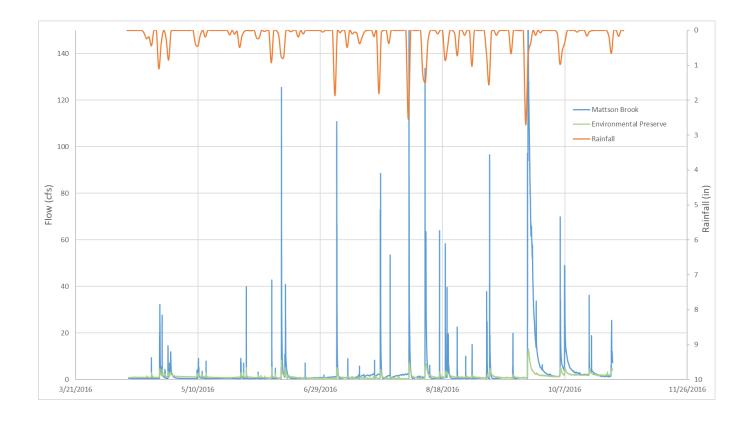
Appendix A: 2016 West Mississippi Outfall Monitoring Data

2016 precipitation measured at the New Hope weather station

	2016	1992-2016 Monthly	Departure from
Month	Precipitation (inches)	Average Precipitation (inches)	Long-Term Average (inches)
January	0.31	0.99	-0.68
February	1.02	0.89	+0.13
March	1.92	1.81	+0.11
April	3.73	3.21	+0.52
May	2.13	4.19	-2.06
June	3.47	4.56	-1.09
July	5.74	4.36	+1.38
August	9.15	3.79	+5.36
September	7.08	2.97	+4.11
October	3.25	2.68	+0.58
November	2.92	1.69	+1.23
December	2.13	1.34	+0.79
TOTAL	42.85	32.47	+10.38



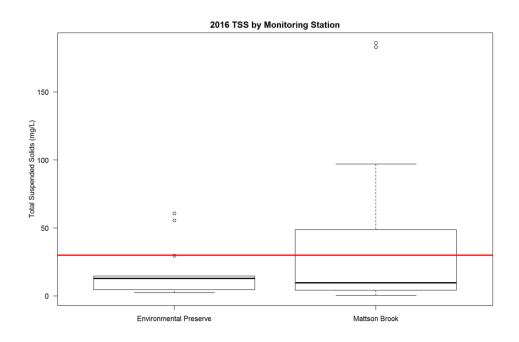
Environmental Preserve Outfall Monitoring 2016

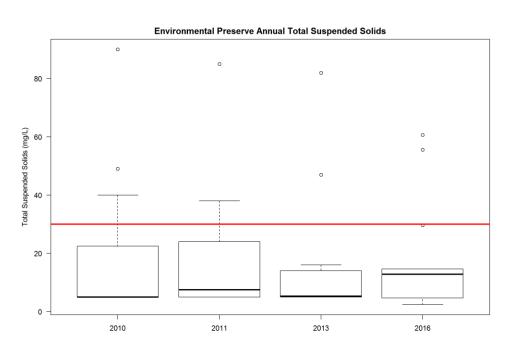
		Temp	DO		Sp.	TP	Ortho-P	TSS	Chloride
Date	Time	[C]	[mg/l]	pН	Cond	[mg/L]	[mg/L]	[mg/L]	[mg/L]
4/11/2016	13:30	8.13	12.98	7.69	968.3	0.055	0.018	13	
4/25/2016	11:30	12.35	9.54	7.65	557.1	0.045	0.024	12.8	
4/29/2016	11:15	10.69	11.88	7.62	606.9	0.041	0.024	5.4	
5/9/2016	17:36					0.042	0.013	14.6	
5/12/2016	14:30	15.28	11.34	8.10	796	0.041	0.021	4.4	
5/26/2016	15:40	19.46	6.48	7.63	1330	0.063	0.047	2.4	
6/9/2016	10:20	19.59	8.55	7.86	599.5	0.251	0.024	12.8	
6/14/2016	12:24					0.045	0.03	55.6	
6/15/2016	9:45	19.95	7.66	7.76	534.2				
6/21/2016	11:15	21.16	7.06	7.85	851.4				
7/14/2016	13:15	21.68	7.64	7.67	843.5	0.028	0.026	4.67	
7/26/2016	10:10	23.81	6.46	7.62	743.9				
8/10/2016	20:11					0.135	0.084	29.6	
8/11/2016	17:40	25.92	7.48	7.59	309.3	0.09	0.068	11.2	
9/8/2016	15:30	23.67	7.83	7.96	680.3	0.08	0.059	3.6	
9/21/2016	18:01					0.216	0.167	60.7	
9/22/2016	10:00	18.33	6.30		218.7				
10/7/2016	11:50	13.08	9.6	7.74	517.9	0.055	0.018	13	

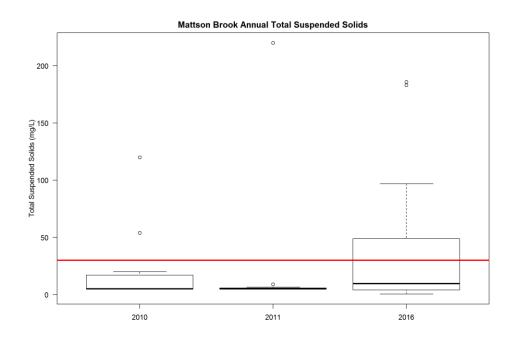
Mattson Brook Outfall Monitoring 2016

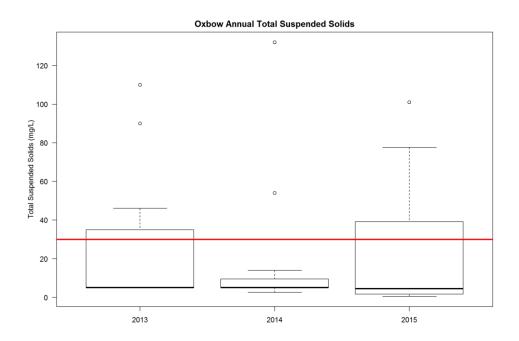
		Temp	DO		Sp.	TP	Ortho-P	TSS	Chloride
Date	Time	[c]	[mg/l]	pН	Cond	[mg/L]	[mg/L]	[mg/L]	[mg/L]
4/11/2016	16:15	9.38	14.97	7.97	1932	0.025	0.011	7	
4/24/2016	6:46					0.066	0.061	62.8	
4/25/2016	10:15	11.64	9.76	7.68	420.3				
4/29/2016	10:55	8.8	11.23	7.57	1052.1	0.028	0.027	4.6	
5/9/2016	14:11					0.091	0.024	3.6	
5/11/2016	15:40	12.53	7.83	7.79	422				
5/12/2016	13:55	12.36	8.79	7.52	1471.5	0.056	0.034	2.4	
5/25/2016	12:08					0.057	0.015	9.6	
5/26/2016	16:20	25.8	7.94	8.26	749.9	0.038	0.024	1.6	
6/9/2016	9:30	17.84	7.18	7.61	959.2	0.087	0.068	21	
6/14/2016	12:41					0.072	0.055	34.8	
6/15/2016	9:00	18.14	8.17	7.79	745.7				
6/21/2016	10:45	17.77	7.12	7.86	1627.3				
7/14/2016	13:45	19.01	6.84	7.5	1766	0.092	0.086	28.3	
7/26/2016	10:45	19.35	7.27	7.61	1381.9				
7/27/2016	13:43					3.07	0.067	97	
8/10/2016	20:03					0.398	0.187	186	
8/11/2016	17:15	24.73	7.4	7.52	390.6	0.099	0.068	4.6	
9/8/2016	14:45	20.58	7.44	7.81	1066.9	0.069	0.059	<1.0	
9/21/2016	16:22					0.324	0.222	183	
9/22/2016	10:30	18.62	7.12		210	0.025	0.011	7	
10/7/2016	11:30	12.65	9.6	7.63	637.6	0.066	0.061	62.8	

