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Memorandum

To: Brooke Asleson and Pam Anderson, MPCA
From: Greg Wilson, Barr Engineering
Subject: Wirth Lake Delisting
Date: December 26, 2013
Project: 23/27-0051
cc: Karen Chandler, Barr Engineering and Laura Jester, Bassett Creek Watershed Management Commission (BCWMC)

Wirth Lake has shown significant water quality improvement in recent years. The TMDL report was approved in 2010 after the lake was originally listed for excess nutrient (phosphorus) impairment.

It is understood that to be listed on the Minnesota Pollution Control Agency's (MPCA) 303(d) Impaired Waters List, the 10-year average of the growing season (June-September) for the causal factor (total phosphorus (TP)) must exceed the established water quality standard along with either one or both of the dependent factors (chlorophyll-*a* (chl-*a*) and Secchi depth(SD)). However, for Wirth Lake, the average of the most recent 10-years of water quality data would suggest that the lake is currently meeting the established water quality standards and/or no longer meet the MPCA 303(d) Impaired Waters listing criteria and should be removed the 303(d) list.

The following summarizes the historic water quality data for Wirth Lake including trends in the observed water quality and also discusses the potential factors that may be contributing to the improved water quality and continued protection of good water quality in Wirth Lake. Because the observed water quality in a lake can vary significantly throughout the seasons as well as from year to year; the long term (10-year average) is used in determining the overall trophic status of a lake and statistical analyses are used to evaluate water quality trends over time. Trend analyses of the data were performed using a Mann-Kendall analysis of the statistical significance of the trends at the 80, 90 and 95 percent confidence levels. For a trend to be statistically significant, the trend must be significant at the 95 percent confidence interval and must show significant improvement in water quality for all three parameters (TP, chl-*a*, and SD).

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Historic Water Quality

Wirth Lake is a 38-acre deep lake with a maximum depth of 26 feet. Historic water quality for the lake indicates that the water quality in Wirth Lake has been steadily improving. The 10-year average of the most recent water quality data (2003-2012) indicates that Wirth Lake is currently meeting the MPCA deep lake standards for TP and SD. The 10-year average chl-*a* concentration for Wirth Lake is 14.7 µg/L, which is within 1 µg/L of the 14 µg/L chl-*a* criteria. If provisional water quality monitoring data from 2013 is considered, the 10-year (2004-2013) average chl-*a* concentration for Wirth Lake becomes 12.9 µg/L, while the 10-year average TP (32.5 µg/L) and SD (2.56 m) are both significantly better than the respective listing criteria. Additionally, trend analysis of the historic water quality data indicates that over the entire period of water quality monitoring data (1992-2013), there have been significant improvements for all three water quality criteria at the 95 percent confidence level. The same is true for the trend analysis of the more recent data (2003-2012).

Reasonable Assurances That Standards Are Met

Much of the Wirth Lake watershed is developed and fairly stable with no undeveloped parcels remaining. Recently, there has been very little watershed disturbance due to development or redevelopment. With the exception of some direct drainage and one subwatershed (along Highway 55), the remaining watershed sources are receiving wet detention treatment of stormwater runoff. In addition, a detailed evaluation of lake level data indicates that the frequency of backwater inundation of Wirth Lake from Bassett Creek has decreased significantly (see Figure 4 in the TMDL Report).

The stabilization of the watershed, due to nearly complete development, along with stricter stormwater quality treatment standards during construction and post-construction since the 1990's likely resulted in less loading from the watershed. Historically, the BCWMC had no water quality treatment requirements with the exception of some erosion control requirements. During the 1990's and early 2000's, water quality treatment to the NURP standards was required. Continued implementation of the Commission requirements for new development and redevelopment will help ensure the protection, and potentially the improvement, of water quality in Wirth Lake.

