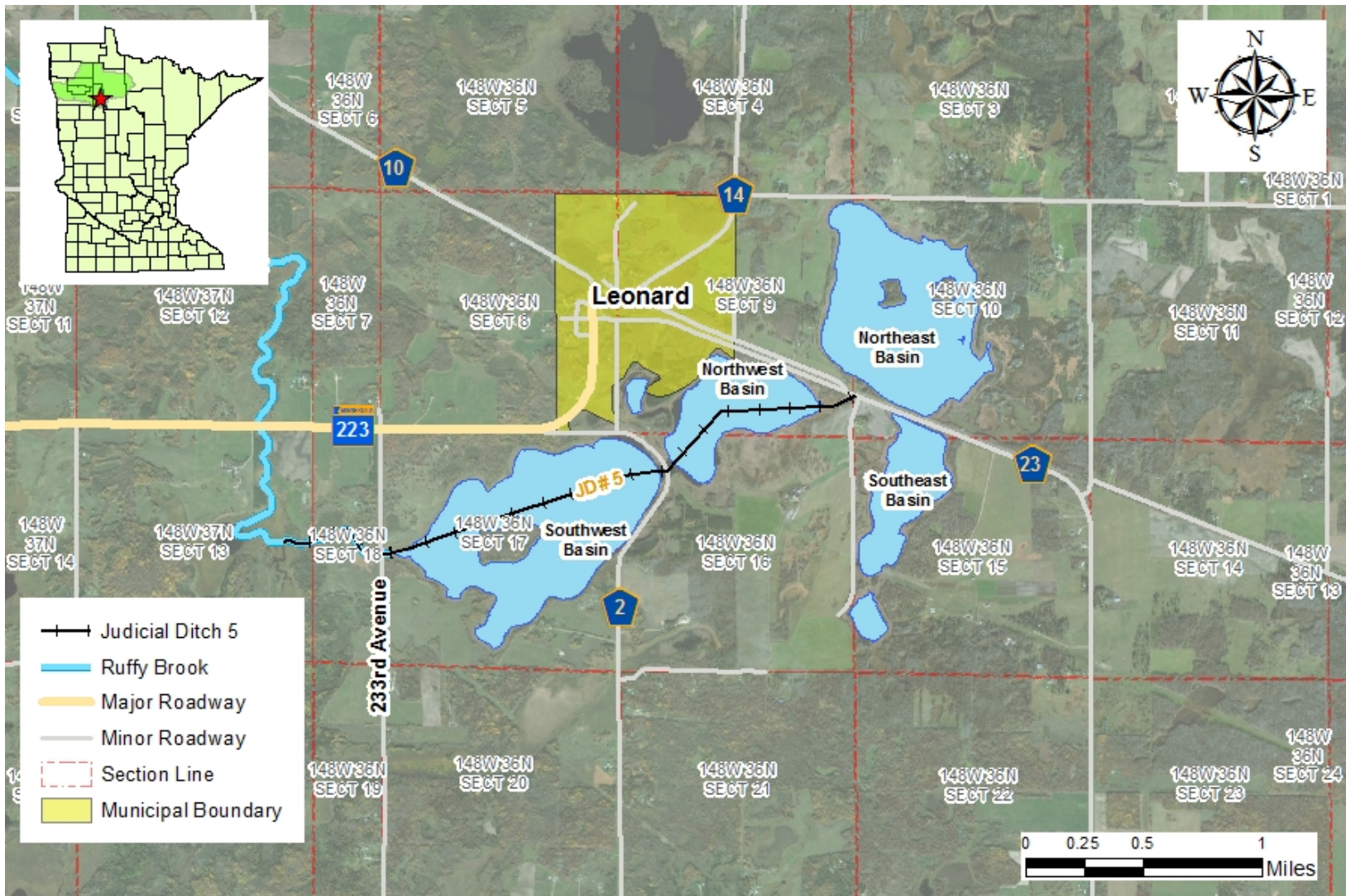