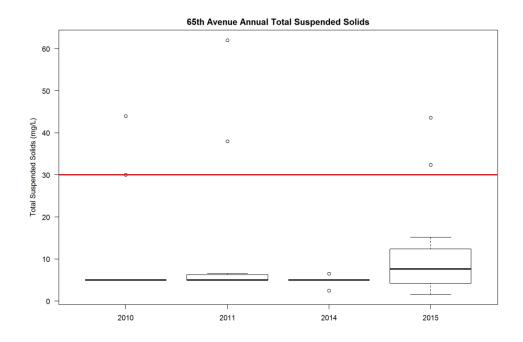
TSS Figures



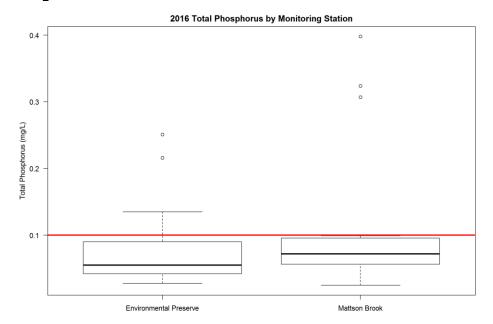


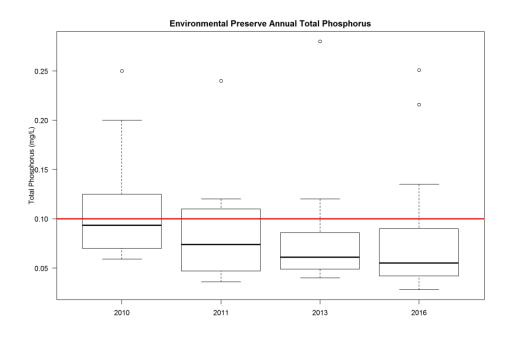


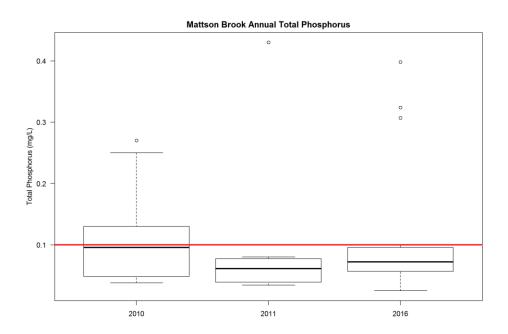


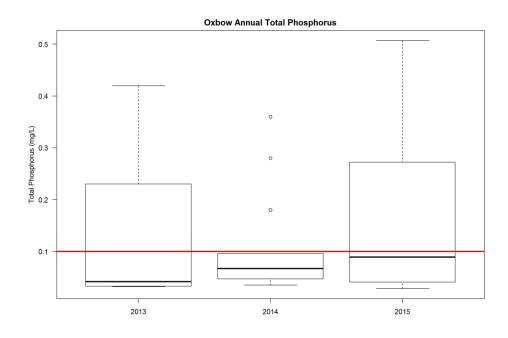


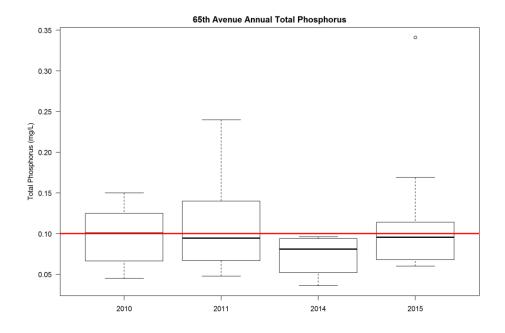
TP Figures



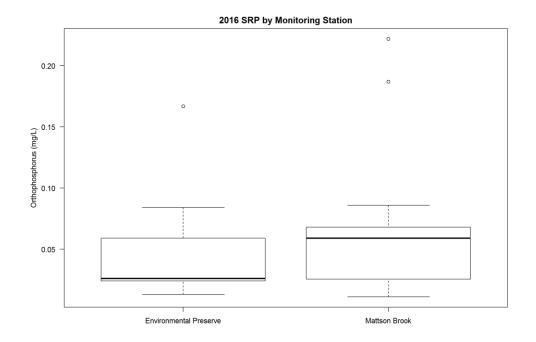


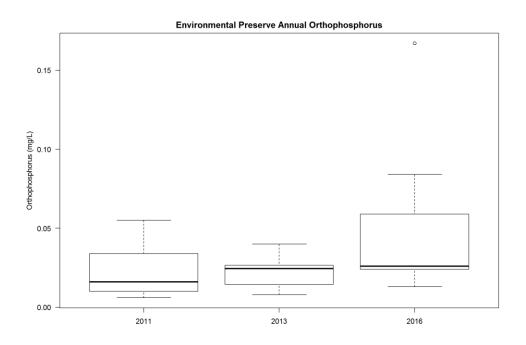


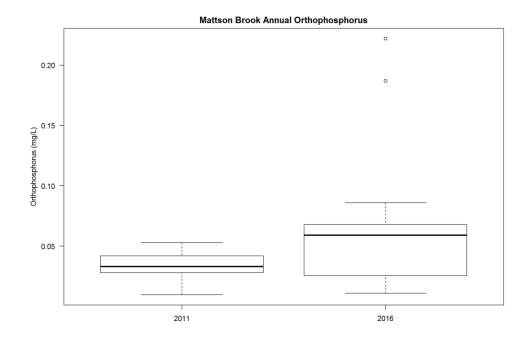


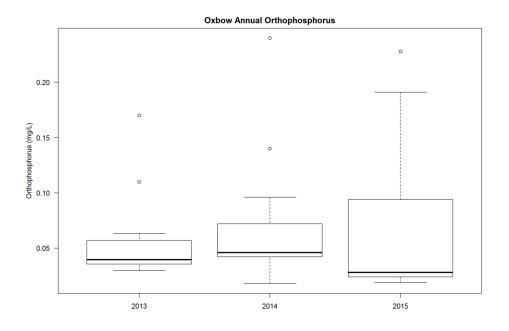


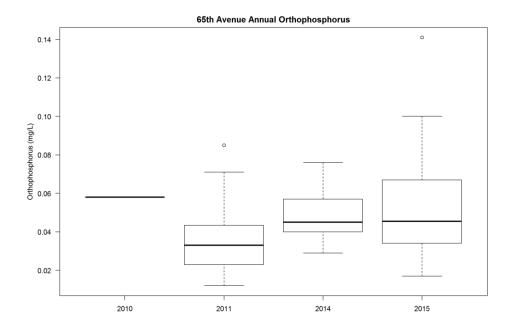
Ortho-P Figures



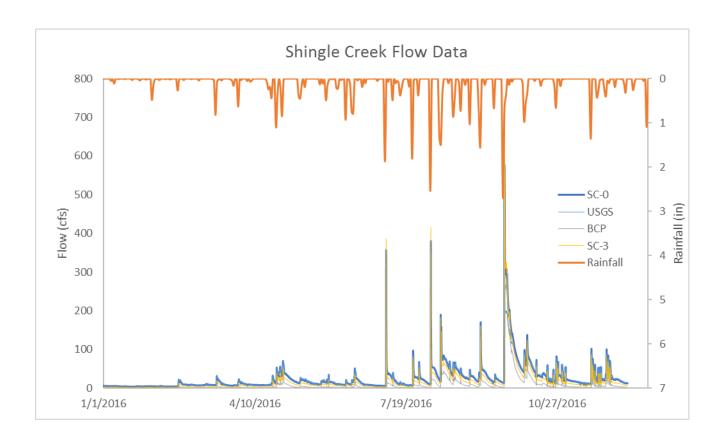








Appendix B: 2016 Shingle Creek Stream Monitoring Data



Shingle Creek SC-0 Monitoring 2016

		Temp	DO		Sp.	TP	Ortho-P	TKN	Nitrate	TSS	Chloride
Date	Time	[C]	[mg/l]	pН	Cond	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
2/19/2016											442
3/22/2016	11:00	6.84	12.98	7.07	1129						236
4/11/2016	9:00	4.92	11.78	7.70	1162.9	0.04	0.018	<.5	0.068	5.4	227
4/24/2016	8:51					0.089	0.085	2.87	0.889	92.8	122
4/25/2016	13:00	12.86	6.91	7.48	487.3	0.08	0.051	0.802	0.566	16	
4/29/2016	10:35	7.71	9.94	7.18	569.7	0.039	0.039	0.85	0.352	8.8	53.3
5/9/2016	23:56					0.054	0.018	2.46	0.19	21.8	145
5/11/2016	15:10	12.93	8.14	7.36	663.8						
5/12/2016	17:55	13.68	10.17	7.61	777.1	0.045	0.023	0.873	0.174	5.8	150
5/26/2016	15:00	22.52	5.84	7.50	829	0.055	0.046	0.108	0.143	5.6	126
6/9/2016	12:30	21.64	6.02	7.60	801	0.047	0.041	0.674	0.214	7.6	125
6/14/2016	13:03					0.049	0.034	0.873		19.2	73.9
6/15/2016	12:50	20.56	4.86	7.47	447.9						
6/21/2016	10:15	21.46	3.74	7.6	877.1	0.093	0.061	0.687	0.469	6.36	139
7/14/2016	14:15	21.94	4.64	7.36	766.3	0.093	0.076	0.595	0.228	1.6	117
7/26/2016	9:30	24.72	3.37	7.28	482.7	0.136	0.099	0.623	0.137	8.4	75.4
7/27/2016	13:47					0.18	0.06	1.19	0.099	104	
8/10/2016	18:03					0.108	0.098	0.695	0.267	88.6	54
8/11/2016	16:30	24.99	4.92	7.3	265.2	0.202	0.072	1.51	0.118	18.2	44.8
8/26/2016	11:30	19.95	5.38	7.29	620.9	0.064	0.056	0.748	<0.03	6.4	
9/8/2016	13:25	21.5	5.43	7.43	458.8	0.103	0.06	0.744	<.030	10.4	81.4
9/21/2016	14:52					0.297	0.083	2.04	0.509	138	35.2
9/22/2016	11:30	18.62	7.83		181.2	0.112	0.105	0.884	0.313	41.8	25.9
10/7/2016	11:00	12.27	7.28	7.46	417.6	0.073	0.049	0.664	0.276	11	67.6
10/26/2016	11:45	8.85	8.85	7.47	685.6	0.098	0.052	0.71	0.216	11.6	113
11/11/2016	14:30	8.53	7.85	7.69	1002.4						
11/30/2016	16:15	4.98	10.41	4.76	622						118

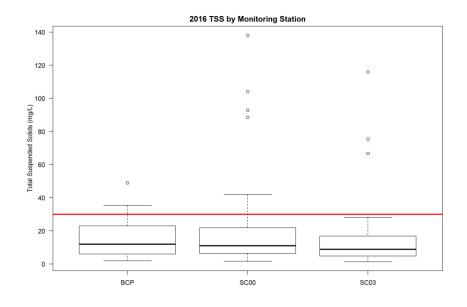
Shingle Creek SC-3 Monitoring 2015

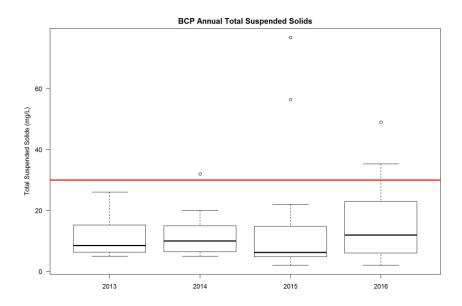
		Temp	DO		Sp.	TP	Ortho-P	TKN	Nitrate	TSS	Chloride
Date	Time	[C]	[mg/l]	pН	Cond	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
	-	Temp	DO		Sp.	TP	Ortho-P	TKN	Nitrate	TSS	Chloride
Date	Time	[C]	[mg/l]	pН	Cond	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
2/19/2016		12.11	7.76	7.55	635.6						684
3/22/2016	10:10	7.03	9.81	7.12	639.8						265
4/11/2016	10:57	13.26	9.70	7.45	773.1	0.026	0.011	0.556	< 0.03	3	206
4/24/2016	6:32										153
4/25/2016	12:30	22.8	6.08	7.53	805.8						
4/29/2016	9:05	20.68	3.84	7.41		0.032	0.026	0.826	0.113	7.6	169
5/12/2016	16:30					0.036	0.016	0.873	0.063	1.4	163
5/25/2016	10:13	20.08	5.15	7.26	503.9	0.088	0.047	1.48	0.403	11.6	
5/26/2016	17:00	20.17	3.75	7.49	754.7	0.066	0.047	0.868	0.047	1.6	169
6/9/2016	12:15	21.26	4.57	7.15	724.4	0.068	0.065	2.29	0.509	4.8	78.6
6/14/2016	12:31	23.85	4.16	7.24	511.7	0.077	0.055	1.08		16.8	92.6
6/15/2016	12:00										
6/21/2016	9:00	23.75	5.07	7.23	267.4	0.114	0.081	0.87	0.266	4.17	153
7/14/2016	12:00	19.49	5.28	7.11	582.5	0.094	0.085	0.698	0.049	11.2	131
7/26/2016	11:45	20.9	4.56	7.21	465.6	0.136	0.103	0.667	0.035	7.6	89.3
7/27/2016	13:31					0.177	0.101	1.21	0.04	116	
8/11/2016	15:20	18.57	5.62		120.1	0.115	0.062	0.782	0.088	28.2	58.6
8/26/2016	9:45	12.49	6.43	7.33	410.4	0.074	0.054	0.91	< 0.03	7.6	
9/8/2016	12:15	8.81	9.02	7.39	302.7	0.094	0.054	0.676	<.030	8.8	85.9
9/21/2016	17:04	8.64	7.84	7.71	713.6	0.207	0.139	1.15	0.278	75.4	21.3
9/22/2016	14:00	4.43	10.62	4.57	660	0.143	0.139	0.861	0.234	66.7	21.3
10/7/2016	10:10	12.11	7.76	7.55	635.6	0.059	0.045	< 0.5	0.128	10.8	72.4
10/26/2016	11:00	7.03	9.81	7.12	639.8	0.099	0.06	<0.5	0.166	9	49.1
11/11/2016	16:00	13.26	9.70	7.45	773.1						
11/30/2016	15:45										132

