Lake Hiawatha Site-Specific Eutrophication Criteria Justification

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The purpose of this document is to provide justification for assigning a site-specific total phosphorus (TP) standard to Lake Hiawatha (Lake ID 27-0018-00) in Hennepin County, Minnesota.

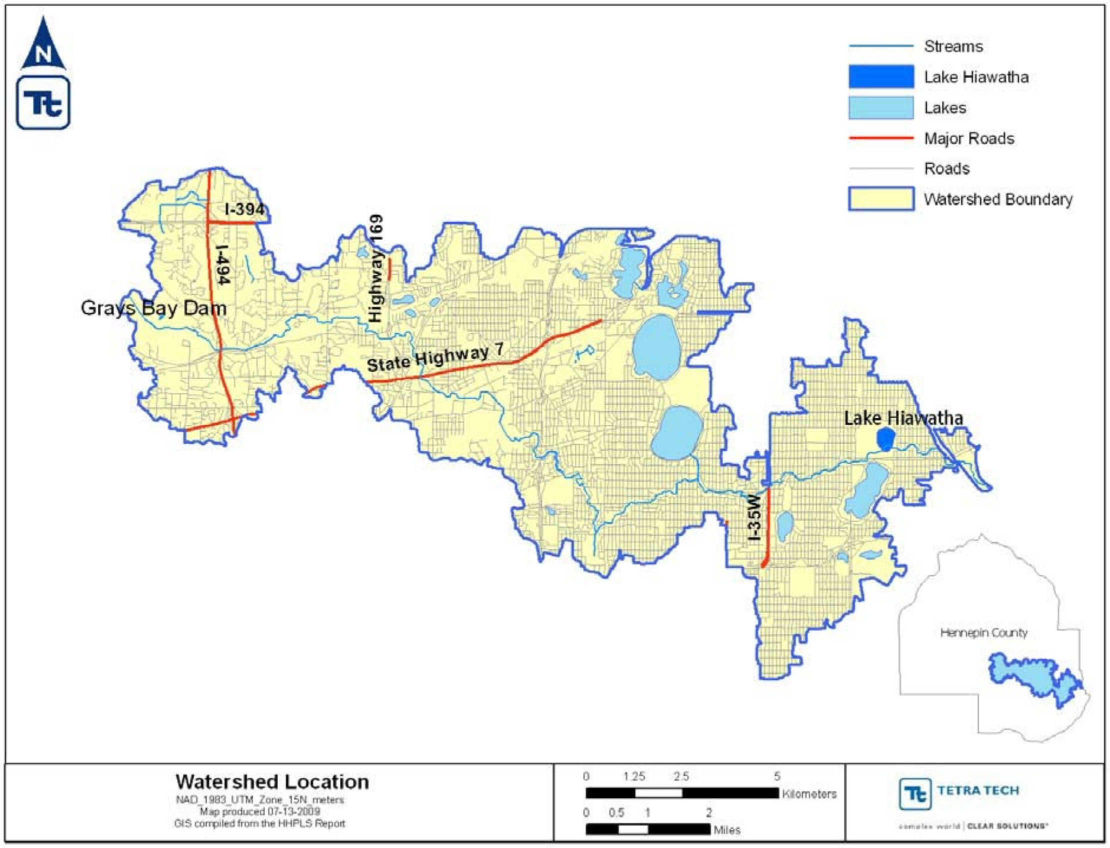

Figure 1. Map of Minnehaha Creek – Lake Hiawatha Watershed (portion below Gray's Bay dam).

The current lake eutrophication water quality standards and the site specific standards for TP and the associated response variables, chlorophyll-a (Chl-a) and Secchi disk depth (SD), are provided in Table 1. The current standards correspond to those for deep lakes in the North Central Hardwoods Forests ecoregion.

Table 1. Current lake eutrophication water quality standards and the site specific standards for Lake Hiawatha.

Parameter, units	Current standard	Proposed standard
Total Phosphorus, µg/L	40	50
Chlorophyll-a, µg/L	14	14
Secchi disk depth, m (minimum value)	1.4	1.4

Background on Minnesota's lake standards

As outlined in the Statement of Need and Reasonableness document (SONAR; 2007) written in support of the current lake standards in Minn. Rules 7050, the purpose of lake water quality standards is to achieve designated beneficial uses. Achieving designated beneficial uses for lakes means control of cultural eutrophication to allow water-related recreation, fishing and aesthetic enjoyment. Control of cultural eutrophication translates to the lake producing minimal nuisance algal blooms and exhibiting desirable water clarity. The rules establish water quality standards for TP, which is considered the "causal factor", and Chl-a and SD, which are considered the "response variables" as they are a direct expression of algal growth and water clarity.