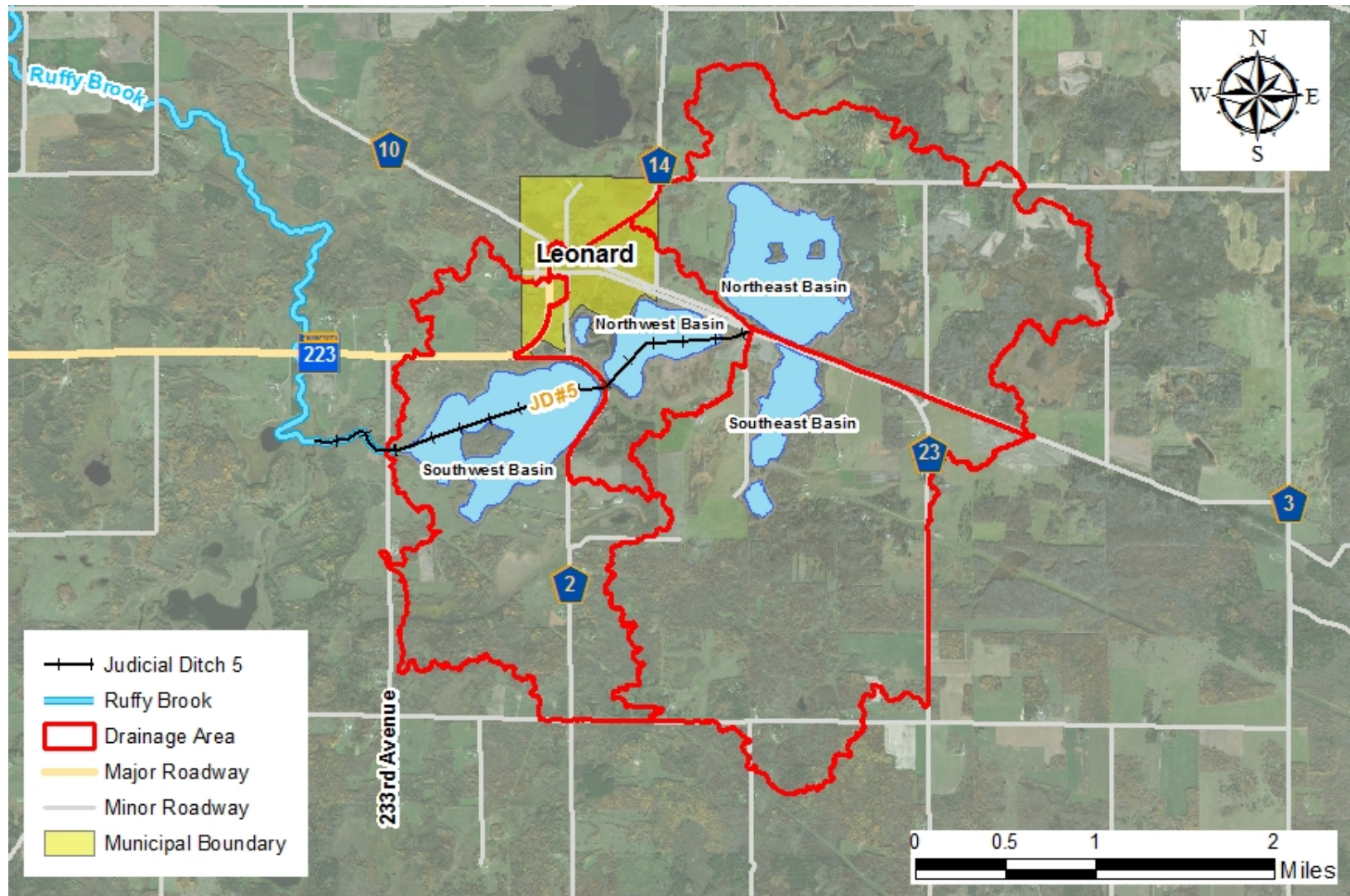




