STATEMENT OF NEED AND REASONABLENESS

BOOK II of III

In the Matter of Proposed Revisions
Of Minnesota Rules Chapter 7050,
Relating to the Classification and
Standards for Waters of the State;

The Proposed Addition of a New Rule,
Minnesota Rules Chapter 7053,
Relating to Point and Nonpoint Source Treatment Requirements; and

The Repeal of Minn. R. Chapters 7056 and 7065

BOOK II

1. Numeric eutrophication standards for lakes, shallow lakes and reservoirs.
2. Requirement for new or expanding dischargers to meet a 1 mg/L phosphorus effluent
   limit, if they discharge more than 1,800 pounds of total phosphorus per year.

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<th>ACR</th>
<th>Acute to chronic ratio</th>
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<td>Minnesota Pollution Control Agency</td>
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<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<tr>
<td>AWDF</td>
<td>Average [monthly] wet weather design flow</td>
</tr>
<tr>
<td>BAF</td>
<td>Bioaccumulation factor</td>
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<tr>
<td>BAP</td>
<td>Bioavailable phosphorus</td>
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<tr>
<td>BCF</td>
<td>Bioconcentration factor</td>
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<tr>
<td>BEACH</td>
<td>Beach Environmental Assessment and Coastal Health (BEACH) Act</td>
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<tr>
<td>Bio-P</td>
<td>Biological phosphorus removal treatment technologies</td>
</tr>
<tr>
<td>BMP</td>
<td>Best management practice</td>
</tr>
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<td>BOD₅</td>
<td>Biochemical oxygen demand; BOD₅ is BOD measured over a 5-day period</td>
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<td>BWCAW</td>
<td>Boundary Waters Canoe Area Wilderness</td>
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<td>CAS</td>
<td>Chemical abstract services registry number</td>
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<td>CBOD₅</td>
<td>Carbonaceous biochemical oxygen demand; CBOD₅ is CBOD measured over a 5-day period</td>
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<td>CESARS</td>
<td>Chemical Evaluation Search and Retrieval System database</td>
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<td>Code of Federal Regulations</td>
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<tr>
<td>cfs</td>
<td>cubic feet per second</td>
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<tr>
<td>cfu</td>
<td>colony-forming units</td>
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<td>Coalition of Greater Minnesota Cities</td>
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<td>Citizens Lake Monitoring Program</td>
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<td>Chronic standard</td>
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<td>Cancer slope factor</td>
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<td>Citizens Stream Monitoring Program</td>
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<td>Clean Water Act</td>
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<td>Clean Water Partnership</td>
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<td>DMR</td>
<td>Discharge monitoring report</td>
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<td>DO</td>
<td>Dissolved oxygen</td>
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<td>DOC</td>
<td>Dissolved organic carbon</td>
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<td>DWS</td>
<td>Drinking water standard</td>
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<td>EC20, EC50</td>
<td>Effect concentration; concentration of chemical that has a significant effect on 20 percent and 50 percent of the test organisms in a specified time period, respectively</td>
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<td>Ecotoxicology database</td>
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<td>FAV</td>
<td>Final Acute Value</td>
</tr>
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<td>FPE</td>
<td>fullest practicable extent</td>
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<td>FTE</td>
<td>Full time equivalent – measurement of staff resources</td>
</tr>
<tr>
<td>g/d</td>
<td>grams per day</td>
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<td>GLI</td>
<td>Great Lakes Water Quality Initiative</td>
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<tr>
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<td>Index of Biotic Integrity</td>
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<tr>
<td>IEPA</td>
<td>Illinois Environmental Protection Agency</td>
</tr>
<tr>
<td>HBV</td>
<td>Health based value</td>
</tr>
<tr>
<td>HH</td>
<td>Human health-based standard</td>
</tr>
<tr>
<td>HRL</td>
<td>Health risk limit</td>
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<tr>
<td>IRIS</td>
<td>Integrated Risk Information System</td>
</tr>
<tr>
<td>L</td>
<td>Liter</td>
</tr>
<tr>
<td>LAP</td>
<td>Lake Assessment Program</td>
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<tr>
<td>LC50</td>
<td>Lethal concentration; concentration of chemical that results in death of 50 percent of the test organisms in a specified time period</td>
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<tr>
<td>LOEC</td>
<td>Lowest observable effect concentration</td>
</tr>
<tr>
<td>M</td>
<td>meter or meters</td>
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<tr>
<td>MATC</td>
<td>Maximum acceptable toxicant concentration</td>
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<td>MCEA</td>
<td>Minnesota Center for Environmental Advocacy</td>
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<td>MCES</td>
<td>Metropolitan Council, Environmental Services</td>
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<tr>
<td>MCL</td>
<td>Maximum contaminant levels (EPA drinking water standards)</td>
</tr>
<tr>
<td>MDA</td>
<td>Minnesota Department of Agriculture</td>
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MDEP Massachusetts Department of Environmental Protection
MDH Minnesota Department of Health
MDNR Minnesota Department of Natural Resources
MeHg Methylmercury
MESERB Minnesota Environmental Science and Economic Review Board
MFC A Minnesota Fish Consumption Advice or Advisory
μg/L microgram per liter or parts per billion
Mg/kg milligram per kilogram or parts per million
Mg/L milligram per liter or parts per million
mgd million gallons per day
μm micron, one millionth of a meter
MPCA Minnesota Pollution Control Agency
Minn. R. ch. Minnesota Rules chapter
Minn. Stat. ch. Minnesota Statutes chapter
MS Maximum standard
NA or na Not applicable or not available
NALMS North American Lake Management Society
NCHF North Central Hardwood Forest Ecoregion (CHF in Figure II-9)
NE No effect concentration
ng/L nanogram per liter or parts per trillion
NGP Northern Glaciated Plains Ecoregion
NLF Northern Lakes and Forest Ecoregion
NHD National Hydrography Data
NOEC No observable effect concentration
NPDES National Pollutant Discharge Elimination System
O&M operation and maintenance
OPP Office of Pesticide and Planning, EPA
ORVW Outstanding Resource Value Water
P Rule Existing Minn. R. 7050.0211, subp. 1a; proposed Minn. R. 7053.0255
PAH Polynuclear aromatic hydrocarbons
PCB Polychlorinated biphenyl
PMP Phosphorus management plan
POTW Publicly owned treatment works
ppm parts per million
RfD Reference dose
RSC Relative Source Contribution Factor
SCV Species chronic value
SD Secchi depth or Secchi transparency
SDS Minnesota State Disposal System permits
SONAR Statement of Need and Reasonableness
SR Minnesota State Register
SSS Site-specific standard
STORET EPA water quality data storage and retrieval system
su standard units, units for pH measurements
TBEL Technology-based effluent limit (limit = limitation)
TMDL Total Maximum Daily Load
TSI Carlson Trophic State Index
Tox Toxicity-based standard
TP Total phosphorus or phosphorus
TSS Total suspended solids
UAA Use attainability analysis
USDA United States Department of Agriculture
USGS United States Geological Survey
VOC Volatile organic carbon
WCBP Western Corn Belt Plains Ecoregion (WCP in Figure II-9)
WDNR Wisconsin Department of Natural Resources
WQBEL Water quality- [standard] based effluent limit
WQS Water quality standard
WWTP Wastewater treatment plant
Table II-A. Reader’s Guide to Location of Major Topics on Proposed Eutrophication Standards in SONAR Book II.

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<td>Major Topics, Proposed Eutrophication Standards</td>
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<td>What’s proposed in this rulemaking*</td>
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<td>Secchi disk transparency</td>
<td>10</td>
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<tr>
<td>Lake trophic data</td>
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<tr>
<td>Assessment of lakes for impairment due to nutrients</td>
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<td>EPA guidance on nutrient standards</td>
<td>19</td>
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<td>EPA nutrient criteria</td>
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<td>Development of MPCA nutrient criteria</td>
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<td>How eutrophication standards will help protect lakes</td>
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<td>Lake types and uses</td>
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<td>Trout lakes</td>
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<td>Deep lakes</td>
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<td>Shallow lakes</td>
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<tr>
<td>What other states are doing</td>
<td></td>
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<tr>
<td>Economic value of lakes</td>
<td>5</td>
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<tr>
<td>Economic impact, miscellaneous</td>
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<tr>
<td>Costs to point sources</td>
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<td>Costs to nonpoint sources</td>
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<tr>
<td>Impact on agriculture</td>
<td></td>
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</tbody>
</table>

*See SONAR Book I, pages 1 and 3.
Table II-B. Reader’s Guide to Location of Major Topics on Proposed Extension of 1 mg/L Phosphorus Effluent Limit to New or Expanded Dischargers in SONAR Book II.

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>SECTIONS AND PAGE NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Section in SONAR:</td>
</tr>
<tr>
<td>Major Topics, Proposed Extension of 1 mg/L Phosphorus Effluent Limit</td>
<td>Phosphorus as an important pollutant</td>
</tr>
<tr>
<td></td>
<td>Sources of phosphorus to MN waters</td>
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<td></td>
<td>Impact of phosphorus on rivers</td>
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<td></td>
<td>Phosphorus Strategy</td>
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<td></td>
<td>History of point source phosphorus limits</td>
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<td></td>
<td>Proposed extension of phosphorus limit</td>
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<td>Definitions</td>
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<td>De-minimis plant flow</td>
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<td></td>
<td>Possible exemptions from limit</td>
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<td></td>
<td>- TMDL complete</td>
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<td></td>
<td>- environmental impact</td>
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<td></td>
<td>- exempt watersheds, winter limits</td>
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<td>- variance</td>
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<td></td>
<td>Best practicable treatment</td>
</tr>
<tr>
<td></td>
<td>Averaging period for phosphorus limit</td>
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<td></td>
<td>Mercury and phosphorus removal</td>
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<td></td>
<td>Biological phosphorus treatment</td>
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<td></td>
<td>Gross costs to point sources</td>
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<tr>
<td></td>
<td>- municipalities</td>
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<td></td>
<td>- industries</td>
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<td></td>
<td>Real costs attributable to extension of limit</td>
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<td></td>
<td>Economic benefit</td>
</tr>
<tr>
<td></td>
<td>What other states are doing</td>
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<tr>
<td></td>
<td>Repeal of Minn. R. ch. 7065</td>
</tr>
</tbody>
</table>
I. INTRODUCTION

A. SCOPE [I. introduction]

The Minnesota Pollution Control Agency (Agency) is proposing to amend Minn. R. ch. 7050, establish a new rule, Minn. R. ch. 7053, and repeal two rules, Minn. R. ch. 7056 and 7065. This book of the Statement of Need and Reasonableness (SONAR) covers the proposed eutrophication standards for lakes, shallow lakes and reservoirs, and the proposed extension of the total phosphorus effluent limit to new or expanding dischargers that discharge more than 1,800 pounds of phosphorus per year. The change to the phosphorus effluent limit would take effect on May 1, 2008.

B. STATEMENT OF NEED AND REASONABLENESS [I. introduction]

The Administrative Procedures Act (Minn. Stat. ch. 14) requires the agency to address certain questions and issues in rulemaking that are discussed in the SONAR. The SONAR contains the Agency’s affirmative presentation of facts on the need for and reasonableness of the proposed rule amendments. It also addresses all the statutory requirements associated with proposed administrative rules. As mentioned, Book II of the SONAR covers the proposed eutrophication standards and the extension of the phosphorus effluent limit, and these two major proposals are discussed in separate need, reasonableness and economic impact sections.

The proposed eutrophication standards and all the proposed additions and changes to Minn. R. ch. 7050 are shown in Exhibit A-15a. The proposed changes to the 1 mg/L phosphorus effluent limit (Minn. R. 7053.0255) are shown in Exhibit A-15b.

Book I of the Agency's SONAR covers background information on topics relevant to these proposed revisions, which is not repeated in SONAR Books II or III (see list below).

- Beneficial uses and use classification system;
- Water quality standards;
- Triennial review of water quality rules;
- Assessment of impaired waters;
- Total maximum daily loads (TMDL);
- Items originally considered, but postponed for this rulemaking;
- Response to comments outside scope of proposed amendments; and
- Public participation.

References to Minn. R. ch. 7050 or 7053 in this SONAR are to the proposed revised or new rules\(^1\), unless specifically stated otherwise.

\(^1\) Throughout the SONAR some terms or phrases are in bold for emphasis.
Numerous exhibits pertinent to the proposed amendments are cited throughout SONAR Book II. Exhibits have been catalogued in an Access file for ease of tracking, sorting and numbering. The list of exhibits pertinent to the subjects covered in Book II is attached. The prefixes used to identify the categories exhibits are placed in are shown in Table II-1.

Table II-1. Prefixes for Categories of Numbered Exhibits.

<table>
<thead>
<tr>
<th>Prefix to Exhibit Number</th>
<th>Category of Exhibits</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Administrative, legal authority, Board appearances, rule language changes, public comments, etc.</td>
</tr>
<tr>
<td>EU</td>
<td>Eutrophication standards for lakes and reservoirs</td>
</tr>
<tr>
<td>PL</td>
<td>Phosphorus effluent limit</td>
</tr>
<tr>
<td>M</td>
<td>Mercury standard</td>
</tr>
<tr>
<td>HH</td>
<td>Human health-based and drinking water standards</td>
</tr>
<tr>
<td>H</td>
<td>Standards for herbicides acetochlor and Metolachlor</td>
</tr>
<tr>
<td>EC</td>
<td>E. coli standard</td>
</tr>
<tr>
<td>UC</td>
<td>Use classification changes: Class 1-Domestic Consumption, Class 2-Aquatic Life and Recreation, Class 3-Industrial Consumption, and Class 7-Limited Resource Value Waters.</td>
</tr>
</tbody>
</table>

The SONAR has been assigned the following exhibit numbers:

- SONAR Book I is Exhibit A-1
- SONAR Book II is Exhibit A-2
- SONAR Book III is Exhibit A-3
- A complete list of all exhibits is Exhibit A-5

Due to the large number of exhibits and the large size of some, exhibits will not be available on the Agency’s Web pages. They will available for the cost of reproduction upon request.

Throughout the text the reader is referred to relevant sections elsewhere in the SONAR. The references are to sections rather than page numbers. To help locate the cited sections, section and subsection headings are followed [in brackets] by the Roman numeral and capital letter, if needed, that identifies the location of that section or subsection. Also in the same brackets as an aid to the reader is an abbreviated name of the major section. For example, a heading in the need Section is: “Promulgation of the Nutrient Criteria is the Appropriate Step [IV.D. EU standards, need].”

This SONAR can be made available in other formats, including Braille, large print and audio tape. TTY users may call the Agency teletypewriter at 651-282-5332 or 800-657-3864. The Agency will make the State Register notice, the SONAR and the proposed rule available during the public comment period on the Agency’s Public Notices Web site: http://www.pca.state.mn.us/news/data/index.cfm?PN=1
C. AGENCY’S STATUTORY AUTHORITY [I. introduction]

The Agency’s authority to adopt water quality standards and to classify waters of the state is found in Minn. Stat. § 115.03 (2005), particularly subdivisions 1(b) and 1(c). Subdivision 1(b) authorizes the Agency to classify waters, while subdivision 1(c) authorizes the Agency:

To establish and alter such reasonable pollution standards for any waters of the state in relation to the public use to which they are or may be put as it shall deem necessary for the purposes of this chapter and, with respect to the pollution of waters of the state, chapter 116;

Additional authority for adopting standards is established under Minn. Stat. § 115.44, subd. 2 and 4. Subdivision 2 authorizes the Agency to:

...group the designated waters of the state into classes, and adopt classifications and standards of purity and quality therefor. ...

Subdivision 4 authorizes the Agency to:

...adopt and design standards of quality and purity for each classification necessary for the public use or benefit contemplated by the classification. The standards shall prescribe what qualities and properties of water indicate a polluted condition of the waters of the state which is actually or potentially deleterious, harmful, detrimental, or injurious to the public health, safety, or welfare; to terrestrial or aquatic life or to its growth and propagation; or to the use of the waters for domestic, commercial and industrial, agricultural, recreational, or other reasonable purposes, with respect to the various classes established...

Finally, the Agency is authorized under Minn. Stat. § 115.03, subd. 5 to perform any and all acts minimally necessary, including the establishment and application of standards and rules, for the Agency’s ongoing participation in the NPDES2 permitting program.

Under these statutory provisions, the Agency has the necessary authority to adopt the proposed rules.

The adoption of administrative rules is regulated under Minn. Stat. ch. 14. This statute and Minn. R. ch. 1400 lay out the rulemaking process, and obligations of the Agency to, for example, involve the public, consider the impact of the rule amendments on certain subsets of Minnesotans, and assess the economic impact of the proposed amendments. They also serve to assure fairness and openness in the process.

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2 NPDES means National Pollutant Discharge Elimination System.
If approved and adopted, the proposed new rule (Minn. R. ch. 7053) and the changes to the existing rule will be enforceable by the Agency in accordance with the authority provided to the Agency by Minn. Stat. ch. 116 and 115. The Agency has general authority to enforce its rules under these statutes.
II. PROPOSED EUTROPHICATION STANDARDS FOR LAKES, SHALLOW LAKES AND RESERVIORS, BACKGROUND

A. IMPORTANCE OF LAKES [II. background]

Minnesota is defined by its lakes. Our license plates have claimed for decades that we are the land of 10,000 lakes. The quarter commemorating Minnesota’s statehood features an image of a lake, a fishing boat and a loon. Lakes are very important to Minnesota’s overall economy, a value which is quantifiable in dollars. Minnesota’s water resources are the cornerstone of a $10 billion a year tourism industry. Possibly even more valuable than this however, is the contribution lakes make to the overall quality of life in Minnesota. This “value” of lakes is much more difficult if not impossible to quantify, but the skyrocketing value of lakeshore property is certainly one indication. However, no one can put a dollar value on the peace of mind one gets gazing out on a beautiful lake setting, taking in the sounds and smells as well as the scenery. However, this image is disappearing in many parts of Minnesota’s lake country, as lakeshore property is becoming increasingly developed, and seasonal cabins are replaced by large, year-round homes (Exhibit EU-2). The demand for the finite amount of buildable lakeshore is not likely to let up any time soon. Popular articles about the importance of lakes and the mounting threats to them appear routinely in newspapers, magazines and state agency publications and on TV (for example, see Exhibits EU-3a to 3c). A survey of lake users in 1998 indicated that the close proximity of lakes to many Minnesota residents was an important reason they visited lakes. Other important reasons were scenery and fishing (Exhibit EU-4).

Governor Pawlenty made protection of water quality a priority in his first administration.

“More so that any other state, the quality and quantity of water in Minnesota is central to our way of life. It helps define who we are and what we value.”

Governor Pawlenty

A particularly relevant example of the Governor’s commitment to water quality is the Central Lakes Initiative, which is part of the Governor’s Clean Water Initiative. This project involves five counties in North Central Minnesota in the heart of the northern lakes region. It is a multifaceted effort to shape the inevitable development in such a way that the very resource (lakes) that brings people (and money) to the area is not destroyed.

Probably almost every person in Minnesota that fishes, swims, canoes, boats, water skis or recreates in any way on Minnesota lakes, including many lakeshore property owners, has experienced the negative impacts of excess nutrient loading to lakes – poor water clarity, green water, algae blooms, floating algal mats – conditions that make a lake much less enjoyable for

4 http://www.dnr.state.mn.us/lakes/ncml.html.

Book II 5
recreation. Excess phosphorus loading is almost always responsible for these degraded conditions.

Phosphorus comes from both point and nonpoint sources. The distinction between point and nonpoint sources has changed somewhat in the last several years, but point sources are generally controlled through use of some type of wastewater treatment facility, usually under the terms of a permit. Point sources include discharges from municipal and industrial wastewater treatment plants, discharges from permitted stormwater systems and feedlots, and failing individual septic systems. Nonpoint sources include uncontrolled or poorly controlled runoff from urban landscapes, agricultural land, construction sites and other altered landscapes⁵. These sources are generally controlled through application of best management practices. The relative contribution of nutrients from point and nonpoint sources depends on many factors including the frequency, duration and magnitude of rainfall events.

The 2003 Minnesota State Legislature requested a detailed study to quantify all sources of phosphorus to Minnesota’s watersheds⁶. The study was in response to legislative initiatives to lower the phosphorus content in automatic dishwasher detergents⁷. Barr Engineering was contracted to do the study and they issued a report in February 2004. Exhibit EU-6 is the executive summary of their report. Under average flow conditions, nonpoint sources contribute 69 percent, and point sources 31 percent, of the total loading of phosphorus to state waters. These percentages are strongly affected by the effluent concentration for the very large Metro Plant in St. Paul (Metropolitan Council, Environmental Services). They were calculated assuming an average effluent phosphorus concentration of 3 mg/L for the Metro Plant, which was valid at the time the study was done. A 1 mg/L phosphorus effluent limit went into effect in January, 2006; but, in fact, the Metro Plant has been achieving an effluent concentration of 1 mg/L for about a year prior to the required change. Because the size of the Metro Plant (about 220 million gallons per day) dwarfs all other plants in Minnesota, the reduction from 3 to 1 mg/L for this single facility has a dramatic effect on the relative point/nonpoint source phosphorus loading percentages. With the Metro Plant effluent at 1 mg/L, the revised percentages are 75 (nonpoint) and 25 (point) (Exhibit EU-6).

In general, phosphorus loading is reduced in two basic ways. For the most part, nonpoint sources are controlled by the application of a wide range of best management practices (BMP). BMPs reduce the quantity of runoff or reduce the concentration of phosphorus in runoff, or both. All citizens need to be mindful of personal actions that increase phosphorus in runoff that will impact rivers and lakes. Lakeshore property owners bear a particularly important responsibility in this area because of their close proximity to the lake. They should manage their property with an eye toward minimizing nutrient loading to the very lake resource they so highly treasure. Numerous publications, Web pages and resources are available to help property owners manage their property to protect lake water quality.

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⁵ Urban stormwater runoff and construction site runoff controlled by permit are considered point sources.
⁶ Minnesota Laws 2003, ch. 128, art. 1, §166.
⁷ The study found that about 3 percent of the total loading of phosphorus to Minnesota surface waters was from commercial and residential dishwashing detergent.
Point sources are controlled through phosphorus effluent limits in NPDES\(^8\) permits, and through mandatory and voluntary phosphorus reduction programs. A phosphorus management plan is required in many NPDES permits in situations where phosphorus loading is a concern but the permit does not include a numeric limit. Phosphorus management plans seek to locate and identify concentrated sources of phosphorus loading to the sanitary sewer system, and to work with these contributors to reduce their contributions, if possible. Less phosphorus loading to the front end of the wastewater treatment plant means less coming out and going into the receiving stream.

Over the last eight to ten years the Agency has focused considerable attention on phosphorus as a state-wide pollutant of major concern. The Agency developed a Phosphorus Strategy (Strategy) as a guide for the Agency and the public on how the Agency interprets the 1 mg/L total phosphorus effluent limit in existing Minn. R. 7050.0211, subp. 1a. In brief, the Strategy emphasizes a basin-wide approach to evaluating phosphorus loadings to lakes and a more holistic approach to phosphorus reductions while providing guidance on implementing the 1 mg/L limit (Exhibit PL-1c, see Section IX.C).

Given our love for lakes, and considering the pressures we place on them as a result, the Agency believes that multiple tools are needed to help protect lake water quality, and to safeguard the many beneficial uses lakes provide. The proposed numeric eutrophication standards for lakes, shallow lakes and reservoirs will provide one such tool.

B. LAKE SCIENCE [II. background]

The science of freshwater lakes and rivers is called limnology. Most of the discussion in this SONAR deals with lakes or static fresh water systems rather than flowing waters. The chemical, physical and biological properties of freshwater lakes have been extensively studied. Exhibit EU-45 provides a good introduction to lake biology, as well as a discussion of the pressures we place on lakes, trends in lake quality indicators, and lake programs.

For background purposes it is important to discuss some fundamental limnological concepts, and to define some terms because they will be used throughout this SONAR. The terms below marked with an asterisk (*) are defined in existing Minn. R. 7050.0150, subp. 4; those marked with a “#” are proposed to be defined in rule as part of this rulemaking.

**Aquatic Plants and Nutrients.** All lakes support a community of aquatic plants and animals of some type. Typically, the plant community can be divided into two major groups. One is the submerged and emergent rooted aquatic plants or macrophytes. The area of a lake shallow enough to support macrophytes, which is typically that portion of the lake 15 feet or less in depth, is called the **littoral zone**. The second major part of the plant community is the mostly microscopic single-celled green plants called algae or phytoplankton. Algae in lakes are typically suspended in the water column, but they can float on the surface or attach to plants, rocks, bottom sediments or other substrates. Attached algae can be long and stringy and make

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\(^{8}\) NPDES. National Pollutant Discharge Elimination System.
rocks feel slimy. It is the suspended or floating species of algae that contribute most to objectionable conditions in the form of algae blooms.

Just like terrestrial plants, aquatic plants need nutrients to grow and thrive. Lake water serves as a “nutrient medium” for the plants living in it that are not rooted to the bottom. This is true regardless of whether the lake water is very nutrient poor (oligotrophic) or very nutrient rich (eutrophic). The primary macro-nutrients (nutrients needed in relatively large amounts) plants need are carbon, hydrogen, oxygen, nitrogen and phosphorus. The first four in this list are almost always available in abundant supply in Minnesota lakes. Thus, algae that depend on nutrients supplied by the water very seldom want for carbon, hydrogen, oxygen or nitrogen. The growth of algae in a lake is controlled by the nutrient that is in the shortest supply, which is called the “limiting” nutrient. If more of the limiting nutrient is added to the water, algae respond very quickly to take advantage of the needed nutrient. This is reflected by the increased growth and abundance of algae. If a non-limiting nutrient such as nitrogen is added to a lake, the algae respond very little if at all because algal growth is still controlled by the supply of the limiting nutrient. Phosphorus is almost always the limiting nutrient in Minnesota lakes. Thus, as phosphorus concentrations increase or decrease algal biomass increases or decreases. Therefore, phosphorus is the focus of proposed eutrophication standards and the proposed extension of the phosphorus effluent limit.

An often quoted statement from a well known limnology textbook is that “phosphorus can theoretically generate 500 times its weight in living algae”; a response based on the relationship between phosphorus and algal growth requirements (Exhibit EU-5). Adding just one pound of phosphorus to a lake can result in 500 pounds of additional algae. Thus, any additional phosphorus loading to a lake can have a negative effect and should be avoided if possible or practical, even if the resulting change is not measurable due to variability within the system.

Phosphorus is the pollutant of concern in most Clean Water Partnership and Clean Lakes Program projects. Phosphorus tends to persist as it moves downstream, making it a pollutant of regional, state-wide and even national concern.

Occasionally lakes at the extreme ends of the trophic spectrum, that is lakes that are either extremely nutrient poor (ultraoligotrophic) or nutrient rich (hypereutrophic), can become nitrogen limited. While the Agency’s goal is to limit the influx of nutrients to surface waters in general, it is not usually practical to try to limit nitrogen as a nutrient due to its abundance in nature. Also, blue-green algae have the ability to utilize (fix) nitrogen directly from the atmosphere; they do not necessarily rely solely on the nitrogen in water. No standards are being proposed for nitrogen as a nutrient and, in general, nitrogen will not be discussed in this SONAR. The Agency will need to evaluate any nitrogen limited lakes on a case-by-case basis. In the case of a nitrogen-limited hypereutrophic lake, a substantial reduction of in-lake phosphorus is usually required to bring the lake back to a phosphorus-limited condition.

Phosphorus is an element, and as noted above, it is commonly accepted as being the nutrient that limits algal biomass in freshwater systems. Total phosphorus (TP) in the water column is a

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direct measure of all forms of phosphorus present in a given volume of water (usually expressed as µg/L or parts per billion). Over the years of sampling lakes, most Agency samples have been analyzed for total phosphorus using a colorimetric method (method 365.4, EPA, 1979). The Agency is most interested in measurements of TP.

Additional analysis of phosphorus is operationally separated into particulate or dissolved categories when the sample is filtered. A filter with a standard pore size of 0.45 microns (µm) is usually used. Particulate phosphorus is that phosphorus attached to particles larger than 0.45 µm and retained by the filter; dissolved phosphorus is the phosphorus in the water that passed through the filter. Total, particulate and dissolved phosphorus can be further subdivided analytically into three chemical types: reactive, acid-hydrolysable and organic. These specific forms of phosphorus are typically not measured in eutrophication studies but rather used for detailed studies on the chemical reactivity of phosphorus.

General eutrophication studies can include analysis of TP and total dissolved phosphorus. Total dissolved phosphorus provides an indication of phosphorus that is immediately available for algal uptake. Bio-available phosphorus (BAP) is an estimate of the fraction of total phosphorus that is available for algal growth generally in less than 30 days and is typically greater than total dissolved phosphorus. The percent of BAP varies depending on the phosphorus source. Exhibit EU-6 includes best estimates of the bioavailability of TP by source categories (shown below), and a more detailed discussion of BAP. Bio-available phosphorus assessments are used infrequently and typically only in complex studies where detailed source categorization is needed to evaluate trophic response.

<table>
<thead>
<tr>
<th>Source Category</th>
<th>TP fraction that is bio-available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial/Industrial WWTP effluent</td>
<td>0.88</td>
</tr>
<tr>
<td>POTW Effluent</td>
<td>0.85</td>
</tr>
<tr>
<td>Crop Land Runoff</td>
<td>0.58</td>
</tr>
<tr>
<td>Forested Land</td>
<td>0.44</td>
</tr>
</tbody>
</table>

As stated, for the purpose of the proposed eutrophication standards and assessing the trophic status of lakes, the Agency is most interested in total phosphorus; and the proposed phosphorus standards are expressed as **Total Phosphorus.** The reasons are summarized below:

- TP indicates the overall trophic condition of an aquatic resource and is used in load response modeling in lake studies;
- Chemical and biological process in lakes allow for the conversion of TP to BAP;
- TP exhibits strong correlations with the amount of algae and water clarity;
- TP is the form typically measured in lakes and in point and nonpoint source load assessments; and
- The extensive state TP data base is the basis for the proposed standards.

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10 Total phosphorus in lakes is measured from an unfiltered surface water sample, usually collected from a boat at the deep point in the lake, or mid-lake, using a 2-meter PVC tube. The tube, called an integrated sampler, is open at both ends and is allowed to fill as it is lowered vertically into the water. With the upper end just below the surface, a stopper is placed into the upper opening; the sampler is raised out of the water and the contents poured into a bottle. The result is an “integrated sample” of the top 2 meters of the lake.
Chlorophyll-a* Chlorophyll is a green pigment in plants including algae. The concentration of chlorophyll-a, one of several green pigments, provides an indirect measurement of the abundance of algae in surface waters. It is a very useful indicator of lake trophic status.

Secchi disk transparency* is a measurement of water clarity. The Secchi disk is a white or white and black disk, suspended in the center on a calibrated rope, such that the disk hangs perpendicular to the rope. The Secchi depth is determined by lowering the disk into the water from a boat until it can no longer be seen. This depth is noted on the calibrated rope; the disk is raised until it is visible again and that depth noted. The average of these two depths is the Secchi disk transparency or Secchi depth. The greater the Secchi disk reading the clearer the water. Secchi depth is inversely correlated with concentrations of TP and chlorophyll-a.

The proposed eutrophication standards are for total phosphorus, chlorophyll-a and Secchi depth. Because these three terms will be used so frequently throughout this SONAR, they will be abbreviated as:

| TP   | Total Phosphorus |
| Chl-a | Chlorophyll-a |
| SD   | Secchi disk transparency or Secchi depth |

Algae and algae blooms* Algae are very important to lake ecosystems. Like all green plants, they use the sun’s energy to grow. They are the foundation of the aquatic food chain: algae → zooplankton → macroinvertebrates (aquatic insects and crustaceans) → small fish → large fish.

Excess nutrients in a lake can result in undesirable amount of algae called “algae blooms”, which give the water a green color and reduce water clarity. Algae blooms are all too obvious to lake users in Minnesota. Blooms range from an occasional “nuisance” bloom to very severe blooms that may persist most of the summer. Nuisance or mild blooms are characterized by an obvious green tint to the water and the possibility of thin and patchy accumulations of algae on the surface (e.g. on the windward side of the lake). Mild to moderate blooms often are limited to the latter half of the summer. Severe blooms produce very objectionable green opaque water, floating mats of dead and dying algae (usually dominated by a few species) and unpleasant odors. Also, severe blooms can adversely affect fish populations. As algae die and decay, dissolved oxygen is consumed and it can be reduced below levels needed to support fish. Some algal species associated with severe algae blooms are toxic to animals and humans if ingested. Numerous animal deaths, mostly dogs, have been recorded in Minnesota as a result of ingesting lake water that contained algal toxins.¹¹

Aquatic plants or macrophytes – Macrophytes are the submerged or emergent green plants that grow in essentially all lakes. These plants, sometimes inaccurately called “weeds”, are a natural and important part of the lake ecosystem. They provide oxygen to the water through photosynthesis; cover for minnows and other small fish, nursery areas for young game fish; and habitat for numerous invertebrates and other fish food organisms. Macrophytes also dampen the

erosional impact of waves on the shoreline by absorbing wave energy. Aquatic plants can become very lush in the shallow parts of eutrophic lakes and may become a nuisance to lake users. Because of their value to lakes, particularly to fish populations, the Department of Natural Resources regulates the removal of aquatic plants by lakeshore property owners. In very eutrophic lakes, aquatic plants may die due to the shading effect of the abundant algae; and with the macrophytes suppressed or gone, the severity of algae blooms may be exacerbated.

**Trophic status** – Trophic status of a lake refers to the productivity or fertility of a lake. It is typically determined by measuring the concentrations of TP, Chl-a and SD. Trophic status is also reflected in the type of fish and aquatic invertebrate community the lake supports. Lakes are divided into four main trophic categories described below.

**Oligotrophic** – Oligotrophic lakes have low or very low levels of nutrients. Oligotrophic lakes typically have an algal community low in abundance (low Chl-a levels), very good water clarity, and a less productive fishery, relative to lakes richer in nutrients. Oligotrophic lakes usually maintain dissolved oxygen in the hypolimnion (see below) throughout the summer, and can support native or stocked populations of cold-water fish such as trout. Examples: Lake Superior and Burntside Lake near Ely.

**Mesotrophic** – Mesotrophic lakes have moderate levels of nutrients and low to moderate levels of Chl-a. Mesotrophic lakes typically have SD readings in the 12 to 20 foot range. Some of Minnesota’s most well known and popular fishing and recreational lakes are in this category. Algae blooms will be absent or very rare. Examples: Mille Lacs, Otter Tail, Gull and White Bear Lakes.

**Eutrophic** – Eutrophic lakes have high levels of nutrients. Water clarity and Chl-a levels are usually acceptable for recreation (swimming) at least part of the summer. Fishing is often very good. Examples: Lake Minnetonka and Bald Eagle Lake in the metro area.

**Hypereutrophic** – Hypereutrophic lakes have very high levels of nutrients and Chl-a, and poor water clarity. Recreation will be limited most of the summer, algae blooms will be frequent and may be severe. There is a risk of blooms of toxic blue-green algae. The fishery may be dominated by less desirable species, such as bullhead and carp. Example: Como Lake in St. Paul.

As noted, most of the very popular fishing and recreational lakes in Minnesota tend to be mesotrophic to mildly eutrophic. Lakes in these categories can be very susceptible to small increases in TP loading; that is, a small increase in loading can be reflected in a noticeable increase in algae and reduced transparency.

**Eutrophication** – Eutrophication refers to the increased productivity of the biological community in waterbodies in response to increased nutrient loading. Eutrophication is usually characterized by increased growth and abundance of algae and other aquatic plants, reduced water clarity, reduction or loss of dissolved oxygen in the hypolimnion, and other chemical and biological changes. If eutrophication proceeds too far, the recreational and aesthetic beneficial uses we expect our lakes to provide can be lost.
Lakes in a completely natural environment (i.e., no human activity) establish a condition of “trophic equilibrium” with the surrounding watershed. That is, lakes establish a natural trophic condition that depends on the morphometry of the lake and the characteristics of the surrounding watershed. The natural trophic condition can range from oligotrophic to eutrophic depending on these variables. The balanced condition persists over the long-term, and eutrophication proceeds very slowly over a time span measured in thousands of years (even millions of years in the case of the rare very old lakes such as the large and deep Lake Baikal in Siberian Russia). The gradual increase in plant productivity in natural lakes seems to be due in part to the gradual filling in of the lake basin by sedimentation and subsequent loss of depth, rather than from an increased rate of nutrient flux from the surrounding undisturbed watershed. As a lake becomes shallower and the water volume decreases, there tends to be an increase in the rate of cycling of available nutrients. It is a fallacy, however, to believe that left alone and without any influence from humans, all Minnesota lakes would become eutrophic in a matter of a few hundred years. After all, Minnesota’s lakes have been around for at least 9,000 years (see Section VI.C.3).

Cultural Eutrophication# – This term is used to describe the acceleration of eutrophication due to excess nutrient loading from human sources and activities. Lakes in much of the state suffer from cultural eutrophication, usually a result of a combination of point and nonpoint sources of nutrients attributable to human activities. In some cases the acceleration of eutrophication has been very rapid, dramatic and noticeable to even the most casual observer. Lakes that received inadequately treated municipal wastewater such as Lake Washington in Seattle, Minnetonka in the Twin Cities and Shagawa at Ely are good examples. Cultural eutrophication can and has caused a degradation of lake quality and the loss of beneficial uses.

Summer stratification (mixing status*) – Lakes that are deep, relatively small in size, or protected from strong prevailing winds will thermally stratify in the summer months. In such lakes two distinct and separate water layers are maintained by temperature differences throughout the summer. The warmer surface water (epilimnion) is lighter and “floats” on the colder and heavier deeper water (hypolimnion). A middle zone characterized by a rapid temperature transition, called the thermocline, separates the upper and lower layers. The temperature difference between the epilimnion and hypolimnion often ranges from 10 to 15 °C, and the resulting difference in density between the warm and cold water makes the stratification quite resistant to destruction by wind energy.

Opposing biological activities take place in the two zones. The epilimnion is the zone of photosynthesis, productivity and growth. Light penetrates the epilimnion, it is in contact with the air, and it tends to circulate and mix within itself from wind energy. The hypolimnion is cut off from the atmosphere and light, and is a zone of decomposition. Because the hypolimnion is cut off from the surface and the light needed to support oxygen producing photosynthesis, the store of oxygen it starts with in early summer is not replenished as long as stratification persists. The supply of hypolimnetic oxygen is progressively depleted by decomposition. In all but oligotrophic lakes the depletion progresses until oxygen is too low to support fish. Thus, fish are restricted to the epilimnion and thermocline in most Minnesota lakes in the summer. Sustaining adequate dissolved oxygen in the hypolimnion is the critical consideration in the development of the proposed eutrophication standards for lakes that support trout species (see Section VI.E).
Low productivity in the epilimnion of oligotrophic lakes means a low decomposition rate in the hypolimnion and a slower rate of oxygen depletion. This allows the oxygen stored in the hypolimnion to last throughout the summer, which allows trout and other fish that need cold water temperatures to live in the hypolimnion. This is the reason oligotrophic trout lakes need to be protected from even a slight increase in productivity, because it could result in depletion of the hypolimnetic oxygen and loss of the trout population (see Section VI.E and Figure II-7).

After ice-out in the spring and before ice-up in the fall, when water temperatures are about the same from top to bottom, all the water in the lake can mix and circulate in response to wind energy. This is called the spring and fall “turnover.” Turnover restores oxygen to the whole water column in lakes that stratify.

Lakes that are shallow and exposed to wind energy typically do not stratify. A temporary stratification may become established during a period of relative calm only to be destroyed when the wind picks up. A pattern of periodic temporary stratifications followed by mixing in some lakes can increase the amount of “internal loading” of TP to the water column from phosphorus-rich bottom sediments. Phosphorus is released to the anoxic water immediately above the sediments during the short periods of stratification, and this TP is then mixed with the whole lake when wind energy breaks down the relatively weak temporary stratification. The released TP is thereby made available to algae for growth. Internal loading can be an important source of TP to consider when identifying sources of TP loading to certain lakes.

Lake morphometry* – Morphometry refers to the physical characteristics and shape of lake basins, such as surface area, maximum depth, mean depth, percent littoral zone and shoreline complexity. These and other factors affect the natural trophic status of a lake, and they can affect how a lake responds, or its vulnerability, to nutrient loading. For example, shallow lakes tend to be more eutrophic than deep lakes.

It is unlikely the average person needs a definition of “lake”, but for the purposes of the proposed rule, the following terms will be defined to differentiate lakes, from shallow lakes, reservoirs and wetlands.

Lake# – A lake is defined as an enclosed basin filled or partially filled with standing fresh water with a maximum depth greater than 15 feet. Most lakes have natural outlets and inlets, but some may have one but not the other or neither.

Shallow lake# – A shallow lake is defined as an enclosed basin filled or partially filled with standing fresh water with a maximum depth of 15 feet or less, or where 80 percent or more of the lake area is littoral (shallow enough to support emergent and submerged rooted aquatic plants). Shallow lakes typically do not thermally stratify during the summer. Shallow lakes may need to be differentiated from wetlands and deeper lakes on a case-by-case basis. It is particularly difficult to define reliable criteria that will work in all cases to separate shallow lakes from wetlands. Shallow lakes and wetlands are not static. A waterbody may fit the definition of shallow lake one year and the definition of wetland the next, depending on many factors, not the
least of which is the amount of rainfall. Wetlands are already defined in the existing rule (Minn. R. 7050.0186, subp. 1a).

Reservoir# – A reservoir is a waterbody in a natural or artificial basin or watercourse where the outlet or flow is artificially controlled by a structure such as a dam. Run-of-the-river reservoirs are distinguished from river systems by the length of time the water resides in the reservoir before continuing on downstream. Reservoirs may not respond to nutrient enrichment the same way or to the same degree a natural lake does, and reservoirs have limnological attributes that are different from lakes (Exhibit EU-17, pages 3-4). For this reason site-specific eutrophication standards will often need to be determined for reservoirs on a case-by-case basis. The narrative portion of the proposed eutrophication standards will state this (Section VI.L.6).

Reference lake* – A reference lake is a lake minimally impacted by point or nonpoint sources of pollution. They are representative of the ecoregion in which they are located, and they are used as a base for comparing the quality of other lakes in the same ecoregion or geographical area. Reference lakes are often not the most pristine lakes in the ecoregion.

Summer-average* – Lakes are sampled during the summer growing season, typically from late May through September. A common lake sampling regime is one sample per month of the surface water through the summer, or about four to five samples per year. Total phosphorus, Chl-a and SD and other water quality characteristics are measured at each visit and the results are averaged to obtain “summer average” values. Summer averages for two or more years may then be averaged together for comparison to the eutrophication standards.

Ecoregion* – Ecoregion is not a limnological term but the ecoregion concept is central to the development of proposed eutrophication standards for Minnesota, and the term will be frequently mentioned in this SONAR (see Section III.D.2). Ecoregions are areas with similar ecological systems and characteristics such as surface geology, soils, land use, and native vegetation. Minnesota has seven ecoregions.

C. LAKE STANDARDS, A BRIEF HISTORY AND THE 2003 RULEMAKING
[II. background]

The Agency is proposing numeric eutrophication standards for lakes in this rulemaking. In the assessment factor rulemaking, completed in 2003, the Agency added substantial detail to the long-standing but brief narrative nutrient standard in existing Minn. R. 7050.0150. The purpose was to make the assessment process for determining the impairment of lakes due to excess nutrients more transparent by including the criteria (or factors) used in the assessment process in the rule, which was why this was called the “assessment factor” rulemaking. That rulemaking laid much of the groundwork for the promulgation of numeric standards in this rulemaking. The proposed eutrophication standards, like the existing narrative standard, are designed to protect the designated beneficial uses which lakes provide, including water-related recreation, fishing and aesthetic enjoyment. The promulgation of eutrophication standards in this rulemaking is the culmination of 20 years of research and planning by the Agency leading up to adoption of numeric standards for lakes. This is not a new undertaking by the Agency.
The Agency explored options for the adoption of nutrient standards for lakes in the mid-1980s. A report issued by an Agency nonpoint source standards work group in January 7, 1986 recommended the adoption of standards for lakes and outlined a plan to accomplish that, which is remarkably similar to what the Agency is now proposing (Exhibit EU-7). The report:

- Noted the concern expressed to the Agency by citizens about deteriorating lake water quality;
- Recommended numeric standards over enhanced narrative standards;
- Recommended standards for phosphorus, chlorophyll-a and possibly Secchi depth;
- Noted that the natural variability in lake quality must be addressed as part of the standards;
- Noted that the ecoregion concept (new at the time) might provide at least a partial solution to the lake diversity issue; and
- Noted the actions of other states that had adopted nutrient standards of various types.

This report laid out a time-table for action and called for final adoption of numeric lake standards by May of 1989. Needless to say, the recommendations of this report were not acted upon in this time frame.

The effort to develop and promulgate lake standards was taken up again by the Agency in the mid-1990s, due in part to the growing problem of eutrophication of Minnesota’s lakes. A memorandum from staff member Steven Heiskary to the manager of the Monitoring and Assessment Section in January, 1995 recommended the adoption of numeric, ecoregion-based eutrophication standards (Exhibit EU-8). This memo suggested the formation of two work groups within the Agency, one to review the existing phosphorus effluent limit and one to review ambient eutrophication standards. Mr. Heiskary’s memo also discussed plans for involving interested parties and the public at large in the process, and it established a schedule leading up to rulemaking. The standards would be based on data from the Agency’s lake monitoring program. The work of the two workgroups was summarized in a 20-page report issued in 1996 (Exhibit EU-9). Other priorities for water quality standards rulemaking once again forced the postponement of the promulgation of eutrophication standards. Both Heiskary’s memo and the report discuss some of the attributes of numeric standards and the issues that need to be addressed in the development of eutrophication standards, which are still relevant today. In particular, the report addressed:

- “Citizens, local units of government, and other state agencies all look to us [the Agency] for leadership on this issue.” The issue referred to in this quote is nutrient loading to lakes, particularly from nonpoint sources.
- The positive link between lake standards and the basin planning process that has highlighted nutrient loading as an important issue in several watersheds;
- The cultural eutrophication of rivers;
- Using the ecoregion framework as a basis for separating lakes into categories;

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12 The major rulemaking priority in the 1990s for Minnesota was the adoption of the federally mandated Great Lakes Initiative, Minn. R. ch. 7052.
The large variability in quality and characteristics among lakes; and
Standards will be exceeded in a large number of lakes, and TMDLs may be required for waterbodies that don’t meet the standards.

The Agency’s response to the recommendations in the 1996 report was to focus attention on the implementation of the 1 mg/L TP effluent limit in existing Minn. R. 7050.0211, subp. 1a. Another work group was set up to prepare a more detailed “Phosphorus Strategy” (Strategy) in the late-1990s. The purpose of developing the Strategy was to clarify, for Agency staff as well as outside parties, how the Agency planned to implement the TP limit for point source discharges in the future. The Strategy (Exhibit PL-1c) will be discussed in more detail in Section IX.C.

Following the completion of the Strategy in 2000 and the placement of lakes on the 2000 and 2002 303(d) lists due to excess nutrients (see Section IV.C), outside parties asked the Agency to adopt the “assessment factors” into rule. As mentioned above, this rulemaking was completed in 2003 and included the adoption of detailed assessment guidance or “factors” that greatly expanded on the general narrative standard that prevents excess plant growth due to nutrient loading. The broadly worded narrative standard is quoted below. It has not changed since it was adopted as part of the first state-wide water quality rule in 1967.

[Minn. R. 7050.0150, subp. 3] …there shall be no material increase in undesirable slime growths or aquatic plants, including algae,...

Important principles and issues surrounding the assessment of lake trophic status were discussed in the SONAR for the assessment factor rulemaking and in Agency response to comments. The assessment factors that were adopted and the rulemaking record established an important record for the proposed numeric standards in this rulemaking (Exhibits EU-46a, EU-46b and EU-46c). The narrative standard as it reads now after the 2003 rulemaking is shown below:

Subp. 5. **Impairment of waters due to excess algae or plant growth.** In evaluating whether the narrative standards in subpart 3, which prohibit any material increase in undesirable slime growths or aquatic plants including algae, are being met, the commissioner will use all readily available and reliable data and information for the following factors of use impairment:

A. representative summer-average concentrations of total phosphorus and total nitrogen measured in the water body throughout the summer growing season;
B. representative summer-average concentrations of chlorophyll-a measured in the water body throughout the summer growing season;
C. representative measurements of light transparency in the water body, as measured with a Secchi disk in lakes or a transparency tube in rivers and streams, throughout the growing season; and
D. any other scientifically objective, credible, and supportable factor.

A finding of an impaired condition must be supported by data showing elevated levels of nutrients in item A, and at least one factor showing impaired conditions resulting from nutrient over-enrichment in items B and C. The trophic status data described in items A to D must be assessed in light of the magnitude, duration, and frequency of nuisance
algae blooms in the water body; and documented impaired recreational and aesthetic
conditions observed by the users of the water body due to excess algae or plant growth,
reduced transparency, or other deleterious conditions caused by nutrient over-
enrichment.

Assessment of trophic status and the response of a given water body to nutrient
enrichment will take into account the trophic status of reference water bodies; and all
relevant factors that affect the trophic status of the given water body appropriate for its
geographic region, such as the morphometry, hydraulic residence time, mixing status,
watershed size, and location. The factors in this subpart apply to lakes and, where
scientifically justified, to rivers, streams, and wetlands.

In summary, the expanded narrative standard added the following concepts into Minn. R.
7050.0150:

- In assessing the trophic status of lakes, the Agency must compare eutrophication criteria
to the in-lake measurements of TP, Chl-a and SD averaged over the summer growing
season.
- An impaired condition must be supported by TP concentrations above appropriate criteria
(causal factor), and either elevated Chl-a concentrations, or poor water clarity as
measured by SD (response factors).
- The magnitude, duration and frequency of algae blooms, and the recreational suitability
and aesthetic conditions reported by lake users are valid data (user perception data).
- Assessment of a lake must take into account all the factors that affect trophic status, such
as lake morphometry, location, mixing status and watershed size.

In addition, nine definitions specifically related to the assessment of lake trophic status were
added to Minn. R. 7050.0150, subp. 4 in this rulemaking. Again, the definitions for these terms,
now in rule, are critical to the proposed numeric eutrophication standards. The Agency is
proposing to add six more definitions to Minn. R. 7050.0150, subp. 4, as part of the proposed
eutrophication standards (Table II-2).

Table II-2. Terms Currently Defined and Proposed New Definitions in Minn. R. 7050.0150,
subp. 4 Associated with Proposed Eutrophication Standards.

<table>
<thead>
<tr>
<th>Definitions Adopted in 2003</th>
<th>Definitions Proposed as Part of this Rulemaking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorophyll-a</td>
<td>Eutrophication and cultural eutrophication</td>
</tr>
<tr>
<td>Ecoregion</td>
<td>Lake</td>
</tr>
<tr>
<td>Hydraulic residence time</td>
<td>Measurable increase or impact</td>
</tr>
<tr>
<td>Lake morphometry</td>
<td>Natural causes</td>
</tr>
<tr>
<td>Mixing status</td>
<td>Reservoir</td>
</tr>
<tr>
<td>Nuisance algae bloom</td>
<td>Shallow lake</td>
</tr>
<tr>
<td>Secchi disk transparency</td>
<td></td>
</tr>
<tr>
<td>Summer average</td>
<td></td>
</tr>
<tr>
<td>Trophic status</td>
<td></td>
</tr>
</tbody>
</table>
As noted, the Agency acted on a recommendation of the 1996 report by establishing a work group to prepare a more detailed “Phosphorus Strategy.” The Strategy laid the foundation for the proposed extension of the TP effluent limit to new and expanding dischargers greater than a certain size (Exhibit PL-1c). The Strategy is discussed in Section IX.C.
III. EPA GUIDANCE, EPA AND AGENCY NUTRIENT CRITERIA

A. EPA GUIDANCE [III. EU criteria & guidance]

The U.S. Environmental Protection Agency (EPA) reports that excess nutrient loading is one of the leading causes of impairment of the nation’s surface waters, based on their review of state lists of impaired waters (Exhibit EU-16).13 In 1987, the North American Lake Management Society (NALMS) established a task force on Lake Water Quality Standards to determine the thinking of states regarding the need for lake standards, and to gather information related to existing lake standards. NALMS issued a report in 1992 summarizing the information assembled by the committee, which used the work of seven states including Minnesota as examples (Exhibit EU-25).14

The re-authorized Clean Water Act of 1987 (Section 319) established the need to develop new or implement existing standards as a basis for submitting and evaluating clean-lakes projects eligible for 319 funding. EPA began a nutrient criteria development program in the 1990s, and moved quickly from 1998 to 2001 to publish a number of documents, including a nutrient strategy, nutrient criteria for lakes and rivers, technical guidance for states and tribes, fact sheets and policy memos, which are the exhibits listed below.

Exhibits:
- EU-10. EPA National Nutrient Strategy
- EU-11. EPA Lakes and Reservoirs in Nutrient Ecoregion VI, NGP and WCBP
- EU-12. EPA Lakes and Reservoirs in Nutrient Ecoregion VII, NCHF
- EU-13. EPA Lakes and Reservoirs in Nutrient Ecoregion VIII, NLF
- EU-15. Federal Register, notice of final nutrient criteria, January 9, 2001
- EU-16. EPA Nutrient Criteria Technical Guidance Manual, Lakes and Reservoirs EPA-822-B00-001
- EU-17. EPA Memo from Geoffrey Grubbs to Water Directors, etc. Development and adoption of nutrient criteria into water quality standards, November 14, 2001.

Numeric water quality criteria should reflect the latest scientific knowledge on the identifiable effects of pollutants on public health and welfare, aquatic life, and recreation. Water quality criteria are qualitative estimates of the concentration of a water constituent, which when not exceeded, will ensure water quality sufficient to protect a designated water use. Nutrient criteria are developed in a very different way than traditional toxicity-based criteria (see Section III.E).

It is worth mentioning that the latest round of nutrient criteria from the EPA is not the first time nutrient criteria have been issued by that agency. In a letter dated April 20, 1973, EPA recommended that the Agency adopt TP standards for both flowing water and lakes by 1983

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13 The 305(b) and 303(d) reports, compiled by states and authorized tribes every two years, as required by the Clean Water Act (see SONAR Book I, Section II.B).
14 NALMS committee chaired by Steven Heiskary of the Agency staff.
(Exhibit EU-18). The recommended TP values were 200 µg/L for free flowing streams and 50 µg/L for lakes. The recommended values were a little more lenient than the criteria in the support document attached to the letter, which were 100 µg/L for free flowing streams, 50 µg/L in any stream where it enters a reservoir or lake, and 25 µg/L in any reservoir or lake\textsuperscript{15}. The support document stressed that these numbers were strictly guidance to states, and the criteria adopted could be more or less stringent depending on the local conditions in each state. The support document also discusses issues relevant today, such as the need to address situations when standards cannot be met and the variability in trophic condition among lakes.

The EPA expects states to adopt nutrient criteria\textsuperscript{16} into their state water quality rules (e.g. see Exhibit EU-49). The EPA has indicated a willingness to step in and promulgate nutrient criteria for any state that fails to take action on their own (Exhibits EU-10, page 6; EU-15, page 1674; EU-17, page 3). At the same time, EPA repeatedly emphasizes the importance of states developing the nutrient standards that best fit the resources and nutrient source issues in their state. EPA intends for states to use the nutrient criteria, published under section 304(a) of the Clean Water Act, as guidance in the development of their own proposed nutrient standards (Exhibits EU-11, EU-12 and EU-13). EPA is providing states considerable flexibility, as the following quote from EPA’s 2002 fact sheet indicates (Exhibit EU-14):

\textit{What are EPA’s expectations for these [nutrient] criteria?}

\textit{EPA expects that states and tribes will use these three ecoregional nutrient criteria documents as starting points to identify more precise numeric levels for nutrient parameters needed to protect aquatic life, recreation, or other uses on site-specific or subregion-specific conditions. EPA expects these more precise numerical levels to be developed on a smaller geographical scale than the ecoregional values presented in the nutrient water quality criteria documents. States and tribes may also develop criteria using other scientifically defensible methods and appropriate water quality data or simply adopt EPA’s recommended water quality criteria in their water quality standards.}

The above quote sums up exactly what the Agency has done to develop the proposed eutrophication standards. Key aspects of EPA’s statement above are “more precise numerical levels to be developed on a smaller geographical scale” and the protection of uses “on site-specific or subregion-specific conditions”. The combination of the Agency’s ecoregion-specific approach, plus the division of lakes into four types (lake trout, stream trout, lakes in general plus reservoirs and shallow lakes), is entirely consistent with EPA’s guidance. In addition, the specific beneficial uses emphasized, within the overall Class 2 aquatic life and recreation umbrella, are tailored to the characteristics of each lake type.

\textsuperscript{15} The 1973 criteria seem to be loosely based on recommendations in, \textit{Water quality criteria, Report of the National Technical Advisory Committee} (Federal Water Pollution Control Administration, Washington DC, page 56, commonly referred to as the “Green Book”). Subsequent EPA criteria were in the form of a narrative (“Blue Book,” 1972), or a repeat of the 25/50/100 µg/L criteria (see text) in the 1986 EPA “Red Book.”

\textsuperscript{16} Throughout this document the terms “nutrient” and “eutrophication”, when associated with “criteria” or “proposed standards”, are used essentially interchangeably. EPA uses the term “nutrient” in referring to their criteria, which include criteria for chlorophyll-a and a measurement of water clarity (e.g., Secchi depth) as well as the nutrients phosphorus and nitrogen. The Agency prefers the term “eutrophication” to reflect the fact that the proposed standards are not just for nutrients; this is the term we associate with the proposed standards.
Specifically, EPA recommended the following three options, in order of preference as guidance to the states (Exhibit EU-15, page 1673).

1. Develop nutrient criteria that fully reflect local conditions and protect specific designated beneficial uses, using processes described in EPA’s technical guidance. Nutrient standards the states adopt can be either numeric [as proposed by the Agency] or procedures to translate a narrative standard into a quantitative endpoint.

2. Adopt EPA’s Section 304(a) criteria, either as numeric standards or as procedures to translate a narrative standard into a quantitative endpoint.

3. Develop nutrient criteria protective of designated beneficial uses, using other scientifically defensible methods and appropriate water quality data.

In Mr. Grubbs’ memo (Exhibit EU-17, page 6), EPA presents a somewhat different set of three options. In Exhibit EU-17 the first option is the same as above, the second option is the same as number three above, and the third option is to carry out use attainability analyses (UAA) to refine beneficial uses. The Agency prefers not to use the UAA option as part of any general approach to setting eutrophication standards. The Agency is concerned that the UAA approach would require a huge and completely unacceptable amount of staff time. Given the hundreds if not thousands of waterbodies that potentially might require a UAA, and the fact that a change in use classification requires rulemaking, with an uncertain outcome, the UAA option is considered impractical.

The Agency used a combination of EPA’s options one and three listed above to develop the proposed eutrophication standards (Exhibit EU-14). The Agency’s proposed eutrophication standards reflect:

- Localized conditions in Minnesota, including the diversity within the state (ecoregions);
- Levels of TP, Chl-a and SD designed to protect a range of designated Class 2 beneficial uses; and
- Scientifically defensible methods and a very robust and multifaceted Minnesota water quality data base upon which the proposed numeric standards are based.

B. RTAG MEETINGS [III. EU criteria & guidance]

As EPA started to develop nutrient criteria for the nation they also formed Regional Technical Assistance Groups (RTAG), also called “regional nutrient teams” (Exhibit EU-10). The RTAGs consist of state and tribal representatives that met with staff from EPA and other federal agencies to develop more refined and localized nutrient criteria using approaches described in the EPA technical guidance (Exhibit EU-16). Minnesota was part of the EPA Region 5 RTAG group, which usually met in Chicago\textsuperscript{17}. The Region 5 RTAG continues to meet today. As part of

\textsuperscript{17} EPA Region 5, based in Chicago, includes Minnesota, Wisconsin, Michigan, Ohio, Indiana and Illinois.
RTAG, EPA designated a regional nutrient coordinator for each of the 10 EPA regions\textsuperscript{18}. Their function was to facilitate the collection and analysis of local nutrient data, provide technical assistance to the states on criteria development, report progress to EPA Headquarters in Washington D.C., and award financial assistance. EPA encouraged states to have their RTAG provide a technical review of proposed state nutrient standards.

The Minnesota local data-driven and ecoregion-based approach is recognized as a model by EPA. The Agency started monitoring lakes, developed nutrient criteria, and using them in lake programs and impairment assessments ahead of most other states. Minnesota has shared this experience with RTAG, the North American Lake Management Society (NALMS) and with other limnological organizations at a variety of local and national conferences on numerous occasions, including a recent NALMS meeting in Madison, Wisconsin in November, 2005, and at the All States National Criteria meeting in Dallas, Texas in February, 2006. Steve Heiskary of the Agency staff is a past president of NALMS, has published numerous papers on limnological topics, was one of the authors of the EPA nutrient criteria technical guidance (Exhibit EU-16), and he served on a panel of experts that provided an external peer review of EPA’s criteria documents (Exhibits EU-11, EU-12 and EU-13).

C. STATE NUTRIENT PLANS [III. EU criteria & guidance]

The EPA proposed a simple two-step process for the states to follow that would culminate in the adoption of nutrient standards by the state (Exhibit EU-17). Step one was for each state to submit a plan to EPA that described how the state proposed to develop nutrient criteria and a schedule for adoption. Step two was the promulgation and adoption of the nutrient criteria into the state’s rules.

The Agency submitted a final plan for EPA’s consideration in April 2003 (Exhibit EU-19a; cover letter, Exhibit EU-20). The plan has undergone periodic updating since; for example, see Exhibits EU-22a and 22b. The most recent version of the plan is Exhibit EU-19b. In its plan the Agency outlined:

- A strategy for developing eutrophication standards for lakes and rivers,
- The causal (TP) and response variables (Chl-a and SD) for which standards will be proposed,
- A description of the Agency’s approach and data utilized to arrive at the proposed standards (Attachment I to the plan), and
- A time-table for adopting the standards.

The EPA approved Minnesota’s 2003 plan in a letter dated May 5, 2003 (Exhibit EU-21), and EPA has approved the most recent update as well (September 2006). In Exhibit EU-21, EPA reiterates the possibility of promulgating nutrient standards for Minnesota, if the Agency fails to meet the terms agreed upon in the plan. The Agency is lagging behind the schedule provided in the 2003 plan for adoption, but EPA wants states to complete their own adoption process, and so

\textsuperscript{18} The EPA Region 5 coordinator, formally Dr. Candice Bauer, is now Edward Hammer (February 2006).
far EPA has not indicated it plans to take action. The 2006 update reiterates the Agency’s intent to adopt the proposed eutrophication standards in this rulemaking.

D. EPA NUTRIENT (EUTROPHICATION) CRITERIA [III. EU criteria & guidance]

1. **Introduction** [III.D. EU criteria & guidance]

The EPA developed nutrient criteria under the authority of Section 304(a) of the Clean Water Act. EPA’s nutrient criteria are unlike essentially all other 304(a) criteria. Most EPA 304(a) criteria developed over the years are for toxic substances. Because nutrients are not regulated as toxins, the data and methods used to establish nutrient criteria are very different from the data and methods EPA uses to develop criteria based on the toxicity of a substance to aquatic life, humans or wildlife. Nutrient criteria are based on trophic condition monitoring data from lakes and reservoirs across the nation. Toxicity-based criteria are based mostly on laboratory derived, toxicity test data for aquatic organisms. Also, EPA’s nutrient criteria are regional, specifically tailored to ecoregions, whereas most EPA 304(a) criteria are applicable nation-wide.

2. **Ecoregions** [III.D. EU criteria & guidance]

Dividing the nation geographically into zones with similar geological and ecological characteristics called ecoregions is fundamental to the development of nutrient criteria by EPA and the Agency’s proposed eutrophication standards. Lake characteristics reflect the ecoregion in which they are located. Ecoregions have been mapped by the EPA for the lower 48 states based on overlaying maps of land form, soil type, land use, and potential natural vegetation. Ecoregions are areas where these features and surface water resources are similar. The Agency added a definition for ecoregions in the 2003 rulemaking as follows:

[Minn. R. 7050.0150, subp. 4] B. *Ecoregion means an area of relative homogeneity in ecological systems based on similar soils, land use, land surface form and potential natural vegetation.*

Minnesota is characterized by seven ecoregions (Exhibit EU-23), four of which contain 98 percent of Minnesota’s lakes; these four are the:

- Northern Lakes and Forests (NLF),
- North Central Hardwood Forests (NCHF),
- Western Corn Belt Plains (WCBP), and
- Northern Glaciated Plains (NGP) ecoregions

Eutrophication standards are proposed for these four ecoregions, but the proposed standards for the WCBP and NGP ecoregions in southern Minnesota are the same. Thus, in effect, the proposed standards can be summarized as applicable to the lakes in the following two distinct regions with a transition zone in between:

- Northeastern Minnesota forests, NLF
- Southern Minnesota prairie, WCBP and NGP
- A transitional zone of predominately deciduous forest, NCHF

Major drainage basins within the state may drain water from one or more ecoregions. For example, the Lake Superior basin drains a portion of just one ecoregion, NLF, while the Red River Basin drains portions of five ecoregions. Ecoregions are the framework of choice for developing nutrient criteria as per the EPA technical guidance (Exhibit EU-16).

The EPA ecoregion-based nutrient criteria relevant to Minnesota are found in three documents, Exhibits EU-11, EU-12 and EU-13. The EPA national nutrient criteria were developed for 14 “aggregate” ecoregions. The EPA aggregate ecoregions include one or more “sub-ecoregions”, called level III ecoregions. The level III ecoregions are what the Agency is using. Table II-3 lists the EPA aggregate ecoregions and the smaller scale level III ecoregions in Minnesota for which eutrophication standards are being proposed.

Table II-3. EPA Aggregate Ecoregions and Corresponding Minnesota (Level III) Ecoregions. Ecoregions in Bold Contain 98 Percent of Lakes in Minnesota.

<table>
<thead>
<tr>
<th>EPA Aggregate or “Nutrient” Ecoregions</th>
<th>Includes these Level III Ecoregions in Minnesota</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.&amp; Ex.</td>
<td>Name</td>
</tr>
<tr>
<td>VI (Ex.EU-11)</td>
<td>Corn belt and northern great plains</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>VII (Ex.EU-12)</td>
<td>Mostly glaciated dairy region</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>VIII (Ex.EU-13)</td>
<td>Nutrient poor largely glaciated upper Midwest and northeast</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No.: EPA assigned Roman numerals to aggregate ecoregions and Arabic numbers to level III ecoregions.
Ex. means Exhibit.

3. **EPA Nutrient Criteria [III.D. EU criteria & guidance]**

To develop the numeric nutrient criteria, EPA applied an empirical, statistically-based approach to the lake data for each aggregate and level III ecoregion. They used data spanning a 10-year period for lakes and selected percentile values from the distribution of that data, to arrive at numeric criteria.

EPA developed criteria for TP, Chl-a and SD. In addition, EPA developed criteria for total nitrogen, total kjeldahl nitrogen, and nitrite plus nitrate. The EPA TP, Chl-a and SD criteria are
of most interest to the Agency. The Agency is not proposing any nitrogen standards, mainly because TP is almost always the limiting nutrient in Minnesota lakes, and we have a 20 year history of assessing lake trophic status using TP (and Chl-a and SD) data.

The EPA criteria are intended to represent conditions that are minimally impacted by human activity, and to be protective of aquatic life and recreational uses. The EPA criteria documents provide details on how the criteria were developed, including data sources, QA/QC procedures, number of data points for each parameter and their statistical methods (Exhibits EU-11, EU-12 and EU-13). The EPA approach can be summarized as follows:

- Assembled representative data for lakes and reservoirs for a 10-year period (1990-1999), for TP, Chl-a and SD (plus nitrogen) data for each aggregate ecoregion.
- Data collection and analysis followed QA/QC procedures; it was screened for duplication, and data for waterbodies receiving a permitted discharge were not used. Data spanning all four seasons, or three seasons if winter data were missing, was used in the analysis.
- All data was from STORET\textsuperscript{19}, and much of the data was the product of state monitoring programs.
- Used the data to establish reference conditions for lakes in each ecoregion. Reference site conditions are based on a population distribution of the data. Models were not used.
- Reference conditions were defined as the 75\textsuperscript{th} percentile values from the distribution of a subset of data representing reference lakes; or the 25\textsuperscript{th} percentile values from the distribution of the data representing all lakes in the aggregate ecoregion.

The EPA’s preferred method for determining the criteria was to use the 75\textsuperscript{th} percentile value from lakes identified as minimally impacted, the reference lakes. The second option was to use the 25\textsuperscript{th} percentile value from data for all lakes. The fact that reference lakes are typically not identified in most of the aggregate ecoregions, precluded EPA from using the preferred approach. They anticipated that the states would provide information on reference lakes. EPA compared 25\textsuperscript{th} percentile values for all lakes to the 75\textsuperscript{th} percentile values from reference lakes, including data from Minnesota, and concluded that the 25\textsuperscript{th} percentile (all lakes) was a reasonable approximation of the 75\textsuperscript{th} percentile (reference lakes). Table II-4 summarizes the EPA nutrient criteria for Minnesota ecoregions based on the 25\textsuperscript{th} percentile values.

\textsuperscript{19} STORET means EPA water quality data STOrage and RETrieval system.
Table II-4. EPA Nutrient Criteria for Aggregate Ecoregions (shaded rows) and for the Four Level III Ecoregions in Minnesota; 25<sup>th</sup> Percentile Values (see text).

<table>
<thead>
<tr>
<th>Ecoregion: Aggregate, Level III</th>
<th>Ecoregion Name</th>
<th>Parameter</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate, VI</td>
<td>Corn belt</td>
<td>TP, µg/L</td>
<td>37.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chl-a, µg/L</td>
<td>8.59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD, meters</td>
<td>1.36</td>
<td></td>
</tr>
<tr>
<td>Level III, 46</td>
<td>NGP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level III, 47</td>
<td>WCBP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate, VII</td>
<td>Dairy region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level III, 51</td>
<td>NCHF</td>
<td></td>
<td>20</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD, meters</td>
<td>3.33</td>
<td></td>
</tr>
<tr>
<td>Aggregate, VIII</td>
<td>Nutrient poor</td>
<td></td>
<td>8.00</td>
<td>2.39</td>
</tr>
<tr>
<td>Level III, 50</td>
<td>NLF</td>
<td></td>
<td>9.69</td>
<td>2.46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD, meters</td>
<td>4.93</td>
<td></td>
</tr>
</tbody>
</table>

Chl-a values measured by the spectrophotometric method with acid correction.

E. AGENCY NUTRIENT (EUTROPHICATION) CRITERIA [III. EU criteria & guidance]

1. Development of Agency Nutrient Criteria [III.E. EU criteria & guidance]

Minnesota’s lakes and reservoirs are currently protected from cultural eutrophication by a narrative standard in Minn. R. 7050.0150, subp. 5 (Section II.C). As already mentioned, this standard was substantially enhanced in the assessment factor rulemaking. The story of the development of the Agency’s nutrient (eutrophication) criteria is really the story of the development of the proposed eutrophication standards (Exhibit EU-1). The criteria have been refined and expanded (e.g., addition of separate standards for shallow lakes), but the nutrient criteria developed in the late-1980s are clearly the precursors of the proposed standards. For this reason, the development of the criteria is introduced here and described in more detail in Section VI.D.

In the mid-1980s the Agency started applying the newly published ecoregion framework to existing lake water quality data. Distinct regional patterns in lake trophic status, morphometry and fishery ecological class were identified (Exhibits EU-24 and EU-27). This led to the selection of several reference lakes in each ecoregion for further monitoring. Reference lakes are minimally impacted by human activity but representative of lakes in the respective ecoregions. Data for the reference lakes was analyzed by ecoregion and the results reported in 1990, in the form of an Agency guide for lake assessments (Exhibit EU-28). Examples of how the reference lake data have been used as a basis for evaluating lake condition are in Exhibit EU-29. These data were particularly useful for establishing criteria for TP and the relationships between TP and the frequency and severity of nuisance algal blooms (Exhibit EU-30).
The 1990 ecoregion-based TP criteria are shown in Table II-5. The overall approach used to develop these criteria is consistent with current EPA guidance in Exhibit EU-16, which came later.

Table II-5. Ecoregion-based Total Phosphorus Criteria for Minnesota Lakes.

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Use and Level of Support</th>
<th>TP Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Lakes and Forests</td>
<td>Cold water fishery</td>
<td>&lt; 15 μg/liter</td>
</tr>
<tr>
<td></td>
<td>Full support</td>
<td></td>
</tr>
<tr>
<td>Northern Lakes and Forests</td>
<td>Primary-contact recreation and aesthetics</td>
<td>&lt; 30 μg/liter</td>
</tr>
<tr>
<td></td>
<td>Full support</td>
<td></td>
</tr>
<tr>
<td>North Central Hardwood Forests</td>
<td>Primary-contact recreation and aesthetics</td>
<td>&lt; 40 μg/liter</td>
</tr>
<tr>
<td></td>
<td>Full support</td>
<td></td>
</tr>
<tr>
<td>Western Corn Belt Plains and</td>
<td>Primary-contact recreation,</td>
<td>&lt; 40 μg/liter</td>
</tr>
<tr>
<td>Northern Glaciated Plains</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full support</td>
<td></td>
</tr>
<tr>
<td>Western Corn Belt Plains and</td>
<td>Primary-contact recreation,</td>
<td>&lt; 90 μg/liter</td>
</tr>
<tr>
<td>Northern Glaciated Plains</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Partial support</td>
<td></td>
</tr>
</tbody>
</table>

Following closely behind the development of the ecoregion-specific TP criteria, the Agency developed criteria for Chl-a and SD (response variables, Exhibit EU-1).

