Lake by Lake Analysis

1. Review Current Water Quality Condition
2. Phosphorus Sources
   A. Watershed
   B. Near Shore
   C. In-lake
3. Lake Goals and Phosphorus Reductions
4. Management Strategies
Northern Chain of Lakes – Shallow Lakes

<table>
<thead>
<tr>
<th>Lake Name</th>
<th>Maximum depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goggins</td>
<td>14.9</td>
</tr>
<tr>
<td>Lynch (North Bay)</td>
<td>4.2</td>
</tr>
<tr>
<td>Lynch (South Bay)</td>
<td>15.2</td>
</tr>
<tr>
<td>Plaisted</td>
<td>13.9</td>
</tr>
<tr>
<td>North School Section</td>
<td>12.2</td>
</tr>
<tr>
<td>South School Section</td>
<td>15.9</td>
</tr>
</tbody>
</table>
Clear Lakes

< 12 μg/L TP

Limited Diversity in Fish Population

Sparse Vegetation

Small Amount of Accumulated Sediment and Organic Matter
Moderately Clear Lakes

12 - 24 μg/L TP

Diverse, Increasing Fish Population

Increasing Vegetation

Increasing Amount of Accumulated Sediment and Organic Matter
Fertile Lakes

24 - 96 μg/L TP

Dense Vegetation
“Weedy”

Dense, Less Diverse Fish Population

Large Amount of Accumulated Sediment and Organic Matter
Shallow lake water quality is also influenced by fish and plant dynamics...

Large gamefish and abundant rooted plants keep water CLEAR

Too many panfish or too few rooted plants keep water TURBID
Shallow lake water quality is also influenced by fish and plant dynamics...

Two relatively stable “states”:

- **Clear**
  - fish
  - zooplankton
  - algae
  - aquatic plants

- **Turbid**
  - fish
  - zooplankton
  - algae
  - aquatic plants

Images of organisms courtesy of Lakes of Missouri Volunteer Program.
Plaisted

Good aquatic plant cover
Good water clarity
Mostly bullheads
No gamefish

Pie chart showing:
- Black Bullhead: 63.00%
- Black Crappie: 19.97%
- Bluegill: 9.85%
- Golden Shiner: 7.17%
- No Plants: 1.7%
North School Section

Few aquatic plants
High amounts of algae
Few fish
Winter fishkills

Legend:
- Emergent
- Floating
- Submerged
- No Plants Observed

- Golden Shiner: 4.20%
- Black Bullhead: 95.80%
South School Section

Some areas without plants
Game fish
No bullheads
Goggins Lake

- Few aquatic plants
- High amounts of algae
- No game fish
- Mostly minnows

Legend:
- Emergent
- Floating
- Submerged
- No Plants Observed

Pie chart showing:
- Fathead Minnow: 65.44%
- Northern Redbelly Dace: 2.54%
- Brook Stickleback: 21.62%
- Central Mudminnow: 10.40%
Nutrients – Multi-year Average

Phosphorus (ppb)

- Goggins: 115 (Current Conditions), 60 (Goal)
- Lynch (North Bay): 467 (Current Conditions), 60 (Goal)
- Lynch (South Bay): 241 (Current Conditions), 60 (Goal)
- Plaisted: 86 (Current Conditions), 60 (Goal)
- South School Section: 59 (Current Conditions), 60 (Goal)
Algae – Multi-year Average

Chlorophyll-a (ppb)

- Goggins: 44, Current Conditions 20, Goal 20
- Lynch (North Bay): 205, Current Conditions 20, Goal 20
- Lynch (South Bay): 211, Current Conditions 20, Goal 20
- Plaisted: 37, Current Conditions 20, Goal 20
- South School Section: 78, Current Conditions 20, Goal 20
Water Clarity – Multi-year Average

<table>
<thead>
<tr>
<th>Location</th>
<th>Current Conditions</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goggins</td>
<td>3.1</td>
<td>3.3</td>
</tr>
<tr>
<td>Lynch (North Bay)</td>
<td>2.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Lynch (South Bay)</td>
<td>1.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Plaisted</td>
<td></td>
<td>3.3</td>
</tr>
<tr>
<td>South School Section</td>
<td>4.8</td>
<td>5.4</td>
</tr>
</tbody>
</table>
Recent Water Clarity - Plaisted
Recent Water Clarity – Goggins

