

HDR

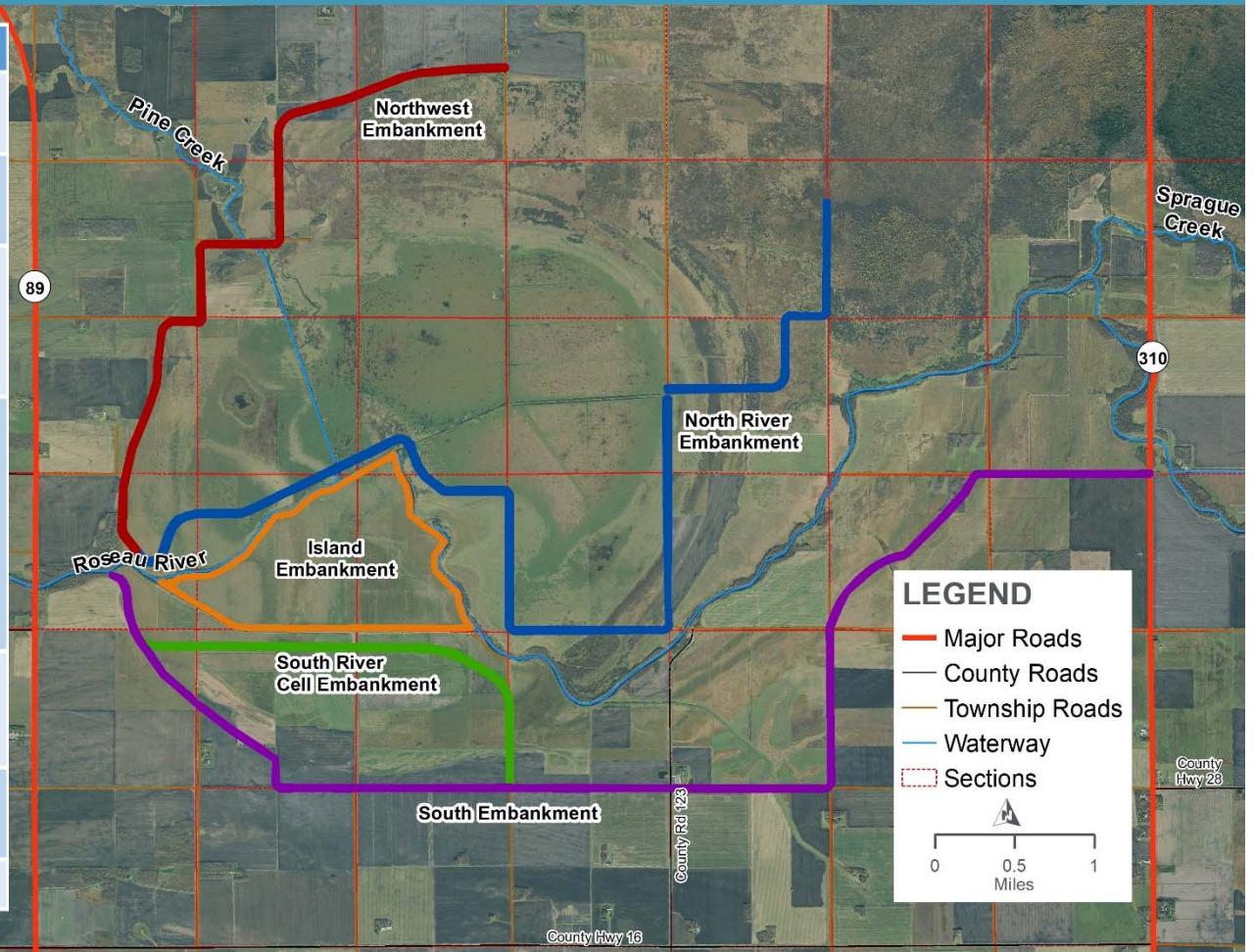
Roseau Lake – Alternatives

Discussion

- Individual Features
- Pros / Cons
- Alternatives Carried Forward - Concurrence Point #3

ROSEAU LAKE PROJECT ALTERNATIVES

Alternative	Description
Existing Conditions	No constructed embankments
1	Only Northwest and North River embankments in place
2a	No Island Embankment or South River Cell Embankment, all other embankments in place
2a-1	No Island Embankment or South River Cell Embankment, all other embankments in place. River restriction placed downstream of Roseau Lake and upstream of Ross
2c	No South River Cell Embankment, all other embankments in place
2d	No Island Embankment, all other embankments in place
2e	All embankments in place



FDR Tiers – Adjacent Lands and Downstream

Frequent Benefit

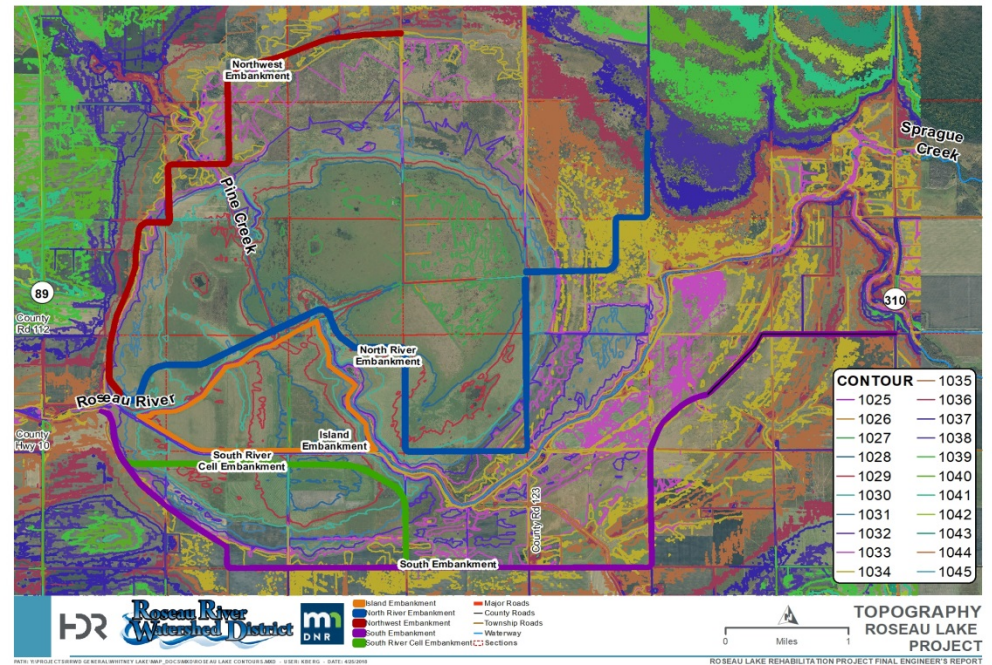
- 2-5 year flood frequency....improved conditions up to about 35 feet for adjacent lands and downstream

10 year 10 day Benefit

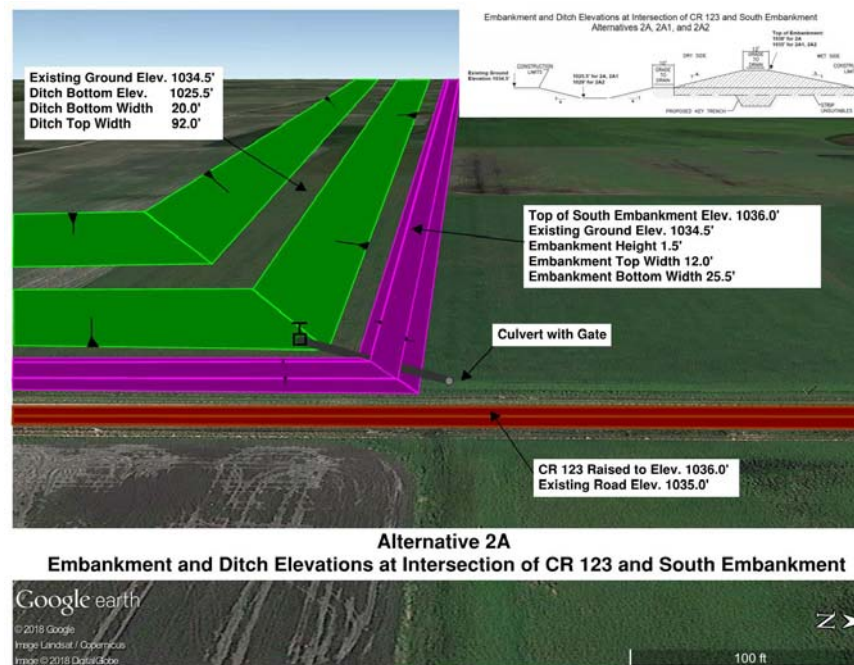
- Improved conditions downstream and similar to existing conditions and/or flowage easement for affected lands

