Memorandum

To: Matt Moore —South Washington Watershed District Administrator
From: Bob Fossum, Wendy Griffin, Karen Kill, and Travis Thiel--Washington Conservation District
Date: March 20, 2003
Re: SWWD 2002 Monitoring: MS1, MS2, Powers, 100th Street Station, Fox Run, Tamarack Road, 80th Street, 90th Street, Armstrong Lake, Bailey Lake, Lake Gages, & Observation Wells

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At the request of the South Washington Watershed District (SWWD), the Washington Conservation District (WCD) conducted stream monitoring at four existing stream monitoring stations (MS1, MS2, Powers, and 100th Street), monitored four stormwater sites (Fox Run, Tamarack Road, 80th Street, and 90th Street), monitored water quality and level on Armstrong Lake, monitored level and precipitation on Bailey Lake (at the Lift Station), installed and read eight lake staff gages, and monitored seven groundwater observation wells. The following report summarizes our methods and results for monitoring conducted from January 1 - December 31, 2002. This report and the accompanying data will also be provided in an electronic format.

Stream Sites: MS1, MS2, Powers & 100th Street

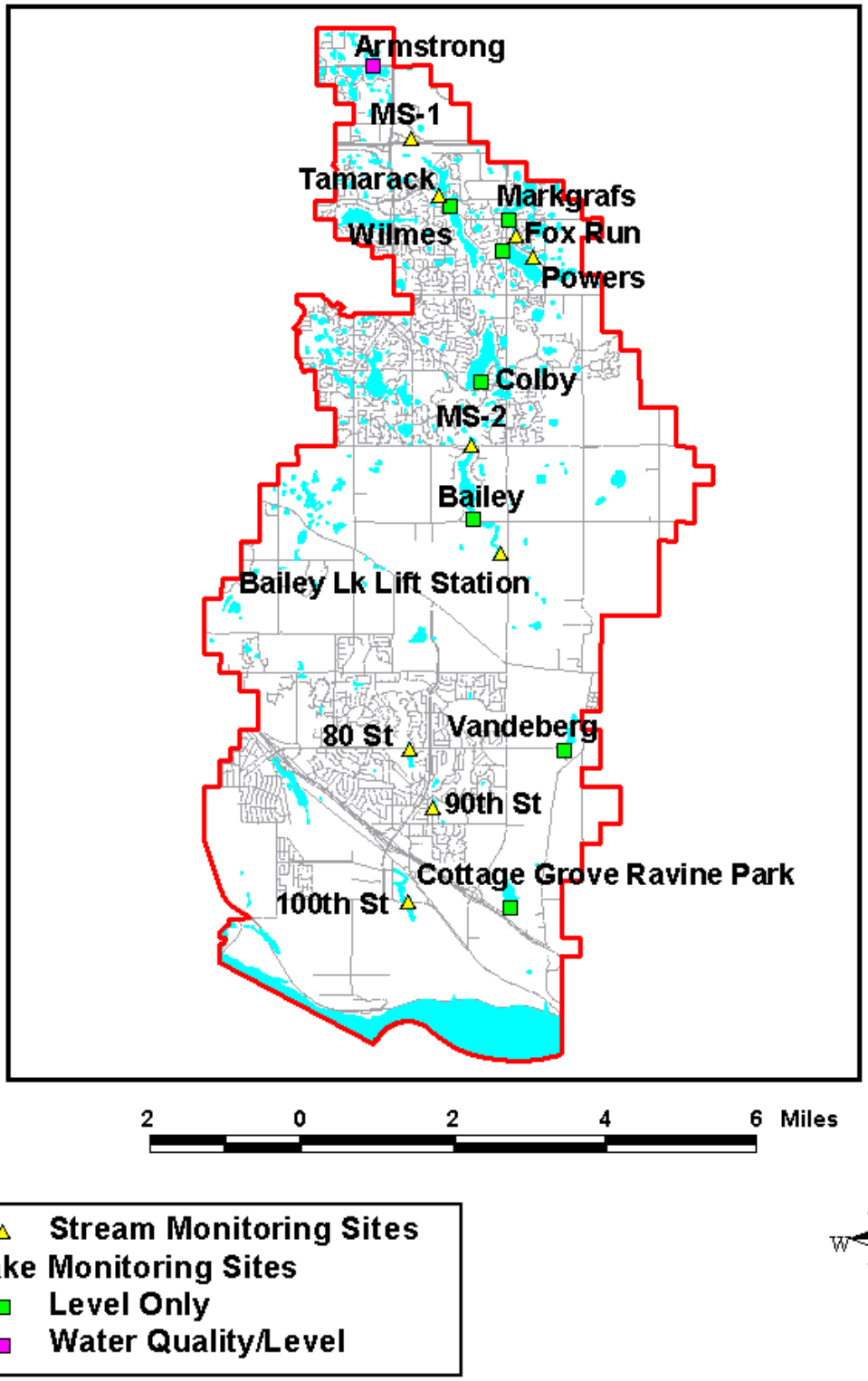
Continuous stage and velocity measurements were taken every 15 minutes at MS1 from April 12–November 4, 2002, at MS2 from April 13–November 4, 2002, at Powers from April 12-November 5, 2002 and at 100th Street from May 6-November 4, 2002. Precipitation data was also continuously collected at each of these sites during the same time period.

Staff gages were installed and read at each site. Field stage measurements were taken in the outflow culverts. Temperature, dissolved oxygen, and transparency tube measurements were also taken. Flow weighted storm event samples, storm event grab samples, snowmelt grab samples, as well as baseflow composite and grab samples were collected at all stream sites. In addition to these samples, fecal grab samples were also taken at all four sites. The samples were analyzed at the Metropolitan Council Lab.

Stage to discharge relationships were developed at all stream sites. When the area-velocity probe was covered with debris, erroneous velocity readings were given. Each site had backup level logger stage recorders that allowed for data collection during periods when the primary equipment was not recording.

Figure 1

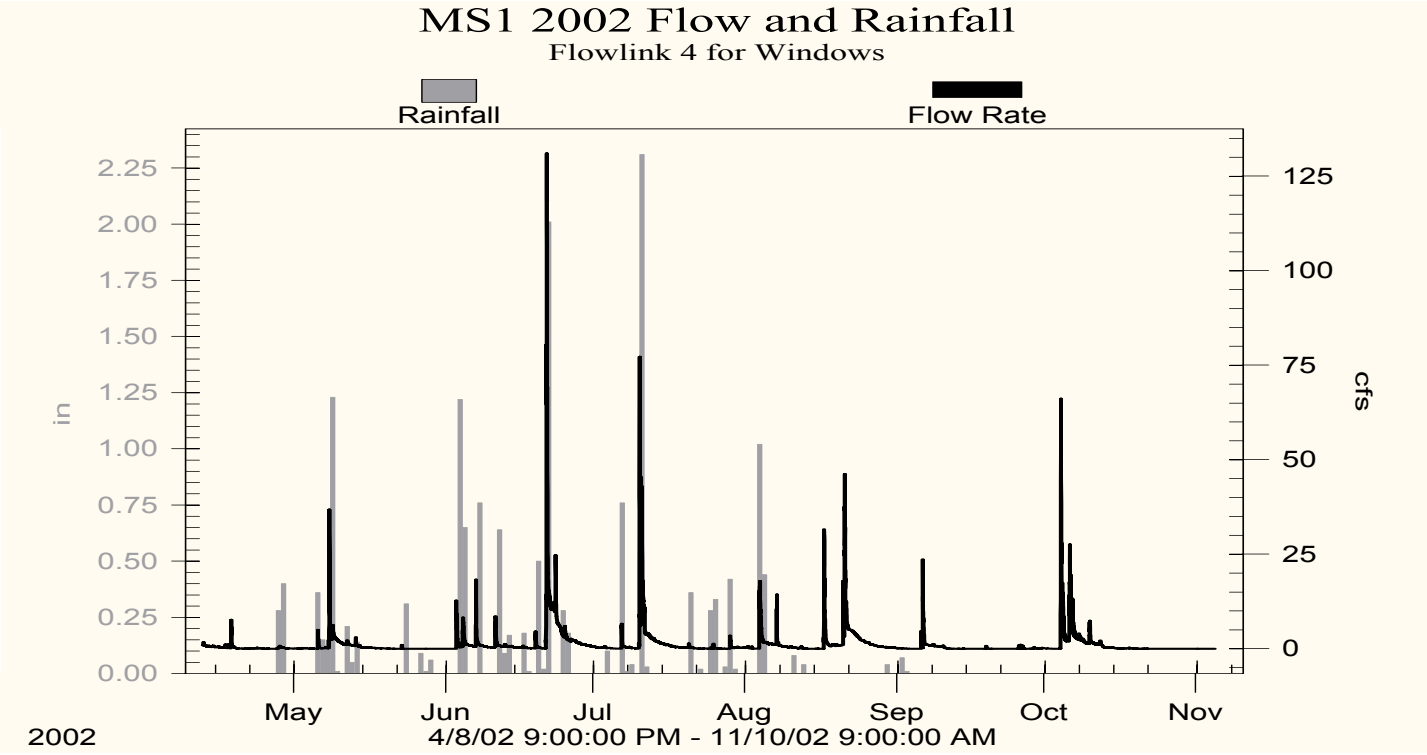
SWWD Monitoring Sites



MS1 (I94)

The hydrograph for the MS1 site shows flows between April 12–November 4, 2002 (Figure 1). Total discharge during this period was 20,033,970 cf or 459 acre-ft. The peak discharge—131.05 cfs, was on June 21, 2002 from daily precipitation of 2.01 inches. The highest daily precipitation—2.31 inches, was on July 10, 2002, and yielded a peak discharge of 77.32 cfs.

Figure 2. MS1 2002 Continuous Flow and Daily Rainfall



Grab and flow weighted composite samples were taken at the MS1 site to determine water quality. Samples were taken during snowmelt and storm runoff, as well as during base flow conditions. The total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total phosphorus (TP), volatile suspended solids (VSS), chemical oxygen demand (COD), and Fecal Coliform concentrations from all collected samples are listed in Table 1. The highest TSS, TKN, and TP concentrations, 1720 mg/L, 6.60 mg/L, and 1.94 mg/L respectively, were all from storm composite samples taken on June 21, 2002. Metals and other Nitrogen species chemical results are listed in Table 2.

Table 1. MS1 2002 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100 mL)	VSS (mg/L)	COD (mg/L)
Snowmelt Grab	3/13/02	14:00	3/13/02	14:00	226	2.00	0.614			66
Snowmelt Grab	3/28/02	16:00	3/28/02	16:00	153	1.80	0.476			61
Snowmelt Grab	4/8/02	15:25	4/8/02	15:25	~5	0.69	0.098		<2	23
Storm Grab	4/11/02	12:10	4/11/02	12:10	320	2.70	0.733		~30	87
Storm Grab	4/18/02	14:55	4/18/02	14:55	28	0.51	0.087		<4	25
Storm Composite	5/9/02	11:59	5/10/02	14:45	34	0.36	0.166		~4	24
Storm Composite	6/3/02	1:29	6/3/02	11:14	796	2.90	1.290		~60	111
Storm Composite	6/4/02	8:00	6/6/02	3:29	342	1.70	0.472		~34	82
Storm Composite	6/7/02	0:44	6/8/02	12:29	572	2.30	0.766		~52	75
Storm Composite	6/11/02	0:00	6/11/02	7:00	560	2.60	1.090		60	114
Storm Composite	6/21/02	8:30	6/21/02	11:18	1720	6.60	1.940		~190	125
Fecal Grab	7/9/02	10:25	7/9/02	10:25				930		
Storm Composite	7/10/02	9:14	7/10/02	16:25	1020	1.70	0.755		<100	87
Storm Composite	8/3/02	19:15	8/4/02	5:00	600	~1.10	1.070		~48	101
Fecal Grab	8/14/02	12:45	8/14/02	12:45				22		
Storm Grab	10/8/02	10:30	10/8/02	10:30	~9	0.68	0.108		<4	27
Storm Grab	10/10/02	11:30	10/10/02	11:30	19	0.87	0.173		<4	23
Fecal Grab	10/14/02	10:00	10/14/02	10:00				450		
Base Grab	10/25/02	13:15	10/25/02	13:15	<2	0.28	~0.041		<2	19
Fecal Grab	10/30/02	10:55	10/30/02	10:55				480		
Fecal Grab	11/14/02	9:20	11/14/02	9:20				4		

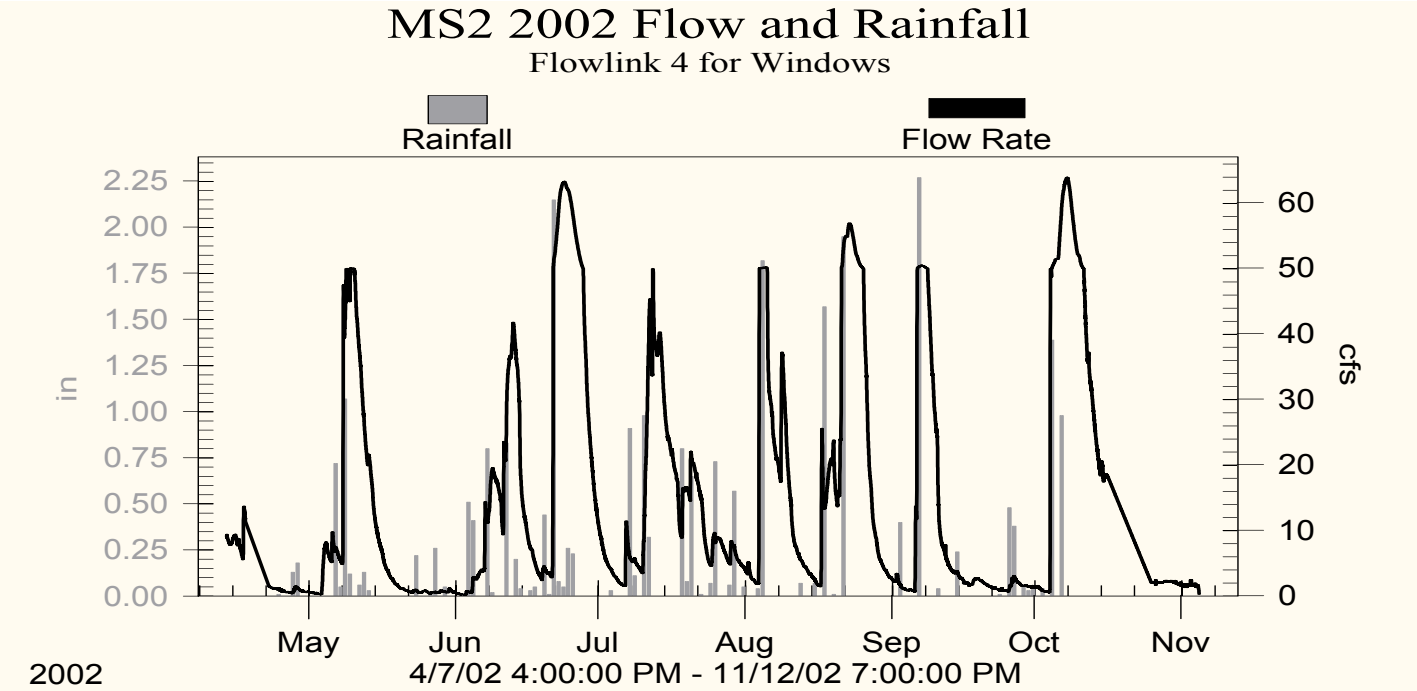
Table 2. MS1 Sample Metals and Nitrogen Species Chemical Results

