Cross, Connection, and Turtle Lakes

The following notes are from Paul Stolen dated April 18, 1994:

- The 1950s and 1960s were a period of low water.
- The Turtle Lake outlet structure washout occurred after the mid-1960s with the big washout probably occurring in the mid-to-late 1970s when the road across Connection Lake washed out. The boards were never installed at the Turtle Lake structure and the channel was often dry in the 1950s and early 1960s.
- In the 1950s and 1960s, there were large numbers and a large variety of ducks on Turtle Lake with divers, canvasbacks, redheads, wigeon, mallards, and black ducks noted. One October morning in 1960 or 1961, conservation officer and federal biologist Carl Johnson estimated 40,000 birds overnighted on Turtle Lake. Duck numbers decreased in the 1960s.
- Turtle Lake has been a major stopping point for migratory birds on their way down the Mississippi flyway and to Chesapeake Bay. Ducks and other migratory waterbirds don't use just any lake – this one has had significantly different habitats.
- In the 1950s there were tremendous algae blooms on Turtle Lake, and you could smell it for long distances in the spring and when the blooms were on. Water quality has

improved dramatically in recent years (1990s). Cross Lake's water quality seems to have declined in the last 15 to 20 years (1974 to 1994). In the 1950s and 1960s during low water levels the algal blooms on Cross Lake were not as extensive as on Turtle Lake. Up until the 1970s and 1980s Cross Lake was a popular swimming area. Water quality is dependent on land practices. There has been a big decrease in pasturing of cattle around the lake shore reducing nutrients. There has been an increase in the use of fertilizers on farm fields that increases nutrients in the lakes.

- Turtle Lake has always been subject to explosions of fish and crashes from winterkill. There are stories of adjacent landowners taking wagonloads of netted northern pike out of Turtle Lake around the World War I timeframe.
- Cross Lake was a reliable fishing lake during the 1950s and 1960s with northern pike, walleyes, suckers, and crappies. The Connection Lake had boards installed and Paul observed in the spring when there was too little water for northern pike and walleyes to get over the dam and also times when there was enough water for the fish to get over the dam.
- Cattails have increased enormously along the shorelines of Connection and Turtle Lakes since the 1960s. Bulrush beds have become much more abundant in Turtle Lake since 1970 and less common in Cross Lake.

The following notes are from Orrin Torgerson dated January 1989:

- County Ditch #68 was cut to lower Turtle and Connection Lakes and since the main watershed came into the southeast side of Connection Lake Turtle Lake did not get any water and became lower and lower until about 1920 when the fish died. Then during the drought of the 1930s the lake continued to get lower becoming an Upper and Lower Turtle Lake.
- A survey was completed to the north shore of Turtle Lake with a heavy iron stake driven the top of which established the water level as it was before the ditch was dug to lower the lakes.
- Court order dated July 18, 1932 established the lake levels with Turtle and Connection Lakes 3.5 feet higher than Cross Lake. Water level easements were paid, and dams were constructed in 1933. (Maps of the easements were produced.)
- The lake levels were restored in fall of 1941 and heavy rains continued in 1942 so the State Conservation Department removed one stop log at the Connection Lake dam.
- One half mile north of Turtle Lake is a small lake (Rikansrud Lake?) with a flowing well entering it. When Turtle Lake was low the flowing well quit. When Turtle Lake was restored the well started flowing again. Chapek Lake and Sawmill Lake located northeast of Turtle Lake have small drainage areas and their water levels were restored when Turtle Lake was restored so it would seem the water levels of these lakes are maintained by Turtle Lake and Connection Lake.

3 Compatibility with Existing Plans, Statutes, and Permits

The following plans, statutes, rules, and initiatives were used to establish the criteria for Project design.

3.1 East Polk Soil and Water Conservation District

The purpose of the East Polk Soil and Water Conservation District is to "assist landowners in applying proper practices for the conservation of soil erosion, land resource planning and development, reduction of siltation, and flood prevention." The East Polk Water Conservation District also encourages "conservation development, utilization and management of the waters in the area, and preserving natural areas with the fish and wildlife which inhabit them."

3.2 Red Lake Watershed District

The RLWD was established in 1970 under the Minnesota Watershed District Act, Minnesota State Statutes Chapter 103D. "The mission of the RLWD is to reduce flooding and flood damages, to seek to improve water quality, and enhance fish and wildlife habitat through sound water management."

3.3 Clearwater River Comprehensive Water Management Plan

The Clearwater River Comprehensive Water Management Plan (CRCWMP) was developed in 2021-2022 through the One Watershed, One Plan program administered by the Board of Water and Soil Resources (BWSR), Minnesota Statutes §103B.801. The CRCWMP began with a memorandum of agreement (MOA) between all the entities in the watershed including Clearwater County, Clearwater Soil and Water Conservation District (SWCD), Polk County, East Polk SWCD, Red Lake County, Red Lake SWCD, Pennington County, Pennington SWCD, and the Red Lake Watershed District.

The purpose of the plan is to guide the watershed managers (local counties, soil and water conservation districts, and watershed district) as they work to protect and restore the watershed's resources. This plan focuses both on restoration and protection of water quality, hydrology, and habitat.

3.4 Red River Basin Flood Damage Reduction Initiative

The Red River Flood Damage Reduction Work Group (RRFDRWG) Agreement of December 1998 is the framework for FDR projects in the Red River Basin. The purpose of the mediation process was to reach an agreement on long-term solutions for reducing flood damage and ensuring the protection and enhancement of natural resources. The RLWD encourages participation by local, state and federal governments, natural resource agencies, conservation organizations, and local citizens in the planning process.

The Technical and Scientific Advisory Committee of the Red River Basin Flood Damage Reduction Work Group developed Technical Paper (TP) No. 11, which provides recommendations for locations and types of flood damage reduction measures that could be effective for meeting flood damage reduction goals in the greater Red River watershed. TP 11 indicates that the location of flood reduction measures in the watershed is especially critical in determining effectiveness because of influences on timing of flows entering the Red River.

TP 11 has divided the Red River Basin into three timing zones for flows entering the main stem of the Red River of the North. These zones are the "Early Zone", "Middle Zone", and "Late Zone" runoff areas. Each area has recommended potential flood damage reduction measures that can be implemented to reduce flooding throughout the watershed. The Hill River Subwatershed is located near the border of the "Middle Zone" and "Late Zone".

Although the primary goal for the Project is flood damage reduction within the Clearwater River subwatershed, supporting the greater Red River Basin flood reduction goals is a secondary benefit of the Project.

3.5 Minnesota Administrative Rules and Statutes

The following are the Minnesota Administrative Rules and Statutes that pertain to the project.

3.5.1 Watershed Districts

Section 103D of Minnesota Statutes pertains to Watershed Districts. Section 103D.335, Subd. 5 enables watershed districts to exercise the power to "…make necessary surveys or utilize other reliable surveys and data and develop projects to accomplish the purposes for which the district is organized." Section 103D.335, Subd. 8 gives the watershed district the power to "…construct, clean, repair, alter, abandon, consolidate, reclaim, or change the course or terminus of any public ditch, drain, sewer, river, watercourse, natural or artificial, within the district." In addition, Section 103D.335, Subd. 9 give the power to "…acquire, operate, construct, and maintain dams, levees, and reservoirs, and appurtenant works.

Also required by Section 103D.711 is the preparation of an "Engineer's Report" with the following requirements:

- A scaled map of the area to be improved.
- Location of the proposed improvements; location of respective outlets.
- The watershed of the Project Area; the location of existing highways, bridges and culverts.
- All lands, highways, and utilities affected, together with the names of the owners thereof, so far as known; the outlines of any public lands and public bodies of water affected; potential benefiting lands; easement maps; and principal Project features.

This Engineer's Report complies with Sec. 103D.711 MN Statutes.

3.5.2 Water Level Controls

Minnesota Administrative Rule Part 6115.0220 Water Level Controls Subp. 5 – 6115.0220 – MN Rules Part

Permits are required for the construction, repair, reconstruction, or abandonment of any water level control structure, except as provided in subparts 3 and 4, and a project must meet the following general criteria:

A. the project will involve a minimum of encroachment, change, or damage to the environment, including but not limited to fish and wildlife habitat, navigation, water supply, stormwater retention, and agricultural uses;

B. adverse effects on the physical or biological character of the waters are subject to feasible and practical measures to mitigate the effects;

C. the proposed project is consistent with applicable floodplain, shoreland, and wild and scenic rivers management standards and ordinances for the waters involved;

D. the proposed project is consistent with water and related land management plans and programs of local and regional governments, provided such plans and programs are consistent with state plans and programs;

E. the construction or reconstruction complies with parts 6115.0300 to 6115.0520 with respect to dam safety for the protection of human life and property;

F. the construction or reconstruction of water level control structures or changing the level of an existing structure shall be approved only to:

(1) control and store flood waters;

(2) maintain low flows for instream flow or water level protection;

(3) manage water quality, including the prevention or control of erosion and sedimentation;

(4) improve water-based recreation;

(5) create, improve, and maintain water supplies;

(6) create, improve, or maintain aquatic habitat for fish and wildlife species;

(7) establish, improve, or maintain the generation of hydroelectric power; or

(8) restore the existing control elevation to a historic natural water elevation if detailed engineering surveys establish that the proposed control elevation does not exceed the estimated natural control elevation; and

G. the construction or reconstruction of water level control structures or changing the level of an existing structure on watercourses shall be approved only to:

(1) control and store flood waters;

(2) improve water-based recreation;

(3) create, improve, and maintain water supplies;

(4) establish, improve, or maintain the generation of hydroelectric power; or

(5) create, improve, or maintain aquatic habitat for fish and wildlife species

Minnesota Statute 103G.407 Water Level Control for Public Waters with Outlet

(a) The commissioner, upon due consideration of recommendations and objections as provided in paragraph (c), may issue a public-waters-work permit to establish a control elevation for a public water with an outlet that is different than any previously existing or established control level when:

(1) all of the property abutting the ordinary high-water mark of the public water is in public ownership or the public entity has obtained permanent flowage easements; and

(2) the commissioner finds that the proposed change in the control level is in the public interest and causes minimal adverse environmental impact.

(b) In addition to the requirements in section 103G.301, subdivision 6, if the proposed control elevation differs from any historical control level, the permit applicant shall serve a copy of the application on each county and municipality within which any portion of the lake is located and on the lake improvement district, if one exists.

(c) A county, municipality, watershed district, watershed management organization, or lake improvement district required to be served under paragraph (b) or section 103G.301, subdivision 6, may file a written recommendation for the issuance of the permit or an objection to the issuance of the permit with the commissioner within 30 days after receiving a copy of the application.

3.5.3 Environmental Assessment Worksheet (EAW)

Minnesota Rules Chapter 4410 4410.4300 - MN Rules Part and 4410.4600 - MN Rules Part require the preparation of an Environmental Assessment worksheet (EAW). The mandatory preparation of an EAW (Minnesota Rules 4410.4300, subpart 24.B and C) is necessary for "Construction of a dam with an upstream drainage area of 50 square miles or more" or "permanent impoundment of water creating additional water surface of 160 or more acres", or (Minnesota Rules 4410.4300, subpart 27) "for projects that will change or diminish the course, current, or cross-section of one acre or more of any public water or public waters wetland except for those to be drained without a permit pursuant to Minnesota Statutes, chapter 103G." Below are the general permit application procedures:

103G.301 General Permit; Application Procedures Subd. 6.

An application for a permit must be filed with the commissioner. If the proposed activity for which the permit is requested is within a municipality, is within or affects a watershed district or a soil and water conservation district, or is within the boundaries of a reservation or Tribal community of a federally recognized Indian Tribe in Minnesota, a copy of the application with maps, plans, and specifications must be served on the mayor of the municipality, the secretary of the board of managers of the watershed district, the secretary of the board of supervisors of the soil and water conservation district, or the Tribal chair of the federally recognized Indian Tribe, as applicable.

3.5.4 Dam Safety

The proposed Project requires a dam safety permit from the MNDNR in accordance with the following Minnesota Rules:

- 6115.0320. – Definitions Subp. 5. Dam 6115.0320 - MN Rules Part
- 6115.0340 – Classification of Dams 6115.0340 - MN Rules Part
- 6115.0350 – General Procedures for Alteration, Repair, or Removal of a Dam 6115.0350 - MN Rules Part
- 6115.0410 - New Dams or Enlargements 6115.0410 - MN Rules Part.

The purpose of these rules is to regulate the construction and enlargement of dams, as well as the repair, alteration, maintenance, operation, and abandonment, in such a manner as to best provide for public health, safety, and welfare.

Criteria for dam hazard classification are provided from the State of Minnesota. The State of Minnesota may regulate dams if the height of dam is more than 6 feet regardless of storage capacity or the impoundment storage is more than 15 acre-feet regardless of height. The State classifies dams into three hazard types, as described in Minnesota Administrative Rules 6115.0340, Classification of Dams:

- Hazard Class I: any loss of life or serious hazard, or damage to health, main highways, high-value industrial or commercial properties, major public utilities, or serious direct or indirect, economic loss to the public;
- Hazard Class II: possible health hazard or probable loss of high-value property, damage to secondary highways, railroads, or other public utilities, or limited direct or indirect economic loss to the public other than that described in Class III; and
- Hazard Class III: property losses restricted mainly to rural buildings and local county and township roads which are an essential part of the rural transportation system serving the area involved.

Below is a summary of requirements according to MN Rule 6115.0410, New Dams or Enlargements.

- Permit Application – owner and dam description
- Preliminary Report
  - project features
  - site maps,
  - site conditions,
  - typical cross sections,
  - design assumptions,
  - hydrology & hydraulics,
  - flood routing/breach analysis,
  - operations,
  - structural,
  - geotech,
  - boring logs,
  - cost estimate,
- Final Design Requirements – project description, service life, storage area, free board, dam break flood, construction considerations, construction quantities, seepage studies, responsibilities, emergency procedure, detailed cost estimate
- Plans and Specifications
- Permit Standards – potential hazards to the public and environment
- Work Inspection and Construction Reports – conformity with approved designs, plans, and specs, permanent vertical and horizontal control, construction report
- As-built Plans
- Statement of Completion
- Issuance of Approval
- Performance Reports

3.5.5 Drainage of Public Waters

6115.0270. – Drainage of Public Waters Subp. 4. 6115.0270 - MN Rules Part

A permit is required for the partial drainage or temporary drawdown of public waterbasins and public water wetlands and shall be granted if all of the following conditions are met:

A. the proposed project is intended to achieve one or more of the following purposes:

(1) improve navigational or recreational uses;

(2) improve or restore fish or wildlife habitat;

(3) expose sediment in order to remove or eliminate nutrients or contaminants;

(4) alleviate flooding of agricultural lands caused by artificial obstruction of downstream drainage or increased upstream discharge; or

(5) allow the mining of iron ore, taconite, copper, copper-nickel, or nickel under Minnesota Statutes, section 103G.297;

B. the project will involve a minimum of encroachment, change, or damage to the environment, including but not limited to fish and wildlife habitat, navigation, water supply, water quality, and stormwater retention;

C. adverse effects on the physical or biological character of the waters are subject to feasible and practical measures to mitigate the effects;

D. the proposed project is consistent with applicable floodplain, shoreland, and wild and scenic rivers management standards and ordinances for the waters involved; and

E. the proposed project is consistent with water and related land management plans and programs of local and regional governments, provided such plans and programs are consistent with state plans and programs.

3.5.6 Fill Below OHW

A Minnesota Department of Natural Resources Public Waters Permit, in accordance with Minnesota Rules 6115.0190 Filling into Public Waters. 6115.0190 - MN Rules Part, will be required for construction taking place within a public water or below the Ordinary High Water (OHW) elevation of a public water.

3.6 US Army Corps of Engineers Section 404

A Section 404 permit will be required by the USACE because wetland impacts will occur by the construction and operation of the proposed Project, such as placement of fill within wetlands, common excavation, and impacts from general construction practices within the construction footprint.

3.7 Wetland Conservation Act

A Wetland Conservation Act (WCA) permit will be required for the Project. The permit will include a review of all wetland impacts due to the footprint, operation, bounce, flood frequency, water depth, and construction of the proposed Project.

3.8 Water Quality

3.8.1 National Pollutant Discharge Elimination System Requirements (NPDES)

A storm water permit will be required for the construction of this Project. The permittee will develop a stormwater pollution prevention plan (SWPPP) that focuses on discharges from the site into public waters. Each party under regulation determines the most appropriate best management practices (BMPs) that should be implemented to minimize pollution for the specific site.

3.8.2 401 Water Quality

The following text comes from the Minnesota Pollution Control Agency (MPCA) website Clean Water Act Section 401 water quality certifications | Minnesota Pollution Control Agency (state.mn.us)

> *When a project that will impact WOTUS in Minnesota requires a federal Section 404 permit, the MPCA reviews the project under Section 401 to ensure that it will not violate the more restrictive water quality standards that the MPCA has established for that body of water. The 401 certification becomes an enforceable component of the associated federal license or permit issued under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act and Federal Energy Regulatory Commission (FERC) Projects.*
>
> *The federal agency, U.S. Army Corps of Engineers (USACE), cannot issue a permit or license until the MPCA has either certified that the project impacting WOTUS will comply with state water quality standards, or waived its review of the project. This review gives the state a unique role in water quality protection.*

3.9 FEMA Map Revision

The Cross, Connection, and Turtle lakes are outside of a mapped FEMA Special Flood Hazard Area, so a submittal to the FEMA floodplain administrator is not required.

4 Existing Lake and Outlet Structure Information

The Hill River enters South Connection Lake and flows north to Cross Lake before exiting Cross Lake and flowing north. South Connection Lake is connected on the northwest corner to North Connection Lake which is hydraulically connected to Turtle Lake. These connections allow for equalization of water levels in South Connection Lake, North Connection Lake, and Turtle Lake; see **Figure 6** for lake connections and flow direction.

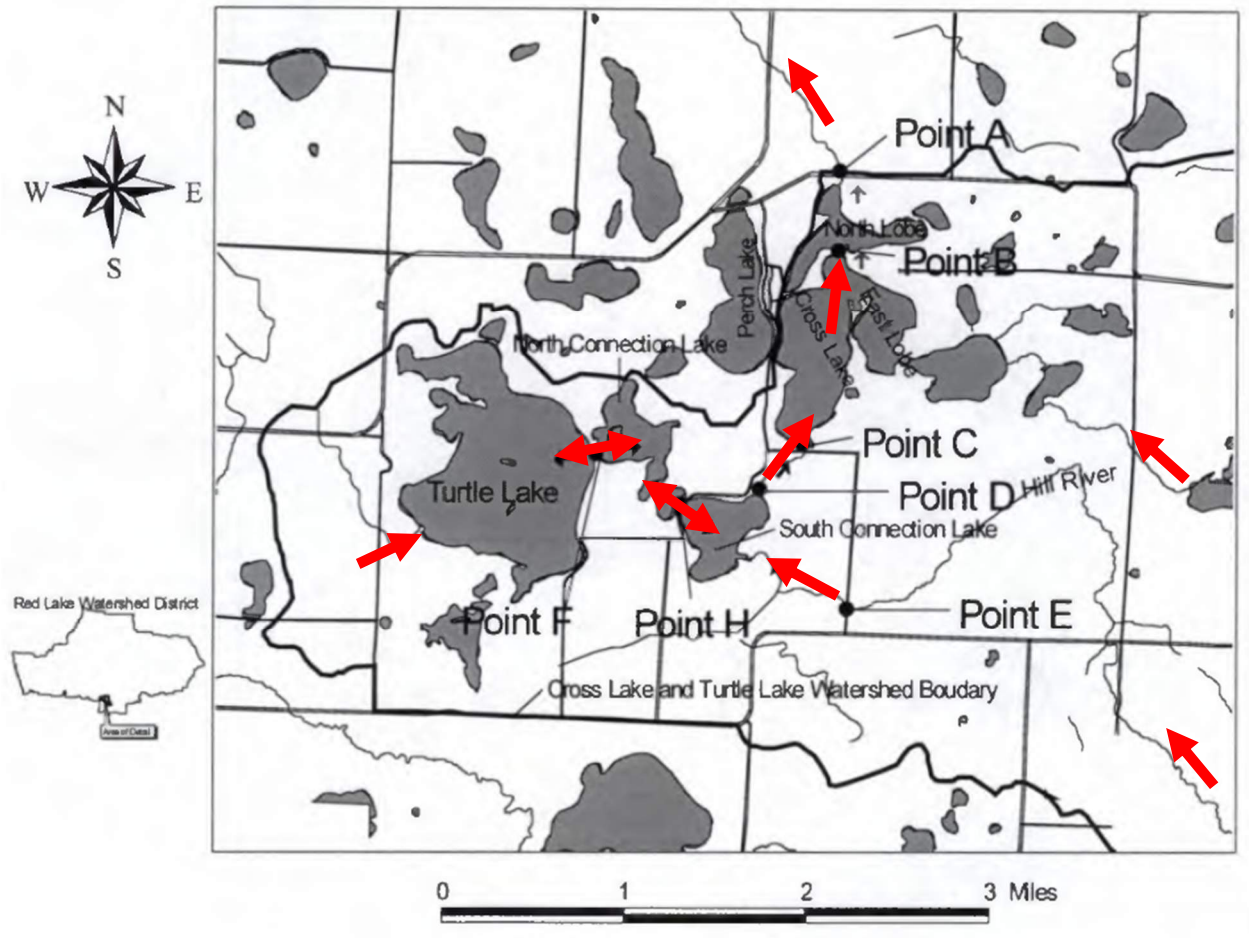

Figure 6: Lake Connections and Flow Direction

4.1 Survey

HDR conducted a field survey on January 4, 2024 collecting channel cross section, channel profile, general topo at the outlet structures, culvert inverts, and road overtopping information. This information was collected with a survey grade GPS unit with 0.1 foot vertical accuracy. Light detecting and ranging (LiDAR) was used to extend cross section overbank information where necessary.

LiDAR information was obtained from the Red River Basin Commission collected October 29, 2021 during a period of low water levels with the following metadata:

- horizontal coordinates – 1983_2011_UTM Zone 15
- vertical datum - NAVD 88

- vertical and horizontal accuracy - 0.001 m

4.2 Lake Stage Storage Curve

The LiDAR information was used to define the stage storage curve from the water level at the time of the LiDAR data collection up the bank. The LiDAR water level is assumed to be the low water level, and the stage-storage calculations are not a factor below this elevation. For viewing purposes, the area below the LiDAR water level was extended to the lake bottom using available MNDNR lake topography from the following website LakeFinder | Minnesota DNR (state.mn.us).

The following lake information is also available on the MNDNR Lake Finder Site:

- Turtle Lake
  - ID - 60003200
  - Area - 525 acres
  - Maximum Depth – 12 feet
  - Mean Depth – not available
- Cross Lake
  - ID - 60003200
  - Area - 320 acres
  - Maximum Depth – 19 feet
  - Mean Depth – 12 feet
- Connection Lake
  - ID - 60003500
  - Area - 197 acres
  - Maximum Depth – not available
  - Mean Depth – not available

4.3 Existing Outlet Structures

Concrete outlet structures were constructed in 1932 and are present at the outlets of Cross Lake, South Connection Lake, and Turtle Lake, see **Figure 7** for outlet structure locations.