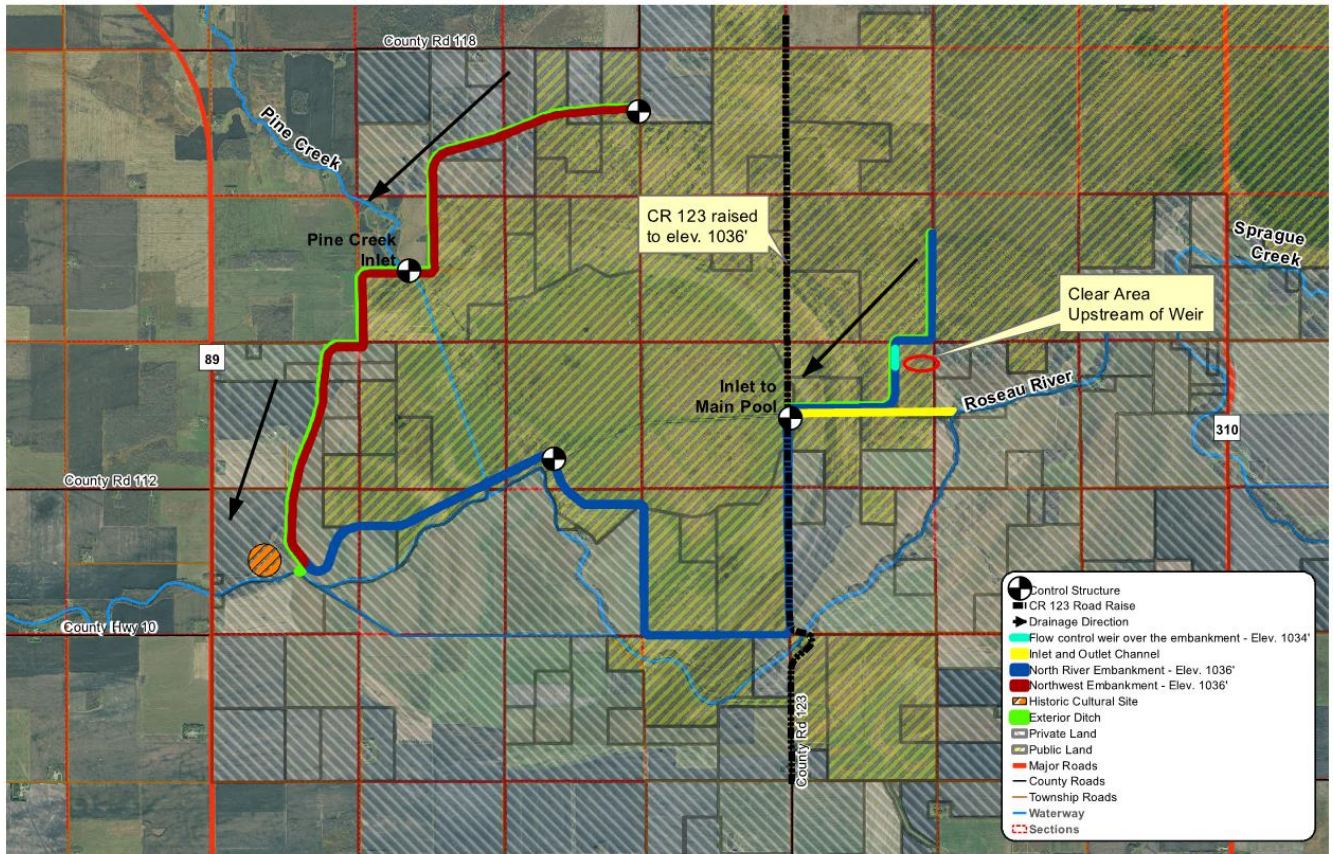
100 year Flood

- Minimal impact



Alternatives and Landowner Perspectives

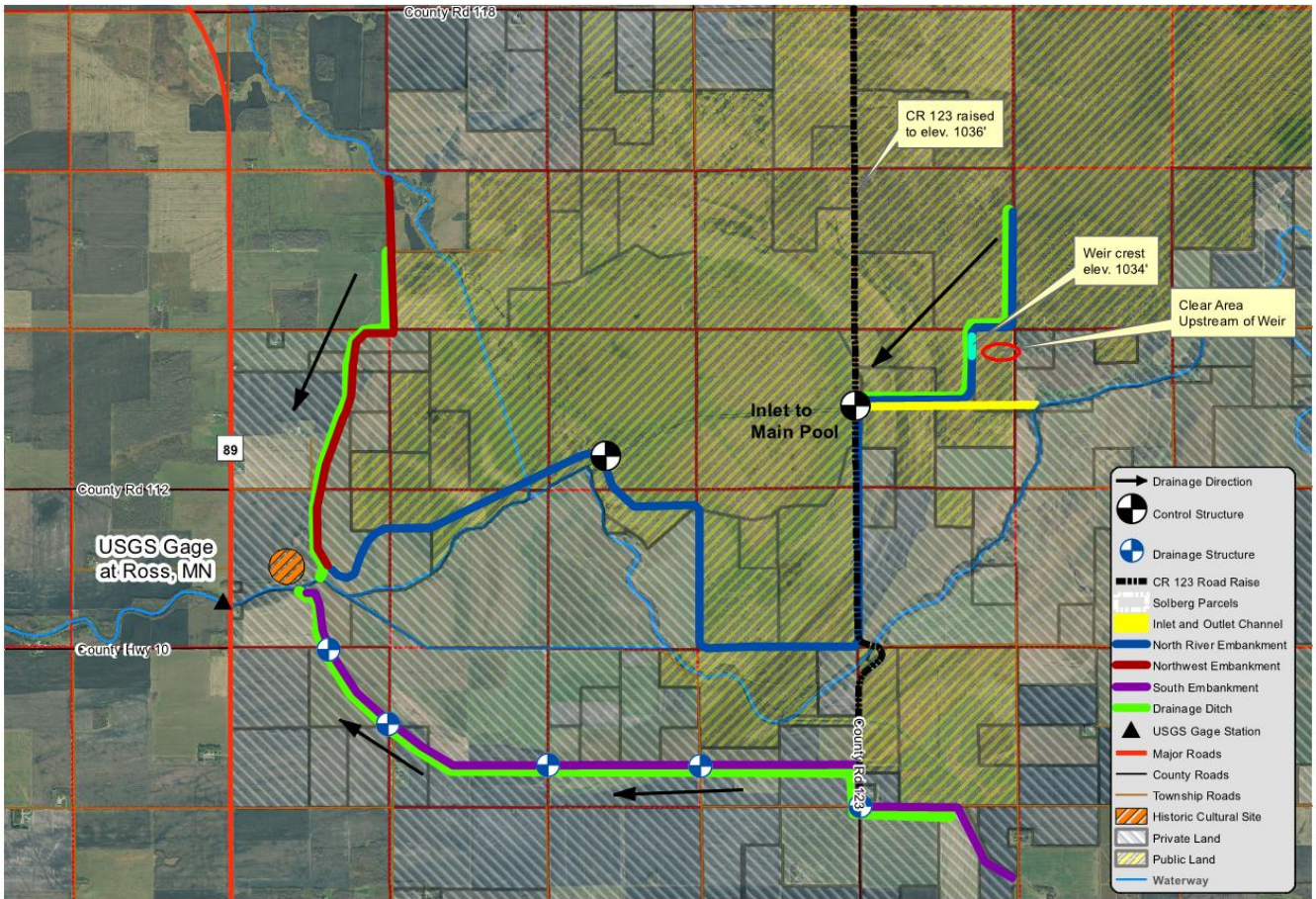




ALTERNATIVE 1



ROSEAU LAKE PROJECT

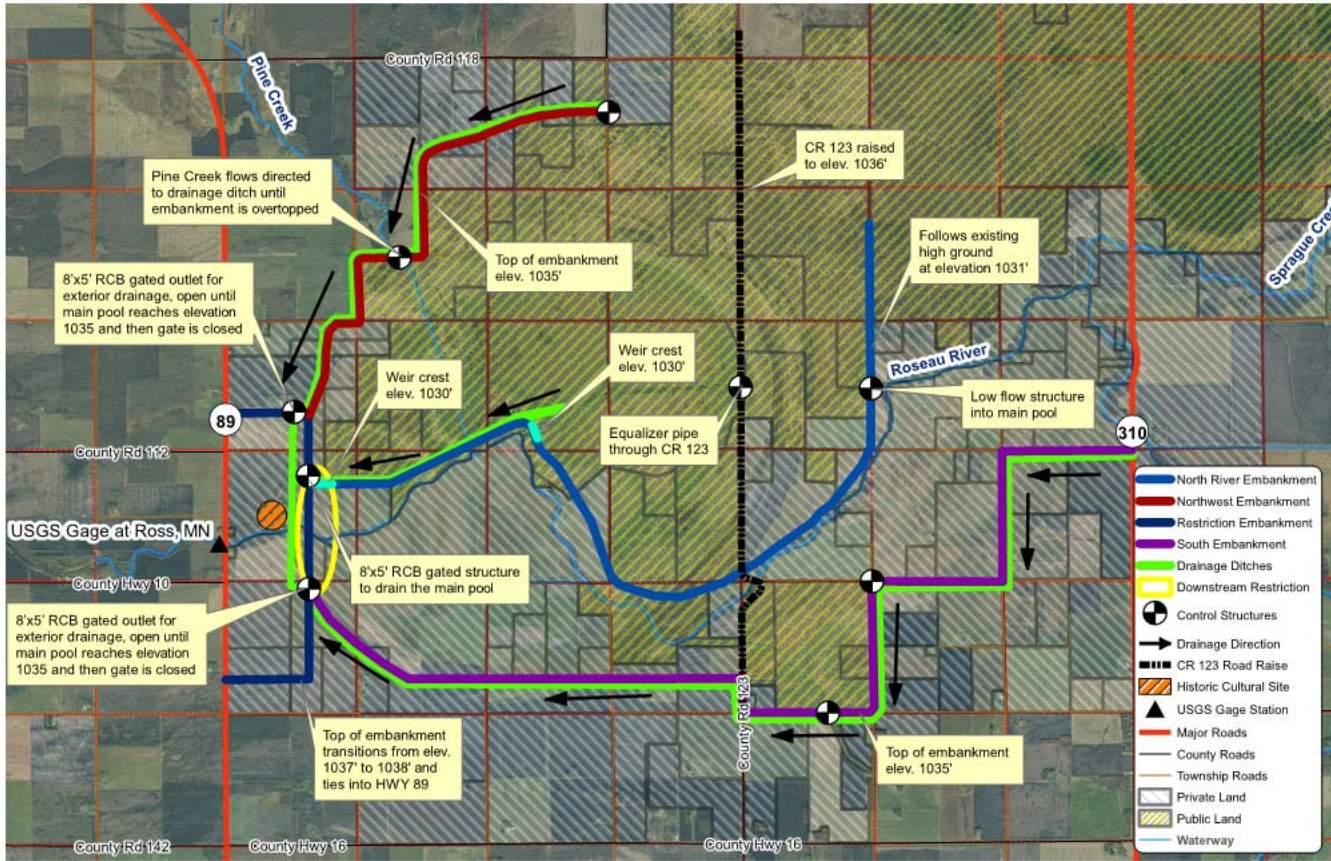


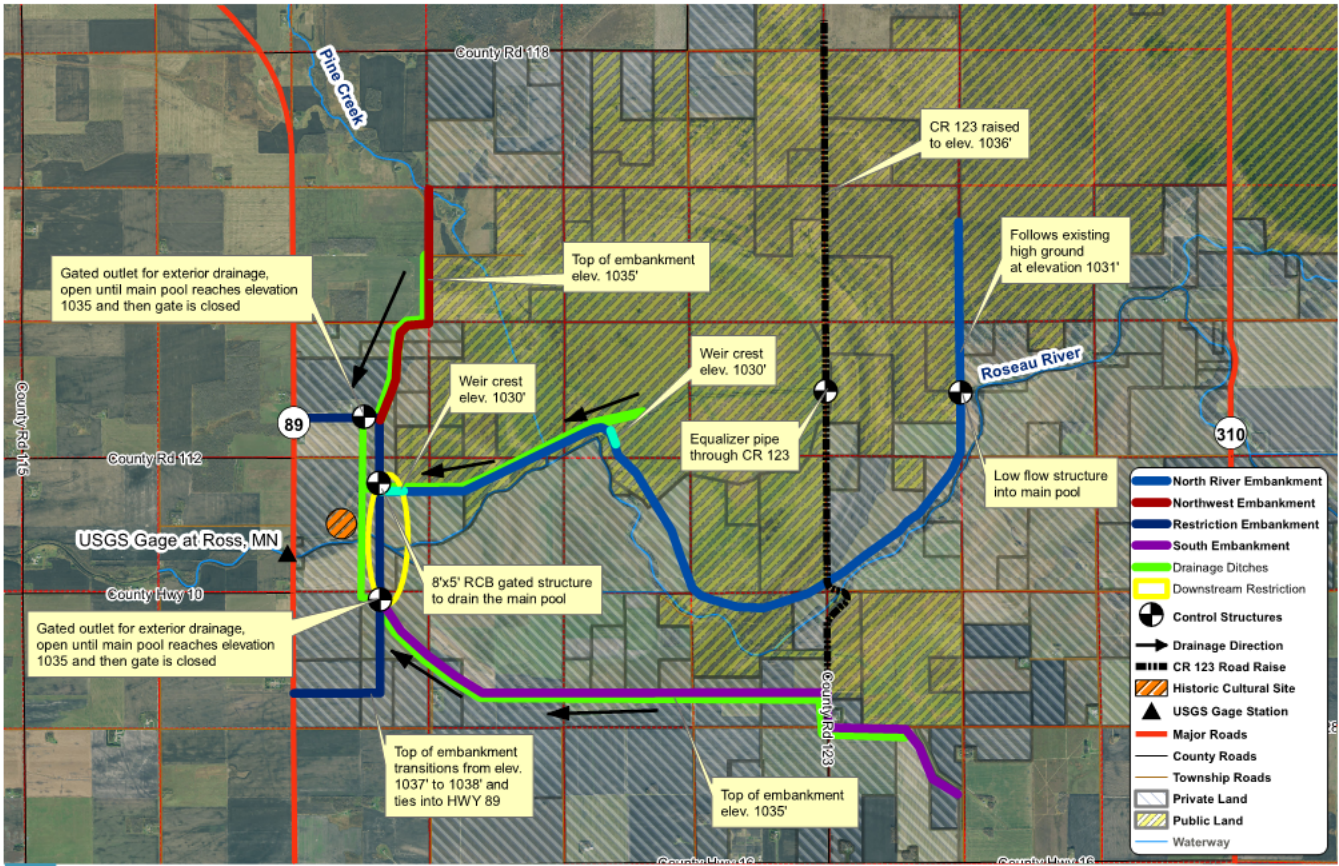
ALTERNATIVE 2A'



ROSEAU LAKE PROJECT

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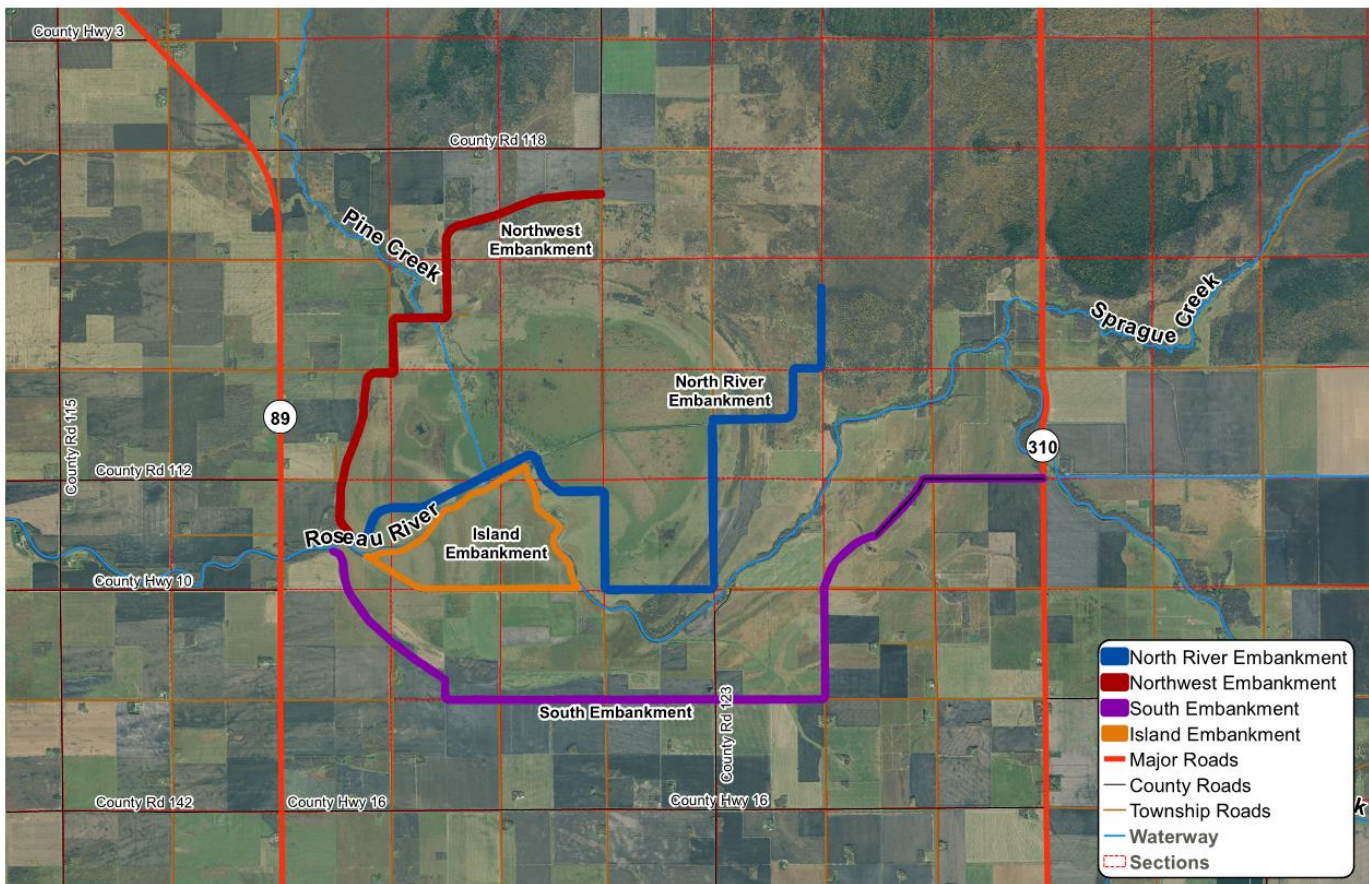




ALTERNATIVE 2A - 2
6/12/2018



ROSEAU LAKE PROJECT

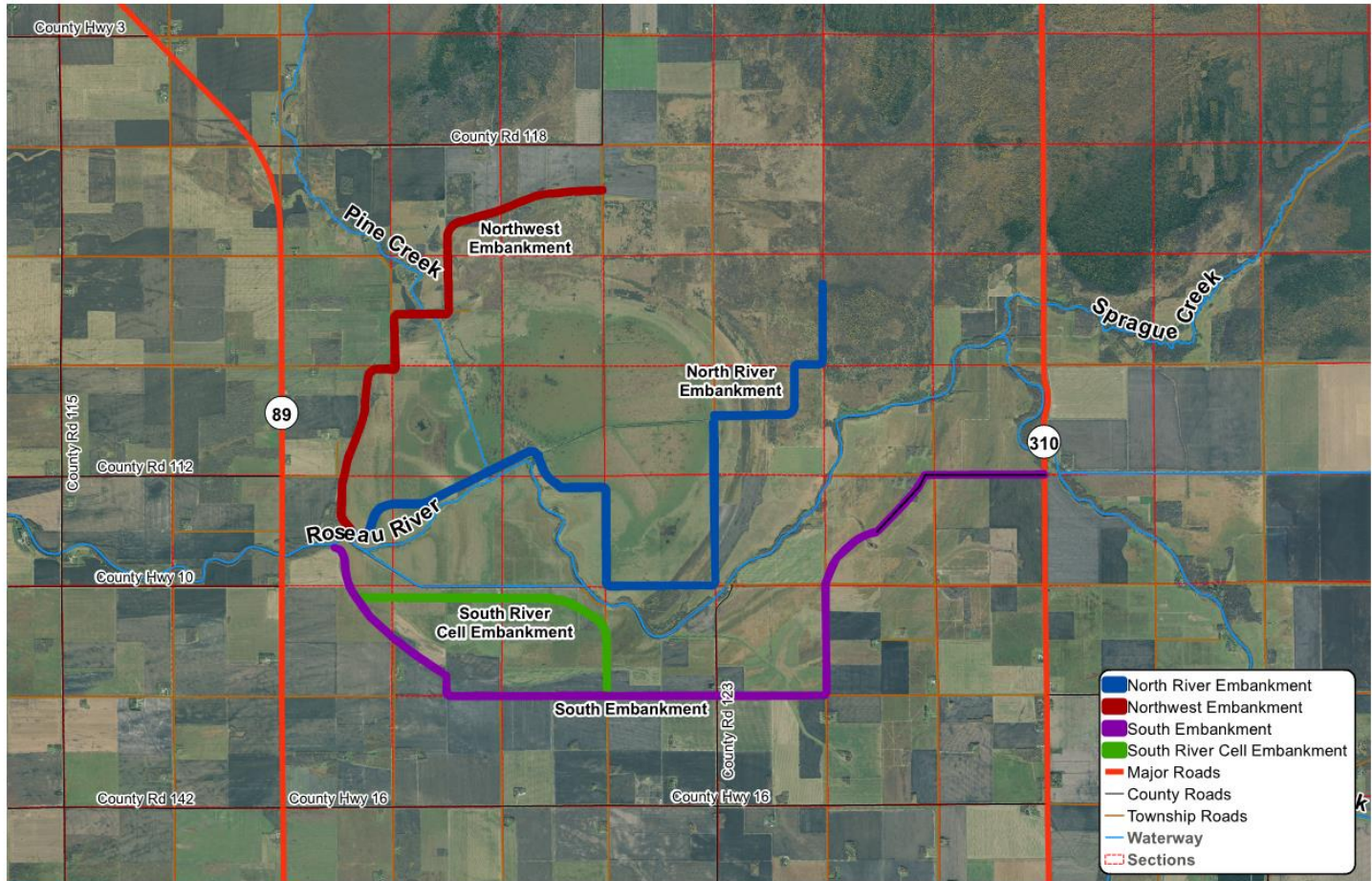


ALTERNATIVE 2C
 NO SOUTH RIVER CELL EMBANKMENT,
 ALL OTHER EMBANKMENTS IN PLACE



**ROSEAU LAKE
 PROJECT**

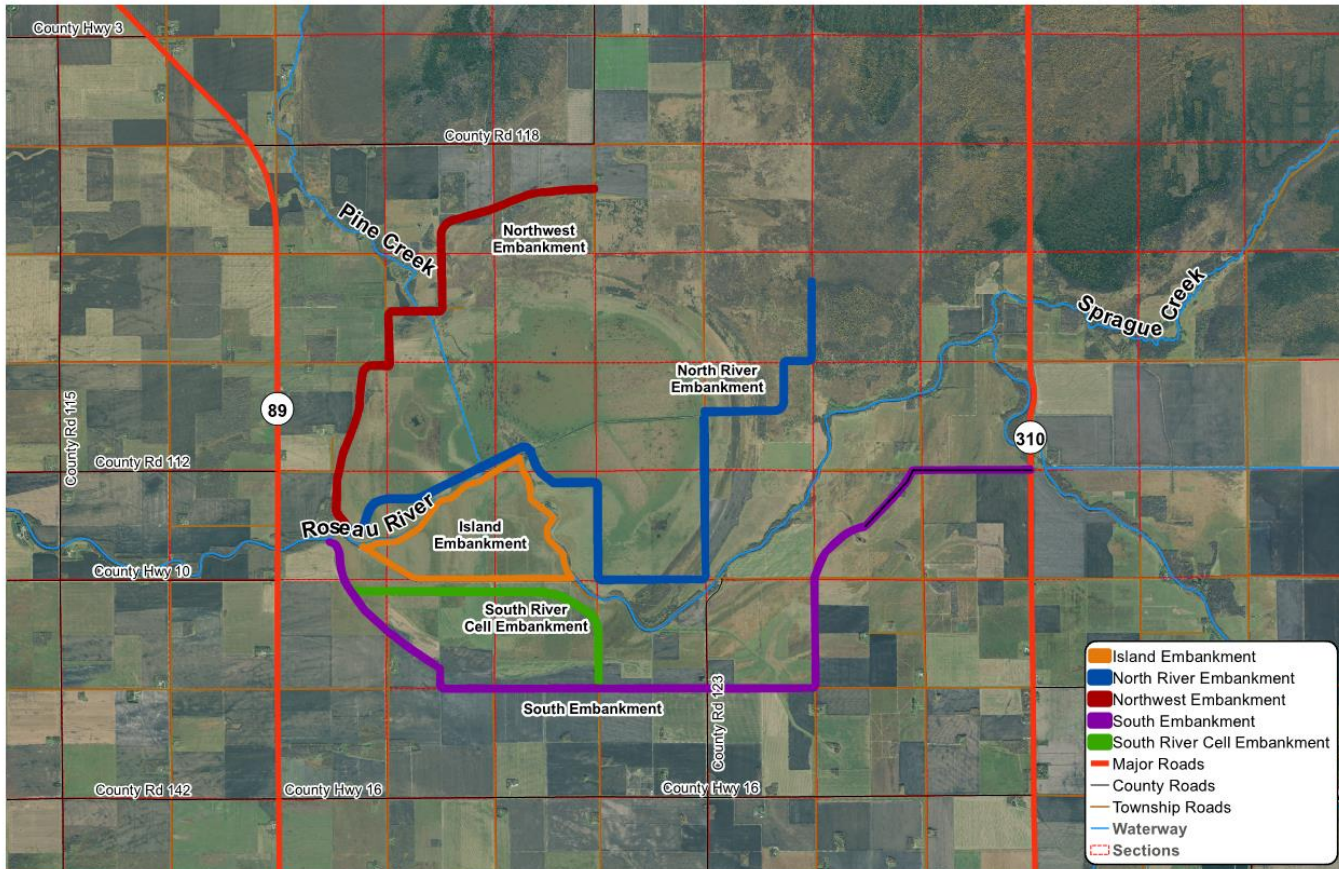
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ALTERNATIVE 2D
 NO ISLAND EMBANKMENT, ALL
 OTHER EMBANKMENTS IN PLACE



**ROSEAU LAKE
 PROJECT**



ALTERNATIVE 2E
ALL EMBANKMENTS IN PLACE

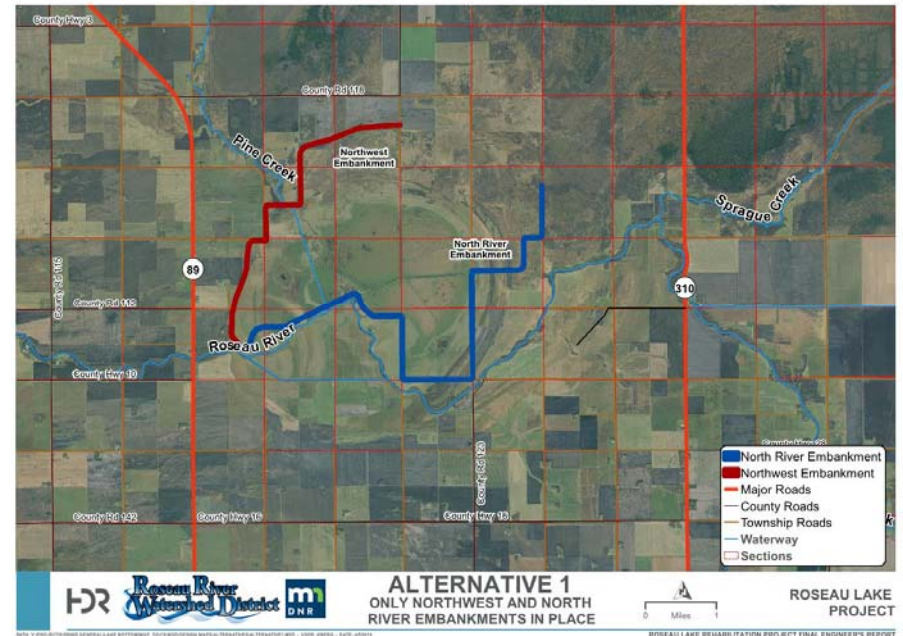


ROSEAU LAKE
PROJECT

Alternative 1

Benefits

- Reduce peak flows and flood durations on the Roseau River
- Reduce damage to crops and infrastructure ★
- Additional compensation via flowage easement
- Improved exterior drainage on a more frequent basis
- Improved protection along south exterior
- Improved protection of "island"
- Raised County Road on east side of Roseau Lake – improved access
- Replace bridge to island with box culverts
- Natural Resource Enhancements ★
- 2nd lowest wetland impacts (104 acres) ★
- Lowest Cost ★ ★

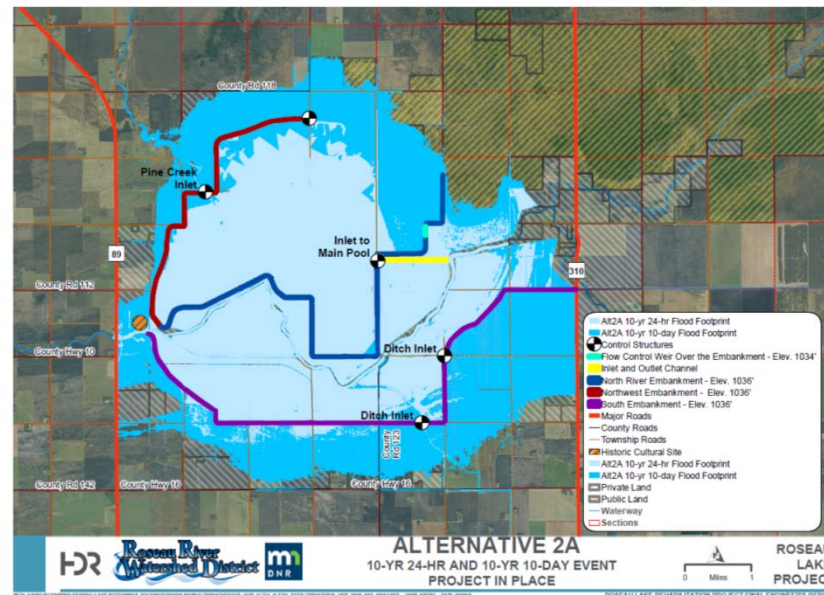


Alternative	Peak water surface elevation/flooding duration of the island area during 10-year, 10-day event	Peak water surface elevation/flooding duration of the Main Pool area during 10-year, 10-day event	Peak overbank elevation/flooding duration along the river corridor in event 10-year, 10-day event (Immediately upstream of the diversion channel) (see figure below)	Peak water surface elevation /duration of flooding during 10-year, 10-day event in the South Cell.	Metric related to peak flow at Ross Gage during 10-year, 10-day event. (cfs) (see figure below)	Flooded areas between Highway 89 and County Road 113 (acres)	Downstream reduction in Flooded Acres	FDR Relative Scale
Existing	1037.22/80 days	1037.24/85 days	1037.24/80 days	1037.24/85 days	3,771	10,338	-	-
1	1037.06/70 days	1037.06/80 days	1037.06/70 days	1037.06/70 days	3,568	9,976	362	
2a	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,626	10,092	246	
2c	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,621	10,092	246	
2d	1037.05/70 days	1037.06/80 days	1037.05/70 days	1037.05/70 days	3,574	10,009	329	
2e	1037.05/70 days	1037.05/80 days	1037.05/70 days	1037.05/70 days	3,569	9,976	362	
2a-1	1038.45/95 days	1038.45/90 days	1038.45/95 days	-	3,365	9,618	720	