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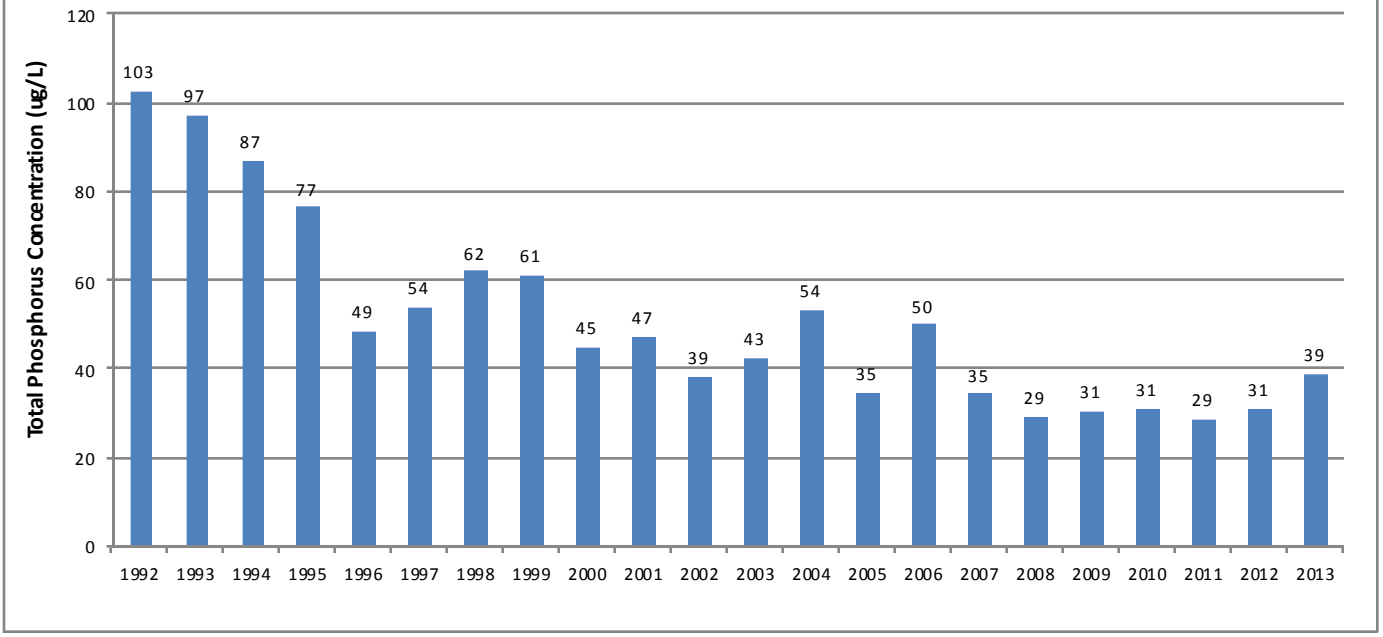
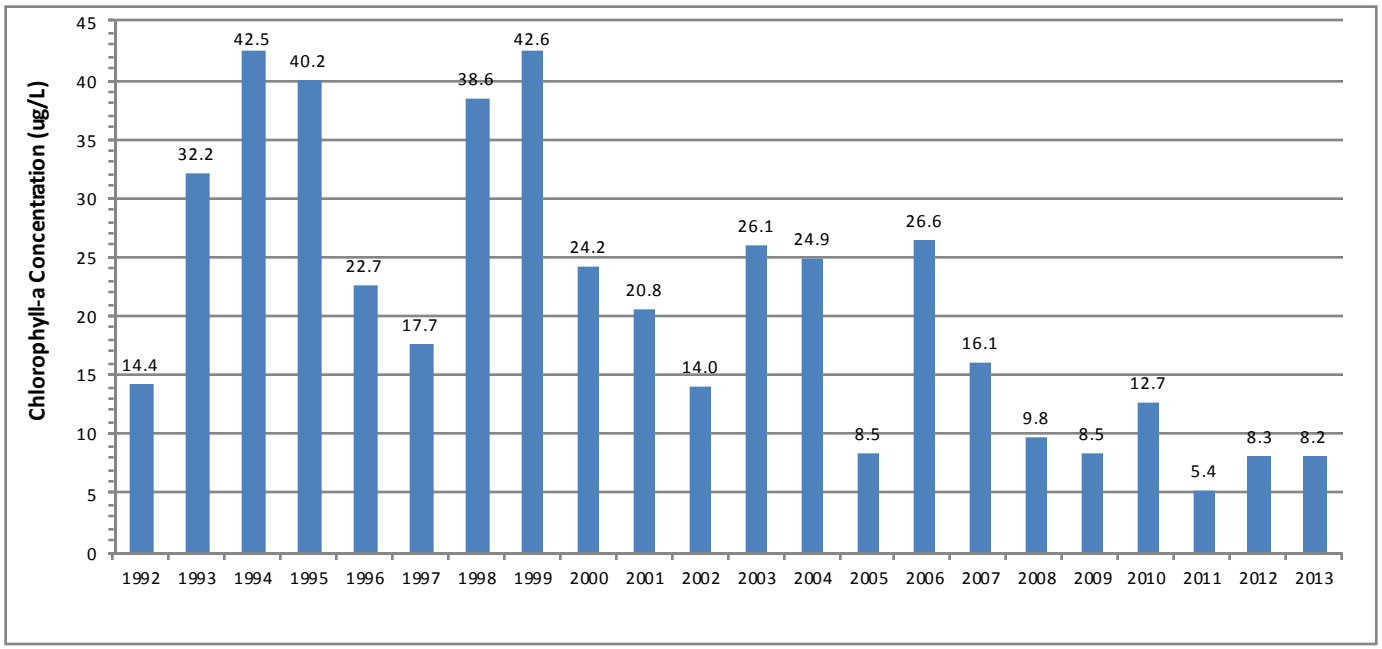
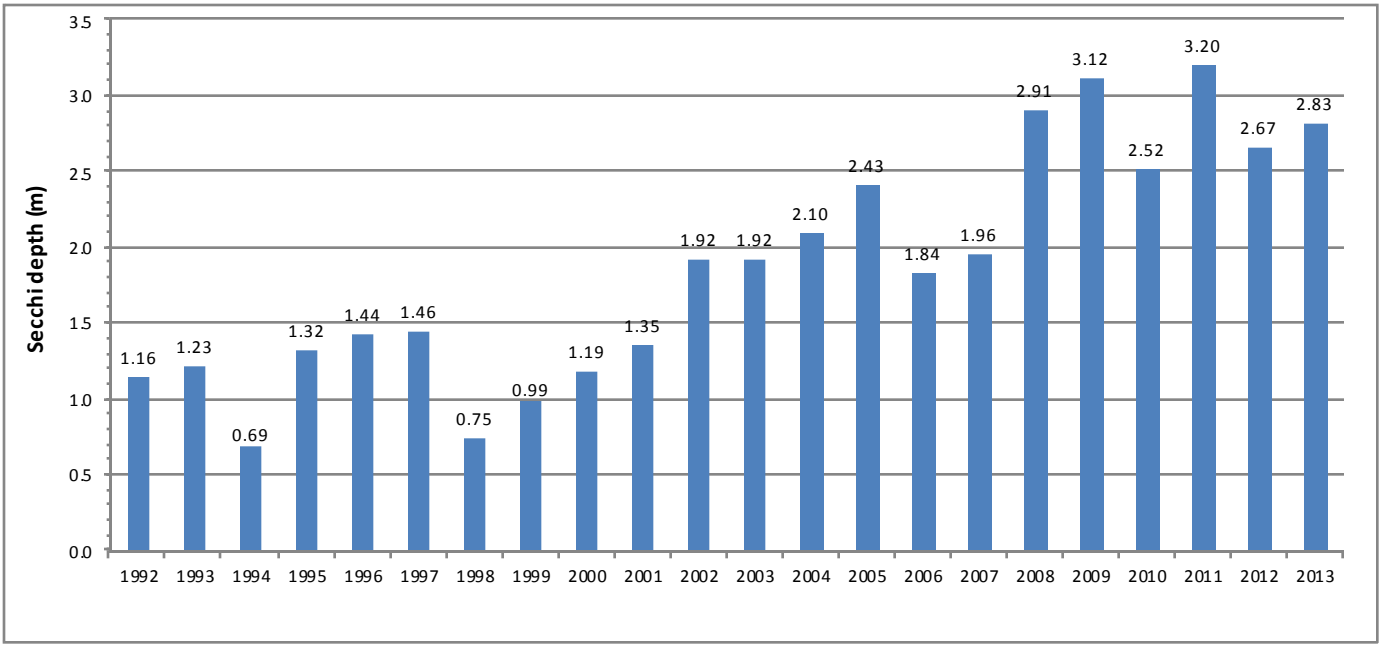
In addition to stabilization of the watershed and the development of stormwater management requirements, the BCWMC and local project partners have implemented several water quality improvement projects within the watershed since the completion of the *Wirth Lake Watershed and Lake Management Plan* in 1996. The following is a list of the projects implemented in the Wirth Lake watershed, including a brief description:

- BCWMC and the City of Minneapolis entered into an agreement in 2005 to improve a stormwater quality treatment pond immediately west of the lake. That project was completed by the Minneapolis Park and Recreation Board (MPRB) in the spring of 2006.
- In the mid 1990's the MPRB modified the outlet structure for the lake to minimize flood flows to the lake from Bassett Creek, except for semi-rare backflow events.
- In 2002 the MPRB in cooperation with the Minnesota Department of Natural Resources installed an aeration system to prevent winter fish kills.
- As part of the 2006 renovation of the facilities at the swimming beach on the southeast corner of the lake, the MPRB constructed a stormwater treatment basin to treat stormwater runoff from the impervious surfaces at the beach.
- This past year a new lake outlet structure, designed to prevent backflow from Bassett Creek, was installed to ensure that future backflow events cannot deteriorate the water quality of Wirth Lake.

Wirth Lake Summer (June-Sept.) Average Data







Barr Engineering Co. **Mann-Kendall Statistical Test (revised 2/8/2005)**

Notice: This spreadsheet is a modified version of the Wisconsin DNR Form 4400-215 (2/2001) referenced in Appendices A of Comm 46 and NR 746, Wis. Adm. Code. It was provided to consultants as an optional tool for groundwater contaminant trend analysis to support site closure requests Earlier versions of this form should not be used.

Instructions: Do not change formulas or other information in cells with a blue background; only cells with a yellow background are used for data entry. To use the spreadsheet, provide at least four rounds and not more than forty rounds of data that is not seasonally affected. Use consistent units. The spreadsheet contains several error checks, and a data entry error may cause "DATA ERR" or "DATE ERR" to be displayed. Dates that are not consecutive will show an error message and will not display the test results. The spreadsheet tests the data for both increasing and decreasing trends at 80 percent, 90 percent, and 95 percent confidence levels. If an increasing or decreasing trend is not present, an additiona coefficient of variation test may be used to test for stability (Wiedemeier et al, 1999). For additional information, refer to the Interim Guidance on Natural Attenuation for Petroleum Releases, dated October 1999. Refer to the guidance for recommendations on data entry for non-detect values.

Site Name =	Wirth Lake--Period of Record		BRRTS No. =		Well Number =	

	Compound ->	TP	Chl-a	SD			
Event Number	Sampling Date (most recent last)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)	Concentration (leave blank if no data)
1	1992	103	14.4	1.16			
2	1993	97	32.2	1.23			
3	1994	87	42.5	0.69			
4	1995	77	40.2	1.32			
5	1996	49	22.7	1.44			
6	1997	54	17.7	1.46			
7	1998	62	38.6	0.75			
8	1999	61	42.6	0.99			
9	2000	45	24.2	1.19			
10	2001	47	20.8	1.35			
11	2002	39	14.0	1.92			
12	2003	43	26.1	1.92			
13	2004	54	24.9	2.10			
14	2005	35	8.5	2.43			
15	2006	50	26.6	1.84			
16	2007	35	16.1	1.96			
17	2008	29	9.8	2.91			
18	2009	31	8.5	3.12			
19	2010	31	12.7	2.52			
20	2011	29	5.4	3.20			
21	2012	31	8.3	2.67			
22	2013	39	8.2	2.83			
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Mann Kendall Statistic (S) =	-165.0	-125.0	165.0	0.0	0.0	0.0
Number of Rounds (n) =	22	22	22	0	0	0
Average =	51.22	21.14	1.86	#DIV/0!	#DIV/0!	#DIV/0!
Standard Deviation =	21.996	11.989	0.771	#DIV/0!	#DIV/0!	#DIV/0!
Coefficient of Variation(CV)=	0.429	0.567	0.414	#DIV/0!	#DIV/0!	#DIV/0!