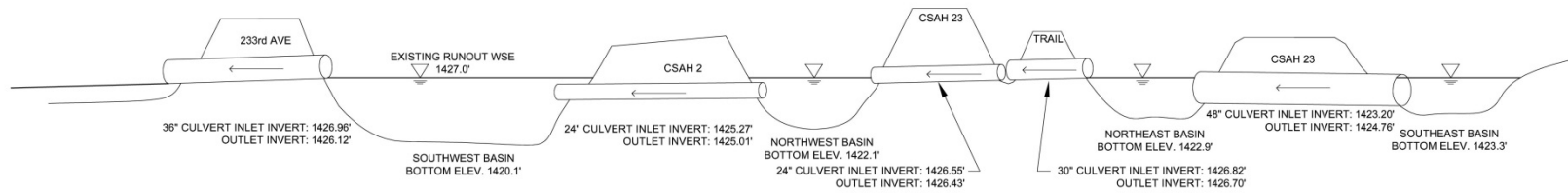
Four Legged Lake
Preliminary Engineer's Report Update
4/26/2018



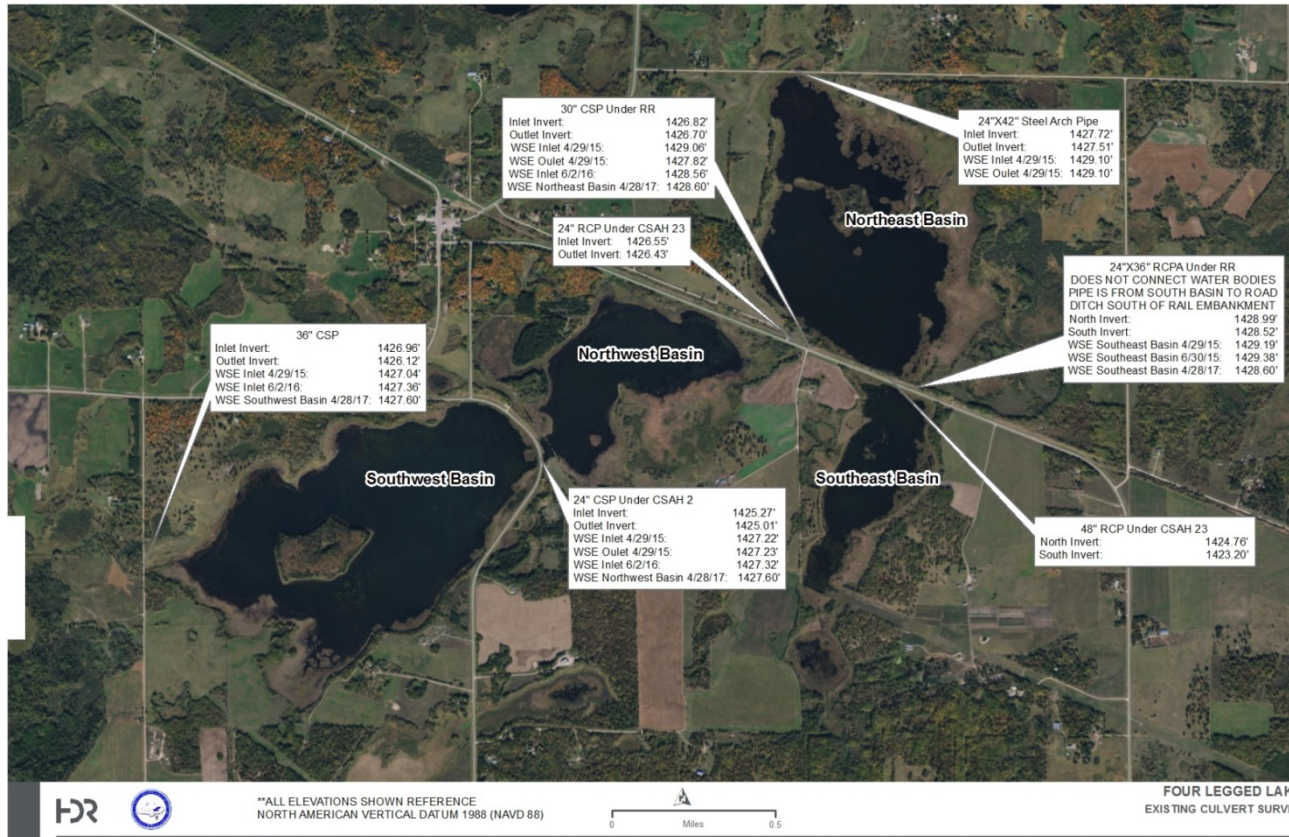




FOUR LEGGED LAKE
EXISTING CONDITIONS SYSTEM DIAGRAM
ARROWS INDICATE FLOW DIRECTION



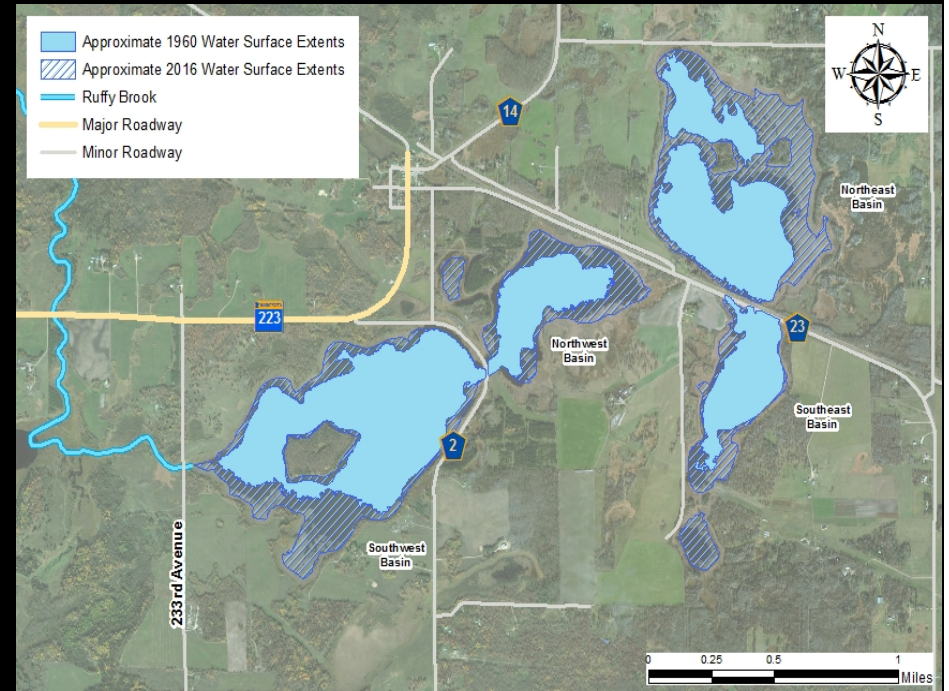
CULVERT SURVEY - FALL 2016



BRIEF HISTORY

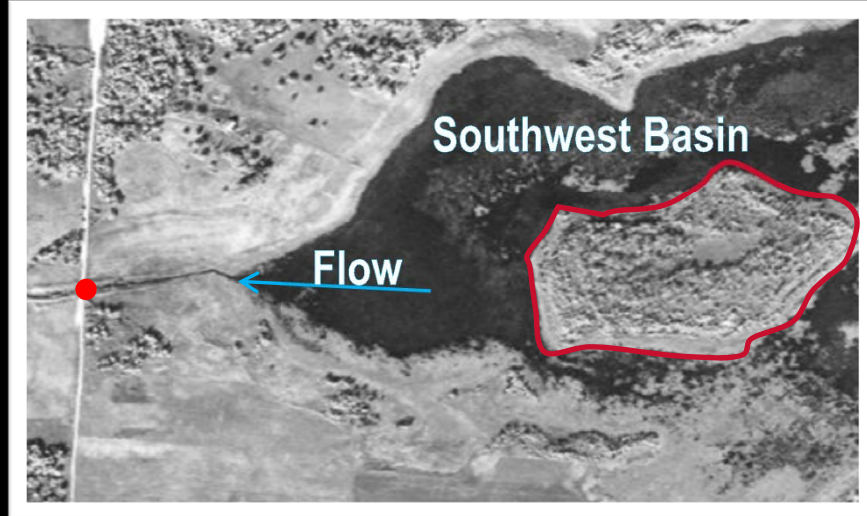
- Established about 1921
- Raising of culverts without record of drainage authority approval
- Water levels raised as much as 6 feet over time
- Increased size and depth of lake
- Resulted in potential flooding of private lands and adjacent roadways

1960 water surface: 494 acres
2010 water surface: 910 acres



1960 ERA OUTLET VS. CURRENT OUTLET

1960



2010



PROJECT MILESTONES

- 2010 – 2018 Public and Project Team meetings held to discuss Project and issues associated with water levels

- 2015 - Petition Received for Abandonment of JD (Judicial Ditch) #5 - Tabled

- 2018 - Board requested Engineers investigation of alternatives to:
 - Modify/replace existing drainage structures
 - Manage Four Legged Lake's Water Surface Elevations for each basin
 - Provide Flood Damage Reduction (FDR) benefits

PROJECT GOALS DEVELOPED WITH PROJECT TEAM

- The purpose of this Project is to reduce flood damages to Clearwater County roads, lakeshore property, and the shoreline of Four Legged Lake.
- Secondary benefits from the Project may include:
