2007 WATER MONITORING REPORT

February 2008

Prepared for:

South Washington Watershed District

Prepared by:

WASHINGTON CONSERVATION DISTRICT

Memorandum

To: Matt Moore —South Washington Watershed District Administrator
From: Wendy Griffin, Travis Thiel, Tim Sundby, Erik Anderson, and Jessica Arendt--Washington Conservation District
Date: February, 2008
Re: SWWD 2007 Monitoring: MS1, MS2, Powers Lake North Tributary, Powers Lake East Tributary, 100th Street, St. Paul Park, Newport, Fox Run, Tamarack Road, Bailey Lift Station, 80th Street, 90th Street, West Draw 1, West Draw 2, Armstrong Lake, Powers Lake, Cottage Grove Ravine Park Lake, Colby 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 stormwater monitoring at six existing stormwater quality monitoring stations and one new stormwater quality monitoring station (MS1, MS2, Powers Lake East Tributary, 100th Street, Newport, St. Paul Park, and Powers Lake North Tributary respectively), monitored six stormwater flow-only sites (West Draw 1, West Draw 2, Fox Run, Tamarack Road, 80th Street, and 90th Street), monitored water quality and level on Armstrong Lake, Colby Lake, Cottage Grove Regional Park Lake, and Powers Lake, monitored level and precipitation at the Bailey Lift Station, installed and read eight lake staff gages, and monitored seven groundwater observation wells. The locations of the monitoring sites can be found in Figure 1. The following report summarizes our methods and results for monitoring conducted from January 1 - December 31, 2007. This report and the accompanying data will also be provided in an electronic format.

Stormwater Sampling Sites: MS1, MS2, Powers East, Powers North, 100th Street, Newport, & St. Paul Park

Continuous stage, velocity, and discharge measurements were taken every 15 minutes at Newport from April 10-October 29, 2007, at St. Paul Park from April 10-October 29, 2007, at 100th Street from March 29-October 30, 2007, at Powers East from April 22-October 30, 2007, at Powers North from June 14-October 29, 2007, at MS1 from March 26-October 30, 2007 and at MS2 from April 11-September 26, 2007. Precipitation data was also continuously collected at 100th Street, Powers East, MS2, and MS1 during the same time period for 2007.

Field stage measurements were taken in culverts and/or channel at all sites. Flow weighted storm event samples, storm event grab samples, snowmelt grab samples, baseflow composite samples, and baseflow grab samples were collected at all sites. In addition to these samples, *E. coli* bacteria grab samples were also taken or were attempted at all seven sites. The samples were analyzed at the Metropolitan Council Environmental Services Lab.

Stage to discharge relationships were developed at all stormwater sites, if possible. When the area-velocity probe was covered with debris or erroneous velocity readings were given, stage to discharge relationships had to be used. When data gaps were present, stage/velocity relationships based upon individual site data were used to interpolate missing data. MS1 and MS2 had backup level logger stage recorders that allowed for data collection during periods when the primary equipment was not recording or malfunctioned.

Continuous Stormwater Stage Site: Bailey Lift Station

Continuous stage and precipitation measurements were taken every hour at Bailey Lift Station from April 20-October 30, 2007.

A permanent staff gage was read at the Bailey Lift Station. Offsets between the level logger and staff gage allowed for a continuous stage to be measured.

Continuous Stormwater Flow and Stage Sites: 80th Street, 90th Street, Fox Run, Tamarack Road, West Draw 1, & West Draw 2.

Continuous stage measurements were taken every 15 minutes at 80th Street from April 20-October 30, 2007.

Continuous stage, velocity, and discharge measurements were taken every 15 minutes at 90th Street from April 18-October 29, 2007, at Fox Run from March 26-October 19, 2007, at Tamarack Road from March 26-July 3, 2007, at West Draw 1 from April 12-October 21, 2007, and at West Draw 2 from May 10-october 29, 2007.

Lake Water Quality Sites: Armstrong Lake, Colby Lake, Powers Lake, and Cottage Grove Ravine Park Lake

Included in the 2007 work plan for SWWD were monitoring of four lakes. Armstrong, Cottage Grove Ravine Park, and Colby Lakes were monitored monthly from April to October. Powers Lake was monitored biweekly from April to October. All lakes were monitored by collecting Secchi transparencies, temperature, and dissolved oxygen profiles. Secchi transparencies are used for general comparisons of water quality across the watershed and for monitoring general water quality trends in a given lake from year to year. Temperature and dissolved oxygen profiles provide information on the in-lake dynamics and how each lake may be functioning each year. All four lakes had surface composite water quality samples taken for analysis of total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a concentrations. Armstrong, Cottage Grove Ravine, and Powers Lakes were also sampled for chloride ions.

Further Lake quality discussion is provided by the Metropolitan Council in the annual "Study of the Water Quality of Metropolitan Area Lakes" reports found at http://www.metrocouncil.org/environment/RiversLakes/Lakes/index.htm.

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

CAMP	Citizen-Assisted Lake Monitoring Program
cfs	cubic feet per second
Chl-*a*	Chlorophyll-*a*
CMSCWD	Carnelian Marine St. Croix Watershed District
COD	Total Chemical Oxygen Demand
CS	Chronic Standard
DO	Dissolved Oxygen
E. Coli	*Escherichia coli*
FAV	Final Acute Standard
mg/L	milligram per liter
MN DNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
MPN	most probable number
MS	Maximum Standard
NTU	nephelometric turbidity units
Ortho-P	Ortho-phosphate
TBOD	Total Biochemical Oxygen Demand
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TP	Total Phosphorus
TSI	Trophic State Index
TSS	Total Suspended Solids
µg/L	microgram per liter
µmhos/cm	micromhos per centimeter
VSS	Volatile Suspended Solids
WCD	Washington Conservation District

7050.0222 SPECIFIC STANDARDS OF QUALITY AND PURITY FOR CLASS 2B WATERS OF THE STATE; AQUATIC LIFE AND RECREATION.

Chemical	Units	CS	Basis	MS	FAV	Basis

Cadmium, total µg/l

The CS shall not exceed: exp.(0.7852[ln(total hardness mg/l)]-3.490)
The MS shall not exceed: exp.(1.128[ln(total hardness mg/l)]-1.685)
The FAV shall not exceed: exp.(1.128[ln(total hardness mg/l)]-0.9919)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Chloride mg/l 230 Tox. 860 1720 Tox.

Chromium +3, total µg/l

The CS shall not exceed: exp.(0.819[ln(total hardness mg/l)]+1.561)
The MS shall not exceed: exp.(0.819[ln(total hardness mg/l)]+3.688)
The FAV shall not exceed: exp.(0.819[ln(total hardness mg/l)]+4.380)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Copper, total µg/l

The CS shall not exceed: exp.(0.6200[ln(total hardness mg/l)]-0.570)
The MS shall not exceed: exp.(0.9422[ln(total hardness mg/l)]-1.464)
The FAV shall not exceed: exp.(0.9422[ln(total hardness mg/l)]-0.7703)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Fecal coliform organisms: Not to exceed 200 organisms per 100 milliliters as a geometric mean of not less than five samples in any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 2,000 organisms per 100 milliliters. The standard applies only between April 1 and October 31.

Lead, total µg/l

The CS shall not exceed: exp.(1.273[ln(total hardness mg/l)]-4.705)
The MS shall not exceed: exp.(1.273[ln(total hardness mg/l)]-1.460)
The FAV shall not exceed: exp.(1.273[ln(total hardness mg/l)]-0.7643)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Nickel, total µg/l

The CS shall not exceed: exp.(0.846[ln(total hardness mg/l)]+1.1645)
The MS shall not exceed: exp.(0.846[ln(total hardness mg/l)]+3.3612)
The FAV shall not exceed: exp.(0.846[ln(total hardness mg/l)]+4.0543)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

Zinc, total µg/l

The CS shall not exceed: exp.(0.8473[ln(total hardness mg/l)]+0.7615)
The MS shall not exceed: exp.(0.8473[ln(total hardness mg/l)]+0.8604)
The FAV shall not exceed: exp.(0.8473[ln(total hardness mg/l)]+1.5536)
For hardness values greater than 400 mg/l, 400 mg/l shall be used to calculate the standard.

The MPCA defines standards as follows: “Chronic standard is the highest concentration of a toxicant to which aquatic organisms can be exposed indefinitely with no harmful effects, or to which humans or wildlife consumers of aquatic organisms can be exposed indefinitely with no harmful effects”. “Maximum standard is a concentration that protects aquatic organisms from potential lethal effects of a short-term “spike” in toxicant concentrations. This is always equal to one-half the final acute value”. “Final acute value is the concentration that would kill about half of the exposed individuals of a very sensitive aquatic species”.

(http://www.pca.state.mn.us/water/standards/index.html). MPCA has proposed to change current water quality standards from fecal coliform to E. coli bacteria. These changes would set the 30-day geometric mean to 126 cfu/100mL and 10% of Values not to Exceed 1260 cfu/mL.
(http://proteus.pca.state.mn.us/water/standards/rulechange.html)

The following paragraphs link where high concentrations of heavy metals are coming from. This is not an all-inclusive list of sources for the individual metals discussed.

Copper: A major source for copper in stormwater is from roads, specifically from corrosion of cars and trucks. Corrosion of copper pipes also leads to a source of copper in drinking water. Smelting operations and municipal incineration are other sources of copper concentrations.
(http://www.freedrinkingwater.com/water-contamination/copper-contaminants-removal-water.htm)

Nickel: Nickel concentrations may come from power plants, waste incinerators and other metal industries. Other sources include alloys used in the treatment of heavy metal polluted surface water, batteries containing nickel-cadmium, and as a pigment. Also included as a potential source of nickel are the alloys in kitchenware.

Nickel concentrations in soils, which have the potential to erode into surface waters, originate in several sources. Phosphate fertilizers contain trace nickel amounts and dust from waste incinerators all contribute to soil cumliation. (http://www.lenntech.com/elements-and-water/nickel-and-water.htm)

Lead: Sources of lead in drinking water are most notably from lead-based pipes or lead solder used for copper plumbing. This source is usually found in old homes. (http://www.extension.umn.edu/info-u/environment/BD303.html)

Lead is also released in to the environment from mining operations, ore processing, lead smelting, refining, recycling and disposal via the atmosphere. Water entry is usually from atmospheric deposition, runoff, or wastewater. (http://www.epa.gov/ogwdw/dwh/t-ioc/lead.html)

Zinc: Zinc is released to the environment largely through human activities. Main activities are mining, smelting, and steel production. Burning coal and waste are other sources of zinc deposition to the environment. Industrial release of dust containing zinc will eventually settle out onto soil and surface waters. Rain and snow will also act as conduit for removal of zinc from the air. If high levels of zinc are present, most likely other metals, such as lead and cadmium, will also be present.
(http://www.idph.state.il.us/envhealth/factsheets/zinc.htm)

Cadmium: Sources to air include the combustion of fossil fuels, iron and steel production, non-ferrous metals production, and municipal solid waste combustion. Sources to water include use of phosphate fertilizers, non-ferrous metals production, and the iron and steel industry. (http://www.cadmium.org/env_emi.html)

Chromium: Emissions to air and water may result from leather tanning industries, chemical manufacturing industries (e.g. dyes for paints, rubber and plastic products), metal finishing industries (e.g. chrome plating), manufacturers of pharmaceuticals, wood, stone, clay and glass products, electrical and aircraft manufacturers, steam and air conditioning supply services, cement producing plants (cement contains chromium), incineration of council refuse and sewage sludge, and combustion of oil and coal. Chromium may be oxidised and leached from stainless steel into a water-soluble form..
(http://www.npi.gov.au/database/substance-info/profiles/24.html#sourcesof)

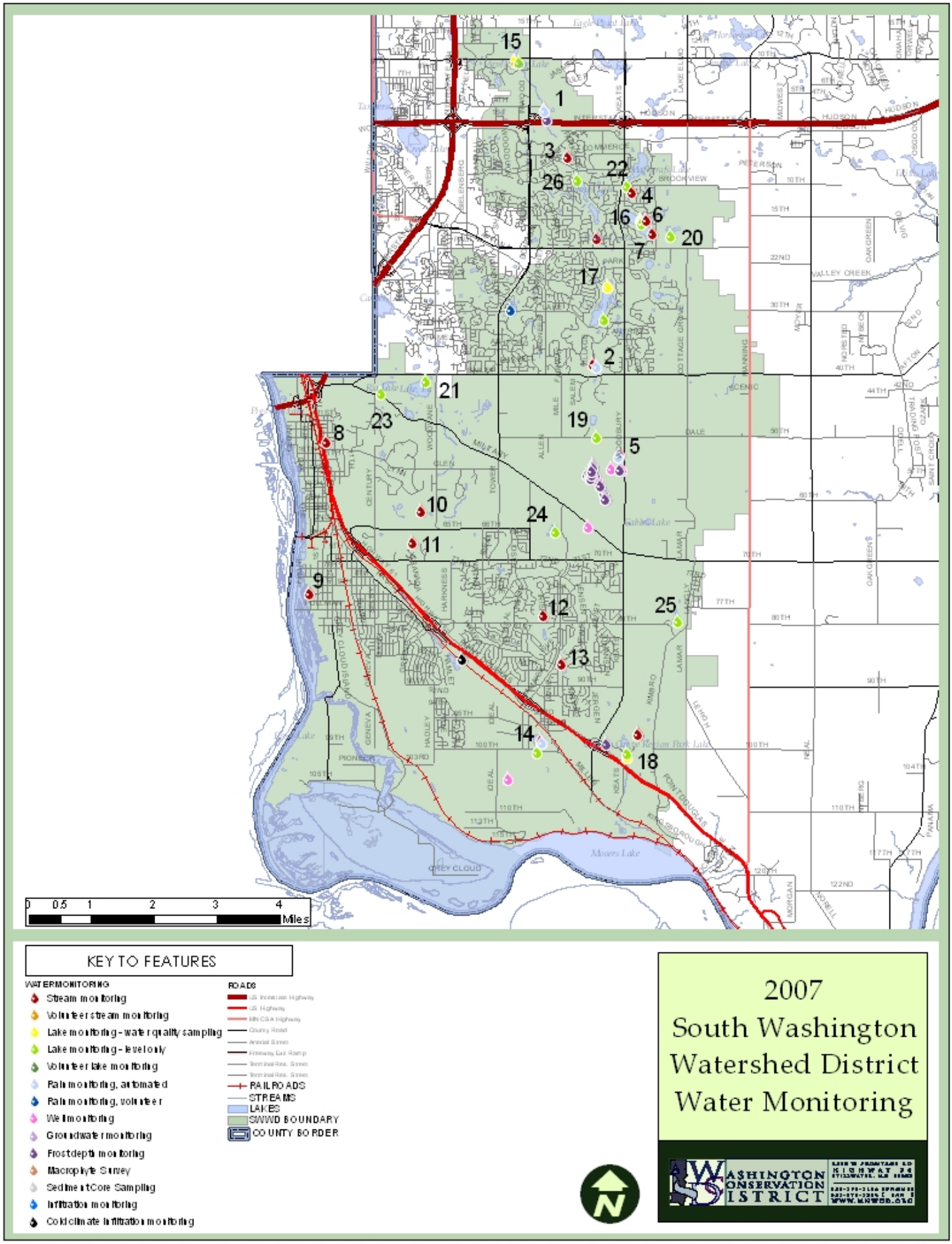


Figure 1. SWWD Water Monitoring Locations

Table 1. Parameters sampled for each South Washington Watershed District site.

Site Description	Map Site ID #	Site Name	Monitoring Parameters
Stream Monitoring	1	MS-1	Discharge, Water Quality Composite Samples, Rainfall
Stream Monitoring	2	MS-2	Discharge, Water Quality Composite Samples, Rainfall
Stream Monitoring	3	Tamarack Road	Discharge
Stream Monitoring	4	Fox Run Road	Discharge
Stream Monitoring	5	Bailey Lift Station	Stage, Rainfall
Stream Monitoring	6	Powers Lake North Inlet	Discharge, Water Quality Composite Samples
Stream Monitoring	7	Fish Lake Outlet at Powers Lake	Discharge, Water Quality Composite Samples, Rainfall
Stream Monitoring	8	Tributary to Mississippi R. at St. Paul Park	Discharge, Water Quality Composite Samples
Stream Monitoring	9	Tributary to Mississippi R. at Newport	Discharge, Water Quality Composite Samples
Stream Monitoring	10	West Draw 1	Discharge
Stream Monitoring	11	West Draw 2	Discharge
Stream Monitoring	12	80th St.	Stage
Stream Monitoring	13	90th St.	Discharge
Stream Monitoring	14	100th St.	Discharge, Water Quality Composite Samples, Rainfall
Lake Monitoring	15	Armstrong Lake	Surface Water Quality Samples, Elevation
Lake Monitoring	16	Powers Lake	Surface Water Quality Samples, Hypolimnion Water Quality Samples, Elevation
Lake Monitoring	17	Colby Lake	Surface Water Quality Samples, Elevation
Lake Monitoring	18	Cottage Grove Ravine Park Lake	Surface Water Quality Samples, Elevation
Lake Monitoring	19	Bailey Lake	Elevation
Lake Monitoring	20	Fish Lake	Elevation
Lake Monitoring	21	La Lake	Elevation
Lake Monitoring	22	Markgrafs Lake	Elevation
Lake Monitoring	23	Ria Lake	Elevation
Lake Monitoring	24	Shepard's Pond	Elevation
Lake Monitoring	25	Vandeberg Lake	Elevation
Lake Monitoring	26	Wilmes Lake	Elevation

Sample Sites: MS1, MS2, Powers East, Powers North, 100th, Newport, and St. Paul Park

MS1 (I94)

The hydrograph for the MS1 site shows flows from March 26–October 30, 2007 (Figure 2). Total discharge during this period was 11,434,790 cf or 262 acre-ft. The peak discharge of 82 cfs was on September 20, 2007 from a storm precipitation of 1.17 inches. The highest storm precipitation of 2007 occurred during the September 18th storm, with a total of 1.34 inches.

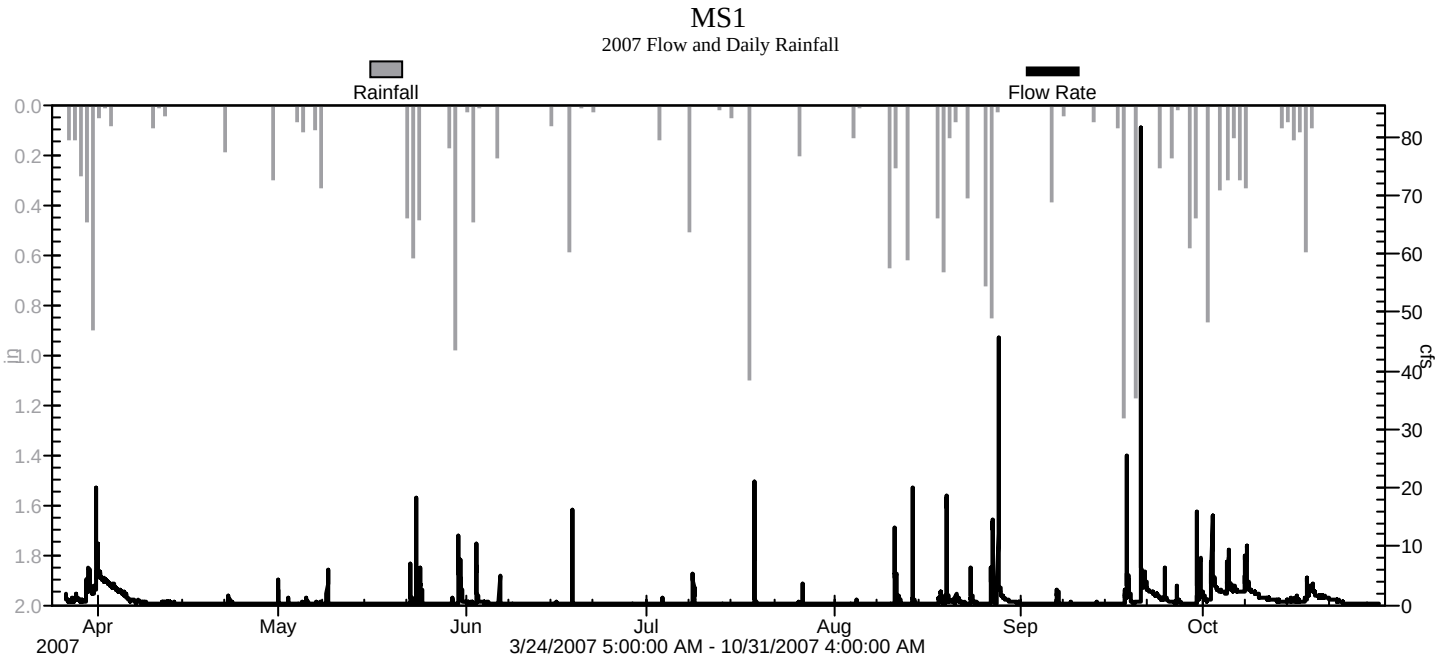


Figure 2. MS1 2007 Continuous Flow and Daily Rainfall

Table 2. MS1 Stormwater Total Phosphorus and Total Suspended Solids Loading Table

	Sample Collection Time				Loading Interval				
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval TSS (lb)	Interval TP (lb)
*Base***			*23*	*0.139*	*1/1/2007 0:00*	*3/12/2007 12:00*	*304,560*	*428*	*2.6*
Snowmelt Grab**	3/13/07 12:53	3/13/07 12:53	547	0.482	3/12/2007 12:00	3/14/2007 12:00	86,400	2,950	2.6
*Base***			*23*	*0.139*	*3/14/2007 12:00*	*3/26/2007 16:00*	*262,800*	*369*	*2.3*
Base			*23*	*0.139*	*3/26/2007 16:00*	*3/27/2007 19:00*	*66,432*	*93*	*0.6*
Storm			*118*	*0.323*	*3/27/2007 19:00*	*3/28/2007 20:00*	*85,034*	*626*	*1.7*
Base			*23*	*0.139*	*3/28/2007 20:00*	*3/30/2007 3:00*	*74,858*	*105*	*0.6*
Storm Composite	3/30/07 04:20	4/2/07 02:33	66	0.234	3/30/2007 3:00	3/30/2007 22:00	237,841	980	3.5
Base			*23*	*0.139*	*3/30/2007 22:00*	*3/31/2007 8:00*	*75,515*	*106*	*0.7*
Storm			*118*	*0.323*	*3/31/2007 8:00*	*4/1/2007 14:00*	*672,029*	*4,943*	*13.6*
Base			*23*	*0.139*	*4/1/2007 14:00*	*4/10/2007 21:00*	*1,271,183*	*1,785*	*11.0*
Storm			*118*	*0.323*	*4/10/2007 21:00*	*4/13/2007 5:00*	*64,360*	*473*	*1.3*
Base			*23*	*0.139*	*4/13/2007 5:00*	*4/22/2007 16:00*	*103,742*	*146*	*0.9*
Storm	4/22/07 17:01	4/23/07 11:14	46	0.415	4/22/2007 16:00	4/23/2007 12:00	23,986	69	0.6
Base			*23*	*0.139*	*4/23/2007 12:00*	*4/30/2007 20:00*	*24,758*	*35*	*0.2*
Storm			*118*	*0.323*	*4/30/2007 20:00*	*4/30/2007 22:00*	*5,272*	*39*	*0.1*
Storm			*118*	*0.323*	*4/30/2007 22:00*	*5/1/2007 2:00*	*8,883*	*65*	*0.2*
Base			*23*	*0.139*	*5/1/2007 2:00*	*5/4/2007 3:00*	*10,168*	*14*	*0.1*
Storm			*118*	*0.323*	*5/4/2007 3:00*	*5/5/2007 1:00*	*11,856*	*87*	*0.2*
Base			*23*	*0.139*	*5/5/2007 1:00*	*5/5/2007 15:00*	*2,218*	*3*	*0.0*
Storm			*118*	*0.323*	*5/5/2007 15:00*	*5/6/2007 0:00*	*8,943*	*66*	*0.2*
Base			*23*	*0.139*	*5/6/2007 0:00*	*5/7/2007 7:00*	*5,036*	*7*	*0.0*
Storm			*118*	*0.323*	*5/7/2007 7:00*	*5/7/2007 10:00*	*1,903*	*14*	*0.0*
Base			*23*	*0.139*	*5/7/2007 10:00*	*5/7/2007 19:00*	*1,673*	*2*	*0.0*
Storm			*118*	*0.323*	*5/7/2007 19:00*	*5/7/2007 23:00*	*3,256*	*24*	*0.1*
Base			*23*	*0.139*	*5/7/2007 23:00*	*5/8/2007 23:00*	*5,055*	*7*	*0.0*
Storm			*118*	*0.323*	*5/8/2007 23:00*	*5/9/2007 10:00*	*33,459*	*246*	*0.7*
Base			*23*	*0.139*	*5/9/2007 10:00*	*5/22/2007 20:00*	*28,536*	*40*	*0.2*
Storm			*118*	*0.323*	*5/22/2007 20:00*	*5/23/2007 2:00*	*26,792*	*197*	*0.5*
Base			*23*	*0.139*	*5/23/2007 2:00*	*5/23/2007 14:00*	*5,323*	*7*	*0.0*
Storm Composite	5/23/07 15:54	5/23/07 18:41	387	0.257	5/23/2007 14:00	5/23/2007 23:00	100,463	2,427	1.6
Base			*23*	*0.139*	*5/23/2007 23:00*	*5/24/2007 8:00*	*5,063*	*7*	*0.0*
Storm Composite	5/24/07 09:38	5/24/07 14:00	24	0.099	5/24/2007 8:00	5/24/2007 21:00	88,143	132	0.5
Base			*23*	*0.139*	*5/24/2007 21:00*	*5/29/2007 16:00*	*50,928*	*72*	*0.4*
Storm			*118*	*0.323*	*5/29/2007 16:00*	*5/29/2007 19:00*	*4,715*	*35*	*0.1*
Base			*23*	*0.139*	*5/29/2007 19:00*	*5/30/2007 18:00*	*4,752*	*7*	*0.0*
Storm Composite	5/30/07 18:39	5/31/07 04:32	125	0.157	5/30/2007 18:00	5/31/2007 10:00	180,691	1,410	1.8
Base			*23*	*0.139*	*5/31/2007 10:00*	*6/2/2007 16:00*	*74,224*	*104*	*0.6*
Storm Composite	6/2/07 16:25	6/2/07 19:48	78	0.149	6/2/2007 16:00	6/3/2007 2:00	99,014	482	0.9
Base			*23*	*0.139*	*6/3/2007 2:00*	*6/6/2007 12:00*	*78,755*	*111*	*0.7*
Storm			*118*	*0.323*	*6/6/2007 12:00*	*6/6/2007 19:00*	*20,436*	*150*	*0.4*
Base			*23*	*0.139*	*6/6/2007 19:00*	*6/18/2007 12:00*	*36,827*	*52*	*0.3*
Storm Composite	6/18/07 12:26	6/18/07 13:34	430	0.508	6/18/2007 12:00	6/18/2007 20:00	61,862	1,661	2.0
Base Grab	6/29/07 12:23	6/29/07 12:23	36	0.211	6/18/2007 20:00	7/3/2007 14:00	16,290	39	0.2
Storm			*118*	*0.323*	*7/3/2007 14:00*	*7/3/2007 17:00*	*2,928*	*22*	*0.1*
Base			*23*	*0.139*	*7/3/2007 17:00*	*7/8/2007 15:00*	*6,067*	*9*	*0.1*
Storm Composite	7/8/07 16:03	7/8/07 18:01	151	0.286	7/8/2007 15:00	7/9/2007 1:00	42,601	402	0.8
Base			*23*	*0.139*	*7/9/2007 1:00*	*7/18/2007 16:00*	*17,236*	*24*	*0.1*
Storm Composite	7/18/07 16:33	7/18/07 21:23	173	1.79	7/18/2007 16:00	7/19/2007 2:00	169,665	1,832	19.0
Base			*23*	*0.139*	*7/19/2007 2:00*	*7/26/2007 15:00*	*36,294*	*51*	*0.3*
Storm			*118*	*0.323*	*7/26/2007 15:00*	*7/26/2007 22:00*	*17,504*	*129*	*0.4*
Base			*23*	*0.139*	*7/26/2007 22:00*	*8/4/2007 14:00*	*54,647*	*77*	*0.5*
Storm			*118*	*0.323*	*8/4/2007 14:00*	*8/5/2007 2:00*	*8,179*	*60*	*0.2*
Base			*23*	*0.139*	*8/5/2007 2:00*	*8/11/2007 3:00*	*21,488*	*30*	*0.2*
Storm			*118*	*0.323*	*8/11/2007 3:00*	*8/11/2007 10:00*	*70,547*	*519*	*1.4*
Base			*23*	*0.139*	*8/11/2007 10:00*	*8/11/2007 20:00*	*7,771*	*11*	*0.1*
Storm			*118*	*0.323*	*8/11/2007 20:00*	*8/12/2007 1:00*	*9,556*	*70*	*0.2*
Base			*23*	*0.139*	*8/12/2007 1:00*	*8/13/2007 22:00*	*12,638*	*18*	*0.1*
Storm Composite	8/13/07 23:32	8/14/07 02:42	42	0.173	8/13/2007 22:00	8/14/2007 7:00	102,555	269	1.1
Base			*23*	*0.139*	*8/14/2007 7:00*	*8/18/2007 10:00*	*34,397*	*48*	*0.3*
Storm Composite	8/19/07 15:18	8/19/07 19:31	25	0.162	8/18/2007 10:00	8/19/2007 23:00	246,857	385	2.5
Base			*23*	*0.139*	*8/19/2007 23:00*	*8/21/2007 3:00*	*51,251*	*72*	*0.4*
Storm			*118*	*0.323*	*8/21/2007 3:00*	*8/21/2007 8:00*	*18,792*	*138*	*0.4*
Base			*23*	*0.139*	*8/21/2007 8:00*	*8/23/2007 12:00*	*69,184*	*97*	*0.6*
Storm			*118*	*0.323*	*8/23/2007 12:00*	*8/23/2007 23:00*	*84,184*	*619*	*1.7*
Base			*23*	*0.139*	*8/23/2007 23:00*	*8/27/2007 2:00*	*54,651*	*77*	*0.5*
Storm Composite	8/27/07 02:32	8/27/07 06:25	46	0.175	8/27/2007 2:00	8/27/2007 11:00	141,330	406	1.5
Base			*23*	*0.139*	*8/27/2007 11:00*	*8/28/2007 2:00*	*21,578*	*30*	*0.2*
Storm Composite	8/28/07 03:01	8/28/07 08:48	78	0.234	8/28/2007 2:00	8/28/2007 18:00	361,708	1,761	5.3
Base			*23*	*0.139*	*8/28/2007 18:00*	*9/6/2007 21:00*	*222,779*	*313*	*1.9*
Storm			*118*	*0.323*	*9/6/2007 21:00*	*9/7/2007 7:00*	*29,476*	*217*	*0.6*
Base Composite	9/13/07 13:32	9/17/07 03:33	7	0.066	9/7/2007 7:00	9/18/2007 5:00	81,354	36	0.3
Storm Composite	9/18/07 12:23	9/18/07 16:09	64	0.197	9/18/2007 5:00	9/19/2007 3:00	288,080	1,151	3.5
Base			*23*	*0.139*	*9/19/2007 3:00*	*9/20/2007 18:00*	*69,079*	*97*	*0.6*
Storm Composite	9/20/07 18:28	9/20/07 20:48	211	0.389	9/20/2007 18:00	9/21/2007 7:00	634,602	8,359	15.4
Storm			*118*	*0.323*	*9/21/2007 7:00*	*9/21/2007 20:00*	*200,441*	*1,474*	*4.0*
Base			*23*	*0.139*	*9/21/2007 20:00*	*9/24/2007 18:00*	*443,109*	*622*	*3.8*
Storm			*118*	*0.323*	*9/24/2007 18:00*	*9/25/2007 0:00*	*47,679*	*351*	*1.0*
Base			*23*	*0.139*	*9/25/2007 0:00*	*9/26/2007 19:00*	*80,179*	*113*	*0.7*
Storm			*118*	*0.323*	*9/26/2007 19:00*	*9/27/2007 0:00*	*21,184*	*156*	*0.4*
Base			*23*	*0.139*	*9/27/2007 0:00*	*9/30/2007 3:00*	*55,600*	*78*	*0.5*
Storm Composite	9/30/07 04:53	9/30/07 18:13	27	0.152	9/30/2007 3:00	10/1/2007 1:00	255,897	431	2.4
Base			*23*	*0.139*	*10/1/2007 1:00*	*10/2/2007 12:00*	*123,971*	*174*	*1.1*
Storm			*118*	*0.323*	*10/2/2007 12:00*	*10/3/2007 11:00*	*457,328*	*3,364*	*9.2*
Base			*23*	*0.139*	*10/3/2007 11:00*	*10/5/2007 1:00*	*313,012*	*440*	*2.7*
Storm Composite	10/5/07 02:34	10/5/07 08:17	30	0.120	10/5/2007 1:00	10/5/2007 20:00	297,804	558	2.2
Base			*23*	*0.139*	*10/5/2007 20:00*	*10/6/2007 5:00*	*84,243*	*118*	*0.7*
Storm			*118*	*0.323*	*10/6/2007 5:00*	*10/6/2007 12:00*	*69,793*	*513*	*1.4*
Base			*23*	*0.139*	*10/6/2007 12:00*	*10/7/2007 22:00*	*270,112*	*379*	*2.3*
Storm			*118*	*0.323*	*10/7/2007 22:00*	*10/9/2007 4:00*	*434,289*	*3,194*	*8.8*
Base			*23*	*0.139*	*10/9/2007 4:00*	*10/14/2007 16:00*	*554,337*	*779*	*4.8*
Storm			*118*	*0.323*	*10/14/2007 16:00*	*10/17/2007 3:00*	*131,252*	*965*	*2.6*
Base			*23*	*0.139*	*10/17/2007 3:00*	*10/17/2007 22:00*	*34,414*	*48*	*0.3*
Storm			*118*	*0.323*	*10/17/2007 22:00*	*10/19/2007 20:00*	*379,086*	*2,788*	*7.7*
Base			*23*	*0.139*	*10/19/2007 20:00*	*10/30/2007 11:00*	*511,170*	*718*	*4.4*
*Base***			*23*	*0.139*	*10/30/2007 11:00*	*1/1/2008 0:00*	*270,180*	*379*	*2.3*
Storm Average			118	0.323					
Base Average			23	0.139					
Snowmelt Average			547	0.482					
All Average			130	0.313					
Total							**12,358,075**	55,587	178
SWWD Major Subwatershed Total Acres							1,482		
Total TP/TSS(lb/ac/yr)								37.51	0.12
Total TP/TSS (kg/ha/yr)								42.04	0.13