Concurrence Point #3 Discussions

- Examples



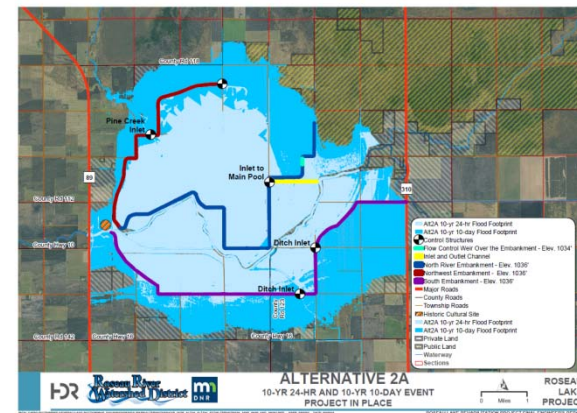
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Comparison of Alt 1 and 2A – See Table

Alternative	Wetland Impacts (Acres)
1 - Northwest and North River Embankments	286.1
2a - Northwest, South, and North River Embankments	358.4
2c - Northwest, South, North River, and Island Embankments	442.5
2d - Northwest, South, North River, and South River Cell	431.2
2e - Northwest, South, North River embankment with Island and South River Cell	515.4

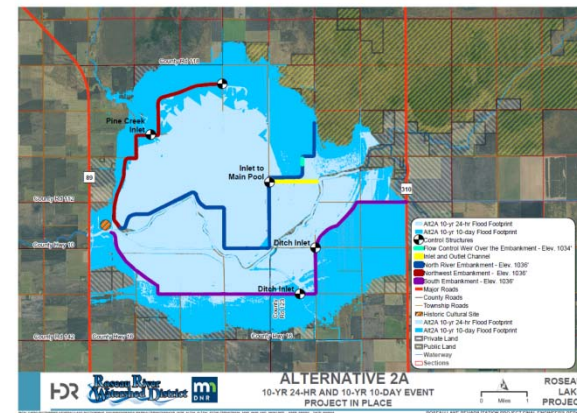
Comparing Alternatives

- Benefits - FDR and NRE
- Cost
- Wetland Impacts
- Complexity – O&M
- Consensus



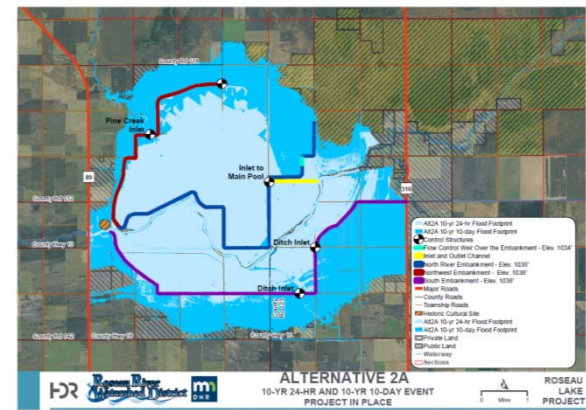
Benefits and Comparisons to Existing Conditions

- Peak Flood Reductions
- Duration Reductions
- Growing Season Reductions
- Adjacent and Downstream Drainage Benefits While Floodwaters are Retained



Conclusion

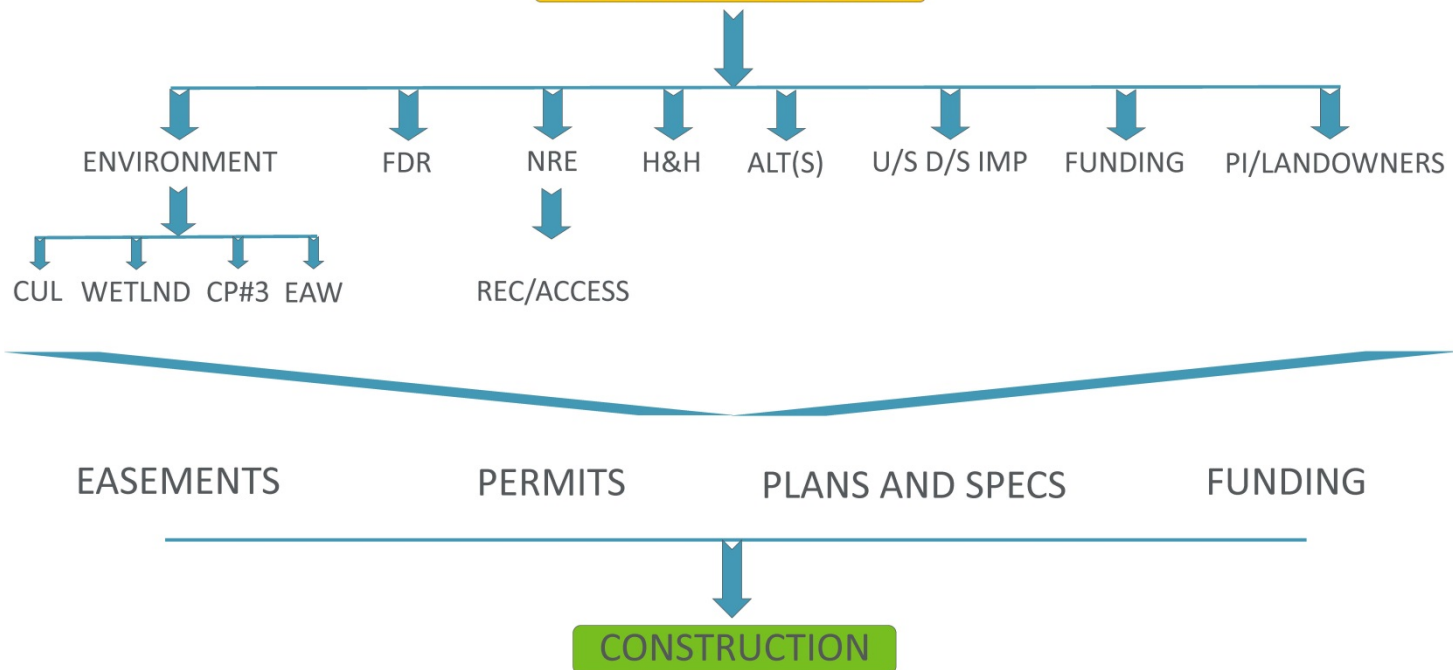
- Alternatives 1 and 2a (plus 2a' with alternative exterior drainage) provide maximum benefits and “permittability” with least costs. Final alignments TBD.



ROSEAU LAKE WORK FLOW

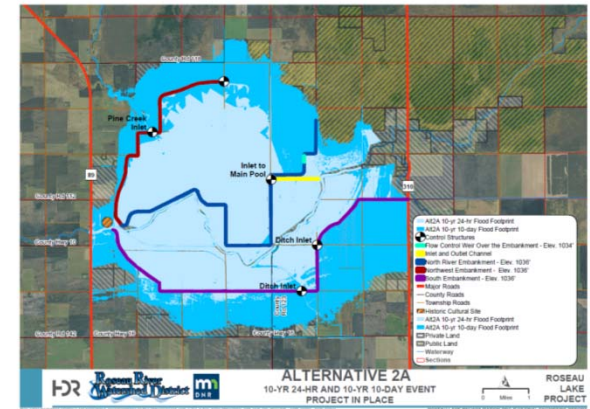
PRELIMINARY ENGINEERING

FINAL ENGINEERING

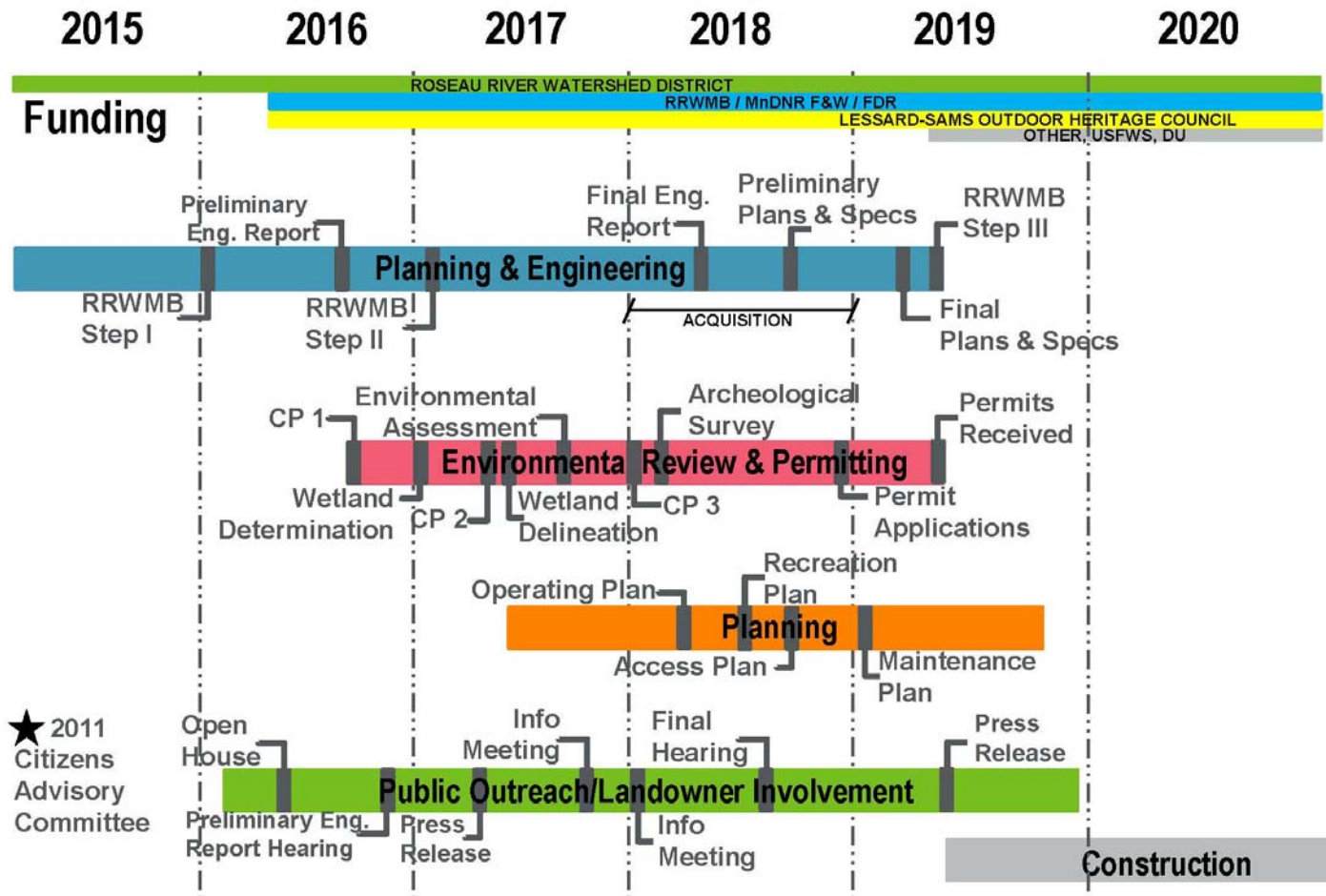


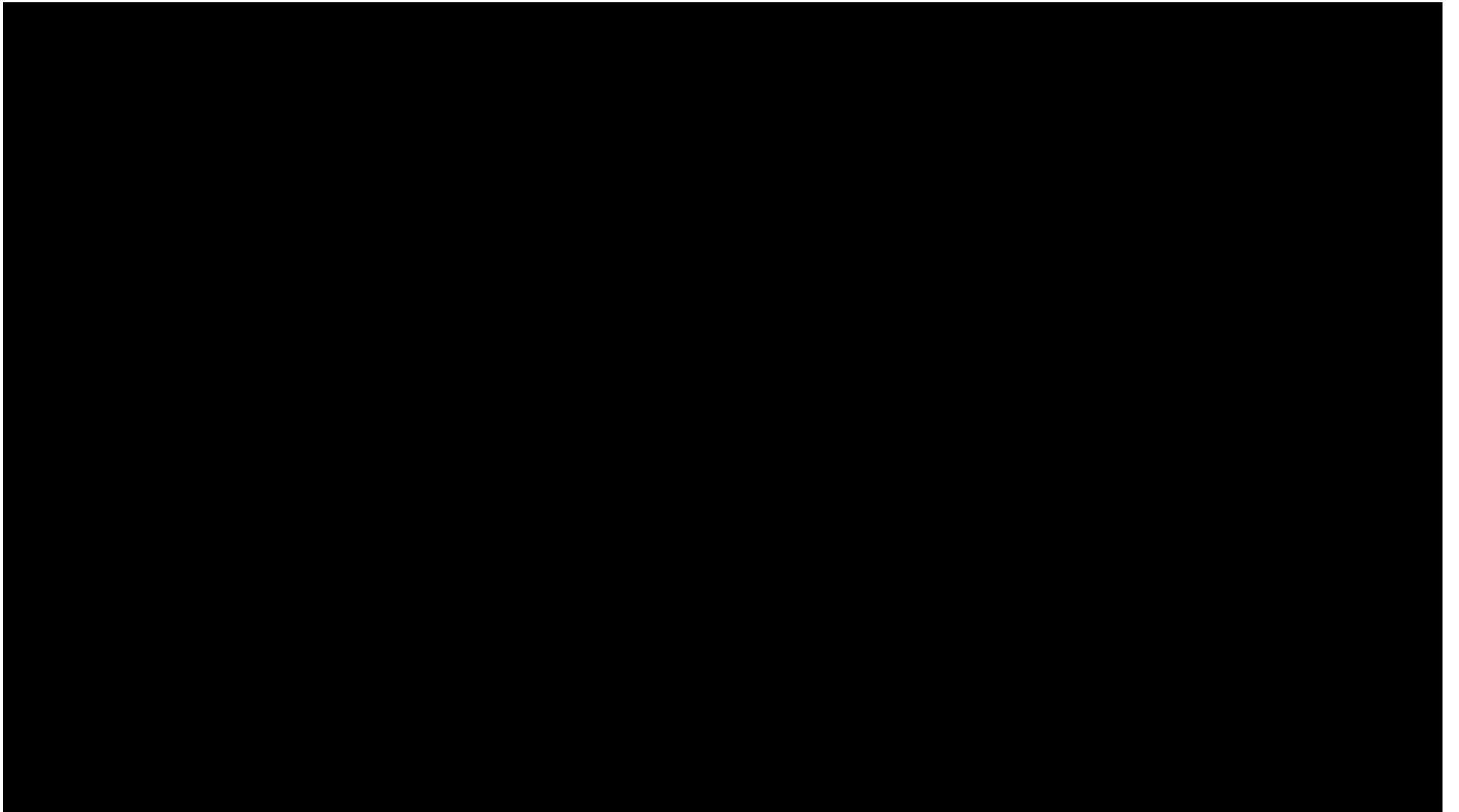
Next Steps ~ 1 Year

- CP #3 in 2018
- Finalize alignment for preferred alternative
- Develop Operating Plan
- Finish TEP/Determine wetland impacts
- EAW
- Update Eng Report and Plans/Specs?
- Meet with landowners to discuss R-W acquisition