The data analysis done in support of the rulemaking involved large datasets relating TP, Chl-a and SD. This analysis varied by lake type (depth and presence of trout) and by ecoregion and resulted in establishment of eight combinations of allowable TP, Chl-a and SD values. The SONAR establishes the reasonableness of this approach, but also acknowledges that these eight options may not provide appropriate targets for all of the state's lakes for a variety of reasons. Thus, Minn. Rules 7050 allows for establishment of site-specific standards for waterbodies when supported by data.

The rules specifically mention reservoirs as an appropriate candidate for a site-specific standard due to unique characteristics of these waterbodies (e.g., variations in hydraulic residence time and watershed size). ("Reservoir" means *"a body of water in a natural or artificial basin or watercourse 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."*)

Relevant lake and watershed characteristics of Lake Hiawatha

According to the Minneapolis Park & Recreation Board's (MPRB) website (www.minneapolisparks.org) Lake Hiawatha was a shallow wetland named Rice Lake before it was acquired by the MPRB in 1923. The lake had strands of wild rice that grew in the shallow waters. The lake was renamed and major changes occurred to the shape and depth of Lake Hiawatha. In 1929 the Hiawatha Golf Course was constructed using over 1.25 million cubic yards of dredged material.

When Lake Hiawatha was assessed for impairment status it was evaluated against the "deep" lake criteria contained in Minn. Rules 7050. It is 62 percent littoral (80 percent being the cut-off for shallow vs. deep) and has a maximum depth of 33 feet. Its depth is maintained by a weir in its outlet.

The surface area of Lake Hiawatha is 55 acres and receives drainage via Minnehaha Creek from 47.3 square miles (the area of the Minnehaha Creek – Lake Hiawatha watershed below Gray's Bay dam). This corresponds to a very large watershed to lake area ratio (550:1) and is even larger when factoring in the 123 square mile area above Gray's Bay dam, which generally contributes flow to Minnehaha Creek and ultimately to Lake Hiawatha during the summer months. This means that the hydraulic residence time of the lake is correspondingly very short (4.4 days based on an 11-year average; see Minnehaha Creek / Lake Hiawatha Linkage Analysis, April 2012; http://www.minnehahacreek.org/sites/minnehahacreek.org/files/MC-LH%20(Linkage%20Analysis%20--%202012-04-25)_reduced.pdf). Based on available information it appears that Lake Hiawatha meets the definition of a reservoir. Regardless, the relevant conclusion to draw is that a short residence time means that algae have less time to grow. In other words, it takes a greater concentration of TP to produce a given amount of algae than it would under a more typical residence time.

Recent water quality data

Due to efforts by the MPRB we have a solid water quality dataset available for Lake Hiawatha from which to evaluate a site-specific standard. The summer season means for TP, Chl-a and SD for the last 12 years are shown in Table 2.

Table 2. Summer (June-September) water quality means for 2000-2011 for Lake Hiawatha. (Values meeting the state standard are shown in red.)

Year	TP	Chl-a	SD
	µg/L	µg/L	m
2000	99	46	1.1
2001	62	17	1.4
2002	68	11	1.3
2003	71	18	1.7
2004	60	14	1.4
2005	66	8	1.9
2006	64	15	1.2
2007	96	33	0.9
2008	75	22	1.4
2009	95	44	0.8
2010	64	18	1.6
2011	59	11	1.5

Observations and conclusions from this dataset include:

- TP did not meet either the 40 nor 50 µg/L target during this time period. The overall average seasonal TP was 73 µg/L.
- The lake more frequently met its SD target than its Chl-a target.
- The lake met both response variables in three of the twelve years. In these years the TP ranged from 59 to 66 µg/L.
- A simple regression between Chl-a and TP shows a fairly good linear relationship (R-squared = 0.87). With this regression a Chl-a value of 14 µg/L corresponds to a TP value of 64 µg/L. A similar regression for SD and TP (R-squared = 0.57) shows a SD value of 1.4 m corresponding to a TP value of 72 µg/L. See figures 2 and 3 below.