*Italics indicate estimated concentrations based on average base and storm flow concentrations

** Interval flow values from 1/1/07 to 3/26/07 and 10/30/07 to 1/1/08 were estimated from base flow

Grab and flow weighted composite samples were collected 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), total dissolved phosphorus (TDP), volatile suspended solids (VSS), total chemical oxygen demand (COD), Soluble COD, TOC, and *E. coli* concentrations from all collected samples are listed in Table 3. The highest TSS concentrations were collected in a snowmelt grab on March 13, 2007. The highest TP concentration was collected in a storm composite on July 18, 2007. The highest TKN concentration was collected in a storm composite on April 22, 2007. Metals, chloride, other Nitrogen species, and hardness chemical results are listed in Table 4. Table 3 outlines any chronic standards exceedences as stated within Chapter 7050 of the water quality rules of the MPCA. Both Copper and Lead had multiple samples that were above the chronic standard, with Copper also having multiple samples above the maximum standard. Parameters that were tested under MPCA 7050 were copper, nickel, lead, cadmium, chromium and chloride. Samples that could not determine exceedence standards were due to missing hardness test parameters. The MPCA defines these standards as follows: "Chronic standard is the highest concentration of a toxicant to which aquatic organisms can be exposed indefinitely with no harmful effects, or to which humans or wildlife consumers of aquatic organisms can be exposed indefinitely with no harmful effects". "Maximum standard is a concentration that protects aquatic organisms from potential lethal effects of a short-term "spike" in toxicant concentrations. This is always equal to one-half the final acute value". "Final acute value is the concentration that would kill about half of the exposed individuals of a very sensitive aquatic species". (http://www.pca.state.mn.us/water/standards/index.html). MPCA has proposed to change current water quality standards from fecal coliform to *E. coli* bacteria. These changes would set the 30-day geometric mean to 126 cfu/100mL and 10% of Values not to Exceed 1260 cfu/mL. (http://proteus.pca.state.mn.us/water/standards/rulechange.html)

Table 3. MS1 2007 Sample Chemistry Results

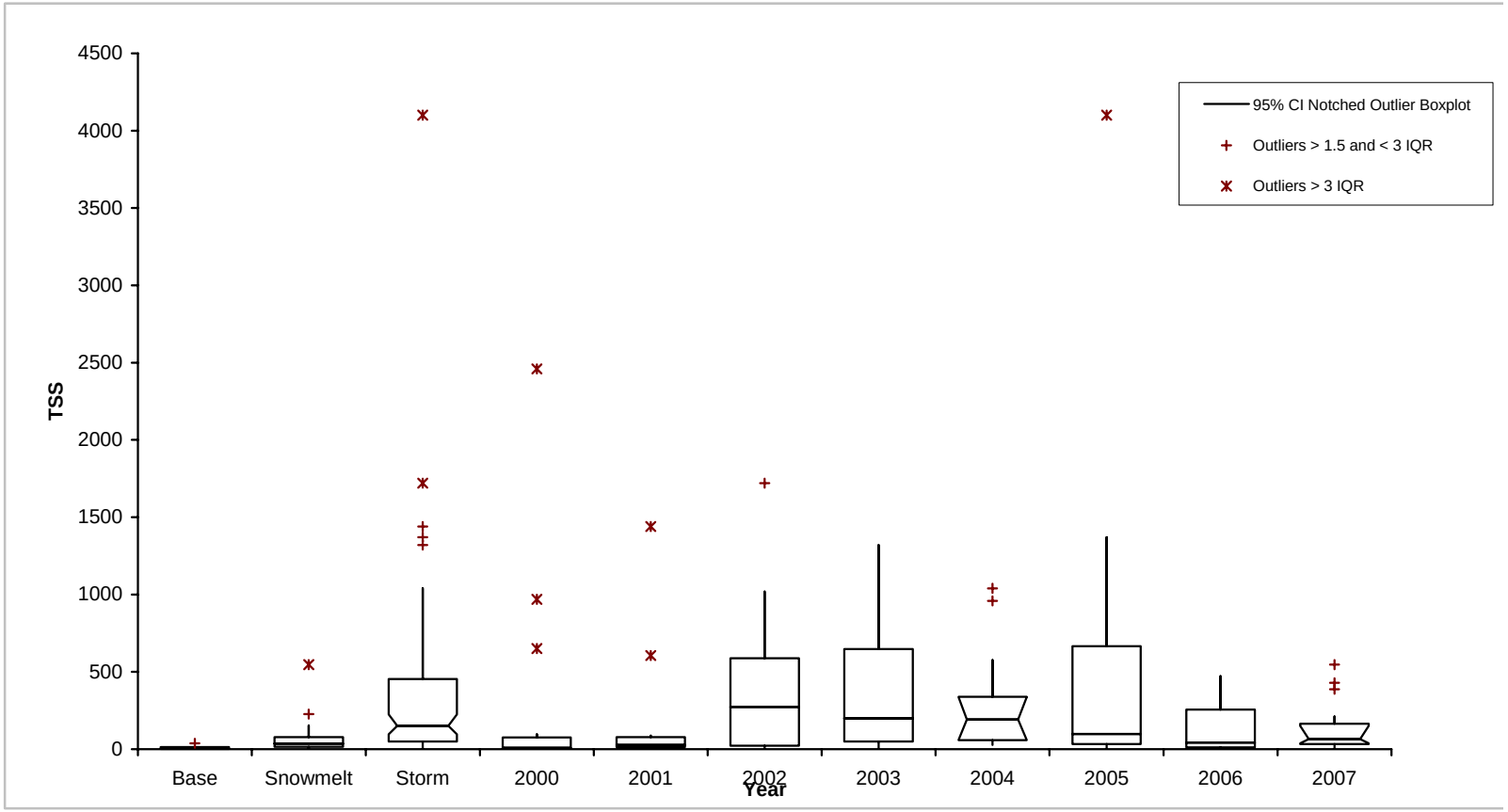
Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	*E. coli* (mpn/100 mL)	COD (mg/L)	TDP (mg/L)	TOC (mg/L)	Soluble COD (mg/L)
Snowmelt Grab	3/13/07 12:53	3/13/07 12:53	547	30	2.90	0.482		64	0.1770	22.4	40
Storm Composite	3/30/07 4:20	4/2/07 2:33	66	~9	2.60	0.234		36	0.0560	6.5	25
Storm Composite	4/22/07 17:01	4/23/07 11:14	46	31	6.20	0.415		100	~0.0210	7.8	37
E. coli Grab	5/2/07 11:45	5/2/07 11:45					668				
Storm Composite	5/23/07 15:54	5/23/07 18:41	387	45	1.70	0.257		50	0.0760	5.4	20
Storm Composite	5/24/07 9:38	5/24/07 14:00	24	6	1.30	0.099		30	~0.0450	6.5	24
Storm Composite	5/30/07 18:39	5/31/07 4:32	125	~13	1.10	0.157		29	~0.0480	5.5	42
Storm Composite	6/2/07 16:25	6/2/07 19:48	78	13	1.20	0.149		38	~0.0430	7.5	30
E. coli Grab	6/13/07 11:30	6/13/07 11:30					308				
Storm Composite	6/18/07 12:26	6/18/07 13:34	430	~38	1.60	0.508		66	~0.0340	9.7	27
Base Grab	6/29/07 12:23	6/29/07 12:23	38	5	0.73	0.211		21	0.0810	5.1	20
Storm Composite	7/8/07 16:03	7/8/07 18:01	151	45	1.80	0.286		70	0.0680	13.6	63
Storm Composite	7/18/07 16:33	7/18/07 21:23	173	19	1.10	1.790		55	0.0093	10.8	41
Storm Composite	8/13/07 23:32	8/14/07 2:42	42	~10	1.00	0.173		43	0.0740	8.0	32
Storm Composite	8/19/07 15:18	8/19/07 19:31	25	6	0.74	0.162		28	0.0580	6.1	44
Storm Composite	8/27/07 2:32	8/27/07 6:25	46	~10	0.96	0.175		36	0.0720	9.0	28
Storm Composite	8/28/07 3:01	8/28/07 8:48	78	12	1.10	0.234		41	0.0850	9.3	29
E. coli Grab	8/28/07 10:43	8/28/07 10:43					>2420				
Base Composite	9/13/07 13:32	9/17/07 3:33	7	4	0.56	0.066		21	~0.0220	6.6	19
Storm Composite	9/18/07 12:23	9/18/07 16:09	64	9	0.69	0.197		58	0.0740	6.2	18
Storm Composite	9/20/07 18:28	9/20/07 20:48	211	21	1.40	0.389		39	0.1770	9.2	28
Storm Composite	9/30/07 4:53	9/30/07 18:13	27	~5	0.94	0.152		33	0.0650	9.0	36
Storm Composite	10/5/07 2:34	10/5/07 8:17	30	~4	0.75	0.120		28	0.0650	5.5	22
E. coli Grab	10/18/07 11:50	10/18/07 11:50					1046				

Table 4. MS1 2007 Sample Metals, Chloride, Nitrogen Species, and Hardness Chemical Results including MPCA 7050 Water Quality Standard Exceedences
(http://www.revisor.leg.state.mn.us/arule/7050/)

Sample Type	Start Date	End Date	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/13/07 12:53	3/13/07 12:53	0.0083	0.0077	0.0040	0.0200	<0.00004	0.0057	76	0.04	0.51	0.32	
Storm Composite	3/30/07 4:20	4/2/07 2:33	0.0060	0.0031	0.0016	0.0191	<0.00004	0.0025	97	<0.03	0.20	0.08	80
Base Composite	4/22/07 17:01	4/23/07 11:14	0.0111	0.0038	0.0013	0.0330	<0.00004	0.0048	508	0.21	1.09	0.18	192
E. coli Grab	5/2/07 11:45	5/2/07 11:45											
Storm Composite	5/23/07 15:54	5/23/07 18:41	0.0137	0.0077	0.0059	0.0520	0.00010	0.0083	70	0.38	0.78	0.07	76
Storm Composite	5/24/07 9:38	5/24/07 14:00	0.0061	0.0024	0.0009	0.0165	0.00040	0.0021	78	0.07	0.47	0.23	66
Storm Composite	5/30/07 18:39	5/31/07 4:32	0.0105	0.0038	0.0020	0.0192	<0.00004	0.0036	55	0.07	0.44	0.06	56
Storm Composite	6/2/07 16:25	6/2/07 19:48	0.0078	0.0040	0.0022	0.0220	<0.00004	0.0035	46	0.03	0.33	~0.06	56
E. coli Grab	6/13/07 11:30	6/13/07 11:30											
Storm Composite	6/18/07 12:26	6/18/07 13:34	0.0141	0.0109	0.0086	0.0450	<0.00004	0.0113	26	<0.03	0.06	0.13	64
Base Grab	6/29/07 12:23	6/29/07 12:23	0.0027	0.0034	0.0007	0.0081	<0.00004	0.0029	81	<0.03	0.39	0.09	138
Storm Composite	7/8/07 16:03	7/8/07 18:01	0.0089	0.0030	0.0015	0.0400	0.00040	0.0034	16	0.03	0.44	0.08	54
Storm Composite	7/18/07 16:33	7/18/07 21:23	0.0089	0.0046	0.0028	0.0290	0.00009	0.0057	16	<0.03	0.58	~0.06	52
Storm Composite	8/13/07 23:32	8/14/07 2:42	0.0051	0.0020	0.0010	0.0138	<0.00050	0.0014	14	<0.03	0.38	~0.06	56
Storm Composite	8/19/07 15:18	8/19/07 19:31	0.0038	0.0018	0.0007	0.0111	0.00070	0.0017	14	<0.03	0.24	~0.05	52
Storm Composite	8/27/07 2:32	8/27/07 6:25	0.0074	0.0022	0.0012	0.0160	<0.00050	0.0016	10	<0.03	<0.05	0.09	48
Storm Composite	8/28/07 3:01	8/28/07 8:48	0.0068	0.0030	0.0017	0.0193	<0.00050	0.0023	11	<0.03	0.17	0.14	48
E. coli Grab	8/28/07 10:43	8/28/07 10:43											
Base Composite	9/13/07 13:32	9/17/07 3:33	0.0109	0.0025	0.0002	0.0084	<0.00050	0.0023	38	<0.03	0.43	~0.02	162
Storm Composite	9/18/07 12:23	9/18/07 16:09	0.0165	0.0029	0.0019	0.0184	<0.00050	0.0027	10	<0.03	0.28	0.10	54
Storm Composite	9/20/07 18:28	9/20/07 20:48	0.0128	0.0059	0.0057	0.0280	<0.00050	0.0059	11	0.09	0.43	0.08	46
Storm Composite	9/30/07 4:53	9/30/07 18:13	0.0064	0.0026	0.0009	0.0083	<0.00050	0.0012	15	<0.03	0.23	~0.04	56
Storm Composite	10/5/07 2:34	10/5/07 8:17	0.0038	0.0018	0.0008	0.0102	<0.00050	0.0014	27	<0.03	0.06	~0.04	70
E. coli Grab	10/18/07 11:50	10/18/07 11:50											

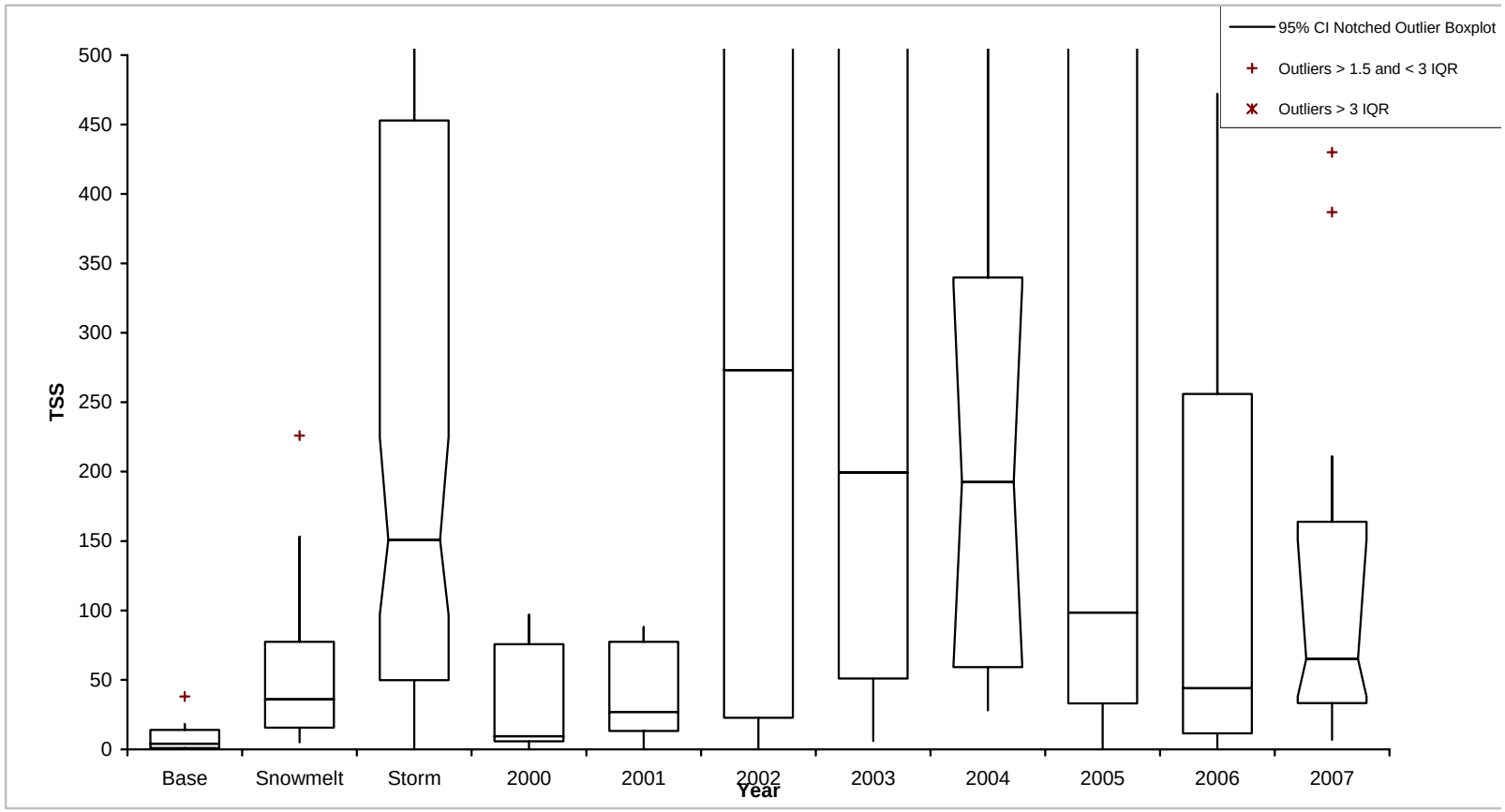
No exceedence determinable
Exceeds Chronic Standard
Exceeds Maximum Standard
Exceeds Final Acute Standard

Statistical summaries for MS1 for the monitoring seasons 2000-2007 are shown as box plots in figures 3-10. The 2002 monitoring season recorded the largest increases in median values for total suspended solids, volatile suspended solids, total phosphorus, and total Kjedahl nitrogen. Further analysis of factors around this site is needed to fully understand why this occurred, but one conclusion is the overall higher precipitation causing increased runoff in 2002. Median values decline over the next four years for TSS, VSS, and TP. 2007 had a slight increase in the median values for TSS, VSS, and TP. TKN maintains a slight declining trend from 2005-2007. Total chloride ions for MS1 had a stable trend since the first year of monitoring in 2003. Fecal Coliform statistical summary is difficult due to low numbers of samples, with the years 2003 and 2004 unable to perform tests because of these low numbers of samples. It should be noted that the geometric means of fecal coliform exceeds the numerical limits for water quality standards, however it does not violate the water quality standard due to the low amount of samples taken each year. The standard is as follows: "Not to exceed 200 organisms per 100 milliliters as a geometric mean of not less than five samples in any calendar month, nor shall more than ten percent of all samples taken during any calendar month individually exceed 400 organisms per 100 milliliters. The standard applies only between April 1 and October 31." (Minnesota Pollution Control Agency. Waters of the State. Chapter 7050, Subsection 0222.). The box plots indicate further and more intensive *E. coli* bacteria sampling to verify the flowing waters at MS1 are within the Minnesota Pollution Control Agency's water quality standards. The geometric mean for MS1 in 2002 was 377 organisms per 100 mL, 2005 was 555 organisms per 100 mL, 2006 was 343 organisms per 100 mL, and 2007 was 1111 organisms per 100 mL. A breakout of different sample types indicates the range of concentrations found for all sampling years. It is interesting to note that snowmelt samples had the highest range and highest median concentrations for TP, TKN, and total Chloride ions. This points to the capacity of snow to accumulate and hold chemicals and sediments throughout the winter season, releasing them during melting events.