 - Contribution to the regional goal of reducing peak flows downstream to Ruffy Brook and along the Red River of the North (Red River) by 20% during large flooding events
 - Establishing stable water surface elevation for the benefit of flood damage reduction, wildlife, and lake aesthetics
 - Establish an outlet structure and culverts that will provide operational variability and maintenance access throughout the Four Legged Lake system

STAKEHOLDER CONSIDERATIONS

RLWD

- Follow and administer appropriate drainage law procedures
- Provide storage for downstream areas to reduce peak flows (FDR)
- Manage agreeable lake levels
- Maintain lake characteristics
- Maintain water quality
- Provide maintenance of system as appropriate

Clearwater County Highway Department (CCHD)

- Maintain water levels to minimize road damages
 - Minimize encroachments to the clear zone/recovery area
 - Provide 5 feet of vertical separation between water levels and roadway centerline elevation
- Maintain safe roads
- Provide and maintain infrastructure to protect the integrity of the road

Landowners

- Manage water levels in an acceptable and equitable manner for all four basins
- Reduce high or flooding water levels
- Maintain lake aesthetics

Board of Soil and Water Resources (BWSR)

- Maintain or improve water quality

MnDNR

- Maintain and enhance waterfowl habitat diversity
- Maintain or improve water quality
- Establish appropriate water levels pursuant Minnesota Rule 6115