Sample Type	Start Date	Start Time	End Date	End Time	Copper (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
Snowmelt Grab	3/13/02	14:00	3/13/02	14:00	0.0111	0.0047	0.0253	<0.0001	0.22	0.08	0.83
Snowmelt Grab	3/28/02	16:00	3/28/02	16:00	0.0087	0.0030	0.0230	<0.0001	0.29	0.05	0.32
Snowmelt Grab	4/8/02	15:25	4/8/02	15:25	0.0035	<0.0001	0.0062	<0.0001	<0.02	<0.03	0.25
Storm Grab	4/11/02	12:10	4/11/02	12:10	0.0186	0.0094	0.0430	0.0001	0.08	0.07	0.37
Storm Grab	4/18/02	14:55	4/18/02	14:55	0.003	0.0006	0.0050	<0.0001	<0.02	<0.03	0.05
Storm Composite	5/9/02	11:59	5/10/02	14:45	0.0045	0.0008	0.0100	0.0003	<0.02	<0.03	<0.05
Storm Composite	6/3/02	1:29	6/3/02	11:14	0.0300	0.0167	0.0610	0.0003	0.08	0.25	0.58
Storm Composite	6/4/02	8:00	6/6/02	3:29	0.0143	0.0071	0.0280	0.0003	~0.04	0.06	0.12
Storm Composite	6/7/02	0:44	6/8/02	12:29	0.0192	0.0125	0.0420	0.0003	0.16	0.06	0.40
Storm Composite	6/11/02	0:00	6/11/02	7:00	0.0220	0.0146	0.0490	0.0005	0.10	0.08	0.71
Storm Composite	6/21/02	8:30	6/21/02	11:18	0.0510	0.0500	0.1330	0.0019	0.14	0.17	0.52
Fecal Grab	7/9/02	10:25	7/9/02	10:25							
Storm Composite	7/10/02	9:14	7/10/02	16:25	0.0217	0.0152	0.0490	0.0003	<0.02	0.14	0.52
Storm Composite	8/3/02	19:15	8/4/02	5:00	0.0229	0.0156	0.0510	0.0005	0.10	0.09	0.31
Fecal Grab	8/14/02	12:45	8/14/02	12:45							
Storm Grab	10/8/02	10:30	10/8/02	10:30	0.0017	0.0004	0.0056	<0.00001	~0.05	<0.03	0.57
Storm Grab	10/10/02	11:30	10/10/02	11:30	0.0034	0.0008	0.0076	<0.00001	0.10	<0.03	0.13
Fecal Grab	10/14/02	10:00	10/14/02	10:00							
Base Grab	10/25/02	13:15	10/25/02	13:15	0.0018	<0.0001	0.0065	<0.0001	<0.02	<0.03	0.09
Fecal Grab	10/30/02	10:55	10/30/02	10:55							
Fecal Grab	11/14/02	9:20	11/14/02	9:20							

MS2 (Bailey)

The hydrograph for the MS2 site shows flow between April 13 – November 4, 2002 (Figure 2). Total discharge during this period was 257,829,400 cf or 5,918 acre-ft. The highest flow—63.92 cfs occurred on October 7, 2002, from a total rainfall of 2.37 inches from October 4-October 7, 2002. The highest daily rainfall—2.27 inches, was on August 6, 2002, which yielded a discharge of 50.09 cfs.

Figure 3. MS2 2002 Continuous Flow and Daily Rainfall



Grab samples and flow weighted composite samples were taken at the MS2 site. The TSS, TKN, TP, VSS, COD and Fecal Coliform results from all collected samples are listed in Table 3. The highest TSS concentration of ~21 mg/L was from the August 15, 2002 base grab sample. TKN concentrations had a range of 0.84 to 2.00 mg/L. The highest TKN concentrations were from a March 14, 2002 snowmelt grab sample (2.00 mg/L) and an August 15, 2002 base grab sample (2.00 mg/L). The highest TP concentration (0.36 mg/L) was from a March 14, 2002 snowmelt grab sample. Metals and other Nitrogen species chemical results are listed in Table 4.

Table 3. MS2 2002 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100ml)	VSS (mg/L)	COD (mg/L)
Snowmelt Grab	3/14/02	11:20	3/14/02	11:20	~14	2.00	0.36			45
Snowmelt Grab	4/1/02	13:50	4/1/02	13:50	8	1.50	0.15		7	29
Snowmelt Grab	4/8/02	14:30	4/8/02	14:30	~6	1.20	0.11		~8	32
Storm Grab	4/11/02	15:15	4/11/02	15:15	14	1.30	0.11		~5	29
Storm Grab	4/18/02	15:15	4/18/02	15:15	18	1.00	0.13		~5	30
Storm Grab	4/22/02	16:06	4/22/02	16:20	14	1.60	0.14		~8	32
Storm Grab	5/7/02	9:15	5/7/02	9:15	~10	0.80	0.17		~9	34
Storm Composite	5/9/02	9:39	5/10/02	13:38		1.30	0.13			34
Storm Composite	6/10/02	21:00	6/12/02	13:00	14	1.30	0.11		8	47
Storm Composite	6/14/02	10:10	6/17/02	14:25	16	1.20	0.11		~8	32
Storm Composite	6/21/02	11:45	6/22/02	9:46	15	1.40	0.14		15	52
Fecal Grab	7/9/02	10:00	7/9/02	10:00				77	6	29
Storm Grab	7/29/02	15:45	7/29/02	15:45	20	1.30	0.20		14	55
Storm Grab	8/5/02	14:25	8/5/02	14:25	20	1.80	0.20		~8	40
Fecal Grab	8/14/02	13:40	8/14/02	13:40				170		
Base Grab	8/15/02	10:50	8/15/02	10:50	~21	2.00	0.18			
Storm Grab	10/8/02	8:30	10/8/02	8:30	14	1.50	0.15		~14	46
Storm Grab	10/10/02	10:50	10/10/02	10:50	11	1.20	0.14			
Fecal Grab	10/14/02	9:35	10/14/02	9:35				39	6	30
Base Grab	10/25/02	13:45	10/25/02	13:45	9	1.00	0.08		6	29
Fecal Grab	10/30/02	10:20	10/30/02	10:20				8		
Fecal Grab	11/14/02	9:00	11/14/02	9:00				6		

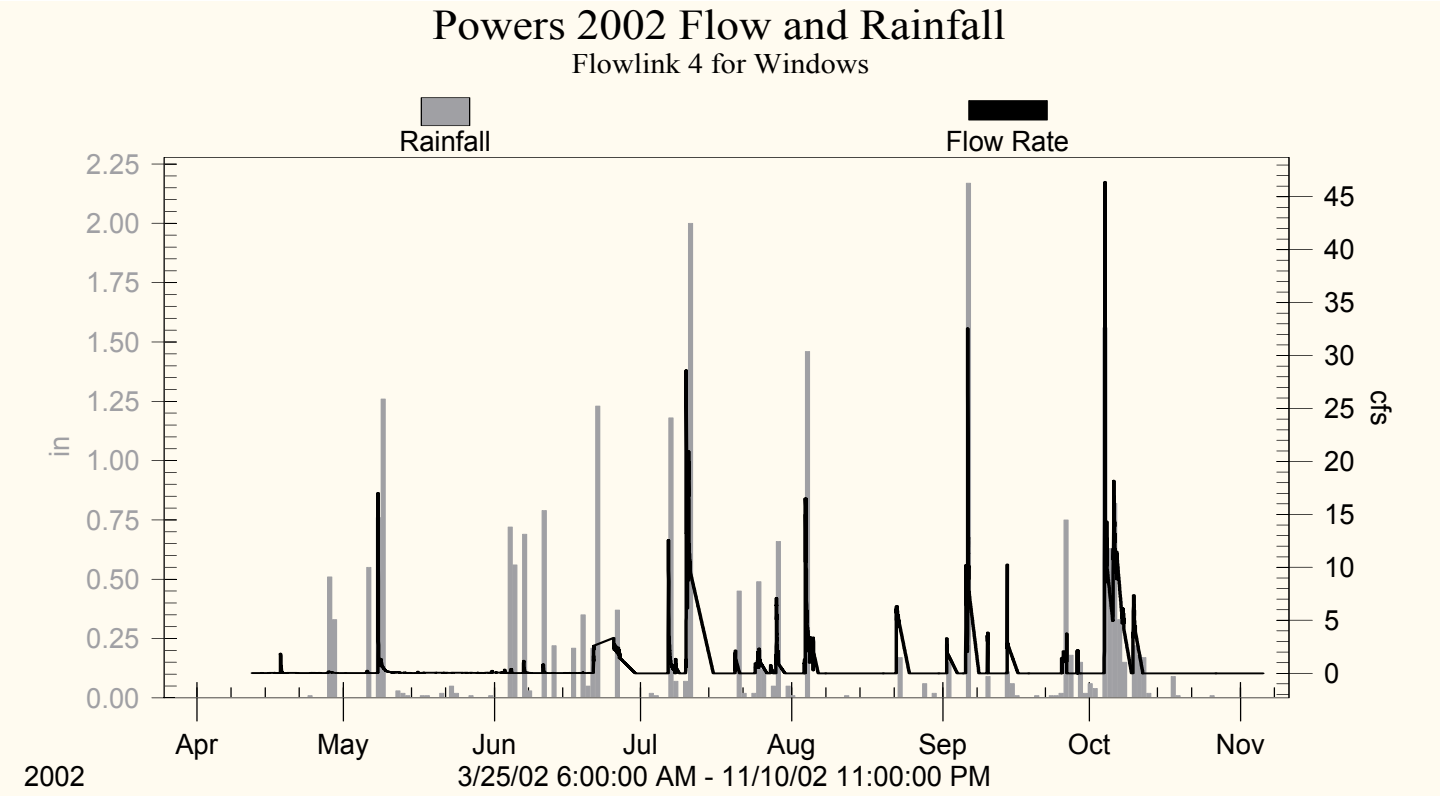
Table 4. MS2 Sample Metals and Nitrogen Species Chemical Results

Sample Type	Start Date	Start Time	End Date	End Time	Copper (mg/L)	Chromium (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
Snowmelt Grab	3/14/02	11:20	3/14/02	11:20	0.007	0	0.16	<0.03	0.23
Snowmelt Grab	4/1/02	13:50	4/1/02	13:50	0.003	<0.0005	<0.02	<0.03	<0.05
Snowmelt Grab	4/8/02	14:30	4/8/02	14:30	0.003	<0.0005	<0.02	<0.03	<0.05
Storm Grab	4/11/02	15:15	4/11/02	15:15	0.004	<0.0005	<0.02	<0.03	0.19
Storm Grab	4/18/02	15:15	4/18/02	15:15	0.006	<0.0005	<0.02	<0.03	<0.05
Storm Grab	4/22/02	16:06	4/22/02	16:20	0.002	0	~0.03	<0.03	0.07
Storm Grab	5/7/02	9:15	5/7/02	9:15	0.002	<0.0005	~0.04	<0.03	<0.05
Storm Composite	5/9/02	9:39	5/10/02	13:38	0.008	0	0.11	<0.03	0.10
Storm Composite	6/10/02	21:00	6/12/02	13:00	0.006	0	<0.02	<0.03	<0.05
Storm Composite	6/14/02	10:10	6/17/02	14:25	0.004	<0.0002	0.06	<0.03	0.06
Storm Composite	6/21/02	11:45	6/22/02	9:46	0.005	0	0.22	<0.30	<0.30
Fecal Grab	7/9/02	10:00	7/9/02	10:00				0.04	0.10
Storm Grab	7/29/02	15:45	7/29/02	15:45	0.002	<0.0002	<0.02	<0.03	<0.05
Storm Grab	8/5/02	14:25	8/5/02	14:25	0.003	0	<0.02	<0.03	0.65
Fecal Grab	8/14/02	13:40	8/14/02	13:40					
Base Grab	8/15/02	10:50	8/15/02	10:50	0.002	0	~0.03		
Storm Grab	10/8/02	8:30	10/8/02	8:30	0.002	0	0.09	<0.03	<0.05
Storm Grab	10/10/02	10:50	10/10/02	10:50	0.002	0	0.12		
Fecal Grab	10/14/02	9:35	10/14/02	9:35				<0.03	0.13
Base Grab	10/25/02	13:45	10/25/02	13:45	0.002	0	<0.02	<0.03	0.50
Fecal Grab	10/30/02	10:20	10/30/02	10:20					
Fecal Grab	11/14/02	9:00	11/14/02	9:00					

Powers Lake Northeast Tributary

The hydrograph for the Powers site shows flow between April 12-November 5, 2002 (Figure 3). The total discharge for this period was 12,980,600 cf or 297 acre-ft. The highest recorded flow was 46.41 cfs on October 4, 2002. The highest amount of daily precipitation—2.17 inches, was recorded on September 6, 2002 and yielded a discharge of 32.26 cfs.

Figure 4. Powers 2002 Continuous Flow and Daily Rainfall



Grab samples and flow weighted composite samples were taken at the Powers site. The TSS, TKN, TP, VSS, COD, and Fecal Coliform results from all collected samples are listed in Table 5. The highest TSS & TP concentrations, 756 mg/L and 1.45 mg/L respectively, were from samples taken on April 1, 2002. The TKN concentration (1.50 mg/L) was also high on April 1, 2002; however, the highest TKN concentration (2.50 mg/L) was from the sample taken on June 10, 2002. Metals and other Nitrogen species chemical results are listed in Table 6.