TSS by Year	n	Min	Median	95% CI	Max	IQR
Base	14	1	4.0	1.0 to 15.0	38	13.1
Snowmelt	15	5	36.0	15.0 to 83.0	547	62.0
Storm	90	1	151.0	97.0 to 225.0	4100	403.0
2000	16	1	9.5	5.0 to 97.0	2460	69.9
2001	19	1	27.0	13.0 to 83.0	1440	64.2
2002	16	1	273.0	19.0 to 600.0	1720	565.6
2003	14	6	199.5	18.0 to 771.0	1320	596.3
2004	18	28	192.5	60.0 to 335.0	1040	280.6
2005	16	1	98.5	21.0 to 708.0	4100	633.3
2006	16	1	44.0	9.0 to 296.0	472	244.5
2007	20	7	65.0	38.0 to 151.0	547	130.5

Figure 3. MS1 Total Suspended Solids Box Plot (2000-2007)



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Snowmelt	15	5	36.0	15.0 to 83.0	547	62.0
Storm	90	1	151.0	97.0 to 225.0	4100	403.0
2000	16	1	9.5	5.0 to 97.0	2460	69.9
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2002	16	1	273.0	19.0 to 600.0	1720	565.6
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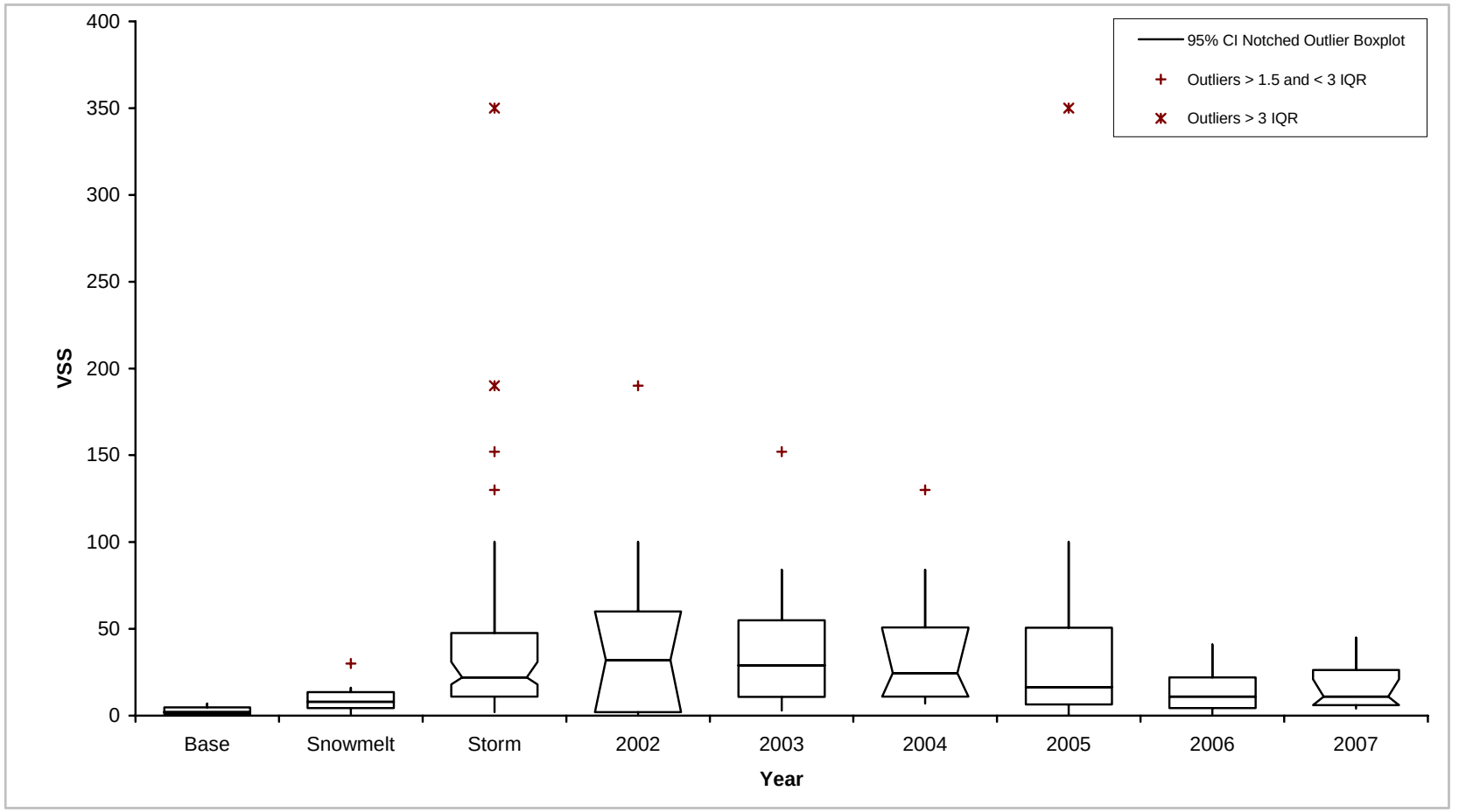
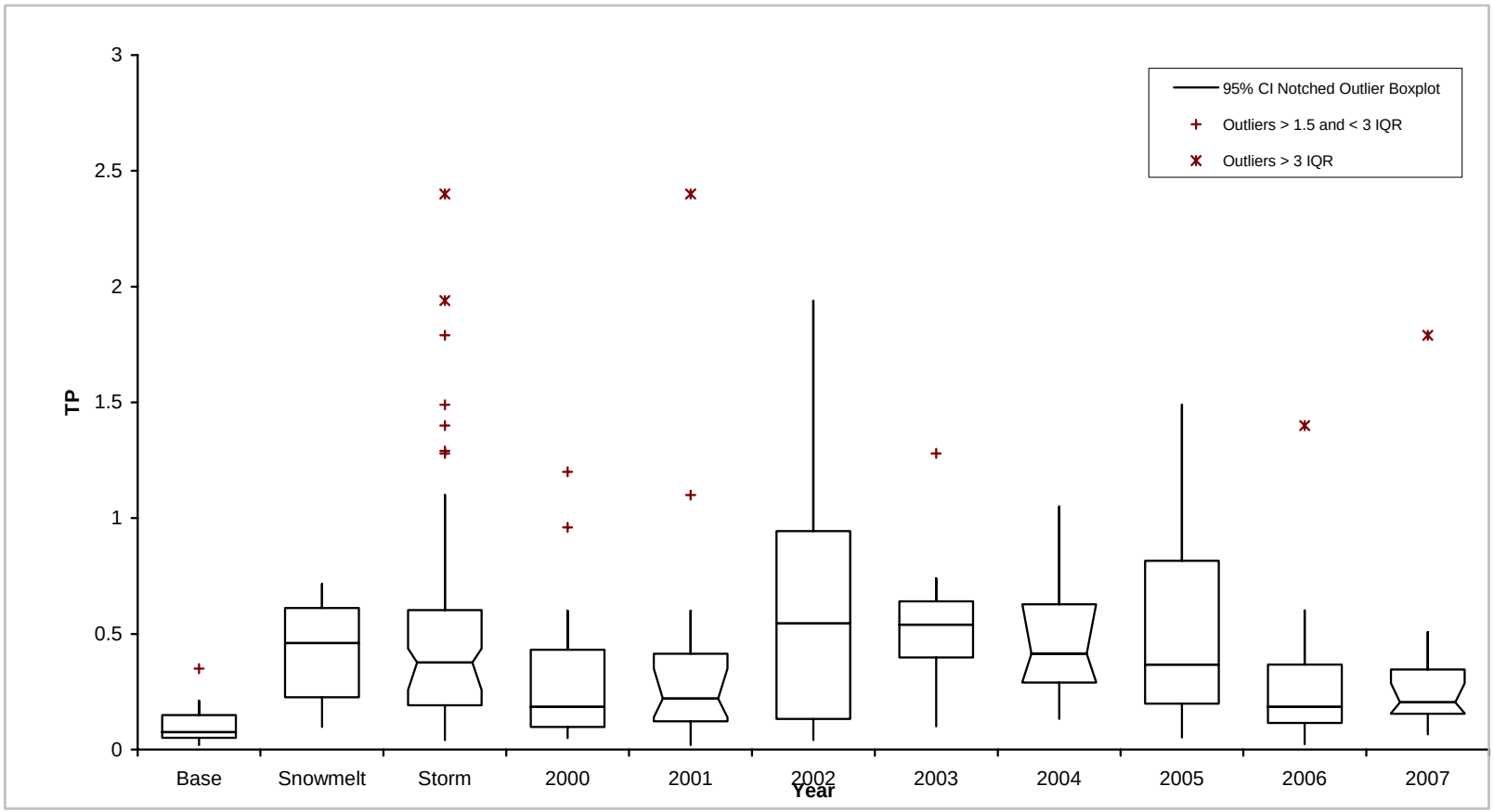
2005	16	1	98.5	21.0 to 708.0	4100	633.3
2006	16	1	44.0	9.0 to 296.0	472	244.5
2007	20	7	65.0	38.0 to 151.0	547	130.5

Figure 4. MS1 Total Suspended Solids Box Plot (2000-2007) without outliers



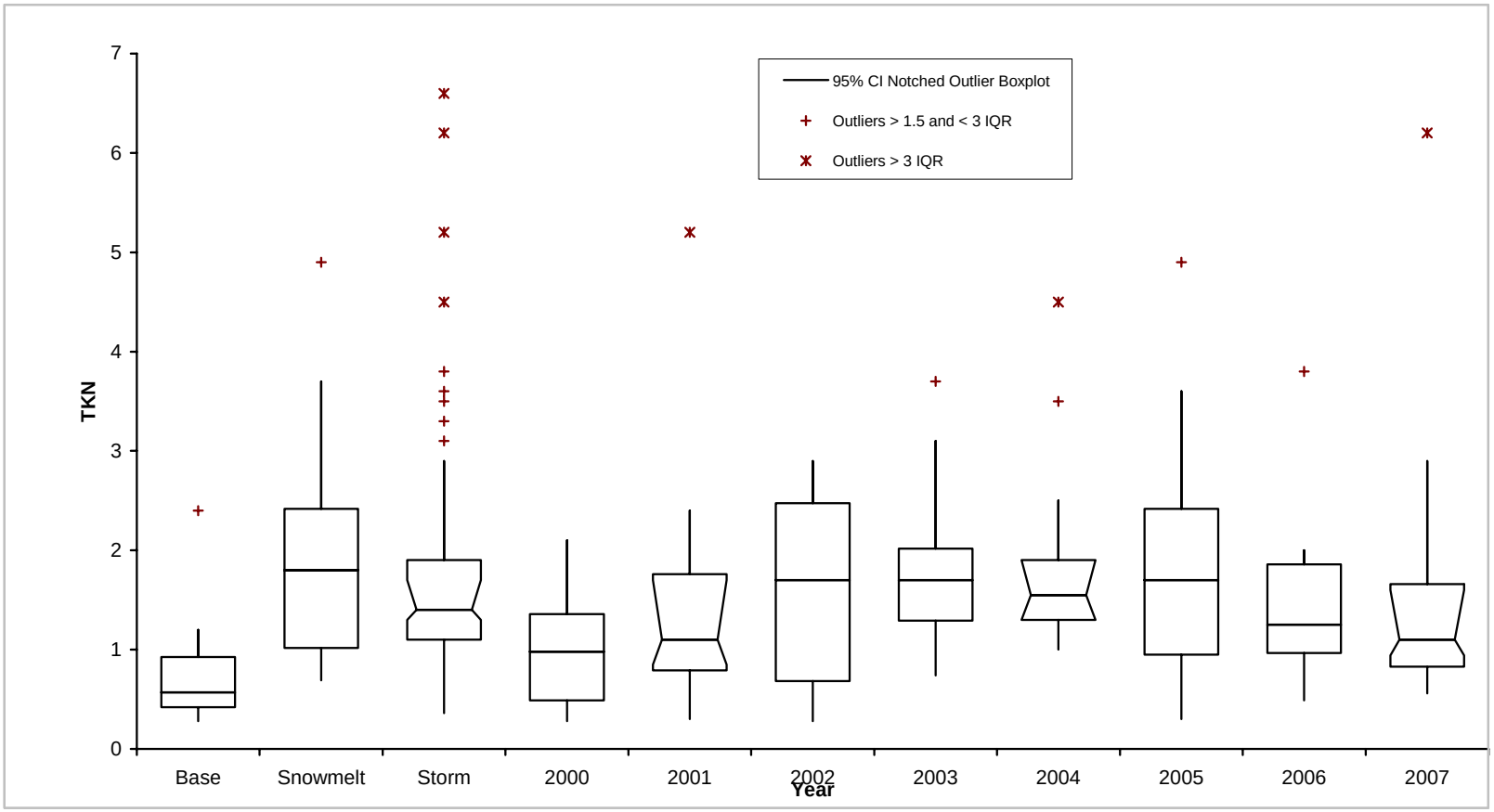
VSS by Year	n	Min	Median	95% CI	Max	IQR
Base	11	0.5	2.00	0.50 to 6.00	7.0	3.83
Snowmelt	8	1.0	8.00	1.00 to 30.00	30.0	9.25
Storm	79	2.0	22.00	18.00 to 31.00	350.0	36.50
2002	14	1.0	32.00	2.00 to 60.00	190.0	58.00
2003	14	3.0	29.00	8.00 to 66.00	152.0	44.25
2004	18	7.0	24.50	11.00 to 50.00	130.0	39.92
2005	16	0.5	16.50	6.00 to 51.00	350.0	44.17
2006	16	1.0	11.00	3.00 to 22.00	41.0	17.75
2007	20	4.0	11.00	6.00 to 21.00	45.0	20.25

Figure 5. MS1 Volatile Suspended Solids Box Plot (2000-2007)



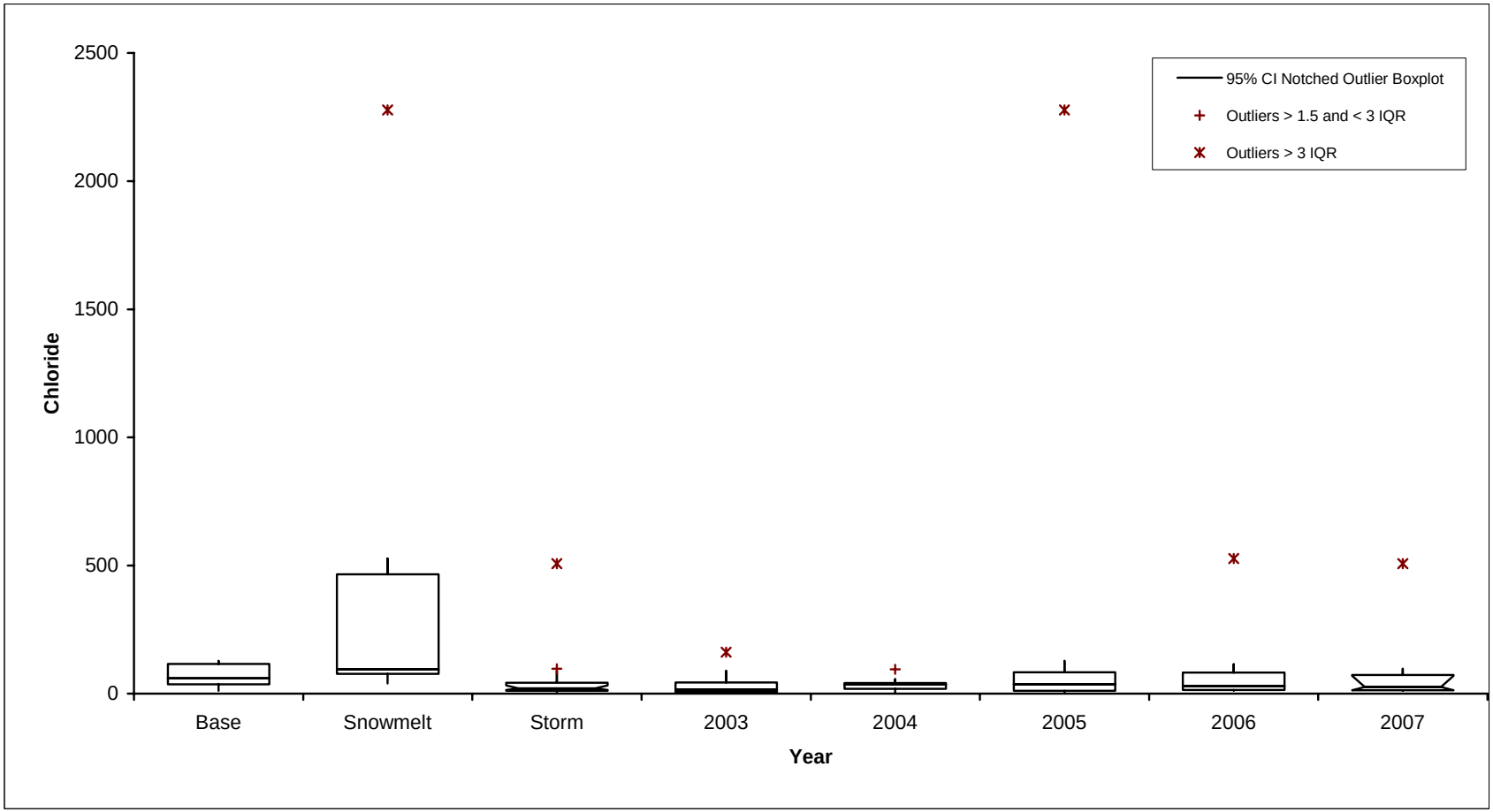
TP by Year	n	Min	Median	95% CI	Max	IQR
Base	14	0.020	0.0745	0.0410 to 0.1700	0.350	0.0978
Snowmelt	15	0.098	0.4600	0.2200 to 0.6140	0.715	0.3850
Storm	91	0.040	0.3760	0.2570 to 0.4360	2.400	0.4098
2000	16	0.050	0.1850	0.0900 to 0.4400	1.200	0.3333
2001	20	0.020	0.2200	0.1400 to 0.3500	2.400	0.2917
2002	16	0.041	0.5450	0.1080 to 1.0700	1.940	0.8112
2003	14	0.100	0.5400	0.3800 to 0.6400	1.280	0.2417
2004	18	0.133	0.4140	0.2930 to 0.6260	1.050	0.3373
2005	16	0.052	0.3675	0.1910 to 0.8870	1.490	0.6168
2006	16	0.023	0.1845	0.1130 to 0.3910	1.400	0.2522
2007	20	0.066	0.2040	0.1570 to 0.2860	1.790	0.1920

Figure 6. MS1 Total Phosphorus Box Plot (2000-2007)



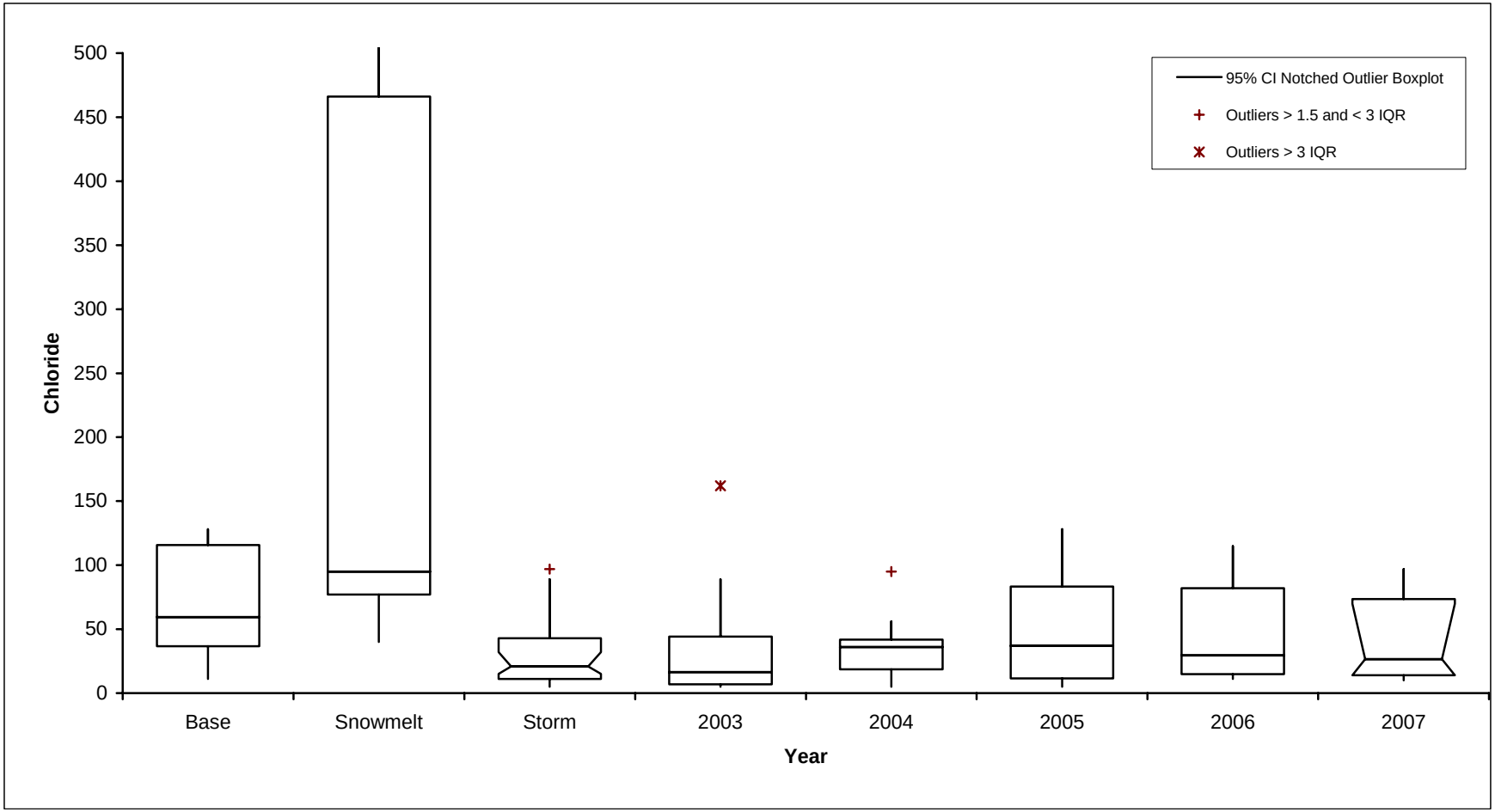
TKN by Year	n	Min	Median	95% CI	Max	IQR
Base	14	0.28	0.570	0.300 to 0.990	2.40	0.507
Snowmelt	15	0.69	1.800	1.000 to 2.500	4.90	1.400
Storm	91	0.36	1.400	1.300 to 1.700	6.60	0.800
2000	16	0.28	0.980	0.480 to 1.400	2.10	0.870
2001	20	0.30	1.100	0.850 to 1.700	5.20	0.967
2002	16	0.28	1.700	0.680 to 2.600	6.60	1.791
2003	14	0.74	1.700	1.200 to 2.200	3.70	0.725
2004	18	1.00	1.550	1.300 to 1.900	4.50	0.600
2005	16	0.30	1.700	0.940 to 2.500	4.90	1.468
2006	16	0.49	1.250	0.950 to 1.900	3.80	0.892
2007	20	0.56	1.100	0.940 to 1.600	6.20	0.829

Figure 7. MS1 Total Kjedahl Nitrogen Box Plot (2000-2007)



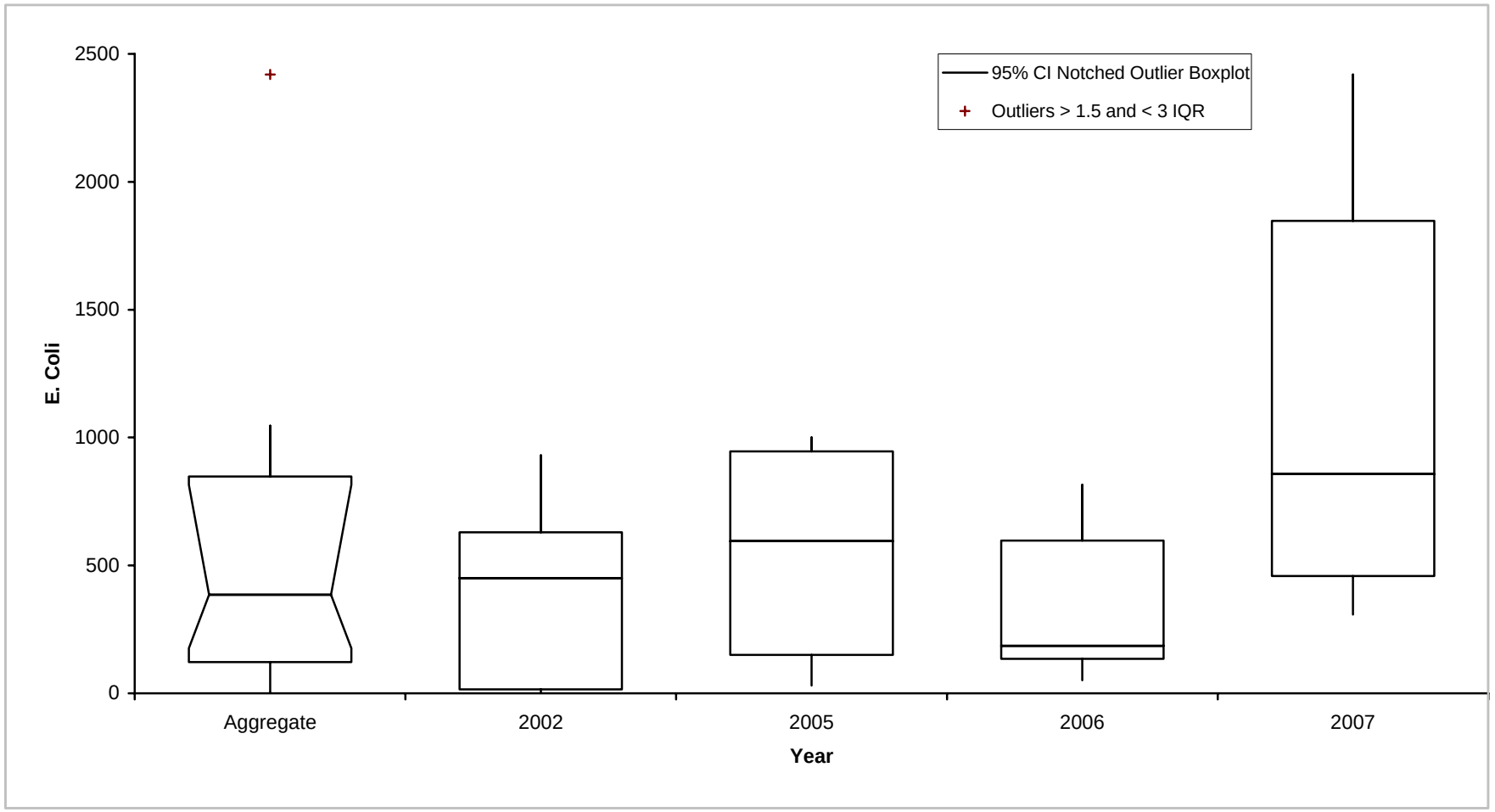
Chloride by Year	n	Min	Median	95% CI	Max	IQR
Base	10	11	59.5	33.0 to 123.0	128	79.0
Snowmelt	7	40	95.0	40.0 to 2278.0	2278	389.2
Storm	67	5	21.0	15.0 to 32.0	508	31.7
2003	14	5	16.5	7.0 to 67.0	162	37.1
2004	19	5	36.0	18.0 to 42.0	95	23.2
2005	15	5	37.0	11.0 to 85.0	2278	71.8
2006	16	11	29.5	14.0 to 82.0	527	67.2
2007	20	10	26.5	14.0 to 70.0	508	59.5

Figure 8. MS1 Total Chloride Ions Box Plot (2003-2007)



Chloride by Year	n	Min	Median	95% CI	Max	IQR
Base	10	11	59.5	33.0 to 123.0	128	79.0
Snowmelt	7	40	95.0	40.0 to 2278.0	2278	389.2
Storm	67	5	21.0	15.0 to 32.0	508	31.7
2003	14	5	16.5	7.0 to 67.0	162	37.1
2004	19	5	36.0	18.0 to 42.0	95	23.2
2005	15	5	37.0	11.0 to 85.0	2278	71.8
2006	16	11	29.5	14.0 to 82.0	527	67.2
2007	20	10	26.5	14.0 to 70.0	508	59.5

Figure 9. MS1 Total Chloride Ions Box Plot (2003-2007) without Outliers



E. Coli by Year	n	Min	Median	95% CI	Max	IQR
Aggregate	20	4	385.0	176.0 to 816.0	2420	725.8
2002	5	4	450.0	- to -	930	614.0
2005	4	30	595.0	- to -	1000	795.0
2006	5	51	186.0	- to -	816	463.0
2007	4	308	857.0	- to -	2420	1389.5

Figure 10. MS1 *E. coli* Bacteria Box Plot (2002-2007)

***not enough samples to complete statistical analysis for 2003 and 2004.**

******E. coli*** **bacteria has been sampled since 2006, prior season samplings was for total fecal coliform**

MS2 (Bailey)

The hydrograph for the MS2 site shows flow from April 11 – September 26, 2007 (Figure 11). Equipment was pulled at this time due to aquatic vegetation removal at the monitoring location and concern for the safety of the equipment. Precipitation was recorded for MS2 from April 11 – October 30, 2007. Total discharge during this period was 5,090,574 cf or 117 acre-ft. Peak discharge was 33.33 cfs on September 24, 2007 from removal of the aquatic vegetation. The highest daily rainfall event occurred on July 18th, at 1.79 inches of rain.

