RAMSEY-WASHINGTON
METRO WATERSHED DISTRICT

Snail Lake Overflow/Grass Lake Optimization Studies

May 2, 2018

Ramsey-Washington Metro Watershed District.

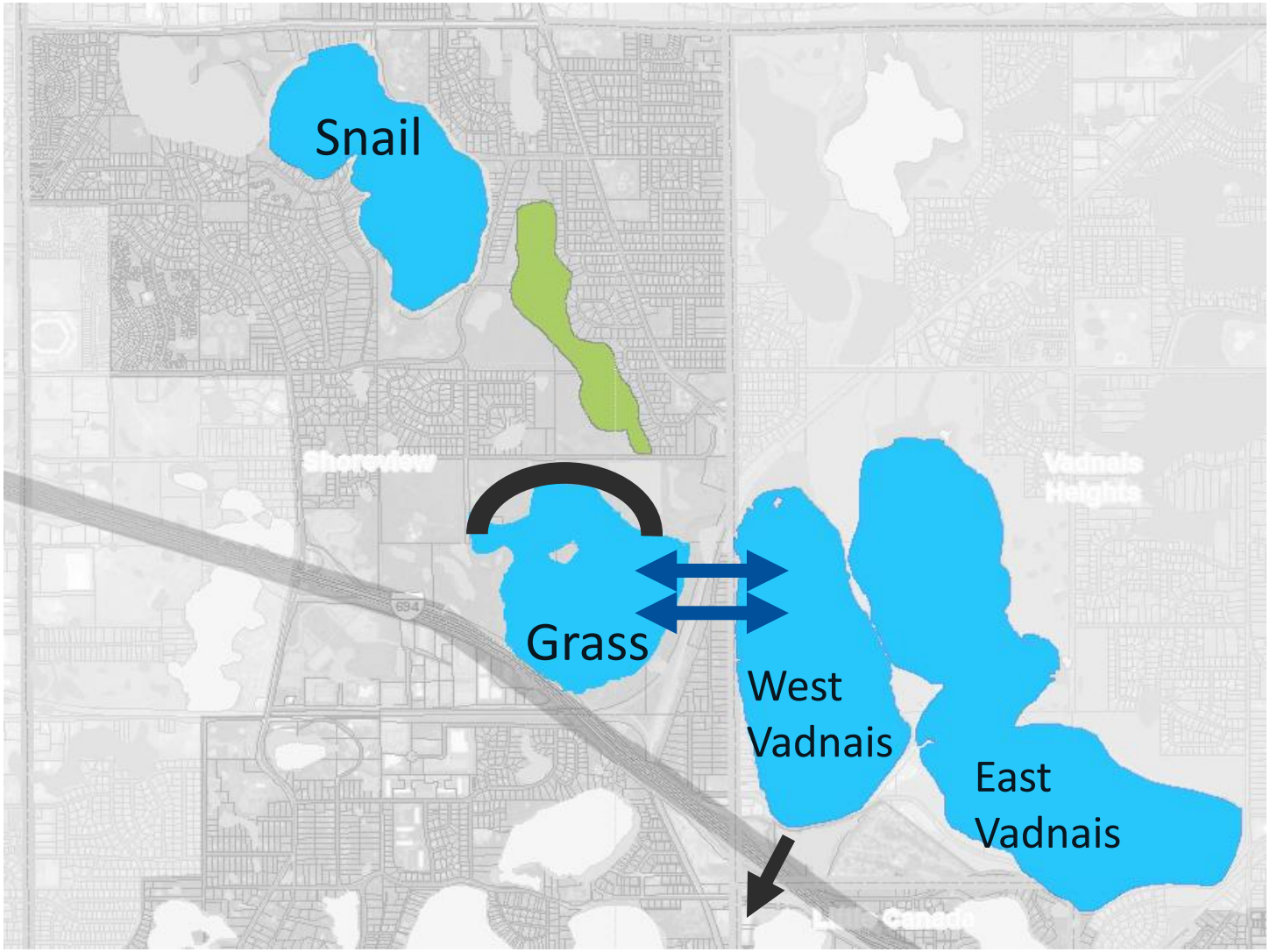
BARR

Purpose

Purpose:

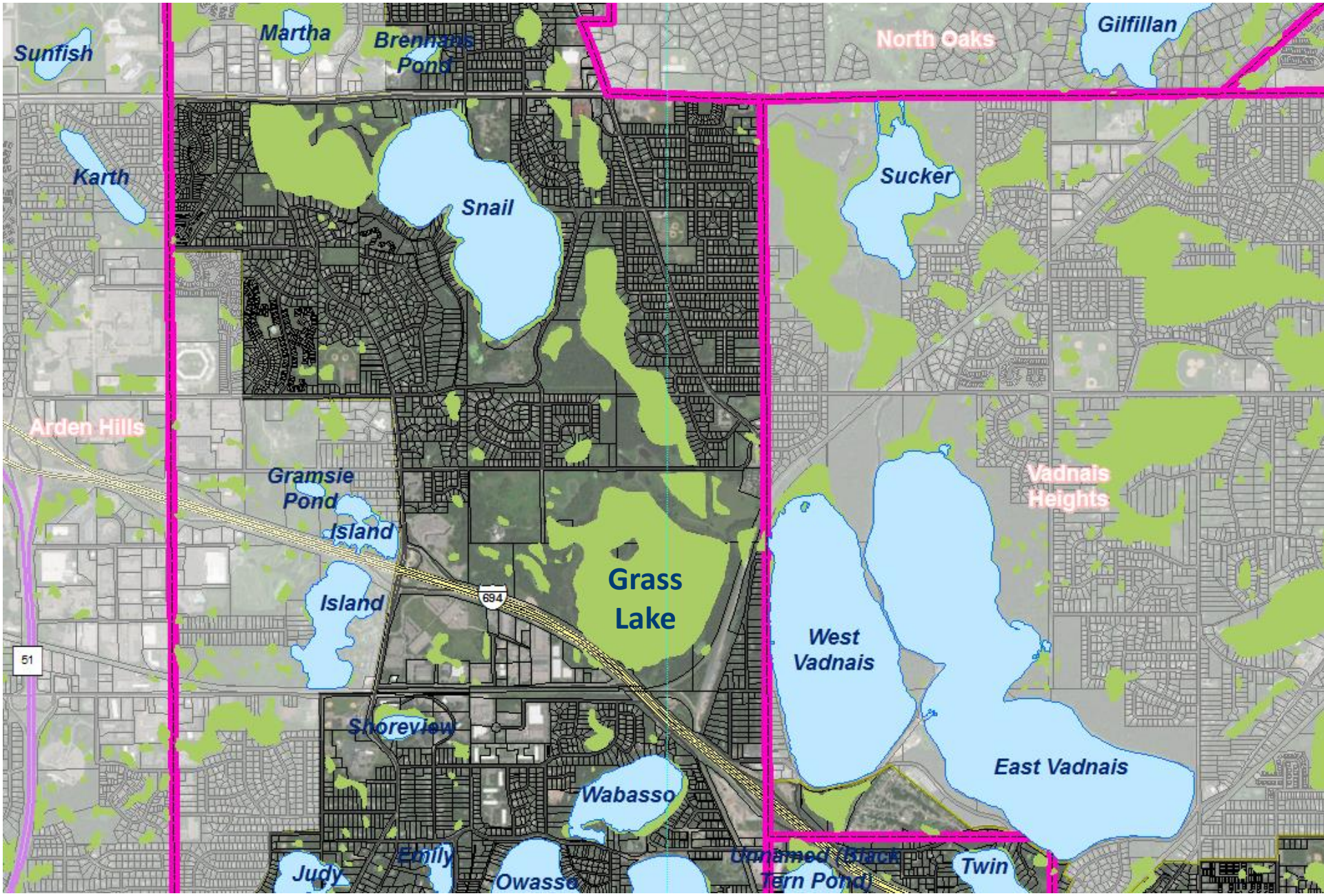
1. Summarize what's been done
2. Update board on cost vs. benefits of various options
3. Discuss recommendations with board
4. Seek board approval of path forward

New Existing Condition



Snail Lake

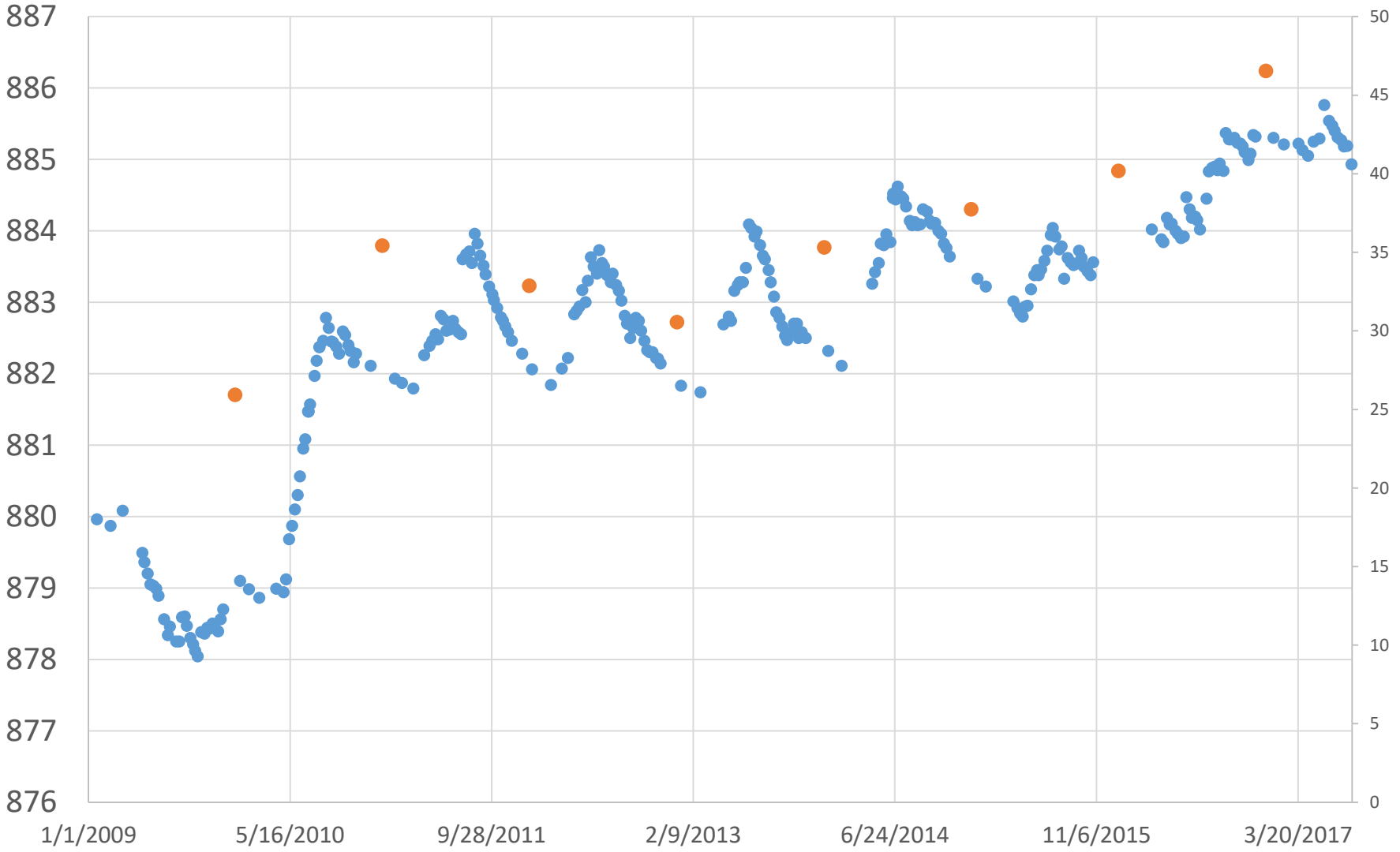
- Snail Lake is “land-locked” (a.k.a. no piped outlet)
  - Lake levels have been steadily rising over past several years
    - Causing concerns for Snail Lake home flooding
    - Causing concerns for potential overland overflow (should a very large event occur) that would likely flood homes in Crestview Addition

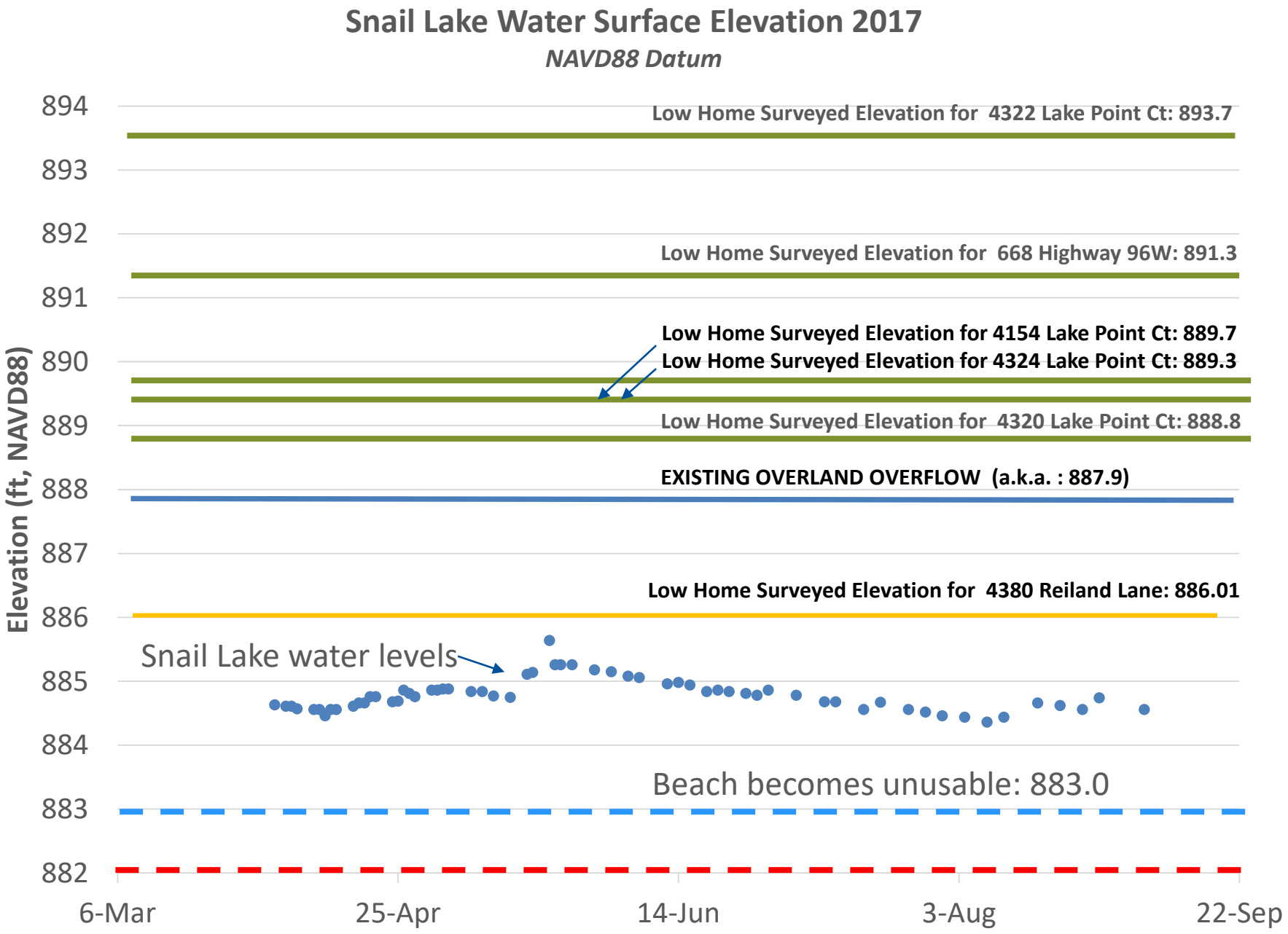

Sunfish
Martha
Brennans Pond
North Oaks
Gilfillan
Karth
Snail
Sucker
Arden Hills
Gramsie Pond
Island
Island
Grass Lake
694
Vadnais Heights
West Vadnais
East Vadnais
51
Shoreview
Wabasso
Emily
Judy
Owasso
Unnamed (Black Tern Pond)
Twin