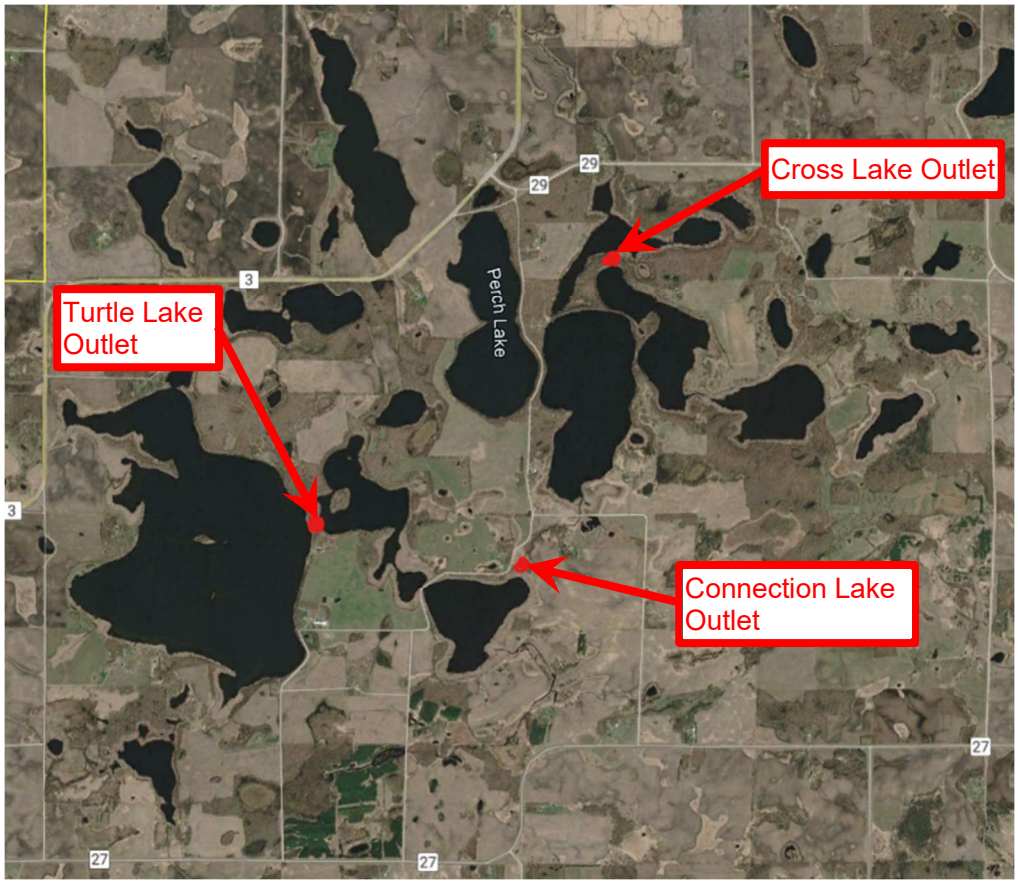

Figure 7: Cross, Connection, and Turtle Lake Outlet Structure Locations

4.3.1 Cross Lake Outlet

Stoplogs could be used at the concrete structure to manage water levels with a weir crest that is 25 feet long, however, there were no stop logs at the time of survey. The elevation of the top of concrete is 1307.5 and the surveyed crest is 1304.44 (**Figure 8**), as compared to the court-ordered elevation 1304.40. This structure was functioning at the time of HDR's January 2024 field survey.

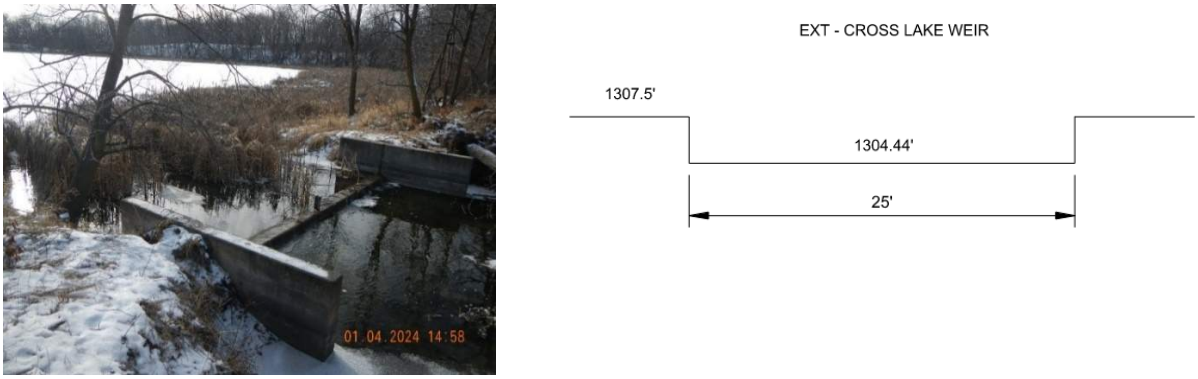

Figure 8: Existing Cross Lake Outlet Structure

4.3.2 Connection Lake Outlet

This structure was functioning at the time of HDR's January 2024 field survey. Stoplogs were present at the concrete structure to manage water levels with a 16-foot long weir crest. The elevation of the top of concrete is 1311.15, and the surveyed top of crest is 1308.06 (**Figure 9**). The court ordered elevation is 1307.60.

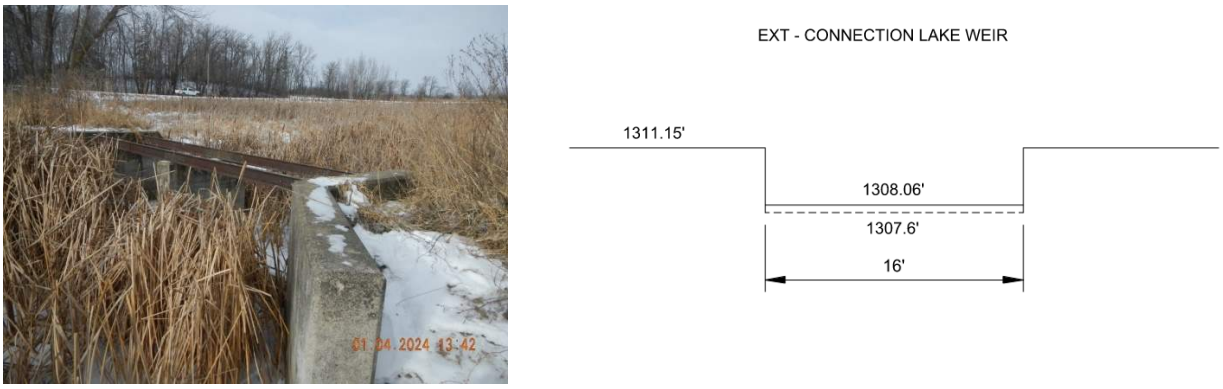

Figure 9: Existing Connection Lake Outlet Structure

4.3.3 Turtle Lake Outlet

The structure was washed out and not functioning at the time of HDR's January 2024 field survey (**Figure 10**).

Figure 10: Existing Turtle Lake Outlet Structure

5 Alternatives Considered

The alternatives considered in the Engineer's Report consists of structures at Cross, Turtle, and Connection lakes to create the ability to adjust water levels up and down, operate for flood damage reduction, and provide for fish passage through the lakes. HDR considered the impact of permanent and temporary changes in water levels, rock arch rapids and gated structures, and the purpose of each change. The structure at Turtle Lake is not proposed for replacement, as the Connection Lake location will have dual purpose for both Turtle and Connection Lakes. **Table 3** provides a general summary with impacts.

Table 3: Impact/Purpose of Lake Elevation Adjustments

Adjustments to Lake Elevation	Turtle and South Connection Lake	Cross Lake	Impact
Court Ordered Runout Elevation	Rock Arch Rapids with outlet crest at court ordered runout elevation	Rock Arch Rapids with outlet crest at court ordered runout elevation	Improved fish passage, No FDR benefit, improvement to recreation
Raise lake 0.5 ft above court ordered runout	N/A	Rock Arch Rapids with outlet crest 0.5 ft above court ordered runout elevation	Improved recreation, No FDR benefit
Drawdown lakes 0.5 ft below court ordered runout	Construct gated outlet structure and bypass channel	N/A	FDR benefit

Table 4 is a site ranking matrix which provides a summary of options considered with the change in storage compared to likely impacts (wetland, landowners, structures, roads, fish, recreation, water quality, and permitting) to create a relative rank. The options that rank highest are a slight increase in lake levels at Cross and Connection Lakes, with rock arch rapids for fish passage also scoring high.

Table 4: Impoundment Site Ranking Matrix

MATRIX OF CROSS TURTLE / CONNECTION

Site	Potential Structure Type	Drainage Area (Mi²)	Lake Area (AC)	Inches of Runoff Captured for FDR	Shoreland Fringe Impact (AC)	Wetland Impact (AC)	Storage (AC-FT)	Number of landowners affected	Number of Homes/Barns Affected	Number of Docks affected	Number of Fields Affected	Roadways/ Pathways Affected	Fish Passage	Winter Kill	Waterfowl	Recreation	Water Quality	Permit Complexity	Score	Relative Rank
A - Cross Existing Runout Elevation	Existing, rock arch, or structure with bypass and rock arch	25	320	0	0	0.07	0	14	0	0	0	0	Yes**	No change	No change	No change	No change	Moderate	7	2
B - Cross increase by 3 in	Rock arch, or structure with bypass and rock arch	25	322	0	2	0.07	0	14	0	0	1	1	Yes	Improve	Improve	Improve	Improve	Moderate	9	1
C - Cross increase by 6 in	Rock arch, or structure with bypass and rock arch	25	325	0	5	0.07	0	14	0	8	1	2	Yes	Improve	Improve	Improve	Improve	Moderate	6	3
D - Turtle Existing Runout Elevation	Rock arch, or structure with bypass and rock arch	17	525	0	0	0.06	0	8	0	0	0	0	Yes	No change	No change	No change	No change	Moderate	7	2
E - Turtle increase by 6 in	Rock arch, or structure with bypass and rock arch	17	566	0	41	0.07	0	8	0	1	3	1	Yes	Improve	Improve	Improve	Improve	Moderate	6	3
F - Turtle 1 ft Drawdown	Structure with bypass and rock arch	17	484	0.6	41	0.17	525	8	0	1	4	2	Yes	Worse	No change	No change	Improve	Moderate	2	6
G - Turtle 1 ft Bounce	Structure with bypass and rock arch	17	607	0.7	82	0.17	607	8	0	1	4	2	Yes	No change	Improve	Improve	Improve	Moderate	5	4
H- Connection Existing Runout Elevation	Rock arch, or structure with bypass and rock arch	17	226	0	0	0.06	0	12	0	0	0	0	Yes	No change	No change	No change	No change	Moderate	7	2
I- Connection increase by 6 in	Rock arch, or structure with bypass and rock arch	17	243	0	8	0.07	0	12	0	0	2	1	Yes	Improve	Improve	Improve	Improve	Moderate	9	1
J - Connection 1 ft Drawdown	Structure with bypass and rock arch	17	194	0.2	32	0.17	225	12	0	0	2	2	Yes	Worse	No change	No change	Improve	Moderate	3	5
K- Connection 1 Ft Bounce	Structure with bypass and rock arch	17	261	0.3	35	0.17	260	12	0	0	2	2	Yes	No change	Improve	Improve	Improve	Moderate	6	3

-All lakes separated by potential stage

Site	Potential Structure Type	Drainage Area (Mi^2)	Lake Area (AC)	Inches of Runoff Captured for FDR	Shoreland Fringe Impact (AC)	Wetland Impact (AC)	Storage (AC-FT)	Number of landowners affected	Number of Homes/Barns Affected	Number of Docks affected	Number of Fields Affected	Roadways/ Pathways Affected	Fish Passage	Winter Kill	Waterfowl	Recreation	Water Quality	Permit Complexity	Score	Relative Rank
L - Cross Existing Runout Elevation	**Existing, rock arch, or structure with bypass and rock arch**	25	320	0	0	0.07	0	14	0	0	0	0	Yes**	No change	No change	No change	No change	Moderate	7	2
M - Cross increase by 3 in	**Rock arch, or structure with bypass and rock arch**	25	322	0	2	0.07	0	14	0	0	1	1	Yes	Improve	Improve	Improve	Improve	Moderate	9	1
N - Cross increase by 6 in	**Rock arch, or structure with bypass and rock arch**	25	325	0	5	0.07	0	14	0	8	1	2	Yes	Improve	Improve	Improve	Improve	Moderate	6	3
***O - Turtle/Connection Existing Runout Elev.**	**Rock arch, or structure with bypass and rock arch**	17	751	0	0	0.06	0	20	0	0	0	0	Yes	No change	No change	No change	No change	Moderate	7	2
***P - Turtle/Connection increase by 6 in**	**Rock arch, or structure with bypass and rock arch**	17	809	0	49	0.07	0	20	0	1	5	2	Yes	Improve	Improve	Improve	Improve	Moderate	5	4
***Q - Turtle/Connection 1 ft Drawdown**	**Structure with bypass and rock arch**	17	678	0.8	73	0.17	750	20	0	1	6	4	Yes	Worse	No change	No change	Improve	Moderate	2	6
***R - Turtle/Connection 1 ft Bounce**	**Structure with bypass and rock arch**	17	868	1	117	0.17	867	20	0	1	6	4	Yes	No change	Improve	Improve	Improve	Moderate	5	4

****-Alternatives with Turtle/Connection managed together with control at Connection Lake***

*****-Fish Passage Cross, assumes replacement of existing structure***

******LEGEND**

Color/Score	Description
-1	Less Favorable
0	Moderately Favorable
1	Favorable

Table 5 is a matrix of features considered during the feasibility study, which is organized by site and relative benefit. The features with the desired benefits were combined together in different configurations to create Alternatives 1 through 6.

Table 5: Matrix of Features Considered

Location	Temporary WSE Increase Above Court Ordered Runout Elevation	Manage WSE's and Temporarily Lower Lake Below Court Ordered WSE	Lake at Court Ordered WSE's	Increase Lake WSE Above Court Ordered WSE
Cross Lake Outlet	Multi-stage Crest at Cross improves FDR by creating temporary storage in Cross.	Not Recommended	Cross Lake Rock Arch Rapids at court ordered elevation does not provide FDR gain. It does improve fish passage.	Cross Lake Rock Arch Rapids above court ordered elevation does not provide FDR gain. It does improve fish passage and improves recreation.
South Connection Lake Outlet	Multi-stage Crest at Connection improves FDR by creating temporary storage in Connection and Turtle.	Gated Bypass at Connection improves FDR by creating storage in Connection and Turtle.	Connection Lake Rock Arch Rapids at court ordered elevation does not provide FDR gain. It does improve fish passage.	Connection Lake Rock Arch Rapids above court ordered elevation does not provide FDR gain. It does improve fish passage and improves recreation.
Turtle Lake Outlet	Multi-stage Crest at Turtle improves FDR by creating storage in Turtle. Remove structure	Gated Bypass at Connection improves FDR by creating storage in Connection and Turtle.	Turtle Lake Rock Arch Rapids at court ordered elevation results in no FDR gain, restricts fish passage as compared to an open channel, and could restrict flow lowering lake WSE during dry years. Turtle Lake elevations can be set by Connection Lake outlet structure so an open channel at Turtle Lake will provide fish passage at the court ordered elevation.	Turtle Lake Rock Arch Rapids above court ordered elevation does not provide FDR gain, restricts fish passage as compared to an open channel, and improves recreation in most years, but could restrict flow lowering WSE during dry years.

Raising Cross Lake by 0.5 feet for recreation benefits, creating drawdown and temporary FDR storage in Connection Lake and Turtle Lake, and installing fish passage channels at Cross and Connection were selected as the preferred features that make up Alternatives 1 through 6.

5.1 Cross Lake

The existing Cross Lake outlet is a concrete structure constructed in 1932 with a court order lake level of 1304.4 feet. The highest ranking option is a slight lake level raise with a bypass and a rock arch.

A stop log could be incorporated into the rock arch riffle crest to provide a 3- to 6-inch draw down capability, if desired, but this would have to be managed and maintained.

5.1.1 Recommended Layout

The court ordered lake level is 1304.4. A 0.5 foot increase in the lake level (to 1304.9 feet) is desired by the project team for recreation benefits. This change in lake level does not impact FDR because the lake level is not raised or lowered to create storage. A rock arch rapids centered on the existing stream, matches the existing channel geometry as close as possible, and has a trapezoidal cross section 14 feet wide and 2:1 side slopes is proposed for fish passage. The slope of the rock arch rapids is 3%, and the boulder riffles are spaced so there is 0.5 feet of vertical drop between the riffles.

The rock arch rapids will incorporate the existing concrete structure into the crest of the riffle. The weir crest has the same trapezoidal cross section as the channel with a 14 foot bottom width and 2:1 side slopes. The weir crest elevation is set at 1304.9 feet, which is 0.5 feet above the court ordered elevation of 1304.4 feet. The weir coefficient changes from a sharp crested weir with a coefficient of 3.1 under existing conditions to a broad crested weir with a coefficient of 2.5 due to the rock rapids. **Figure 11** is the recommended Cross Lake weir crest.

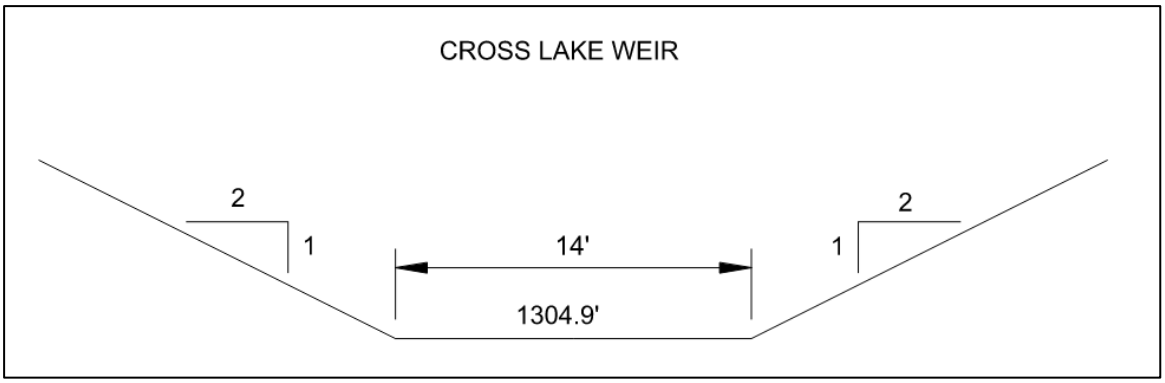

Figure 11: Recommended Cross Lake Weir Crest

5.1.2 Additional Layouts Considered

- Gated Structure with Bypass Channel – A gated structure with bypass channel was considered, but the outlet channel is confined with steep 2(H):1(V) banks, over 20 feet of vertical elevation difference, and substantial tree cover. While the excavation is technically feasible, it is a significant cost and impact for very little benefit. Culverts were also considered to reduce the bypass channel footprint. Ultimately there is a desire to maintain a steady lake level at Cross Lake, eliminating the need for a bypass channel.
- Auxiliary Spillway – An auxiliary spillway was considered to provide a more robust design and safety valve for high water around the main structure. However, the auxiliary spillway was deemed infeasible for the same reasons as the gated structure and bypass channel.
- Weir Crest Configurations – There was a concern that changing from a sharp crested rectangular weir 20 feet long with a weir coefficient of 3.1 to a broad-crested trapezoidal weir with a 14 foot bottom width, 2:1 side slopes, and a weir coefficient of 2.5 would reduce the capacity and cause a rise in water levels during larger events. Numerous weir crest configurations were modeled with the longest weir crest being an arched crest 42 foot long weir. The longer crest reduced 100-year water levels, but the closest match to existing conditions was the 14 foot bottom width trapezoidal weir with 2:1 side slopes.

Figure 12 is an example layout considered in the alternative review showing the 42 foot long arched crest. The shaded areas represent excavated material placement.

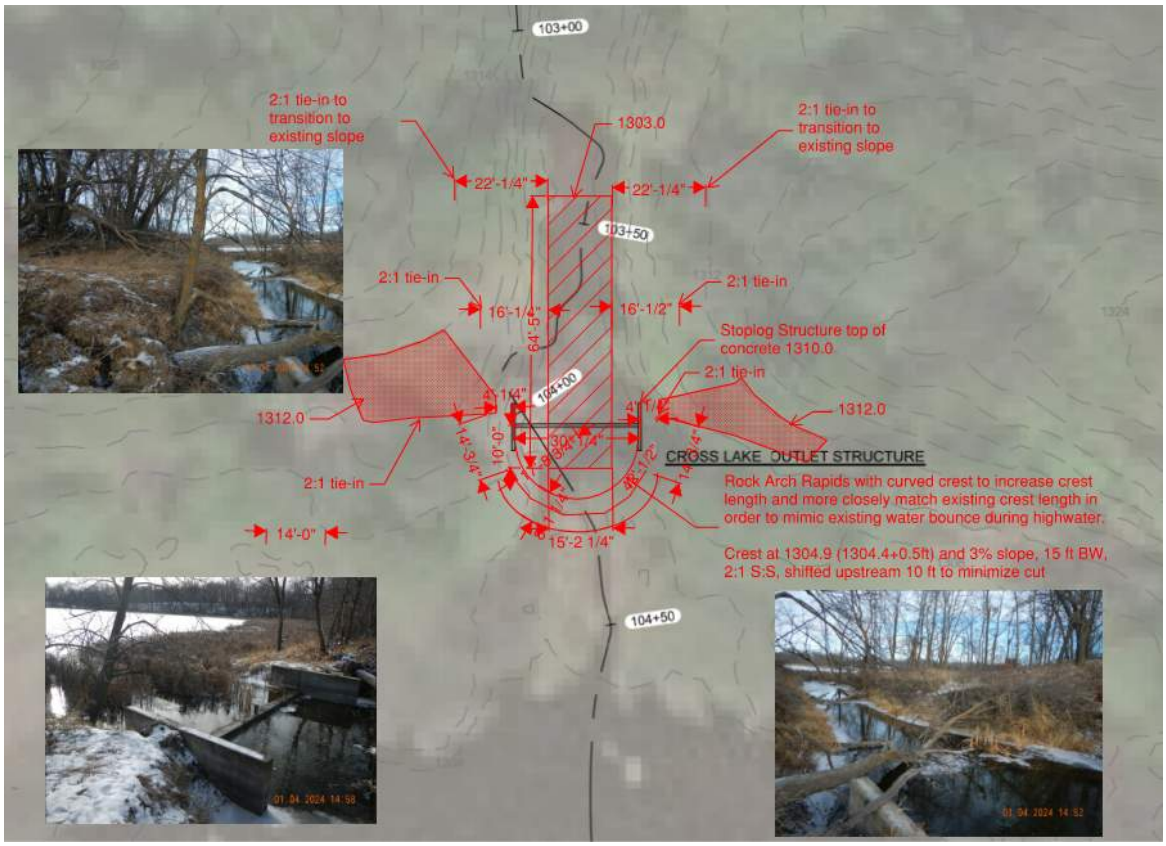

Figure 12: Example Cross Lake Outlet Structure Layout Considered During the Feasibility Study

5.2 Connection Lake

5.2.1 Recommended Layout

Alternative 5 provides for a 0.5 foot drawdown in lake levels in the fall creating 340 acre-feet of gated storage through the use of a sluice gate, stop log structure, and a bypass channel (invert elevation of 1305.0 feet). In addition, Alternative 5 provides 0.5 foot bounce creating 440 acre-feet of temporary storage. This results in a total flood storage of 780 acre-feet.

