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
- Grass
- East Vadnais
- West Vadnais
- East Vadnais
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
Snail Lake Historical Elevations
(source: MnDNR's Lake Finder website, elevations in 1912 datum)

- Annual Precipitation

(source: MN State Climatology Working Group)
Elevation (ft, NAVD88) Snail Lake Water Surface Elevation 2017 NAVD88 Datum

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 4322 Lake Point Ct: 893.7
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 668 Highway 96W: 891.3
Low Home Surveyed Elevation for 4320 Lake Point Ct: 888.8
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)

- 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
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

Snail Lake Peak Water Elevations during the 100-year, 96-hour Storm Event
(for a range of Snail Lake starting elevations)

OVERFLOW TO GRASS LAKE: 889.6 from Snail Lake
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

The highest observed elevation of Snail lake over 93 years of recorded levels was on May 22, 2017: 885.6.

These black lines indicate that if the 100-year, 96 hour storm were to hit the subwatershed with the lake starting at this elevation, Snail Lake’s peak would be approximately 887.5 (no overflow, one home affected).
Scenario 1
Do Nothing/Implement Emergency Response Plan

What if we get another 2015, 2016 and 2017 in Snail Lake?
(assuming evaporation, but no seepage to groundwater)

- Do Nothing
- Lower 15-inch pipe under Hwy 694 + Snail Lake outlet at elev 882

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 AREA: 887.9 from ponding area south of Snail Lake through the “back door route”

Low Home Surveyed Elevation for 4380 Reiland Lane: 886.01

Snail Lake’s elevation stays high despite its proposed outlet because Grass Lake is high, too.

PROPOSED OUTLET from Snail Lake to Grass Lake: 882 (backflow prevented)
Scenario 2
Pipe Snail and Lower West Vadnais

Wetland A

Pipe

Grass

West Vadnais

East Vadnais

$620,000
Scenario 3
Pump Snail Lake Flood Water to Sucker Lake

$2,500,000+
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).
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?

- Existing East Vadnais: ~883' 
- Existing West Vadnais: 881.8'
- Proposed Target for West Vadnais: 881.0'

Graph showing elevation (ft) from 1/1/2015 to 7/4/2017 with lines indicating existing and proposed levels.
Grass Lake – Do nothing further

What if we get another 2015, 2016 and 2017 in Grass Lake?
(assuming evaporation, but no seepage to groundwater)

When water rises to above 884, water flows from Grass Lake north into the parkland south of Gramsie Road.

Grass Lake Emergency Spillway Elev: 884.0

Gramsie Road Low Point: 885.0
Grass Lake
Lower West Vadnais

Snail
Grass
East Vadnais
West Vadnais

Ramsey County Parks
VLAWMO
MN DNR
SPRWS
CITY OF SHOREVIEW

$40,000
Grass Lake
Lower West Vadnais (and Pipe Snail)

$40,000 +
($620,000)
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.
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

No Pumping, 137 days
881.8’ Target NWL

10 cfs, 58 days
20 cfs, 36 days
40 cfs, 19 days

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

881.8’ Target NWL
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.
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 of 15” under Hwy 694 is 881.9). Grass Lake clearly had high levels of seepage under those conditions.
Grass Lake
Pump West Vadnais to East Vadnais

$2,500,000+
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

Cost?
Next steps: Water quality and seepage assessment

- Water quality and seepage assessment
- East Vadnais Lake
- West Vadnais Lake

In-Lake Aeration

FeCl₃ addition

2017 Annual Average TP

- West Vadnais Lake: 130 µg/L
- East Vadnais Lake: 27.5 µg/L

TP Goal: 25 µg/L
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
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.
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.
Table 1: Benefits, costs and feasibility issues associated with the various flood management options evaluated for the Grass Lake area.