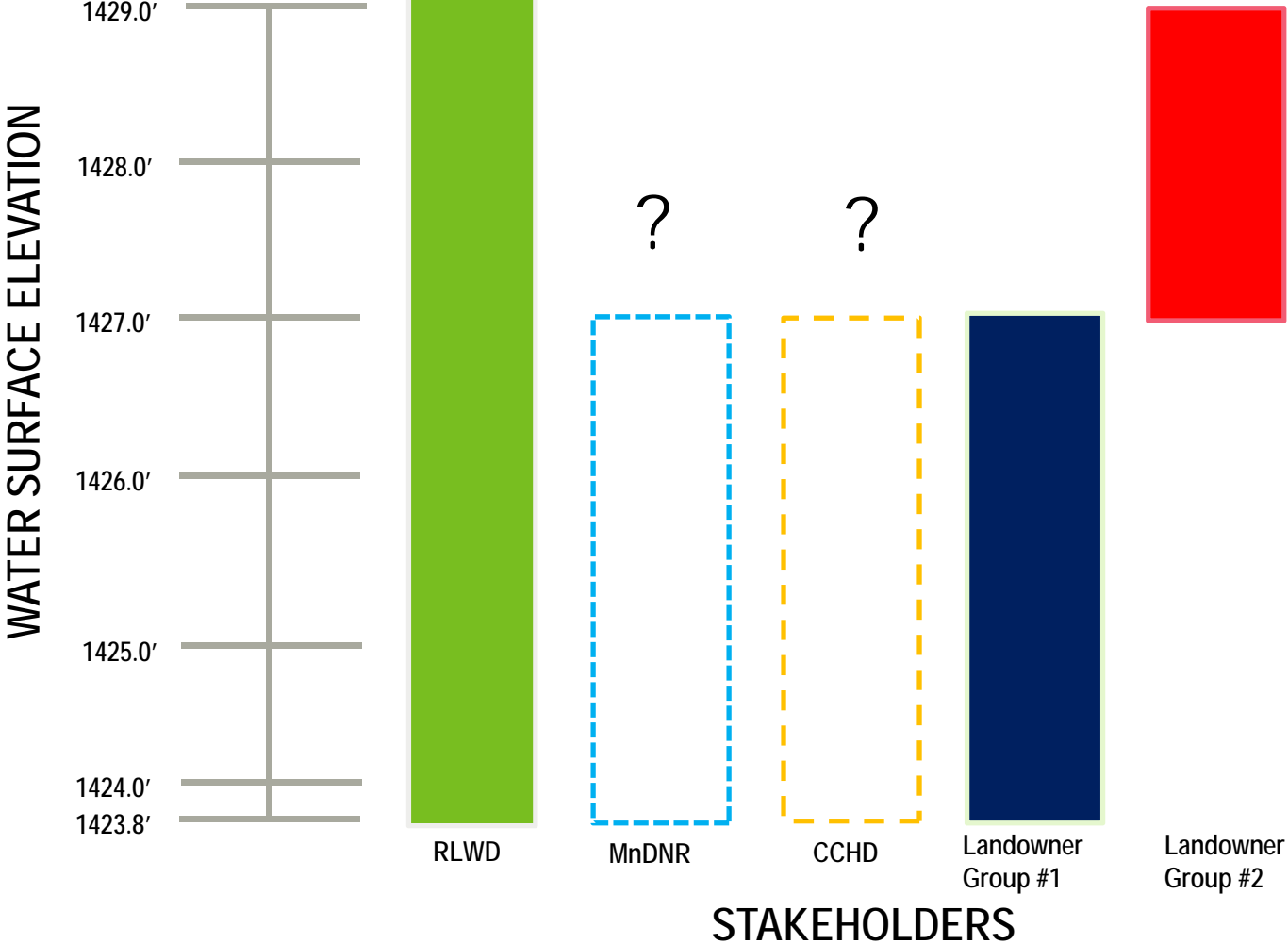
MPCA

- Maintain or improve water quality

USACE

- Follow concurrence points process

FOUR LEGGED LAKE WATER LEVEL PREFERENCES



FACTORS TO CONSIDER

- FDR
- WILDLIFE HABITAT
- ROAD DESIGN STANDARDS & SAFETY
- AESTHETICS
- FLOODING
- LEGAL CHALLENGES
- RISK
- STATUTORY OBLIGATIONS

ENGINEERING DESIGN CRITERIA

Design Element	Criteria
Roadway	Maintain vertical road separation of 5 feet for normal water surface elevations
Roadway	Minimize normal water surface infringement into the roadway clear zone
FDR	Reduce flooding and do not increase inundation of uplands or flooding downstream
Normal Pool Elevations	Establish a long-term water surface elevation that meets the goals and expectations of the Project Team in a fair and equitable manner
Feasibility	WSE must be permissible as discussed with agencies during the Project Team process

PROJECT ALTERNATIVES

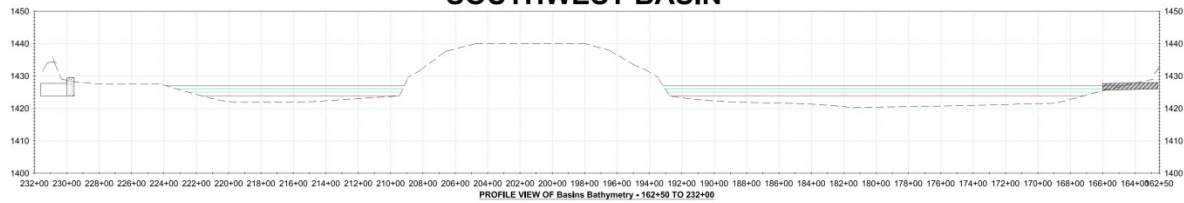
Alternative	Southwest Basin Normal WSE (ft)	Northwest Basin Normal WSE (ft)	Northeast Basin Normal WSE (ft)	Southeast Basin Normal WSE (ft)
Existing Condition ¹	1427.0	1427.0	1427.0	1427.0
Alternative 1	1424.0	1424.0	1427.0	1427.0
Alternative 2	1425.5	1425.5	1427.0	1427.0
Alternative 3	1426.0	1426.0	1427.0	1427.0
Alternative 4	1427.0	1427.0	1427.0	1427.0

¹Existing condition normal WSEs are shown for comparison purposes.
Assumes system has no hydraulic obstructions