2. Criteria for Causal and Response Variables [III.E. EU criteria & guidance]

Excess nutrients, particularly phosphorus are the cause of eutrophication. Algae growth, green water, algae blooms and floating mats of blue-green algae, loss of water clarity and possible loss of aquatic life and recreational uses are the response to the nutrients. As stated, standards are being proposed for one causal variable, TP and two response variables, Chl-a and SD. The Agency believes it is important to have both the cause and the response represented in the numeric standards; and to have standards for two response variables. While rare in lakes, it is possible for the cause (TP) to be at high concentrations, but not completely expressed in the normal response. This is the reason the Agency is proposing the TP standard plus just one of the two response standards must be exceeded to have an exceedance of the standard (Section VI.L.3).

3. Use of Agency Nutrient Criteria [III.E. EU criteria & guidance]

Since their establishment in 1988, the TP criteria have been used in a variety of lake programs. Nutrient criteria have played an important role in the protection and restoration of lake water quality in Minnesota. The criteria can be used with existing regulatory, management, and educational programs. Beginning in 2002 the three criteria (TP, Chl-a and SD) have been used to assess lakes for possible impairment due to excess nutrients for listing on the impaired waters list (303(d)). Below is a list of programs where the TP and response criteria have been used.

1. Assess condition of lakes for the 305(b) water quality status report to EPA and Congress, and the 303(d) impaired waters list.
2. Use in prioritizing and selecting nonpoint source projects to be funded through the Clean Water Partnership Program (Minn. Stat. §§115.091 to 115.103 (Supp. 1987)), and the federally funded Section 314 Clean Lakes and Section 319 Nonpoint Source Management Programs authorized by the Clean Water Act.

3. For use by resource managers in developing water quality management plans. For example, there are currently over 80 water management organizations in Minnesota preparing comprehensive local water management plans required or authorized under Minn. Stat. §473.878 or Minn. Stat. ch. 110B.

4. Use as an educational tool for communicating what can reasonably be expected in terms of lake quality in a given lake.

5. Serve as reasonable targets or goals for degraded lakes (e.g., 303(d) listed lakes).

6. Guide enforcement and permitting decisions (e.g. effluent limits, stormwater permits, feedlot and land application permits).

IV. NEED FOR PROPOSED EUTROPHICATION STANDARDS

A. INTRODUCTION [IV. EU standards, need]

Minnesota Stat. ch. 14 requires the Agency to explain the facts establishing the need for and the reasonableness of the rules as proposed. In general terms, “need” means that the Agency must present the reasons for making the proposed changes to Minn. R. ch. 7050, and for the proposed new Minn. R. ch. 7053. Also, need implies that a problem exists that needs to be fixed or dealt with through administrative attention. This Section of SONAR Book II will discuss why the proposed eutrophication standards are needed.

B. A TOOL TO HELP PROTECT VERY VALUABLE RESOURCES [IV. EU standards, need]

No one doubts the value and importance of lake resources to the state of Minnesota. From the Governor on down, people express the importance of clean lakes and good water quality (see Sections II.A and X.B). The proposed eutrophication standards will provide an important additional tool to help protect these resources from excess nutrient loading, the leading cause of lake impairment.

The Agency receives many calls from citizens with complaints about water quality conditions in specific lakes. Records from 1987, for example, show that the Agency received 338 complaints and 412 requests for technical assistance from citizens, lake associations, watershed districts, and other lake management groups. Analysis of 110 complaints showed the most commonly perceived problems were: (1) excessive algae and plants (42%), (2) lake water quality problems detrimental to human health (22%), and degraded lake water quality (12%). A significant number of citizens responding to questions about recreation suitability stated that their lake was greatly impaired for swimming or aesthetic enjoyment. Citizens attributed their lake problems to nonpoint sources of pollution in 88 percent of the complaints and to point sources in about 12 percent. The two most commonly reported sources affecting lake water quality were failing septic tanks and feedlots. About 74 percent of all complaints concerned lakes in the Central Hardwood Forest ecoregion, which contains 32 percent of Minnesota’s lakes.

C. EXCESS NUTRIENTS ARE LEADING CAUSE OF IMPAIRED WATERS [IV. EU standards, need]

The Agency has been assessing lakes for the purpose of reporting the trophic condition of Minnesota lakes to EPA and the public since the mid-1980s. Results of these assessments first

21 Perceptions do not necessarily reflect reality; failing septic systems and feedlots contribute 3.7 and 1.0 % of the total TP loading to Minnesota in an average flow year, respectively (Fig. EX-3 in Exhibit EU-6).
appeared in the Agency’s 305(b) reports to EPA and Congress, and later in the 303(d) list of impaired waters. The impairment of lakes due to excess nutrient loading has been one of the leading causes of polluted conditions reported in the 305(b) reports. Listing of lakes not meeting the nutrient criteria in 305(b) reports does not have regulatory consequences; listing of lakes not meeting criteria in the 303(d) list does (see Section II.C in SONAR Book I). EPA must approve each state’s 303(d) list. The Agency follows an established protocol when assessing waterbodies for potential impairment, which includes minimum data requirements, data quality assurance, and a review of the data and information for critical waterbodies by teams of experts.

The Agency first assessed lakes for impairment determinations for the draft 303(d) list scheduled to be submitted to EPA in 2000. EPA informed the states that they were not required to submit a 303(d) list for 2000, so this list was never finalized. Data from the 2000 list are discussed here simply to illustrate trends in the numbers of lakes listed as impaired for excess nutrients. Table II-6 shows the number of lakes listed as impaired, the ranking of nutrients as a cause of impairment, and the percent of nutrient impaired lakes compared to other causes of impairments for the 2000 to 2006 lists. An increase in the number of lakes listed as impaired from one 303(d) list to the next is expected because, as more data is acquired over time, more lakes are assessed. And almost all lakes listed as impaired on one list are carried over to the next. The Agency expects the rate of increase in the number of listed lakes to remain essentially unchanged after the eutrophication standards are adopted.

Beginning in 2002 the Agency started listing individual waterbodies (mostly lakes) as impaired due to mercury in fish tissue. Mercury then became the pollutant responsible for the vast majority of all impairment listings (67% of all listings in 2004 and 58% in 2006). As a result, the percent of listings due to nutrients dropped accordingly from 2002 on. After mercury, excess nutrients (in lakes) was the leading cause of impaired waters, until high turbidity (in rivers) became the number one non-mercury cause in 2006. The percent of nutrient impaired waters among all listings (far right column in Table II-6) has been edging upward since 2002. The percentages in Table II-6 with and without mercury reflect a relatively small number of impairments due to other bioaccumulative pollutants like polychlorinated biphenyls included with mercury, but this has very little effect on the percentages.

Table II-6. Total Number of Lakes and Reservoirs Listed as Impaired on 303(d) Lists from 2000 to 2006; and the Ranking and Percent of Nutrient Impaired Lakes Compared to the Number of Impaired Waterbodies Listed for Other Pollutants.

<table>
<thead>
<tr>
<th>303(d) List</th>
<th>No. of Lakes and Reservoirs Listed as Impaired due to Nutrients</th>
<th>Ranking, w/o Mercury Listings</th>
<th>Ranking Among All Listings, Including Mercury</th>
<th>% of Listings, w/o Mercury</th>
<th>% of Total Listings, Including Mercury</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000*</td>
<td>127</td>
<td>1</td>
<td>1</td>
<td>39.2</td>
<td>35.4</td>
</tr>
<tr>
<td>2002</td>
<td>108</td>
<td>1</td>
<td>2</td>
<td>26.3</td>
<td>6.1</td>
</tr>
<tr>
<td>2004</td>
<td>153</td>
<td>1</td>
<td>2</td>
<td>29.2</td>
<td>8.1</td>
</tr>
<tr>
<td>2006**</td>
<td>208</td>
<td>2***</td>
<td>3</td>
<td>25.2</td>
<td>9.0</td>
</tr>
</tbody>
</table>

22 Both the 303(b) and 303(d) lists are prepared every other year, and submitted to EPA on even numbered years.
D. PROMULGATION OF EUTROPHICATION STANDARDS AND THEIR LEGAL STATUS [IV. EU standards, need]

1. Promulgation of the Nutrient Criteria is the Appropriate Step [IV.D. EU standards, need]

As stated, nutrient criteria have been used by the Agency for years in a range of lake-related programs. The authority for use of the criteria rested on the narrative standard in Minn. R. 7050.0150, subp. 5. The Agency’s use of the nutrient criteria as a “translation” of the narrative standard has regulatory and economic ramifications because of their use in the listing of lakes as impaired on the 303(d) list (see Section immediately above). It is the appropriate and responsible step for the Agency to promulgate an improved and expanded version of these criteria as numeric water quality standards. In general, the Agency feels an obligation to replace criteria that are in guidance documents with duly adopted standards in rules, particularly those that have been extensively used. The Agency has gained considerable experience over the years in implementing the criteria, and the adoption of them as standards in the water quality rule is needed and timely.

Promulgation as standards, of course, places significant burdens on the Agency to demonstrate the need for and reasonableness of the proposed standards, and to assess potential costs that might be incurred. The Agency could go on using the criteria as in the past and avoid much of the burdens associated with rulemaking. The Agency believes, however, that promulgation as numeric standards in rule is the appropriate step, and that standards in place of criteria will enhance their effectiveness in protecting lake resources.

2. Eutrophication Standards as Legal Entities [IV.D. EU standards, need]

Adopted numeric standards, as opposed to criteria in guidance, which is what we have now, will have greater legal standing, greater visibility and enhanced accessibility because they will be in legally adopted rules. This should encourage their use by other state agencies, consultants, local governments, lake associations and other organizations.

Standards in water quality rules are a more direct legal entity. For example, if a consultant hired today to review a nutrient loading problem in a particular lake looks in Minnesota’s water quality rules for relevant nutrient standards, they will find only the narrative standard in Minn. R. 7050.0150, subp.5. The consultant may or may not have the wherewithal to follow through to the next step, which is to determine how the Agency has interpreted and implemented the narrative standard. Assuming the consultant knew to look further, they might contact Agency staff or find the numeric criteria in guidance, which is available through the Agency’s Web pages but these resources are easily overlooked (Exhibit A-7). Having located the nutrient criteria, the consultant may not understand their legal standing and how the Agency has used them. After the proposed eutrophication standards are adopted, the consultant in this example will find the

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numeric standards in Minn. R. ch. 7050, and most of the follow-up research outlined above will be unnecessary.

In a similar example, numeric eutrophication standards in rules can be cited to county commissioners, managers of watershed districts and other local decision making bodies, if they are not already aware of them. No “translation” from narrative standards to numeric criteria will be needed. This will make eutrophication standards more difficult to gloss over or ignore than the current narrative standard. The direct applicability of numeric standards should help elected officials and zoning officers make better informed decisions, the goal of which is enhanced protection of lake resources under their jurisdiction. The Agency’s intent is that adoption of the numeric eutrophication standards will augment their application by outside entities, such as consultants, other governmental entities, particularly at the county level, and lake associations.

Water quality standards can be used as educational tools. It is the intent of the Agency that the greater visibility of adopted standards will enhance their use as an educational tool, to help the public protect lake resources. Water quality standards in rules have an inherent “visibility” that criteria in guidance do not have. The standards can be used together with programs like the Citizens Lake Monitoring Program to help lake associations, lakeshore property owners and individual lake users make good decisions to protect lakes. The standards can serve as a benchmark to help lake associations assess the condition of “their” lake. The Agency hopes to enlist the help of lake organizations and other interested parties in this effort.

In conclusion, nutrient criteria based on the narrative standard have been widely used by the Agency and have worked well for the assessment of potentially impaired waters, but the Agency believes that numeric standards for lakes adopted into rules will do more to proactively protect lakes from the threat of eutrophication.

E. EPA GUIDANCE TO STATES, ADOPT NUTRIENT STANDARDS [IV. EU standards, need]

The EPA has made it very clear that they expect states to adopt eutrophication standards, and EPA has indicated a willingness to promulgate standards for those states that don’t adopt them on their own (e.g., Exhibit EU-17). The Agency would much rather promulgate its own standards for lakes and reservoirs than have EPA promulgate the national criteria in Minnesota (see Section III.D and Exhibit EU-17). The Agency’s proposed standards are tailored to Minnesota resources, based on the very robust local data sets, published scientific literature and years of experience implementing criteria. The EPA has approved the Agency’s plans to adopt eutrophication standards (Exhibits EU-20 and EU-21). In a recent (May 25, 2007) memorandum EPA Assistant Administrator Benjamin Grumbles restates the magnitude of the nutrient pollution problem nation-wide and the high priority EPA attaches to state adoption of numeric nutrient standards (Exhibit EU-49). He urges states to accelerate the pace of adoption and reiterates EPA’s offers of technical support and assistance to facilitate state action.
F. NEED FOR NUMERIC EUTROPHICATION ST ANDARDS [IV. EU standards, need]

It seems unlikely that any person would argue that improved standards of some sort are not needed to help protect Minnesota’s lakes. The Agency believes strongly, however, that not only are better lake standards needed, but that numeric eutrophication standards are needed; and that numeric standards will be more effective in protecting lakes than an enhanced or more detailed narrative standard with a “translator” mechanism in guidance.23 The Minnesota Environmental Science and Economic Review Board (MESERB) stated in a comment letter (Exhibit A-40a) that the Agency would be better advised to retain the existing narrative nutrient standards and the associated flexibility that goes with narrative standards. The Agency agrees that in general narrative standards offer flexibility but flexibility comes with a “cost.” The costs, as discussed in this SONAR, include continued reliance on: standards with a less direct legal standing, standards less amenable for use by outside parties, and standards that usually need to be interpreted each time they are implemented, which can be time consuming and cost-ineffective. Narrative standards can be implemented by developing numeric criteria based on the narrative standard, which is what the Agency has done. Numeric standards offer other advantages as discussed in this SONAR. Attached to the MESERB letter was a review of eutrophication standards from states around the country, which discusses issues regarding narrative versus numeric approaches (Exhibit A-40b). The Agency’s response to the MESERB letter is Exhibit A-41.

Comments received during the assessment factor rulemaking (Section II.C) that shallow lakes should be considered separately from “deep” lakes, helps establish the need for development and promulgation of separate standards for shallow lakes.

The Agency feels the adoption of numeric standards is critical to advancing the protection of lakes in Minnesota. However, numeric eutrophication standards tend to magnify issues faced by many Class 2 standards; but these issues are much less visible and less often encountered in the development and application of typical toxicity-based Class 2 standards. These issues, mentioned below as a reminder, will be discussed more thoroughly in the reasonableness sections.

- Tremendous variability in the water quality and trophic condition of Minnesota lakes;
- Some Class 2 uses may not be attainable in some lakes;
- Possible more frequent need for a site-specific modification of the standard;
- The need to consider additional variables in their application; and
- Consequences of excess nutrients on lake quality and lake uses are highly visible to the public (e.g. algae blooms).

For these reasons, the Agency is proposing several narrative statements to accompany the numeric standards. These narrative supplements are needed to properly interpret and apply the numeric standards (next Section and Section VI.L). The proposed eutrophication standards are shown in Table II-7.

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23 A translator is a set of procedures, usually in guidance, used to determine numeric criteria based on a narrative standard.
Table II-7. Proposed Eutrophication Standards by Ecoregion and Lake Type.

<table>
<thead>
<tr>
<th>Ecoregion and Lake Type</th>
<th>Total Phosphorus (TP) µg/L</th>
<th>Chlorophyll-a (Chl-a) µg/L</th>
<th>Secchi Depth (SD) Meters, Not less than:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Units:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Northern Lakes and Forests</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake trout lakes</td>
<td>12</td>
<td>3</td>
<td>4.8</td>
</tr>
<tr>
<td>Stream trout lakes</td>
<td>20</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>Deep and shallow lakes</td>
<td>30</td>
<td>9</td>
<td>2.0</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>30</td>
<td>9</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Central Hardwood Forest</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stream trout lakes</td>
<td>20</td>
<td>6</td>
<td>2.5</td>
</tr>
<tr>
<td>Deep lakes</td>
<td>40</td>
<td>14</td>
<td>1.4</td>
</tr>
<tr>
<td>Shallow lakes</td>
<td>60</td>
<td>20</td>
<td>1.0</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>40</td>
<td>14</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Western Corn Belt Plains and Northern Glaciated Plains</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep lakes</td>
<td>65</td>
<td>22</td>
<td>0.9</td>
</tr>
<tr>
<td>Shallow lakes</td>
<td>90</td>
<td>30</td>
<td>0.7</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>65</td>
<td>22</td>
<td>0.9</td>
</tr>
</tbody>
</table>

The Agency is aware that arguments can be made in favor of adopting only narrative standards plus a “translator” procedure instead of adopting numeric eutrophication standards (e.g. Exhibit A-40b). Both Wisconsin and Michigan, two states with similar water resources as Minnesota, plan to adopt numeric nutrient standards, probably for both lakes and rivers. Some other states around the country have chosen the “narrative” approach.

G. NEED FOR NARRATIVE PORTION OF EUTROPHICATION STANDARDS [IV. EU standards, need]

Eutrophication standards have many unique qualities that set them apart for most other Class 2 numeric standards. In addition to the items listed in the previous Section, which mostly relate to characteristics of the resources being protected, eutrophication standards:

- Are developed through a completely different process;
- Include a “causal” (TP) and “response” (Chl-a and SD) variables;
- Vary by ecoregion and lake type;
- Are implemented as summer season averages rather than 4-day or 30-day averages;
- Are aimed at protecting different sub-uses under the umbrella of aquatic life and recreational uses, and are also aimed at protecting aesthetic uses; and
• Need to protect lakes with water quality better than standards and accommodate lakes that cannot meet the standards due to natural causes.

These facts create a need to supplement the numeric eutrophication standards with narrative statements that provide information and guidance on these aspects. The Agency is proposing language to accompany the numeric standards that cover these issues. Because of the length of the narrative statements, the Revisor’s Office recommended placing them in a new subpart located at the end of each of the tables of numeric standards for Class 2 subclasses, 2A, 2Bd and 2B, and designating the paragraphs in the new subpart as “items.” The Agency agrees with this approach, which will make the tables of standards less cluttered. The narrative statements in proposed Minn. R. 7050.0222, subp. 4a (Class 2B eutrophication standards) are quoted below.


A. Eutrophication standards applicable to lakes, shallow lakes, and reservoirs that lie on the border between two ecoregions or that are in the Red River Valley, Northern Minnesota Wetlands or Driftless Area Ecoregions must be applied on a case-by-case basis. The commissioner shall use the standards applicable to adjacent ecoregions as a guide.

B. Eutrophication standards are compared to data averaged over the summer season (June through September). Exceedance of the total phosphorus and either the chlorophyll-a or Secchi disk standard is required to indicate a polluted condition.

C. It is the policy of the agency to protect all lakes, shallow lakes, and reservoirs from the undesirable effects of cultural eutrophication. Lakes, shallow lakes, and reservoirs with a baseline quality better than the numeric eutrophication standards in subpart 4 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing nondegradation, the discharge of nutrients from point and nonpoint sources, and the protection of lake, shallow lake, and reservoir resources, including, but not limited to:

(1) the nondegradation requirements in parts 7050.0180 and 7050.0185;
(2) the phosphorus effluent limits for point sources, where applicable in chapter 7053;
(3) the requirements for feedlots in chapter 7020;
(4) the requirements for individual sewage treatment systems in chapter 7080;
(5) the requirements for control of stormwater in chapter 7090;
(6) county shoreland ordinances; and
(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.
D. Lakes, shallow lakes, and reservoirs with a baseline quality that is poorer than the numeric eutrophication standards in subpart 4 must be considered to be in compliance with the standards if the baseline quality is the result of natural causes. The commissioner shall determine baseline quality and compliance with these standards using summer-average data and the procedures in part 7050.0150, subpart 5. Natural causes is defined in part 7050.0150, subpart 4, item N.

E. When applied to reservoirs, the eutrophication standards in this subpart and subpart 4 may be modified on a site-specific basis to account for characteristics of reservoirs that can affect trophic status, such as water temperature, variations in hydraulic residence time, watershed size, and the fact that reservoirs may receive drainage from more than one ecoregion. Information supporting a site-specific standard can be provided by the commissioner or by any person outside the agency. The commissioner shall evaluate all data in support of a modified standard and determine whether a change in the standard for a specific reservoir is justified. Any total phosphorus effluent limit determined to be necessary based on a modified standard shall only be required after the discharger has been given notice to the specific proposed effluent limits and an opportunity to request a hearing as provided in part 7000.1800.

The narrative statements for Class 2Bd waters are the same as quoted above. The narrative for trout waters (Class 2A) differs slightly from the above because the standards are tied to the trout classification (waters designated as trout waters by the MDNR), rather than to ecoregions. Therefore item “A” shown above is not needed for trout waters and is absent from proposed Minn. R. 7050.0222, subp. 2a.

In conclusion, there is a need to include the proposed narrative to accompany the numeric eutrophication standards to address their unique characteristics. The reasonableness of each paragraph is discussed in Section VI.L.

H. CONCLUSIONS [IV. EU standards, need]

Numeric eutrophication standards are needed for the following reasons:

- Lakes are an extremely important and valuable resource to the state and numeric standards will be an important tool to help protect this resource from impairment due to excess nutrients.
- Nutrient enrichment is a leading cause of impaired water quality in lakes, which leads to unacceptable algae blooms, reductions in water clarity and possible loss of beneficial uses.
- Promulgation and adoption into rule of the (refined) nutrient criteria, which have been used for years in lake programs, is the appropriate and responsible action for the Agency to take.
• Numeric standards have a direct legal standing and will be more visible to interested parties than the existing criteria in guidance, which are based on a narrative standard.
• EPA expects states to adopt lake standards and has indicated its intent to promulgate standards for those states that do not.
V. REASONABLENESS OF PROPOSED EUTROPHICATION STANDARDS, REQUIRED INFORMATION

A. INTRODUCTION [V. EU standards, reasonableness]

Minnesota Stat. ch. 14 requires the Agency to explain the facts establishing the reasonableness of the proposed rules. “Reasonableness” means: 1) that there is a rational basis for the Agency’s proposed actions, 2) that the Agency’s proposed amendments are appropriate and consistent with its mandate to protect Minnesota’s water resources, and 3) due consideration has been given to the potential economic impacts of the proposals. The reasonableness of the proposed rule amendments is explained in this Section and Section VI.

Minnesota Stat. § 14.131 requires that this SONAR include information about the following 11 issues. The discussion in this Section pertains only to the proposed eutrophication standards.

B. CLASSES OF PERSONS AFFECTED BY THE PROPOSED RULE AMENDMENTS, INCLUDING THOSE CLASSES THAT WILL BEAR THE COSTS AND THOSE THAT WILL BENEFIT [V. EU standards, reasonableness]

Essentially all the citizens of Minnesota could be affected by, and benefit from, the proposed eutrophication standards for lakes, shallow lakes and reservoirs. Some of the benefits to people in general are intangible, such as just the notion that Minnesota will remain a land of valuable lake resources. A more tangible benefit will be a continued robust water-orientated tourism and recreational industry in Minnesota, which the proposed standards should help protect. The many people that fish, swim, boat and simply enjoy the aesthetic quality of lakes will benefit. Counties, cities and other local governments could benefit from the proposed standards by increased tax revenues, increased tourism dollars, added jobs and related benefits (see Section X.B). Also, lakeshore property owners could see a real monetary benefit if the water quality of their lake improves; and, to the contrary, they may see a monetary loss if the water quality of their lake declines.

Potential costs to any party attributed to the eutrophication standards are difficult to quantify, but estimates of possible costs to point source dischargers are discussed in Section X.D.

Other state agencies with a responsibility for programs involving lakes should benefit from the eutrophication standards. In particular, the Minnesota Department of Natural Resources that has the responsibility to enhance and manage the sport fishery in lakes, protect water quality, and protect shallow lakes and wetlands, will benefit because the standards will give them an added tool to carry out their mission.

The Environmental Protection Agency (EPA) has an interest in these proposed amendments. The EPA has been an active partner in the promulgation of Minnesota’s standards for lakes through the EPA Region 5 nutrient coordinator and the RTAG meetings. Also, under the Clean
Water Act, the EPA Regional Administrator must approve all changes to Minnesota’s water quality standards (40 CFR 131.5).

C. ESTIMATE OF THE PROBABLE COSTS TO THE AGENCY AND OTHER AGENCIES OF IMPLEMENTING AND ENFORCING THE RULE AMENDMENTS, AND ANY ANTICIPATED EFFECT ON STATE REVENUES [V. EU standards, reasonableness]

The proposed eutrophication standards will not significantly affect Agency staff needs or work loads and overall Agency costs. It is possible that state revenues could be positively impacted if the standards, as intended, play a role in helping to protect lakes from eutrophication and help to maintain Minnesota as an attractive destination for water oriented tourism.

There is a possibility that the Agency will incur some minor added costs in the future as a result of the proposed eutrophication standards. For example, it’s possible that once the standards are adopted and more visible, lake associations, watershed districts, county Water and Soil Conservation Districts, consultants, and other outside parties might inquire about their application and how they might be applied to their lake of interest. It is possible that requests for information and involvement or actions by the Agency may increase. This is the response the Agency is hoping for. Any added costs would be absorbed into the work loads of the current staff, and Agency budgets will not be affected.

The process of assessing lakes for possible impairment due to excess nutrients will continue as it has since 2002 essentially unchanged. Proposed eutrophication standards will replace the nutrient criteria in the assessment process, and this by itself, will not result in an increase in 303(d) nutrient-impairment listings. With some refinements (explained in later sections) the criteria, upon which assessments have been based to date, are being codified as water quality standards. Assessment protocols will not change. Furthermore, assessments are limited by the availability of adequate data and staff resources. Adoption of the criteria as standards will not change these facts. The Agency expects the number of lakes listed as impaired will continue to increase at the pace it has over the last four years as more data become available and lakes previously listed on the 303(d) list remain on the list pending the completion of a TMDL (see Section IV.C and Table II-6).

The Minnesota Department of Natural Resources (MDNR) was consulted on a regular basis as the proposed eutrophication standards were developed. In particular, the MDNR played an important role in defining shallow lakes, and in defining the ecological beneficial uses the proposed shallow lake standards are designed to protect. The MDNR has an active shallow lakes program.

The Agency does not believe any other state or federal agency will incur any significant added costs in the future due to the proposed eutrophication standards.
There are options open to the Agency that would at least partially achieve the goal of improving our ability to protect lakes, which the Agency rejected in favor of the proposed combination of numeric and narrative eutrophication standards. It is conceivable that the rejected options could be somewhat less costly and less intrusive, but the Agency believes that it is equally possible that these options might be even more costly than the proposed approach. The two most logical options are:

1. Enhance or expand the narrative nutrient standard now in Minn. R. 7050.0150, subp. 5
2. Adopt numeric standards for certain lakes statewide, but continue to use the narrative standard to protect the remaining lakes. For example, it has been suggested that numeric standards should apply only to lakes deeper than 15 feet and that shallow lakes continue to be protected by the narrative standard on a case-by-case basis using a site-specific numeric translator.

First of all the Agency does not believe that either of these options would be as effective as the proposed numeric standards in satisfying the need for standards specifically designed to protect lakes from cultural eutrophication. The EPA has concurred with the Agency and supported the adoption of numeric standards in Minnesota.

The first option is essentially a “do-nothing” option. The Agency believes that the additions to the narrative nutrient standard made in 2003 enhanced the narrative standard about as much as possible, short of actually adopting numeric standards. This option would not advance the ability of the Agency, local governments, citizens or other parties to actively protect lakes.

An argument could be made that option one is less costly because a narrative standard is not as obvious a legal entity as numeric standards and it may not generate as many requests for staff involvement. Also, the Agency’s use of nutrient criteria to date, in a regulatory context, has been mostly limited to assessing waters for potential impairment and 303(d) listing. In general, nutrient criteria have not been used as the basis for setting a TP effluent limit in a permit, which is the most direct regulatory function of water quality standards. It is likely that the proposed numeric standards will be used to set some TP effluent limits resulting in costs to dischargers (see Sections VI.M.4 and X.C). For the same reason, option one might be somewhat less “intrusive” because narrative standards are less visible and less likely to be effective in the protection of lakes, whether it’s through a protective zoning decision by a county, use of the standards by a consultant, or other activity.

A counter argument might be made that option one is more costly to the Agency because of the need to “re-translate” the narrative standard to a numeric criterion for each lake to which the standard is applied, or anywhere a phosphorus effluent limit is needed. However, this argument is mitigated in the case of the nutrient narrative standard because of the well established nutrient criteria the Agency has in place, which have been widely used by the Agency.
The second option is a “combination” approach; i.e., the adoption of numeric standards for most lakes, but not all lakes. It has been suggested by some outside parties that the Agency should not adopt numeric standards for shallow lakes, and that standards for shallow lakes can be developed on a case-by-case basis when needed. Thus, one approach for option two (the Agency has not considered any others) is to not propose numeric standards for shallow lakes.

The development of a separate set of numeric standards specifically for shallow lakes was the direct result of comments and recommendations made by MESERB during the assessment factor rulemaking. Shallow lakes are a very important and numerous subset of lakes in Minnesota, and numeric standards that apply to this category are needed and reasonable. The standards the Agency is proposing for shallow lakes are targeted at protecting the ecological uses of these lakes (see Sections VI.G and VI.K.4).

The Agency believes that option two could result in substantial added costs for the Agency, albeit these costs might be reduced by the factors discussed in the next paragraph. A requirement that the Agency must develop a site-specific standard for each and every shallow lake will mean incurring the expense of gathering data and developing the site-specific standard, and possible costs associated with unnecessary delays in taking action. Also, it could be a strong disincentive to protect shallow lakes from eutrophication because of the costs and time needed to treat each one case-by-case. Numeric standards for all lakes, tailored by ecoregion and lake type, will be more visible and applicable legal entities. The Agency will not be obligated to determine a site-specific standard in each case before action can be taken, but the Agency has the option of modifying a standard on a site-specific basis if necessary (see Section IV.F).

It is not likely that option two would be much less intrusive than the Agency’s proposal to have standards for all lakes because the lakes most often assessed, and the lakes for which we most often have data, are lakes greater than 15 feet deep – the lakes more likely to be used extensively for fishing and recreation. Most of the lakes the Agency has assessed for possible impairment are deeper than 15 feet deep. It is deeper lakes that are more likely to have a concerned citizenry, or have participated in an Agency lake study and restoration program.

The potential costs associated with the eutrophication standards are discussed in Section X.C.

E. DESCRIBE ANY ALTERNATIVE METHODS FOR ACHIEVING THE PURPOSE OF THE PROPOSED RULE AMENDMENTS THAT THE AGENCY SERIOUSLY CONSIDERED AND THE REASONS WHY THEY WERE REJECTED IN FAVOR OF THE PROPOSED AMENDMENTS [V. EU standards, reasonableness]

The Agency has not seriously considered alternatives to the numeric eutrophication standards as proposed, except as discussed in the previous Section.

The proposed numeric standards have a very long history, beginning with the TP criteria from the late-1980s. The proposed numeric standards and the associated narrative statements have

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24 Viewpoint expressed by MESERB at the October 13, 2005 meeting with the Agency.
evolved over the three years this rulemaking has been in development, sometimes as a direct result of public comments. The Agency, with the help of EPA, has been on a path to adopt numeric standards for lakes for some time.

F. ESTIMATE OF THE PROBABLE COSTS OF COMPLYING WITH THE PROPOSED RULE AMENDMENTS, INCLUDING COSTS BORNE BY CATEGORIES OF AFFECTED PARTIES [V. EU standards, reasonableness]

The possible costs to outside parties due to the eutrophication standards are discussed in Section X.C.

G. ESTIMATE OF THE PROBABLE COSTS OF NOT ADOPTING THE PROPOSED RULE AMENDMENTS, INCLUDING COSTS BORNE BY CATEGORIES OF AFFECTED PARTIES [V. EU standards, reasonableness]

In general, it is unlikely that there will be direct costs to most outside parties if the eutrophication standards are not adopted. Were it not for the availability of the existing nutrient criteria, the job of some outside parties could be made more difficult (and possibly more expensive) if the narrative standard had to be re-interpreted on a case-by-case basis for each application.

Groups that possibly could see monetary losses are lakeshore property owners, resort owners and others that depend on lakes to make a living. A decline in water quality could negatively impact these groups. For example lakeshore property values have been shown to decline if the water quality in the lake declines (Exhibit EU-39).

The Agency believes there could be an intangible “cost” to Minnesota if the standards are not adopted. Because Minnesota and the quality of life of its citizenry is so closely identified with lakes, it is not far fetched to assume that, as lake resources continue to degrade, there could be both a tangible and intangible cost to the state. This assumes, as the Agency intends, that the proposed standards will be more effective in protecting lakes than the current narrative standard.

H. DIFFERENCES BETWEEN THE PROPOSED RULE AND EXISTING FEDERAL REGULATIONS AND THE NEED FOR AND REASONABLENESS OF EACH DIFFERENCE [V. EU standards, reasonableness]

The proposed eutrophication standards are consistent with federal regulations and guidance. In fact EPA has used the Agency’s approach as an example of how nutrient standards can be developed using a state’s local lake data.

Minnesota Stat. §§ 14.002 and 14.131 require state agencies, whenever feasible, to develop rules that are not overly prescriptive and inflexible, and rules that emphasize achievement of the Agency’s regulatory objectives while allowing maximum flexibility to regulated parties and to the Agency in meeting those goals.

The proposed numeric eutrophication standards are “prescriptive” as are all numeric standards. However, because lake standards are unique in several respects, greater flexibility is built into these standards than into most numeric standards (see Sections IV.F and IV.G). First, separate standards have been developed for four ecoregions and four lake types to accommodate the regional patterns and variability in lakes statewide. Secondly, accompanying the numeric standards are narrative statements that provide important information on how the numeric standards are to be interpreted and implemented, plus a reminder that site-specific standards should be considered, particularly for reservoirs.

The general concepts of how prescriptive or flexible a rule should be are discussed more extensively in SONAR Book I, Section VIII.I.


Minnesota Stat. §§ 14.131 and 14.23 require the Agency to include in its SONAR a description of its efforts to provide additional notification to persons or classes of persons who may be affected by the proposed rule, or the Agency must explain why these efforts were not made.

The Agency described its efforts to inform and involve interested and affected parties and the public in general in Section III of SONAR Book I. The Agency has gone well beyond the statutory requirements in its efforts to involve the public in this rulemaking. The Agency has made significant changes to the scope and content of the proposed amendments in response to public comments.

The Agency intends to send a copy of the Notice of Hearing to the following people and organizations.

- All parties who have registered with the Agency for the purpose of receiving notice of rule proceedings, as required by Minn. Stat. § 14.14, subd. 1a;
- All individuals and representatives of associations the Agency has on file as interested and affected parties; and
- The chairs and ranking minority party members of the legislative policy and budget committees, with jurisdiction over the subject matter of the proposed rule amendments, will receive a copy of the proposed rule amendments, SONAR and notice, as required by Minn. Stat. § 14.116.

Minnesota Stat. § 115.44, subd. 7 states that notices required under sections 14.14, subd. 1a, and 14.22 must also be mailed to the governing body of each municipality bordering or through which the waters for which standards are sought to be adopted flow. The Agency intends to hold
public hearings, therefore, section 14.22 does not apply. To comply with Minn. Stat. § 115.44, subd. 7, the Agency shall provide a copy of the notice to the following:

- Mayors of cities in Minnesota
- Minnesota County Commissioners Chairs
- Minnesota Township Chairs
- Soil and Water Conservation Districts
- County Water Planners
- Watershed Districts
- Water Management Organizations
- NPDES/SDS industrial permittees
- POTW permittees

Additionally, the Agency will provide notice to:

- Environmental Justice Advocates of Minnesota
- Council of Asian-Pacific Minnesotans
- Chicano-Latino Affairs Council
- Council of Black Minnesotans
- Minnesota Indian Affairs Council
- EPA Tribal Liaison, and the Indian Tribes in Minnesota:
  - Boise Fort Band of Chippewa
  - Fond du Lac Reservation
  - Grand Portage Reservation
  - Leech Lake Reservation
  - Lower Sioux Indian Community
  - Mille Lacs Band of Chippewa
  - Prairie Island Community
  - Red Lake Nation – Red Lake Band of Chippewa
  - Shakopee Mdewakanton Sioux (Dakota) Community
  - Upper Sioux Community
  - White Earth Reservation

The Agency will issue a press release at the time the notice of proposed rule adoption is published in the *State Register*. The press release will include the dates, times and locations of the public hearings, and information on how the public can submit comments. In addition, a copy of the notice, proposed rule amendments and SONAR will be posted on the Agency’s public notice Web site at: http://www.pca.state.mn.us/news/index.html. Due to the large number (and large size of some), the exhibits will not be made available on the Agency’s Web pages. Any exhibit can be made available upon request.

Pursuant to Minn. Stat. § 14.14, subd. 1a, the Agency believes its regular means of notice, including publication in the *State Register* and on the Agency’s public notice Web page will adequately provide notice of this rulemaking to persons interested in or potentially affected by these rules.
K. CONSULTATION WITH THE COMMISSIONER OF FINANCE REGARDING FISCAL IMPACTS ON LOCAL GOVERNMENTS [V. EU standards, reasonableness]

Minnesota Stat. § 14.131 requires the Agency to consult with the Department of Finance to help evaluate the fiscal impact and benefits of proposed rules on local governments. In accordance with the interim process established by the Department of Finance the Agency will provide the Department of Finance with a copy of the proposed rule and SONAR at the same time as these items were sent to the Governor’s Office for approval prior to publication in the State Register. This timing allows the fiscal impacts and fiscal benefits of the proposed rule to be reviewed by the Department of Finance concurrent with the Governor’s Office review.

L. AGENCY DETERMINATION REGARDING WHETHER COST OF COMPLYING WITH PROPOSED RULE IN THE FIRST YEAR AFTER THE RULE TAKES EFFECT WILL EXCEED $25,000 [V. EU standards, reasonableness]

The Administrative Procedures Act was amended in 2005 to include a section on potential first-year costs attributable to the proposed amendments (Minn. Stat. § 14.127, subd. 1 and 2). This amendment requires the Agency to determine if the cost of complying with a proposed rule in the first year after the rule takes effect will exceed $25,000 for:

- Any one business that has less than 50 full-time employees, or
- Any one statutory or home rule charter city that has less than ten full-time employees.

Conceivably hypothetical situations could be devised that would result in the two entities listed above incurring costs as a result of the adoption of the eutrophication standards in the first year. There is no way to estimate or quantify these potential first-year costs and no way to know if they might exceed $25,000. Any projected added costs would be outside the impaired waters and TMDL programs because these potential costs are being incurred now through the application of the existing narrative eutrophication standard and the Agency’s numeric criteria (existing Minn. R. 7050.0150, subp. 5).

An example of a hypothetical situation might be a small business such as a bait shop adjacent to a lake (located in the shoreland impact zone) that is being required by a county or other regulatory entity to implement a set of best management practices to reduce TP enriched runoff from reaching the lake. For this business to incur costs attributable to the proposed eutrophication standards pursuant to this statute, several things need to fall into place: 1) the governmental entity must be aware of the eutrophication standards and have the will and authority to implement them, 2) implementation of the standards results in more expensive BMPs being required, 3) monitoring data for the lake may be needed to relate its trophic condition to the standards, and 4) these events would have to take place in the first year after the standards are adopted and the added costs exceed $25,000.

While we cannot dismiss the possibility of such costs being incurred, the Agency believes that these situations will be unusual in the first year after adoption. Any attempt to quantify such
hypothetical costs is too speculative to have any meaning. The Agency has estimated potential costs to point source dischargers as a result of the eutrophication standards and this could include small cities if they have sanitary sewers and a discharge from a wastewater treatment plant (see Section X.D).
VI. REASONABLENESS OF PROPOSED EUTROPHICATION STANDARDS

A. INTRODUCTION [VI. EU standards, reasonableness]

The development of the proposed eutrophication standards is described in detail in Exhibit EU-1. This publication discusses the sources and types of data used to develop first the nutrient criteria then the proposed eutrophication standards, how the data were analyzed, and the uses the standards are designed to protect. The *reasonableness* section of the SONAR will provide an outline of that process, and many topics covered in this SONAR are discussed in more detail in Exhibit EU-1. To avoid repetition, citations to this exhibit will be kept to a minimum, but its relevance throughout can be assumed.

As a reminder, the following abbreviations will be used extensively:

- TP  phosphorus and total phosphorus
- Chl-a chlorophyll-a
- SD  Secchi depth or Secchi transparency

The Agency’s lake Web pages contain a great deal of information about lake programs, such as accessing lake data, the assessment of lakes, the Secchi disk volunteer monitoring programs, lake protection and stewardship; and PDF files of numerous Agency publications related to lakes. Some of these publications are exhibits to this SONAR. The “home” lake Web page is: [http://www.pca.state.mn.us/water/lake.html](http://www.pca.state.mn.us/water/lake.html).

The eutrophication standards the Agency is proposing are Class 2, aquatic life and recreation, standards. This means the proposed standards are designed to protect lakes for a healthy aquatic community and for aquatic recreation of all kinds, including swimming where that use is attainable. Standards for different lake types (e.g., trout and shallow lakes) focus on particular “sub-uses” under the broader umbrella of aquatic life and recreation (Class 2) standards (Section VI.K).

While not specifically set in order to protect aesthetic uses, the eutrophication standards will provide protection for aesthetics. Aesthetic qualities are very closely tied to recreational uses when it comes to the trophic condition of lakes, and in this context aquatic life and aesthetic uses are closely linked (Exhibit EU-48). For example, a lake that is pea-green with algae is unacceptable both recreationally and aesthetically. Aesthetics are protected under use Class 5, rather than Class 2, but **all** surface waters are protected for Class 5 uses (Minn. R. 7050.0410 and 7050.0430).

Lakes that are protected for use as a domestic drinking water supply (Class 1) are important community resources. Class 2A and 2Bd lakes are also Class 1 waters. The proposed eutrophication standards do not address drinking water uses directly, and drinking water uses will not be discussed in this book of the SONAR. However, similar to aesthetics, the proposed eutrophication standards will help protect drinking water uses where applicable because
protecting one use serves to protect the other. Certain algae species when numerous can impart unpleasant tastes and odors to drinking water. Generally, the less eutrophic the drinking water source, the less extensive and less costly the water treatment needs to be to provide safe and good tasting and smelling finished water to the public. A good example of this was the announcement by the City of St. Paul in February 2006 of costly improvements to the city’s drinking water treatment system to reduce or eliminate the city’s occasional taste and odor problems. St. Paul’s drinking water, much of which comes from the Mississippi River via a conduit, travels through the Vadnais chain of lakes prior to withdrawal for treatment, which provides the opportunity for certain species of algae to impart unpleasant tastes or odors to the raw water.

B. DEFINITIONS [VI. EU standards, reasonableness]

As part of the promulgation of eutrophication standards the Agency is proposing to add definitions for six terms pertinent to the numeric standards into Minn. R. 7050.0150, subp. 4. The terms defined are:

- 122-day, 10-year low flow or 122Q
- Eutrophication
- Lake
- Natural causes
- Reservoir
- Shallow lake

The need and reasonableness of the definitions is discussed in SONAR Book I, Sections VI.B (need) and X.B (reasonableness).

C. DATA SUPPORTING THE PROPOSED NUMERIC EUTROPHICATION STANDARDS [VI. EU standards, reasonableness]

1. Phosphorus, Chlorophyll-a and Secchi Depth Data for Minnesota Lakes [VI.C. EU standards, reasonableness]

The Agency has been monitoring lakes for trophic conditions since the 1970s. Over the years analytical methods have improved and sampling procedures have been standardized. Around 1990 improvements were made on several fronts, including laboratory analysis and in overall quality assurance and quality control. Thus, data collected from this date forward can be combined and used with confidence. The older data can be used together with the newer data with caution.

The Agency has grouped the data used to develop, first the nutrient criteria then the proposed eutrophication standards, into several categories. These data sets have been supplemented by the

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user perception data and the historical trophic status estimates using diatom “shells” in bottom sediments, discussed in the next sections. As an example, the TP data from these data sets is compared by ecoregion in Table II-8.

**Assessment Database.** This large data set extends back to 1970 and includes data for at least one trophic variable, TP, Chl-a or SD. It contains data for about 2,790 lakes. These data have been used for years to assess the trophic status of Minnesota lakes for the 305(b) report, and more recently for the 303(d) list.

**Reference Lake Database by Ecoregion.** Taking advantage of the newly developed ecoregion concept as a logical way to separate lakes into similar geographical areas. In the mid-1980s the Agency selected about 90 “reference lakes" in four Minnesota ecoregions for more intensive sampling. Lakes minimally impacted by point and nonpoint sources of nutrients were selected as reference lakes. The Minnesota Department of Natural Resource (MDNR) area fishery managers assisted in the identification of lakes that were minimally impacted but still representative of the ecoregion in terms of lake morphometry and fish community characteristics. The reference lake data were particularly useful for establishing relationships between TP and the frequency and severity of nuisance algal blooms (Exhibit EU-30).

**EPA Nutrient Criteria Database.** This is the data base EPA used to develop their ecoregion-based criteria (Exhibits EU-11, EU-12 and EU-13). Much of the EPA data is from Minnesota’s assessment database, but it does include data for lakes outside Minnesota that are in the same ecoregion.

**Citizens Lake Monitoring Program (CLMP).** This program of monitoring the water clarity of lakes by a network of volunteers was started in Minnesota by Dr. Joseph Shapiro, a retired University of Minnesota limnology professor. The program was transferred to the Agency to administer in 1978. Many states have adopted similar programs. The program has grown over the years; in 2005, 978 volunteers monitored 888 Minnesota lakes. Volunteers take SD measurements periodically throughout the summer, rate the aesthetic and recreational quality of their lake (next Section), and report the results to the Agency. The program is a huge success for several reasons:

- It provides valuable water clarity data to the Agency and others at very little cost to the state. For many lakes the CLMP SD data is the only water quality data available.
- It provides valuable “user perception” data.
- It promotes interest among citizens in lake resources.
- It serves as an educational tool as citizens become aware of the relationships between water clarity, nutrients and the link between water quality and human activities on the land.
- It is a valuable resource for people shopping for lakeshore property.

CLMP data is entered into the EPA water quality data storage system (STORET) and it has been incorporated into the assessment database for lakes.
Table II-8. Comparison of 25-75 Percentile Ranges of Total Phosphorus Data (µg/L) for Agency Reference, Agency Assessed, EPA Assessed and Pre-Settlement (Diatom Estimated) Data Sets for Three Ecoregions.

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Total Phosphorus µg/L, 25-75 Percentile Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agency Reference</td>
</tr>
<tr>
<td>NLF</td>
<td>14 – 27</td>
</tr>
<tr>
<td>NCHF</td>
<td>23 – 50</td>
</tr>
<tr>
<td>WCBP</td>
<td>65 – 150</td>
</tr>
</tbody>
</table>

2. **User Perception Data** [VI.C. EU standards, reasonableness]

The Secchi disk volunteers are asked to rate the water quality conditions in their lake each time they take a SD reading. Based mostly on water clarity and the amount of algae present at the spot where the reading is taken (mid-lake or over the deepest part of the lake), volunteers rate aesthetic conditions and suitability for swimming on a scale of 1 to 5, with 1 being the best. The rating questions are shown below (Exhibit EU-34):

(A) Which one best describes the physical condition of the lake water:
   1 = Crystal clear water
   2 = Not quite crystal clear - a little algae present/visible
   3 = Definite algae green, yellow, or brown color apparent
   4 = High algal levels with limited clarity and/or mild odor apparent
   5 = Severely high algae levels with one or more of the following: massive floating scums on the lake or washed up on shore, strong, foul odor, fish kill

(B) Which one best describes your opinion of how suitable the lake is for recreation and aesthetic enjoyment:
   1 = Beautiful, could NOT be better
   2 = Very minor aesthetic problems; excellent for swimming, boating
   3 = Swimming and aesthetic enjoyment slightly impaired because of algae levels
   4 = Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels (i.e., would not swim, but boating is okay)
   5 = Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels

The subjective volunteer responses to these questions, when assembled for many lakes across the state and cross-tabulated with SD and Chl-a data, provide a quantitative basis for defining acceptable and unacceptable Chl-a and SD levels. The data show clear regional difference in user perception (Figure II-1). Where lakes tend to be cleaner, user expectations of water quality are higher. Water clarity that might be acceptable for swimming in southern Minnesota, for example, may not be acceptable to people in northern Minnesota.

Analysis of user perception data from nearly 500 Minnesota and Vermont lakes reaffirmed the pattern of regional differences in both states (Exhibit EU-33). User perception data have been used in the development of lake water quality standards in Vermont. EPA cites it as a reasonable
basis for nutrient criteria development (Exhibit EU-16). The individual and collective perceptions of “swimmability” are tied directly to recreational beneficial uses. Closely parallel to “swimmability” are the perceptions of “physical qualities,” which relate directly to aesthetic uses (Class 5).

In summary, user perception data are very helpful in defining the thresholds of water quality condition people find acceptable and unacceptable. The data help to establish the TP, Chl-a and SD thresholds where beneficial uses will be lost. These data are well grounded with SD data; they are scientifically credible, reproducible, and have been published in the scientific literature.

Figure II-1. User Perceptions of Secchi Depths Associated with Unacceptable Conditions for Swimming in Three Ecoregions. Twenty-fifth, 50th and 75th Quartile Selections of Condition “5” to Question “B” (see text, Exhibit EU-1 and Exhibit EU-33).

3. **Historical Trophic Conditions, Diatom Reconstruction Data** [VI.C. EU standards, reasonableness]

In establishing eutrophication standards, it is useful to know what the trophic status of Minnesota lakes was in the early-1800s, prior to European settlement, and before the extensive changes in the Minnesota landscape due to logging, agriculture, mining and urban development. Historical trophic conditions can be estimated by examining “fossil” diatom shells found in bottom sediments of lakes. Diatoms are a type of algae that form hard silicon (glass-like) shells. Different diatom species produce shells of different shapes and surface patterns, making it possible to identify species of diatoms by their shells. When diatoms die their shells sink to the bottom of the lake where they persist in the bottom sediments for hundreds of years. Because sediments are laid down in layers, one layer per year much like tree rings, the age of the diatoms shells can be determined. Different assemblages of diatom species are associated with discrete
trophic conditions (i.e., oligotrophic to eutrophic). By comparing the diatom species assemblage that lived in the lake in the past to assemblages in the lake today with known trophic condition, the trophic history of the lake can be estimated. This work is called diatom reconstruction (Exhibit EU-35).

Exhibit EU-36 is a study of 55 lakes from across Minnesota; it provides some insight into pre-European lake trophic status for three ecoregions. Following this study, additional shallow lakes in southern Minnesota were sampled for diatom reconstruction analysis.

The ranges of total phosphorus concentrations based on the diatom reconstructions are consistently lower than the modern-day data sets, even when compared to reference lake data (Table II-8 and Figure II-2). However, this difference is less pronounced in the NLF and NCHF ecoregions. The diatom reconstruction results show that the regional patterns in lake trophic status seen today existed prior to European settlement (Figure II-2). Figure II-2 also shows that historically, shallow lakes were more eutrophic than deeper lakes in the NCHF and WCB ecoregions. It also shows that the proposed TP standards are well above pre-settlement TP levels.

Figure II-2. Estimated Historic TP Levels in Deep and Shallow Lakes in Three Ecoregions Compared to Proposed TP Standards (horizontal lines).

Note: Some numbers in Figure II-2 may be hard to read: the 25th, 50th and 75th percentile values for the NLF are 11, 14 and 16; and for the NCHF are 18, 21 and 26, µg/L TP, respectively.
In conclusion, the diatom reconstruction data provide valuable insights that help place present-day data sets and proposed TP standards in perspective. The results clearly support using the ecoregion framework for the proposed standards. And it is apparent that the proposed TP standards are not overly protective or stringent. Many lakes in the NLF ecoregion, as shown in Table II-8, are near pre-settlement conditions, and the Agency will do all it can to keep those lakes in their near-pristine state. On the other hand, the Agency realizes that it is not reasonable to base the proposed TP criteria on the trophic status of lakes 200 years ago. Given the modern-day realities of land use by more than 4.5 million Minnesotans, it is not realistic to expect lakes in most parts of the state to meet pre-settlement conditions. The diatom reconstruction data provide a means to put the proposed standards in perspective.

4. Fish Communities in Lakes [VI.C. EU standards, reasonableness]

Because the fishery resource in Minnesota lakes is considered such a valuable natural resource, it is important in developing TP standards for lakes that we examine how in-lake phosphorus concentrations relate to the lake fish communities, particularly game fish. Nutrient loadings and eutrophication may affect the type and abundance of game fish; and, alternately, some fish species may impact lake water quality. The Agency worked closely with the Minnesota Department of Natural Resources (MDNR) to associate TP, Chl-a and SD conditions to fish communities. These relationships can impact the management of desirable game fish populations in lakes that range widely in trophic condition.

Lakes in the North American temperate zone are extremely variable with regard to their biological productivity and fish community structure. This variability is due in large part to the tremendous diversity in the nature of lake watersheds and lake basin morphometry. Studies of the relationship between lake morphometry, lake water chemistry and fish yield have generally shown that more nutrient-rich, shallower lakes are typically more biologically productive with higher fish yields per unit area than deeper, less fertile lakes (Rawson, 1952; Ryder, 1965; Matussek, 1978; Hanson and Leggett, 1982; as cited in Exhibit EU-1; also see Figure 13 in Exhibit EU-1).

In qualitative terms, there is also a shift in the composition of fish species along the productivity continuum ranging from oligotrophic through hypereutrophic. Associated with the various lake categories is a corresponding and predictable fish community, which is optimal for the resources the lake provides. In broad terms, hypereutrophic waterbodies are often dominated by bottom feeding fish such as bullhead and carp, while waterbodies classified as eutrophic are often populated by largemouth bass, sunfish, minnows and other warm water species. Trout and whitefish inhabit coldwater oligotrophic lakes. In the middle of the trophic spectrum, walleye, northern pike, and white suckers typically thrive in mesotrophic to mildly eutrophic lakes. These patterns helped in the development of the proposed eutrophication standards. The proposed standards for trout lakes and shallow lakes, in particular, reflect this relationship between the fish community and trophic condition.
In summary, as lakes become more eutrophic, there is a clear change in fish communities. Likewise, lake fisheries have been demonstrated to respond positively to nutrient reductions. The Lake Sallie case study on page 50 of Exhibit EU-1 is an example of a demonstrated shift from undesirable to more desirable species following nutrient reductions.

D. DEVELOPMENT OF PROPOSED EUTROPHICATION STANDARDS [VI. EU standards, reasonableness]

The process used to arrive at the proposed numeric eutrophication standards for TP, Chl-a and SD will be outlined in this Section. Exhibit EU-1 and the other Exhibits cited should be consulted for details. The proposed standards for trout lakes, deep lakes, shallow lakes and reservoirs will be discussed in the sections that follow.

Water quality standards should reflect the latest scientific knowledge on the effects of pollutants on public health and welfare, aquatic life, and recreation. The development of the proposed ecoregion-based eutrophication standards is based on a rigorous examination of Minnesota lake water quality data, taking into account the beneficial uses lakes provide, user perceptions of those uses, fisheries data and other relevant information. Broadly speaking, the development of the proposed standards (and the nutrient criteria before them) was an iterative process. The individual data sets within the whole body of lake information were evaluated in the context of the other pieces. A range of reasonable TP, Chl-a and SD “criteria” was narrowed down through a “feed-back” process of fitting the information together, to refine the criteria and arrive at final proposed standards.

As described, the development of eutrophication standards began with the development of ecoregion-based total phosphorus (TP) criteria. Because of regional diversity in lake and watershed characteristics, it was felt that a single total phosphorus value would not be workable as a statewide criterion (Exhibit EU-24). The methodology for establishing the original phosphorus criteria in Minnesota considered the following (Exhibit EU-30):

- Impacts of TP on lake condition, as measured by Chl-a, bloom frequency, water clarity, and hypolimnetic oxygen depletion.
- Impacts on lake uses, recreation, fisheries and aesthetics.
- Appropriateness of the TP levels as related to watershed characteristics, regional phosphorus export values, lake morphometry, etc.
- This work clearly established that the ecoregion framework was a reasonable way to deal with the variability in lake conditions across Minnesota.

The resulting TP criteria provided a scientifically sound and reasonable foundation for the proposed eutrophication standards.

Using these ecoregion-based TP criteria as a starting point, relationships between TP and Chl-a and TP and SD were developed. The relationship between TP and Chl-a, TP and SD and Chl-a and SD, based on the reference lake dataset are shown in Figures II-3, II-4 and II-5, respectively. These relationships helped establish the levels of the “response” variables, Chl-a and SD that
correspond to the ecoregion-based TP criteria. Another means of linking the TP criteria to levels of Chl-a and SD readings is the Carlson Trophic State Index (TSI). The Carlson index takes TP, Chl-a and SD data and calculates a trophic condition score from 1 to 100; the higher the number the more eutrophic the lake (see page 12 in Exhibit EU-1). If the relationships between trophic indicators were perfect (which is highly unlikely for any biological relationship), the TSI values calculated separately for TP, Chl-a and SD for a given lake would be the same. By assembling the TSI data for the three parameters for many lakes in an ecoregion, the TP levels in a certain range of TSIs can be used to predict the Chl-a and SD values that correspond to the same range, and vice versa. This helps cement the relationships between the causal (TP) and response (Chl-a and SD) variables.

Preliminary TP, Chl-a and SD criteria were then refined by reviewing TP concentrations and the frequency and severity of algae blooms, user perception data, and the diatom reconstruction data. The relationship between TP and Chl-a (i.e., algae blooms) provides a risk analysis in the sense that, as TP levels increase there is a greater risk that the frequency and severity of blooms will increase also (Exhibit EU-30). At some TP level, algae growth and resulting blooms become unacceptable, and beneficial uses are compromised or lost altogether. The relationship between TP concentrations and the expected magnitude (severity) and frequency of algae blooms (in percent) can be plotted (Figure II-6). The graphical representation of these relationships in Figure II-6 helps visualize potential thresholds of TP levels at which conditions become unacceptable.
Figure II-3. Relationship of Summer-Mean Log TP and Chl-a Based on Reference Lake Data.

Figure II-4. Relationship of Summer-Mean Log TP and SD Based on Reference Lake Data.

Figure II-5. Relationship of Summer-Mean Log Chl-a and SD Based on Reference Lake Data.
Figure II-6. Frequency and Severity of Algae Blooms (Chlorophyll-a) Versus Total Phosphorus in µg/L Based on Reference Lake Data from 1985-1988.

Chlorophyll-a interval frequency versus total phosphorus.

E. PROPOSED EUTROPHICATION STANDARDS FOR TROUT WATERS [VI. EU Standards, reasonableness]

1. Introduction [VI.E. EU standards, reasonableness]

For purposes of the proposed eutrophication standards, trout lakes are divided into two categories, those that support native lake trout and those that support a “stream” trout fishery. The goal of the proposed eutrophication standards for both types of trout lakes is the protection of the sensitive coldwater fishery.

2. Lake Trout Trout Lakes [VI.E. EU standards, reasonableness]

Minnesota has about 110 lakes that support populations of native lake trout, *Salvelinus namaycush*. Almost all of these lakes are in NE Minnesota in northern Lake and Cook Counties near the Canadian border. Lake trout have quite specific temperature and dissolved oxygen requirements. Only nutrient poor or oligotrophic lakes provide these conditions. Even a slight shift to a more eutrophic condition could put the lake trout population in jeopardy. Therefore, the proposed standards reflect the need to protect these oligotrophic conditions; and, accordingly, they are the most stringent set of eutrophication standards the Agency is proposing.

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Maintaining adequate dissolved oxygen (DO) in the cool hypolimnetic waters is essential. Optimal conditions for lake trout occur in the part of the lake having more than 6 mg/L DO and a temperature less than 10 °C. Some populations can be successful at higher temperatures under some circumstances. Late summer is the critical period for determining whether suitable habitat is present because stratification has been firmly established in the lake for several weeks, and no new oxygen has been introduced into the hypolimnion. If the lake becomes more eutrophic and more algae grow, die and decompose in the hypolimnion, further demands are placed on the finite store of hypolimnetic DO.

The Agency assembled the available trophic data for lake and stream trout lakes. There is some overlap in the data because some lakes may contain both lake and stream trout. These data are summarized in Table II-9; the proposed standards for trout waters are shown for comparison.

Table II-9. Trophic Data for Lake Trout and Stream Trout Lakes from Assessment Data Base.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Proposed Standard</th>
<th>No. of Values</th>
<th>Minimum</th>
<th>25th %tile</th>
<th>Median</th>
<th>75th %tile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lake Trout Lakes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP (µg/L)</td>
<td>12</td>
<td>75</td>
<td>2.0</td>
<td>9.0</td>
<td>12</td>
<td>16</td>
<td>69</td>
</tr>
<tr>
<td>Chlorophyll-a (µg/L)</td>
<td>3</td>
<td>57</td>
<td>0.5</td>
<td>1.5</td>
<td>2.3</td>
<td>3.3</td>
<td>24.3</td>
</tr>
<tr>
<td>Secchi (m)</td>
<td>4.8</td>
<td>299</td>
<td>2.1</td>
<td>4.1</td>
<td>5.0</td>
<td>5.8</td>
<td>10.4</td>
</tr>
<tr>
<td><strong>Stream Trout Lakes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP (µg/L)</td>
<td>20</td>
<td>103</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>21</td>
<td>67</td>
</tr>
<tr>
<td>Chlorophyll-a (µg/L)</td>
<td>6</td>
<td>51</td>
<td>0.7</td>
<td>1.9</td>
<td>3.2</td>
<td>6.3</td>
<td>45</td>
</tr>
<tr>
<td>Secchi (m)</td>
<td>2.5</td>
<td>125</td>
<td>1.1</td>
<td>3.3</td>
<td>4.4</td>
<td>5.4</td>
<td>10.9</td>
</tr>
</tbody>
</table>

These data were used to establish relationships between TP, Chl-a and SD for trout lakes. Comparison of Carlson TSI's for the three variables also helped establish the relationships. For the most part, the proposed standards fall between the median and 75th percentile values, or between the median and 25th percentile values in the case of SD.

The Agency conducted late summer DO and temperature profiles for 15 lake trout lakes to determine if there appeared to be a “refuge” in these lakes where temperatures between 8-15 °C and a DO greater than 5 mg/L was maintained. Figure II-7 shows DO levels and temperatures plotted against depth for two lakes as examples. The “refuge” zone is shown as the box within the graph. A lake with a larger refuge (e.g., Burntside in Figure II-7) is more likely to sustain a healthy population of lake trout. The trophic conditions of the lakes that supported the necessary refuge provided further insight into the TP, Chl-a and SD conditions needed to protect lake trout. It appears that summer-mean Chl-a should remain below 3 µg/L, and maximum values should generally remain below about 4 µg/L to minimize the impact of decaying algae (organic matter) on hypolimnetic DO concentrations. This Chl-a range, 3 to 4 µg/L, is close to the recognized
limit between oligotrophy and mesotrophy. The basis for the proposed standards for lake trout lakes is discussed in more detail in Exhibit EU-1.

Figure II-7. Late Summer DO and Temperature Profiles for Burntside and Kabekona Lakes. Box in Graph Represents the Portion of the Lake where Optimal DO and Temperature Conditions for Lake Trout Exist (horizontal axis: DO in mg/L and temperature in °C).

3. Stream Trout Lakes [VI.E. EU standards, reasonableness]

The basis for the proposed eutrophication standards for stream trout lakes is the same as that for lake trout lakes; i.e., to protect a sensitive population of coldwater fish. However, the target DO and temperature conditions do not need to be as stringent for stream trout. Thus, the proposed standards for stream trout lakes are somewhat more lenient than the lake trout lake standards.

Minnesota has 161 designated stream trout lakes. Stream trout are either brook trout, brown trout, rainbow trout or splake (cross between a brook trout and a lake trout). Stream trout are primarily stocked in lakes that provide adequate conditions for survival, but stream trout are not expected to reproduce naturally in lakes. Since these lakes are primarily stocked, the concern is only with adult habitat requirements. The data for stream trout lakes, shown in Table II-9, was used to associate the trophic conditions in MDNR trout lakes successfully managed for stream trout. The proposed standards for stream trout lakes are based on maintaining relatively low TP and Chl-a and high SD in order to provide an adequate temperature and DO “refuge” for the stream trout.

In summary, the proposed eutrophication standards for trout lakes reflect the TP, Chl-a and SD conditions that support the required hypolimnmonic DO and temperature conditions that allow lake trout to reproduce and grow, and allow adult stream trout to thrive. The MDNR managed stream trout lakes are listed in Minn. R. 6264.0050; the list is updated periodically. The Agency takes the MDNR list and adopts it into Minn. R. 7050.0470 (see SONAR, Book III, Section X.C). All lake trout lakes listed in Minn. R. 7050.0470 are designated as outstanding resource value waters (restricted category, Minn. R. 7050.0180, subp. 6).
F. PROPOSED EUTROPHICATION STANDARDS FOR NON-TROUT LAKES, MAXIMUM DEPTH GREATER THAN 15 FEET [VI. EU standards, reasonableness]

1. Northern Lakes and Forest Ecoregion [VI.F. EU standards, reasonableness]

The proposed eutrophication standards for deep (> 15 feet deep) and shallow lakes in the NLF ecoregion are the same. They are:

- Total phosphorus, 30 µg/L
- Chlorophyll-a, 9 µg/L
- Secchi Depth, 2.0 meters minimum

A TP concentration of 30 µg/L corresponds to the 75th percentile for the Agency and EPA assessment databases (Figure II-9). This concentration is only slightly above the pre-European and reference lake 75th percentiles. Thirty µg/L is a reasonable level for the proposed standard given the predominantly forest and wetland vegetation that characterize most of this ecoregion. From a fisheries standpoint, TP concentrations of 30 µg/L or less seem to support robust fish communities that tend to favor walleye, northern pike and perch; in contrast to common carp and bullhead species. A TP concentration of 30 µg/L is often used as a boundary between mesotrophic and eutrophic conditions.

Based on the Agency’s experience monitoring and assessing lakes, Chl-a levels greater than about 10 µg/L are perceived as a bloom condition; and Chl-a levels greater than about 20 µg/L are associated with nuisance to severe nuisance blooms in this ecoregion. At a summer-mean Chl-a of 10 µg/L we expect about 40 percent of summer period will exhibit Chl-a of 10 µg/L or greater, but maximum Chl-a concentrations should remain below 20 µg/L (Exhibit EU-1, Figure 5b). A reasonable goal for the NLF would be to minimize events of 10 µg/L Chl-a or greater, which corresponds to a TP concentration of 30 µg/L or less. A summer-mean Chl-a in the 8 – 10 µg/L range is near the 75th percentile for the Agency reference and assessed databases and the EPA assessment database (Exhibit EU-1, Figure 29). The proposed Chl-a standard of 9 µg/L is often used as a boundary between mesotrophic and eutrophic conditions.

The proposed Secchi depth standard of 2.0 meters (about 6.5 feet) begins with the relationship between Chl-a and SD (figure II-5) in the Agency reference and assessed data sets. This relationship is cross-checked with the Carlson Trophic State Indices for TP, Chl-a and SD. The user perception data provides a means to ground the Chl-a/SD relationship with real-life attitudes about water clarity and swimming use. In the NLF ecoregion, user responses of “definite algal green” or “use slightly impaired” are associated with SD reading of about 2 to 2.2 meters (Section VI.C.2). The “no swimming” response is linked to a SD of about 1.5 meters. Given our primary goal to protect the recreational uses of “deep” lakes (Section VI.K), it is reasonable to maintain SD readings at 2.0 meters or more as a seasonal mean. A 2.0 meter mean will minimize the occurrence of SD readings in the range of 1.5 meters at some times during the summer.
A mean SD of 2.0 meters corresponds to a TP concentration of about 25 µg /L and Chl-a concentration of about 7 µg/L. These values are slightly lower than the proposed standards of 30 and 9 µg /L, respectively, but the Agency believes a proposed SD standard of 2.0 meters is reasonable to provide conditions acceptable for swimming use (Exhibit EU-1, page 112).

2. **North Central Hardwood Forest Ecoregion** [VI.F. EU standards, reasonableness]

The proposed standards for lakes in the NCHF ecoregion with a maximum depth greater than 15 feet are:

- Total phosphorus, 40 µg/L
- Chlorophyll-a, 14 µg/L
- Secchi Depth, 1.4 meters minimum

Applying the EPA criteria development approach as a starting point, the 25th percentile TP value for the Agency and EPA assessed data (20 and 28 µg/L) and the 75th percentile for the reference lakes (50 µg/L) suggest that an appropriate TP standard may lie within a range of about 25 to 50 µg/L (Exhibit EU-1, Figure 30). Within this range possible TP standards were refined by considering the TP/Chl-a and TP/SD relationships.

The 75th percentile Chl-a, value from the reference lakes and the 25th percentile value from the Agency’s assessed data, indicate a potential range for the Chl-a standard of 5 – 22 µg/L. Based on NCHF user perception data, Chl-a values greater than about 20 µg/L are typically perceived as a nuisance bloom and values greater than about 30 µg/L as a severe nuisance bloom. For deep lakes in this ecoregion, a reasonable goal is to minimize bloom events of 20 µg/L or greater. At a summer-mean of 15 µg/L, 70 percent of the summer period would have Chl-a greater than 10 µg/L, 20 percent would be greater than 20 µg/L, and the maximum Chl-a should remain below 25 µg/L (Exhibit EU-1, Figure 5b). The Agency’s proposed Chl-a standard of 14 µg/L is in the range indicated above; it should protect lakes in the NCHF ecoregion from nuisance blooms most of the summer period, and protect the swimming beneficial use.

For Secchi depth, 50 percent of volunteer observers in the NCHF ecoregion associate responses of “definite algal green” or “use slightly impaired” with SD readings of 1.3 meters or less. Responses of “no swimming” correspond to SD readings of about 1.0 meter or less. A reasonable goal in this ecoregion would be to minimize the frequency of SD readings below 1.5 meters and avoid occurrence of SD readings less than 1.3 meters. A summer-mean TP concentration of 40 µg/L equates to SD readings less than 1.0 meter about five percent of the summer, and readings less than 2.0 meters about 50 percent of the summer (Exhibit EU-30). Considering user perception information and 75th percentile values for the NCHF ecoregion (Exhibit EU-1, Figure 30), a summer-mean SD of 1.2 - 1.5 meters is appropriate. The Agency is proposing a standard of 1.4 meters, which corresponds to a summer-mean TP of about 35 - 40 µg/L.
3. Northern Glaciated Plains and Western Corn Belt Plains Ecoregions [VI.F. EU standards, reasonableness]

The proposed standards are:

- **Total phosphorus:**
  - Deep Lakes: 65 µg/L
  - Shallow Lakes: 90 µg/L
- **Chlorophyll-a:**
  - Deep Lakes: 22 µg/L
  - Shallow Lakes: 30 µg/L
- **Secchi Depth, minimum**
  - Deep Lakes: 0.9 meters
  - Shallow Lakes: 0.7 meters

Most lakes in the WCBP and NGP ecoregions are shallow; thus the standards for both are shown above even though the discussion here focuses on the standards for deeper lakes. Shallow lakes are discussed separately in the next Section. The deeper lakes will tend to have lower TP concentrations than the typical shallow lake in both ecoregions, but all lakes in the reference and assessment data bases in these ecoregions would be considered eutrophic to hypereutrophic.

Again using the EPA approach as a starting point, the 75th percentile TP value for the reference lakes and the 25th percentile for the Agency assessed data would place potential TP standards in the 60 – 150 µg/L range in the WCP and 80 – 160 µg/L in the NGP. The proposed TP standards are based on a consideration of associated Chl-a and SD responses to TP levels in this range and an emphasis on protecting ecological beneficial uses.

Mean SD associated with a “no swimming” user perception is 0.6 meter in these two regions. A TP concentration range of 70 – 90 µg/L TP should yield SD readings greater than 0.5 meter over 90 percent of the summer. As TP increases above 80 – 90 µg/L blue-green algae may dominate, and above 100 µg/L nitrogen limitation is increasingly likely. These observations suggest that a TP concentration in the 70 – 90 µg/L range may be an appropriate criteria level for most lakes in these two regions. Also, this would be just below the approximate 100 µg/L boundary between eutrophic to hypereutrophic lakes. Further, as TP increases above 100 µg/L a decline in the number of fish species, reduced percentages of walleye, northern pike and largemouth bass, and increases in the abundance of carp and black bullhead can be expected.

The diatom reconstruction estimates of pre-European median TP concentrations in deep lakes (about 50 µg/L) versus shallow lakes (69 µg/L) in these ecoregions, along with the distribution of modern-day TP concentrations, suggest that it is appropriate to set a TP standard for deep lakes that is lower than for shallow lakes.

Based on user perceptions, a Chl-a level greater than 30 µg/L is perceived as a nuisance bloom and Chl-a greater than 60 µg/L as a very severe nuisance bloom. On average, a summer-mean Chl-a of 25 µg/L means that Chl-a will be greater than 20 µg/L about 60 percent, greater than 30 µg/L about 25 percent, and greater than 60 µg/L about five percent of the summer. A Chl-a concentration of 25 µg/L is probably too low a standard for shallow lakes in the WCBP and NGP ecoregions, and would correspond to TP concentrations in the 60 – 70 µg/L range. However, as mean Chl-a concentrations increase, the frequency and intensity of algal blooms and maximum Chl-a increase as well. Chlorophyll-a concentrations at the level of the proposed standard of 30 µg/L correspond to TP concentrations on the order of 90 µg/L, which is the proposed TP
standard for shallow lakes. The current trophic condition in most NGP and WCBP lakes is in excess of these levels.