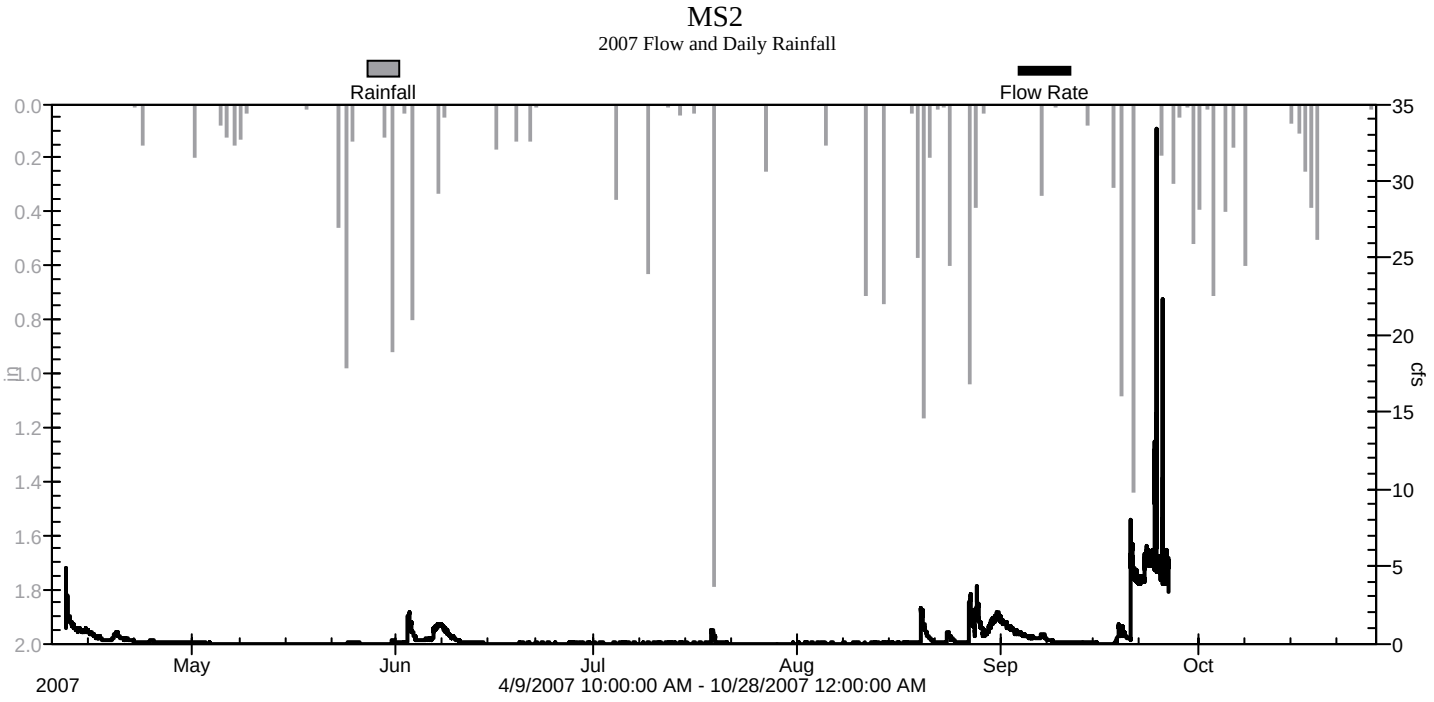


Figure 11. MS2 2007 Continuous Flow and Daily Rainfall

Table 5. MS2 Stormwater Total Phosphorus and Total Suspended Solids Loading Table

	Sample Collection Time				Loading Interval				
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval TSS (lb)**	**Interval TP (lb)**
*Base***			*6*	*0.090*	*1/1/2007 0:00*	*3/13/2007 0:00*	*61,344*	*23.0*	*0.3*
Snowmelt Grab**	3/13/07 13:28	3/13/07 13:28	7	0.280	3/13/2007 0:00	3/14/2007 0:00	43,200	18.9	0.8
*Base***			*6*	*0.090*	*3/14/2007 0:00*	*4/2/2007 0:00*	*410,400*	*153.7*	*2.3*
Storm Grab**	4/2/07 10:13	4/2/07 10:13	5	0.092	4/2/2007 0:00	4/3/2007 0:00	172,800	53.9	1.0
*Base***			*6*	*0.090*	*4/3/2007 0:00*	*4/11/2007 14:45*	*744,300*	*278.8*	*4.2*
Storm			*6*	*0.118*	*4/11/2007 14:45*	*4/12/2007 8:45*	*165,236*	*66.3*	*1.2*
Base			*6*	*0.090*	*4/12/2007 8:45*	*4/19/2007 23:45*	*383,839*	*143.8*	*2.2*
Base Composite	4/19/07 14:24	4/24/07 10:27	6	0.090	4/19/2007 23:45	5/24/2007 12:45	86,197	32.3	0.5
Storm			*6*	*0.118*	*5/24/2007 12:45*	*5/25/2007 11:45*	*3,544*	*1.4*	*0.0*
Storm			*6*	*0.118*	*5/25/2007 11:45*	*6/1/2007 9:45*	*10,335*	*4.1*	*0.1*
Base			*6*	*0.090*	*6/1/2007 9:45*	*6/2/2007 15:45*	*1,290*	*0.5*	*0.0*
Storm Composite	6/2/07 18:11	6/3/07 21:21	4	0.073	6/2/2007 15:45	6/4/2007 1:45	111,609	27.9	0.5
Base			*6*	*0.090*	*6/4/2007 1:45*	*6/5/2007 9:45*	*20,748*	*7.8*	*0.1*
Storm			*6*	*0.118*	*6/5/2007 9:45*	*6/9/2007 21:45*	*255,908*	*102.7*	*1.9*
Base			*6*	*0.090*	*6/9/2007 21:45*	*7/18/2007 17:45*	*22,572*	*8.5*	*0.1*
Storm Composite	7/18/07 20:35	7/19/07 11:23	9	0.126	7/18/2007 17:45	7/19/2007 18:45	40,305	22.6	0.3
Base			*6*	*0.090*	*7/19/2007 18:45*	*8/19/2007 15:45*	*616*	*0.2*	*0.0*
Storm Composite	8/19/07 18:16	8/20/07 8:38	4	0.090	8/19/2007 15:45	8/21/2007 3:45	140,828	35.2	0.8
Base			*6*	*0.090*	*8/21/2007 3:45*	*8/23/2007 14:45*	*13,975*	*5.2*	*0.1*
Storm			*6*	*0.118*	*8/23/2007 14:45*	*8/25/2007 0:45*	*43,560*	*17.5*	*0.3*
Base			*6*	*0.090*	*8/25/2007 0:45*	*8/27/2007 2:45*	*4,361*	*1.6*	*0.0*
Storm Composite	8/27/07 5:13	8/27/07 15:09	4	0.114	8/27/2007 2:45	8/27/2007 16:45	104,893	26.2	0.7
Storm Composite	8/28/07 4:38	8/28/07 19:30	4	0.116	8/27/2007 16:45	8/29/2007 7:45	221,435	55.3	1.6
Base			*6*	*0.090*	*8/29/2007 7:45*	*9/6/2007 23:45*	*653,013*	*244.6*	*3.7*
Storm			*6*	*0.118*	*9/6/2007 23:45*	*9/7/2007 23:45*	*40,310*	*16.2*	*0.3*
Base Grab	9/13/07 14:32	9/13/07 14:32	21	0.159	9/7/2007 23:45	9/18/2007 9:45	34,498	45.2	0.3
Storm			*6*	*0.118*	*9/18/2007 9:45*	*9/19/2007 17:45*	*70,802*	*28.4*	*0.5*
Base			*6*	*0.090*	*9/19/2007 17:45*	*9/20/2007 18:45*	*35,565*	*13.3*	*0.2*
Storm Composite	9/20/07 19:13	9/21/07 8:15	15	0.218	9/20/2007 18:45	9/21/2007 8:45	251,931	235.9	3.4
Base			*6*	*0.090*	*9/21/2007 8:45*	*9/24/2007 11:45*	*1,307,346*	*489.7*	*7.3*
Storm			*6*	*0.118*	*9/24/2007 11:45*	*9/26/2007 11:45*	*1,058,408*	*424.8*	*7.8*
*Base***			*6*	*0.090*	*9/26/2007 11:45*	*1/1/2008 0:00*	*83,385*	*31.2*	*0.5*
Storm Average			6	0.118					
Base Average			6	0.090					
Snowmelt Average			7	0.280					
All Average			8	0.136					
Total							**6,598,550**	2,617	43
SWWD Major Subwatershed Total Acres							10,174		
Total TP/TSS(lb/ac/yr)								0.26	0.004
Total TP/TSS (kg/ha/yr)								0.29	0.005

*Italics indicate estimated concentrations based on average base and storm flow concentrations

** Interval flow values from 1/1/07 to 4/11/07 and 9/26/07 to 1/1/08 were estimated from base flow

Grab and flow weighted composite samples were collected at the MS2 site to determine water quality. Samples were taken during snowmelt and storm runoff, as well as during base flow conditions. The TSS, TKN, TP, VSS, soluble COD, total COD, TDP, and *E. coli* results from all collected samples are listed in Table 6. Both the highest TP and TKN concentrations were collected in a snowmelt grab on March 13, 2007. The highest TSS concentrations were collected in a base grab on September 13, 2007. Metals, chloride, hardness, and other Nitrogen species chemical results are listed in Table 7. Water quality standard exceedences were also included in Table 6. For 2007 at MS2, no samples were above the chronic standard, which is the lowest threshold of water quality standards set forth by the Minnesota Pollution Control Agency. One sample was not analyzed due to missing a Hardness result.

Table 6. MS2 2007 Sample Chemistry Results

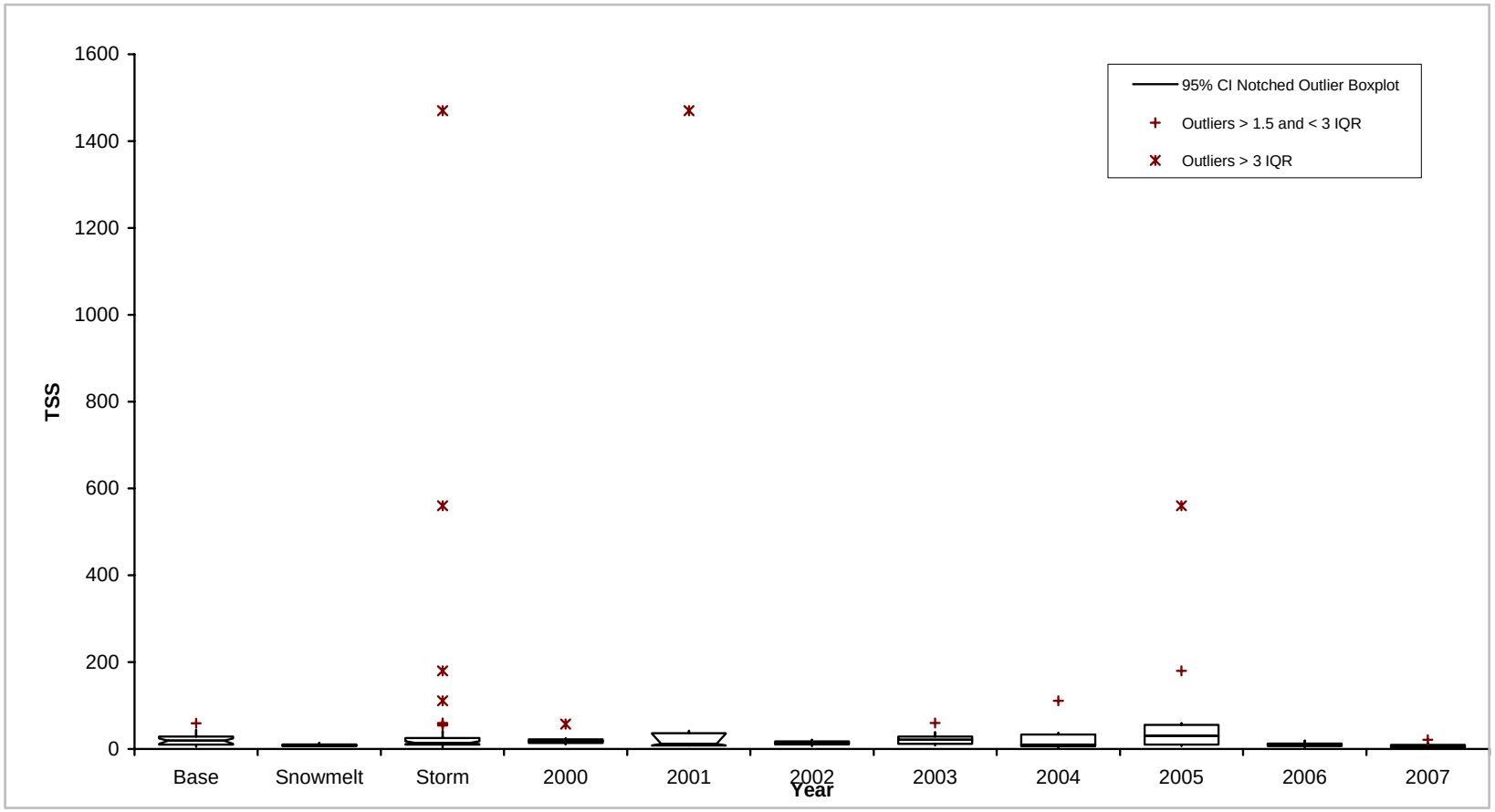
Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	*E. coli* (mpn/100 mL)	COD (mg/L)	TDP (mg/L)	TOC (mg/L)	Soluble COD (mg/L)
Snowmelt Grab	3/13/07 13:28	3/13/07 13:28	7	~4	3.40	0.280		48	0.183	13.1	68
Storm Grab	4/2/07 10:13	4/2/07 10:13	~5	~4	1.80	0.092		40	~0.019	6.5	24
Base Composite	4/19/07 14:24	4/24/07 10:27	6	~5	1.50	0.090		30	~0.020	5.7	22
Storm Composite	6/2/07 18:11	6/3/07 21:21	4	3	1.30	0.073		27	0.055	7.8	29
E. coli Grab	6/13/07 11:00	6/13/07 11:00					13				
Storm Composite	7/18/07 20:35	7/19/07 11:23	9	6	1.50	0.126		43	~0.023	12.1	41
Storm Composite	8/19/07 18:16	8/20/07 8:38	4	3	1.10	0.090		29	~0.046	7.3	33
Storm Composite	8/27/07 5:13	8/27/07 15:09	4	3	0.77	0.114		33	0.054	6.1	39
Storm Composite	8/28/07 4:38	8/28/07 19:30	4	~3	0.90	0.116		27	~0.047	9.7	26
E. coli Grab	8/28/07 9:45	8/28/07 9:45					>2420				
Base Grab	9/13/07 14:32	9/13/07 14:32	21	12	1.80	0.159		46	0.052	8.8	40
Storm Composite	9/20/07 19:13	9/21/07 8:15	15	7	1.50	0.218		35	0.104	9.0	44
E. coli Grab	10/18/07 11:00	10/18/07 11:00					48				

Table 7. MS2 2007 Sample Metals, chloride, hardness, and Nitrogen Species Chemical Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start Date	End Date	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/13/07 13:28	3/13/07 13:28	0.0032	0.0012	0.0003	0.0060	<0.00004	0.0008	74	<0.03	0.50	0.75	
Storm Grab	4/2/07 10:13	4/2/07 10:13	0.0022	0.0014	0.0002	0.0053	<0.00004	0.0007	73	<0.03	0.16	0.08	50
Base Composite	4/19/07 14:24	4/24/07 10:27	0.0049	0.0015	0.0006	0.0063	<0.00004	0.0008	85	<0.03	<0.05	0.14	61
Storm Composite	6/2/07 18:11	6/3/07 21:21	0.0023	0.0015	0.0002	0.0053	<0.00004	0.0006	72	<0.03	0.05	0.13	64
E. coli Grab	6/13/07 11:00	6/13/07 11:00											
Storm Composite	7/18/07 20:35	7/19/07 11:23	0.0023	0.0011	0.0003	0.0091	0.00020	0.0004	49	<0.03	0.14	0.07	68
Storm Composite	8/19/07 18:16	8/20/07 8:38	0.0024	0.0012	0.0003	0.0054	<0.0005	<0.0005	35	<0.03	0.10	0.12	74
Storm Composite	8/27/07 5:13	8/27/07 15:09	0.0030	0.0012	0.0003	0.0091	<0.0005	<0.0005	19	<0.03	0.11	0.10	64
Storm Composite	8/28/07 4:38	8/28/07 19:30	0.0030	0.0011	0.0002	0.0045	<0.0005	<0.0005	18	<0.03	0.05	0.06	64
E. coli Grab	8/28/07 9:45	8/28/07 9:45											
Base Composite	9/13/07 14:32	9/13/07 14:32	0.0016	0.0015	0.0004	0.0074	<0.0005	0.0007	54	<0.03	<0.05	~0.05	70
Storm Composite	9/20/07 19:13	9/21/07 8:15	0.0025	0.0016	0.0007	0.0052	<0.0005	0.0005	38	0.08	0.13	0.27	60
E. coli Grab	10/18/07 11:00	10/18/07 11:00											

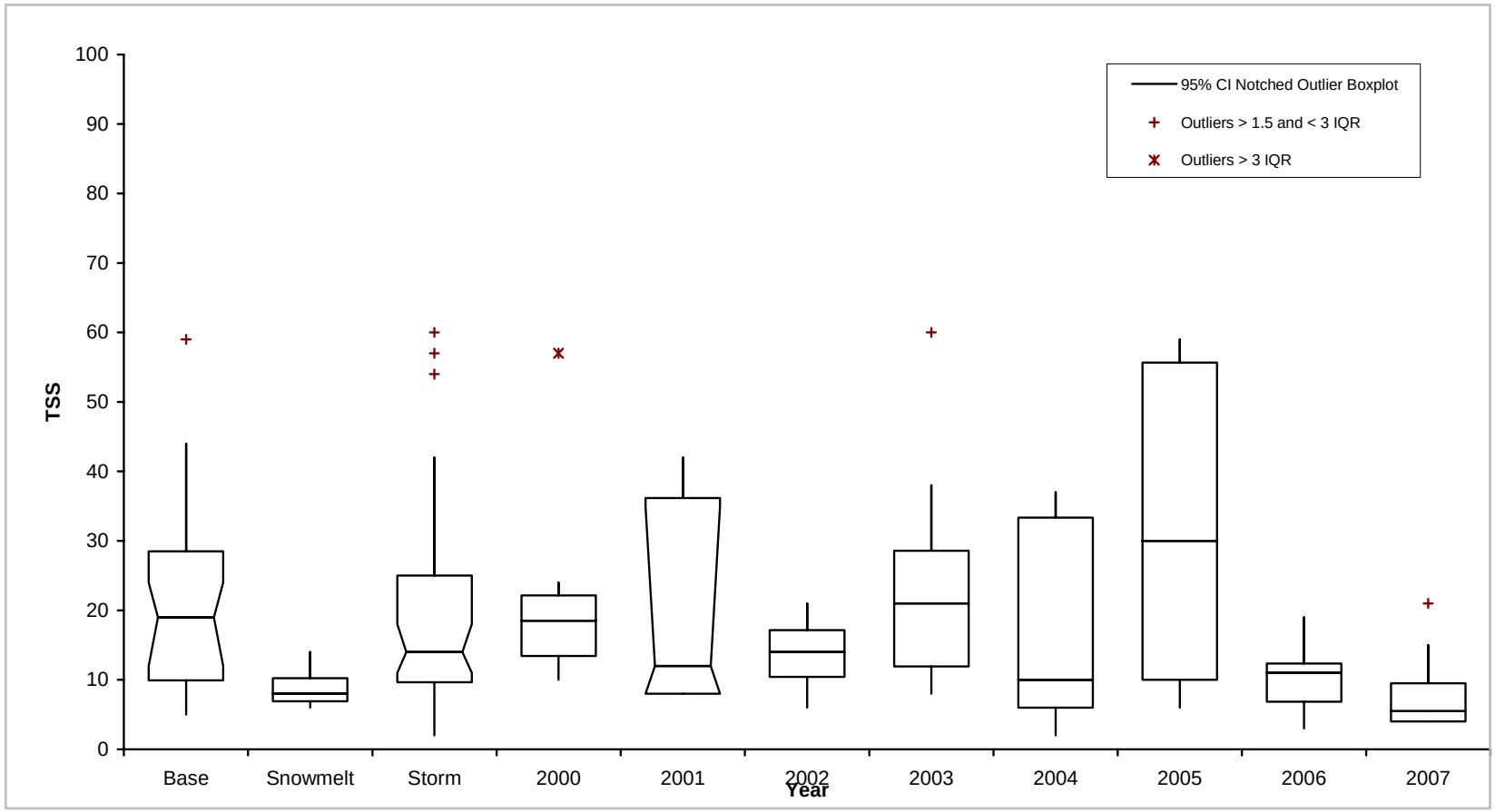
No exceedence determinable
Exceeds Chronic Standard
Exceeds Maximum Standard
Exceeds Final Acute Standard

Statistical summaries of MS2 indicate that the pond is pre-treating water before discharging to Bailey Lake. Total suspended solids, volatile suspended solids, total phosphorus, and total Kjedahl nitrogen all are low in concentration. Total chloride ions had an increase in median values from 2003 to 2005, but results still show that the pond is pre-treating the water leaving the site. Similar results as MS1 for fecal coliform show that the number of samples taken are too few to draw any conclusions at this time. Figures 13-20 show the statistical summaries in the form of box plots for MS2.



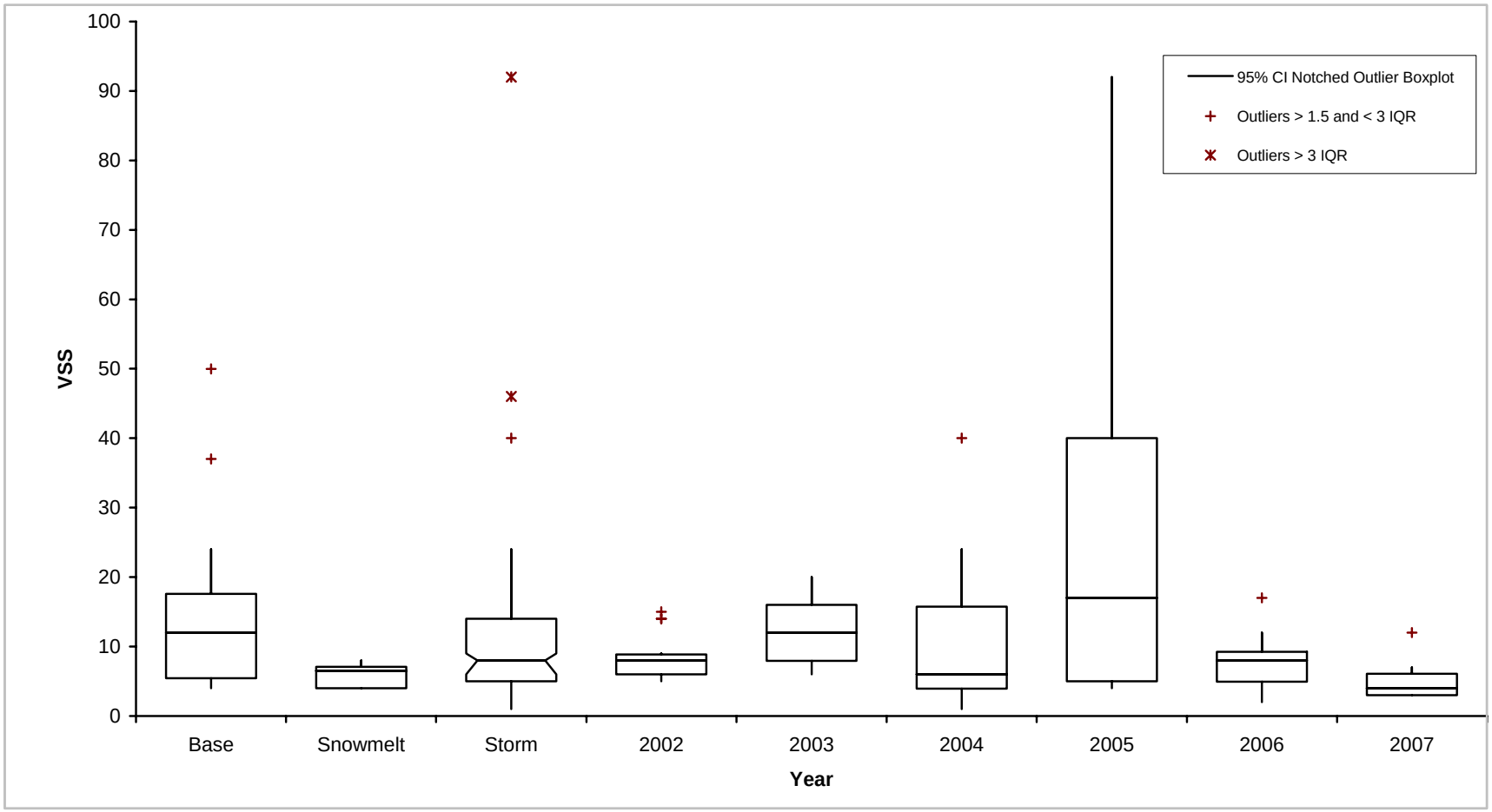
TSS by Year	n	Min	Median	95% CI	Max	IQR
Base	30	5	19.0	12.0 to 24.0	59	18.6
Snowmelt	10	6	8.0	6.0 to 13.0	14	3.3
Storm	69	2	14.0	11.0 to 18.0	1470	15.3
2000	16	10	18.5	13.0 to 23.0	57	8.8
2001	20	8	12.0	8.0 to 35.0	1470	28.2
2002	16	6	14.0	10.0 to 18.0	21	6.8
2003	14	8	21.0	11.0 to 35.0	60	16.7
2004	10	2	10.0	6.0 to 37.0	111	27.3
2005	13	6	30.0	10.0 to 59.0	560	45.7
2006	10	3	11.0	5.0 to 16.0	19	5.5
2007	10	4	5.5	4.0 to 15.0	21	5.5

Figure 12. MS2 Total Suspended Solids Box Plot (2000-2007)



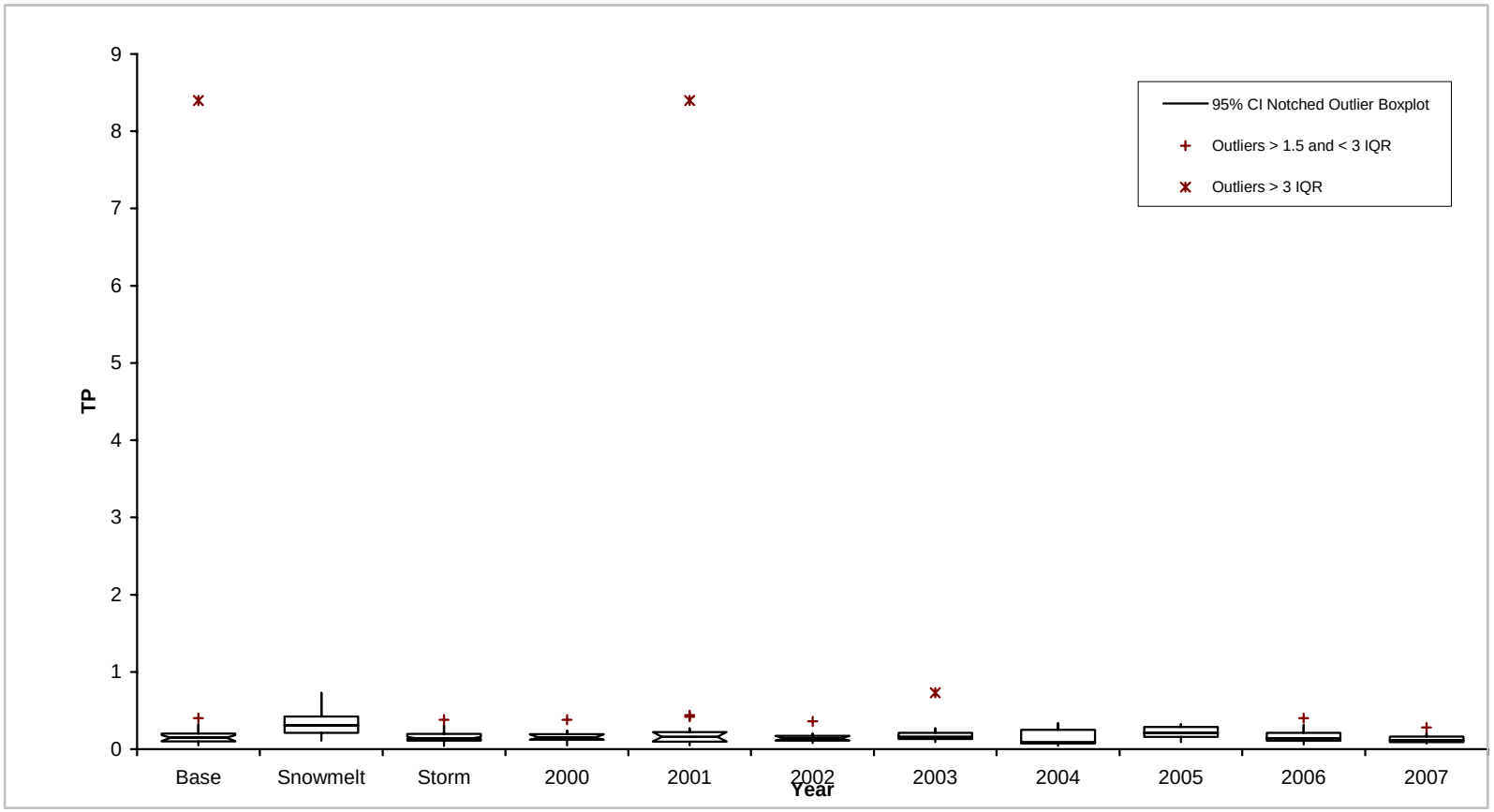
TSS by Year	n	Min	Median	95% CI	Max	IQR
Base	30	5	19.0	12.0 to 24.0	59	18.6
Snowmelt	10	6	8.0	6.0 to 13.0	14	3.3
Storm	69	2	14.0	11.0 to 18.0	1470	15.3
2000	16	10	18.5	13.0 to 23.0	57	8.8
2001	20	8	12.0	8.0 to 35.0	1470	28.2
2002	16	6	14.0	10.0 to 18.0	21	6.8
2003	14	8	21.0	11.0 to 35.0	60	16.7
2004	10	2	10.0	6.0 to 37.0	111	27.3
2005	13	6	30.0	10.0 to 59.0	560	45.7
2006	10	3	11.0	5.0 to 16.0	19	5.5
2007	10	4	5.5	4.0 to 15.0	21	5.5