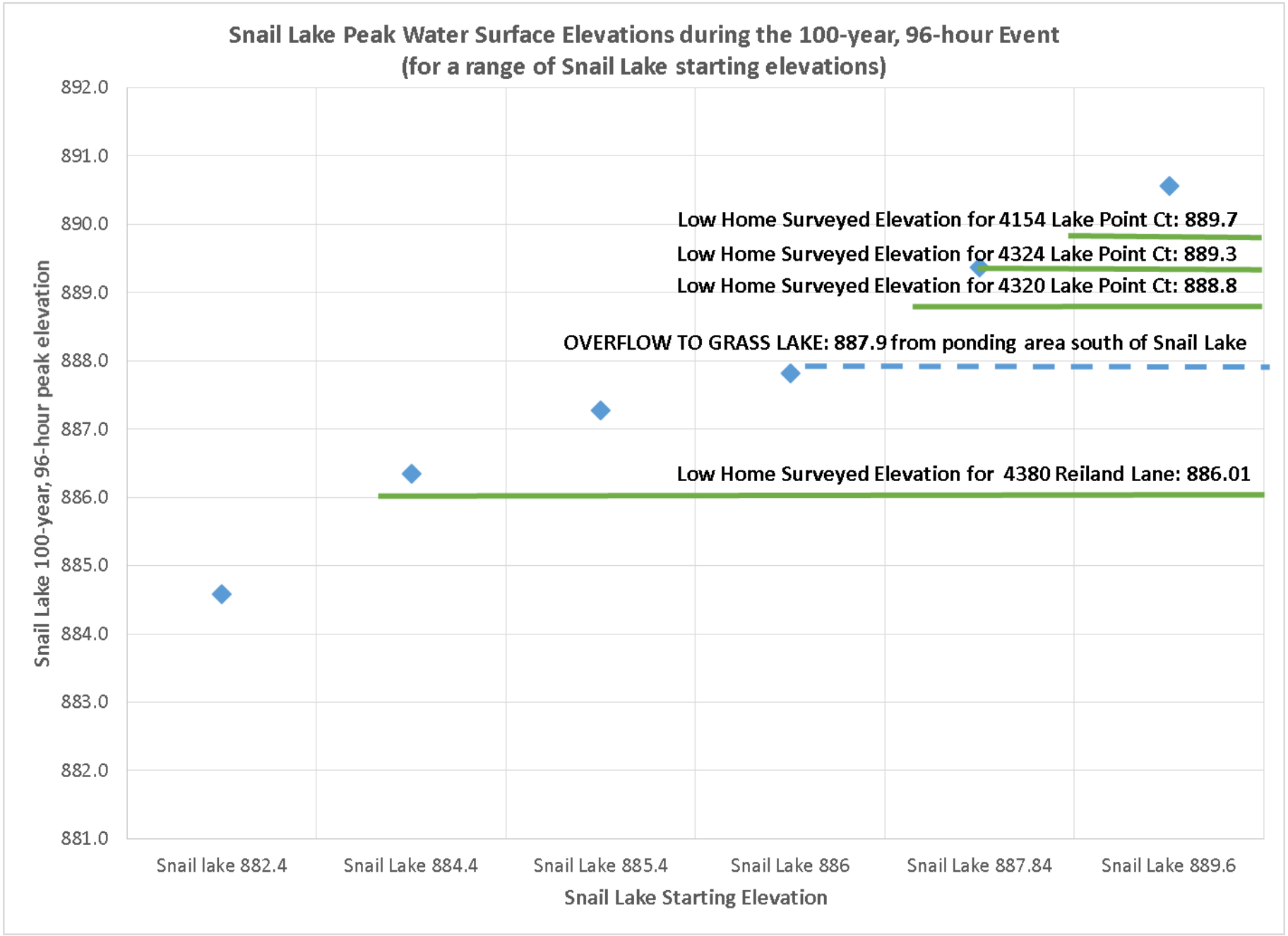
Snail Lake Historical Elevations

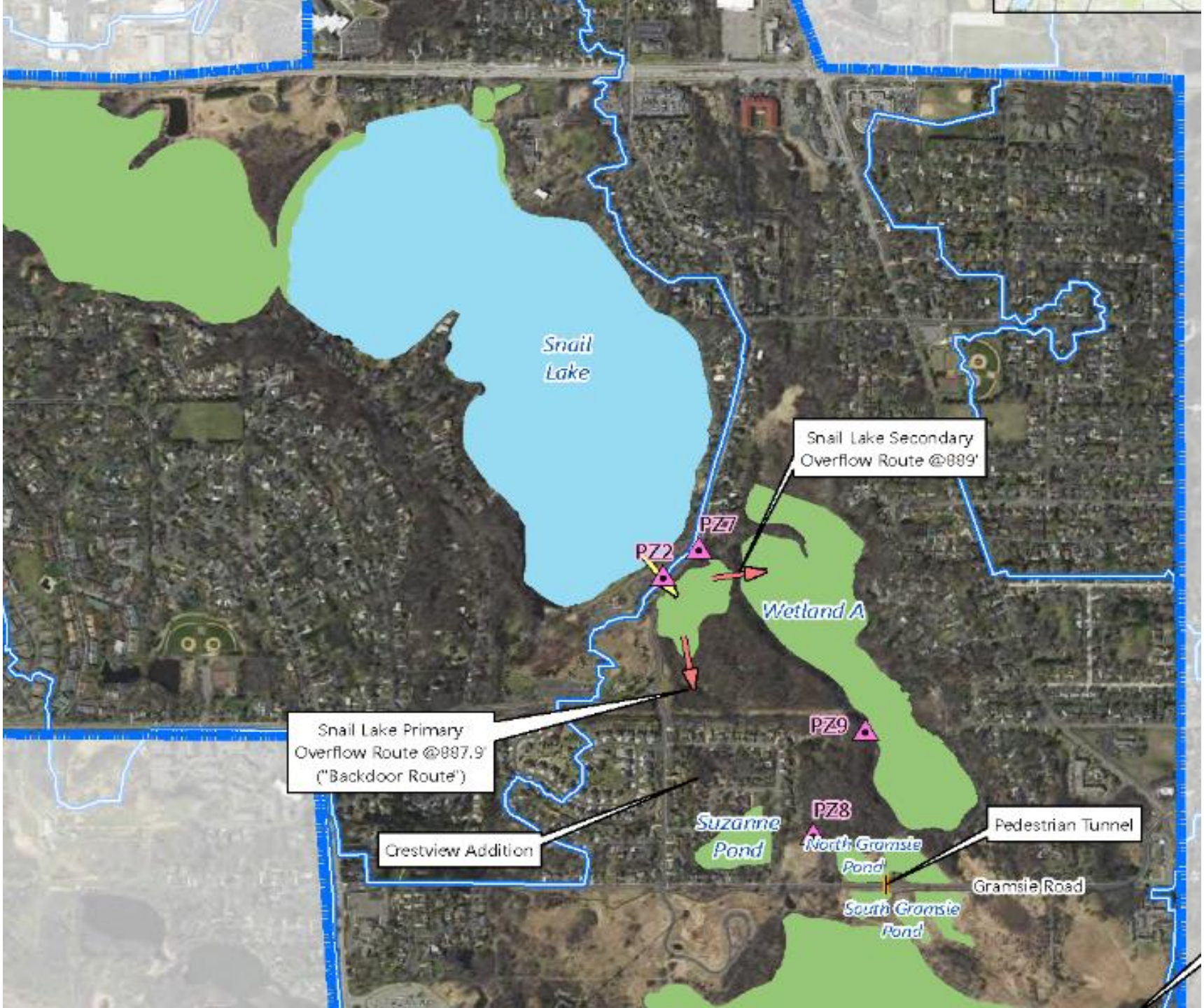
(source: MnDNR's Lake Finder website, elevations in 1912 datum)

Annual Precipitation source: MN State Climatology Working Group




Snail Lake Water Surface Elevation 2017
NAVD88 Datum
Elevation (ft, NAVD88)
894
893
892
891
890
889
888
887
886
885
884
883
882
Low Home Surveyed Elevation for 4322 Lake Point Ct: 893.7
Low Home Surveyed Elevation for 668 Highway 96W: 891.3
Low Home Surveyed Elevation for 4154 Lake Point Ct: 889.7
Low Home Surveyed Elevation for 4324 Lake Point Ct: 889.3
Low Home Surveyed Elevation for 4320 Lake Point Ct: 888.8
EXISTING OVERLAND OVERFLOW (a.k.a. : 887.9)
Low Home Surveyed Elevation for 4380 Reiland Lane: 886.01
Snail Lake water levels
Beach becomes unusable: 883.0
6-Mar
25-Apr
14-Jun
3-Aug
22-Sep


Snail Lake Peak Water Surface Elevations during the 100-year, 96-hour Event
(for a range of Snail Lake starting elevations)
892.0
891.0
890.0
889.0
888.0
887.0
886.0
885.0
884.0
883.0
882.0
881.0
Snail Lake 100-year, 96-hour peak elevation
Low Home Surveyed Elevation for 4154 Lake Point Ct: 889.7
Low Home Surveyed Elevation for 4324 Lake Point Ct: 889.3
Low Home Surveyed Elevation for 4320 Lake Point Ct: 888.8
OVERFLOW TO GRASS LAKE: 887.9 from ponding area south of Snail Lake
Low Home Surveyed Elevation for 4380 Reiland Lane: 886.01
Snail lake 882.4
Snail Lake 884.4
Snail Lake 885.4
Snail Lake 886
Snail Lake 887.84
Snail Lake 889.6
Snail Lake Starting Elevation

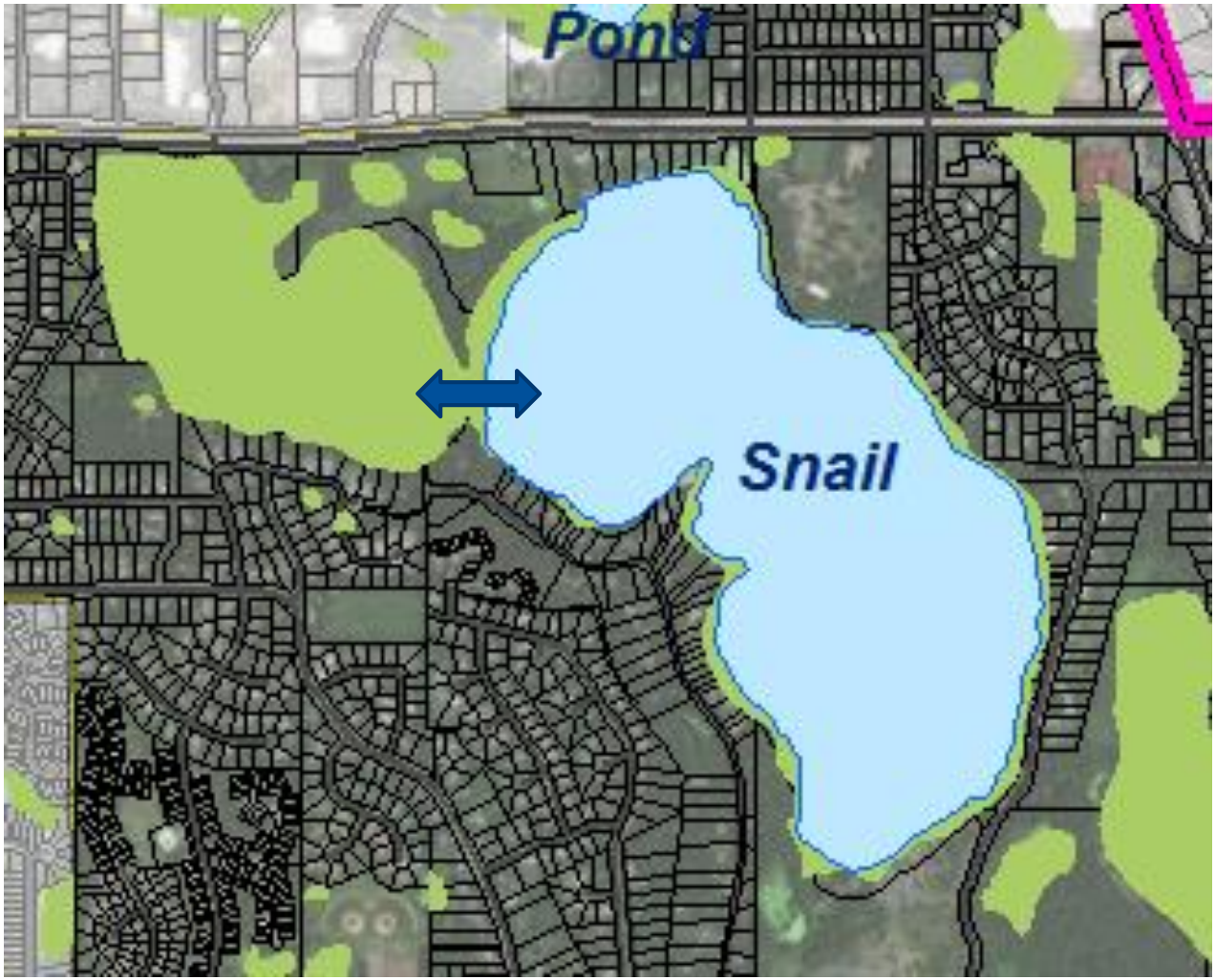

Snail Lake
Snail Lake Secondary Overflow Route @899'
PZ1
PZ2
Wetland A
Snail Lake Primary Overflow Route @887.9' ("Backdoor Route")
PZ9
PZ8
Suzanne Pond
North Gramsie Pond
Pedestrian Tunnel
Crestview Addition
Gramsie Road
South Gramsie Pond

Look for areas to:

- Store more flood water:
- Send discharge water to:

Study: Increase flood storage by creating a connection between Snail Lake and the wetland to the northwest of Snail Lake

Snail Lake Marsh (a.k.a. Little Snail)



Sign at the channel between Snail Lake and the wetland area to its northwest, indicating a fish spawning area

Conclusion and Recommendation

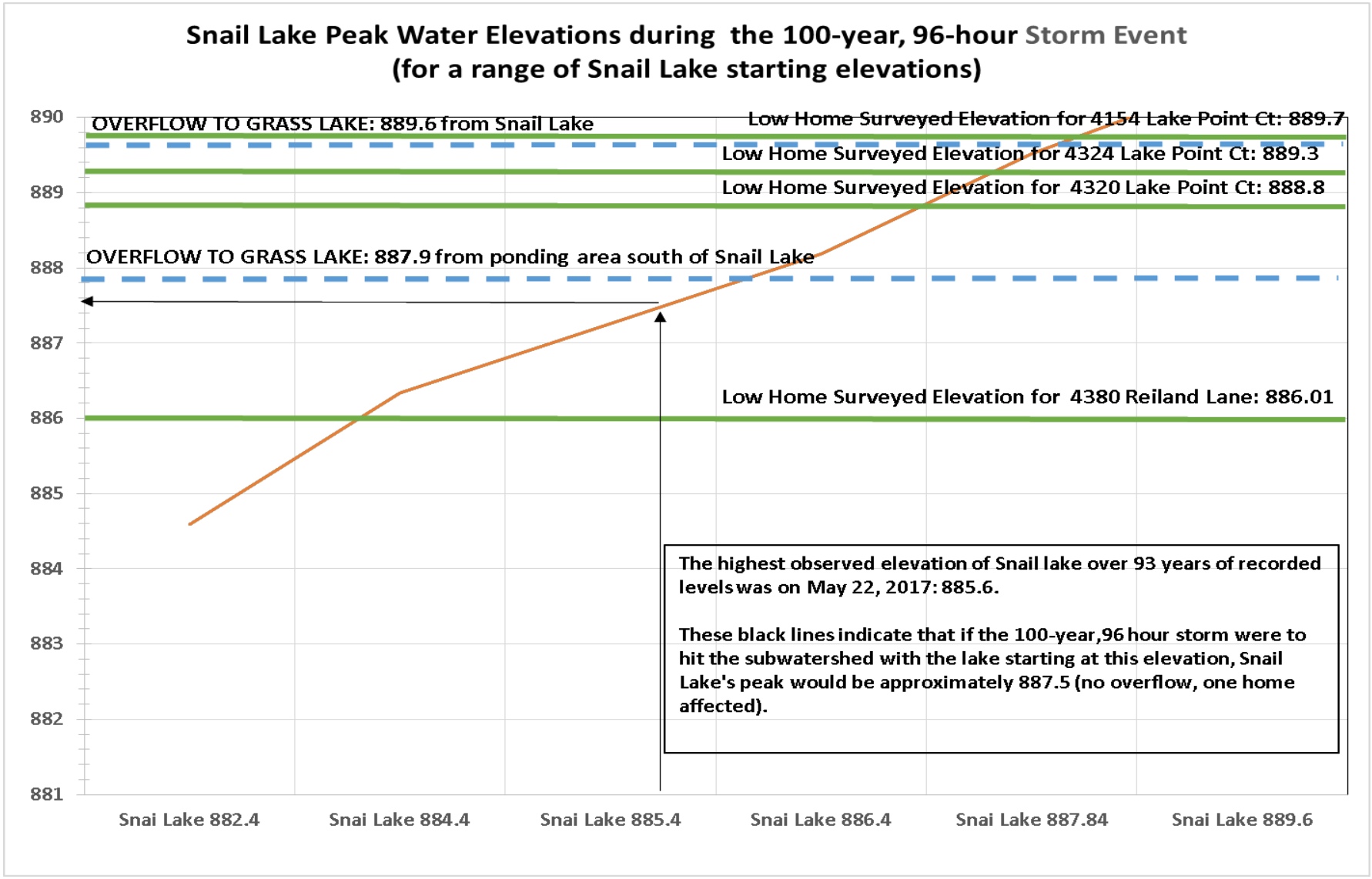
Snail Lake Marsh is already being used to store Snail Lake flood water and has been properly accounted for in our hydrologic modeling.

Recommendation: Do nothing further.

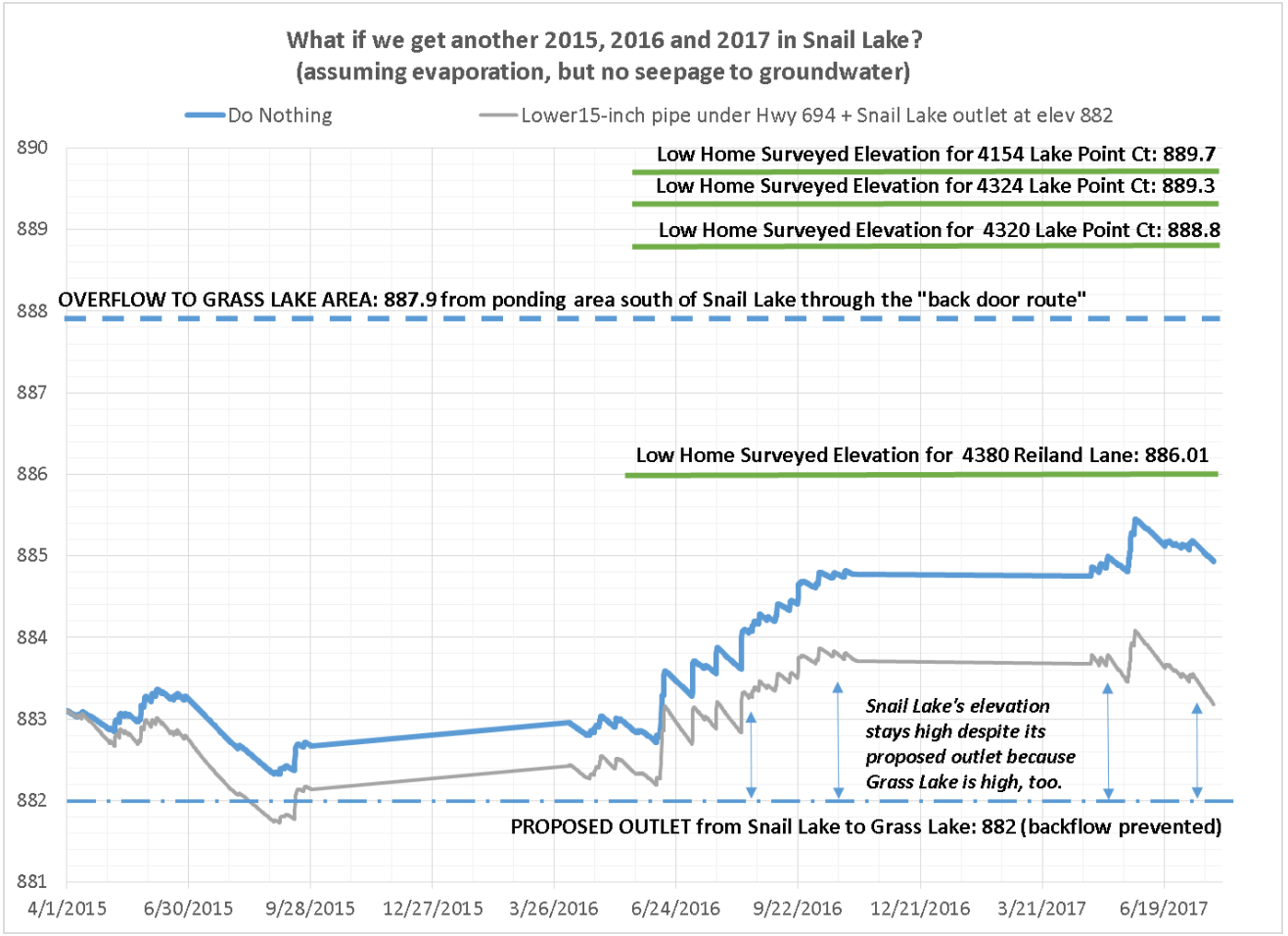
Evaluate the current level of risk of future flood levels on Snail Lake that could cause damage to habitable structures; evaluate these risks for three different management scenarios:

1) Do nothing further/Implement Emergency Response Plan.
2) Lower West Vadnais Lake's 15-inch outlet under Highway 694 to an elevation of 881 to create more and add a Snail Lake outlet to Grass Lake.
3) Pump Snail Lake flood water to Sucker Lake.