Secchi depth readings are quite low in most WCBP and NGP lakes, typically ranging between about 0.5 – 1.2 meters. In these ecoregions user responses of “definite algal green “ or “use slightly impaired” correspond to SD readings of 0.8 meter or less for 50 percent of observers. Responses of “no swimming” correspond to SD readings of about 0.7 meter or lower. A reasonable goal in these regions may be to minimize frequency of SD below about 0.7 - 0.8 meter. Maintaining a summer-mean SD of 0.7 – 0.8 meter requires a TP concentration on the order of 65 – 70 µg/L, which is a reasonable range for the deeper lakes.

In summary, based on the data for reference and assessed lakes, various interrelationships among trophic status variables, user perceptions, fishery considerations, rooted plant metrics (as demonstrated in the shallow west-central NCHF lakes) and other considerations, it is appropriate to select proposed eutrophication standards for protection of aquatic recreation uses in deeper WCP lakes and emphasizing ecological considerations in shallow lakes that predominate in the WCP and NGP ecoregions.

G. PROPOSED EUTROPHICATION STANDARDS FOR SHALLOW LAKES [VI. EU standards, reasonableness]

1. Introduction [VI.G. EU standards, reasonableness]

The development of separate standards for shallow lakes by the Agency is a direct response to issues the Coalition of Greater Minnesota Cities (CGMC) and the Minnesota Environmental Science and Economic Review Board (MESERB) raised during the assessment factor rulemaking in 2003. In general, these groups questioned the Agency’s use of the same criteria to assess shallow lakes for impairment due to excess nutrients that the Agency used to assess deeper lakes. They also questioned the beneficial uses assigned to shallow lakes, particularly the appropriateness of protecting shallow lakes for swimming. The Agency’s response to these comments is touched upon in Sections VI.G and VI.K.4, the SONAR for the Session Law rulemaking (Exhibit A-4) and Exhibit A-36.

Because of the severe statutory limitations on making substantial changes in proposed rule language late in the rulemaking process (as well as fundamental disagreements with some of CGMC’s positions), the Agency could do little to address these concerns in the 2003 rulemaking. However, their comments pointed out gaps in the Agency’s nutrient criteria, and they prompted the Agency to begin a monitoring program specifically for shallow lakes. In particular, shallow lakes in the NCHF, NGP and WCBP ecoregions were sampled. The result is separate proposed standards for shallow lakes that are based more on protecting the important ecological uses shallow lakes provide, and de-emphasizing their potential use for swimming.

The results of the special shallow lake sampling is described in two Agency reports (Exhibits EU-37 and EU-38). How these data were used to develop the proposed shallow lake standards is briefly summarized here, but discussed in detail in Exhibit EU-1. From this work it was evident
that the differences between deep and shallow lakes were particularly evident in the NCHF and WCBP ecoregions.

Lake sampling in the NLF ecoregion showed no consistent or significant difference between deep and shallow lakes in their trophic conditions. For this reason the Agency is not proposing separate standards for shallow lakes in the NLF ecoregion. The same set of standards will apply to both deep and shallow lakes. There are no lake trout or stream trout lakes that fit the definition of “shallow lake.”

2. North Central Hardwood Forest Ecoregion

The proposed standards for lakes in the NCHF ecoregion with a maximum depth of 15 feet or less are:

- Total phosphorus, 60 µg/L
- Chlorophyll-a, 20 µg/L
- Secchi Depth, 1.0 meter minimum

A subset of lakes in the assessed data base (supplemented with data from a study of lakes in west-central Minnesota) was evaluated to determine the proposed standards for shallow lakes in the NCHF ecoregion. For this purpose, data for lakes with a maximum depth of less than 20 feet were assessed as “shallow lakes.” While the Agency subsequently decided, based on the weight of evidence, to define shallow lakes as those having a maximum depth of 15 feet, the data for these lakes are considered representative of lakes that meet the definition of shallow lakes (i.e., maximum depth of 15 feet or 80 percent or more of the lake littoral). Shallow lakes tend to be more nutrient-rich compared to the overall population of lakes in the NCHF ecoregion (Exhibit EU-38).

The range and distributions of TP and Chl-a data for the shallow lakes compared to the ranges and distribution of data for the reference and assessed data for all lakes was used to identify a range for possible TP and Chl-a standards. User perception data is helpful in associating the TP and Chl-a levels with conditions unacceptable for swimming and the associated SD readings. Secchi depth should remain above about 0.7 meter and ideally 1.0 meter or more to minimize the likelihood of a reduced number of rooted plant species. Based on the data from the NCHF assessed lakes, 0.7 meter and 1.0 meter correspond to about the 25th and 50th percentiles values respectively (Exhibit EU-1, Figure 30). A summer average transparency of 0.7 – 1.0 meter should allow submerged aquatic plants to colonize to a depth of about 1.5 – 2.0 meters based on equations developed by Canfield et al. (1985) and Chambers and Kalff (1985) as discussed in Exhibits EU-1 and EU-38. The proposed SD standard is 1.0 meter.
3. Western Corn Belt Plains and Northern Glaciated Plains Ecoregions [VI.G. EU standards, reasonableness]

The proposed standards for lakes in the WCBP and NGP ecoregions with a maximum depth of 15 feet or less are:

- Total phosphorus, 90 µg/L
- Chlorophyll-a, 30 µg/L
- Secchi Depth, 0.7 meter minimum

Based on the Agency’s assessments it is estimated that perhaps 10 percent or less of the lakes in the WCP would be considered deep (> 15 feet deep), and virtually all lakes in the NGP are shallow. Agriculture is the dominant land use in these two ecoregions.

The new shallow lake data from the WCBP and NGP allowed the Agency to examine the relationship between TP and the frequency and magnitude of algae blooms (see Figure 6b, page 25 in Exhibit EU-1; it shows the same relationships for shallow lakes that is shown in Figure II-6 for deep lakes). For example, at TP concentrations in the 70-90 µg/L range, the frequency of severe nuisance blooms in shallow lakes is about 45 percent of the time in the summer, and very severe nuisance blooms is about 10 percent of the time. Above about 110 µg/L TP there is a large increase in the frequency of very severe nuisance blooms. A summer-mean P concentration of 90 µg/L should keep SD above 0.5 meter over 90 percent of the summer and over 1.0 meter about 60 percent of the summer (Exhibit EU-30).

The Agency is targeting the proposed WCBP/NGP shallow lake standards at the threshold of trophic conditions where algae can become dominant at the expense of macrophytes. Figure II-8 shows a general decline, albeit with considerable variability, in the number of macrophyte species as TP concentrations increase, particularly as TP concentrations exceed 100 µg/L.

Two case studies on shallow lakes in Wisconsin and Florida illustrate how shallow lakes can show dramatic positive responses to nutrient reductions, not limited to just improvements in the macrophyte community (see shaded text that follows this Section). These studies show that nutrient reductions can:

- Be successfully combined with other improvement techniques (e.g., rough fish removal);
- Improve the macrophyte community;
- Reduce the frequency and magnitude of algae blooms; and
- Lower Chl-a levels and improve SD readings.

The Lake Apopka case study also shows that restoration to pre-settlement conditions is not a realistic goal and that a reasonable site-specific TP goal for this lake is 55 µg/L.
Figure II-8. Number of Species of Rooted Aquatic Plants Compared to Chlorophyll-a Concentrations in 27 Shallow West-central Minnesota Lakes (see Exhibit EU-38).

Macrophytes are essential to the overall ecology and stability of lakes – shallow lakes in particular. Macrophytes help to retard wave action, increase the settling of particulates in the water column, and enhance light penetration and water clarity. Also, macrophytes and algae attached to macrophytes can take nutrients from the water (luxury uptake), reducing the potential for algae growth; and they provide refuge for zooplankton and insects and provide fish habitat. It has been shown that shorelines with diverse submerged vegetation support significantly more fish than shorelines with little or no vegetation. Finally, macrophytes provide a valuable food source to waterfowl. While excessive rooted macrophytes in a lake may impede recreation for some, they provide many benefits to the overall ecology of the lake.

In conclusion, the proposed eutrophication standards for shallow lakes reflect the generally more eutrophic condition of these lakes compared to deeper lakes outside of the NLF ecoregion. They are targeted at levels needed to encourage macrophyte communities over an algae dominated condition. The proposed shallow lake standards for the NHF and WCBP/NGP ecoregions will not prevent algae blooms; however, they will serve to minimize the intensity and duration of the very severe nuisance blooms, which often make waters unusable (Exhibit EU-1).
Case Studies on the Restoration of Two Shallow Lakes

**Big Muskego Lake** is a large (2,177 acre) but very shallow (1.2 m maximum depth) lake in southeast Wisconsin. It is an example of a lake that has exhibited a significant increase in the amount of emergent and submersed vegetation as the combined result of drawdown, roughfish removal and reduced nutrient concentrations. Prior to these activities, less than 10% of the lake was covered by emergent plants and water quality could be characterized as hypereutrophic with TP ~120 ppb, chlorophyll-a ~44 ppb, and Secchi ~0.3 m. Severe blue-green and filamentous algal blooms were common. Following implementation of the above activities, there was dramatic improvements in water quality with annual average TP ~40 ppb, chlorophyll-a ~ 9 ppb, and Secchi ~ 1 m, an increase in the number of rooted plant species and an expansion of the percent surface area coverage of emergent plants to 54%. Based on data collected over a period from 1988 (prior to) through 2004 (post restoration) an increase in Secchi transparency (0.3 m to 0.9 m) was noted as TP declined from roughly 100-200 ppb to about 60 ppb. For the period 1998-2004 TP has averaged 40-50 ppb and Secchi has ranged between 0.9-1.3 m as an annual average. [History on the restoration of Big Muskego Lake was summarized in three articles in NALMS LakeLine magazine. Vol. 23 (1) Spring 2003. Pages 21 – 36, Exhibit EU-44].

**Lake Apopka** is a very large (32,375 acre) shallow lake (1.7 m mean depth) located northwest of Orlando, Florida. It can be described as hypereutrophic based on average TP = 200 ppb, chlorophyll-a =96 ppb, and Secchi =0.22 m (Lowe et al. 1999). The lake has been the subject of a state-sponsored restoration plan dating back to 1993. A primary focus of that effort was to return the lake to an approximate antecedent condition (state-of-the-lake prior to large-scale agricultural development of its floodplain and concomitant eutrophication), which based on historic photos and other information would mean a return of the submersed vegetation that once covered much of the basin. Through a variety of techniques, they identified a range of trophic status values that likely characterized antecedent condition in the lake as follows: TP 32 - 51 ppb; chlorophyll-a 8 - 38 ppb and Secchi 0.76 – 1.39 m. They note further though that past conditions should not be construed as restoration goals. Instead, past conditions will be the foundation for consideration of other factors such as economics and constraints of law (Lowe et al. 1999). They go on to note that such consideration will often lead to goals that approximate, but do not duplicate, past conditions. It was likely this thinking that led the St. John’s River Water Management District to set by rule (Section11.6, Applicant’s Handbook. Management and Storage of Surface Waters) a TP criterion of 55 ppb (Coveney, 2005; personal communication; note have a draft memorandum to this effect).

H. PROPOSED STANDARDS COMPARED TO EPA CRITERIA [VI. EU standards, reasonableness]

As discussed in Section III.A, EPA guidance to states on the adoption of nutrient standards urges states to use an approach that best reflects local conditions and protects specific beneficial uses, based on local data and information (Exhibit EU-15). This is precisely what the Agency has done to develop the proposed eutrophication standards. The resulting proposed standards are not...
only ecoregion-based but reflect the beneficial uses most important to four lake types (lake and stream trout lakes, deep lakes, shallow lakes and reservoirs). The process EPA used to arrive at the nutrient criteria and the process the Agency used to arrive at the proposed standards differ in several important respects (i.e., EPA’s statistical/percentile approach vs. the Agency’s iterative approach using trophic relationships and multiple data sets).

The standards proposed by the Agency are generally higher or more lenient than the corresponding EPA ecoregion-based criteria as shown in Table II-10, but they were developed in a manner consistent with EPA guidance to the states. The Agency’s approach reflects the use of the Minnesota database, separation of lakes by ecoregion and four lake-types; and, most significantly, the Agency’s proposed standards are pegged to thresholds that will protect specific beneficial uses with no overt or clear margin of safety (next Section).

Table II-10. Agency Proposed Eutrophication Standards Compared to EPA Nutrient Criteria for Minnesota Ecoregions. Proposed Standards in Bold are Equal to or More Stringent than the Corresponding EPA Criterion.

<table>
<thead>
<tr>
<th>Proposed Standards &amp; EPA Criteria By MN Ecoregion</th>
<th>TP µg/L</th>
<th>Chl-a* µg/L</th>
<th>SD Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agency</td>
<td>EPA</td>
<td>Agency</td>
</tr>
<tr>
<td>NLF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake trout lakes</td>
<td>12</td>
<td>9.69</td>
<td>3</td>
</tr>
<tr>
<td>Stream trout lakes</td>
<td>20</td>
<td>9.69</td>
<td>6</td>
</tr>
<tr>
<td>Deep lakes and Reservoirs</td>
<td>30</td>
<td>9.69</td>
<td>9</td>
</tr>
<tr>
<td>Shallow lakes</td>
<td>30</td>
<td>9.69</td>
<td>9</td>
</tr>
<tr>
<td>NCHF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stream trout lakes</td>
<td>20</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>Deep lakes and Reservoirs</td>
<td>40</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Shallow lakes</td>
<td>60</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>NGP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep lakes and Reservoirs</td>
<td>65</td>
<td>90</td>
<td>22</td>
</tr>
<tr>
<td>Shallow lakes</td>
<td>90</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>WCBP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep lakes and Reservoirs</td>
<td>65</td>
<td>55</td>
<td>22</td>
</tr>
<tr>
<td>Shallow lakes</td>
<td>90</td>
<td>55</td>
<td>30</td>
</tr>
</tbody>
</table>

*Chl-a values measured by the spectrophotometric method with acid correction.
Of the four proposed standards that are equal to or lower than the EPA criteria, two are applicable to trout lakes: the SD standard of 4.8 meters for lake trout lakes and the NCHF TP standard of 20 µg/L for stream trout lakes. The other two are the TP standards of 65 and 90 µg/L for the NGP ecoregion (Table II-10). The EPA criteria are based on a data set that includes data for lakes outside Minnesota. For example, the WCBP ecoregion covers most of Iowa and part of eastern Nebraska, as well as much of southern Minnesota (Exhibit EU-11). The Agency’s proposed standards are based on Minnesota data only. Also the more stringent EPA Chl-a and SD criteria for the NGP ecoregion seem too low and “out of sync” with EPA’s TP criterion of 90 µg/L. The Agency found no significant difference in lake data for the two “prairie” ecoregions (NGP and WCBP) in Minnesota, and combined these ecoregions into one geographical area for purpose of the standards. If the EPA TP criteria of 90 and 55 for these two ecoregions are averaged together, the result (72.5 µg/L) is less stringent only than the proposed TP standard for deep lakes in the two ecoregions. Lakes deeper than 15 feet are not very common in these two ecoregions, but those that exist often represent important local recreational resources.

I. PROPOSED STANDARDS COMPARED TO PRESENT-DAY TROPHIC CONDITION OF MINNESOTA LAKES [VI. EU standards, reasonableness]

The comparison of the proposed ecoregion-based eutrophication standards to the current and historical trophic condition of lakes in Minnesota is instructive in several respects. The percent of lakes that exceed the proposed TP standards varies considerably from one ecoregion to another. It is clear that many lakes in their present trophic condition will not meet the proposed standards. It reinforces the need for the proposed language dealing with exceedances of the standards due to natural causes (Section VI.L.5). And it should reinforce the concern among governmental agencies, lakeshore property owners and the public in general about the poor trophic status of many Minnesota lakes, and the need to be proactive in their protection.

It is also important to emphasize, that in spite of the large number of lakes that exceed the proposed standards in some ecoregions, the standards are not overly stringent. The Agency’s analysis of all the supportive information indicates that TP values much greater than those proposed would jeopardize the beneficial uses the standards are designed to protect.

Figure II-9 shows 25th, 50th and 75th percentile values for four data sets compared to the proposed TP standards for three ecoregions (Exhibit EU-1). The four data sets are: 1) the reference lakes, 2) the Agency’s assessment data base, 3) the EPA assessment data and, 4) the diatom reconstruction data which estimates pre-European settlement trophic conditions (Section VI.C.3). The Agency’s large assessment data set probably best represents the average condition of lakes in a given ecoregion.
Figure II-9. Summer-Mean 75<sup>th</sup>, 50<sup>th</sup> and 25<sup>th</sup> Percentile TP Values in µg/L from Four Lake Data Sets Compared to the Proposed TP Standards (solid horizontal line) for Three Ecoregions.
In the NLF ecoregion summer-mean percentile TP values are quite similar among the reference, Agency assessed and EPA assessed databases (Figure II-9). Further, the percentile ranges for these three data sets compare favorably with diatom-inferred pre-European TP concentrations, indicating that the trophic status of many lakes in this ecoregion probably has not been altered dramatically by human activity. The 75th percentile values in both the Agency and EPA assessment data fall on the proposed TP standard of 30 µg/L for the NLF ecoregion. This suggests that about 25 percent of the lakes in this ecoregion would have TP levels above the proposed standard (see discussions in Sections VI.L.5 and VI.M). In this ecoregion no distinction is made between “deep” lakes (> 15 feet deep) and shallow lakes.

The data in Figure II-9 for the NCHF ecoregion focuses on deep lakes. In this ecoregion we see a widening difference between the Agency and EPA assessment data bases and the reference and diatom reconstruction data bases. The two assessment databases exhibit somewhat similar TP percentile values with an overall range between the 75th and 25th percentiles of 84 and 80 µg/L, respectively. This large range is a function of the heterogeneity of the lakes in this ecoregion (e.g., variability in morphometry, watershed characteristics and anthropogenic impacts). The 50th percentile values from the two assessment data bases fall about on the proposed standard of 40 µg/L; thus, about half of the lakes in this ecoregion in their current condition would not be expected to meet the TP standard. The reference and diatom reconstruction data are similar and exhibit a smaller range. This indicates that lakes relatively free from anthropogenic impacts may not have changed very much in the last 200 years.

Because of similarities in land use, lake morphometry, water quality and user perceptions the WCBP and NGP ecoregions have been lumped together for the purpose of nutrient criteria and the proposed eutrophication standards. The WCBP and NGP ecoregions are characterized by relatively small data bases and they are in the same EPA aggregate ecoregion (Exhibit EU-11). Figure II-9 shows data from the WCBP ecoregion, which serves to illustrate the points made here (Exhibit EU-1, Figure 31; data for NGP is shown in Figure 32).

As stated, most lakes in these two ecoregions are shallow (< 15 feet deep). However, the selection of reference lakes tended to emphasize the deeper lakes in these areas, which is reflected in the lower range of TP values. Based on the larger Agency assessment data set most lakes in this ecoregion will not meet the proposed shallow lake TP standard of 90 µg/L. Comparison of the Agency’s assessment data to the diatom reconstruction data suggests that human activities have had an impact on the trophic conditions of lakes in these two ecoregions (Figure II-9).

J. SUMMARY, PROPOSED EUTROPHICATION STANDARDS [VI. EU standards, reasonableness]

The eutrophication standards the Agency is proposing represent a significant advancement over the nutrient criteria used to determine impaired lakes for the 2002, 2004 and 2006 303(d) lists. This is because the proposed standards differentiate between trout, shallow and deep lakes, as well as ecoregions. The addition of a separate category for shallow lakes was an important advancement. For example, the proposed phosphorus standard of 60 µg/L for shallow lakes in
the NCHF ecoregion is 50 percent higher than the criterion used previously for all lakes. And we are confident that for lakes consistently above the proposed standards, reducing TP and Chl-a to levels below the standards, will yield measurable and perceptible improvements in water quality (several of the case studies in Exhibit EU-1 illustrate this). The development of the TP, Chl-a and SD criteria/standards can be summarized as follows:

- TP data spanning many years are assessed by ecoregion, and the relationships between TP and lake morphometry, fisheries information and watershed characteristics is reviewed.
- The relationship between TP and intervals of Chl-a data is used to define different degrees of nuisance algal blooms, based upon Minnesota data and the literature.
- The strong relationships between levels of TP and Chl-a, and TP and SD, which is well established in the literature, is confirmed in the data for Minnesota lakes.
- Lake data for TP, Chl-a and SD is converted to the Carlson Trophic State Index as a means to cross-check relationships and to help establish trophic boundaries.
- The ecoregion-based TP, Chl-a and SD criteria are evaluated in light of the large data set of user-perception data from the Citizen Lake Monitoring Program and results from 20 years of lake-observer surveys, which indicate that the perception of what constitutes unacceptably low water clarity (SD) or severe algal blooms varies by ecoregion.
- The ecoregion-based TP, Chl-a and SD criteria are evaluated in light of the diatom reconstruction estimates of historical trophic conditions.
- The scientific literature and approaches taken by other states are reviewed.
- The Agency’s approach has been cited by EPA as being a reasonable approach for development of nutrient criteria (Exhibit EU-16).

Again, this process is described in detail in Exhibit EU-1.

K. BENEFICIAL USES AND LAKE TYPES [VI. EU standards, reasonableness]

1. Beneficial Use Class [VI.K. EU standards, reasonableness]

The proposed eutrophication standards are properly assigned to the Class 2 use. The uses the standards are designed to protect are consistent with aquatic life and recreational uses, and the national goal in Section 101(a) of the Clean Water Act of achieving “fishable/swimmable” surface waters, where attainable.

Within the Class 2 aquatic life and recreation use are several “sub-uses” that broadly overlap but can differ depending on the type of surface water. For example, we expect wetlands to support a diverse aquatic community of plants and animals, but not a community that includes game fish, or possibly any fish at all. However, the wetland aquatic community may be just as sensitive to the effects of pollution as a community that include game fish. In another example, wetlands may not be an ideal place to go swimming in the traditional sense of “swimming”, but they do provide other important forms of aquatic recreation that require the same level of protection afforded a typical swimming lake. On the other hand, swimming is often the primary “sub-use”
in a good quality lake. This shift in emphasis among the various sub-uses from one type of waterbody to the next all fits under the broad umbrella of the aquatic life and recreation use.

The proposed eutrophication standards for the different lake types reflect such shifts in sub-use emphasis. That is, the standards are based on protecting a sensitive sub-use that must be protected if that lake type is to provide the uses we expect it to. Table II-11 shows the sub-categories of uses on which the standards are based.

Table II-11. Subcategories of Beneficial Uses within the Aquatic Life and Recreation (Class 2) Use that the Proposed Eutrophication Standards for Different Lake Types are Designed to Protect.

<table>
<thead>
<tr>
<th>Waterbody type</th>
<th>Uses. The more sensitive sub-use, which is the primary basis for the proposed standard, is listed as number 1. Other uses follow.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake trout Lakes</td>
<td>1. Protection of sensitive cold water fishery. Specifically, maintenance of adequate dissolved oxygen below the thermocline needed to support lake trout  &lt;br&gt; 2. Water recreation of all types including swimming  &lt;br&gt; 3. Aesthetics</td>
</tr>
<tr>
<td>Stream trout lakes</td>
<td>Same as for lake trout lakes, except that the hypolimnetic dissolved oxygen requirements for stream trout are not as rigorous as for lake trout.</td>
</tr>
<tr>
<td>Lakes and reservoirs &gt; 15 feet deep</td>
<td>1. Water recreation of all types including swimming, at least part of the summer season  &lt;br&gt; 2. Maintenance of a desirable cool or warm water game fishery  &lt;br&gt; 3. Aesthetics</td>
</tr>
<tr>
<td>Shallow lakes &lt; 15 feet deep</td>
<td>1. Protection of aquatic community. Specifically the maintenance of a diverse community of emergent and submerged aquatic plants &lt;br&gt; 2. Waterfowl and wildlife habitat  &lt;br&gt; 3. Water recreation of all types including primary body contact where usable  &lt;br&gt; 4. Aesthetics</td>
</tr>
</tbody>
</table>

The Agency has set the proposed standards at an appropriate and reasonable level that will protect the specific beneficial uses outlined in Table II-11. However, we also feel that based on the extensive body of Minnesota lake data, the proposed eutrophication standards are at the upper end of the range of values that are protective. In other words, the proposed standards represent the threshold for protection of specific uses shown in Table II-11, with no explicit margin of safety. Hence, there is a need to protect resources that are of a quality better than the proposed standards at that level, taking into account normal variability.

2. Lake Trout and Stream Trout Lakes [VI.K. EU standards, reasonableness]

The proposed eutrophication standards for trout lakes (both lake trout and stream trout, Sections VI.E. 2 and VI.E. 3) focus on maintaining a zone of acceptable temperature and dissolved oxygen conditions in the lake that allow lake trout to reproduce and grow, and allow adult stream trout to thrive. The primary basis for these standards is the protection of the sensitive coldwater fishery. Recreational uses, including swimming, are of secondary importance, but it is clear that if the required oligotrophic or near-oligotrophic conditions are maintained to protect the trout, that recreational uses will be protected as well.
3. **Lakes Deeper than 15 Feet [VI.K. EU standards, reasonableness]**

Most of the lakes in Minnesota that support a managed cool water fishery (e.g. walleye) or warm water fishery (e.g. largemouth bass) and a variety of aquatic recreational uses are “deep” lakes, or lakes and reservoirs with a maximum depth greater than 15 feet.

The proposed standards for lakes and reservoirs greater than 15 feet deep focus on maintaining conditions that will support aquatic recreation, particularly swimming (Table II-11). The process used to arrive at the ecoregion-based standards for this category is outlined in Sections III.E and VI.F. In summary, TP levels were associated with Chl-a and SD measurements and the frequency and magnitude of algae blooms (Figure II-6). The suggested standards for the four ecoregions were then fine-tuned with other information, including user perception data. The proposed standards are at the thresholds of trophic conditions, by ecoregion, that are acceptable for swimming and other forms of water-related recreation, with no explicit margin of safety. The Agency believes the proposed standards are very well founded and reasonable, and not overly protective.

4. **Shallow Lakes [VI.K. EU standards, reasonableness]**

Comments received during the assessment factor rulemaking prompted the Agency to re-think which Class 2 “sub-uses” are the most critical for shallow lakes. The result is proposed separate standards for shallow lakes that emphasize protecting the important ecological uses shallow lakes provide, while still protecting them for swimming and other recreational uses, where these uses are attainable.

Using the trophic data from the Agency’s shallow lake monitoring and the data and experience of MDNR staff that work in their shallow lakes program, thresholds were determined for the level of TP at which a shift from a desirable macrophyte community to a much less desirable algae dominated community is likely to occur. The proposed eutrophication standards for shallow lakes reflect an emphasis on an ecological “sub-use”; i.e., encouraging a macrophyte community over an algae-dominated community. The proposed shallow lake TP standards, particularly for the NGP and WCBP ecoregions, will not prevent nuisance algae blooms, or even the possibility of severe blooms, from occurring at least part of the summer. However, they should support trophic conditions for which macrophytes can successfully compete with the algae and recreational uses are possible (Exhibit EU-1).

5. **Reservoirs [VI.K. EU standards, reasonableness]**

The goal is to protect reservoirs for the same uses that “deep” lakes are protected for; i.e., a mix of aquatic life and recreational uses with the emphasis on swimming (Table II-11). We often think of reservoirs as a stream valley flooded by a dam, which creates a “lake” where none existed before. This type of reservoir is less common in Minnesota than elsewhere in the U.S. Examples are Lake Zumbro north of Rochester and Lake Byllesby near Cannon Falls.
Some of Minnesota’s well known large lakes are technically reservoirs because they have at their outlet a structure that controls the flow of water from the “lake.” Most of these “reservoirs” were natural lakes originally and often are not thought of as reservoirs. In some cases the control structure maintains a water level higher than the original natural level, and generally water levels are managed to support aquatic recreation, water storage and flood control. The MDNR Bulletin 25 inventory of Minnesota lakes27 lists the 50 largest lakes in or bordering Minnesota – those with a surface area larger than 5,000 acres. Twenty four of the 50 are listed as reservoirs; included such well known lakes as Lake of the Woods, Rainy, Leech, Winnibigoshish, Gull, Pokegama, Big Sandy, Big Stone and Pepin.

If the maximum depth of the reservoir is less than 15 feet, it may be assessed as a shallow lake in terms of the Class 2 sub-uses that are emphasized; and the numeric standards for shallow lakes may be applied. This would be determined on a case-by-case basis (see next Section).

A key part of the definition of “reservoir” that is needed to separate reservoirs from rivers is the minimum hydraulic residence time of 14 days. The importance of using a standardized stream flow (the 122Q10 low flow) to determine the minimum residence time is discussed in Sections VI.B.2 and X.B.5 of SONAR Book I (also see Exhibits EU-16, page 3-1, and PL-1c).

L. NARRATIVE PORTION OF EUTROPHICATION STANDARDS [VI. EU standards, reasonableness]

1. Introduction [VI.L. EU standards, reasonableness]

As already noted, the proposed eutrophication standards are unlike the typical Class 2 toxicity or human health-based standards (see Section IV.G). For these and the reasons discussed in this Section, it is particularly important for the Agency to add narrative to the proposed numeric eutrophication standards. Because of their length, the Revisor’s Office recommended placing the narrative parts of the eutrophication standards in separate subparts following the listings of the Class 2 numeric standards (Class 2A, 2Bd and 2B). Each “item” of the proposed narrative will be discussed in the sections that follow.

2. Lakes in Other Ecoregions [VI.L. EU standards, reasonableness]

Eutrophication standards are proposed for the four ecoregions that include 98 percent of the lakes in Minnesota. Specific standards are not proposed for lakes in the other three ecoregions because there is insufficient data available on which to base standards. Standards for lakes in these ecoregions, when needed, can be developed on a case-by-case basis. The numeric standards in an adjacent ecoregion can be used as a “guide” or starting point. For example, it is reasonable to use the standards for the NLF ecoregion as a starting point in developing a site-specific standard for a lake in the Northern Minnesota Wetland ecoregion. It is possible that the NLF standards may prove to be appropriate as listed with no need for any adjustment; but if not, a site-specific standard will be developed. Similarly, if a lake lies on the border between two ecoregions, the

standards for that lake will need to be considered on a case-by-case basis. This is a reasonable approach for the lakes in these three ecoregions and for lakes that straddle two ecoregions. The need to develop site-specific standards for these situations should be infrequent. The proposed language for Class 2B waters as an example follows.

[Minn. R. 7050.0222] **Subp. 4a. Narrative eutrophication standards for Class 2B Lakes, Shallow Lakes, and Reservoirs.**

A. Eutrophication standards applicable to lakes, shallow lakes, and reservoirs that lie on the border between two ecoregions or that are in the Red River Valley, Northern Minnesota Wetlands or Driftless Area Ecoregions must be applied on a case-by-case basis. The commissioner shall use the standards applicable to adjacent ecoregions as a guide.

3. **Summer Season Average and Exceedance of Causal and Response Standards**

It is the intent of the Agency that the proposed standards be compared to trophic conditions averaged over the summer growing season. The Agency made it clear in the assessment factor rulemaking that nutrient criteria were to be implemented as summer averages (Minn. R. 7050.0215, subp. 5). The proposed statement follows:

B. Eutrophication standards are compared to data averaged over the summer season (June through September). Exceedance of the total phosphorus and either the chlorophyll-a or Secchi disk standard is required to indicate a polluted condition.

The Agency has compared the nutrient criteria (for TP, Chl-a and SD) to data averaged over the summer growing season to assess the trophic status of lakes since 2002, and before that, for other lake programs. It is the average (or other measurement of central tendency such as a median) trophic condition of a lake from June through September, rather than the conditions that exist on any given sampling day, that is of most interest to the Agency. Algal populations change in species composition and abundance over the course of the summer. Many lakes tend to become “more green” as the summer progresses, and less desirable blue-green (floating) algae may replace less problematic species in late summer. Other characteristics such as the amount of color in the water (which may increase or decrease in response to rainfall and runoff from the surrounding watershed), temperature changes, stratification, and the growth of macrophytes, will change over the course of the season. These complex patterns of change throughout the summer growing season in a wide range of lake types, make it very difficult to select a portion of the summer, or a given month, for example, during which all lakes should be assessed. It is more reasonable to average conditions over the whole summer. Also, by doing so, the Agency can make the best use of usually limited data. The minimum data needed in any one year to assess a lake for potential impairment is monthly sampling over the summer (i.e., four to five samplings spaced over the summer period). Data for at least two years is needed. The Agency’s assessment guidance specifies the minimum data requirements (Exhibit A-7).
It is true that using a summer average condition may tend to mask periods of time when conditions in a lake may be at their worst and possibly unacceptable. In a marginally impaired lake, for example, conditions may be acceptable and within standards early in the summer, but gradually deteriorate to an unacceptable condition as the growing season progresses. Averaging the data for such lakes over the summer dampens the influence of the “good” as well as the “bad” conditions. This means that if conditions support beneficial uses for more than half the summer, the lake may be in compliance with standards. However, the development of the proposed standards and establishing the relationships between summer-mean TP and Chl-a considered the frequency and intensity (or risk) of severe algae blooms or extreme conditions during any part of the summer. That is, the standards take into consideration the range of likely values around, and particularly above or worse than, the summer-average conditions.

In summary, the Agency believes it is not representative or practical to assess lakes for only a part of the summer, for example in late summer when conditions are more likely to be at their worst. It is preferable, in the view of the Agency, to assess conditions over the course of the summer recognizing that conditions can change. Also, a summer-average maximizes the information that can be derived from limited data.

During the assessment factor rulemaking, the Agency adopted language that says for the narrative eutrophication standard to be exceeded, both the TP (cause) and either the Chl-a or SD (response) criteria must be exceeded (Minn. R. 7050.0150, subp. 5). The Agency believes that there should be a measurable negative response to the loading of TP into a lake or reservoir in order to have an exceedance of the standard. This is especially true when lakes are being assessed for impairment and potential 303(d) listing. It is unusual to have a measurable increase in TP loading or in-lake TP concentrations without a response, but it is possible. It is reasonable to require at least one of the response standards (Chl-a or SD) to show an exceedance, in addition to the TP standard, for the conditions to be considered an “exceedance” of the eutrophication standards.

The proposed narrative associated with the standards says that only one of the response standards must be exceeded for the eutrophication standards to be considered exceeded. Situations where the weight of evidence demonstrates impairment based on one response factor but not other will be rare, but examples do occur. The Agency’s proposed language shown above is consistent with the language in Minn. R. 7050.0150, subp. 5 in both these respects. It is reasonable to require exceedance of just one response standard for the reasons outlined below.

It is possible to have very high Chl-a concentrations indicating algae populations at bloom conditions and still have “acceptable” SD measurements. Certain species of blue-green algae, for example, can be numerous in the water column but because of their large size and distribution (some look like grass clippings suspended in the water), and because the water does not become an opaque green color, SD transparency is not reduced as much as the high Chl-a levels would suggest. In this case SD readings may misrepresent the true extent of the eutrophic condition. In other situations Chl-a levels may not reflect the true extent of eutrophication. Blue-green algae may float on the surface, creating surface scums, that if left undisturbed can greatly reduce SD measurements; but an integrated sample (sample averaged over the top 6 feet of water) may not show Chl-a levels that match the very poor SD measurements.
In another example, if a lake has an atypically reduced population of minnows and other small fish for any reason, the lack of predation on the zooplankton community by small fish can allow some zooplankton species (e.g., *Daphnia*) to become very numerous. An abundant population of algae-feeding zooplankton may selectively feed on smaller algae species, leaving behind the larger blue-green species. Again, this can allow for deceptively high SD readings.

Lakes with these, albeit unusual conditions, should be considered in violation of the standards based on high TP and high Chl-a levels or low SD readings. To require data showing exceedance of both response factors will probably result in some lakes not getting listed as impaired that truly are impaired. The Agency feels it is reasonable to require an exceedance of just one response factor.

4. **Lakes Better Than Standards, Nondegradation Policy** [VI.L. EU standards, reasonableness]

   a) Nondegradation Policy

The fundamental principal of nondegradation is to keep waterbodies that have a water quality condition better than water quality standards in their current “better-than-standards” condition, and not allow them to be degraded. Some citizens, particularly members of lake associations that represent lakes with trophic conditions “better-than-standards” (high quality lakes), have voiced a concern that adoption of the eutrophication standards might send an unintentional negative message that degrading a high quality lake “down to” the level of the standards is acceptable. The Agency shares this concern. It is important to be very clear that the adoption of eutrophication standards does **not** mean that the trophic conditions in lakes that are better than standards can be “lowered” (i.e., concentrations of TP, Chl-a increased and SD readings reduced) to the standards because beneficial uses will still be protected. The maintenance of Minnesota’s high quality lakes in their current “better-than-standards” condition is extremely important to the state’s economy and to the general quality of life in Minnesota. With appropriate management, high quality lakes will provide recreational, aesthetic and economic value indefinitely into the future. Therefore, the Agency is proposing to include a strong nondegradation policy statement with the numeric standards, shown below:

*C. It is the policy of the agency to protect all lakes, shallow lakes, and reservoirs from the undesirable effects of cultural eutrophication. Lakes, shallow lakes, and reservoirs with a baseline quality better than the numeric eutrophication standards in subpart 4 must be maintained in that condition through the strict application of all relevant federal, state, and local requirements governing nondegradation, the discharge of nutrients from point and nonpoint sources, and the protection of lake, shallow lake, and reservoir resources, including, but not limited to:

1. the nondegradation requirements in parts 7050.0180 and 7050.0185;
2. the phosphorus effluent limits for point sources, where applicable in chapter 7053;
3. the requirements for feedlots in chapter 7020;
4. the requirements for individual sewage treatment systems in chapter 7080;*
(5) the requirements for control of stormwater in chapter 7090;
(6) county shoreland ordinances; and
(7) implementation of mandatory and voluntary best management practices to minimize point and nonpoint sources of nutrients.

An example will help illustrate the importance of the nondegradation policy. Imagine a family that just spent $200,000 to purchase lakeshore property on a lake in the NLF ecoregion with an average SD of 5 meters (≈ 16.5 feet). According to the proposed standard, and ignoring applicable nondegradation and other protective provisions for the moment, the SD of this lake “could” be reduced to a summer mean of 2.0 meters (≈ 6.5 feet), with the associated increases in Chl-a and TP, and the lake would still meet the proposed NLF SD standard of 1.8 meters. It is very unlikely this family would be comforted by a response to their disappointment over the loss of water clarity in “their” new lake that the lake meets standards and is still usable for fishing and swimming – at least for most of the summer.

This family’s disappointment might be even more tangible if they decide to sell and move to a different high quality lake. It is very likely that the value of their property declined with the decline in water clarity. A recent Minnesota study that relates lakeshore property values to water quality indicates that, other things being equal, such a reduction in water clarity alone would reduce the value of this family’s investment by about $207.00 for each frontage foot of lakeshore they own ($69.00 for each meter loss in water clarity, Exhibit EU-39). While the targeted beneficial uses for this lake should still be met because the standards are met, it is unlikely that this dollar figure would completely reflect this family’s sense of loss; the loss of swimming and aesthetic enjoyment that a lake with a 5 meter SD provides compared to a lake with a 2 meter SD.

The proposed nondegradation language, quoted above, starts with a statement that it is the Agency’s policy to protect all lakes from cultural eutrophication. The language then says that lakes better than standards will be protected through the strict application of all applicable federal, state and local nondegradation provisions, and through application of existing TP reduction requirements for point and nonpoint sources of nutrients. Examples of these provisions are listed in subitems 1 to 7.

It is reasonable to list examples of the requirements the Agency has in mind to prevent an increase in nutrient loading to high quality lakes. In lakes where a decline in water quality can be documented due to anthropogenic nutrient sources, but the lake is still “better-than-standards”, reductions in nutrient loading may be needed to halt the decline. What is listed in the proposed rule are existing rule provisions and treatment requirements already adopted and in place. The nondegradation policy statement establishes no new authority for the Agency or any other governmental entity. It relies on existing nondegradation provisions in Minn. R. 7050.0180 and 7050.0185, and provisions in other existing rules, as well as local ordinances.

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28 Krysel, C., et al. 2003. Lakeshore property values and water quality: evidence from property sales in the Mississippi headwaters region. A publication of the Mississippi River Headwaters Board. The dollar loss used in this example is the median loss for the 37 lakes in the study. Actual loss depends on the individual lake characteristics and location.
For example, the Agency cannot use this language to stop future growth and development unless existing provisions (state or federal) already in place allow the Agency to do so.

The Agency proposes to include the word “strict” in the language (…condition through the strict application of all relevant federal, state and local requirements…, emphasis added). The Agency feels that this is an important and reasonable addition, because it reflects the importance of the resource. High quality lakes are very valuable economically and socially. The application of nondegradation provisions is case-by-case and site-specific. This gives the Agency some latitude, when implementing nondegradation, to interpret and tailor the nondegradation requirements based on the concerns of local citizens, vulnerability of the lake and importance of the resource. Thus a “strict” application could result in greater protection of the resource than a “casual” application, in a specific situation. Again, the existing nondegradation requirements must be applied within the limitations of the authority granted by the provisions in rule. Similarly, the application of zoning and shoreland development ordinances is very site-specific. County commissioners that make these decisions have some flexibility to interpret and enforce shoreland ordinances; and certainly they have considerable latitude in whether or not to grant a variance to a land owner whose project may compromise water quality or aesthetics. Here again, a “strict” application of these provisions by local governments may be more protective of high quality lakes than a “less strict” application. It is assumed that both the strict or lenient interpretations are within the letter of current laws, rules or ordinances. It is the Agency’s intent that the proposed eutrophication standards promote a strict or high level of protection to these important resources.

b) Determination of Current Trophic Status

The Agency recognizes that to keep a lake that is in a “better-than-standards” condition, in that condition, we must know what the current trophic status is. This is not a new concept for the Agency – establishing the existing trophic status of a given lake is an important first step in many lake programs. The assessment guidance manual (Exhibit A-7) specifies minimum data requirements needed to carry out an impairment assessment. Essentially the same guidelines are recommended in this context; i.e., to establish the existing conditions in a high quality lake.

Characterization of existing conditions must account for within season variability and year to year variability. In most situations, the following monitoring regime is considered the minimum needed to provide enough data to establish background trophic conditions.

- Morphometric information;
- Watershed size and characteristics;
- 12 samples each for TP, Chl-a and SD (for determination of summer averages);
- Other water quality data and indicators of trophic status, such as dissolved oxygen/temperature profiles, color, etc; and
- Data that is representative of trophic conditions over at least a two-year period.

Again, the Agency’s clearly stated goal for high quality lakes is that there should be no negative shift in trophic status. In practice, however, in determining whether trophic conditions have changed, the Agency must look for measurable changes over time, supported by a weight of
evidence. The expected variability in the data must be addressed when comparing data over time. The Agency will use whatever assessment, statistical or modeling tools are available and appropriate for the situation to document any change.

In the past the Agency has used standard error of the mean (standard deviation divided by $\sqrt{N}$) and coefficient of variation of the mean (standard error divided by the mean) as ways of expressing variation around the means of TP, Chl-a and SD data. This in turn provides a basis to determine if there may be significant differences in means (e.g., as may be the case when comparing the observed mean to a mean predicted by a model). We have also used the deviation of annual means from a long-term mean (residuals analysis) as a basis for assessing typical annual variability and for detecting trends over time. These tools have proven useful in assessing the variability in relatively small data sets, and in looking for trends.\(^{29}\) A practical management goal, for example, might be annual means plus or minus typically observed variation as expressed by one of the tools just mentioned. It is important to emphasize, however, that a statistically significant change in trophic status is **not** required, for the Agency to conclude that a change in trophic status has taken place. These decisions are normally based on a “weight of evidence” analysis. The limited quantity of data often available to the Agency, and the variability seen in natural systems may make the application of statistical tests impractical.

5. **Lakes Not Able to Meet Standards Due to Natural Causes** [VI.I. EU standards, reasonableness]

   a) Natural Causes

While it is very important to protect lakes that are better than standards, the Agency also realizes that some lakes can never attain the proposed eutrophication standards due to natural causes. Lakes determined to be unable to meet standards due to natural causes will **not** be considered “in violation” of the eutrophication standard. The proposed language is below:

   **D. Lakes, shallow lakes, and reservoirs with a baseline quality that is poorer than the numeric eutrophication standards in subpart 4 must be considered to be in compliance with the standards if the baseline quality is the result of natural causes. The commissioner shall determine baseline quality and compliance with these standards using summer-average data and the procedures in part 7050.0150, subpart 5. Natural causes is defined in part 7050.0150, subpart 4, item N.**

The key to this concept, of course, is determining whether the trophic condition in a given lake is the result of natural causes alone, or the result of the combination of natural TP loading plus loading from human activities in the watershed. The determination will require lake-specific monitoring data, historical information, watershed data and other relevant information. Input from local organizations and units of government and the public could be very important as well.

\(^{29}\) Relatively small compared to the amount of data usually preferred by statisticians.
The Agency is proposing to include a definition of “natural causes” in Minn. R. 7050.0150 (see SONAR Book I, Sections VI.B.5 and X.B.8). The proposed definition is:

[Minn. R. 7050.0150, subp. 4] N. “Natural causes” means the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a water body in the absence of measurable impacts from human activity or influence.

It is important to discuss the Agency’s concept of natural causes in the context of the eutrophication standards and potential TMDLs for nutrient impaired lakes. Figure II-10 helps illustrate how the Agency is interpreting natural causes.

The total loading of TP to any lake can be broadly categorized as follows:

- Loading from natural causes or natural background.
- Loading from nonpoint sources resulting from human activities.
- Loading from point source discharges of treated wastewater.

Loading from natural causes is the loading the lake receives or would receive from the surrounding watershed with essentially no influence from human activity. The result is the trophic status the lake has, “in the absence of measurable impacts from human activity.” This ultimately is the condition the lake was in 200 years ago, prior to European settlement. Pre-settlement trophic conditions can be estimated using proven methods. Diatom reconstruction analysis is one such method (Section VI.C.3). The prediction of trophic condition using nutrient export coefficients developed for undisturbed landscapes supporting the vegetation native to the watershed in which the lake is located is another approach.

Sources of anthropogenic TP loading include uncontrolled or poorly controlled runoff from urban landscapes, agricultural land, construction sites and other altered landscapes. These point and nonpoint sources are generally controlled through application of best management practices (BMP), as required in a permit (e.g., urban stormwater or construction site permits) or through the application of voluntary BMPs. Point source loading includes discharges from municipal and industrial wastewater treatment plants, discharges from permitted stormwater systems, feedlots, and failing individual septic systems. Again, TP in point sources is generally controlled through application of some type of wastewater treatment usually under the terms of a permit.

Figure II-10 illustrates the TP loading to two hypothetical lakes that do not meet the proposed eutrophication standards. The TP loading to both lakes from natural causes is the same (100 mass units). Lake number 1 in its existing condition receives anthropogenic TP loading from nonpoint sources (40 mass units) and point sources (15 mass units) in addition to the natural loading, for a total loading of 155 mass units. Lake number 2 receives a very small amount of TP loading from anthropogenic nonpoint sources (5 mass units) and no loading from point sources for a total loading of 105 mass units. The combined loadings are enough to cause exceedances of the proposed eutrophication standards. For this hypothetical example, the TP mass loading values are selected simply to illustrate these concepts (units are not important).
In the example, the trophic condition of lake 1 can be improved by a combination of point and nonpoint source measures to reduce nutrient loading. Through application of appropriate best management practices in the shoreland and throughout lake 1’s watershed, nonpoint source loading is reduced by two thirds (to 13 mass units); and through the implementation of TP wastewater treatment by the point sources in the watershed, the point source loading is reduced from 15 to 3 mass units (Figure II-10, Lake 1 future conditions). The Agency may seek TP reductions from the point sources in the watershed under one or more of the following: 1) the requirements of existing Minn. R. 7050.0211, 2) the extension of TP limits to new and expanding facilities proposed as part of this rulemaking, 3) application of biological phosphorus treatment technologies, 4) implementation of phosphorus management plans as required by a permit, and 5) any voluntary steps taken to reduce effluent TP in response to nutrient reduction goals established for the watershed by state or local entities, or other nutrient management plans (e.g. the St. Croix basin). In the context of the proposed rule language dealing with impairment due to natural causes, it is assumed that the future trophic status of lake 1 is still in exceedance of the standards, even though it has been measurably improved as a result of the point and nonpoint source improvements. Whether it is the natural loading alone or the combination of natural plus the remaining anthropogenic loading that is causing the exceedance of standards in future lake 1 would be important if lake 1 is on the 303(d) list and a TMDL study is underway.
b) Essentially Irreversible TP Loading

After applying all required, reasonable and practical efforts to minimize point and nonpoint source TP loading to lake 1, 16 mass units of anthropogenic TP remain and continue into the future (Figure II-10). The Agency would review the lake-specific information for lake 1 and determine if further reductions in anthropogenic loading are achievable without heroic and possibly cost ineffective measures. If the Agency determines that further reductions in anthropogenic loading are not feasible, the remaining anthropogenic loading to lake 1 is considered to be due to “essentially irreversible” human induced changes, the lake would be considered in compliance with the standards. Essentially irreversible changes in the watershed are relatively permanent man-made alterations such as dams on major reservoirs, or lakes surrounded by extensive urbanization or agricultural land use. These determinations will need to be made on a case-by-case basis.

The Agency cannot expect all lakes in Minnesota to exhibit the same water quality and trophic conditions they had prior to European settlement. We must recognize that some level of anthropogenic loading cannot be reasonably remedied in the foreseeable future in some situations. On the other hand, we can’t say with certainty that further reductions may never be possible and practical in the future. Unforeseen advances in treatment technologies, advances in agricultural practices, future land set-aside programs, and TP reduction programs that may seem unlikely now are a possibility in the future; and the public’s attitudes evolve over time. We have seen several examples of these changes over the last 30 years. Phosphorus was taken out of detergents in the late-1970s, biological wastewater treatment technologies that remove TP from point source effluents became popular in the 1990s, and, recently, phosphorus was banned from fertilizers for most home use. The Agency cannot rule out the possibility that further TP reductions will be made in the future, even in situations that seem essentially irreversible now. The Agency understands that it may be difficult to identify the “essentially irreversible” human induced changes, and that it must be done on a site-specific basis using a weight of evidence approach.

Lake 2 in Figure II-10 receives essentially all its nutrient loading from natural causes and the TP loading in the future is the same as the existing loading. The small increment of TP loading from anthropogenic nonpoint sources (5 mass units) is considered to be essentially irreversible and not amenable to reduction at the present time; and it may not be consistently measurable above background variability. Lake 2 is an example of a lake that does not meet the standards due to natural causes, and it would not be considered in violation of the standards. However, the Agency cannot rule out the possibility that even this small amount of anthropogenic loading might be reducible in the future.

In recognizing that some “essentially irreversible” anthropogenic loading may be unavoidable in some situations, at the present, it is important to be clear that this is the loading that occurs after all required, reasonable and practical efforts have been made to minimize nutrient loading from both point and nonpoint anthropogenic sources. Thus, all applicable point source controls and

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30 Although many lakes in the NLF ecoregion have changed very little in 200 years; see Figure II-9.
requirements have been implemented, and all reasonable, appropriate and practical best management practices have been implemented throughout the lake’s watershed, to minimize nutrient loading. It is only after these conditions have been met that the remaining anthropogenic loading can be considered essentially irreversible. The goal remains to achieve the best quality feasible in lakes that cannot meet standards.

This concept applies in the present context – the protection of naturally “poor” quality lakes from becoming worse through cultural eutrophication. The concept also could enter into the TMDL analysis for a lake listed as impaired. That is, if after all the required and reasonable point and nonpoint source remediation measures have been carried out, the lake still cannot meet the eutrophication standards, application of Minn. R. 7050.0170 (natural conditions) or development of site-specific eutrophication standards may be appropriate to address the essentially irreversible loading, as long as the modified standards support the designated uses. Alternately, a use attainability analysis may be appropriate to address the essentially irreversible loading if the lake cannot support the Class 2 designated uses. Using lake 2 in Figure II-10 as an example, site-specific standards for TP, Chl-a or SD could be considered that equate to the total loading of 105 mass units of TP, thus accommodating the essentially irreversible loading in the site-specific standards. Similarly, a site-specific standard could be developed for lake 1 that equates to the future total loading of 116 mass units of TP remaining after remedial measures are in place. The Agency intends to use adaptive management techniques in the TMDL process to periodically review “essentially irreversible” determinations and apply site-specific management strategies as necessary.

In conclusion, some lakes in Minnesota will not meet the proposed standards due to natural causes (see Section VI.M). The Agency also recognizes that the trophic status of some lakes will reflect TP loading from essentially irreversible human induced changes in the watershed that are not amenable to remediation in the foreseeable future. Such lakes will not be considered to be in violation of the proposed eutrophication standards. The Agency does not rule out the possibility that unforeseen factors may provide a practical method for reducing essentially irreversible loading in the future. Development of a site-specific standard may be at least a partial solution in such situations.

6. Reservoirs and Site-specific Standards [VI.L. EU standards, reasonableness]

The Agency recognizes that reservoirs are a special category of waterbodies, and that the eutrophication standards as listed in the rule may not be the correct standard for a given reservoir. While the rule already provides the authority to develop site-specific Class 2 standards for reservoirs or any waterbody (existing Minn. R. 7050.0222, subp. 8), the Agency believes it is important and reasonable to mention the site-specific option in the context of the eutrophication standards. Including it serves to emphasize the definite possibility that site-specific standards for reservoirs may become more the “rule” than the exception. Also, including it is a helpful reminder to the reader that they may want to consider a site-specific standard and that the option is available.
Reservoirs have many unique characteristics that can cause them to react somewhat differently to nutrient loading as compared to natural lakes (Exhibit EU-16, page 3-4). Examples of these factors are mentioned in the proposed language, as shown below:

E. When applied to reservoirs, the eutrophication standards in this subpart and subpart 4 may be modified on a site-specific basis to account for characteristics of reservoirs that can affect trophic status, such as water temperature, variations in hydraulic residence time, watershed size, and the fact that reservoirs may receive drainage from more than one ecoregion. Information supporting a site-specific standard can be provided by the commissioner or by any person outside the agency. The commissioner shall evaluate all data in support of a modified standard and determine whether a change in the standard for a specific reservoir is justified. Any total phosphorus effluent limit determined to be necessary based on a modified standard shall only be required after the discharger has been given notice to the specific proposed effluent limits and an opportunity to request a hearing as provided in part 7000.1800.

It is logical for the Agency to use the eutrophication standards for the ecoregion in which the reservoir is located as the applicable standard until evidence is obtained and reviewed that shows the listed standards are not appropriate and that site-specific standards are needed. As in the case for any site-specific standard, if it becomes the basis for an effluent limit the regulated party can ask for a contested case hearing, and the facts upon which the site-specific standard is based can be part of what is contested.

7. Narrative Language, Conclusions [VI.L. EU standards, reasonableness]

The proposed eutrophication standards are unique among numeric standards for several reasons, but mostly because the resource they protect is highly variable, application is different than most other standards, and exceedances of the standards are very obvious to the casual observer. For these reasons, the Agency feels it is very important to include narrative statements with the numeric standards. These statements cover:

- Site-specific standards for lakes in three ecoregions that do not have specific standards, and for lakes that straddle two ecoregions;
- Standards are compared to lake data averaged over the summer growing season;
- Lakes with better-than-standards water quality will be maintained in that condition through nondegradation;
- Lakes that do not meet standards due to natural causes are not in violation of the standards; and
- Standards for reservoirs may need to be developed on a case-by-case basis.

It is important and reasonable to include a narrative portion with the numeric eutrophication standards. The Agency’s proposed wording is consistent with past use of the nutrient criteria, the assessment of lakes for impairment, and the foundation for the eutrophication standards established by the 2003 assessment factor rulemaking.
M. IMPLEMENTATION [VI. EU standards, reasonableness]

1. Introduction [VI.M. EU standards, reasonableness]

Once adopted, the eutrophication standards will be used very much like other water quality standards (see Section II.B.8 in SONAR Book I). In some respects, adoption may cause little notice because the Agency will use the standards in much the same way it has used the nutrient criteria over the years, which is:

- To serve as goals for lakes in the Clean Water Partnership and Clean Lakes programs;
- As thresholds for determination of impaired waters for the 305(b) report;
- As thresholds for determination of impaired waters for the 303(d) list; and
- As the goal for the restoration of impaired waters through the TMDL process.

It is the Agency’s intent, however, that the eutrophication standards will receive greater exposure and be more widely implemented than the current nutrient criteria. In addition, the proposed eutrophication standards will provide a more direct link to possible TP effluent limits for a small subset of dischargers (see Section VI.M.4 and X.D). For the most part to date, the nutrient criteria have not been used as the basis for setting TP effluent limits in NPDES permits, although this regulatory application of the criteria would very likely increase in the future independent of the eutrophication standards.

It is worth summarizing in the implementation section, the Agency’s response to the fact that a large number of Minnesota lakes, based on the Agency’s lake data sets, are projected to exceed the proposed standards (Figure II-9).

As noted in Section VI.I, current TP concentrations in about 25 to 90 percent of Minnesota non-trout lakes, depending on the ecoregion, exceed the corresponding proposed ecoregion TP standard. This does not mean that all of these lakes belong on the impaired waters list. Even if we had data for every lake in Minnesota (we currently have data for about 14 percent of all lakes), many would not be considered impaired due to one or more of the following considerations:

- Natural background exceeds the standard;
- A site-specific modification of the standard indicates the lake is not impaired;
- A use attainability analysis (UAA) shows that an important beneficial use does not exist or is unattainable; or
- The use classification of the lake has been changed through rulemaking.

All of these options require a site-specific analysis of some type, but they vary in complexity and number of administrative steps involved. For example, if the natural background conditions are shown to exceed the standard, the background can be used as the standard under Minn. R. 7050.0170 and no additional steps are required. On the other hand if the UAA option is selected,
the site-specific analysis must demonstrate that the beneficial use (e.g., swimming) is not attainable; and, if it does not exist, a use classification change through rulemaking is required.

2. **Expected Compliance Goal for Eutrophication Standards** [VI.M. EU standards reasonableness]

Typically, associated with Class 2 water quality standards are stated compliance or protection level goals. Some goals are quite specific and some are more general. For example Minn. R. ch. 7050 specifies:

- The dissolved oxygen standard is to be met in rivers 50 percent of the days at flows equal to the 7Q10 (Minn. R 7050.0222, subp. 2 to 5). [For assessment of potentially impaired waters the dissolved oxygen standard must be met 90 percent of the time at all flows greater than the 7Q10 (i.e., the standard is exceeded in more than 10 percent of the samples taken, Exhibit A-7)].
- And in Minn. R. 7050.0217 subp. 2:
  1. Protection of the aquatic community from toxic substances means the protection of no less than 95 percent of the species in a given aquatic community;
  2. Human exposure to noncarcinogenic chemicals through the consumption of fish (and drinking water) must be below levels expected to produce known adverse effects;
  3. The cancer risk to humans through the consumption of fish (and drinking water) must not exceed one in 100,000; and
  4. Protection of wildlife that eat aquatic organisms means the protection of the most sensitive wildlife species or population.

As explained in Section IV.G, the proposed eutrophication standards are different from standards for toxic chemicals in several respects. The proposed standards for TP, Chl-a and SD are not based on the protection of the aquatic community from toxics or the protection of human health. The “endpoints” driving the proposed eutrophication numbers are very different (e.g., the frequency and magnitude of algae blooms, see Section VI.D). This has significant implications when considering compliance expectations for the eutrophication standards. A very high level of compliance such as 95 percent, needed to protect the integrity of an aquatic community from toxicants, is not realistic for eutrophication standards, and it is not the Agency’s intent.

Explicitly stated in the proposed narrative associated with the standards is that they are summer-average values; that is, they are to be compared to data averaged over the course of a summer. Thus, it is clear that the Agency intends the proposed eutrophication standards to apply to the trophic conditions averaged over at least one year.

Year to year variability in trophic conditions is expected. So, if one year trophic conditions equal the standards, the following year conditions may be better than standards and the year after that they may be worse than standards, and so on. Compliance with the standards means that the

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31 The health of animals and humans is a factor if trophic conditions allow the growth of toxic blue-green algae.
conditions averaged over the long-term will be better than the standards. However, the Agency usually does not have the luxury to wait five or ten years for long-term data to become available to make a decision about compliance. The impairment assessment guidance (Exhibit A-7) calls for a minimum of 12 samples taken over two to three summer seasons. Also, decisions concerning the success of remedial actions taken to reduce nutrient loading in the context of a TMDL may be called for in two or three years. The Agency believes that a two to three year period will be adequate to assess compliance in most cases. Typically, compliance will be evaluated on a lake-by-lake basis. The Agency will need to use trophic condition data, relevant watershed information, rainfall/flow data (wet, dry or average year), modeling tools, etc. to predict compliance over the long-term. The Agency’s compliance expectations over the long-term are to maintain and protect the Class 2 “sub-use” that is the focal point for the particular lake type.

3. Use of Eutrophication Standards [VI.M. EU standards, reasonableness]

The intended uses for the proposed eutrophication standards discussed in this Section are uses other than the determination of impaired lakes and reservoirs, which is occurring now under the narrative standard.

If the eutrophication standards are to be effective in helping to protect lakes, they will need to be used, not only by the Agency, but by many other entities as well. The Agency’s intent is that the new standards will be used by a diverse combination of federal, state, county and other local governmental entities; soil and water conservation districts; watershed districts; consulting firms; lake associations; and interested individuals. As discussed in Section IV.D, the greater accessibility, visibility and legal status should enhance their use. Progress in slowing cultural eutrophication of lakes and reservoirs will require a wide range of mandatory and voluntary activities that reduce nutrient loadings.

Federal agencies such as the U.S Fish and Wildlife Service and the U.S. Geological Service may find the standards useful as a benchmark to compare to their water quality and biological monitoring activities, and in their investigations of pollutant loadings in Minnesota. The Minnesota Department of Natural Resources (MDNR) has responsibilities for lakes that relate to water quality and extend beyond just managing the sport fishery; for example, the MDNR answers citizen complaints, investigates fish kills, provides information on lake and lakeshore protection, etc.32 Depending on the location, county Soil and Water Conservation Districts can have active lake sampling and protection programs. Numeric standards could be useful in these activities.

A description of some hypothetical situations might help convey what the Agency has in mind in terms of expanded applicability of the standards. County zoning officers and county boards of commissioners have substantial decision-making authority and responsibility in matters that impact Minnesota’s lake resources. They enforce the shoreland ordinances, they make decisions on the types of development to allow in the shoreland zone, whether to require restitution or penalties if shoreland zoning laws are violated, whether or not to grant variances, etc.

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32 http://www.dnr.state.mn.us/lakes/index.html
Assume a lakeshore property owner proposes a development project on his/her property that would increase the runoff of phosphorus contaminated stormwater to the lake, and the lake in question is on the threshold of exceeding the eutrophication standards. Awareness of the numeric standards and the lake’s current trophic status might move the county commissioners to be more inclined to deny the project, or to require modifications to avoid the additional TP loading, so the lake will not exceed the standards. In a variation of this example, if the lake’s trophic status is much better than the standards, knowledge of that condition relative to the standards, and the proposed narrative nondegradation policy, could help the commissioners make more informed decisions. On the other hand, if the lake standards are already exceeded, appropriate actions would need to be taken to assure that any permitted activities would not worsen existing trophic conditions.

Similarly, if a consultant was asked to review a project adjacent to a lake for potential environmental impact, knowledge of the eutrophication standards and their application would be an important part of the analysis, and help the consultant make recommendations to the client.

Coalitions of lake associations or individual lake associations could use the standards as an additional tool in their efforts to maintain the quality of “their” lake(s). They could be included in the discussions among the members, or part of the information brought to the county commissioners, or to other groups. The Agency visualizes the standards being an aid to educating lakeshore property owners of their responsibilities to protect the lake they love, and for which they have probably paid a very high price to enjoy.

Some parties have expressed concern that the Agency will misapply the eutrophication standards to very shallow lakes, lakes smaller than 10 acres, golf course ponds, farm ponds, etc. (e.g., Exhibit A-35 and Agency response, A-36). There are many lakes less than 10 acres in size (including a couple of designated trout lakes) that support the same beneficial uses provided by larger lakes, which the standards are designed to protect. It is impossible for the Agency to know beforehand whether or not the protected uses logically apply to each and every one of the thousands of lakes less than 10 acres in size. Size, depth and appearance can be very deceiving when it comes to how lakes are used by the public, especially children. From a merely practical standpoint placing limitations on the applicability of the standards to a subset of lakes would require a very large body of data on that subset to support the case; and it might require an individual analysis of each lake to be excluded – potentially hundreds or thousands of waterbodies – at great expense. Also, as a matter of policy, the Agency seldom assesses lakes smaller than 10 acres in size for impairment; a few have been assessed but none has been proposed for the 303(d) list (Exhibit A-7). The Agency simply does not have water quality data for most lakes smaller than 10 acres.

The Agency has broad statutory authority and responsibility to protect all waters of the state (Minn. Stat. ch. 115). Any limits placed on that authority, such as establishing a minimum lake size or minimum depth, below which the standards would not apply, would at least need to be accomplished through rulemaking, if not by a change in state or federal law. A much more reasonable and practical approach in the opinion of the Agency is a site-specific analysis to address the local concerns. That is, if implementation of the eutrophication standards causes
unnecessary expense or hardship to any party in the future, a site-specific modification of the standard may be appropriate or an individual use attainability assessment can be carried out on the waterbody in question. The Agency is opposed to the eutrophication standards being limited to only certain lakes, shallow lakes or reservoirs.

4. **Basis for a Phosphorus Effluent limit [VI.M. EU standards reasonableness]**

It is likely that the proposed eutrophication standards will become the basis for setting a phosphorus effluent limit in an NPDES permit in a limited number of situations. The current and proposed technology-based TP effluent limit in Minn. R. 7053.0255 will remain the primary basis for setting TP limits in NPDES permits even after the eutrophication standards are adopted. Any limits based on the proposed eutrophication standards would most likely be for facilities that already have a 1 mg/L limit based on the existing rule, and a limit more stringent than 1 mg/L is needed to meet the standards.

Since the Phosphorus Strategy was approved in 2000, the Agency adopted a policy of strongly discouraging the permitting of any new discharges directly to a lake. Dischargers proposing a lake discharge, which has always been relatively rare, are being advised to seek an alternative place to discharge, if at all possible. Also, it is becoming Agency policy to freeze the TP loading for any facility that wishes to expand and discharges directly to or “affects” a downstream lake or reservoir. With these policies in place, it makes it difficult to attribute an economic impact to the proposed eutrophication standards, in terms of how often they will be the basis for dischargers getting TP limits more stringent than 1 mg/L. The Agency has made some assumptions about the number of facilities that could be affected in the next five years in its assessment of costs described in Section X.D.

In spite of strongly discouraging any new lake dischargers, the Agency cannot totally rule out the possibility that a new facility might be allowed to discharge directly to a lake (e.g., a very small facility with no alternative but to discharge to a large lake). In such an unlikely situation, the proposed effluent limit might be close to or equal to the TP standard for the ecoregion in which the lake is located, taking into account the limitations of TP removal technologies currently available.

Under the existing TP limit rule\(^{33}\), the Agency has issued limits more stringent than 1 mg/L on two occasions. The city of Ely, which discharges directly to Lake Shagawa, has an effluent limit of 0.3 mg/L. The city of Bemidji discharges to the Mississippi River immediately upstream of Lake Bemidji, and they also have an effluent limit of 0.3 mg/L. Adoption of the eutrophication standards will not result in either city automatically getting an effluent limit of 0.03 mg/L, the proposed TP standard for the NLF ecoregion. Both lakes are meeting the proposed in-lake standards. It is likely, however, that under the second policy mentioned above, that future permits for both cities would cap their TP loadings at current levels. If either city expanded, that would require a lower TP concentration in the effluent to keep the mass load constant. This almost certainly would happen regardless of the adoption of the standards.

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\(^{33}\) See last paragraph in existing Minn. R. 7050.0211, subp. 1a.
The Agency envisions effluent limits more stringent than 1 mg/L based on the proposed eutrophication standards as being required in the following situations:

1. If the receiving lake or downstream lake is on the impaired waters (303(d)) list due to excess nutrients, federal Clean Water Act requirements form the basis for permitting existing, expanding or new discharges. These federal requirements say that effluent limits must control the discharge of pollutants to an impaired waterbody at a level that will not cause or contribute to an exceedance of a state water quality standard. To comply with these federal requirements, the Agency proposes to freeze the permitted mass loading of an existing discharger that wishes to expand. New dischargers would be given a 1 mg/L limit but the entire new mass loading would need to be offset by another mechanism, such as through trading.

2. If the receiving lake or downstream lake is not on the impaired waters list, but the new or expanding discharge is projected to cause an exceedance of the eutrophication standards, a limit lower than 1 mg/L may be imposed. In these case-by-case situations, the limit could be lowered to the level necessary so the standards will be met in the downstream lake. But, again under the Agency’s described policies, the mass of TP discharged would probably be capped anyway. The same is true for the next two situations.

3. If the new or expanded discharge will not cause an exceedance of the standard, but the increased loading of TP to the lake is projected to have a measurable impact on the trophic status of the downstream lake, a limit more stringent than 1 mg/L is possible.

4. If the new or expanded discharge will not cause an exceedance of the standard, and the increased TP loading to the downstream lake is not projected to have a measurable impact (above normal variability); the application of nondegradation provisions or watershed nutrient minimization goals, or citizen concerns about the increased loading, particularly if the existing water quality of the lake in question is very good, a limit of 1 mg/L (or lower) is a possibility.

The possible costs to dischargers based on these scenarios are discussed in Section X.D.

5. **Phosphorus Limits Determined by a TMDL**  
   [VI.M. EU standards, reasonableness]

The Agency has been listing nutrient impaired lakes and reservoirs on the 303(d) list since 2002. As stated, the assessment thresholds have been the nutrient criteria based on the narrative eutrophication standard (existing Minn. R. 7050.0150, subp. 5). Adoption of numeric standards will not change the assessment process. That is, the protocols used to determine impairment now using the nutrient criteria will not change under the eutrophication standards, and the pace of adding new lakes and reservoirs to the list will not change because the pace is governed by the availability of data and staff time needed to carry out the assessments. The adoption of

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34 Code of Federal Regulations, 40 CFR 122.4(i) and 40 CFR 122.44(d)(1).
35 The May 17, 2007 decision by the State Supreme Court on the Annandale/Maple Lake case means that TP trading is an option. The Agency plans to develop a trading policy and prepare protocols to guide TP trading in the future (see Section XI.F).
eutrophication standards will have little impact on this regulatory function of standards (impairment listings and TMDLs).

The TMDL will determine the relative contribution of TP loading from point and nonpoint sources, and the implementation plan will specify the loading reductions from these sources that will be needed to restore the waterbody. Point source TP limits more stringent than 1 mg/L are a possibility. But, again these limits would be imposed whether or not the standards are adopted. The Agency is preparing a detailed lake TMDL strategy document that will provide guidance on how TMDLs for lakes should be carried out.

In summary, the Agency believes the application of the eutrophication standards as the basis for a TP effluent limit more stringent than 1 mg/L is likely to happen but will be a rare occurrence. Requiring a limit lower than 1 mg/L would only happen if one of the four scenarios listed above apply.

N. EUTROPHICATION STANDARDS OF OTHER STATES AND PROVINCES [VI. EU standards, reasonableness]

As discussed in Section III.A, EPA is asking states to adopt nutrient standards on their own or face possible promulgation by EPA (e.g., Exhibit EU-10). Many states are likely to follow essentially the same sequence of steps listed below that Minnesota did leading up to the adoption of nutrient standards.

1. Gather nutrient, trophic condition and water clarity (e.g., SD or turbidity) data, and biological and other data in streams, rivers and lakes;
2. Analyze the data to find relationships between levels of nutrients and a negative response, such as changes in biological communities or water quality;
3. Identify nutrient (TP and possibly nitrogen) “thresholds” or levels that show a significant shift in biological or water quality response; and
4. Selection of criteria or draft nutrient standards based on a combination of data-driven thresholds, and policy decisions on the function of nutrient standards in the state. For example, a state may decide the standards should be set at the point where a significant biological response occurs. Or they may decide to set the standard at a point where beneficial uses are potentially of actually lost. These “endpoints” may or may not be at the same nutrient concentrations, and they certainly will vary with the type of surface water under consideration (lakes or rivers), morphometric characteristics or watershed size, and location. These decisions hinge to some extent on how a state plans to use the standards, particularly in a regulatory context.

Based on progress reports given by many states at an EPA-state nutrient criteria conference held in Dallas, Texas in February 2006, many states are in steps 1, 2 and 3. A few have adopted numeric criteria at this time and several have some type of narrative eutrophication standard. EPA estimates that about half of the states will have promulgated nutrient standards, or will be well on the way by 2008. Among the states in EPA Region 5, Minnesota is in the lead in terms of a time frame for adoption of numeric standards, at least for lakes. It appears that only one
EPA Region 5 state (Ohio) is considering adopting the EPA nutrient criteria for lakes or rivers “as is.” Below is a summary of the progress the five Region 5 states are making in this process (some information was updated following the February 2007 RTAG meeting in Chicago).

Illinois is gathering nutrient data for rivers and streams. They have compared nutrient levels to indices of biotic integrity (IBI) measured in streams. Measured nutrient levels are high and they feel that nutrients almost never are the limiting factor for algae blooms in streams; that poor habitat is more likely the cause of poor IBI scores. For this reason nutrient standards for streams may not be practical in Illinois. Later information (February 2007) suggests they plan on adopting nutrient standards by fall of 2009. They are considering a site-specific approach to nutrient criteria for lakes because of the small number of natural lakes and the prevalence of reservoirs.

Indiana, the U.S. Geological Survey is helping Indiana assemble nutrient data and look for thresholds of effects at various nutrient levels in both steams and lakes. They have been monitoring lakes for a long time, and they have developed some preliminary TP criteria for Indiana lakes. Indiana does not plan to adopt the EPA nutrient criteria and hope to begin rulemaking in 2009.