TOPOGRAPHY - SOUTHWEST OUTLET

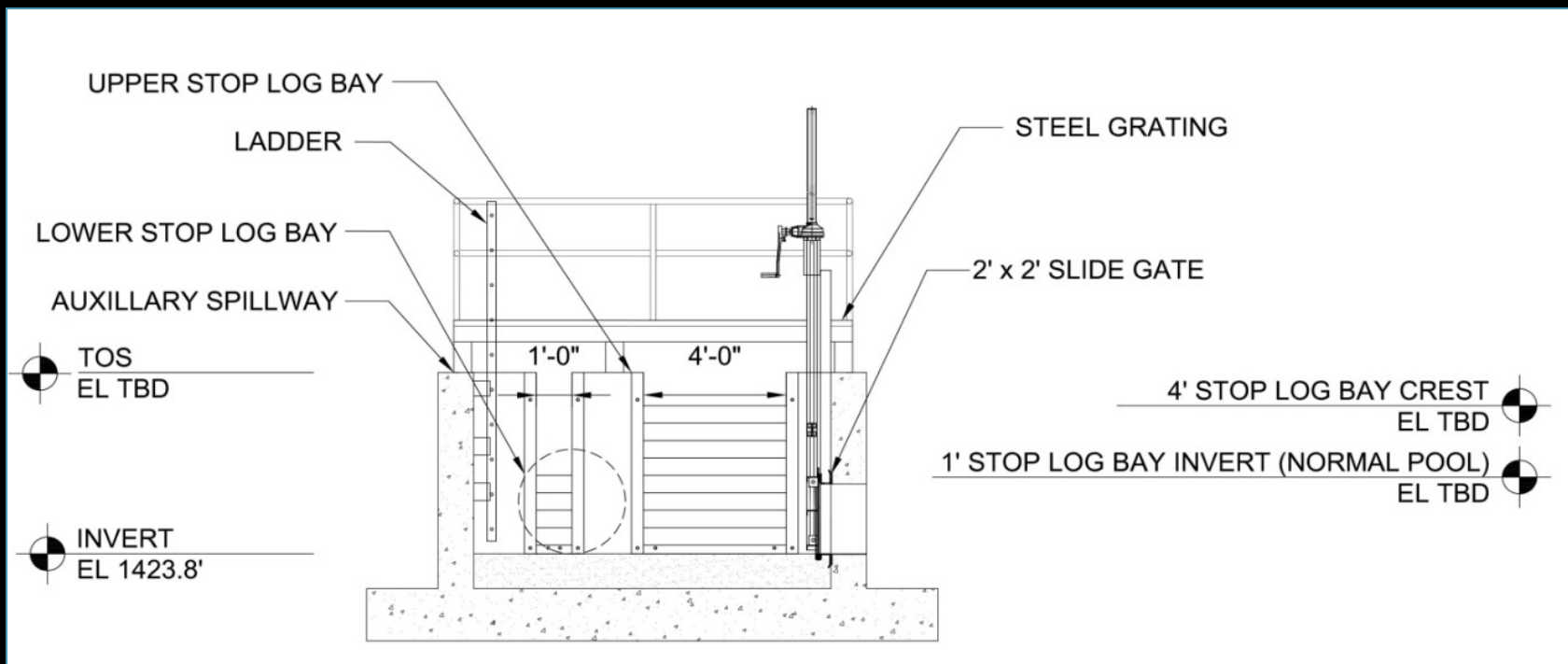


SOUTHWEST BASIN



PROJECT FEATURES - OUTLET STRUCTURE

- Outlet structure on East side of 233RD Avenue

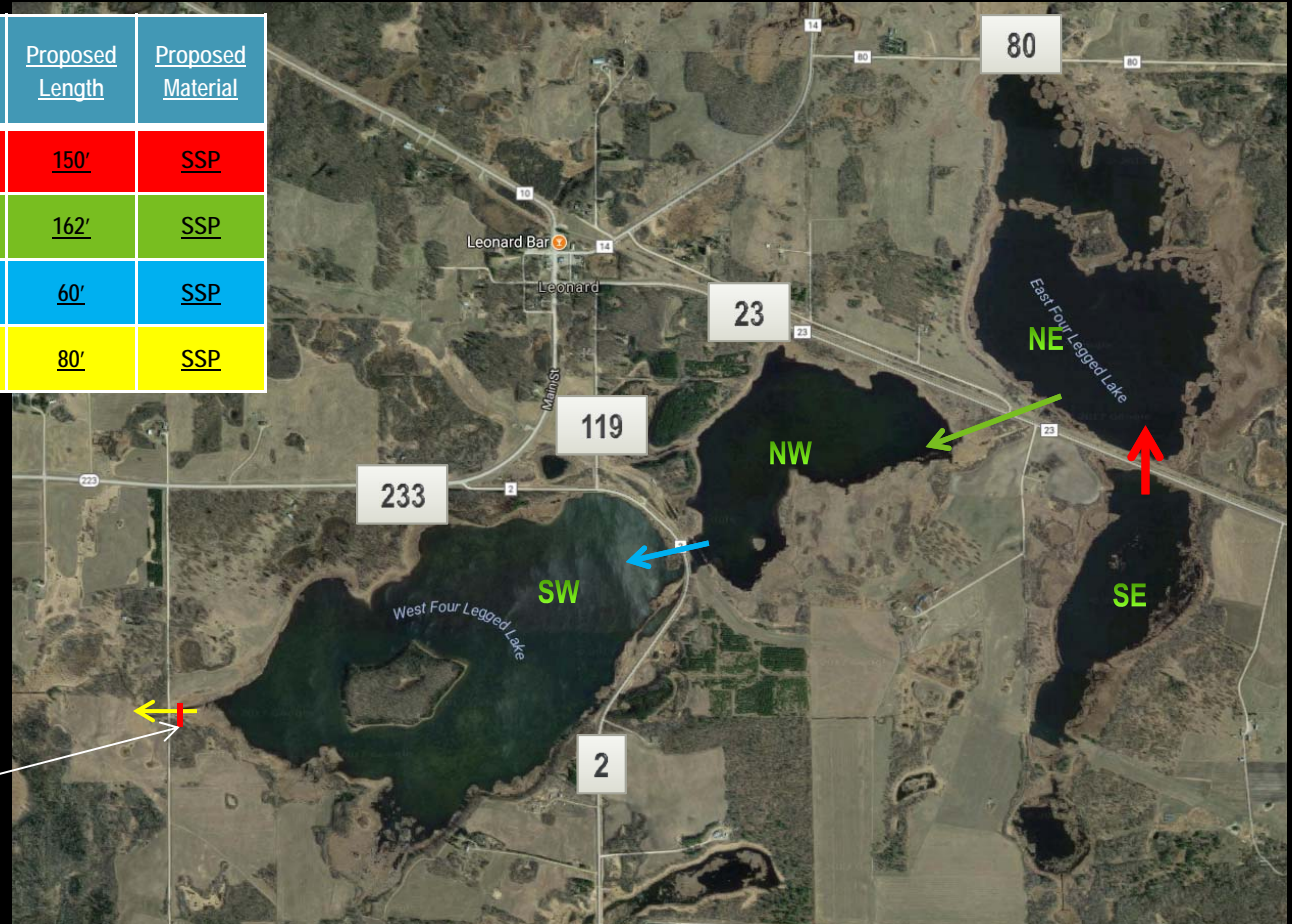


Project Features - Roadway and Outlet Culverts

Location	Existing Culvert	Proposed Shape	Proposed Size	Proposed Length	Proposed Material
CSAH 23	48" RCP	Round	36"	150'	SSP
CSAH 23	30" CSP & 24" RCP	Round	36"	162'	SSP
CSAH 2	24" CSP	Round	36"	60'	SSP
233rd Avenue	36" CSP	Round	36"	80'	SSP

Table Colors Correspond to Arrows

Red Dash Is approximate Outlet Structure Location



Results for 100 Year 24-Hour Storm Event

Characteristics	Leave as is	Alt. 1	Alt. 2	Alt. 3	Alt. 4
East Normal Pool WSE (Ft)	1427.0	1427.0	1427.0	1427.0	1427
West Normal Pool WSE (Ft)	1427.0	1424.0	1425.5	1426.0	1427
Southeast Peak WSE (Ft)	1428.8	1428.4	1428.4	1428.5	1428.7
Northeast Peak WSE (Ft)	1428.8	1428.4	1428.3	1428.4	1428.6
Northwest Peak WSE (Ft)	1428.4	1427.0	1428.0	1428.1	1428.6
Southwest Peak WSE (Ft)	1428.0	1426.9	1427.9	1428.1	1428.6
¹ Discharge Reduction	-	36%	36%	41%	47%

¹ Compared to Abandon as-is alternative (existing condition)

* Denotes an increase in downstream discharge



Roadway	Lowest Surveyed Elevation
CSAH 23	1431.20'
CR 80	1431.10'
CR 119	1432.50'
PRIVATE DRIVE	1430.00'
CSAH 2	1430.60'
233RD AVE	1434.20'