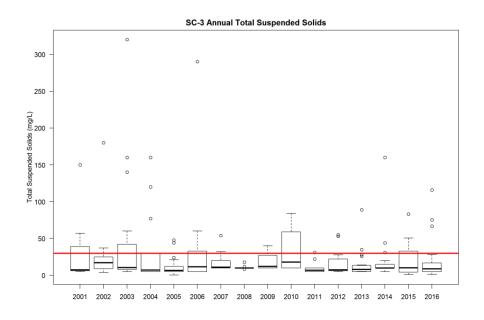
Shingle Creek BCP (Bass Creek Outlet) Monitoring 2015

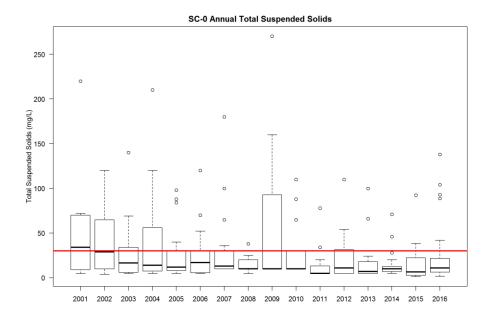
		Temp	DO		Sp.	TP	Ortho-P	TKN	Nitrate	TSS	Chloride
Date	Time	[C]	[mg/l]	pН	Cond	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]	[mg/L]
3/22/2016	9:15	4.1	9.07	7.14	1230						265
4/11/2016	12:00	5.59	12.92	7.54	961.4	0.044	0.029	0.634	0.042	5.8	
4/24/2016	12:49					0.092	0.09	1.27	0.925	33	159
4/25/2016	8:00	11.21	5.40	7.18	822.8						
4/29/2016	8:42	6.42	9.24	7.03	703.6	0.039	0.036	0.873	0.126	6.4	169
5/10/2016	4:38					0.059	0.041	1.15	0.216	24.6	136
5/11/2016	14:30	12.94	9.21	7.32	860						
5/12/2016	16:10	14.77	10.75	7.60	800.7	0.066	0.044	0.885	0.049	16.8	159
5/25/2016	10:16					0.082	0.053	1.31	0.209	4.4	
5/26/2016	17:40	27.46	6.82	7.77	1061.2	0.095	0.094	0.97		2	217
6/9/2016	11:30	20.03	4.43	7.31	556.2	0.138	0.086	0.757	0.396	17.2	102
6/14/2016	12:24					0.108	0.084	0.876		35.3	116
6/15/2016	11:00	19.58	4.04	7.24	662						
6/21/2016	8:30	17.82	3.22	7.42	744.4	0.184	0.154	1.11	0.245	10.9	135
7/14/2016	11:30	20.56	6.5	7.34	755.7	0.191	0.169	0.687	0.03	4	140
7/26/2016	12:15	25.54	6.28	7.34	562.7	0.158	0.122	0.835	0.054	6.8	98.6
7/27/2016	13:27					0.126	0.104	0.913	0.209	30.8	
8/10/2016	19:55					0.248	0.211	1.02	0.109	49	49.4
8/11/2016	14:30	23.18	2.72	7.06	329.3	0.156	0.116	0.728	< 0.03	21.4	63.1
8/26/2016	8:45	19.09	4.68	7.17	547.3	0.082	0.078	0.694	<0.03	4.2	
9/8/2016	12:43	21.79	5.33	7.41	513.9	0.113	0.076	0.755	<.030	6.2	95
9/22/2016	14:30	18.25	7.75		262.7	0.138	0.114	< 0.5	0.244	14	49.1
10/7/2016	9:30	11.8	5.56	7.05	410	0.066	0.066	< 0.5	0.109	8.4	77.2
10/26/2016	10:15	8.44	7.63	7.15	449	0.106	0.078	<0.5	0.179	13	94.1
11/11/2016	15:30	9.31	8.08	7.66	792.7						
11/30/2016	15:15	4.49	11.5	7.23	663						123