Figure 13. MS2 Total Suspended Solids Box Plot (2000-2007) without Outliers



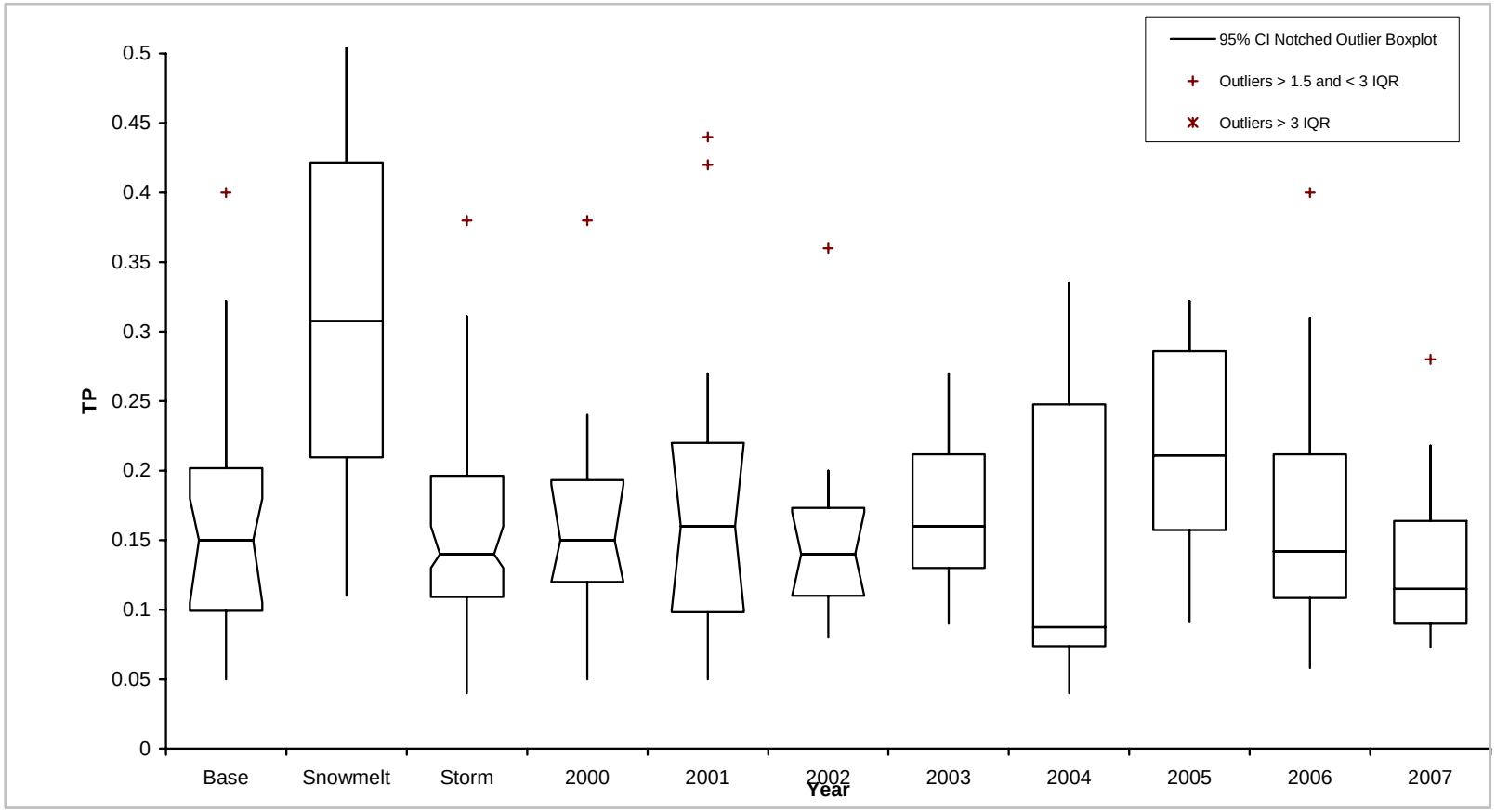
VSS by Year	n	Min	Median	95% CI	Max	IQR
Base	16	4	12.0	5.0 to 18.0	50	12.2
Snowmelt	6	4	6.5	4.0 to 8.0	8	3.1
Storm	48	1	8.0	6.0 to 9.0	92	9.0
2002	15	5	8.0	6.0 to 9.0	15	2.8
2003	14	6	12.0	7.0 to 16.0	20	8.1
2004	10	1	6.0	3.0 to 24.0	40	11.8
2005	13	4	17.0	5.0 to 46.0	92	35.0
2006	10	2	8.0	4.0 to 12.0	17	4.3
2007	10	3	4.0	3.0 to 7.0	12	3.1

Figure 14. MS2 Volatile Suspended Solids Box Plot (2000-2007)



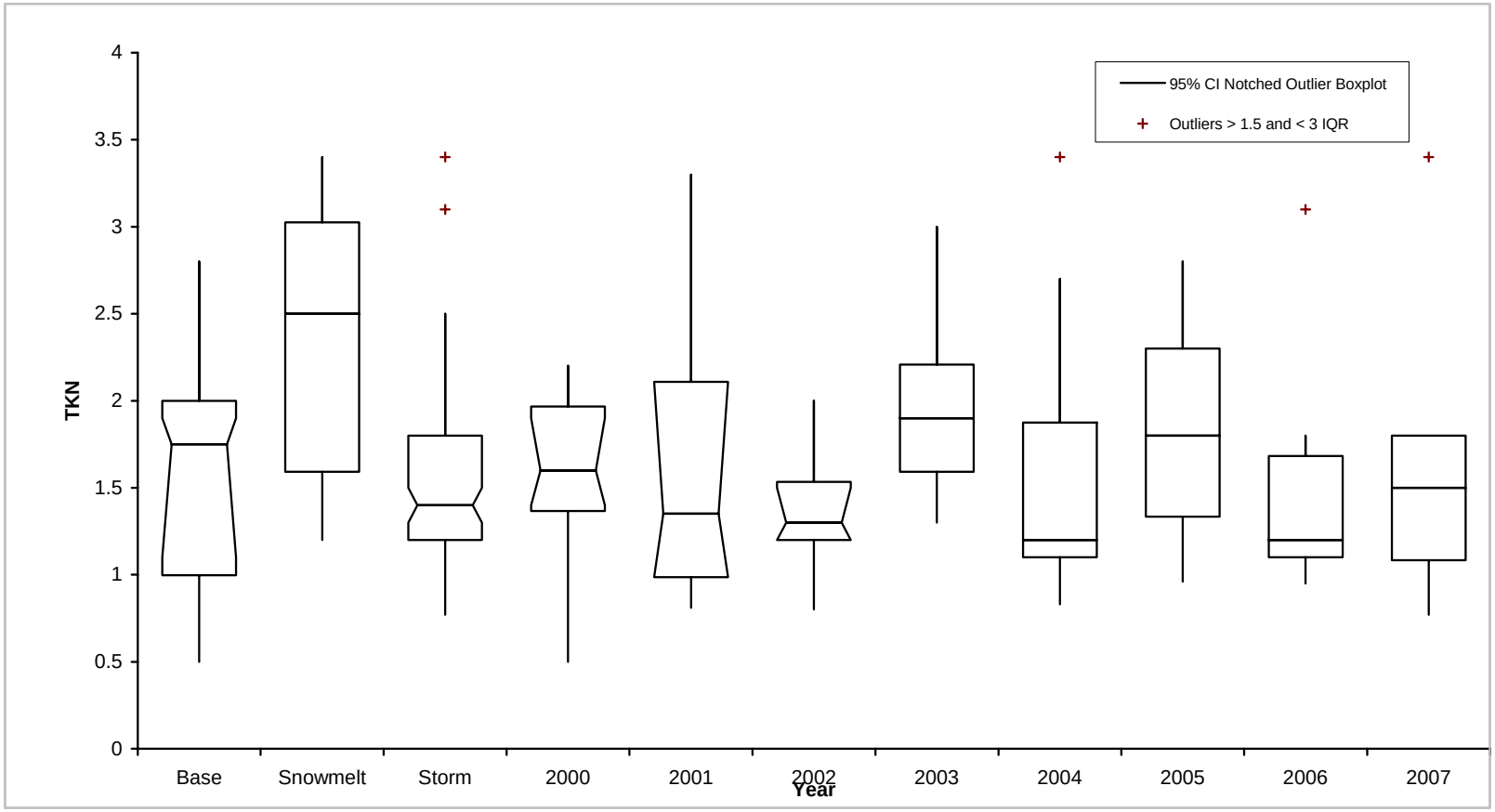
TP by Year	n	Min	Median	95% CI	Max	IQR
Base	30	0.050	0.1500	0.1050 to 0.1800	8.400	0.1025
Snowmelt	10	0.110	0.3075	0.1500 to 0.4400	0.730	0.2121
Storm	74	0.040	0.1400	0.1300 to 0.1600	0.380	0.0872
2000	17	0.050	0.1500	0.1200 to 0.1900	0.380	0.0733
2001	22	0.050	0.1600	0.1000 to 0.2200	8.400	0.1217
2002	17	0.080	0.1400	0.1100 to 0.1700	0.360	0.0633
2003	14	0.090	0.1600	0.1300 to 0.2300	0.730	0.0817
2004	10	0.040	0.0875	0.0510 to 0.3110	0.335	0.1738
2005	13	0.091	0.2110	0.1320 to 0.2920	0.322	0.1287
2006	11	0.058	0.1420	0.0870 to 0.3100	0.400	0.1032
2007	10	0.073	0.1150	0.0900 to 0.2180	0.280	0.0739

Figure 15. MS2 Total Phosphorus Box Plot (2000-2007)



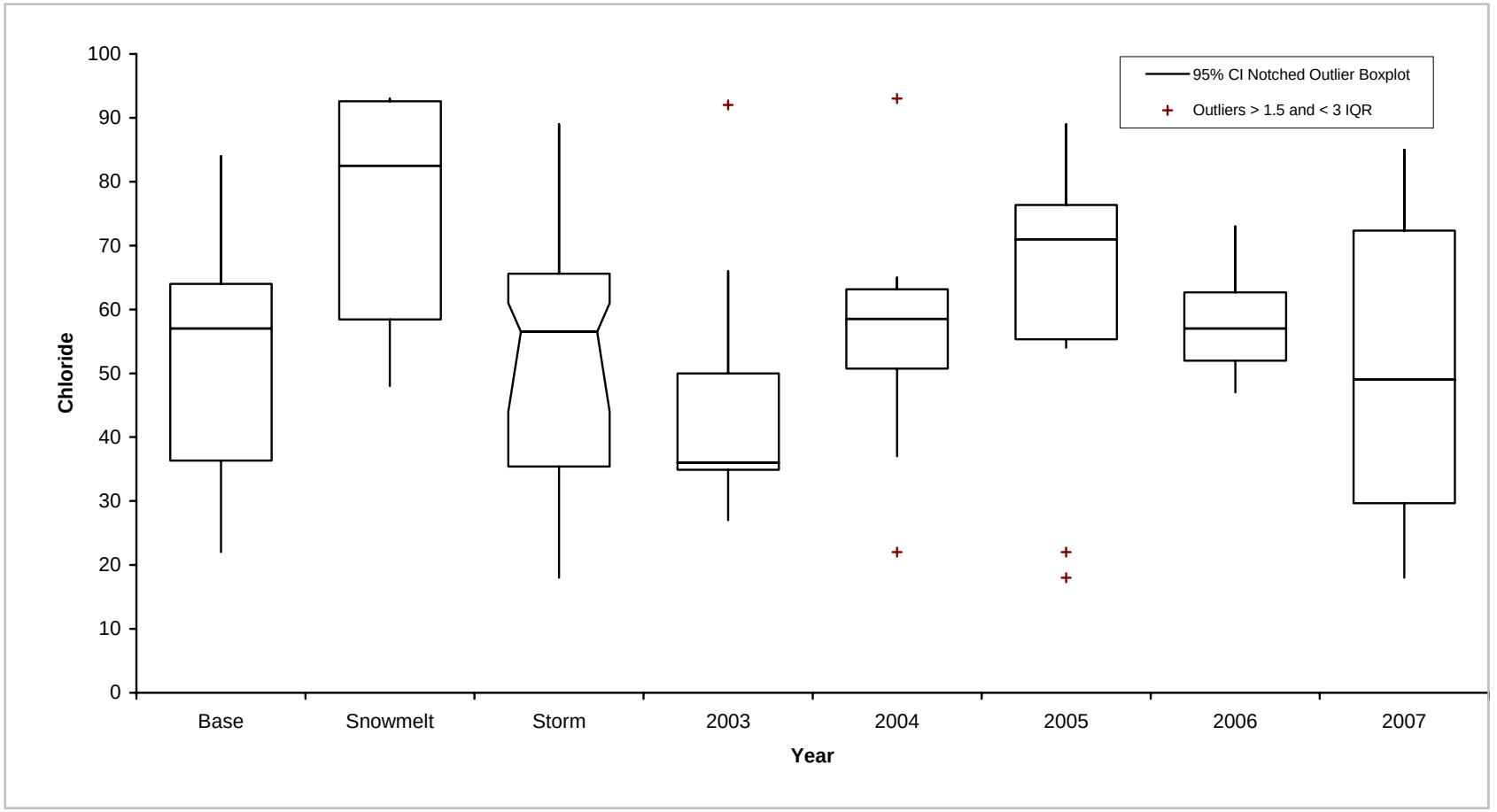
TP by Year	n	Min	Median	95% CI	Max	IQR
Base	30	0.050	0.1500	0.1050 to 0.1800	8.400	0.1025
Snowmelt	10	0.110	0.3075	0.1500 to 0.4400	0.730	0.2121
Storm	74	0.040	0.1400	0.1300 to 0.1600	0.380	0.0872
2000	17	0.050	0.1500	0.1200 to 0.1900	0.380	0.0733
2001	22	0.050	0.1600	0.1000 to 0.2200	8.400	0.1217
2002	17	0.080	0.1400	0.1100 to 0.1700	0.360	0.0633
2003	14	0.090	0.1600	0.1300 to 0.2300	0.730	0.0817
2004	10	0.040	0.0875	0.0510 to 0.3110	0.335	0.1738
2005	13	0.091	0.2110	0.1320 to 0.2920	0.322	0.1287
2006	11	0.058	0.1420	0.0870 to 0.3100	0.400	0.1032
2007	10	0.073	0.1150	0.0900 to 0.2180	0.280	0.0739

Figure 16. MS2 Total Phosphorus Box Plot (2000-2007) without Outliers



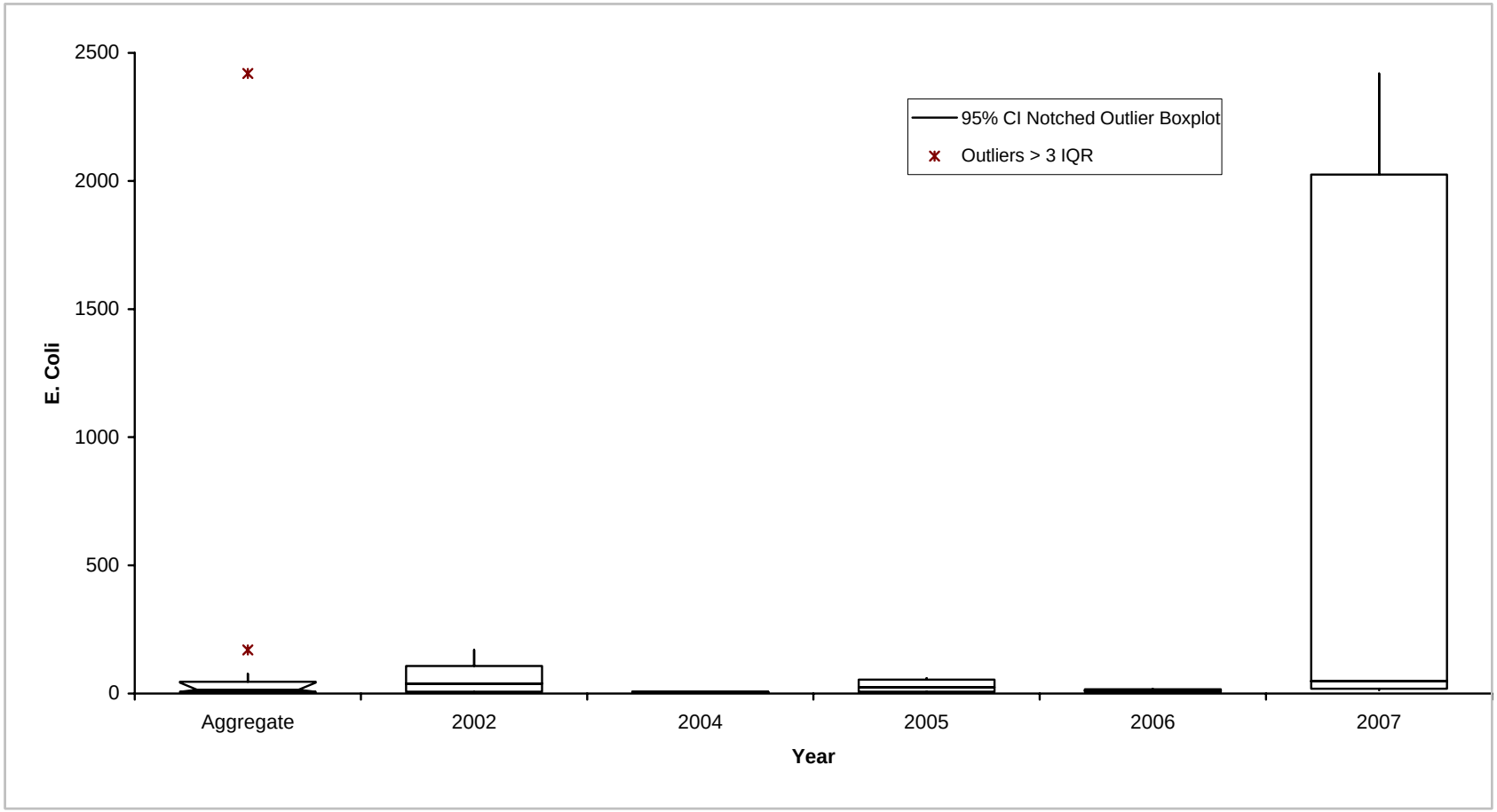
TKN by Year	n	Min	Median	95% CI	Max	IQR
Base	30	0.50	1.750	1.100 to 1.900	2.80	1.003
Snowmelt	10	1.20	2.500	1.500 to 3.300	3.40	1.433
Storm	74	0.77	1.400	1.300 to 1.500	3.40	0.600
2000	17	0.50	1.600	1.400 to 1.900	2.20	0.600
2001	22	0.81	1.350	0.990 to 2.100	3.30	1.122
2002	17	0.80	1.300	1.200 to 1.500	2.00	0.333
2003	14	1.30	1.900	1.500 to 2.300	3.00	0.617
2004	10	0.83	1.200	1.100 to 2.700	3.40	0.775
2005	13	0.96	1.800	1.200 to 2.500	2.80	0.967
2006	11	0.95	1.200	0.970 to 1.800	3.10	0.583
2007	10	0.77	1.500	0.900 to 1.800	3.40	0.717

Figure 17. MS2 Total Kjedahl Nitrogen Box Plots (2000-2007)



Chloride by Year	n	Min	Median	95% CI	Max	IQR
Base	15	22	57.0	36.0 to 64.0	84	27.7
Snowmelt	4	48	82.5	- to -	93	34.2
Storm	36	18	56.5	44.0 to 61.0	89	30.2
2003	14	27	36.0	34.0 to 61.0	92	15.1
2004	10	22	58.5	37.0 to 65.0	93	12.4
2005	13	18	71.0	54.0 to 77.0	89	21.0
2006	11	47	57.0	48.0 to 64.0	73	10.7
2007	9	18	49.0	19.0 to 73.0	85	42.7

Figure 18. MS2 Total Chloride Ions Box Plot (2003-2007)

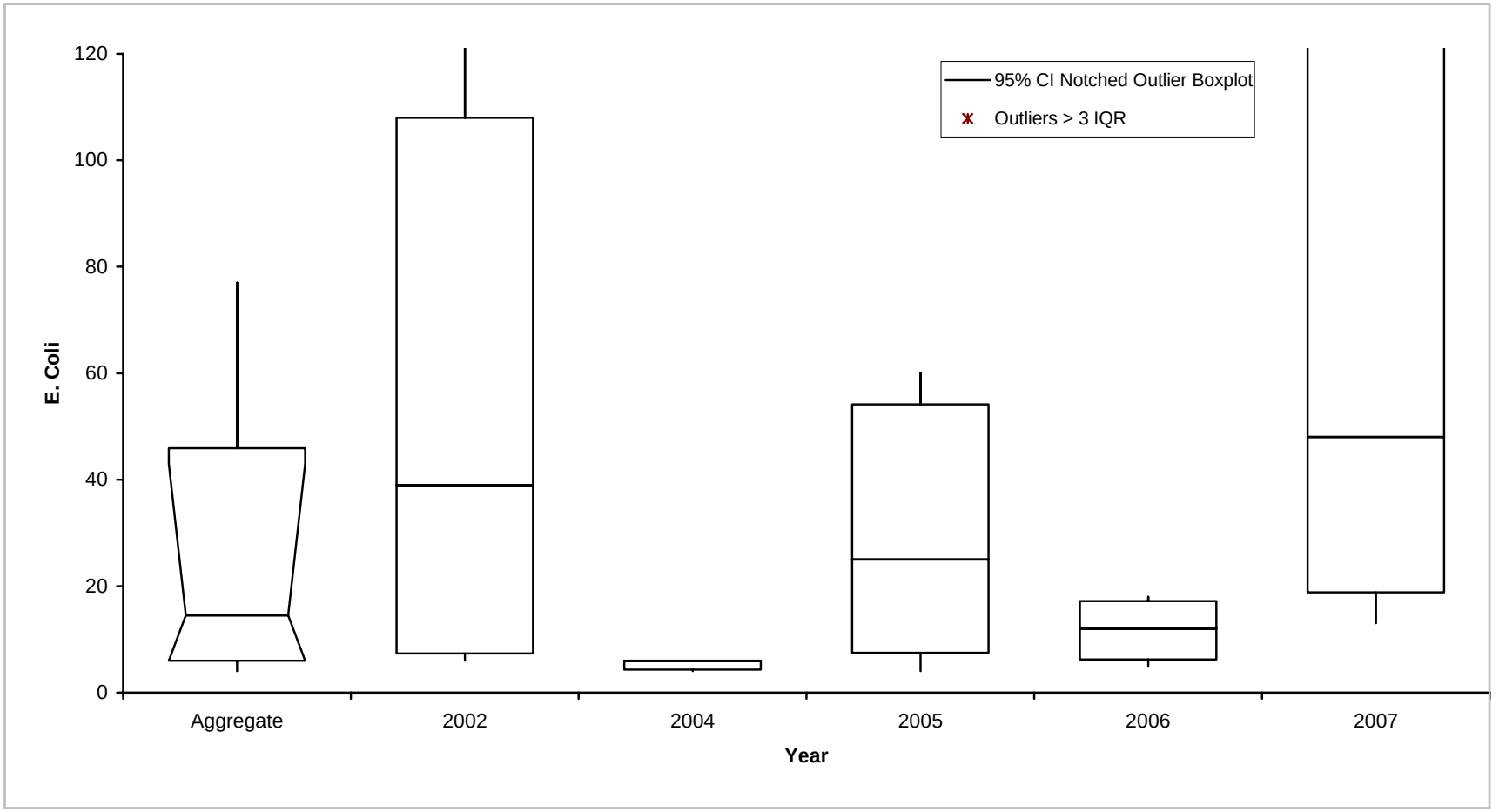


E. Coli by Year	n	Min	Median	95% CI	Max	IQR
Aggregate	20	4	14.5	6.0 to 43.0	2420	39.9
2002	5	6	39.0	- to -	170	100.7
2004	3	4	6.0	- to -	6	1.7
2005	3	4	25.0	- to -	60	46.7
2006	4	5	12.0	- to -	18	10.9
2007	3	13	48.0	- to -	2420	2005.8

Figure 19. MS2 *E. coli* Box Plot (2002-2007)

******E. coli* **bacteria have been sampled since the 2006 monitoring season. Prior season sampling was for total fecal coliform**

* 2003 was not graphed due to inadequate samples



E. Coli by Year	n	Min	Median	95% CI	Max	IQR
Aggregate	20	4	14.5	6.0 to 43.0	2420	39.9
2002	5	6	39.0	- to -	170	100.7
2004	3	4	6.0	- to -	6	1.7
2005	3	4	25.0	- to -	60	46.7
2006	4	5	12.0	- to -	18	10.9
2007	3	13	48.0	- to -	2420	2005.8

Figure 20. MS2 *E. coli* Box Plot (2002-2007) without Outliers

***E. coli* bacteria have been sampled since the 2006 monitoring season. Prior season sampling was for total fecal coliform**

* 2003 was not graphed due to inadequate samples

Powers Lake East Tributary

The hydrograph for the Powers Lake site shows flow between April 22-October 30, 2007 (Figure 21). Precipitation was logged between March 29-October 30, 2007. Total discharge during this period was 3,703,588 cf or 85 acre/ft. The highest discharge—3.60 cfs occurred on October 19, 2007 from a total rainfall of 0.75 inches, which fell between October 17, 2007-October 19, 2007. The highest rainfall for a storm occurred on September 18, 2007 with 1.08 inches.

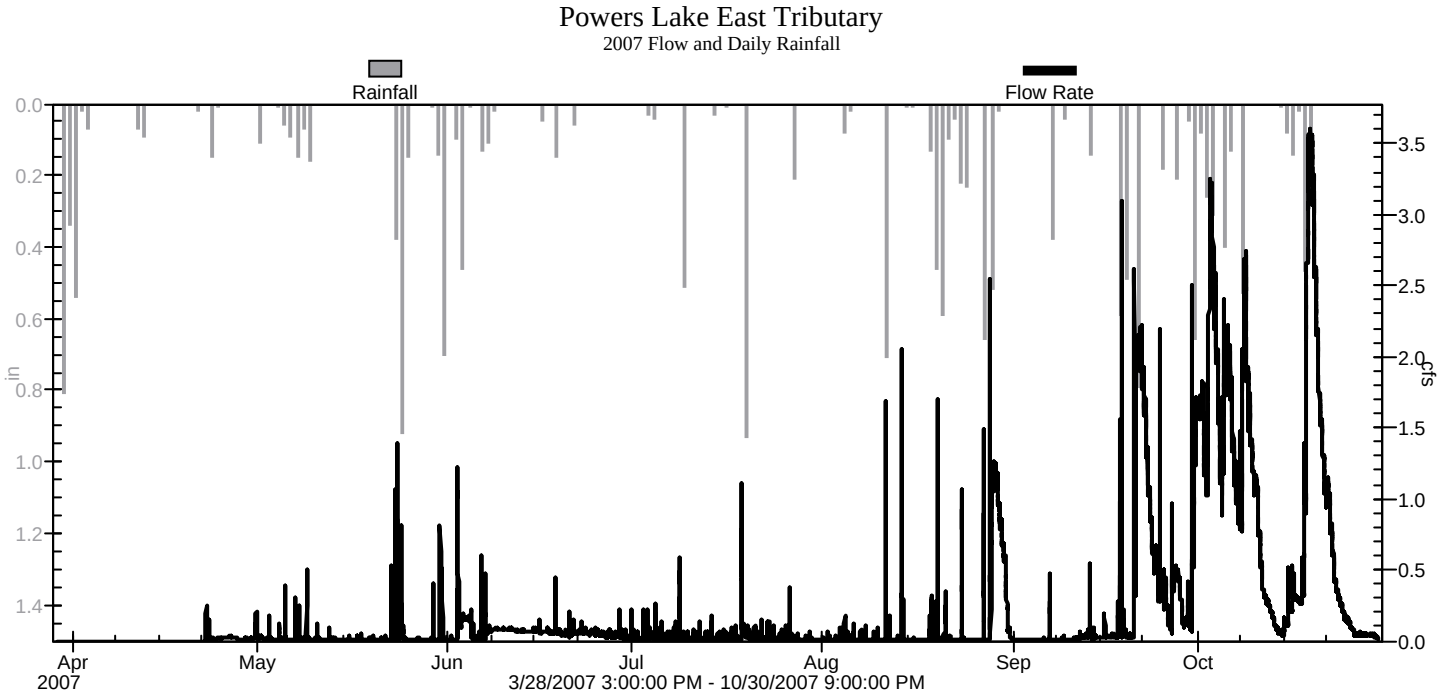


Figure 21. Powers Lake East Tributary 2007 Flow and Daily Rainfall

Table 8. Powers Lake East Tributary Stormwater Total Phosphorus and Total Suspended Solids Loading Table