A rock arch rapids with a trapezoidal cross section 20 feet wide, 3:1 side slopes matching the existing channel geometry as close as possible, and 3% slope provides fish passage. Boulder riffles are spaced so there is 0.5 feet of vertical drop between the boulder riffles. The weir crest that creates the temporary storage bounce is located upstream of the rock arch rapids fish passage channel.

5.2.2 Alternatives to Consider

The project team should consider the amount of acceptable bounce in water levels and winter draw down on Connection and Turtle Lakes. Alternatives 1 through 3 have a starting lake level matching

the court ordered lake level of 1307.6 feet. Alternatives 4 through 6 have a drawdown lake level 0.5 feet below the court ordered lake level.

The weir crest has a tiered cross section to create a bounce in water levels. Alternative 1 (**Figure 13**) and Alternative 4 (**Figure 16**) create a bounce in the 10-year water level with no increase in the 100-year water level. Alternative 2 (**Figure 14**) and Alternative 5 (**Figure 17**) create a 0.5 foot bounce with 440 acre-feet of temporary storage (**Figure 17**). Alternative 3 (**Figure 15**) and Alternative 6 (**Figure 18**) create a 1 foot bounce with 898 acre-feet of temporary storage. The temporary storage is separate from and in addition to the proposed gated storage. The tiered crest could be achieved with sheet pile or concrete weir. The low flow notch invert of the weir crest is set at the court ordered elevation of 1307.6 feet. The weir coefficient changes from a sharp-crested weir with a coefficient of 3.1 under existing conditions to a broad crested weir with a coefficient of 2.5 due to the rock rapids.

The weir configuration and starting lake levels were adjusted to create a variety of impacts to lake levels. The following alternatives were modeled and results provided for consideration by the project team.

- Alternative 1 - no rise in 100-year and 1.0 foot rise in 10-year Connection Lake level with starting WSE at court ordered
- Alternative 2 - 0.5 foot rise in 100-year Connection Lake level with starting WSE at court ordered
- Alternative 3 - 1.0 foot rise in 100-year Connection Lake level with starting WSE at court ordered
- Alternative 4 - no rise in 100-year and 1.0 foot rise in 10-year Connection Lake level with starting WSE 0.5 foot below court ordered
- Alternative 5 – 0.5 foot rise in 100-year Connection Lake level with starting WSE 0.5 foot below court ordered
- Alternative 6 – 1.0 foot rise in 100-year Connection Lake level with starting WSE 0.5 foot below court ordered

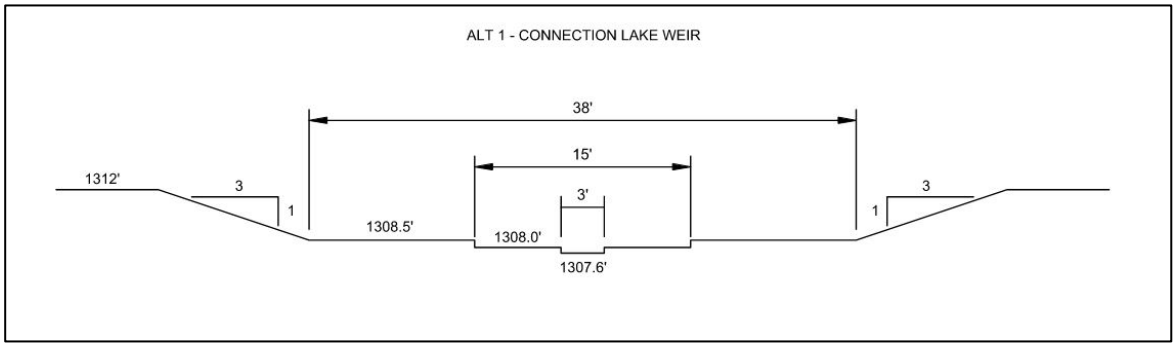

Figure 13: Alternative 1 Connection Lake Outlet Structure Layout

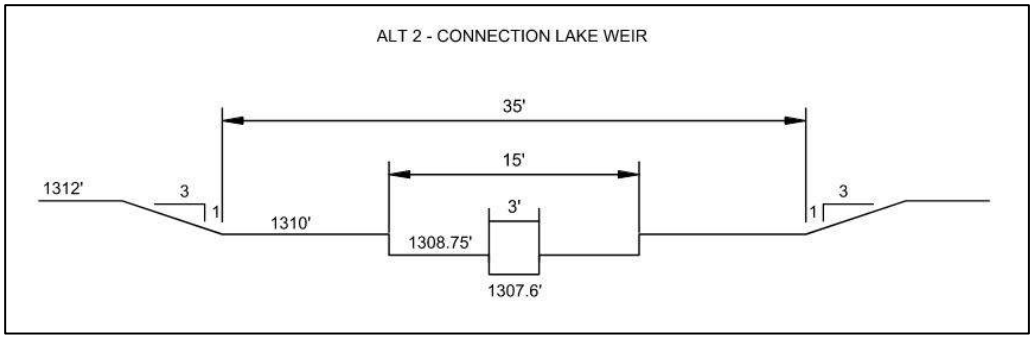

Figure 14: Alternative 2 Connection Lake Outlet Structure Layout

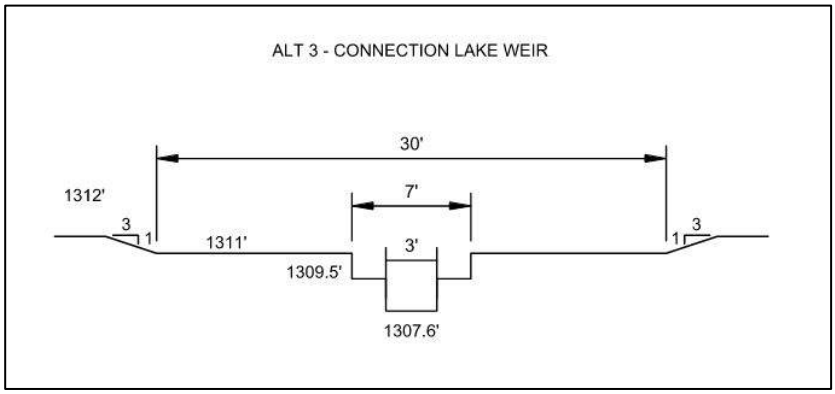

Figure 15: Alternative 3 Connection Lake Outlet Structure Layout

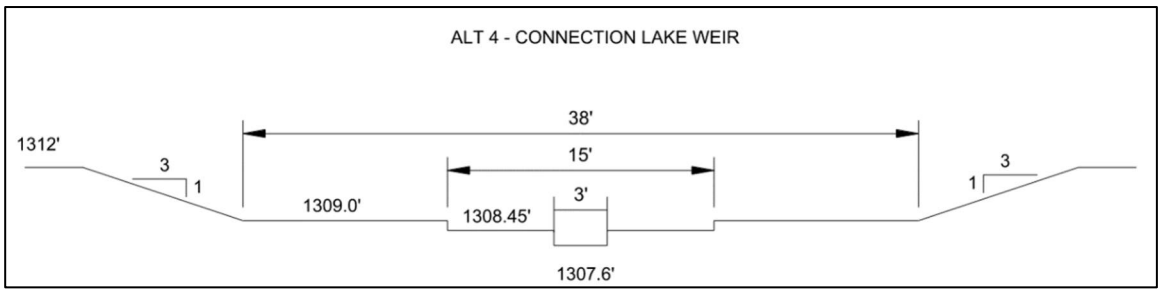

Figure 16: Alternative 4 Connection Lake Outlet Structure Layout

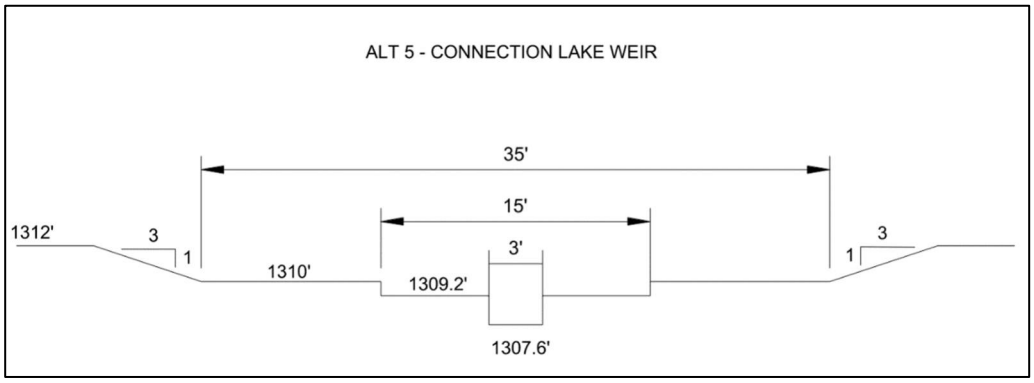

Figure 17: Alternative 5 Connection Lake Outlet Structure Layout

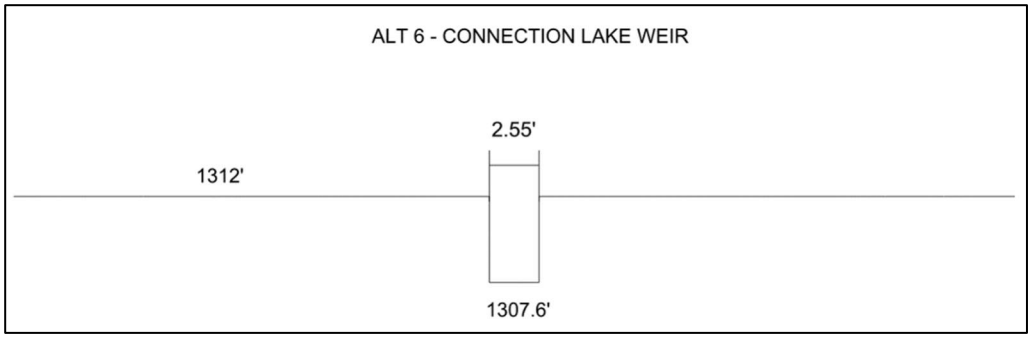

Figure 18: Alternative 6 Connection Lake Outlet Structure Layout

The weir configurations are each different to achieve the lake level objective. An overflow section (auxiliary spillway) is proposed for water levels above the 100-year event to provide a relief valve to direct erosive flows away from the structure.

5.2.3 Other Alternatives Considered

- Gated Structure with Bypass Channel – A gated structure with a sluice gate and stop log structure provides maximum flexibility. However, the operator may decide during design that only one or the other is needed. The bypass channel has a sinuous alignment**,** but a straighter alignment was considered to minimize the grading and project footprint. This is a shallow channel so straightening had little impact on the excavation volume.
- Auxiliary Spillway – Overtopping at the concrete structure was considered but would require additional riprap to mitigate erosion at the structure and was discounted because an auxiliary spillway could be provided for by leaving an opening in the tie to high ground embankment.
- Weir Crest Configurations – There was a concern that changing from a sharp crested rectangular weir with a weir coefficient of 3.1 to a broad-crested trapezoidal weir with a crest shorter than the existing weir crest with a weir coefficient of 2.5 would reduce the capacity and cause a rise in water levels during larger events. Longer weir crest configurations were modeled to try to match existing conditions. However, the weir crest creating a bounce in lake levels and temporary storage is the recommended option.

5.3 Turtle Lake

5.3.1 Recommended Layout

The court ordered lake level is 1307.54 feet. The Turtle Lake outlet has washed out and is not a functioning outlet. Water levels on Turtle Lake are controlled by the Connection Lake outlet structure, so removal of the existing Turtle Lake concrete structure is recommended with no riprap or concrete replacement structure proposed.

5.3.2 Alternatives Considered

A rock arch rapids was considered as a replacement for the Turtle Lake structure, which led to a discussion on which was the upstream and downstream side, since the major drainage was from the Hill River entering South Connection Lake east of Turtle Lake. During larger floods there is a backwater condition, which raises the lake level relatively quickly. The water levels then recede at a slower pace over a longer period of time. If a rock riffle structure with a higher crest than the existing channel invert were installed, then during normal flow periods the lake level could potentially be

raised above existing conditions. However, the major drainage and therefore volume of water is from the east. If a rock structure was installed and backwater from the east was not high enough to overtop the rock structure, then it is possible that flow could be prevented from entering Turtle Lake. This situation would cause lower lake levels during a period of prolonged low flow. (**Figure 19)**. For this reason, the preferred option is to remove the concrete structure, not install a rock structure, and allow the Connection Lake outlet to set Turtle Lake water levels.

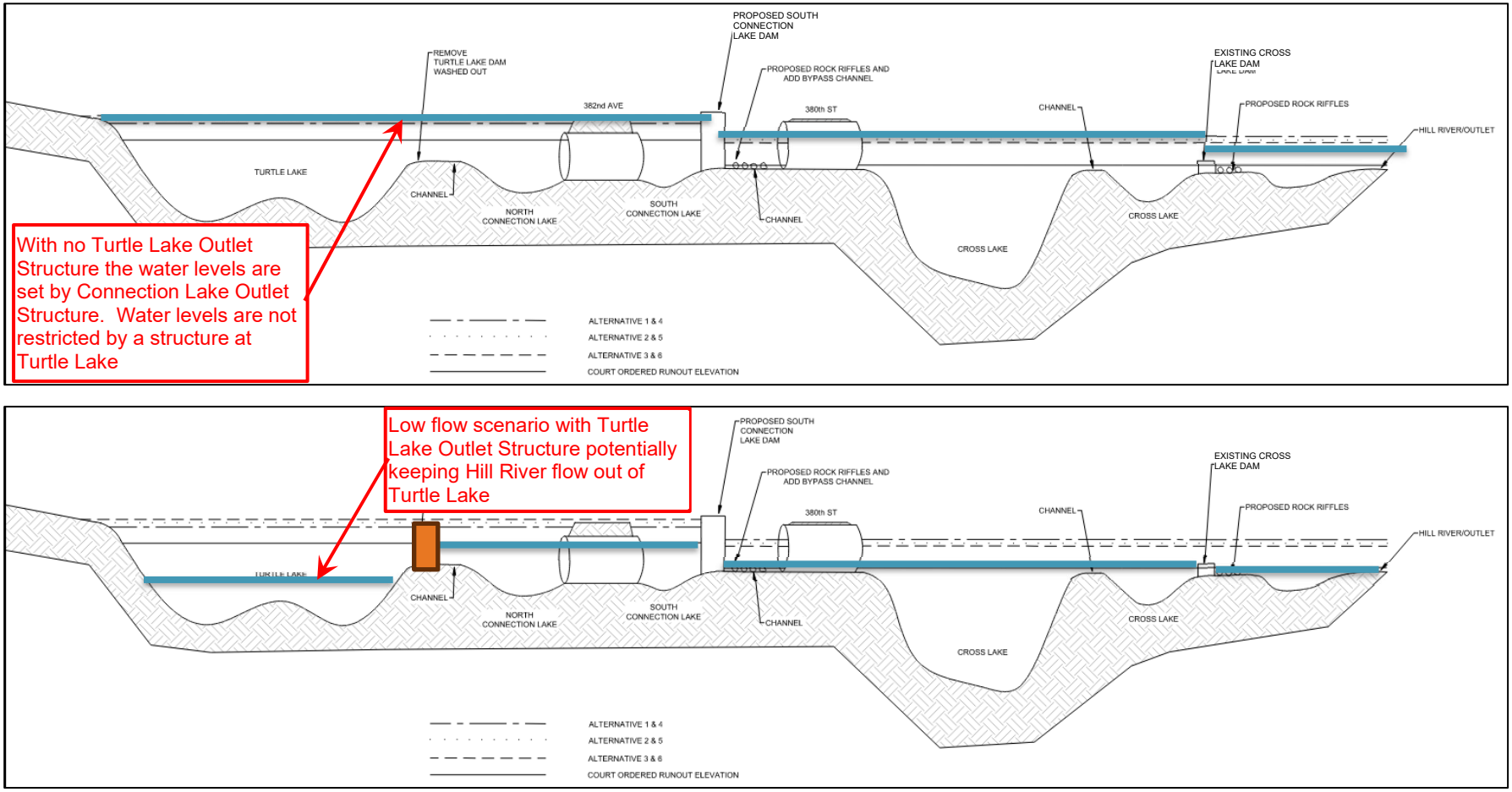

Figure 19: With and Without Turtle Lake Outlet Structure

5.4 Other Items Consistent with the Project

Below are items that do not impact water levels but are necessary to construct the project or are impacted by the project.

5.4.1 Access

Access roads need to be constructed to get to the outlets at Cross, Connection, and Turtle Lakes and conduct the recommended work. These roads provide no hydraulic benefit but are necessary for construction.

Cross

Proposed site access is from the east turning off of gravel County Highway 29 onto 370th Ave SE for 4,100 feet, continuing on a trail to a private camping spot for 2,750 feet, and through the woods on high ground for 1,800 feet. Easements will be required for site access but are not required for outlet structure construction.

Connection

Proposed site access is off of 382nd Ave with the outlet structure 250 feet to the east of the gravel road. Easements are not required for site access but will be required for construction.

Turtle

Proposed site access is off of 385th St SE with the outlet structure 2,500 feet to the north of the gravel road. There is an existing trail to the structure. Easements are required for site access and removal of the structure.

5.4.2 382nd Ave Road

382nd Ave does not overtop during the 100-year under existing conditions but overtops by 0.5 feet under Alternative 6, which raises the proposed 100-year by 1 foot above existing conditions. In order to match current overtopping conditions a 0.5 foot road raise is recommended. A second culvert is proposed to promote equalization of water levels. The existing culvert is a 72 inch CMP 40 feet long in unknown condition. Since the road is being raised, replacement of the existing culvert with two new 72-inch CMP 46 foot long culverts is proposed at the existing crossing location. The twin pipes reduce the chance of road overtopping and equalize water levels on each side of the road, reducing the chance of road washout and providing an improved hydraulic connection between North and South Connection Lakes.

5.4.3 Olson Farms

The proposed increase in Turtle Lake levels impacts hayed agricultural land on the southwest side of Turtle Lake. In order to mitigate the impact, a flowage easement or earthen overflow berm, drain tile, and drain tile pump station are recommended.

6 Hydrology and Hydraulic Model Development and Results

6.1 Hydrology

The Clearwater subbasin HEC-HMS model developed for the USACE in 2012 as part of the Red River of the North Basin-Wide Modeling Approach project and modified in 2013 for the Red Lake Watershed Expanded Distributed Detention Study was used as an initial base condition to obtain inflow hydrographs. The Hill River was a single subwatershed in the HEC-HMS model so additional subwatersheds were defined to isolate runoff entering Turtle Lake, North Connection Lake, South Connection Lake, Cross Lake drainage south, and Cross Lake drainage east.

The time of concentration was calculated for each sub-watershed using LiDAR topography and travel times from the 2013 Red Lake Watershed Expanded Distribution Delineation Study. Shapefiles of the drainage areas and a raster of the travel times were entered into ArcGIS to determine the time of concentration. Curve numbers were determined using the vegetation and soil types within each sub-watershed with soil types identified using the United States Department of Agriculture's (USDA) Web Soil Survey, and vegetation types from the National Land Cover Database. The curve numbers were calculated using the Red Lake River 24-hour curve number table in the 2013 Red Lake Watershed Expanded Distribution Detention Study. Areas of each land type and the corresponding curve numbers were entered into HydroCAD to compute the average for each sub-basin. Curve numbers ranged from 77 for forest areas to 100 for open water. The curve numbers were relatively high due to the ample about of water in each sub-basin. **Table 6** provides a summary of hydrologic data.

Table 6: Hill River Subwatershed Hydrology Inputs

Drainage Basin	Area (Square Miles)	Time of Concentration (Hours)	Curve Number
Turtle Lake	3.29	5.32	84
North Connection Lake	0.52	3.98	84
South Connection Lake	11.46	20.00	80
Cross Lake - South Drainage Area	0.50	4.02	89
Cross Lake - Central Drainage Area	0.56	4.34	80
Cross Lake - North Drainage Area	5.16	15.74	83

Atlas 14 was used to determine the rainfall for the given time of concentration. The size following events were entered into HEC-HMS.

- 2-year 24-hour rainfall event - 2.45 inches
- 10-year 24-hour rainfall event - 3.72 inches
- 100-year 24-hour rainfall event - 6.66 inches

Per recommendation by the USDA, the MSE III was the selected rainfall distribution for the HEC-HMS model. This rainfall distribution provides a greater precipitation intensity over a shorter time interval compared to the previous SCS Type II distribution. Also, the 24-hour runoff event corresponds to a summer rainfall event rather than a spring snowmelt event. The resulting hydrographs derived from HEC-HMS were entered into EPA SWMM. The existing condition 100-

year peak flow at the outlet of South Connection Lake is 105 cfs and the 100-year peak flow at the outlet of Cross Lake is 138 cfs.

6.2 EPA-SWMM Existing Conditions

The hydrographs developed in HEC-HMS for Turtle Lake, North Connection Lake, South Connection Lake, the Cross Lake south drainage, and Cross Lake east drainage were input into the EPA-SWMM model.

Lake stage storage curves were entered into the model for Turtle, North Connection, South Connection, and Cross Lakes south of the Cross Lake outlet. In addition channels with overbank sections, channel slope, culverts and road embankments, and outlet structures were used to define the connections between lakes.

The figures in **Appendix A** include hydrographs and lake levels.

6.3 Alternative Analysis Results

The EPA-SWMM model was used to evaluate alternatives with the rock arch rapids installed for fish passage, adjustment of the crest elevation to achieve desired lake levels, a gated structure and bypass channel to manage lake levels for FDR, and a weir crest that produces a bounce in lake levels to provide temporary storage. **Table 7** provides a summary of storage for the alternatives presented.

Table 7: Storage Options

Lake Level Adjustment	Storage (Acre-Feet)
Connection and Turtle 0.5 foot Drawdown Below Court Ordered	340
Connection and Turtle 0.5 foot Increase Above Court Ordered	440
Connection and Turtle 1.0 foot Increase Above Court Ordered	898

Table 8 provides a summary of alternatives modeled and the lake level adjustments considered.