TSS Figures

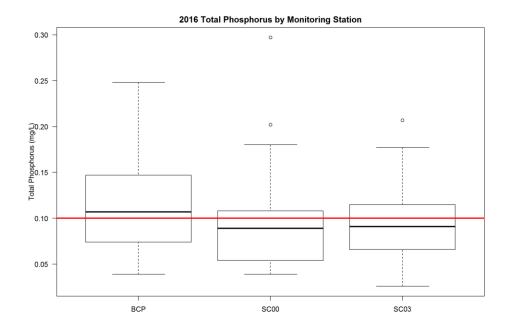


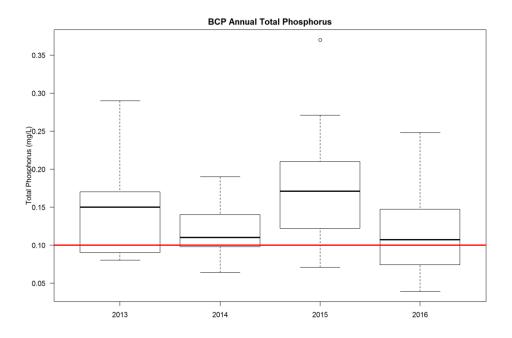


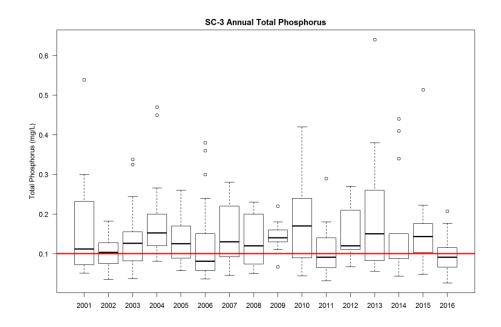


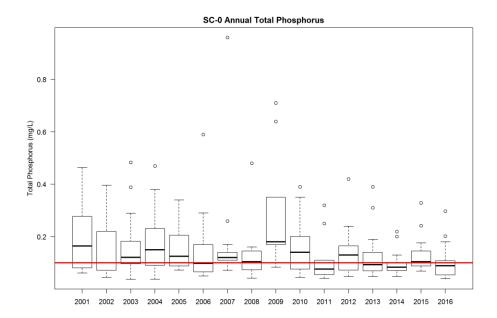


TP Figures

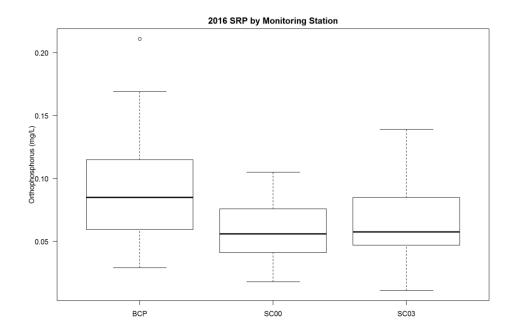


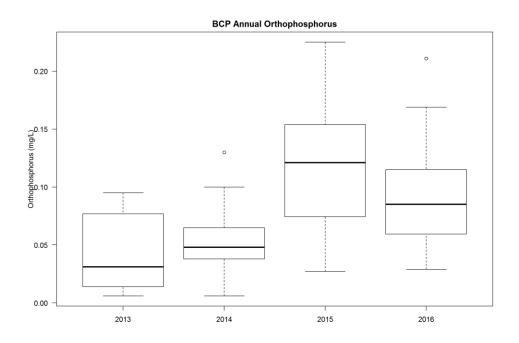


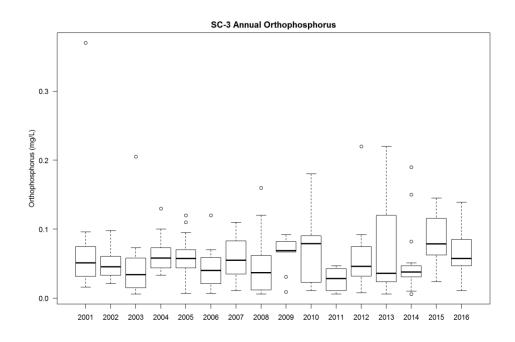


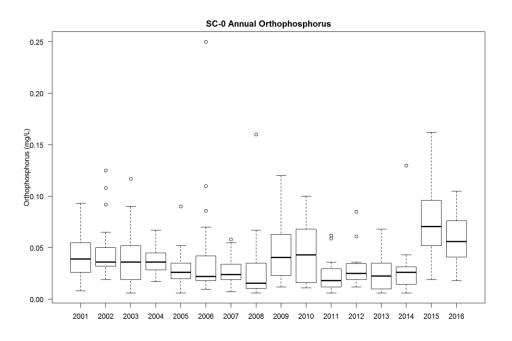


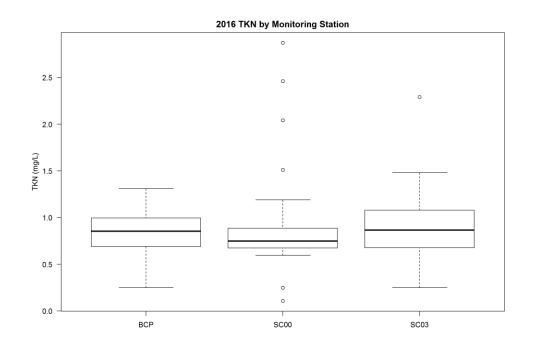
Ortho-P Figures

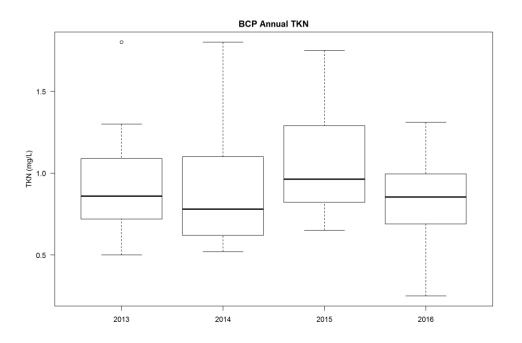


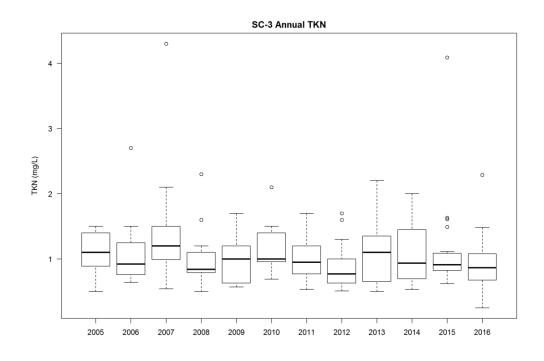


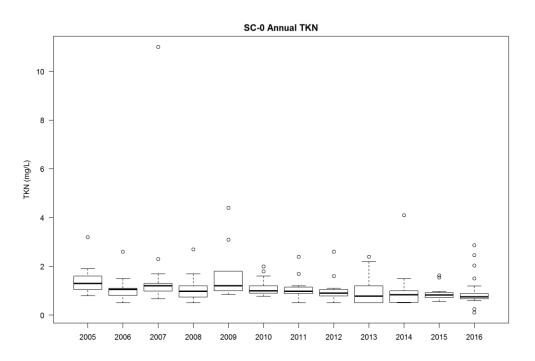


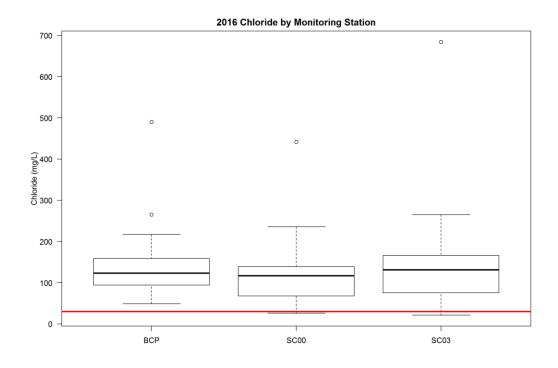


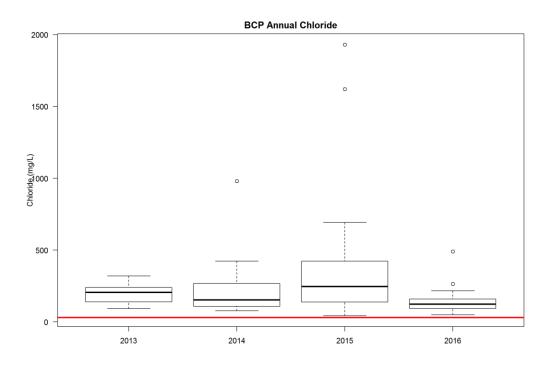


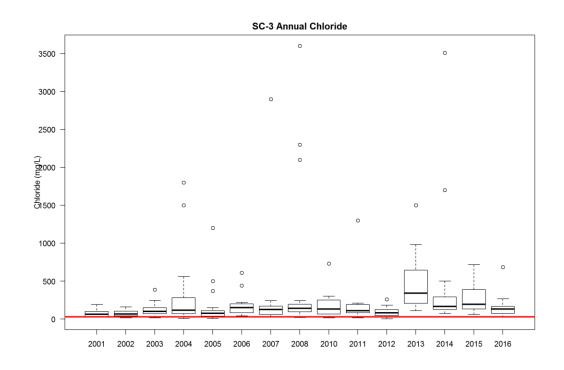


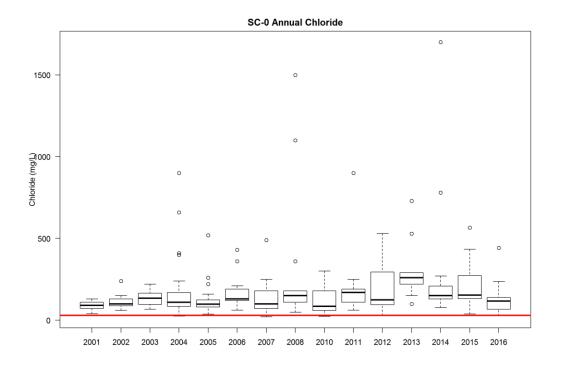


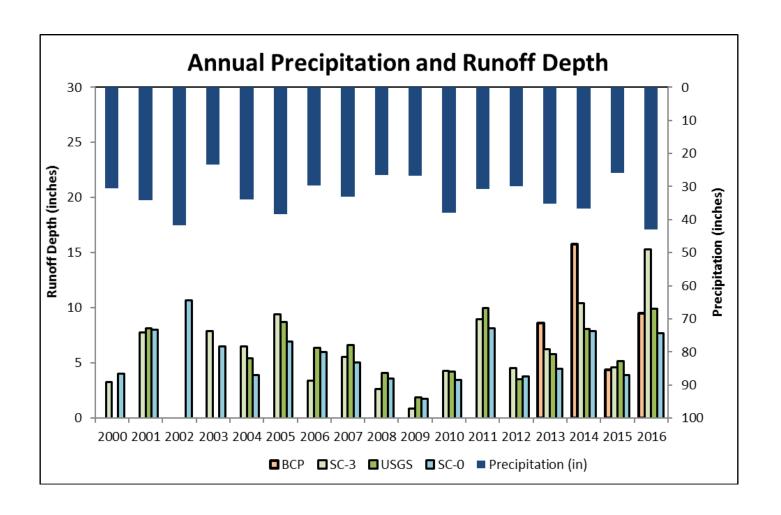












SC-0 Pollutant Load Trends

	Flow	Т	P	Ort	ho-P	TS	5	VS	S	Nit	rate	T	KN
Year	Acre-ft	Load (lbs)	Conc (µg/L)	Load (lbs)	Conc (µg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)
2004	8,612	3,748	160	882	38	749,572	32	308,647	13	4,409	0.19		
2005	15,367	6,820	163	1,320	32	1,577,400	38	1,031,800	25	13,420	0.32	52,800	1.26
2006	13,255	5,060	140	1,540	43	1,095,600	30	459,800	13			39,600	1.10
2007	11,239	3,960	130	880	29	811,800	27	431,200	14	9,240	0.30	38,720	1.27
2008	7,950	3,080	142	660	31	367,400	17	248,600	12	6,380	0.30	25,080	1.16
2009	3,917	880	83	220	21	231,000	22	92,400	9	1,320	0.12	5,720	0.54
2010	7,634	3,300	159	660	32	561,000	27	233,200	11	3,740	0.18	22,000	1.06
2011	18,023	5,814	119	1,255	26	1,098,478	22	465,297	9	14,807	0.30	54,294	1.11
2012	7,943	3,384	157	579	27	648,520	30	286,019	13			21,219	0.98
2013	9,916	4,382	163	511	19	660,628	24	583,448	22	-		36,177	1.34
2014	17,483	5,945	125	1,131	24	1,239,189	26					55,102	1.16
2015	8,630	2,187	113	1,679	71	683,057	29.1			4,680	0.073	23,688	1.01
2016	17,007	4,241	148	3,538	72	785,013	58					7,069	0.309

Note: Annual flows presented in acre-feet/year, pollutant loads in pounds/year, and pollutant flow weighted mean concentrations in mg/L

SC-3 Pollutant Load Trends

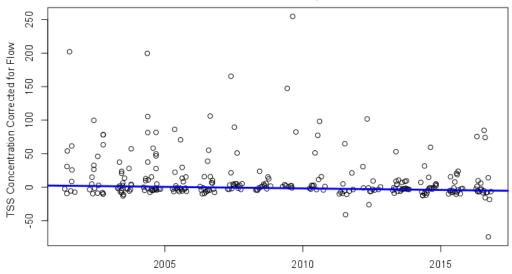
	Flow	Т	Р	Ort	ho-P	TS	5	VS	S	Nit	rate	Т	KN
Year	Acre-ft	Load (lbs)	Conc (µg/L)	Load (lbs)	Conc (µg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)
2004	7,355	4,189	209	1,543	77	599,657	30	255,736	13	6,173	0.31		
2005	10,616	5,500	191	2,640	92	464,200	16	215,600	7	8,800	0.30	35,200	1.22
2006	3,843	2,200	211	880	84	451,000	43	138,600	13	-		20,240	1.94
2007	6,270	2,200	129	880	52	391,600	23	105,600	6	3,960	0.23	24,200	1.42
2008	2,962	880	109	220	27	85,800	11	92,400	11	1,540	0.19	8,580	1.07
2009	961	220	84	1		33,000	13	15,400	6	440	0.17	1,320	0.51
2010	4,799	1,980	152	660	51	391,600	30	147,400	11	4,180	0.32	17,820	1.37
2011	10,099	3,192	116	719	26	591,218	22	211,470	8	3,326	0.12	25,419	0.93
2012	5,147	2,024	145	615	44	287,380	21	108,114	8	-		12,572	0.90
2013	7,033	4,110	215	1,012	53	633,717	33	395,899	21	-		43,336	2.27
2014	11,736	5,042	158	1,594	54	983,344	31			8,865	0.28	34,023	1.07
2015	5,159	2,334	166	1,289	75	293,355	20.9	-		2,101	0.15	15,950	1.14
2016	17,247	4,301	149	3,588	108	796,091	54.7					7169	0.201

BCP Pollutant Load Trends

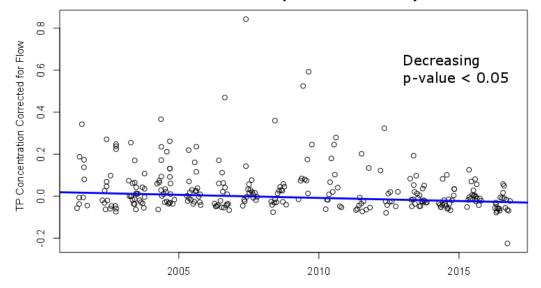
	Flow	Т	Ъ	Ort	ho-P	TS	5	VS	S	Nit	rate	Т	KN
Year	Acre-ft	Load (lbs)	Conc (µg/L)	Load (lbs)	Conc (µg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)	Load (lbs)	Conc (mg/L)
2004													
2005				-				1					
2006													
2007													
2008													
2009													
2010				-									
2011													
2012													
2013													
2014	6,837	1,881	101	776	42	106,971	6	1		4,281	0.23	13,736	0.74
2015	1,493	792	192	531	129	107,640	23.1			1,856	0.148	5,123	1.14
2016	4,107	1,024	99	854	82	189,576	18.2					1,707	0.16