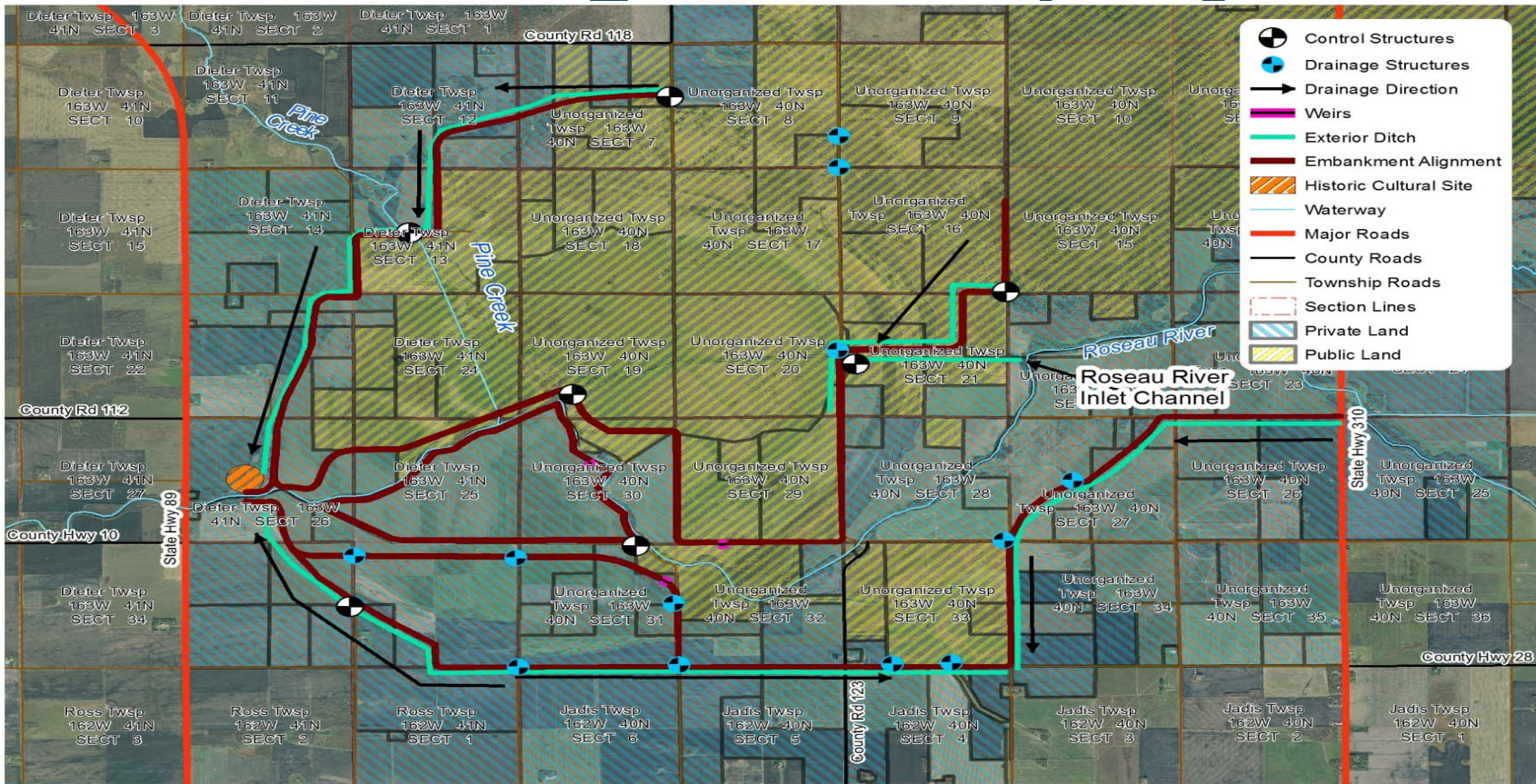


Timeline ROSEAU LAKE REHABILITATION

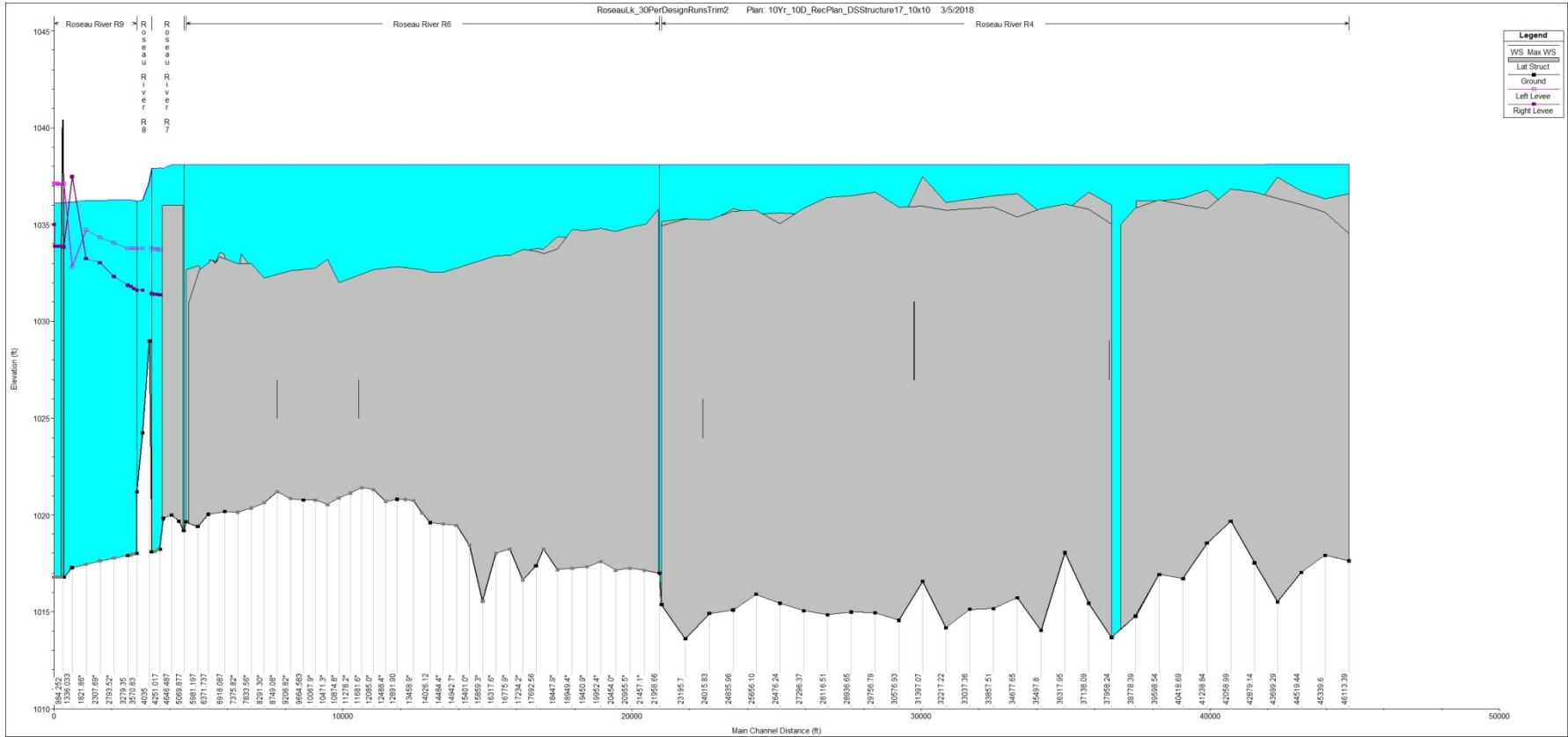




Exterior Drainage and Property Parcels



Exterior Drainage and Property Parcels



Roseau Lake Rehabilitation Project Benefits

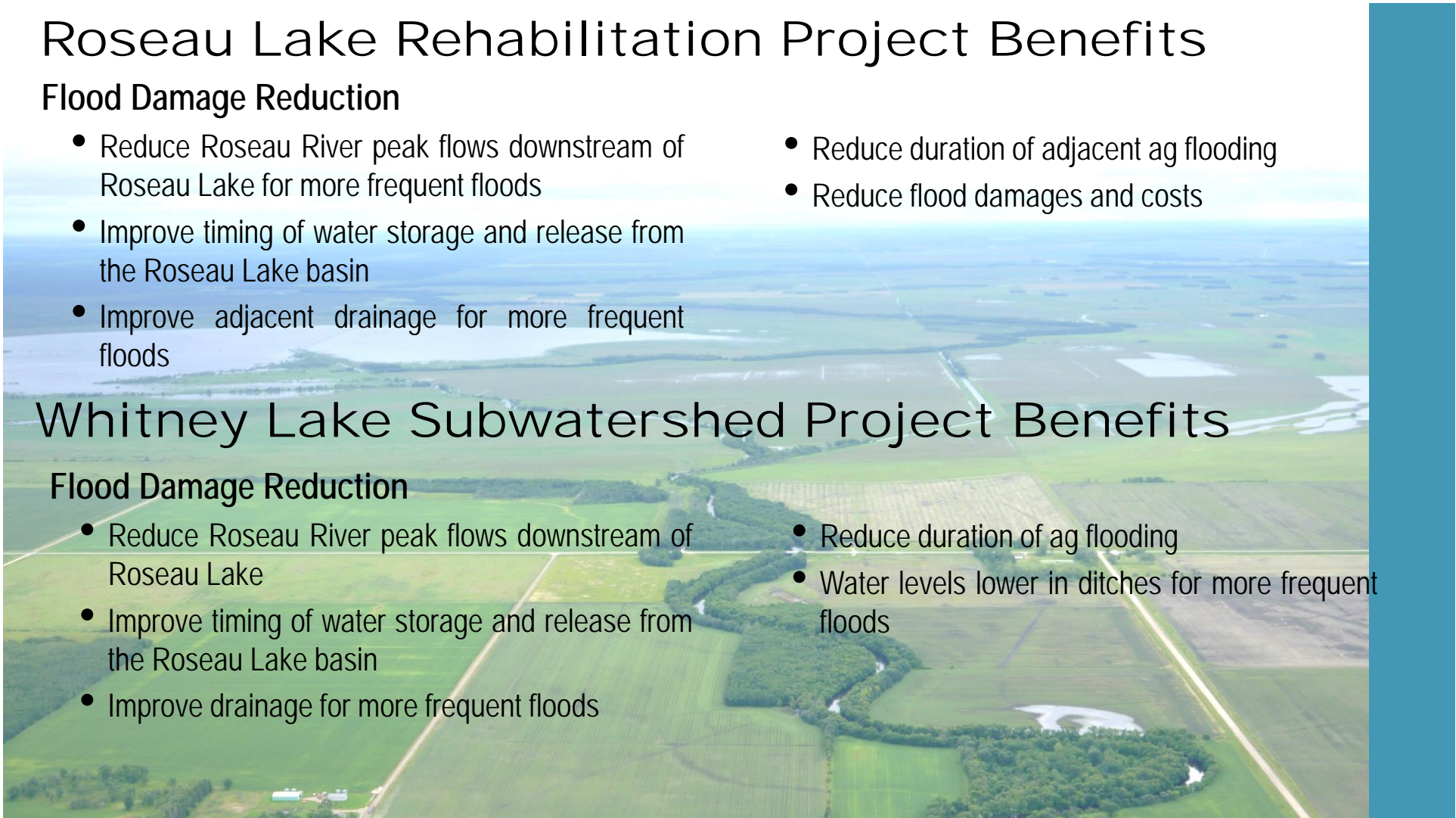
Flood Damage Reduction

- Reduce Roseau River peak flows downstream of Roseau Lake for more frequent floods
- Improve timing of water storage and release from the Roseau Lake basin
- Improve adjacent drainage for more frequent floods
- Reduce duration of adjacent ag flooding
- Reduce flood damages and costs

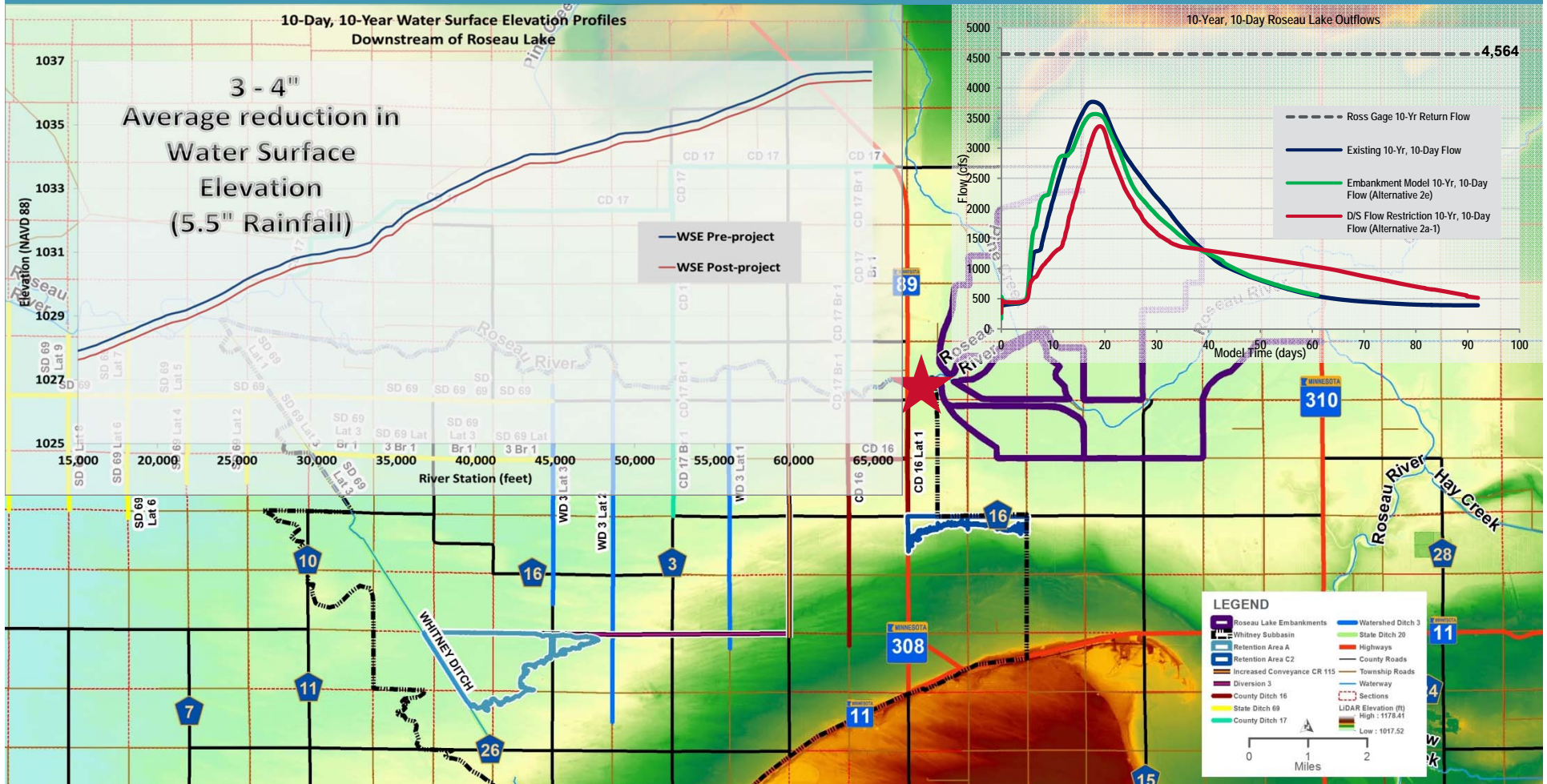
Whitney Lake Subwatershed Project Benefits

Flood Damage Reduction

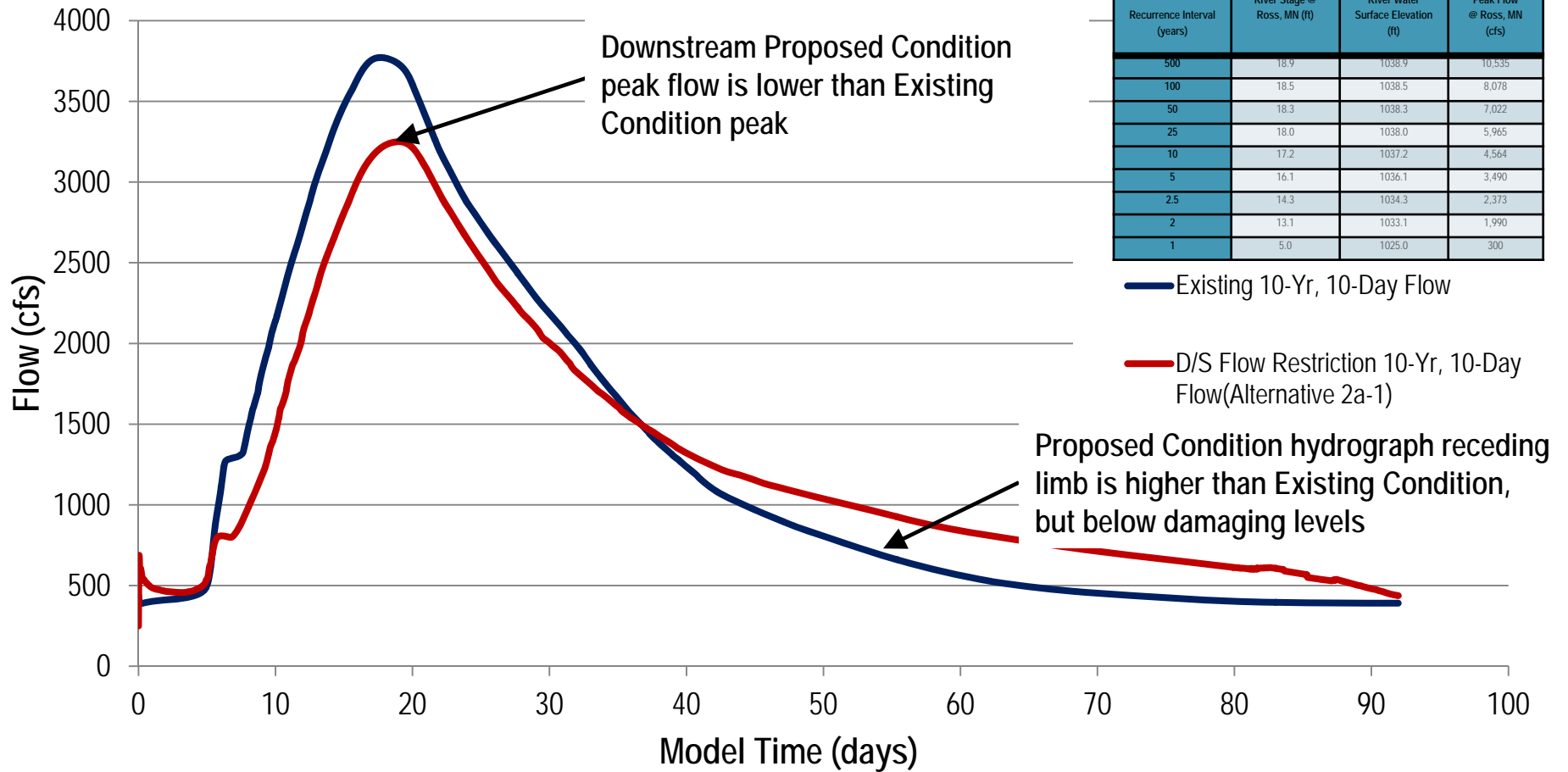
- Reduce Roseau River peak flows downstream of Roseau Lake
- Improve timing of water storage and release from the Roseau Lake basin
- Improve drainage for more frequent floods
- Reduce duration of ag flooding
- Water levels lower in ditches for more frequent floods



Roseau Lake - Whitney Lake Potential Impacts



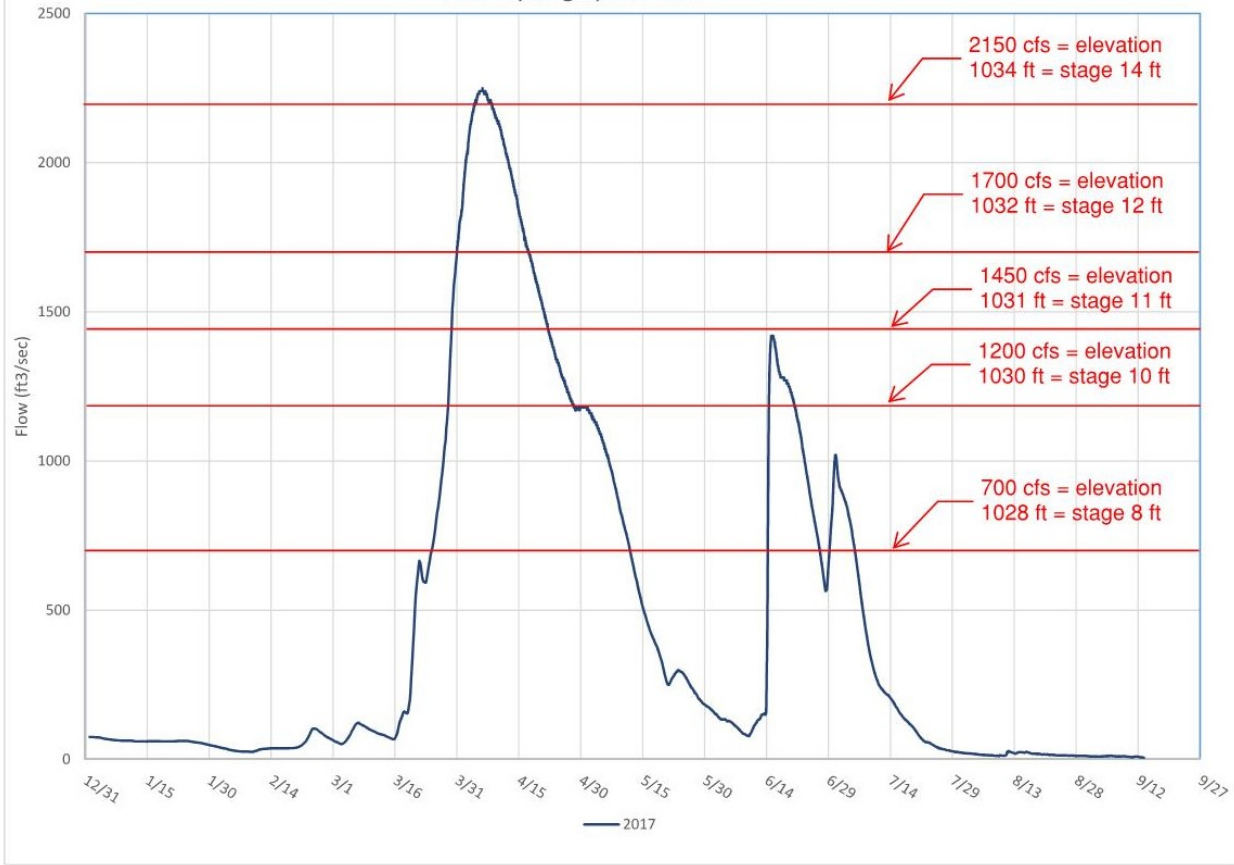
Existing Condition vs Proposed Project 10-year Flow Downstream of Roseau Lake