Table 5. Powers 2002 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	TKN (mg/L)	TP (mg/L)	Fecal Coliform (#/100ml)	COD (mg/L)	VSS (mg/L)
Snowmelt Grab	3/13/02	16:15	3/13/02	16:15	~18	2.20	0.339		24	~5
Snowmelt Grab	4/1/02	14:10	4/1/02	14:10	756	1.50	1.450		50	34
Snowmelt Grab	4/8/02	15:00	4/8/02	15:00	~11	0.96	0.146		36	~10
Storm Grab	4/11/02	11:25	4/11/02	11:25	81	3.00	0.373		33	~10
Storm Grab	4/18/02	15:50	4/18/02	15:50	13	0.80	0.080		30	~8
Storm Composite	5/5/02	21:13	5/6/02	4:35	63	1.30	0.153		74	35
Storm Composite	5/8/02	0:52	5/8/02	5:25	409	1.40	0.413		62	~21
Storm Composite	5/9/02	10:19	5/14/02	0:12	17	0.42	0.162		40	
Storm Composite	6/3/02	0:47	6/3/02	6:17	62	1.50	0.155		43	103
Storm Composite	6/3/02	22:47	6/4/02	15:48	44	1.60	0.279		68	~26
Storm Composite	6/6/02	23:37	6/8/02	9:35	46	0.96	0.137		22	~6
Storm Composite	6/10/02	22:45	6/11/02	0:31	196	2.50	0.440		34	<4
Storm Grab	6/25/02	12:40	6/25/02	12:40	7	0.97	0.158		36	~10
Fecal Grab	7/9/02	10:10	7/9/02	10:10				1000	30	~2
Storm Composite	7/10/02	8:41	7/10/02	12:53	215	1.80	0.356			
Base Grab	8/21/02	13:25	8/21/02	13:25	14	1.60	0.260		44	8
Storm Grab	10/10/02	11:10	10/10/02	11:10	~2	0.78	0.092			
Fecal Grab	10/14/02	9:50	10/14/02	9:50				70	22	~2
Base Grab	10/25/02	13:30	10/25/02	13:30	17	0.18	0.093		10	~3
Fecal Grab	10/30/02	10:40	10/30/02	10:40				30		
Fecal Grab	11/14/02	9:10	11/14/02	9:10				60		

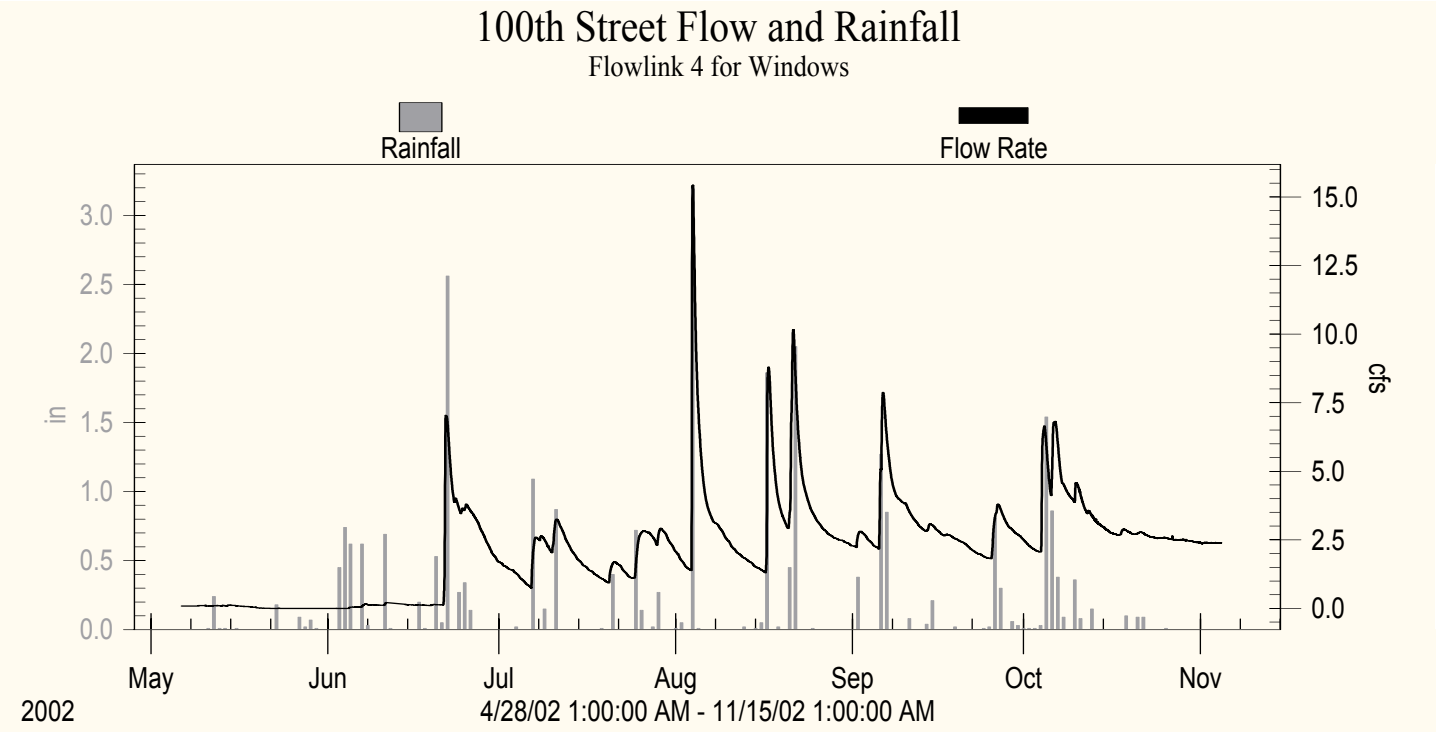
Table 6. Powers 2002 Sample Metals and Nitrogen Species Chemical Results

Sample Type	Start Date	Start Time	End Date	End Time	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Ammonia Nitrogen (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)
Snowmelt Grab	3/13/02	16:15	3/13/02	16:15	0.0097	0.0022	0.0008	0.0140	<0.0001	0	0.26	<0.03	0.05
Snowmelt Grab	4/1/02	14:10	8	14:10	0.0135	0.0106	0.0053	0.3540	0.0001	0.0100	<0.02	<0.03	0.72
Snowmelt Grab	4/8/02	15:00	4/8/02	15:00	0.0050	0.0020	<0.0010	0.0074	0.0001	<0.0005	<0.02	0.03	0.11
Storm Grab	4/11/02	11:25	4/11/02	11:25	0.0089	0.0029	0.0011	0.0130	<0.0001	0	0.07	<0.03	0.14
Storm Grab	4/18/02	15:50	4/18/02	15:50	0.0047	0.0020	0.0005	0.0071	<0.0001	0	<0.02	0.03	0.14
Storm Composite	5/5/02	21:13	5/6/02	4:35	0.0080	0.0038	0.0014	0.0125	0.0001	0	0.18	<0.03	0.15
Storm Composite	5/8/02	0:52	5/8/02	5:25	0.0116	0.0069	0.0045	0.0220	0.0001	0.0100	0.19	<0.03	0.44
Storm Composite	5/9/02	10:19	5/14/02	0:12	0.0037	0.0020	<0.0010	0.0045	0.0001	0	<0.02	0.03	0.26
Storm Composite	6/3/02	0:47	6/3/02	6:17	0.0053	0.0026	<0.0010	0.0079	<0.0001	0	~0.02	<0.03	0.16
Storm Composite	6/3/02	22:47	6/4/02	15:48	0.0055	0.0027	0.0008	0.0084	0.0001	0	0.16	0.05	0.23
Storm Composite	6/6/02	23:37	6/8/02	9:35	0.0038	0.0025	0.0006	0.0070	0.0001	0	0.12	<0.03	0.05
Storm Composite	6/10/02	22:45	6/11/02	0:31	0.0143	0.0062	0.0034	0.0260	0.0004	0.0100	0.29	<0.03	0.08
Storm Grab	6/25/02	12:40	6/25/02	12:40	0.0020	0.0022	0.0002	0.0034	<0.0001	<0.0004	0.14	<0.03	0.11
Fecal Grab	7/9/02	10:10	7/9/02	10:10								<0.03	0.08
Storm Composite	7/10/02	8:41	7/10/02	12:53	0.0068	0.0041	0.0018	0.0144	0.0003	0	0.13		
Base Grab	8/21/02	13:25	8/21/02	13:25	0.0033	0.0017	0.0002	0.0040	<0.0001	0	0.06	<0.03	0.14
Storm Grab	10/10/02	11:10	10/10/02	11:10	0.0026	0.0017	0.0001	0.0038	<0.0001	0	~0.03		
Fecal Grab	10/14/02	9:50	10/14/02	9:50								<0.03	0.08
Base Grab	10/25/02	13:30	10/25/02	13:30	0.0020	0.0041	0.0001	0.0044	<0.0001	0	<0.02	<0.03	<0.05
Fecal Grab	10/30/02	10:40	10/30/02	10:40									
Fecal Grab	11/14/02	9:10	11/14/02	9:10									

100th Street (Cottage Grove)

The hydrograph for the 100th Street site shows flow between May 6-November 4, 2002 (Figure 4). Total discharge during this period was 34,867,590 cf or 800 acre/ft. The highest discharge—15.42 occurred on August 4, 2002, from a total rainfall of 3.21 inches, which fell late on August 3rd. The rainfall on August 3rd was also the highest daily rainfall for the monitoring period.

Figure 5. 100th Street 2002 Flow (cfs) and Daily Rainfall (in)



Grab samples and flow weighted composite samples were taken at the 100th Street site. The TSS, TKN, TP, VSS, COD, and Fecal Coliform results from all collected samples are listed in Table 7. The highest TSS and TP concentrations (38 mg/L) and (0.15 mg/L) respectively, were collected from a storm composite sample on June 4, 2002. The highest TKN concentration (2.20 mg/L) was collected from a base grab on April 16, 2002. Metals and other Nitrogen species chemicals are listed in Table 8.

Table 7. 100th Street 2002 Sample Chemistry Results

Sample Type	Start Date	Start Time	End Date	End Time	TSS (mg/L)	TKN (mg/L)	TP (mg/L)	COD (mg/L)	Fecal Coliform (#/100ml)	VSS (mg/L)
Base Grab	4/16/02	13:00	4/16/02	13:00	9	2.20	0.11	29		8
Storm Grab	4/18/02	13:55	4/18/02	13:55	10	1.10	0.09	23		~4
Storm Grab	4/22/02	15:15	4/22/02	15:15	~2	0.62	0.06	15		~5
Base Grab	4/26/02	14:05	4/26/02	14:05	~4	0.74	0.07	14		7
Storm Composite	5/10/02	14:57	5/14/02	7:51	11	1.00	0.11	15		~2
Storm Composite	6/4/02	18:27	6/5/02	5:11	38	2.10	0.15	42		~2
Storm Composite	6/7/02	0:49	6/8/02	4:54	27	1.10	0.09	19		~5
Storm Composite	6/21/02	7:04	6/21/02	12:52	22	1.00	0.12	24		16
Fecal Grab	7/9/02	9:48	7/9/02	9:48					90	6
Storm Composite	7/25/02	5:22	7/25/02	15:14	~5	0.29	0.09	21		7
Storm Composite	8/3/02	19:18	8/3/02	22:27	24	0.68	0.14	26		6
Fecal Grab	8/14/02	14:30	8/14/02	14:30					420	~5
Storm Composite	8/14/02	17:48	8/16/02	10:09	8	0.62	0.06	13		7
Storm Composite	8/16/02	23:23	8/17/02	6:20	11	1.00	0.10	18		
Storm Composite	9/5/02	19:35	9/6/02	22:06	10	0.70	0.06	17		
Storm Grab	10/4/02	7:24	10/4/02	20:37	18	0.77	0.11	28		~4
Storm Grab	10/10/02	10:30	10/10/02	10:30	~3	0.65	0.08	13		
Fecal Grab	10/14/02	9:10	10/14/02	9:10					59	~2
Base Grab	10/25/02	14:05	10/25/02	14:05	<2	0.18	~0.03	10		<2
Fecal Grab	10/30/02	10:00	10/30/02	10:00					26	
Fecal Grab	11/14/02	8:30	11/14/02	8:30				<1	<1	

Table 8. 100th Street 2002 Sample Metals and Nitrogen Species Chemical Results

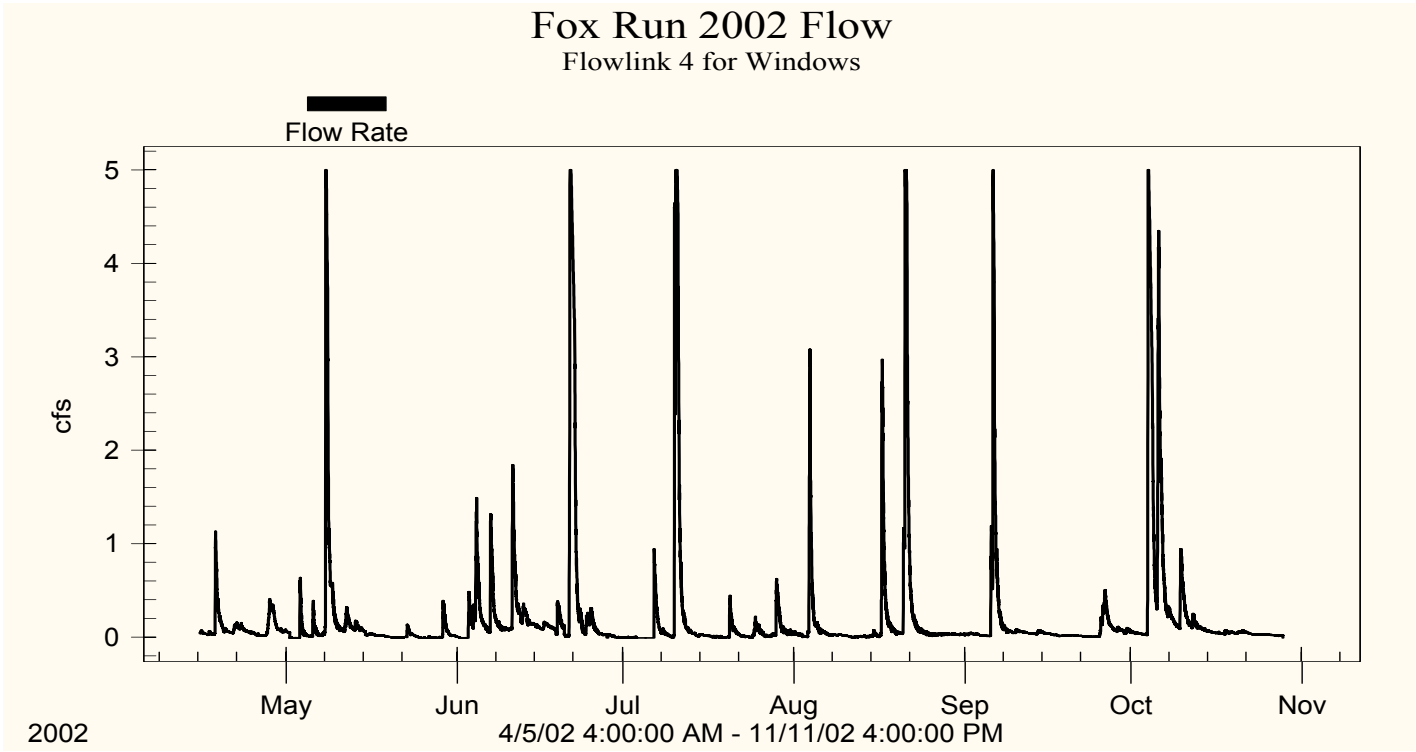
Sample Type	Start Date	Start Time	End Date	End Time	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)
Base Grab	4/16/02	13:00	4/16/02	13:00	<0.03	0.06	<0.02	0.0030	0.0025	0.0003	0.0044	<0.0001	<0.0001
Storm Grab	4/18/02	13:55	4/18/02	13:55	<0.03	0.10	0.11	0.0013	0.0016	0.0001	0.0021	0.0001	<0.0002
Storm Grab	4/22/02	15:15	4/22/02	15:15	0.10	1.14	0.88	0.0032	0.0028	<.00005	0.0028	<0.0001	<0.0005
Base Grab	4/26/02	14:05	4/26/02	14:05	0.07	0.75	0.15	0.0040	0.0025	<0.0005	0.0032	<0.0001	<0.0005
Storm Composite	5/10/02	14:57	5/14/02	7:51	<0.03	0.40	0.15	0.0012	0.0021	<00005	0.0019	<0.0001	<0.0005
Storm Composite	6/4/02	18:27	6/5/02	5:11	<0.03	0.09	~0.04	0.0023	0.0023	<0.0005	0.0023	<0.0001	<0.0005
Storm Composite	6/7/02	0:49	6/8/02	4:54	<0.03	<0.05	0.11	0.0025	0.0026	<0.0005	0.0037	0.0001	<0.0005
Storm Composite	6/21/02	7:04	6/21/02	12:52	<0.03	<0.05	0.09	0.0033	0.0032	0.0012	0.0093	0.0001	0.0005
Fecal Grab	7/9/02	9:48	7/9/02	9:48	<0.03	0.09	0.09	0.0022	0.0022	0.0005	0.0072	0.0001	<0.0004
Storm Composite	7/25/02	5:22	7/25/02	15:14	<0.03	0.15	0.13	0.0031	0.0023	0.0009	0.0060	0.0001	0.0012
Storm Composite	8/3/02	19:18	8/3/02	22:27	<0.03	0.23	0.23	0.0022	0.0019	0.0005	0.0055	<0.0001	0.0005
Fecal Grab	8/14/02	14:30	8/14/02	14:30	0.04	0.97	~0.05	0.0024	0.0020	0.0003	0.0045	<0.0001	0.0006
Storm Composite	8/14/02	17:48	8/16/02	10:09	0.03	0.88	<0.02	0.0025	0.0026	0.0006	0.0071	0.0001	0.0010
Storm Composite	8/16/02	23:23	8/17/02	6:20									
Storm Composite	9/5/02	19:35	9/6/02	22:06									
Storm Grab	10/4/02	7:24	10/4/02	20:37	0.04	0.65	<0.02	0.0020	0.0020	0.0002	0.0033	<0.0001	<0.0002
Storm Grab	10/10/02	10:30	10/10/02	10:30									
Fecal Grab	10/14/02	9:10	10/14/02	9:10	0.06	0.77	0.08	0.0025	0.0018	0.0002	0.0040	<0.0001	0.0003
Base Grab	10/25/02	14:05	10/25/02	14:05	0.05	1.54	<0.02	0.0018	0.0024	0.0001	0.0027	<0.0001	<0.0002
Fecal Grab	10/30/02	10:00	10/30/02	10:00									
Fecal Grab	11/14/02	8:30	11/14/02	8:30									