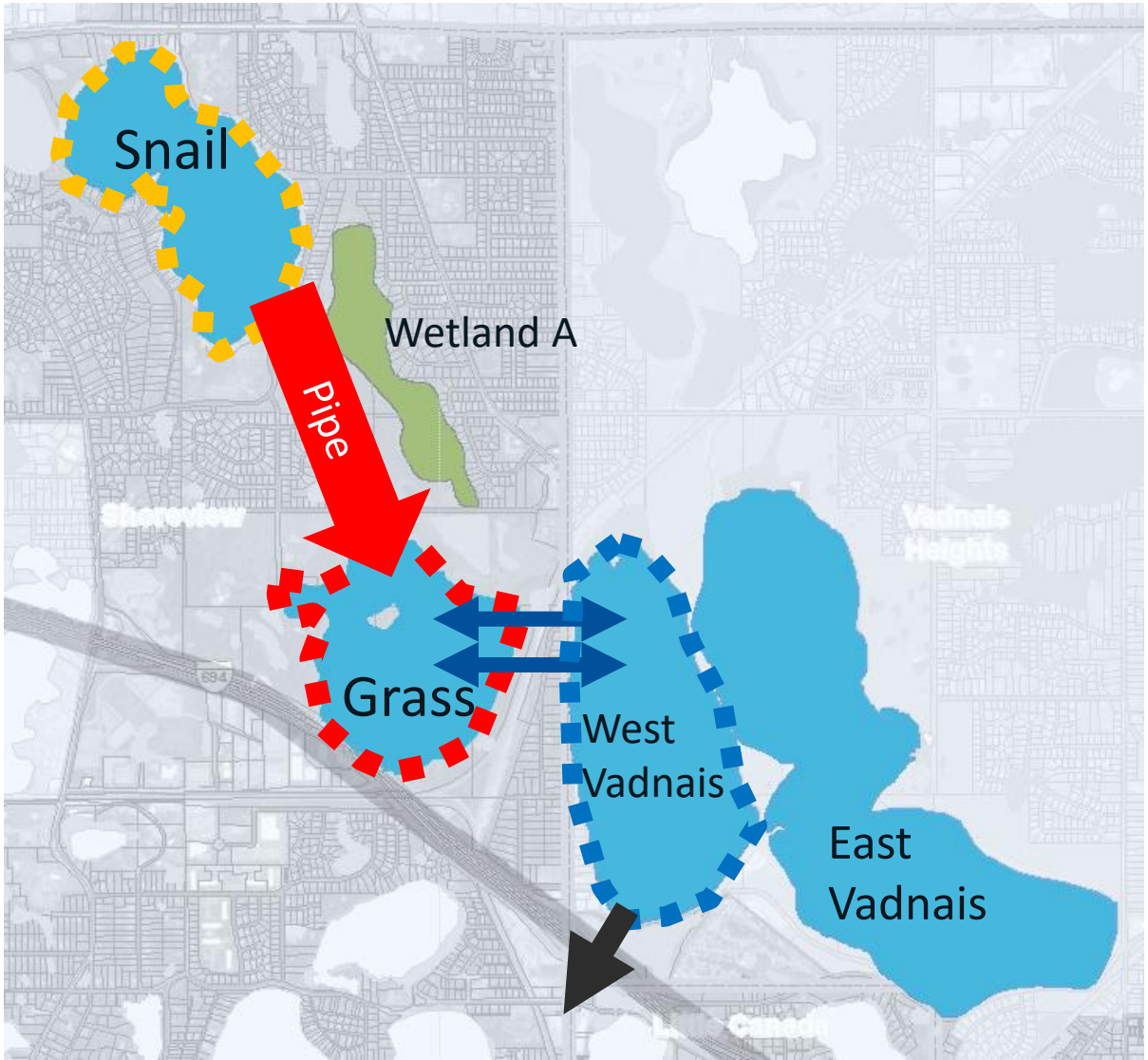
Scenario **1**
Do Nothing/Implement Emergency Response Plan



Scenario **1**
Do Nothing/Implement Emergency Response Plan



Scenario **2**
Pipe Snail and Lower West Vadnais



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MN DNR

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CITY OF SHOREVIEW

$620,000

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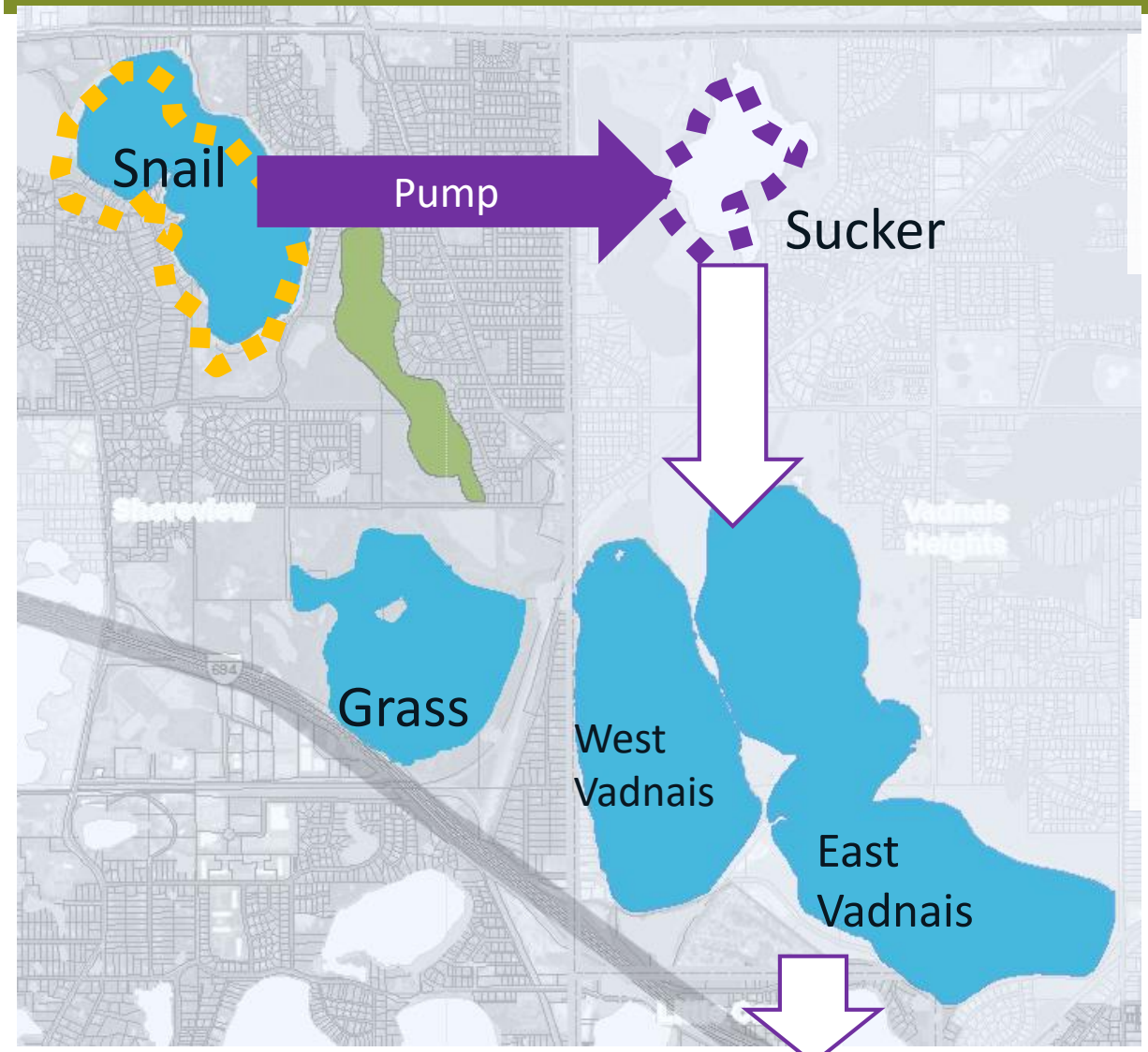
Scenario **3**
Pump Snail Lake Flood Water to Sucker Lake



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Conclusion and Recommendation

Recommendations:

- Partner with the city of Shoreview to prepare and implement an emergency response plan for Snail Lake.
- Partner with the city of Shoreview and Ramsey County Parks and Recreation to install an off-peak drawdown pipeline that connects Snail Lake to Grass Lake.
- Include in the Emergency Response Plan actions to divert Snail Lake overland overflow from the "back-door path" to Wetland A.

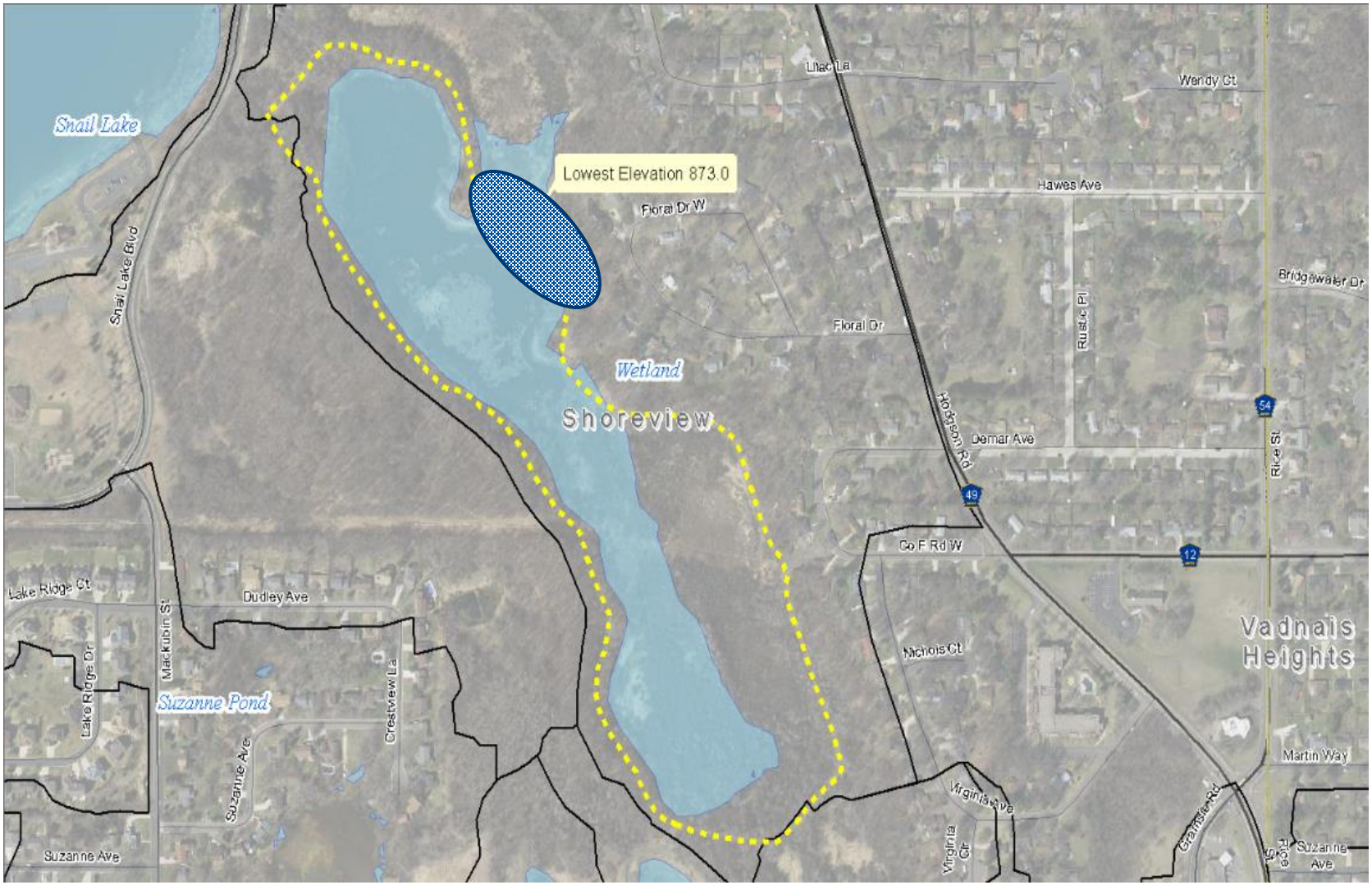
Wetland A

Wetland A is land-locked (no piped outlet) and is the lowest point in the area.

- Water levels have remained high in Wetland "A" after Grass Lake flooded the wetland in 2016.
  - Causing concerns for trail closures in park and limiting full usage of park.

April 24, 2018

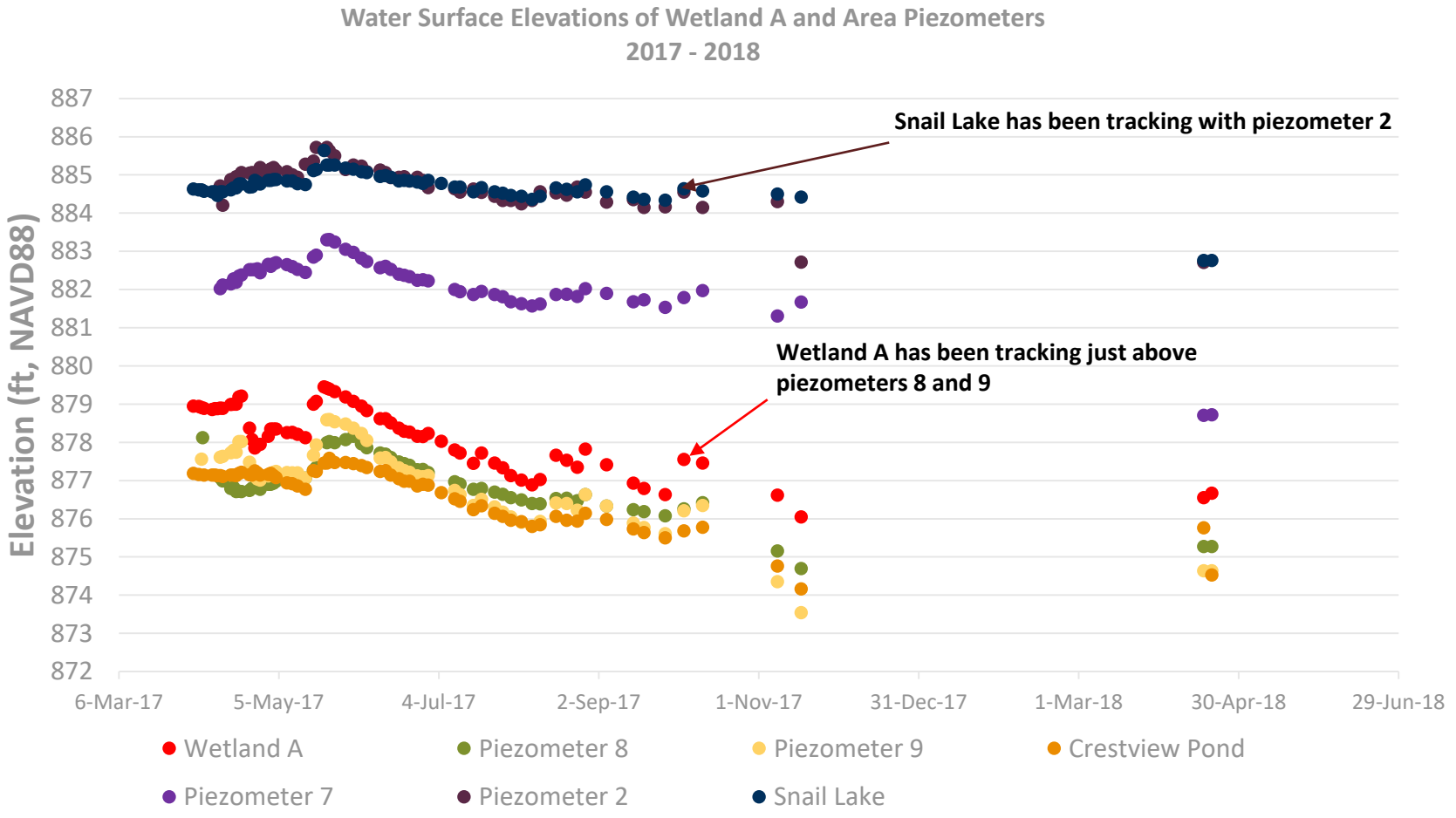
Wetland A trail impacts



Wetland A

- Provide guidance for Ramsey County Parks and Recreation regarding the future levels in wetland A to inform future placement of trails.

Wetland A and Snail Lake water surface elevations shows a close correlation between the water level in these water bodies and associated groundwater tables.



Recommendation for Wetland A

- **Recommendation:** Assist Ramsey County Parks and Recreation in choosing an alternative path alignment through the north and east sides of Wetland A that elevates the pathway to approximately elevation 876 (final elevation to be confirmed after the county conducts a soil and vegetation survey to better define the future alignment).

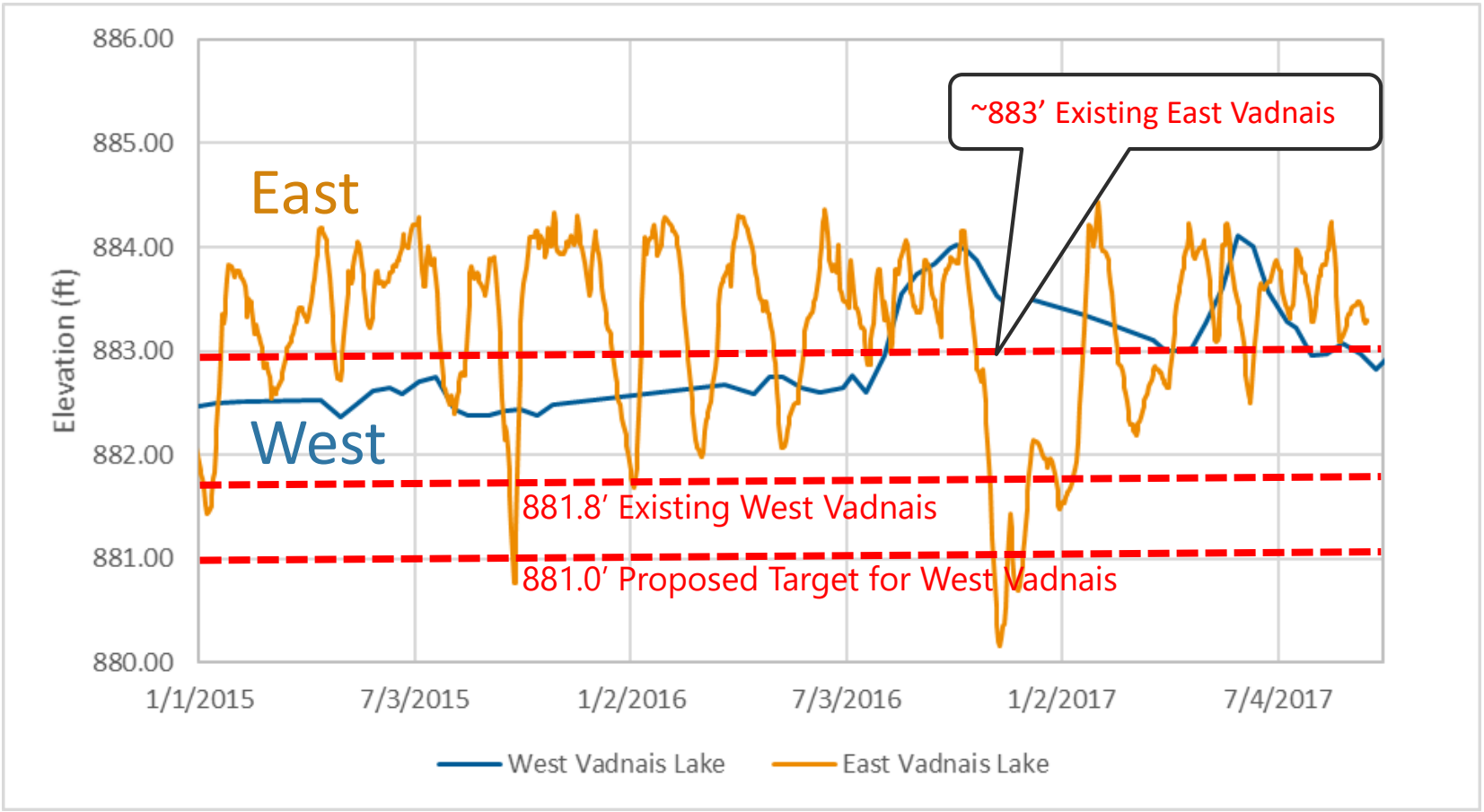
Grass Lake

Evaluate flood management options:

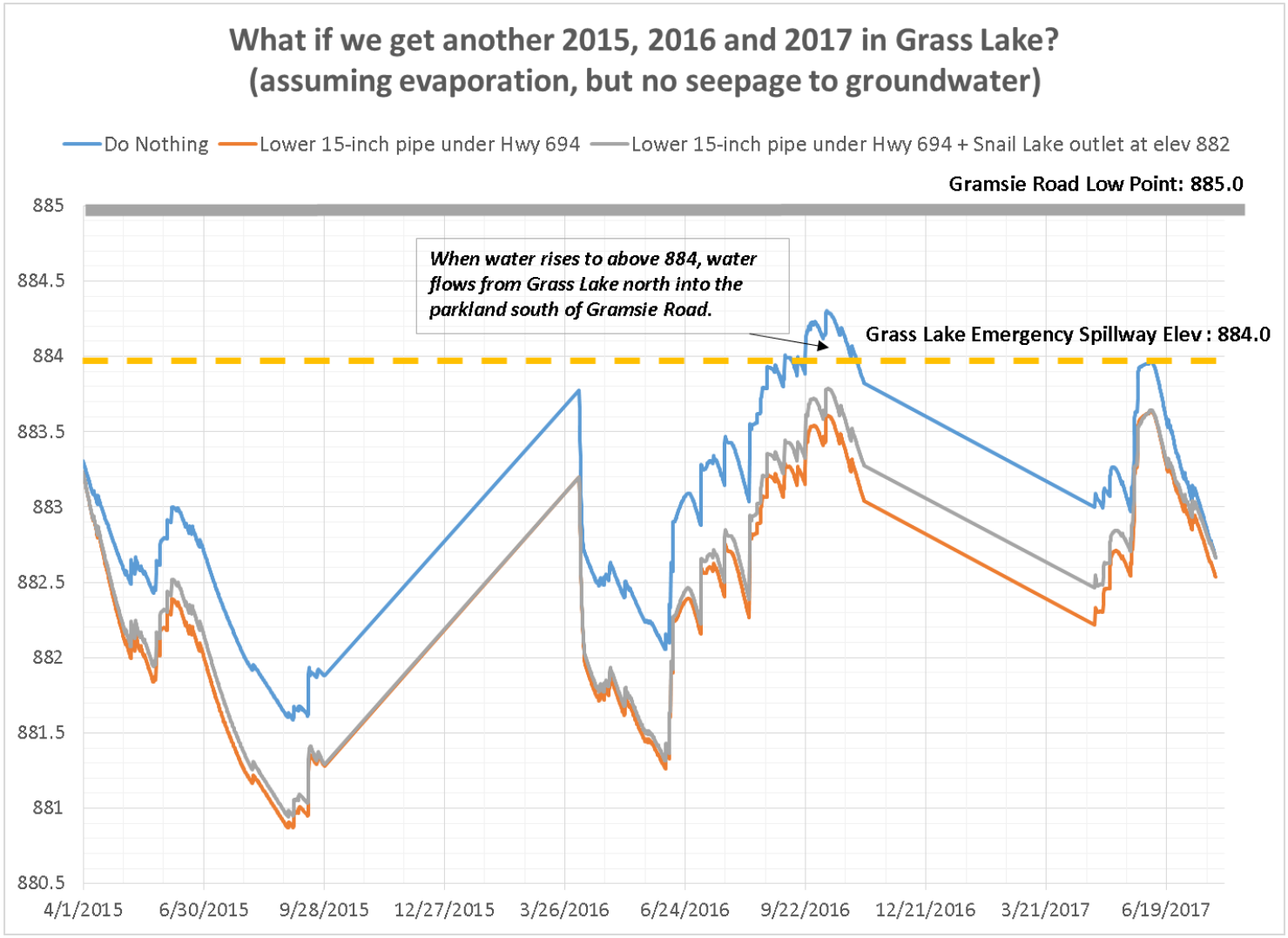
1. Do nothing further.
2. Lower West Vadnais Lake's 15-inch outlet under Highway 694 to elevation 881.

West Vadnais Lake to East Vadnais Lake

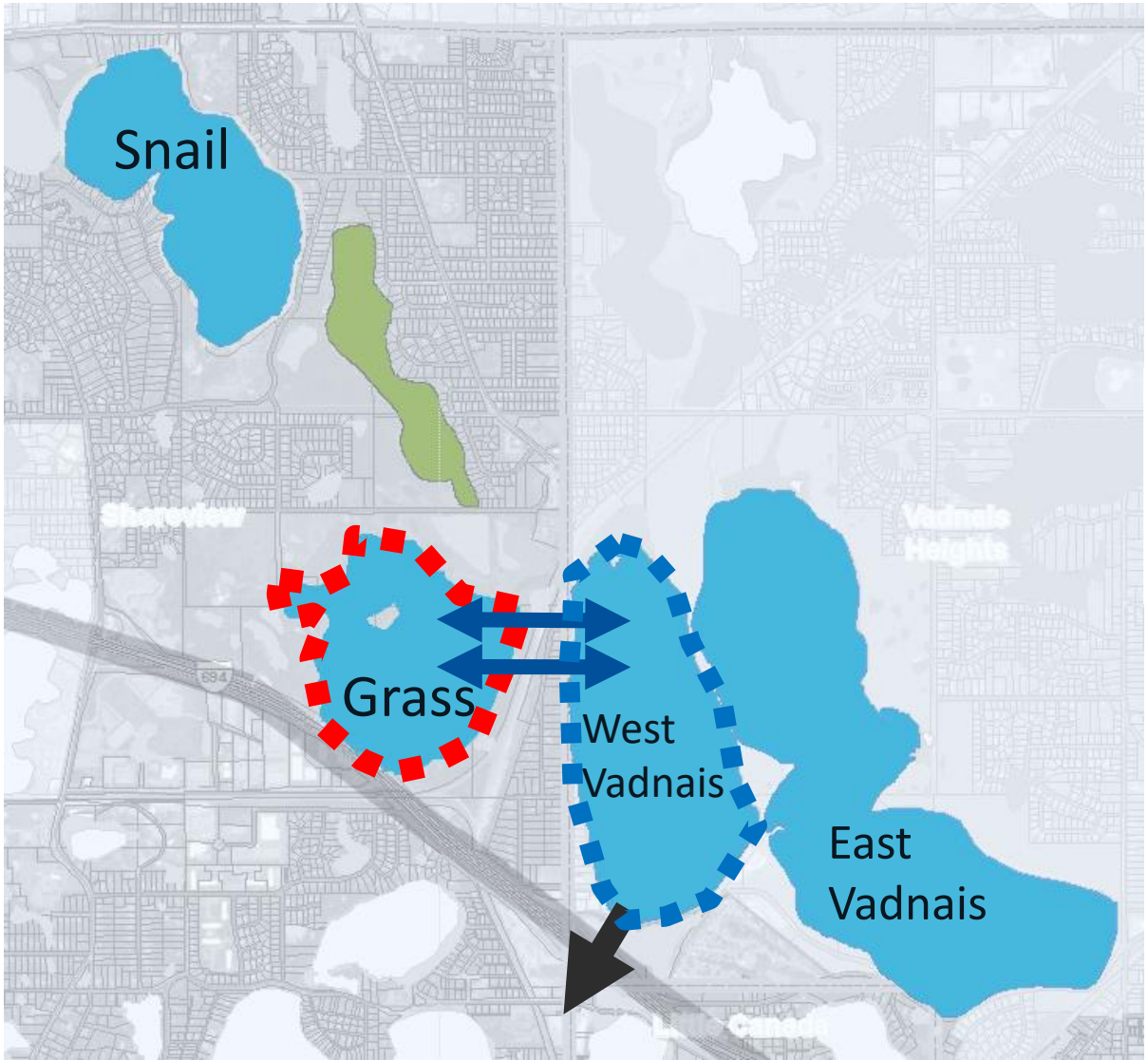
How do existing lake level conditions compare?



Grass Lake – Do nothing further



Grass Lake
Lower West Vadnais



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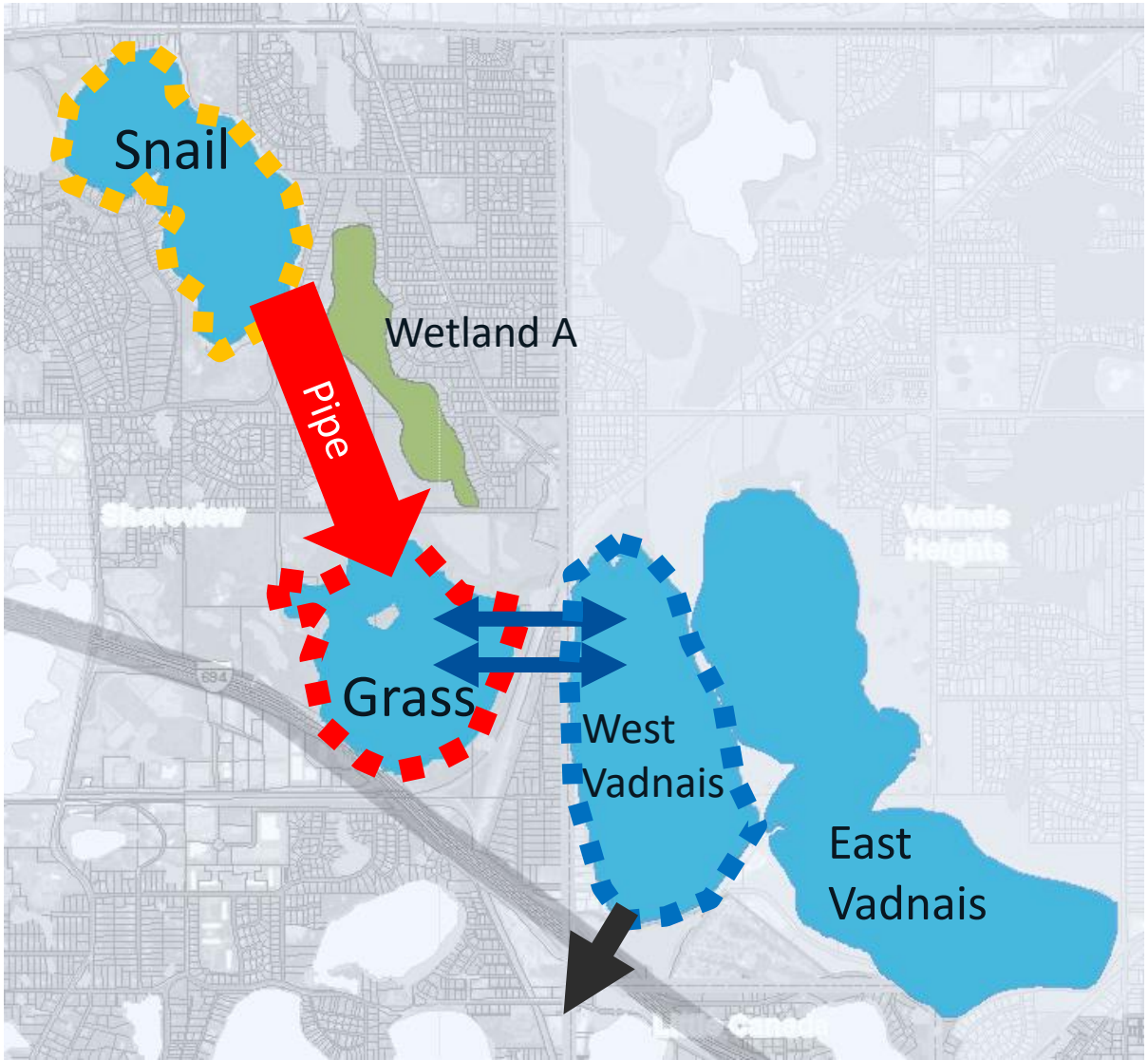
Grass Lake
Lower West Vadnais (and Pipe Snail)



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$40,000 +
($620,000)

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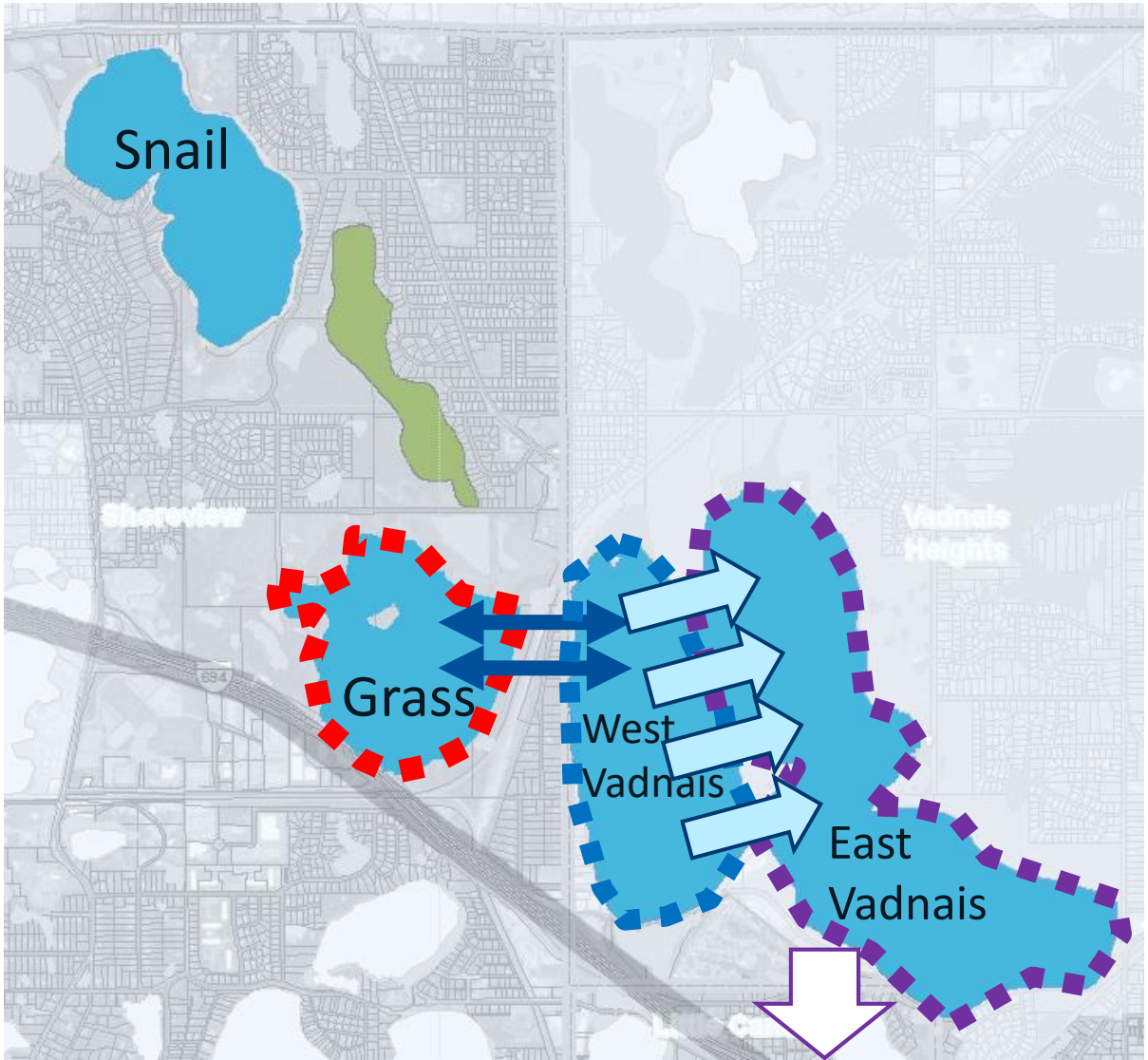
Grass Lake
Lower West Vadnais and Lower East Vadnais Lake



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Cost?

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Recommendations

- **Recommendation**:

  Continue to pursue lowering the 15-inch pipe under Highway 694 with the DNR and VLAWMO to elevation 881.0. But, only implement if East Vadnais Lake can be operated also at that elevation (881.0) to minimize the seepage of East Vadnais Lake water into West Vadnais Lake.

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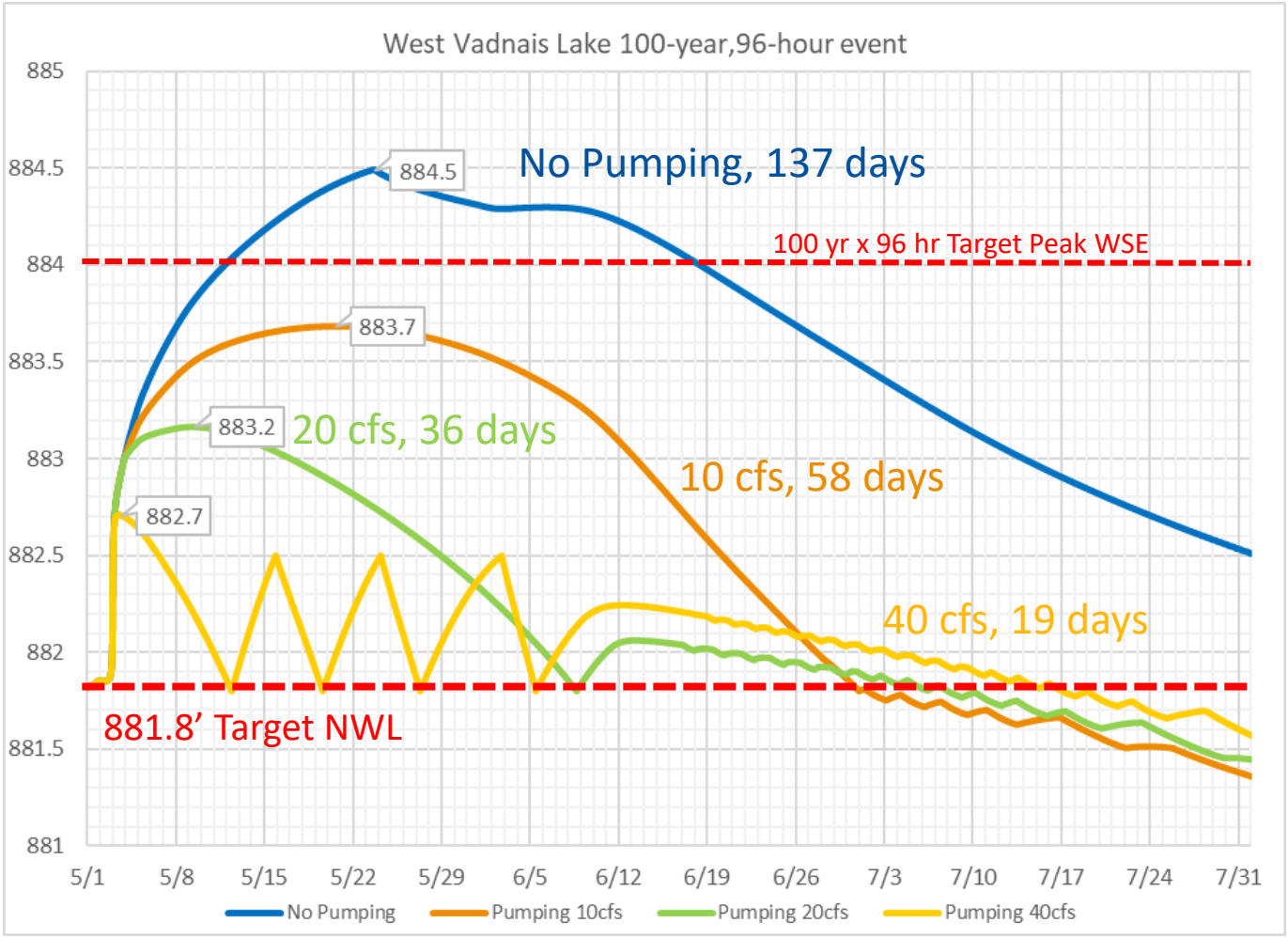
Grass Lake