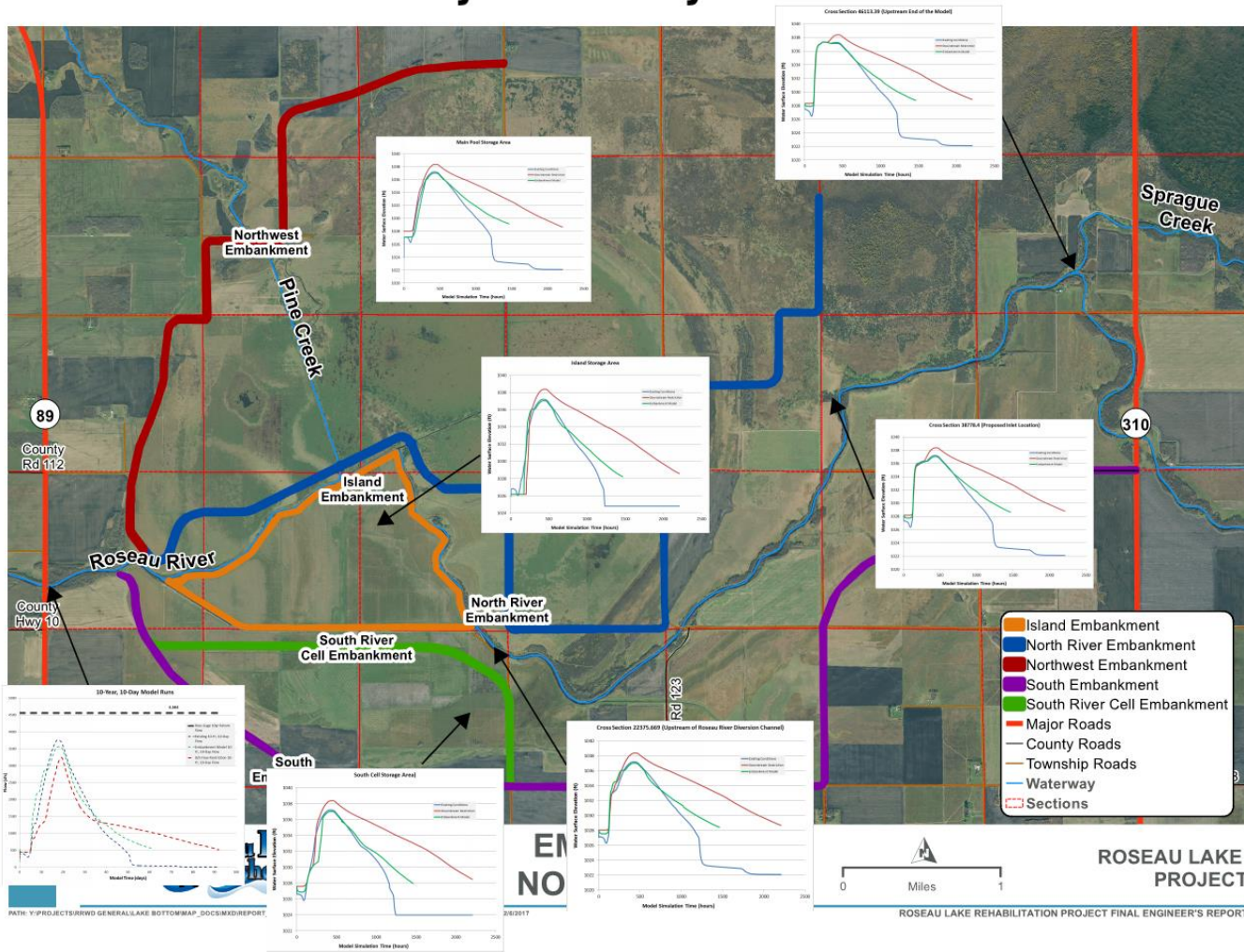
Concurrence Point #3 - Project purpose assessment – Flood Damage Reduction for the 10-year, 10-day modeled event

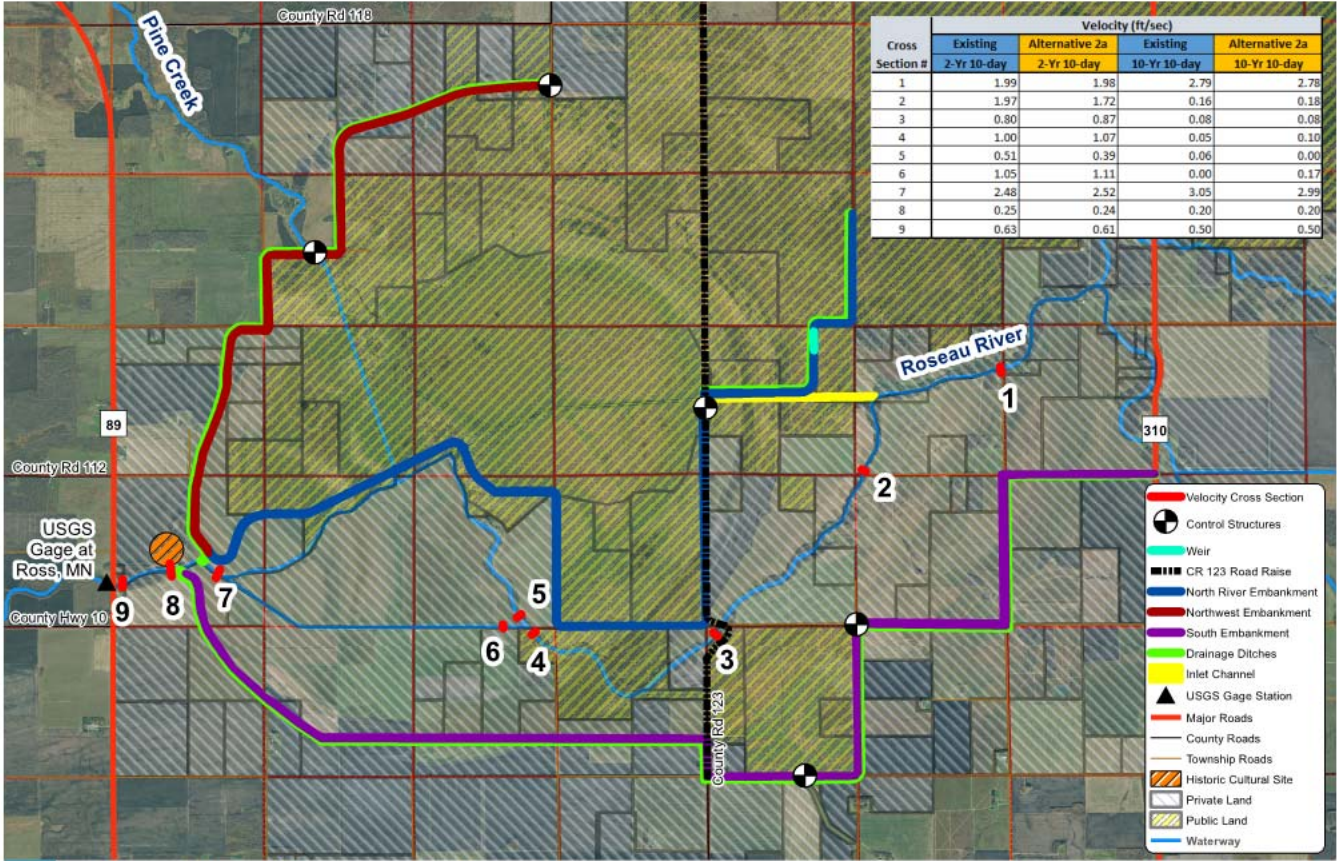
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2a-1	1038.45/95 days	1038.45/90 days	1038.45/95 days	-	3,365	9,618	720	

2017 Hydrograph at Ross



10-year 10-day Results



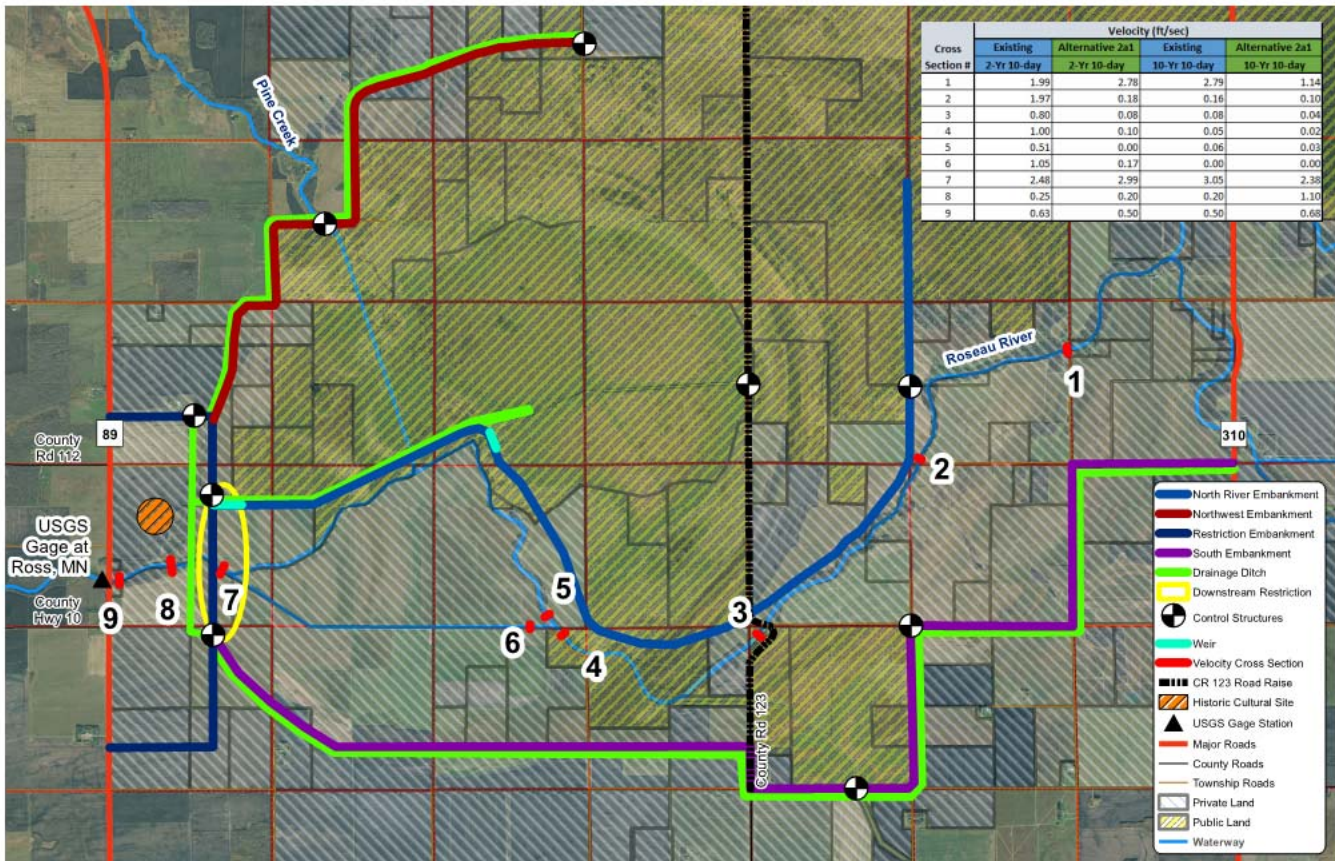


ALTERNATIVE 2A
VELOCITY AT THE MAXIMUM
WATER SURFACE ELEVATION



ROSEAU LAKE PROJECT

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ALTERNATIVE 2A - 1
VELOCITY AT THE MAXIMUM
WATER SURFACE ELEVATION



ROSEAU LAKE
PROJECT

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Flow	Stage	Elevation	Recurrence Interval Based on 1961 to 2014	Percent Exceeded since 1961	Number of Times the Annual Peak Flow Exceeded This Value since 1961
(cfs)	(ft)	(NAVD 1988)		(%)	
100	3.0	1023.0		100%	52
200	3.9	1023.9		100%	52
300	6.0	1026.0	1-year	98%	51
400	6.5	1026.5		96%	51
500	7.6	1027.6		96%	50
600	7.8	1027.8		94%	50
700	8.0	1028.0		94%	49
800	8.1	1028.1		90%	47
900	8.8	1028.8		85%	44
1000	9.2	1029.2		83%	43
1062	9.4	1029.4	1.25-year	83%	43
1100	9.5	1029.5		83%	43
1200	10.1	1030.1		81%	42
1300	10.7	1030.7		71%	37
1400	10.8	1030.8		67%	36
1500	11.3	1031.3		65%	35
1600	11.7	1031.7		60%	31
1659	11.8	1031.8	1.667-year	59%	29
1700	11.9	1031.9		58%	29
1800	13.0	1033.0		56%	28
1900	13.1	1033.1		50%	25
1990	13.1	1033.1	2-year	48%	24
2000	13.2	1033.2		48%	24
2100	13.6	1033.6		46%	23
2200	14.2	1034.2		44%	22
2300	14.3	1034.3		44%	22

2373	14.3	1034.3	2.5-year	42%	21
2400	14.4	1034.4		42%	21
2500	14.6	1034.6		38%	20
2600	14.8	1034.8		35%	18
2700	14.9	1034.9		33%	17
2800	15.0	1035.0		27%	16
2900	15.1	1035.1		27%	14
3000	15.6	1035.6		27%	14
3100	15.7	1035.7		27%	14
3200	15.8	1035.8		27%	14
3300	15.9	1035.9		23%	13
3400	16.0	1036.0		19%	11
3490	16.1	1036.1	5-year	13%	9
3500	16.2	1036.2		13%	9
3600	16.4	1036.4		13%	7
3700	16.5	1036.5		13%	7
3800	16.6	1036.6		12%	6
3900	16.7	1036.7		12%	6
4000	16.8	1036.8		12%	6
4100	16.9	1036.9		12%	6
4200	17.0	1037.0		12%	6
4300	17.1	1037.1		10%	6
4400	17.1	1037.1		10%	5
4500	17.2	1037.2		8%	4
4564	17.2	1037.2	10-year	6%	4
4600	17.4	1037.4		6%	3
4700	17.4	1037.4		2%	1
4800	17.4	1037.4		2%	1
4900	17.5	1037.5		2%	1
5000	17.5	1037.5		2%	1
5965	18.0	1038.0	25-year	2%	1
7022	18.3	1038.3	50-year	2%	1
8078	18.5	1038.5	100-year	2%	1
10535	18.9	1038.9	500-year	0%	0

ROSEAU LAKE REHABILITATION

The primary *PURPOSE* of this project is *to manage the existing flood storage capacity of the Roseau Lake Area in order to reduce peak flows in the Roseau River and to improve aquatic habitat conditions*. The project is designed to reduce peak flows on the Roseau River by up to 25% for 2 – 50 year flood frequency events, compared to current conditions. This peak flow reduction will be accomplished by altering the timing of water storage in the lake bottom area so the available storage is more effectively used to reduce peak flows downstream. JH1

The project will also improve the condition of Roseau Lake for aquatic habitat. A key objective of the project is to provide migratory habitat for waterfowl and shorebirds in spring and in fall. With proper infrastructure and water-level management the lake can provide up to 6,000 acres of shallow water habitat which can provide resting areas and abundant forage during migration.

The *NEED for the proposed action is:*

- The conveyance capacity of the Roseau River near Roseau Lake will be modified to provide more timely and effective discharges to reduce peak flows in the Roseau River. The ability to discharge more water through the Roseau River corridor prior to peak flows at Roseau Lake will improve the effective storage potential of the Roseau Lake basin and consequently decrease the peak flow in the Roseau River downstream.
- The lower reaches of the Roseau River, Big Swamp area, and adjacent lands are flood prone. Public and private lands, road infrastructure, and residences in this area are flooded and damaged almost annually. High water levels from the Roseau River also overflow into the Two Rivers Watershed on about a 5-year interval. As proposed, optimal use of available flood storage in the Roseau Lake area will provide meaningful reductions in adjacent and downstream peak flood flows, river stages, and flood duration.
- Roseau Lake was historically an important wildlife lake providing a diversity of habitats for many aquatic mammals, birds, fish, amphibians, and reptiles. The lake was almost completely drained in 1914 after channelization of the Roseau River and creation of a legal ditch through the lake basin. The basin area now functions as a lake only when flows exceed 800 cfs on the Roseau River resulting in significantly degraded habitats, and reduced waterfowl production and wildlife use. Managing water levels to reduce bounce and restore shallow lake functions improves the ability to manage habitat for select wildlife species.

Slide 38

JH1

pulled from purpose and need dated March 30, 2016

Jacob Huwe, 3/3/2018

WHITNEY LAKE SUBWATERSHED MANAGEMENT

The *PURPOSE of the proposed project is Flood Damage Reduction*: Reduce damages to agricultural lands for a 10 year 24 hour storm (total 3.3 inches of rainfall) and reduce damages to roadways for a 25 year 24 hour storm event (total 3.9 inches of rainfall) in the Whitney Lake Watershed.

The *NEED for the proposed action is*:

- Roseau River levels cause flood damage to agricultural properties during frequent runoff events (i.e. a 2-year, 24-hour event or 2.1 inches of rainfall). The Roseau River will frequently backup into area drainage ditches as much as two miles or more causing backwater effects in the drainage systems.
- The ditch systems in the Whitney Lake Watershed contain many culvert crossings, which have a lower capacity than a 2-year, 24-hour precipitation event. Additionally, the channels are undersized and not able to contain or convey the existing 2-year, 24-hour event in many places because the natural ground slope is too low to prevent flows from overtopping banks and flowing into adjacent lands. These adjacent lands become inundated for up to ten or more days, which is long enough to destroy crops that have been planted or delay access to the land for planting and harvesting.
- In Roseau County approximately 50% of landuse is farmland and an average of over 136 million dollars of crops are sold annually (USDA 2012 Census of Agriculture). Within the Whitney Lake watershed, 78% of landuse is cropland. Review of crop information and insurance records of four landowners in the Whitney Lake watershed over the past 10 years show a decrease in yields of up to 100% during wet years (precipitation data shows that 8 out of the past 10 years were wet years).
- The Roseau County Highway department confirmed that during heavy rainfall events water overtops at County Road 115 and 270th Ave. Overtopping occurs approximately once every two years and requires frequent maintenance. While costs for minor road repairs due to flooding are not well documented, repair costs of major flooding sites are documented and over the past 15 years have resulted in over \$340,000 in damages.