Stormwater Sites: Fox Run, Tamarack Road, 80th Street, 90th Street, and Bailey Lake (at Lift Station)

Fox Run

The hydrograph for the Fox Run stormwater site shows flow between April 15-October 28, 2002 (Figure 5). The total discharge for this period was 3,463,527 cf or 79 acre-ft. The highest recorded flow was 5 cfs on May 8, June 21, July 10, August 21, September 6, and October 4. Peak Discharge from this site had to be estimated because of numerous periods when the inlet was submerged. The 5-cfs maximum discharge was estimated based upon stage-discharge relationships established from manual readings and the pipe diameter. Although the maximum discharge was a fixed number, the stage on June 21, 2002 was the highest at 3.76 ft. There was no precipitation gage at this site. No chemistry data was collected at this site.

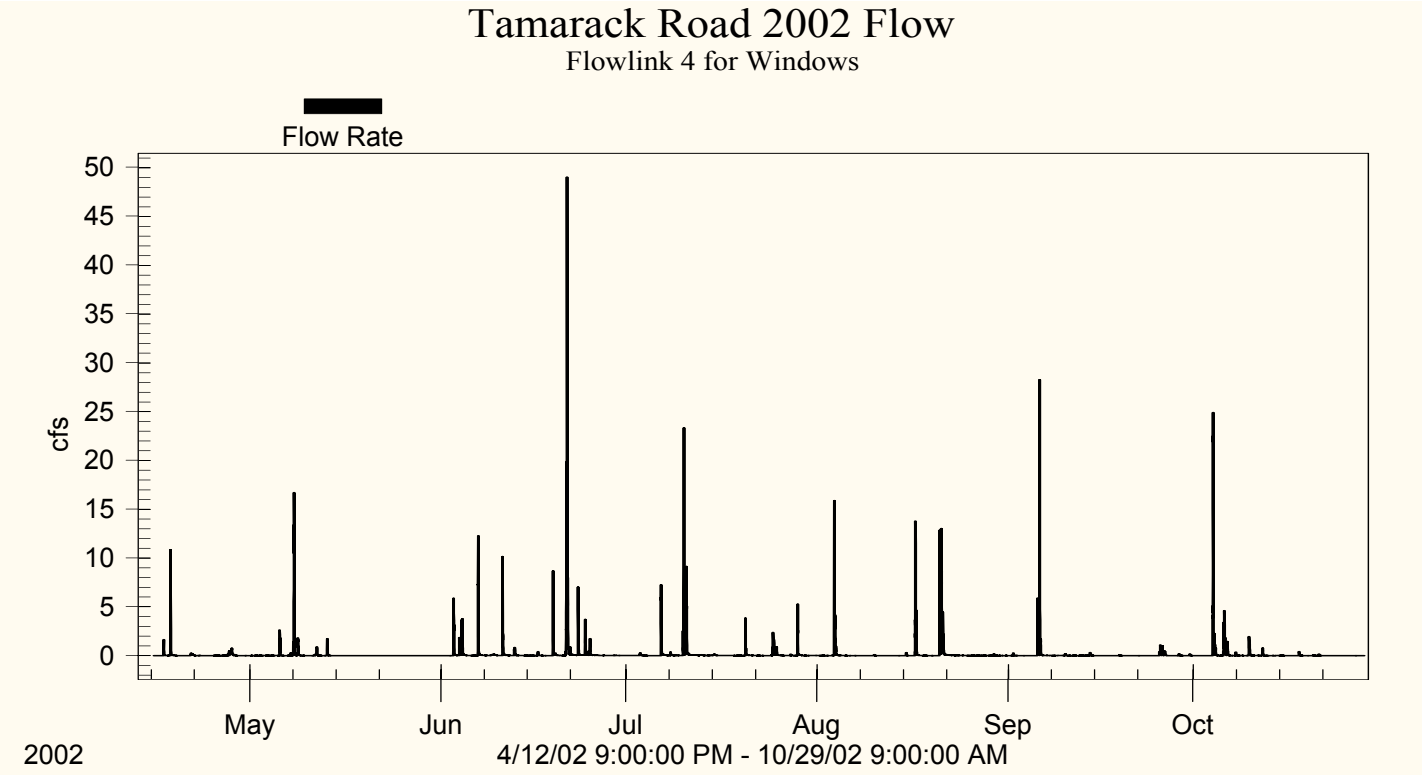
Figure 6. Fox Run 2002 Continuous Flow



Tamarack Road

The hydrograph for the Tamarack Road stormwater site shows flow between April 15-October 28, 2002 (Figure 6). The total discharge for this period was 1,715,602 cf or 39 acre-ft. The highest discharge at this site--49.05 cfs was on June 21, 2002. There was no precipitation gage at this site. No chemistry data was collected at this site.

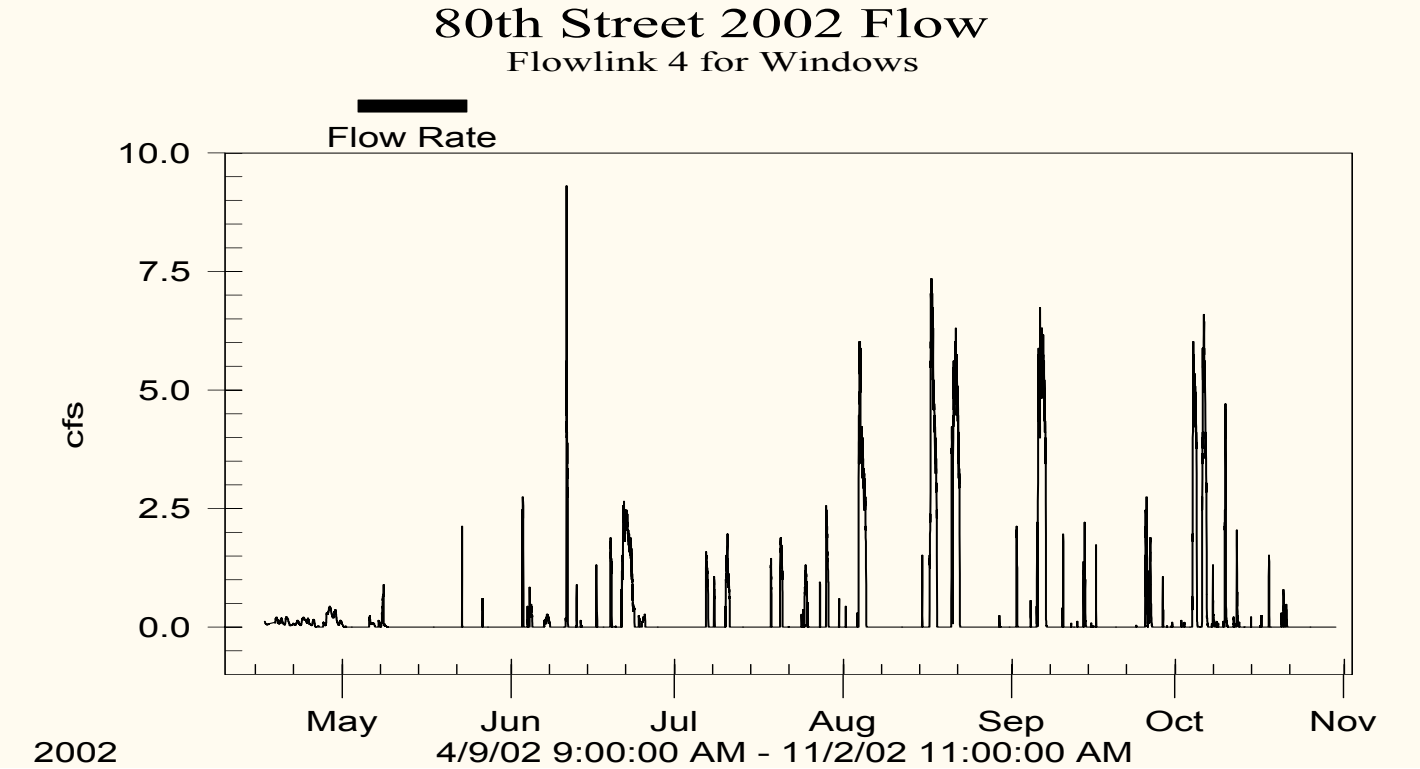
Figure 7. Tamarack Road 2002 Continuous Flow



80th Street

The hydrograph for the 80th Street stormwater site shows flow between April 16-October 30, 2002 (Figure 7). The total discharge for this period was 4,187,958 cf or 96 acre-ft. The high flow at this site—9.31 cfs was on June 11, 2002. There was no precipitation gage at this site. No chemistry data was collected at this site.