<table>
<thead>
<tr>
<th>Conceptual Project No.</th>
<th>Conceptual Alternative Description</th>
<th>Primary Benefits: Increased Flood Storage</th>
<th>Secondary Benefits: Portland &amp; Trails</th>
<th>No. of Permits</th>
<th>Implementation Timeline</th>
<th>Capital Cost</th>
<th>O&amp;M Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>West Yeadon Outlet Channel: 2018 - Clear channel to West Yeadon Outlet (1st at L464)</td>
<td>Improve conveyance from West Yeadon Lake to outlet. None</td>
<td>Less tail water frequency &amp; duration due to renewed trails and park land</td>
<td>1 permit</td>
<td>Complete by 1st half of 2018</td>
<td>$55,000</td>
<td>Inspect and maintain channel</td>
</tr>
<tr>
<td>Under Construction</td>
<td>Raise Grass Lake Dam and Trail at Gravel Road</td>
<td>No change</td>
<td>None</td>
<td>2 permits</td>
<td>Complete by 1st half of 2018</td>
<td>$397,400</td>
<td>Inspect and maintain dam and emergency spillway</td>
</tr>
<tr>
<td>Under Construction</td>
<td>Lower Grass Lake: 2016 - Lower Grass Lake Outlet B01.3 to B01.2</td>
<td>Improve conveyance from Grass Lake to West Yeadon Lake</td>
<td>None</td>
<td>2 permits</td>
<td>Complete by 1st half of 2018</td>
<td>$170,000</td>
<td>Inspect and maintain outlet</td>
</tr>
<tr>
<td>Project 1</td>
<td>Emergency Flood Response Plan &amp; Temporary Measures: Cannon Valley</td>
<td>No change</td>
<td>None</td>
<td>2 permits</td>
<td>6 to 18 months</td>
<td>$12,000</td>
<td>Design and remove existing levees and pre-emptory trail safety measures</td>
</tr>
<tr>
<td>Project 2</td>
<td>Manage the water level in North Glens Falls Pond: Manage the water level in North Glens Falls Pond to 697 to 697 and protect it from Grass Lake overflow.</td>
<td>None</td>
<td>None</td>
<td>2 permits</td>
<td>6 to 18 months</td>
<td>TBD</td>
<td>Pipe and debris pond maintenance</td>
</tr>
<tr>
<td>Project 3</td>
<td>Improve Park Trail Resiliency to Flooding Levels in Verend A</td>
<td>No change</td>
<td>None</td>
<td>2 permits</td>
<td>6 to 18 months</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Project 4</td>
<td>Lower East Yeadon Lake - Elevetion to B01</td>
<td>Increase flood storage on East Yeadon Lake to buffer upstream flooding.</td>
<td>No direct benefit to homes on Slalove</td>
<td>1 permit</td>
<td>6 to 18 months</td>
<td>TBD</td>
<td>Continuous monitoring of East Yeadon Lake levels</td>
</tr>
<tr>
<td>Project 5</td>
<td>Lower West Yeadon Lake to B01</td>
<td>Increase flood storage on West Yeadon Lake to buffer upstream flooding.</td>
<td>May direct benefit to homes on Slalove</td>
<td>5 permits</td>
<td>12 to 24 months</td>
<td>$41,000</td>
<td>Seasonal gate operation between Grass Lake and West Yeadon Lake during dry years may be needed</td>
</tr>
<tr>
<td>Project 6</td>
<td>Lower East Yeadon Lake - Elevetion to B01</td>
<td>Increase flood storage on East Yeadon Lake to buffer upstream flooding.</td>
<td>No direct benefit to homes on Slalove</td>
<td>3 permits</td>
<td>12 to 24 months</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Project 7</td>
<td>Small Lake to Grass Lake 19 Pipe</td>
<td>Increase flood storage at Small Lake to 1.7 million gallons over 10 days @ 12 cfs.</td>
<td>Mine ability to achieve Small Lake S.L.E. for 2 rehabilitation's homes on Slalove</td>
<td>4 permits</td>
<td>2 to 30+ months</td>
<td>$600,000</td>
<td>New or upgraded levees, seasonal management or operations staff</td>
</tr>
<tr>
<td>Not Recommended</td>
<td>Sampling from Grass Lake to East Yeadon Lake</td>
<td>Check the feasibility of sampling from Grass Lake to East Yeadon Lake</td>
<td>No direct benefit to homes on Slalove</td>
<td>10 permits</td>
<td>24 to 48 months</td>
<td>$1.0 million</td>
<td>Significant, electricity, maintenance</td>
</tr>
</tbody>
</table>
| Not Recommended        | Sampling from West to East Yeadon Lake | Check the feasibility of sampling from Grass Lake to East Yeadon Lake | No direct benefit to homes on Slalove | 10 permits | 24 to 48 months | $2.5 million | Significant, electricity, maintenance, chemicals, sedimentation and dredging.
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