BENEFITS OF ROSEAU LAKE REHABILITATION

Flood Control

- Improve water level management in Roseau Lake
- Control pool bounce to improve nesting success
- Provide more efficient flood storage and improve the timing of flooding
- Provide flood damage reduction downstream at Caribou
- Manage storage and flow release in beneficial consideration of Red River flows
- Provide flood damage reduction in agricultural areas both in surrounding areas and downstream of Roseau Lake

Erosion Reduction

- Reduction in riverbank erosion and bank sloughing on the Roseau River

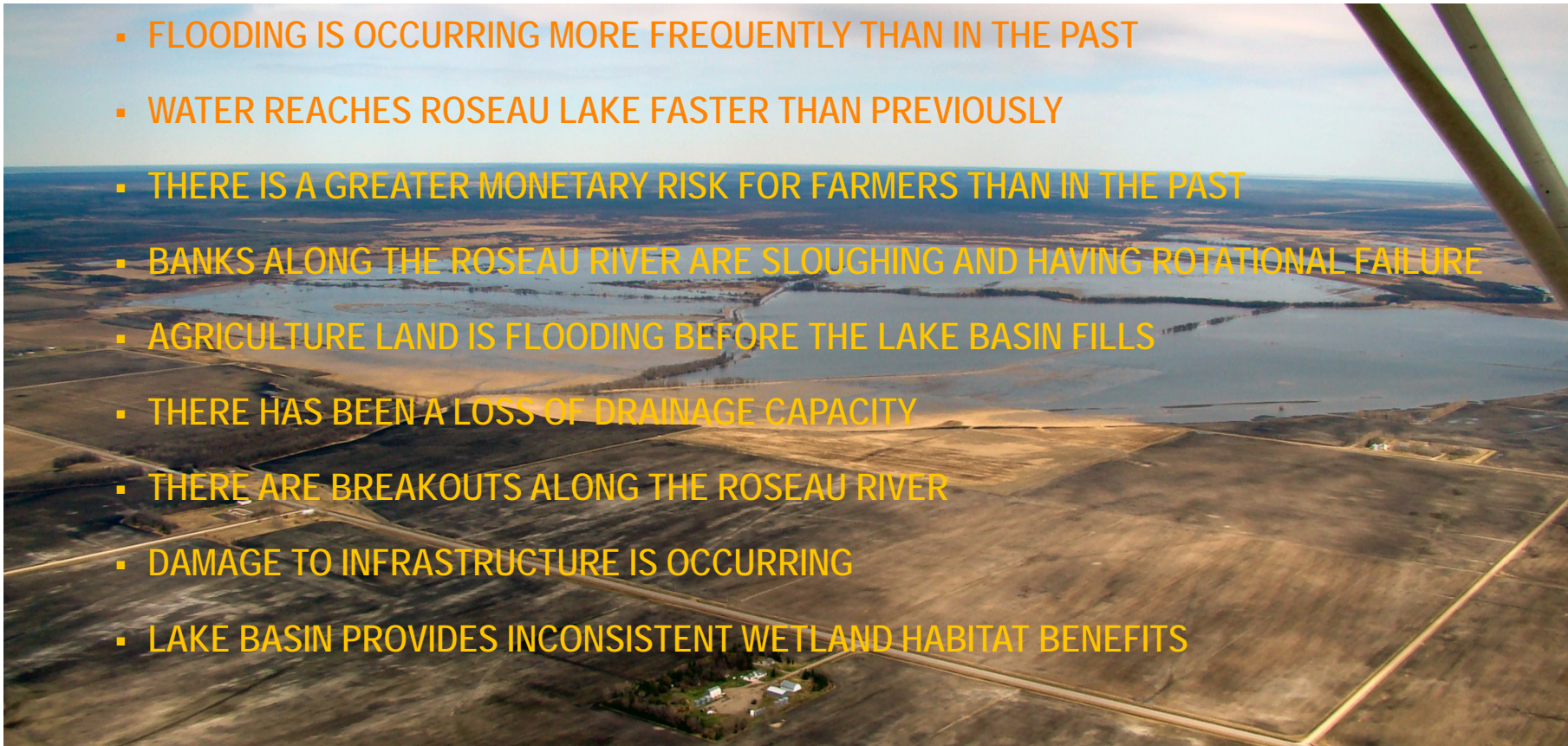
Habitat Restoration

- Stream flow augmentation
- Improved dissolved oxygen levels
- Enhanced waterfowl, fish and wildlife habitat
- Improved water level management on WMA lands to improve vegetation



ROSEAU LAKE - PROBLEMS WITH EXISTING CONDITIONS

- FLOODING IS OCCURRING MORE FREQUENTLY THAN IN THE PAST
- WATER REACHES ROSEAU LAKE FASTER THAN PREVIOUSLY
- THERE IS A GREATER MONETARY RISK FOR FARMERS THAN IN THE PAST
- BANKS ALONG THE ROSEAU RIVER ARE SLOUGHING AND HAVING ROTATIONAL FAILURE
- AGRICULTURE LAND IS FLOODING BEFORE THE LAKE BASIN FILLS
- THERE HAS BEEN A LOSS OF DRAINAGE CAPACITY
- THERE ARE BREAKOUTS ALONG THE ROSEAU RIVER
- DAMAGE TO INFRASTRUCTURE IS OCCURRING
- LAKE BASIN PROVIDES INCONSISTENT WETLAND HABITAT BENEFITS



Slide 41

PRE(3

NRE bullet added.

Prachar, Randy E (DNR), 6/2/2017

4 Strategies

1.0 Drainage

- Ditch improvements
- Add new systems



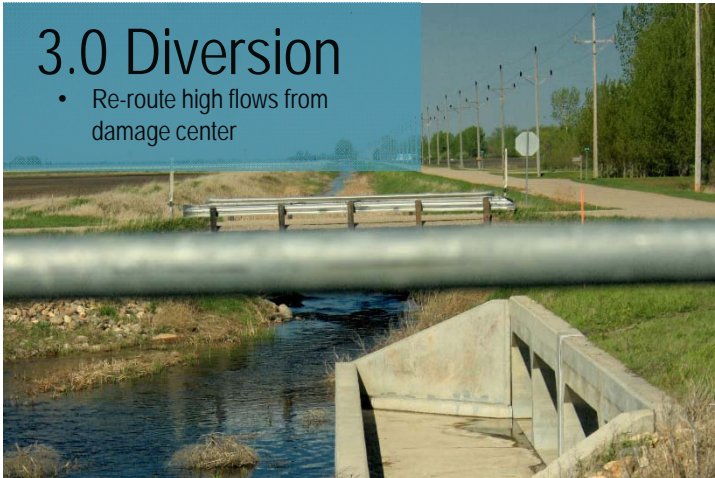
2.0 Protection

- Diking on field side
- Part of drainage



3.0 Diversion

- Re-route high flows from damage center



4.0 Retention

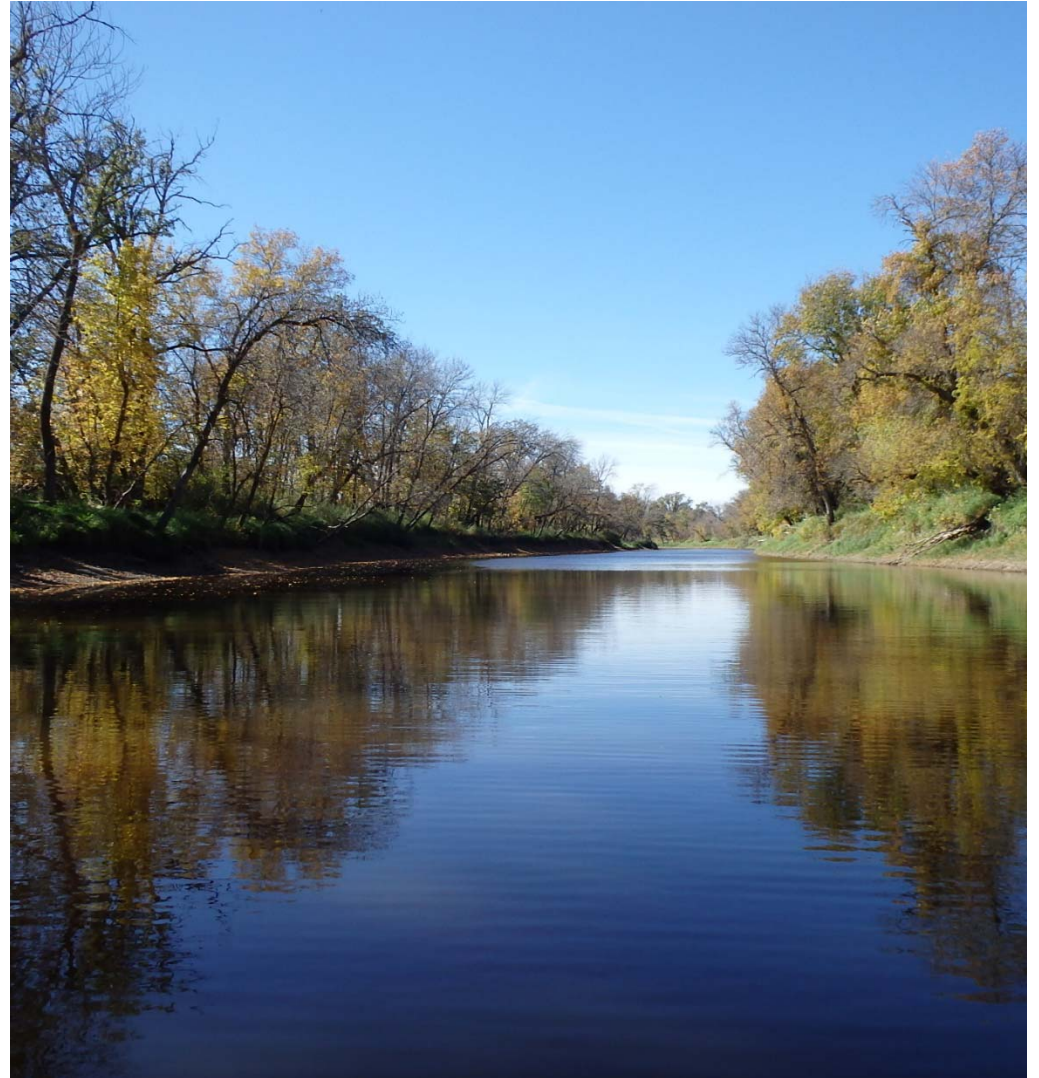
- Creating storage to reduce downstream peak flows



ROSEAU LAKE PROJECT GOALS AND BENEFITS

RRWD and Landowner FDR goals:

- Reduce peak flows and flood durations on the Roseau River
- Reduce damage to crops and infrastructure
- Additional compensation via flowage easement
- Improved exterior drainage on a more frequent basis
- Reduced duration of exterior flooding
- Improved protection along south and north exterior
- Improved protection of “island” – alternative
- Raised County Road on east side of Roseau Lake – improved access
- Replace bridge to island with box culverts



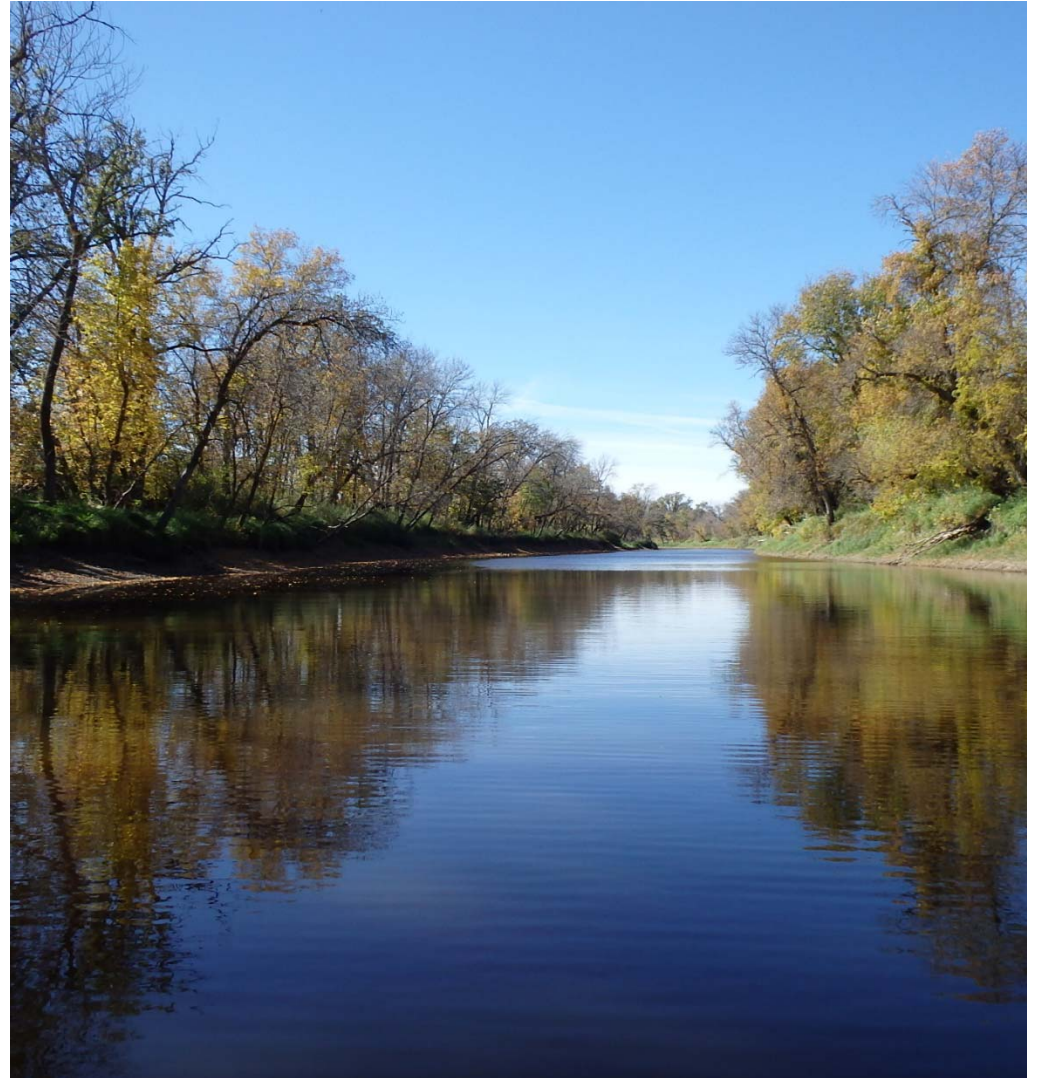
Flood Damage Reduction Objectives

- Project changes timing; does not increase flooding without flowage easement
- Downstream impacts to agriculture, public infrastructure, and natural resources should be decreased, with appropriate operating plan
- Benefits for flood reduction and natural resources in the Big Swamp will be enhanced
- Project should benefit landowners adjacent to and downstream of Roseau Lake

ROSEAU LAKE PROJECT GOALS

NRE goals:

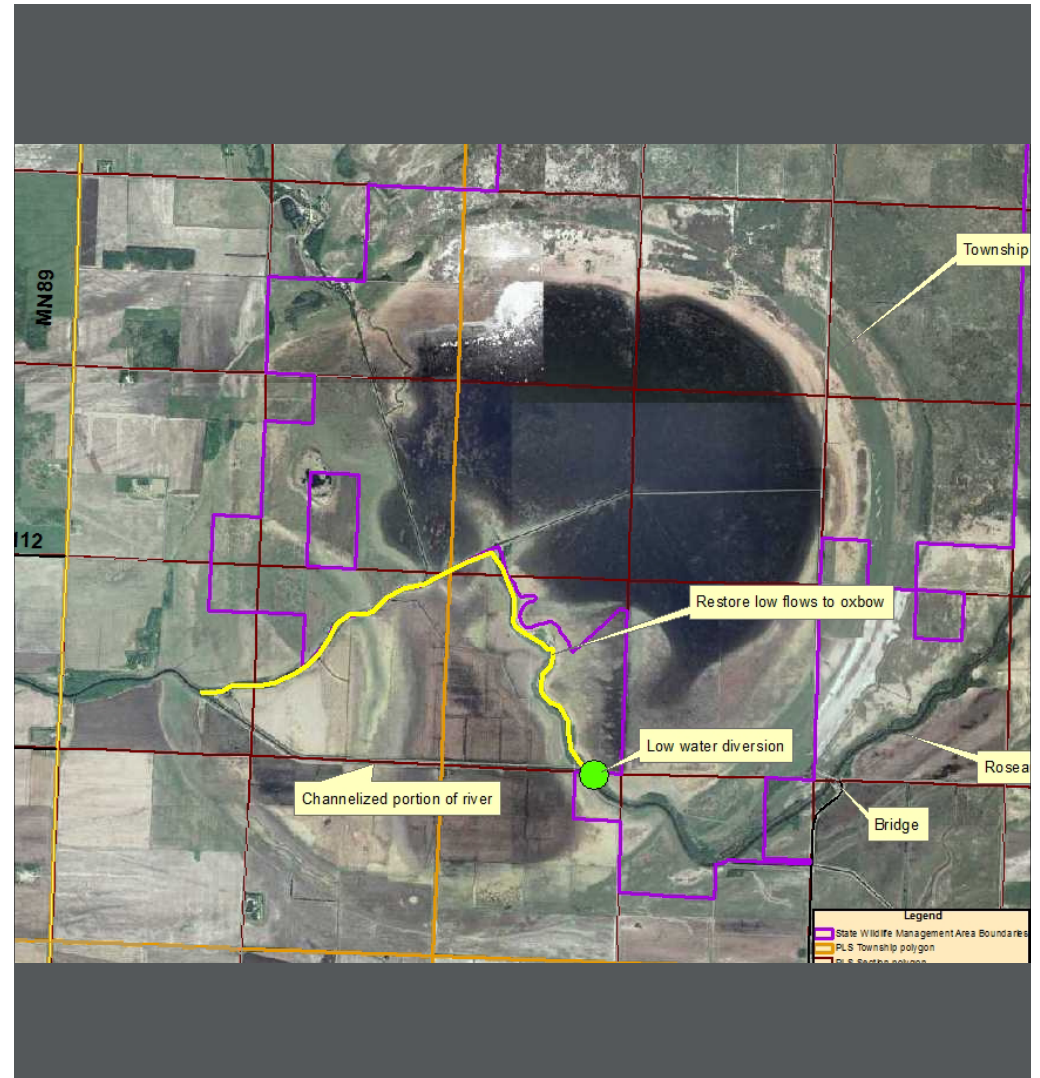
- Improve the condition of Roseau Lake for aquatic habitat
- Provide migratory habitat for waterfowl and shorebirds in spring and fall
- More stable water-level management in the Roseau Lake area during the nesting season
- Improved instream hydrology, connectivity, water quality, and overall physical habitat conditions for fish and aquatic biota
- Increase the capacity to manage and reduce water-levels fluctuations (bounce) in Roseau Lake to improve plant community diversity and condition



ROSEAU LAKE NATURAL RESOURCES

GOAL 3

- Improve the quality of the Roseau River's fish habitat.
 - Minimize entrapment of fish with the lake basin.
 - Maintain stream habitat downstream of the lake basin through managing flows.
 - Maintain connectivity of the river up- and downstream of the lake basin for fish populations.
 - Restore flow to the oxbow of the river that traverses the lake basin for low-to-moderate flood events to reduce stream gradient.
 - Reduce sediment loading