Michigan, as of early 2006, Michigan was on a very fast track to propose and adopt nutrient standards for both lakes and streams. Subsequent information indicates that they plan to be in rulemaking in 2008. Michigan is not planning on adopting the EPA nutrient criteria. The Michigan Department of Natural Resources enlisted the help of Michigan State University faculty and students to assemble and analyze nutrient data for both streams and lakes. They have used several regression techniques with the data to identify TP and total nitrogen “break points”, or levels at which they see a definite biological response, such as a shift in IBI scores for fish, invertebrates and algae communities. They are seeing TP/bio-response thresholds at 15, 40 and 80 µg/L TP for streams and rivers depending on their size and location; and thresholds of about 10, 20 and 30 µg/L TP for lakes. These TP thresholds for lakes are lower than what the Agency is proposing. Based on our understanding of the data upon which Michigan’s stream and lake preliminary thresholds are based, they do not necessarily coincide with a loss of beneficial use (whereas Minnesota’s proposed standards are linked to loss of use). Michigan has not decided at this time (March, 2006) if these thresholds will become the proposed standards.

Ohio is acquiring data on nutrients and dissolved oxygen levels in streams, and they will be looking for any relationship between high nutrient levels and low DO readings. Because they lack data on their lakes they may consider using the EPA criteria.

Wisconsin is near the end of their data acquisition phase and they plan (as of early 2006) to publish a report with their results in 2006. Wisconsin is not planning on adopting the EPA nutrient criteria. They plan to propose numeric criteria for both lakes and small streams and promulgate them in 2008. Their work so far indicates that separation of streams by ecoregion does help explain the variability and relationships they see between TP and biological responses.
Outside EPA Region 5 some states have adopted numeric or narrative nutrient standards or are taking other actions to reduce nutrient loading. Information about a few states, and British Columbia, that appear to be more advanced in the process, is summarized below.

**California** is using a risk-based approach to define beneficial uses; level I is no risk, level II is possible risk and level III is definite risk to beneficial uses. Level I or II Chl-a criteria are 5 µg/L for cold water fish and 10 µg/L for warm water fish. Level II or III Chl-a criteria are 10 µg/L for cold water fish and 20 – 25 µg/L for warm water fish.

**Maine** implemented a narrative standard in 1986 requiring a “stable or declining [improving] trophic status” for its lakes. This standard, in effect, does not allow changes in the land use in the watershed of a lake that may adversely impact the trophic status of the lake. Maine is using nutrient and Chl-a criteria to identify streams that appear to be impaired due to nutrients but require more study.

**Massachusetts**, 56 of Massachusetts’ 116 POTWs that range in size from 0.02 to 350 mgd have TP effluent limits ranging from 0.1 to 1.0 mg/L. Those with limits more stringent than 1 mg/L break down as follows:

- 0.1 mg/L – four plants
- 0.2 mg/L – six plants
- 0.75 – 1.0 mg/L – 34 plants; 11 of these are slated for upgrades to 0.2 mg/L and two to 0.1 mg/L.

Limits lower than 1.0 mg/L are applicable from April through October; a 1 mg/L limit applies the rest of the year. Massachusetts is looking at multi-point chemical addition and sand filtration as well as new and innovative treatment technologies that they feel will achieve TP effluent concentrations in the 0.05 to 0.1 mg/L range. Massachusetts has developed site-specific criteria for total nitrogen which they use to help restore impaired estuaries. They use historical information to establish “background” conditions and use models to develop the site-specific targets and nitrogen reductions needed to achieve the target.

**Missouri** plans to develop and adopt nutrient criteria for lakes in 2006 and for streams in 2008.

**Oklahoma** adopted a TP criterion of 37 µg/L for their scenic rivers, which they apply as a 30-day geometric mean.

**Tennessee** has worked extensively on nutrient criteria for small streams. They have associated total nitrogen and TP to negative changes in streams. They use the 90th percentile values from reference sites as a basis for impairment determinations. Application of Tennessee’s original narrative nutrient standard was successfully challenged in court as being overly broad. Also Tennessee failed in their first attempt to adopt numeric nutrient standards. They have refined their narrative standard and are using numeric “translators” to identify nutrient levels that cause harm.
British Columbia established phosphorus criteria to protect the most sensitive uses of lakes in that province, citing in particular, drinking water or recreation and aesthetics. Among the most sensitive uses is the protection of a coldwater fishery, for which they have a criterion of 10 µg/l TP.
O. REASONABLENESS OF EUTROPHICATION STANDARDS, CONCLUSIONS [VI. EU standards, reasonableness]

The Agency’s proposed eutrophication standards are based on nearly 20 years of work developing and implementing nutrient criteria on behalf of Minnesota’s lake resources. The Agency has analyzed data on over 2,000 lakes, assessed the relationships between nutrient levels and response variables using a variety of data and approaches, reviewed the published literature (and contributed to that body of literature with scientific articles by Agency staff), worked closely with EPA on the development of nutrient criteria and kept abreast of what other states are doing. The Agency has acquired a great deal of credibility and experience through the development and implementation of the nutrient criteria, including using them to identify impaired waters. The proposed eutrophication standards are built on this solid foundation and represent a refinement of the nutrient criteria developed in the late-1980s.

The proposed eutrophication standards are:

- Broken out by four ecoregions (standards for two are the same) and four lake types;
- Proposed for shallow lakes as a separate category (one of the four lake types) at the urging of interested parties;
- Consistent with EPA guidance to states on the development of nutrient criteria using local data;
- Generally less stringent than EPA criteria;
- Established at the thresholds for protecting Class 2 uses with no overt or clear margin of safety; and
- Based on protecting sub-uses within the Class 2 beneficial use according to the lake type.

Also it is reasonable to supplement the numeric standards with a narrative portion of the standard because:

- Of the great natural variability of lake characteristics and lake trophic status;
- Of the importance of protecting high quality lakes from eutrophication through a clearly stated nondegradation policy;
- Not all lakes can achieve the standards due to natural causes, and as a result of “essentially irreversible” human-induced changes;
- The implementation of eutrophication standards is different than other Class 2 standards; and
- Site-specific standards may be needed for reservoirs.

The proposed eutrophication standards are needed and reasonable.
VII. NEED FOR PROPOSED EXTENSION OF PHOSPHORUS EFFLUENT LIMIT

A. INTRODUCTION [VII. TP limit, need]

Minnesota Stat. ch. 14 requires the Agency to explain the facts establishing the need for and the reasonableness of the rules as proposed. In general terms, “need” means that the Agency must present the reasons for making the proposed changes to Minn. R. ch. 7050, and for the proposed new Minn. R. ch. 7053. Also, need implies that a problem exists that needs to be fixed or dealt with through administrative attention.

The Agency is proposing that municipal and industrial facilities that expand or build new after May 1, 2008, and discharge more than 1,800 pounds of phosphorus per year, treat and remove phosphorus to 1 mg/L. This Section of SONAR Book II will discuss why the proposed amendment to the phosphorus effluent limit is needed.

B. PETITIONS TO ADOPT RULES [VII. TP limit, need]

1. Introduction [VII.B. TP limit, need]

While still in the planning stages for this rulemaking the Agency received two formal petitions from outside parties to consider rule-language changes pertaining to the 1 mg/L phosphorus effluent limit currently in Minn. R. 7050.0211, subp. 1a. The first petition was from the Coalition of Greater Minnesota Cities (CGMC), the Minnesota Environmental Science and Economic Review Board, the League of Minnesota Cities, and the Minnesota Association of Small Cities (referred to as the CGMC petition). The CGMC petition and cover letter from Flaherty & Hood, P.A. dated December 15, 2003 is Exhibit A-28. The Agency’s response letter dated January 13, 2004 is Exhibit A-29. The CGMC petition prompted the Agency to review its approach to the setting phosphorus effluent limits under the current rule and the Phosphorus Strategy. Staff recommended to Agency management that the phosphorus limit should be extended to new and expanding facilities that discharge more than 1,800 pound of phosphorus per year (Exhibit PL-9).

The second petition was from the Minnesota Center for Environmental Advocacy (MCEA). The MCEA petition and cover letter dated July 27, 2004 is Exhibit A-30. The Agency’s response letter dated August 18, 2004 is Exhibit A-31.

2. CGMC Petition [VII.B. TP limit, need]

The CGMC petition asked the Agency to define the following three terms in the context of existing Minn. R. 7050.0211, subp. 1a:

- Lake
- Reservoir
- Affects
The petitioners suggested language (underlined) follows:

[Minn. R. 7050.0211, subp. 1a.] **Total phosphorus effluent limits.** Where the discharge of effluent is directly to or affects a lake or reservoir, phosphorus removal to one milligram per liter shall be required. For purposes of this rule, “lake or reservoir” means a body of water with an average annual hydraulic residence time exceeding 14 days, and the term “affects” means the measurable impact of an individual facility’s phosphorus discharge on scientifically-documented algal growth in a lake or reservoir. The limit must be a calendar month arithmetic mean unless the commissioner finds, after considering the criteria listed in items A and B, that a different averaging period is acceptable. …

The Agency, in its response to CGMC and the other petitioners (Exhibit A-29), said that it intended to define the three terms mentioned in the petition but preferred to do it as part of this triennial review of water quality standards rather than enter into a separate rulemaking that would address only the petitioner’s request. Given the time and costs associated with even a minor rulemaking, this was a reasonable and prudent response.36

More importantly, the Agency believes that to do only what the CGMC petition asks with regard to the existing TP effluent limit could undermine the progress made in reducing TP loading from point sources over the last six years under the Phosphorus Strategy (Exhibit PL-1c). It could result in a step backwards in the control of point source phosphorus. The Phosphorus Strategy (Strategy) has been the impetus for assigning TP effluent limits to 35 to 40 facilities across the state since 2000, including situations where the downstream “affects” due to the added TP may not have been measurable. The Agency wants to continue this six-year record of progress. The Agency feels that the best way to do that is to “codify” in rule portions of the Strategy by proposing to extend the phosphorus effluent limit to new and expanding dischargers above a certain size.

The Agency is proposing definitions for “reservoir” and “affects” that are similar to what the petitioners suggest. That is, our definition of “reservoir” includes a minimum residence time of 14 days, and our definition of “affects” clarifies that the TP loading causing the affect is from an individual point source discharger. The Agency is proposing separate definitions for lakes and shallow lakes, plus the terms, “122Q10,” “eutrophication” and “natural causes” (see Sections VI.B and X.B in SONAR Book I).

While the Agency is proposing definitions for two of the three terms that are similar to the petitioner’s suggested language, there are some details in the latter with which the Agency disagrees. The first pertains to lumping lakes and reservoir together and defining lakes only on the basis of a 14-day residence time. A reference to a minimum residence time is not needed in the definition of “lake,” and the definition needs to include other lake attributes. The Agency staff is not aware of any examples of natural lakes (or lakes with controlled outlets) with a

36 The relatively minor “assessment factor” rulemaking, which was in response to a petition from essentially the same parities plus the Minnesota Farm Bureau required two years to complete.
residence time as short as 14 days. Any waterbody with a residence time approaching 14 days would clearly be a run of the river reservoir.

Secondly, while the petitioners and the Agency agree on the minimum hydraulic residence time of 14 days used to distinguish between reservoirs and rivers, we disagree on the flow used to determine the residence time. The petitioners suggest an average flow and the Agency is proposing a lower flow, the four-month summer average low flow with a once in ten-year recurrence interval (122-day $Q_{10}$). This is analogous to the use of the 7$Q_{10}$ low flow used to define allowable dilution in the control of toxic pollutants. Phosphorus loading to a reservoir typically requires near-stagnant (lake-like) conditions for 14 days or longer to be fully manifested in increased algal growth. Clearly the greater the flow moving through the reservoir, the shorter the length of time the water spends in the reservoir and the less time the algae have to take full advantage of the available TP. The Agency’s proposed use of the 122$Q_{10}$ is more protective than an average flow. The Agency is using a 122$Q_{10}$ for this purpose now under the Phosphorus Strategy. For example, this flow was used by the Agency to determine the residence time for the Mississippi River Coon Rapids pool in the contested case hearing related to St. Cloud’s NPDES permit. In this instance, the residence time for the Mississippi River pool up stream of the Coon Rapids dam was shorter than 14 days at the 122$Q_{10}$. The pool behind the dam did not meet the requirements to be considered a reservoir. The rationale for using the 122-day low flow is also discussed in Section X.B.5 in SONAR Book I.

The third point of disagreement, albeit minor, is the petitioner’s inclusion of the words “scientifically-documented” in the suggested definition of “affects.” The Agency’s decisions on the effects of phosphorus loading on downstream resources and whether or not a limit should be imposed (“affects”) are always data-driven and scientifically-documented. The Agency’s proposed definition for “affects” does not use the term “scientifically-documented” but goes one step further by providing examples of the type of scientific data needed to show effects, such as increases in Chl-a, reductions in water clarity and an increase in algae blooms. The Agency feels the addition of the suggested term is unnecessary.

As noted, both the petitioner’s and Agency’s proposed definition of “affects” clarify that when assessing the need for a TP effluent limit it is the effects from the individual point source that is considered. The Agency’s proposed definition is below:

[Minn. R. 7053.0255, subp.2] B. “Affects” means a measurable increase in the adverse effects of phosphorus loading as determined by monitoring or modeling, including, but not limited to, an increase in chlorophyll-a concentrations, a decrease in water transparency, or an increase in the frequency or duration of nuisance algae blooms, from an individual point source discharge.

37 City of St. Cloud NPDES/SDS Permit, MCEA v. MPCA and City of St. Cloud, 696 N.W. 2d 398 (Minn. Ct. App. 2005).
3. **MCEA Petition** [VII.B. TP limit, need]

The petition from the Minnesota Center for Environmental Advocacy (MCEA, Exhibit A-30) includes several suggested changes to what the Agency proposes, which the Agency rejected in its response (Exhibit A-31). The Agency will respond to MCEA’s main suggestion, but not to all the claims in their petition, in this SONAR, (see Exhibit A-31). The heart of the MCEA proposed language is quoted below.

[Minn. R 7050.0211] *Subp. 1a. Total phosphorus effluent limits.* Phosphorus removal to one milligram per liter shall be required of all discharges where the discharge of effluent contributes phosphorus, excess algae, or excess Biological Oxygen Demand to a downstream nutrient-impaired lake or reservoir. …

In essence, the MCEA suggested approach would have the Agency:

- Continue to focus the setting of TP limits on the interpretation of “affects;”
- Assign TP effluent limits based on the “affects” of cumulative TP loading from all point sources in the watershed; and
- Link the setting of TP limits for discharges only when the receiving waterbodies have been determined to be impaired.

The setting of TP effluent limits based on the current rule for a discharge not directly to a lake relies on the demonstration of individually measured “affects” in the downstream lake or reservoir. These determinations are made for each applicable permit on a case-by-case basis. The process requires a considerable amount of data and staff time for the analysis, including modeling the projected impacts and, finally, a decision as to whether the added load exceeds a threshold of measurable effects. These demonstrations have proven to be a source of uncertainty, potential controversy, and an invitation for litigation. For example, in the last several years MCEA has contested several NPDES permits when the Agency determined that the threshold of measurable effects from the individual source had not been exceeded and no TP limit was imposed. The Agency believes that the MCEA proposal could acerbate the problems of resolving the “measurable affects” question, particularly when the cumulative effects of all point sources must be assessed. This could increase the uncertainties in the analysis and expand opportunities for controversy, delay and potential litigation.

The MCEA proposal includes the word “contributes,” which we interpret to mean that any discharger that contributes any amount of TP to the downstream lake or reservoir would get a TP limit. That is, the “affects” analysis would be expanded to consider the cumulative load from all point sources in the watershed. As noted, this could further complicate the “affects” analysis. Or, the result could be that even the smallest discharge would get a TP limit regardless of how small they are and how little they contribute to the cumulative load. While any addition, no matter how small, contributes to the cumulative load, controlling the very small sources may not be cost effective and might drain resources from the more significant larger sources (see percent

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38 NPDES permits for Mankato, St. Cloud, Faribault and Owatonna.
contribution from small point sources in Tables II-13 and II-14). Also, this might force small dischargers to seek a variance from this provision on the basis of economic hardship.

MCEA’s proposal appears to apply TP limits only in situations where the discharge is to a waterbody already impaired due to excess nutrients. This is a curious proposal given MCEA’s mission. Certainly the Agency does not want to wait until a lake becomes impaired before a TP limit is imposed for a discharger that impacts a downstream lake, and we do not believe that is MCEA’s goal either.

MCEA also suggested deleting the Agency’s proposed definition of “affects,” and suggested changes to the proposed definitions of “lake,” “shallow lake” and “reservoir.” The need for a definition of “affects” became apparent in the assessment factor rulemaking, and it is an important part of the Agency’s proposal. The separation of shallow lakes (< 15 feet deep) from lakes in general is an integral part of the Agency’s proposed eutrophication standards. Also, the 14-day residence time is a vital component of the Agency’s proposed definition of “reservoir.” The Agency rejected these proposals (see Exhibits A-30 and A-31).

The Agency believes that its proposal is a better approach to advancing reductions in point source TP loading in the future at less cost in time and money to the Agency, and possibly less cost to outside parties as well by avoiding protracted contested case hearings or litigation. The Agency’s approach is much more clear-cut and easy to implement. It requires neither a demonstration of “affects,” nor an assessment of cumulative loading.

In summary, the Agency decided not to adopt the suggestions of either the CGMC or MCEA petition in favor of the Agency’s own proposal.

C. CONTRIBUTION OF PHOSPHORUS FROM POINT SOURCES [VII. TP limit, need]

Phosphorus entering surface waters comes from both point and nonpoint sources. Point sources of phosphorus are relatively constant over time while nonpoint sources are largely dependent on the amount of precipitation falling on the landscape. The TP Loading Study introduced in SONAR Section II.A (Exhibit EU-6) estimated the amount of phosphorus entering Minnesota’s surface waters from both point and nonpoint sources under three flow conditions, low, average and high. Total phosphorus (TP) and bioavailable phosphorus (BAP) contributions were evaluated in this study. TP is all forms of phosphorus present in water (unfiltered sample) while BAP is the fraction of total phosphorus that is more readily available for algal growth. Table II-12 shows the relative contributions of TP loading from point and nonpoint sources at the three flow conditions.

The study estimated phosphorus loading three ways.

1. Loading estimates using TP concentrations assuming TP in wastewater treatment plant effluents remains at their current reported levels;
2. Loading estimates using only the fraction of BAP in the point and nonpoint sources; and
3. Loading estimates using TP concentrations assuming all point source effluent concentrations were at 1 mg/L.

Significantly, the relative contribution of TP from point sources is reduced by half, and even more during high flow, when it is assumed that all point sources are meeting 1 mg/L. The relative contribution from point sources goes up by 13 - 17 percent when only BAP is considered in the analysis. This points out that more of the TP in point source effluents is readily available for algae growth than the TP from nonpoint sources.
Table II-12. Point Source TP and BAP Loads as a Percent of Total Load to Minnesota Surface Waters (Exhibit EU-6).

<table>
<thead>
<tr>
<th>Conditions</th>
<th>River Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Loadings at current effluent flow and TP</td>
<td>45%</td>
</tr>
<tr>
<td>concentrations</td>
<td></td>
</tr>
<tr>
<td>Loadings at current effluent flow and BAP</td>
<td>62%</td>
</tr>
<tr>
<td>concentrations</td>
<td></td>
</tr>
<tr>
<td>Loadings at current effluent flow but effluent</td>
<td>23%</td>
</tr>
<tr>
<td>TP at 1mg/L</td>
<td></td>
</tr>
</tbody>
</table>

The TP Loading Study also provides information of the relative contribution of TP to surface waters based on the size of the wastewater treatment plants. Table II-13 shows the greatest number of facilities are small in size (less than 0.2 mgd AWWDF). Relatively few small facilities have 1 mg/L TP effluent limits while 44 percent of medium and 62 percent of large facilities have 1 mg/L limits (two have lower limits).

The very large Metro Plant (Metropolitan Council Environmental Services, MCES) alone was 41 percent of the total statewide point source load. On December 31, 2005 the Metro Plant was required to meet a 1 mg/L effluent limit. The facility actually reduced effluent concentrations from 2.9 mg/L to less than 1 mg/L a year earlier. Because of the size of this single facility (251 mgd AWWDF), there are separate columns in Table II-13 to show relative loads with this facility at 2.9 mg/L and at 1 mg/L effluent TP concentrations. Among point sources, the greatest relative TP load is from large domestic facilities, industrial facilities have the second largest, and medium size domestic facilities contribute the third largest load.
Table II-13. Number of Facilities and Point Source TP Loads by Category as Percent of Point Source Total Load (Exhibit EU-6).

<table>
<thead>
<tr>
<th>Facility Size and Type</th>
<th>No. of facilities:</th>
<th>Percent TP Loading at Current Plant Flows, And:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>total</td>
<td>With TP limits (% with limits)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current effluent concentrations &amp; Metro Plant at 2.9 mg/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current effluent concentrations &amp; Metro Plant at 1 mg/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effluent concentrations, all facilities at 1 mg/L</td>
<td></td>
</tr>
<tr>
<td>POTW, Small (&lt; 0.2 mgd)</td>
<td>316</td>
<td>49 (15%)</td>
<td>3%</td>
</tr>
<tr>
<td>POTW, Medium (0.2 – 1.0 mgd)</td>
<td>149</td>
<td>65 (44%)</td>
<td>7%</td>
</tr>
<tr>
<td>POTW, Large (&gt; 1.0 mgd)</td>
<td>68</td>
<td>42 (62%)</td>
<td>72%</td>
</tr>
<tr>
<td>Privately Owned WWT Systems for Domestic Use</td>
<td>na</td>
<td>na</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Commercial &amp; Industrial WWT Systems</td>
<td>na</td>
<td>na</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>na</td>
<td>Na</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

The data in Table II-14 show the TP load reductions that would be achieved if all facilities met 1 mg/L TP at their current discharge flow rates now. Load reductions of nearly 50 percent for all point source categories would be expected if all current discharges were to discharge at 1 mg/L TP. The greatest reduction in TP load is from large POTWs followed by industrial facilities (Exhibit EU-6).

Table II-14. Percent TP Load Reduction by Category of Point Sources if All Point Sources Met a 1 mg/L Effluent Concentration (Metro Plant at 1 mg/L).

<table>
<thead>
<tr>
<th>Category</th>
<th>Percent Reduction in TP Loading at Current Effluent Flow and TP Concentration of 1 mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small POTWs (&lt; 0.2 MGD)</td>
<td>2 %</td>
</tr>
<tr>
<td>Medium POTWs (0.2 – 1.0 MGD)</td>
<td>6 %</td>
</tr>
<tr>
<td>Large POTWs (&gt; 1.0 MGD)</td>
<td>26 %</td>
</tr>
<tr>
<td>Privately Owned WWT Systems for Domestic Use</td>
<td>&lt; 1 %</td>
</tr>
<tr>
<td>Commercial Industrial WWT Systems</td>
<td>14 %</td>
</tr>
<tr>
<td>Total</td>
<td>49 %</td>
</tr>
</tbody>
</table>

The proposed extension of the TP limit will require 1 mg/L limits as facilities expand or build new, if they discharge more than 1,800 pounds of TP per year. We have equated an annual load of 1,800 lbs. to an AWWDF of 0.2 mgd. Thus, based on these data, the Agency’s proposal could
reduce TP loading by as much as 47 percent if fully implemented across the whole state. This is probably a best-case figure however as explained in the next paragraph.

A number of factors complicate estimating just how much the proposed extension of the TP limit will reduce TP loading in the future. Some factors result in an increase in TP loading while others do the opposite. It is important to understand that future **new discharges** will mean a TP **load increase** to surface waters, although at a reduced rate due to the 1 mg/L effluent limit under the Agency’s proposal. Expanding dischargers getting a 1 mg/L effluent limit probably will result in overall load reductions since in most cases the expected concentration reductions will be greater than the flow increases. For example, a doubling in design flow combined with a four fold (e.g., 4 mg/L to 1 mg/L) reduction in TP concentrations would cut the load in half. Expansions will result in load reductions smaller than those shown in the Table II-14 however because the percentages in Table II-14 are calculated at current plant flows. Also, the rule as proposed will allow facilities that already have a 1 mg/L effluent limit to expand with no change in effluent concentration, resulting in a load increase to surface waters. However, other considerations could result in an effluent limit lower than 1 mg/L, such as a freeze of the mass loading or a more stringent limit required to meet the proposed eutrophication standards (Sections VI.M.4 and X.D). Finally, new TP limits will be phased in within the five-year life of the NPDES permits for the impacted facilities. While the proposed extension of the 1 mg/L effluent limit will achieve nutrient load reductions to the state’s surface waters, at some future time the reduction gains achieved will be at least partially offset by continued population growth (particularly in the attractive lake-rich counties) and the resulting need to increase wastewater flows.

**D. IMPACTS OF NUTRIENTS IN RIVERS AND STREAMS [VII. TP limit, need]**

No one questions the impact excess nutrients can have on lakes and other static bodies of water, but it is less well known that excess nutrients can have significant impacts on rivers and streams. A common misconception is that, while nutrients (i.e., phosphorus) may be present in relatively high concentrations in moving water systems, because the water is moving there is not enough time for the plant community to “take advantage” of the extra nutrients; and that most of the TP load is flushed out and moved harmlessly downstream. Aquatic scientists have reported for decades that nutrients impact rivers and streams. But until recently these impacts have gone largely undocumented, at least by governmental water quality monitoring programs. The increased nutrient and biological monitoring of rivers and streams by the Agency, other states and federal agencies is providing new documentation of negative impacts of nutrients on rivers and streams.

The Agency has nutrient and algal abundance data from several rivers and streams around the state that show excess phosphorus increases the abundance of suspended algae in rivers. Recent studies and monitoring data on river systems consistently show negative impacts from nutrients where in the past it might have been assumed impacts would be negligible. In one case, the lower Minnesota River, excess phosphorus and very abundant algae have caused dissolved

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oxygen levels to fall below standards. This led to the Minnesota River being listed as impaired due to nutrients and the subsequent TMDL. The effects of excess nutrients in the lower Minnesota River was manifested by low dissolved oxygen (DO) levels caused by algal respiration and the die-off and decay of algae, which consume oxygen.

In a published journal article and subsequent report, Agency staff members Heiskary and Markus looked at the impacts of nutrients on several medium to large rivers throughout Minnesota (Exhibits PL-7 and PL-8). Monitoring took place over three years. They document several impacts, such as relationships between increased phosphorus with increased algae (Chl-a), increased in-river biochemical oxygen demand (BOD₅), increased daily DO changes and poorer fish and invertebrate indices of biological integrity (IBI). Highly significant regression equations were established between TP, Chl-a and BOD₅. Summer average Chl-a concentrations ranged from about 3 to 120 µg/L in the water column of rivers sampled (1999 and 2000). As stated, as algal biomass increases the demand on oxygen resources also increases. The direct relationship between river TP and Chl-a has been documented in other published research as well. Also other states, as part of their programs to develop and adopt nutrient standards for rivers, are documenting similar relationships between increased nutrients and negative responses in rivers and streams.

The increased amplitude of daily DO cycles also is an indicator of increased algal growth. Abundant algae generate oxygen during the day through photosynthesis driving concentrations up; at night photosynthesis stops but respiration continues dropping DO concentration to low levels. Of the variables reviewed, Chl-a and BOD₅ exhibit the highest correlation (inverse relationships) with indices (IBI scores) measuring the quality of the fish and invertebrate communities, although IBI scores are also influenced by habitat quality. Based on these negative responses related to changes in TP concentrations, the report recommends a strategy of maintaining existing TP concentrations for protection of good quality resources; and reductions in TP to achieve improved BOD₅ and Chl-a levels, reductions in the magnitude of DO cycles, and improvements in other response variables in impacted waterbodies.

Excess phosphorus loading to rivers and streams is likely to increase the growth of attached algae as well, which appears as the green “slime” or long green filaments growing on rocks and other substrates. This is a more typical response to added nutrients in smaller, shallower streams than in larger rivers. Impacts to the rivers themselves is a concern, but several major river systems in Minnesota eventually drain to a lake or reservoir, such as Lake Pepin, Lake of the Woods or Lake Winnipeg in Manitoba. Once there, the phosphorus loading can be expressed in the well known negative effects of cultural eutrophication in static waterbodies, such as algae blooms and loss of water clarity.

Algal growth does not cease during the winter season. While most assessments on river trophic conditions focus on warmer seasons, algal growth can also be excessive in winter. Algae can grow under the ice in rivers and in backwater areas, depending on light conditions. Monitoring of the Minnesota River at river mile 39.4 (39.4 miles upstream from the mouth) showed algal bloom conditions throughout the winter of 1990/1991. Average Chl-a at this site was 177 µg/L.

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40 For example, Van Nieuwenhuyse and Jones 1996, and Basu and Pick 1996.
in December through February with a maximum concentration of 454 µg/L. These Chl-a levels indicate severe to very severe algae bloom conditions. BOD$_5$ concentrations were also elevated during this time, and daytime DO was higher than saturation levels. Diurnal DO change was not monitored but can be expected to be large with such algal populations. This is not an isolated condition at this one monitoring location. Additional river monitoring locations exhibit elevated winter Chl-a concentrations, although not every winter season.

Phosphorus discharged in the winter can adhere to particulates. As particulates move downstream some will settle to the bottom in slack-water reaches and pools in the river system. Depending on where these particulates settle out, the attached phosphorus may become resuspended or released and available for algal growth during the summer months. The Mississippi River, for example, has extensive backwater areas, which respond more like lakes to nutrient inputs than rivers. Backwater areas often act as sinks for sediments rich in nutrients, which can contribute to eutrophication during the summer.

Minnesota has the enviable position geographically of being “upstream” of much of the rest of North America. Minnesota is home to the headwaters of three major river basins, the Mississippi, Red/Rainy and Lake Superior. This means that, for most of the state, we don’t have to be concerned about pollutant loading via rivers from states or provinces upstream of us. However, our downstream neighboring states or provinces may have cause to be concerned about what we send downstream to them. Minnesota has an obligation to consider the downstream ramifications of our actions. Nutrients that are carried downstream beyond Minnesota’s borders can have impacts far downstream. For example, the load of nitrogen and phosphorus from the Minnesota River contributes to the hypoxia problem (a large zone of low oxygen levels) far downstream in the coastal waters off the mouth of the Mississippi River.

In conclusion:

- The deleterious impacts excess nutrients have on rivers, streams and run-of-the-river reservoirs has been known for decades and is being well documented with new data. Organisms at all levels of the food chain, algae, higher plants, invertebrates and fish, can be negatively impacted.
- The Agency has documented negative responses in Minnesota rivers. High Chl-a, loss of dissolved oxygen and wide swings in daily dissolved oxygen levels, for example, have been documented.
- Impacts are not limited to the warmer months. Winter nutrient loading can result in spring blooms of diatoms, zooplankton, and bacteria. These blooms, through their release of bio-available nutrients can exacerbate summer blooms further downstream.

E. PROMULGATION APPROPRIATE ACTION [VII. TP limit, need]

In general the Agency has an obligation to promulgate in rule policies and practices it has implemented based on guidance and policy documents. Implemented policies that have economic repercussions especially should be adopted into administrative rules. The acceptance of 1 mg/L TP limits under the Phosphorus Strategy by dischargers (for a variety of reasons) has
made this a very successful policy for over five years. It has resulted in dramatic reductions in the amount of TP discharged, but it has had economic ramifications as well. This policy was formally approved by the Agency Board in March 2000 which enhanced its authority. Promulgation of the Strategy is the proper course of action. The rulemaking process means the Agency must:

- Follow the requirements of the Administration Procedures Act (Minn. Stat. ch. 14);
- Assess the economic impacts;
- Contact all potentially impacted parties;
- Provide ample opportunity for public involvement;
- Publish a formal notice in the State Register;
- Hold public hearings; and
- Respond to comments.

By promulgating what essentially is being implemented now under the Strategy, the Agency is assuming the responsibility to meet all the burdens listed above. Most significantly, this process guarantees public exposure and the assessment of costs, steps that go beyond what the Agency felt obligated to do for the development and implementation of the Strategy.

F. CONSOLIDATION OF EXISTING AND PROPOSED TP LIMITS [VII. TP limit, need]

This Section is largely a repeat of Section V.E.10 in SONAR Book I that discusses the need for consolidating and reorganizing all the phosphorus effluent (TP) limit provisions in one place, including those now in Minn. R. ch. 7065. Consolidation is associated with the proposed extension of the TP limit to new and expanding dischargers. The proposed additions and changes to the TP effluent limit provisions, including possible exemptions to the extension of the TP limit, requiring treatment to the fullest practicable extent and options for effluent limit averaging periods, are treated separately in Sections VII.G to VII.J.

The consolidation of all TP limit provisions in a newly created subpart of Minn. R. 7053.0255 will bring all the provisions that deal directly with TP limits into one place in the proposed new rule, Minn. R. ch. 7053. The separation of Minn. R. ch. 7050 into two rules provides an ideal time to consolidate the TP effluent limit requirements in one place and to repeal the outdated Minn. R. ch. 7065 (see Sections VI.J.3 and X.J in SONAR Book I).

The title of proposed Minn. R. 7053.0255 includes the terms “point source discharges of sewage, industrial, and other wastes” consistent with existing rule language. The definition of “other wastes” is broadly inclusive and some of the sources listed in the statutory definition could be interpreted as nonpoint sources (Minn. Stat. § 115.01, subd. 9). Proposed Minn. R. 7053.0255 in its entirety follows.
Subpart 1. **Scope.** The phosphorus effluent limits in this part are in addition to the effluent limits specified elsewhere in this chapter. In the event of any conflict between this part and other applicable regulations, the more stringent requirement applies.

**Subp. 2 Definitions.** For the purposes of this part, the following definitions apply. Other relevant definitions are found in part 7050.0150, subpart 4.

A. "122-day ten-year low flow" or "122Q_{10}" means the lowest average 122-day flow with a once in ten-year recurrence interval. A 122Q_{10} is derived using the same methods used to derive a 7Q_{10}, and the guidelines regarding period of record for flow data and estimating a 7Q_{10} apply equally to determining a 122Q_{10} as described in part 7053.0135, subpart 3.

B. “Affects” means a measurable increase in the adverse effects of phosphorus loading as determined by monitoring or modeling, including, but not limited to, an increase in chlorophyll-a concentrations, a decrease in water transparency, or an increase in the frequency or duration of nuisance algae blooms, from an individual point source discharge.

C. "Expanded discharge" means a disposal system that after May 1, 2008, discharges more than 1,800 pounds of total phosphorus per year to a surface water on an annual average basis, and increases in wastewater treatment capacity as indicated by an increase in the:

1. design average wet weather flow for the wettest 30-day period for point source dischargers of sewage with a continuous discharge, typically a mechanical facility;
2. design average wet weather flow for the wettest 180-day period for point source dischargers of sewage with a controlled discharge, typically a pond facility; or
3. design average daily flow rate for dischargers of industrial or other wastes.

D. “Lake” means an enclosed basin filled or partially filled with standing fresh water with a maximum depth greater than 15 feet. Lakes may have no inlet or outlet, an inlet or outlet, or both an inlet and outlet.

E. “Measurable increase” or “measurable impact” means a change in trophic status that can be discerned above the normal variability in water quality data using a weight of evidence approach. The change in trophic status does not require a demonstration of statistical significance to be considered measurable. Mathematical models may be used as a tool in the data analysis to help predict changes in trophic status.
F. "New discharge" means a discharge that was not in existence before May 1, 2008, and discharges more than 1,800 pounds of total phosphorus per year.

G. “Reservoir” means a body of water in a natural or artificial basin or water course where the outlet or flow is artificially controlled by a structure such as a dam. Reservoirs are distinguished from river systems by having a hydraulic residence time of at least 14 days. For purposes of this item, residence time is determined using a flow equal to the $122Q_{10}$ for the months of June through September, a $122Q_{10}$ for the summer months.

H. “Shallow lake” means an enclosed basin filled or partially filled with standing fresh water with a maximum depth of 15 feet or less or with 80 percent or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (the littoral zone). It is uncommon for shallow lakes to thermally stratify during the summer. The quality of shallow lakes will permit the propagation and maintenance of a healthy indigenous aquatic community and they will be suitable for boating and other forms of aquatic recreation for which they may be usable. For purposes of this chapter, shallow lakes will be differentiated from wetlands and lakes on a case-by-case basis. Wetlands are defined in part 7050.0186, subpart 1a.

Subp. 3. Total phosphorus effluent limits.

A. Phosphorus removal to one milligram per liter is required when subitem (1), (2), or (3) applies:

1. the discharge of effluent is directly to or affects a lake, shallow lake, or reservoir;

2. the discharge is to the specific basins and water bodies designated in subpart 5; or

3. the discharge is new or expanded as defined in subpart 2 except when the discharger can demonstrate to the commissioner that the discharger qualifies for an alternative phosphorus limit as provided in subpart 4.

B. In addition, if a phosphorus effluent limit is required under item A, removal of nutrients from all wastes shall be provided to the fullest practicable extent wherever sources of nutrients are considered to be actually or potentially detrimental to preservation or enhancement of the designated water uses. Dischargers required to control nutrients under this subpart are subject to the variance provisions of parts 7000.7000 and 7053.0195.

Subp. 4. Alternative phosphorus effluent limits for new or expanded discharges. New or expanded discharges subject to a one milligram per liter phosphorus effluent limit in subpart 3, item A, subitem (3) may request an alternative limit or no limit if one or more of items A to C apply. New or expanded discharges are defined in subpart 2.
The exemptions in this subpart do not apply to facilities that discharge directly to or affect a lake, shallow lake or reservoir or to discharges to the waters listed in subpart 5. Dischargers seeking an alternative limit due to very high per capita treatment costs or economic hardship must apply for a variance under parts 7000.7000 and 7053.0195.

The information submitted to the commissioner for consideration of an alternative limit must include, at a minimum, a description of the treatment technology used, influent and effluent total phosphorus concentrations, a phosphorus management plan for the facility, descriptions of any measures already taken to reduce phosphorus sources to the facility, and expected reductions in phosphorus concentrations following implementation of the phosphorus management plan. The discharger may qualify for an alternative total phosphorus limit or no limit if it can demonstrate:

A. the discharge is to or upstream of a water body listed on the applicable impaired water list, section 303(d) of the Clean Water Act and the total maximum daily load study is complete and approved by the United States Environmental Protection Agency at the time the new or expanding facility is in the planning and design phase. The total maximum daily load study must have considered impacts from phosphorus loading on the impaired water body. In this case the total maximum daily load study will determine the applicable phosphorus effluent limit;

B. the environmental benefits to be achieved by meeting a phosphorus limit are outweighed or negated by the environmental harm caused by meeting a limit; or

C. the treatment works, regardless of the type of treatment technology, must use chemical addition to achieve compliance with the one milligram per liter limit, and the discharge is to a receiving stream in a watershed listed in subitems (1) to (3). In this case the discharger may be granted a seasonal one milligram per liter limit, applicable from May 1 through September 30 and not applicable from October 1 through April 30:

(1) the lower Mississippi River and its tributaries from the mouth of the Chippewa River in Wisconsin to the Minnesota border;
(2) the Bois de Sioux and Red Rivers and their tributaries from the southern end of Lake Traverse at Browns Valley to the Canadian border; and
(3) the Missouri, Des Moines, and Cedar Rivers and their tributaries in Minnesota.

Subp. 5. Designated waters. The one milligram per liter phosphorus limit established in subpart 3 applies to the waters designated in items A to F.

A. All intrastate waters lying within the drainage basin of Lake Superior in the counties of Aitkin, Carlton, Cook, Itasca, Lake, Pine, and St. Louis (Townships 45 to 65 North, Ranges 7 East to 23 West).

B. The interstate waters of Lake St. Croix in Washington County (Townships 26 to 30 North, Range 20 West).
C. The St. Louis River from its source at Seven Beaver Lake (Township 58 North, Range 12 West) to and including St. Louis Bay (Townships 49 and 50 North, Ranges 14 and 15 West) and Superior Bay (Townships 49 and 50 North, Ranges 13 and 14 West).

D. The Mississippi River from its source to the Blandin Dam at the outlet of Paper Mill Reservoir in the City of Grand Rapids approximately 400 feet upstream from the bridge on U.S. Highway 169 including Lake Andrusia (Township 146 North, Range 31 West), Lake Bemidji (Townships 146 and 147 North, Range 33 West), Cass Lake (Townships 145 and 146 North, Ranges 30 and 31 West), Lake Itasca (Township 143 North, Range 36 West), Pokegama Lake (Townships 54 and 55 North, Ranges 25 and 26 West), and Winnibigoshish Lake (Townships 145, 146, and 147 North, Ranges 27, 28, and 29 West).

E. The Little Minnesota River and Big Stone Lake from the South Dakota border crossing to the outlet of Big Stone Lake at the dam immediately upstream from the U.S. Highway 12 bridge in Ortonville.

F. Albert Lea Lake (Township 102 North, Ranges 20 and 21 West) in Freeborn County.

Subp. 6. Averaging period for phosphorus limit. The phosphorus limit required under subpart 3 must be a calendar month arithmetic mean unless the commissioner finds, after considering the criteria listed in items A and B, that a different averaging period is acceptable. In no case shall the one milligram per liter limit exceed a moving mean of 12 monthly values reported on a monthly basis, or a simple mean for a specified period, not to exceed 12 months. Calendar month effluent limits in effect on February 7, 2000, must remain in effect unless an assessment of the criteria listed in items A and B indicate a different averaging period is acceptable. An different averaging period other than monthly is acceptable when:

A. the effects of the phosphorus loading from the facility on the receiving water or downstream water resources is generally not measurable. there is no measurable or predictable difference in the adverse effects of the phosphorus loading from the facility on the receiving water or downstream water resources compared to the loading that would result using a 30-day average limit; and

B. the treatment technologies being considered offer environmental, financial, or other benefits

In summary, the consolidation of the TP limits in one place is needed. This will simplify application of TP limits as they become more commonplace in permits. A reorganization of the TP limits is needed to accommodate the proposed extension of the TP limit and the proposed move of the waterbody-specific limits, now in Minn. R. ch. 7065, into Minn. R. 7053.0255.
G. NEW LANGUAGE, SCOPE AND DEFINITIONS, MINN. R. 7053.0255, SUBP. 1 AND 2. [VII. TP limit, need]

Proposed subpart 1 of Minn. R 7053.0255 is a brief statement of the scope of this part, followed by eight pertinent definitions in subpart 2. The definitions are for terms used in Minn. R. 7053.0255 as listed below. The need for these definitions is discussed in Section VI.B of SONAR Book I.

- 122Q_{10}
- Affects
- Expanded discharge
- Lake
- Measurable increase or measurable impact
- New discharge
- Reservoir
- Shallow lake

H. NEW LANGUAGE, EFFECTIVE DATE, TP LIMITS AND EXEMPTIONS, MINN. R. 7053.0255, SUBP. 3. [VII. TP limit, need]

1. Effective Date of May 1, 2008 [VII.H. TP limit, need]

The proposed date of May 1, 2008 at which the proposed extension of the TP limit will take effect was established by statute during the 2007 legislative session (2007 Minn. Laws, ch. 131, art. 1, § 81).

2. TP Limits [VII.H. TP limit, need]

Proposed new Minn. R. 7053.0255, subp. 3 contains the 1 mg/L TP limits for three categories of waterbodies or situations (see language in Section VII.F).

The first category (subitem (1)) is the TP limit applicable to discharges directly to or affecting a lake, shallow lake, or reservoir. This is the existing TP limit that has been in Minn. R. ch. 7050 since 1973. This provision is not being changed but is being moved to the new location. The term “shallow lake” is being added because the Agency plans to make a distinction between “shallow” and “deep” lakes in the proposed eutrophication standards. The application of the existing TP limit (existing Minn. R. 7050.0211, subp. 1a) has not differentiated lakes by depth in the past. This addition is needed to be sure the existing TP limit continues to be applicable to all lakes, both deep and shallow, as has been the case since 1973. This addition does not change the existing TP limit or how it is applied.

The second category (subitem (2)) is the TP limit applicable to dischargers to any of the specific waterbodies listed in the existing Minn. R. ch. 7065. The Agency proposes to move these TP limits from Minn. R. ch. 7065 to Minn. R. 7053.0255, subp. 5. Again, this will consolidate the
TP limits in one place and allow for the repeal of Minn. R. ch. 7065 (see Sections VI.J.3 and X.J in SONAR Book I).

The third category (subitem (3)) is the proposed 1 mg/L TP limit applicable to new or expanding discharges that discharge more than 1,800 pounds of TP per year. This subitem references the three possible exemptions from a TP effluent limit that a new or expanding facility may qualify for upon request. The exemptions in Minn. 7053.0255, subp. 4 are needed to allow dischargers potential relief from a TP limit in certain situations.

3. Possible Exemption to TP Limit if TMDL is Complete [VII.H. TP limit, need]

Proposed Minn. R. 7053.0255, subp. 4, item A states that if a TMDL for a waterbody impaired due to nutrients or a nutrient-related pollutant has been completed, and the new or expanding facility is in a planning or design phase, the TMDL may determine the TP effluent limit to be included in the NPDES permit for that discharger (see language in Section VII.F). It should be noted that TMDL implementation applies to any discharger within its scope, not just those that are new or expanding, but the context for the proposed rule discussed here is only new or expanding discharges above the de minimis TP load.

The waterbody must be on the 303(d) list because of exceedance of the eutrophication standards or because the excess nutrients have caused exceedances of another standard, such as dissolved oxygen. This provision applies in situations where the TMDL is complete and approved by EPA, and the reductions in TP loading from point sources needed to restore the waterbody has addressed the possible need for permit limits. The new or expanding facility must be in a planning and design phase at the time the TMDL is approved to incorporate the TMDL’s recommendations into the permit. The TMDL-determined limit may be 1 mg/L or lower than 1 mg/L. And, while probably less likely, if the TMDL determines that a limit more lenient than 1 mg/L or no limit at all is needed then the permit will reflect those recommendations. This potential exemption applies to any facility that discharges to the impaired waterbody or to an upstream waterbody flowing into the impaired waterbody.

Originally the Agency had proposed rule language that automatically allowed the TMDL to determine the TP effluent limit if certain conditions were met. That is, dischargers would not have to petition for the TMDL exemption. However, as the Agency has gained more experience with nutrient-caused or nutrient-related TMDLs, it has become clear that the solutions recommended by a TMDL are complex, somewhat site-specific, and may not be applicable to all discharges in the watershed. Developing rule language that tries to cover all the possible situations and conditions becomes too complex and awkward. Therefore, the Agency is now proposing to include the “TMDL exemption” as one of three potential exemptions to the TP limit that a discharger can apply for. The Agency believes that this is the best way to deal with the site-specific aspects of each TMDL situation (see reasonableness section, Section IX.H.3).

In summary, a provision is needed that allows, upon request, the TMDL to determine a TP limit if certain conditions are met. The basic conditions are:

- The discharge is to or upstream of a waterbody listed on the 303(d) impaired waters list;
The total maximum daily load has considered impacts from phosphorus loading on the impaired waterbody;

- The total maximum daily load is complete and approved by the EPA at the time the new or expanding facility is in the planning and design phase; and

- The phosphorus loading from the new or expanding discharge is included as part of the point source waste load allocation in the total maximum daily load study. In other words, this exemption does not apply to discharges upstream of the impaired waterbody but outside the scope of the TMDL study.

The purpose of TMDLs is to assign point and nonpoint source loading reductions necessary to bring the impaired water into compliance with standards. If the TMDL is approved at the time the expansion or new construction is being planned, and the other site-specific conditions are met, it is appropriate for the TMDL to determine the TP permit limit. By placing the burden on the discharger to request a TMDL-related exemption, the Agency is not trying to put roadblocks in the way of dischargers, or discourage dischargers from petitioning the Agency. If it is clear that the TMDL-determined limits are appropriate in a particular case, the Agency will advise the discharger to submit a petition. The granting of an exemption in these situations should be straightforward and proceed smoothly.

4. **Possible Exemption to TP Limit if Environmental Harm Outweighs Gain** [VII.H. TP limit, need]

The Agency’s overall goal and purpose is to improve water quality and environmental conditions through its regulations and programs. If it can be demonstrated that an action, in this case the imposition of a TP permit limit, results in net harm to the environment, then that action should be modified or not be taken at all, consistent with federal and state laws. The opportunity to demonstrate such a situation is needed in the context of the proposed extension of the TP effluent limit. The wording of this exemption is simple and straightforward, and it gives the Agency the latitude needed to evaluate the data presented and decide if the exemption should be granted. The Agency believes latitude is needed in this context because each situation will be unique and must be evaluated on a case-by-case basis (language in Section VII.F). The Agency Citizens’ Board may be asked to approve the staff decision on an exemption and the permittee can contest the decision through the permit process.

5. **Possible Exemption to TP Limit, No Winter Limit in Certain Watersheds** [VII.H. TP limit, need]

Excess nutrients may be less of a concern during the winter months in some Minnesota watersheds than in others. The Agency is proposing to provide the opportunity for a discharger that must use chemicals to meet the TP limit to show that a winter limit (from October 1 through April 30) is not needed. This potential exemption is needed because there may be evidence available that shows the loading of TP during the winter in the designated watersheds does not contribute to an excess nutrient problem downstream (language in Section VII.F). The watersheds, which includes all their tributaries in Minnesota, are shown below.

- Lower Mississippi River below Lake Pepin to the Iowa border;
• Bois de Sioux and Red Rivers to the Canadian border;
• Missouri, Des Moines, and Cedar Rivers to the Minnesota border.

It is important to restate that this exemption, and the exemptions discussed in the previous sections, is not automatically granted. The discharger must request an exemption and submit the data the Agency will need to evaluate the merits of the request.
I. CLARIFICATION OF FULLEST PRACTICABLE EXTENT LANGUAGE, MINN. R. 7053.0255, SUBP. 3. [VII. TP limit, need]

The Agency believes that with the proposed extension of the TP limit to new and expanded dischargers there is a need to clarify the “fullest practicable extent” language in Minn. 7053.0255, subp. 3, item B. This provision, which has been in the water quality rules since 1971, says that wastewater treatment plants should remove TP from the effluent to the “fullest practicable extent.” The provision showing the proposed changes is shown below.

[Minn. 7053.0253, subp. 3] B. In addition, If a phosphorus effluent limit is required under item A, removal of nutrients from all wastes shall be provided to the fullest practicable extent wherever sources of nutrients are considered to be actually or potentially detrimental to preservation or enhancement of the designated water uses. Dischargers required to control nutrients by under this subpart are subject to the variance provisions of part parts 7000.7000 and 7053.0195.

There has been some question and disagreement about whether this provision:

- Applies to any and all dischargers regardless of whether or not they have a 1 mg/L TP limit, or
- Applies only to dischargers that have a 1 mg/L permit limit.

The Agency believes strongly that the latter interpretation is the correct one and this interpretation needs to be clarified (see discussion of history in Section IX.G.4). It can be clarified with minor changes to the paragraph.

J. CLARIFICATION OF AVERAGING PERIOD FOR TP LIMITS, MINN. R. 7053.0255 SUBP. 6. [VII. TP limit, need]

In 2000 the Agency added language to Minn. R. 7050.0211, subp. 1a that allowed the option of setting TP effluent limits in NPDES permits that could be averaged over a period longer than the previously required one month. TP limits with a longer averaging period are usually 12-month moving averages; or, in a few cases, the limits are simple calendar-year averages. Since this change to the rule, approximately 35 municipal dischargers and several industrial discharges have been given a 1 mg/L TP limit with an averaging period longer than one month (numbers include both interim and final TP permit limits).

The Agency is proposing to clarify one of the two criteria the Commissioner can use to decide when a TP limit with a longer averaging period is appropriate, and to make some very minor clarifying language changes. The proposed changes, which will be in the new Minn. R. 7053.0255, subp. 6 are repeated below:
Subp. 6. **Averaging period for phosphorus limit.** The phosphorus limit required under subpart 3 must be a calendar month arithmetic mean unless the commissioner finds, after considering the criteria listed in items A and B, that a different averaging period is acceptable. In no case shall the one milligram per liter limit exceed a moving mean of 12 monthly values reported on a monthly basis, or a simple mean for a specified period, not to exceed 12 months. Calendar month effluent limits in effect on February 7, 2000, must remain in effect unless an assessment of the criteria listed in items A and B indicate a different averaging period is acceptable. An different averaging period other than monthly is acceptable when:

A. the effects of the phosphorus loading from the facility on the receiving water or downstream water resources is generally not measurable. there is no measurable or predictable difference in the adverse effects of the phosphorus loading from the facility on the receiving water or downstream water resources compared to the loading that would result using a 30-day average limit; and

B. the treatment technologies being considered offer environmental, financial, or other benefits.

As mentioned before, the proposed consolidation of TP limits into one part, plus the other proposed changes to the TP effluent limit rule, provide an opportunity to make this proposed clarification. The change will not affect the process the Agency uses now to decide case-by-case when a longer averaging period is appropriate.

The purpose of proposing the longer averaging period is summed up by the following two quotes from the SONAR for the 1999 triennial review of Minn. R. ch. 7050.

Page 25. “This change is needed to encourage the use of treatment technologies other that chemical addition to remove phosphorus, specifically to encourage the use of the biological phosphorus removal process, and to promote the implementation of the Agency’s phosphorus reduction strategy.”

And on page 91: “In conclusion, the proposal to allow a longer averaging period for the phosphorus limit of 1 mg/L is reasonable because it will, 1) facilitate the reduction of phosphorus loading to watersheds, 2) encourage the use of the Bio-P technology, 3) facilitate the implementation of the Agency’s phosphorus control strategy, and 4) allow flexibility in the implementation of, and choice of treatment options to meet, the phosphorus limit.”

The language in the existing Minn. R. 7050.0211, subp. 1a includes two criteria the Commissioner and his/her staff uses to determine when the longer averaging period is appropriate. The existing first criterion, “the effects of the phosphorus ... is generally not measurable” seems inconsistent in general with the way the current TP limit has been implemented over the years, which is to require a demonstration of measurable “affects” in the downstream resource due to the TP loading from the individual discharger.
The Agency is proposing to clarify the language in the first criterion so that the lack of a measurable or predictable impact (e.g., though modeling) relates to the difference in the loading that would occur with a limit averaged over a longer period compared to the loading that would occur with a monthly limit. This clarification is needed in light of the Agency’s proposed definition of the word “affects” and the extension of the TP limit to new and expanded dischargers that discharge more than 1,800 pounds of TP per year. The Agency is proposing no change to the second criterion.

K. SUMMARY, NEED [VII. TP limit, need]

In summary, the Agency’s fundamental rationale for the proposed extension of the phosphorus limit is listed below:

- To help reduce phosphorus loading to essentially all watersheds in Minnesota in the knowledge that anthropogenic phosphorus contributes to water quality degradation.
- To be proactive in the effort to protect waterbodies that are not impaired.
- To help achieve watershed-specific or TMDL driven nutrient reduction goals.
- To help protect downstream water resources including those beyond Minnesota’s borders.
- To support and encourage consideration of the phosphorus removal capabilities using biological phosphorus removal treatment technologies.
- To codify in rule the progress in phosphorus removal that has taken place since March 2000 under the Phosphorus Strategy.
- Implementation is straightforward, which should help reduce the number of contested case hearings and legal challenges.
- The proposal is consistent with statewide efforts to improve Minnesota’s water quality through major initiatives at the executive and legislative levels of state government.
VIII. REASONABLENESS OF PROPOSED EXTENSION OF PHOSPHORUS EFFLUENT LIMIT, REQUIRED INFORMATION

A. INTRODUCTION [VIII. TP limit, reasonableness]

Minnesota Stat. § 14.131 requires that this SONAR include information about 11 aspects of the potential impacts of this rulemaking. The discussion in Sections VIII.B to VIII.L that follows pertains only to the proposed extension of TP limits to new and expanded discharges above a certain size.

B. CLASSES OF PERSONS AFFECTED BY THE PROPOSED RULE AMENDMENTS, INCLUDING THOSE CLASSES THAT WILL BEAR THE COSTS AND THOSE THAT WILL BENEFIT [VIII. TP limit, reasonableness]

Most citizens of Minnesota should benefit from the proposed extension of the TP limit to new and expanded discharges that discharge more than 1,800 pounds of TP per year. The benefits will be largely intangible, and the expected improvements in water quality are likely to go unnoticed by most Minnesotans. Reduced loading of TP from point sources should reduce the growth of attached algae in streams and rivers, and suspended algae in larger rivers, and it could improve dissolved oxygen conditions in rivers already impacted by excess nutrients. The Agency realizes that the costs of meeting TP limits for new and expanding facilities will not be borne equally by Minnesota citizens. People living in communities just large enough to surpass the de minimis load of 1,800 pounds per year (equates approximately to a population of 2000) as a result of a planned expansion or new wastewater treatment plant, could see higher costs than those living in larger communities, or people in rural areas with individual septic systems.

A conservative or high estimate of the total capital and total annual operation and maintenance (O&M) costs (i.e., annual O&M costs for five years) for 35 POTWs in a range of sizes, projected to be impacted by the proposed change to the TP limit over the next five years, is estimated to be about $134 million. The number of POTWs (35) projected to be impacted in the next five years is based on the number of new and expanding facilities that got TP limits from March 2000 through December 2005. The $134 million figure assumes that the limits for all 35 facilities go into effect today, and all use chemical addition as the sole means of meeting a 1 mg/L limit with no benefit from Bio-P. To repeat, this figure is the total capital and total annual O&M costs for all 35 POTWs projected to be impacted over the next five years. Most of these TP treatment costs will be incurred regardless, even if the Agency did not propose the extension of the TP limit, as explained in Section XI.F.

A conservative or high estimate of the total capital and total O&M costs to industries to be impacted by the proposed change to the TP limit over the next five years, is estimated to be about $5 million. This estimate is based on projections of six new or expanded facilities in seven industrial categories getting TP limits over the last five years. Similar to the estimates for POTWs this figure assumes that the limits go into effect today, and all use chemical addition to meet a 1 mg/L limit.
The municipal and industrial costs and the methods used to arrive at the estimates are discussed in detail in Sections XI.D and XI.E, respectively.

C. ESTIMATE OF THE PROBABLE COSTS TO THE AGENCY AND OTHER AGENCIES OF IMPLEMENTING AND ENFORCING THE RULE AMENDMENTS, AND ANY ANTICIPATED EFFECT ON STATE REVENUES [VIII. TP limit, reasonableness]

The proposed extension of the TP limits will not significantly affect Agency staff needs or work loads and overall Agency costs. As stated, to a large extent the Agency has been implementing the proposed extension of the TP limit for the last five years under the Phosphorus Strategy. The Agency has two staff people whose primary responsibility is to review permits being reissued, particularly the permits for new or expanding facilities, for possible inclusion of a TP limit in the NPDES permit. This level of staff commitment is not likely to change due to the proposed extension of the TP limit.

No other state or federal agency will incur any costs due to this proposed change, because it is the sole responsibility of the Agency to issue NPDES permits and to determine the appropriate effluent limits (subject to public comments, possible contested case hearings, and EPA review). The Department of Natural Resources regularly reviews NPDES permits when they go on public notice, and they often provide comments to the Agency. The MDNR looks for consistency between the proposed effluent limits and their policies and responsibilities for protection of surface waters. This is an ongoing activity by the MDNR and the proposed change should not change their current staff and time requirements. There should be no impact on state revenues.

The Environmental Protection Agency (EPA) has an interest in these proposed amendments. The EPA has been an active partner in the promulgation of Minnesota’s standards for lakes. Under the Clean Water Act, the EPA Regional Administrator (Region 5 in Chicago) must approve all changes to Minnesota’s water quality standards (40 CFR 131.5).

D. DETERMINATION OF WHETHER THERE ARE LESS COSTLY OR LESS INTRUSIVE METHODS FOR ACHIEVING THE RULE AMENDMENT’S PURPOSE [VIII. TP limit, reasonableness]

To not promulgate the proposed extension of the TP effluent limit to new and expanding dischargers might prove to be less costly and less intrusive. In all probability, however, the Agency will continue to put TP limits in NPDES permits based on the Phosphorus Strategy as we have been doing for the last six years. Also, the setting of TP limits is very likely to continue to expand regardless, due to existing rules, large-scale nutrient related TMDLs, watershed nutrient reduction goals and the other reasons discussed in Sections IX.D and XI.F.

The Agency believes that inaction risks losing the momentum for point source TP reductions established under the Strategy. Continued reliance on guidance (the Strategy) in the absence of
rules sets up the possibility of retreat from the gains achieved. As explained, the Agency believes that codification of the Strategy is the more straightforward course of action.

E. DESCRIBE ANY ALTERNATIVE METHODS FOR ACHIEVING THE PURPOSE OF THE PROPOSED RULE AMENDMENTS THAT THE AGENCY SERIOUSLY CONSIDERED AND THE REASONS WHY THEY WERE REJECTED IN FAVOR OF THE PROPOSED AMENDMENTS [VIII. TP limit, reasonableness]

The Agency evaluated the options suggested in the CGMC and MCEA petitions, but neither option would achieve the purpose of the rule amendments as effectively in the opinion of the Agency. The Agency’s reasons for rejecting the petitioner’s approaches are described in Section VII.B. Other than doing nothing, the options presented by the petitioners are the only options the Agency has seriously considered outside of what is being proposed.

F. ESTIMATE OF THE PROBABLE COSTS OF COMPLYING WITH THE PROPOSED RULE AMENDMENTS, INCLUDING COSTS BORNE BY CATEGORIES OF AFFECTED PARTIES [VIII. TP limit, reasonableness]

The estimated costs to outside parties due to the proposed extension of the TP limits are discussed in detail Section XI.

G. ESTIMATE OF THE PROBABLE COSTS OF NOT ADOPTING THE PROPOSED RULE AMENDMENTS, INCLUDING COSTS BORNE BY CATEGORIES OF AFFECTED PARTIES [VIII. TP limit, reasonableness]

In general it is unlikely that there would be any direct costs to any party if the proposed extension of the TP limit was not adopted. However, the proposed rule is clear in its application and implementation will be straightforward. Because of this, it is not unreasonable to assume that there could be cost savings to some outside parties and the Agency due to fewer contested case hearings and less litigation under the proposed rule.

Some unquantifiable and intangible “costs” may be borne by the public in general if they perceive that the lack of action, real or imagined, will perpetuate or exacerbate poor water quality conditions in rivers and streams.

H. DIFFERENCES BETWEEN THE PROPOSED RULE AND EXISTING FEDERAL REGULATIONS AND THE NEED FOR AND REASONABLENESS OF EACH DIFFERENCE [VIII. TP limit, reasonableness]

There are no specific federal regulations that the Agency is aware relevant to the extension of TP limits to new or expanding discharges that discharge more than 1,800 pounds of TP per year.

Minnesota Stat. §§ 14.002 and 14.131 require state agencies, whenever feasible, to develop rules and that are not overly prescriptive and inflexible, and rules that emphasize achievement of the Agency’s regulatory objectives while allowing maximum flexibility to regulated parties and to the Agency in meeting those goals.

The proposed extension of the TP limits combines a “prescriptive” component with a more flexible component. The former is the 1 mg/L limit itself, which is prescriptive. The latter is exemplified by the three possible exemptions available to dischargers, which allows them to request an alternative limit or no limit at all. Any petition the Agency receives from a discharger for relief under one of the exemptions (Section IX.H) will need to be reviewed and processed on a case-by-case basis. The Agency will have discretion as to the disposition of future petitions. It may be prudent for the Agency to establish a policy framework for the consideration of petitions, and to write technical guidance to help dischargers prepare a petition is a possibility.

The general concepts of how prescriptive or flexible a rule should be are discussed more in SONAR Book I, Section VIII.I.

J. ADDITIONAL NOTIFICATION OF THE PUBLIC UNDER MINN. STAT. §§ 14.131 AND 14.23 [VIII. TP limit, reasonableness]

Minnesota Stat. §§ 14.131 and 14.23 require the Agency to include in its SONAR a description of its efforts to provide additional notification to persons or classes of persons who may be affected by the proposed rule, or the Agency must explain why these efforts were not made.

The Agency has outlined its efforts to inform and involve interested and affected parties and the public in general in Section III of SONAR Book I. As noted, the Agency has gone beyond these statutory requirements in its efforts to involve the public in this rulemaking. The Agency has made significant changes to the scope and content of the proposed amendments in response to public comments.

Section V.J lists all the parties the Agency intends to send a copy of the notice of intent to adopt the rule amendments to and includes other information about public notice that is not repeated here. A copy of the notice, proposed rule amendments and SONAR will be posted on the Agency’s public notice Web site at: http://www.pca.state.mn.us/news/index.html.

Pursuant to Minn. Stat. § 14.143, subd. 1a, the Agency believes its regular means on notice, including publication in the State Register and on the Agency’s public notice Web page will adequately provide notice of this rulemaking to persons interested in or potentially regulated by these rules.
K. CONSULTATION WITH THE COMMISSIONER OF FINANCE REGARDING FISCAL IMPACTS ON LOCAL GOVERNMENTS [VIII. TP limit, reasonableness]

Minnesota Stat. § 14.131 requires the Agency to consult with the Department of Finance to help evaluate the fiscal impact and benefits of proposed rules on local governments. In accordance with the interim process established by the Department of Finance on June 21, 2004, the Agency provided the Department of Finance with a copy of the proposed rule and SONAR at the same time as these items were sent to the Governor’s Office. This timing allows the fiscal impacts and fiscal benefits of the proposed rule to be reviewed by the Department of Finance concurrent with the Governor’s Office review.

L. AGENCY DETERMINATION REGARDING WHETHER COST OF COMPLYING WITH PROPOSED RULE IN THE FIRST YEAR AFTER THE RULE TAKES EFFECT WILL EXCEED $25,000 [VIII. TP limit, reasonableness]

The Administrative Procedures Act was amended in 2005 to include a section on potential first-year costs attributable to the proposed amendments (Minn. Stat. § 14.127, subd. 1 and 2). This amendment requires the Agency to determine if the cost of complying with a proposed rule in the first year after the rule takes effect will exceed $25,000 for:

- Any one business that has less than 50 full-time employees, or
- Any one statutory or home rule charter city that has less than ten full-time employees.

The Agency believes it is highly unlikely that the cost of complying with the proposed extension of the TP limit to new and expanding dischargers will exceed $25,000 in the first year after it takes effect, for the two categories of outside parties listed above, for two reasons.

First, the proposal will not impact most small business and small cities due to the *de minimis* threshold of 1,800 pounds of TP discharged in one year. An annual discharge of 1,800 pounds of TP equates to cities with a population of about 2000 at a TP concentration of 3 mg/L, which is roughly the median TP effluent concentration for POTWs without TP removal. Agency staff contacted representatives of the League of Minnesota Cities and the Minnesota Association of Small Cities and, while there are no hard data they could point to, based on their experience both (independently) felt that cities with fewer than 10 employees generally had populations in the 1000-1200 range. A city with a population of 1200 would need a TP effluent concentration of about 5 mg/L to exceed the 1,800 pound *de minimis* threshold. An analysis of 2005 effluent TP data for municipalities without TP removal, 20 out of 111 (18%) had an average TP effluent concentration greater than 5 mg/L. Thus, few small cities, those with fewer than 10 employees, are likely to trigger the *de minimis* threshold.

Second, the number of parties of any size that will incur costs in the first year after adoption is likely to be small because of the time it takes to issue permits for new or expanding facilities and the time it takes for the city or business to let contracts for planning, design and construction of
the new facilities. Estimated municipal and industrial costs are discussed in Sections XI.D and XI.E.
IX. REASONABLENESS OF PROPOSED EXTENSION OF PHOSPHORUS EFFLUENT LIMIT

A. INTRODUCTION [IX. TP limit, reasonableness]

Minnesota Stat. ch. 14 requires the Agency to explain the facts establishing the reasonableness of the proposed rules. “Reasonableness” means: 1) that there is a rational basis for the Agency’s proposed actions, 2) that the Agency’s proposed amendments are appropriate and consistent with its mandate to protect Minnesota’s water resources, and 3) due consideration has been given to the potential economic impacts of the proposals.

The Agency is proposing that municipal and industrial facilities that expand or build new after May 1, 2008, and discharge more than 1,800 pounds of phosphorus per year, treat and remove phosphorus to 1 mg/L. This Section of SONAR Book II will discuss why the proposed amendment to the phosphorus effluent limit is reasonable.

B. BACKGROUND AND HISTORY [IX. TP limit, reasonableness]

The Agency has a long history of controlling the discharge of phosphorus from point sources. The following chronology outlines the major steps in the evolution the 1 mg/L TP limit. Also discussed are other provisions or rules pertaining to the control of nutrients.

1. The Phosphorus Rule [IX.B. TP limit, reasonableness]

June 1967, WPC 1541. Water quality standards and treatment requirements for discharges to Interstate waters are adopted. This first version of WPC 15 included a 1 mg/L TP effluent limit applicable to any discharge to a dilution-limited receiving water. That is, a TP limit was applicable to any discharger that must provide better than minimum secondary treatment of its wastewater in order to protect downstream water quality standards under low flow conditions.

The 1967 language is quoted below.

“In any instance where it is evident that natural mixing or dispersion of an effluent is not effective in preventing pollution, .... In addition, the following effluent standards may be applied without any allowance for dilution where stream flow or other factors are such as to prevent adequate dilution or where it is otherwise necessary to protect the interstate waters for the stated uses:

…
Total phosphorus 1 mg/L “

41 WPC means “Water Pollution Control”.
It is worth emphasizing that this early 1 mg/L limit applied to any discharger discharging to a receiving water with limited dilution regardless of whether the discharge was to a lake or affected a downstream lake or reservoir.

**August 1967, WPC 14.** Water quality standards and treatment requirements for discharges to *intrastate* waters are adopted with the same TP limit shown above for WPC 15. WPC 14 and 15 together are the state’s first statewide water quality rules.

**July 1969, WPC 15.** Language was added to the standards for interstate waters (but not to WPC 14, intrastate waters) to supplement the 1 mg/L limit applicable to discharges to low flow situations. The new language immediately follows the numeric effluent limits for BOD, TSS and TP in the rule, and is:

“It is the intent of the Agency to require the removal of nutrients from all sources to the fullest practicable extent whenever sources of nutrients are considered to be actually or potentially inimical to preservation or enhancement of the designated uses.” (emphasis added)

As in 1967, the context of this statement is effluent limits applicable to discharges with limited dilution, to which the 1 mg/L TP limit applies. This would seem to confirm that the 1 mg/L was more applicable to discharges to rivers than discharges to lakes, because, unlike rivers, lakes do not have a “low flow.” Also, the 1969 language included the words “all sources;” whereas in 1967 “sources” seemed to be implied by the context.

A statement in a 1973 document42 prepared for the proposed 1973 amendments to WPC 15 suggests that the Agency, at this early date, intended for nutrients to be removed wherever necessary to preserve and enhance the designated water uses. It is not entirely clear at this time whether or not the Agency intended the removal of nutrients to apply broadly; i.e., to discharges to low flow rivers (and lakes?) from all sources. However, following the 1973 amendments and subsequent amendments, plus the Agency’s history of applying the TP limit after 1973, a more narrow interpretation emerged as the intent of the Agency, as described below.

**October 1973, WPC 14 and WPC 15.** Both the intra- and interstate water quality rules were amended to change the applicability of the TP limit from any discharger with limited dilution to facilities discharging directly to or affecting a downstream lake or reservoir. The TP limit was moved from the part of the rule containing advanced treatment requirements (low dilution situations) to the part of the rule containing minimum technology-based (secondary treatment) requirements. The 1973 TP language is quoted below:

*Phosphorus*** 1 milligram per liter

***Where the discharge of effluent is directly to or affects a lake or reservoir. Removal of nutrients from all wastes shall be provided to the fullest practicable extent wherever

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sources of nutrients are considered to be actually or potentially detrimental to preservation or enhancement of the designated water uses.

This is the introduction of the requirement that has become known as the “phosphorus rule” or “P rule” that is still in place today. The P rule has been the cornerstone for the Agency’s efforts to reduce point source nutrient loading to the state’s lakes and reservoirs for over 30 years. The P rule has resulted in 1 mg/L TP limits in the permits of about 148 POTWs.\(^\text{43}\) This is about 25 percent of all permitted domestic facilities. But when this percentage is put in terms of the amount of treated wastewater that receives TP removal relative to the total amount of treated domestic wastewater statewide, it jumps to about 72 percent.\(^\text{44}\) Thus, TP is being removed from nearly three fourths of all the treated domestic wastewater covered by NPDES permits in Minnesota. The removal of TP at the MCES Metro plant in St. Paul, by far the state’s largest with an AWWDF of 251 mgd, is a major reason this figure is as high as it is.

There were other changes made in 1973 worth noting. Also moved from the part of the rule specifying requirements for dischargers to low-dilution situations to the secondary treatment requirements was the “Removal of nutrients from all wastes shall be provided to the fullest practicable, extent” language. The “fullest practicable extent” (FPE) language follows immediately after the TP limit as part of the double asterisk footnote shown above. Also, the wording of the FPE clause was changed from the 1969/1971 version. The earlier version said the Agency required nutrient removal from “all sources;” the 1973 version requires nutrient removal from “all wastes” to the fullest practicable extent wherever “sources” are detrimental. Thus, in 1973 the FPE language becomes closely associated only with situations that require the 1 mg/L limit. From this time forward the Agency has been consistent in its interpretation of the FPE language as applicable to those facilities that have a TP limit and not all facilities (see Section VII.I). The FPE language has been used as the basis for requiring TP limits more stringent than 1 mg/L.