![Graph showing recent water clarity data for Goggins. The graph plots Secchi depth (m) against year (1999 to 2014). The data points are marked with error bars indicating the mean and ±SE, showing variation over time. The graph highlights significant fluctuations in water clarity.]
Phosphorus Sources

Atmosphere

Waves and wind

Winter anoxia

Sediment Release (Internal Loading)

Rough fish

Curly leaf pondweed

Watershed
Phosphorus Reductions

Reductions Needed to Meet Lake Goal

North School Section
-52%
-25%

Plaisted
-34%

Goggins’
81.6%
78%

South School Section
-51%
-50%
1. High Priority Watershed Ag BMPs

- Uses soils, climate, land use data to predict erosion “hotspots”

**Purpose**
- Prioritize areas of erosion
- Target potential practices
- Measure outcomes

***Requires Field Verification***
Developed areas with large amounts of impervious surfaces allow stormwater carrying pollutants to reach lakes
Many wetlands have been ditched and drained; these make perfect locations to restore hydrology and provide the natural filter that wetlands are to surface water.
Grassed Waterways

Gullies lose substantial amounts of soil through erosion; many of these gullies end at surface water.
Plaisted, N. & S. School Section

- 3 ponds
- 3 infiltration basins
Goggins

8 grassed waterways
1 sediment pond
1 infiltration basin
1 wetland restoration

Legend
TP_mass_ft
- High: 0.892
- Low: 0
Agricultural Runoff Treatment

Manure storage, Nutrient management practices, Conservation tillage, etc.
2. Near-Shore Practices

<table>
<thead>
<tr>
<th>Lake</th>
<th>Acres of Developed, Cropland &amp; Pasture/Hay w/ in 500 Feet of Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaisted</td>
<td>16</td>
</tr>
<tr>
<td>N. School Section</td>
<td>16</td>
</tr>
<tr>
<td>S. School Section</td>
<td>63</td>
</tr>
<tr>
<td>Goggins</td>
<td>46</td>
</tr>
</tbody>
</table>
A buffer planted adjacent to water can filter out pollutants and contaminates by over 50%

A marginal buffer may already exist – with some seeding, sizing, and maintenance this buffer can increase effectiveness
Since 2007 – MN law states that phosphorus fertilizer may not be used.

Grass clippings and leaves contain large amounts of phosphorus – they should be disposed of properly and not allowed into a storm drain or lake.
Failing septic systems can add large amounts of phosphorus and nutrients to nearby lakes and streams.
3. In-lake Management

Alum Treatment
Alum binds with phosphorus in lake sediments

Trophic State Alteration
Fish kill
Fish stocking
Curly-leaf pondweed control
Lake drawdown
Floating vegetation mats
Algaecides
Many more!
### In-lake Opportunities

**Aquatic Plants**
- Curly-leaf pondweed control
- May/June Aquatic Plant Survey

**Fisheries**
- North School Section
  - Boom and Bust
- South School Section / Plaisted
  - D.O. Monitoring
  - Supplemental gamefish stocking program
- Goggins
  - D.O. Monitoring
  - Stocking program focused on northern pike

**Sediment**
- Consider alum treatment following reductions in external loads
2017-2026 Watershed Management Plan

- Monitoring and Data Collection
- Stormwater Management
- Stream Management
- Lake Management
- Regulations
- Funding
- Education, Outreach & Stewardship
- Land Conservation
- Ecological Health
- Erosion Prevention and Sediment Control
- Climate Change Adaptation (<1%)
- Floodplain Management (0%)
| Work with landowner at western end of lake on nutrient reduction efforts - 2018 - $5,000 |
| In-Lake Treatment & High Priority Ag BMPs 2025 - $10,000 |
| Evaluate the impact North School Section Lake outflows have on water quality 2018 - $5,000 |
| 2025 - $10,000 |
| 2026 - $10,000 |
| Near shore practices & high priority watershed ag. BMPs (all 3 lakes) 2020 - $5,000 |
| 2021 - $10,000 |
| 2023 - 2026 - $10,000/year |
| In-Lake Management – South School Section 2022- $25,000 |
| 2023- $15,000 |
| 2024- $5,000 |
| 2025- $5,000 |
| 2026 - $10,000 |
50% matching grant - up to $2500.00

What practices qualify for the grant?
Lakeshore buffers, rainwater gardens, restored wetlands, sediment ponds, grassed swales

Review Criteria
Public Benefit
Collaboration
Water Quality Improvement
Erosion Control
Wildlife Habitat Improvement
Innovative Applications