SC-0 Trend analysis

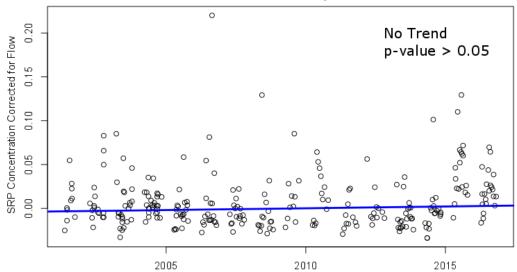
SC-0 TSS Trend Analysis



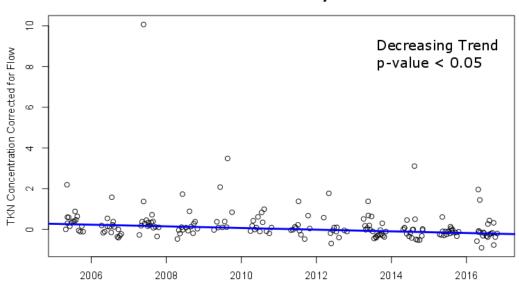
SC-0 Total Phosphorus Trend Analysis



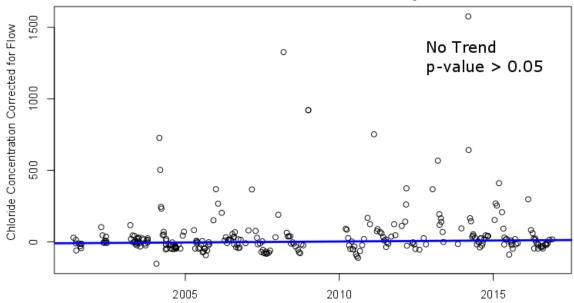
SC-0 SRP Trend Analysis



SC-0 TKN Trend Analysis

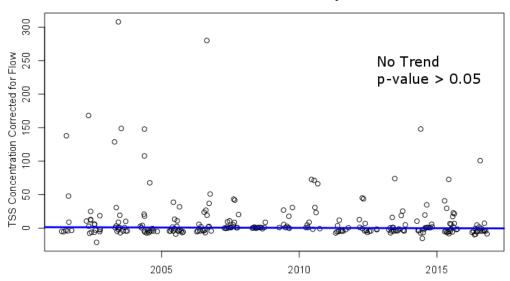


SC-0 Chloride Trend Analysis

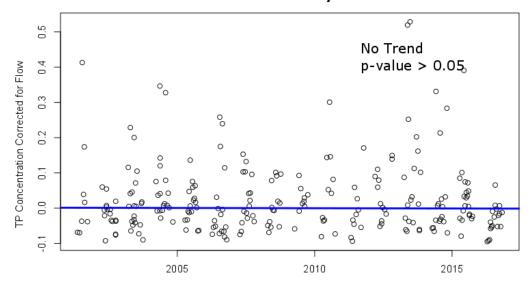


SC-3 Trend analysis

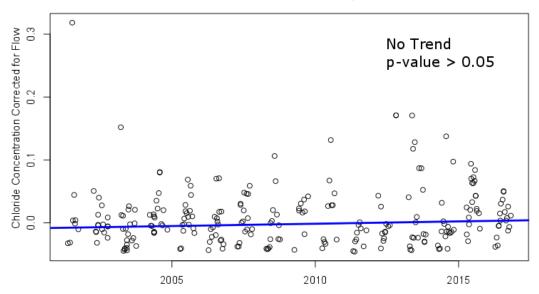
SC-3 TSS Trend Analysis



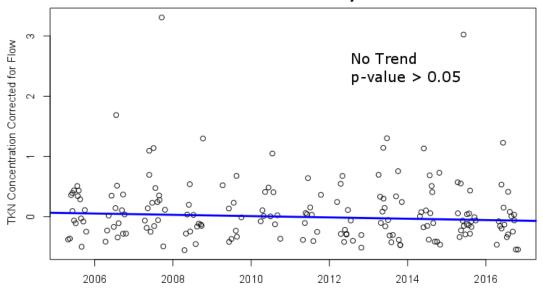
SC-3 TP Trend Analysis



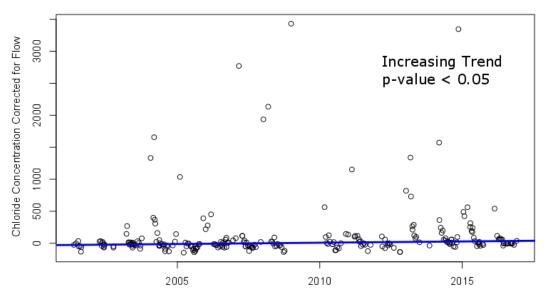
SC-3 SRP Trend Analysis



SC-3 TKN Trend Analysis

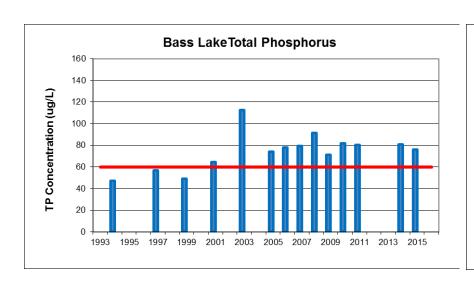


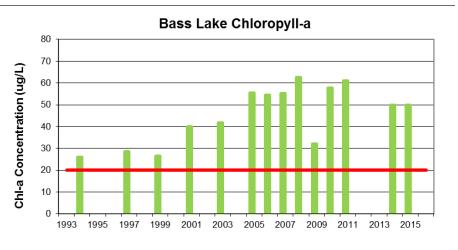
SC-3 Chloride Trend Analysis

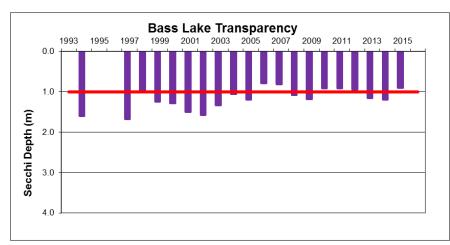


Appendix D: Shingle Creek Lake Trend Analysis

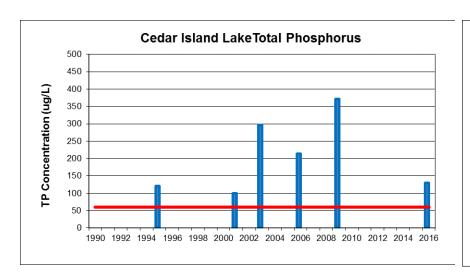
Bass Lake

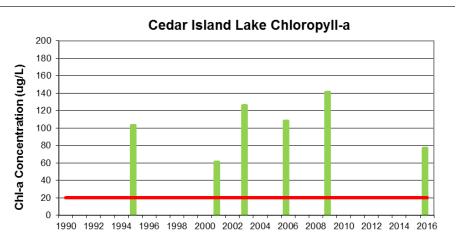


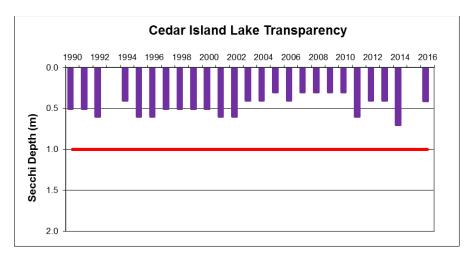




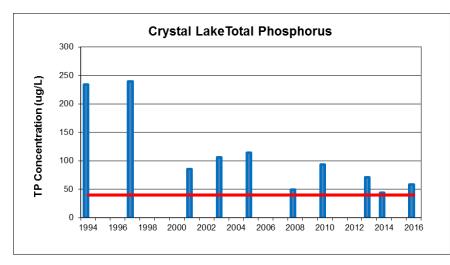
Cedar Island Lake

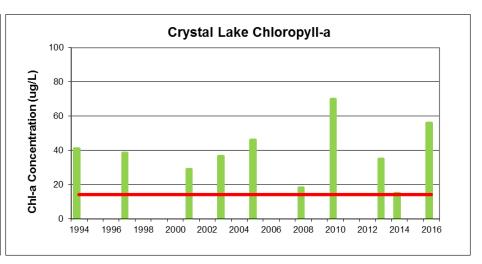


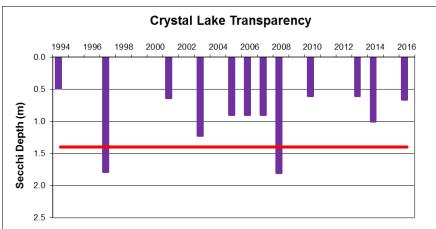




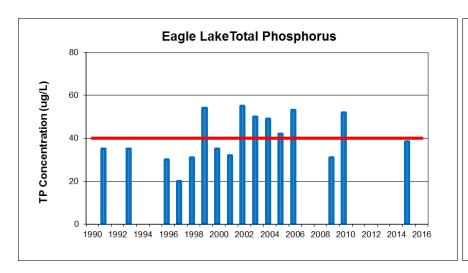
Crystal Lake

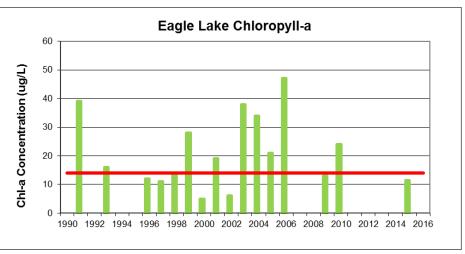


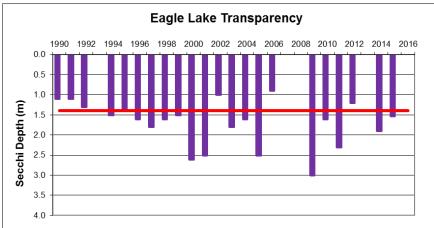




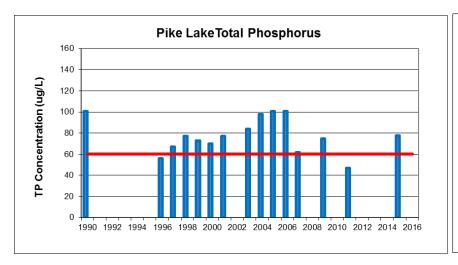
Eagle Lake

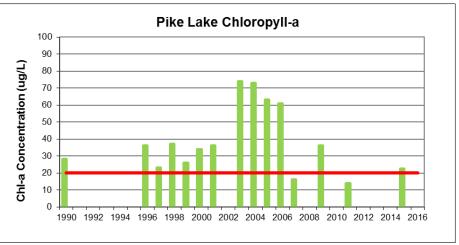


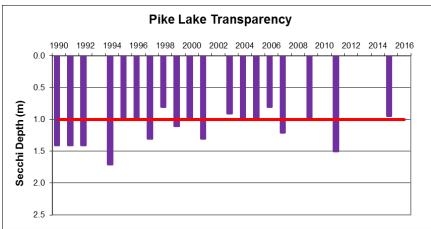




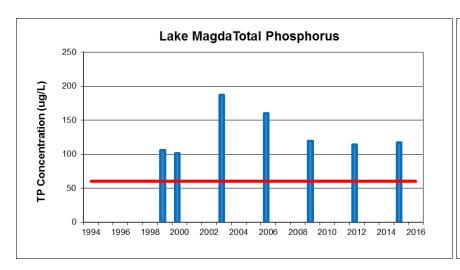
Pike Lake

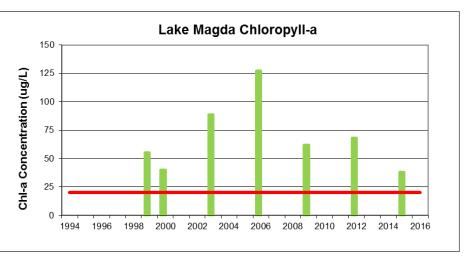


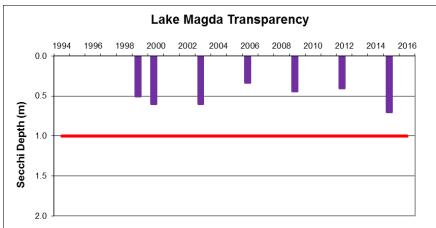




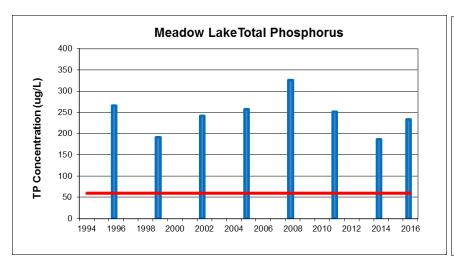
Lake Magda

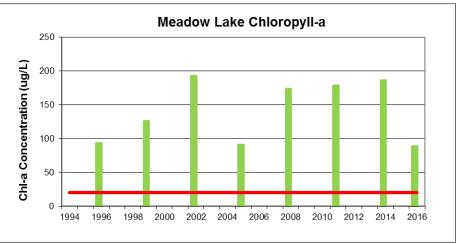


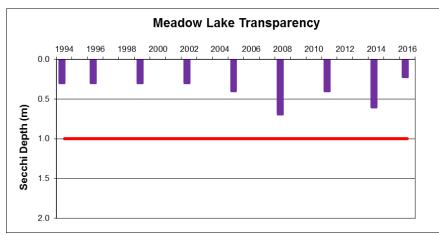




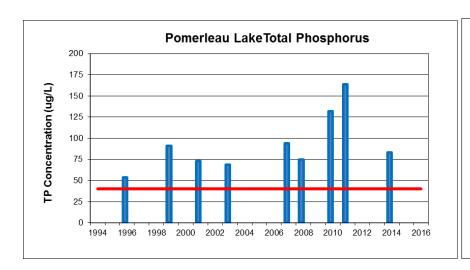
Meadow Lake

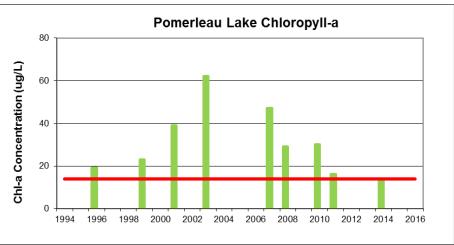


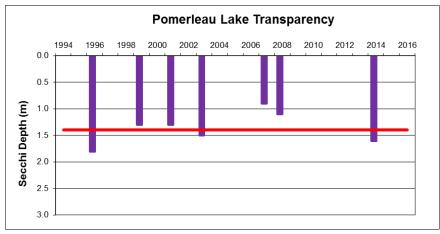




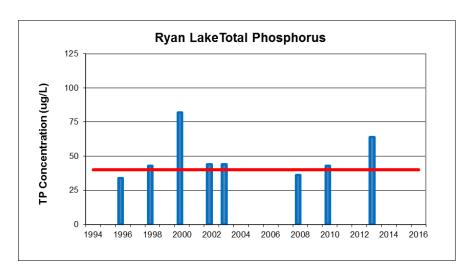
Pomerleau Lake

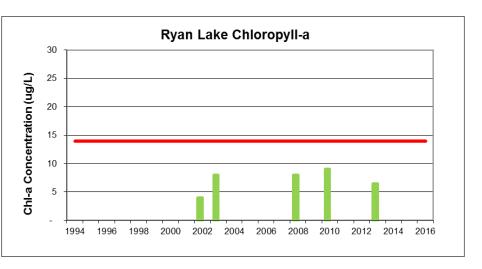


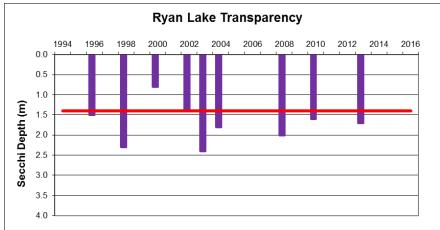




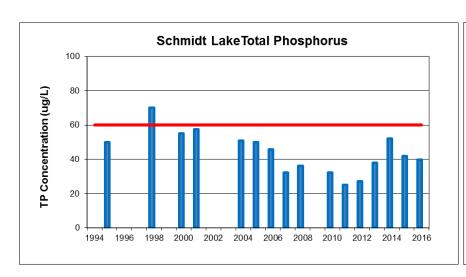
Ryan Lake

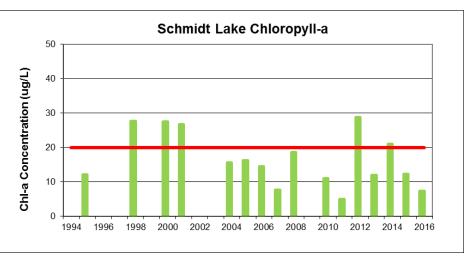


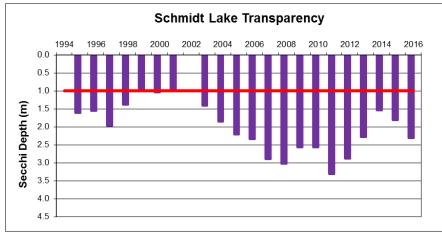




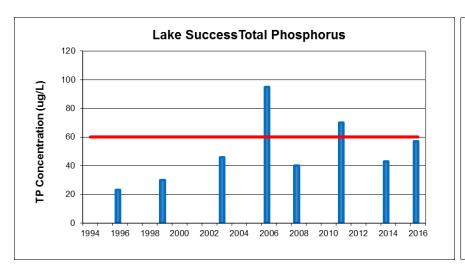
Schmidt Lake

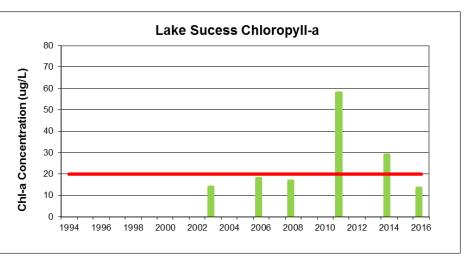


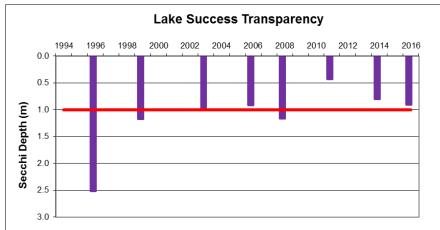




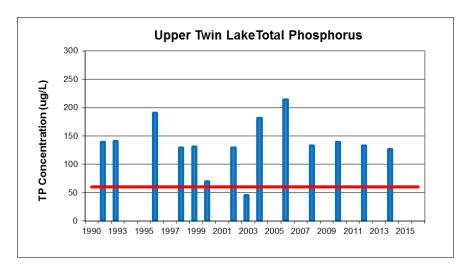
Lake Success

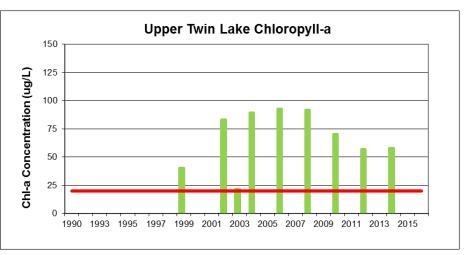


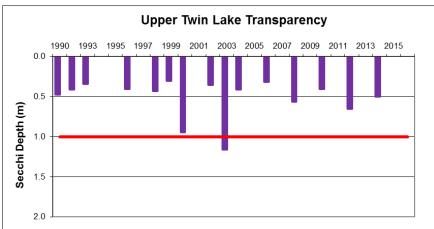




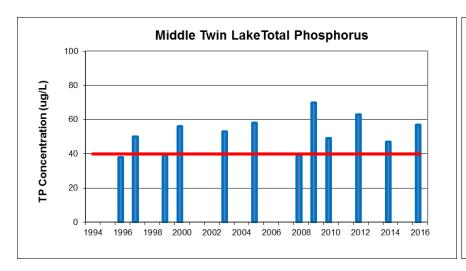
Upper Twin Lake

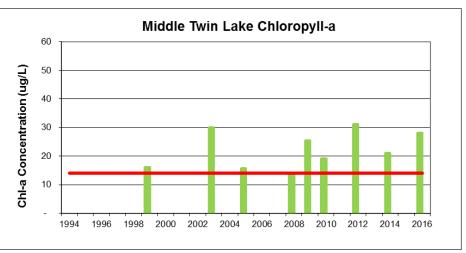


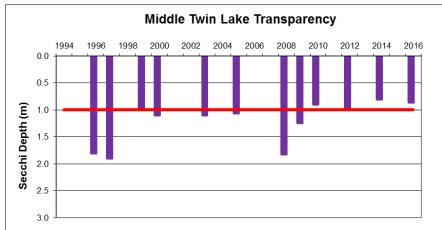




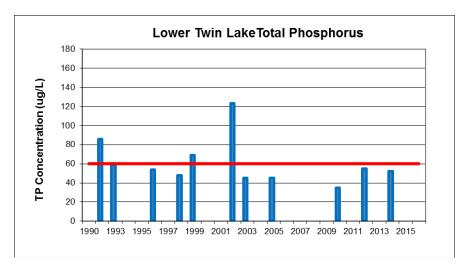
Middle Twin Lake

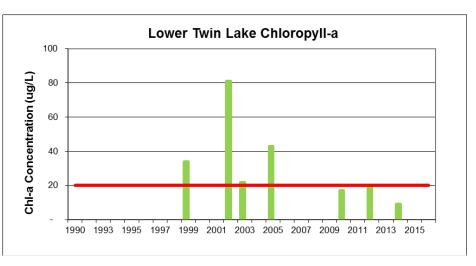


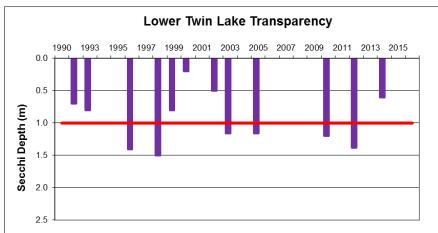




Lower Twin Lake







Appendix E: 2016 5-Year TMDL Review Lake Monitoring

OVERVIEW

The Shingle Creek Third Generation Watershed Management Plan recommends a rotating schedule of intensive monitoring on all lakes in the Shingle Creek Watershed. The primary purpose of the intensive lake monitoring program is to evaluate protection efforts for lakes that are not impaired, and to assess progress toward achieving the TMDLs and state water quality standards for all impaired lakes throughout the watershed. Activities included in the intensive lake monitoring program include water quality monitoring, aquatic vegetation surveys, and fish sampling coordinated with the Department of Natural Resources (DNR).