	Sample Collection Time				Loading Interval				
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval TSS (lb)	Interval TP (lb)
Base			*3*	*0.110*	*1/1/2007 0:00*	*3/13/2007 0:00*	*61,344*	*9.6*	*0.4*
Snowmelt Grab	3/13/07 13:14	3/13/07 13:14	13	0.367	3/13/2007 0:00	3/14/2007 0:00	4,320	3.5	0.1
Base			*3*	*0.110*	*3/14/2007 0:00*	*4/2/2007 0:00*	*1,728*	*0.3*	*0.0*
Storm Grab	4/2/07 10:25	4/2/07 10:25	11	0.137	4/2/2007 0:00	4/3/2007 0:00	135,864	93.3	1.2
Base			*3*	*0.110*	*4/3/2007 0:00*	*4/22/2007 15:45*	*432*	*0.1*	*0.0*
Storm Composite	4/22/07 16:36	4/23/07 2:14	142	0.423	4/22/2007 15:45	4/23/2007 3:45	2,615	23.2	0.1
Base			*3*	*0.110*	*4/23/2007 3:45*	*4/30/2007 16:45*	*10,032*	*1.6*	*0.1*
Storm			*221*	*0.534*	*4/30/2007 16:45*	*5/1/2007 0:45*	*1,070*	*14.8*	*0.0*
Base			*3*	*0.110*	*5/1/2007 0:45*	*5/4/2007 13:45*	*4,416*	*0.7*	*0.0*
Storm			*221*	*0.534*	*5/4/2007 13:45*	*5/4/2007 19:45*	*903*	*12.5*	*0.0*
Base			*3*	*0.110*	*5/4/2007 19:45*	*5/5/2007 14:45*	*1,345*	*0.2*	*0.0*
Storm			*221*	*0.534*	*5/5/2007 14:45*	*5/5/2007 19:45*	*1,252*	*17.3*	*0.0*
Base			*3*	*0.110*	*5/5/2007 19:45*	*5/7/2007 2:45*	*769*	*0.1*	*0.0*
Storm			*221*	*0.534*	*5/7/2007 2:45*	*5/7/2007 9:45*	*1,427*	*19.7*	*0.0*
Base			*3*	*0.110*	*5/7/2007 9:45*	*5/7/2007 18:45*	*451*	*0.1*	*0.0*
Storm			*221*	*0.534*	*5/7/2007 18:45*	*5/7/2007 22:45*	*638*	*8.8*	*0.0*
Base			*3*	*0.110*	*5/7/2007 22:45*	*5/8/2007 22:45*	*963*	*0.2*	*0.0*
Storm			*221*	*0.534*	*5/8/2007 22:45*	*5/9/2007 2:45*	*1,161*	*16.0*	*0.0*
Base			*3*	*0.110*	*5/9/2007 2:45*	*5/22/2007 17:45*	*8,695*	*1.4*	*0.1*
Storm			*221*	*0.534*	*5/22/2007 17:45*	*5/23/2007 0:45*	*1,935*	*26.7*	*0.1*
Base			*3*	*0.110*	*5/23/2007 0:45*	*5/23/2007 12:45*	*124*	*0.0*	*0.0*
Storm Composite**	5/23/07 13:48	5/23/07 16:13	221	0.417	5/23/2007 12:45	5/23/2007 23:45	6,942	95.8	0.2
Base			*3*	*0.110*	*5/23/2007 23:45*	*5/24/2007 6:45*	*141*	*0.0*	*0.0*
Storm			*221*	*0.534*	*5/24/2007 6:45*	*5/24/2007 17:45*	*6,352*	*87.6*	*0.2*
Base			*3*	*0.110*	*5/24/2007 17:45*	*5/29/2007 16:45*	*3,074*	*0.5*	*0.0*
Storm			*221*	*0.534*	*5/29/2007 16:45*	*5/29/2007 17:45*	*427*	*5.9*	*0.0*
Base			*3*	*0.110*	*5/29/2007 17:45*	*5/30/2007 17:45*	*551*	*0.1*	*0.0*
Storm			*221*	*0.534*	*5/30/2007 17:45*	*5/31/2007 6:45*	*4,995*	*68.9*	*0.2*
Base			*3*	*0.110*	*5/31/2007 6:45*	*6/2/2007 13:45*	*421*	*0.1*	*0.0*
Storm			*221*	*0.534*	*6/2/2007 13:45*	*6/2/2007 22:45*	*8,728*	*120.4*	*0.3*
Fish Lake			*8*	*0.084*	*6/2/2007 22:45*	*6/4/2007 22:45*	*25,761*	*12.9*	*0.1*
Base			*3*	*0.110*	*6/4/2007 22:45*	*6/6/2007 11:45*	*2,379*	*0.4*	*0.0*
Storm			*221*	*0.534*	*6/6/2007 11:45*	*6/6/2007 16:45*	*1,833*	*25.3*	*0.1*
Base			*3*	*0.110*	*6/6/2007 16:45*	*6/7/2007 2:45*	*2,254*	*0.4*	*0.0*
Storm			*221*	*0.534*	*6/7/2007 2:45*	*6/7/2007 7:45*	*2,894*	*39.9*	*0.1*
Base			*3*	*0.110*	*6/7/2007 7:45*	*6/18/2007 11:45*	*67,003*	*10.5*	*0.5*
Storm			*221*	*0.534*	*6/18/2007 11:45*	*6/18/2007 14:45*	*1,332*	*18.4*	*0.0*
Base			*3*	*0.110*	*6/18/2007 14:45*	*6/20/2007 20:45*	*9,530*	*1.5*	*0.1*
Storm			*221*	*0.534*	*6/20/2007 20:45*	*6/21/2007 2:45*	*1,376*	*19.0*	*0.0*
Base Grab	6/29/07 11:44	6/29/07 11:44	3	0.124	6/21/2007 2:45	7/8/2007 15:45	49,800	9.3	0.4
Storm			*221*	*0.534*	*7/8/2007 15:45*	*7/8/2007 22:45*	*3,992*	*55.1*	*0.1*
Base			*3*	*0.110*	*7/8/2007 22:45*	*7/18/2007 15:45*	*13,214*	*2.1*	*0.1*
Storm Composite**	7/18/07 16:47	7/18/07 17:01	221	0.422	7/18/2007 15:45	7/19/2007 10:45	11,336	156.4	0.3
Base			*3*	*0.110*	*7/19/2007 10:45*	*7/26/2007 15:45*	*14,403*	*2.2*	*0.1*
Storm			*221*	*0.534*	*7/26/2007 15:45*	*7/26/2007 18:45*	*1,288*	*17.8*	*0.0*
Base			*3*	*0.110*	*7/26/2007 18:45*	*8/4/2007 12:45*	*4,261*	*0.7*	*0.0*
Storm			*221*	*0.534*	*8/4/2007 12:45*	*8/4/2007 16:45*	*848*	*11.7*	*0.0*
Base			*3*	*0.110*	*8/4/2007 16:45*	*8/11/2007 3:45*	*5,277*	*0.8*	*0.0*
Storm Composite**	8/11/07 4:13	8/11/07 4:30	221	0.455	8/11/2007 3:45	8/11/2007 7:45	4,986	68.8	0.1
Base			*3*	*0.110*	*8/11/2007 7:45*	*8/13/2007 21:45*	*828*	*0.1*	*0.0*
Storm Composite**	8/13/07 23:41	8/14/07 12:08	221	0.312	8/13/2007 21:45	8/14/2007 3:45	6,797	93.8	0.1
Base			*3*	*0.110*	*8/14/2007 3:45*	*8/18/2007 9:45*	*540*	*0.1*	*0.0*
Storm Composite	8/19/07 15:08	8/19/07 16:56	111	0.503	8/18/2007 9:45	8/19/2007 18:45	16,168	112.0	0.5
Base			*3*	*0.110*	*8/19/2007 18:45*	*8/21/2007 2:45*	*603*	*0.1*	*0.0*
Storm			*221*	*0.534*	*8/21/2007 2:45*	*8/21/2007 5:45*	*1,005*	*13.9*	*0.0*
Base			*3*	*0.110*	*8/21/2007 5:45*	*8/23/2007 10:45*	*302*	*0.0*	*0.0*
Storm			*221*	*0.534*	*8/23/2007 10:45*	*8/23/2007 18:45*	*7,487*	*103.3*	*0.2*
Base			*3*	*0.110*	*8/23/2007 18:45*	*8/27/2007 1:45*	*824*	*0.1*	*0.0*
Storm Composite**	8/27/07 2:55	8/27/07 4:18	221	0.573	8/27/2007 1:45	8/27/2007 7:45	9,113	125.7	0.3
Base			*3*	*0.110*	*8/27/2007 7:45*	*8/28/2007 2:45*	*621*	*0.1*	*0.0*
Storm			*221*	*0.534*	*8/28/2007 2:45*	*8/28/2007 6:45*	*6,806*	*93.9*	*0.2*
Fish Lake	8/28/07 13:26	8/30/07 9:13	12	0.088	8/28/2007 6:45	8/31/2007 2:45	196,835	147.5	1.1
Base			*3*	*0.110*	*8/31/2007 2:45*	*9/6/2007 21:45*	*5,485*	*0.9*	*0.0*
Storm			*221*	*0.534*	*9/6/2007 21:45*	*9/7/2007 4:45*	*3,004*	*41.4*	*0.1*
Base			*3*	*0.110*	*9/7/2007 4:45*	*9/13/2007 10:45*	*6,842*	*1.1*	*0.0*
Storm			*221*	*0.534*	*9/13/2007 10:45*	*9/13/2007 12:45*	*1,471*	*20.3*	*0.0*
Base Grab	9/13/07 13:30	9/13/07 13:30	2	0.095	9/13/2007 12:45	9/18/2007 3:45	11,401	1.4	0.1
Storm Composite	9/18/07 7:28	9/18/07 18:29	688	1.780	9/18/2007 3:45	9/19/2007 0:45	26,954	1157.7	3.0
Base			*3*	*0.110*	*9/19/2007 0:45*	*9/20/2007 17:45*	*4,728*	*0.7*	*0.0*
Storm Composite	9/20/07 18:59	9/21/07 14:08	53	0.196	9/20/2007 17:45	9/23/2007 4:45	349,752	1157.2	4.3
Base			*3*	*0.110*	*9/23/2007 4:45*	*9/24/2007 17:45*	*81,506*	*12.7*	*0.6*
Storm			*221*	*0.534*	*9/24/2007 17:45*	*9/24/2007 22:45*	*11,154*	*153.9*	*0.4*
Base			*3*	*0.110*	*9/24/2007 22:45*	*9/26/2007 18:45*	*43,091*	*6.7*	*0.3*
Storm			*221*	*0.534*	*9/26/2007 18:45*	*9/27/2007 0:45*	*8,416*	*116.1*	*0.3*
Fish Lake			*8*	*0.084*	*9/27/2007 0:45*	*9/28/2007 2:45*	*42,922*	*21.4*	*0.2*
Base			*3*	*0.110*	*9/28/2007 2:45*	*9/29/2007 7:45*	*19,011*	*3.0*	*0.1*
Storm			*221*	*0.534*	*9/29/2007 7:45*	*9/29/2007 16:45*	*5,416*	*74.7*	*0.2*
Base			*3*	*0.110*	*9/29/2007 16:45*	*9/30/2007 0:45*	*2,698*	*0.4*	*0.0*
Storm Composite	9/30/07 4:34	10/1/07 12:45	32	0.150	9/30/2007 0:45	10/2/2007 12:45	303,598	606.5	2.8
Storm			*221*	*0.534*	*10/2/2007 12:45*	*10/4/2007 6:45*	*363,293*	*5012.0*	*12.1*
Base			*3*	*0.110*	*10/4/2007 6:45*	*10/5/2007 1:45*	*92,473*	*14.4*	*0.6*
Storm			*221*	*0.534*	*10/5/2007 1:45*	*10/5/2007 9:45*	*42,369*	*584.5*	*1.4*
Fish Lake			*8*	*0.084*	*10/5/2007 9:45*	*10/6/2007 18:45*	*218,993*	*109.4*	*1.1*
Base			*3*	*0.110*	*10/6/2007 18:45*	*10/7/2007 21:45*	*105,862*	*16.5*	*0.7*
Storm			*221*	*0.534*	*10/7/2007 21:45*	*10/8/2007 10:45*	*61,019*	*841.8*	*2.0*
Fish Lake	10/9/07 9:49	10/9/07 9:49	4	0.080	10/8/2007 10:45	10/9/2007 15:45	208,221	52.0	1.0
Base			*3*	*0.110*	*10/9/2007 15:45*	*10/14/2007 22:45*	*208,907*	*32.6*	*1.4*
Storm			*221*	*0.534*	*10/14/2007 22:45*	*10/16/2007 21:45*	*35,019*	*483.1*	*1.2*
Base			*3*	*0.110*	*10/16/2007 21:45*	*10/17/2007 21:45*	*25,037*	*3.9*	*0.2*
Storm			*221*	*0.534*	*10/17/2007 21:45*	*10/18/2007 0:45*	*4,339*	*59.9*	*0.1*
Base			*3*	*0.110*	*10/18/2007 0:45*	*10/18/2007 4:45*	*4,544*	*0.7*	*0.0*
Storm			*221*	*0.534*	*10/18/2007 4:45*	*10/18/2007 13:45*	*30,626*	*422.5*	*1.0*
Base			*3*	*0.110*	*10/18/2007 13:45*	*10/21/2007 16:45*	*645,116*	*100.7*	*4.4*
Storm			*221*	*0.534*	*10/21/2007 16:45*	*10/30/2007 10:15*	*189,198*	*2610.2*	*6.3*
Base			*3*	*0.110*	*10/30/2007 10:15*	*1/1/2008 0:00*	*54,063*	*8.4*	*0.4*
Storm Average			221	0.534					
Base Average			3	0.110					
Fish Lake			8	0.084					
Snowmelt Average			12	0.252					
All Average			128	0.367					
Total							**3,961,340**	15,502	55
SWWD Major Subwatershed Total Acres							549		
Total TP/TSS(lb/ac/yr)								28.24	0.099
Total TP/TSS (kg/ha/yr)								31.66	0.111

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**TSS concentrations are based upon Storm Average

*** Interval flow values from 1/1/07 to 4/22/07 and 10/30/07 to 1/1/08 were estimated from base flow

Grab and flow weighted composite samples were taken at the Powers site in 2007. The TSS, TKN, TP, VSS, total COD, soluble COD, TDP, TOC, and *E. coli* results from all collected samples are listed in Table 9. The highest concentrations of TSS, TKN, VSS, TP, and TDP all cam from a storm composite sample on September 18, 2007 that produced 688 mg/L, 13.00 mg/L, 220mg/L, 1.780 mg/L, and 0.306 mg/L respectively. Metals, chloride, hardness, and other Nitrogen species chemical results are listed in Table 10. Minnesota Pollution Control Agency's water quality standard exceedences are listed in Table 10. Four samples could not be assessed for standards due to missing hardness values. Two samples exceeded the chronic standard and two samples exceeded the maximum standard for copper. Three samples exceeded the chronic standard for lead at the Powers Lake East Tributary.

Table 9. Powers Lake East Tributary 2007 Sample Chemistry Results

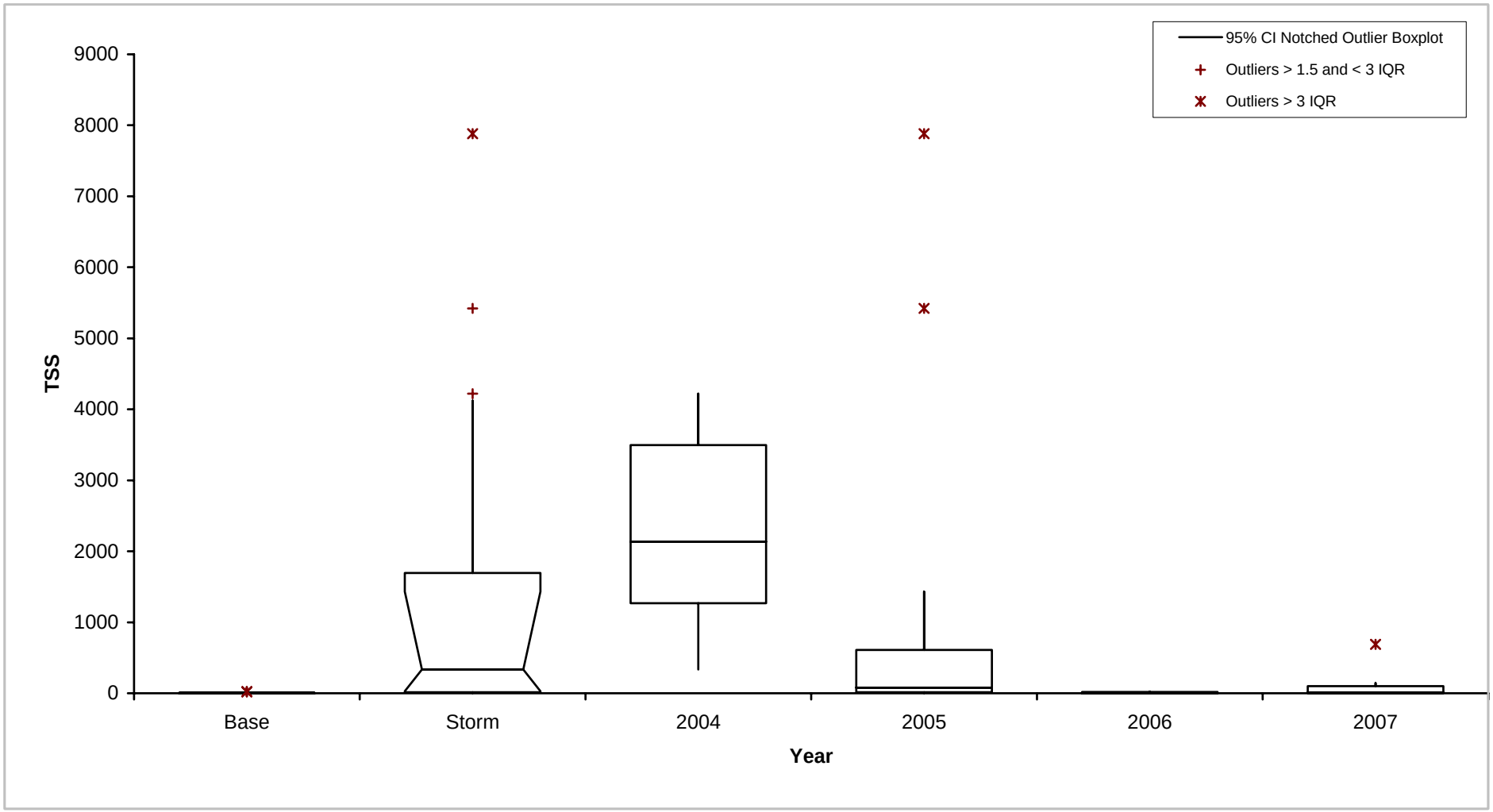
Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	*E. coli* (mpn/100 mL)	COD (mg/L)	TDP (mg/L)	TOC (mg/L)	Soluble COD (mg/L)
Snowmelt Grab	3/13/07 13:14	3/13/07 13:14	13	~4	1.30	0.367		40	0.278	15.5	
Storm Grab	4/2/07 10:25	4/2/07 10:25	11	6	1.30	0.137		27	~0.018	6.7	24
Storm Composite	4/22/07 16:36	4/23/07 2:14	142	51	3.40	0.423					
E. coli Grab	5/2/07 11:30	5/2/07 11:30					2				
Storm Composite	5/23/07 13:48	5/23/07 16:13			1.70	0.417		56			
E. coli Grab	6/13/07 11:15	6/13/07 11:15					46				
Base Grab	6/29/07 11:44	6/29/07 11:44	~3	~2	2.70	0.124		50	0.093	13.7	50
Storm Composite	7/18/07 16:47	7/18/07 17:01			2.30	0.422		154			
Storm Composite	8/11/07 4:13	8/11/07 4:30			3.10	0.455		128			
Storm Composite	8/13/07 23:41	8/14/07 12:08			2.00	0.312		79			
Storm Composite	8/19/07 15:08	8/19/07 16:56	111	26	1.80	0.503		64	0.228	13.3	46
Storm Composite	8/27/07 2:55	8/27/07 4:18			2.80	0.573		99			
Storm Composite	8/28/07 13:26	8/30/07 9:13	12	~5	1.70	0.088		44	<0.010	9.6	40
E. coli Grab	8/28/07 10:24	8/28/07 10:24					>2420				
Base Grab	9/13/07 13:30	9/13/07 13:30	~2	~1	1.00	0.095		29	0.075	8.4	32
Storm Composite	9/18/07 7:28	9/18/07 18:29	688	220	13.00	1.780			0.306		
Storm Composite	9/20/07 18:59	9/21/07 14:08	53	10	0.91	0.196		34	0.066	12.7	34
Storm Composite	9/30/07 4:34	10/1/07 12:45	32	9	1.70	0.150		48	~0.029	14.3	59
Storm Grab	10/9/07 9:49	10/9/07 9:49	4	~2	1.00	0.080		36	0.054	7.9	28
E. coli Grab	10/18/07 11:30	10/18/07 11:30					>2420				

Table 10. Powers Lake East Tributary 2007 Sample Metals, Chloride, Hardness, and Nitrogen Species Chemical Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start Date	End Date	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/13/07 13:14	3/13/07 13:14	0.0031	0.0015	0.0004	0.0058	<0.00004	0.0009	10	<0.03	0.23	0.22	
Storm Grab	4/2/07 10:25	4/2/07 10:25	0.0017	0.0014	0.0003	0.0048	<0.00004	0.0008	37	<0.03	<0.05	0.10	42
Base Composite	4/22/07 16:36	4/23/07 2:14											
E. coli Grab	5/2/07 11:30	5/2/07 11:30											
Storm Composite	5/23/07 13:48	5/23/07 16:13	0.0145	0.0149	0.0060	0.0400	0.00040	0.0051	15	0.09	0.47	0.15	142
E. coli Grab	6/13/07 11:15	6/13/07 11:15											
Base Grab	6/29/07 11:44	6/29/07 11:44	0.0104	0.0035	<0.00007	0.0030	0.00007	0.0009	23	<0.03	0.49	0.07	210
Storm Composite	7/18/07 16:47	7/18/07 17:01	0.0290	0.0054	0.0046	0.0450	0.00060	0.0036	4	<0.03	0.35	~0.05	
Storm Composite	8/11/07 4:13	8/11/07 4:30	0.0149	0.0036	0.0020	0.0290	<0.00050	0.0021	5	<0.03	<0.05	<0.02	
Storm Composite	8/13/07 23:41	8/14/07 12:08	0.0137	0.0050	0.0041	0.0390	<0.00050	0.0059	5	<0.03	0.10	~0.03	
Storm Composite	8/19/07 15:08	8/19/07 16:56	0.0115	0.0047	0.0040	0.0250	<0.00050	0.0041	3	<0.03	0.26	~0.04	45
Storm Composite	8/27/07 2:55	8/27/07 4:18	0.0195	0.0060	0.0065	0.0380	<0.00050	0.0049	4	<0.03	<0.05	<0.02	46
Storm Composite	8/28/07 13:26	8/30/07 9:13	0.0039	0.0016	0.0002	0.0048	<0.00050	<0.0005	32	<0.03	<0.05	<0.02	82
E. coli Grab	8/28/07 10:24	8/28/07 10:24											
Base Grab	9/13/07 13:30	9/13/07 13:30	0.0054	0.0029	0.0002	0.0043	<0.00050	0.0008	36	<0.03	0.47	~0.04	156
Storm Composite	9/18/07 7:28	9/18/07 18:29											
Storm Composite	9/20/07 18:59	9/21/07 14:08	0.0056	0.003	0.0015	0.0081	<0.00050	0.0016	27	0.04	0.07	0.19	82
Storm Composite	9/30/07 4:34	10/1/07 12:45	0.0147	0.0026	0.0009	0.0080	<0.00050	0.0009	23	<0.03	<0.05	0.26	74
Storm Grab	10/9/07 9:49	10/9/07 9:49	0.0011	0.0018	0.0001	0.0020	<0.00050	<0.0005	19	<0.03	<0.05	0.12	72
E. coli Grab	10/18/07 11:30	10/18/07 11:30											

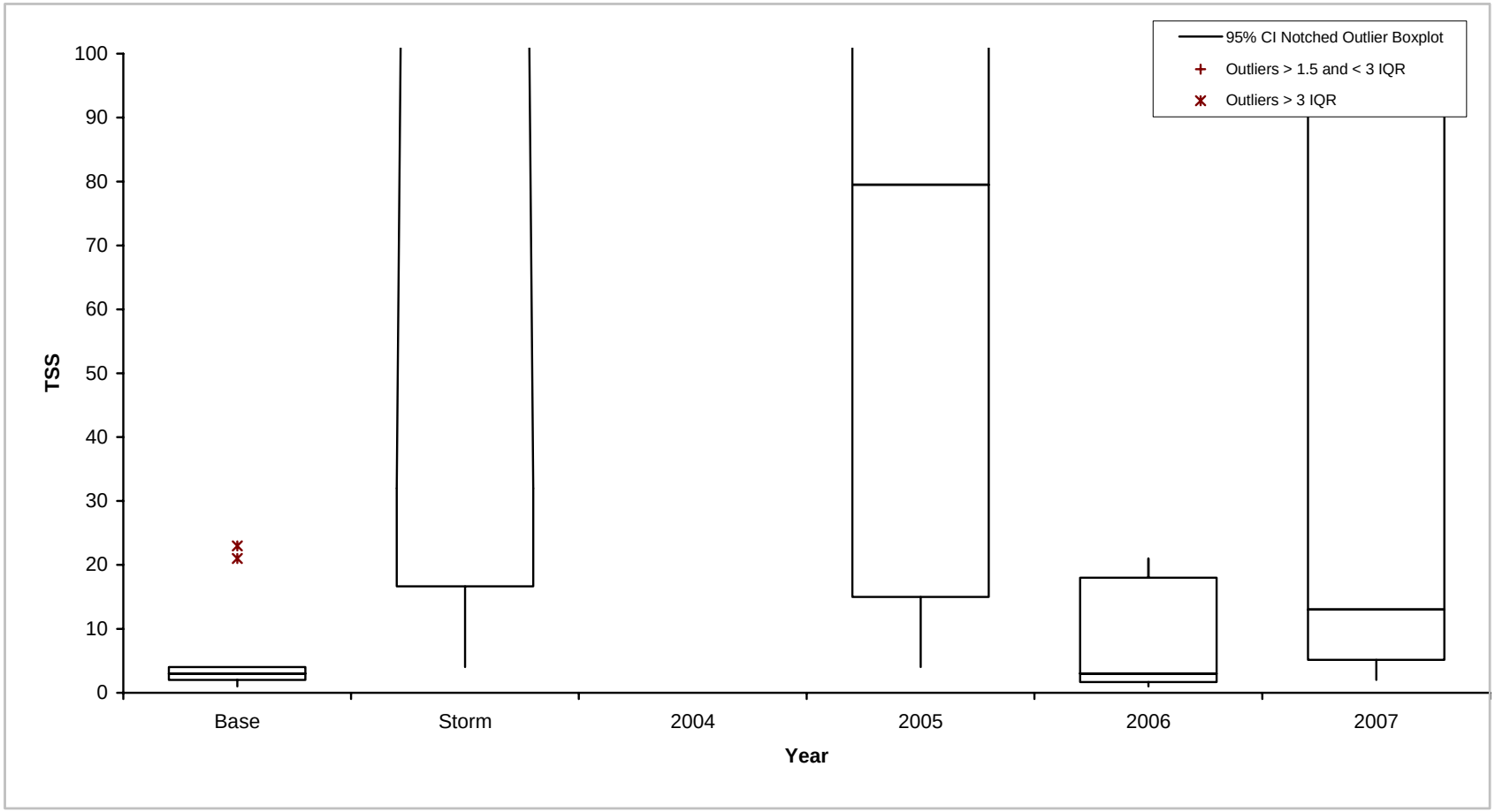
No exceedence determinable
Exceeds Chronic Standard
Exceeds Maximum Standard
Exceeds Final Acute Standard

Box plots for Powers Lake East Tributary for 2004 to 2007 are in figures 22-31. Total suspended solids, volatile suspended solids, total phosphorus, and total Kjedahl nitrogen all have median values decreasing over time, with variability within the box plot decreasing as well. For all parameters, large decreases in concentrations are occurring between years. Such decreases may be attributed to the large amount of construction in the nearby development during the early monitoring seasons. Increased erosion and sediment control over the last couple years, combined with vegetation and cover establishment, may be contributing to lower concentrations being observed. 2007 had a small increase in median values, as well as variability within the box plot. Further analysis of possible factors within this drainage area will be needed to fully understand both the large decreases over time and for such high results observed in 2004. Total chloride ion median values have an increasing trend over the past three monitoring seasons. These increases may be contributed to the establishment of roads and salt applications in recently constructed developments. It is interesting to note that storm samples are transporting the highest concentrations and the largest loads, which indicates the need for additional BMPs to control stormwater runoff. E. Coli samples are too few to draw statistical conclusions between monitoring seasons.