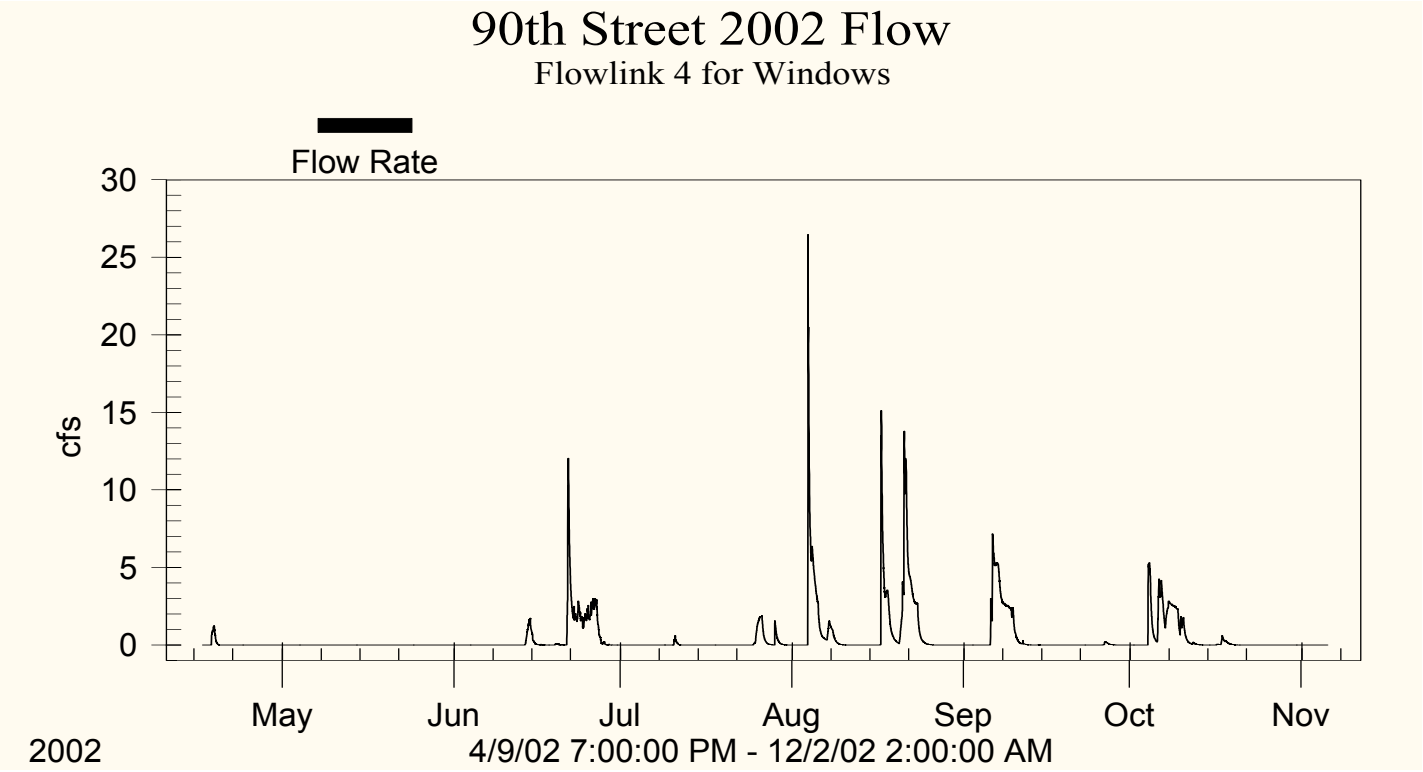
Figure 8. 80th Street Continuous Flow



90th Street

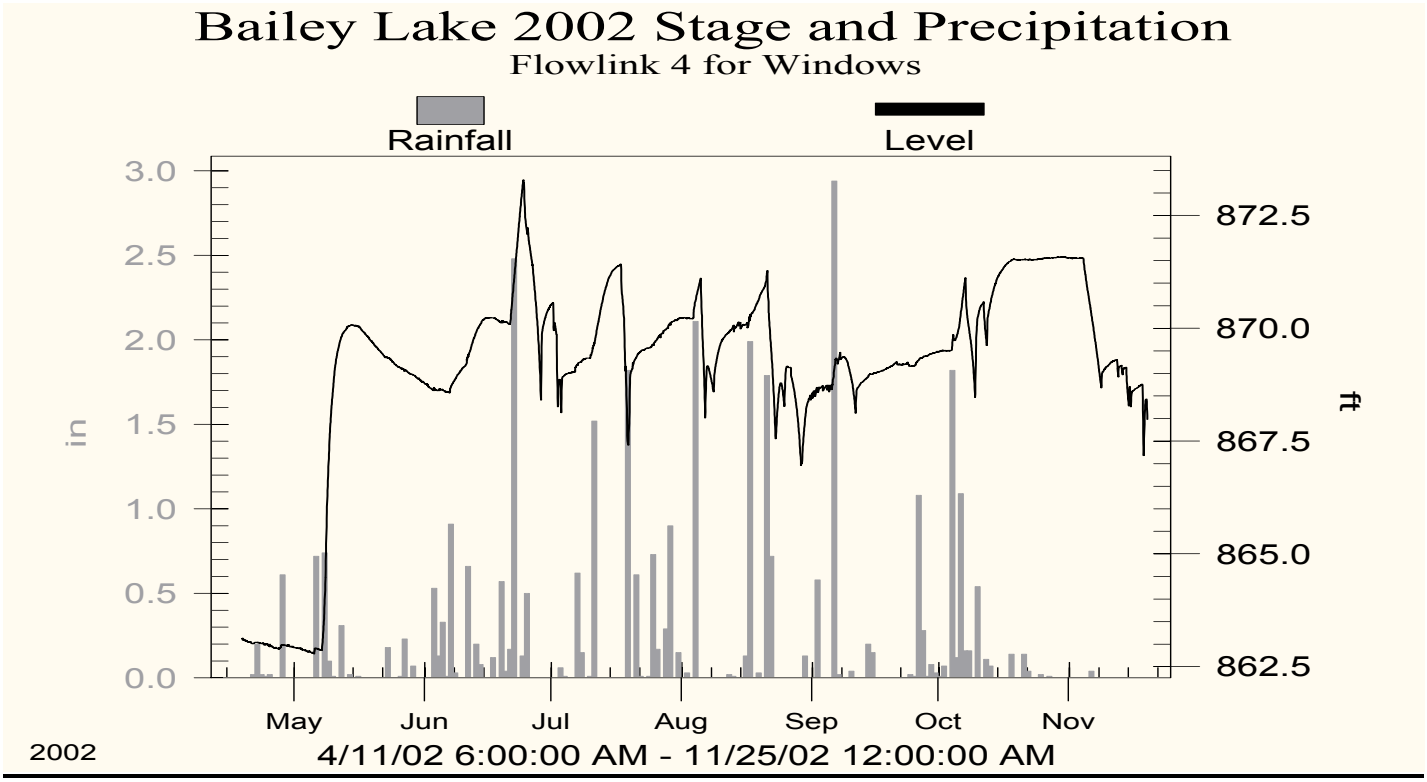
The hydrograph for the 90th Street stormwater site shows flow between April 16-November 5, 2002 (Figure 8). The total discharge for this period was 7,950,107 cf or 182 acre-ft. The highest discharge at this site—26.46 cfs was on August 3, 2002. There was no precipitation gage at this site. No chemistry data was collected at this site.

Figure 9. 90th Street Continuous Flow



Bailey Lake (at Lift Station)
Continuous stage and precipitation measurements were recorded between April 18-November 19, 2002 at this site (Figure 9). The highest recorded stage—873.29 ft., was recorded on June 24, 2002. The average stage during the monitoring season was 869.13 ft. The highest recorded daily precipitation—2.94 inches, was recorded on September 6, 2002.

Figure 10. Bailey Lake (at Lift Station) Level and Precipitation



Armstrong Lake

Vital Statistics:

DNR ID #: 82-0116
LOCATION: NW$^{1/4}$ Section 33 T29N-R21W
MUNICIPALITY: City of Lake Elmo
LAKE SIZE: 28.1 acres (North—7.3 acres, South—20.8 acres)
ORDINARY HIGH WATER MARK: 1019.1 ft

Armstrong Lake was monitored from May 1 to October 24, 2002, in accordance with the Metropolitan Council Citizen-Assisted Monitoring Program (CAMP). Monitoring consisted of 14 biweekly lake gage readings and samplings of Secchi disk, surface total phosphorus, surface total Kjeldahl nitrogen, surface chlorophyll-*a*, and surface total chloride ion. In addition, a temperature and dissolved oxygen profile was taken during each sampling round. The Metropolitan Council Lab analyzed the samples.

Table 9 gives the Armstrong Lake 2002 high, low, and average lake levels. Individual lake level readings are shown in Figure 10.

Table 9. Armstrong 2002 Lake Level

	High	High Date	Low	Low Date	Average
Lake Level (ft)	1019.01	8/23/02	1018.31	7/23/02	1018.58

Figure 11. Armstrong Lake Elevations 2001-02

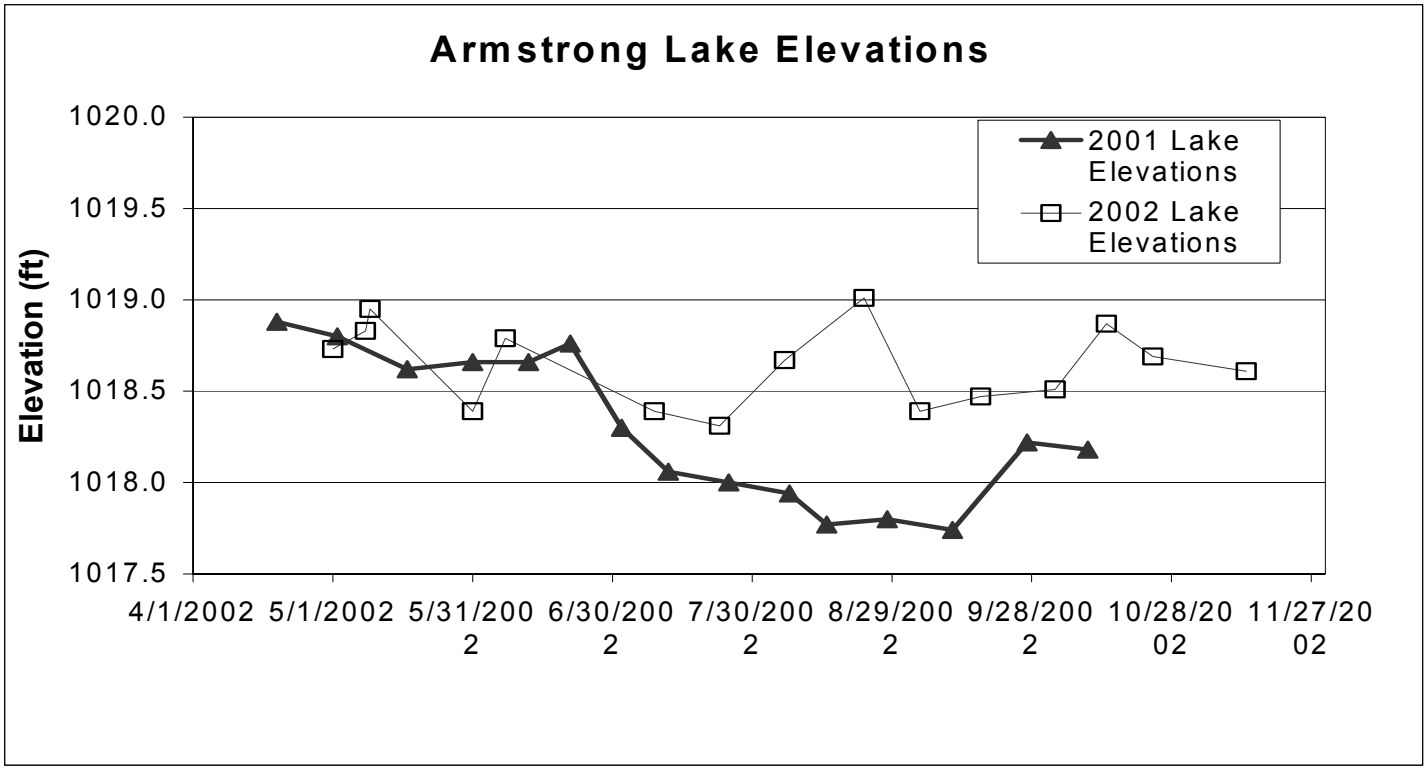


Table 10 gives the 2002 Armstrong Lake monitoring chemistry results for the 2002 water-monitoring season.

Table 10. Armstrong Lake 2002 Monitoring Results

Date	Surface Total Phosphorus (mg/L)	Surface Total Kjeldahl Nitrogen (mg/L)	Chlorophyll *a* (ug/L)	Chloride (mg/L)	Surface Dissolved Oxygen (mg/L)	Surface Temperature (C)
5/1/02	0.041	0.99	4.10	75	13.26	10.90
5/8/02	0.048	0.95	6.00	104	NA	NA
5/31/02	0.099	1.20	12.00	107	3.49	22.50
6/7/02	0.099	1.30	26.00	95	5.26	19.00
6/26/02	0.114	0.88	6.90	31	4.65	26.90
7/9/02	0.068	0.87	16.00	43	8.64	28.50
7/23/02	0.086	0.84	34.00	43	10.13	27.10
8/6/02	0.400	1.10	45.00	41	8.71	21.60
8/23/02	0.091	0.89	14.00	37	7.40	21.50
9/4/02	0.044	0.90	9.50	18	7.18	24.80
9/17/02	0.047	0.86	NA	46	7.58	21.20
10/3/02	0.024	0.86	47.00	50	11.43	13.00
10/14/02	0.044	0.66	NA	36	11.12	8.80
10/24/02	0.029	0.52	NA	30	18.65	2.80
2002 Averages	**0.088**	**0.92**	**20.05**	**54.0**	**9.04**	**19.12**

Table 11 shows the Armstrong Lake Water Quality Summary. Armstrong Lake experienced degradation in water quality in 2002. The lake received an average lake grade of a D for 2002, compared to a C in 2001.

Table 11. Lake Grade and Trophic Status.

	Trophic Status (2001 Average)	Lake Grade (2001 Average)	Trophic Status (2002 Average)	Lake Grade (2002 Average)
Total Phosphorus (mg/L)	Hypereutrophic	D	Hypereutrophic	D
Chlorophyll-a (ug/L)	Eutrophic	B	Eutrophic	C+
Secchi disk (ft)	Eutrophic	D	Eutrophic	D
Overall	Eutrophic	C	Eutrophic	D

Figure 11-15 compare the lake chemistry data and Secchi disk readings. Although there were no statistically significant correlations between water quality parameters, general trends can be noted. There were weak negative relationships between Secchi and total phosphorous, Secchi and Total Kjeldahl Nitrogen, and Secchi and Chlorophyll *a*: as Secchi readings increased, TP, TKN, and CLA decreased. There was also a weak negative correlation between Total Chloride ions and CLA. As CLA increased, Total Chloride ion decreased. There was a weak positive relationship between TKN and TP as well as between TKN and CLA. As TKN increased, TP and CLA also increased. No correlation was found between TP and Total Chloride ions as well as no correlation between Secchi and Total Chloride ions. There were somewhat stronger correlations were between TKN and Total Chloride ion and CLA and TP. As TKN increased, Total Chloride ion increased and as TP increased, CLA increased. These correlations are further simplified in Table 12.