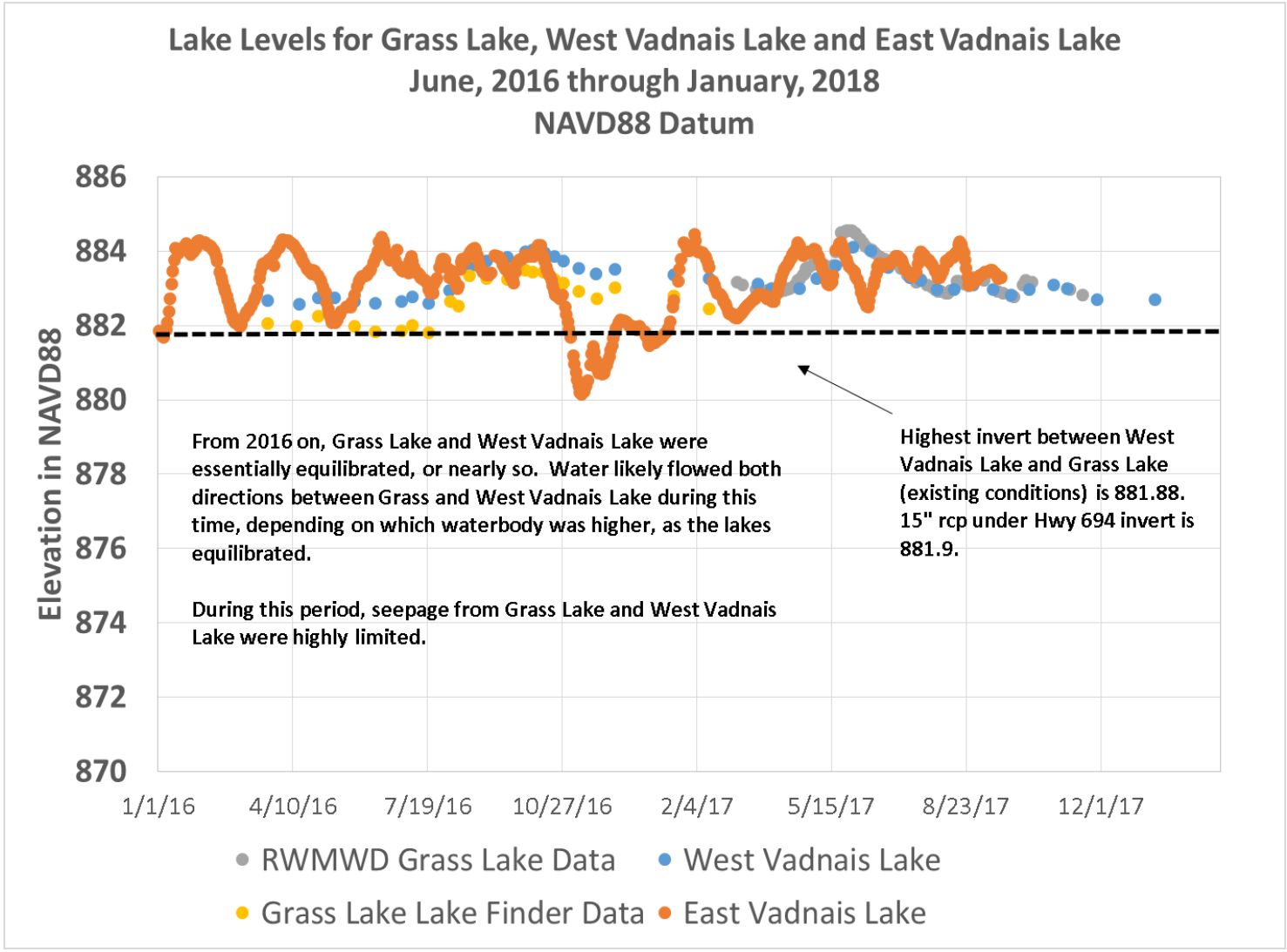
Evaluate decreasing draw down time

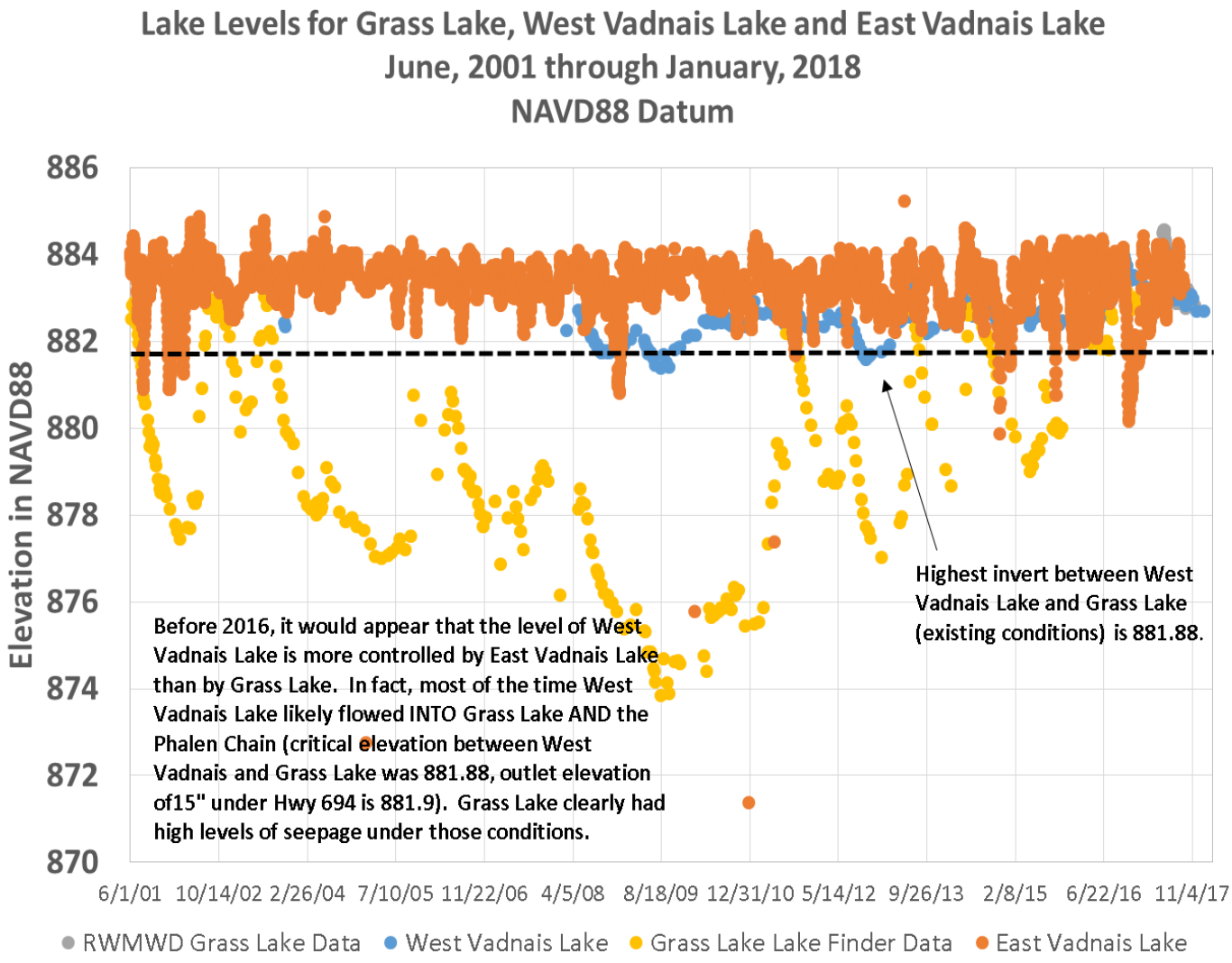
1. **Do nothing further**
2. **Pump water from West Vadnais to East Vadnais**
3. **Promote infiltration of water from West to East, laterally, through the existing berm**

Grass Lake/West Vadnais Lake Model estimated Drawdown Times

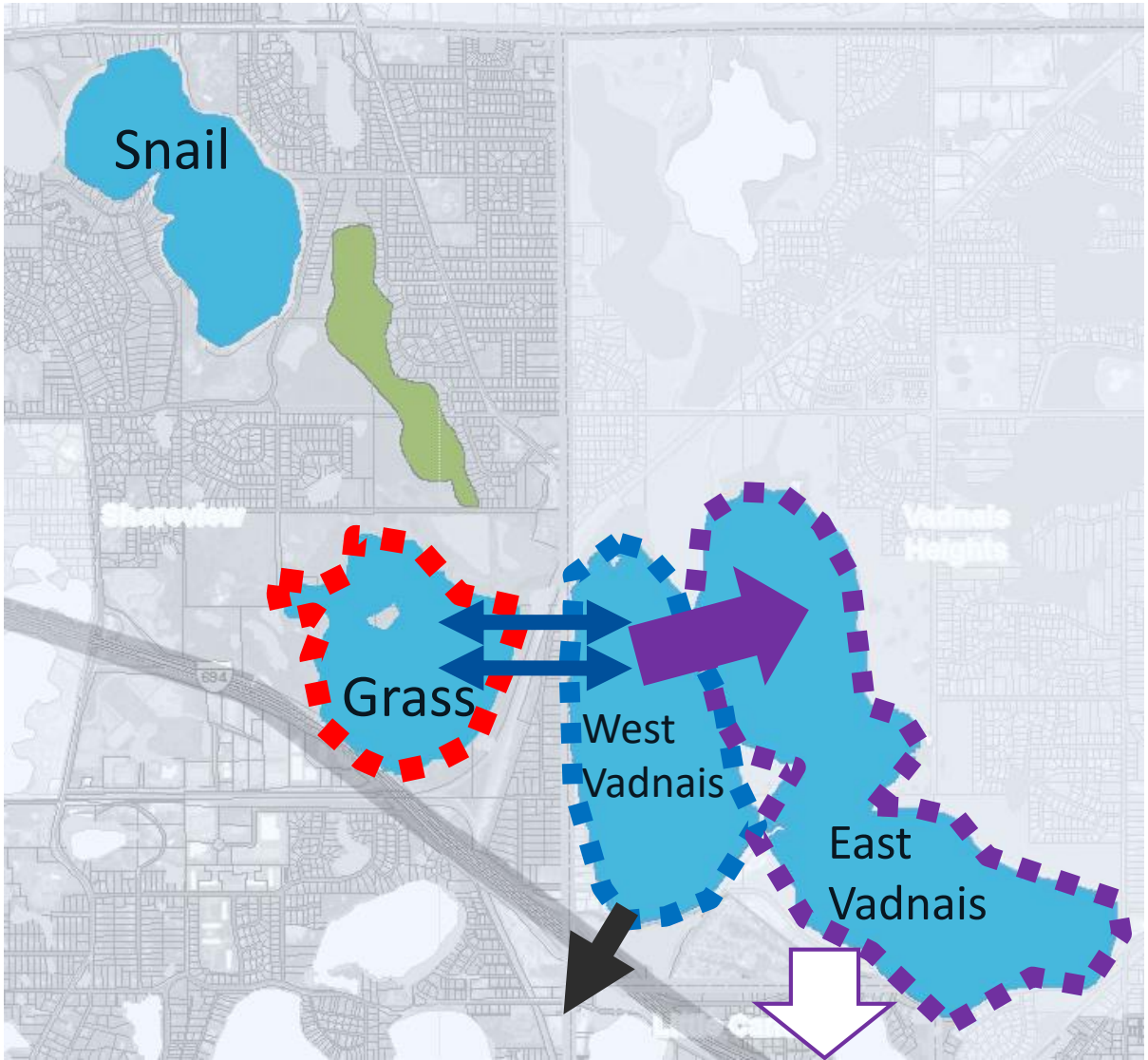
Note: the WSE of Grass Lake and West Vadnais Lake equalize




Lake Levels for Grass Lake, West Vadnais Lake and East Vadnais Lake
June, 2016 through January, 2018
NAVD88 Datum
Elevation in NAVD88
886
884
882
880
878
876
874
872
870
1/1/16
4/10/16
7/19/16
10/27/16
2/4/17
5/15/17
8/23/17
12/1/17
From 2016 on, Grass Lake and West Vadnais Lake were essentially equilibrated, or nearly so. Water likely flowed both directions between Grass and West Vadnais Lake during this time, depending on which waterbody was higher, as the lakes equilibrated.
During this period, seepage from Grass Lake and West Vadnais Lake were highly limited.
Highest invert between West Vadnais Lake and Grass Lake (existing conditions) is 881.88. 15" rcp under Hwy 694 invert is 881.9.
RWMWD Grass Lake Data
West Vadnais Lake
Grass Lake Lake Finder Data
East Vadnais Lake


Lake Levels for Grass Lake, West Vadnais Lake and East Vadnais Lake
June, 2001 through January, 2018
NAVD88 Datum
Elevation in NAVD88
886
884
882
880
878
876
874
872
870
6/1/01
10/14/02
2/26/04
7/10/05
11/22/06
4/5/08
8/18/09
12/31/10
5/14/12
9/26/13
2/8/15
6/22/16
11/4/17
Highest invert between West Vadnais Lake and Grass Lake (existing conditions) is 881.88.
Before 2016, it would appear that the level of West Vadnais Lake is more controlled by East Vadnais Lake than by Grass Lake. In fact, most of the time West Vadnais Lake likely flowed INTO Grass Lake AND the Phalen Chain (critical elevation between West Vadnais and Grass Lake was 881.88, outlet elevation of15" under Hwy 694 is 881.9). Grass Lake clearly had high levels of seepage under those conditions.
RWMWD Grass Lake Data
West Vadnais Lake
Grass Lake Lake Finder Data
East Vadnais Lake

Grass Lake
Pump West Vadnais to East Vadnais



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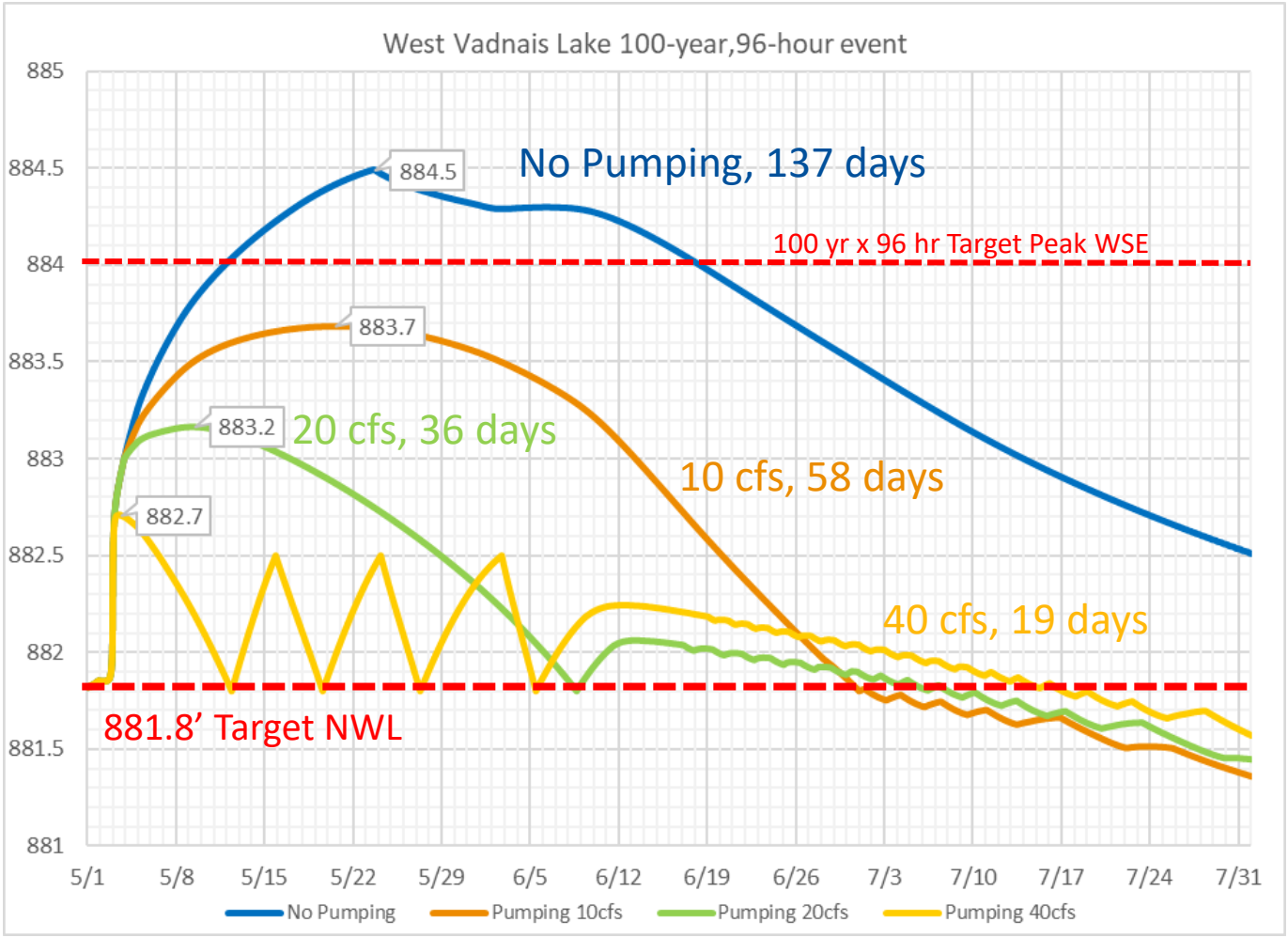
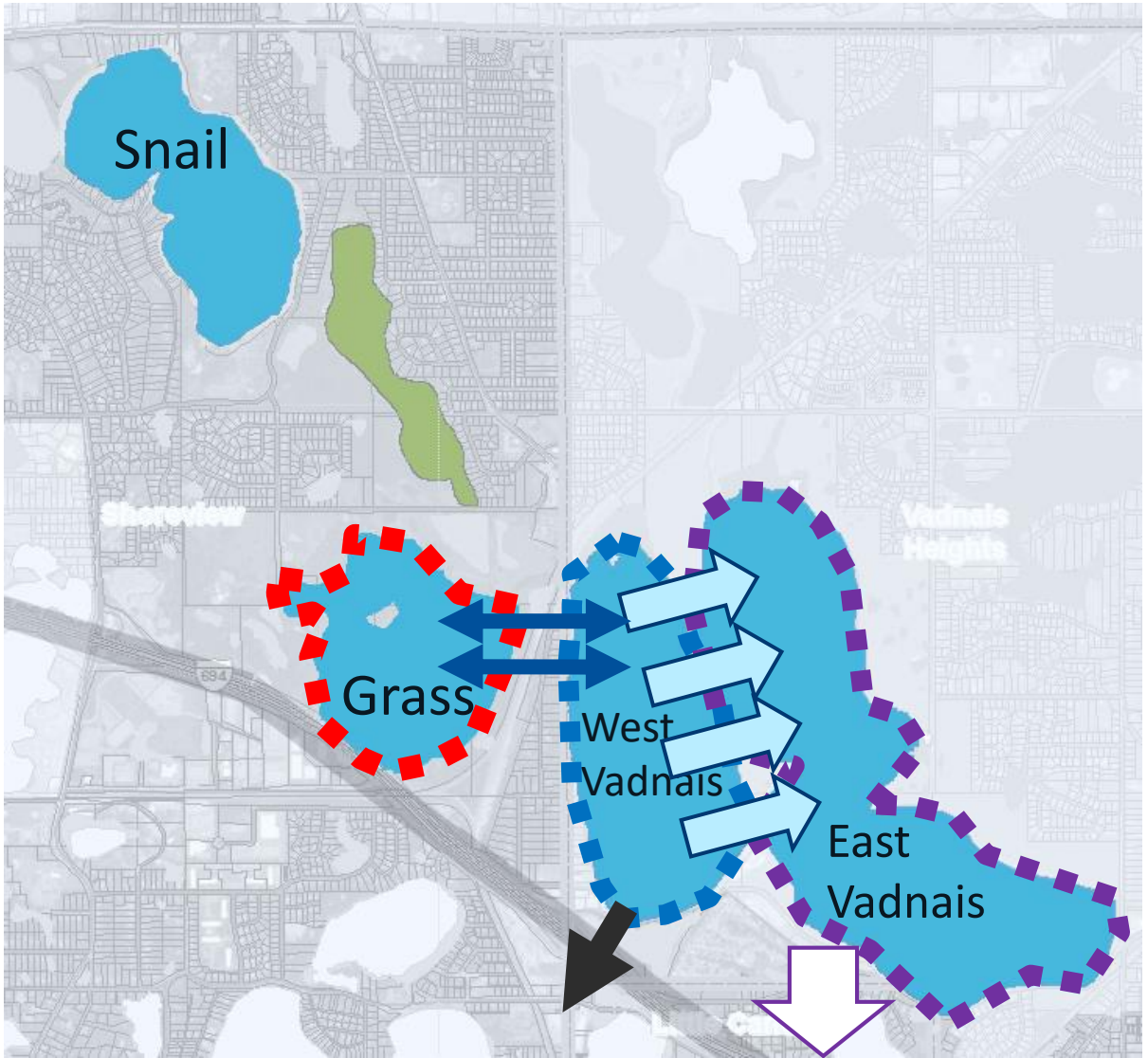
Grass Lake/West Vadnais Lake Model estimated Drawdown Times

Note: the WSE of Grass Lake and West Vadnais Lake equalize



Grass Lake
Lower West Vadnais, Lower East Vadnais below West Vadnais



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Cost?