Table 8: Alternative and Lake Impact

Alternative	Starting Connection/Turtle Lake Elevation	Adjustments to Connection/Turtle Lake Elevation	South Connection Lake Outlet Structure	Cross Lake	Impact
Alternative 1	Connection/Turtle Runout Elevation **at Court Ordered**.	No change between existing and proposed 100-year lake elevation	Multi-tiered weir crest at the Rock Arch Rapids	Cross 0.5 ft above Court Ordered.	FDR benefit for the 10-year event, but not for the 100-year event. Creates a temporary bounce in Turtle and Connection Lake elevations for the 10-year with no change in 100-year.
Alternative 2	Connection/Turtle Runout Elevation **at Court Ordered**.	0.5 ft increase between existing and proposed 100-year lake elevation	Multi-tiered weir crest at the Rock Arch Rapids	Cross 0.5 ft above Court Ordered.	FDR benefit for the 100-year event by creating a temporary 0.5 ft bounce in 100-year Turtle and Connection Lake elevation.
Alternative 3	Connection/Turtle Runout Elevation **at Court Ordered**.	1.0 ft increase between existing and proposed 100-year lake elevation	Multi-tiered weir crest at the Rock Arch Rapids	Cross 0.5 ft above Court Ordered.	FDR benefit for the 100-year event by creating a temporary 1.0 ft bounce in 100-year Turtle and Connection Lake elevation.
Alternative 4	Connection/Turtle Runout Elevation **0.5 ft below Court Ordered**.	No change between existing and proposed 100-year lake elevation	Multi-tiered weir crest at the Rock Arch Rapids	Cross 0.5 ft above Court Ordered.	FDR benefit for the 10-year event, but not for the 100-year event. Creates a temporary bounce in Turtle and Connection Lake elevations for the 10-year with no change in 100-year. Additional storage by 0.5 ft Connection/Turtle drawdown prior to event also provides FDR benefit.
Alternative 5	Connection/Turtle Runout Elevation **0.5 ft below Court Ordered**.	0.5 ft increase between existing and proposed 100-year lake elevation	Multi-tiered weir crest at the Rock Arch Rapids	Cross 0.5 ft above Court Ordered.	FDR benefit for the 100-year event by creating a temporary 0.5 ft bounce in 100-year Turtle and Connection Lake elevation. Additional storage by 0.5 ft Connection/Turtle drawdown prior to event also provides FDR benefit.
Alternative 6	Connection/Turtle Runout Elevation **0.5 ft below Court Ordered**.	1.0 ft increase between existing and proposed 100-year lake elevation	Multi-tiered weir crest at the Rock Arch Rapids	Cross 0.5 ft above Court Ordered.	FDR benefit for the 100-year event by creating a temporary 1.0 ft bounce in 100-year Turtle and Connection Lake elevation. Additional storage by 0.5 ft Connection/Turtle drawdown prior to event also provides FDR benefit.

- The existing condition lake elevations are assumed to be the court ordered runout elevation.
- Turtle Lake water elevations are set by the South Connection Lake outlet structure, so a structure is not required at Turtle Lake. Options were considered at Turtle Lake; however, a structure has the potential to harm fish passage and even lower the lake elevation during droughts because most of the flow comes from Hill River to the east. For this reason, the alternatives considered do not include a structure at Turtle Lake.
- A gated structure at Cross Lake was considered but required significant earthwork. In addition, the project team preferred raising the Cross Lake elevation for recreation purposes rather than lowering Cross Lake. Therefore, a gated structure was not advanced at the Cross Lake outlet.

6.3.1 Cross Lake Outlet

Runoff from the main Hill River drainage area enters South Connection Lake and flows north to Cross Lake. Additional runoff from the east enters Cross Lake downstream of the Connection Lake outlet. There is an existing concrete structure at the Cross Lake outlet constructed in 1932 which remains functional. The court ordered lake level is 1304.4. A 0.5 foot increase in the lake level (to 1304.9 feet) is desired by the landowners for recreation benefits. This change in lake level does not impact FDR because the lake level is not raised or lowered to create storage.

A rock arch rapids with a trapezoidal cross section 14 feet wide, 2:1 side slopes, and slope of 3% is centered on the existing stream. The rock arch rapids will incorporate the existing concrete structure into the weir crest. The weir crest has the same trapezoidal cross section as the channel with the weir crest elevation set at elevation 1304.9.

6.3.2 South Connection Lake Outlet

Runoff from the main Hill River drainage area enters South Connection Lake and flows north to Cross Lake. Additional runoff from the west enters Turtle Lake which flows into North Connection Lake before flowing into South Connection Lake. There is an existing concrete structure at the South Connection Lake outlet constructed in 1932 which remains functional. Flow entering South Connection Lake also equalizes water levels in North Connection Lake and Turtle Lake through connections to the west. The court ordered lake level in Connection Lake is 1307.6 feet.

The recommended Alternative 5 has a 0.5 foot lake drawdown, a 0.5 foot temporary storage bounce in the 100-year lake level, a rock arch rapids fish passage channel, and gated structure with a bypass channel.

The rock arch rapids will be centered on the existing stream, and the existing concrete structure will be incorporated into the crest of the riffle. The adjacent ground is approximately 4 feet above the channel invert, so excavation for a bypass channel is minimal. The gated structure provides flexibility to adjust water levels and create storage in South Connection Lake, North Connection Lake, and Turtle Lake for flood damage reduction. A water level drawn down of 6 inches or less could be accomplished with a stop log structure that is incorporated into the riffle, but a slide gate or stoplog structure that is separate from the riffle is easier to access, maintain, and operate.

An auxiliary spillway is recommended because it provides a more resilient design at minimal cost by directing higher flows away from the gated structure or rock arch riffle, so any erosion would occur in an area away from the structure that costs less to repair.

6.3.3 Turtle Lake Outlet

Runoff from adjacent farm fields enters Turtle Lake. In addition, there is a hydraulic connection with South Connection Lake, so flow from the main Hill River drainage area backs up into Turtle Lake and then flows back east from Turtle Lake to North and South Connection lakes on the receding limb of the hydrograph. The majority of flow entering Turtle Lake comes from the Hill River by way of North and South Connection lakes.

There is an existing concrete structure at the Turtle Lake outlet that was constructed in 1932 with a court order lake level of 1307.54 feet. The structure washed out prior to 1984, but concrete remains at this location.

The recommended FDR Turtle Lake water levels are the same as Connection Lake, so there is no reason for a structure at Turtle Lake outlet. A rock arch riffle at the Turtle Lake outlet would not help with fish passage as long as water levels are controlled downstream at South Connection Lake.

If improved fish passage between North Connection Lake and Turtle Lake is desired, then the existing concrete structure should be removed and the channel invert between the two lakes lowered to improve conveyance. The recommended alternative is to remove the Turtle Lake concrete structure.

6.3.4 Hydraulic Results

Cross Lake, South Connection Lake, North Connection Lake, and Turtle Lake are hydraulically connected. There are court ordered lake runout elevations for the three lakes, but the project proposes adjusting water levels in the lakes to create storage and provide downstream FDR. A change to the court ordered runout elevation requires approval from 100% of the surrounding landowners.

Creation of FDR storage is proposed in South Connection, North Connection, and Turtle lakes through gated storage at the outlet of South Connection Lake. Temporary storage is created by a tiered weir crest at the South Connection Lake outlet which causes a temporary bounce in lake levels. Alternatives 1 through 6 were modeled with the 2, 10, and 100-year events and the results are shown in **Appendix A**.

Figure 20 provides the 100-year Existing and Alternative 4-6 results. **Table 9** provides the 100-year Alternative 5 results at Connection and Cross Lake.

Table 9: 100-year Existing and Alternative 5 Results

Model Run	Connection / Turtle Lakes Peak Lake Level (ft)	Cross Lake Peak Lake Level (ft)	Connection Lake Outlet Peak Flow (cfs)	Cross Lake Outlet Peak Flow (cfs)	Connection Lake Outlet Peak Velocity (fps)	Cross Lake Outlet Peak Velocity (fps)
Existing	1309.65	1308.06	103.86	137.39	3.17	1.52
Alternative 5	1309.97	1307.54	64.05	96.17	2.94	1.89
Change	+0.32	-0.52	-39.81	-41.22	-0.23	+0.37
% Change			-38.3%	-30.0%	-7.3%	+24.3%

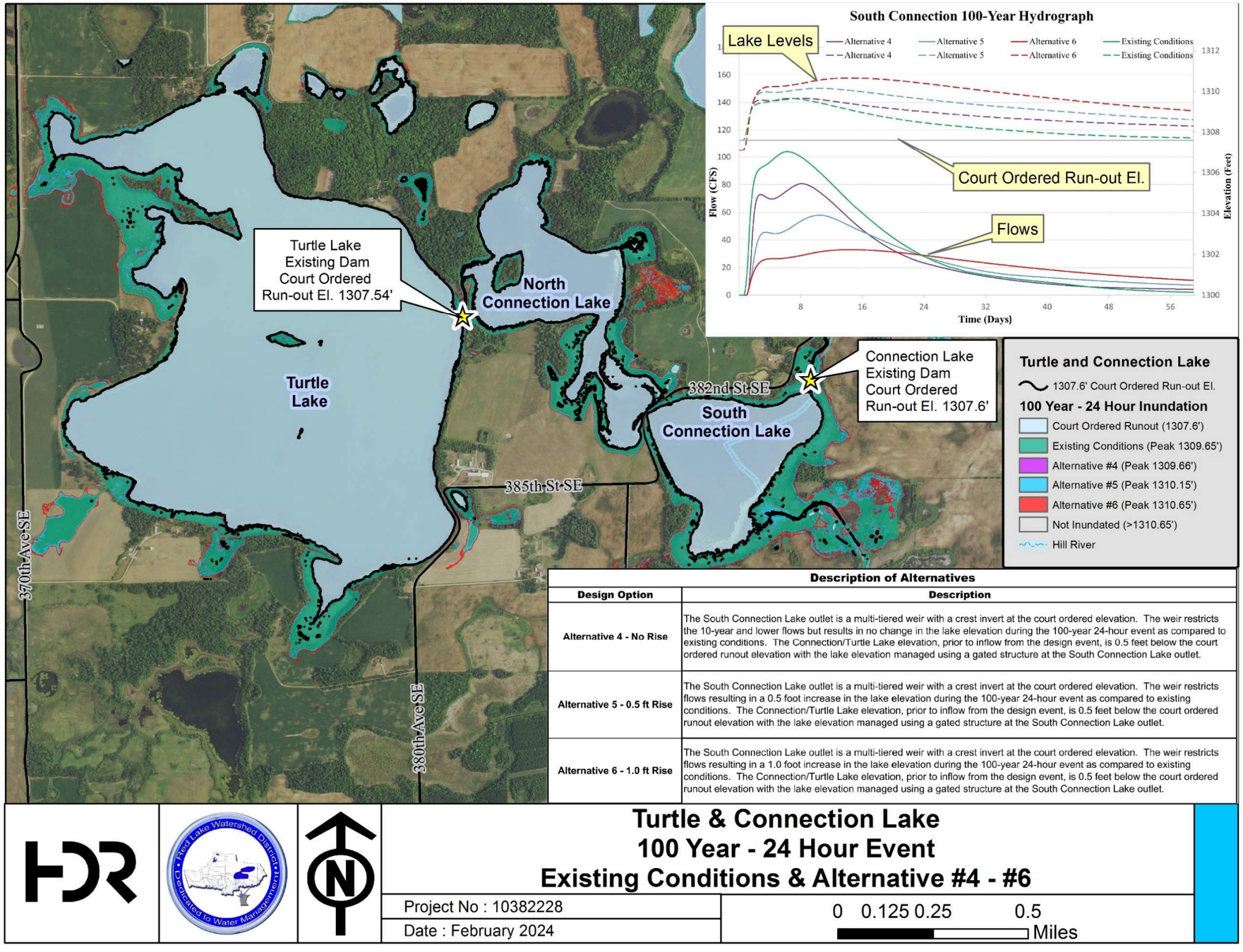

Figure 20: 100-year Existing and Alternative 4-6 Results

6.3.5 Water Balance

HDR used the EPA SWMM model to generate a water balance based on precipitation, evaporation, and starting lake levels for an average year. The model results define the relative changes to lake levels due to the proposed project. A period from November 1, 2017 to October 31, 2018 was selected as an average year with approximately 28 inches of precipitation falling in this time period, see **Figure 21.**

The precipitation information was obtained from PRISM Climate Group at Oregon State University. The precipitation that fell in November through March was assumed to be snow which melted in 5 days starting April 10th.

Monthly evaporation was obtained from pan evaporation information at the following website Monthly Pan Evaporation - U. of M. St. Paul Campus | Minnesota DNR (state.mn.us). **Table 10** is the 2018 pan evaporation in St Paul, MN.

Table 10: Monthly Evaporation at St. Paul, MN

Year	April (inches)	May (inches)	June (inches)	July (inches)	August (inches)	September (inches)	October (inches)	Total (inches)
2018	1.82	7.06	6.20	6.86	5.67	4.46	0.39	32.46

The starting lake level in the water balance calculation was taken from the last water level reading in 2017 from the MNDNR stage gage, which is 1304.31 feet for Cross Lake and 1307.81 feet for Turtle/Connection Lake. Lake Water Level Report: Cross (60002700) | LakeFinder | Minnesota DNR (state.mn.us).

The water balance calculation is sensitive to the outlet structure crest elevation. The HDR surveyed Connection Lake outlet crest on January 2024 was 1308.06 feet, whereas the court ordered runout elevation is 1307.60 feet. In order to get the EPA SWMM existing condition model results to correspond with measured Turtle Lake levels, the crest elevation was set at the surveyed elevation of 1308.06 feet. A second existing condition model run with the court ordered runout elevation was created to make a direct comparison with the proposed alternatives. See **Figure 22** and **Figure 23** for the water balance calculation results using 2018 precipitation.

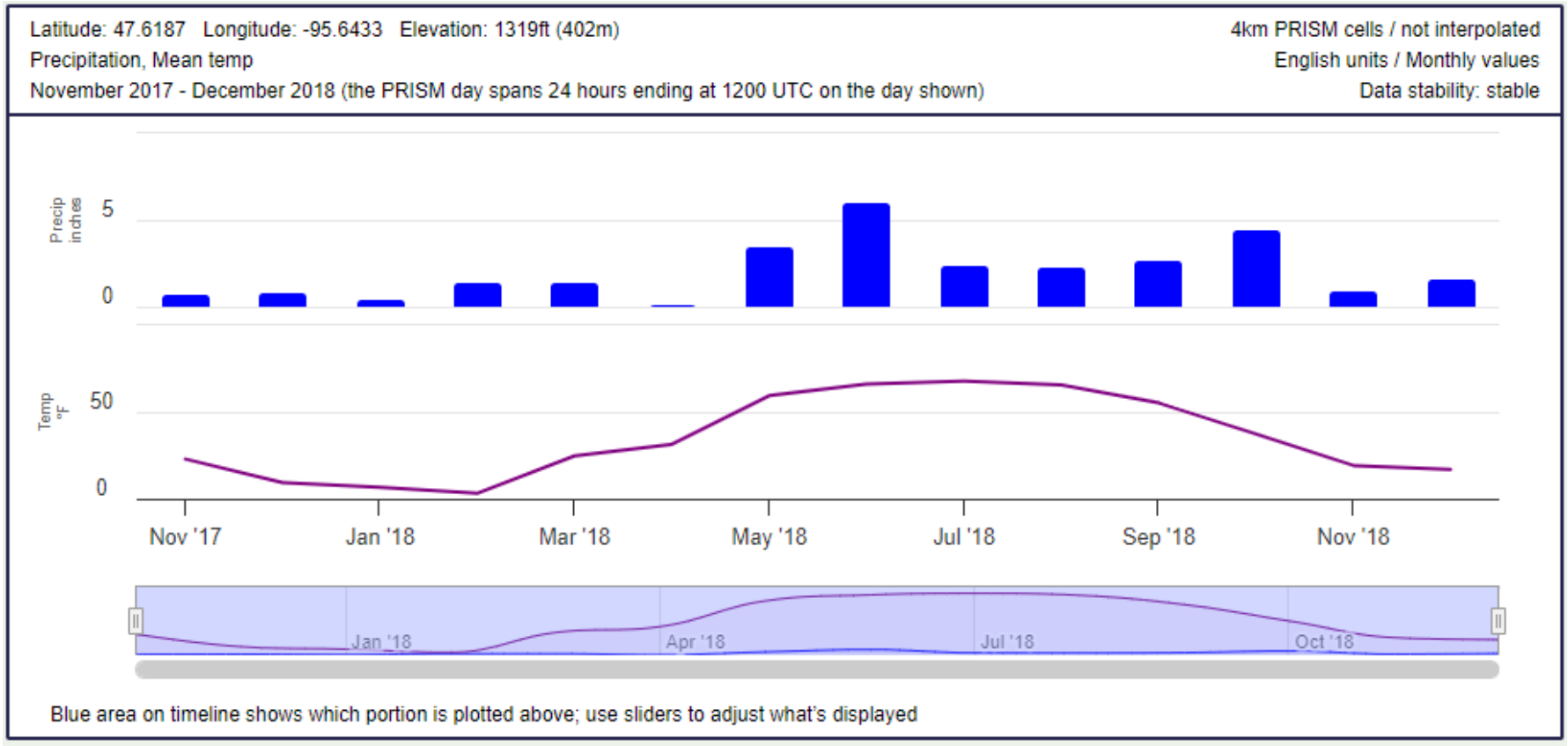

Figure 21: Precipitation Information

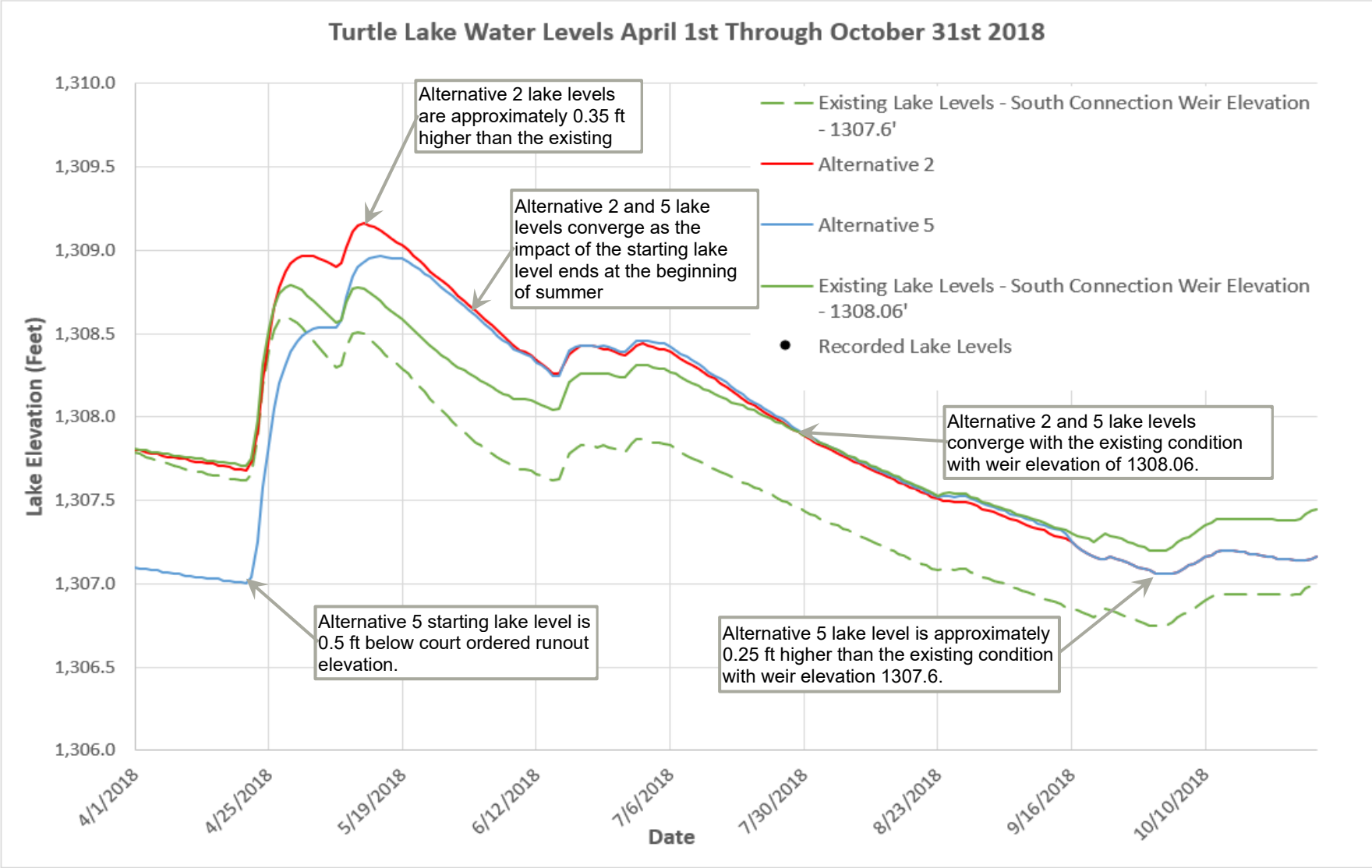

Figure 22: Turtle Lake Water Balance

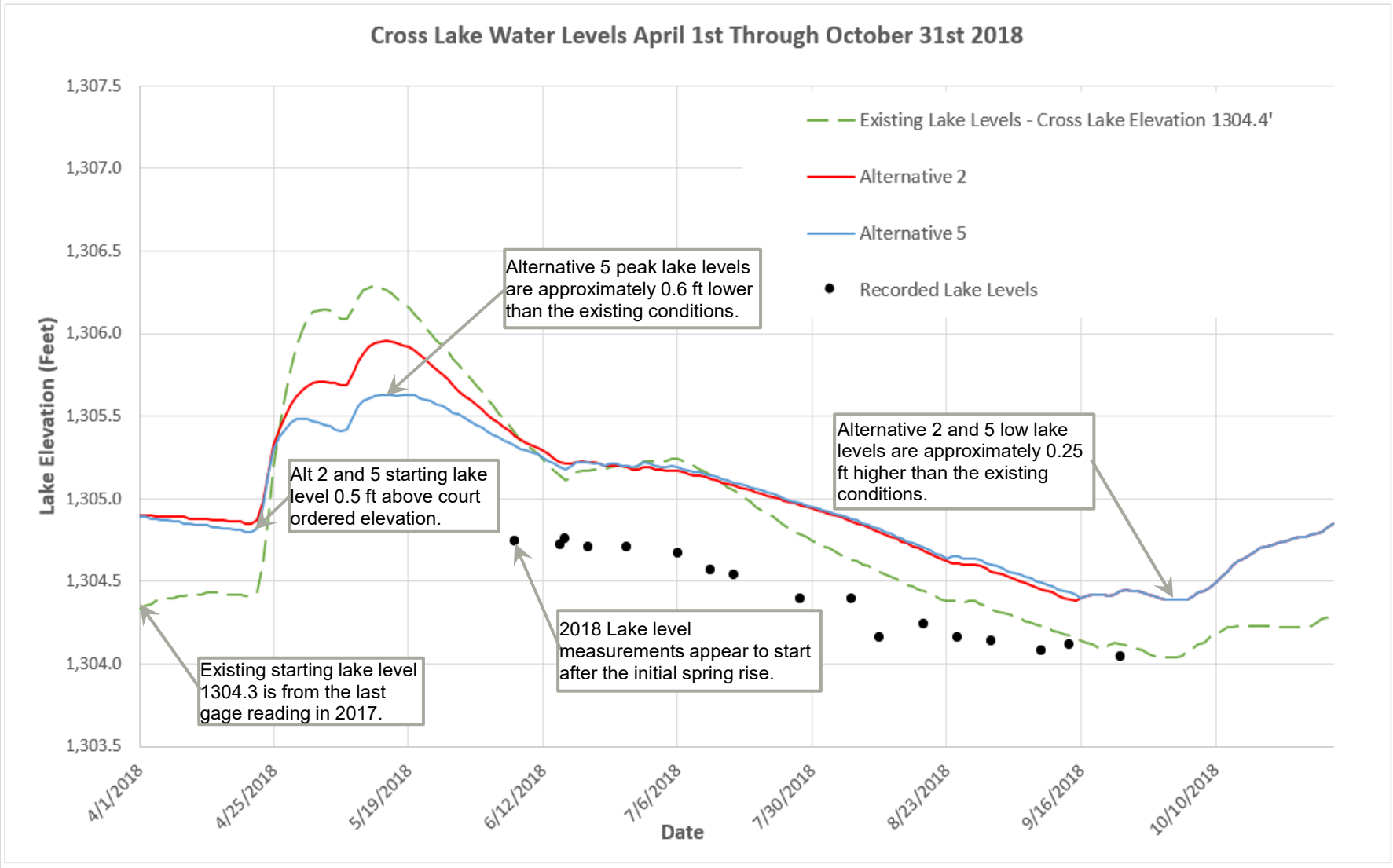

Figure 23: Cross Lake Water Balance

6.3.6 Results Summary

The gated and temporary storage in Connection and Turtle Lakes results in reduced flows downstream of Connection Lake, which carries through to the outlet of Cross Lake. The reduced flow rate is largest for the 100-year event, but the percentage difference is larger for the smaller design events. The existing condition velocity at the weir crest is V_2=1.4 fps, V_{10}=2.4 fps, and V_{100}=3.2 fps as compared to the Alternative 5 weir crest velocities which are V_2=2.0 fps, V_{10}=2.9 fps, and V_{100}=2.6 fps.