<table>
<thead>
<tr>
<th>1 of 6</th>
<th>2 of 6</th>
<th>3 of 6</th>
<th>4 of 6</th>
<th>5 of 6</th>
<th>6 of 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower West Vadnais</td>
<td>Pipe Snail and Lower West Vadnais</td>
<td>Pump Snail</td>
<td>Lower East Vadnais</td>
<td>Lower East Vadnais &amp; Lower West Vadnais</td>
<td>Pump West Vadnais</td>
</tr>
<tr>
<td>$40,000</td>
<td>$620,000</td>
<td>$2,500,000+</td>
<td>?</td>
<td>?</td>
<td>$2,500,000+</td>
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<td>VLAWMO</td>
<td>VLAWMO</td>
<td>VLAWMO</td>
<td>VLAWMO</td>
<td>VLAWMO</td>
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<td>MNDNR</td>
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<td>MNDNR</td>
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<td>SPRWS</td>
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</tr>
<tr>
<td>Shoreview</td>
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<td></td>
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</table>
### Incremental Implementation

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

### Table 4: Permitting considerations

<table>
<thead>
<tr>
<th>Approval entity</th>
<th>Permit/approval</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Army Corps of Engineers (USACE)</td>
<td>Section 404 permit</td>
<td>Required for work activities below the ordinary high water level of waters/wetlands under agency jurisdiction</td>
</tr>
<tr>
<td>U.S. Fish and Wildlife Service</td>
<td>Section 7 (Endangered Species Act)</td>
<td>Compliance. Required as part of the USACE’s Section 404 permitting process.</td>
</tr>
<tr>
<td>Minnesota DNR</td>
<td>Work in public waters permit</td>
<td>Required for work activities below the OHWL of a designated public water.</td>
</tr>
<tr>
<td></td>
<td>Water appropriations permit</td>
<td>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.</td>
</tr>
<tr>
<td>Minnesota Pollution Control Agency</td>
<td>General stormwater permit for</td>
<td>Required for projects that result in more than 1 acre of ground disturbance.</td>
</tr>
<tr>
<td>construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minnesota Wetland Conservation Act</td>
<td>Project compliance</td>
<td>Required for impacts to wetlands that are not under jurisdiction of the USACE or DNR.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Administered by the VLAWMO and RWMWD in their jurisdiction.</td>
</tr>
<tr>
<td>State Historic Preservation Office</td>
<td>Section 106 (National Historic</td>
<td>Required as part of the USACE’s Section 404 permitting process.</td>
</tr>
<tr>
<td></td>
<td>Preservation Act) compliance</td>
<td></td>
</tr>
<tr>
<td>City of Shoreview (Snail Lake is in Shoreview)</td>
<td>Erosion/excavating/grading permit</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>Right-of-way excavation permit</td>
<td>Construction would occur in a City of Shoreview right-of-way.</td>
</tr>
<tr>
<td></td>
<td>Floodplain management special district compliance</td>
<td>Required for projects in floodplain overlay district.</td>
</tr>
<tr>
<td></td>
<td>Shoreland management special district compliance</td>
<td>Applied to all projects within 1,000 feet of a protected water body.</td>
</tr>
<tr>
<td>City of Vadnais Heights (Sucker Lake is in Vadnais Heights)</td>
<td>Excavation permit</td>
<td>Project activities are expected to require movement of over 6 cubic yards of soil.</td>
</tr>
<tr>
<td></td>
<td>Engineering and public works approval</td>
<td>Engineering and Public Works departments typically provide input on significant projects.</td>
</tr>
<tr>
<td></td>
<td>Utilities approval</td>
<td>Project will require modifications to city utilities.</td>
</tr>
<tr>
<td></td>
<td>Floodplain area approval</td>
<td>Required for projects that take place within designated floodplain area.</td>
</tr>
<tr>
<td></td>
<td>Shoreland area approval</td>
<td>Required for all work within 1,000 feet of designated shoreland area.</td>
</tr>
<tr>
<td>SPRWS (manages chain of Pleasant, Sucker, and East Vadnais lakes)</td>
<td>Update source water protection plan (SWPP)</td>
<td>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).</td>
</tr>
</tbody>
</table>