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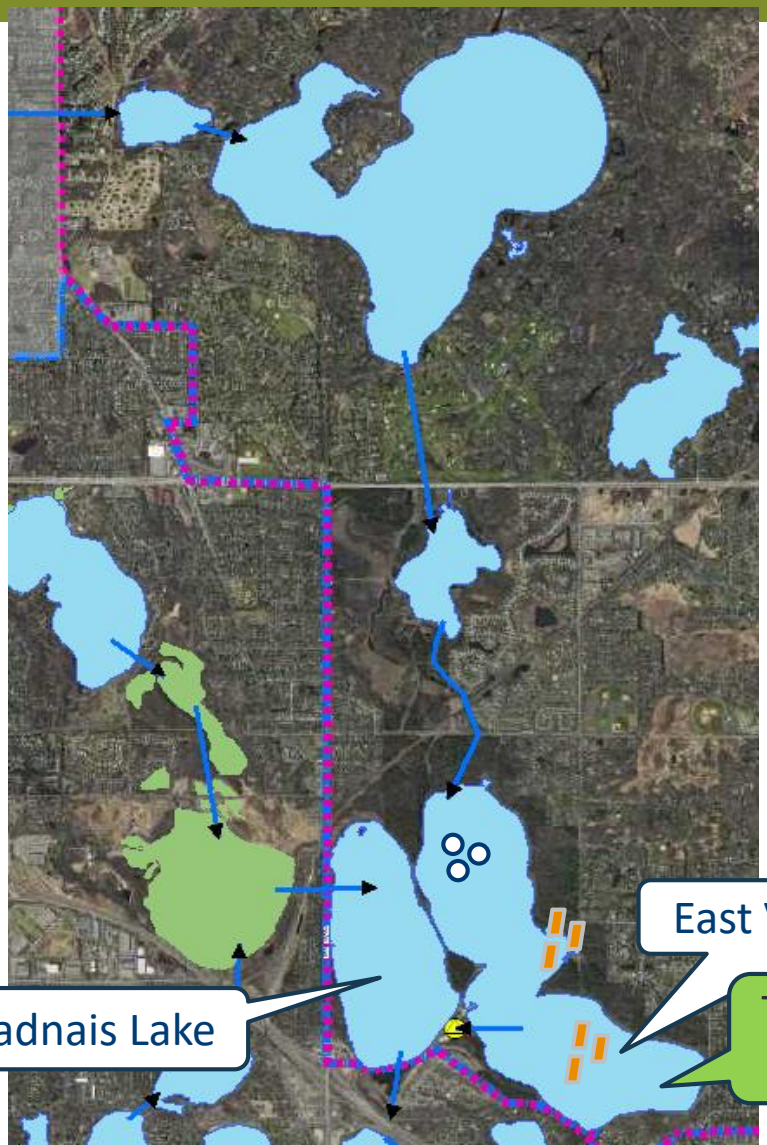
Next steps: Water quality and seepage assessment



In-Lake Aeration

In-Lake $FeCl_3$ addition

2017 Annual Average TP

East Vadnais Lake 27.5 µg/L

TP Goal: 25 µg/L

West Vadnais Lake 130 µg/L

60 µg/L Goal

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Recommendation

Recommendation:

1. Continue to pursue further lowering of East Vadnais below West Vadnais with the SPRWS
2. Complete the proposed scope of work -West Vadnais Lake to East Vadnais Lake Gravity Flow – Feasibility Evaluation per scope summary

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North Gramsie Pond

- **Manage the water level in North Gramsie Pond to Elevation 877 or lower and protect it from Grass Lake overflows (above Grass Lake elevation 884)**

North Gramsie Pond - conclusions

- The data and modeling inferred that Wetland A can be as high as Elevation 880 with little to no measureable impact on groundwater levels in the vicinity of the Crestview Addition
- The "North Gramsie Pond" does influence groundwater levels in Crestview Addition.
  - Manage at elevation 877 or lower to minimize related groundwater impacts.
- Suzanne Pond does influence groundwater levels in Crestview Addition.
  - Manage at elevation 873 or lower to minimize related groundwater impacts.

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North Gramsie Pond - recommendations

- Develop an emergency response plan to implement flow diverting, in the event Grass Lake overflows.
- Partner with the city of Shoreview to install a pipeline at elevation 877 with a manual gate valve to link the North Gramsie Pond to Suzanne Pond.
- Partner with the city of Shoreview to inspect the Suzanne Pond pumps and lift station and consider upgrading the pumps to increase their dependability and longevity.
- Partner with the city of Shoreview to prepare/agree on an operation and maintenance plan for Suzanne Pond pumping and North Gramsie gate valve operations.

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Please refer to this summary table in the packet

Table 1: Benefits, costs and feasibility issues associated with the various flood management options evaluated for the Grass Lake area.

Conceptual Project No.	Conceptual Alternative Description	Primary Benefits: Increase Flood Storage: Drawdown Time (Lake, Days)	Primary Benefits: Homes and Beach at Snail Lake and Crestview Addition	Secondary Benefits: Parkland & Trails	No. of Permits	Implementation Timeline	Capital Cost	O&M Activities
Complete	**West Vadnais Outlet Cleanout:** 2018 - Cleanout channel to West Vadnais Outlet (15" at I-694)	Improve conveyance from West Vadnais Lake to outlet.	None	Less trail inundation frequency & duration due to recreational trails and park land	1 permit	Complete by first half of 2018	$55,000	Inspect and maintain channel
Under Construction	**Raise Grass Lake Berm and Trail at Gramsie Road**	No change	None	Less trail inundation frequency & duration due to recreational trails and park land	2+ permits	Complete by first half of 2018	$337,400	Inspect and maintain berm and emergency spillway
Under Construction	**Lower Grass Outlet:** 2018 - Lower Grass Lake Outlet 881.8 to 881.2	Improve conveyance from Grass Lake to West Vadnais Lake.	None	Less trail inundation frequency & duration due to recreational trails and park land	2+ permits	Complete by first half of 2018	$170,000	Inspect and maintain outlet
Project 1	**Emergency Flood Response Plan & Temporary Measures:** Partner with the City of Shoreview and Ramsey County Parks and Recreation to implement an emergency response plan for Snail Lake, including the emergency diversion of Snail Lake overflows to wetland A (and away from the "back-door route").	No change	Sandbag levees or other response actions to reduce risk to 1 home below the overflow (887.9) from Snail Lake to Grass Lake. Sandbag backdoor route to reduce risk to Crestview Addition and force water through wetland A instead.	Less trail inundation frequency & duration due to recreational trail raises and possible floating walkways	2+ permits	6 to 18 months	$15,000 (plan development cost)	Deploy and remove sandbag levees and precautionary trail safety measures
Project 2	**Manage the water level in North Gramsie Pond:** Manage the water level in North Gramsie Pond to Elevation 877 or lower and protect it from Grass Lake overflows.	None	Protects low homes in the Crestview Addition from flooding from groundwater.	Increases the likelihood that the pedestrian tunnel below Gramsie Road stays navigable during high water periods.	2+ permits	6 to 18 months	TBD	Pipe and Suzanne Pond pumps maintenance
Project 3	**Improve Park Trail Resiliency to Fluctuating Water Levels in Wetland A:** Assist Ramsey County Parks and Recreation in choosing an alternative path alignment through the north and east sides of wetland A that elevates the pathway (final elevation to be confirmed after the county conducts topographic, soil and vegetation surveys to better define the future alignment and elevation).	None	None	Navigable trail around wetland A, at higher water levels	2+ permits	6 to 18 months	TBD	TBD
Project 4	**Lower East Vadnais Lake Elevation to 881:** Formally request that the SPRWS start to operate East Vadnais Lake at an elevation of 881.	Increase flood storage on East Vadnais Lake to buffer Lambert Creek high flows. Potential to reduce flood risk to SPRWS facilities on East Vadnais.	No direct benefit to homes on Snail Lake.	May lessen the frequency and duration of park and trail inundation	1 permit?	6 to 18 months	TBD	Continuous monitoring of West Vadnais Lake levels
Project 5	**Lower West Vadnais Outlet to 881:** Lower the15" at I-694 from elevation 881.8 to 881.0 . Continue pursuing this option with the DNR and VLAWMO, but only implement if East Vadnais Lake can be operated at a lower elevation to prevent the seepage of East Vadnais Lake water into West Vadnais Lake.	Increase flood storage at West Vadnais and Grass Lake.	No direct benefit to homes on Snail Lake	May lessen the frequency and duration of park and trail inundation	5+ permits	12 to 24 months	$41,000 + costs for shoreline restorations	Seasonal gate operation between Grass Lake and West Vadnais Lake during dry years may be needed.
Project 6	**Lower East Vadnais Lake Elevation to below 881 to promote seepage from West Vadnais Lake to East Vadnais Lake:** Continue to pursue this option with the SPRWS, including completion of the proposed scope of work that will be presented to the district board at its May meeting. Perform water quality assessment for SPRWS (TP+MCL) and seepage assessment (West to East).	Increase flood storage on East Vadnais Lake to buffer Lambert Creek high flows. Potential to reduce flood risk to SPRWS facilities on East Vadnais. Increased flood storage at West Vadnais and Grass Lake.	No direct benefit to homes on Snail Lake.	May lessen the frequency and duration of park and trail inundation	3+ permits	18 to 24 months	TBD - scoping this work is underway	Ongoing monitoring of water levels, water quality and subsurface flow.
Project 7	**Snail Lake to Grass Lake 15" Pipe:** Partner with the City of Shoreview and Ramsey County Parks to install an off-peak drawdown pipeline that connects Snail Lake to Grass Lake (1.2 cfs gravity flow).	Increase flood storage at Snail Lake: 80 million gallons over 100 days @ 1.2 cfs	More ability to actively manage Snail Lake W.S.E. for 2' freeboard to homes and available flood storage. Less beach inundation.	Less variable Snail Lake level, less Snail Lake shoreline vegetation maintenance	4+ permits	12 to 36+ months	$620,000 disturb park land, wetland impacts	New regular lake level monitoring, seasonal management to open/close gate.
~~Not Recommended~~	~~Pumping from Snail to Bucker:~~ ~~Snail Lake to Bucker Lake Pumping (1.2 cfs, 10 cfs, 20 cfs)~~	Draw down 100-year X 96 hour event to 882.0 and increase flood storage at Snail Lake: 80 million gallons over 100 days @ 1.2 cfs, 160 million gallons over 24 days @ 10 cfs, 170 million gallons over 13 days @ 20 cfs	Reduce flood risk to 4 homes on Snail Lake. Preserve 2 feet freeboard at 1 lowest home on Snail Lake. Less beach inundation.	Little or no benefit to trails and parkland at Grass Lake. Less Snail Lake shoreline maintenance.	10+ permits	24 to 48 months	$1.0 million to $3.5 million	Significant: electricity, maintenance
~~Not Recommended~~	~~Pumping from West to East Vadnais:~~ ~~West Vadnais to East Vadnais Pumping (10 cfs, 20 cfs)~~	Draw down 100-year X 96 hour event to 881.8 and increase flood storage at West Vadnais and Grass Lake: 137 days @ 0 cfs (infiltration and evap), 375 million gallons over 58 days @ 10 cfs, 462 million gallons over 38 days @ 20 cfs	No direct benefit to homes on Snail Lake.	May lessen park and trail inundation associated with primary benefits	10+ permits	24 to 48 months	$2.5 million to $4.0 million	Significant: electricity, maintenance, chemicals, sedimentation pond cleanouts. In-lake treatment may also be required.

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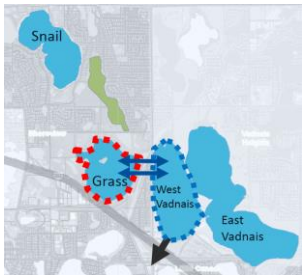
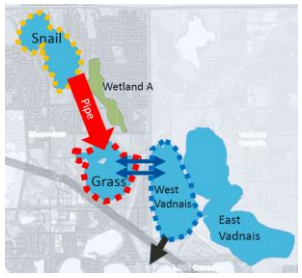
If approved, what's next?

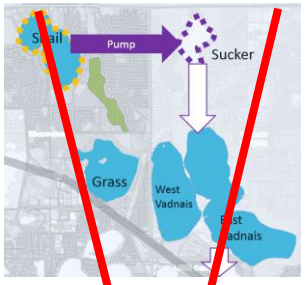
- Meet with the city and county to discuss potential partnering and cost implications associated with the recommended options.
- Prepare ERPs for Snail and Grass Lake and seek formal agreements by city to implement.
- Make formal request to SPRWS to operate EVL at 881.0 for interim.
- Prepare scope of work for information and studies and discuss with DNR.
- Conduct seepage study per scope of work in handout.

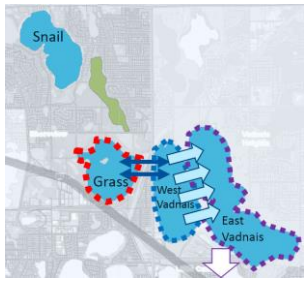
Additional Slides

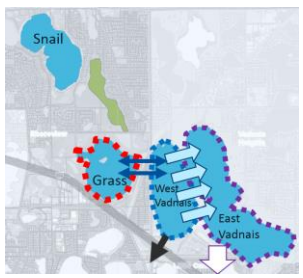
Studied Options Summary











1 of 6	2 of 6	3 of 6	4 of 6	5 of 6	6 of 6
Lower West Vadnais	Pipe Snail and Lower West Vadnais	Pump Snail	Lower East Vadnais	Lower East Vadnais & Lower West Vadnais	Pump West Vadnais
$40,000	$620,000	$2,500,000+	?	?	$2,500,000+
	Ramsey Co. Parks		Ramsey Co. Parks	Ramsey Co. Parks	Ramsey Co. Parks
VLAWMO	VLAWMO	VLAWMO	VLAWMO	VLAWMO	VLAWMO
MNDNR	MNDNR	MNDNR	MNDNR	MNDNR	MNDNR
		SPRWS	SPRWS	SPRWS	SPRWS
	Shoreview	Shoreview			

Incremental Implementation

	Alternative Responses to Mitigating Flood Risk	Benefits
✓	Raise Berm and Trail along Gramsie Road	Lessens risk of Grass overflows to Wetland A
✓	Lower Grass Lake Outlet 881.6 to 881.2 (2018 project)	Optimize Flow Capacity to West Vadnais
✓	Cleanout channel to West Vadnais Outlet 15-Inch at 694: elevation 881.8	Optimize Flow Capacity out of West Vadnais
Study Complete	Snail Lake to Grass Lake 15" Gravity Pipe (1.2 cfs) and Lower West Vadnais 15" Outlet 881.8 to 881.0	More flood storage
	Pump Snail Lake Water to Sucker Lake	More flood storage, active management of high lake levels
	Pump West Vadnais Water to East Vadnais	More flood storage
	Lower East Vadnais Water Level	More flood storage
	Emergency Flood Response Plan & Temporary Measures by City of Shoreview	Protect homes & infrastructure

Permitting needs

Table 4: Permitting considerations

Approval entity	Permit/approval	Justification
U.S. Army Corps of Engineers (USACE)	Section 404 permit	Required for work activities below the ordinary high water level of waters/wetlands under agency jurisdiction
U.S. Fish and Wildlife Service	Section 7 (Endangered Species Act) compliance	Required as part of the USACE's Section 404 permitting process
Minnesota DNR	• Work in public waters permit • Water appropriations permit	▪ Required for work activities below the OHWL of a designated public water ▪ Required for withdrawing more than 10,000 gallons of water per day or 1 million gallons per year; also required to appropriate or transport any amount of infested water
Minnesota Pollution Control Agency	General stormwater permit for construction	Required for projects that result in more than 1 acre of ground disturbance
Minnesota Wetland Conservation Act	Project compliance	▪ Required for impacts to wetlands that are not under jurisdiction of the USACE or DNR. ▪ Administered by the VLAWMO and RWMWD in their jurisdiction
State Historic Preservation Office	Section 106 (National Historic Preservation Act) compliance	Required as part of the USACE's Section 404 permitting process
City of Shoreview (Snail Lake is in Shoreview)	▪ Erosion/excavating/grading permit ▪ Right-of-way excavation permit ▪ Floodplain management special district compliance ▪ Shoreland management special district compliance	▪ Project activities are expected to require movement of more than 10 cubic yards of soil and disturb an area of more than 1,000 square feet ▪ Construction would occur in a City of Shoreview right-of-way ▪ Required for projects in floodplain overlay district ▪ Applied to all projects within 1,000 feet of a protected water body
City of Vadnais Heights (Sucker Lake is in Vadnais Heights)	▪ Excavation permit ▪ Engineering and public works approval ▪ Utilities approval ▪ Floodplain area approval ▪ Shoreland area approval	▪ Project activities are expected to require movement of over 6 cubic yards of soil ▪ Engineering and Public Works departments typically provide input on significant projects ▪ Project will require modifications to city utilities ▪ Required for projects that take place within designated floodplain area ▪ Required for all work within 1,000 feet of designated shoreland area
SPRWS (manages chain of Pleasant, Sucker, and East Vadnais lakes)	Update source water protection plan (SWPP)	▪ Minnesota Department of Health required to complete source water assessments for public water systems ▪ SPRWS not required under Safe Drinking Water Act, but proactive in developing SWPP ▪ New source potentially being introduced from West to East Vadnais lakes (West Vadnais Lake outside of Vadnais Lake Source Water Protection Area)

2 Cities

- Shoreview
- Vadnais Heights

3 Water Jurisdictions

- RWMWD
- VLAWMO
- SPRWS (Drinking Water)

Crossing Two State Aid Roadways

Wetlands at Pumping Inlet & Outlet

Invasives Species

- East Vadnais (EWM, ZM)

MnDNR Appropriations

BARR

How do existing water quality conditions compare?