7 Right of Way and Easements

7.1 Permanent Right of Way

The outlet structures on Cross, Connection, and Turtle lakes are all on MNDNR property. The proposed construction at Cross and Turtle will be on MNDNR property. The proposed Connection Lake rock riffles and outlet channel are off MNDNR property and additional right of way is required, see **Figure 24**.

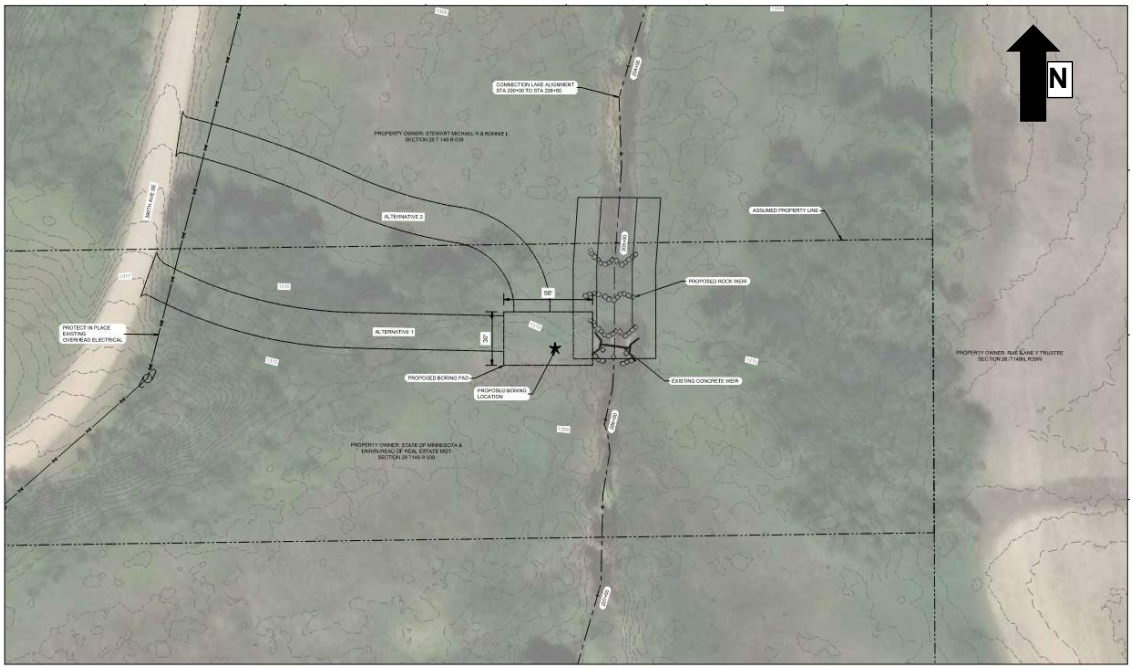

Figure 24: Connection Lake Permanent Right of Way

7.2 Construction Easements

7.2.1 Cross Lake

Construction access will be from 370th Avenue SE and for approximately 0.5 miles through private land, and 0.25 miles through forfeited land. The 0.25 miles through forfeited land is through dense trees, see **Figure 25**.

Figure 25: Cross Lake Construction Easement

7.2.2 Connection Lake

The MNDNR parcel abuts 382nd Avenue so Construction access will likely be on MNDNR property, however, to construct the work at the outlet easements may be required through private property.

7.2.3 Turtle Lake

Construction access will be from 385th Street SE and for approximately 1 mile through private land, see **Figure 26**.

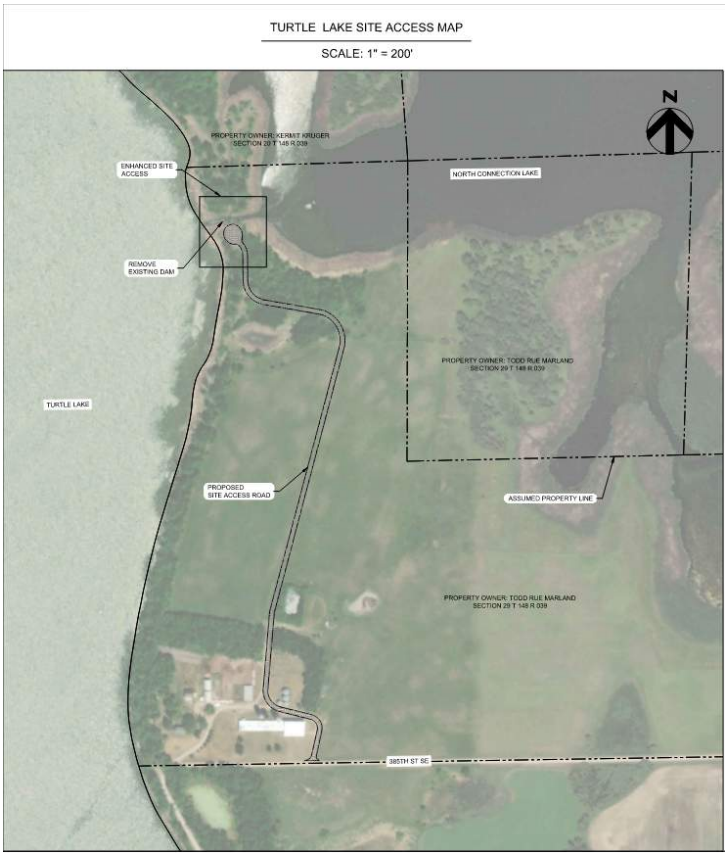

Figure 26: Turtle Lake Construction Easement

7.3 Flowage Easements

Purchase or donation of flowage easements and consent from all owners of land abutting the lake, as well as connected waters that are affected by the lake, are necessary to change the runout elevation of a lake per Minnesota Statute 103G. Each alternative results in different impacts. Note the alternative with the greatest flood damage reduction also requires the greatest flowage easement.

8 Engineer's Estimate of Probable Cost

The cost for Alternatives 4 through 6 is essentially the same and are presented in **Table 11**. The cost for Alternatives 1 through 3 could be reduced since the gated structure and bypass channel at Connection Lake is unnecessary and could be eliminated.

Table 11: Alternative 5 through 6 Estimate of Probable Costs

TURTLE CONNECTION CROSS LAKE OUTLETS					
STATEMENT OF ESTIMATED QUANTITIES					
ITEM NO.	ITEM DESCRIPTION	UNIT	TOTAL ESTIMATED QUANTITY	Unit Cost	Line Item Cost
2021.501	MOBILIZATION	LUMP SUM	1	$65,000.00	$65,000.00
2101.501	CLEARING AND GRUBBING (P)	LUMP SUM	1	$25,000.00	$25,000.00
2105.607	COMMON EXCAVATION (P)	CU YD	1,670	$16.00	$26,720.00
2105.607	COMMON EMBANKMENT (P)	CU YD	925	$20.00	$18,500.00
2106.601	SITE GRADING (P)	LUMP SUM	1	$30,000.00	$30,000.00
2118.507	AGGREGATE SURFACING, CLASS 5 MOD.	TON	1360	$28.00	$38,080.00
2411.601	FLOOD CONTROL STRUCTURE	EACH	1	$340,000.00	$340,000.00
2411.601	FLOOD CONTROL STRUCTURE	EACH	1	$260,000.00	$260,000.00
2451.507	COARSE FILTER AGGREGATE	TON	301	$55.00	$16,555.00
2501.502	FLAP GATE FOR 18" CS PIPE	EACH	1	$1,500.00	$1,500.00
2501.502	18" CS PIPE APRON	EACH	1	$375.00	$375.00
2501.503	18" CS PIPE CULVERT	LIN FT	22	$55.00	$1,210.00
2511.507	RANDOM RIPRAP (CLASS 3)	CU YD	778	$125.00	$97,250.00
2511.602	PLACE BOULDER (30" TO 36" DIAMETER, D50=33")	EACH	103	$300.00	$30,900.00
2511.609	RANDOM RIPRAP SPECIAL (3" - 6" COBBLE STONE)	CU YD	152	$120.00	$18,240.00
2563.601	TRAFFIC CONTROL	LUMP SUM	1	$5,000.00	$5,000.00
2573.501	STABILIZED CONSTRUCTION EXIT	LUMP SUM	2	$3,000.00	$6,000.00
2573.503	SEDIMENT CONTROL LOG TYPE WOOD CHIP	LIN FT	500	$6.00	$3,000.00
2573.503	FLOTATION SILT CURTAIN TYPE MOVING WATER	LIN FT	150	$30.00	$4,500.00
2575.501	TURF ESTABLISHMENT	LUMP SUM	1	$3,000.00	$3,000.00
2575.504	ROLLED EROSION PREVENTION CATEGORY 25	SQ YD	1325	$4.00	$5,300.00
2575.508	SEED MIXTURE, 25-131	POUND	440	$8.00	$3,520.00
	Subtotal				$999,650.00
	Permanent Right-of-Way	Acres	0.00	$1,000.00	$0.00
	Temporary Right-of-Way	Acres	2.00	$1,000.00	$2,000.00
	Engineering and Administration		20%		$199,930.00
	Contingency		30%		$299,895.00
	Total Construction				**$1,501,475.00**

9 Summary

Alternative 5 draws down Connection Lake and Turtle Lake 0.5 foot in the Fall creating 340 acre-feet of drawdown storage. In addition, the multi-tiered notched weir results in a 0.5 foot bounce in 100-year water levels creating an additional 440 acre-feet of temporary storage. This results in a total of 780 acre-feet of FDR storage during a 100-year frequency flood event. There is a 40 cubic feet per second (cfs) (38.3%) decrease in the 100-year flow downstream of the Connection Lake outlet, and a 40 cfs decrease is also observed downstream of the Cross Lake outlet. The 100-year outlet velocity remains unchanged between existing and proposed conditions at approximately 3 feet per second (fps). At Cross Lake the normal water runout elevation is raised 0.5 feet above the existing court-ordered runout elevation. The cost for Alternative 5 is estimated at approximately $1.5 million.

10 References

Minnesota Statutes, Water, Chapter 103D, Section 103D.711 Engineer's Report, Sec. 103D.711 MN Statutes, 2023.

Clearwater River Watershed Comprehensive Watershed Management Plan, ClearwaterCWMP_FINAL.pdf (redlakewatershed.org) , 2022.

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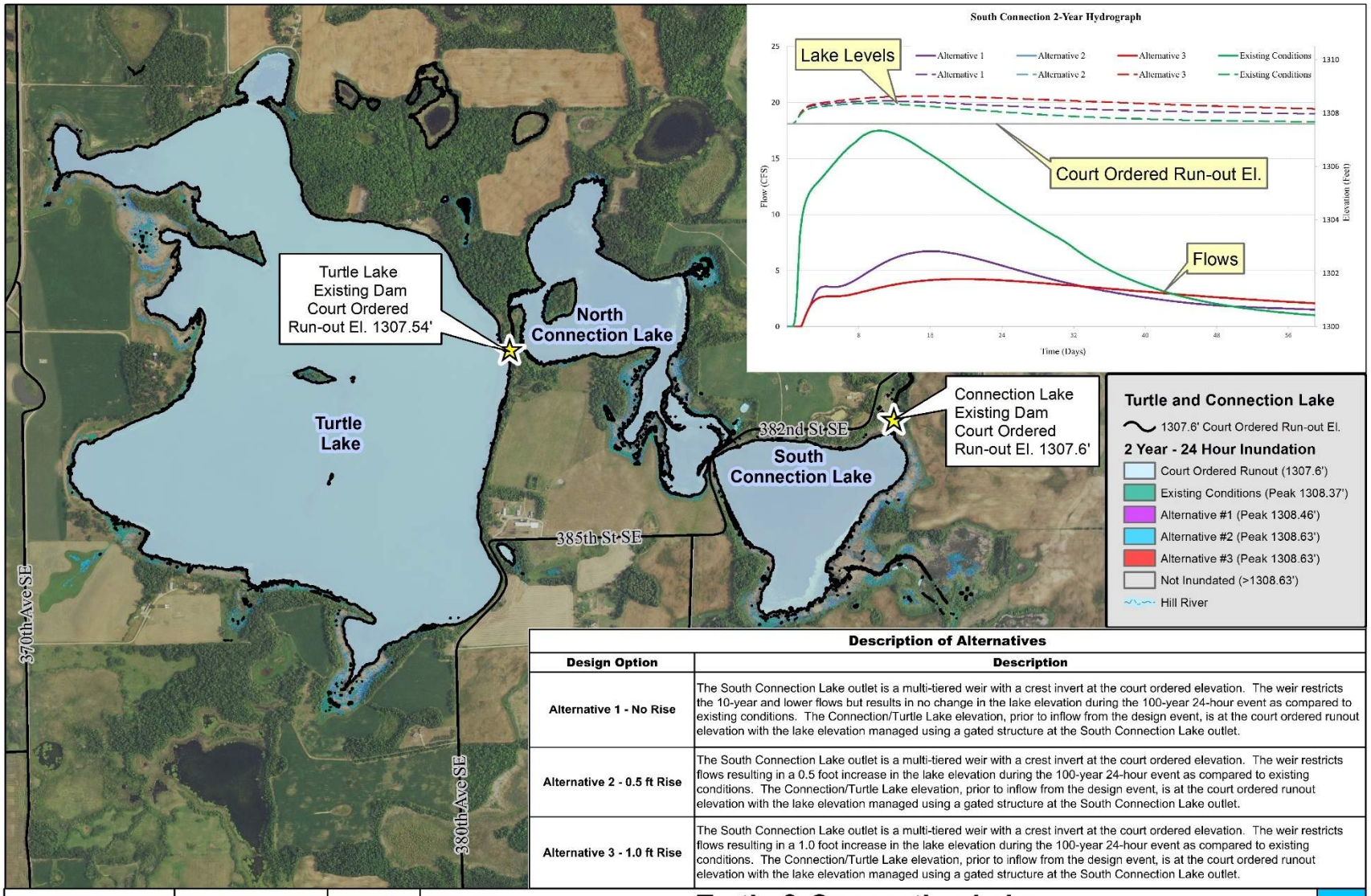
Northwest Alliance for Computational Science and Engineering, Interactive Tool for Individual Location Time Series Values, PRISM Climate Group at Oregon State University , Period of Record 1895 - 2023.

Minnesota Department of Natural Resources, Monthly Pan Evaporation - U. of M. St. Paul Campus | Minnesota DNR (state.mn.us), Period of Record 1972 - 2023.

United States Army Corps of Engineers, HEC-HMS Hydrologic Modeling System: Version 3.5. August 2010.

Fargo-Moorhead Metro Basin-Wide Modeling Approach - Hydrologic Modeling. HEC-HMS Model Development for Various Tributaries below the Red River of the North at Halstad, MN. October 2012.

Appendix A. Hydraulic Results



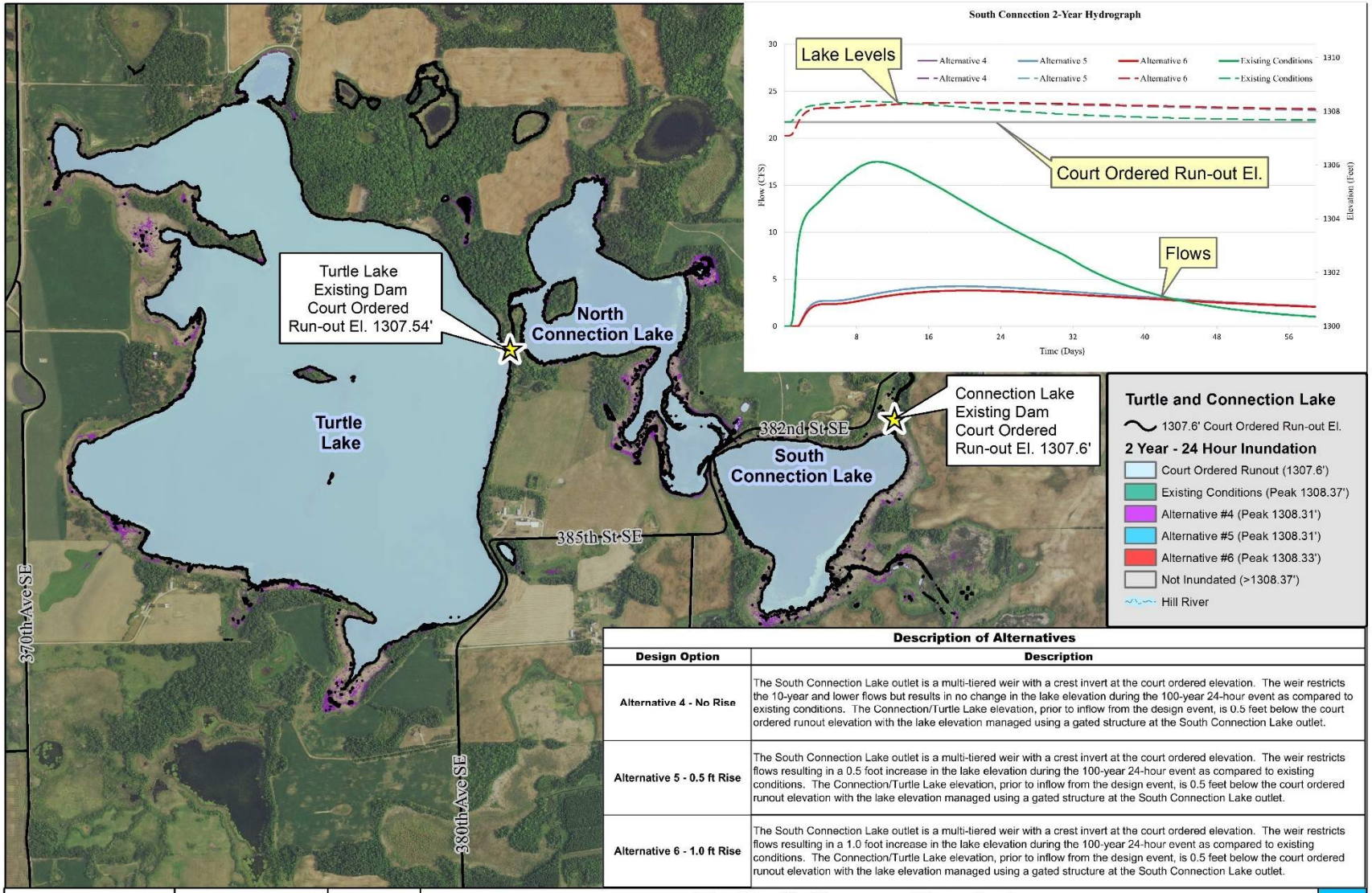
Description of Alternatives

Design Option	Description
Alternative 1 - No Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts the 10-year and lower flows but results in no change in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 2 - 0.5 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 0.5 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 3 - 1.0 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 1.0 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.

Turtle & Connection Lake
2 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3

Project No : 10382228
Date : February 2024

0 0.125 0.25 0.5 Miles



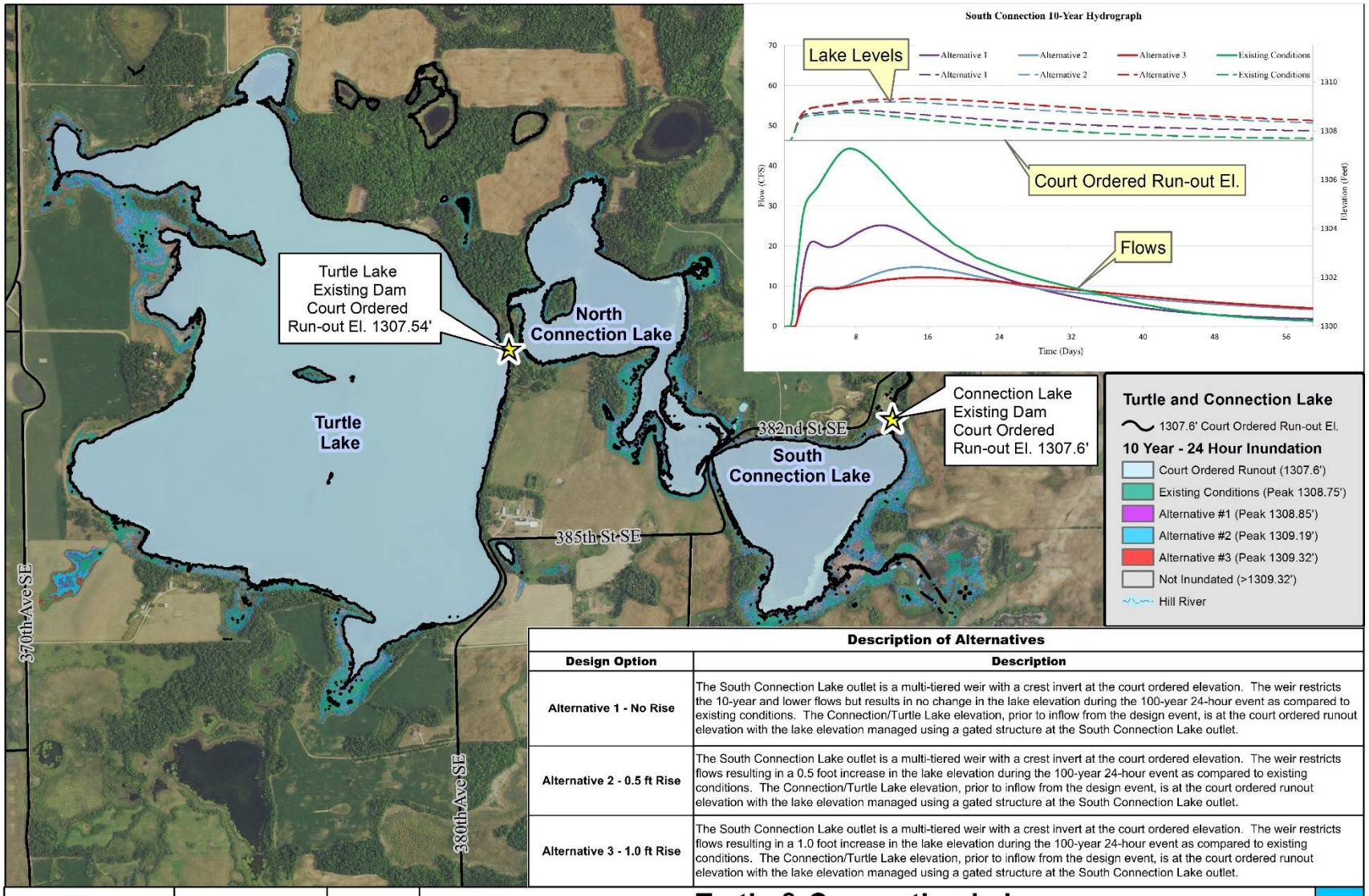
Description of Alternatives

Design Option	Description
Alternative 4 - No Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts the 10-year and lower flows but results in no change in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 5 - 0.5 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 0.5 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 6 - 1.0 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 1.0 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.