Meadow Lake was placed on Minnesota's 303(d) list of impaired waters for nutrients (total phosphorus) in 2002. A Total Maximum Daily Load (TMDL) study and Implementation Plan for Meadow Lake was completed and approved in 2010. Lake Success has not been placed on the 303(d) list of impaired waters, however monitoring data indicates that the lake is close to exceeding state water quality standards for multiple parameters. This section details the results of the intensive lake sampling conducted in 2016 on Meadow Lake and Lake Success. The data collected for Meadow Lake will be used in the upcoming five year review of TMDL progress which will be started in 2017 and completed in 2018. The data collected for Success Lake will be used to support development of protection strategies to ensure the lake remains below state water quality standards and off the 303(d) list of impaired waters.

LAKE DESCRIPTIONS

Meadow Lake is approximately 12 acres in size with an average depth of 1.5 feet. Thus, 100% of the surface area is littoral and, therefore, fish, sediment and aquatic vegetation has an impact on the water quality in this shallow. The residence time indicates that runoff from the watershed displaces the lake volume approximately once every 0.12 years (approximately 1.5 months). There are six storm sewer outfalls discharging into the lake and the lake outlets into a storm sewer that discharges to Bass Creek.

Lake Success is approximately 7 acres in size with an average depth of 8.1 feet and 100% littoral area. Wenck will be compiling and reviewing more information on Lake Success as part of the 5-year review, including watershed area, storm sewer outfalls, residence time and other features.

WATER QUALITY MONITORING

Water quality sampling was conducted by Wenck staff at the long-term monitoring sites on Meadow and Success in 2016. Water depth at the Meadow and Success monitoring sites is approximately 3 and 12 feet deep, respectively. For each lake, surface samples were collected bi-weekly from late May to late September and analyzed for TP, Secchi depth, and chlorophyll-a.

Meadow Lake Water Quality

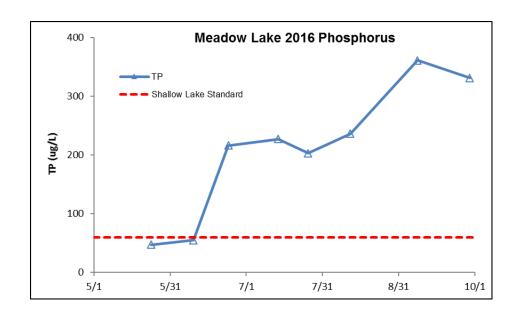
Surface TP concentrations in 2016 initially met the 60 μ g/L standard until mid-June when concentrations increased above the State standard from mid-June until the end of the

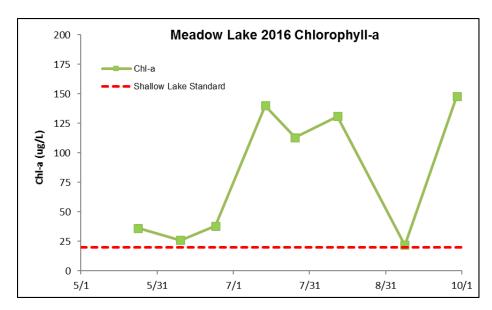
sampling season (see figure below). Chlorophyll-a concentrations and transparency (Secchi depth) did not meet state water quality standards during any of the sampling events in 2016. Historic data (see Appendix D) indicates growing season average TP, chlorophyll-a, have never met state water water quality standards since monitoring began in 1994.

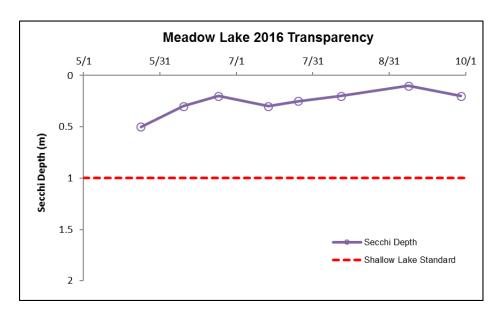
Lake Success Water Quality

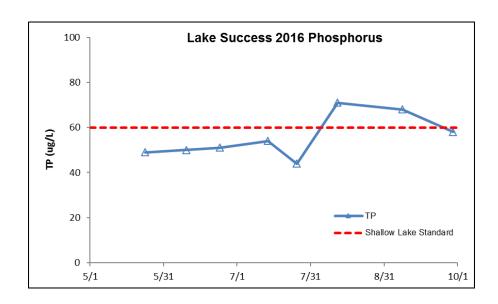
Surface TP concentrations in 2016 initially met the 60 μ g/L standard until mid-August when concentrations increased above the State standard from mid-June until late September (see figure below). Chlorophyll-a concentrations followed a similar pattern to TP and were below the state standards for six of the eight sample events in 2016. Secchi depth, however, did not meet state water quality standards during six of the eight sample events in 2016. Overall, the average summer growing season TP (57 μ g/L) and chlorophyll-a (13 μ g/L) concentrations both met state water quality standards in 2016. Secchi depth (0.9 meters), however, did not meet the 1.0 meter standard in 2016.

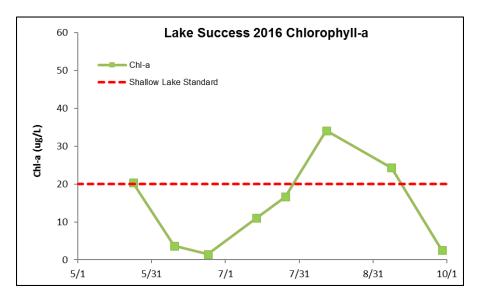