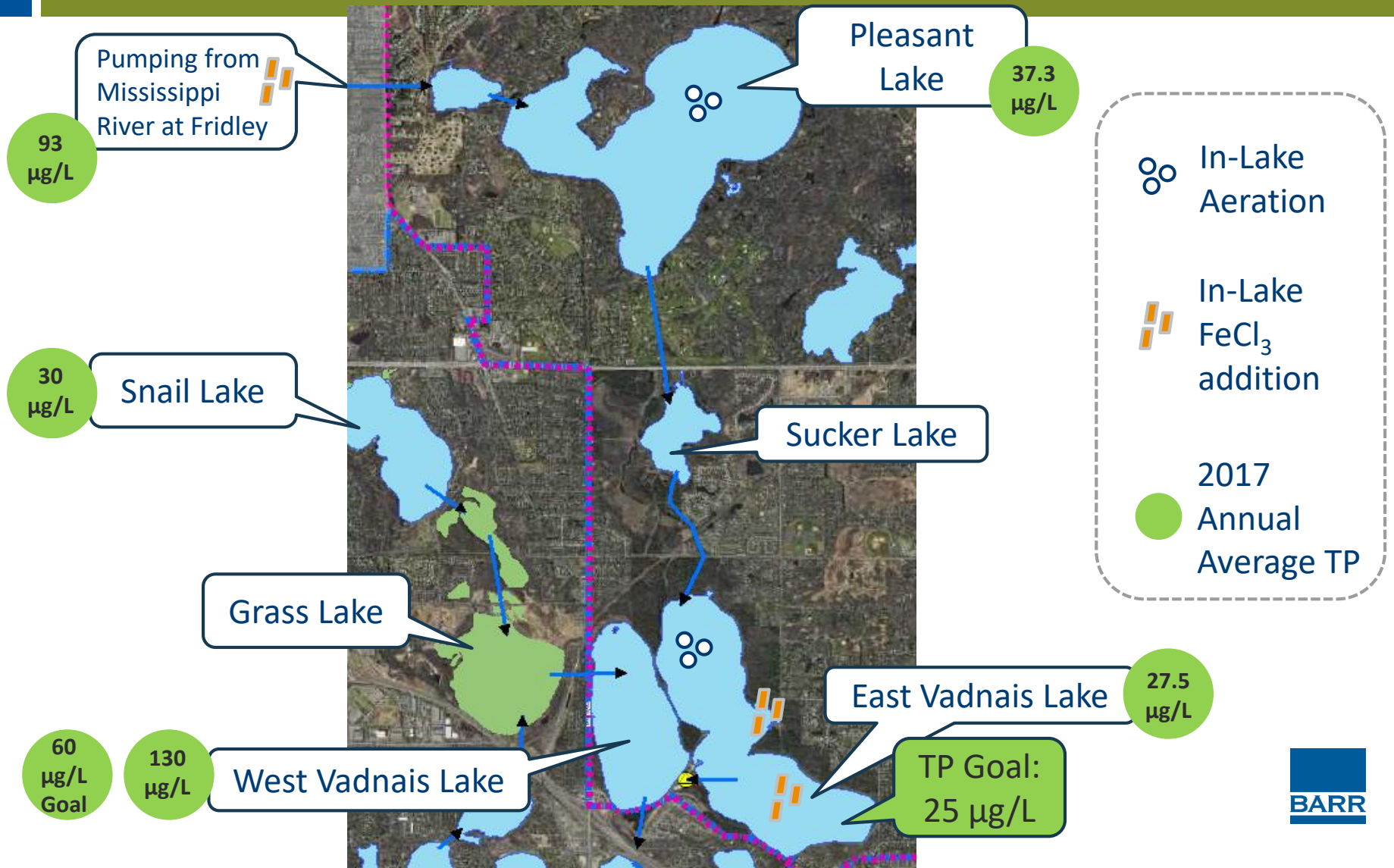


Table 3: TP (µg/L) in water bodies of interest (average annual concentration)

Year	Fridley	Pleasant Lake	Sucker Lake	**East Vadnais Lake**	**West Vadnais Lake**	SPRWS plant effluent
2009	57.3	414.3	39.6	**31.9**	**185.2**	14.4
2010	79.6	189.9	80.5	**49.5**	**137.6**	27.9
2011	53.8	118.1	-	**30.6**	**137**	10.9
2012	42.8	168.2	-	**27.8**	**-**	7.1
2013	46.9	191.8	-	**16.5**	**79.1**	-
2014	68.4	42.2	-	**28.6**	**70.1**	3.9
2015	52.6	58.9	-	**26.6**	**88.2**	7.0
2016	52.2	80.3	-	**34.6**	**110.86**	13.7
2017	-	37.3	-	**25.7**	**130.4**	-

Next Steps
Incremental Implementation

- ✓ 2018 - Raise Berm and Trail along Gramsie Road **benefits**
- ✓ 2018 - Lower Grass Lake Outlet 881.6 to 881.2 **benefits**
- ✓ 2018 - Cleanout channel to W. Vadnais Outlet 15-Inch at 694 **benefits**
- West Vadnais water quality assessment for SPRWS (TP + MCL)
- West Vadnais to East Vadnais seepage assessment
- Emergency Response Plans – City of Shoreview
- Snail emergency overflow change
- Study Underway — Future? – Lower East Vadnais Lake Level
- Study Complete — Future? - Lower West Vadnais 15” Outlet 881.8 to 881.0
- Study Complete — Future? - Snail Lake to Grass Lake 15” Gravity Pipe

etc.

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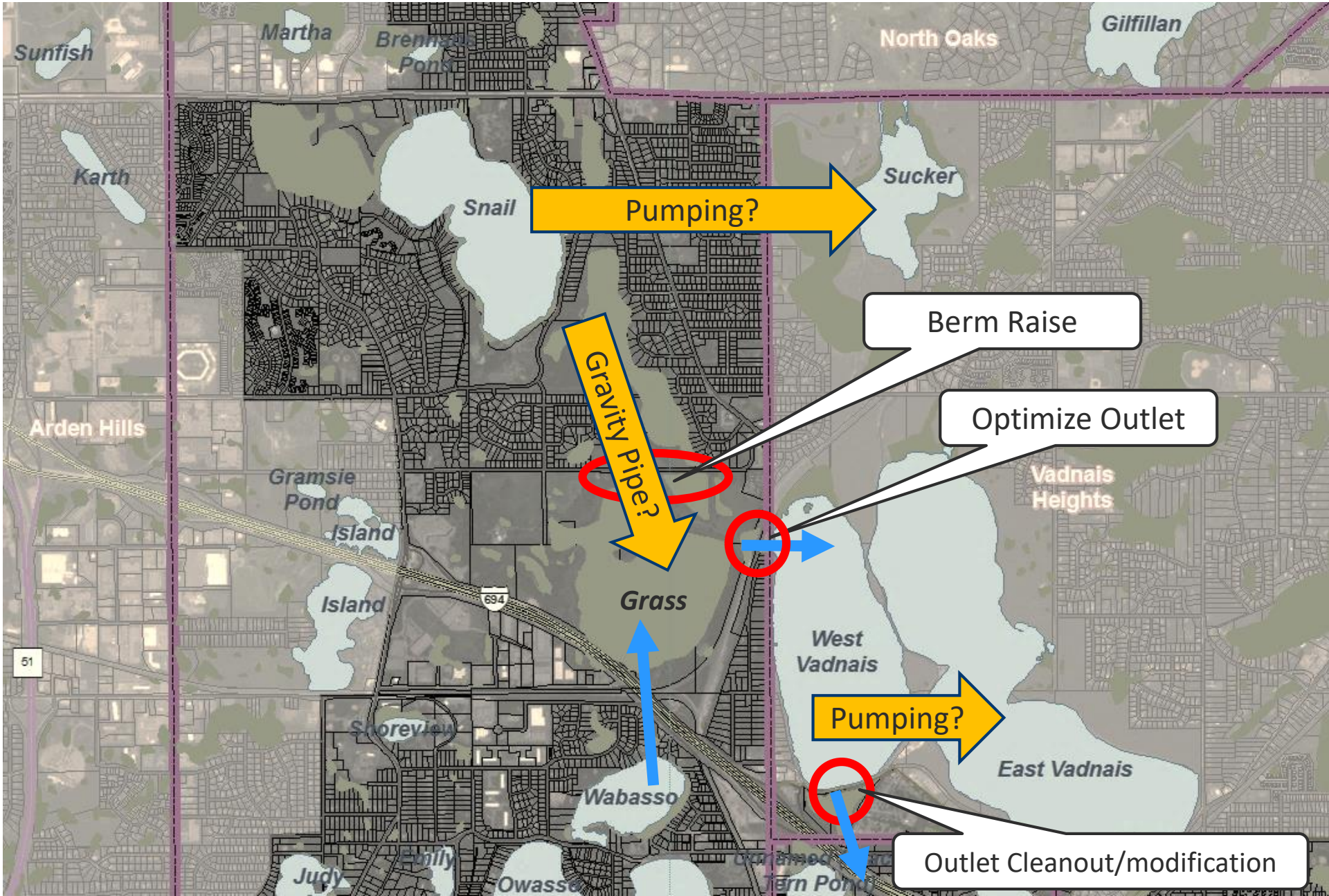
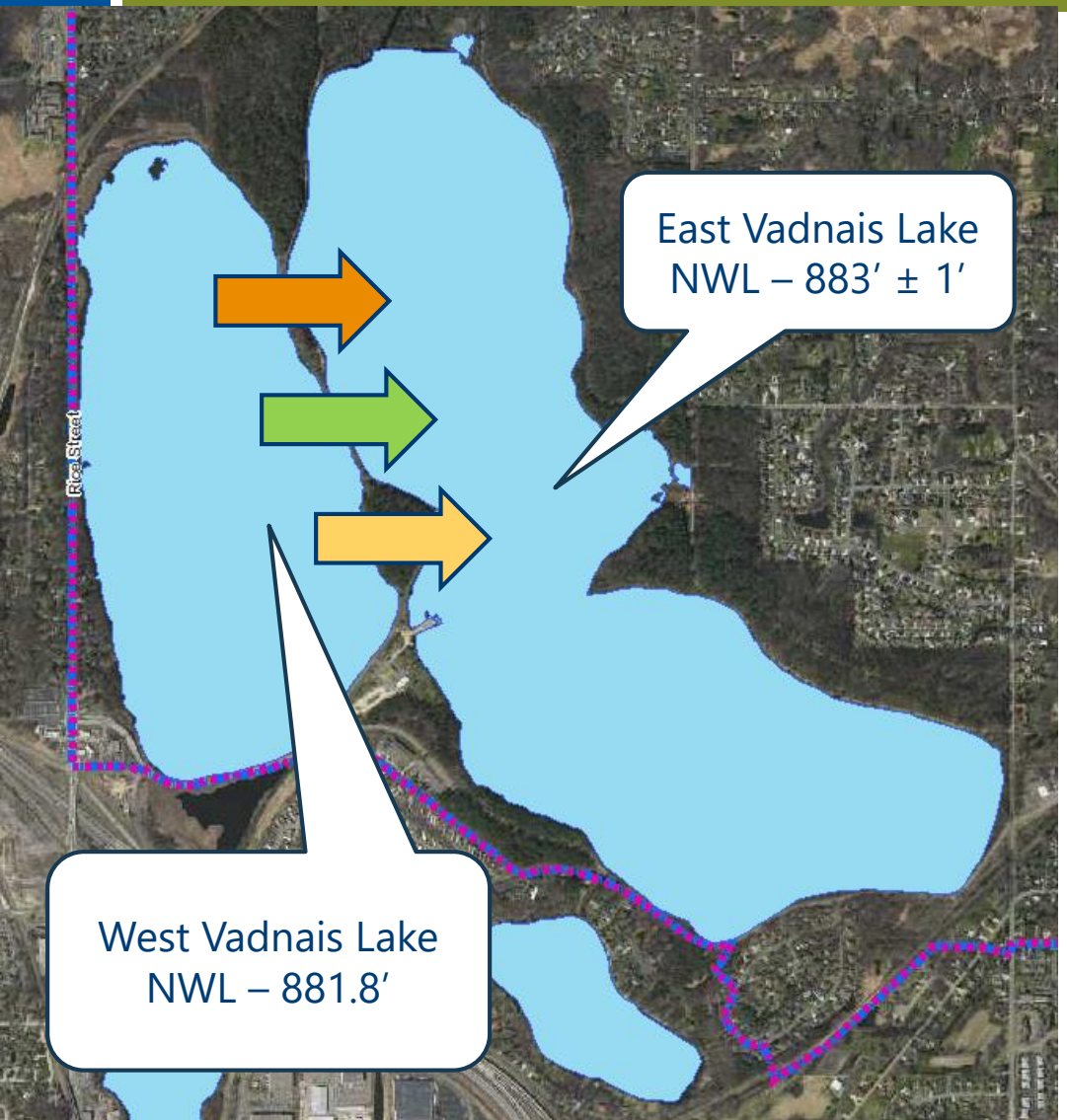
What option(s) will best manage lake levels?



West Vadnais Lake and East Vadnais Lake
System Pumping and Related drawdown times



For the critical event: 100 yr x 96 hr

10 cfs

- 375 million gallons
- 58 day drawdown
- 408 lbs TP / year

20 cfs

- 462 million gallons
- 36 day drawdown
- 502 lbs TP / year

40 cfs

- 489 million gallons
- 19 day drawdown
- 531 lbs TP / year

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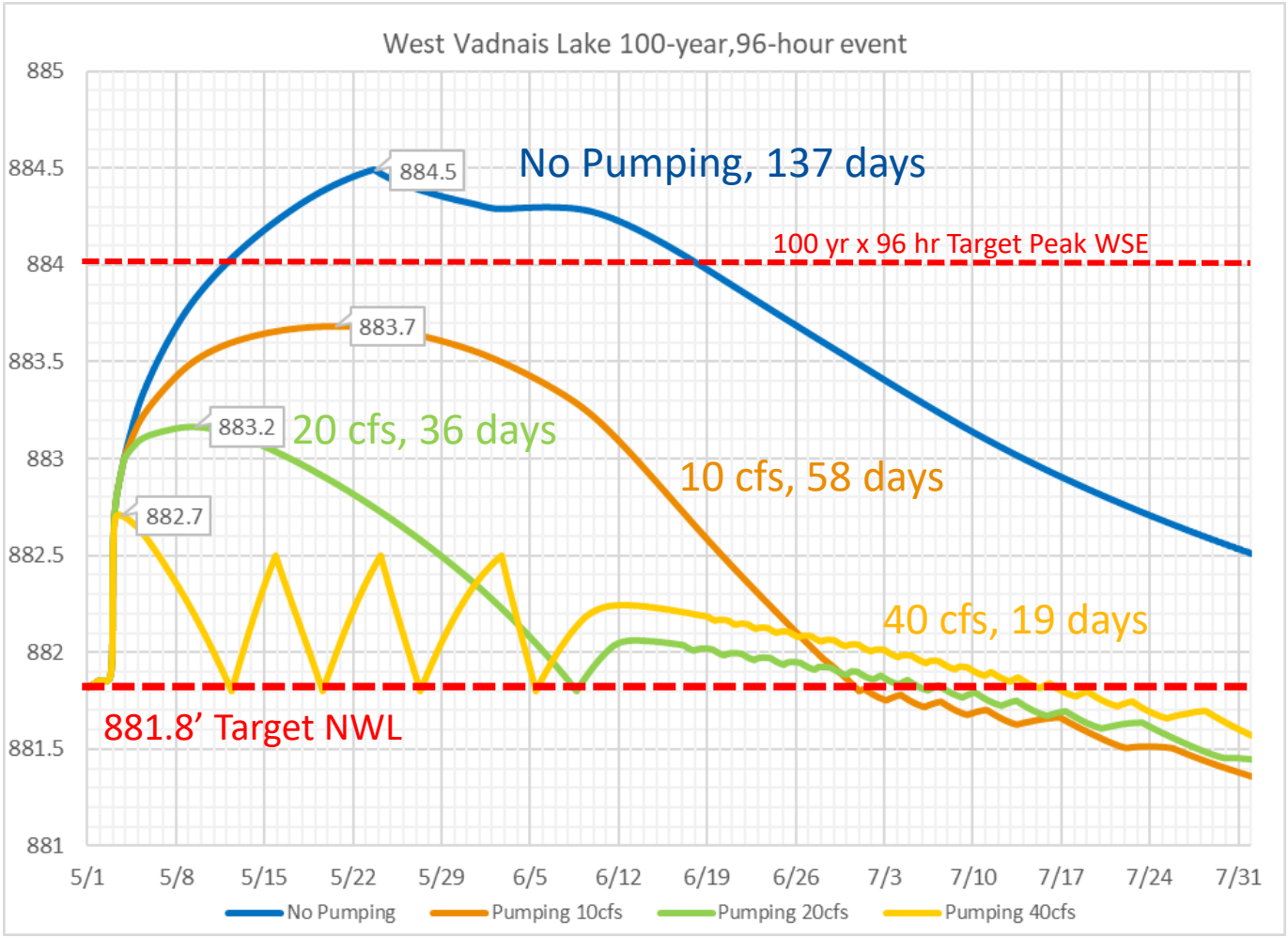
West Vadnais Lake to East Vadnais Lake Pumping Evaluation

Model estimated West Vadnais Lake Drawdown

Note: the WSE of Grass Lake and West Vadnais Lake equalize



Can we pump West Vadnais Lake water to Saint Paul Regional Water Services (SPRWS) ?