Figure 12. Secchi, Total Kjeldahl Nitrogen and Chlorophyll-*a*

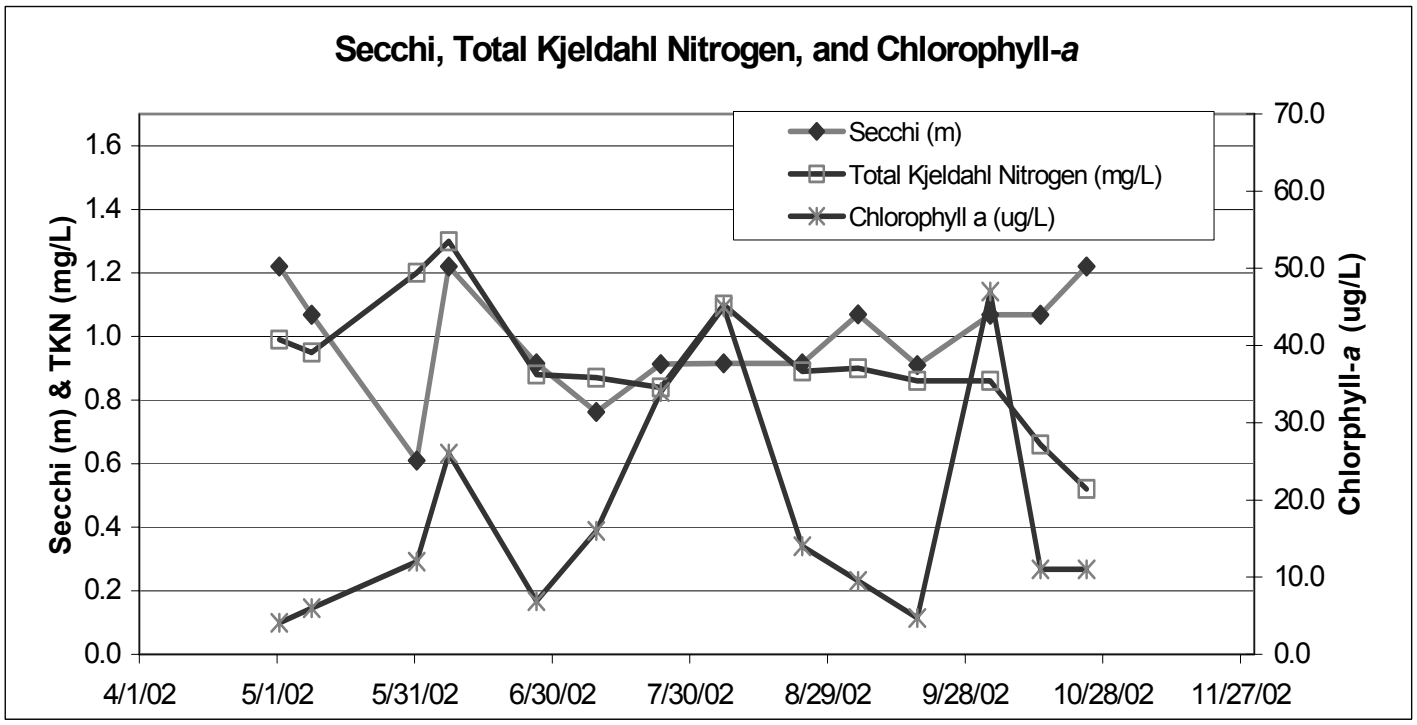


Figure 13. Secchi, Total Kjeldahl Nitrogen, and Total Phosphorus

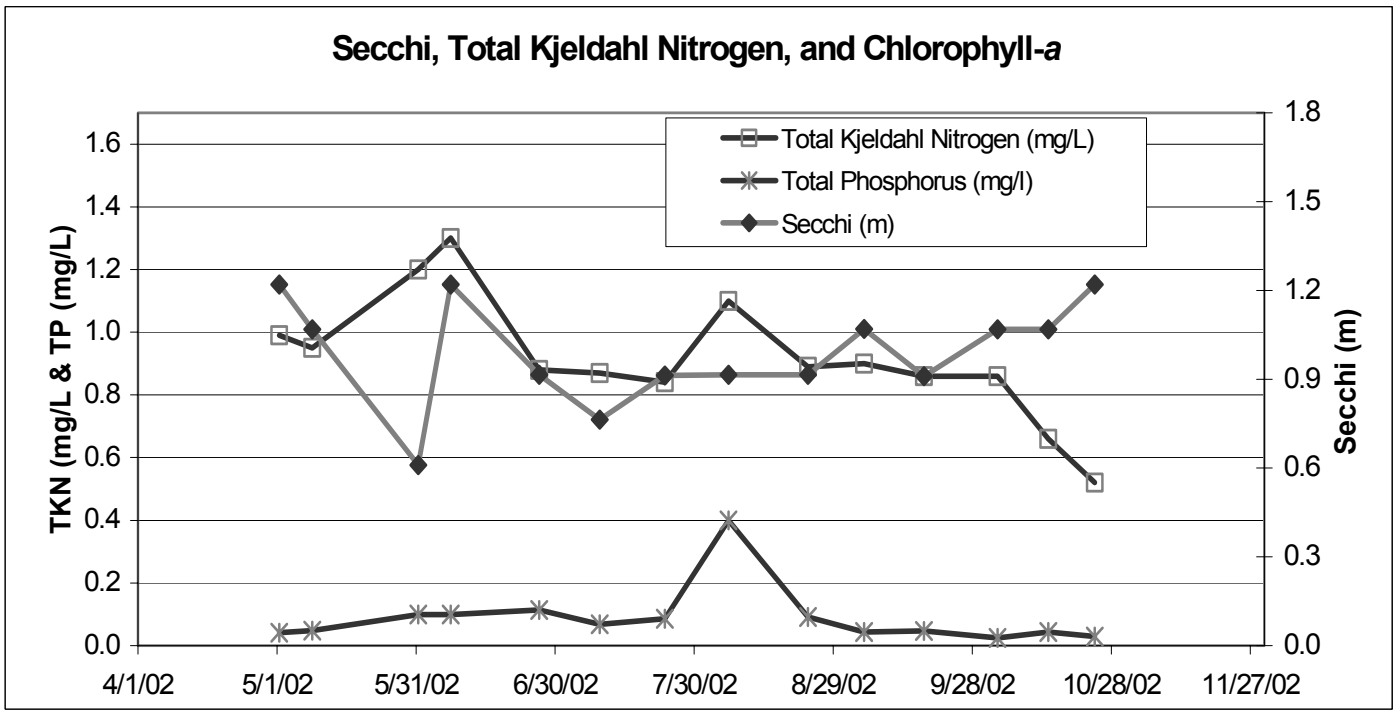


Figure 14. Secchi and Chloride ion

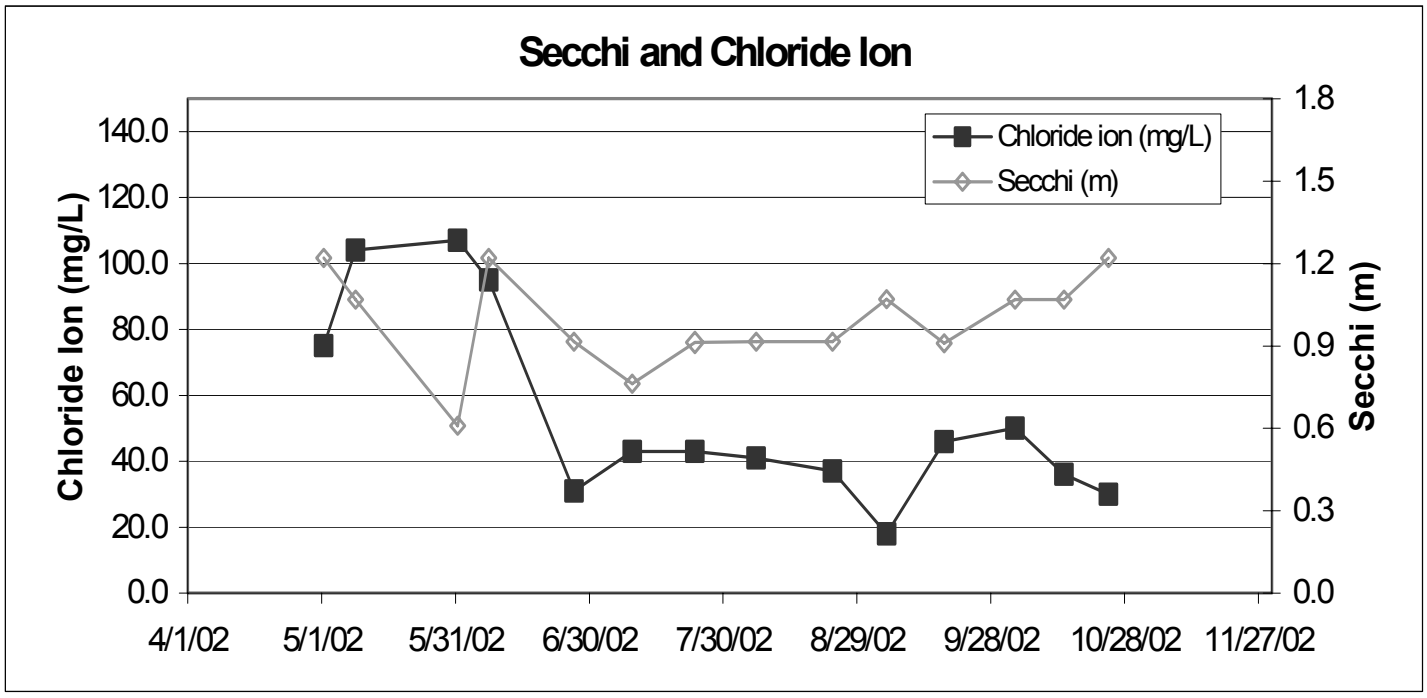


Figure 15. Total Phosphorous and Chlorophyll *a*

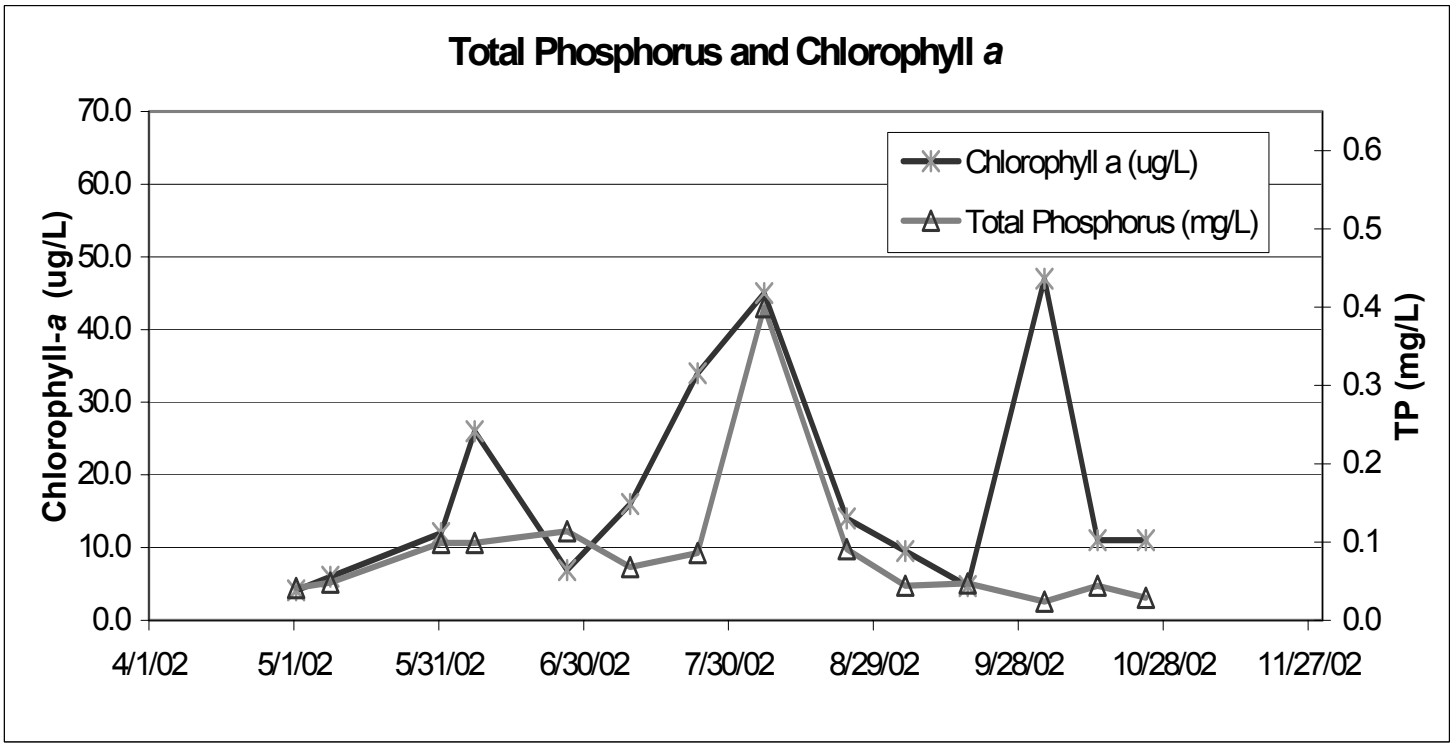


Figure 16. Total Kjeldahl Nitrogen and Chloride ion

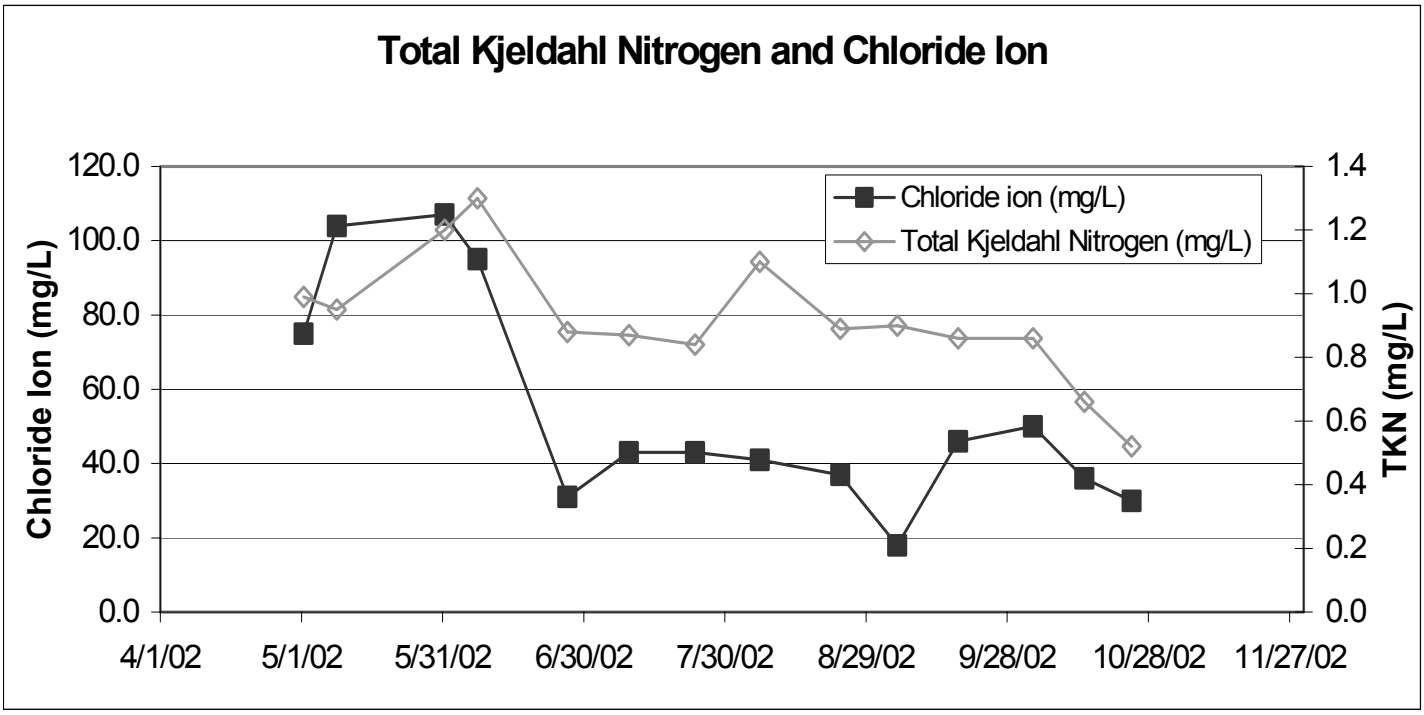


Table 12. Lake Parameter Relationships

	Secchi	TKN	TP	CLA	Chloride
Secchi		--	--	--	None
TKN			+	+	**+**
TP				**+**	None
CLA					--
Chloride					

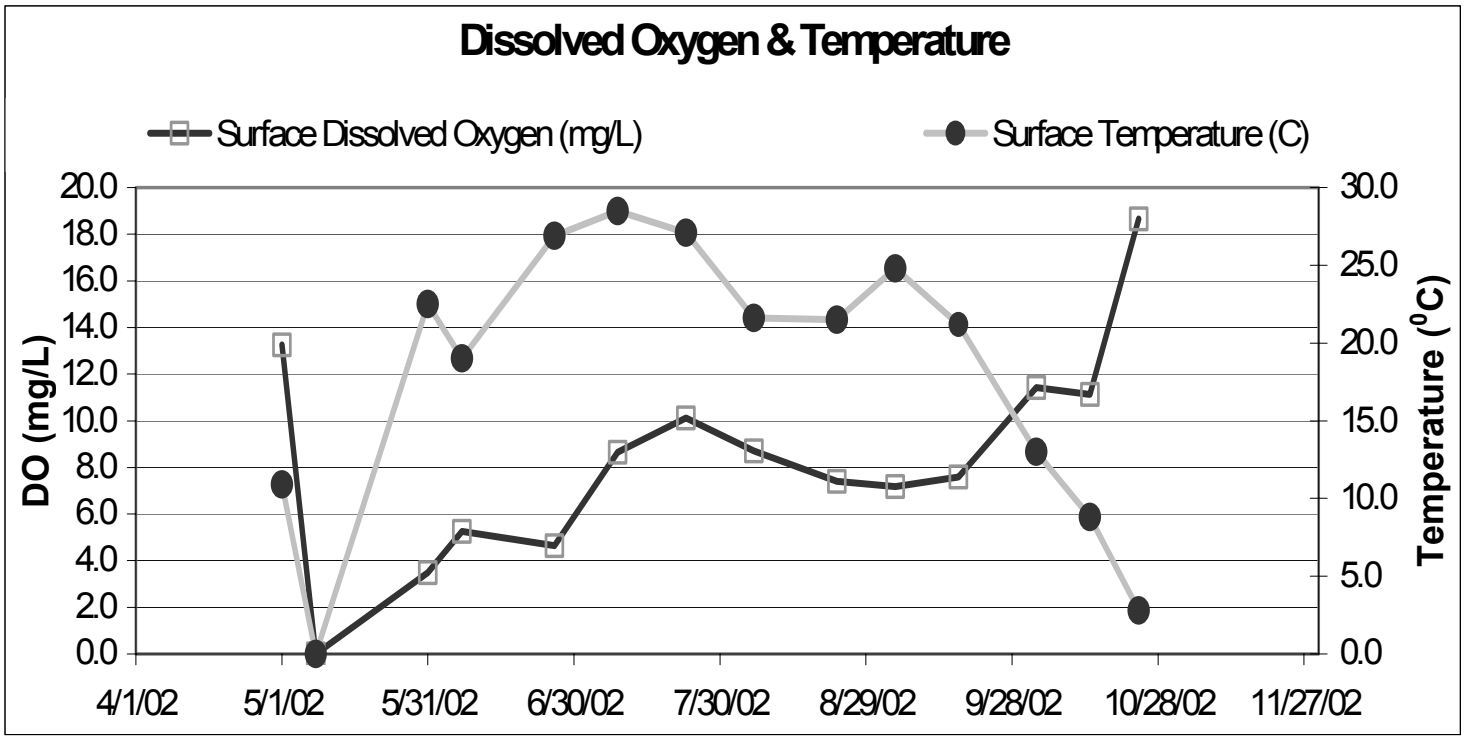
Table 13 lists the dissolved oxygen and temperature profiles. The maximum depth was between 1 and 2 meters. No thermocline was present in the lake. The surface dissolved oxygen and surface temperatures are shown in Figure 16.