The Agency modified the P rule language in subsequent rulemakings – amendments completed in 1984, 1988, 1990, and 1994. The details of these mostly minor changes are not important for this discussion and rulemaking. In 2000 the Agency added the option of allowing an averaging period for the TP limit longer than one month, up to one year. At the same time the FPE language become a separate paragraph. Through all these amendments the heart of the P rule remained the same. That is, a 1 mg/L TP limit applied to discharges directly to, or discharges that significantly impact a downstream lake or reservoir, and the FPE provision applied only to dischargers that received a TP limit due to the “to or affects” language.

\(^{\text{February 1971, WPC 27, 28 and 30.}}\) Former WPC 27 is a reflection of Canadian and U.S. efforts to protect the Great Lakes from eutrophication in the late-1960s and early-1970s. To reduce the loading of nutrients, states bordering the Great Lakes adopted basin-wide 1 mg/L TP effluent limits applicable to all dischargers in watersheds draining to the lakes. Minnesota adopted WPC 27 in February 1971 to protect the Minnesota portion of the Lake Superior basin; it established a 1 mg/L limit for all point source dischargers in the basin. Michigan, for example, requires

\(^{\text{43}}\) Current as of July 2006. In the last 6 years some of the 148 limits would be attributable to the Phosphorus strategy and permittee/Agency negotiations.

\(^{\text{44}}\) This percentage is based on treatment plant design flows, not actual flows.
essentially all point source dischargers in the state to meet a 1 mg/L TP limit because the entire
state (except for a tiny portion in the SW corner) drains to one of the Great Lakes. A limit of 1
mg/L has been widely adopted because it can be achieved by proven and readily implementable
treatment technologies (chemical addition).

TP limits were adopted for other basins or waterbodies in Minnesota at the same time in separate
rules, WPC 28 and 30. These two rules plus WPC 27 are now combined in existing Minn. R. ch.
7065. The combined rule establishes a 1 mg/L TP effluent limit for discharges in: 1) all waters
in the Lake Superior basin, 2) portions of the upper Mississippi River, Lake St. Croix, and 3) the
Little Minnesota River, Big Stone Lake and Albert Lea Lake. The Agency is proposing to
combine all TP limits now in Minn. R. ch. 7050 and 7065 into new Minn. R. 7053.0255 (Section
VII.F, and Section V.E.10 of SONAR Book I).

2. Other Provisions and Rules With Phosphorus Control Measures [IX.B. TP limit,
reasonableness]
Several parts of existing Minn. R. ch. 7050, outside of Minn. R. 7050.0211, subp. 1a, incorporate
phosphorus or nutrient control for point source dischargers. For the most part these provisions
refer back to the 1 mg/L TP limit in existing Minn. R. 7050.0211, subp. 1a and the “to or affects”
language. Table II-15 is a list of these provisions. Again, the TP provisions in existing Minn. R.
ch. 7050 are to be moved into the proposed new Minn. R. ch. 7053.

Table II-15. References to Point Source Phosphorus Effluent Limits in Existing Minn. R. ch.
7050 and Proposed New Minn. R. ch. 7053.

<table>
<thead>
<tr>
<th>Existing Minn. R. ch. 7050</th>
<th>Proposed New Minn. R. ch. 7053</th>
<th>Provision; References are to Proposed Minn. R. 7053</th>
</tr>
</thead>
<tbody>
<tr>
<td>7050.0211, subp. 1a</td>
<td>7053.0255</td>
<td>Phosphorus rule</td>
</tr>
<tr>
<td>7050.0212, subp. 2a</td>
<td>7053.0225, subp. 3</td>
<td>Exempts dredge disposal return water from the phosphorus limit, contingent on certain conditions.</td>
</tr>
<tr>
<td>7050.0212, subp. 4</td>
<td>7053.0225, subp. 4</td>
<td>Industries must meet requirements of Minn. R. 7053.0255</td>
</tr>
<tr>
<td>7050.0213</td>
<td>7053.0235, subp. 1</td>
<td>Advanced treatment requirements include limits in Minn. R. 7053.0255</td>
</tr>
<tr>
<td>7050.0214, subp. 1</td>
<td>7050.0245, subp. 1</td>
<td>Treatment requirements for discharges to limited resource value waters include limits in Minn. R. 7053.0255</td>
</tr>
<tr>
<td>7050.0215, subp. 2 (also 7020.2003, subp. 3)</td>
<td>7050.0305, subp.2</td>
<td>Treatment requirements for animal feedlots include limits in Minn. R. 7053.0255, except feedlots are not included in the definitions of “new” or “expanding” discharges.</td>
</tr>
<tr>
<td>7050.0216, subp.3, item B</td>
<td>7050.0405, subp.3, item B</td>
<td>Requirements for aquaculture facilities include the requirements in 7053.0405, subp. 3, which in turn refers back to the phosphorus limit in Minn. R. pt. 7053.0255.</td>
</tr>
<tr>
<td>7050.0216, subp. 5, item E</td>
<td>7050.0405, subp.5, item E</td>
<td>Closure plan for abandoned aquaculture facilities; must restore the affected waterbody back to its mean pre-aquaculture trophic condition.</td>
</tr>
</tbody>
</table>
The parts of existing Minn. R. ch. 7050 listed below contain general narrative provisions dealing with nutrient control. Also, the nondegradation evaluations include an assessment of potential impacts of nutrients on outstanding resource value waters and all waters of the state.

- Minn. R. pt. 7050.0210, subp.2. Nuisance Conditions Prohibited. No point or nonpoint sources should cause pollution resulting in excessive plant growth
- Minn. R. pt. 7050.0222, subp. 7. Additional Standards. There should be no material increase in undesirable slime growth or aquatic plants including algae to Class 2 waters.

Existing Minn. R. 7100.0210 (Nutrient Limitation) limits the nutrient (phosphorus) content of cleaning products. The Agency is not proposing any changes to this rule.

Minnesota Stat. § 18C.60 restricts the use of lawn fertilizers containing phosphorus to certain special situations, such as new lawns or where a soil test indicates that the home owner’s soil is deficient in phosphorus.

C. AGENCY’S PHOSPHORUS STRATEGY [IX. TP limit, reasonableness]

In 1996, in response to the threat to the state’s water resources from phosphorus loading, the Agency set out to develop a comprehensive Phosphorus Strategy (Strategy), Exhibits PL-1a is a copy of the Strategy Web page, PL-1b is a fact sheet and PL-1c is the complete Strategy with the decision tree. The “decision tree” guides the reader through the steps to determine when a phosphorus limit is called for. The purposes of the Strategy are to:

- Promote the reduction of TP loading from both point and nonpoint sources to lakes and reservoirs;
- Provide a consistent framework for applying phosphorus controls (primarily the P rule) in setting TP limits in NPDES permits;
- Serve as a guide to Agency staff and to outside parties on how TP issues will be addressed, particularly in NPDES permits;
- Clarify or define terms that have been used in setting TP limits for years, such as “affects,” “lake” and “reservoir;” and
- Define new concepts introduced as part of the Strategy such as de minimis loading.

In the fall of 1999, the Agency held informal meetings with interested parties such as watershed districts, environmental groups, cities, lake associations and other state agencies to discuss the Strategy. The Agency received hundreds of comments, and several changes were made to the Strategy as a result (Exhibit PL-1b).

The Strategy also laid out seven action steps to be taken by the Agency to reduce the loading of TP from both point and nonpoint sources; they are:
1. Develop education/outreach information on environmental impacts of phosphorus.
2. Co-sponsor basin-wide phosphorus forums.
3. Use basin management as the main policy context for implementing the phosphorus strategy.
4. Broadly implement Minnesota's point-source phosphorus controls.
5. Broadly promote lake protection activities.
6. Address phosphorus impacts on rivers.
7. Modify water-quality standards if necessary.

Action steps 4 and 7 are the most relevant to this rulemaking. Eutrophication water quality standards are being “modified” by proposing numeric eutrophication standards to supplement the existing narrative standards. The proposed extension of the TP limit to new and expanded facilities will broaden the implementation of the P rule.

The Citizens’ Board approved the Strategy as Agency policy in March 2000. At that time the Board expressed interest in adopting a “universal” 1 mg/L phosphorus effluent limit for all discharges. The Agency’s proposed extension of the P Rule is consistent with the Strategy’s general purpose and goals; and more specifically, it incorporates into the rule the de minimis threshold for implementation of TP limits for new or expanding dischargers. The proposed extension of the phosphorus limit is to a large extent being implemented now under the Phosphorus Strategy. The proposed rule represents a codification of the strategy except the rule will allow certain exemptions (see Section IX.H).

By any measure, the Strategy has been very successful. Under the Strategy dischargers that previously may not have had to reduce effluent phosphorus have, 1) accepted a 1 mg/L TP limit, 2) adopted treatment options that reduce effluent phosphorus such as Bio-P, or 3) taken other measures to reduce effluent TP. As permits come up for reissuance, Agency staff evaluates them for possible TP limits. Over the last five to six years there has been a clear trend that when new facilities are built or existing facilities expand, 1 mg/L TP limits have been added to the permit. Since March 2000, about 34 POTWs that have design flows (AWWDF) greater than 0.2 mgd have gotten limits that are attributed to the Strategy (Exhibit PL-10). An additional nine POTWs with AWWDFs less than 0.2 mgd have gotten limits under the Strategy. Facilities smaller than 0.2 mgd may be below the de minimis loading of 1,800 pounds per year (depending on effluent TP concentrations); if so, they would not be impacted by the proposed extension of the TP limit. Such facilities may, however, continue to get TP limits in the future for other reasons including the Strategy.

Also under the Strategy, in addition to or in lieu of a numeric limit, many dischargers were asked to develop and implement a phosphorus management plan (PMP) when their permit was reissued. A PMP asks the facility to monitor influent and effluent TP, monitor the contributions of TP from industries or other sources discharging to the POTW and identify sources with high TP concentrations. Major sources are asked to review their practices and use of phosphorus containing products, and to make changes or product substitutions if possible to reduce the discharge of TP to the sanitary sewer. The Agency has used an average effluent TP concentration of 4 mg/L as a rule-of-thumb threshold for requiring a PMP in a permit (Exhibit...
PL-1c). Recent data assembled for POTWs with mechanical treatment (continuous discharges) and with no TP limit indicate that 54 percent have TP effluent concentrations greater than 4 mg/L. 45 In general, the lower the concentration of influent TP, the lower the concentration of effluent TP. As of July 2006 nearly 74 percent of all NPDES permittees (424 out of 577) are required to prepare a PMP; 26 percent have actual TP limits.

The Strategy for all its effectiveness and public involvement is not a rule; it has no intrinsic authority. The proposed extension of the phosphorus limit will codify what has taken place under the Strategy, and continue the gains made in reducing phosphorus loadings state-wide. Critical elements of the Strategy will become rule as part of this rulemaking (Exhibit PL-1b).

In summary, the proposed extension of the 1 mg/L phosphorus limit is, to a large extent, being implemented now under the Phosphorus Strategy. This is due at least in part to the popularity and inherent advantages of the Bio-P technology. Depending on the watershed in which they are located, many communities are already being encouraged if not mandated under the terms of a TMDL, for example, to reduce effluent TP as they build new facilities or expand (next Section). Also, the proposal seeks to protect major watersheds before they become impaired and a TMDL is required. If society waits until a waterbody is impaired (i.e., water quality standards are exceeded and beneficial uses are actually or potentially lost), not only will water quality of surface waters suffer, but the cost to bring these waterbodies back to health, if possible at all, is usually far more than the cost of preventive measures. The Agency believes it is reasonable to codify portions of the Strategy in rule.

D. ONE MG/L PHOSPHORUS LIMITS BEING IMPLEMENTED NOW THROUGHOUT MUCH OF STATE [IX. TP limit, reasonableness]

The removal of phosphorus from point sources is required now in several major watersheds in Minnesota. The proposed extension of the TP limit to new and expanding facilities will have no impact in these watersheds. In other major watersheds in Minnesota pending TMDLs, adopted nutrient reduction goals, watershed management plans or downstream concerns about the impact of nutrient loading is likely to result in additional limits for facilities in these watersheds independent of the proposed extension of the TP limit. While some focus more on non-point sources of nutrients rather than point sources, the basin management plans for the Rainy, Red, Lower Mississippi and Cedar River watersheds have established nutrient management goals for the protection of surface waters.46 Also, essentially every permittee is being asked to do a phosphorus management plan (to look for ways to reduce influent TP) whether or not they get a numeric TP limit.

Lake Superior Basin and Lake St. Croix. As described in Section IX.B, rules adopted in 1971 require all dischargers in the Lake Superior basin, discharges to Lake St. Croix and to several other specific waterbodies, to meet a 1 mg/L effluent limit. And, as stated, the limits in existing Minn. R. ch. 7065 are proposed to be moved into the new Minn. R. 7053.0255.

Minnesota River TMDL. Requirements for phosphorus removal at facilities throughout the Minnesota River are being driven by the lower Minnesota River dissolved oxygen TMDL. The implementation plan for the Minnesota River TMDL includes a general permit that establishes seasonal TP limits applicable from May through September for the 40 largest facilities in the basin (> 1,800 pounds TP/yr.). However, the two largest discharges, the MCES operated Seneca and Blue Lake plants, will have year-round limits in 2008. Also, two new ethanol facilities with individual permits will have essentially year-round limits. Under the proposed rule, if facilities in the basin with seasonal limits expand in the future (to over 1,800 pounds TP/yr.), they would be subject to a year-round limit, unless they qualify for one of the proposed exemptions (Section IX.H).

It should be noted that the Minnesota River TMDL is a result of exceedances of the Class 2 dissolved oxygen (DO) standard in the lower 22 miles of the Minnesota River under low flow conditions. The low DO is caused by the decay of the abundant algae which result from excess phosphorus. This has a bearing on the fact that the general permit includes seasonal TP limits rather than year-round limits. The low DO is a side effect of excess nutrients but low DO itself is usually not a problem in rivers during the winter (except sometimes under total ice cover). Cold water holds more DO than warm water before it becomes saturated, and the metabolic rate of living organisms is much slower at cold temperature reducing their DO requirements. Also, warm water fish are not spawning in the winter, thus the more low-DO-sensitive early life stages are not present in the winter. The problem to be remedied in the lower Minnesota is a DO problem not a eutrophication problem per se. Year-round limits might be appropriate if the impairment was based on exceedance of nutrient criteria. Nutrient loading during the winter months can have direct negative impacts, and phosphorus that attaches to particulates in the winter can settle to the bottom and become available for algal growth the following summer.

At the present time rivers are not being directly assessed for impairment due to excess nutrients because the Agency has not developed numeric nutrient criteria applicable to rivers as it has for lakes.

Upper Mississippi River Basin and Lake Pepin TMDL. Lake Pepin is a natural lake on the Mississippi River downstream from Red Wing, Minnesota. Lake Pepin exceeds the Agency’s nutrient criteria for lakes and is impaired due to excess nutrients (also impaired for turbidity). Lake Pepin was added to the impaired waters list in 2004. The watershed above Lake Pepin includes about half of the area of Minnesota. The Lake Pepin nutrient TMDL is well underway but the implementation plan will not be complete for some time. In all likelihood, however, the implementation phase of this TMDL will call for TP limits for at least the larger discharges in the watershed that do not already have them.

St. Croix Basin. An interstate agreement to achieve ambitious nutrient reduction goals for the St. Croix basin was signed by the Commissioner of the Agency and the Secretary of the Wisconsin Department of Natural Resources on April 6, 2006 (Exhibit PL-2b). The Agreement formalizes a 20 percent TP loading reduction goal for the St. Croix basin. Achievement of this goal will reduce TP levels in Lake St. Croix to 1950 levels, which is projected to mean a decrease in the current average TP concentration of 50 µg/L to about 40 µg/L (Exhibit PL-2b). An earlier
Report (August 2004) containing the recommended water quality goals of the St. Croix Basin Water Resources Planning Team established the same goal of a 20 percent reduction TP loading to Lake St. Croix (Exhibit PL-2a).

Phosphorus limits are commonly issued to dischargers in the St. Croix basin now because of the importance of this national scenic and recreational river and the sensitivity of Lake St. Croix to impacts from excess nutrients. The recently sanctioned nutrient reduction goals can only increase the likelihood that point sources will get TP limits when their permits come up for reissuance, independent of the proposed extension of the TP limit to new and expanding dischargers.

Rainy River Basin. Lake of the Woods is an important recreational lake in northern Minnesota and is an international border water. Limited monitoring was conducted historically to assess lake conditions; however, lake monitoring has increased in intensity the past three years due to concerns over periodic algae blooms. A 2005 lake trophic status report shows mean TP, Chl-a and Secchi depth in the lake are near the proposed NLF ecoregion standards.\(^47\) Additionally, occasional high concentrations of Chl-a are found in the lake and the algal community is dominated by the less desirable blue-green algae most of the time. Follow-up sampling was conducted in 2006 to determine whether the lake should be placed on the 2008 impaired waters list. There is an extensive volunteer monitoring network on the Canadian side of the lake and the water quality in this portion is often better than the more southerly portion of the lake. The Rainy River is the largest water source entering the lake, making up 80 percent of the lake’s drainage basin. The 2005 report (footnote 46) documents that TP concentrations in the Minnesota portion of the lake reflect the TP concentration in the Rainy River. Additional lake monitoring is being conducted that will facilitate 303(d) assessment in 2008. Maintaining or improving the quality of Lake of the Woods will require management of phosphorous loads in the Rainy River upstream of the lake.

Red River Basin. The high level of suspended sediments and turbidity in the Red River appears to reduce the impact of nutrient loading to the river itself. The proposed third exemption is in partial recognition of this situation (Section IX.H.5). Downstream, however, Lake Winnipeg in Manitoba is becoming eutrophic.\(^48\) Manitoba has adopted a Lake Winnipeg Action Plan that, among other things, calls to:

"identify further actions necessary to reduce nitrogen and phosphorous to pre-1970 levels in the lake" and "commencement of cross-border nutrient management discussions".\(^49\)

The Red River flows into Lake Winnipeg downstream from the city of Winnipeg. Clearly Manitoba and the city of Winnipeg have a large stake in slowing and reversing the eutrophication of this large lake (about the size of Lake Erie). The city of Winnipeg has three wastewater treatment plants. One plant (west end) has a permit requirement to meet a 1 mg/L TP


limit that became effective at the end of 2006. Limits for the other two plants will follow.\textsuperscript{50} Because the Minnesota portion of the Red River basin is upstream of Lake Winnipeg, reducing the TP loading from Minnesota will help Canada in its efforts to improve the water quality in Lake Winnipeg.

Des Moines Basin. Heron Lake in the Des Moines River Basin has a history of excess nutrients, resulting in an overabundance of algae that shade the growth of rooted aquatic plants. This has had serious detrimental effects on duck populations on this historic prime waterfowl resource. The lake has been on the impaired waters list since 2002. The lower reaches of the Des Moines River have been on the impaired waters list for dissolved oxygen since 1994. Recent evaluations suggest high levels of algae in the river that stagnate behind small main-stem dams as a possible cause of the low DO. Nutrient reductions may be necessary to mitigate the low DO problem in the river as is the case in the lower Minnesota River Dissolved Oxygen TMDL.

Lower Mississippi River Basin (below Lake Pepin). Nutrients influence the function of the diverse surface water resources in the Lower Mississippi River Basin. The basin contains the Mississippi River, which is a large floodplain river, and tributaries, such as the Zumbro, Whitewater, and Root. There are many trout streams which drain the bluffs of the “Driftless Area” ecoregion. Lakes are most prevalent in the western portion of the Cannon River Watershed. Development of river nutrient standards will help us determine the ultimate nutrient goals for the waters of the Lower Mississippi River Basin.

The Mississippi River is an extremely productive river that contains a mosaic of impounded areas, side channels, backwaters and main channel habitats. The portion of the Mississippi River downstream of Lake Pepin is part of the Upper Mississippi River National Wildlife Refuge. The river serves as a nationally important resting area for migratory birds, a productive fishery and a navigational channel for the upper Midwest. The implications of nutrient loading to this system are not fully understood, but there are several indications that nutrients are an issue of concern for riverine health. Excess algal production can be detrimental to submersed aquatic plants (in shallow backwater and impounded areas) which are very important to the ecology of the Mississippi River. Wisconsin has recently expressed concern regarding excessive amounts of filamentous algae which may be negatively impacting submersed aquatic plants. Concentrations of TP often exceed 200 µg/L in the main channel and backwaters of the Mississippi River downstream of Lake Pepin. Average Chl-a levels exceed 50 µg/L especially during spring and summer. Concentrations of Chl-a can exceed 100 µg/L in channel areas during low flow conditions.

Algal growth occurs in winter, but it is difficult to determine its significance as a contributor to low dissolved oxygen in relatively isolated backwaters due to high densities of submersed aquatic vegetation that are also present in these areas. Also, it is difficult to determine the impact of winter TP influx due to a large pulse of water that is routed through the riverine systems during spring flooding. Relatively isolated backwaters are flushed during this period. Detention time in most areas in the Lower Mississippi Basin are generally measured in days rather than weeks. Low DO is less problematic in channel areas and some fish can move to channel

\textsuperscript{50} E-mail from Dwight Williamson, Director Water Science and Management Branch Manitoba Water Stewardship, May 9, 2005.
habitats during periods of low dissolved oxygen in backwaters, but fish such as bluegills and largemouth bass typically do not move due to low temperatures and high water velocities which they prefer to avoid in the winter.

Two lakes on the impaired waters list, Lakes Byllesby and Zumbro are located in the lower Mississippi Basin. The TMDLs for these waterbodies will determine the significance of winter discharges of TP above these lakes.

Cedar and Missouri Basins. The Cedar and Missouri Basins in Minnesota are smaller geographic headwater areas of the state and are characterized by small tributaries. As a result, fewer nutrient assessments have been undertaken in these basins. However, select assessments in these areas are of note. Excess nutrients were evaluated in a Clean Water Partnership project for Lakes Okabena, Ocheda and Bella near Worthington. Nutrient goals were established in these projects. The Iowa Department of Natural Resources has developed a TMDL for Little Spirit Lake on the Iowa Minnesota border in the Missouri River Basin. The TMDL is for impairments of algae and turbidity due to excess nutrient (phosphorus) loading to the lake. A 60 percent phosphorus load reduction is needed to meet the TMDL and achieve the designated use for Little Spirit Lake. A general review of water quality data shows elevated phosphorus and chlorophyll concentrations in the rivers in these basins. Considering the close proximity of these basins to the Minnesota River Basin and the land use similarity between the basins it is not unexpected that river nutrient conditions are similar.

E. COMMENTS FROM MESERB [IX. TP limit, reasonableness]

The Minnesota Environmental Science and Economic Review Board (MESERB) commented in letters (Exhibits A-34 and A-35) that Minn. Laws 2005 ch. 1, art. 2, § 151 Subdivision 1.(g) prevents the Agency from adopting the proposed extension of the TP limit to new and expanding discharges above a certain size. The part of the Session law that MESERB cites is shown below:

Sec. 151. [WATER QUALITY ASSESSMENT PROCESS.]
Subd. 1. [RULEMAKING]

(g) The rules must provide that the agency, in considering impairment due to nutrients and application of nutrient objectives and effluent limitations related to riverine systems or riverine impoundments, must consider temperature and detention time effects on algal populations when the discharge of nutrients is expected to cause or contribute to algal growth that impairs existing or attainable uses.

The Session law says the Agency must take the effects temperature and hydraulic detention time have on algae populations into account when considering effluent limits for dischargers to “riverine systems” and river impoundments when the discharge is expected to cause or contribute to impairment of existing or attainable uses.

51 The rulemaking required by this Session Law was adopted by the Agency Board in October 2006. The SONAR for the separate Session Law rulemaking is Exhibit A-4.
It is the opinion of the Agency that this part of the Session Law does not preclude the Agency from promulgating the changes to the 1 mg/L phosphorus effluent limit as proposed (Exhibit A-36). The Session Law mandated a rulemaking separate from this proposed rulemaking. The Session Law pertained to the current phosphorus rule, which relies on a demonstration of measurable “affects” on a downstream lake or reservoir due to the TP loading – a demonstration that considers the effects temperature and, where relevant (reservoirs), residence time have on effects of TP loading. The Agency has always addressed these two factors where relevant irrespective of the Session Law, and will continue to do so in implementing the current phosphorus rule (existing Minn. R. 7050.0211, subp. 1a). The Session Law does not preclude the Agency from taking an action, separate from the Session Law, to regulate the discharge of phosphorus to sustain the progress in point source TP reductions started under the policy of the Phosphorus Strategy. The proposed extension of the TP effluent limit is not keyed to a finding of measurable impacts from the additional TP load on riverine or lake systems.

Apart from MESERB’s issues regarding Agency authority to set effluent limits, the Agency believes that MESERB’s basic concern about TP limits being imposed in situations where no negative impacts have been demonstrated are substantially mitigated by the facts presented in the reasonableness section of this SONAR as highlighted below.

- Under the proposal TP limits will not apply to small dischargers (more than half of all POTWs) – those discharging less than 1,800 pounds of TP in a year (next Section).
- Twenty six percent of all POTWs have TP limits now (about 72 percent of the total volume of treated wastewater in Minnesota).
- The Proposal is being substantially implemented now under the Phosphorus Strategy. Over the five-year period following adoption of the Strategy (March of 2000) about 34 POTWs (> 0.2 mgd) got TP effluent limits years that may not have gotten limits before.
- TP effluent limits are already required in much of the state due to existing rules, nutrient -related TMDLs or nutrient reduction goals.
- Dischargers may request relief from the TP limit under one or more of the proposed exemptions. The third exemption provides for the possibility of summer-only limits in certain watersheds.

Phosphorus has been shown to be one of the most pervasive and damaging nontoxic pollutants the Agency deals with. Nutrient loading to rivers has negative impacts that often go unmeasured or undetected because of the lack of monitoring. Phosphorus is not degraded and it can be carried far downstream. Some portion of the TP released under conditions of high flow and low temperatures, if not manifested under these conditions, can contribute to a degraded condition when flows decline and temperatures increase.

In summary, the Agency has broad authority to set effluent limits to prevent the pollution of waters of the state and to prevent the physical chemical or biological degradation of receiving waters (Minn. Stat. § 115.03). The Session Law does not prevent the Agency from promulgating the extension of the TP limit to new and expanding discharges that exceed the de minimis TP load in a separate rulemaking because:
• TP limits in the rule required by the Session Law are dependant on a finding of impacts to the receiving water due to the TP load.
• The proposed TP rule is a separate action. The proposed limits are not dependent on making a finding of measurable effects.
• The Session Law does not say the Agency can only set effluent limits when there is a demonstration of effects. It did not preclude the Agency from proposing rulemaking that takes regulatory actions beyond the 1973 TP rule.

F. **DE MINIMIS SIZE EXEMPTION [IX. TP limit, reasonableness]**

Included in the proposed extension of the TP effluent limit to new and expanded discharges is a de minimis mass TP loading from point sources. Municipal and industrial facilities that discharge less than the de minimis load, 1,800 pounds of TP per year, are not subject to the proposed 1 mg/L effluent limit. Wisconsin adopted a de minimis of 1,800 pounds in their “P-rule” (Exhibit PL-13), and the Agency used the Wisconsin experience as a starting point in their own investigation of an appropriated de minimis.

The selection of 1,800 pounds of TP per year is a result of research carried out for the development of the Strategy (Exhibit PL-1c, page 3). This analysis was completed in 2000. The concept of de minimis in the context of TP loading implies a diminishing return that would be realized if TP limits were to be applied to facilities discharging this amount or less. The de minimis loading does not apply to dischargers to or affecting a lake, shallow lake or reservoir, or waterbodies covered by existing Minn. R. ch. 7065, as is the case today.

Exhibit PL-1c describes in detail the data and the analysis that supports the selection of the de minimis amount. In brief, data for publicly owned treatment works (POTW) in three major basins were investigated (Upper Mississippi, Minnesota, and St. Croix basins). The data for the POTWs in these three watersheds are assumed to be representative of POTWs state-wide. The data used includes:

- Size of the treatment facility as indicated by the monthly average wet weather design flow (AWWDF), which is used to divide POTWs into two categories: those with AWWDFs ≤ 0.2 mgd and > 0.2 mgd;
- Number of mechanical and pond treatment systems;
- Population served;
- Effluent TP concentrations; and
- TP mass loading.

The AWWDF of 0.2 mgd is used as a convenient estimate of the size facility that will discharge about 1,800 pounds of TP per year, or be at the threshold of the de minimis loading. Table II-16 shows the data from the three watersheds used in the Strategy to estimate the number of POTWs likely to be above and below the de minimis loading. Also included in Table II-16 is more recent data for all POTWs state-wide. These data show that the majority of all POTWs have AWWDFs less than 0.2 mgd. Mechanical wastewater treatment plants have a continuous discharge and tend to be the treatment choice of larger communities. The typical stabilization pond discharges
twice per year for about two to three weeks in the spring and fall. Stabilization ponds are more likely to be the choice of smaller communities. This is reflected in the data in Table II-16. Roughly a third of all mechanical POTWs and over 80 percent of all pond systems will be exempt from the proposed extension of the TP limit to new and expanded discharges.
Table II-16. Number of All, Mechanical, and Pond POTWs with Average Monthly Wet Weather Design Flows Below 0.2 mgd (percentages in parentheses).

<table>
<thead>
<tr>
<th>POTW Category*</th>
<th>Data Used in the Strategy, Exhibit PL-1c</th>
<th>State-wide Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper Miss. R. Basin</td>
<td>Minn. R. Basin</td>
</tr>
<tr>
<td>No. of POTWs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total, All</td>
<td>123</td>
<td>133</td>
</tr>
<tr>
<td>Less than 0.2 mgd</td>
<td>69 (56%)</td>
<td>85 (64%)</td>
</tr>
<tr>
<td>Total, Mechanical</td>
<td>65</td>
<td>56</td>
</tr>
<tr>
<td>Less than 0.2 mgd</td>
<td>24 (37%)</td>
<td>25 (45%)</td>
</tr>
<tr>
<td>Total, Ponds</td>
<td>57</td>
<td>77</td>
</tr>
<tr>
<td>Less than 0.2 mgd</td>
<td>45 (79%)</td>
<td>60 (78%)</td>
</tr>
</tbody>
</table>

* Number of facilities in each category will vary slightly depending on how some less typical facilities are counted, and the plant design flows were not available for a few facilities.

The information in Table II-17 shows that the mass loading of phosphorus from POTWs smaller than the *de minimis* loading (0.2 mgd) represents a small fraction of the total basin-wide loading from all sources, point and nonpoint – about eight percent or less at low river flows and about two percent or less at average river flows. Thus, exempting small discharges from the proposal will have little impact on overall TP loading; and, conversely including them will gain little in the way of TP loading reductions basin-wide. The TP loading data in Table II-17 is based on median effluent TP concentrations and AWWDFs. Therefore, the percentages should be considered high-end estimates because plant design flows are larger than the actual plant flows (see Exhibit PL-1c for details).

Table II-17. Percent Mass Contribution of TP from Facilities with a Design Flow Less Than 0.2 mgd Relative to Basin-wide TP Loading.

<table>
<thead>
<tr>
<th>Flow Conditions in Receiving Stream</th>
<th>Upper Miss. R. Basin</th>
<th>Minn. R. Basin</th>
<th>St. Croix R. Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Flow</td>
<td>6.5 %</td>
<td>8.2 %</td>
<td>2 %</td>
</tr>
<tr>
<td>Average Flow</td>
<td>1.8 %</td>
<td>1.3 %</td>
<td>1 %</td>
</tr>
</tbody>
</table>

The Strategy investigated TP loading data for industries located in the same three basins listed in Table II-17, plus industries in the Lower Mississippi, Cedar and Des Moines River basins. The Agency concluded that the 1,800 pound TP *de minimis* could be applied to industries as well as POTWs. In general, industries of all sizes contribute a very small fraction of the total TP loading in these watersheds (the Des Moines being the major exception). The contribution from industries with
design flows below 0.2 mgd, of which there are very few in any basin, contributed less than 0.1 percent of the cumulative basin-wide TP mass loading. Also, the mean or median effluent TP concentration of the industries below 0.2 mgd in size were less than 1 mg/L (Exhibit PL-1c, page 10).

In conclusion, the proposed extension of the TP limit to new and expanding dischargers will include a *de minimis* size facility; facilities below this size will not be impacted. This is a continuation of the policy adopted in the Phosphorus Strategy. Data for POTWs state-wide indicates that the proposal will not apply to more than half of all POTWs because of the *de minimis* threshold. Less than 20 percent of communities with pond systems will be impacted. Facilities discharging less than the *de minimis* (1,800 pounds TP per year or about 0.2 mgd AWWDF) contribute very little to the overall nutrient loading to rivers and streams. Excluding these facilities will not have measurable impact on the environment. Including a *de minimis* threshold in the proposal is a reasonable and cost effective means to assure that phosphorus removal dollars will be spent where they will have the greatest impact.

G. TP EFFLUENT LIMIT LANGUAGE CHANGES [IX. TP limit, reasonableness]

I. *Introduction and Proposed Language in Minn. R. 7053.0255* [IX.G. TP limit, reasonableness]

As described in the *need* section (Section VII.F), the Agency is proposing to consolidate all the TP effluent limits in one part of the proposed new rule, Minn. R. ch. 7053. All of proposed Minn. R. 7053.0255 is repeated below and should be referred to for the discussion of the six subparts in the sections that follow.

7053.0255 PHOSPHORUS EFFLUENT LIMITS FOR POINT SOURCE DISCHARGES OF SEWAGE, INDUSTRIAL, AND OTHER WASTES.

**Subpart 1. Scope.** The phosphorus effluent limits in this part are in addition to the effluent limits specified elsewhere in this chapter. In the event of any conflict between this part and other applicable regulations, the more stringent requirement applies.

**Subp. 2 Definitions.** For the purposes of this part, the following definitions apply. Other relevant definitions are found in part 7050.0150, subpart 4.

A. "122-day ten-year low flow" or "122Q_{10}" means the lowest average 122-day flow with a once in ten-year recurrence interval. A 122Q_{10} is derived using the same methods used to derive a 7Q_{10} and the guidelines regarding period of record for flow data and estimating a 7Q_{10} apply equally to determining a 122Q_{10} as described in part 7053.0135, subpart 3.
B. “Affects” means a measurable increase in the adverse effects of phosphorus loading as determined by monitoring or modeling, including, but not limited to, an increase in chlorophyll-a concentrations, a decrease in water transparency, or an increase in the frequency or duration of nuisance algae blooms, from an individual point source discharge.

C. "Expanded discharge" means a disposal system that after May 1, 2008, discharges more than 1,800 pounds of total phosphorus per year to a surface water on an annual average basis, and increases in wastewater treatment capacity as indicated by an increase in the:

(1) design average wet weather flow for the wettest 30-day period for point source dischargers of sewage with a continuous discharge, typically a mechanical facility;
(2) design average wet weather flow for the wettest 180-day period for point source dischargers of sewage with a controlled discharge, typically a pond facility; or
(3) design average daily flow rate for dischargers of industrial or other wastes.

D. “Lake” means an enclosed basin filled or partially filled with standing fresh water with a maximum depth greater than 15 feet. Lakes may have no inlet or outlet, an inlet or outlet, or both an inlet and outlet.

E. “Measurable increase” or “measurable impact” means a change in trophic status that can be discerned above the normal variability in water quality data using a weight of evidence approach. The change in trophic status does not require a demonstration of statistical significance to be considered measurable. Mathematical models may be used as a tool in the data analysis to help predict changes in trophic status.

F. "New discharge" means a discharge that was not in existence before May 1, 2008, and discharges more than 1,800 pounds of total phosphorus per year.

G. “Reservoir” means a body of water in a natural or artificial basin or water course where the outlet or flow is artificially controlled by a structure such as a dam. Reservoirs are distinguished from river systems by having a hydraulic residence time of at least 14 days. For purposes of this item, residence time is determined using a flow equal to the 122Q₁₀ for the months of June through September, a 122Q₁₀ for the summer months.

H. “Shallow lake” means an enclosed basin filled or partially filled with standing fresh water with a maximum depth of 15 feet or less or with 80 percent or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants (the littoral zone). It is uncommon for shallow lakes to thermally stratify during the summer. The quality of shallow lakes will permit the propagation and maintenance of a healthy indigenous aquatic community and they will be suitable for boating and other forms of aquatic recreation for which they may be usable. For purposes of this chapter, shallow
lakes are differentiated from wetlands and lakes on a case-by-case basis. Wetlands are
defined in part 7050.0186, subpart 1a.

Subp. 3. Total phosphorus effluent limits.

A. Phosphorus removal to one milligram per liter is required when subitem (1),
(2), or (3) applies:

(1) the discharge of effluent is directly to or affects a lake, shallow lake, or
reservoir;

(2) the discharge is to the specific basins and water bodies designated in
subpart 5; or

(3) the discharge is new or expanded as defined in subpart 2 except when the
discharger can demonstrate to the commissioner that the discharger qualifies for an
alternative phosphorus limit as provided in subpart 4.

B. In addition, if a phosphorus effluent limit is required under item A, removal of
nutrients from all wastes shall be provided to the fullest practicable extent wherever
sources of nutrients are considered to be actually or potentially detrimental to
preservation or enhancement of the designated water uses. Dischargers required to
control nutrients by under this subpart are subject to the variance provisions of part
parts 7000.7000 and 7053.0195.

Subp. 4. Alternative phosphorus effluent limits for new or expanded discharges.

New or expanded discharges subject to a one milligram per liter phosphorus effluent
limit in subpart 3, item A, subitem (3) may request an alternative limit or no limit if one
or more of items A to C apply. New or expanded discharges are defined in subpart 2.
The exemptions in this subpart do not apply to facilities that discharge directly to or
affect a lake, shallow lake or reservoir or to discharges to the waters listed in subpart 5.
Dischargers seeking an alternative limit due to very high per capita treatment costs or
economic hardship must apply for a variance under parts 7000.7000 and 7053.0195.

The information submitted to the commissioner for consideration of an alternative
limit must include, at a minimum, a description of the treatment technology used, influent
and effluent total phosphorus concentrations, a phosphorus management plan for the
facility, descriptions of any measures already taken to reduce phosphorus sources to the
facility, and expected reductions in phosphorus concentrations following implementation
of the phosphorus management plan. The discharger may qualify for an alternative total
phosphorus limit or no limit if it can demonstrate:

A. the discharge is to or upstream of a water body listed on the applicable
impaired water list, section 303(d) of the Clean Water Act and the total maximum daily
load study is complete and approved by the United States Environmental Protection
Agency at the time the new or expanding facility is in the planning and design phase. The
total maximum daily load study must have considered impacts from phosphorus loading on the impaired water body. In this case the total maximum daily load study will determine the applicable phosphorus effluent limit;

B. the environmental benefits to be achieved by meeting a phosphorus limit are outweighed or negated by the environmental harm caused by meeting a limit; or

C. the treatment works regardless of the type of treatment technology, must use chemical addition to achieve compliance with the one milligram per liter limit, and the discharge is to a receiving stream in a watershed listed in subitems (1) to (3). In this case the discharger may be granted a seasonal one milligram per liter limit, applicable from May 1 through September 30 and not applicable from October 1 through April 30:

(1) the lower Mississippi River and its tributaries from the mouth of the Chippewa River in Wisconsin to the Minnesota border;
(2) the Bois de Sioux and Red Rivers and their tributaries from the southern end of Lake Traverse at Browns Valley to the Canadian border; and
(3) the Missouri, Des Moines, and Cedar Rivers and their tributaries in Minnesota.

Subp. 5. Designated waters. The one milligram per liter phosphorus limit established in subpart 3 applies to the waters designated in items A to F:

A. All intrastate waters lying within the drainage basin of Lake Superior in the counties of Aitkin, Carlton, Cook, Itasca, Lake, Pine, and St. Louis (Townships 45 to 65 North, Ranges 7 East to 23 West).

B. The interstate waters of Lake St. Croix in Washington County (Townships 26 to 30 North, Range 20 West).

C. The St. Louis River from its source at Seven Beaver Lake (Township 58 North, Range 12 West) to and including St. Louis Bay (Townships 49 and 50 North, Ranges 14 and 15 West) and Superior Bay (Townships 49 and 50 North, Ranges 13 and 14 West).

D. The Mississippi River from its source to the Blandin Dam at the outlet of Paper Mill Reservoir in the City of Grand Rapids approximately 400 feet upstream from the bridge on U.S. Highway 169 including Lake Andrusia (Township 146 North, Range 31 West), Lake Bemidji (Townships 146 and 147 North, Range 33 West), Cass Lake (Townships 145 and 146 North, Ranges 30 and 31 West), Lake Itasca (Township 143 North, Range 36 West), Pokegama Lake (Townships 54 and 55 North, Ranges 25 and 26 West), and Winnibigoshish Lake (Townships 145, 146, and 147 North, Ranges 27, 28, and 29 West).

E. The Little Minnesota River and Big Stone Lake from the South Dakota border crossing to the outlet of Big Stone Lake at the dam immediately upstream from the U.S. Highway 12 bridge in Ortonville.
F. Albert Lea Lake (Township 102 North, Ranges 20 and 21 West) in Freeborn County.

**Subp. 6. Averaging period for phosphorus limit.** The phosphorus limit required under subpart 3 must be a calendar month arithmetic mean unless the commissioner finds, after considering the criteria listed in items A and B, that a different averaging period is acceptable. In no case shall the one milligram per liter limit exceed a moving mean of 12 monthly values reported on a monthly basis, or a simple mean for a specified period, not to exceed 12 months. Calendar month effluent limits in effect on February 7, 2000, must remain in effect unless an assessment of the criteria listed in items A and B indicate a different averaging period is acceptable. An different averaging period other than monthly is acceptable when:

A. the effects of the phosphorus loading from the facility on the receiving water or downstream water resources is generally not measurable. There is no measurable or predictable difference in the adverse effects of the phosphorus loading from the facility on the receiving water or downstream water resources compared to the loading that would result using a 30-day average limit; and

B. the treatment technologies being considered offer environmental, financial, or other benefits.

2. **Scope and Definitions, Minn. R. 7053.0255, Subparts 1 and 2 [IX.G. TP limit, reasonableness]**

Proposed 7053.0255, subpart 1 outlines the contents of this new section.

Proposed 7053.0255, subp. 2 contains eight new definitions relevant to TP effluent limits. SONAR Book I describes the need and reasonableness of the proposed definitions (Sections VI.B and X.B. in SONAR Book I). Critical terms needing definitions are: “affects,” “measurable increase” and “measurable impact,” “lake” and “reservoir.” The lack of definitions in rule has caused disagreement over the meaning of these terms, which has resulted in controversy and litigation. It is reasonable to define terms that have been used for decades but have not been defined in rule for future permitting decisions. It is also reasonable to define new terms relevant to the proposed extension of the TP limit to new and expanded dischargers; these are: “new discharge,” “expanded discharge”, 122Q10” and “shallow lake.”

3. **TP Effluent Limits, Minn. R. 7053.0255,subp. 3 [IX.G. TP limit, reasonableness]**

Three bases for applying a TP effluent limit to a point source discharge are consolidated into this subpart. They are:

1. The discharge is directly to or affects a lake, shallow lake or reservoir. This is the existing P rule which is not being changed except for the addition of “shallow lake.”
2. The discharge is to a specific basin or waterbody listed in existing Minn. R. ch. 7065. The TP limits in this rule are not being changed except to move the list of waterbodies affected to Minn. R. ch. 7053, subp. 5.

3. The discharge is from a new or expanding facility that discharges more than 1,800 pounds of TP per year. The proposal being considered in this part of SONAR Book II.

Minnesota R. 7053.0255, subp. 3 also contains proposed new language related to TP limits and TMDLs and proposed changes to existing language dealing with the “fullest practicable treatment” paragraph. These are discussed separately in the next two sections.

4. Fullest Practicable Extent for TP Treatment Applies to Dischargers with a TP Limit

The proposed extension of the TP limit to new and expanded dischargers and the other changes that are part of the restructuring and consolidation of the TP limits provide a good opportunity to clarify this provision (Minn. 7053.0255, subp. 3, item B.). This long-standing provision says that wastewater treatment plants should remove TP from the effluent to the “fullest practicable extent.” The provision showing the proposed changes is shown above.

As stated in the need section (Section VII.I), there has been some misunderstandings about the interpretation of this provision; i.e., whether it means all dischargers regardless of whether or not they have a 1 mg/L TP limit, or only dischargers with a TP limit, have to provide nutrient removal to the “fullest practicable extent” (FPE).

The Agency has interpreted FPE as applying only to facilities that have a TP limit. This is based on the context of the provision and the long history of how this provision has been applied for over 30 years. This paragraph was originally, and continues today, to be in the part of the rule that includes the TP effluent limit. This context clearly suggests that the paragraph is associated with TP effluent limits. The Agency has consistently interpreted this paragraph as applying only to dischargers that have a phosphorus limit. The following quote from the SONAR for the rulemaking completed in 2000 in which the option of a longer averaging period for TP limits was adopted illustrates this point.

“Also it [TP limits with averaging periods longer than one month] is consistent with the existing narrative concerning nutrient removal associated with the 1 mg/L phosphorus limit which is quoted below.” (emphasis added) 52

“In addition, removal of nutrients from all wastes shall be provided to the fullest practicable extent wherever sources of nutrients are considered to be actually or potentially detrimental to preservation or enhancement of the designated water uses. Dischargers required to control nutrients by this subpart are subject to the variance provisions of part 7050.0190.”

52 SONAR, In the matter of proposed revisions of Minnesota Rules Chapter 7050, page 90, June 16, 1999.
The Minnesota Environmental Science and Economic Review Board (MESERB) commented that the intent of this paragraph needs clarification. The Agency agrees and that is what we are proposing. The Agency is reluctant, however, to completely remove the paragraph as suggested by MESERB (Exhibit A-34, page 3, no. 9). The Agency believes that removing the paragraph is neither needed nor desirable, as opposed to simply clarifying the language. The general concept of requiring a wastewater treatment plant to perform at their best is a sound policy and it has important environmental benefits. Also, the same provision, only applicable more broadly, is included in existing Minn. R. 7050.0210, subp. 4. The Agency’s proposed clarification is reasonable.

5. Possible Exemptions from TP Limit [IX.G. TP limit, reasonableness]

The reasonableness of the three proposed exemptions to the 1 mg/L TP limit to new or expanded discharges is discussed in Section IX.H, below. The exemptions allow possible relief for dischargers impacted by the proposed extension of the TP limit.

6. Clarification of Criteria for Longer Averaging Period for TP Limits [IX.G. TP limit, reasonableness]

The Agency has the option of setting TP effluent limits in NPDES permits that can be averaged over a period longer than one calendar month, up to one year (Minn. R. 7053.0255 subp. 6). Permits with a longer averaging period are usually 12-month moving averages. Approximately 35 municipal dischargers and several industrial discharges now have 1 mg/L TP limits with an averaging period longer than one month. Such facilities typically use Bio-P technology to remove TP, but most use some chemical as well.

The Agency is proposing to clarify the first of two criteria the Commissioner can use to decide when a TP limit with a longer averaging period is appropriate, and to make some other very minor clarifying language changes. The need for this clarification is found in Section VII.J; the proposed language changes are shown above.

In retrospect, the language in the existing first criterion, “the effects of the phosphorus ... is generally not measurable” (Minn. R. 7050.0211, subp. 1a, item A) seems to conflict with the way the current TP limit has been implemented over the years. That is, in order for a limit to be issued, regardless of the averaging period, the impacts of the phosphorus loading should be measurable in the downstream lake or reservoir. This is consistent with the way the Agency proposes to define the word “affects.”

The proposed new language will indicate that the lack of a measurable impact or predictable impact (e.g., though modeling) refers to the difference in the loading that would occur with a limit averaged over a longer period compared to the loading that would occur with a monthly limit. Thus, a discharger with a longer averaging period should not have a greater impact on the downstream resources than they would have if the limit were a monthly average; that is, any difference should not be discernable. The duration of the TP limit should not have a significant or measurable difference in downstream trophic conditions. However, the longer averaging...
period provides permittees with a possible “compliance cushion,” and it allows operators to place greater confidence in the performance of Bio-P – that over the long-term the 1 mg/L limit can be met. This was the intended outcome when the longer averaging period was adopted in 2000.

It is the Agency’s intent that the option of a longer averaging period for a TP limit should apply to any TP limit issued under proposed Minn. R. 7053.0255; i.e.:

- When the discharge is to or affects a lake, shallow lake or reservoir;
- New and expanded dischargers (> 1,800 pounds TP per year);
- To the specific waterbodies listed in the current Minn. R. ch. 7065.

The Agency’s reasoning regarding the 1 mg/L limits in existing Minn. R. ch. 7065 when the longer averaging period was proposed was that no averaging period was specified for the limits in this rule. The Agency believed that it was reasonable, since the rule is silent as to any averaging period, that assignment of an averaging period is left to the discretion of the Commissioner. The Agency suggested that the same criteria included in the proposed rule language (as revised in this rulemaking) would apply to the dischargers to the waterbodies listed in Minn. R. ch. 7065. Thus, averaging periods longer than a calendar month would be a possibility. The Agency believes that it is reasonable to extend this option to any facilities impacted by the proposed extension of the TP limit as well.

7. **TP Limits Applicable to Limited Resource Value Waters** [IX.G. TP limit, reasonableness]

Limited resource value waters (Class 7) are surface waters able to support only a very limited aquatic community, and offer only very limited opportunities for water recreation. Most are short headwater stream segments, usually channalized ditches that often have no flow in dry years. They range in length from less than a mile to about 20 miles. Class 7 waters are not afforded the same level of protection for aquatic life and recreation that Class 2 waters are. All candidate Class 7 waters undergo a use attainability analysis and the change in classification must be adopted through rulemaking (see SONAR Book III, Section XI).

Despite the limited beneficial uses assigned to Class 7 waters the Agency believes that the proposed extension of the TP limit to new and expanding dischargers should apply to dischargers to Class 7 waters. Class 7 dischargers have not been exempt from TP limits under the current rule. Fourteen of the 96 POTWs that currently discharge to Class 7 waters have TP limits. This course of action is consistent with the fact that phosphorus is conservative (not degraded), and it will move downstream potentially impacting downstream Class 2 resources. Most Class 7 reaches are only a few miles in length, thus the possibility for downstream impacts is real. Existing Minn. R. 7050.0214, subp. 3 provides for the protection of downstream Class 2 waters and associated beneficial uses.

From a practical standpoint probably less than half of the existing dischargers to Class 7 waters will be eligible for a TP limit, at least in the foreseeable future, because most will not exceed the *de minimis* loading of 1,800 pounds per year. Using current design flows, 55 of the total of 96...
POTWs than discharge to Class 7 waters are below 0.2 mgd, 41 are equal to or greater than 0.2 mgd. Nine of the 14 discharges that have TP limits now are in the larger size group.

Dischargers to Class 7 waters can petition for relief under one or more of the proposed exemptions. While each request will be evaluated individually and protection of the downstream Class 2 water must be considered, dischargers to Class 7 waters may be able to bolster their case for an exemption simply by the fact that the receiving waterbody is a limited resource value water.

H. POSSIBLE EXEMPTIONS TO 1 MG/L TP LIMIT [IX. TP limit, reasonableness]

1. Introduction and Removal of an Originally Proposed Exemption [IX.H. TP limit, reasonableness]

The proposed extension of the 1 mg/L TP limit to new and expanded dischargers larger than 1,800 pounds TP per year provides options for dischargers to seek relief from the requirement if they meet certain criteria. Dischargers may request a TP limit more lenient than 1 mg/L (alternative limit) or no limit at all. The potential exemptions are also called “off ramps.” The three proposed off ramps are not mutually exclusive; that is, a discharger may indicate in their request that they qualify for relief under one or more. Each will be discussed in turn.

The Agency is aware that the proposed extension of the TP limit may result in a limit being imposed in situations where the benefits will not be discernable, or meeting the limit may not seem cost-effective. This does not mean that there is no environmental gain in reducing TP from wastewater treatment plant effluents, even when the improvements to the receiving stream may not be measurable. In general, the less TP discharged to receiving waters the better. However, the Agency believes that there will be situations when the imposition of a TP limit may have minimal benefits for the environment, and the proposed rule needs to provide for these situations. The Agency intends to evaluate each request for an exemption on a case-by-case basis using a weight of evidence approach, consistent with the fundamental rationale and goal of the proposed extension of the phosphorus limit, which is to prevent the eutrophication of surface waters by reducing the loading of TP from point sources.

The Agency originally proposed an exemption that has now been removed and is no longer part of the proposed rule. The draft rule amendments that have been available to interested parties for about the last two years included the now deleted off ramp. In November 2006 after final discussions among the staff, the Agency decided that one of the three original off ramps was unworkable. This off ramp allowed for no limit if the amount of TP discharged in one year without a limit was essentially the same (no more than five percent more) as the amount of TP that would be discharged with a limit. The off ramp was aimed at facilities that use biological phosphorus removal technologies (Bio-P) that might not be able to consistently meet a 1 mg/L limit. The Agency continues to be encouraged by the promise of Bio-P technologies, partly because it can achieve low effluent TP while minimizing the use of chemicals. But we felt this off ramp as worded was unworkable and not needed. The Agency decided to remove it for the reasons outlined below.
1. The off ramp required the Agency to predict TP removal performance with and without a limit before the facility was operational. While confidence seems to be growing that Bio-P facilities can and will achieve TP effluent concentrations of about 1 mg/L without chemical addition, it would be difficult to predict beforehand whether any facility could achieve essentially the same TP removal with or without a permit limit. Each facility is unique and many variables influence TP removal performance.

2. The proposal to allow up to five percent more TP discharged without the limit is too small a difference to measure consistently and it provides almost no real “relief” to the discharger.

3. It would be difficult (and time consuming) to develop a more realistic and supportable “no-limit” cap to replace the five percent cap, based on the experience to date of TP removal performance of Bio-P plants in Minnesota.

4. Effluent limits must be met virtually 100 percent of the time for the facility to remain in compliance with a monthly mean limit (or as an annual mean for many Bio-P facilities). It is a well accepted concept that the permit limit is a strong incentive for operators to provide better wastewater treatment over the long-term in order to stay in compliance. Given the uncertainties and variability associated with the wastewater treatment process, it is common for wastewater treatment plant operators to produce an effluent that is considerably better in quality than the permit allows to provide a margin of compliance safety. This is true generally for any pollutant controlled by a permit limit, not just TP. The off ramp as proposed gave up much of this inherent advantage and the resulting reduction in TP loading to the receiving stream.

The other proposed off ramps can accommodate situations where relief for a Bio-P facility is warranted.

2. Exemption Rule Language, General [IX.H. TP limit, reasonableness]

The proposed exemptions are loosely based on the exemptions included in Wisconsin rules, Chapter NR 217 adopted in 1992 (NR 217.04(2), Exhibit PL-13, see Section IX.J). The Agency’s proposed exemptions represent a consolidation and, we believe, a logical and appropriate refinement of the exemptions adopted by Wisconsin. The exemptions in Chapter NR 217 are not applicable to dischargers in Wisconsin’s Lake Superior and Lake Michigan watersheds (NR 217.04(2)(B)(1)). Similarly, the proposed exemptions in Minn. R. 7053.0255 do not apply to dischargers in Minnesota’s Lake Superior basin or the other waterbodies listed in existing Minn. R. ch. 7065, or dischargers that discharge “to or affect” a lake or reservoir. The Wisconsin Department of Natural Resources developed an implementation guidance document that outlines how the four exemptions in NR 217 will be administered (Exhibit PL-14). The Agency will consider developing a similar guidance document for Minnesota.

It is our belief that the three proposed off ramps, plus the variance option, can adequately address the anticipated variety of situations – that they are broad enough to apply to a wide range of individual situations. It is impossible to anticipate every scenario that might warrant an alternative limit or no limit. In this situation it is appropriate to provide enough flexibility in the rule language to accommodate the inevitable unforeseen situations.
Alternative limits granted under an exemption can be a monthly average or an annual average if appropriate under Minn. R. 7053.0255, subp. 6.

Once granted, an exemption is not necessarily permanent. Situations can change and the Agency may have reason to revoke an exemption in the future. For example a future TMDL may call for all discharges in the watershed to implement treatment for TP. Revocation of an exemption and the addition of a TP limit would be done at the time the permit is reissued, or through a permit modification if necessary, as with any change to a permit condition. Such changes are made in consultation with the discharger and their consultants. The public at large will have the opportunity to comment on the change as part of the NPDES permit process.

The granting of an exemption is in the context of the proposed extension of the TP limit to new or expanding facilities. The exemptions are not applicable to facilities that already have a TP limit. Antibacksliding provisions would apply to facilities with existing TP limits unless they expand. Expansion (> 1,800 pounds TP/yr.) triggers the proposed TP limit, and expansion generally negates antibacksliding requirements; therefore, the exemptions would be applicable. However, it is unlikely that an expanding facility that already has a TP limit would be a candidate for an exemption.

The proposed exemptions in Minn. R. 7053.0255, subp. 4 are repeated below in the context of the proposed reorganization of the TP limits in Minn. R. ch. 7053.

[Minn. 7053.0255] **Subp. 3. Total phosphorus effluent limits.**

A. *Phosphorus removal to one milligram per liter is required when subitem (1), (2), or (3) applies:*

   (1) *the discharge of effluent is directly to or affects a lake, shallow lake, or reservoir;*

   (2) *the discharge is to the specific basins and water bodies designated in subpart 5; or*

   (3) *the discharge is new or expanded as defined in subpart 2 except when the discharger can demonstrate to the commissioner that the discharger qualifies for an alternative phosphorus limit as provided in subpart 4.*

B. *In addition, if a phosphorus effluent limit is required under item A, removal of nutrients from all wastes shall must be provided to the fullest practicable extent wherever sources of nutrients are considered to be actually or potentially detrimental to preservation or enhancement of the designated water uses. Dischargers required to control nutrients by under this subpart part are subject to the variance provisions of part parts 7000, 7000 and 7053.0195.*
Subp. 4. Alternative phosphorus effluent limits for new or expanded discharges.

New or expanded discharges subject to a one milligram per liter phosphorus effluent limit in subpart 3, item A, subitem (3) may request an alternative limit or no limit if one or more of items A to C apply. New or expanded discharges are defined in subpart 2. The exemptions in this subpart do not apply to facilities that discharge directly to or affect a lake, shallow lake or reservoir or to discharges to the waters listed in subpart 5. Dischargers seeking an alternative limit due to very high per capita treatment costs or economic hardship must apply for a variance under parts 7000.7000 and 7053.0195.

The information submitted to the commissioner for consideration of an alternative limit must include, at a minimum, a description of the treatment technology used, influent and effluent total phosphorus concentrations, a phosphorus management plan for the facility, descriptions of any measures already taken to reduce phosphorus sources to the facility, and expected reductions in phosphorus concentrations following implementation of the phosphorus management plan. The discharger may qualify for an alternative total phosphorus limit or no limit if it can demonstrate:

A. the discharge is to or upstream of a water body listed on the applicable impaired water list, section 303(d) of the Clean Water Act and the total maximum daily load study is complete and approved by the United States Environmental Protection Agency at the time the new or expanding facility is in the planning and design phase. The total maximum daily load study must have considered impacts from phosphorus loading on the impaired water body. In this case the total maximum daily load study will determine the applicable phosphorus effluent limit;

B. the environmental benefits to be achieved by meeting a phosphorus limit are outweighed or negated by the environmental harm caused by meeting a limit; or

C. the treatment works, regardless of the type of treatment technology, must use chemical addition to achieve compliance with the one milligram per liter limit, and the discharge is to a receiving stream in a watershed listed in subitems (1) to (3). In this case the discharger may be granted a seasonal one milligram per liter limit, applicable from May 1 through September 30 and not applicable from October 1 through April 30:

1. the lower Mississippi River and its tributaries from the mouth of the Chippewa River in Wisconsin to the Minnesota border;
2. the Bois de Sioux and Red Rivers and their tributaries from the southern end of Lake Traverse at Browns Valley to the Canadian border; and
3. the Missouri, Des Moines, and Cedar Rivers and their tributaries in Minnesota.

3. Possible Exemption to TP Limit if TMDL is Complete [IX.H. TP limit, reasonableness]

The Agency believes it is important for the rule to state how the proposed extension of the TP limit to new and expanding facilities will be implemented in conjunction with nutrient-related TMDLs. A TMDL is required when a waterbody is listed as impaired. Impairment means a
water quality standard is exceeded and beneficial uses are actually or potentially lost. The addition of a paragraph in the rule that addresses TMDLs and the proposed extension of the TP limit was in response to public comments mostly from MESERB. The proposed language is shown in the previous Section (Minn. R. 7053.0255, subp. 4, item A).

As explained in the need section (Section VII.H.3) the Agency’s original proposal was to have relevant TMDLs determine the TP limits for affected dischargers without the dischargers needing to make a request. However, rule language that would allow an automatic TMDL exemption that covers all possible situations and TMDL conditions proved to be unworkable. The Agency believes now that the petition process will facilitate the site-specific aspects of deciding whether the TMDL exception is applicable to a particular discharger. Therefore, the Agency is now proposing to include the “TMDL exemption” as one of three potential exemptions to the TP limit that a discharger can apply for. The reasons for this change will be discussed in this Section.

The proposed language says that if the discharge is to or upstream of a waterbody impaired due to exceedance of the eutrophication standards (or the precursor nutrient criteria) or other nutrient-related standard, and the TMDL is complete and approved by EPA at the time a new or expanding discharger is in the planning and design phase, then the TMDL will determine the need for and magnitude of the TP effluent limit. Also, the discharge in question must be within the scope of the TMDL study. The TMDL study first quantifies nutrient loading from both point and nonpoint sources that caused the impaired condition. Next the TMDL study determines the load reductions needed from all sources to bring the waterbody back into compliance with standards. Reductions needed from point sources will be achieved through TP effluent limits in NPDES permits. Thus, if applicable, the TMDL will determine:

- If a limit more stringent than 1 mg/L is needed;
- If a 1 mg/L limit is needed;
- If a limit less stringent than 1 mg/L is adequate; or
- If no limit at all is needed.

If the timing of the TMDL and the plan to build new or expand coincide, it is logical and reasonable for the TMDL to be the basis for the TP limits for the affected dischargers assuming other conditions are met. The basic conditions that must be met are:

- The discharge is to or upstream of a waterbody listed on the 303(d) impaired waters list;
- The total maximum daily load has considered impacts from phosphorus loading on the impaired waterbody;
- The total maximum daily load is complete and approved by the EPA at the time the new or expanding facility is in the planning and design phase; and
- The phosphorus loading from the new or expanding discharge is included as part of the point source waste load allocation in the total maximum daily load study. In other words, this exemption does not apply to discharges upstream of the impaired waterbody but outside the scope of the TMDL study.
Discharge to or upstream of impaired waterbody. If the discharge is directly to the impaired waterbody, which currently is usually a lake, the discharge most likely has a TP limit under the current rule. In this situation, the TMDL is the appropriate means to determine new limits needed to restore the waterbody to compliance with standards. A limit more stringent than 1 mg/L is a strong possibility. A new discharger would be discouraged from discharging to an impaired lake or reservoir.

The situation is more complex if the new or expanded discharge is upstream of the impaired waterbody. To be eligible for the TMDL exemption, the discharge must be included among the discharges whose TP loading was assessed in the TMDL study. In other words, if the discharge is upstream of the impaired waterbody but so far removed as to be outside the scope of the TMDL (or beyond the scope for any reason), then the TMDL will not determine the TP limit for that discharge.

The Lake Pepin TMDL provides a good example of why the qualifications for the TMDL-related exemption are needed and reasonableness.

The upper Mississippi River watershed is so large that discharges far upstream of Lake Pepin, either on the main stem of the river or on a tributary, may be beyond the scope of the Lake Pepin TMDL. The TMDL study is about two to three years from completion, but at this time it is anticipated that the TP loading from point sources upstream of approximately Little Falls will not be included in the waste load allocation for this TMDL. If this holds true, the loading from discharges upstream of this point will be considered too inconsequential and too far upstream to impact Lake Pepin. The TMDL is likely be silent on the need for TP limits for facilities upstream of this point. The concern for the Agency is that, while the TP loading from these discharges may have very little impact on Lake Pepin, it very well could have an impact on the immediate receiving stream or other more local waterbodies within the Lake Pepin watershed. The upper Mississippi River watershed includes some highly valued and heavily used resources that should be protected from excess nutrients. Besides the head waters of the Mississippi River itself, examples of important tributaries are the Shell, Crow Wing, Boy and Prairie Rivers.

The Minnesota and St. Croix Rivers are part of the Lake Pepin watershed, but the point sources in these two major watersheds may not be included in the Lake Pepin TMDL. The Minnesota River is covered by its own nutrient-related TMDL. However, as discussed below, this TMDL may not fully address the eutrophication problems in the Minnesota River. The need to reduce phosphorus loading to the St. Croix basin from point sources is already being driven by the importance of protecting the trophic status of Lake St. Croix (plus the required 1 mg/L TP limit for discharges to Lake St. Croix under existing Minn. R. ch. 7065), and ambitious bi-state nutrient reduction goals and nondegradation requirements applicable to the watershed.

In summary, the focus of a TMDL is to restore the impaired waterbody to compliance with standards. The TP loading from dischargers far upstream in the watershed may have little impact on the impaired waterbody itself, but the discharge may impact the local receiving stream or other local resources not germane to the TMDL. It is reasonable to have the proposed extension of the TP limit apply to dischargers outside the scope of a nutrient-related TMDL.
The impairment must be nutrient-related. The TMDL must to be based on the exceedance of eutrophication standards (or the predecessor nutrient criteria) directly, or based on an impairment caused by excess nutrients. The Lake Pepin TMDL is an example of the former and the TMDL for the lower Minnesota River is an example of the latter.

When the TMDL is based on an exceedance of the eutrophication standards, the resulting TMDL becomes the direct basis for TP effluent limits for dischargers that are included in the scope of the TMDL analysis. Since eutrophication is the problem being addressed, the use of the TMDL as the basis for the permit limits should be straightforward. However, when the TMDL is based on the exceedance of a standard that is nutrient-related such as dissolved oxygen (DO), the recommendations of the TMDL may not fully address potential eutrophication problems in the watershed. Again the TMDL for the lower Minnesota River provides a useful example. This TMDL is complete and implementation has started.

The lower Minnesota River is impaired due to low DO traced to excess nutrients. The high levels of nutrients (phosphorus) produce a very abundant algal population, which, when the algae die and decay, create a demand for oxygen that the river cannot meet. The result is exceedances of the DO standard. Low DO in the lower Minnesota River is more likely to be a problem when temperatures are warm and flow is low. To correct the DO problem, reductions in phosphorus loading needs to occur in the summer months and possibly only during periods of relatively low-flow. The implementation plan for reducing point source TP loading in the watershed is to impose summer (May through September) TP limits on all the larger dischargers in the basin. The TMDL considers a five-year period and has set a goal to reduce TP loading to the lower river by 35 percent. The TMDL determined that the TP limits should be applicable at all flows. The point of this discussion is that, while the imposition of seasonal TP limits may be appropriate to solve the DO problem in the lower Minnesota River, seasonal limits may not be adequate to reduce the overall eutrophication problem in the Minnesota River. If impairment was based directly on the eutrophication of the river, year-round TP limits may have been the recommended TMDL solution. It is reasonable for these situations to be assessed on a case-by-case basis. Requiring the discharger to petition the Agency to consider relief under the TMDL exemption is an appropriate means to accomplish this.

The assignment of TP permit limits to future expansions or newly constructed facilities in a watershed once the TMDL is complete and implemented also helps make the case for a site-specific approach. Such “post-TMDL” TP limit questions are best evaluated on a case-by-case basis because the nature of the new point source(s) and possibly timing issues will affect how the TMDL addresses the new TP loading.

If the facility is all new (or the expansion is large) and the TMDL study is complete and being implemented, the facility represents a potential future increase in TP loading to the watershed that the TMDL did not directly consider. The TMDL has already allocated the acceptable point source TP loading in the watershed. Presumably the TMDL includes a process to deal with potential increases in future loadings. Future increases in TP loading may be accommodated by “using” some of the loading allocated to a “reserve capacity” by the TMDL, by a TP load trading
process, or possibly absorbed as part of the TMDL “safety factor.” TMDLs are expected to allocate some loading to a reserve to accommodate future growth. The TMDL safety factor is typically not a quantifiable “reserve” but a margin of safety that reflects uncertainties in the analysis. However, the safety factor may help accommodate some future increases in loading.

If the post-TMDL change is an expansion of an existing facility, the TMDL most likely considered the loading from the existing facility in its point source waste load allocation. This may make it easier to accommodate the potential increased loading from the expanded facility within the waste loads considered by the TMDL. It is possible, however, that the expanded facility may be required to stay within the previously allocated load amount.

**Applicability of proposed TP limit if TMDL not complete.** The proposed rule says that the new or expanding facility must be in the planning or design phase at the time the TMDL is complete for the TMDL to determine the TP limit. The timing of TMDL completion and the timing of the design of the facility, therefore the applicability of the TMDL exemption, will be case-specific. As noted above, potential questions related to timing are another reason for a case-by-case approach.

If the new or expanded discharge is to, or upstream of, a nutrient-impaired waterbody (or a waterbody impaired due to exceedances of a standard caused by excess nutrients) and the TMDL study has not started or is incomplete, then the 1 mg/L TP limit applies to that discharger. The Agency believes that the proposed extension of the TP limit and TMDLs must proceed independently except when the timing allows the TMDL to determine the limit. TMDLs are about restoring impaired waterbodies. The proposed phosphorus limit is about reducing phosphorus loading to surface waters, not only to help restore impaired waters but to help prevent waters from becoming impaired in the first place. Also, it will take decades to complete all the pending TMDLs. It is very likely that the number of waterbodies considered impaired due to eutrophication will continue to increase. This includes the possibility that more non-lake waterbodies will be listed in the future as impaired for nutrients or nutrient-related pollutants as more data, both chemical and biological, are accumulated showing the negative impacts of nutrients on rivers and streams.

The Agency believes it would be shortsighted to wait for a clear demonstration of impairment before action is taken, and then count on the TMDL to restore the waterbody to health. If we wait until a waterbody is impaired not only will more surface waters be in a degraded condition, but the cost to bring these waterbodies back to health, if possible at all, is usually far more than the cost of preventive measures.

The Agency will make the timing decisions. A decision will need to be made whether a nutrient-related TMDL that is pending approval from EPA, for example, will be available in time to determine the TP limit for a facility that has advanced through the planning and design phase and may be under deadlines to complete construction. The requirement that EPA must approve the

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53 The TMDL study assesses the loading of the pollutant causing the exceedance, determines the total load that will meet standards (and reductions needed to achieve that load), and “allocates” the acceptable load between point sources, nonpoint sources and a reserve for future growth, all with a margin of safety due to uncertainties.

54 The federal requirements of 40 CFR 122.4(i) also apply.
TMDL helps establish a firm date for that part of the process. These decisions will be case-by-case and permit-specific. The Agency will make these decisions in consultation with the discharger and with other interested parties. The staff may ask the Agency Citizens’ Board to approve a staff decision, and any decision can be challenged during the NPDES/SDS permit process.

Summary. The Agency is confident that the TMDL process will correctly determine the TP effluent limits needed to restore nutrient-impaired waterbody to health. However, a new or expanding discharger in the watershed of an impaired waterbody should get a 1 mg/L limit under the proposed extension of the TP limit if certain conditions are not met. Because each TMDL is potentially unique, the Agency believes that the assessment of whether the TMDL should or should not determine the TP limit needs to be done on a case-by-case basis. Requiring the discharger to petition for relief under the TMDL exemption will facilitate the case-by-case analysis. By placing the burden on the discharger to request a TMDL-related exemption, the Agency is not trying to put roadblocks in the way of dischargers, or discourage dischargers from petitioning the Agency. If it is clear that the TMDL-determined limits are appropriate in a particular case, the Agency will advise the discharger to submit a petition. The granting of an exemption in these situations should be straightforward and proceed smoothly.

The following is an outline of the basic steps that must be met for the Agency to consider using the TMDL as the basis for a TP limit.

1. The discharge will get a TP limit if it is new or expands after May 1, 2008 and the annual loading of phosphorus from the facility will exceed 1,800 pounds per year, unless: (To reiterate, the Agency’s goal for this proposed change to the TP effluent limit is to maintain the gains in reducing point source TP loading made under the Phosphorus Strategy over the last six years, and to codify the Strategy in rule.)

2. The new or expanding discharge is to or upstream of a waterbody on the 303(d) impaired waters list (the other two potential exemptions are discussed in the next two sections); and:

3. The impairment is due to excess nutrients. The impairment may be due to the exceedance of the nutrient criteria or eutrophication standards directly, or due to exceedance of another standard caused by the excess nutrients such as dissolved oxygen; and:

4. The TMDL study for the impaired waterbody is complete and approved by EPA at the time the new or expanding discharger is in the planning or design phase; and:

5. TP loading from the discharge is included in the phosphorus waste load allocation for point sources upstream of the impaired waterbody. That is, the discharge in question must be included in the scope of the TMDL study; then:

6. The TMDL may determine the TP effluent limit for the new or expanding discharge pending the site-specific analysis. (Note: the context here is the proposed extension of the TP limit to new and expanding dischargers. A facility would not need to be new or expanding to be impacted by a TMDL.)
If the expansion or new construction occurs before the TMDL is complete and approved, or it is outside the scope of the TMDL, it is reasonable to require the 1 mg/L limit as a means to reduce phosphorus loading to Minnesota’s receiving waters.

4. Environmental Harm Exceeds Gain [IX.H. TP limit, reasonableness]

The second proposed exception considers a situation where the environmental harm may outweigh or negate the environmental benefit from meeting a 1 mg/L TP effluent limit. The Agency is mindful that the removal of TP from wastewater does not come without costs, both environmental and monetary. Examples of environmental costs may include additional sludge production from chemical addition, energy consumption and nonrenewable resource depletion, and materials transport. Environmental benefits, besides reduced TP loading and improvements to water quality may include a generally better quality effluent all around and reduced concentrations and loadings of non-target (non-TP) pollutants (see next Section).