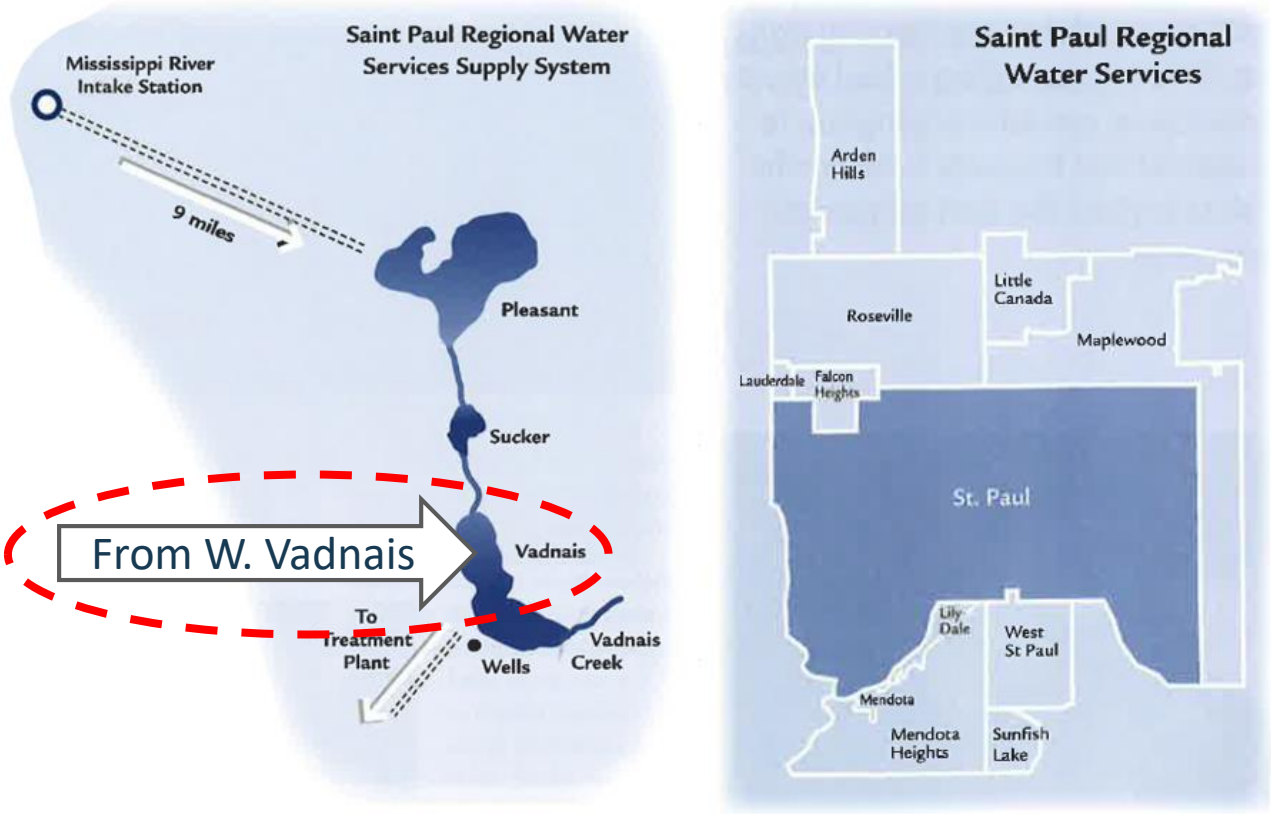
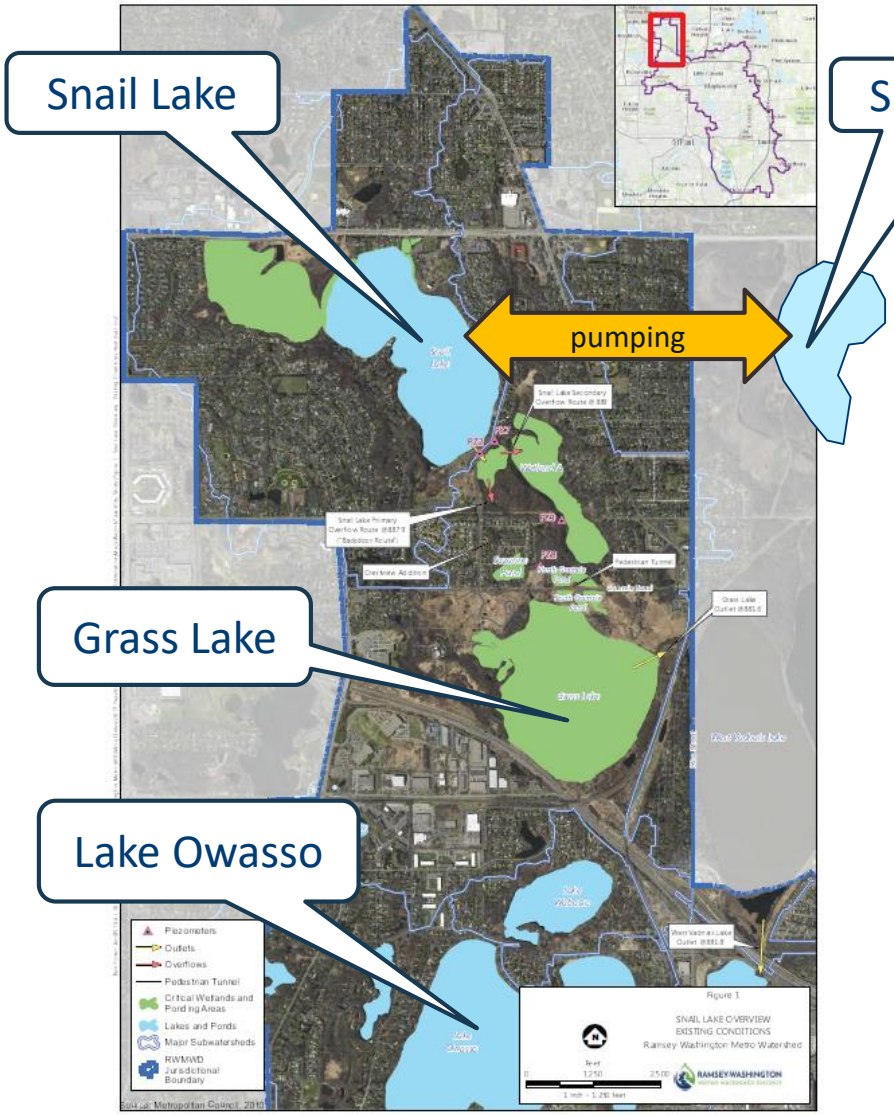


Figure 3 – Overview: SPRWS Supply System and Service Area

Image courtesy of Saint Paul Regional Water Services. The Saint Paul Regional Water System 2016 average annual water use was 14,603 million gallons with a maximum pumping capacity of 144 million gallons per day for an average 2016 daily water use of 38.2 million gallons (59 cfs).

Snail Lake to Sucker Lake Pumping Evaluation

Existing Snail Lake Augmentation pumping system



Existing pumping Sucker to Snail
Along Snail Lake Road
1,800 gpm (4 cfs)

Evaluated pumping Snail to Sucker
Two alignment concepts
1.2 cfs, 10.0 cfs and 20.0 cfs options

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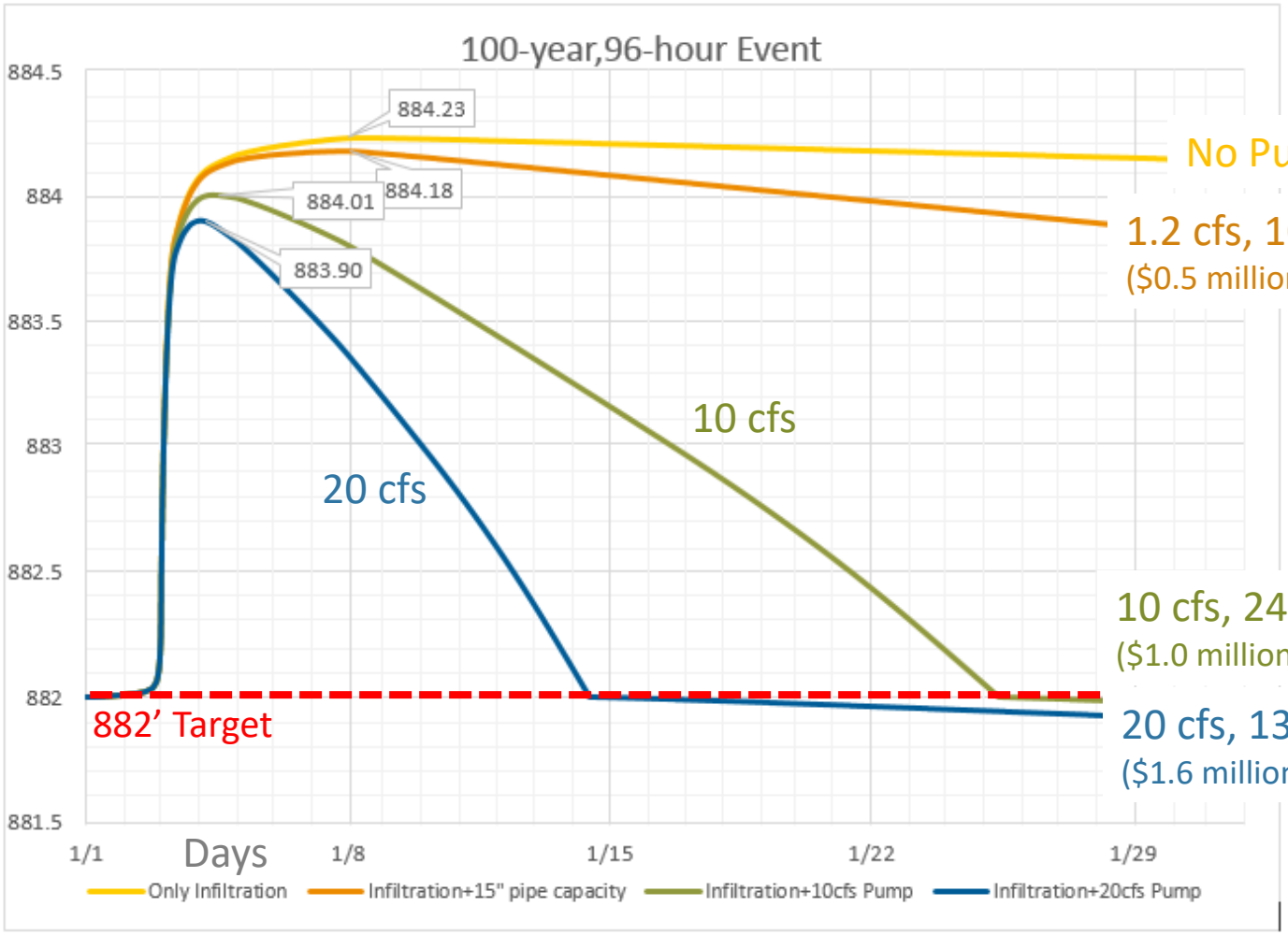
Snail Lake to Sucker Lake Pumping Evaluation
Model estimated Snail Lake Drawdown



No Pumping, 200 days

1.2 cfs, 100 days, $1.0 million
($0.5 million to $2.2 million), 8"+ pipe

10 cfs, 24 days, $2.2 million
($1.0 million to $4.8 million), 1x24" pipe

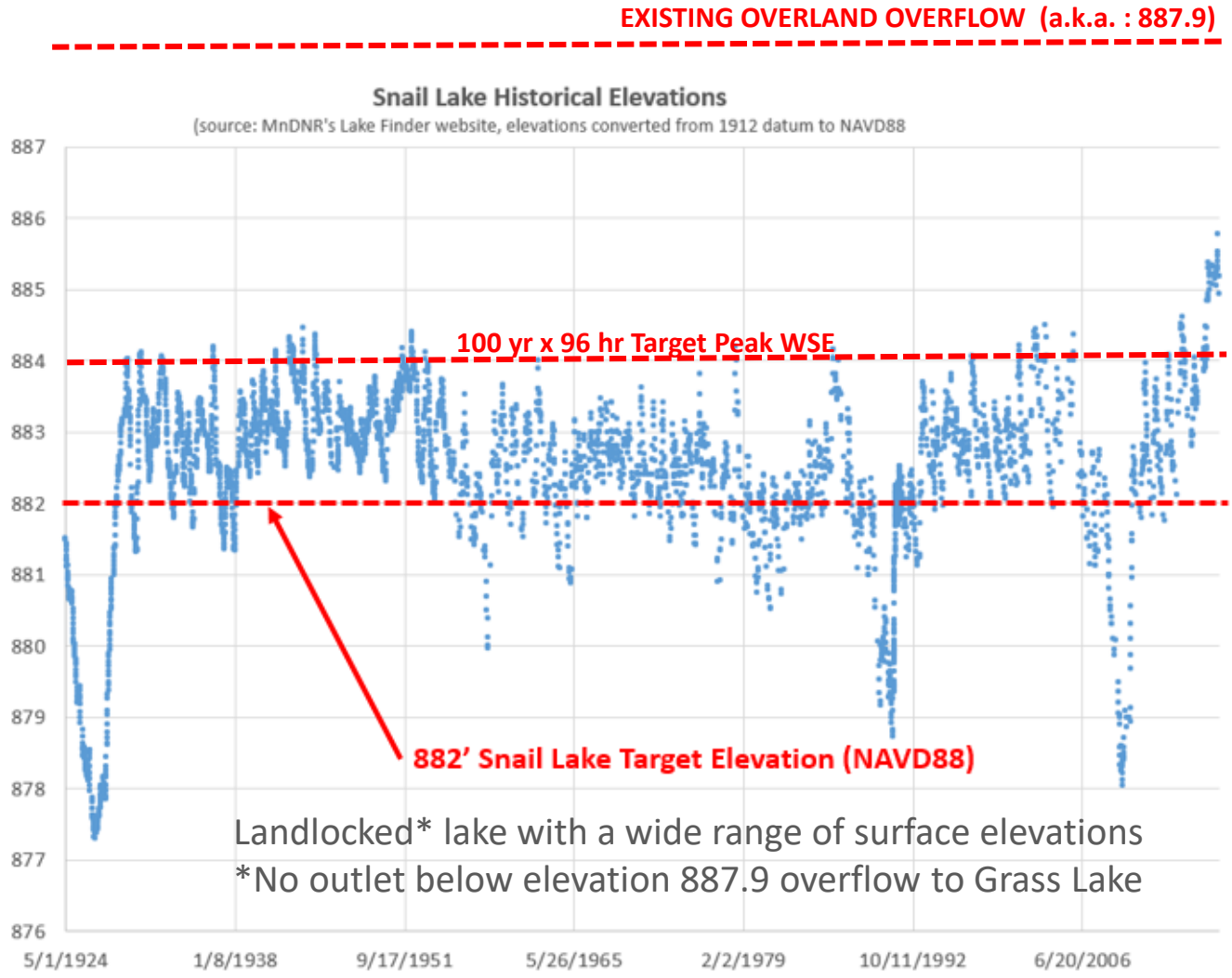
20 cfs, 13 days, $3.5 million
($1.6 million to $7.6 million), 2x24" pipes

Figure 4 – XP SWMMM Hydrologic Model Results:
Typical Snail Lake Water Surface Elevation Response to 100-yr, 96-hr Critical Event vs. No. Drawdown Days

BARR

Snail Lake to Sucker Lake Pumping Evaluation

Critical Event 100-yr, 96-hour



Landlocked* lake with a wide range of surface elevations

*No outlet below elevation 887.9 overflow to Grass Lake

Table 1 – Summary of 2017 Survey of Low Habitable Structures at Snail Lake

Snail Lake Habitable Structure	Unofficial 2017 Survey of Low Elevation at Habitable Structure (NAVD88)
4322 Lake Point	893.65
668 Highway 96	891.32
4154 Reiland Lane	889.66
4324 Lake Point	889.26
4320 Lake Point	888.80
4380 Reiland Lane	886.01

BARR

Can we pump Snail Lake water to Saint Paul Regional Water Services (SPRWS) ?

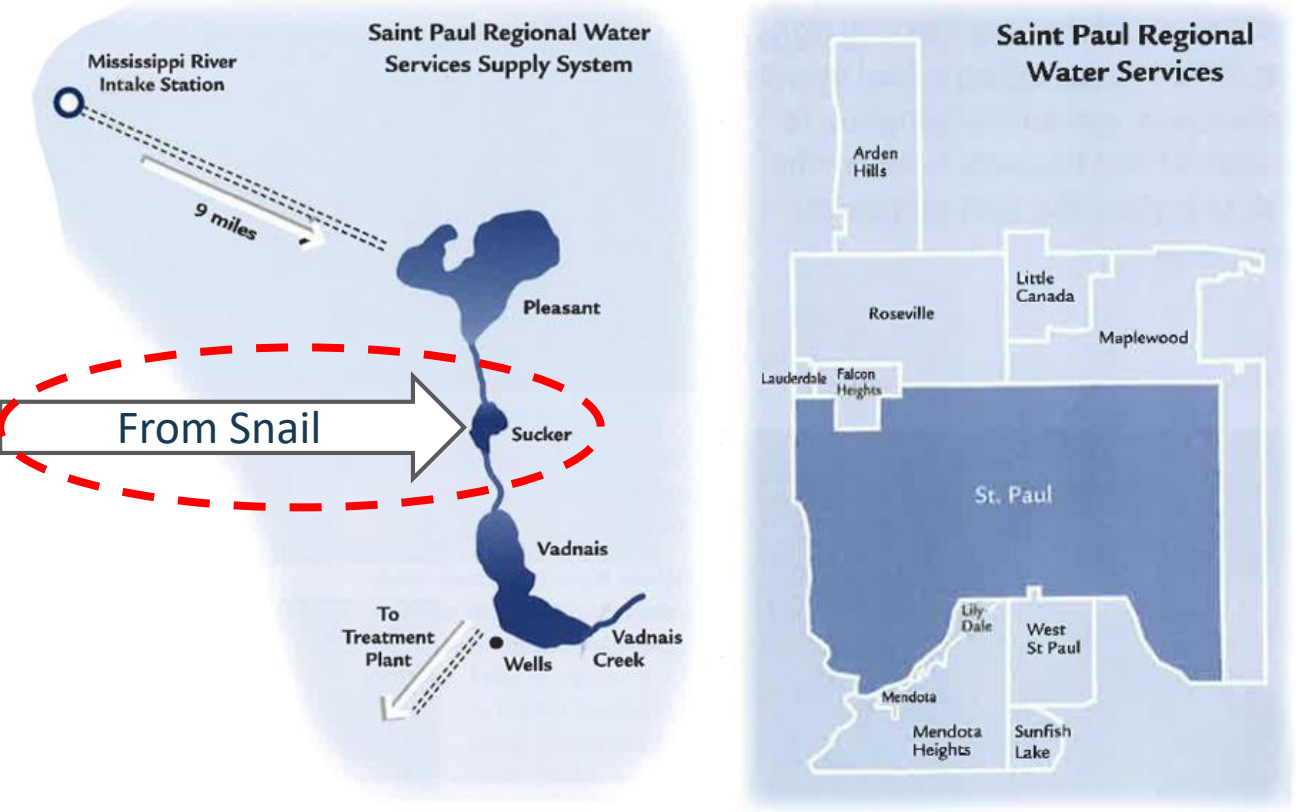


Figure 3 – Overview: SPRWS Supply System and Service Area

38 million gallons
(SPRWS avg. daily use)

80 million gallons
(1.2 cfs critical event drawdown, 100 days)

160 million gallons
(10 cfs critical event drawdown, 24 days)

170 million gallons
(20 cfs critical event drawdown, 13 days)

Image courtesy of Saint Paul Regional Water Services. The Saint Paul Regional Water System 2016 average annual water use was 14,603 million gallons with a maximum pumping capacity of 144 million gallons per day for an average 2016 daily water use of 38.2 million gallons (59 cfs).

BARR

Additional data

Table 5: Eutrophication water-quality parameters for water bodies of interest

Year	Fridley			Pleasant Lake			Sucker Lake		
	Chl-A (µg/L)	*NO_2+NO_3 (mg/L)*	OP (µg/L)	*Chl-A (µg/L)*	*NO_2+NO_3 (mg/L)*	OP (µg/L)	*Chl-A (µg/L)*	*NO_2+NO_3 (mg/L)*	OP (µg/L)
2009	-	0.76	35.1	15.4	0.3	114.3	-	0.28	32.3
2010	-	0.60	43.5	12.4	0.1	223.5	-	0.14	48.2
2011	-	0.80	23.3	-	0.4	94.7	-	-	-
2012	-	0.72	35.1	12.0	0.6	142.8	-	-	-
2013	-	0.56	60.7	9.4	0.1	0.0	-	-	-
2014	-	0.66	94.0	11.2	-	0.0	-	-	-
2015	-	0.58	35.3	18.1	-	21.3	-	-	-
2016	-	1.1	46.4	14.6	-	21.4	-	-	-
2017	-	-	-	-	-	-	-	-	-

Year	East Vadnais Lake			West Vadnais Lake			Plant Effluent		
	Chl-A (µg/L)	*NO_2+NO_3 (mg/L)*	OP (µg/L)	*Chl-A (µg/L)*	*NO_2+NO_3 (mg/L)*	*TP (µg/L)*	*Chl-A (µg/L)*	*NO_2+NO_3 (mg/L)*	OP (µg/L)
2009	6.5	0.19	16.8	-	0.10	-	-	-	10.9
2010	8.6	0.26	32.9	-	0.02	-	-	-	18.6
2011	12.8	0.37	17.1	-	0.03	-	-	-	5.0
2012	8.4	0.31	38.5	-	-	-	-	-	12.4
2013	10.9	0.23	22.6	58.7	0.02	-	-	0.35	4.0
2014	9.8	0.33	12.8	56.6	-	-	-	0.42	4.6
2015	10.5	0.22	12.1	108.2	-	-	-	0.35	5.9
2016	10.2	0.24	14.0	71	0.02	5.0	-	0.31	10.1
2017	-	-	-	54	0.03	-	-	-	-