Historic data suggests Lake Success (see Appendix D) has met state standards for TP in four of six years since 2000. Similarly, average chlorophyll-a have concentrations have met state water quality standards in four of six years since 2000. Secchi depth, on the other hand, has only met the state water quality standard in one of six years since 2000.

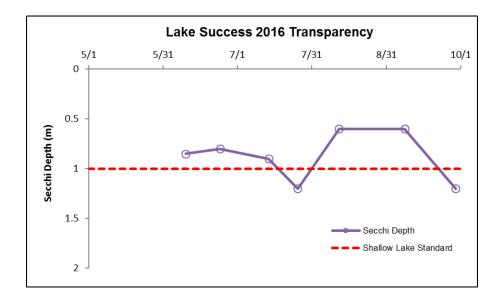












VEGETATION SURVEYS

Point-intercept surveys using methodology developed by the Minnesota Department of Natural Resources (DNR) were conducted on June 12, 2016 and August 25, 2015 on Lake Success and Meadow Lake. Point-intercept sample points were established in GIS across each lake basin using a 25x25 meter grid file which resulted in a total of 56 sample point locations on Lake Success and 75 locations on Meadow Lake. The survey grids were downloaded onto a GPS unit that was used to navigate to each sample point during the surveys. One side of the boat was designated as the sampling area. Water depth was recorded at each sample point using an electronic depth finder.

A double sided weighted 14 tine rake was thrown from the boat and retrieved across three meters of the lake bottom to represent approximately one square meters of vegetation sampling. We refer to this as a rake toss. For each rake toss, all vegetation species collected on the rake tines were identified, placed in a perforated bucket, weighed and assigned a proportion of the total biomass based on visual approximation (i.e. 80% of total weight was curly-leaf pondweed). All biomass values are reported in wet weights (kg). Water clarity was also recorded during each survey by measuring the depth at which a Secchi disk was visible when lowered into the water.

The late summer surveys were conducted to assess each lake's overall plant community and diversity during the peak of the summer growing season. The early summer surveys were conducted to target and estimate the distribution and abundance of curly-leaf pondweed, which senesces by early summer and is missed during late season vegetation surveys.

Native Submerged Vegetation

Native plant species often co-exist with each other and provide a robust and versatile community and habitat for aquatic biota. In the presence of AIS native species are often threatened and reduced to low frequency of abundance, compromising the integrity of the vegetation community. Thus, monitoring the presence of native species provides insight in to what species could be targeted to restore and/or protect the lake's vegetation community. Native vegetation establishment is often an afterthought and typically not the primary motive for lake users, however a native dominated vegetation community should be considered a primary goal to promote water quality and the overall health of the lake's ecosystem.

Curly-leaf Pondweed

Curly-leaf pondweed is dormant through late summer and begins growing in the fall. The plant grows under the ice and reaches its maximum growth in May and June, when most native plant growth is still hindered by cool water temperatures. Since it has little competition from native species early in the year, curly-leaf pondweed can form dense stands that incorporate nutrients from the lake sediments. When the plants begin to die back (senesces) in early summer the nutrients stored in the stems and leaves of the plants are released back into the lake. The timing of the large pulse of nutrients to the lake (typically mid-summer) can cause excess algal blooms or impact water quality negatively in other ways.