#### 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
How do existing water quality conditions compare?

- **Pumping from Mississippi River at Fridley**: 93 µg/L
- **Snail Lake**: 30 µg/L
- **Grass Lake**: 60 µg/L Goal
- **West Vadnais Lake**: 130 µg/L
- **East Vadnais Lake**: 27.5 µg/L
- **Pleasant Lake**: 37.3 µg/L
- **Sucker Lake**: 27.5 µg/L
- **Snail Lake**: 30 µg/L

**In-Lake Aeration**

**FeCl₃ addition**

**2017 Annual Average TP**

**TP Goal**: 25 µg/L
### Table 3: TP (μg/L) in water bodies of interest (average annual concentration)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fridley</th>
<th>Pleasant Lake</th>
<th>Sucker Lake</th>
<th>East Vadnais Lake</th>
<th>West Vadnais Lake</th>
<th>SPRWS plant effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>57.3</td>
<td>414.3</td>
<td>39.6</td>
<td>31.9</td>
<td>185.2</td>
<td>14.4</td>
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<tr>
<td>2010</td>
<td>79.6</td>
<td>189.9</td>
<td>80.5</td>
<td>49.5</td>
<td>137.6</td>
<td>27.9</td>
</tr>
<tr>
<td>2011</td>
<td>53.8</td>
<td>118.1</td>
<td>-</td>
<td>30.6</td>
<td>137</td>
<td>10.9</td>
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<tr>
<td>2012</td>
<td>42.8</td>
<td>168.2</td>
<td>-</td>
<td>27.8</td>
<td>-</td>
<td>7.1</td>
</tr>
<tr>
<td>2013</td>
<td>46.9</td>
<td>191.8</td>
<td>-</td>
<td>16.5</td>
<td>79.1</td>
<td>-</td>
</tr>
<tr>
<td>2014</td>
<td>68.4</td>
<td>42.2</td>
<td>-</td>
<td>28.6</td>
<td>70.1</td>
<td>3.9</td>
</tr>
<tr>
<td>2015</td>
<td>52.6</td>
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</table>
Next Steps
Incremental Implementation

2018 - Raise Berm and Trail along Gramsie Road

2018 - Lower Grass Lake Outlet 881.6 to 881.2

2018 - Cleanout channel to W. Vadnais Outlet 15-Inch at 694

- 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

e tc.
What option(s) will best manage lake levels?

- Pumping?
- Grass
- Berm Raise
- Optimize Outlet
- Gravity Pipe?
- Outlet Cleanout/modification
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

West Vadnais Lake NWL – 881.8’

East Vadnais Lake NWL – 883’ ± 1’
West Vadnais Lake to East Vadnais Lake Pumping Evaluation

Model estimated West Vadnais Lake Drawdown

No Pumping, 137 days
881.8' Target NWL

10 cfs, 58 days
20 cfs, 36 days
40 cfs, 19 days

Note: the WSE of Grass Lake and West Vadnais Lake equalize 100 yr x 96 hr Target Peak WSE

881.8' Target NWL
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
Snail Lake to Sucker Lake Pumping Evaluation

Model estimated Snail Lake Drawdown

882’ Target

- No Pumping, 200 days
  - 1.2 cfs, 100 days, $1.0 million ($0.5 million to $2.2 million), 8”+ pipe
- 10 cfs
  - 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 SWMM Hydrologic Model Results:
Typical Snail Lake Water Surface Elevation Response to 100-yr, 96-hr Critical Event vs. No. Drawdown Days
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

<table>
<thead>
<tr>
<th>Snail Lake Habitable Structure</th>
<th>Unofficial 2017 Survey of Low Elevation at Habitable Structure (NAVD88)</th>
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<tbody>
<tr>
<td>4322 Lake Point</td>
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<td>4380 Reiland Lane</td>
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Can we pump Snail Lake water to Saint Paul Regional Water Services (SPRWS) ?

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).
## Additional data

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

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