TSS by Year	n	Min	Median	95% CI	Max	IQR
Base	11	1	3.0	1.0 to 21.0	23	2.0
Storm	29	4	336.0	32.0 to 1430.0	7880	1680.0
2004	8	336	2135.0	336.0 to 4220.0	4220	2225.8
2005	14	4	79.5	4.0 to 1430.0	7880	595.5
2006	9	1	3.0	1.0 to 20.0	21	16.3
2007	11	2	13.0	3.0 to 142.0	688	96.2

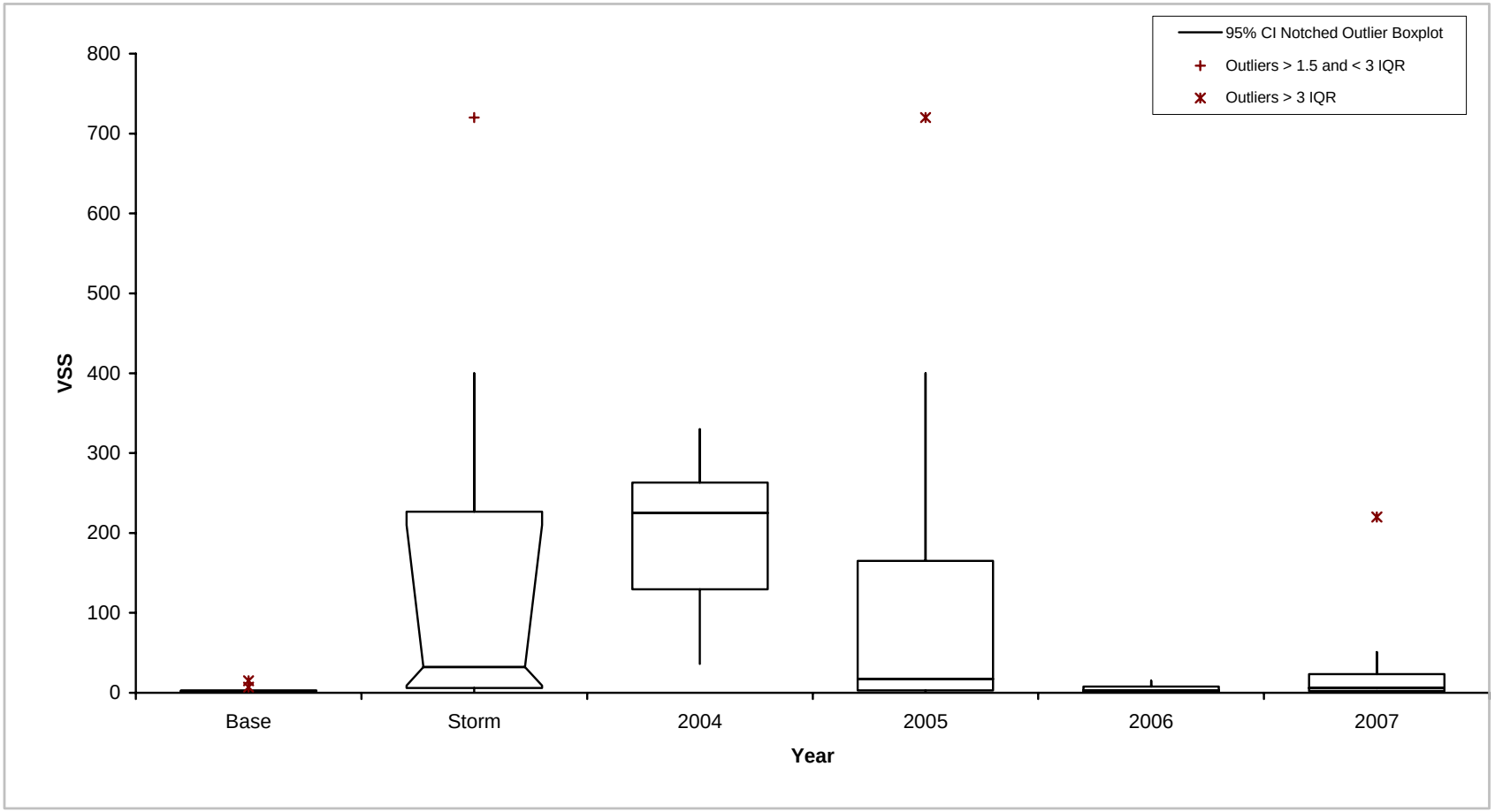
Figure 22. Powers Lake East Tributary Total Suspended Solids Box Plot (2004-2007)



TSS by Year	n	Min	Median	95% CI	Max	IQR
Base	11	1	3.0	1.0 to 21.0	23	2.0
Storm	29	4	336.0	32.0 to 1430.0	7880	1680.0
2004	8	336	2135.0	336.0 to 4220.0	4220	2225.8
2005	14	4	79.5	4.0 to 1430.0	7880	595.5
2006	9	1	3.0	1.0 to 20.0	21	16.3
2007	11	2	13.0	3.0 to 142.0	688	96.2

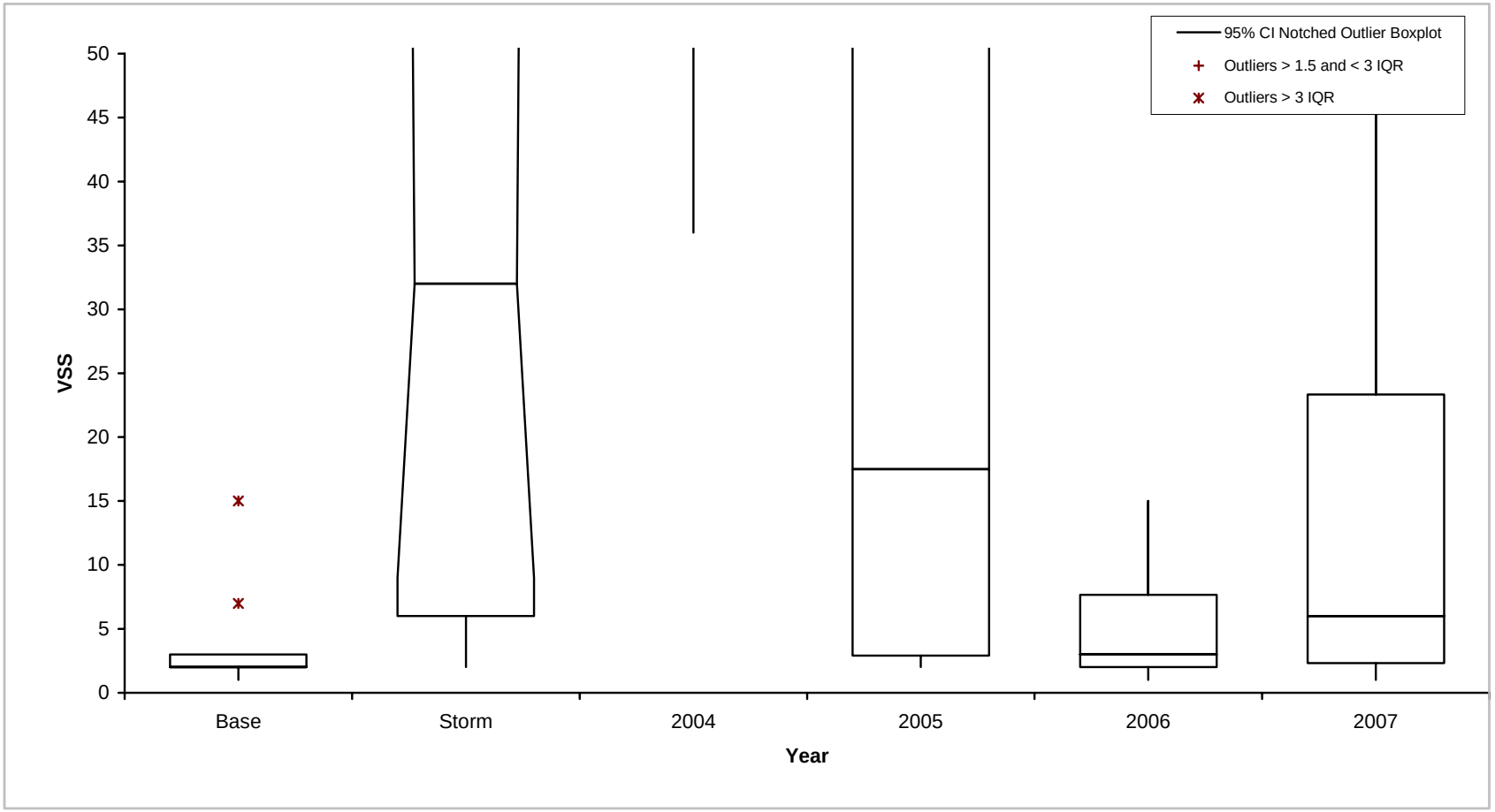
Figure 23. Powers Lake East Tributary Total Suspended Solids Box Plot (2004-2007) without Outliers

*2004 values are above the visible scale



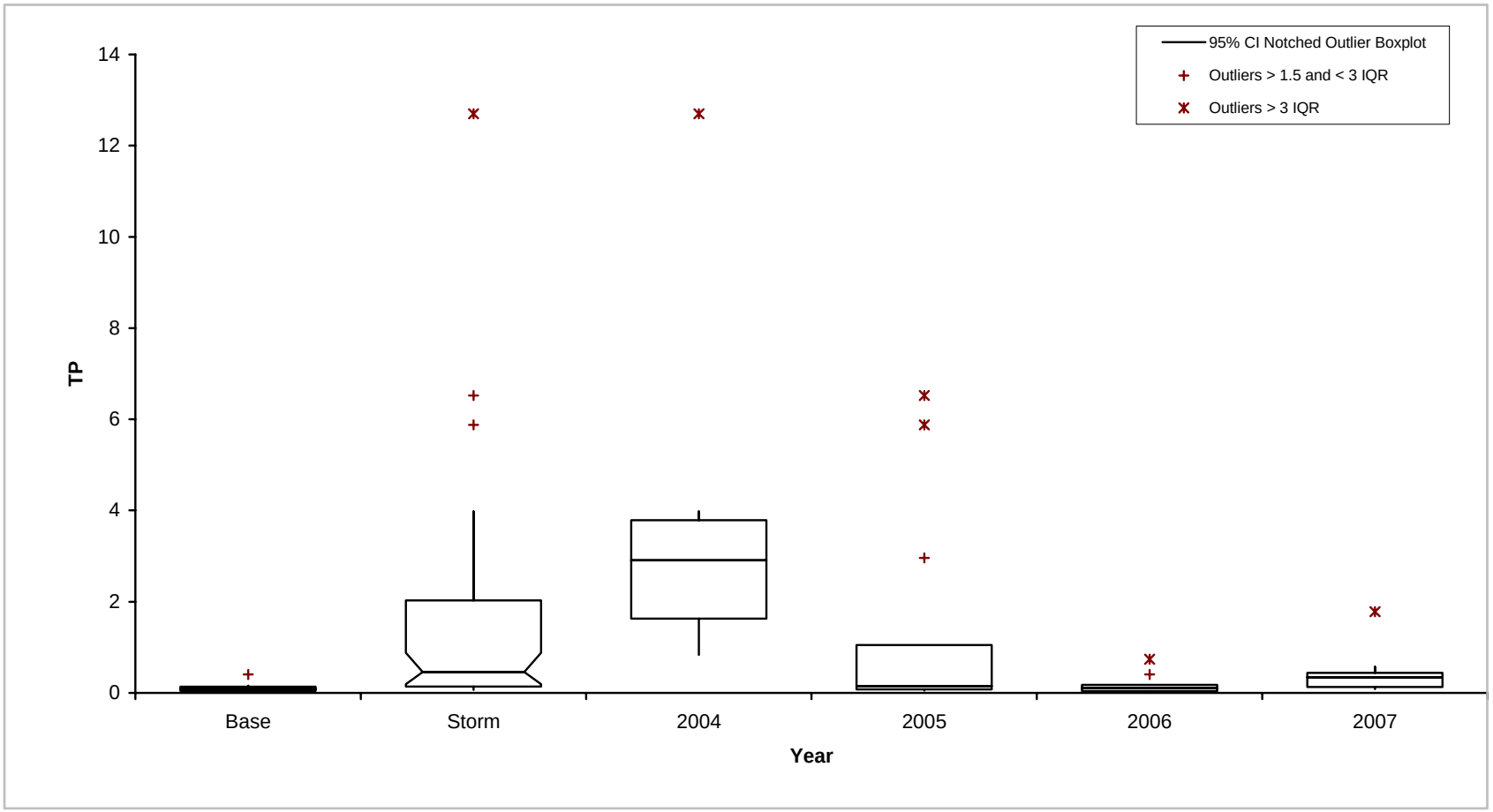
VSS by Year	n	Min	Median	95% CI	Max	IQR
Base	11	1	2.0	1.0 to 7.0	15	1.0
Storm	29	2	32.0	9.0 to 210.0	720	220.7
2004	8	36	225.0	36.0 to 330.0	330	133.8
2005	14	2	17.5	2.0 to 266.0	720	162.3
2006	9	1	3.0	2.0 to 11.0	15	5.7
2007	11	1	6.0	2.0 to 51.0	220	21.0

Figure 24. Powers Lake East Tributary Volatile Suspended Solids Box Plot (2004-2007)



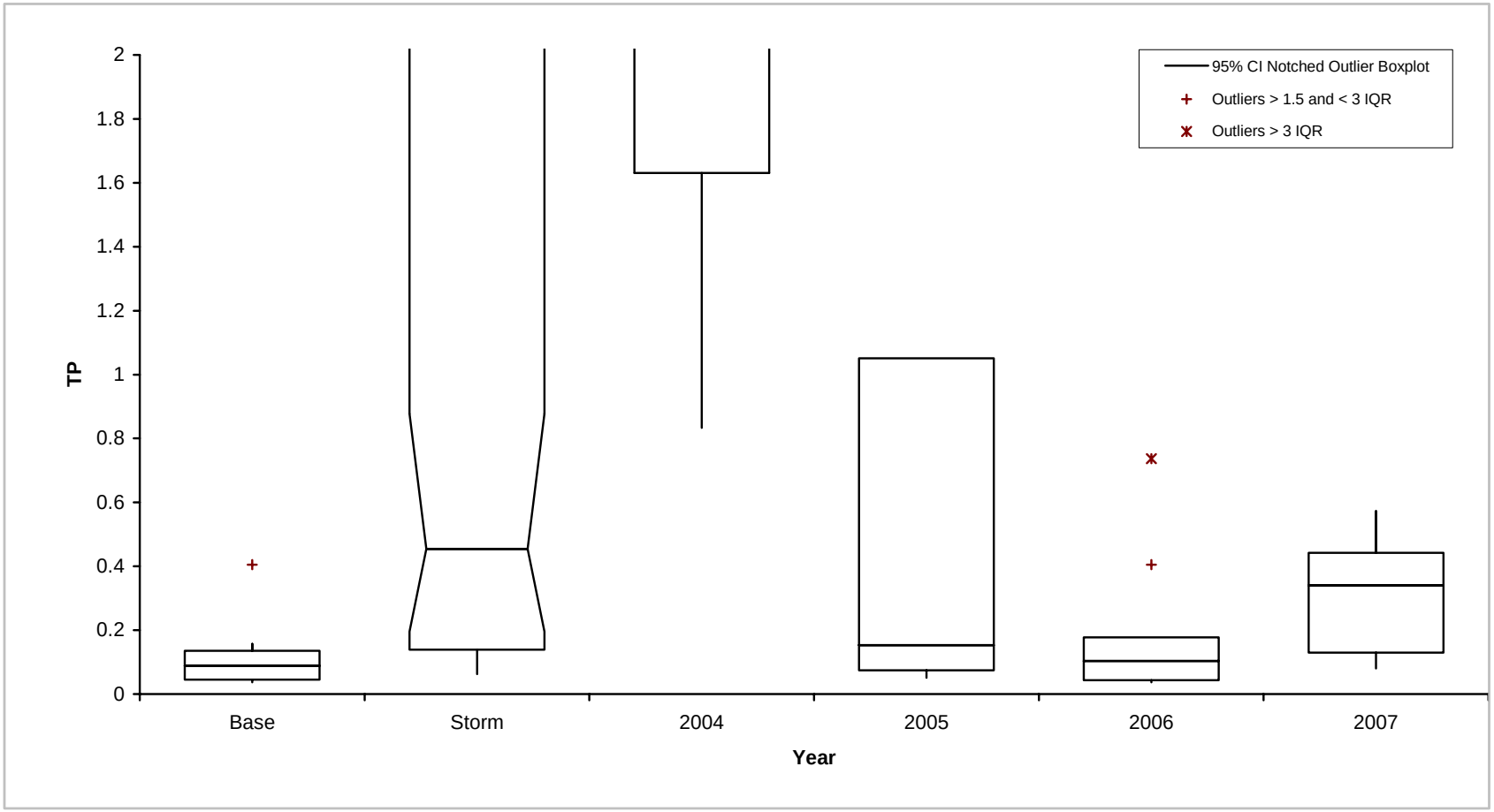
VSS by Year	n	Min	Median	95% CI	Max	IQR
Base	11	1	2.0	1.0 to 7.0	15	1.0
Storm	29	2	32.0	9.0 to 210.0	720	220.7
2004	8	36	225.0	36.0 to 330.0	330	133.8
2005	14	2	17.5	2.0 to 266.0	720	162.3
2006	9	1	3.0	2.0 to 11.0	15	5.7
2007	11	1	6.0	2.0 to 51.0	220	21.0

Figure 25. Powers Lake East Tributary Volatile Suspended Solids Box Plot (2004-2007) without Outliers



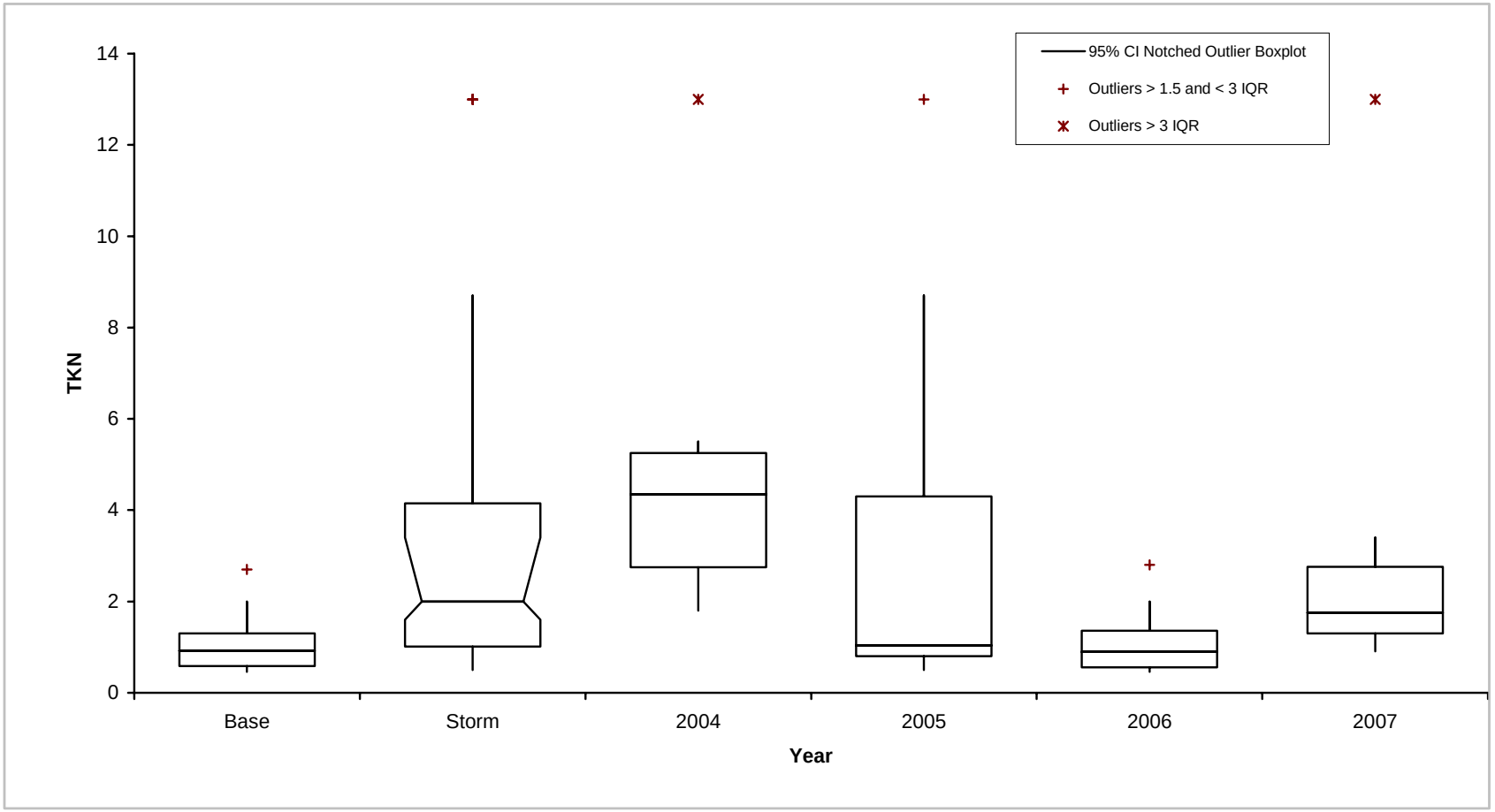
TP by Year	n	Min	Median	95% CI	Max	IQR
Base	11	0.037	0.0890	0.0420 to 0.1570	0.405	0.0905
Storm	35	0.063	0.4550	0.1960 to 0.8770	12.700	1.8908
2004	8	0.833	2.9050	0.8330 to 12.7000	12.700	2.1575
2005	14	0.051	0.1535	0.0680 to 2.9600	6.520	0.9762
2006	10	0.037	0.1035	0.0420 to 0.4050	0.737	0.1338
2007	16	0.080	0.3395	0.1240 to 0.4550	1.780	0.3123

Figure 26. Powers Lake East Tributary Total Phosphorus Box Plot (2004-2007)



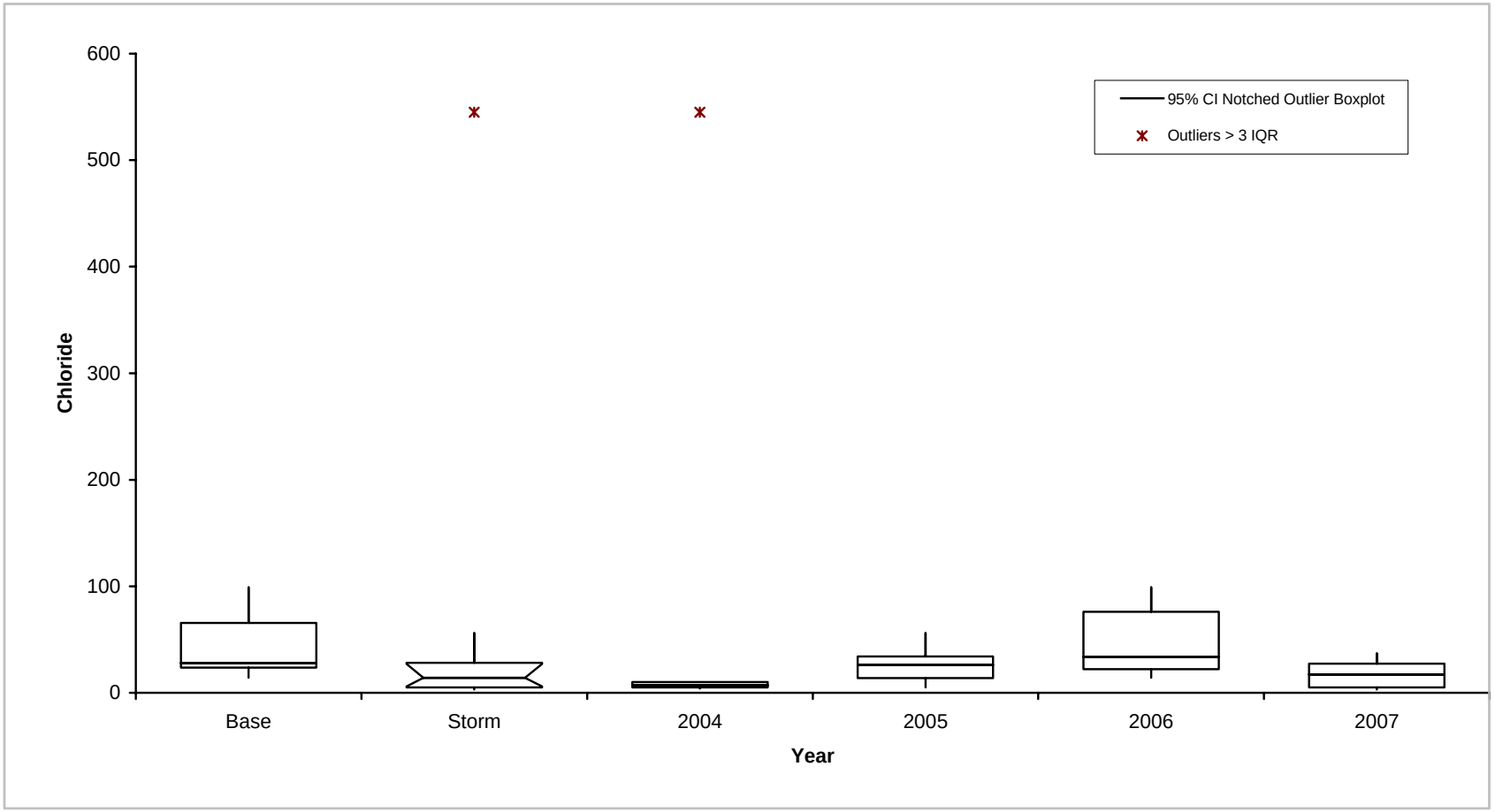
TP by Year	n	Min	Median	95% CI	Max	IQR
Base	11	0.037	0.0890	0.0420 to 0.1570	0.405	0.0905
Storm	35	0.063	0.4550	0.1960 to 0.8770	12.700	1.8908
2004	8	0.833	2.9050	0.8330 to 12.7000	12.700	2.1575
2005	14	0.051	0.1535	0.0680 to 2.9600	6.520	0.9762
2006	10	0.037	0.1035	0.0420 to 0.4050	0.737	0.1338
2007	16	0.080	0.3395	0.1240 to 0.4550	1.780	0.3123

Figure 27. Powers Lake East Tributary Total Phosphorus Box Plot (2004-2007) without Outliers



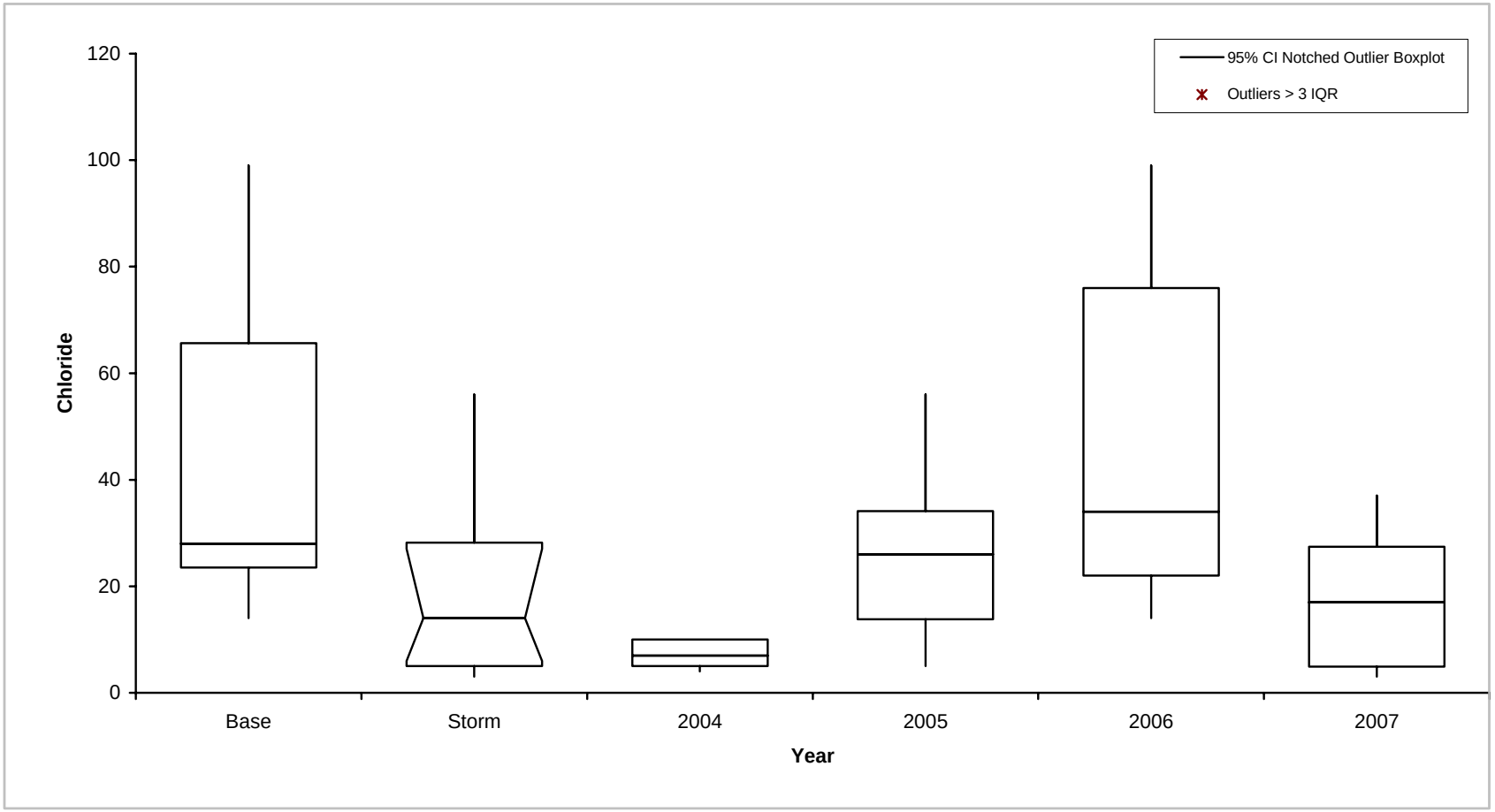
TKN by Year	n	Min	Median	95% CI	Max	IQR
Base	11	0.46	0.920	0.540 to 2.000	2.70	0.713
Storm	35	0.50	2.000	1.600 to 3.400	13.00	3.133
2004	8	1.80	4.350	1.800 to 13.000	13.00	2.500
2005	14	0.50	1.040	0.730 to 5.400	13.00	3.497
2006	10	0.46	0.895	0.540 to 2.000	2.80	0.800
2007	16	0.91	1.750	1.300 to 2.800	13.00	1.458