Under this off ramp, a discharger may be granted either an alternative limit less stringent that 1.0 mg/L or no limit. While the Agency has not specified a cap on an alternative limit, it is unlikely that any alternative limit would exceed 1.5 mg/L as a monthly mean or a mean for a longer period.

A situation in which this off ramp may be applicable, and the types of information that would be relevant in the request, is illustrated by the following hypothetical example.

A growing city discharges to a large river and needs to expand their wastewater treatment facility. The current population is about 3,000 and the current TP loading of about 3,200 pounds per year exceeds the *de minimis* of 1,800 pounds per year. The city decides to adopt biological phosphorus removal treatment technologies (Bio-P). This much information alone is not enough to qualify the city for this off ramp. However, if the following information is presented to the Agency, relief under the second exemption might be applicable.

- The receiving river provides extensive dilution even under low-flow conditions (e.g., > 100:1), and there are no lakes or reservoirs downstream.
- The city’s contribution of the total TP loading to the river at the point of discharge is very small relative to all other sources.
- In spite of the increased flow due to the expansion, the adoption of Bio-P technology will reduce overall TP loading below current levels.
- The city has implemented a phosphorus management plan and can document reduced influent and effluent TP concentrations as a result.
- The capital and operation and maintenance costs of adding chemical treatment to guarantee meeting a 1 mg/L limit are relevant to the consideration of this (and any) off ramp, but economics may not be the deciding factor for this off ramp (see Section IX.H.6).
- The operator plans to use some chemical to assure compliance with the 12-month average 1 mg/L TP limit. Local options for disposal of additional sludge are limited and costly.
- The Bio-P technology will achieve an effluent TP concentration close to 1 mg/L without use of chemical.
The last bullet above merits some further explanation. The Agency believes that Bio-P treatment technologies have proven to be a very viable option for Minnesota POTWs and we wish to avoid any rule amendments that might be a disincentive for someone to consider Bio-P. Therefore, a new or expanded Bio-P facility that can demonstrate the ability to meet an effluent TP concentration of 1 mg/L without a limit and without the use of chemical addition might be a candidate for this off ramp, if other facts such as those outlined above also apply. Some pond systems may be able to qualify under this off ramp.

In conclusion, it is the intent of this exemption that achievement of a 1 mg/L TP effluent limit not be at the expense of other environmental considerations. The exemption provides an opportunity to consider in a more comprehensive or holistic manner the balance between environmental gains, and the environmental and monetary costs of a TP limit.

5. Potential Winter Exemption [IX.H. TP limit, reasonableness]

The third proposed exemption would allow a seasonal limit applicable only during the warm months rather than year-round in certain watersheds, and when chemicals need to be added to meet the limit. This exemption recognizes the relatively higher overall potential costs, both in dollars and environmentally, of removing phosphorus by chemical addition. Under this off ramp a discharger can request relief from a TP effluent limit from November 1 through April 30 each year; the limit would be enforced from May 1 through October 31. This off ramp is patterned after the seasonal TP limit in the general permit developed for the Minnesota River TMDL. The potential exempted winter months match those in the general permit. The watersheds this off ramp is applicable to are:

- The lower Mississippi River and its tributaries from the mouth of the Chippewa River in Wisconsin (below Lake Pepin) to the Minnesota border;
- The Bois de Sioux and Red Rivers and their tributaries from the southern end of Lake Traverse at Browns Valley, Minnesota to the Canadian border; and
- The Missouri, Des Moines and Cedar Rivers and their tributaries in Minnesota.

In general, these watersheds are proposed for this exemption because at the current time they do not include river segments with TMDLs for nutrients or nutrient-related pollutants. In general, they do not have major lakes or reservoirs immediately downstream, and none of the watersheds includes rivers with TP removal required by rule or recommended by major nutrient reduction agreements such as in place for the St. Croix River. The geography and land use patterns in these watersheds suggests that nonpoint sources of TP may overshadow the loading from point sources. Also, the rivers in these watersheds may have characteristics or factors that limit algal growth. For example, the turbidity of the Red and Bois de Sioux Rivers seems to limit algal growth such that TP loading may not have the same impact it would have in a less turbid river. The lower Mississippi River is a very large system with a large flow and most point sources represent a small fraction of the total TP loading to the main stem. Finally, the off ramp recognizes that TP loading is generally less likely to have as direct or obvious a negative impact when temperatures are cold.
In general, the Missouri, Des Moines and Cedar River watersheds have similar watershed and water quality characteristics as the adjacent Minnesota River watershed, and it seems reasonable to make this off ramp available to dischargers in these watersheds at this time.

It is worth emphasizing that this off ramp (as for the other off ramps) is not automatic, that dischargers must request the exemption and the Agency will need to evaluate each request. Otherwise the limit will be year-round. TP loading is an issue in essentially all watersheds; in fact the basin management plans for Lower Mississippi and Cedar Rivers list nutrients and phosphorus specifically as a pollutant of concern. Also, if the discharge impacts a trout stream in the lower Mississippi River watershed, the special importance and unique water quality concerns for these resources will need to be carefully considered as part of any request.

6. **Economic Hardship -Variance [IX.H. TP limit, reasonableness]**

The Agency believes that cities or industries seeking relief from the proposed 1 mg/L TP limit based wholly on economic concerns do so through the variance process (Minn. R. 7050.0190, Minn. R. 7053.0195 and 7000.7000). While economic issues are likely to be part of the justification for a request for an alternative limit under one of the exemptions discussed above, if the primary basis for the request is high treatment costs or economic hardship for the residents, then the variance is the proper approach. Example economic considerations would be the total or amortized capital and projected annual operation and maintenance costs to meet a 1 mg/L limit, the overall economic vitality of the community, the per capita treatment costs compared to the costs in similar sized communities, and the average or median household income.

The proposed rule language that suggests seeking a variance for economic concerns is in the first paragraph of Minn. R. 7053.0255, subp. 4.

7. **Review of Requests for an Exemption [IX.H. TP limit, reasonableness]**

The criteria the Agency staff will use to evaluate the requests are broadly articulated in the proposed rule language shown above. The criteria listed consider the overall environmental cost/benefit, facility operation, effluent quality and the type and location of the receiving water. Additional information likely to be needed by the Agency to make a decision includes influent and effluent TP data, the discharger’s phosphorus management plan and progress made implementing it, water quality data for the receiving water, anticipated TP treatment costs, and the comments of concerned and interested parties.

There is no way to predict the number of requests for an alternative limit the Agency will receive, but based on the experience of the last six years under the Strategy, it is anticipated that utilization of these exceptions will be infrequent (i.e., anywhere from none to three per year). It is the Agency’s intent to carefully review all requests, assess the merits of the request, and make a fair and reasonable decision, consistent with the stated overall purpose of the proposed extension of the TP limit, which is to prevent the eutrophication of surface waters through the reduction of TP loading from point sources. Depending on the number of requests and public input, the Agency may find it advantageous to prepare guidance that advises parties on how to
prepare and support a request along the lines of the Wisconsin Department of Natural Resources guidance (Exhibit PL-14).

It is anticipated that the process for the review and disposition of requests will unfold more or less as follows.

1. A community or industry plans to build a new or expand an existing wastewater treatment facility which will exceed the \textit{de minimis} loading of TP.
2. The responsible party is submitting a permit application and decides to request an alternative limit. The request can accompany the permit application or it can be submitted at any time prior to the permit being finalized. Logically the request would be made in the initial phase of preparing the permit and while the facility is in a planning or design phase prior to any construction.
3. The Agency receives the request which is forwarded to staff that review permits for possible TP limits, and permit engineers and writers, as needed.
4. The request is reviewed for completeness, and if found to be incomplete, the petitioner is contacted to obtain the needed information.
5. Once complete, Agency staff will complete their review and make a preliminary determination to grant or deny the request.
6. Discussions about the preliminary decision are held with the responsible party and the broader public, if appropriate.
7. If the request is denied the Agency will spell out its reasons in writing to the petitioner and provide the supporting data/information used to make the decision.
8. If denied, the permit is issued with the 1 mg/L TP limit.
9. The Commissioner may ask the Agency Board to approve a decision in certain cases.
10. Any party can comment on the limit during the public comment period for the permit, and any party can request a contested case hearing to have the limit reviewed.
11. If the exemption request is granted, the permit is issued with a more lenient limit or no limit, as appropriate, and steps 9 and 10 follow as outlined above.

Just as there is no way to know how many requests will be received, it is also impossible to guess how many requests might be granted or denied. But, as stated previously, it is the Agency’s intent to seriously and carefully review all requests. While the goal is to reduce point source phosphorus loading, the Agency is not interested in requiring treatment when the weight of evidence suggests that there is little to be gained for the costs. Costs can be both environmental as well as monetary.

8. **Conclusions** [IX.H. TP limit, reasonableness]

The proposed rules requiring a 1 mg/L TP effluent limit for new and expanding discharges of greater than 1,800 pounds per year provide for the possibility of an alternate TP effluent limit or no limit. The Agency will review all requests consistent with the overall purpose of this provision, which is to reduce anthropogenic sources of phosphorus to the state’s surface waters. The Agency does not anticipate getting a large number of petitions. The exemptions do not apply to discharges determined to be directly to or affecting a lake, shallow lake or reservoir or to waters listed in 7053.0255 Subpart 5 of the rule.
The first exemption allows the TMDL for a nutrient-impaired waterbody to determine the TP effluent limit if certain conditions are met. The second exemption considers environmental harm that may outweigh or negate environmental benefit from a 1 mg/L TP effluent limit. This exemption is applicable to situations where the discharger can demonstrate a net environmental disadvantage from the TP limit (including a consideration of costs). This exemption, under some conditions, might apply to Bio-P facilities that can achieve an effluent TP concentration of 1 mg/L without use of chemicals. An alternative limit or no limit is possible under this exemption. The third exemption recognizes the properties of certain watersheds that may minimize the impacts of TP loading in the winter months, and the greater requirements of TP removal by chemical addition. A variance is the proper avenue for dischargers if they are seeking relief mainly on economic considerations.

I. INCIDENTAL REDUCTION OF POINT SOURCE MERCURY [IX. TP limit, reasonableness]

Phosphorus removal from wastewater carries significant benefits beyond reductions in TP loading to surface waters. In general any wastewater treatment process that enhances the reduction of total suspended solids (TSS) will also reduce the levels of pollutants that adhere to particulates. Trace metals including mercury are good examples of such pollutants. Because both chemical addition and the Bio-P treatment technologies are efficient in removing solids, effluents from these facilities generally have low concentrations of mercury and other metals. The draft regional mercury TMDL identifies implementation of mercury minimization plans and enhanced phosphorus removal as the two means of achieving point source wasteload reductions of mercury (Exhibit M-2, page 37).

One of the advantages of the Bio-P treatment process is improved sludge handling qualities and reduced levels of suspended solids (see Section XI.B). Data from three facilities that use the Bio-P process show average total mercury effluent concentrations of 2.56, 3.26 and 3.65 ng/L. Wastewater treatment plants with conventional non-Bio-P secondary treatment average about 5.5 ng/L mercury in their effluents. These concentrations are below the current mercury water quality standard of 6.9 ng/L.

Mercury (shaded rows), phosphorus and TSS data from two Metropolitan Council Environmental Services (MCES) plants, Eagles Point and Metro are shown in Table II-18. Both plants use Bio-P. The Eagles Point data are shown graphically in Figure II-11. These data illustrate the effectiveness TP removal has in reducing effluent mercury concentrations.55

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55 It should be noted that the mean mercury concentration in the Metro plant effluent for the first six months of 2006 is 7.8 ng/L. We do not know the reason for this increase.
Table II-18. Mercury Concentrations in the Effluent of Two MCES Plants Before and After the Approximate Dates of Implementing TP Removal by Bio-P.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Eagles Point</th>
<th>Metropolitan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury, ng/L*</td>
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<td></td>
</tr>
<tr>
<td>Median</td>
<td>7.3</td>
<td>3.4</td>
</tr>
<tr>
<td>Mean</td>
<td>7.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Total Suspended solids, mg/L</td>
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<td></td>
</tr>
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<td>Median</td>
<td>7.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Mean</td>
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<td>3.7</td>
</tr>
<tr>
<td>Phosphorus, µg/L</td>
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<td></td>
</tr>
<tr>
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<td>0.50</td>
</tr>
<tr>
<td>Mean</td>
<td>3.8</td>
<td>0.67</td>
</tr>
</tbody>
</table>

*Eagles Point and Metro plants have 6.9 and 9 ng/L monthly average mercury limits, respectively.
J. PHOSPHORUS LIMITS OF OTHER STATES [IX. TP limit, reasonableness]

Other states have adopted rules governing phosphorus discharges from wastewater treatment plants. Discussed below are phosphorus effluent limit requirements from the states of Wisconsin, Illinois and Massachusetts.

Wisconsin In 1973 the Wisconsin Department of Natural Resources (WDNR) adopted rules similar to those in Minnesota for dischargers tributary to the Great Lakes requiring a 1 mg/L TP effluent limit. In December 1992 the WDNR adopted a statewide 1 mg/L TP effluent limit applicable to municipal and industrial dischargers (chapter NR 217, Exhibit PL-13). The rule includes de minimis TP loadings, below which the rule does not apply. The de minimis TP loadings are 150 and 60 pounds of TP per month for POTWs and industries, respectively. A loading of 150 pounds per month equates to 1,800 pounds per year. TP effluent limits have been incorporated into existing permits as they were reissued. Wisconsin currently has about 10 POTWs with TP limits in the 0.2 to 0.3 mg/L range (Jim Bauman at the February 2007 RTAG meeting).
The Wisconsin rule offers alternate effluent limits based on the following four considerations.

- Where achieving the 1 mg/L TP effluent limit is not practically achievable.
- Where the operation of specific biological phosphorus removal technologies will achieve a level of performance equivalent to a 1 mg/L TP effluent standard.
- Where phosphorus deficient wastewaters necessitate the addition of phosphorus to a biological treatment system to assure efficient operation and compliance with other effluent limits.
- Where achieving the 1 mg/L effluent standard will not result in an environmentally significant improvement in water quality.

Wisconsin published guidance for implementing NR 217 in 1999 (Exhibit PL-14). Statewide the rule has resulted in approximately 340 TP limits in NPDES permits. Of these about one third are industrial discharges and two thirds are municipal. About 100 of those with TP limits have alternate effluent limits greater than 1 mg/L. The majority of the alternate limits are based on the first two exemptions listed above. The third exemption is applicable to essentially only pulp and paper facilities (5 permits with effluent limits greater than 1 mg/L) which typically have very nutrient deficient wastewater. The final exemption has been used only once and is currently discouraged from consideration.

Alternate effluent limits are reevaluated with each permit reissuance. Over time the number of facilities with alternate effluent limits is decreasing and this trend is expected to continue. This is largely the result of facility upgrades and expansions, and improved understanding of treatment operations with biological phosphorus removal and resultant lower TP effluent concentrations.

As noted in Section IX.H the Agency carefully reviewed the exemptions in the Wisconsin rule and the similarities between that rule and the exemptions in the proposed Minnesota rule are apparent.

**Illinois** The Illinois Environmental Protection Agency (IEPA) has existing rules that require 1 mg/L TP effluent limits for discharges within the Lake Michigan Basin. Additionally, existing rules require 1 mg/L effluent limits for discharges to lakes or reservoirs of 20 acres of surface area or greater and their tributaries with the following considerations.

- Limits do not apply to lakes or reservoirs with mean hydraulic retention times of 18 days or less.
- Tributary limits apply only to discharges of 0.25 mgd or greater but not to third-stage treatment lagoon (pond) treatment systems.

Dischargers to lakes or reservoirs may apply for an adjusted effluent limit if it can be shown that the effluent resulting from the adjusted limit will not contribute to cultural eutrophication, unnatural plant growth or algal growth or dissolved oxygen deficiencies in the lake or reservoir.

New and more universal TP removal requirements were adopted by the IEPA on February 2, 2006 (Exhibit PL-15). These new amendments require removal of TP to 1 mg/L for new and...
expanding municipal discharges with a design flow of 1.0 mgd or greater, and treatment facilities other than those treating primarily municipal or domestic wastewater (i.e. industrial facilities) with a TP load of 25 lbs per day (equivalent to a flow of 1 mgd at a concentration of 3 mg/L) or more. New and expanding dischargers can be considered for an exemption from the 1 mg/L TP limit provided the discharger demonstrates that phosphorus from the treatment works is not the limiting nutrient in the receiving water. The rule lets IEPA set alternative TP limits where supportive information warrants the adjusted limit. This rule change is meant to be an interim requirement until numeric water quality standards for phosphorus are adopted by the state.

There are many similarities between Illinois’ new rule and what the Agency is proposing for Minnesota. One obvious difference is the size of the facility that is exempt due to the \textit{de minimis}, 1.0 vs. 0.2 mgd. Given the differences between Illinois and Minnesota in population density, overall land use and their water resources, we view this difference as understandable and not very significant.

\textbf{Massachusetts} The Massachusetts Department of Environmental Protection (MDEP) has been issuing NPDES permits with 1 mg/L TP effluent limits since the early-1970s. Presently the MDEP has included phosphorus effluent limits in permits for 56 of the 90 larger facilities in the state. Of the 56 with phosphorus effluent limits, 26 have limits more stringent than 1 mg/L, and four of these have a very low limit of 0.1 mg/L.\footnote{E-mail and information sent to Mark Tomasek (Agency staff) from Bryant Firmin, Massachusetts Department of Environmental Protection, July 26, 2006.}

Few discharges in the state go directly to lakes, rather they are to river systems that contain small impoundments where eutrophication is a concern. Recent efforts to meet water quality criteria in these impoundments has resulted in the low level TP effluent limits (less than 1 mg/L). Additionally, TMDL wasteload allocations are responsible for setting low level TP limits. In determining the lowest TP effluent limit to issue, the MDEP requires the “highest and best practicable treatment.” A MDEP draft policy defines a TP effluent limit of 0.1 mg/L as achievable through the highest and best practicable treatment. Implementation of this draft policy has been the basis for the four 0.1 mg/L TP limits noted above. MDEP is adopting rules that codify this draft policy, and define “highest and best practicable treatment” and its relationship to “best available technology economically achievable” (the latter is EPA terminology in Section 301(b) of the Clean Water Act). The draft rules do not set a specific TP effluent concentration as meeting “highest and best practicable treatment.” Instead it defines this term such that the rule will accommodate new treatment technologies that are capable of meeting low effluent concentrations.

The EPA Region 10 (AK, ID, OR and WA) recently published a report on advanced wastewater treatment to achieve low concentrations of effluent TP, which is summarized on their Web pages.\footnote{http://yosemite.epa.gov/r10/water.nsf/2fb9887c3bbafaaf88256b5800609bf0/cb96b4286526ad4a882572b8006df9c0!OpenDocument.}

Twenty three municipal treatment plants in the U.S. were studied. They conclude that low levels can be achieved cost effectively (as low as 0.01 mg/L by some plants) using a range of technologies as discussed in Section X.D.2, including biological phosphorus removal technologies (Section XI.B). They also cite the secondary advantages of TP removal such as a
better quality effluent in general (e.g., lower BOD and TSS), and the environmental and economic benefits of biological TP removal such as reduced concentrations of toxics and pharmaceuticals (see Section IX.I).

K. SUMMARY, REASONABLENESS [IX. TP limit, reasonableness]

The Agency’s fundamental rationale for the proposed extension of the phosphorus limit to new and expanding dischargers that discharge more than 1,800 pounds TP per year is listed below:

- To be proactive in the prevention of the eutrophication of Minnesota’s water resources through the reduction of point source phosphorus loading.
- To protect the water quality of waterbodies that have water quality better than standards.
- To help restore waterbodies that are impaired due to excess nutrients.
- To help achieve TMDL driven or watershed-specific nutrient reduction goals.
- To help protect downstream water resources including those beyond Minnesota’s borders.

The proposal will codify in rule the Agency’s Phosphorus Strategy. It will assure a continuation of the impressive gains made in phosphorus removal from point sources that has taken place since March 2000 under the Strategy. It will continue to encourage biological phosphorus removal treatment technologies. It will have a significant secondary benefit of reducing effluent concentrations of other solids-associated pollutants such as mercury.

The proposed TP limit will only impact municipalities and industries as they expand or build new treatment facilities, and only if they discharge more than 1,800 pounds of TP per year. This will automatically exempt more than half of all permitted POTWs. Excluding the smaller facilities will have very little negative environmental effect. Implementation of the Agency’s proposal is straightforward and simple; it will avoid the uncertainties and potential controversy of determining the meaning of “affects,” which can be a stumbling block under the current rule. This could reduce the number of contested case hearings and legal challenges generated by proposed TP limits.

Other states including Wisconsin have rules similar to what the Agency is proposing already in place. The proposal is consistent with statewide efforts to improve Minnesota’s water quality through major initiatives at the executive and legislative levels of state government.

The treatment costs attributed to this proposal described in Section XI are substantial, but a significant portion of these costs will be incurred independent of the proposed rule. The combination of TP limits in existing rules (Lake Superior basin), major nutrient-related TMDLs (Lake Pepin and Minnesota River), significant basin-wide nutrient reduction goals (St. Croix), means point source TP removal is already, or soon will be, required in much of the state. Also under the Strategy, TP limits for new and expanding facilities were becoming commonplace. The proposal includes three potential exemptions, plus the option of a variance, to a TP limit that a discharger may qualify for upon request.
X. CONSIDERATION OF ECONOMIC FACTORS, PROPOSED EUTROPHICATION STANDARDS

A. INTRODUCTION [X. EU standards, economics]

As mentioned in Section II, Minnesota’s lakes have a huge economic value. About 500,000 visitors come to Minnesota each year to fish – mostly on lakes. To not vigorously protect this valuable resource risks costing the state money in the long run.

Studies of the economic value of water cover a broad range of uses and values attached to water resources, and estimates have been made in all parts of the world. Study methods range from those that are tightly connected with real market data to others that estimate the value of rather abstract human values and preferences. The number of studies has reached the point that analysts find it useful to spend time compiling databases that catalogue relevant studies.58 A small selection of studies that are most relevant to Minnesota’s lakes will be highlighted in this section of the SONAR.

The possibility of added costs to either point and nonpoint sources due to the adoption of the eutrophication standards is discussed in Sections X.C and X.D.

B. ECONOMIC BENEFIT OF ADOPTING EUTROPHICATION STANDARDS [X. EU standards, economics]

The old adage, an ounce of prevention is worth a pound of cure, is true when it comes to lakes. In general, it is far cheaper to take steps to protect lakes from becoming eutrophic than it is to try to restore lakes to an earlier condition after they have suffered from cultural eutrophication. The Agency has had considerable experience in this area through the administration of the Clean Lakes Program and Clean Water Partnerships, which provide funding and technical help to restore degraded lakes. There are examples of dramatic improvements in lake quality following restoration actions (usually following diversion of point sources of TP away from the lake); but not all lakes respond well to remedial efforts, and few ever return to their pre-impacted condition. Work at the University of Wisconsin has shown that restrictions which protect lakes from degradation improves the value of lakeshore property.

The Agency believes that proposed eutrophication standards and the extension of the TP effluent limit will improve the water quality in Minnesota. It is reasonable to expect that these improvements will sustain and possibly increase the economic value of lakes and rivers. The Agency does not have the resources to carry out the types of studies that would be required to quantify the specific economic values associated with the proposed rules. Such studies would be very expensive and time consuming. However, published or reported studies of the economic

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58 A Beneficial Use Values Database (BUVD) was compiled in 2001 at the University of California Davis campus. The BUVD reports on over 2,000 water-related values estimated in 128 documents. Copies of the BUVD and directions for its use can be found at http://buvd.ucdavis.edu.
value of water resources in other locations and in Minnesota indicate that water quality improvements in Minnesota lakes are likely to have a positive economic value. Likely improvements include:

- Enhanced outdoor recreation opportunities for local residents and for tourists from other states,
- Market value increases for properties located on waterbodies and
- Increased non-use values (e.g., bequests, “option” value) that some residents associate with knowing that water quality is improving.

Fishing leads the list of water-related recreation activities. A national survey in 2001 found that 1.6 million people (over age 15) fished in Minnesota. They accumulated 27.5 million days fishing and spent $1.3 billion for supplies and services in Minnesota ($407 million on equipment).59 About 330,000 people came from other states and countries to fish in Minnesota. Along with fishing, other valued recreation activities include boating and swimming. Tourism generally in Minnesota is now estimated to contribute nearly $10 billion annually to the state’s economy.60 Considering the estimate of spending related to fishing, it seems likely that water-related tourism accounts for a significant share of tourism’s total economic impact. Recreation and tourism studies show that people are willing to spend time and money to use water resources, but these studies do not indicate how water resources affect value.

Property-based studies in several states have shown that people are willing to pay for water resources of higher quality. Research done in Maine, Vermont and New Hampshire have shown a direct correlation between water clarity and the market value of shoreland property. The Maine study examined the relationship between Secchi disk transparency and the selling price of over 900 properties on 34 lakes in Maine in from 1990 to 1994. They found that a decrease in Secchi disk transparency of one meter in 10 years was associated with significant declines in property values, from $3,000-$9,000 per lot (Exhibit EU-43, page 24. This exhibit, a special issue of LakeLine, is devoted to the economic value of lakes).

Closer to home, a study conducted in the late-1980s estimated the contribution of water clarity to lake-front property values on 53 lakes in northern Minnesota (Exhibit EU-47). In this study significant correlation was demonstrated among water transparency and measures of lake lot price. The author found that a one foot increase in Secchi disk transparency raised lakeshore prices by an average of $206 to $240 per lakeshore lot (average lake frontage of lots was 121 feet). Other variables tested, including lake size, lake depth and accessibility, did not prove to have a significant effect on lakeshore value. This study compiled estimates from land value assessments that, although they were influenced by market factors, were less direct than actual market sales data. The author suggests, however, that factors such as acid rain (making water

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60 Estimated by the Minnesota Department of Employment and Economic Development. This estimate takes into account more than direct expenditures by tourists. It includes the value of input suppliers’ purchases (e.g., petroleum purchased by refiners) and demand from households that benefit from income changes induced by demand increases. Find the estimate at http://www.deed.state.mn.us/tourism/economy/EconomicImpact.htm.
appear more clear) or dark, bog-stained water (making the water appear less clear) can alter people’s perceptions of water quality and their perceptions of the value of the adjacent land.

An important recent Minnesota study, already mentioned in Section VI.L.4, that used actual property sales data, found that lakeshore property values increase when water clarity increases and decrease when water clarity decreases (Table 3 in Exhibit EU-39). This study was patterned after the Maine study mentioned above. The authors report that a one meter improvement in Secchi transparency increased the value of lakeshore property by an average of $45.64 for each frontage foot on the lake (median increase, $13.59; range $1.08 to $423.58). A one meter decrease in Secchi transparency decreased lakeshore property values by an average of $69.36 per frontage foot (median decrease, $22.92; range $1.43 to $594.16).61

Informal research by the Minnesota Department of Revenue confirms the expected influence of lake frontage on property values. Acting on a recent request from the Agency, Department of Revenue staff members asked some county assessors about the difference in estimated market value between lakeshore properties and properties that have no lakeshore.62 The results are striking, as shown in Table II-19. The median estimated market value of the lakeshore lots is $100,550 compared to $15,500 for the off-lake locations (mean values are $142,520 vs. $17,360, respectively).

61 The lake with both the largest increase ($423.58) and largest decrease ($594.16) in dollar value with a one meter change in water clarity is Leech Lake. The lake with both the smallest increase ($1.08) and smallest decrease ($1.43) in dollar value with a one meter change in water clarity is Balsam Lake in Itasca County.
62 Phone and e-mail communications with John Hagen, Minnesota Department of Revenue.
Table II-19. Difference in Value Between a Residential Lakeshore Lot and a Similar Lot Located Off the Water.

<table>
<thead>
<tr>
<th>County</th>
<th>Size</th>
<th>Off Lake Location</th>
<th>EMV*</th>
<th>Size</th>
<th>On Lake Location</th>
<th>EMV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Becker</td>
<td>Min. 1 acre</td>
<td>Audubon Twp.</td>
<td>8,000</td>
<td>150 Width</td>
<td>Lake Cormorant</td>
<td>62,000</td>
</tr>
<tr>
<td>Becker</td>
<td>Min. 1 acre</td>
<td>Callaway Twp.</td>
<td>4,500</td>
<td>200 Width</td>
<td>Birch Lake</td>
<td>19,000</td>
</tr>
<tr>
<td>Becker</td>
<td>Min. 1 acre</td>
<td>Eagle View</td>
<td>4,500</td>
<td>150 Width</td>
<td>Tulaby Lake</td>
<td>64,500</td>
</tr>
<tr>
<td>Becker</td>
<td>Min. 1 acre</td>
<td>Lake Eunice</td>
<td>11,600</td>
<td>150 Width</td>
<td>Maud Lake</td>
<td>69,900</td>
</tr>
<tr>
<td>Cass</td>
<td>100X300</td>
<td>Birch Lake</td>
<td>15,000</td>
<td>100X300</td>
<td>Birch Lake</td>
<td>140,000</td>
</tr>
<tr>
<td>Cass</td>
<td>2.5 acres</td>
<td>Leech Lake-Walker</td>
<td>25,000</td>
<td>2.5 acres</td>
<td>Leech Lake-Walker</td>
<td>300,000</td>
</tr>
<tr>
<td>Crow Wing</td>
<td>85X135</td>
<td>Gull Lake-back lot</td>
<td>14,300</td>
<td>85X135</td>
<td>On Gull Lake</td>
<td>396,700</td>
</tr>
<tr>
<td>Crow Wing</td>
<td>80 X ?</td>
<td>Crow Wing Lake</td>
<td>14,300</td>
<td>80 X ?</td>
<td>On Crow Wing Lake</td>
<td>71,700</td>
</tr>
<tr>
<td>Crow Wing</td>
<td>Similar Size</td>
<td>Off Blue Lake</td>
<td>15,000</td>
<td>Similar</td>
<td>On Blue Lake</td>
<td>102,500</td>
</tr>
<tr>
<td>Douglas</td>
<td>100X200</td>
<td>Le Homme Dieu Lake</td>
<td>25,000</td>
<td>100X200</td>
<td>Lettomme Dieu Lake</td>
<td>315,000</td>
</tr>
<tr>
<td>Douglas</td>
<td>200X300</td>
<td>Mina Lake</td>
<td>12,500</td>
<td>200X300</td>
<td>Mina Lake</td>
<td>115,000</td>
</tr>
<tr>
<td>Hubbard</td>
<td>2.50 acres</td>
<td>Yes</td>
<td>13,800</td>
<td>2.48 acres</td>
<td>Yes</td>
<td>69,900</td>
</tr>
<tr>
<td>Hubbard</td>
<td>3.00 acres</td>
<td>Yes</td>
<td>23,000</td>
<td>2.69 acres</td>
<td>Yes</td>
<td>113,600</td>
</tr>
<tr>
<td>Hubbard</td>
<td>3.00 acres</td>
<td>Yes</td>
<td>33,000</td>
<td>2.93 acres</td>
<td>Yes</td>
<td>98,600</td>
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<tr>
<td>Itasca</td>
<td>8.1 acres</td>
<td>Island Lake</td>
<td>26,000</td>
<td>4.2 acres</td>
<td>Island Lake</td>
<td>69,500</td>
</tr>
<tr>
<td>Itasca</td>
<td>9.1 acres</td>
<td>Bluewater Lake</td>
<td>17,400</td>
<td>2.4 acres</td>
<td>Bluewater Lake</td>
<td>332,900</td>
</tr>
<tr>
<td>Lake</td>
<td>2.36 acres</td>
<td>Off Lake Ojibway</td>
<td>22,100</td>
<td>2.24 acres</td>
<td>On Lake Ojibway</td>
<td>78,100</td>
</tr>
<tr>
<td>Lake</td>
<td>2.50 acres</td>
<td>Near Two Harbors</td>
<td>30,200</td>
<td>2.20 acres</td>
<td>Lake Superior</td>
<td>194,500</td>
</tr>
<tr>
<td>Otter Tail</td>
<td>2.02 acres</td>
<td>Aurdal Township</td>
<td>16,000</td>
<td>150X345</td>
<td>Swan Lake</td>
<td>94,900</td>
</tr>
<tr>
<td>Otter Tail</td>
<td>2.02 acres</td>
<td>Aurdal Township</td>
<td>16,000</td>
<td>280X400</td>
<td>Long Lake</td>
<td>142,100</td>
</tr>
</tbody>
</table>

* EMV = Estimated market value, in dollars.

Notes: Becker County - Only frontage given and off lake lots are a minimum of one acre. Crow Wing - all rural neighborhoods. Lake County - Lake Ojibway lots are both in Town of Fall Lake.

The economic value of several individual Minnesota lakes or lakes in a small watershed have been estimated using methods first used by Todd (1990) in a study on the economic value of Minnesota’s lakes (Exhibit EU-41). An example of these economic analyses was published in the Minnesota Lakes Association Reporter (November 2005). The study quantified the economic potential of the Turtle Lake watershed, a watershed that includes 10 lakes near Bigfork, Minnesota. The study estimated the value of direct consumer purchases associated with lake activities; and estimates of people’s willingness to pay to protect the resource over and above necessary expenditures, and willingness to pay to protect the resource for the future (Exhibit EU-40). The combined annual consumer purchases and willingness to pay value was just under $5 million for the 10-lake watershed. The “income” from these lakes was about 15 times greater that the annual property tax for properties in the watershed (which was $333,348 in 1999). The Turtle Lake study also estimated that 54 water-related jobs are created based on the
combined acreage for the 10 lakes in the watershed (16.5 jobs for each 1000 acres of fishable lake)\textsuperscript{63}. 

Stream trout lakes are also important to Minnesota's economy. The overall annual economic impact of anglers fishing inland trout lakes is $52 million, with another $33 millions in direct income. These expenditures support over 1,000 full and part time jobs.\textsuperscript{64}

Studies that focus more broadly on water-related values reinforce the specific findings that relate to tourism and property. In the region around the Minnesota River, researchers found general public opinion in favor of programs that reduce phosphorus in the river by 40 percent.\textsuperscript{65}

Acceptable levels of annual household payments ranged from $14 to $40. This result compares well with recent national research. A national panel surveyed in 2004 indicated a willingness to pay $23 per year for a one percent improvement in lake and river water quality.\textsuperscript{66}

Without the benefit of direct value studies, the Agency must rely on indirect evidence of the economic benefit of the proposed rules. Review of national and local studies shows that:

- When analysts look for economic value in water-related resources, they find it. People are willing to pay to use and protect water resources.
- Water resources comprise an important factor in the operation of Minnesota’s economy.
- Property values respond positively to improvements in the clarity of water in lakes and negatively to declines in water clarity.

The weight of the indirect evidence indicates to the Agency that the proposed rules will add to the economic value of Minnesota’s water resources.

C. GENERAL ASSESSMENT OF POTENTIAL COSTS ATTRIBUTED TO ADOPTION OF EUTROPHICATION STANDARDS [X. EU standards, economics]

The Agency considered the possibility that the proposed eutrophication standards might result in added costs to the following programs.

1. NPDES permits for POTWs and industries
2. Individual sewage treatment systems
3. Storm water permits, MS-4 and construction activities
4. Feedlot permits

\textsuperscript{63} This study is also published in a special issue of *Lake Line*, vol. 23, page 21 devoted to the economic value of lakes, Exhibit EU-43, page 21.
\textsuperscript{64} Gartner, W., L. Love, Erkilla and Fulton. 2002 Economic impact and social benefits study of coldwater angling in Minnesota. Univ. of Minn. Dept. of Fisheries and Wildlife. Prepared for MDNR. 126 pages.
\textsuperscript{65} Mathews, Leah Greden, Frances R. Homans and K. William Easter, “Reducing Phosphorus in the Minnesota River: How Much is it Worth?” Staff Paper P99-4, Department of Applied Economics, College of Agricultural, Food and Environmental Sciences, University of Minnesota, April 1999.
The Agency concluded that potential future costs, attributable specifically to the proposed eutrophication standards, were likely for just the first of the categories listed above; i.e., potentially a very small subset of NPDES permittees. It is the opinion of the Agency that the other programs listed above will not be significantly impacted, or that the possibility of added costs are so hypothetical that it defies estimation. Implementation of the existing or developing programs listed as 2 - 5 above will proceed independent of the proposed standards and should not be significantly affected. Also, if the proposed eutrophication standards are not adopted, the Agency will continue to vigorously implement the narrative standard in Minn. R. 7050.0150, subp. 5.

5. Nonpoint sources activities

While the Agency has not identified added costs for nonpoint sources (including those regulated under a permit which are considered point sources), it does not mean that the reduction of nutrient loading to surface waters from septic systems, stormwater runoff, feedlots, or nonpoint sources in general is not a major goal for these programs. The contributions of nutrients from all these sources can be a major concern locally as well as state-wide (Exhibit EU-6). It is the Agency’s intent that the proposed standards be a factor considered when these programs are being implemented; and that adopted standards might influence a decision by the regulating authority to require more effective (and possibly more costly) best management practices, to influence the setting of priorities for regulatory actions, or to spur a more proactive response to reduce nutrient loading. However, the Agency believes that the possibility that these actions will result in added costs, due just to the eutrophication standards, is very hypothetical and speculative, and that any attempt to guess at costs would have little meaning. These programs are discussed individually in the next paragraphs.

It is conceivable that the eutrophication standards might re-invigorate or spur counties to advance their programs to inspect and require upgrading of failing onsite sewage treatment systems around a lake. Or they might focus attention on those lakes in jeopardy of exceeding standards. However, many lake-rich counties have had aggressive septic system inspection and replacement programs in place for many years. The Agency feels the proposed standards might play a roll in reinforcing these programs, but the county’s programs will proceed regardless.

The Agency’s stormwater permit program has undergone significant expansion since March 2003 when the program broadened to include many more cities and smaller construction sites. NPDES or state disposal system permits are required for construction sites, industrial sites and municipalities. The tremendous expansion of the program (e.g., from 900 to 3000 construction site permits) has led to the development of general permits that apply to most construction sites collectively. Permittees are required to develop pollution prevention plans and to implement

67 Statewide contributions of TP, from Exhibit EU-6:
- Human waste products, 10.9 %
- Individual sewage treatment systems, 3.7 %
- Urban and non-agricultural rural runoff, 10.5 %
- Feedlots, 1.0 %
- Total nonpoint sources, 69 % (this changes to 75 % now that the Metro plant is meeting a 1 mg/L limit).
appropriate best management practices (BMP) to reduce pollutants in stormwater. The general permits do not contain numeric limits for TP, or numeric limits for any pollutant.

As discussed in other contexts, the possibility exists that the eutrophication standards might result in added costs; if, for example, a construction site was adjacent to a lake and the standards were the impetus to require more rigorous BMPs to control runoff. The Agency has not attempted to estimate the costs of this possibility because separating the costs that would be incurred without the standards to those attributable to the standards is too hypothetical. The proximity of a lake to the construction zone may prompt the application of the best available BMPs independent of the standards.

Phosphorus limits are a possibility in the future for municipal stormwater permits, but this will not be due to the eutrophication standards.

The Agency and delegated counties permit approximately 990 feedlots in Minnesota. All but 40 of these feedlots are covered under a general permit. The general and individual permits do not allow any discharge of manure wastes to surface waters, except under conditions of extreme rain events. These permits also include special conditions and management practices to prevent the flow of phosphorus containing runoff from entering surface waters following land application of manure. The proposed eutrophication standards will have no impact on feedlot permits.

In general, pollutants from non-point sources are controlled through the voluntary implementation of BMPs. A variety of educational and incentive programs are in place at several levels of government to encourage the application of BMPs. The eutrophication standards will not change the basic voluntary/incentive approach to controlling nonpoint source pollution. As has been repeatedly stated, however, the Agency’s intent with the promulgation of numeric standards is that they may be an additional consideration and possible incentive to implement BMPs to protect valuable lake resources. The Agency believes that this possible response to the eutrophication standards is too speculative to be the basis for a meaningful prediction of costs for implementing BMPs.

The possibility of costs to any small business or city exceeded $25,000 in the first year the proposed eutrophication standards are adopted is discussed in Section V.L.

D. POTENTIAL COSTS TO POINT SOURCE DISCHARGERS ATTRIBUTED TO ADOPTION OF EUTROPHCIATION STANDARDS [X. EU standards, economics]

1. Introduction [X.D. EU standards, economics]

The Agency is assuming that the proposed addition of the eutrophication standards will result in additional treatment costs to some municipal dischargers (POTWs). It is impossible to know with certainty what those future costs to point sources might be because we do not know the number or size of POTWs that might be impacted. A series of factors must fall into place for

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any discharger to incur costs. Also, a portion of the estimated costs for point sources might be incurred regardless, if the proposed standards are not adopted, due to a range of factors, such as:

- Continued application of the Phosphorus Strategy;
- Use of the nutrient criteria as a basis for TP effluent limits;
- New or renewed watershed TP reduction goals; and
- Continued emphasis on phosphorus as a major pollutant by all branches and levels of governments.

The Agency is making a good faith effort to estimate costs using our experience of setting TP effluent limits over the last five years. We believe that our cost estimates are conservative and likely to over estimate true costs.

The Agency has not attempted to estimate potential added costs specifically for industries attributable to the eutrophication standards. The possible costs to industries due to the proposed extension of the TP limit to new and expanded discharges can be used as an indication of possible treatment costs (Section XI.E), but the Agency believes very few industries will fall into the categories of potentially impacted discharges listed below.

To estimate potential costs to municipalities, the Agency will use hypothetical situations and make several assumptions. In all situations described for this purpose the discharger is already required to meet a 1 mg/L TP effluent limit based on the current rules. It is assumed that when the TP limit is due to the proposed eutrophication standards, the limit will be more stringent than 1 mg/L.

The situations the Agency believes could result in costs to a municipal discharger are:

1. Discharge **directly** to a lake with water quality that meets, or is better than, the proposed standards; nondegradation and loading minimization will be the basis for the effluent limit.
2. Discharge affects a **downstream** lake with water quality that meets, or is better than, the proposed standards; nondegradation will be the basis for the effluent limit.
3. Discharge to **downstream** lake for which the increased TP loading is likely to cause an exceedance of eutrophication standards; maintenance of standards will be the basis for the effluent limit.
4. Discharge to **downstream** lake on the impaired waters list due to excess nutrients; federal requirements and load minimization will be the basis for the effluent limit until the TMDL is completed.

Also, in order for any discharger to be impacted, one of the following situations would need to be true:

- The permit has expired and is being reissued;
- The facility is new or expanding (a *de minimis* loading is not applicable in these situations);
• The public or an outside party has brought to the Agency’s attention that the facility is negatively impacting a lake; or
• The facility is impacting a lake for which a TMDL has been completed.

To estimate future costs the Agency is making assumptions about the number and size of dischargers impacted based largely on our experience setting TP limits, and in light of recent improvements in TP removal treatment technologies. The number of POTWs assumed to be impacted in the next five years and the treatment technologies that may be required to meet TP limits more stringent than 1 mg/L are shown in Table II-24.

2. **Basis for Cost Estimates [X.D. EU standards, economics]**

The information the Agency used to compile cost estimates comes from: 1) previous work and cost estimates for phosphorus removal completed by Agency staff (Section X.I.D); 2) a search of some of the available literature on estimating costs for phosphorus removal by POTWs; and 3) information collected from Minnesota wastewater treatment facilities that have completed construction of phosphorus removal projects or have prepared estimates contemplating future phosphorus removal related construction projects.

The costs to achieve effluent TP concentrations in the range of 1.0 to 0.04 mg/L are estimated for three facility design flows, and for different removal techniques. The removal techniques evaluated, which are designated as “good, better and best” Tiers are:

1. Tier 1, chemical removal,
2. Tier 2, chemical removal with sand filters, and
3. Tier 3, chemical removal with microfiltration or membrane biological reactor (MBR) processes.

The focus of this analysis is the additional costs incurred to treat effluent TP to levels lower than 1 mg/L. It is assumed that the plants, at a minimum, will require new chemical addition facilities (capital costs) and subsequent operation and maintenance (O&M) costs, including additional biosolids (sludge) storage and treatment.

For advanced treatment of effluent phosphorus to the range of 0.1 to 0.04 mg/L, it is assumed that additional settling, sand filters, or microfiltration processes, are required (Exhibit PL-12). For the purposes of this evaluation, it was assumed that all treatment plants will use chemical precipitation to remove phosphorus. This does not imply a recommendation of chemical phosphorus removal over biological phosphorus removal on the part of the Agency. On the contrary, biological phosphorus removal with chemical backup followed by additional treatment or microfiltration will generally result in less O&M cost than treatment to the same level with chemicals alone due to the need for less chemical and less sludge production.
3. Methods and Capital and O&M Costs to Meet 1.0 mg/L TP Effluent Limit Using Chemical Addition [X.D. EU standards, economics]

While the focus of this analysis is costs to meet a limit more stringent than 1 mg/L, it is useful to start with estimates of the costs to meet a 1 mg/L effluent limit in situations where the facility has not previously had a TP limit. The common use of chemical addition in the form of alum or ferric chloride to remove TP in wastewater treatment facilities, and the associated capital costs to meet a 1 mg/L limit for a range of POTW sizes, is discussed in Section XI.D (estimated costs for industries are discussed in Section XI.E). The analysis discussed in this Section, to meet 1 mg/L TP in the context of the proposed eutrophication standards, is analogous to the estimates shown in Tables II-25 and II-26.
Many of the same references were reviewed by Agency staff for both analyses to arrive at the best cost estimates for chemical removal of phosphorus to 1 mg/L. In addition, the following two references were used in this analysis.


In this analysis an average cost for a given size of facility is estimated. It is important to point out that treatment costs are generally very site specific, and it is quite possible that different wastewater treatment facilities that have similar design flows will not have the same cost estimate for chemical phosphorus removal processes and sludge handling.

The cost estimates assume construction to treat to the design flow of the facility and the use of alum as the TP removal chemical. The estimates include costs for a chemical feed system with a 15 day storage supply of alum, incremental costs of clarifier improvements, and biosolids treatment and handling to accommodate the increased biosolids volume above the amount normally generated by using non-chemical removal processes or with chemical removal as a backup to achieve 1.0 mg/L TP. The costs provided in the EPA and Chesapeake Bay references are in 1984 and 2002 dollars, but they have been updated based on the June 2006 Engineering News Record (ENR) (construction cost index value of 7700).

The estimated average capital and O&M costs for three sizes of POTWs are shown in Table II-20. The estimated range of costs could be from one half to twice that of the average costs. The range in potential costs is large due to variations in the level of phosphorus coming into the treatment facility, and the amount of biosolids treatment and storage needed at the specific facility. In particular, the large range in costs depends on the need, or the lack of need, for the latter. For example, many facilities currently have the capacity to store one year’s production of biosolids when only six months of storage capacity is needed. Therefore they would be able to store more biosolids each year without significant increased cost by just increasing their frequency of land application. The costs for additional treatment processes, such as sand filters, are not included in the Table 20 figures but are discussed in the next sections. The costs in Table 20 are comparable to the costs shown in Tables II-25 and 26 for the same facility sizes (see Section XI.D.3).

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3. Nutrient Reduction Technology Cost Estimations for Point Sources in the Chesapeake Bay Watershed (also see Exhibit PL-12).
5. Information from state of Wisconsin.
4. **Capital and O&M Costs to Meet a TP Limit More Stringent Than 1.0 mg/L Using Chemical Addition** [X.D. EU standards, economics]

The additional costs to treat to levels of effluent TP below 1 mg/L are determined for three “Tiers” of available treatment technologies capable of achieving effluent TP in the range of 0.5 to 0.04 mg/L. Tier 1 is TP removal with chemical addition only (without filters or other processes). Tier 1 is assumed to be capable of meeting a TP limit of 0.5 mg/L. Tier 2 assumes chemical addition plus sand filtration. Tier 2 is assumed to be capable of meeting a TP limit of 0.1 mg/L. Tier 3 is chemical addition plus the addition of polymers and ultra filtration. Tier 3 is assumed to be capable of meeting a TP limit as low as 0.04 mg/L.

Table II-21 is a summary of the costs to achieve a Tier 1 level of TP removal. These costs assume the addition of a limited amount of phosphorus removal capability, and that the facility is already able to achieve a 1.0 mg/L limit. Thus, chemical addition TP removal systems would already be in place. The capital cost for implementing a “Tier 1” upgrade would only include the capital costs for additional storage and treatment and the O&M costs for the additional chemical needed to achieve the lower TP level. Such systems, however, may also require a more sophisticated chemical addition process to introduce chemical at more points at the facility, or additional settling capability, which could add to the costs shown.

Table II-21 is a summary of the costs to achieve a Tier 1 level of TP removal. These costs assume the addition of a limited amount of phosphorus removal capability, and that the facility is already able to achieve a 1.0 mg/L limit. Thus, chemical addition TP removal systems would already be in place. The capital cost for implementing a “Tier 1” upgrade would only include the capital costs for additional storage and treatment and the O&M costs for the additional chemical needed to achieve the lower TP level. Such systems, however, may also require a more sophisticated chemical addition process to introduce chemical at more points at the facility, or additional settling capability, which could add to the costs shown.

Table II-21. POTWs, Summary of Additional Costs for Tier 1 Phosphorus Removal Using Alum. TP Removal to as Low as 0.5 mg/L.

<table>
<thead>
<tr>
<th>Cost in Dollars For:</th>
<th>Average Monthly Wet Weather Plant Design Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2 mgd</td>
</tr>
<tr>
<td>Total Capital</td>
<td>$100,000</td>
</tr>
<tr>
<td>Annual O&amp;M</td>
<td>$20,000</td>
</tr>
</tbody>
</table>

Table II-22 is a summary of the costs to achieve a Tier 2 level of TP removal. These costs assume a significant amount of phosphorus removal capability, which requires additional treatment units beyond what the facility needs to achieve a 1.0 mg/L limit. Again, it is assumed that the facility is already achieving a 1.0 mg/L limit through chemical addition. The capital cost for a Tier 2 upgrade would include costs for the addition of sand filters or additional settling mechanisms, and additional biosolids storage and treatment. Additional use of chemicals, the sand filtration and any additional settling processes are included in the estimated annual O&M costs.

Table II-22. POTWs, Summary of Estimated Costs for Phosphorus Removal to 1.0 mg/L Using Alum.

<table>
<thead>
<tr>
<th>Cost in Dollars For:</th>
<th>Average Monthly Wet Weather Plant Design Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2 mgd</td>
</tr>
<tr>
<td>Total Capital</td>
<td>$400,000</td>
</tr>
<tr>
<td>Annual O&amp;M</td>
<td>$50,000</td>
</tr>
</tbody>
</table>
Table II-23 is a summary of the costs to achieve a Tier 3 level of TP removal. These costs assume a phosphorus removal capability that will achieve very low effluent TP concentrations – concentrations within the range of the proposed TP standards for lakes. As before, it is assumed that the facility is meeting a 1.0 mg/L TP limit through chemical addition. The cost for implementing the Tier 3 upgrades would include the capital costs for one of the following options.

- The addition of dual stage sand filtration, or
- Ion exchange technology, or
- Micro filtration, or
- Membrane reactor filtration.

A description of these treatment technologies is beyond the scope of this SONAR, but it should be noted that they all are proven and currently being used to treat TP to levels as low as 0.04 mg/L. 70 (also see Exhibit PL-12.) Since just one of the treatment technologies listed above would be added to the chemical addition system already be in place, the capital costs may not be dramatically more than the costs for the Tier 2 systems. For example, a facility would not need dual stage sand filtration and a microfiltration system at the same time. Also, chemical costs and additional biosolids storage costs may not be significantly more than the costs for Tier 2 since the additional amount of phosphorus removed is a smaller percentage over the amount that would be actually removed to achieve the Tier 2 limit. However, the costs for energy, operation and maintenance would be significantly higher than for most systems meeting a Tier 2 limit.

The estimated O&M costs for Tier 3 level removal are higher because, in addition to the cost of additional chemical and additional biosolids storage and treatment, the advanced treatment systems are very likely to require a more sophisticated computer operating system and a more highly trained or experienced operator. The operation of these facilities will be more complex and older computer operating system probably will need to be replaced. Therefore, the added O&M costs for Tier 3 may be significant.

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Table II-23. POTWs, Summary of Additional Costs for Phosphorus Removal Using Alum and a Tier 3 Level of Treatment. TP Removal to as Low as 0.04 mg/L.

<table>
<thead>
<tr>
<th>Cost in Dollars For:</th>
<th>Average Monthly Wet Weather Plant Design Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.2 mgd</td>
</tr>
<tr>
<td>Total Capital</td>
<td>$400,000</td>
</tr>
<tr>
<td>Annual O&amp;M</td>
<td>$80,000</td>
</tr>
<tr>
<td></td>
<td>1.5 mgd</td>
</tr>
<tr>
<td>Total Capital</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>Annual O&amp;M</td>
<td>$400,000</td>
</tr>
<tr>
<td></td>
<td>5 mgd</td>
</tr>
<tr>
<td>Total Capital</td>
<td>$3,500,000</td>
</tr>
<tr>
<td>Annual O&amp;M</td>
<td>$800,000</td>
</tr>
</tbody>
</table>

5. Summary and Total Estimated Costs Due to Eutrophication Standards [X.D. EU standards, economics]

To estimate potential costs to municipalities over the next five years the Agency is projecting, based on our experience over the previous five years, that relatively few POTWs will need to remove TP beyond 1 mg/L due to the proposed eutrophication standards. Also, as outlined in Section X.D.1, a portion of the estimated costs could occur even if the standards are not adopted.

As stated, the Agency is very reluctant now to permit a discharge directly to a lake, and few such permits have been granted over the last several years. Nevertheless, there is always the possibility that a small POTW may have no option but to discharge to a lake. The receiving lakes in these situations are usually large and the discharge is small to very small. It is likely that a POTW that must discharge directly to a lake in the future will have AWWDF less than 0.2 mgd, but the estimated costs are based on a POTW of that size. The Agency is projecting three such dischargers in the next five years.

Table II-24 summarizes the estimated costs for the number of facilities projected to be impacted in the four categories outlined in the introduction Section above. A total of 15 facilities in two size categories are projected to be impacted. It is assumed that any new discharge directly to a lake will be required to provide the best treatment achievable with current proven technologies; i.e., a Tier 3 level of treatment. If the additional loading of TP from the POTW is projected to cause an exceedance of the standards in a downstream lake, it is assumed that these dischargers would need to provide a Tier 2 level of treatment. If the POTW is in a situation where nondegradation or the implementation of a TMDL determines the TP effluent limit, it is assumed a Tier 1 level of treatment will be adequate. We need to emphasize, however, that a POTW in any of the four categories could get a TP limit requiring treatment at any of the three Tier levels, depending on the situation.
Table II-24. Summary of Estimated Average Costs to Municipal Dischargers Over the Next Five Years Due to the Eutrophication Standards.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Size mgd</th>
<th>No. in 5 years</th>
<th>Treatment Technology</th>
<th>Potential TP Limit mg/L</th>
<th>Projected Total Costs over 5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Capital cost $ millions</td>
<td>Annual O&amp;M $ millions</td>
<td>Total costs* $ millions</td>
</tr>
<tr>
<td>Direct discharge to lake</td>
<td>0.2</td>
<td>3</td>
<td>Tier 3</td>
<td>0.05</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge impacts lake down-</td>
<td>0.2</td>
<td>2</td>
<td>Tier 1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>stream</td>
<td>5.0</td>
<td>2</td>
<td>Tier 1</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>- Nondegradation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicted measurable increase</td>
<td>0.2</td>
<td>2</td>
<td>Tier 2</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>- Expected exceedance of</td>
<td>0.2</td>
<td>2</td>
<td>Tier 2</td>
<td>0.1</td>
<td>4.8</td>
</tr>
<tr>
<td>standard</td>
<td>5.0</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Impacts impaired</td>
<td>0.2</td>
<td>2</td>
<td>Tier 1</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>water (TMDL complete)</td>
<td>5.0</td>
<td>2</td>
<td>Tier 1</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

* Total capital plus one year of O&M costs

Treatment technologies (any may be combined with biological phosphorus removal):
  Tier 1. chemical addition
  Tier 2. chemical addition and sand filtration
  Tier 3. dual stage sand filtration, or ion exchange, or micro filtration or membrane reactor filtration.

In summary the Agency predicts that roughly 15 POTWs may be required to remove TP to a level below 1 mg/L due to the proposed eutrophication standards at an estimated total capital cost of $8.2 million and a total O&M cost for one year of $2.02 million.
XI. CONSIDERATION OF ECONOMIC FACTORS, EXTENSION OF PHOSPHORUS EFFLUENT LIMIT

A. INTRODUCTION [XI. TP limit, economics]

The Agency has made a concerted effort to estimate as accurately as possible the costs some municipalities and industries may incur as a result of the proposed extension of the 1 mg/L phosphorus (TP) limit to new and expanded discharges. At the same time the Agency believes that the full costs of removing TP from point sources cannot be attributed to the extension of the TP effluent limit alone. In other words, the costs due to this proposal will be substantially mitigated for the reasons discussed in Section XI.F.

The possibility of costs to any small business or city exceeded $25,000 in the first year the proposed extension of the TP limit is discussed in Section VIII.L.

Isolating the treatment costs that can be attributed to just one phase of a complex treatment facility is difficult. Wastewater treatment costs are not usually broken out in such a way that the costs for removing just CBOD or TSS or, in this case TP, are readily available. This is probably even more true for facilities designed for biological phosphorus removal (Bio-P). Bio-P seems to be the treatment technology of choice today for many cities because of the advantages it offers, in addition to the removal of TP. A full discussion of this technology is outside the scope of the SONAR, but the following brief description is warranted.

B. BIOLOGICAL PHOSPHORUS TREATMENT TECHNOLOGIES [XI. TP limit, economics]

In general, Bio-P technology is a variation of the standard activated sludge secondary treatment process. The Bio-P variation creates conditions that promotes the growth of phosphorus accumulating bacteria. This is accomplished by exposing the microorganisms in the wastewater to a sequence of anaerobic then aerobic zones in the biological treatment process. The bacteria first release the small amounts of phosphorus that are naturally stored in their cell mass into the wastewater, but in the aerobic step the organisms take up the readily bio-available phosphorus from the wastewater. The organisms become heavy and settle out in the final clarifiers. The phosphorus containing organisms are removed with the waste sludge. Bio-P can be accomplished through design (new or expansion); or, in some cases, it can be achieved by altering operation modes or making other alterations to existing facilities to provide an anaerobic step to enhance the phosphorus removing bacteria (retrofits). In some cases the motivation to operate an existing facility in a “Bio-P” mode is the savings in energy cost the technology offers, and TP removal is a secondary benefit.

As with most biological treatment process there are advantages and disadvantages associated with Bio-P that need to be considered before a decision is made whether or not to convert to, or build an enhanced Bio-P facility. From the results achieved so far by the increasing number of Bio-P facilities in the metro area and throughout Minnesota (conservatively 30 to 35 facilities
statewide), the advantages seem to outweigh the disadvantages. The advantages and disadvantages are listed below:

**Advantages:**

- Effluent phosphorus concentrations average 1 to 2 mg/L or less over the long-term (recent information indicates that Bio-P should be able to meet 1 mg/L);
- Chemical addition for phosphorus removal can be eliminated or at least substantially reduced. This can also reduce or eliminate alkalinity addition required to restore what is consumed by chemical phosphorus precipitation;
- Better settling of solids resulting in improved clarification, dewatering, and sludge handling;
- Produces less sludge compared to the chemical addition process;
- Can reduce aeration requirements, equipment and energy costs;
- Can accommodate simple and low-cost retrofits to existing wastewater treatment facilities; and
- Potential exists for total nitrogen removal providing additional improvement in effluent quality.
- Overall environmental benefits typically include reductions in energy consumption, chemical use, sludge production and reduced truck traffic.

**Disadvantages:**

- Can be more complicated to operate;
- Needs a more consistent influent, waste loads that vary in strength or quality can be problematic;
- Requires more careful design considerations; and
- May only be reliable for an effluent concentration of 1.0 to 2.0 mg/L total phosphorus on any given month.

Over the last 10 to 15 years the Bio-P treatment technology has become a popular choice for municipalities that need to build new or expand. Results of the joint League of Minnesota Cities and Agency survey of cities that have a 1 mg/L TP limit and use Bio-P technology (Exhibit PL-5, see Sections XI.D.4 - 7) indicate that Bio-P facilities outside the metro area generally add some chemical to assure compliance with the limit. The Agency believes that as wastewater treatment plant operators gain experience and confidence in the technology (combined with an annual average limit), chemical use may be reduced in the future. Recent experience has shown that the technology can consistently achieve a 1 mg/L limit without chemicals. For example, several large Metropolitan Council Environmental Services (MCES) facilities, including the very large Twin Cities Metro Plant, meet a 1 mg/L limit with Bio-P alone.

C. **ECONOMIC BENEFITS OF EXTENDING THE TP LIMIT [XI. TP limit, economics]**

The Agency believes that the extension of the TP limit to new and expanding dischargers (above 1,800 pounds of TP per year) will have economic benefits for the state by preventing declines in
the biology and water quality of rivers and streams. The Agency has not attempted to quantify assumed benefits; to do so would be extremely difficult and time consuming, if not impossible in our opinion. The expected nutrient reductions will more directly benefit rivers and streams. Essentially all the discharges affected by this proposal are to rivers and streams, but downstream lakes and reservoirs will benefit as well. Discharges directly to lakes or discharges that measurably affect a downstream lake will be covered by the existing P Rule (Minn. R. 7053.0255, subp. 3, item A, subitem 1) and by the proposed eutrophication standards for lakes.

The study of the negative impacts anthropogenic sources of excess nutrients have on riverine systems is relatively new, compared to the long history and extensive literature on the eutrophication of lakes. One such study is: “Economic value of aesthetic amenities of rivers” (Exhibit PL-6, also see Exhibit EU-48, page 21). Important work by Agency staff in this area have been reported in Exhibits PL-7 and PL-8. Other states in EPA Region 5 (e.g. Michigan, Ohio and Indiana), and elsewhere around the country, are beginning to document the impact nutrients have on rivers and streams as they assemble data for the promulgation of numeric nutrient standards. These data show that, in general, as nutrients increase in streams and rivers the quality of the aquatic community declines. Negative impacts have been demonstrated in fish, invertebrate, and plant communities. Some of these states plan to adopt numeric standards for rivers and streams at the same time or before they adopt standards for lakes. The Agency plans to adopt nutrient standards for rivers and streams in a future triennial review.

D. POTENTIAL COSTS TO MUNICIPALITIES ATTRIBUTED TO EXTENDING THE TP LIMIT [XI. TP limit, economics]

1. TP Limits Under the Phosphorus Strategy as Model for Future [XI.D. TP limit, economics]

The Agency is using the five-year record of establishing TP limits under the Phosphorus Strategy (Strategy) to estimate future costs to facilities expected to be impacted by the proposed extension of the TP limit. The role the Strategy has played in establishing TP limits in POTW and industrial NPDES permits is described in Section IX.C. The Agency believes that this record, spanning from March 2000 to September 2005, provides a reasonably accurate model to estimate the number of discharges expected to be impacted over the next five years. The Agency has not explicitly tried to project costs beyond the first five years. It is probably reasonable to assume that costs to municipalities that build new or expand (and discharge more than 1,800 pounds of TP per year) in the second five-year time frame will incur treatment costs comparable to costs projected for the first five years (with adjustments for inflation). It seems likely, however, that overall costs should decline over the long term, because of the declining number of facilities that do not already have a TP limit based on this or some other requirement.

The municipal (POTW) and industrial permittees that have gotten limits from 2000 - 2005 are shown in Exhibits PL-10 and PL-11, respectively. The Agency determined that 34 POTWs with average wet weather design flows (AWWDF) of 0.2 mgd or larger got TP limits based on implementation of the Strategy. An additional nine POTWs with AWWDF smaller than 0.2 mgd, shown in the shaded part of Exhibit PL-10, also got limits during this five-year period. Not
listed in Exhibit PL-10 are about 10 POTWs that got TP limits over the last five years based on the current requirements in Minn. R. 7050.0211, subp.1a, because they discharge to or affect a downstream lake.

2. Methods Used to Estimate Costs [XI.D. TP limit, economics]

Listed below are the assumptions and approaches used by the Agency to estimate future costs to POTWs due to the extension of the TP limit.

1. The history of giving TP limits during the five year period the Strategy has been in place is a reasonable time frame from which to projects future costs. Also, five years is the life of NPDES permits.
2. Facilities that got limits for the reasons listed in Exhibit PL-10 as “P strategy”, “Volunteered for limit”, or “Negotiated” are attributed to the Strategy. It is assumed that these facilities would have gotten a limit also if the proposed extension of the TP limit to new and expanding facilities had been in place since March 2000.
3. Facilities with AWWDF of 0.2 mgd or larger are assumed to be large enough to exceed the de minimis TP loading of 1,800 pounds per year. This assumes an effluent TP concentration of about 3 mg/L (3 mg/L X 0.2 mgd X 8.337 [conversion to pounds] X 365 days = 1826 pounds per year).
4. Essentially the same number of POTWs (34) will get TP limits in the next five years that got limits from March 2000 to September 2005. The Agency does not have any solid basis to project that either more or fewer facilities will be impacted in the next five years.
5. TP treatment costs are estimated for seven size categories of POTWs based on AWWDFs (see Table II-25). Estimates were not made for the > 100 mgd category because no new or expanded plants this large are expected in the next five years.
6. No POTW in the 5-10 mgd size category got a limit in the previous five years. The Agency is assuming that one facility in this relatively large size group will be impacted by the proposal in the next five years. This brings the total number of POTWs projected to be impacted to 35.
7. Estimated capital costs are the costs attributed to the portion of the treatment facility directly related to the removal of phosphorus; they are total costs, not amortized costs.
8. Estimated costs have been updated to February 2005 dollars where appropriate.
9. The Agency is aware that the cost of some materials and construction costs in general have increased in 2006, which might make the estimated “high” costs more plausible. However, the Agency still believes the “average” costs are the best estimates of expected costs over the next five years.

Agency wastewater treatment plant design and NPDES permit review engineers estimated the costs attributable to phosphorus removal for POTWs. The Agency’s analysis of potential costs to municipalities is described in Exhibit PL-3. The discussion in the next six sections is taken from this Exhibit. Total capital construction costs and annual operational and maintenance (O&M) costs attributed to TP removal have been estimated. Any extra costs associated with the handling and disposal of sludge due to use of chemical is included in the cost estimates.
Costs are estimated for three different removal technologies: 1) chemical addition (including stabilization ponds), 2) Bio-P with chemical addition for polishing, and 3) Bio-P alone. Projected costs for the three treatment options are the complete costs of phosphorus removal for each option alone. For example, the costs for chemical addition alone are not added to the costs for Bio-P with chemical back-up to arrive at the total costs for the latter option. All cost estimates are based on meeting a monthly average effluent limit of 1 mg/L total phosphorus (TP).

Cost estimates are based on:

1. Previous work and cost estimates for TP removal completed by Agency staff;
2. Research in the published literature on the subject of estimating costs for wastewater treatment projects, particularly for TP removal;
3. TP removal project cost estimates provided by consulting engineers based on their experience in Minnesota;
4. A report prepared by Hydroqual, Inc. for MESERB on wastewater phosphorus control (Exhibit PL-4); and
5. Information from a survey, conducted by the League of Minnesota Cities and the Agency, of Minnesota wastewater treatment facilities that have completed construction of phosphorus removal projects, or have prepared estimates contemplating future phosphorus removal related construction projects at their facilities, (Exhibit PL-5).

3. **Chemical Addition** [XI.D. TP limit, economics]

The most common phosphorus removal technique currently practiced by mechanical wastewater treatment facilities in Minnesota is chemical addition; i.e., coagulation and precipitation with salts of aluminum or iron. Alum (aluminum sulfate), or ferric chloride (including possible addition of a polymer) is typically fed into the wastewater flow path prior to or at entry points into primary or secondary clarifiers to provide for mixing, coagulation, and then settling of the phosphorus into the sludge blanket in the clarifiers. The phosphorus is then removed from the clarifiers with the waste sludge (solids), which is usually applied to tillable farmland.

Several internal and external references were reviewed to determine the best method to arrive at the cost estimates for chemical removal of phosphorus. Chemical treatment cost estimates using alum include costs for a chemical feed system with a 15 day storage supply, incremental costs of clarifier improvements, and sludge treatment and handling to accommodate the increased sludge volume above the amount normally generated when using chemical phosphorus removal.

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4. EPA. The cost digest: cost summaries of selected environmental control technologies.
5. Information from Water Environment Federation.
6. Information from state of Wisconsin.
The Agency was able to make high and low cost estimates for the seven size categories, as shown in Tables II-25 and II-26 (Table A in Exhibit PL-3). The Agency believes making high, low and average cost estimates is a reasonable way to bracket the range in possible costs. Costs are often very site-specific. Even facilities that have similar design flows may not have the same costs associated with chemical phosphorus removal processes and sludge handling. The average cost estimate is the average of the high and low estimates for each category. The Agency believes that overall, the average costs represent the most likely or reasonable estimates of future costs. The low costs may under estimate and the high costs may over estimate true costs.

A summary of total capital costs and annual O&M costs for chemical addition (using alum) are shown in Tables II-25 and II-26, respectively. The low capital cost estimates are for alum dosages based on influent TP concentrations of approximately 5 to 9 mg/L, which is a typical range for Minnesota POTWs. The high capital cost estimates are for alum dosages based on high influent TP concentrations of 13 to 17 mg/L.

Table B in Exhibit PL-3 shows estimated costs for TP removal for a number of specific facilities in Minnesota using ferric chloride, based on February 2005 dollars. The ferric chloride costs were compared to cost estimates completed by the state of Wisconsin to support revisions to their water quality rules (Table C in Exhibit PL-3). A comparison of capital cost estimates in Table A to those in Table B (Exhibit PL-3) indicates that the total capital cost estimates for ferric chloride generally fall into the lower part of the total capital cost ranges for alum. Annual O&M costs for ferric chloride also appear to fall in the lower range of the O&M cost estimates for alum.

Table II-25. Total Capital Costs for TP Removal – Estimated High, Low, and Average Capital Costs for Alum Addition for Seven Size Categories of Municipal Wastewater Treatment Plants, Projected Over the Next Five Years.

<table>
<thead>
<tr>
<th>Plant Size AWWDF Mgd</th>
<th>No. of N/E Projected Over Next 5 Years</th>
<th>Estimated Total Capital Costs for Alum Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cost Per Plant $ in millions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2-0.5</td>
<td>6</td>
<td>0.20</td>
</tr>
<tr>
<td>0.5-1.0</td>
<td>13</td>
<td>0.30</td>
</tr>
<tr>
<td>1.0-5.0</td>
<td>11</td>
<td>0.40</td>
</tr>
<tr>
<td>5-10</td>
<td>1</td>
<td>1.05</td>
</tr>
<tr>
<td>10-20</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>20-40</td>
<td>2</td>
<td>5.0</td>
</tr>
<tr>
<td>40-100</td>
<td>1</td>
<td>10.0</td>
</tr>
<tr>
<td>&gt; 100</td>
<td>0</td>
<td>na</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>

N/E = New or expanded; na means not applicable or not available.

72 A recent Agency analysis of permittee discharge monitoring report data showed a mean influent TP of 6.4 mg/L for 166 POTWs.
Table II-26. Operation and Maintenance Costs for TP Removal – Summary of Estimated High, Average, and Low O&M Costs for Alum Addition for Seven Size Categories of Municipal Wastewater Treatment Plants, Projected Over the Next Five Years.

<table>
<thead>
<tr>
<th>Plant Size AWWDF Mgd</th>
<th>No. of N/E Projected Over Next 5 Years</th>
<th>Estimated Total Annual O&amp;M Costs for Alum Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cost Per Plant $ in millions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>0.2-0.5</td>
<td>6</td>
<td>0.04</td>
</tr>
<tr>
<td>0.5-1.0</td>
<td>13</td>
<td>0.05</td>
</tr>
<tr>
<td>1.0-5.0</td>
<td>11</td>
<td>0.08</td>
</tr>
<tr>
<td>5-10</td>
<td>1</td>
<td>0.35</td>
</tr>
<tr>
<td>10-20</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>20-40</td>
<td>2</td>
<td>1.08</td>
</tr>
<tr>
<td>40-100</td>
<td>1</td>
<td>2.60</td>
</tr>
<tr>
<td>&gt; 100</td>
<td>0</td>
<td>na</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>na</td>
</tr>
</tbody>
</table>

$7.58 $25.28 $42.8

N/E = New or expanded; na means not applicable or not available.

4. Verification of Estimated Costs for Chemical Addition [XI.D. TP limit, economics]

The Agency sought to verify or “crosscheck” the cost estimates shown in Tables II-25 and II-26 by comparing them to estimates from references other than those identified in footnote 71, and information from a small number of actual costs for phosphorus removal projects completed in Minnesota. Agency cost figures were also crosschecked with cost information from:

- A study of 17 facilities in Minnesota by Hydroqual (Exhibit PL-4). This work provides useful cost estimates for possible chemical and biological phosphorus removal enhancements for these facilities, but it does not include costs for sludge handling. Thus, its value as a “crosscheck” is limited.
- Information from a consulting engineering firm in the Twin Cities (Bonestroo), and
- A joint League of Minnesota Cities/Agency (LMC/Agency) Bio-P cost survey (Exhibit PL-5).

Details about how the capital cost information from the Bonestroo and the LMC/Agency survey are provided in Exhibit PL-3 under “Chemical Capital Cost Analysis”. The crosschecks in general are very helpful in determining if the Agency’s estimated ranges are reasonable, and to narrow the range of the cost estimates. Also, it helps the Agency characterize the cost ranges as high, low or average.
5. **Cost Information for Stabilization Ponds** [XI.D. TP limit, economics]

Stabilization pond treatment systems represent a subset of chemical phosphorus treatment, but limited information on costs to pond systems is available. Pond treatment systems typically store and passively treat the wastewater in a series of connected primary and secondary ponds or cells. If TP removal is required, it is usually accomplished by adding chemical to one of the secondary cells to precipitate the TP from the water. Pond treatment systems normally discharge twice a year, once in the spring and once in the fall.