Error Check, Blank if No Errors Detected				n<4	n<4	n<4
Trend ≥ 80% Confidence Level	DECREASING	DECREASING	INCREASING	n<4	n<4	n<4
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	INCREASING	n<4	n<4	n<4
Trend ≥ 95% Confidence Level	DECREASING	DECREASING	INCREASING	n<4	n<4	n<4
Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	n<4 n<4	n<4 n<4	n<4 n<4

Data Entry By =	Greg Wilson	Date =	26-Dec-13	Checked By =	

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Instructions: Do not change formulas or other information in cells with a blue background; only cells with a yellow background are used for data entry. To use the spreadsheet, provide at least four rounds and not more than forty rounds of data that is not seasonally affected. Use consistent units. The spreadsheet contains several error checks, and a data entry error may cause "DATA ERR" or "DATE ERR" to be displayed. Dates that are not consecutive will show an error message and will not display the test results. The spreadsheet tests the data for both increasing and decreasing trends at 80 percent, 90 percent, and 95 percent confidence levels. If an increasing or decreasing trend is not present, an additiona coefficient of variation test may be used to test for stability (Wiedemeier et al, 1999). For additional information, refer to the Interim Guidance on Natural Attenuation for Petroleum Releases, dated October 1999. Refer to the guidance for recommendations on data entry for non-detect values.

Site Name =	Wirth Lake (2003-2012)			BRRTS No. =		Well Number =	
	Compound ->	TP	Chl-a	SD			
		Concentration	Concentration	Concentration	Concentration	Concentration	Concentration
Event Number	Sampling Date (most recent last)	(leave blank if no data)	(leave blank if no data)	(leave blank if no data)	(leave blank if no data)	(leave blank if no data)	(leave blank if no data)
1	2003	43	26.1	1.92			
2	2004	54	24.9	2.10			
3	2005	35	8.5	2.43			
4	2006	50	26.6	1.84			
5	2007	35	16.1	1.96			
6	2008	29	9.8	2.91			
7	2009	31	8.5	3.12			
8	2010	31	12.7	2.52			
9	2011	29	5.4	3.20			
10	2012	31	8.3	2.67			
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Mann Kendall Statistic (S) =	-25.0	-27.0	25.0	0.0	0.0	0.0
Number of Rounds (n) =	10	10	10	0	0	0
Average =	36.70	14.69	2.47	#DIV/0!	#DIV/0!	#DIV/0!
Standard Deviation =	8.903	8.244	0.504	#DIV/0!	#DIV/0!	#DIV/0!
Coefficient of Variation(CV)=	0.243	0.561	0.204	#DIV/0!	#DIV/0!	#DIV/0!

Error Check, Blank if No Errors Detected				n<4	n<4	n<4
Trend ≥ 80% Confidence Level	DECREASING	DECREASING	INCREASING	n<4	n<4	n<4
Trend ≥ 90% Confidence Level	DECREASING	DECREASING	INCREASING	n<4	n<4	n<4
Trend ≥ 95% Confidence Level	DECREASING	DECREASING	INCREASING	n<4	n<4	n<4
Stability Test, If No Trend Exists at 80% Confidence Level	NA	NA	NA	n<4 n<4	n<4 n<4	n<4 n<4

Data Entry By =	Greg Wilson	Date =	26-Dec-13	Checked By =	