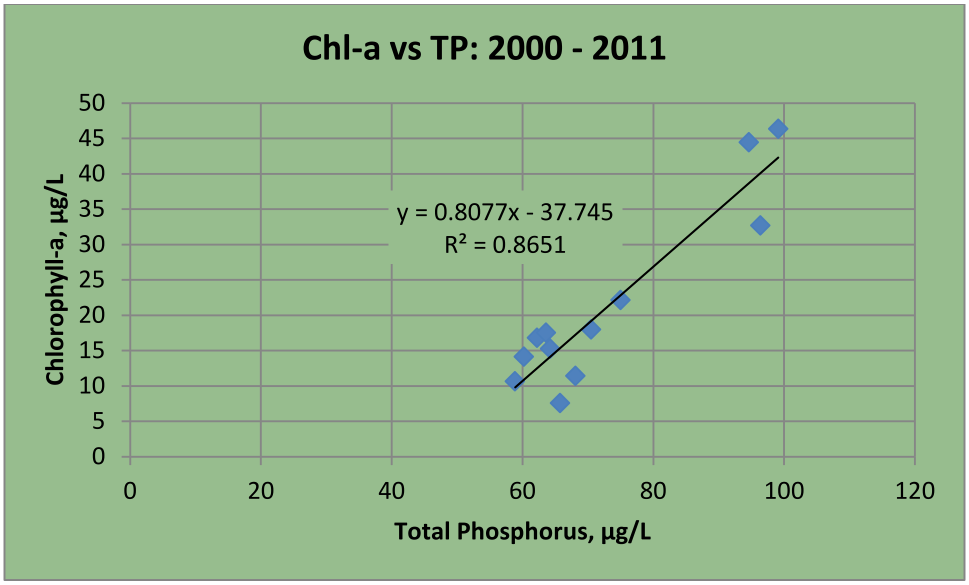

Figure 2. Summer season means for chlorophyll-a vs. total phosphorus for 2000 – 2011.

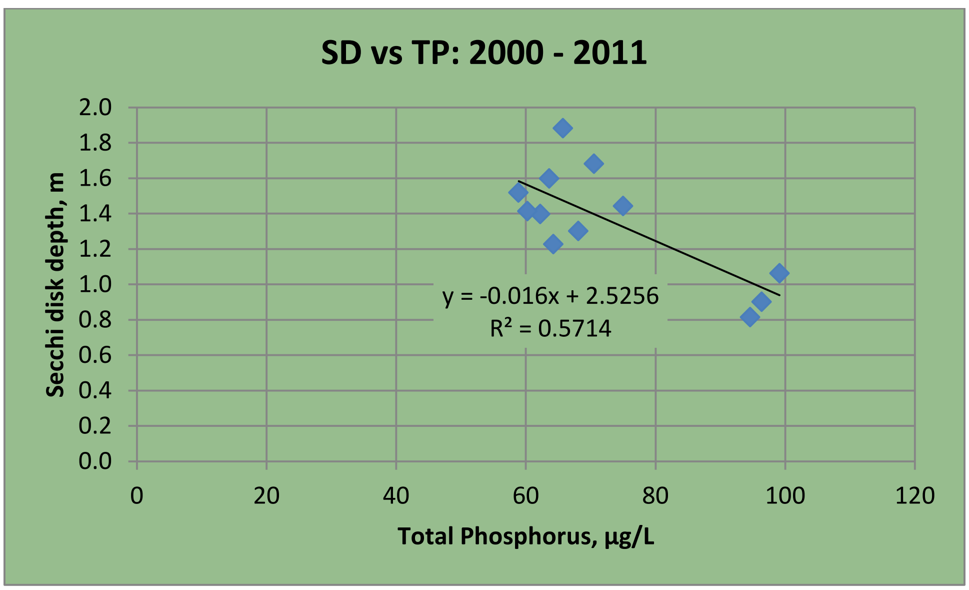

Figure 3. Summer season means for Secchi disk depth vs. total phosphorus for 2000 – 2011.

Selection of site-specific standard

Based on the empirical observations and analysis above there is a solid basis that a TP site-specific standard for Lake Hiawatha of 50 µg/L will result in the lake's meeting the existing standards for the response variables, Chl-a and SD (14 µg/L and 1.4 m, respectively) and thereby producing minimal nuisance algal blooms and exhibiting desirable water clarity, i.e., achieving the designated beneficial uses of the lake. While it appears a value higher than 50 µg/L would be sufficient, 50 µg/L was conservatively chosen to provide a margin of safety (MOS) for the Total

Maximum Daily Load (TMDL) study that will follow for this lake. Justification for this MOS will be provided in the TMDL.