Most pond systems have a design capacity of less than 0.2 mgd, and therefore most will not trigger the *de minimis* annual load of 1,800 pounds of TP. Facilities below the *de minimis* loading will not get a TP limit under the proposal. Of the 295 pond treatment systems in Minnesota, 52 have an AWWDF greater than 0.2 mgd. Nine of these 52 larger pond systems already have a TP limit of 1 mg/L under the existing rule, Minn. R. 7050.0211.75

Information, albeit limited, was obtained from Bonestroo and the LMC/Agency survey on estimated capital and O&M costs for stabilization pond systems. The first facilities listed in Tables D and E in Exhibit PL-3 under the treatment type heading “chemical” show estimated capital costs for TP removal in stabilization ponds. Based on the design flow of 0.07 mgd for the facility listed in Table E of Exhibit PL-3, it is unlikely it would trigger a limit (i.e., annual TP loading less than 1,800 pounds per year), but it is included in this discussion because of the small amount of data available for ponds. TP treatment costs for a third pond system are available from Agency files. The costs for these three facilities, and the projected costs over the next five years, are shown in Table II-27. The small number of municipalities with pond systems projected to be impacted, a total of six, is based on the Agency’s experience over the last five years. The ability to crosscheck estimated costs for stabilization pond systems is very limited. An indirect approach that can provide a reasonable estimate of total capital and annualized O&M costs for ponds is to use the average costs for mechanical systems in the appropriate size category (Tables II-25 and II-26).

Table II-27. Pond Systems – Total Capital and Annual O&M Costs for Alum Addition for Three Pond Wastewater Treatment Facilities, and Projected Costs Over the Next Five Years.

<table>
<thead>
<tr>
<th>Plant Size AWWDF Mgd</th>
<th>No. of N/E Projected Over Next 5 Years</th>
<th>Estimated Total Costs for Alum Addition in Pond Systems</th>
<th>Total Average Cost Over 5 Years, $ in millions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average Cost Per Pond Facility, $ in millions</td>
<td>Total Capital</td>
</tr>
<tr>
<td>0.07</td>
<td>na</td>
<td>0.050</td>
<td>na</td>
</tr>
<tr>
<td>0.236</td>
<td>4</td>
<td>0.093</td>
<td>0.021</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
<td>0.1717</td>
<td>0.1522</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td></td>
<td>$0.71</td>
</tr>
</tbody>
</table>

N/E = New or expanded; na means not applicable or not available.

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75 Numbers based on information from October 2005. Thirty four of all 295 ponds currently have TP limits. There are an additional 74 pond systems covered under a general permit, and two of these have TP limits.
6. Costs for Biological Phosphorus with Chemical Back-up [XI.D. TP limit, economics]

The biological phosphorus removal (Bio-P) process is described in Section XI.B. Almost all facilities that have built new or expanded in the last five years have incorporated Bio-P into the design. This treatment technology is gaining popularity because of its TP removal capabilities as well as other advantages.

Very little information seems to be available in the published literature that discusses costs for just the TP removing components of a Bio-P plant or for Bio-P with chemical back-up. This may be because the design of Bio-P facilities is still fairly new in the United States, although it has been successfully applied in Minnesota starting in the late-1990s. Due to the lack of published literature on costs, we used the cost information provided by Bonestroo, the LMC/Agency survey, and the MESERB study (Tables D, E and F, respectively, in Exhibit PL-3). The Bonestroo information provides the only estimates for annual O&M costs. The cost figures shown for Bio-P plus chemical back-up in Table II-28 are the average of the “high” and “low” values from Table F in Exhibit PL-3, so that these costs might be more comparable to the “average” Bio-P alone costs (Table D in Exhibit PL-3), and the chemical addition costs in Table II-25. Costs are not available for facilities larger than 40 mgd.

There is a fairly wide range in reported Bio-P plus chemical back-up costs when costs for TP removal are expressed as a **percentage** of the total project capital costs. Percentages range from 1 to 29 percent, but mean percentages center around 8 to 15 (percent values are in *italics* in Table II-28). The 8 to 15 percent range may be a reasonable rule of thumb estimate of the increase in total capital costs attributable to removing TP for the Bio-P plus chemical backup option.

<table>
<thead>
<tr>
<th>Plant Size AWWDF Mgd</th>
<th>TP Capital Costs $ in millions</th>
<th>% Costs for TP of Total Project Capital Costs</th>
<th>TP Capital Costs $ in millions</th>
<th>% Costs for TP of Total Project Capital Costs</th>
<th>Annual O&amp;M $ in millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: Bonestroo</td>
<td>LMC/Agency</td>
<td>MESERB</td>
<td>Bonestroo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2-0.5</td>
<td>0.390 (2)</td>
<td>8.2 (1.4-15)</td>
<td>0.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5-1.0</td>
<td>0.545 (1)*</td>
<td>8</td>
<td>0.929 (4)</td>
<td>12 (1.2-29)</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0033 (1)</td>
</tr>
<tr>
<td>1.0-5.0</td>
<td>0.563 (6)</td>
<td>10 (1-21)**</td>
<td>1.63 (2)</td>
<td>15 (6-23)</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0049 (6)</td>
</tr>
<tr>
<td>5-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.65</td>
</tr>
<tr>
<td>10-20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.75</td>
</tr>
<tr>
<td>20-40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.0</td>
</tr>
</tbody>
</table>

Blank cells means there is no information.

* Number in parenthesis is number of facilities for which costs are averaged.

** Number in parenthesis is range of percent values.
7. **Costs for Biological Phosphorus Removal** [XI.D. TP limit, economics]

Cost estimates for Bio-P processes alone are limited to the information shown in Table E in Exhibit PL-3. Most of the designs for existing Bio-P facilities in Minnesota incorporate chemical back-up, as a guarantee that the facility can consistently meet the 1 mg/L TP effluent limit. Operating experience, as reported in the Hydroqual/MESERB study (Exhibit PL-4) indicates that Bio-P processes, in general, are capable of removing about 80 to 90 percent of the influent phosphorus. Therefore, if influent TP concentrations are in the normal 5 to 9 mg/L range, one could expect effluent concentrations in the 0.5 to 1.8 mg/L range. With the current state of the Bio-P technology in Minnesota, Bio-P facilities with a 1 mg/L TP limit generally need to polish with chemical to consistently meet the limit. Major exceptions to the need for chemical polishing are some of the metro area wastewater treatment facilities operated by the Metropolitan Council Environmental Services (MCES), including the very large Metro Plant (AWWDF of 251 mgd). The Metro Plant and several other MCES facilities are meeting a 1 mg/L limit with Bio-P alone.\(^{74}\)

Verification of the cost figures for Bio-P removal only is not possible, due to a lack of information. Agency staff (reference 2 in Exhibit PL-3) offers a possible range of capital costs for Bio-P removal for newly designed treatment facilities, and for retrofitted facilities. Through contacts with consultants and the MCES, the Agency has estimated Bio-P capital construction costs of $0.30 to $0.50 per gallon for new designs, and $0.10 to $1.00 per gallon for retrofitted facilities. The Bio-P capital cost figures for the projects shown in Table E in Exhibit PL-3, expressed as cost per gallon treated, range from $0.03 to $0.21 per gallon, which is considerably less than the figures from Agency staff. The latter are based on estimates reported by the municipalities themselves; they should reflect real-world Bio-P costs in Minnesota. These costs are shown in Table II-29 (the $36 million figure for the > 100 mgd category is the MCES Metro Plant).

Table II-29. **Bio-P Alone – Estimates of Total Capital Costs for TP Removal Using Bio-P Alone from LMC/Agency Survey (Table E in Exhibit PL-3).**

<table>
<thead>
<tr>
<th>Plant Size AWWDF Mgd</th>
<th>TP Capital Costs $ in millions</th>
<th>% Costs for TP Removal of Total Project Capital Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0-5.0</td>
<td>0.1 (1)*</td>
<td>0.2</td>
</tr>
<tr>
<td>10-20</td>
<td>0.9 (1)</td>
<td>1.8</td>
</tr>
<tr>
<td>20-40</td>
<td>5.0 (2)</td>
<td>27 (1.3-53)**</td>
</tr>
<tr>
<td>40-100</td>
<td>8.0 (1)</td>
<td>6.4</td>
</tr>
<tr>
<td>&gt; 100</td>
<td>36 (1)</td>
<td>45</td>
</tr>
</tbody>
</table>

* Number in parenthesis is number of facilities for which costs are averaged.
** Number in parenthesis is range in percents.

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\(^{74}\) Including Seneca, Blue Lake and Eagles Point as well as the Metro Plant.
Capital costs for Bio-P with chemical back-up and Bio-P alone, projected to be incurred over the next five years, are summarized in Table II-30. Total cost figures are not provided because data is missing for some size categories.

Table II-30. Summary of Estimated Average Capital Costs for Bio-P with Chemical Back-up and for Bio-P Alone, Projected Over the Next Five Years.

<table>
<thead>
<tr>
<th>Plant Size AWWDF Mgd</th>
<th>No. of N/E Projected Over Next 5 Years</th>
<th>Estimated Average Capital Costs for TP Removal Using Bio-P with Chemical Back-up In $ millions</th>
<th>Estimated Average Capital Costs for TP Removal Using Bio-P Alone In $ millions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per Plant</td>
<td>Total Cost Over 5 Years</td>
<td>Per Plant</td>
</tr>
<tr>
<td>0.2-0.5</td>
<td>0.39</td>
<td>2.34</td>
<td>na</td>
</tr>
<tr>
<td>0.5-1.0</td>
<td>0.65</td>
<td>8.45</td>
<td>0.1</td>
</tr>
<tr>
<td>1.0-5.0</td>
<td>1.0</td>
<td>11.0</td>
<td>na</td>
</tr>
<tr>
<td>5-10</td>
<td>1.65</td>
<td>1.65</td>
<td>0.9</td>
</tr>
<tr>
<td>10-20</td>
<td>2.75</td>
<td>2.75</td>
<td>5.0</td>
</tr>
<tr>
<td>20-40</td>
<td>5.0</td>
<td>10.0</td>
<td>16</td>
</tr>
<tr>
<td>40-100</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>&gt; 100 (251)</td>
<td>na</td>
<td>na</td>
<td>36</td>
</tr>
</tbody>
</table>

N/E = New or expanded; na means not available or not applicable
*No plant in the 5-10 mgd size range got a TP limit in the last five years; we are assuming that one will get a limit over the next five years for purposes of this cost estimate.

8. Conclusions on Costs to POTWs [XI.D. TP limit, economics]

The Agency has made a good faith effort to estimate TP treatment costs that might be incurred by new or expanding municipal wastewater treatment plants (> 1,800 pounds of TP discharged per year) over the next five years. The Agency believes it is important to estimate the total costs for phosphorus removal over the next five years for this rulemaking, but most of these costs should not be attributed to the proposed extension of the TP limit to new and expanding facilities, as discussed in Section XI.F.

The Agency believes that where high, low and average cost estimates can be made, that the average costs represent our best estimate of likely true costs. Estimated capital costs for TP removal are total, not amortized costs. Most estimates of annual O&M costs are for facilities that rely only on chemical addition to remove TP. Our own experience and information on Bio-P facilities from the LMC/Agency survey suggest strongly that chemical costs are reduced when bio-P technology is used.

The total estimated average capital costs for TP removal using chemical addition for the estimated 35 municipalities likely to be impacted over the next five years is over 61 million dollars (Table II-31). The total O&M costs for chemical addition for 35 municipalities over the next five years is over 25 million dollars (Table II-26). Comparable totals cannot be determined.
for the other two treatment options (Bio-P with chem. back-up and Bio-P alone) because cost values are missing for some POTW size categories. Gaps in the data are indicated by “na” in Table II-31. With possibly one exception (the 1-5 mgd size) the capital costs for chemical addition tend to be larger than the costs for Bio-P with or without chemical back-up (Table II-31).

Table II-31. Estimated Average Total Capital Costs for TP Removal for Municipal Wastewater Treatment Plants Projected Over the Next Five Years for the Three Treatment Options.

<table>
<thead>
<tr>
<th>Plant Size AWWDF Mgdl</th>
<th>No. of N/E Projected Over Next 5 Years</th>
<th>Chemical Treatment In $ Millions</th>
<th>Bio-P with Chemical Back-up In $ Millions</th>
<th>Bio-P Alone In $ Millions</th>
<th>Stabilization Ponds* Chem. Treat. In $ Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2-0.5</td>
<td>6</td>
<td>2.76</td>
<td>2.34</td>
<td>na</td>
<td>0.37</td>
</tr>
<tr>
<td>0.5-1.0</td>
<td>13</td>
<td>8.45</td>
<td>8.45</td>
<td>0.1</td>
<td>0.34</td>
</tr>
<tr>
<td>1.0-5.0</td>
<td>11</td>
<td>10.23</td>
<td>11.0</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>5-10</td>
<td>1</td>
<td>4.53</td>
<td>1.65</td>
<td>0.9</td>
<td>na</td>
</tr>
<tr>
<td>10-20</td>
<td>1</td>
<td>6.1</td>
<td>2.75</td>
<td>5.0</td>
<td>na</td>
</tr>
<tr>
<td>20-40</td>
<td>2</td>
<td>17.0</td>
<td>10.0</td>
<td>16</td>
<td>na</td>
</tr>
<tr>
<td>40-100</td>
<td>1</td>
<td>12.5</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>&gt; 100</td>
<td>0</td>
<td>na</td>
<td>na</td>
<td>36**</td>
<td>na</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35</td>
<td>$61.57</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

N/E = New or expanded; na means not applicable or not available.

*The Agency is projecting four and two new or expanding pond facilities in the 0.2-0.5 and 0.5-1.0 mgd categories over the next five years, respectively.

** Costs attributed to the 251 mgd MCES Metro Plant

E. POTENTIAL COSTS TO INDUSTRIES ATTRIBUTED TO EXTENDING THE TP LIMIT [XI. TP limit, economics]

1. Introduction and Industry Categories [XI.E. TP limit, economics]

The treatment technologies used for total phosphorus (TP) removal at municipal wastewater treatment plants are also applicable to industrial facilities. Typically, facilities to remove TP from an industrial waste stream means adding wastewater treatment capacity at the end of the existing treatment process. In most cases industrial wastewater treatment plants use chemical addition of alum and/or ferric chloride for precipitation and removal of TP in their discharge effluents. However, some industrial facilities may also use biological wastewater treatment processes or Bio-P processes to removal TP. Biological treatment processes for TP removal at industries is generally more applicable to industrial categories that generate higher organic loadings in their wastewater and discharge directly to receiving waters in Minnesota (as opposed to discharging to a sanitary sewer). In some cases Bio-P processes are not applicable to certain industries because biological treatment is not needed to remove other pollutants generated in the industrial process wastewater.
For the estimation of costs, industrial plants are described according to industrial categories rather than by size or flow as in the case of municipalities. This is primarily because dry versus wet weather flow is typically not applicable to industrial plants. Although a range of process wastewater flows and pollutant loadings may occur, a specific industry typically generates a certain pollutant concentration level and loading, which is related primarily to the industrial category and the specific industry’s production rate. For example an industry category may generate a specific mass loading (e.g., pounds per day) of a pollutant per production rate. In addition, pollutant characteristics vary from one industrial category to another. Some industries generate minimal amounts of phosphorus in their wastewater, such as mining and power generating facilities. In some cases industrial wastewater with biological treatment processes are phosphorus deficient with respect to nutrient requirements, and therefore may need to add phosphorus for efficient biological treatment to occur. For other industry categories, for example food processing, dairy related production, rendering, meat processing, etc., high concentrations of TP are often generated in the process.

Therefore, the applicability of the proposed extension of the TP limit is very industry specific. Some industries within an industrial category may not discharge wastewater but treat wastewater via land application systems. In those instances treatment technologies to remove TP are usually not applicable or required and there will be no costs. To analyze the cost for removal of TP at industries, an evaluation of industries which may discharge significant loadings of TP was completed. Examples of these industries include, but are not limited to, wet mill corn processing, food processing, beet sugar processing, dairy processing, rendering and pulp and paper. As a starting point, calculations were completed to determine the existing TP discharge mass loadings from industries discharging to a receiving water in Minnesota. Total capital and annual operation and maintenance (O&M) costs are estimated.

It is difficult to predict over what time frame the estimated costs will be incurred by Minnesota industries. The Agency can’t be sure which types of industries may expand or be newly constructed over the next five years. Industrial development is dependent on many factors, most prominently market conditions. Therefore, determining which industries may potentially expand or construct new facilities, and subsequently generate TP to levels of concern (>1,800 pounds TP per year), is an estimate at best. The following assumptions were used to determine the number of new or expanded facilities expected to generate at least 1,800 lbs of phosphorus per year in process wastewater:

1. The Agency assumes the costs estimated in this analysis will be incurred over a five-year period, which correlates with the term of NPDES permits. Only three of the TP limits given to roughly 14 industries over the last five years are attributed to the Phosphorus Strategy (Exhibit PL-11), which is an indication of the number that may get limits over the next five years due to this proposal. For the purpose of estimating costs, the Agency is projecting that about six facilities in the seven categories described below may get TP limits (Table II-32).
2. Only industries that may generate TP in wastewater at appreciable levels that may trigger a TP treatment or removal requirement were evaluated.
3. A flow and TP concentration level in the effluent was used for a specific industry category based on TP and flow information from the Agency’s discharge monitoring reports (DMR) for specific existing industrial permittees.
4. If flow and TP concentration information are not available from DMRs, information from EPA categorical development documents and literature were used.

The following industries that generate TP at levels that may trigger a TP discharge limit and would also potentially discharge to a receiving water were used in this analysis:

**Ethanol Industry.** The ethanol industry in Minnesota is expanding rapidly with several new plants anticipated. Costs are considered for one new ethanol production plant and one expanding plant. New ethanol plants recycle and internally treat all process wastewaters which contain high organic loadings. Therefore, no process wastewater is discharged. However, ethanol plants must pre-treat water used in the production process, typically using reverse osmosis systems, and they also discharge cooling tower blowdown. In most cases TP is kept at relatively low levels in the discharge. However, in some cases greater amounts of TP may be generated and potentially discharged. This may be due to the higher levels of TP in the source water. Phosphorus may also be used as an additive for cooling tower treatment purposes, and in addition the “concentration effects” of reverse osmosis and closed cycle cooling tower systems serve to increase TP concentrations. Therefore, one new ethanol plant was evaluated which may trigger a TP discharge limit. In general, however, ethanol plants do not comprise a significant source of TP to receiving waters.

The second example is an ethanol plant in Minnesota planning an expansion, and assumed to have TP levels in the discharge that will exceed 1,800 pounds per year.

**Dairy Processing Industry.** Dairy processing generates TP, sometimes at significant levels, due to TP in raw materials and cleaning processes. Most of these plants use land application as a wastewater treatment technology and do not discharge to receiving water. However, for purposes of estimating costs we assume one dairy processing facility with a discharge to receiving water is expanding, and will discharge above the *de minimis* amount.

**Rendering Industry.** Animal rendering is a potential industry which may undergo expansion in the current market. We assume one facility will expand over the next five years.

**Poultry Processing Industry.** An expanding chicken processing plant was selected to represent a food or meat processing industry expansion. Minnesota has a relatively high number of food processing facilities, although many of these plants do not directly discharge to receiving waters but use land application as a wastewater treatment technology.

**Corn Processing Industry.** The corn processing industry employing wet milling may potentially undergo expansion due to market conditions.

**Pulp and Paper Milling Industry.** Pulp and paper mills have completed a number of expansions in the past 10 to 15 years in Minnesota, and while future expansions may be possible they are likely to be limited within the next five years.
Refining Industry. Expansion of existing petroleum refining may occur in the next five years due to market conditions.

In addition to the seven categories listed above, there are a number of other industrial categories that could potentially undergo an expansion or be proposed for new construction within Minnesota in the next five years. However, most industrial expansions and/or new industry construction are related to industries that do not generate TP or generate TP at minimal levels. Therefore, these industries, for example power cogeneration, mining, power plants, etc., are not included in this analysis.

2. Estimated Costs by Industry Category [XI.E TP limit, economics]

The Agency anticipates that the economic impact of the proposed extension of the TP limit on industries that do not already have an existing TP discharge limit and discharge directly to a receiving water, is likely to be relatively minimal. If anything, we believe the estimated costs shown in Table II-32 are likely to overstate the true costs.

Estimates for capital and O&M costs to meet a 1.0 mg/L TP effluent concentration are shown in Table II-32. Annualized capital cost is based on 20 year useful life (equivalent uniform annual cost) and an eight percent interest rate. The costs for the industry examples listed in Table II-32 represent our estimates for the industries likely to be impacted over approximately a five-year period. The $1.115 million total figure in Table II-32 represents the estimated annual amortized capital costs plus the annual O&M costs for all eight examples.
Table II-32. Estimated Total Average Capital and Annual O&M Costs for TP Removal for
Seven Categories of Industries (see text below).

<table>
<thead>
<tr>
<th>Industry</th>
<th>Flow MGD</th>
<th>Influent TP mg/L (range)</th>
<th>Capital Cost $ millions</th>
<th>Annualized Capital Cost $ millions</th>
<th>Annual O and M $ millions</th>
<th>Total Annual Cost $ millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Ethanol Plant</td>
<td>0.25</td>
<td>2.4 (low)</td>
<td>0.92</td>
<td>0.094</td>
<td>0.08</td>
<td>0.174</td>
</tr>
<tr>
<td>Expansion Ethanol Plant</td>
<td>0.278</td>
<td>2.38</td>
<td>0.92</td>
<td>0.094</td>
<td>0.08</td>
<td>0.174</td>
</tr>
<tr>
<td>Dairy Processing</td>
<td>seasonal pond discharge</td>
<td>3.53</td>
<td>0.08</td>
<td>0.008</td>
<td>0.035</td>
<td>0.043</td>
</tr>
<tr>
<td>Rendering Plant</td>
<td>Seasonal pond discharge</td>
<td>8.25</td>
<td>0.15</td>
<td>0.015</td>
<td>0.08</td>
<td>0.095</td>
</tr>
<tr>
<td>Poultry Processing Plant</td>
<td>1.10</td>
<td>6.98</td>
<td>0.90</td>
<td>0.092</td>
<td>0.125</td>
<td>0.217</td>
</tr>
<tr>
<td>Corn Wet Milling Plant</td>
<td>1.50</td>
<td>11.65</td>
<td>0.70 to 1.3</td>
<td>0.132</td>
<td>0.20 to 0.28</td>
<td>0.412</td>
</tr>
<tr>
<td>Pulp and Paper Plant</td>
<td>11.62</td>
<td>2.625</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Petroleum Refining</td>
<td>4.25</td>
<td>0.73</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total (all plants)</strong></td>
<td></td>
<td><strong>4.27</strong></td>
<td><strong>0.435</strong></td>
<td><strong>0.68</strong></td>
<td><strong>1.115</strong></td>
<td></td>
</tr>
</tbody>
</table>

Ethanol. Estimates for the new ethanol plant are based on a hypothetical plant with a production level of 50 million gallons ethanol per year or more, discharging reverse osmosis and cooling tower blowdown wastewaters at a continuous rate of about 0.25 mgd, with an anticipated TP generated per year at 1,800 lbs. The TP removal is anticipated to occur through a chemical addition treatment system added to the end of the treatment process already in place (chemical storage, chemical feeding equipment and pumps, rapid mixing, coagulation and flocculation, and clarification). The estimated total capital cost of this system is estimated to be $920,000 with annual O&M costs of $80,000.

Estimates for an expanding ethanol plant are based on a plant assumed to expand from a production rate of about 45 million gallons to about 57 million gallons of ethanol per year. Flow is continuous and is estimated to increase from an average of 0.2 mgd to an expanded flow rate of 0.3 mgd. TP generated annually and discharged would be projected to increase from a current level of about 1,460 lbs per year to 2,190 lbs per year, at an effluent concentration of 2.4 mg/L. As for the new ethanol plant, TP removal is anticipated to occur post process wastewater treatment through chemical addition (chemical storage, chemical feeding equipment and pumps,
rapid mixing, coagulation and flocculation, and clarification). The estimated total capital cost of this system is estimated to be $920,000 with annual O&M costs of $80,000.

**Dairy Processing.** Estimates for the dairy processing plant are based on a 20 percent hypothetical expansion of a milk processing rate of about 1.25 million pounds per day into natural and aseptic cheese and whey products. Current TP discharged is about 3,100 lbs/year, average TP concentration of effluent discharged is 3.5 mg/L, with a discharge flow average of 2.2 mgd based on a total discharge of about 90 million gallons per year. Wastewater treatment at the plant consists of the screening, dissolved air flotation, holding tank, two trickling filter towers, a 2.5 million gallon oxidation ditch, final clarification, and a two-cell stabilization pond system consisting of a 19-acre primary cell and a 15-acre secondary cell. Treated effluent is stored in the stabilization ponds and is discharged seasonally (spring and fall, totaling 52 days in 2005).

Based on a 20 percent expansion of the dairy processing production rate, a proportional increase in flow and TP mass load was used to estimate costs. Effluent TP concentration (untreated) remains the same. Because of the seasonal discharge, TP removal would be anticipated to be achieved most cost effectively through chemical addition at the existing final stabilization pond (chemical addition to pond method), with chemical addition used seasonally. A capital cost of $80,000 is based on boat application and chemical feed equipment for seasonal treatment only. An annual O&M cost of about $30,000 is based on alum treatment cost of $8.00 per pound phosphorus.

**Rendering Plant.** The rendering plant example is based on a theoretical 20 percent expansion of a rendering plant. The principal activity at the rendering plant is the rendering, feather processing, hide curing, and pet food processing from animal meat by-products. The facility currently processes approximately 300,000 tons of raw materials (meat by-products) each year. Currently the TP mass discharged is about 8100 lbs., the total discharge flow was about 136 million gallons, and the average TP concentration in the discharge was 8 mg/L. Based on a 20 percent expansion of the plant production rate, a proportional increase of 20 percent flow and TP mass load generated was used to estimate costs. TP concentration (untreated) remains the same. Wastewater from the rendering plant is treated at a series of wastewater treatment ponds including an anaerobic pond, four aerobic ponds, two aerated holding ponds and a final polishing pond. The discharge occurred intermittently for 95 days via the final polishing pond throughout the year (intermittently for eight months in 2005).

It is possible that chemical precipitation for TP removal could be accomplished in this system by pond treatment application at the final polishing pond, discharging on an intermittent basis. It would be more efficient to adjust operations such that only periodic additions of chemical to the final polishing pond are made, by extending the periods of time for discharge. The capital cost for pond application method for chemical precipitation is estimated at about $150,000 with annual O&M at about $80,000 based on a cost of about $8.00 per pound phosphorus treated.

**Poultry Processing.** The poultry processing plant example is based on a theoretical 20 percent expansion of a poultry processing plant. The plant processes chickens at an average rate of 170,000 birds per day, five days per week. The plant packages whole, cut-up, chill pack, marinated, and de-boned chicken, and stores these products in coolers until shipped, either fresh
or frozen. It is assumed that the plant currently discharges 19,375 lbs. of TP per year at a total annual flow of 332 million gallons, and an average TP concentration in the discharge of 7.0 mg/L. Based on a 20 percent expansion of the plant production rate, a proportional increase of 20 percent flow and TP mass load generated was used to estimate costs. TP concentration (untreated) remains the same. Wastewater treatment at the plant consists of screening, grit removal, final screening, dissolved air flotation, equalization, activated sludge, final clarification, tertiary filtration (for recycle of treated effluent for process waster makeup), and UV disinfection. The effluent is discharged continuously. The TP removal technology would likely occur by chemical addition treatment utilizing the existing final clarifiers with modifications (adding chemical storage and feeding systems, and rapid mixing for the alum and/or ferric chloride feed). Additional sludge handling capacity could be required. The estimated capital cost for the modifications required to the wastewater treatment system are $900,000 (includes additional sludge handling) with annual O&M at $125,000.

Corn Wet Milling. The corn wet milling plant example is based on a theoretical 20 percent expansion of a corn wet milling plant. The existing corn wet milling plant is assumed to have a production capacity of about 180,000 bushels of corn per day and processes corn into corn syrup, fructose, gluten, fiber feed, and ethanol. It is assumed that the plant currently discharges 42,000 lbs. of TP per year at a total annual flow of 420 million gallons (~1.15 mgd), and an average TP concentration in the discharge of 12 mg/L. Based on a 20 percent expansion of the plant production rate, a proportional increase of 20 percent flow and TP mass load generated was used to estimate costs. TP concentration (untreated) remains the same. Wastewater treatment at the plant consists of equalization, anaerobic fluidized bed reactor, sequential batch reactors (aerobic system), effluent equalization, polymer feed, sand filtration, and effluent aeration. The TP removal technology would likely occur by chemical addition treatment utilizing the existing treatment system with chemical addition prior to sand filtration. Modifications would be required including addition of chemical storage and handling systems, rapid mixing for the alum and/or ferric chloride feed). Additional sand filtration capacity could be required. The estimated capital cost for the modifications required to the wastewater treatment system are $700,000 with annual O&M at $200,000. If additional sand filtration capacity is needed due to TP treatment the additional capital cost to add a pressurized sand filter is estimated at about $600,000 with an additional annual O&M cost of about $80,000.

Pulp and Paper. The pulp and paper example is based on a theoretical 20 percent expansion of a pulp and paper mill. The hypothetical paper mill manufactures uncoated and coated publication grade (magazine) paper using groundwood pulp via thermo-mechanical process, purchased bleached kraft pulp, and other raw materials. The mill produces 240 tons/day of supercalendered printing paper, 480 tons/day of coated magazine grade paper, and 360 tons/day of thermo-mechanical pulp. It is assumed that the plant currently discharges 76,000 lbs. of TP per year at a total annual flow of 3,500 million gallons (~9.6 mgd), and an average TP concentration in the discharge of 2.6 mg/L. Based on a 20 percent expansion of the plant production rate, a proportional increase of 20 percent flow and TP mass load generated was used to estimate costs. The untreated TP concentration remains the same. Wastewater treatment at the mill consists of cyclone degritting, polymer feed, primary clarification, nutrient feed system, activated sludge, final clarification, activated sludge reaeration, and sludge processing equipment.
Under normal conditions pulp and paper mill influent wastewater is nutrient deficient and phosphorus and nitrogen must be added to provide for efficient biological wastewater treatment. In most cases the chemical addition is managed such that only the required mass of phosphorus and nitrogen are added, and the effluent TP is usually well below 1.0 mg/L. For example, a pulp and paper mill in Minnesota achieves an average effluent TP of 0.40 mg/L by managing the nutrient feed ratios properly. For this mill the expectation is that through proper management of nutrient feed rates of phosphoric acid and ammonia, in accordance with established BOD:nitrogen:phosphorus treatment ratios, the TP in the effluent will be reduced to well below a 1.0 mg/L concentration⁷⁵. Therefore, there would be no capital and O&M costs to meet a 1.0 mg/L TP in the effluent.

Petroleum Refining. The petroleum refining example is based on a theoretical 18 percent expansion of a petroleum refinery. The refinery processes crude oil at a rate of about 280,000 barrels per day into petroleum products such as gasoline, diesel, propane, butane, heating fuels, asphalt, sulfur, petroleum coke, and jet fuel. It is assumed that the refinery currently discharges 7,600 lbs. of TP per year at a total annual flow of 1,300 million gallons (~ 3.56 mgd), and an average TP concentration in the discharge of 0.7 mg/L. Based on a possible 18 percent expansion of the plant production rate by 50,000 barrels per day, a proportional increase of 18 percent flow and TP mass load generated was used to estimate costs, although flow would not necessarily be expected to increase by 18 percent due to potential internal recycling. TP concentration (untreated) remains the same or less. Wastewater treatment at the refinery consists of oil/water separation, dissolved air flotation, activated sludge process, powdered activated carbon system, final clarification, and polishing ponds, in addition to in-plant process water recycling and reuse systems.

Phosphorus may be added to refinery cooling water systems for scaling control, and pose a limited TP contribution source in the wastewater from cooling tower blowdown. However, phosphorus concentrations in refinery process wastewaters are generally low. The refinery has maintained TP levels in the treated effluent through proper management of phosphorus additions and maintaining overall wastewater treatment efficiency. Powdered activated carbon addition may also serve to lower TP by removal of particulate attached phosphorus. Expansion of refinery production would not cause an increase in the effluent TP concentration beyond current levels. Accordingly there would be no costs expected for TP removal as a result of a refinery expansion. Also, current Agency policy is to not impose a TP limit on facilities that discharge at a concentration less than 1 mg/L, unless the discharge impacts or is expected to impact a downstream lake.

In summary the Agency has estimated potential costs to seven categories of industries that potentially may get TP limits due to the proposed extension of the TP limit to new and expanding facilities that discharge more than 1,800 pounds TP per year. Projected cost for two of the seven categories is zero. While it is very difficult to predict the number of industries likely to be impacted over the next five years, the Agency has estimated costs for eight examples (one new and one expanded ethanol plant plus the other six, Table II-32). Costs will be incurred

⁷⁵ As of June 2006 the pulp and paper mill on which our example is based indicated to the Agency that they would be making changes to substantially reduce the TP concentration in their effluent to below 1 mg/L, possibly significantly below 1 mg/L.
over time. The total estimated capital costs are $4.27 million and the annual operational and maintenance (O&M) costs are $0.68 million (Table II-32). The estimated total (annual) cost for five years (annualized capital cost times 5 plus 5 years of O&M) is about $5.6 million, and the total costs (total capital cost plus 5 years of O&M) is about $7.8 million.

Current Agency policy is to not impose a TP limit on facilities that discharge at a concentration less than 1 mg/L, unless the discharge impacts or is expected to impact a downstream lake or reservoir.

F. TRUE COSTS DUE TO PROPOSED EXTENSION WILL BE FAR LESS THAN FULL ESTIMATES [XI. TP limit, economics]

As noted in the introduction to this Section, there are several reasons why much of the costs for removing TP from municipal and industrial dischargers, as discussed in the previous two sections, cannot be attributed just to the proposed extension of the TP effluent limit in this rulemaking. The Agency believes it is better to start with full cost estimates, which can be determined with some degree of accuracy, and then discuss the reasons why a significant portion of these costs should not be attributed to the proposal. Determining exactly what fraction of the total future costs should be attributed to the proposed extension of the TP limit is very difficult. The reasons full costs should not be attributed to the proposal have been mentioned throughout the reasonableness sections and will be summarized in this Section.

1. There has been a clear trend over the last five years that as permits are reissued, especially when a facility expands (or builds new), that the permit will include a limit for phosphorus. There are a number of reasons for this. A general reason is the increased awareness that phosphorus is a conservative (not degraded over time) pollutant of major concern not only for lakes but for rivers and stream as well, and the growing number of waterbodies (mostly lakes) listed as impaired due to nutrients. Phosphorus removal generally provides a higher quality effluent, lower in suspended solids and possibly lower in CBOD5. Reduced solids generally mean lower effluent concentrations of some other pollutants such as mercury.

2. TP effluent limits have been issued to new and expanding facilities under the Phosphorus Strategy. About 35 facilities have gotten limits that can be attributed to the strategy since the Strategy was approved in March of 2000. To a large extent the proposed extension of the TP limit to new or expanding facilities is already being implemented, and has been for five years, as Agency policy under the Strategy.

3. TP limits are being or will be required in several major watersheds in Minnesota, which includes a large portion of the state (see Section IX.D).

- Lake Superior basin: 1 mg/L TP limits under existing Minn. R. 7065.
- Minnesota River TMDL: seasonal TP limits for about 40 larger dischargers.
- Lake Pepin TMDL: the implementation plan for this TMDL has not been completed yet but it seems likely that any plan would include 1 mg/L TP limits for at least the larger facilities. The Lake Pepin watershed includes half of the area of Minnesota.
• St. Croix: newly signed interstate agreement reinforces a previous goal to reduce TP loading to Lake St. Croix by 20 percent. Most permits reissued for facilities in the basin include a TP limit.
• Rainy River basin: there is increased concern about the eutrophication of Lake of the Woods. The Rainy River watershed makes up 80 percent of the lake’s drainage basin, which means the TP concentrations in the river most certainly have a major impact on the trophic status of this very large lake. The Rainy River basin plan calls for managing TP loading to surface waters to minimize impacts.
• Basin plans for the Red, Lower Mississippi and Cedar Rivers have established nutrient reduction goals.

4. The discharge of a pollutant(s) to a waterbody listed as impaired for that same pollutant(s) is controlled by federal requirements. A new discharge to any waterbody cannot cause or contribute to a violation of water quality standards (40 CFR 122.4(i)). Also the Agency cannot issue a permit to an existing facility that would cause, have reasonable potential to cause, or contribute to an exceedance of a water quality standard (40 CFR 122.44(d)(1)(i)). Since impaired waterbodies by definition exceed one or more water quality standards, additional loading of the pollutant(s) causing the impairment is severely limited.76

These federal regulations would require TP limits in situations involving impaired waters even if the proposed eutrophication standards and extension of the TP limit are not adopted. The nutrient criteria, based on the existing narrative standard in Minn. R. 7050.0150, subp. 5, would continue to be the basis for assessing lakes for impairment. The proposed eutrophication standards will provide a more precise assessment benchmark and a more direct vehicle to assess lakes. Also, expanded application of the nutrient criteria in the setting of effluent limits is a possibility in the future.

5. Permittees may request relief from the extension of the TP limit through one or more of the three proposed exemptions or through the variance process. The estimated costs for POTWs and industries discussed in the previous two Sections assume the Agency will receive no requests for relief.

6. The Clean Water Legacy Act passed by the 2006 legislature and signed by the Governor provides funding to help pay for phosphorus removal. In its first year the act provides grants totaling $3.2 million to cover 75 percent of the capital cost for TP removal infrastructure. The money can go to communities building new or to cover costs already incurred retroactively; however, new construction will be given priority. Requests for funding have already exceeded the first year’s allocation of funds. The Agency is hopeful the legislature will continue funding TP removal and will increase the allotment.

7. TP limits will be implemented gradually over time. First the facility must expand or build new and exceed the *de minimis* loading of 1,800 pounds TP per year after May 1, 2008. The

76 A test of the Agency’s interpretation of the federal requirements was provided by a challenge to the issuance of the NPDES permit for a proposed new Annandale/Maple Lake treatment plant. On May 17, 2007 the State Supreme upheld the Agency’s authority to interpret the Clean Water Act and issue the Annandale/Maple Lake permit as proposed, reversing the findings of the lower courts.
issued permit normally includes a compliance schedule which gives the community time to complete construction and bring the new treatment components on line before the limit becomes effective.
XII. IMPACTS ON AGRICULTURE

Minnesota Statute § 14.111 requires agencies to send a copy of any proposed rule that affect farming operations to the Commissioner of Agriculture no latter than 30 days prior to publication of the proposed rule in the *State Register*. The Agency maintains that the proposed amendments to Minn. R. ch. 7050 and Minn. R. ch. 7053 discussed in Book II of the SONAR will have no direct affect on farming operations. The proposed eutrophication standards might have an indirect impact on agriculture if they result in the implementation of best management practices to minimized nutrient loading to lakes. The Agency has not attempted to estimate these very hypothetical costs as discussed Section X.C.

On April 18, 2007, the Agency sent a letter, together with a draft copy of the proposed rule amendments, to the Commissioner of Agriculture well in advance of the targeted *State Register* publication date. The letter, which will be introduced as an exhibit at the beginning of the public hearings, highlighted the proposed water quality standards for two herbicides, acetochlor and metolachlor. Staff in the Department of Agriculture asked the Agency to develop and adopt standards for these two herbicides because they have been detected in Minnesota’s surface waters. The Agency has received substantial help and support in preparing the information supporting the proposed standards from the Department of Agriculture. These proposed standards are discussed in SONAR Books III. Department of Agriculture staff and other representatives of the agricultural community are on the Agency’s interested party contact list for this rulemaking.
XIII. NOTICE TO THE COMMISSIONER OF TRANSPORTATION

Minnesota Stat. § 174.05, subd. 1 requires the Agency to inform the Commissioner of Transportation of all activities which relate to the adoption, revision or repeal of any standard or rule concerning transportation. A representative of the Minnesota Department of Transportation (MDOT) is on the Agency’s interested party contact list and received all the notifications discussed in Section III of SONAR Book I. The proposed revisions discussed in this Book will have no direct affect on transportation. As the case for agriculture, the proposed eutrophication standards might have an indirect impact on transportation if they result in the implementation of more extensive or more expensive best management practices at road construction and repair sites to minimized nutrient loading to lakes. The Agency has not attempted to estimate or quantify these hypothetical added costs because there are too many unknowns, as discussed Section X.D.1. On April 18, 2007, the MPCA sent a letter, together with a draft copy of the proposed rule amendments, to the Commissioner of MDOT. The letter will be introduced as an exhibit at the beginning of the public hearings.

In an earlier letter, the Agency informed MDOT that we would not be revising the Class 2 standard for chloride as they had requested (see Section III.F in Book I and Exhibits A-14j and A-22).
XIV. LIST OF WITNESSES AND EXHIBITS

A. WITNESSES

The Agency plans to have the following staff available to testify at the public hearings on issues covered in Book II. The principal areas on which they would testify are listed.

David Maschwitz – The proposed amendments in general, history of their development and author of SONAR Book II.
Steve Heiskary – Lake and river eutrophication sampling and assessment process, proposed Minnesota eutrophication standards and development of federal nutrient criteria.
David Kortan – Estimated costs to dischargers due to the proposed adoption of the eutrophication standards and treatment technologies for removing phosphorus.
Mark Tomasek – Supervisor of Water Standards Unit. Proposed extension of the phosphorus limit to new and expanding dischargers and the setting of TP limits in NPDES permits.
Randy Thorson – Estimated costs to municipalities due to the proposed extension of the phosphorus limit to new and expanding dischargers and treatment technologies for removing phosphorus.
Don Kriens – Estimated costs to industries due to the proposed extension of the phosphorus limit to new and expanding dischargers and industrial treatment technologies

B. EXHIBITS

The list of all exhibits is attached.
XV. CONCLUSION

Based on the foregoing, the proposed rule amendments discussed in SONAR Book II are both needed and reasonable.

Dated: 7/16/09

Brad Moore
Commissioner
Exhibit List: Statement of Need and Reasonableness, Books I-III

A-1 Statement of Need and Reasonableness, Book I of III, In the Matter of Proposed Revisions of Minnesota Rules Chapter 7050, Relating to the Classification and Standards for Waters of the State; the Proposed Addition of a New Rule, Minnesota Rules Chapter 7053, Relating to Point and Nonpoint Source Treatment Requirements; and the Repeal of Minn. R. Chapters 7056 and 7065

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Document  MPCA  St. Paul

July 2007  Book I of III

A-2 Statement of Need and Reasonableness, Book II of III, In the Matter of Proposed Revisions of Minnesota Rules Chapter 7050, Relating to the Classification and Standards for Waters of the State; the Proposed Addition of a New Rule, Minnesota Rules Chapter 7053, Relating to Point and Nonpoint Source Treatment Requirements; and the Repeal of Minn. R. Chapters 7056 and 7065

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Document  MPCA  St. Paul

July 2007  Book II of III

A-3 Statement of Need and Reasonableness, Book III of III, In the Matter of Proposed Revisions of Minnesota Rules Chapter 7050, Relating to the Classification and Standards for Waters of the State; the Proposed Addition of a New Rule, Minnesota Rules Chapter 7053, Relating to Point and Nonpoint Source Treatment Requirements; and the Repeal of Minn. R. Chapters 7056 and 7065

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Document  MPCA  St. Paul

Book III of III

A-4 Statement of Need and Reasonableness (SONAR): In the Matter of Proposed Additions To Minnesota Rules Chapter 7050, Relating to the Classification and Standards for Waters of the State; Proposed Additions Required By Minnesota Session Law 2003, Chapter 128, Article 1, Section 156 As Amended By Minnesota Session Law 2005, First Special Session, Chapter 1, Article 2, Section 156

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Document  MPCA  St. Paul

May 2006  http://www.pca.state.mn.us

A-5 Exhibit List for Statement of Need and Reasonableness, Books I-III

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Document  MPCA  St. Paul

July 2007

A-6 2006 303(d) List. (Final 2004 MPCA Clean Water Act Section 2004 303(d) Total Maximum Daily Load (TMDL) List of Impaired Waters)

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Publication  MPCA  St. Paul

June 1, 2006  http://www.pca.state.mn.us

The List identifies impaired streams and lakes in ten major River Basins.

A-7 Guidance Manual For Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List

Author: Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Guidance  MPCA  St. Paul

October 2005  pp1-106 & Appendices  http://www.pca.state.mn.us/water/tmdl/index

URL: See first document under "publications"

A-8a Subject: Triennial Review -Revised

From Larry C. Salmela, Department Manager - Environmental, United States Steel Corporation (USS)

Comment Letter  Mount Iron

September 22, 2003  To Mr. Marvin Hora, Environmental Outcomes Division, MPCA
A-8b
From Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB)
Comment Letter
October 31, 2003
To David Maschwitz and Greg Gross, Environmental Outcomes Division, MPCA
Follow-up to Meeting on October 24, 2003 in New Ulm, Minnesota

A-9
Request for Comments on Possible Amendments to Rules Governing State Water Quality Standards, Minnesota Rules Chapters 7050 and 7052
Author: Minnesota Pollution Control Agency (MPCA)  
Public Notice State Register (SR)  
St. Paul  

A-10
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Letter MPCA St. Paul  
November 6, 2003 http://www.pca.state.mn.us
To Interested Parties for 7050, 7052 and 7055 Water Quality Rules
1st Notice to mailing list. MPCA Cover Letter with State Register Notice to Interested Parties for 7050, 7052 and 7055.

A-11a
Subject: State Register of November 10, 2003 - Possible Amendments to Rules Governing State Water Quality Standards
From Larry C. Salmela, Department Manager - Environmental, United States Steel Corporation (USS)
Comment Letter Mount Iron
December 12, 2003
To David E. Maschwitz, Environmental Outcomes Division, MPCA
Comment Letter from 1st Notice.

A-11b
Subject: Possible Amendments to Rules Governing State Water Quality Standards, Minnesota Rules Chapters 7050 and 7052
From Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB), Christopher M. Hood, Flaherty & Hood, P.A.
Comment Letter
December 31, 2003
To David Maschwitz, Environmental Outcomes Division, MPCA
Comment Letter from 1st Notice.

A-11c
Subject: Request for Comments on Possible Amendments to Rules Governing State Water Quality Standards, Minnesota Rules Chapters 7050 and 7052
From Rebecca J. Flood, Manager - Environmental Compliance Section, Environmental Services Division, Metropolitan Council
Comment Letter St. Paul
December 31, 2003
To David Maschwitz, Environmental Outcomes Division, MPCA
Comment Letter from 1st Notice.

A-11d
Subject: Proposed Water Quality Standards Rules Revision Invitation to Comment
From Janette K. Brimmer, Kris Sigford of the Minnesota Center for Environmental Advocacy (MCEA)
Comment Letter St. Paul
January 9, 2004
To David E. Maschwitz, Environmental Outcomes Division, MPCA
Comment Letter from 1st Notice.

A-11e
Subject: Request for Comments on Possible Amendments to Rules Governing State Water Quality Standards, Minnesota Rules Chapters 7050 and 7052
From Keith E. Hanson, Minnesota Chamber of Commerce Water Quality Subcommittee - Chair
Comment Letter St. Paul
December 31, 2003
To David E. Maschwitz, Environmental Outcomes Division, MPCA
Comment Letter from 1st Notice.
A-11f  **Subject:** Possible Amendments to Rules Governing State Water Quality Standards, Minnesota Rules Chapters 7050 and 7052  
From Steven Colvin, Environmental Management Unit Supervisor, Division of Ecological Services, Minnesota Department of Natural Resources (MDNR)  
*Comment Letter*  
December 31, 2003  
To David E. Maschwitz, Environmental Outcomes Division, MPCA  
*Comment Letter from 1st Notice.*

A-11g  **Subject:** Syngenta Comments & Input to MPCA WQ Standards Rule Revision Process... (Importance: High)  
From David Flakne, State Government Relations Manager, Syngenta Crop Protection  
e-mail  
September 29, 2003  
To David E. Maschwitz, Environmental Outcomes Division, MPCA  
*Comment Letter from 1st Notice.*

A-11h  **Subject:** RE: MPCA WQ Standards Rule Revision...  
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)  
e-mail  
September 29, 2003  
To David Flakne, Syngenta  
*Comment Letter from 1st Notice.*

A-11i  **Subject:** Syngenta Comments & Input to MPCA WQ Standards Rule Revision Process... (Importance: High)  
From David Flakne, State Government Relations Manager, Syngenta Crop Protection  
e-mail  
December 19, 2003  
To David E. Maschwitz, Environmental Outcomes Division, MPCA  
*Comment Letter from 1st Notice.  3 Attachments: EPA DWLOC Values iRED.ppt; EPA LOC CASM Screening Values...; US EPA Atrazine Aquatic Life Water Quality (see Exhibit H-59)*

A-11j  **Subject:** RE: Syngenta Comments & Input to MPCA WQ Standards Rule Revision Process...  
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)  
e-mail  
December 22, 2003  
To David Flakne, Syngenta  
*Comment Letter from 1st Notice.  Attachment: Atrazine U.S. EPA.doc*

A-11k  **Subject:** Syngenta Comments/Questions on MPCA Proposed Revisions to WQ Standards 7050 and 7052... (Importance: High)  
From David Flakne, State Government Relations Manager, Syngenta Crop Protection  
e-mail  
May 25, 2004  
To David E. Maschwitz, Environmental Outcomes Division, MPCA  
*Comment Letter from 1st Notice.  Comment Letter from 1st Notice.  3 Attachments: EPA DWLOC Values iRED.ppt; EPA LOC CASM Screening Values...; US EPA Atrazine Aquatic Life Water Quality*

A-11l  **Subject:** RE: Syngenta Comments/Questions on MPCA Proposed Revisions to WQ Standards 7050 and 7052...  
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)  
e-mail  
May 25, 2004  
To David Flakne, State Government Relations Manager, Syngenta Crop Protection  
*Comment Letter from 1st Notice.*

A-12  **Request for Comments on Possible Amendments to Rules Governing State Water Quality Standards, Minnesota Rules Chapters 7050 and 7052**  
Minnesota Pollution Control Agency (MPCA)  
*Public Notice*  
State Register (SR)  
May 17, 2004  
*Notice to solicit in SR, May 17, 2004*
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Letter

May 11, 2004

To Interested Party

Cover Letter & Mailing List - 2nd Notice

A-14a Subject: Water Quality Rule Revisions

From Paula West, Executive Director, Minnesota Lakes Association (MLA)

e-mail

May 13, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

A-14b Subject: Proposed Extension of 1 mg/L Phosphorous Effluent Limit to New or Expanding Discharges

From Steven Colvin, Environmental Management Unit Supervisor, Division of Ecological Services, Minnesota Department of Natural Resources (MDNR)

Letter

May 14, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

A-14c Subject: RE: Syngenta Comments/Questions on MPCA Proposed Revision to WQ Standards Chapter 7050 and 7052...

(Importance: High)

From David Flakne, State Government Relations Manager, Syngenta Crop Protection

e-mail

May 25, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

A-14d

From Crosby-Ironton Presbyterian Church

Letter

June 11, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

Re: Upholding Strict Standards to Protect Water Quality in Our State

A-14e Subject: Clean Water/Public Input

From Tine Thevenin, Author/Speaker

e-mail

June 18, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

A-14f Subject: Request for Development of Water Quality Standards

From Dan Stoddard, Manager, Agricultural Chemical Environmental Section, Minnesota Department of Agriculture (MDA)

Letter

June 23, 2004

To Greg Gross, Environmental Outcomes Division, MPCA

A-14g Subject: Mercury Comments

From Donald Barron

Comment Letter

Received June 24, 2004

To Environmental Protection Agency Administrator, Ariel Rios Building (Washington, D.C.)

Copy Mailed To: David E. Maschwitz, Environmental Outcomes Division, MPCA, St. Paul, MN

A-14h Subject: Comments - Proposed Changes to MS Ch. 7050

From Terry Noonan, Project Manager - Water Resources, Ramsey County Public Works

e-mail

June 25, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA
Comment Letter

Subject: Comments on Possible Amendments to Rules Governing State Water Quality Standards, Minnesota Rules Chapters 7050 and 7052

From Al Christopherson, President, Minnesota Farm Bureau Federation (MFBF)

June 28, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

with Cover Letter (e-mail from Jackie Gauger sent on June 29, 2004)

Comment Letter

Subject: Mn/DOT Comments on Water Quality Standards Revision

From Richard Elasky, Chief Environmental Officer, Minnesota Department of Transportation (MNDot)

June 29, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

3 Attachments: Derivation of Acute and Chronic Toxicity Criteria for Chloride (January, 2000) prepared by: Jim Schmidt - WDNR; Chronic Data - Chlorides spread sheet provided by Jim Schmidt - WDNR; Ambient Aquatic Life Criteria For Chloride - Chloride Issue Paper (2003) provided by Connie Due - Iowa DNR, Environmental Services Division, Water Quality Bureau

Comment Letter

Subject: MESERB/CGMC Data Practices Act Request Relative to Proposed Amendments to the Phosphorus Rule, Minn. R. 7050.0211, subp. 1a

From Christopher M. Hood, Flaherty & Hood, P.A.

June 30, 2004

To Commissioner Sheryl Corrigan

Included an Attached Memo (Exhibit A-14I)

Letter

Subject: Supplemental Data Practices Act Request

From Christopher M. Hood, Flaherty & Hood, P.A. for Coalition of Greater Minnesota Cities (CGMC)

July 16, 2004

To Sheryl A. Corrigan, Commissioner, Minnesota Pollution Control Agency (MPCA)

Letter

Subject: Proposed Water Quality Standards Rule Revision Invitation to Comment

From Sol Simon, President - Mississippi River Revival (MRR)

June 30, 2004

To David E. Maschwitz, Environmental Outcomes Division, MPCA

Proposed Amendments to Minnesota Rules Chapter 7050 [RULES AS PROPOSED]

Author: Minnesota Pollution Control Agency (MPCA)

Rule

July 16, 2007

Proposed New Minnesota Rules Chapter 7053 [RULES AS PROPOSED]

Author: Minnesota Pollution Control Agency (MPCA)

Rule

July 16, 2007

NEWS RELEASE: MPCA Seeks Input on Proposed Changes to State Water-Quality Standards

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Publication

For Release: June 4, 2004

News Release for the public meetings

http://www.pca.state.mn.us
A-17  Subject: Plans for Additions and Revisions to Water Quality Standards in Minn. R. chs. 7050 and 7052
From David E. Maschwitz, Greg Gross - Supervisor, and Marvin E. Hora, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Memo

September 23, 2003
To MPCA's Citizens' Board

with cover letter to interested parties from David Maschwitz dated September 12, 2003, and list of 59 interested parties that received a copy of the memo to the Agency Board. (Agency Board meeting was on September 23, 2003)

A-18  Triennial Review of Water Quality Standards, Minn. R. ch. 7050 & 7052
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Presentation

September 23, 2003
For MPCA's Citizens' Board

PowerPoint presentation

A-19  Subject: Update on Proposed Revisions and Additions to Minnesota Water Quality Standards
From David E. Maschwitz, Greg Gross - Supervisor, and Marvin E. Hora, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Memo

August 13, 2004
To MPCA's Citizens' Board

with cover letter to interested parties dated August 16, 2004, and list of 72 interested parties that received a copy of the memo to the Agency Board. (Agency Board meeting was on August 24, 2004)

A-20  Update of Plans to Revise MN Water Quality Standards
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Presentation

August 24, 2004
To MPCA's Citizens' Board

PowerPoint presentation

A-21  Health Risk Limits for Groundwater Water Intake and Cancer Potency Adjustment Factors
Author: Helen Goeden, Ph.D., Minnesota Department of Health (MDH)

Presentation

August 24, 2004
To MPCA's Citizens' Board

PowerPoint presentation - New MDH Slides

A-22  Subject: Request for Change to the Class 2 Standard for Chloride
From Marvin E. Hora, Manager, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Letter

September 24, 2004
To Mr. Richard Elasky, Chief Environmental Officer, Minnesota Department of Transportation (MNDOT)

A-23  Subject: Update on Proposed Revisions and Additions to Minnesota Water Quality Standards
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Memo

September 21, 2004
To MPCA's Citizens' Board

Cover letter to interested parties; 2 Attachments: Agency Board Meeting was on September 28, 2004.

A-24  Update of Plans to Revise MN Water Quality Standards
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

Presentation

September 28, 2004
To MPCA's Citizens' Board

PowerPoint presentation
2003 Administrative Rule Preliminary Proposal Form
Author: David E. Maschwitz, Environmental Outcomes Division, MPCA
Form MPCA
October 27, 2003
with cover memorandum To: Scott Wiggins, Legislative Coordinator; From: Kevin Molloy, Water Quality Rule Coordinator; 1st of three forms to the Governor’s Office

2007 Administrative Rule Proposed Rule and SONAR form:
Minnesota's Water Quality Standards, Proposed Revision of Minnesota Rules Chapter (Minn. R. Ch.) 7050, Proposed Addition of a New Rule, Minn. R. Ch. 7053, Proposed Repeal of Out-dated Rules, Minn. R. Ch. 7056 and 7065
Author: David E. Maschwitz (Rule/SONAR Content) and Kevin Molloy (Rulemaking Coordinator), Minnesota Pollution Control Agency (MPCA)
Form MPCA
April 9, 2007
Adm. Rule Tracking #: AR081(B)
Attached to Memo: Letters to Commissioner Tom Hanson, Department of Finance, Commissioner Gene Hugoson, Minnesota Department of Agriculture, and Commissioner Carol Molnau, Minnesota Department of Transportation

No Exhibit

Petition for Rulemaking to the Minnesota Pollution Control Agency -Pursuant to Minnesota Statutes § 14.09 et seq.
From Christopher M. Hood, Flaherty & Hood, P.A.
Petition St. Paul
December 15, 2003
To Commissioner Sheryl Corrigan, Minnesota Pollution Control Agency (MPCA)
Includes cover letter to Commissioner Sheryl Corrigan Re: Petition to amend Minn. R. 7050.0211, subp. 1a (the “phosphorus rule”)

Subject: Response to Petition to Amend Minn. R. 7050.0211, subp. 1a (the "phosphorus rule")
From Commissioner Sheryl Corrigan, Minnesota Pollution Control Agency (MPCA)
Letter St. Paul
January 13, 2004
To Christopher M. Hood, Flaherty & Hood, P.A.

Phosphorus Rulemaking Petition
From Janette K. Brimmer, Kris Sigford of the Minnesota Center for Environmental Advocacy
Petition Minnesota Center for Environmental Advocacy (MCEA) St. Paul
July 27, 2004
To Commissioner Sheryl Corrigan, Minnesota Pollution Control Agency (MPCA)
Includes cover letter (Re: Petition to Amend Minn. R. 7050.0211)

Subject: Petition to Amend Minn. R. 7050.0211
From Commissioner Sheryl Corrigan, Minnesota Pollution Control Agency (MPCA)
Letter St. Paul
August 18, 2004
To Janette K. Brimmer, Kris Sigford of the Minnesota Center for Environmental Advocacy
(Response to MCEA's July 27, 2004 Petition)

Subject: MPCA Proposed Phosphorous Rule and Phosphorous Strategy Amendments
From Christopher M. Hood, Flaherty & Hood, P.A.
Letter St. Paul
June 30, 2004
To Sheryl A. Corrigan, Commissioner, Minnesota Pollution Control Agency (MPCA)
Attached Technical Memo from MESERB (see Exhibit A-32b)
A-32b  Subject: MPCA Approach to Phosphorus Effluent Limits in NPDES Permitting
From Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB)
Memo
June 30, 2004
To Commissioner Sheryl Corrigan
Attachment to Exhibit A-14k

A-33
From Sheryl A. Corrigan, Commissioner, Minnesota Pollution Control Agency (MPCA)
Letter
August 5, 2004
To Christopher M. Hood, Flaherty & Hood, P.A.

A-34  Subject: Amendments to Phosphorus Rule, Minn. R. 7050.0211, subp. 1a
From Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB)
Comment Letter
February 11, 2005
To David E. Maschwitz, Environmental Outcomes Division, MPCA
Additional Contact: Steve Nyhus, Flaherty & Hood, P.A.

A-35  Subject: MPCA Proposed Water Quality Assessment Rules Revisions and Ecoregion-Based Eutrophication Standards
From Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB)
Comment Letter
March 18, 2005
To David E. Maschwitz, Environmental Outcomes Division, MPCA
Additional Contact: Steve Nyhus, Flaherty & Hood, P.A.

A-36  Subject: Response to MESERB February 11, 2005 Letter, Comments on Amendments to Phosphorus Rule; and March 18, 2005 Letter, Comments on Proposed Eutrophication Standards
From Greg Gross, Supervisor, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Letter
May 12, 2005
To Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB)
Attachment: Draft Amendments to Minnesota Rules Chapter 7050; Excerpt of Planned Revision of Water Quality Standards

A-37a  Minn. Session Law 2003, ch. 128, art. 1, § 156, subdivisions 1 and 2  Water Quality Assessment Process
Law
2003
Minnesota Office of Revisor of Statutes
St. Paul
(Original Law)
http://www.revisor.leg.State.mn.us

A-37b Minn. Special Session Law 2005 ch. 1, art. 2, § 151, subdivisions 1, 2 and 3  Water Quality Assessment Process
Law
2005
(Minn. Special Session Law 2003, ch. 128, art. 1, § 156, subdivisions 1 and 2)
http://www.revisor.leg.State.mn.us

A-38 No Exhibit

A-39 No Exhibit
A-40a **Subject: Critical Concerns Regarding Draft Nutrient Standards and Phosphorous Rule**
From Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB)
Comment Letter
June 16, 2005
To Sheryl A. Corrigan, Commissioner, Minnesota Pollution Control Agency (MPCA)

A-40b **Water Quality Standards: A Review with an Emphasis on Numeric Nutrient Criteria**
Author: Walt Poole, Ph.D., America's Clean Water Foundation (ACWF)
Report
ACWF
March 2005
In Cooperation with the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA)

A-41 **Subject: MESERB's Concerns Regarding Nutrient Standards and Phosphorous Rule**
From Sheryl A. Corrigan, Commissioner, Minnesota Pollution Control Agency (MPCA)
Letter
June 29, 2005
To Bruce A. Nelson, Executive Director, Alexandria Lake Area Sanitary District, Minnesota Environmental Science and Economic Review Board (MESERB)

A-42a **Changes to Proposed Amendments to Minn. Rules, ch. 7050**
Author: Minnesota Pollution Control Agency (MPCA)
MPCA Document
March 9, 1990

A-42b **Revised Changes to Proposed Amendments to Minn. Rules pts. 7050.0218, subp. 2 and 7050.0220, subp. 4**
Author: Minnesota Pollution Control Agency (MPCA)
MPCA Document
March 16, 1990

A-43 **No Exhibit**

A-44a **Sensitivity of Mussels to Ammonia Toxicity, Implications for a Revised Minnesota Ammonia Standard Considering the Biology and Distribution of Mussels in Minnesota**
Author: Minnesota Pollution Control Agency (MPCA)
Agenda
March 25, 2004
Contact List on back

A-44b **Subject: Meeting at MPCA, 1:00-4:30p.m., March 25, 2004**
Sensitivity of Mussels to Ammonia Toxicity, Implications for a Revised Minnesota Ammonia Standard Considering the Biology and Distributions of Mussels in Minnesota
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Letter
March 15, 2004
To Ammonia Toxicity Experts (see exhibit A-44c for list)

A-44c **Author: Minnesota Pollution Control Agency (MPCA)**
MPCA Document
2004
List of Attendees (for March 25, 2004 Mtg.: exhibit A-44b)

A-45 **Notice of Intent To Re-Evaluate the Aquatic Life Ambient Water Quality Criteria for Ammonia**
Author: Geoffrey H. Grubbs, Director, Office of Science and Technology, Environmental Protection Agency (EPA)
Public Notice
Federal Register - Online via GPO Access
Vol 69(130); pp.41262-4
July 8, 2004
http://www.gpoaccess.gov/fr/index.html
A-46a  Proposed Water Quality Standards Rule Revisions (Update)
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Website  MPCA  St. Paul
December 3, 2004  http://www.pca.state.mn.us

Included excerpts from Minn. Rule ch 7050 revisions (See Exhibit A-46b).

A-46b  Excerpts of Planned Revision of Water Quality Standards:
Preliminary Draft Amendments to Minn. R. 7050.0150 and 7050.0222 - Relevant Definitions and Eutrophication Standards for
Lakes, Reservoirs and Shallow Lakes [DRAFT]
Author: Minnesota Pollution Control Agency (MPCA)
Rule  Minnesota Office of Revisor of Statutes  St. Paul
November 1, 2004  http://www.pca.state.mn.us
Attachment to December 3, 2004 website, "Proposed Water Quality Standards Rule Revisions".

A-47  Proposed Water Quality Standards Rule Revisions
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Website  MPCA  St. Paul
Revised: June 16, 2005  http://www.pca.state.mn.us

A-48a  Proposed Water Quality Standards Rule Revisions
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Website  MPCA  St. Paul
Revised: August 9, 2005  http://www.pca.state.mn.us
Includes complete versions of Minn. Rules ch 7050 & 7055 [Drafts]. (See Exhibit A-48b & A-48c)

A-48b  Proposed Amendments to Minnesota Rules Chapter 7050 [DRAFT]
Author: Minnesota Pollution Control Agency (MPCA)
Rule  MPCA  St. Paul
July 28, 2005  http://www.pca.state.mn.us

A-48c  Proposed Amendments to Minnesota Rules Chapter 7055 [DRAFT]
Author: Minnesota Pollution Control Agency (MPCA)
Rule  Office of Revisor of Statutes, State of Minnesota  St. Paul
July 28, 2005
Attached to August 9, 2005 Rule Revision Website

A-49a  Proposed Water Quality Standards Rule Revisions
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Website  MPCA  St. Paul
Revised: January 26, 2006  http://www.pca.state.mn.us
Includes complete versions of Minn. Rules ch 7050 & 7055 [Drafts] (Updated January 1, 2006; See Exhibit A-49b & A-49c) and Derivation of
acetochlor and metolachlor standards (See Exhibit A-49d)

A-49b  Proposed Amendments to Minnesota Rules Chapter 7050 [DRAFT]
Author: Minnesota Pollution Control Agency (MPCA)
Rule  MPCA  St. Paul
Revised January 1, 2006  http://www.pca.state.mn.us

A-49c  Proposed New Minnesota Rule Chapter 7055 [DRAFT]
Author: Minnesota Pollution Control Agency (MPCA)
Rule  MPCA  St. Paul
Revised January 1, 2006  http://www.pca.state.mn.us

A-49d  Outline of Basis for Draft Proposed Acetochlor and Metolachlor Class 2 Water Quality Standards
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
MPCA Document  MPCA  St. Paul
January 17, 2006  http://www.pca.state.mn.us
[5.3] Variances From Water Quality Standards

**A-50 Water Quality Standards Handbook: 2nd Ed.**

Author: Office of Water, Environmental Protection Agency (EPA)


**A-51 National Recommended Water Quality Criteria: 2002**

Author: Office of Water and Office of Science and Technology, Environmental Protection Agency (EPA)


**A-52 Announcement: Health Risk Limits Expert Advisory Panel**

From Patricia Bloomgren, Director, Division of Environmental Health, Minnesota Department of Health (MDH)

Letter St. Paul 2005 http://www.health.state.mn.us

(General Posting on MDH website)

**A-53 Subject: Exclusions/Inclusions for DWS in 7050**

From Richard D. Clark e-mail St. Paul May 20, 2005 To David E. Maschwitz, Environmental Outcomes Division, MPCA

Include Attachment: SONAR excerpt on Drinking Water Standards

**A-54 40 CFR parts 141 and 143**

Author: Environmental Protection Agency (EPA) -From the US Gov. Print. Office via GPO Access


Title 40 "Protection of Environment"; Part 141 "National Primary Drinking Water Regulations" and Part 143 "National Secondary Drinking Water Regulations"

**A-55a Statement of Need and Reasonableness [Excerpt]**

Author: Minnesota Pollution Control Agency (MPCA)


Excerpt on Proposed Amendments for WPC 14 C.9. and 15 C.9. - 5 mg/L TSS Limit & Pretreatment

**A-55b Report of the Hearing Examiner [Excerpt]**


Excerpt related to Proposed Amendments for WPC 14 C.9. and 15 C.9. - 5 mg/L TSS Limit & Pretreatment

**A-55c Proposed Findings of Fact and Conclusions [Excerpt]**

Minnesota Pollution Control Agency (MPCA)


Cover Sheet: Agenda Item Control Sheet; Excerpt on Proposed Amendments for WPC 14 C.9. and 15 C.9. - 5 mg/L TSS Limit & Pretreatment

**A-55d Order Adopting Rules**

Author: Minnesota Pollution Control Agency (MPCA)

MPCA Document St. Paul 1980 PCA-80-004-AK, p. 3, no. 4

In the Matter of the Proposed Amendments to MPCA Rules WPC 14, 15, 24 and 25 and the Proposed Repeal of WPC 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21, 23, 26, 29, 31 and 32.
A-56  Minn. R. ch. 7056  
Author: Minnesota Pollution Control Agency (MPCA)  
Rule  
November 3, 1998  
Mississippi River and Tributaries  
http://www.revisor.leg.state.mn.us/

A-57  Minn. R. ch. 7065  
Author: Minnesota Pollution Control Agency (MPCA)  
Rule  
November 3, 1998  
Effluent Standards for Disposal Systems  
http://www.revisor.leg.state.mn.us/

A-58  No Exhibit

A-59  No Exhibit

A-60  40 CFR 131.10 (a) Designation of Uses  
Author: Environmental Protection Agency (EPA) -From the US Gov. Print. Office via GPO Access  
Rule  
Revised July 1, 2004  
(Waste Assimilation Not a Beneficial Use).

A-61  Water Quality Standards Handbook: 2nd Ed.  
Author: Office of Water, Environmental Protection Agency (EPA)  
Guide  
August 1994  
[2.1] Use Classification - 40 CFR 131.10(a) in Chapter 2, "Designation of Uses"

A-62  40 CFR 131.12 Antidegradation Policy  
Author: Environmental Protection Agency (EPA) -From the US Gov. Print. Office via GPO Access  
Rule  
Revised July 1, 2005  
Title 40 "Protection of Environment"; Part 131 "Water Quality Standards"

A-63  Water Quality Standards Handbook: 2nd Ed.  
Author: Office of Water, Environmental Protection Agency (EPA)  
Guide  
August 1994  
Chapter 4 - Antidegradation

A-64a  Subject: Update on Proposed Revisions and Additions to Minnesota Water Quality Standards  
From David E. Maschwitz, Greg Gross - Supervisor, and Marvin E. Hora, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)  
Memo  
January 13, 2006  
To MPCA Citizens' Board  
with cover letter to interested parties dated January 13, 2006, and list of 72 interested parties that received a copy of the memo to the Agency Board. (Agency Board meeting was on January 24, 2006)

A-64b  Triennial Review of Water Quality Standards: Update on Revisions of Minn. R. ch. 7050  
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)  
Presentation  
January 24, 2006  
To MPCA's Citizens' Board
A-65a Proposed Water Quality Standards Rule Revisions (Update)
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Website MPCA St. Paul
Revised July 28, 2006 http://www.pca.state.mn.us
Included Draft Minn. R. chs. 7050 and 7053 and Outline of Acetochlor and Metolachlor Standards

A-65b Proposed Water Quality Standards Rule Revisions (Update)
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Website MPCA St. Paul
June 6, 2007 http://www.pca.state.mn.us
Includes Proposed Minn. R. chs. 7050 (Exhibit A-15a) and 7053 (Exhibit A-15b) and Outline of Acetochlor and Metolachlor Standards; Attached email to Interested Parties

A-66 Subject:
From Tom Poleck, Water Quality Branch, Environmental Protection Agency (EPA)
Letter Chicago
December 19, 2005
To Dave Maschwitz, Environmental Outcomes Division, MPCA
"...initial response to changes that the Minnesota Pollution Control Agency (MPCA) is considering making to certain aspects of Minn. R. ch. 7050, including proposed rule revisions that MPCA posted on its website on August 9, 2005."