Curly-leaf pondweed spreads across the lake by forming turions at the end of each stem tip in early summer which break off and fall to the lake bottom. The turions are distributed across the lake by currents and wave action and germinate into new plants in the early fall.

Vegetation was found at 75 of 75 (100%) sampling sites during the June 2016 survey and only 14 of 75 (19%) sampling sites during the August 2016 survey. Four species of aquatic vegetation were documented during the June survey and only one species was documented during the August survey (Table E-1). Secchi depth was measured at 0.25 meters (\sim 10 inches) during both survey events. In general, vegetation occurrence and diversity decreased over the open water season.

Of the 75 vegetated locations in June the most common species observed was sago pondweed (97%). Of the 14 vegetated locations in August Canadian waterweed was the only species observed. As expected, curly-leaf pondweed observation dropped from 57% occurrence to low/not observed by August. Frequency of occurrence of each plant species observed in Meadow Lake is summarized in Table E-2.

Table E-1: Vegetation sample summary on Meadow Lake.

Sample Date	June 2016	August 2016
Total Observations	75	75
Total Vegetated points	75	14
% of Lake with Vegetation	100%	19%
Total Observed Biomass (kg)	53.0	5.0
Lake Taxa	4	1
Lake FQI	8.0	3.0
Lake FQI Threshold		
Lake FQI Status		

Table E-2: Frequency of species occurrence during Meadow Lake vegetation surveys.

Species		June 2016	August 2016
Common Scientific Name Name		% Occ	currence
muskgrass	Chara sp.	9%	
Canadian waterweed	Elodea canadensis	48%	19%
curly-leaf pondweed	Potamogeton crispus	57%	
sago pondweed	Stuckenia pectinata	97%	

Lake Success Survey Results

No vegetation was observed in Lake Success during either the June or August vegetation surveys. Water clarity is sufficient (Secchi depth = 1.4 and 0.8 meters, respectively) for light penetration to support plant growth, therefore, sediment and/or a viable seed bank appear to be limiting plant growth with Meadow Lake. Communication with lake shore owners indicate that submerged aquatic vegetation used to exist in the lake, however plant growth did not respond after lake levels declined beginning in the early 2000s. At this time, it is unclear as to why vegetation growth is not present in the lake.



Figure E-1: Meadow Lake curly-leaf pondweed locations.

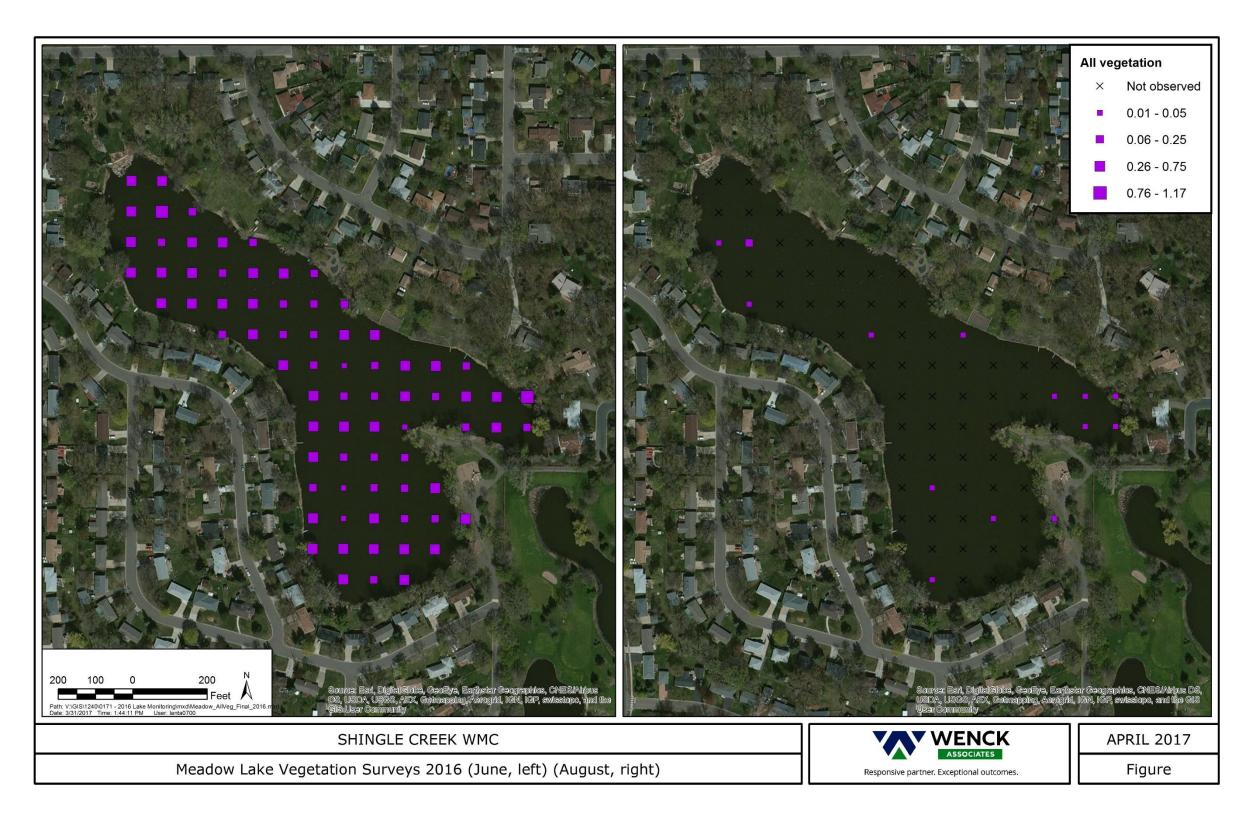


Figure E-2: Meadow Lake total vegetation biomass and locations.



Figure E-3: Lake Success total vegetation biomass and locations.

Appendix F: Macroinvertebrate Monitoring

OVERVIEW

The Commission does not routinely undertake biological monitoring, but does obtain biological data by sponsoring volunteer monitoring through Hennepin County Department of Environment and Energy. High school students and their teachers monitor macroinvertebrates in streams through the River Watch program, and adult volunteers led by trained leaders monitor macroinvertebrates and vegetation in wetlands through the Wetland Health Evaluation Program (WHEP)

STREAM MACROINVERTEBRATE MONITORING

Routine stream macroinvertebrate monitoring in both watersheds is conducted by volunteers through Hennepin County's River Watch program. This program was initiated in 1995 to provide hands-on environmental education for high school and college students, promote river stewardship, and obtain water quality information on the streams in Hennepin County. It is a program of the River Network, a national non-profit organization that promotes community-based programs to restore and protect rivers and watersheds. Through the River Watch program, over 550,000 volunteers nationwide assist in watershed monitoring and assessment. Hennepin County coordinates student and adult volunteers who use the River Watch protocols to collect physical, chemical, and biological data to help determine the health of streams in the watershed.

One of the Commissions' goals is to track changes in streams. Examining the macroinvertebrate community provides a picture of the health of the stream. The results are qualitative and should be interpreted as one indicator of the rivers' health, not scientifically precise data. Another goal is to promote an understanding of the watershed and how water quality is related to land use. The water quality found in one short stretch of stream does not just reflect what is happening in one area. It reflects the water quality of all upstream areas draining into it.

The program began on Shingle Creek in spring 1996 and on Mattson Brook in West Mississippi in spring 1998. 2015 was the 19th year the site at Park Center High School was monitored. Mattson Brook was in the past regularly monitored, but has been irregularly monitored since 2013. Some other sites on Shingle Creek have been monitored for a few years and then for one reason or another dropped from the program.

Retention of volunteer groups is an ongoing issue for this program. Changes in the high school graduation standards, key teaching staff retirements, and school budget reductions all make it difficult to attract and retain school groups.

2015 Monitoring

In 2015, across the county 18 stream stretches were monitored in the spring and/or fall. Overall, two sites received an "A-" grade; three sites received a "B" grade; ten sites a "C" grade; and one site a "D" grade. The SCWM sponsored monitoring at two sites in Shingle Creek in 2015; no volunteer group was found for Mattson Brook in West Mississippi. The grading below shows annual variability that is likely related to precipitation and wet/dry periods. The site adjacent to Park Center High School has one of the longest data records of any of the Riverwatch sites in Hennepin County (Table 7.1). Because this site is currently under construction as part of the Connections at Shingle Creek project, in 2016 the monitoring will be completed upstream of the usual site. This is also where one of the public art reaeration structures will be placed in 2016, to improve dissolved oxygen levels that are currently stressing the biologic community.

Riverwatch site Park Center High School, Brooklyn Park.

Monitored by Park Center High School.

Year	Grade	Year	Grade
2015	D+	2005	С
2014	D+	2004	D
2013	D+	2003	D+
2012	C-	2002	С
2011	C-	2001	D
2010	С	2000	D+
2009	C-	1999	D+
2008	C-	1998	D+
2007	C+	1997	C+
2006	С	1996	B-

Riverwatch site Lions Park, Brooklyn Center.

Monitored by Calvin Christian High School.

Year	Grade	Year	Grade
2015	C-	2011	None
2014	С	2010	None
2013	С	2009	C+
2012	B-		

Sites monitored in previous years but not in 2015:

Riverwatch site Mattson Brook, Brooklyn Park.

Monitored by Minneapolis South High School.

Year	Grade	Year	Grade
2014	С	2004	С
2013	None*	2003	С
2012	C-	2001	С
2010	С	2000	С
2009	С	1999	В
2008	C-	1998	В
2007	C-		

^{*}Water levels too low

Riverwatch site Webber Park, Minneapolis.

Monitored by Patrick Henry High School.

Year	Grade	Year	Grade
2012	D+	2004	С
2011	D+	2003	C-
2010	С	2002	C+
2009	C+	2001	С
2008	С		

${\bf Riverwatch\ site\ North\ Hennepin\ Community\ College,\ Brooklyn\ Park.}$

Monitored by Metro Tech Academy.

Year	Grade	Year	Grade
2013	D+	2011	D+
2012	С		

Riverwatch site Boone Avenue, Brooklyn Park.

Year	Grade	Year	Grade
2010	С	2007	C-
2009	Not monitored	2002	D+
2008	C-	2001	D

Riverwatch site Brookdale Library, Brooklyn Center.

	Year	Grade	Year	Grade
Ī	2009	C+		

Discussion

Based on the limited River Watch sampling, organisms found indicate average to impaired conditions for impacted urban streams. Variability is likely due to the amount of sustained flow in the streams.

Appendix G: Management Unit Maps