Table 13. Dissolved Oxygen and Temperature Profiles

	5/1/02		5/8/02		5/31/02		6/7/02		6/26/02		7/9/02		7/23/02	
Depth (m)	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**
surface	13.26	10.90	NA	NA	3.49	22.50	5.26	19.00	4.65	26.90	8.64	28.50	10.13	27.10
1	13.87	10.60	NA	NA	0.27	20.50	5.17	18.90	0.89	22.80	0.61	26.20	2.16	23.40
2					0.16	18.30	1.75	18.40	0.89	22.80			0.76	23.00

	8/6/02		8/23/02		9/4/02		9/17/02		10/3/02		10/14/02		10/24/02	
Depth (m)	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**	**DO (mg/L)**	**Temp (ºC)**
surface	8.71	21.60	7.40	21.50	7.18	24.80	7.58	21.20	11.43	13.00	11.12	8.80	18.65	2.80
1	8.68	21.60	1.99	19.90	2.31	2170	7.86	19.70	11.35	13.00	10.06	8.80	22.80	4.30
2	7.59	21.60	1.88	19.90	0.52	21.70	0.75	19.70	7.40	13.00	6.01	8.80		

Figure 17. Surface Dissolved Oxygen and Surface Temperatures



Lake Gages

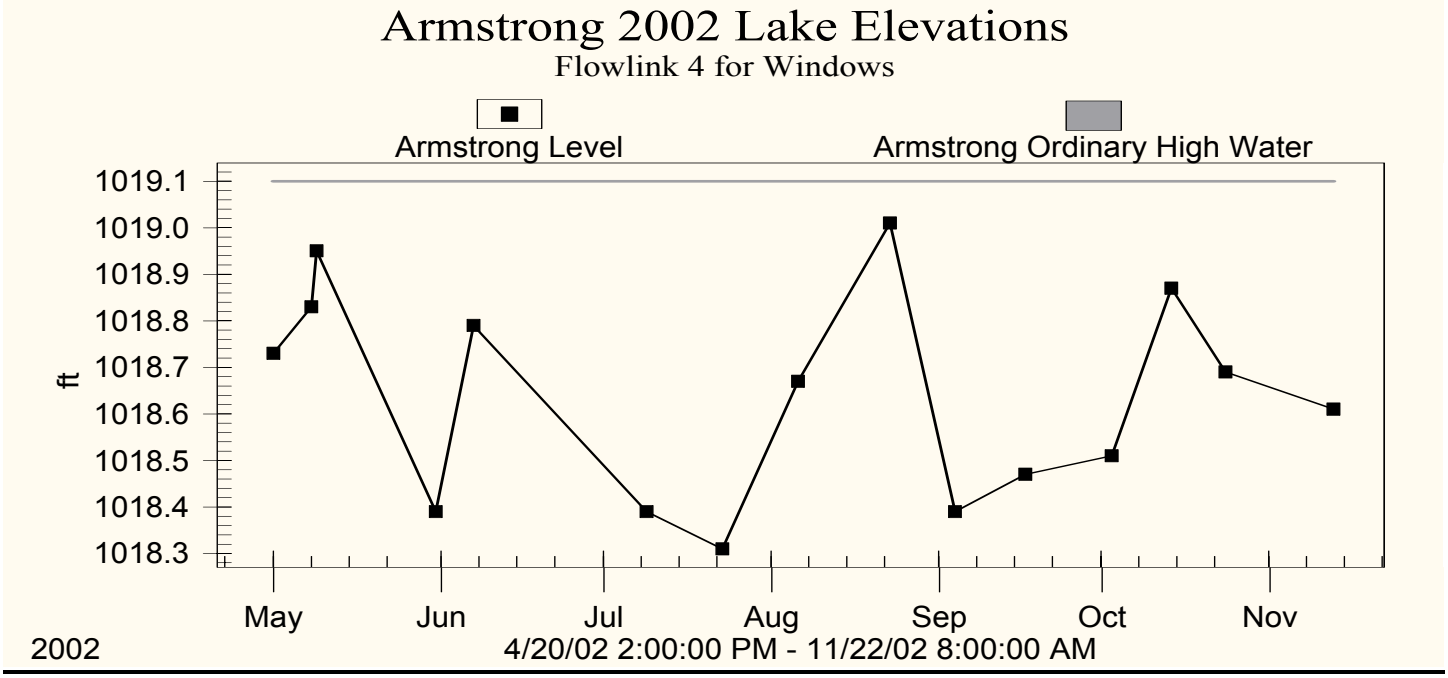
Lake gages were read biweekly on eight lakes in SWWD from May 1-November 13, 2002. Table 14 lists the high, low, range and average elevations for each lake monitored in 2002. Figure 17a-17h shows the fluctuation in elevation for each lake monitored in 2002.

Table 14. SWWD 2002 Lake Gage Readings

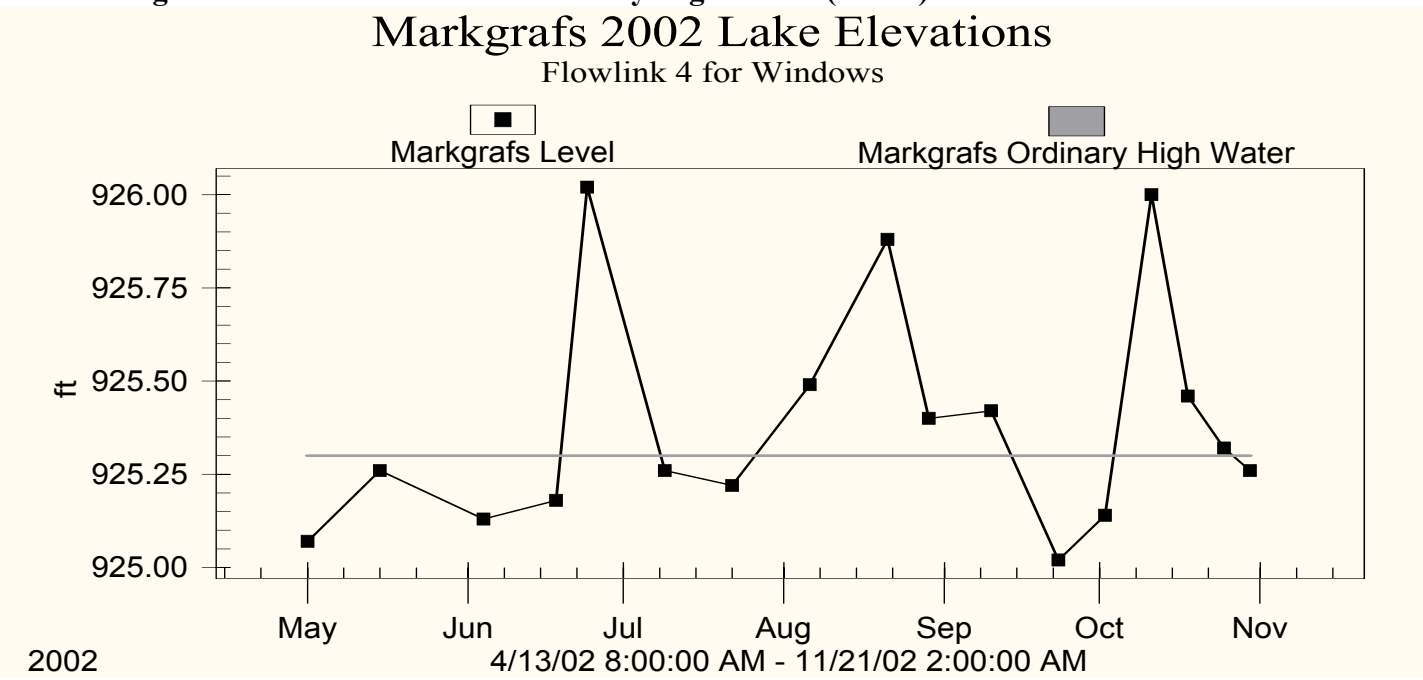
Lake Name	DNR ID#	Dates Monitored	# Readings	Lowest Reading (ft) Date	Highest Reading (ft) Date	Range (ft)	Average Elevation (ft)	OHW (ft)
Cottage Grove Ravine Park	82-0087	5/1/02-11/13/02	17	770.74 5/1/02	772.16 7/22/02	2.02	771.42	770.70
Markgrafs	82-0089	5/1/02-11/13/02	17	925.02 9/23/02	926.02 6/24/02	1.00	925.35	925.30
Wilmes	82-0090	5/1/02-11/13/02	17	901.61 11/13/02	904.69 8/21/02	3.08	902.97	902.60
Powers	82-0092	5/1/02-11/13/02	116	884.64 6/4/02	889.46 10/21/02, 10/22/02	4.82	887.56	891.30
Colby	82-0094	5/1/02-11/13/02	20	890.41 10/2/02	892.07 6/24/02	1.66	890.88	891.80
Bailey	82-0456	5/1/02-11/13/02	17	867.08 5/1/02	871.42 10/30/02	4.34	869.91	NA
Armstrong	82-0116-02	5/1/02-11/13/02	15	1018.31 7/23/02	1019.01 8/23/02	0.70	1018.58	1019.10
Vandeberg	82-0084	5/1/02-11/13/02	15	839.05 6/4/02	840.27 10/11/02, 10/18/02	1.22	839.69	NA

Figure 18a-18h. SWWD 2002 Lake Elevations

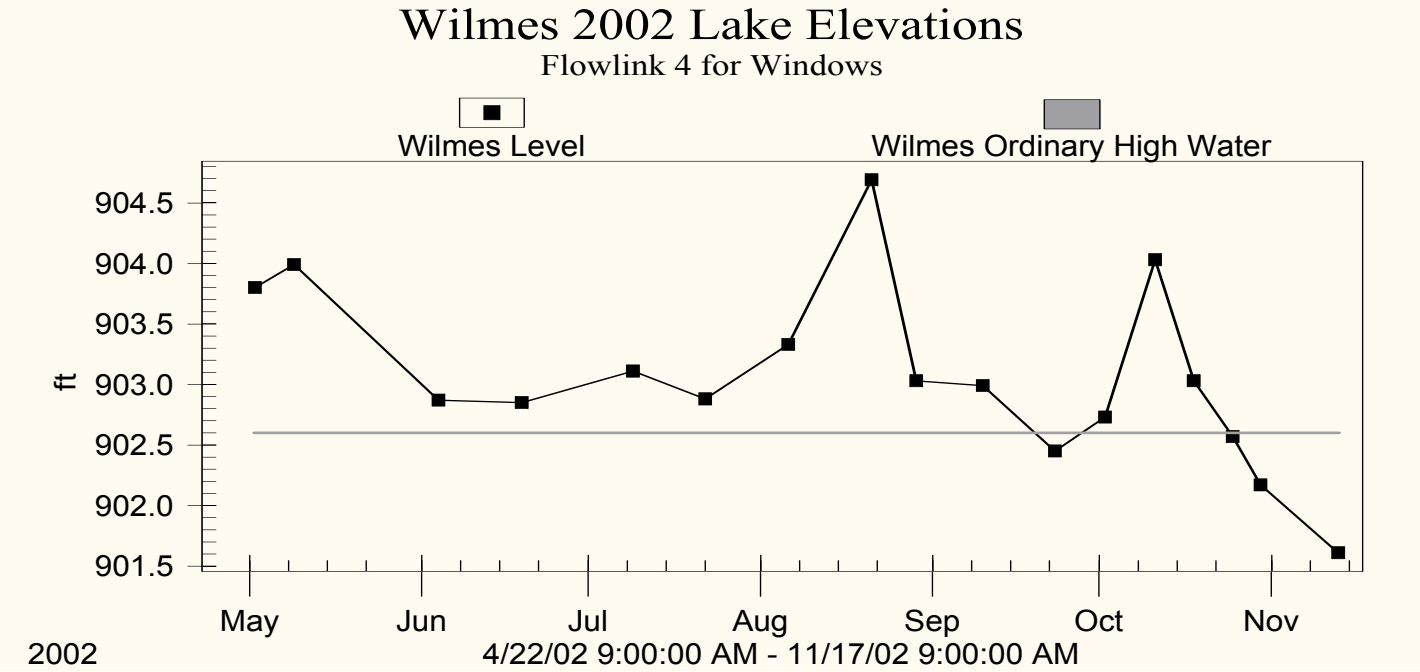
18a. Armstrong Lake Elevations and Ordinary High Water (OHW)



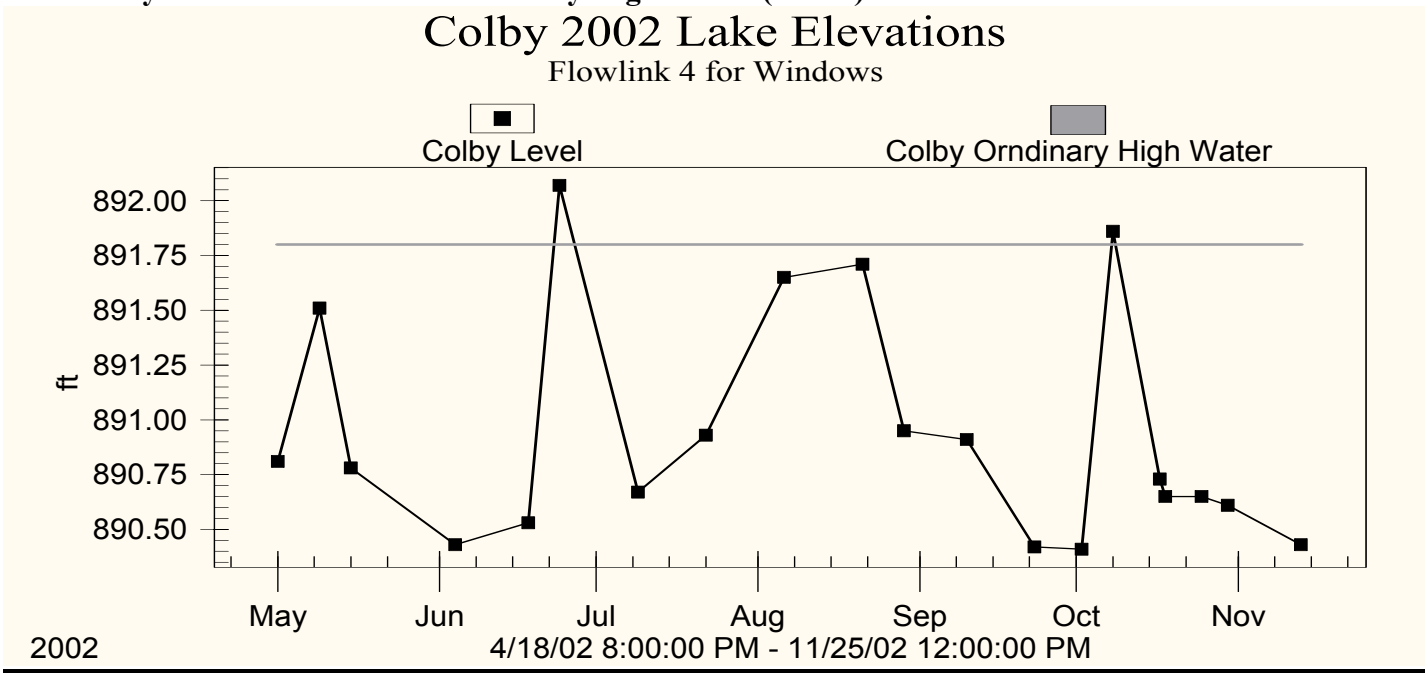
18b. Markgrafs Lake Elevations and Ordinary High Water (OHW)