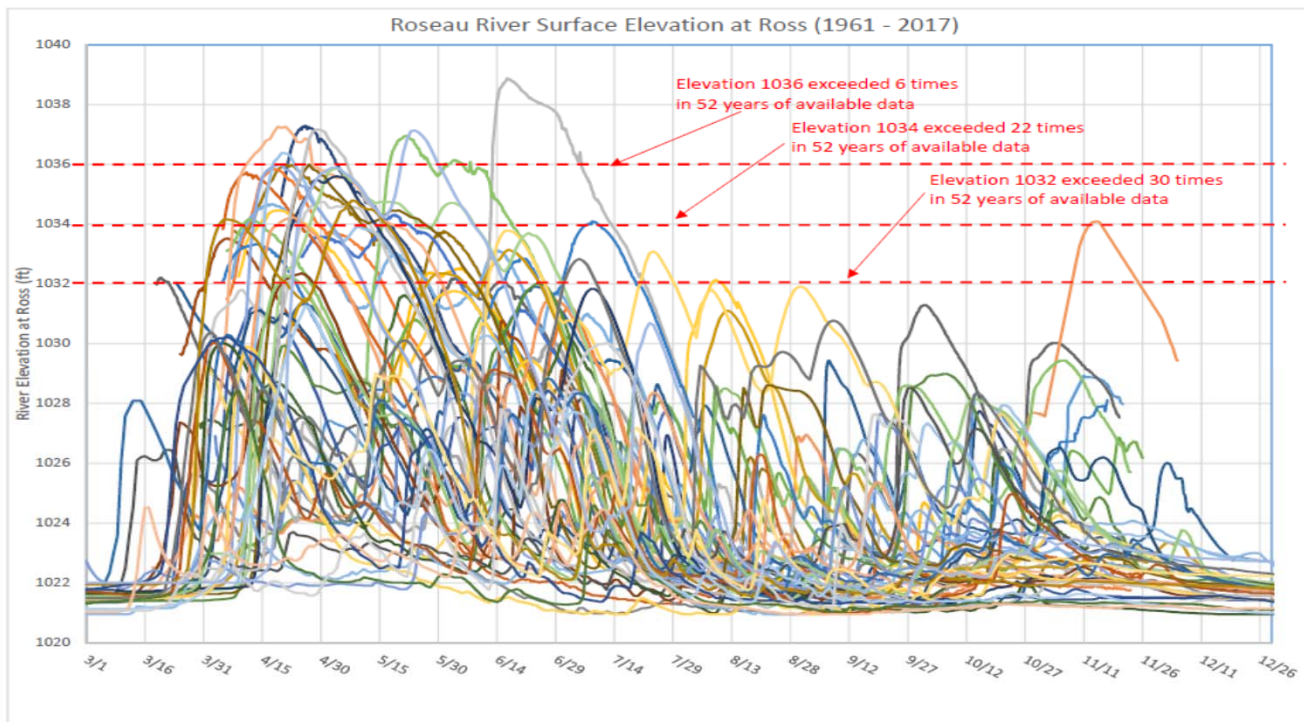


Table 1. Analysis of the USGS Gage 05107500 on the Roseau River at Ross, MN

Recurrence Interval (years)	USGS Published Peak Flows ¹	FEMA Peak Flows ²	Log-Pearson Type III Analysis of the Last 50-years		
			River Stage @ Ross, MN (ft)	River Water Surface Elevation (ft)	Peak Flow @ Ross, MN (cfs)
1	-	-	5	1025	300
2	1,720	-	13.1	1033.1	1,990
2.5	-	-	14.3	1034.3	2,373
5	3,070	-	16.1	1036.1	3,490
10	4,030	3,990	17.2	1037.2	4,564
25	5,280	-	18	1038	5,965
50	6,230	6,200	18.3	1038.3	7,022
100	7,170	7,160	18.5	1038.5	8,078
500	9,340	9,380	18.9	1038.9	10,535

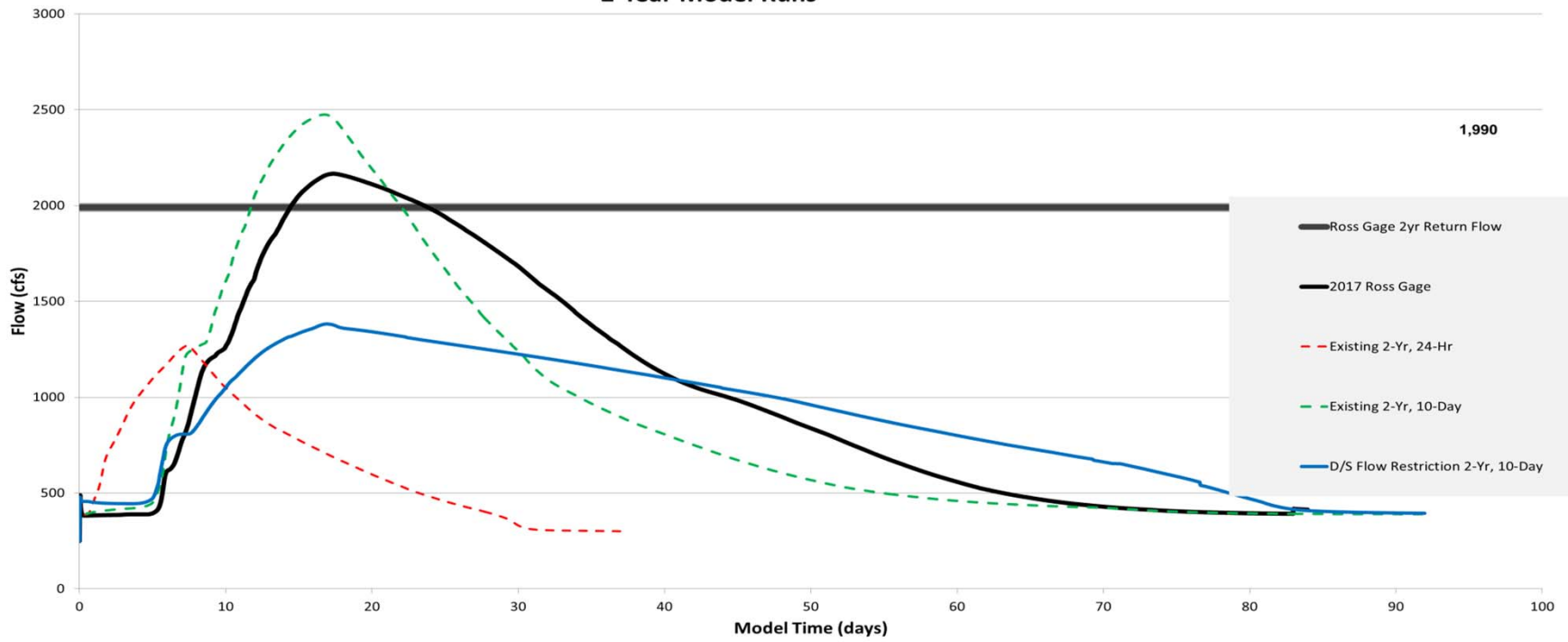
¹ Lorenz et al, Techniques for Estimating the Magnitude and Frequency of Peak Flows on Small Streams in Minnesota Based on Data through Water Year 2005, USGS Scientific Investigations Report 2009-5250, 2010

² FEMA FIS, 2017, Approximately 300 feet downstream of State Highway 89. The data consisted of 47 years of record (1929-1975) at the gaging station located at Ross

Table 2. Resulting Existing Condition Flows at the Downstream End of the Model

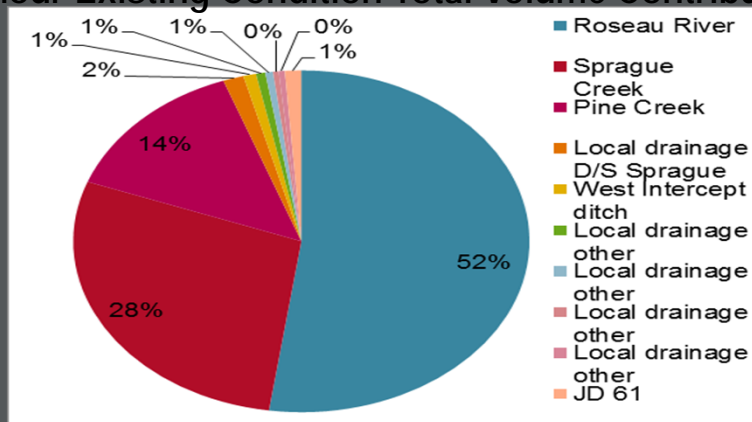
Recurrence Interval	River Water Surface Elevation (ft)	Peak Flow @ Ross, MN (cfs)
24-Hour Duration Events		
1-year, 24-hour	1029.64	992.97
2-year, 24-hour	1030.9	1,270
5-year, 24-hour	1032.2	1,667
10-year, 24-hour	1033.7	2,151
100-year, 24-hour	1037.4	4,668
10-Day Duration Events		
2-year, 10-day	1034.6	2,475
5-year, 10-day	1035.8	3,068
10-year, 10-day	1036.7	3,771
100-year, 10-day	1038.62	8,649

2-Year Model Runs



Flow Contribution and Storage

2-year, 24-hour Existing Condition Total Volume Contribution



Project Stage-Storage

Elevation (Feet)	Main Pool Acre-Feet	South Cell Acre-Feet	Island Acre-Feet
1022	1	0	0
1026	89	0	0.65
1027	118	0.5	4.2
1028	1,655	17.5	45.5
1029	3,192	210	261
1030	5,650	540	697
1031	10,020	1,180	1,432
1032	13,700	1,900	2,150
1033	17,618	2,611	2,856
1034	21,090	3,500	3,570
1035	27,500	4,409	4,283
1036	33,854	5,387	4,997

Contributing Drainage Areas

Description	HMS ID	Drainage Area (sq. mi.)	Percent (%)
Roseau River	Reach-61	646.2	59.5%
Sprague Creek	Reach-189	332.4	30.6%
Pine Creek	Reach-91	23.5	2.2%
JD 61	Reach-83	22.8	2.1%
Local drainage D/S Sprague	W35000	18.7	1.7%
West Intercept Ditch	W27460	14.2	1.3%
Other Local Drainage	W34300,W36350, and W34990	27.7	2.6%

- Drainage Area at Malung gage 430 sq.mi.
- Drainage Area at Sprague Creek gage 176 sq.mi.
- Drainage Area at Ross gage 1090 sq.mi.

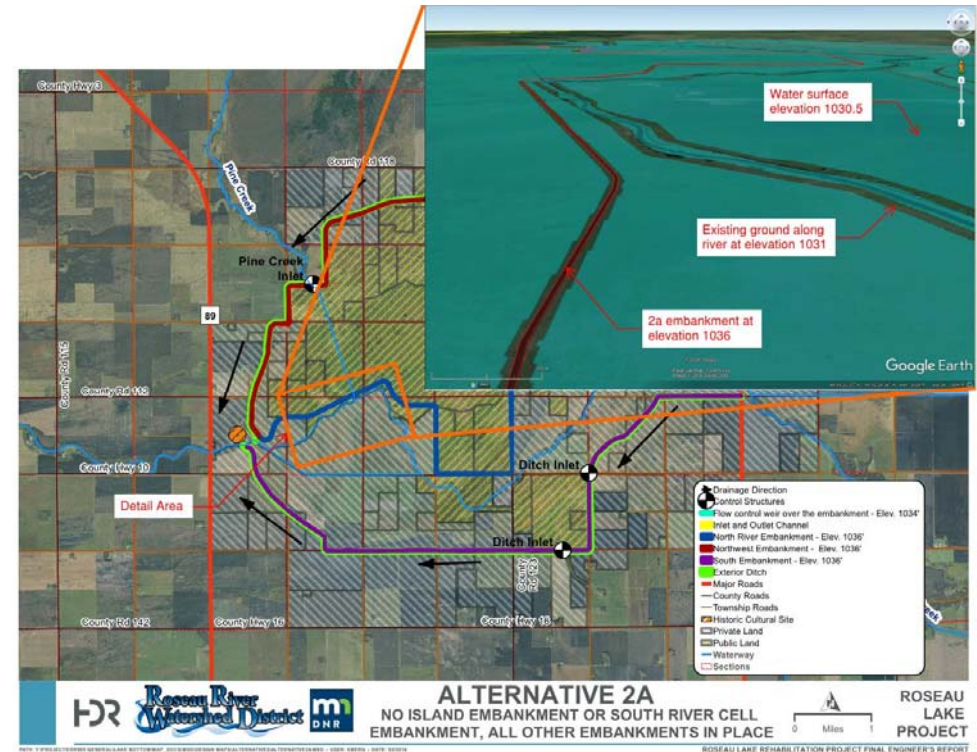
Observations

- River is frequently higher than 1028' (1033' is 2 year frequency stage)
- NRE infrastructure would add value about every other year (1 out of 2), effective mostly after annual event(s) subside

Alternative 2a

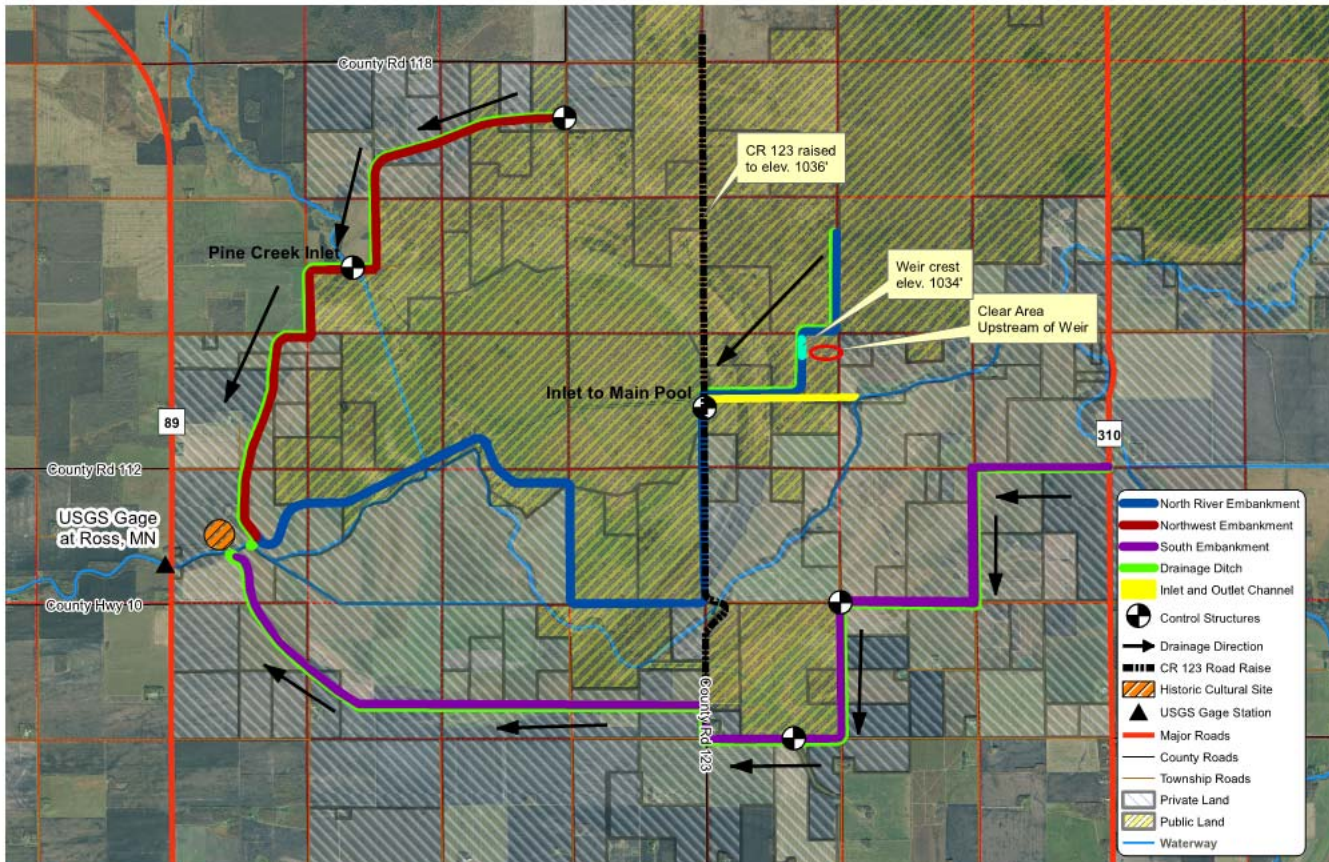
Benefits

- Reduce peak flows and flood durations on the Roseau River ★
- Reduce damage to crops and infrastructure ★
- Additional compensation via flowage easement
- Improved exterior drainage on a more frequent basis ★
- Improved protection along south exterior ★
- Improved protection of "island"
- Raised County Road on east side of Roseau Lake – improved access
- Replace bridge to island with box culverts
- Natural Resource Enhancements ★
- 3rd lowest wetland impacts (124 acres)
- Cost ★



Alternative	Peak water surface elevation/flooding duration of the island area during 10-year, 10-day event	Peak water surface elevation/flooding duration of the Main Pool area during 10-year, 10-day event	Peak overbank elevation/flooding duration along the river corridor in event 10-year, 10-day event (immediately upstream of the diversion channel) (see figure below)	Peak water surface elevation/duration of flooding during 10-year, 10-day event in the South Cell.	Metric related to peak flow at Ross Gage during 10-year, 10-day event. (cfs) (see figure below)	Flooded areas between Highway 89 and County Road 113 (acres)	Downstream reduction in Flooded Acres	FDR Relative Scale
Existing Conditions	1037.22/80 days	1037.24/85 days	1037.24/80 days	1037.24/85 days	3,771	10,338	-	-
2a	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,626	10,092	246	6★'s
2c	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,621	10,092	246	
2d	1037.05/70 days	1037.06/80 days	1037.05/70 days	1037.05/70 days	3,574	10,009	329	
2e	1037.05/70 days	1037.05/80 days	1037.05/70 days	1037.05/70 days	3,569	9,976	362	
2a-1	1038.45/95 days	1038.45/95 days	1038.45/95 days	-	3,365	9,618	720	