A-67a Subject: Water Quality Standards for Mercury
From Char Brooker
e-mail Maplewood
February 3, 2006
To David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Example of emails received after January 24, 2006 presentation at the MPCA's Citizen Board Meeting

A-67b Subject: FW: FW: Act to Reduce Mercury in Minnesota Fish!
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
e-mail St. Paul
March 2, 2006
To Interested Party

EC-1 Ambient Water Quality Criteria for Bacteria-1986
Author: Environmental Protection Agency's (EPA's) Office of Research and Development Microbiology and Toxicology Div., Cincinnati, OH and Office of Water Regulations and Standards, Criteria and Standards Div., Washington, D.C.
EPA Report EPA Washington, D.C
Bacteriological Ambient Water Quality Criteria for Marine and Fresh Recreational Waters

EC-2 Implementation Guidance for Ambient Water Quality Criteria for Bacteria
Primary Authors: Jim Keating, Jennifer Wigal, and Lars Wilcut, Office of Water (4305T), Environmental Protection Agency (EPA)
Guidance EPA Washington, D.C

EC-3 Fecal Contamination of Surface and Recreational Waters: Disease Transmission and Public Health Protection [DRAFT]
Prepared by Tetra Tech EM Inc. for Minnesota Pollution Control Agency (MPCA);
Report MPCA St. Paul
September 30, 1997 pp. i- ii, 1-28 http://www.pca.state.mn.us

EC-4 Microbial Indicators of Faecal Contamination In Water: A Current Perspective
Author: Pam Tallon, Brenda Magajna, Cassandra Lofranco and Kam Tin Leung, Department of Biology, Lakehead University, and Ontario Ministry of the Environment, Standards Development Branch, Etobicoke
Journal Water, Air and Soil Pollution Ontario -Canada
2005 Vol 166; pp.139-166 http://springerlink.metapress.com/content/1573-2932/
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<tr>
<th>EC-5</th>
<th>Do U.S. Environmental Protection Agency Water Quality Guidelines for Recreational Waters Prevent Gastrointestinal Illness? A Systematic Review and Meta-Analysis</th>
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<tr>
<td>Author: Timothy J. Wade, N. Pai, Joseph N.S. Eisenberg, and J. Colford, Jr., Epidemiology and Biomarkers Branch, Environmental Protection Agency (EPA), Research Triangle Park, NC; School of Public Health, Div. of Epidemiology, Univ. of California</td>
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<td>June 2003</td>
<td>Environmental Health Perspectives (EHP) Berkeley</td>
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<td>EC-6a</td>
<td>Method 1603: Escherichia coli (E. coli) in Water by Membrane Filtration Using Modified membrane-Thermotolerant Escherichia coli Agar (Modified mTEC)</td>
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<td>Author: Office of Water (4303T) Environmental Protection Agency (EPA)</td>
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<td>September 2002</td>
<td>EPA EPA-821-R-02-023 <a href="http://www.epa.gov">http://www.epa.gov</a></td>
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<td>Author: Environmental Protection Agency (EPA)</td>
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<td>July 21, 2003</td>
<td>Federal Register (FR) Vol 68(139); pp.43271-83 <a href="http://www.epa.gov/fedrgstr">http://www.epa.gov/fedrgstr</a></td>
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<td>EC-6c</td>
<td>Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Notice of Data Availability</td>
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<td>Author: Environmental Protection Agency (EPA) -from Online via GPO Access</td>
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<td>April 11, 2006</td>
<td>Federal Register (FR) Vol 71(69); pp.18329-31 <a href="http://www.epa.gov/fedrgstr/">http://www.epa.gov/fedrgstr/</a></td>
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<td>EC-7</td>
<td>Rapidly Measured Indicators of Recreational Water Quality are Predictive of Swimming Associated Gastrointestinal Illness</td>
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<td>Author: Timothy J. Wade, Rebecca L. Calderon, Elizabeth Sams, Michael Beach, Kristen P. Brenner, Ann H. Williams, and Alfred P. Dufour, The National Institute of Environmental Health Sciences, U.S. Department of Health and Human Services</td>
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<td>Online: September 1, 2005</td>
<td>Environmental Health Perspectives (EHP) Vol 114 (1); pp.24-8 <a href="http://www.ehponline.org">http://www.ehponline.org</a></td>
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<td>EC-8</td>
<td>South Zumbro River in Rochester Fecal Coliform and E. coli Monitoring (2001) [DRAFT]</td>
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<td>Author: Norman Senjem and Lee Ganske, Minnesota Pollution Control Agency (MPCA)</td>
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<td>April 2003</td>
<td>MPCA Document St. Paul pp.i-vii, 1-29 <a href="http://www.pca.state.mn.us">http://www.pca.state.mn.us</a></td>
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<td>EC-9</td>
<td>Regional Total Maximum Daily Load Evaluation of Fecal Coliform Bacteria Impairments in the Lower Mississippi River Basin in Minnesota</td>
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<td>Submitted by: Norman Senjem, Lee Ganske, Gregory Johnson, David Morrison, and Bill Thompson, Regional Environmental Management Division, Minnesota Pollution Control Agency (MPCA)</td>
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<td>EC-10</td>
<td>Water-Resources Investigations. Escherichia coli and Fecal-coliform Bacteria as Indicators of Recreational Water Quality</td>
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<td>Author: Donna S. Francy, Donna N. Myers, and Kevin D. Metzker, U.S. Geological Survey</td>
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<td>EC-11</td>
<td>Surface Water Pathogen Study</td>
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<td>Prepared by Wenck Associates, Inc.</td>
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<td>Study Minnehaha Creek Watershed District</td>
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<td>Study Completion: July 2003</td>
<td>pp.i-vii, 2-1 to 6-3, Appendix A &amp; B</td>
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<td>Prepared for the Minnehaha Creek Watershed District</td>
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<td>EC-12</td>
<td>1984 Mississippi River Bacteria Study</td>
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<tr>
<td>Author: Gary L. Fandrei, Minnesota Pollution Control Agency (MPCA)</td>
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<td>April 1985</td>
<td>MPCA Study pp.i-vii, 1-29 <a href="http://www.pca.state.mn.us">http://www.pca.state.mn.us</a></td>
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EC-13  **Health Effects Criteria for Fresh Recreational Waters**
Author: Alfred P. Dufour, Toxicology and Microbiology Division, Environmental Protection Agency (EPA)
EPA Report EPA
August 1984 EPA-600/1-84-004 http://www.epa.gov

EC-14  **Fecal Coliform vs. E. coli Water Quality Standards**
Author: Dave Christopherson, Minnesota Pollution Control Agency (MPCA)
MPCA Document MPCA
May 2003

EC-15  **Water Pollution Control Act of 1972 Amendment to Section 303(i) Beaches Environmental Assessment and Coastal Health Act of 2000.**
106th Congress
Law U.S. Code

BEACH Act Amendment to the Clean Water Act

EC-16a  **Subject: Reminder of Deadline and Advisement of EPA's Plans to Comply with Requirements of Section 303(i) of the Clean Water Act, Also Known As the BEACH Act**
From Benjamin H. Grumbles, Office of Water, Environmental Protection Agency (EPA)
Letter EPA
April 19, 2004 Washington, D.C.
To Sheryl A. Corrigan, Commissioner, Minnesota Pollution Control Agency (MPCA)
with Attachment - Outline/Requirements: "General Background of the BEACH Act"

EC-16b  **Subject: Federal Promulgation of Water Quality Criteria for Bacteria**
From Sheryl A. Corrigan, Commissioner, Minnesota Pollution Control Agency (MPCA)
Letter MPCA
May 7, 2004 St. Paul
To Benjamin H. Grumbles, Office of Water Environmental Protection Agency (EPA)
Response to EPA

EC-17  **40 CFR Part 131 Part II. Water Quality Standards for Coastal and Great Lakes Recreation Waters; Final Rule**
Author: Environmental Protection Agency (EPA)
Public Notice Federal Register (FR)
November 16, 2004 Vol 69(220); pp.67218-67243 http://www.epa.gov/fedregstr
Rules and Regulations. (EPA Promulgation of Standards for States Not Meeting Deadline)

EC-18  **Minnesota Lake Superior Beach Program**
Author: Minnesota Pollution Control Agency (MPCA)
Website MPCA

EC-19  **Draft Matrix of Protocols and Criteria Used in Beach Closing Decisions [DRAFT]**
Prepared by the Metro Area Beach Monitoring Group, Minnesota Pollution Control Agency (MPCA)
MPCA Document MPCA
September 2005 St. Paul
Headings: Sampling and Analysis Methods; ods; Thresholds; Actions; Other Items

EC-20  **Subject: Comments on the May 2002 Draft "Implementation Guidance for Ambient Water Quality Criteria for Bacteria"**
From Marvin E. Hora, Manager, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Letter MPCA
August 2002 St. Paul
To Mr. William Morrow, Assistant Branch Chief, Water Quality Standards Branch, U.S. Environmental Protection Agency (EPA)
EU-5  **Limnology. Ontogeny and Evolution of Lake Ecosystems**  
Author: Robert G. Wetzel, Professor of Botany, Kellogg Biological Station, Michigan State University  
*Book Section*  
W. B. Saunders Company  
Philadelphia  
1975  
p.640 of 743

EU-6  **Detailed Assessment of Phosphorus Sources to MN Watershed: Under TMDL Master Contract [Executive Summary]**  
Prepared by Barr Engineering  
*Report*  
MPCA  
St. Paul  
February 2004  
pp.1, 2, ii-xxiv  
http://www.pca.state.mn.us

EU-7  **Rules and Standards Development for Nonpoint Source Controls**  
Author: Minnesota Pollution Control Agency (MPCA)  
*MPCA Publication*  
MPCA  
St. Paul  
January 7, 1986  
http://www.pca.state.mn.us

EU-8  **Subject: Lake Eutrophication Standards Development**  
From Steven A. Heiskary, Environmental Analysis & Outcomes Division, Water Assessment & Environmental Information, Minnesota Pollution Control Agency (MPCA)  
*Memo*  
MPCA  
January 26, 1995  
To Duane L. Anderson, Manager, Monitoring & Assessment Section, Water Quality Division, MPCA

EU-9  **Phosphorus Strategy Task Force**  
Author: Water Quality Division, Minnesota Pollution Control Agency (MPCA)  
*Report*  
MPCA  
St. Paul  
June 1996  
http://www.pca.state.mn.us

EU-10  **National Strategy for the Development of Regional Nutrient Criteria**  
Author: Office of Water, Environmental Protection Agency (EPA)  
*EPA Report*  
EPA  
Washington, D.C.  
June 1998  
EPA 822-R-98-002  
http://www.epa.gov

EU-11  **Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria. Lakes and Reservoirs in Nutrient Ecoregion VI**  
Author: Office of Water, Office of Science & Technology, Health & Ecological Criteria Division, Environmental Protection Agency (EPA)  
*EPA Report*  
EPA  
Washington, D.C.  
December 2000  
EPA 822-B-00-008; pp.i-x, 1-27,  
http://www.epa.gov/OST/standards/nutrien
Appendix A, B, C, ii-iii, 1-20, A-1 - t.html  
7, B-1 - 3, & C-1

*Northern Glaciated Plains and Western Corn-belt Plains Ecoregions*

EU-12  **Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria. Lakes and Reservoirs in Nutrient Ecoregion VII**  
Author: Office of Water, Office of Science & Technology, Health & Ecological Criteria Division, Environmental Protection Agency (EPA)  
*EPA Report*  
EPA  
Washington, D.C.  
December 2000  
EPA-822-B-00-009; pp.i-xii, 1-28,  
http://www.epa.gov/OST/standards/nutrien
Appendix A, B, C, ii-iii, 1-20, A-1 - t.html  
7, B-1 - 3, & C-1

*Northcentral Hardwood Forests Ecoregion*

EU-13  **Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria. Lakes and Reservoirs in Nutrient Ecoregion VIII**  
Author: Office of Water, Office of Science & Technology, Health & Ecological Criteria Division, Environmental Protection Agency (EPA)  
*EPA Report*  
EPA  
Washington, D.C.  
December 2000  
EPA-822-B-00-010; pp.i-x, 1-26,  
http://www.epa.gov/OST/standards/nutrien
Appendix A, B, C, ii-iii, 1-20, A-1 - t.html  
7, B-1 - 3, & C-1

*Northern Lakes and Forests Ecoregions*
EU-14  **Ecoregional Nutrient Criteria**
Author: Office of Water, Environmental Protection Agency (EPA)
Fact Sheet  EPA
October 2002  EPA-822-F-02-008  http://www.epa.gov/OST/standards/nutrient.html

EU-15  **Nutrient Criteria Development; Notice of Ecological Nutrient Criteria** (66 FR 1671)
Author: Environmental Protection Agency (EPA)
Public Notice  Federal Register (FR)
January 9, 2001  Vol 66(6); pp.1671-4  http://www.epa.gov/fedregstr/

Author: George Gibson, et al., Office of Water, Office of Science and Technology, Environmental Protection Agency (EPA)
Guidance  EPA  Washington,
April 2000  EPA-822-B00-001  http://www.epa.gov

EU-17  **Subject: Development and Adoption of Nutrient Criteria into Water Quality Standards**
From/Signed by Geoffrey Grubbs, Director, Office of Science & Technology, Environmental Protection Agency (EPA)
Memo  EPA
November 14, 2001  http://www.epa.gov/OST/standards/nutrient.html
To Water Directors, Regions I - X; Directors, State Water Programs; Directors, Great Water Body Programs; Directors, Authorized Tribal Water Quality Standards Programs; State & Interstate Water Pollution Control Administrators

EU-18  **Subject: EPA Policy as it Relates to the Phosphorus Objectives for the Nation's Receiving Waters**
From Francis T. Mayo, Regional Administrator, Environmental Protection Agency (EPA)
Letter  EPA Region V  Chicago
April 20, 1973
To Clarence A. Johannes, Director, Division of Water Quality, MPCA

EU-19a  **Minnesota's Plan for Development of Nutrient Criteria**
Author: Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Plan  MPCA
April 2003
To U. S. Environmental Protection Agency (EPA), Region V, Chicago, IL
(Including: Schematic, Summary, Timeline & Narrative)

EU-19b  **Minnesota's Plan for Development of Nutrient Criteria**
From Environmental Outcomes and Analysis Division, Minnesota Pollution Control Agency (MPCA)
Plan  MPCA  St. Paul
September 2006
To U. S. Environmental Protection Agency (EPA), Region V, Chicago, IL
(Including: Schematic, Summary, Timeline & Narrative)

EU-20  **Subject: Minnesota's Nutrient Criteria Development Plan**
From Michael J. Sandusky, Division Director, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Letter  St. Paul
April 2003
To Mr. David Pfeifer, U.S. Environmental Protection Agency (EPA), Region V
Cover Letter to April 2003 Nutrient Plan (Exhibit EU-19a)

EU-21  From Jo Lynn Traub, Director Water Division, Environmental Protection Agency (EPA), Region V
Letter  EPA Region V  Chicago
May 5, 2003
To Michael Sandusky, Director, Environmental Outcomes Division, MPCA
EPA Approval of 2003 Nutrient Plan (Exhibit EU-19a)
EU-32  **A Chlorophyll a Trophic Status Classification System for South African Impoundments**  
Author: R. D. Walmsley  
*Journal of Environmental Quality*  
1984  
Vol 13(1); pp.97-104  
http://jeq.scijournals.org

EU-33  **Analysis and Application of Lake User Survey Data**  
Author: Eric Smeltzer, Vermont Department of Environmental Conservation and S. A. Heiskary, Environmental Outcomes & Analysis, Minnesota Pollution Control Agency (MPCA)  
*Lake and Reservoir Management (LRM)*  
1990  
Vol 6(1); pp. 109-18  
http://www.nalms.org/journal/lrm.htm

EU-34  **Citizen Lake-Monitoring Program - 2001 Secchi Data Sheet**  
From Minnesota Pollution Control Agency (MPCA)  
*Form*  
November 17, 2001  
http://www.pca.state.mn.us  
Includes choices for perceptions of physical condition and suitability for recreation.

EU-35  **Reconstructing Historical Water Quality in Minnesota Lakes from Fossil Diatoms**  
Author: Steven A. Heiskary, Edward B. Swain, Minnesota Pollution Control Agency (MPCA), and Mark B. Edlund, Science Museum of Minnesota, St. Croix Watershed Research Station  
*MPCA Publication*  
Environmental Bulletin  
September 2004  
No. 4  
http://www.pca.state.mn.us

EU-36  **Water Quality Reconstruction from Fossil Diatoms: Applications for Trend Assessment, Model Verification, and Development of Nutrient Criteria for Lakes in Minnesota, USA**  
Author: Steven A. Heiskary, Environmental Analysis & Outcomes Division, Water Assessment & Environmental Information and Edward B. Swain, Ph.D., Minnesota Pollution Control Agency (MPCA)  
*Report*  
MPCA  
September 2002  
St. Paul  
http://www.pca.state.mn.us/water/lakequality.html reports

EU-37  **Shallow Lakes of Southeastern Minnesota: Status and Trend Summary for Selected Lakes**  
Author: Steven A. Heiskary, Howard Markus, and Matt Lindon, Environmental Analysis & Outcomes Division, Minnesota Pollution Control Agency (MPCA)  
*Report*  
MPCA  
July 2003  
St. Paul  
Part of a Series on Minnesota Lake Water Quality Assessment  
www.pca.state.mn.us/publications/reports/lakes-shallowlake-swmn.pdf

EU-38  **Interrelationships Among Water Quality, Lake Morphometry, Rooted Plants and Related Factors for Selected Shallow Lakes of West-Central Minnesota**  
Author: Steven A. Heiskary and Matt Lindon, Environmental Analysis & Outcomes Division, Minnesota Pollution Control Agency (MPCA)  
*Report*  
MPCA  
March 2005  
St. Paul  
Part of a Series on Minnesota Lake Water Quality Assessment  
http://www.pca.state.mn.us

EU-39  **Lakeshore Property Values and Water Quality: Evidence from Property Sales in the Mississippi Headwaters Region**  
Author/Submitted by: Charles Krysel, Elizabeth Marsh Boyer, Charles Parson, Ph.D., and Patrick Welle, Ph.D., Mississippi Headwaters Board & Bemidji State University  
*Report*  
Mississippi Headwaters Board  
June 2003  
Bemidji  
Submitted To the Legislative Commission on Minnesota Resources  
http://www.mississippihheadwaters.org
EU-40  Economic Value of Protecting Minnesota's Lakes
Author: Harold E. Dziuk, Ph.D., Board Member for the Itasca Coalition of Lake Associations (CLA)
Newspaper  Minnesota Lakes Association Reporter
November 2005  Vol 9(4); pp.1, 6-7  http://www.mnlakes.org

EU-41  Importance of Lakes to Minnesota's Economy
Author: Hank Todd, Minnesota Office of Tourism
Report  Minnesota Lake Management Conference
October 1989  http://www.mnlakes.org

EU-42  No Exhibit

EU-43  Economic Values of Lakes
A publication of the North American Lake Management Society (NALMS)
Journal  LakeLine
Fall 2003  Vol 23(3); pp.1-48  http://www.nalms.org/lakeline/lakeline.htm

EU-44  Shallow Lakes
A publication of the North American Lake Management Society (NALMS)
Journal  LakeLine
Spring 2003  Vol 23(1); pp.11-36  http://www.nalms.org/lakeline/lakeline.htm

EU-45  Developing Environmental Indicators for Minnesota. Lakes. The Environmental Indicators Initiative
Author: State of Minnesota, Funded by the Minnesota Legislature on Recommendation of the Legislative Commission on Minnesota Resources (LCMR), Sponsored by The Environmental Quality Board (EQB)
Report  Legislative Commission on Minnesota Resources (LCMR)
1998  http://www.commissions.leg.state.mn.us/lcmr/lcmr.htm

EU-46a  Statement of Need and Reasonableness: In the Matter of Proposed Revisions of Minnesota Rules Chapter 7050, Relating to the Classification and Standards for Waters of the State
Author: Minnesota Pollution Control Agency (MPCA)
MPCA Document  MPCA
April 2002  Assessment Factors Rule Revision  St. Paul

EU-46b  Staff Post-hearing Response to Public Comments
Author: Minnesota Pollution Control Agency (MPCA)
MPCA Document  MPCA
July 8, 2002  Assessment Factor Rule Revision  St. Paul  [Attachments not part of the exhibit]

EU-46c  Staff Final Response to Public Comments
Author: Minnesota Pollution Control Agency (MPCA)
MPCA Document  MPCA
July 15, 2002  Assessment Factor Rule Revision  St. Paul

EU-47  Measuring the Economic Value of Water Quality: The Case of Lakeshore Land
Author Donald N. Steinnes, Department of Economics, University of Minnesota Duluth
Journal  The Annals of Regional Science
1992  Vol 26; pp.171-6
EU-48  **Protecting Aesthetics and the Visual Resource Quality of Lakes**
Author: Eric J. Macbeth, Minnesota-Wisconsin Boundary Area Commission
Journal: Proceedings of a National Conference on Enhancing the States' Lake Management Program
April 1992

EU-49  **Subject: Nutrient Pollution and Numeric Water Quality Standards**
From Benjamin H. Grumbles, Assistant Administrator, Office of Water Environmental Protection Agency (EPA)
Memo  EPA  Washington, D.C.
May 25, 2007
To Director, State Water Programs

H-1  **Subject: Request for Development of Water Quality Standards**
From Dan Stoddard, Manager, Agricultural Chemical Environmental Section, Minnesota Department of Agriculture (MDA)
Letter  St. Paul
February 27, 2002
To Greg Gross, Environmental Outcomes Division, MPCA

H-2a  **Subject: Water Quality Criterion for the Wrogge Spill**
Author: Dann D. White, Monitoring and Assessment, Water Quality Division, Minnesota Pollution Control Agency (MPCA)
Letter  St. Paul
June 10, 1996
To Ms. Michelle Puchalski, Agronomy Services Division, Incident Response Section, Minnesota Department of Agriculture (MDA)

H-2b  **Aquatic Life Criteria (Summary Sheet): Acetochlor**
Author: Minnesota Pollution Control Agency (MPCA)
Summary  MPCA  St. Paul
January 29, 1998
Includes Cover Letter
To Ms. Michele Puchalski, Agronomy Services Division, Incident Response Section, Minnesota Department of Agriculture. From Dann D. White

H-3  **Subject: Interim Water Quality Guideline Value for Metolachlor**
From Dann D. White, Monitoring and Assessment, Water Quality Division, Minnesota Pollution Control Agency (MPCA)
Letter  St. Paul
February 23, 1998
To Ms. Michelle Puchalski, Agronomy Services Division, Incident Response Section, Minnesota Department of Agriculture (MDA)

H-4  **Acetochlor Supplement: Supplementary Information on Acetochlor and Metolachlor**
Author: Angela L. H. Preimesberger and David E. Maschwitz, Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency (MPCA)
MPCA Document  MPCA  St. Paul
November 7, 2005
Developed by the Water Quality Standards Unit, MPCA, in Cooperation with the Minnesota Department of Agriculture, Agronomy and Plant Protection Division

H-5  **Metolachlor Supplement: Supplementary Information on Acetochlor and Metolachlor**
Author: Angela L. H. Preimesberger and David E. Maschwitz, Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency (MPCA)
MPCA Document  MPCA  St. Paul
November 8, 2005
Developed by the Water Quality Standards Unit, MPCA, in Cooperation with the Minnesota Department of Agriculture, Agronomy and Plant Protection Division

H-6  **Subject: Request for Development of Water Quality Standards**
From Dan Stoddard, Manager, Agricultural Chemical Environmental Section, Minnesota Department of Agriculture (MDA)
Letter  St. Paul
April 11, 2003
To Greg Gross, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
**H-7**  
**Subject: Request for Development of Water Quality Standards**  
From Dan Stoddard, Manager, Agricultural Chemical Environmental Section, Minnesota Department of Agriculture (MDA)  
Letter  
June 23, 2004  
To Greg Gross, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)

**H-8**  
**Water Quality Best Management Practices for Agricultural Herbicides**  
Author: Minnesota Department of Agriculture (MDA)  
Guide  
February 2004  
http://www.mda.sate.mn.us

**H-9**  
**Aquatic Life Criteria: Acetochlor [PROPOSED]**  
Author: Minnesota Pollution Control Agency (MPCA)  
Summary  
March 14, 2006  
Summary Sheet (5pgs) & Tables 1-5

**H-10a**  
**Aquatic Life Criteria: Metolachlor (50:50 Formula) [PROPOSED]**  
Author: Minnesota Pollution Control Agency (MPCA)  
Summary  
March 15, 2006  
Summary Sheets (4pgs) & Tables 1-5

**H-10b**  
**Aquatic Life Criteria: Metolachlor (88:12) formula [PROPOSED]**  
Author: Minnesota Pollution Control Agency (MPCA)  
Summary  
February 7, 2006  
Summary Sheets (4pgs) & Tables 1-5

**H-11**  
**Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses**  
Guide  
Duluth  
July 30, 1985  
pp.i-vi, 1-98  
http://www.epa.gov

**H-12a**  
**Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:**  
Acetochlor: Acute Toxicity to Rainbow Trout (Salmo gairdneri). Prepared by ICI Group Environmental Laboratory, Brixham, Devon, UK. Submitted by ICI Americas, Inc.  
Reviewed by Mark A. Mossler, M.S., Associate Scientist, KBN Engineering and Applied Sciences, Inc.  
Evaluation  
EPA  
Reviewed: November 18, 1991  
OPP# (MRID No.) 419633-06; Registrant Report# BL3960/B  
http://www.epa.gov  
Attachment: MPCA Reference Review Form by D. White

**H-12b**  
Acetochlor: Acute Toxicity to Rainbow Trout (Salmo gairdneri). Prepared by ICI Group Environmental Laboratory, Brixham, Devon, UK. Submitted by ICI Americas, Inc.  
Author: J. F. Tapp, S. A. Sankey, J. E. Caunter, P. A. Johnson and D. S. Adams  
Study  
Monsanto  
1991  
Registrant Report# BL3960/B; OPP# (MRID No.) 419633-06  
Attachment: MPCA Reference Review Form by D. White (Exhibit H-12a)

**H-13a**  
**Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:**  
Reviewed by J. Tice, Fish & Wildlife Biologist; HED/EEB  
Evaluation  
EPA  
Reviewed: November 5, 1981  
OPP# 85993 and OPP# ACC246128  
http://www.epa.gov  
Attachment: MPCA Reference Review Form by D. White

Author: J. Griffin and C. M. Thompson
Study  Monsanto  1981  OPP# 85993 and OPP# ACC246128

For Monsanto Company
Attachment: MPCA Reference Review Form by D. White (Exhibit 13a)

H-14a  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation: Acetochlor: Determination of Acute Toxicity to Bluegill Sunfish (Lepomis macrochirus). Brixham Study No. R1072/B. Study performed by Imperial Chemical PLC, Brixham Laboratory, Freshwater Quarry, Brixham, Devon, U.K. Submitted by ICI Americas, Inc.

Reviewed by Rosemary Graham Mora, M.S., Associate Scientist, KBN Engineering and Applied Sciences, Inc.
Attachment: MPCA Reference Review Form by D. White

H-14b  Acetochlor: Determination of Acute Toxicity to Bluegill Sunfish (Lepomis macrochirus). Brixham Study No. R1072/B. Study performed by Imperial Chemical PLC, Brixham Laboratory, Freshwater Quarry, Brixham, Devon, U.K. Submitted by ICI Americas, Inc. EPA

Author: J. F. Tapp, S. A. Sankey, J. E. Caunter, and B. J. Harland
Study  Monsanto  1989  OPP# (MRID No.) 415651-33

Attachment: MPCA Reference Review Form by D. White (Exhibit H-14a)

H-15  Acetochlor Fish Studies - Acetochlor: Determination of Acute Toxicity to Mirror Carp (Cyprinus carpio), Submitted by ICI Brixham Environmental Laboratory

Author: J. F. Tapp, S. A. Sankey, J. E. Caunter, and H. M. Miller
Study  Monsanto  1989  Report# BL/B/3554,

Attachment: MPCA Reference Review Form by D. White

H-16a  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation: Acetochlor: An Investigation of the Toxicity of Technical Material and Formulation WF2061 to First Instar Daphnia magna. Laboratory Report No. RJ 0744B. Study performed by ICI Agrochemicals, Jealott's Hill Research Station, Bracknell, Berkshire, U.K. Submitted by ICI Americas, Inc.

Reviewed by Rosemary Graham Mora, M.S., Associate Scientist, KBN Engineering and Applied Sciences, Inc.
Attachment: MPCA Reference Review Form by D. White

H-16b  Acetochlor: An Investigation of the Toxicity of Technical Material and Formulation WF2061 to First Instar Daphnia magna. Study performed by ICI Agrochemicals, Jealott's Hill Research Station, Bracknell, Berkshire, U.K. Submitted by ICI Americas, Inc.

Author: E. Farrelly, M. J. Hamer
Study  Monsanto  1989  Registrant Report# RJ 0744B,  OPP# (MRID No.) 415651-34

Attachment: MPCA Reference Review Form by D. White (Exhibit H-16a)

H-17  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation: Acute Toxicity to Daphnids (Daphnia magna) Under Static Conditions, Springborn Laboratories, Inc., Wareham, MA. Ciba-Geigy Corporation, Greensboro, NC

Reviewed by Rosemary Graham Mora, M.S., Environmental Scientist, KBN Engineering and Applied Sciences, Inc.
Evaluation  EPA  Reviewed: May 14, 1996  OPP# (MRID No.) 439289-12  http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White
H-18a  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Reviewed by Mark Mossler, M.S., Environmental Toxicologist, Golder Associates Inc.
Evaluation EPA
Reviewed: May 20, 1996 OPP# (MRID No.) 439289-11 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-19a  Data Evaluation Record (Validation Sheet) - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Acute Toxicity of CGA-24705 to Rainbow Trout (Salmo gairdneri) Report# BW-78-6-186
Author: R. Balcomb
Evaluation EPA
Reviewed: July 20, 1978 OPP# (MRID No.) 18722 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-19b  Acute Toxicity of CGA-24705 to Rainbow Trout (Salmo gairdneri)
Prepared by Robert J. Buccafusco, EG & G, Bionomics, Aquatic Toxicology Laboratory
Study Syngenta (Ciba-Geigy Corporation)
June 1978 Report# CGA-24705; OPP# (MRID No.) 18722
Attachment: MPCA Reference Review Form by D. White

H-20  Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals
Author: Foster L. Mayer and Mark R. Ellersieck

H-21a  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
(Acetochlor: Daphnia magna Life-Cycle Study. Prepared by ICI Agrochemicals, Jealott's Hill Research Station, Bracknell, Berkshire, UK. Submitted by ICI Americas, Inc. Wilmington, DE)
Reviewed by Louis M. Rifici, M.S., Associate Scientist, KPN Engineering and Applied Sciences, Inc.
Evaluation EPA
Reviewed: October 4, 1991 OPP# (MRID No.) 415651-38 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-21b  Acetochlor Aquatic Invertebrate Studies - Acetochlor: Daphnia magna Life-Cycle Study
Prepared by ICI Agrochemicals
Study Monsanto
1990 Report# RJ0785B; OPP# (MRID No.) 415651-38
Attachment: MPCA Reference Review Forms by D. White

H-22a  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Acetochlor: Determination of Chronic Toxicity to Fathead Minnow (Pimphales promelas) Embryos and Larvae. Prepared by ICI PLC, Brixham Laboratory, Brixham, Devon, UK. Submitted by ICI Americas, Inc.
Reviewed by Louis M. Rifici, M.S., Associate Scientist, KPN Engineering and Applied Sciences, Inc.
Evaluation EPA
Reviewed: October 4, 1991 OPP# (MRID No.) 415920-11 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White
H-22b Acetochlor: Determination of Chronic Toxicity to Fathead Minnow (Pimephales promelas) Embryos and Larvae. Prepared by ICI PLC, Brixham Laboratory, Brixham, Devon, UK.; Submitted by ICI Americas, Inc.  
Author: J. F. Tapp, J. E. Caunter and R. D. Stanley  
Study  
1989 Report# BL/B/3669; OPP# (MRID No.) 415920-11  
Attachment: MPCA Reference Review Form by D. White (Exhibit H-22a)

H-23 Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation: 
Chronic Toxicity of Acetochlor to Daphnia magna Under Flow-Through Test Conditions. Study conducted by Analytical Biochemistry Laboratories, Inc., Columbia, MO. Submitted by Acetochlor Registration Partnership, c/o Monsanto Agricultural Company, St. Louis, MO 
Reviewed by William S. Rabert, Biologist, Ecological Effects Branch, Environmental Fate and Effects Division (7507C), Environmental Protection Agency (EPA) 
Evaluation  
EPA 
Reviewed: November 2, 1993 OPP# (MRID No.) 427131-05 http://www.epa.gov  
Attachment: MPCA Reference Review Form by D. White

H-24a Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:  
S-Metolachlor (CGA-77102): Early Life-Stage Toxicity Test with Fathead Minnow (Pimephales promelas). Springborn Laboratories, Inc, Wareham, MA. Novartis Crop Protection Inc., Greensboro, NC 
Reviewed by Mark Mossler, M.S., Environmental Toxicologist, Golder Associates Inc. 
Evaluation  
EPA 
Reviewed: May 2, 2000 OPP# (MRID No.) 449959-03 http://www.epa.gov  
Attachment: MPCA Reference Review Form by D. White

H-24b Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:  
s-Metolachlor (CGA-77102): Final Report  
s-Metolachlor (CGA-77102) - Early Life-Stage Toxicity Test with Fathead Minnow (Pimephales promelas)  
Author: J. V. Sousa, Study Director, Springborn Laboratories Inc. 
Study  
Syngenta (Novartis Crop Protection, Inc.)  
Study Completion: November 30, 1999 Registrant Report# CGA-77102; OPP# (MRID No.) 449959-03  
Attachment: MPCA Reference Review Form by D. White

H-25a Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:  
Acetochlor: Determination of Toxicity to the Green Alga Selenastrum capricornutum. Laboratory ID No. R1072/I. Conducted by Imperial Chemical Industries PLC, Brixham, Devon, UK. Submitted by ICI Americas, Inc. 
Reviewed by Mark A. Mossler, M.S., Associate Scientist, KBN Engineering and Applied Sciences, Inc. 
Evaluation  
EPA 
Reviewed: January 17, 1992 OPP# (MRID No.) 415651-41 http://www.epa.gov 
Attachment: MPCA Reference Review Form by D. White

H-25b Acetochlor: Determination of Toxicity to the Green Alga Selenastrum Capricornutum. Laboratory ID No. R1072/I. Conducted by Imperial Chemical Industries PLC, Brixham, Devon, UK. Submitted by ICI Americas, Inc. 
Author: D. V. Smyth, J. F. Tapp, S. A. Sankey and R. D. Stanley  
Study  
Monsanto  
1989 OPP# (MRID No.) 415651-41  
Attachment: MPCA Reference Review Form by D. White

H-26a Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:  
Acetochlor Toxicity to the Duckweed (Lemna gibba). Laboratory ID No. W556/D (FT21/92). Conducted by ZENECA Agrochemicals, Surrey, UK 
Reviewed by William S. Rabert, Biologist, Ecological Effects Branch, Environmental Fate and Effects Division (7507C) 
Evaluation  
EPA 
Reviewed: November 4, 1993 OPP# (MRID No.) 427131-07 http://www.epa.gov 
Attachment: MPCA Reference Review Form by D. White

H-26b Acetochlor Toxicity to the Duckweed (Lemna gibba). Laboratory ID No. W556/D (FT21/92). Conducted by ZENECA Agrochemicals, Surrey, UK 
Author: D. V. Smyth, S. A. Sankey, and A. J. Penwell  
Study  
Monsanto  
1993 OPP# (MRID No.) 427131-07  
Attachment: MPCA Reference Review Form by D. White (Exhibit H-26a)
H-27 Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Acetochlor: Toxicity to the Freshwater Diatom Navicula pelliculosa. Laboratory ID No. W566/C (FT20/92). Conducted by
Imperial Chemical Industries PLC, Devon, UK. Submitted by ICI Agrochemicals, Surrey, UK
Reviewed by Mark A. Mossler, M.S., Associate Scientist, KBN Engineering and Applied Sciences, Inc.
Evaluation EPA
Reviewed: May 24, 1993
Attachment: MPCA Reference Review Form by D. White

OPP# (MRID No.) 427131-08 http://www.epa.gov

H-28 Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Acetochlor: Toxicity to Blue-green Alga Anabaena flos-aqua. Laboratory ID No. W566/A (FT18/92). Conducted by Imperial
Chemical Industries PLC, Devon, UK. Submitted by ICI Agrochemicals, Surrey, UK
Reviewed by Mark A. Mossler, M.S., Associate Scientist, KBN Engineering and Applied Sciences, Inc.
Evaluation EPA
Reviewed: June 1, 1993
Attachment: MPCA Reference Review Form by D. White

OPP# (MRID No.) 427131-09 http://www.epa.gov

H-29 Acetochlor Laboratory Aquatic Macrophyte Tests - Determination of the Effect of One Day Exposure to Technical Acetochlor
on Elodea canadensis Acquired from an Outdoor Pond
Author: E. M. Foekema, M. T. Collombon, G. Hoornsman
Study Monsanto
Attachment: MPCA Reference Review Form by D. White

H-30 Acetochlor Laboratory Aquatic Macrophyte Tests - Determination of the Effect of a Single Application of Technical Acetochlor
in a Static Test on Elodea canadensis Acquired from an Outdoor Pond
Author: E. M. Foekema, M. T. Collombon, G. Hoornsman
Study Monsanto
2004 Registrant Report# TN-2004-009
Attachment: MPCA Reference Review Form by D. White

H-31 Acetochlor Laboratory Aquatic Macrophyte Tests - Determination of the Effect of a Single Application of Technical Acetochlor
in a Static Test on Elodea canadensis Acquired from a Commercial Supplier
Author: E. M. Foekema, M. T. Collombon, G. Hoornsman
Study Monsanto
2004 Registrant Report# TN-2004-010
Attachment: MPCA Reference Review Form by D. White

H-32 Acetochlor Outdoor Microcosm/Mesocosm Studies - The Determination of the Biological Effects of a Single Pulse of Technical
Acetochlor in Outdoor Ponds
Author: E. M. Foekema
Study Monsanto
Attachment: MPCA Reference Review Form by D. White

H-33 Acetochlor Algae Studies - Acetochlor Technical-Toxicity Test and Recovery Period with Freshwater Green Alga,
Psudokchneriella subcapitata
Author: J. R. Hoberg
Study Monsanto
Attachment: MPCA Reference Review Form by D. White

H-34 Acetochlor Algae Studies - Acetochlor Technical-Toxicity Test and Recovery Period with Marine diatom, Skeletonema costatum
Author: J. R. Hoberg
Study Monsanto
2003 Registrant Report# SE-2003-098
Attachment: MPCA Reference Review Form by D. White
H-35 Acetochlor Outdoor Microcosm/Mesocosm Studies - An Assessment of Toxicity of Technical Acetochlor to the Aquatic
Macrophytes Glyceria maxima, Myriophyllum spicatum, and Lagarosiphon major.
Study Monsanto (Dow Agrosciences)
2003 Registrant Report# DAS 011246
Attachment: MPCA Reference Review Form by D. White

H-36 Acetochlor Laboratory Aquatic Macrophyte Tests - Acetochlor Technical-Toxicity Test and Period with Duckweed, Lemna gibba
Author: A. E. Putt
Study Monsanto
2003 Registrant Report# SE-2003-095
Attachment: MPCA Reference Review Form by D. White

H-37 Factors Determining the Bioaccumulation Potential of Pesticides in the Individual Compartments of Aquatic Food Chains
Author: H. Ellgehausen, J. A. Guth, and H. O. Esser, Agricultural Division, CIBA-GEIGY Ltd., Basel, Switzerland
Journal Ecotoxicology and Environmental Safety
1980 Vol 4 (2); pp.134-157; ECOTOX# 6458
http://www.elsevier.com/wps/find/journaldescription.cws_home/622819/description#description#
Attachment: MPCA Reference Review Form by D. White

H-38 Short-Term Effects of Herbicides on Primary Productivity of Periphyton in Lotic Environments
Author: K. E. Day
Journal Ecotoxicology
1993 Vol 2 (2); pp.123138; ECOTOX# 13325
http://www.springerlink.com/content/1573-3017
Attachment: MPCA Reference Review Form by D. White

H-39 Metolachlor and 2,4-Dichlorophenoxyacetic Acid Sensitivity of Salvinia natans
Author: A. M. Goncz, and L. Sencic
Journal Bulletin of Environmental Contamination and Toxicology
1994 Vol 53 (6); pp.852-5; ECOTOX# 13738
Attachment: MPCA Reference Review Form by D. White

H-40 Aquatic Phyto-Toxicity of 23 Pesticides Applied at Expected Environmental Concentrations
Author: H. G. Peterson, C. Boutin, P. A. Martin, K. E. Freemark, N. J. Ruecker, and M. J. Moody
Journal Aquatic Toxicology
1994 Vol 28 (3/4); pp.275-92; ECOTOX# 13800
http://www.elsevier.com/wps/find/journaldescription.cws_home/505509/description#description#
Attachment: MPCA Reference Review Form by D. White

H-41 Comparative Sensitivity of Selenastrum capricornutum and Lemna minor to Sixteen Herbicides
Author: J. F. Fairchild, D. S. Ruessler, P. S. Haverland, and A. R. Carlson
Journal Archives of Environmental Contamination and Toxicology
1997 Vol 32; pp.353-57; ECOTOX# 18093
Attachment: MPCA Reference Review Form by D. White

H-42 Comparative Sensitivity of Five Species of Macrophytes and Six Species of Algae to Atrazine, Metribuzin, Alachlor, and
Metolachlor
Author: J. F. Fairchild, D. S. Ruessler, and A. R. Carlson
Journal Environmental Toxicology and Chemistry
1998 Vol 17 (9); pp.1830-4; ECOTOX# 19461
http://etc.allenpress.com/entconline/?request=index-html
Attachment: MPCA Reference Review Form by D. White
H-43  **Comparative Assessment of Herbicide Phytotoxicity to Selenastrum capricornutum Using Microplate and Flask Bioassay Procedures**

Author: D. St. Laurant, and C. Blaise

*Journal* Environmental Toxicology and Water Quality: An International Journal

1992  Vol 7: pp.35-48 (OECDG Data File); ECOTOX# 56387  [http://www3.interscience.wiley.com/cgi-bin/jhome/10008541](http://www3.interscience.wiley.com/cgi-bin/jhome/10008541)

*Attachment:*  MPCA Reference Review Form by D. White

H-44  **An Aquatic Risk Assessment of Four Herbicides Using Six Species of Algae and Five Species of Aquatic Macrophytes**

Author: J. F. Fairchild, S. D. Ruessler, M. K. Nelson, and A. R. Carlson

*Journal* Society of Environmental Toxicology and Chemistry (SETAC)

1994  Conference Proceeding; ECOTOX# 61707  [http://www.setac.org](http://www.setac.org)

*Presented at the 1994 SETAC Meeting, Oct. 30-Nov. 3, 1994, Denver, CO*

*Attachment:*  MPCA Reference Review Form by D. White

H-45  **The Toxicity of the Herbicide Metolachlor, Some Transformation Products and a Commercial Safener to an Alga (Selenastrum capricornutum), a Cyanophyte (Anabaena cylindrica) and a Macrophyte (Lemna gibba)**

Author: K. E. Day, and V. Hodge

*Journal* Water Quality Research Journal -Canada


*Attachment:*  MPCA Reference Review Form by D. White

H-46  **Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:**

Metolachlor-technical-5 Day Toxicity to Freshwater Green Alga, Anabaena flos-aqua. Springborn Laboratories, Inc., Wareham, MA. Ciba Crop Protection, Greensboro, NC

Reviewed by William Erickson, Biologist, EEB/EFED

*Evaluation*  EPA

Reviewed: January 26, 1995  OPP# (MRID No.) 434871-04  [http://www.epa.gov](http://www.epa.gov)

*Attachment:*  MPCA Reference Review Form by D. White

H-47a  **Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:**

Metolachlor technical -Toxicity to Duckweed (Lemna gibba). Springborn Laboratories, Inc., Wareham, MA. Ciba Crop Protection, Greensboro, NC

Reviewed by William Erickson, Biologist, EEB/EFED

*Evaluation*  EPA

Reviewed: January 26, 1995  OPP# (MRID No.) 434871-05  [http://www.epa.gov](http://www.epa.gov)

*Attachment:*  MPCA Reference Review Form by D. White

H-47b  **Metolachlor technical - Toxicity to Duckweed (Lemna gibba)**

Author: James R. Hoberg

*Study*  Syngenta (Ciba-Geigy Corporation)

January 9, 1995  SLI Registrant Report# 94-8-5404; OPP# (MRID No.) 43487105

*Attachment:*  MPCA Reference Review Form by D. White

H-48  **Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:**

Metolachlor technical-Toxicity to the Marine diatom, Skeletonema costatum. Springborn Laboratories, Inc., Wareham, MA. Ciba Crop Protection, Greensboro, NC

Reviewed by William Erickson, Biologist, EEB/EFED

*Evaluation*  EPA

Reviewed: January 26, 1995  OPP# (MRID No.) 434871-06  [http://www.epa.gov](http://www.epa.gov)

*Attachment:*  MPCA Reference Review Form by D. White

H-49  **Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:**

Metolachlor technical-5-Day Toxicity to the Freshwater Green Alga, Selenastrum capricornutum, Using Acetone as a Carrier Solvent. Springborn Laboratories, Inc., Wareham, MA. Ciba Crop Protection, Greensboro, NC

Reviewed by William Erickson, Biologist, EEB/EFED

*Evaluation*  EPA

Reviewed: March 1, 1995  OPP# (MRID No.) 435413-01  [http://www.epa.gov](http://www.epa.gov)

*Attachment:*  MPCA Reference Review Form by D. White
H-50  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Metolachlor technical-5-Day Toxicity to the Freshwater diatom, Navicula pelliculosa, Using Acetone as a Carrier Solvent. Springborn Laboratories, Inc., Wareham, MA. Ciba Crop Protection, Greensboro, NC
Reviewed by William Erickson, Biologist, EEB/EFED
Evaluation EPA
Reviewed: March 1, 1995 OPP# (MRID No.) 435413-01 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-51  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Acute Toxicity of CGA-51202 to the Duckweed, Lemna gibba G3
Reviewed by Karl Bullock, M.S. Environmental Scientist, Golder Associates, Inc.
Evaluation EPA Marblehead
Reviewed:November 10, 1999 OPP# (MRID No.) 449295-14 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-52  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Report on the Growth Inhibition Test of CGA-51202 to Green Algae (Scenedesmus subspicatus). Ciba-Geigy Ltd, Crop Protection Division, Basle, Switzerland. Novartis Crop Protection, Inc., Greensboro, NC
Reviewed by Karl Bullock, M.S. Environmental Scientist, Golder Associates, Inc.
Evaluation EPA
Reviewed: November 10, 1999 OPP# (MRID No.) 449295-15 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-53  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
Reviewed by Mark Mossler, M.S., Environmental Toxicologist, Golder Associates Inc.
Evaluation EPA
Reviewed: April 13, 2000 OPP# (MRID No.) 449317-20 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-54  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
CGA 77102: 5-Day Toxicity to the Marine Diatom Skeletonema costatum. Springborn Laboratories, Inc, Wareham, MA
Reviewed by Max Feken, M.S., Environmental Toxicologist, KBN Engineering and Applied Sciences, Inc.
Evaluation EPA
Reviewed: May 16, 1996 OPP# (MRID No.) 439289-30 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-55a Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation:
CGA 77102: 5-Day Toxicity to the Fresh Water Green Alga Selenastrum capricornutum. Springborn Laboratories, Inc, Wareham, MA
Reviewed by Max Feken, M.S., Environmental Toxicologist, KBN Engineering and Applied Sciences, Inc.
Evaluation EPA
Reviewed: May 16, 1996 OPP# (MRID No.) 439289-29 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

H-55b Final Report:
CGA 77102: 5-Day Toxicity to the Fresh Water Green Alga Selenastrum capricornutum. Springborn Laboratories, Inc, Wareham, MA
Author: James R. Hoberg
Study: Syngenta (Cib-Geigy Corporation)
September 20, 1995 Registrant Report# 95-8-6031; OPP# (MRID No.) 439289-29
Submitted To: Ciba-Geigy Corporation, Crop Protection Division (Greensboro, NC)
Attachment: MPCA Reference Review Form by D. White
H-56a  Data Evaluation Record - EPA, Office of Pesticide Programs (OPP) Database - Citation: CGA 77102: Toxicity to Duckweed Lemna gibba. Springborn Laboratories, Inc., Wareham, MA. Ciba-Geigy Corporation, Greensboro, NC
Reviewed by Max Feken, M.S., Environmental Toxicologist, KBN Engineering and Applied Sciences, Inc.
Evaluation EPA
Reviewed: May 16, 1996 OPP# (MRID No.) 439289-31 http://www.epa.gov
Attachment: MPCA Reference Review Form by D. White

Author: James R. Hoberg
Study Syngenta (Ciba-Geigy Corporation)
Study Completion: September 28, 1995 Registrant Report# 95-8-6068; OPP# (MRID No.) 439289-31
Attachment: MPCA Reference Review Form by D. White

H-57  Acetochlor Plant Toxicity Data from Table 4a, Proposed Water Quality Standard
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
MPCA Document MPCA
January 19, 2006 Spreadsheets: Species Chronic Value (SCV), and Ranked Toxicity Values (January 20, 2006)

H-58  Metolachlor Plant Toxicity Data from Table 4a, Proposed Water Quality Standard
Author: David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Agency (MPCA)
MPCA Document MPCA
January 19, 2006 Spreadsheets: Species Chronic Value (SCV), and Ranked Toxicity Values (January 20, 2006)

H-59  Ambient Aquatic Life Water Quality Criteria for Atrazine [REVISED DRAFT]
Author: Office of Water, Environmental Protection Agency (EPA)
EPA Report EPA Washington, D.C.
October 2003 EPA-822-R-03-23 http://www.epa.gov

H-60  New York State-Aquatic Fact Sheet: Ambient Water Quality Value for Protection of Aquatic Life [DRAFT]
From New York State
Fact Sheet
August 10, 2005

H-61  Health Risk Limits for Groundwater Chemical: Acetochlor, CAS# 34256-82-1 [DRAFT]
Author: Minnesota Department of Health (MDH)
Summary MDH St. Paul
December 28, 2006 http://www.health.state.mn.us
Part of Groundwater HRL Rule, Minnesota Rule ch. [Draft]

H-62  Subject: Health Based Values for Acetochlor ESA & Acetochlor OXA
From Helen Goeden, Health Risk Assessment Unit, Environmental Health Division, Minnesota Department of Health (MDH)
Memo St. Paul
February 13, 2006 To Dan Stoddard, Joseph Zachmann, Minnesota Department of Agriculture (MDA)
Includes Attachment: Data for Derivation of Ground Water Health Based Value (HBV)

H-63  Acetochlor Fish Studies - Acetochlor: An Investigation of Accumulation and Elimination in Bluegill Sunfish in a Flow-Through System (ICI Americas Report# RJ0846B) and Calculation of Bioconcentration Factors in Bluegill Sunfish (Addendum to RJ0846B)
Study Monsanto
Attachment: MPCA Reference Review Form by D. White (BCF Studies)
H-64  **Health Risk Limits for Groundwater Chemical: Metolachlor, CAS# 51218-45-2 (and s-Metolachlor) [DRAFT]**  
Author: Minnesota Department of Health (MDH) 
**Summary** MDH  
July 26, 2004  
http://www.health.state.mn.us  
St. Paul

H-65  **Subject: Health Based Value for Metolachlor OA and Metolachlor ESA**  
From Anne Kukowski, Health Risk Assessment Unit, Minnesota Department of Health (MDH)  
**Memo**  
July 7, 2004  
To Joseph Zachmann, Dan Stoddard, Minnesota Department of Agriculture (MDA)

H-66  **Metabolism of [14C] Metolachlor in Bluegill Sunfish**  
Author: Sean M. Cruz, Margaret N. Scott, and Andrew K. Merrit, Metabolism Department, Agricultural Division, Ciba-Geigy Corporation  
**Journal** Journal of Agricultural Food Chemistry  
1993  
Vol 41; pp.662-8  
http://www.health.state.mn.us  
Attachment: MPCA Reference Review Form by D. White

H-67  **CORN - Minnesota Agriculture in the Classroom Program**  
Author: Minnesota Department of Agriculture (MDA)  
**Fact Sheet** MDA  
2004  
http://www.mda.state.mn.us/maitc

H-68a  **S-Metolachlor; Pesticide Tolerance**  
Author: Environmental Protection Agency (EPA)- From the Federal Register Online via GPO Access  
**Public Notice** Federal Register (FR)  
August 30, 2006  
Vol 71(168); pp.51505-10  
http://www.epa.gov/fedrgstr/

H-68b  **Subject: Transmittal Memo for the Ecological Risk Assessment for the Use of S-Metolachlor on Pumpkins and Winter Squash (IR-4, DP 324973) and on Pumpkins in New York State (S18, DP 327861)**  
From Paige Doelling Brown, Ph.D., Fisheries Biologist, James Hetrick, Ph.D., Senior Chemist, and Nancy Andrews, Ph.D. Branch Chief Environmental Risk Branch 1, Environmental Fate and Effects Division  
**Memo** EPA  
May 31, 2006  
To Joanne Miller, Product Manager, Herbicide Branch, Barbara Madden, Risk Integration, Minor Use, Emergency Response Branch, and Daniel Rosenblatt, Team Leader, Emergency Response Team, Registration Division

H-68c  **Ecological Risk Assessment for Use of S-Metolachlor (PC 108800) on Pumpkins and Winter Squash (DP324973, DP327861)**  
Author Environmental Fate and Effects, Environmental Protection Agency (EPA)  
**EPA Document** EPA  
May 2006  
http://www.epa.gov

H-68d  **Subject: S-metolachlor Human Health Risk Assessment for Proposed Section 18 Uses on Cilantro, Collards, Kale, and Mustard Greens; Section 3 Use on Pumpkins; and Tolerance on Winter Squash without a US Registration. PC Code: 108800 S-metolachlor & 108801 Metolachlor, ID#: 06OH5 & PP#E7015, DP Numbers: 329117 & 326011. [Executive Summary]**  
From W. Cutchin, Chemist, ARIA Team, Technical Review Branch, Registration Division  
**Memo** EPA  
July 13, 2006  
pp.1-11  
To Barbara Madden and A. Ertman PM-5, Risk Integration Minor Use and Emergency Response Branch, Registration Division; Through Christina Swartz, Chief Registration Action Branch, Health Effects Division
Toxicity to *Daphni magna*, *Hyalella azteca*, *Oncorhynchus kisutch*, *Oncorhynchus mykiss*, *Oncorhynchus tshawytscha*, and *Rana catesbeiana* of Atrazine, Metolachlor, Simazine, and Their Formulated Products

Author: M. T. Wan, C. Buday, G. Schroeder, J. Kuo, and J. Pasternak

*Journal* Environmental Contamination and Toxicology

2006 Vol 76; pp.52-58


HH-1 **Current Drinking Water Standards: List of Drinking Water Contaminants and MCLs**

Author: Ground Water and Drinking Water, Environmental Protection Agency (EPA)

*Website* EPA Washington, D.C.

July 2002, Accessed: July 14, 2005  
EPA 816-F-02-013 http://www.epa.gov/safewater/mcl.html

HH-2 **2006 Edition of the Drinking Water Standards and Health Advisories**

Author: Environmental Protection Agency (EPA)

*EPA Report* EPA Washington, D.C.

August 2006  
EPA 822-R-06-013 http://www.epa.gov/waterscience

HH-3 **Guidelines for the Development of Surface Water Quality Standards. For Protection of Aquatic Life, Including Human Health and Wildlife [DRAFT]**

Author: David E. Maschwitz, Environmental Outcomes Division, Environmental Standards and Analysis Section, Minnesota Pollution Control Agency (MPCA)

*Guide* MPCA St. Paul

August 28, 2000  
pp.1-40, and Appendix A - G1. http://www.pca.state.mn.us

1st Version: January 1990

HH-4 **Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health**

Author: Office of Water, Office of Science and Technology, Environmental Protection Agency (EPA)

*Guide* EPA Washington, D.C.

October 2000  
EPA-822-B-00-004; pp.i-xvii, 1-1 through 5-67 http://www.epa.gov

FINAL

HH-5 **Health Risk Limits for Groundwater Chemical Summary: Benzene, CAS# 71-43-2 [DRAFT]**

Author: Minnesota Department of Health (MDH)

*Summary* MDH St. Paul

November 24, 2004  
http://www.health.state.mn.us

Part of Groundwater HRL Rule, Minnesota Rule ch. [Draft]

HH-6 **Health Risk Limits for Groundwater Chemical Summary: Naphthalene, CAS# 91-20-3 [DRAFT]**

Author: Minnesota Department of Health (MDH)

*Summary* MDH St. Paul

February 17, 2004  
http://www.health.state.mn.us

Part of Groundwater HRL Rule, Minnesota Rule ch. [Draft]

HH-7 **Aquatic Life Criteria: Benzene, CAS# 71432**

Author: Minnesota Pollution Control Agency (MPCA)

*Summary* MPCA St. Paul

January 1990, Revised February 1993  
Summary Sheets (3pgs) and Tables 1-5a

HH-8 **Aquatic Life Criteria: Benzene, CAS# 71-43-2 [PROPOSED]**

Author: Minnesota Pollution Control Agency (MPCA)

*Summary* MPCA St. Paul

February 1993, Revised January 2006  
Summary Sheets (3pgs) and Tables 1-5a
HH-9  **Aquatic Life Criteria: Naphthalene, CAS# 91203**
Author: Minnesota Pollution Control Agency (MPCA)
Summary  MPCA  St. Paul
April 1991
*Summary Sheets (4pgs) and Tables 1-5b*

HH-10  **Aquatic Life Criteria: Naphthalene, CAS# 91-20-3 [PROPOSED]**
Author: Minnesota Pollution Control Agency (MPCA)
Summary  MPCA  St. Paul
April 1991, Revised January 2006
*Summary Sheets*

HH-11  **Fact Sheet for the National Pollutant Discharge Elimination System (NPDES)/State Disposal System (SDS) Permit Program**
**General Permit No. MN G790000 [DRAFT]**
Author: Minnesota Pollution Control Agency (MPCA)
Fact Sheet  MPCA  St. Paul
April 20, 2006  http://www.pca.state.mn.us
*with Attachments (pp.1-21)*

M-1  **Water Quality Criterion for the Protection of Human Health: Methylmercury**
Author: Office of Science and Technology, Office of Water, Environmental Protection Agency (EPA)
Report  EPA  Washington, D.C.
through 7-2, R-1-29, A, A1-33;

M-2  **Minnesota's Total Maximum Daily Load Study of Mercury [DRAFT]**
*Draft Report Until Approved by U.S. EPA*
Prepared by Minnesota Pollution Control Agency (MPCA)
Study  MPCA  St. Paul
June 1, 2006  Study# wq-iw4-01b; pp.i-xiii, 1-57; www.pca.state.mn.us
#4-06  http://www.pca.state.mn.us
Apd.A and B

M-3  **Sources of Mercury Pollution and the Methylmercury Contamination of Fish in Minnesota**
Author: Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency (MPCA)
Fact Sheet  MPCA  St. Paul
August 2005  http://www.pca.state.mn.us
Pollution Prevention & Sustainability Fact Sheet

M-4  **Eat Fish Often?**
Author: Minnesota Department of Health (MDH)
Pamphlet  MDH  St. Paul
May 2004  IC# 141-0378  http://www.health.state.mn.us
*A Minnesota Guide to Eating Fish*

M-5  **Water Quality Criteria: Notice of Availability of Water Quality Protection of Human Health: Methylmercury**
Author: Environmental Protection Agency (EPA) -From the Federal Register Online via GPO Access
Public Notice  Federal Register (FR)
January 8, 2001  Vol 66(5); pp.1344-59;  http://www.epa.gov/fedregstr/
[DOCID:fr08ja01-55]

M-6  **Subject: Bioaccumulation Factors (BAF) for Mercury in Northern Pike and Walleye: Rivers**
Author: Dennis Wasley (update by Bruce Monson), Minnesota Pollution Control Agency (MPCA)
Memo  MPCA  St. Paul
September 30, 2005 (Updated: August 5, 2003)
To David E. Maschwitz, Environmental Outcomes Division, MPCA
Includes Tables
From Bruce Monson, Minnesota Pollution Control Agency, (MPCA)

Memo MPCA

July 30, 2003
To David E. Maschwitz, Environmental Outcomes Division, Dennis Wasley, Gary Kimball, MPCA

Notice of Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion

Author: Environmental Protection Agency

Notice of Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion

Author: Environmental Protection Agency

Phosphorus Strategy: NPDES Permits (000306) - Strategy for Addressing Phosphorus in National Pollutant Discharge Elimination System (NPDES) Permitting

Author: Minnesota Pollution Control Agency (MPCA)

Fact Sheet MPCA

March 2000 (000306) http://www.pca.state.mn.us

Referenced in fact sheet (Exhibit PL-1b)


Prepared by Pamela J. Davis, Coordinator, St. Croix Basin Water Resources Planning Team

Report St. Croix Basin Water Resources Planning Team

August 2004 Report# wq-b6-01 http://www.pca.state.mn.us

Wisconsin Department of Natural Resources and Minnesota Pollution Control Agency: Agreement on Nutrient and Sediment Reduction in the St. Croix River Basin

Signed: Sheryl Corrigan, Commissioner Minnesota Pollution Control Agency and Scott Hassett, Secretary Wisconsin Department of Natural Resources

Agreement

Signed: April 6, 2006

Subject: Cost Estimates for Phosphorus Removal

From Randy Thorson, Municipal Division, Minnesota Pollution Control Agency (MPCA)

Memo

August 17, 2005
To David E. Maschwitz, Environmental Analysis and Outcomes Division, MPCA

Wastewater Phosphorus Control and Reduction Initiative

Author: Hydroqual, Inc. in Association with H. David Stensel, Ph.D., P.E., University of Washington

Study Minnesota Environmental Science and Economic Review Board (MESERB) Seattle

Study Completion Date: April 2005 Project #MESE0001; ppES1-14

Bio-P Study (Executive Summary)

Joint LMC/MPCA Survey of Bio-P Costs

Survey
PL-6 Economic Evaluation of Aesthetic Amenities: A Case Study of River View
S. N. Kulshreshtha and J. A. Gillies, University of Saskatchewan
Journal Water Resources Bulletin
April 1993 Vol 29(2); pp.257-66

PL-7 Establishing Relationships Among Nutrient Concentrations, Phytoplankton Abundance, and Biochemical Oxygen Demand in Minnesota, USA, Rivers
Author: Steven A. Heiskary, Environmental Analysis & Outcomes Division, Water Assessment & Environmental Information, and Howard Markus, Monitoring & Assessment, Minnesota Pollution Control Authority (MPCA)
Journal Lake and Reservoir Management (LRM) St. Paul
2001 Vol 17(4); pp.251-62 http://www.nalms.org/journal/lrm.htm

PL-8 Establishing Relationships Among In-Stream Nutrient Concentrations, Phytoplankton and Periphyton Abundance and Composition, Fish and Macroinvertebrate Indices, and Biochemical Oxygen Demand in Minnesota USA Rivers - Final Report
Author: Steven A. Heiskary, Environmental Analysis & Outcomes Division, Water Assessment & Environmental Information, and Howard Markus, Monitoring & Assessment, Minnesota Pollution Control Authority (MPCA)
Report MPCA St. Paul
July 2003 pp.i-iv, 1-100
To USEPA Region V

PL-9 Subject: Proposed Extension of 1mg/L Phosphorus Effluent Limit to New or Expanding Discharges
From David E. Maschwitz, Environmental Outcomes Division, Minnesota Pollution Control Authority (MPCA)
Memo St. Paul
March 18, 2004
To Michael Sandusky, Director, Environmental Outcomes Division, MPCA
(without attachments)

PL-10 Municipalities Given 1 mg/L Total Phosphorus Effluent Limits Since Phosphorus Strategy Was Approved, March 2000
Author: Minnesota Pollution Control Authority (MPCA)
MPCA Document September 2005

PL-11 Industries Given 1 mg/L Total Phosphorus Effluent Limits Since Phosphorus Strategy Was Approved, March 2000 [Working DRAFT]
Author: David E. Maschwitz, Environmental Outcomes Division, MPCA
MPCA Document St. Paul
September 2005

PL-12 Evaluation of Membrane Bioreactor Process Capabilities to Meet Stringent Effluent Nutrient Discharge Requirements
Author: Edwin J. Fleischer, Thomas A. Broderick, Glen T. Daigger, Anabela D. Fonseca, R. David Holbrook, Sudhir N. Murthy
Journal Water Environment Research (WER) St. Paul

PL-13 Chapter NR 217-Effluent Standards and Limitations
Wisconsin Department of Natural Resources
Rule St. Paul

PL-14 Implementation Guidance for Chapter NR 217: Phosphorus Effluent Standards and Limitations [Final Document]
Author: Wisconsin Department of Natural Resources and Bureau of Watershed Management
Guidance WI DNR St. Paul
June 1999 http://www.dnr.state.wi.us/

PL-15 Notice of Adopted Amendment
Illinois Pollution Control Board
Public Notice Illinois Register
February 17, 2006 Vol 30(7); pp.2365-72
UC-1  **Subject: Stream Reclassification Request of Renville County Ditch No. 45, (Branch Lateral 3)**
From Craig R. Olson (Yaggy Colby Associates) on behalf of Midwest Investors of Renville, Inc., dba Golden Oval Eggs Cooperative
Letter
June 13, 2003
To Marvin E. Hora, Manager, Environmental Outcomes Division, MPCA

UC-2  **Stream Assessment Worksheet Use Attainability Analysis, County Ditch No. 45 (Branch Lateral 3)**
Golden Oval Eggs Cooperative
Form
November 8, 2004
Renville

UC-3  **Stream Assessment Worksheet Use Attainability Analysis, County Ditch No. 45 (Branch Lateral 3)**
Southern Minnesota Beet Sugar Cooperative
Form
November 8, 2004
Renville

UC-4  **Subject: Requesting Discharge Variance and Reclassification of Judicial Ditch No. 29, Evan, Minnesota**
From Sylvia Schwarz, Arden Environmental Engineering, Inc. on behalf of the City of Evan, Minnesota
Letter
August 14, 2001
To Marvin E. Hora, Manager, Environmental Outcomes Division, MPCA
Evan

UC-5  **Stream Assessment Worksheet Use Attainability Analysis, Lateral Judicial Ditch No. 29 and Judicial Ditch No. 29**
City of Evan, Minnesota
Form
October 24, 2002
Evan

UC-6  **MPCA Board Item and Attachments Re: Evan NPDES/SDS Permit Issuance and Variance Request, Brown County – Request for Variance from the Dissolved Oxygen, Un-ionized Ammonia Nitrogen and Fecal Coliform Bacteria Water Quality Standards for Judicial Ditch No. 29**
Author: Minnesota Pollution Control Agency (MPCA)
MPCA Document
MPCA
April 22, 2003
Evan
http://www.pca.state.mn.us

UC-7  **Subject: Requesting Reclassification of Judicial Ditch No. 4**
From Scott A. Johnson, Terracon on behalf of Lac Qui Parle Oil Cooperative
Letter
April 28, 2003
To Marvin E. Hora, Manager, Environmental Outcomes Division, MPCA
Dawson

UC-8  **Stream Assessment Worksheet Use Attainability Analysis, County Ditch No. 4**
Lac Qui Parle Oil Cooperative
Form
November 4, 2004
Dawson

UC-9  **Subject: Dawson Ditch**
From Chris Domeier, Minnesota Department of Natural Resources (MDNR) Fisheries, Ortonville, MN
e-mail
January 26, 2006
To Gerald Blaha, Environmental Outcomes Division, MPCA
Ortonville
Referencing April 1982 sodium hydroxide spill to Jud. Dt. No. 4 at Dawson, MN Spill File No. 10403

UC-10 **Subject: Requesting a Total Chloride Variance Request for Discharge to an Unnamed Ditch to Sater's Creek**
From Rick Serie, Agri-Energy, LLC
Letter
February 27, 2002
To Becky Olson, MPCA
Luverne
UC-11 Stream Assessment Worksheet Use Attainability Analysis, Unnamed Ditch and Sater's Creek
Agri-Energy, LLC
Form
November 4, 2004

UC-12 Subject: Requesting Stream Reclassifications for Unnamed Ditches and Freeborn County Ditch No. 71 and Discharge Variances, Myrtle, Minnesota
From Dan Bigalke (Arden Environmental Engineering, Inc.), on behalf of the City of Myrtle
Letter
December 23, 2003
To Marvin E. Hora, Manager, Environmental Outcomes Division, MPCA

UC-13 Stream Assessment Worksheet Use Attainability Analysis, Unnamed Ditches and County Ditch No. 71
City of Myrtle, MN
Form
November 3, 2004

UC-14 Subject: Requesting Stream Reclassification for Freeborn County Ditch No. 11 and Discharge Variances, Manchester, Minnesota
From Dan Bigalke (Arden Environmental Engineering, Inc.) on behalf of the City of Manchester
Letter
December 23, 2003
To Marvin E. Hora, Manager, Environmental Outcomes Division, MPCA

UC-15 Stream Assessment Worksheet Use Attainability Analysis, County Ditch No. 11
City of Manchester, MN
Form
November 3, 2004

UC-16 Stream Assessment Worksheet Use Attainability Analysis, County Ditch No. 45: Class 7 Reclassification back to a Class 2B Water Use Classification
Form
November 8, 2004

UC-17 Biological Monitoring Report for CD45 and Sacred Heart Creek
Author: Barr Engineering
Report
March 2006

UC-18 2003 Aerial Photograph of the Wright Lake, Hoot Lake Area at Fergus Falls, Minnesota Showing the Locations of Waters Proposed for Class 1C Classification
U. S. Department of Agriculture, Farm Service Agency
Map(s)
2003

UC-19 Overview of Minnesota's NPDES/SDS Construction Stormwater Permit
Author: Minnesota Pollution Control Agency (MPCA)
Fact Sheet MPCA
November 2005

UC-20 Summary Comparison of Chloride Water Quality Standards for EPA Region V States, North Dakota, South Dakota, and Iowa
Author: Minnesota Pollution Control Agency (MPCA)
MPA Document MPCA
Not Given
UC-21  Minnesota Subregional Hydrologic Unit Code Chloride Data Summary retrieved from the EPA STORET National Environmental Data System
   Author: Environmental Protection Agency (EPA)
   Summary EPA
   Accessed: May 2006
   http://www.epa.gov/storet/
   STORET (short for STOrage and RETrieval)

UC-22  Figure 5. – Mean Hardness of Calcium Carbonate at NASQAN (National Stream Quality Accounting Network) Stations During 1975 Water Year from Quality of Rivers in the United States
   J.C. Briggs and J. F. Fricke
   Report U.S Geological Survey
   1977
   Open-file Report 78-200

   Author: Minnesota Pollution Control Agency (MPCA)
   MPCA Document MPCA
   Not Given

UC-24  Minnesota Subregional Hydrologic Unit Code Total Hardness Data Summary retrieved from the EPA STORET National Environmental Data System
   Author: Environmental Protection Agency (EPA)
   Summary EPA
   Accessed: May 2006
   STORET (short for STOrage and RETrieval)

UC-25  Water Quality Criteria, Second Edition
   Editors: Jack E. McKee and Harold W. Wolf
   Report California State Water Resources Board
   Revised 1963
   Publication No. 3 – A

   Author: American Society for Testing and Materials
   Manual ASTM
   1959
   ASTM Special Technical Publication No. 148-D

   Author: U.S. Department of Interior, Federal Water Pollution Control Administration.
   Guidance
   May 1966

UC-28  Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior [Excerpt]
   Author: U.S. Department of the Interior, Federal Water Pollution Control Administration
   Report April 1, 1968
   [a.k.a Green Book]
   pp.185-215

UC-29  Categorization of Surface Waters for Industrial Consumption for WPC-15
   Author: George R. Koonce, Chief - Section of Industrial and Other Wastes, Division of Water Quality, Minnesota Pollution Control Agency
   MPCA Document MPCA
   1973
   Rulemaking exhibit from the 1973 revisions to WPC-15 (PCA Exhibit 41, 5-31-73)
UC-30  Water Quality Criteria 1972 [Excerpt]
EPA Report  EPA
March 1973  EPA.R3.73.033; pp.368-96  http://www.epa.gov
[a.k.a. Blue Book]

UC-31  Quality Criteria for Water 1986 [Excerpt page entries regarding Hardness]
Author: Office of Water Regulations and Standards, Environmental Protection Agency (EPA)
EPA Report  EPA
May 1, 1986  EPA 440/5-86-001; Unnumbered  http://www.epa.gov
[a.k.a. Gold Book]

UC-32  Non-irrigation Surface Water Permit Locations Retrieved from Minnesota Department of Natural Resources Water Appropriation Permits Database
Author: Minnesota Department of Natural Resources (MDNR)
Summary  DNR
Accessed: May 2006

Author: Industrial Environmental Research Laboratory, Environmental Protection Agency (EPA)
Manual  EPA
Not Given  EPA-600/7-79-001; pp.237-61

UC-34  Subject: Soliciting Comments on the MPCA Proposed Class 3B to Class 3C Changes as Outlined in a May 26, 2004 Email Message from David Maschwitz (MPCA) to Keith Hanson
From Keith Hanson, Minnesota Power
e-mail
May 27, 2004
To Minnesota Chamber of Commerce Environment and Water Quality Committee

UC-35  Subject: Response to Comments on the Proposed Class 3B to Class 3C Changes
From David E. Maschwitz, Environmental Outcomes Division, MPCA
e-mail
March 4, 2005
To Kevin Kangas, Sappi Paper Cloquet, LLC,

UC-36  Cluster Rule Impact on Recovery Boiler Operations: Chloride and potassium Concentrations in the Kraft Liquor Cycle
Author: J. M. Jordan and P.S. Bryant
Journal  TAPPI
December 12,1996  Vol 79(12); pp.108-16

UC-37  Dynamic Modeling of Potassium and Chloride in the Recovery Area
Author: B. Malmberg, L. Edwards, et al.
Journal  TAPPI
June 2002  Vol 1(4); pp.3-6

UC-38  Selective Removal of Chloride and Potassium in Kraft Mills.
Author: L. Manuel, G.A. Ferreira, et al.
Journal  TAPPI
April 2003  Vol 2(4); pp.21-5

UC-39  Mineral Scale Management, Part I. Case Studies
Author: P.W. Hart and A.W. Rudie
Journal  TAPPI
June 2006  Vol 5(6); pp.22-7
UC-40 Mineral Scale Management. Part II. Fundamental Chemistry
Author: A.W. Rudie and P.W. Hart
Journal TAPPI
July 2006 Vol 5(7); pp.17-23

UC-41 Stream Assessment Worksheet Use Attainability Analysis, Unnamed Ditch to County Ditch No. 42
Form Winthrop
November 4, 2004

UC-42 Stream Assessment Worksheet Use Attainability Analysis, Unnamed Creek to Cedar Creek
Author: Isanti Estates Mobile Home Park
Form Isanti
November 9, 2004