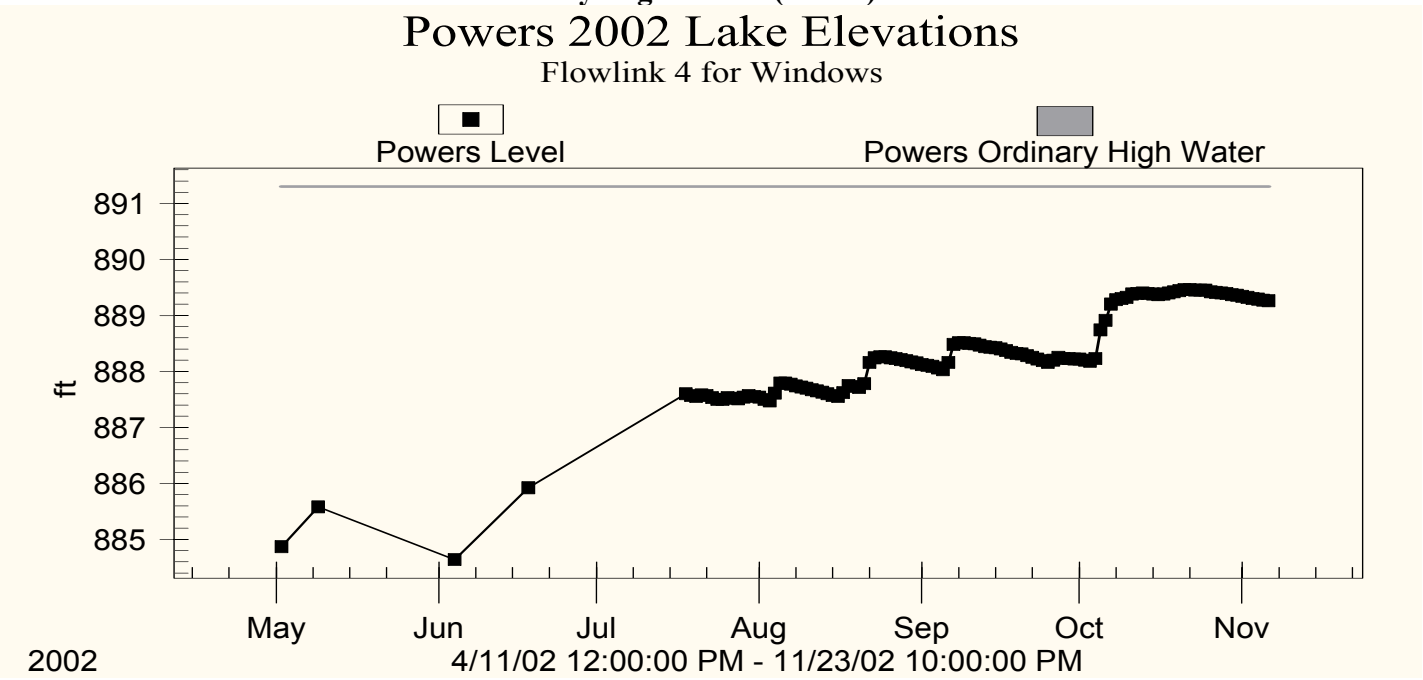
18c. Wilmes Lake Elevations and Ordinary High Water (OHW)



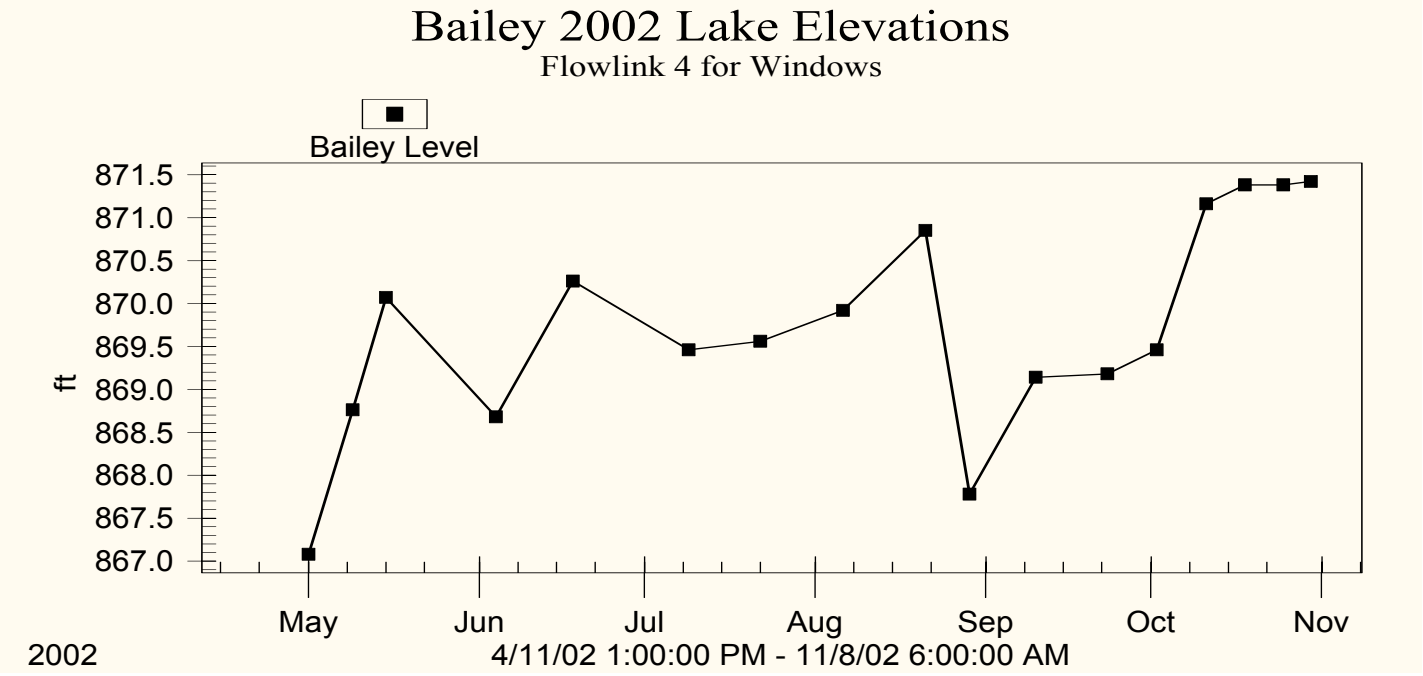
18d. Colby Lake Elevations and Ordinary High Water (OHW)



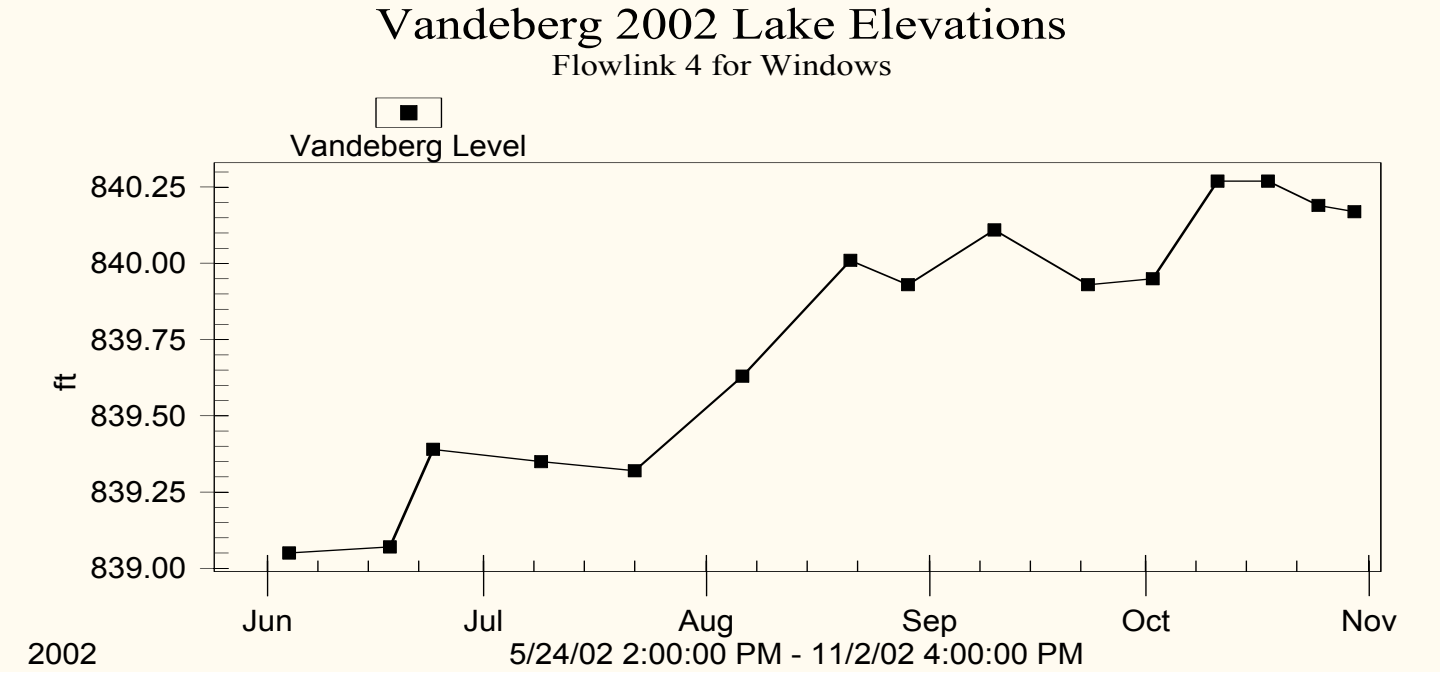
18e. Powers Lake Elevations and Ordinary High Water (OHW)



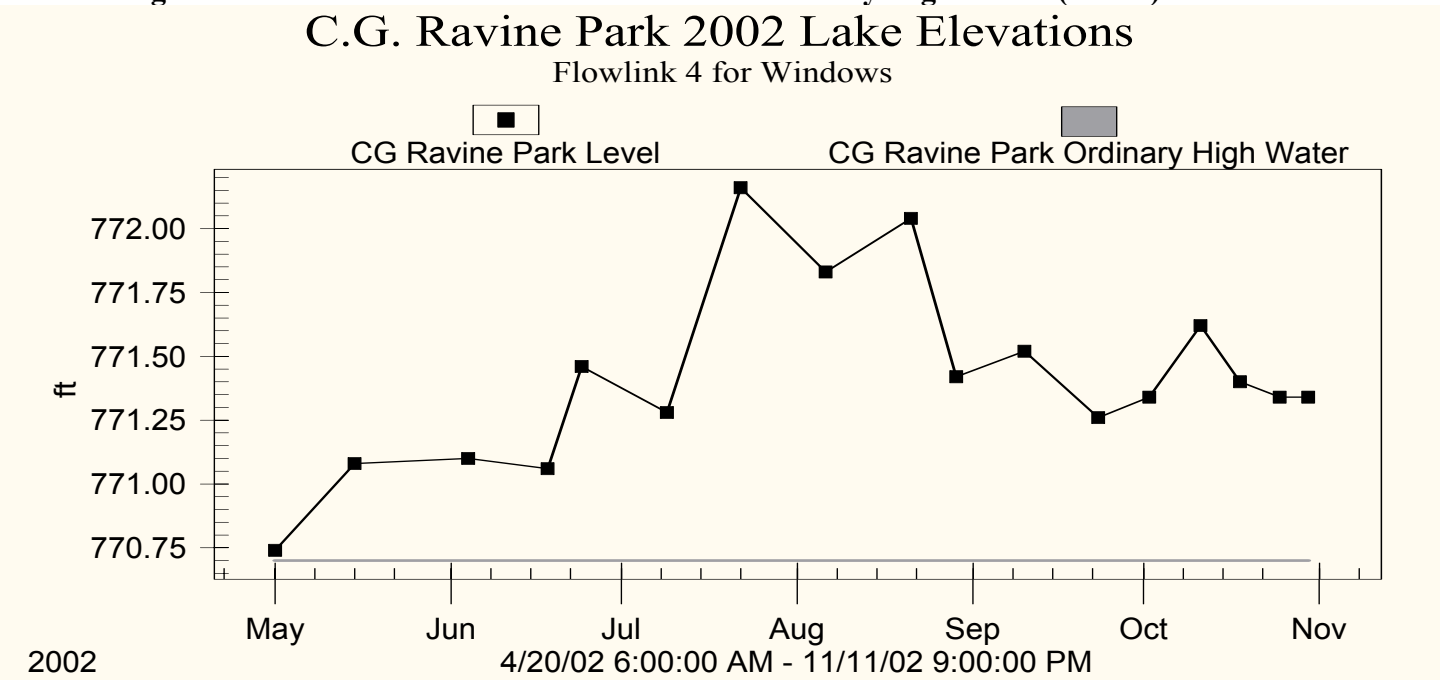
18f. Bailey Lake Elevations



18g. Vandeberg Lake Elevations



18h. Cottage Grove Ravine Park Lake Elevations and Ordinary High Water (OHW)



Observation Wells

Five observation wells were monitored ten times and two wells were monitored 8 times from March 26-December 27, 2002. Table 15 shows the high, low, range and average groundwater elevation during the 2002 monitoring. Figure 18 shows the fluctuation of the groundwater elevations for each well during the 2002 monitoring. Water levels for observation wells were at their highest in October, November and December. Water levels in observation wells #616497 and #616498 reached their highest levels in June and August.

Table 15. SWWD 2002 Observation Well Elevations

Well #	Dates Monitored	# Readings	Surface Elevation (ft)	Lowest Reading (ft) Date	Highest Reading (ft) Date	Range (ft)	Average Elevation (ft)
545602	3/26/02-12/27/02	10	904.39	834.05 6/20/02	838.27 12/27/02	4.22	835.54
545603	3/26/02-12/27/02	10	906.42	848.97 4/15/02	865.27 10/31/02	16.3	857.77
545604	3/26/02-12/27/02	10	886.6	845.35 4/15/02	854.74 10/31/02	9.39	851.08
616493	3/26/02-12/27/02	8	917.32	840.37 5/31/02	861.64 10/31/02	21.27	850.00
616494	3/26/02-12/27/02	10	916.95	840.54 5/31/02	859.93 10/31/02	19.39	851.00
616497	3/26/02-12/27/02	10	920.34	869.00 3/26/02	898.49 8/27/02	29.49	879.36
616498	3/26/02-12/27/02	8	913.55	859.13 3/26/02	887.72 6/20/02	28.59	873.23

Figure 19. SWWD 2002 Observation Well Elevations