Turtle & Connection Lake
2 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6

Project No : 10382228
Date : February 2024

0 0.125 0.25 0.5 Miles



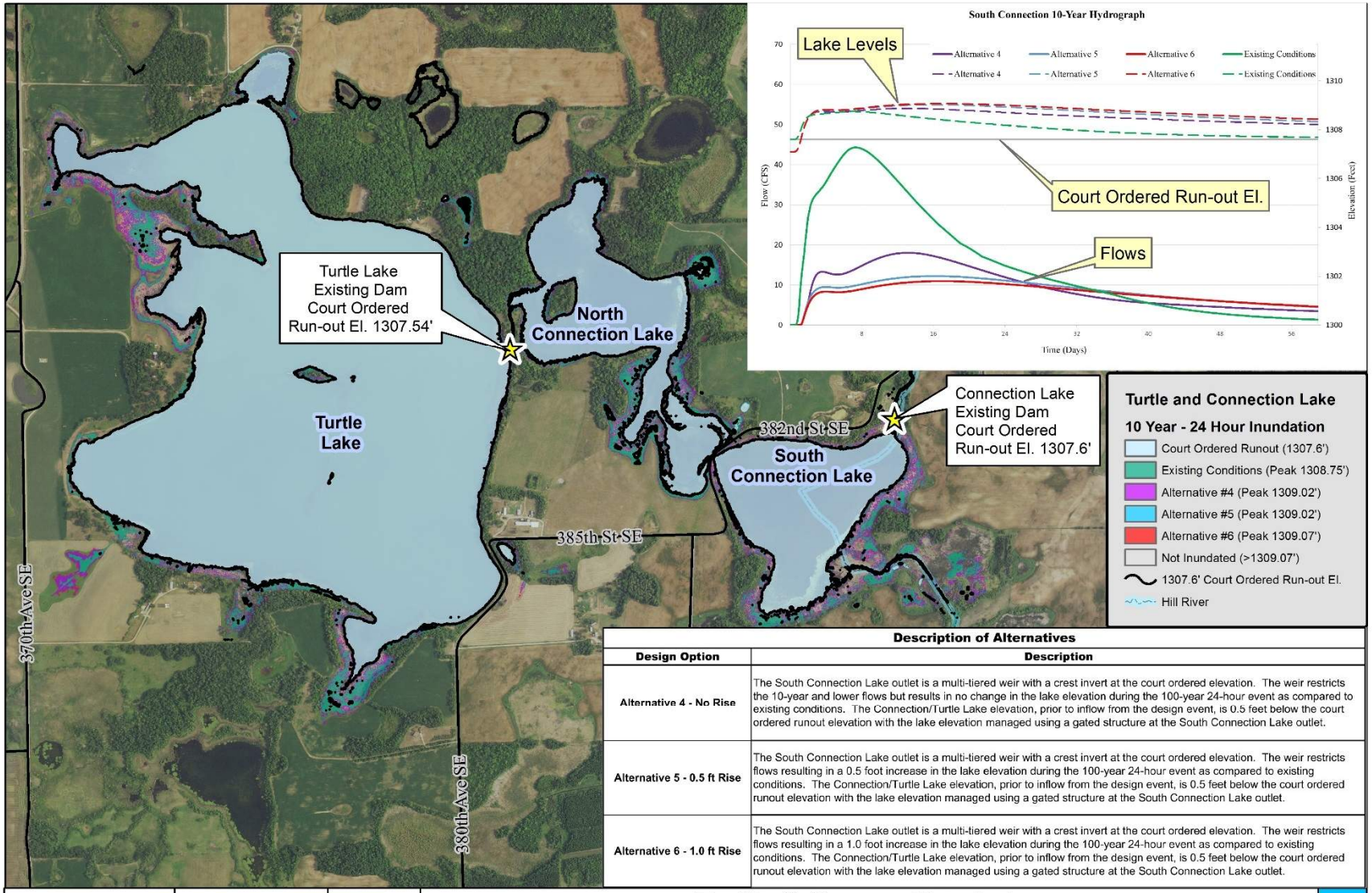
Description of Alternatives

Design Option	Description
Alternative 1 - No Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts the 10-year and lower flows but results in no change in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 2 - 0.5 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 0.5 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 3 - 1.0 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 1.0 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.

Turtle & Connection Lake
10 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3

Project No : 10382228
Date : February 2024

0 0.125 0.25 0.5 Miles



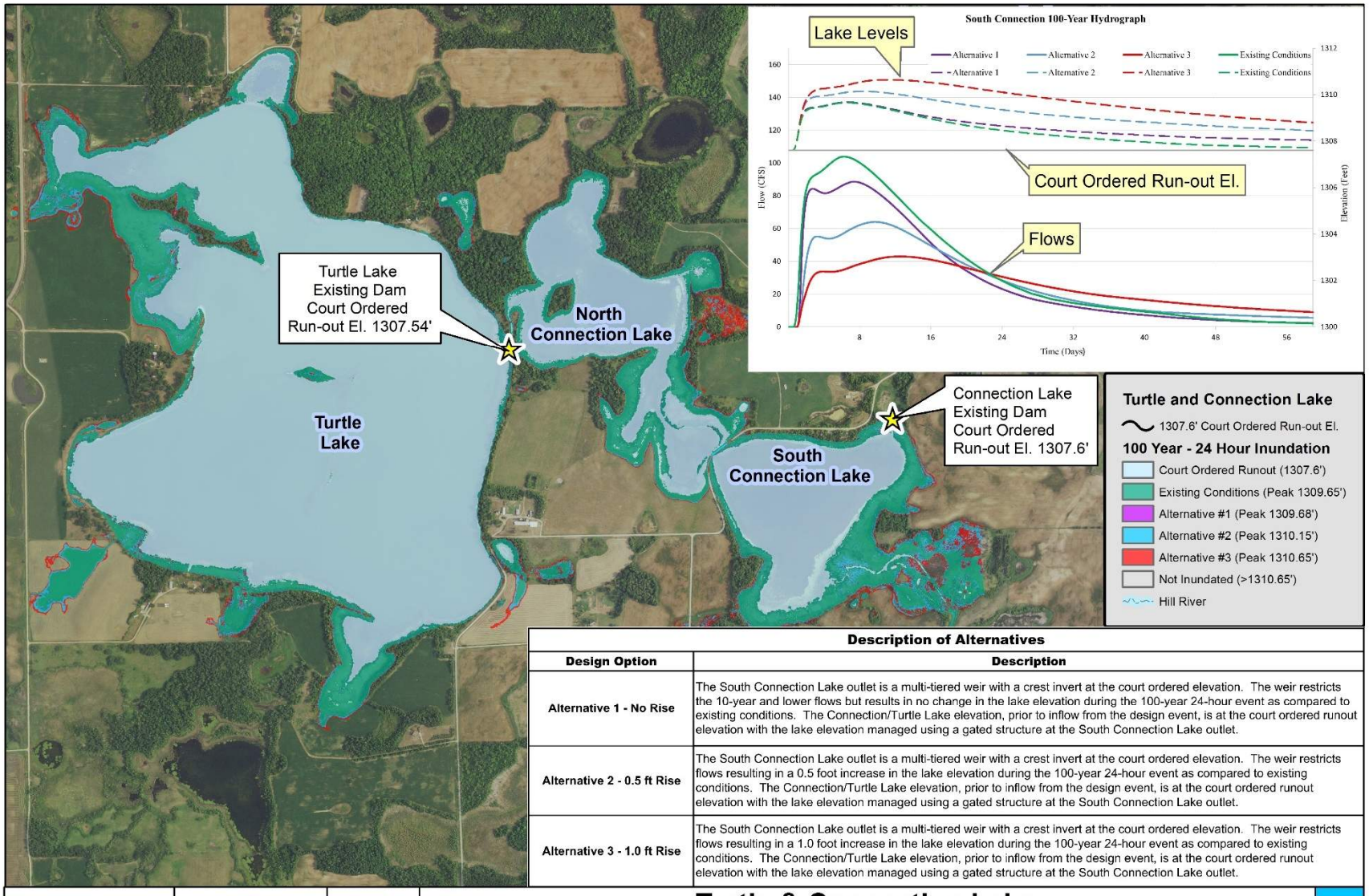
Description of Alternatives

Design Option	Description
Alternative 4 - No Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts the 10-year and lower flows but results in no change in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 5 - 0.5 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 0.5 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 6 - 1.0 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 1.0 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.

Turtle & Connection Lake
10 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6

Project No : 10382228
Date : February 2024

0 0.125 0.25 0.5 Miles



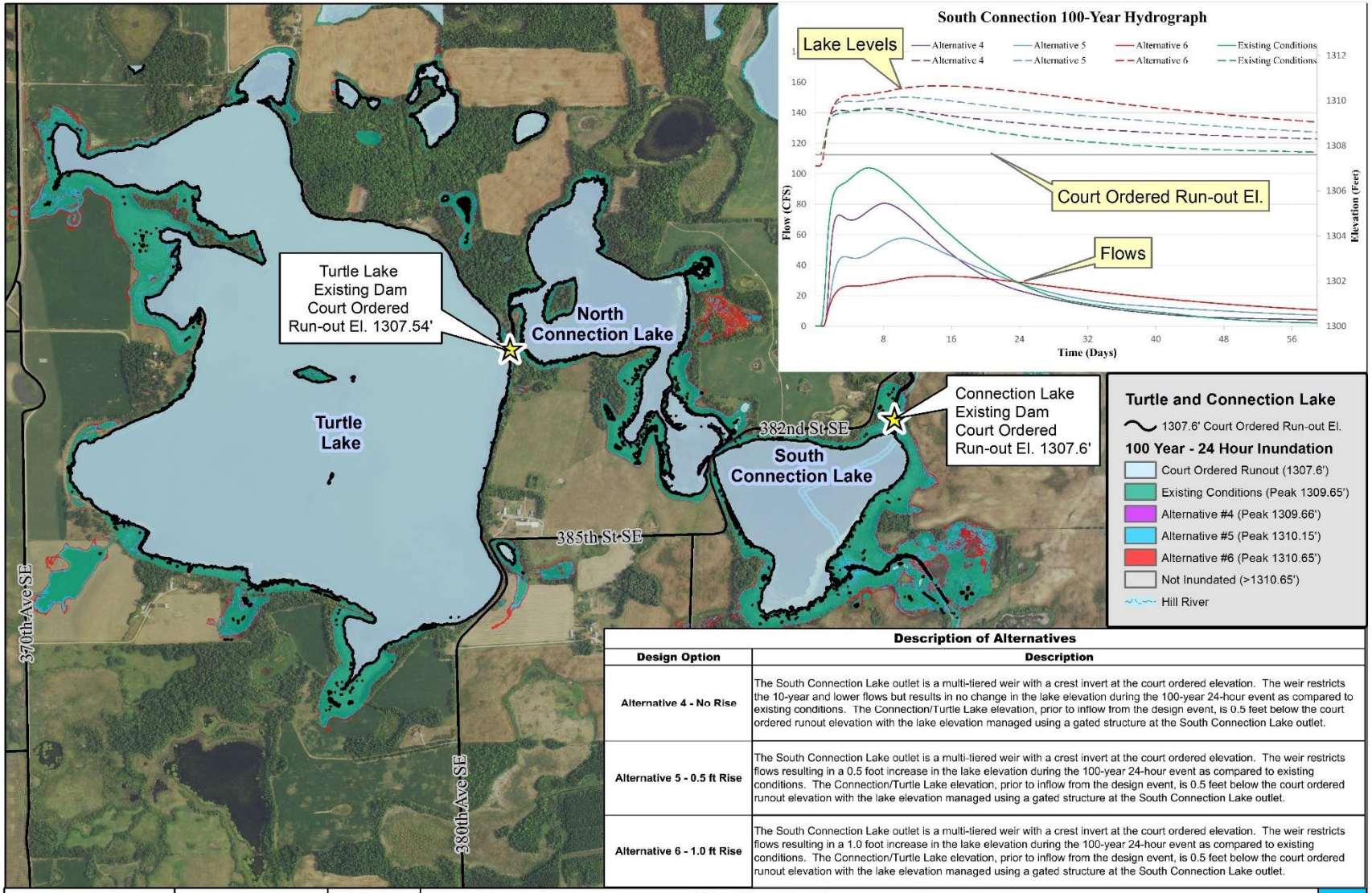
Description of Alternatives

Design Option	Description
Alternative 1 - No Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts the 10-year and lower flows but results in no change in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 2 - 0.5 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 0.5 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 3 - 1.0 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 1.0 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is at the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.

Turtle & Connection Lake
100 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3

Project No : 10382228
Date : February 2024

0 0.125 0.25 0.5 Miles



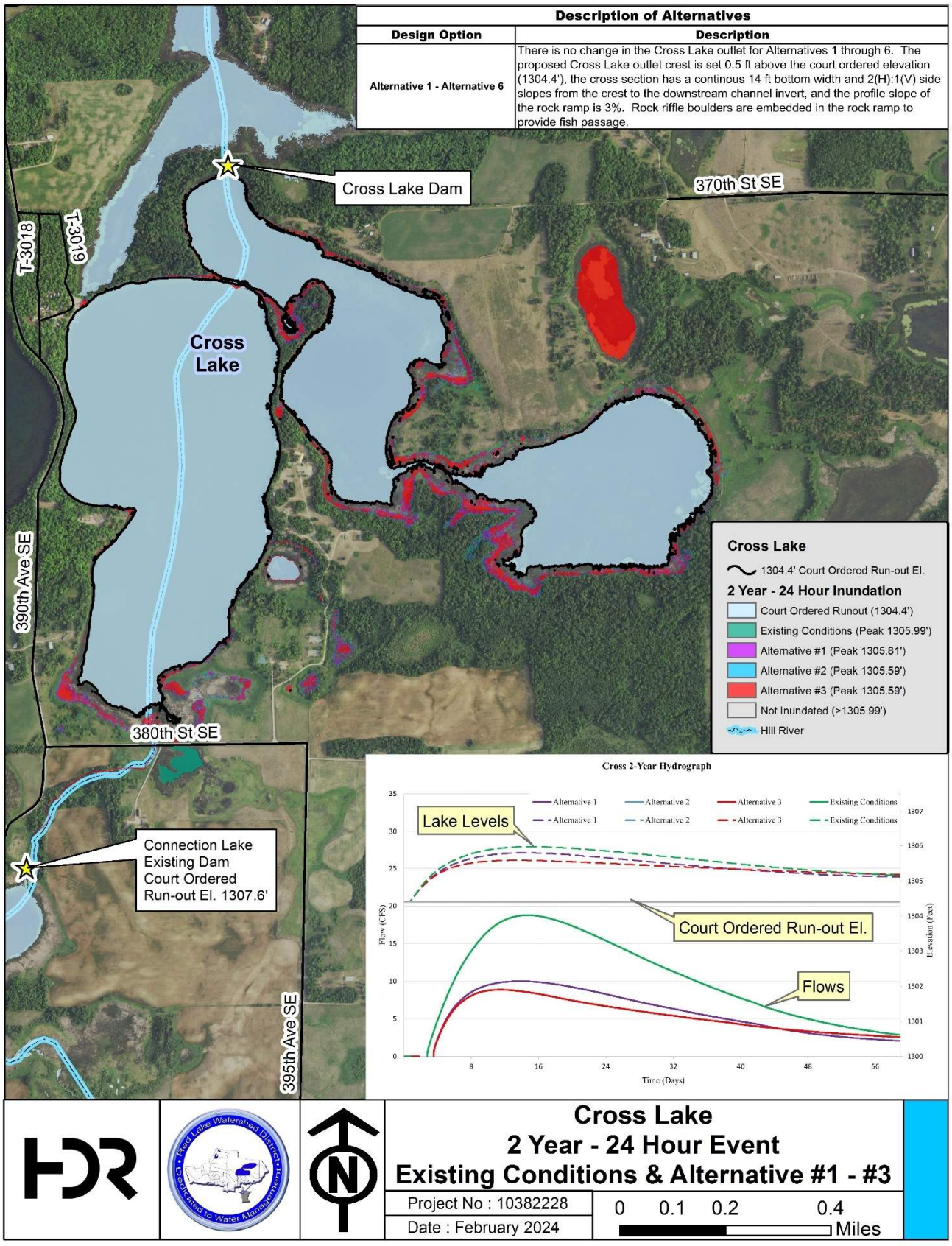
Description of Alternatives

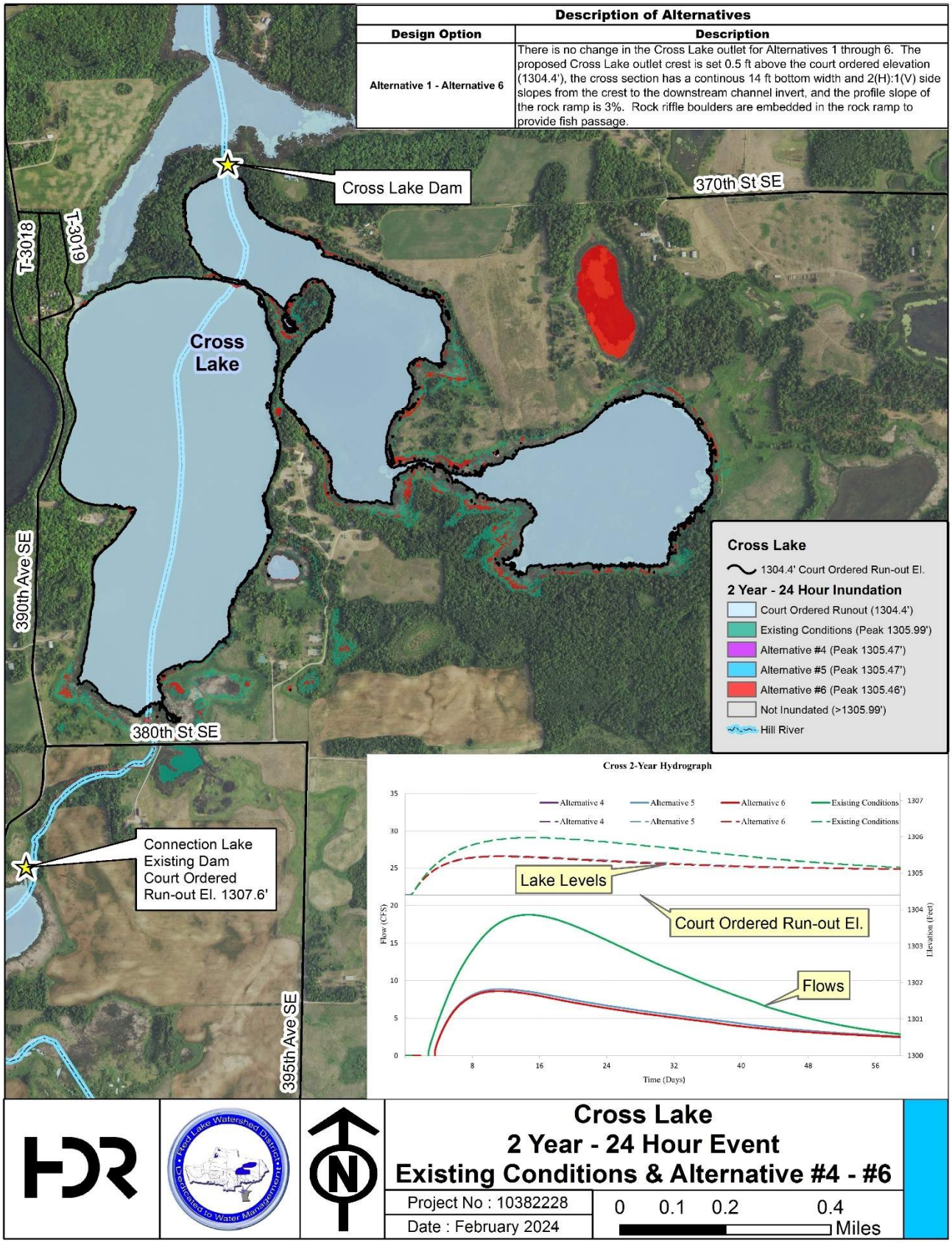
Design Option	Description
Alternative 4 - No Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts the 10-year and lower flows but results in no change in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 5 - 0.5 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 0.5 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.
Alternative 6 - 1.0 ft Rise	The South Connection Lake outlet is a multi-tiered weir with a crest invert at the court ordered elevation. The weir restricts flows resulting in a 1.0 foot increase in the lake elevation during the 100-year 24-hour event as compared to existing conditions. The Connection/Turtle Lake elevation, prior to inflow from the design event, is 0.5 feet below the court ordered runout elevation with the lake elevation managed using a gated structure at the South Connection Lake outlet.