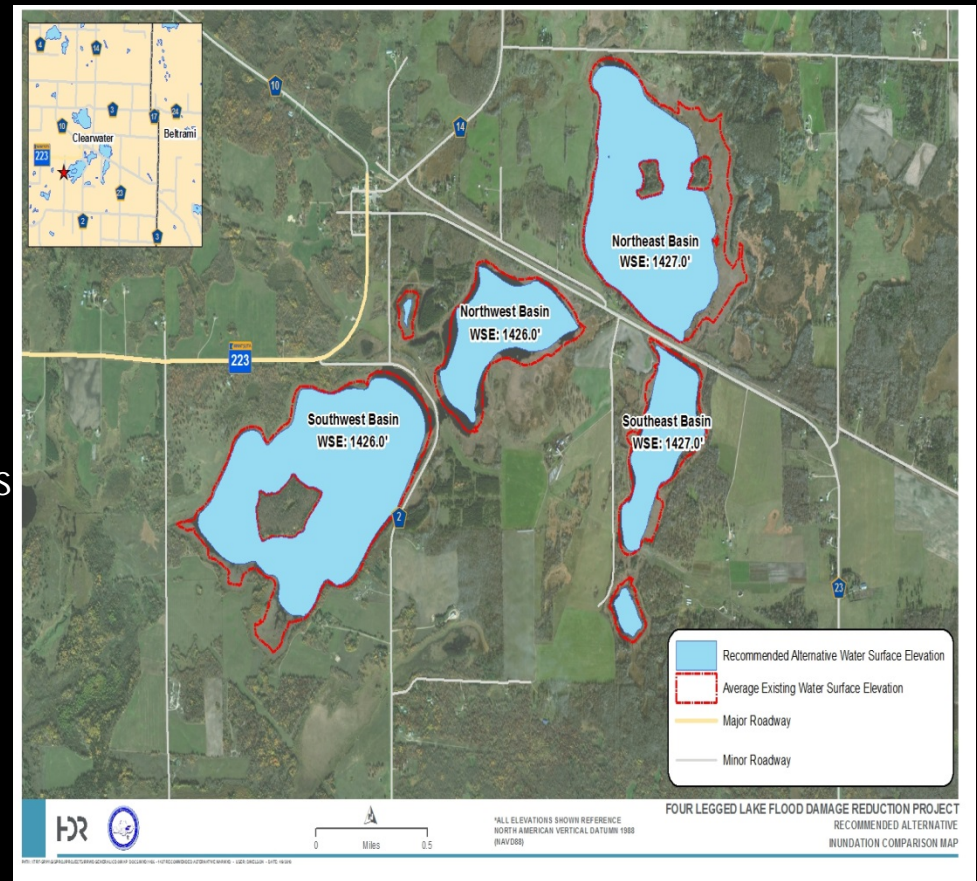
RECOMMENDATION OF ALTERNATIVE

ALTERNATIVE 3

- West Basins at normal pool elevation 1426.0'
- East Basins at normal pool elevation 1427.0'

BENEFITS

- Provides greatest average reduction in discharge downstream while reducing peak WSE of basins
 - Addresses design criteria responsibly
- Reduces potential damages to Clearwater County roads
- Improves roadway safety
- " Best fit " compromise between Project Team stated goals and interests
- Achieves compromise between maintaining lake aesthetics and reducing area of upland inundation



PROBABLE COST

Item Description	Units	Total Estimated Quantities	Unit Price	Total Price
Control Structure Items				
Mobilization	LS	1	\$20,000	\$20,000
Clearing and Grubbing	AC	0.5	\$4,000	\$2,000
Cofferdam	LS	1	\$20,000	\$20,000
Common Excavation	CY	200	\$8.00	\$1,600
Structural Concrete	CY	24	\$3,500	\$84,000
Install 36" RC Pipe	LF	80	\$95.00	\$7,600
Sluice Gate	EACH	1	\$20,000	\$20,000
Stop Log Bay	EACH	1	\$20,000	\$20,000
Catwalk and Steel Handrails	LF	25	\$500	\$12,500
Control Structure Subtotal				\$187,700
Roadway Items – Jack and Bore Pipes				
Traffic Control	LS	1	\$5,000	\$5,000
Common Excavation	CY	2000	\$4.00	\$8,000
Remove Existing 36" CSP	LF	32	\$15.00	\$480
Install 36" CS Pipe	LF	172	\$70.00	\$12,000
Install 4' Drainage Structure	EACH	2	\$7,000	\$14,000
Jack and Bore 36" Lake Connection Culverts	LF	200	\$350	\$70,000
Culvert Bedding	TON	150	\$10.00	\$1,500
Plug Existing Culverts	EACH	3	\$2,000	\$6,000
Aggregate Surfacing	TON	300	\$10.00	\$3,000
Random Riprap	CY	120	\$75.00	\$9,000
Turf Establishment	AC	0.2	\$6,000	\$1,200
Roadway Subtotal				\$130,180
Control Structure + Roadway Subtotal				\$317,880
Materials Testing (construction)				\$6,000
Contingencies			25% of Subtotal	\$79,470
Construction Subtotal				\$403,350
Engineering and Administration			25% of Construction Subtotal	\$100,837
Total Construction				\$504,187

RECOMMENDED ALTERNATIVE – CONSIDERATIONS AND CHALLENGES

- Flood Damage Reduction – Up to 1,800 acre-ft of storage (gated potential versus existing ungated)
- Wildlife Habitat – DNR Wildlife has documented prime waterfowl habitat in the past..would like lake lower?
- Road Design Standards and Public Safety – Improved
- Aesthetics - Reasonable
- Flooding Damage Reduction – Flooding Reduced
- Risk Factors - Limited
- Drainage, Permitting and Watershed Laws – Under Mn Statute 103D, Mn Rules (DNR public waters) apply, and % landowner approval required....Project may be difficult to implement based upon Project history and diverse opinions and water level preferences

HDR