ALTERNATIVE 2A
6/12/2018

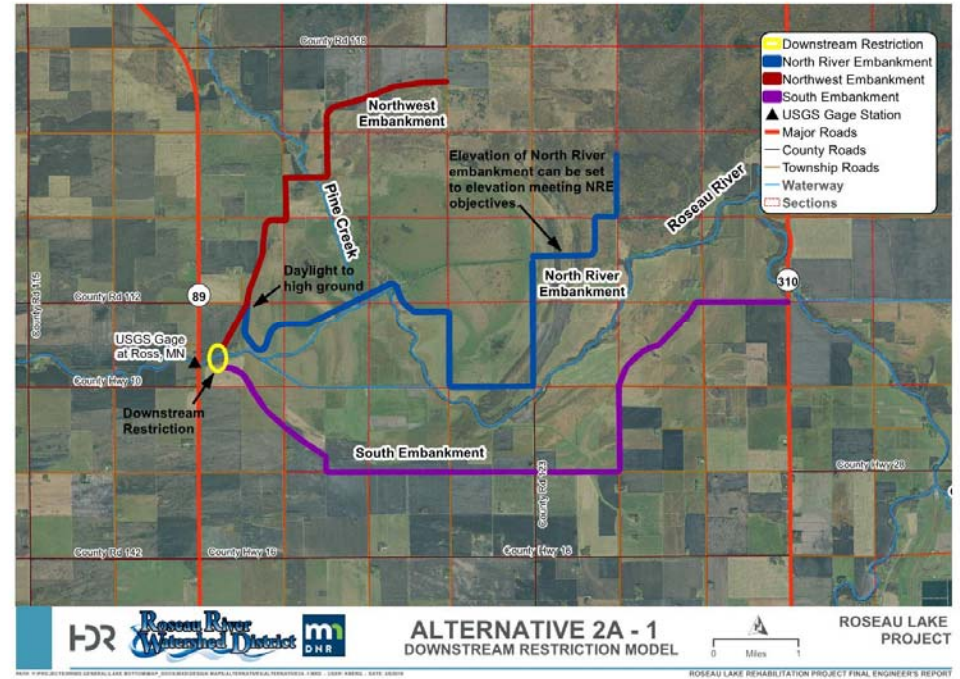


**ROSEAU
LAKE
PROJECT**

Alternative 2a-1

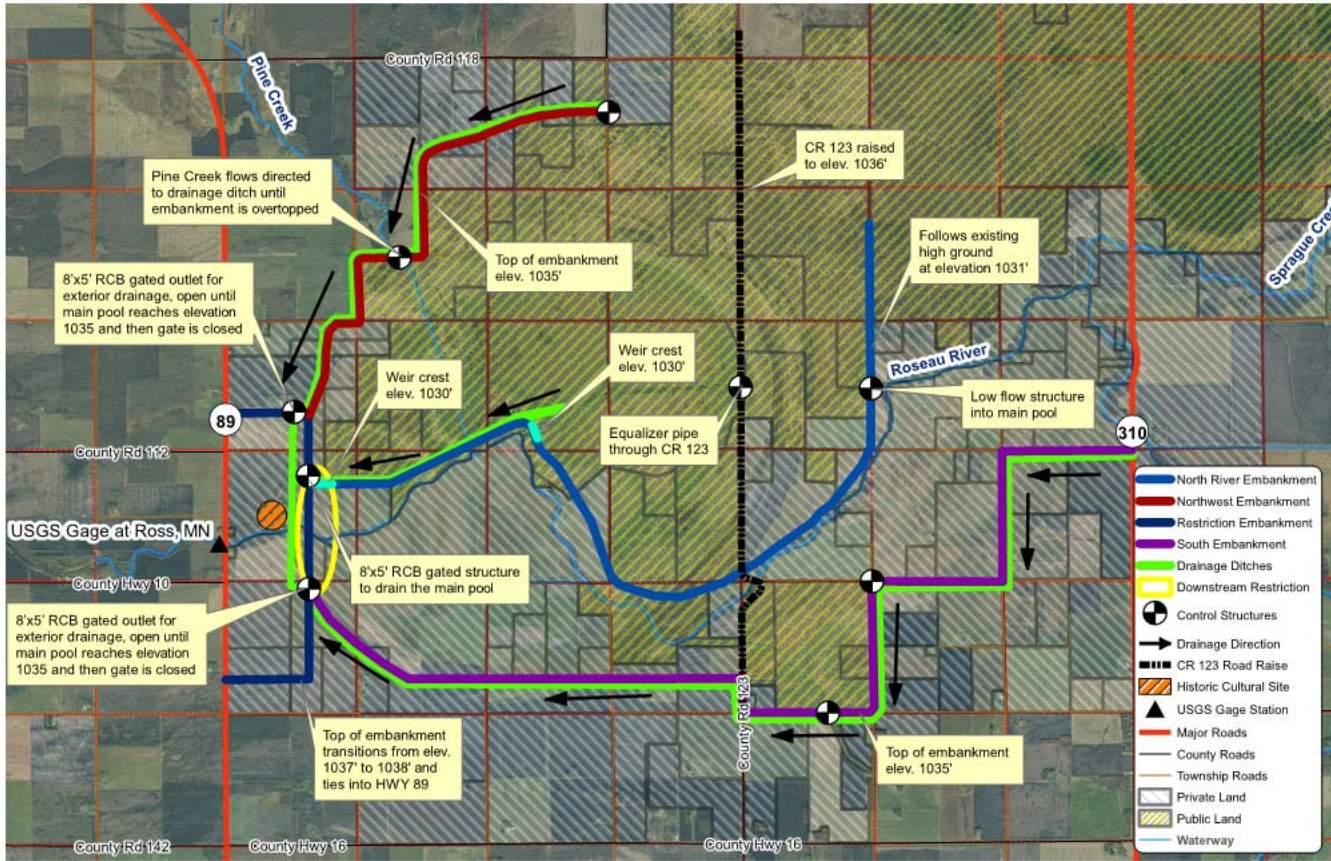
Benefits

- Reduce peak flows and flood durations on the Roseau River ★
- Reduce damage to crops and infrastructure ★
- Additional compensation via flowage easement ★
- Improved exterior drainage on a more frequent basis ★
- Improved protection along south exterior ★
- Improved protection of "island" ★
- Raised County Road on east side of Roseau Lake – improved access
- Replace bridge to island with box culverts
- Natural Resource Enhancements ★
- Lowest wetland impacts (55 acres) ★ ★
- Cost ★



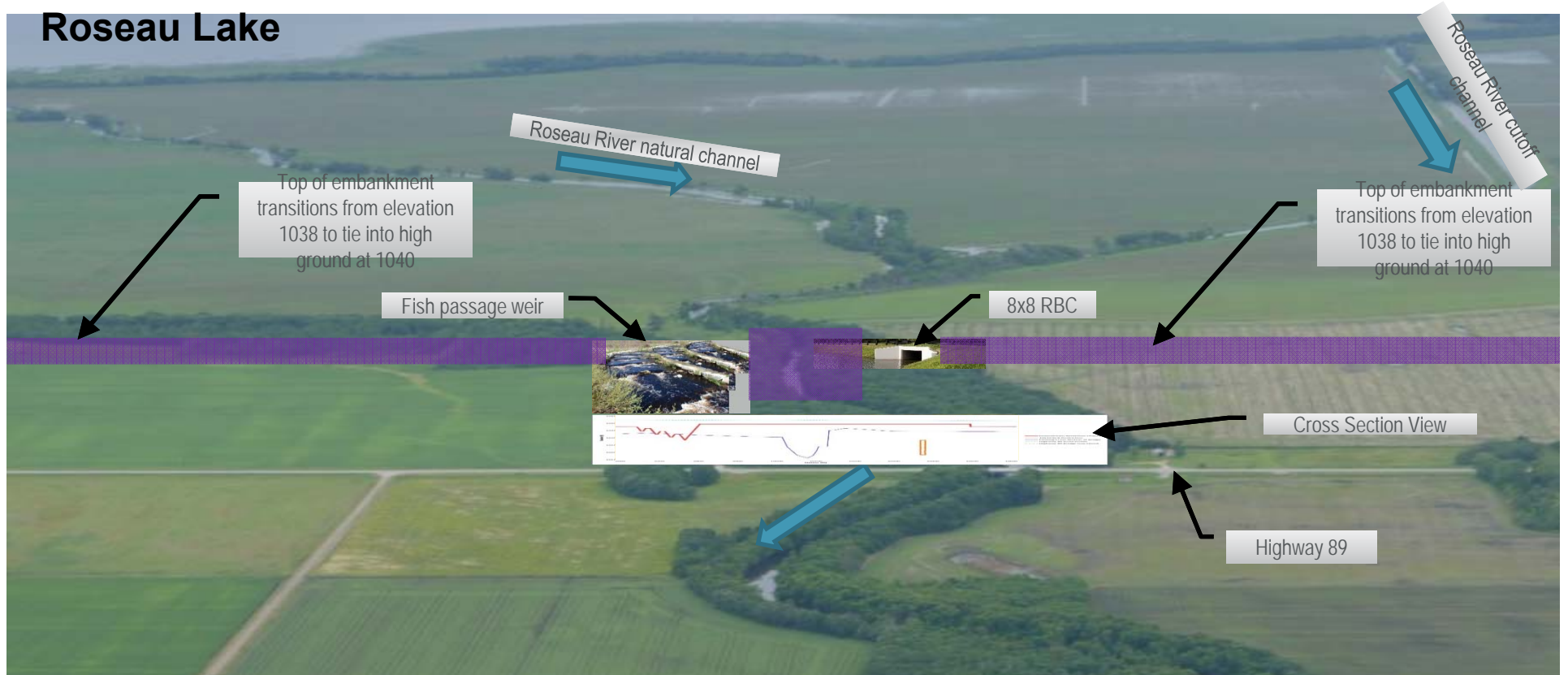
Alternative	Peak water surface elevation/flooding duration of the island area during 10-year, 10-day event	Peak water surface elevation/flooding duration of the Main Pool area during 10-year, 10-day event	Peak overbank elevation/flooding duration along the river corridor in event 10-year, 10-day event (immediately upstream of the diversion channel) (see figure below)	Peak water surface elevation /duration of flooding during 10-year, 10-day event in the South Cell.	Metric related to peak flow at Ross Gage during 10-year, 10-day event. (cfs) (see figure below)	Flooded areas between Highway 89 and County Road 113 (acres)	Downstream reduction in Flooded Acres	FDR Relative Scale
Existing Conditions	1037.22/80 days	1037.24/85 days	1037.24/80 days	1037.24/85 days	3,771	10,338	-	-
1	1037.06/70 days	1037.06/80 days	1037.06/70 days	1037.06/70 days	3,568	9,976	362	
2a	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,626	10,092	246	
2c	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,621	10,092	246	
2d	1037.05/70 days	1037.06/80 days	1037.05/70 days	1037.05/70 days	3,574	10,009	329	
2e	1037.05/70 days	1037.05/80 days	1037.05/70 days	1037.05/70 days	3,560	9,976	362	
2a-1	1038.45/95 days	1038.45/90 days	1038.45/95 days	-	3,365	9,618	720	





- North River Embankment
- Northwest Embankment
- Restriction Embankment
- South Embankment
- Drainage Ditches
- Downstream Restriction
- Control Structures
- Drainage Direction
- CR 123 Road Raise
- Historic Cultural Site
- USGS Gage Station
- Major Roads
- County Roads
- Township Roads
- Private Land
- Public Land
- Waterway

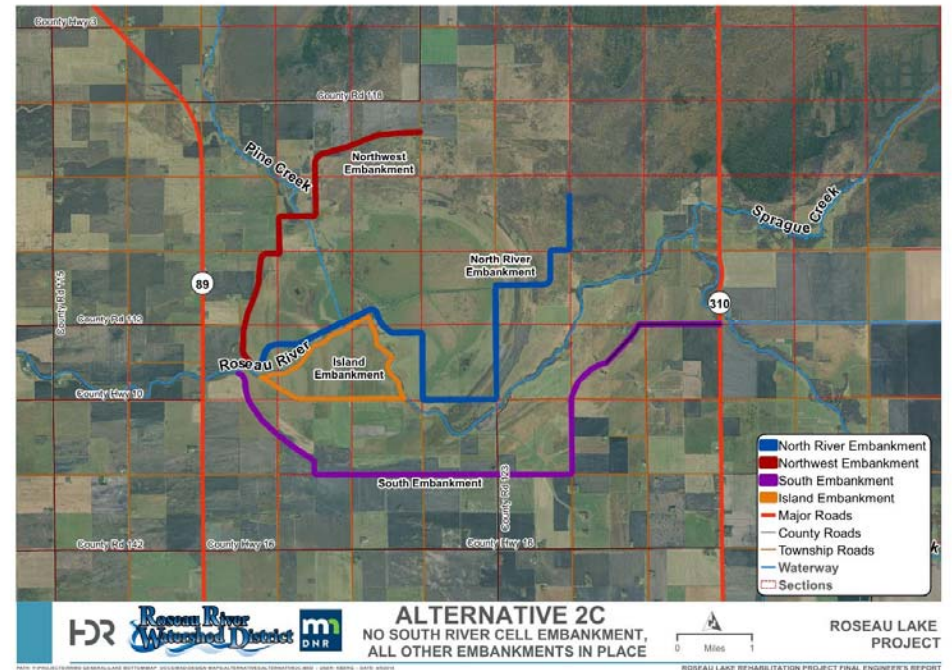
Roseau Lake



Alternative 2c

Benefits

- Reduce peak flows and flood durations on the Roseau River ★
- Reduce damage to crops and infrastructure ★
- Additional compensation via flowage easement
- Improved exterior drainage on a more frequent basis ★
- Improved protection along south exterior ★
- Improved protection of "island"
- Raised County Road on east side of Roseau Lake – improved access
- Replace bridge to island with box culverts
- Natural Resource Enhancements ★
- 3rd highest wetland impacts (137 acres)
- More Cost



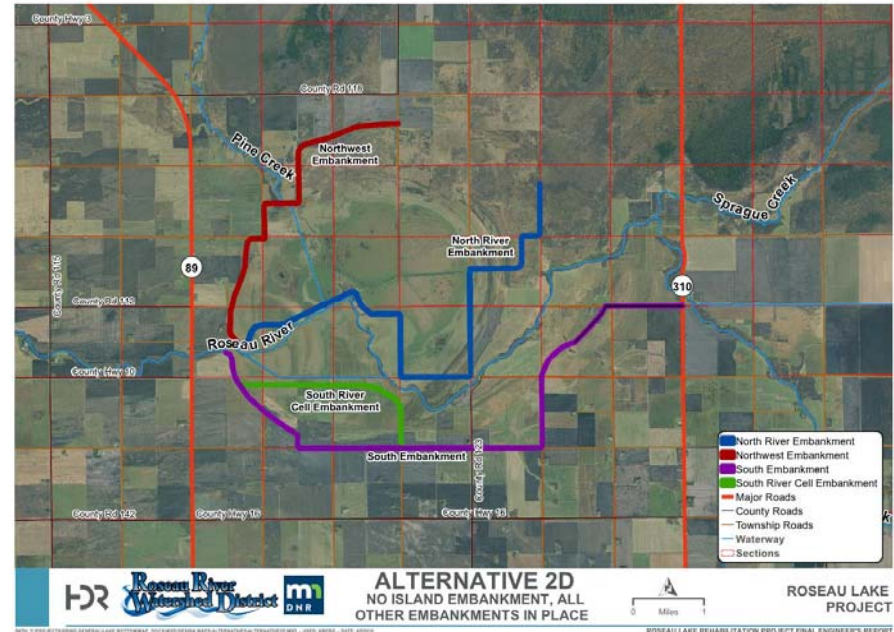
Alternative	Peak water surface elevation/flooding duration of the island area during 10-year, 10-day event	Peak water surface elevation/flooding duration of the Main Pool area during 10-year, 10-day event	Peak overbank elevation/flooding duration along the river corridor in event 10-year, 10-day event (immediately upstream of the diversion channel) (see figure below)	Peak water surface elevation /duration of flooding during 10-year, 10-day event in the South Cell.	Metric related to peak flow at Ross Gage during 10-year, 10-day event. (cfs) (see figure below)	Flooded areas between Highway 89 and County Road 113 (acres)	Downstream reduction in Flooded Acres	FDR Relative Scale
Existing Conditions	1037.22/80 days	1037.24/85 days	1037.24/80 days	1037.24/85 days	3,771	10,338	-	-
1	1037.06/70 days	1037.06/80 days	1037.06/70 days	1037.06/70 days	3,568	9,976	362	
2a	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,621	10,092	246	
2c	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,621	10,092	246	←
2u	1037.05/70 days	1037.06/80 days	1037.05/70 days	1037.05/70 days	3,574	10,009	329	
2e	1037.05/70 days	1037.05/80 days	1037.05/70 days	1037.05/70 days	3,569	9,976	362	
2a-1	1038.45/95 days	1038.45/90 days	1038.45/95 days	-	3,365	9,618	720	



Alternative 2d

Benefits

- Reduce peak flows and flood durations on the Roseau River ★
- Reduce damage to crops and infrastructure ★
- Additional compensation via flowage easement
- Improved exterior drainage on a more frequent basis ★
- Improved protection along south exterior ★
- Improved protection of "island"
- Raised County Road on east side of Roseau Lake – improved access
- Replace bridge to island with box culverts
- Natural Resource Enhancements ★
- 2nd highest wetland impacts (145 acres)
- More Cost



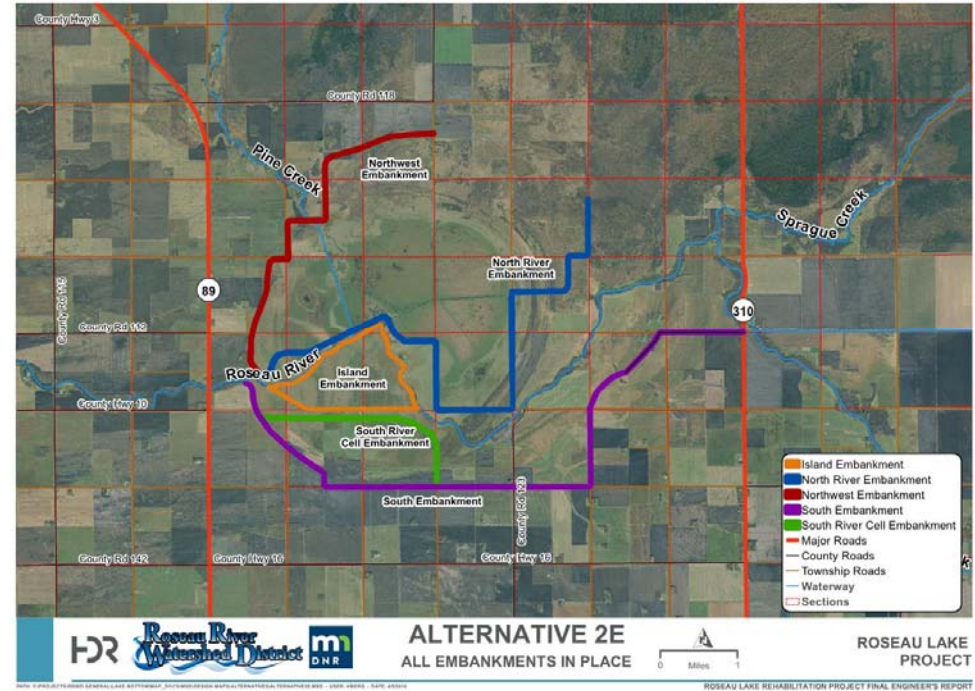
Alternative	Peak water surface elevation/flooding duration of the island area during 10-year, 10-day event	Peak water surface elevation/flooding duration of the Main Pool area during 10-year, 10-day event	Peak overbank elevation/flooding duration along the river corridor in event 10-year, 10-day event (immediately upstream of the diversion channel) (see figure below)	Peak water surface elevation /duration of flooding during 10-year, 10-day event in the South Cell.	Metric related to peak flow at Ross Gage during 10-year, 10-day event. (cfs) (see figure below)	Flooded areas between Highway 89 and County Road 113 (acres)	Downstream reduction in Flooded Acres	FDR Relative Scale
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1	1037.06/70 days	1037.06/80 days	1037.06/70 days	1037.06/70 days	3,568	9,976	362	
2a	1037.11/70 days	1037.11/80 days	1037.11/70 days	1037.11/70 days	3,626	10,092	246	
2c	1037.12/70 days	1037.12/80 days	1037.12/70 days	1037.12/70 days	3,621	10,092	246	
2d	1037.05/70 days	1037.06/80 days	1037.05/70 days	1037.05/70 days	3,574	10,009	329	
2e	1037.05/70 days	1037.05/80 days	1037.05/70 days	1037.05/70 days	3,569	9,976	362	
2a-1	1038.45/95 days	1038.45/90 days	1038.45/95 days	-	3,365	9,618	720	



Alternative 2e

Benefits

- Reduce peak flows and flood durations on the Roseau River ★
- Reduce damage to crops and infrastructure ★
- Additional compensation via flowage easement ★
- Improved exterior drainage on a more frequent basis ★
- Improved protection along south exterior ★
- Improved protection of "island" ★
- Raised County Road on east side of Roseau Lake – improved access
- Replace bridge to island with box culverts
- Natural Resource Enhancements ★
- Highest wetland impacts (158 acres)
- Most Costly



Alternative	Peak water surface elevation/flooding duration of the island area during 10-year, 10-day event	Peak water surface elevation/flooding duration of the Main Pool area during 10-year, 10-day event	Peak overbank elevation/flooding duration along the river corridor in event 10-year, 10-day event (immediately upstream of the diversion channel) (see figure below)	Peak water surface elevation /duration of flooding during 10-year, 10-day event in the South Cell.	Metric related to peak flow at Ross Gage during 10-year, 10-day event. (cfs) (see figure below)	Flooded areas between Highway 89 and County Road 113 (acres)	Downstream reduction in Flooded Acres	FDR Relative Scale
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2d	1037.05/70 days	1037.05/80 days	1037.05/70 days	1037.05/70 days	3,574	10,009	329	
2e	1037.05/70 days	1037.05/80 days	1037.05/70 days	1037.05/70 days	3,569	9,976	362	
2a-1	1038.45/95 days	1038.45/90 days	1038.45/95 days	-	3,365	9,618	720	