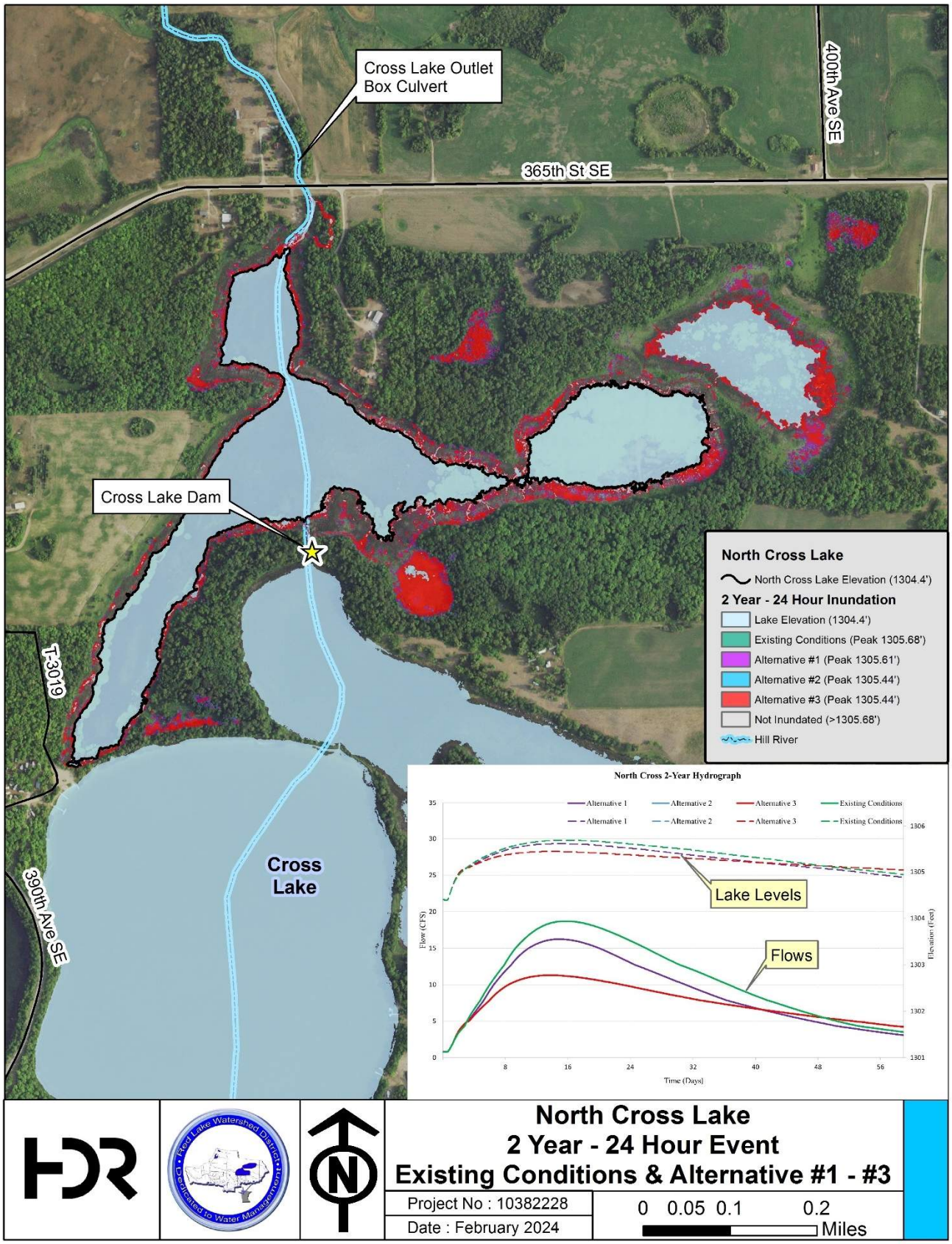
Turtle & Connection Lake
100 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6

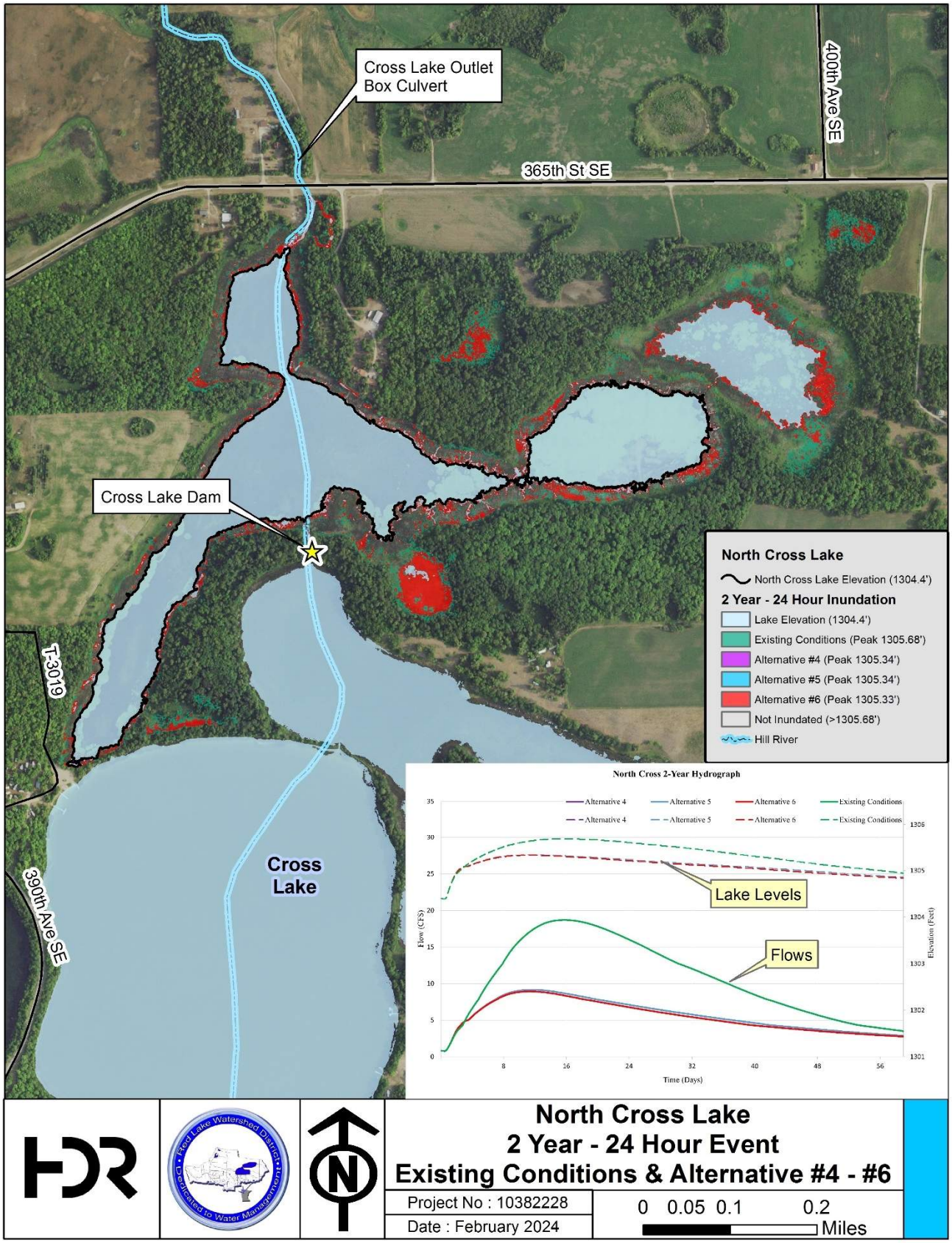
Project No : 10382228
Date : February 2024

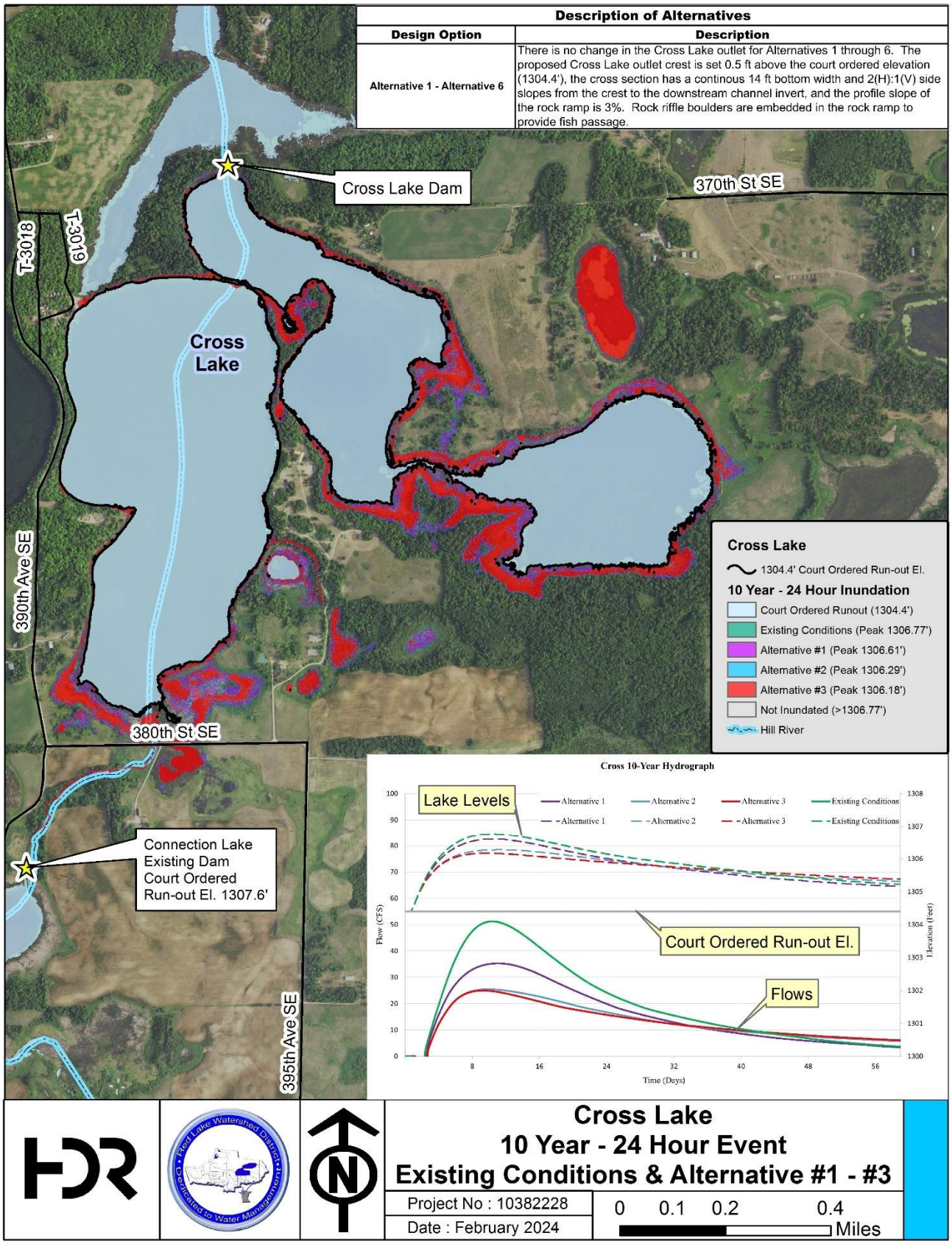
0 0.125 0.25 0.5 Miles


Description of Alternatives
Design Option
Description
Alternative 1 - Alternative 6
There is no change in the Cross Lake outlet for Alternatives 1 through 6. The proposed Cross Lake outlet crest is set 0.5 ft above the court ordered elevation (1304.4'), the cross section has a continous 14 ft bottom width and 2(H):1(V) side slopes from the crest to the downstream channel invert, and the profile slope of the rock ramp is 3%. Rock riffle boulders are embedded in the rock ramp to provide fish passage.
Cross Lake Dam
370th St SE
T-3018
T-3019
Cross Lake
390th Ave SE
380th St SE
Connection Lake Existing Dam Court Ordered Run-out El. 1307.6'
395th Ave SE
Cross Lake
1304.4' Court Ordered Run-out El.
2 Year - 24 Hour Inundation
Court Ordered Runout (1304.4')
Existing Conditions (Peak 1305.99')
Alternative #1 (Peak 1305.81')
Alternative #2 (Peak 1305.59')
Alternative #3 (Peak 1305.59')
Not Inundated (>1305.99')
Hill River
Cross 2-Year Hydrograph
Alternative 1
Alternative 2
Alternative 3
Existing Conditions
Lake Levels
Court Ordered Run-out El.
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
Cross Lake
2 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3
Project No : 10382228
Date : February 2024
0 0.1 0.2 0.4
Miles

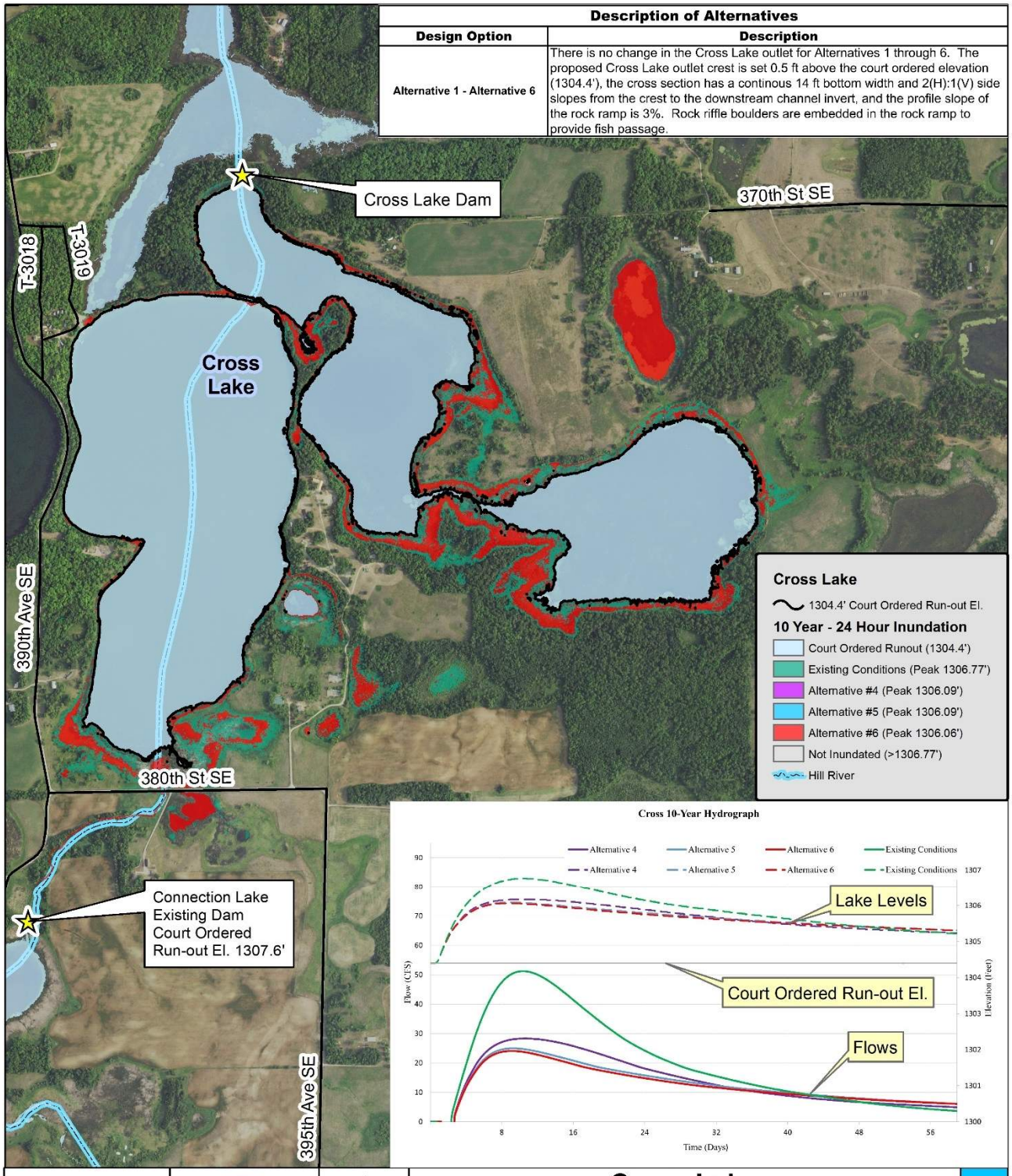

Description of Alternatives
Design Option
Description
Alternative 1 - Alternative 6
There is no change in the Cross Lake outlet for Alternatives 1 through 6. The proposed Cross Lake outlet crest is set 0.5 ft above the court ordered elevation (1304.4'), the cross section has a continous 14 ft bottom width and 2(H):1(V) side slopes from the crest to the downstream channel invert, and the profile slope of the rock ramp is 3%. Rock riffle boulders are embedded in the rock ramp to provide fish passage.
Cross Lake Dam
370th St SE
T-3018
T-3019
Cross Lake
390th Ave SE
380th St SE
395th Ave SE
Connection Lake Existing Dam Court Ordered Run-out El. 1307.6'
Cross Lake
1304.4' Court Ordered Run-out El.
2 Year - 24 Hour Inundation
Court Ordered Runout (1304.4')
Existing Conditions (Peak 1305.99')
Alternative #4 (Peak 1305.47')
Alternative #5 (Peak 1305.47')
Alternative #6 (Peak 1305.46')
Not Inundated (>1305.99')
Hill River
Cross 2-Year Hydrograph
Alternative 4
Alternative 5
Alternative 6
Existing Conditions
Lake Levels
Court Ordered Run-out El.
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
Red Lake Watershed District
Dedicated to Water Management
Cross Lake
2 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6
Project No : 10382228
Date : February 2024
0 0.1 0.2 0.4
Miles


Cross Lake Outlet
Box Culvert
400th Ave SE
365th St SE
Cross Lake Dam
T-3019
390th Ave SE
Cross
Lake
North Cross Lake
North Cross Lake Elevation (1304.4')
2 Year - 24 Hour Inundation
Lake Elevation (1304.4')
Existing Conditions (Peak 1305.68')
Alternative #1 (Peak 1305.61')
Alternative #2 (Peak 1305.44')
Alternative #3 (Peak 1305.44')
Not Inundated (>1305.68')
Hill River
North Cross 2-Year Hydrograph
Alternative 1
Alternative 2
Alternative 3
Existing Conditions
Lake Levels
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
North Cross Lake
2 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3
Project No : 10382228
Date : February 2024
0 0.05 0.1 0.2
Miles


Cross Lake Outlet Box Culvert
400th Ave SE
365th St SE
Cross Lake Dam
T-3019
Cross Lake
390th Ave SE
North Cross Lake
North Cross Lake Elevation (1304.4')
2 Year - 24 Hour Inundation
Lake Elevation (1304.4')
Existing Conditions (Peak 1305.68')
Alternative #4 (Peak 1305.34')
Alternative #5 (Peak 1305.34')
Alternative #6 (Peak 1305.33')
Not Inundated (>1305.68')
Hill River
North Cross 2-Year Hydrograph
Alternative 4
Alternative 5
Alternative 6
Existing Conditions
Lake Levels
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
North Cross Lake
2 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6
Project No : 10382228
Date : February 2024
0 0.05 0.1 0.2
Miles


Description of Alternatives
Design Option
Description
Alternative 1 - Alternative 6
There is no change in the Cross Lake outlet for Alternatives 1 through 6. The proposed Cross Lake outlet crest is set 0.5 ft above the court ordered elevation (1304.4'), the cross section has a continous 14 ft bottom width and 2(H):1(V) side slopes from the crest to the downstream channel invert, and the profile slope of the rock ramp is 3%. Rock riffle boulders are embedded in the rock ramp to provide fish passage.
Cross Lake Dam
370th St SE
T-3018
T-3019
Cross Lake
390th Ave SE
380th St SE
Connection Lake Existing Dam Court Ordered Run-out El. 1307.6'
395th Ave SE
Cross Lake
1304.4' Court Ordered Run-out El.
10 Year - 24 Hour Inundation
Court Ordered Runout (1304.4')
Existing Conditions (Peak 1306.77')
Alternative #1 (Peak 1306.61')
Alternative #2 (Peak 1306.29')
Alternative #3 (Peak 1306.18')
Not Inundated (>1306.77')
Hill River
Cross 10-Year Hydrograph
Lake Levels
Alternative 1
Alternative 2
Alternative 3
Existing Conditions
Court Ordered Run-out El.
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
Cross Lake
10 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3
Project No : 10382228
Date : February 2024
0 0.1 0.2 0.4
Miles

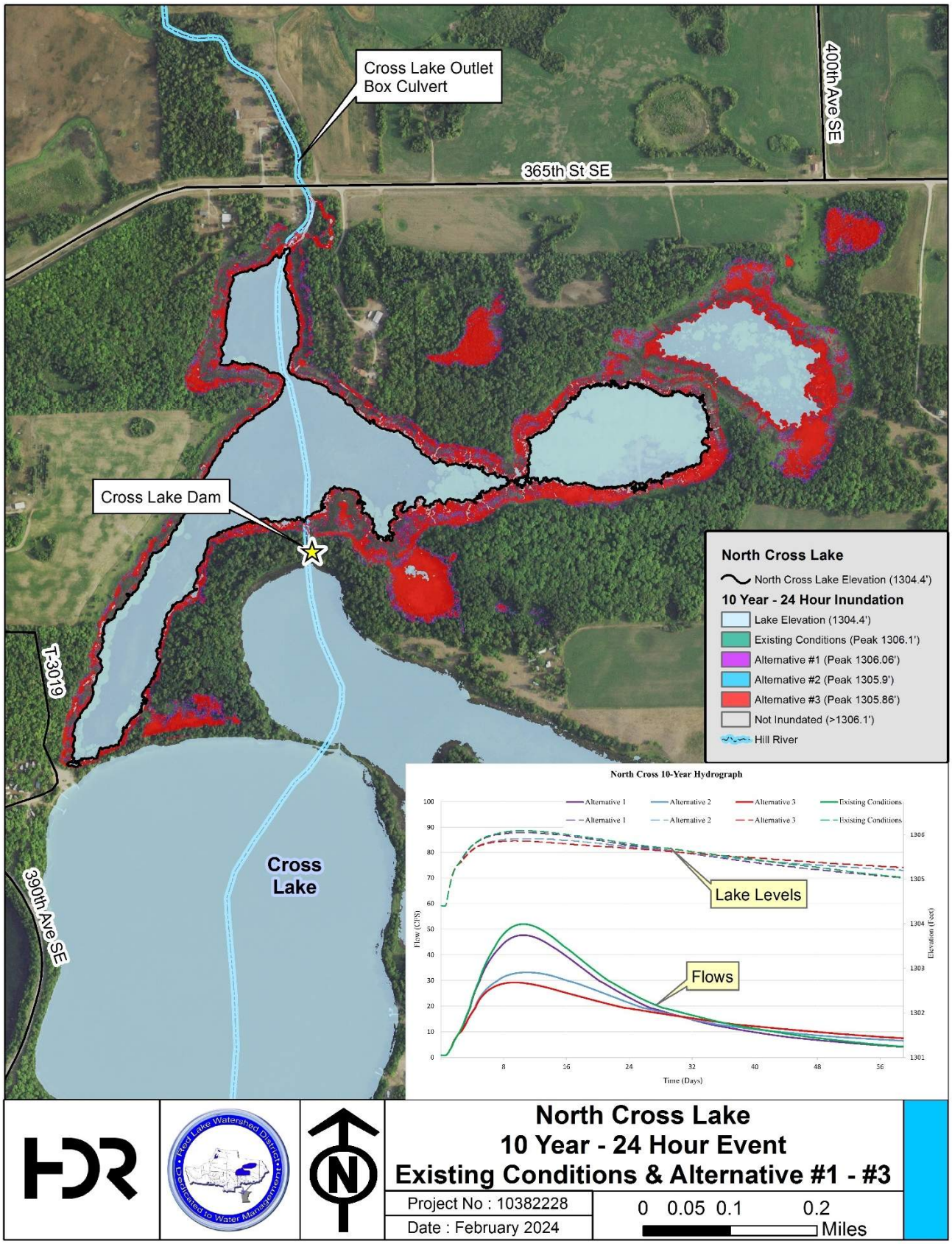
Description of Alternatives	
Design Option	**Description**
Alternative 1 - Alternative 6	There is no change in the Cross Lake outlet for Alternatives 1 through 6. The proposed Cross Lake outlet crest is set 0.5 ft above the court ordered elevation (1304.4'), the cross section has a continous 14 ft bottom width and 2(H):1(V) side slopes from the crest to the downstream channel invert, and the profile slope of the rock ramp is 3%. Rock riffle boulders are embedded in the rock ramp to provide fish passage.

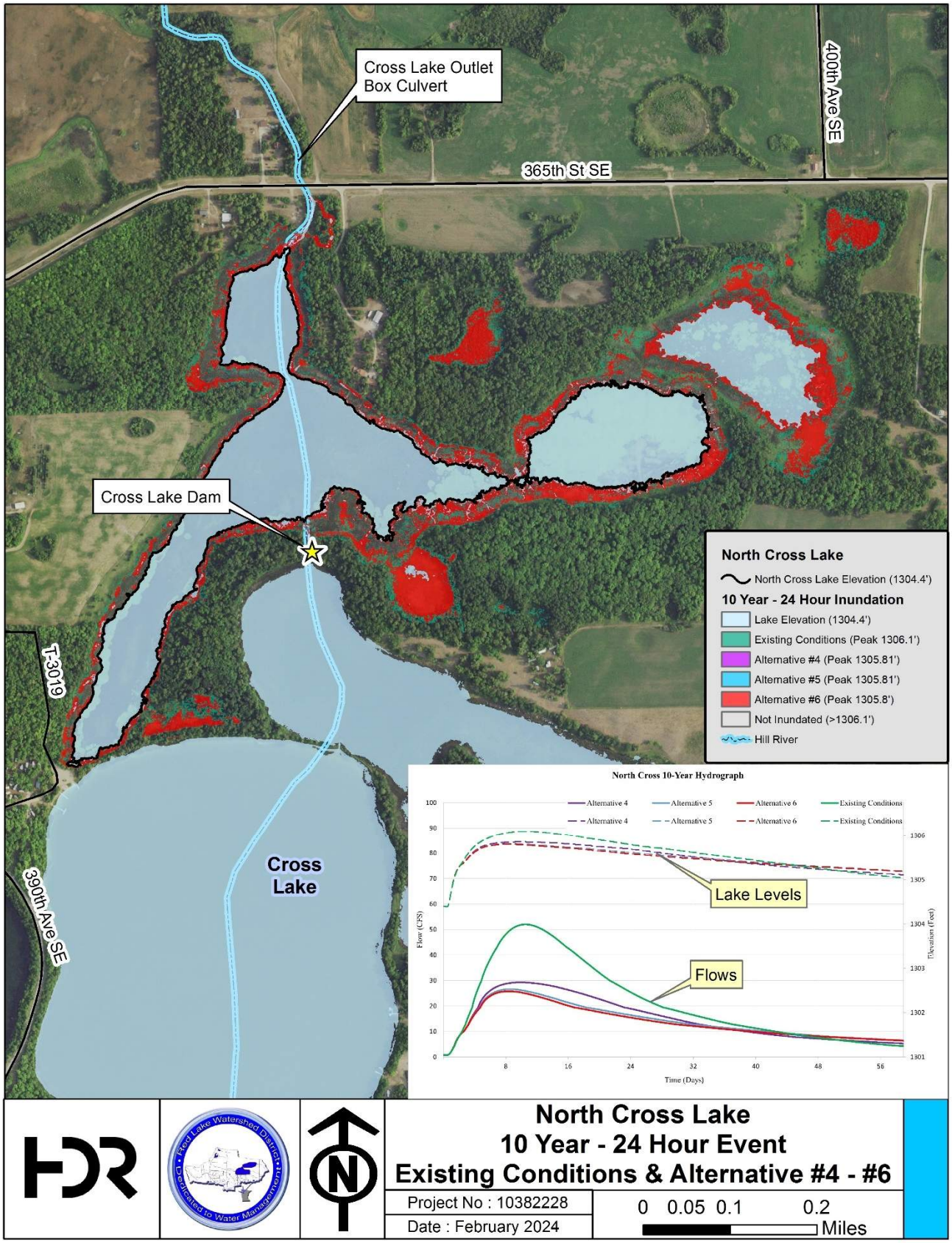


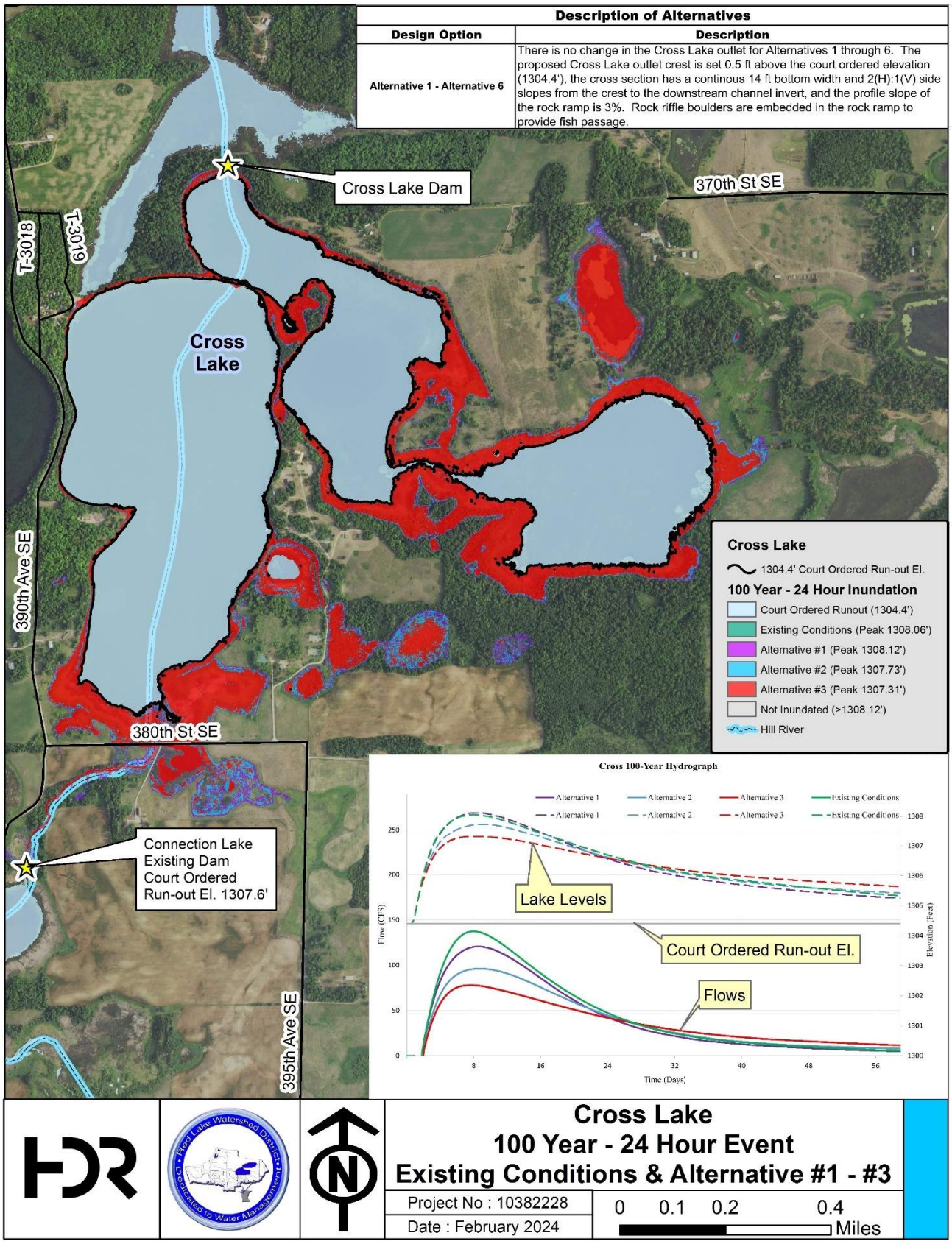
Cross Lake
10 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6

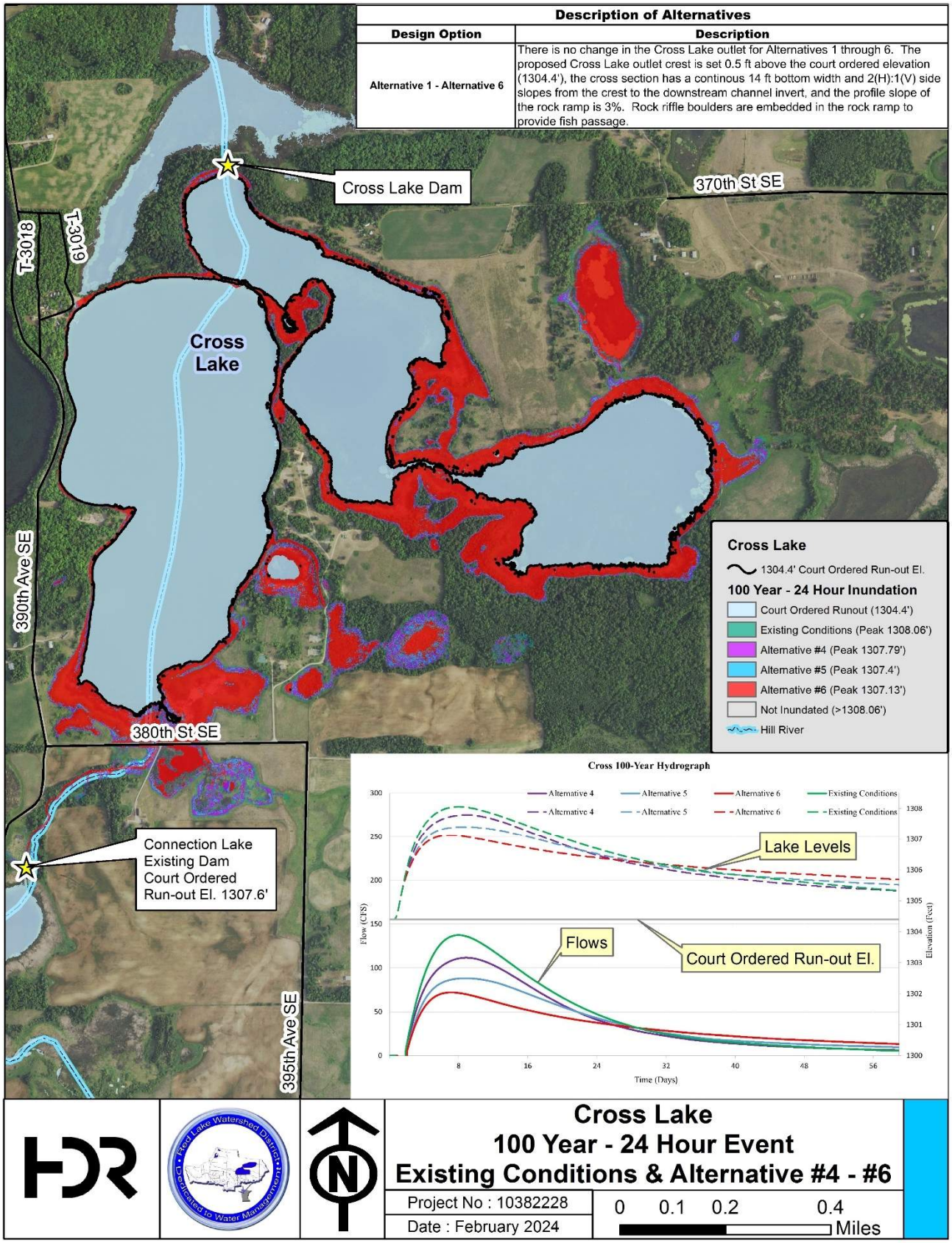
Project No : 10382228
Date : February 2024

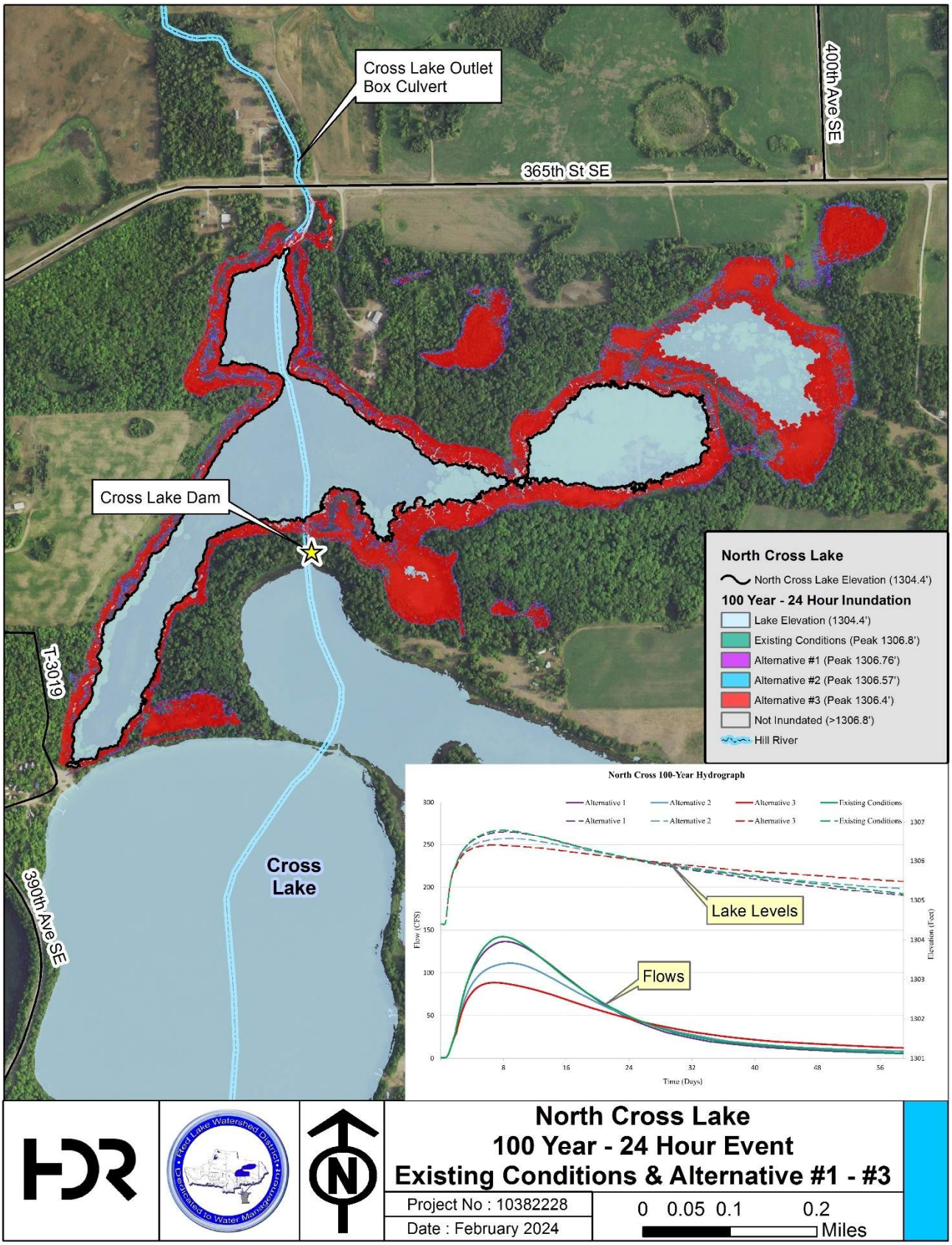
0 0.1 0.2 0.4 Miles

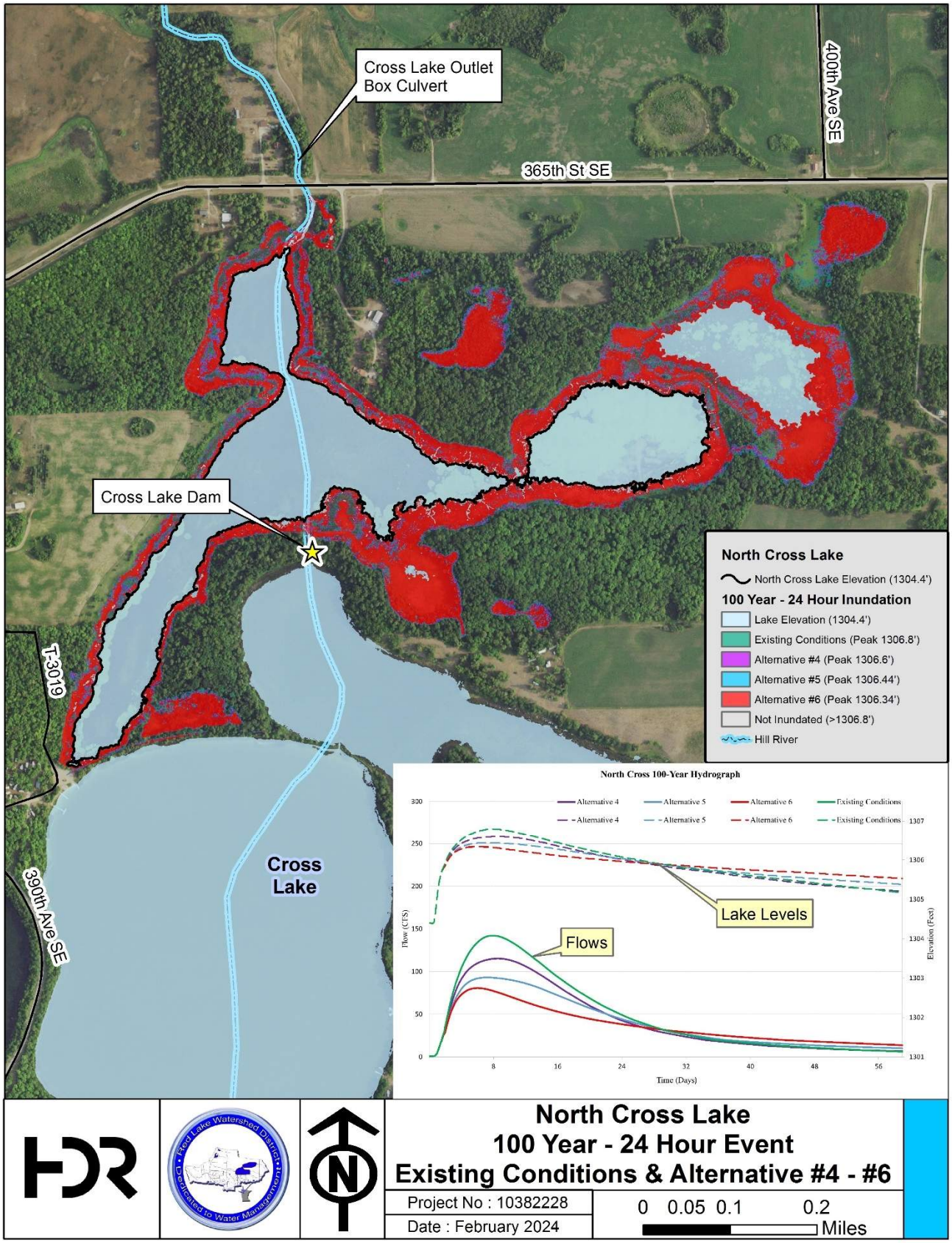

Cross Lake Outlet
Box Culvert
400th Ave SE
365th St SE
Cross Lake Dam
T-3019
390th Ave SE
Cross
Lake
North Cross Lake
North Cross Lake Elevation (1304.4')
10 Year - 24 Hour Inundation
Lake Elevation (1304.4')
Existing Conditions (Peak 1306.1')
Alternative #1 (Peak 1306.06')
Alternative #2 (Peak 1305.9')
Alternative #3 (Peak 1305.86')
Not Inundated (>1306.1')
Hill River
North Cross 10-Year Hydrograph
Alternative 1
Alternative 2
Alternative 3
Existing Conditions
Lake Levels
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
North Cross Lake
10 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3
Project No : 10382228
Date : February 2024
0 0.05 0.1 0.2
Miles


Cross Lake Outlet
Box Culvert
400th Ave SE
365th St SE
Cross Lake Dam
T-3019
Cross
Lake
390th Ave SE
North Cross Lake
North Cross Lake Elevation (1304.4')
10 Year - 24 Hour Inundation
Lake Elevation (1304.4')
Existing Conditions (Peak 1306.1')
Alternative #4 (Peak 1305.81')
Alternative #5 (Peak 1305.81')
Alternative #6 (Peak 1305.8')
Not Inundated (>1306.1')
Hill River
North Cross 10-Year Hydrograph
Alternative 4
Alternative 5
Alternative 6
Existing Conditions
Lake Levels
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
North Cross Lake
10 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6
Project No : 10382228
Date : February 2024
0 0.05 0.1 0.2
Miles


Description of Alternatives
Design Option
Description
Alternative 1 - Alternative 6
There is no change in the Cross Lake outlet for Alternatives 1 through 6. The proposed Cross Lake outlet crest is set 0.5 ft above the court ordered elevation (1304.4'), the cross section has a continous 14 ft bottom width and 2(H):1(V) side slopes from the crest to the downstream channel invert, and the profile slope of the rock ramp is 3%. Rock riffle boulders are embedded in the rock ramp to provide fish passage.
Cross Lake Dam
370th St SE
T-3018
T-3019
Cross Lake
390th Ave SE
380th St SE
Connection Lake Existing Dam Court Ordered Run-out El. 1307.6'
395th Ave SE
Cross Lake
1304.4' Court Ordered Run-out El.
100 Year - 24 Hour Inundation
Court Ordered Runout (1304.4')
Existing Conditions (Peak 1308.06')
Alternative #1 (Peak 1308.12')
Alternative #2 (Peak 1307.73')
Alternative #3 (Peak 1307.31')
Not Inundated (>1308.12')
Hill River
Cross 100-Year Hydrograph
Alternative 1
Alternative 2
Alternative 3
Existing Conditions
Lake Levels
Court Ordered Run-out El.
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
Cross Lake
100 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3
Project No : 10382228
Date : February 2024
0 0.1 0.2 0.4
Miles


Description of Alternatives
Design Option
Description
Alternative 1 - Alternative 6
There is no change in the Cross Lake outlet for Alternatives 1 through 6. The proposed Cross Lake outlet crest is set 0.5 ft above the court ordered elevation (1304.4'), the cross section has a continous 14 ft bottom width and 2(H):1(V) side slopes from the crest to the downstream channel invert, and the profile slope of the rock ramp is 3%. Rock riffle boulders are embedded in the rock ramp to provide fish passage.
Cross Lake Dam
370th St SE
T-3018
T-3019
Cross Lake
390th Ave SE
380th St SE
Connection Lake Existing Dam Court Ordered Run-out El. 1307.6'
395th Ave SE
Cross Lake
1304.4' Court Ordered Run-out El.
100 Year - 24 Hour Inundation
Court Ordered Runout (1304.4')
Existing Conditions (Peak 1308.06')
Alternative #4 (Peak 1307.79')
Alternative #5 (Peak 1307.4')
Alternative #6 (Peak 1307.13')
Not Inundated (>1308.06')
Hill River
Cross 100-Year Hydrograph
Alternative 4
Alternative 5
Alternative 6
Existing Conditions
Lake Levels
Flows
Court Ordered Run-out El.
Flow (CFS)
Elevation (Feet)
Time (Days)
Cross Lake
100 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6
Project No : 10382228
Date : February 2024
0 0.1 0.2 0.4
Miles


Cross Lake Outlet
Box Culvert
400th Ave SE
365th St SE
Cross Lake Dam
T-3019
390th Ave SE
Cross
Lake
North Cross Lake
North Cross Lake Elevation (1304.4')
100 Year - 24 Hour Inundation
Lake Elevation (1304.4')
Existing Conditions (Peak 1306.8')
Alternative #1 (Peak 1306.76')
Alternative #2 (Peak 1306.57')
Alternative #3 (Peak 1306.4')
Not Inundated (>1306.8')
Hill River
North Cross 100-Year Hydrograph
Alternative 1
Alternative 2
Alternative 3
Existing Conditions
Lake Levels
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
North Cross Lake
100 Year - 24 Hour Event
Existing Conditions & Alternative #1 - #3
Project No : 10382228
Date : February 2024
0 0.05 0.1 0.2
Miles


Cross Lake Outlet
Box Culvert
400th Ave SE
365th St SE
Cross Lake Dam
T-3019
Cross
Lake
390th Ave SE
North Cross Lake
North Cross Lake Elevation (1304.4')
100 Year - 24 Hour Inundation
Lake Elevation (1304.4')
Existing Conditions (Peak 1306.8')
Alternative #4 (Peak 1306.6')
Alternative #5 (Peak 1306.44')
Alternative #6 (Peak 1306.34')
Not Inundated (>1306.8')
Hill River
North Cross 100-Year Hydrograph
Alternative 4
Alternative 5
Alternative 6
Existing Conditions
Lake Levels
Flows
Flow (CFS)
Elevation (Feet)
Time (Days)
North Cross Lake
100 Year - 24 Hour Event
Existing Conditions & Alternative #4 - #6
Project No : 10382228
Date : February 2024
0 0.05 0.1 0.2
Miles