Figure 28. Powers Lake East Tributary Total Kjedahl Nitrogen Box Plot (2004-2007)



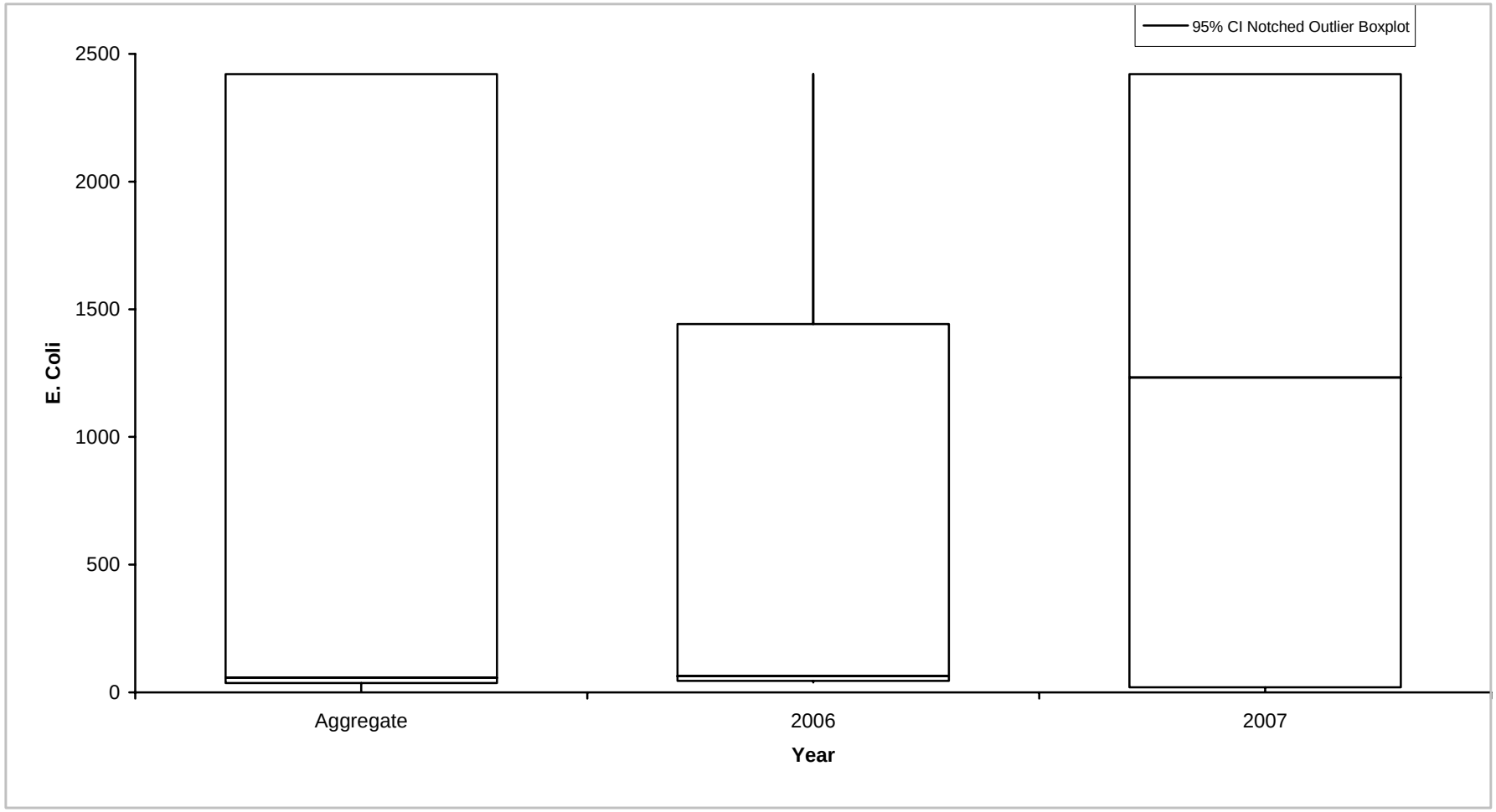
Chloride by Year	n	Min	Median	95% CI	Max	IQR
Base	11	14	28.0	20.0 to 90.0	99	42.2
Storm	32	3	14.0	6.0 to 27.0	545	23.2
2004	8	4	7.0	4.0 to 545.0	545	5.0
2005	14	5	26.0	12.0 to 46.0	56	20.3
2006	9	14	34.0	14.0 to 90.0	99	54.0
2007	14	3	17.0	4.0 to 32.0	37	22.5

Figure 29. Powers Lake East Tributary Total Chloride Ions Box Plot (2004-2007)



Chloride by Year	n	Min	Median	95% CI	Max	IQR
Base	11	14	28.0	20.0 to 90.0	99	42.2
Storm	32	3	14.0	6.0 to 27.0	545	23.2
2004	8	4	7.0	4.0 to 545.0	545	5.0
2005	14	5	26.0	12.0 to 46.0	56	20.3
2006	9	14	34.0	14.0 to 90.0	99	54.0
2007	14	3	17.0	4.0 to 32.0	37	22.5

Figure 30. Powers Lake East Tributary Total Chloride Ions Box Plot (2004-2007) without Outliers



E. Coli by Year	n	Min	Median	95% CI	Max	IQR
Aggregate	10	2	58.0	10.0 to 2420.0	2420	2383.4
2006	4	39	63.5	- to -	2420	1396.8
2007	4	2	1233.0	- to -	2420	2399.7

Figure 31. Powers Lake East Tributary *E. coli* Box Plot (2005-2007)

**E. coli* bacteria have been sampled since the 2006 monitoring season. Prior season sampling was for total fecal coliform
* 2005 was not graphed due to inadequate samples

Powers Lake North Tributary

The hydrograph for the Powers Lake North Tributary site shows flow between June 14-October 29, 2007 (Figure 32). Total discharge during this period was 669,471 cf or 15.37 acre/ft. The highest discharge—0.69 cfs occurred on October 19, 2007. Very little flow was observed at this site for the 2007 sampling season. This result maybe due to low amounts of precipitation, resulting in limited runoff to stormwater ponds and wetlands. Little to no runoff to these ponds and wetlands in turn will have a reduced amount of discharge from these water bodies.

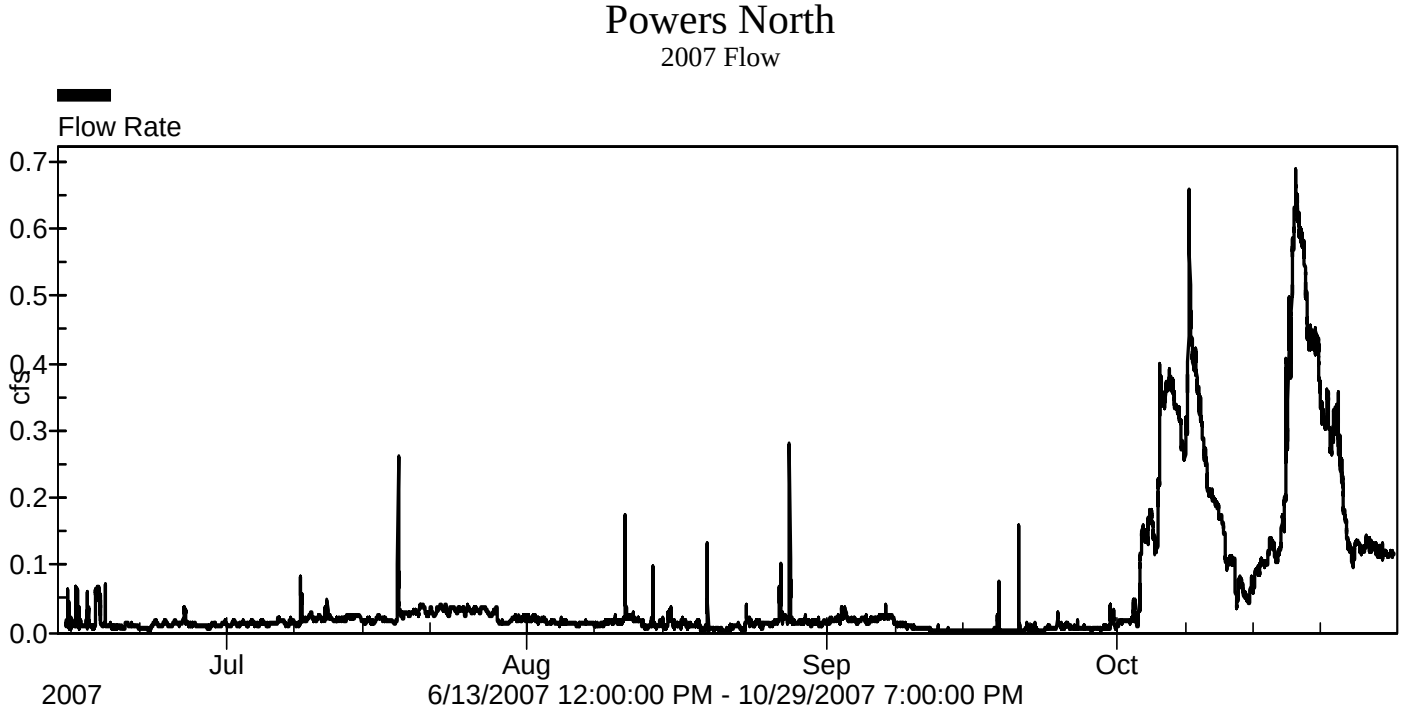


Figure 32. Powers Lake North Tributary 2007 Flow

Table 11. Powers Lake North Tributary Stormwater Total Phosphorus and Total Suspended Solids Loading Table

	Sample Collection Time				Loading Interval				
Sample Type	**Start**	**End**	**TSS (mg/L)**	**TP (mg/L)**	**Start**	**End**	**Interval Volume (cf)**	**Interval TSS (lb)**	**Interval TP (lb)**
Base			*13*	*0.076*	*1/1/2007 0:00*	*3/1/2007 0:00*	*50,976*	*39.8*	*0.2*
Base			*13*	*0.076*	*3/1/2007 0:00*	*5/1/2007 0:00*	*263,520*	*205.6*	*1.3*
Base			*13*	*0.076*	*5/1/2007 0:00*	*6/1/2007 0:00*	*53,568*	*41.8*	*0.3*
Base			*13*	*0.076*	*6/1/2007 0:00*	*6/14/2007 14:30*	*23,508*	*18.3*	*0.1*
Storm			*15*	*0.235*	*6/14/2007 14:30*	*6/18/2007 14:30*	*6,786*	*6.4*	*0.1*
Base			*13*	*0.076*	*6/18/2007 14:30*	*7/8/2007 15:30*	*19,764*	*15.4*	*0.1*
Storm			*15*	*0.235*	*7/8/2007 15:30*	*7/8/2007 21:30*	*701*	*0.7*	*0.0*
Base			*13*	*0.076*	*7/8/2007 21:30*	*7/18/2007 15:30*	*16,935*	*13.2*	*0.1*
Storm			*15*	*0.235*	*7/18/2007 15:30*	*7/18/2007 23:30*	*1,642*	*1.5*	*0.0*
Base			*13*	*0.076*	*7/18/2007 23:30*	*8/11/2007 3:30*	*44,759*	*34.9*	*0.2*
Storm			*15*	*0.235*	*8/11/2007 3:30*	*8/11/2007 8:30*	*792*	*0.7*	*0.0*
Base			*13*	*0.076*	*8/11/2007 8:30*	*8/11/2007 22:30*	*1,157*	*0.9*	*0.0*
Storm			*15*	*0.235*	*8/11/2007 22:30*	*8/12/2007 0:30*	*166*	*0.2*	*0.0*
Base			*13*	*0.076*	*8/12/2007 0:30*	*8/13/2007 20:30*	*2,053*	*1.6*	*0.0*
Storm			*15*	*0.235*	*8/13/2007 20:30*	*8/14/2007 6:30*	*649*	*0.6*	*0.0*
Base			*13*	*0.076*	*8/14/2007 6:30*	*8/19/2007 13:30*	*4,982*	*3.9*	*0.0*
Storm			*15*	*0.235*	*8/19/2007 13:30*	*8/19/2007 17:30*	*566*	*0.5*	*0.0*
Base			*13*	*0.076*	*8/19/2007 17:30*	*8/23/2007 9:30*	*1,665*	*1.3*	*0.0*
Storm			*15*	*0.235*	*8/23/2007 9:30*	*8/23/2007 22:30*	*820*	*0.8*	*0.0*
Base			*13*	*0.076*	*8/23/2007 22:30*	*8/27/2007 1:30*	*3,511*	*2.7*	*0.0*
Storm			*15*	*0.235*	*8/27/2007 1:30*	*8/27/2007 10:30*	*1,032*	*1.0*	*0.0*
Base			*13*	*0.076*	*8/27/2007 10:30*	*8/28/2007 2:30*	*1,197*	*0.9*	*0.0*
Storm			*15*	*0.235*	*8/28/2007 2:30*	*8/28/2007 9:30*	*1,225*	*1.1*	*0.0*
Base Grab	9/12/07 11:22	9/12/07 11:22	8	0.076	8/28/2007 9:30	9/18/2007 11:30	19,758	9.9	0.1
Storm			*15*	*0.235*	*9/18/2007 11:30*	*9/18/2007 20:30*	*281*	*0.3*	*0.0*
Base			*13*	*0.076*	*9/18/2007 20:30*	*9/20/2007 18:30*	*211*	*0.2*	*0.0*
Storm			*15*	*0.235*	*9/20/2007 18:30*	*9/20/2007 23:30*	*508*	*0.5*	*0.0*
Base			*13*	*0.076*	*9/20/2007 23:30*	*9/24/2007 17:30*	*1,534*	*1.2*	*0.0*
Storm			*15*	*0.235*	*9/24/2007 17:30*	*9/24/2007 23:30*	*318*	*0.3*	*0.0*
Base			*13*	*0.076*	*9/24/2007 23:30*	*9/30/2007 3:30*	*2,952*	*2.3*	*0.0*
Storm			*15*	*0.235*	*9/30/2007 3:30*	*9/30/2007 18:30*	*886*	*0.8*	*0.0*
Base			*13*	*0.076*	*9/30/2007 18:30*	*10/2/2007 11:30*	*2,263*	*1.8*	*0.0*
Storm			*15*	*0.235*	*10/2/2007 11:30*	*10/2/2007 21:30*	*1,009*	*0.9*	*0.0*
Base			*13*	*0.076*	*10/2/2007 21:30*	*10/3/2007 4:30*	*283*	*0.2*	*0.0*
Storm			*15*	*0.235*	*10/3/2007 4:30*	*10/5/2007 1:30*	*22,745*	*21.3*	*0.3*
Storm Composite	10/5/07 2:59	10/6/07 4:18	15	0.235	10/5/2007 1:30	10/7/2007 3:30	61,017	57.1	0.9
Base			*13*	*0.076*	*10/7/2007 3:30*	*10/7/2007 23:30*	*21,265*	*16.6*	*0.1*
Storm			*15*	*0.235*	*10/7/2007 23:30*	*10/10/2007 9:30*	*73,687*	*69.0*	*1.1*
Base			*13*	*0.076*	*10/10/2007 9:30*	*10/14/2007 14:30*	*43,885*	*34.2*	*0.2*
Storm			*15*	*0.235*	*10/14/2007 14:30*	*10/17/2007 8:30*	*23,863*	*22.3*	*0.4*
Base			*13*	*0.076*	*10/17/2007 8:30*	*10/17/2007 18:30*	*4,141*	*3.2*	*0.0*
Storm			*15*	*0.235*	*10/17/2007 18:30*	*10/20/2007 15:30*	*113,380*	*106.2*	*1.7*
Base Grab**	10/29/07 11:27	10/29/07 11:27	17	0.076	10/20/2007 15:30	10/29/2007 11:15	164,893	175.0	0.8
Base			*13*	*0.076*	*10/29/2007 11:15*	*1/1/2008 0:00*	*5,489*	*4.3*	*0.0*
Storm Average			15	0.235					
Base Average			13	0.076					
Snowmelt Average			**NA**	**NA**					
All Average			13	0.129					
Total							**1,066,338**	922	8
SWWD Major Subwatershed Total Acres							233		
Total TP/TSS(lb/ac/yr)								3.95	0.035
Total TP/TSS (kg/ha/yr)								4.43	0.039

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**TP Concentration based upon Base Average

*** Interval flow values from 1/1/07 to 6/14/07 and 10/29/07 to 1/1/08 were estimated from base flow

Grab and flow weighted composite samples were collected at the Powers Lake North Tributary site in 2007. The TSS, TKN, TP, VSS, soluble COD, total COD, TOC, TDP, and *E. coli* results from all collected samples are listed in Table 12. The highest TSS concentration of 17 mg/L was from an October 29, 2007 base grab sample. The highest TKN and TP concentration was from an October 5, 2007 storm composite sample, which produced 2.10 mg/L and 0.236 mg/L, respectively. Metals, chloride, hardness, and other Nitrogen species chemical results are listed in Table 13. Water quality standard exceedences were included in Table 13. No samples were above any chronic standard.

Table 12. Powers Lake North Tributary 2007 Sample Chemistry Results

Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	*E. coli* (mpn/100 mL)	COD (mg/L)	TDP (mg/L)	TOC (mg/L)	Soluble COD (mg/L)
E. coli Grab	7/16/07 11:20	7/16/07 11:20					39				
Base Grab	9/12/07 11:22	9/12/07 11:22	8	~2	0.74	0.076		~10	<0.010	2.2	~12
Storm Composite	10/5/07 2:59	10/6/07 4:18	15	3	2.10	0.235		44	0.096	8.3	30
E. coli Grab	10/18/07 11:40	10/18/07 11:40					210				
Base Grab	10/29/07 11:27	10/29/07 11:27	~17	<10				~9			15

Table 13. Powers Lake North Tributary 2007 Sample Metals and Nitrogen Specie Chemical Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start Date	End Date	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
E. coli Grab	7/16/07 11:20	7/16/07 11:20											
Base Grab	9/12/07 11:22	9/12/07 11:22	0.0010	0.0033	<0.0001	0.0055	<0.0005	<0.0005	64	<0.03	0.10	~0.06	220
Storm Composite	10/5/07 2:59	10/6/07 4:18	0.0018	0.0027	0.0003	0.0033	<0.0005	0.0007	56	<0.03	<0.05	~0.03	146
E. coli Grab	10/18/07 11:40	10/18/07 11:40											
Base Grab	10/29/07 11:27	10/29/07 11:27							60			<0.02	200

No exceedence determinable
Exceeds Chronic Standard
Exceeds Maximum Standard
Exceeds Final Acute Standard

No statistical analysis was done for Powers Lake North Tributary. Analysis is preferably done after a data set has over three years of discrete samples.

100th Street (Cottage Grove)

The hydrograph for the 100th Street site shows flow recorded between March 29-October 30, 2007 (Figure 33). Total discharge during this period was 8,296,404 cf or 190 acre/ft. The highest discharge—7.823 cfs occurred on September 20, 2007 from a storm rainfall of 0.87 inches. The highest precipitation event occurred on September 18, 2007 with 1.30 inches, likely contributing to the previously mentioned highest discharge recorded for the season.

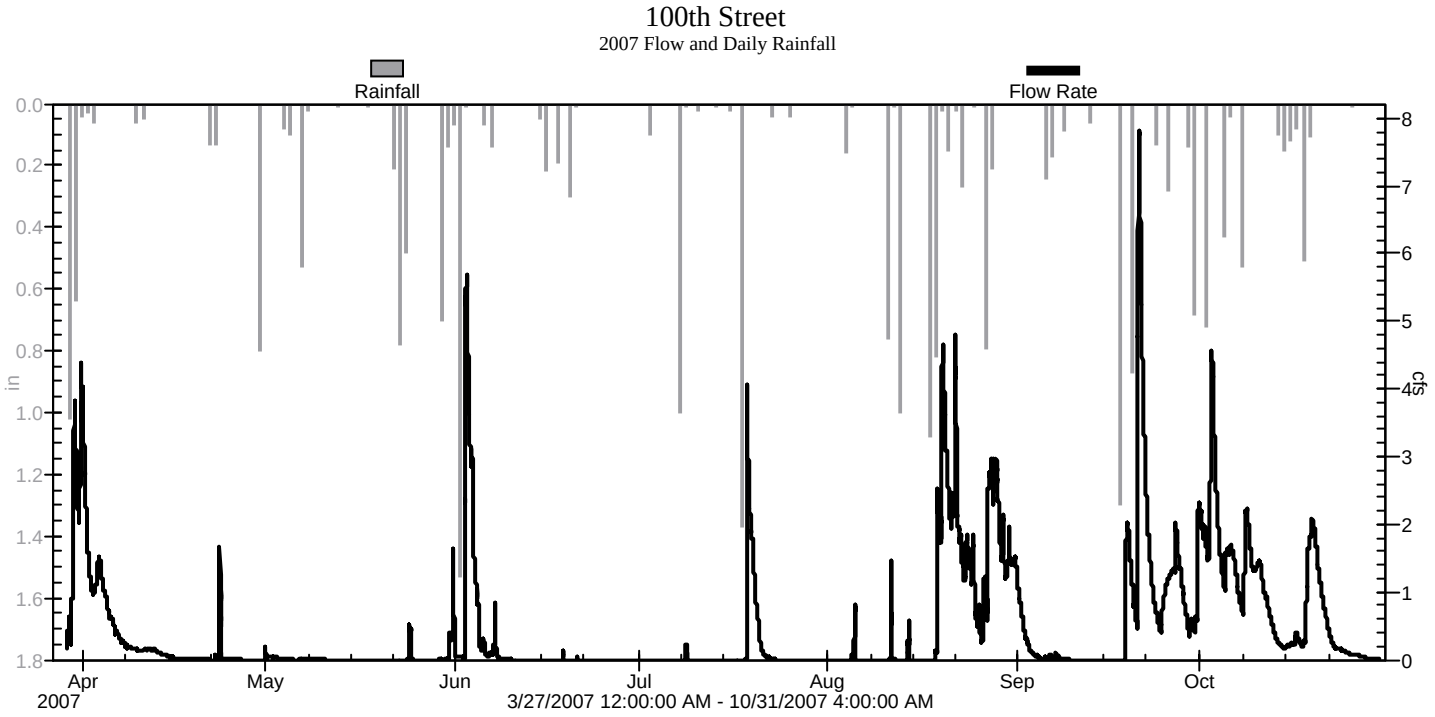


Figure 33. 100th Street 2007 Flow and Daily Rainfall

Table 14. 100th Street Stormwater Total Phosphorus and Total Suspended Solids Loading Table

	Sample Collection Time				Loading Interval				
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval TSS (lb)	Interval TP (lb)
Base			*2.0*	*0.040*	*1/1/2007 0:00*	*3/12/2007 0:00*	*60,480*	*7.6*	*0.2*
Snowmelt Grab	3/13/07 11:00	3/13/07 11:00	8.0	0.297	3/12/2007 0:00	3/14/2007 0:00	345,600	172.6	6.4
Base			*2.0*	*0.040*	*3/14/2007 0:00*	*3/29/2007 12:15*	*536,040*	*66.9*	*1.3*
Base			*2.0*	*0.040*	*3/29/2007 12:15*	*3/30/2007 2:45*	*18,260*	*2.3*	*0.0*
Storm Composite	3/30/07 8:52	3/31/07 8:54	9.0	0.117	3/30/2007 2:45	3/31/2007 8:45	257,631	144.7	1.9
Storm			*5.0*	*0.089*	*3/31/2007 8:45*	*4/1/2007 2:45*	*208,823*	*65.2*	*1.2*
Base			*2.0*	*0.040*	*4/1/2007 2:45*	*4/3/2007 9:45*	*315,177*	*39.4*	*0.8*
Storm			*5.0*	*0.089*	*4/3/2007 9:45*	*4/4/2007 6:45*	*103,617*	*32.3*	*0.6*
Base			*2.0*	*0.040*	*4/4/2007 6:45*	*4/22/2007 18:45*	*269,771*	*33.7*	*0.7*
Storm			*5.0*	*0.089*	*4/22/2007 18:45*	*4/22/2007 20:45*	*247*	*0.1*	*0.0*
Base			*2.0*	*0.040*	*4/22/2007 20:45*	*4/23/2007 6:45*	*431*	*0.1*	*0.0*
Storm			*5.0*	*0.089*	*4/23/2007 6:45*	*4/23/2007 17:45*	*15,478*	*4.8*	*0.1*
Base Grab	4/24/07 11:08	4/24/07 11:08	2.0	0.040	4/23/2007 17:45	4/30/2007 18:45	1,743	0.2	0.0
Storm			*5.0*	*0.089*	*4/30/2007 18:45*	*5/3/2007 0:45*	*7,189*	*2.2*	*0.0*
Base			*2.0*	*0.040*	*5/3/2007 0:45*	*5/7/2007 17:45*	*2,394*	*0.3*	*0.0*
Storm			*5.0*	*0.089*	*5/7/2007 17:45*	*5/9/2007 15:45*	*3,641*	*1.1*	*0.0*
Base			*2.0*	*0.040*	*5/9/2007 15:45*	*5/24/2007 8:45*	*481*	*0.1*	*0.0*
Storm Composite	5/24/07 10:57	5/24/07 19:54	4.0	0.186	5/24/2007 8:45	5/24/2007 23:45	14,874	3.7	0.2
Base			*2.0*	*0.040*	*5/24/2007 23:45*	*5/30/2007 17:45*	*2*	*0.0*	*0.0*
Storm Composite	5/31/07 3:33	5/31/07 18:48	3.0	0.074	5/30/2007 17:45	6/1/2007 0:45	45,031	8.4	0.2
Base			*2.0*	*0.040*	*6/1/2007 0:45*	*6/2/2007 14:45*	*4,949*	*0.6*	*0.0*
Storm Composite	6/2/07 15:46	6/2/07 20:42	3.0	0.084	6/2/2007 14:45	6/5/2007 1:45	534,491	100.1	2.8
Base			*2.0*	*0.040*	*6/5/2007 1:45*	*6/7/2007 3:45*	*21,264*	*2.7*	*0.1*
Storm			*5.0*	*0.089*	*6/7/2007 3:45*	*6/7/2007 18:45*	*18,465*	*5.8*	*0.1*
Base			*2.0*	*0.040*	*6/7/2007 18:45*	*6/18/2007 13:45*	*2,381*	*0.3*	*0.0*
Storm			*5.0*	*0.089*	*6/18/2007 13:45*	*6/18/2007 18:45*	*1,137*	*0.4*	*0.0*
Base			*2.0*	*0.040*	*6/18/2007 18:45*	*6/20/2007 21:45*	*0*	*0.0*	*0.0*
Storm			*5.0*	*0.089*	*6/20/2007 21:45*	*6/21/2007 0:45*	*121*	*0.0*	*0.0*
Base			*2.0*	*0.040*	*6/21/2007 0:45*	*7/8/2007 15:45*	*0*	*0.0*	*0.0*
Storm			*5.0*	*0.089*	*7/8/2007 15:45*	*7/9/2007 6:45*	*3,997*	*1.2*	*0.0*
Base			*2.0*	*0.040*	*7/9/2007 6:45*	*7/18/2007 10:45*	*0*	*0.0*	*0.0*
Storm Composite	7/18/07 18:45	7/20/07 9:47	5.0	0.102	7/18/2007 10:45	7/21/2007 5:45	303,566	94.8	1.9
Base			*2.0*	*0.040*	*7/21/2007 5:45*	*8/4/2007 21:45*	*7,342*	*0.9*	*0.0*
Storm			*5.0*	*0.089*	*8/4/2007 21:45*	*8/5/2007 12:45*	*13,095*	*4.1*	*0.1*
Base			*2.0*	*0.040*	*8/5/2007 12:45*	*8/11/2007 5:45*	*11*	*0.0*	*0.0*
Storm			*5.0*	*0.089*	*8/11/2007 5:45*	*8/11/2007 9:45*	*4,451*	*1.4*	*0.0*
Base			*2.0*	*0.040*	*8/11/2007 9:45*	*8/13/2007 23:45*	*71*	*0.0*	*0.0*
Storm			*5.0*	*0.089*	*8/13/2007 23:45*	*8/14/2007 9:45*	*7,679*	*2.4*	*0.0*
Base			*2.0*	*0.040*	*8/14/2007 9:45*	*8/18/2007 13:45*	*11*	*0.0*	*0.0*
Storm			*5.0*	*0.089*	*8/18/2007 13:45*	*8/18/2007 20:45*	*2,578*	*0.8*	*0.0*
Storm Composite	8/18/07 21:46	8/19/07 21:08	3.0	0.049	8/18/2007 20:45	8/19/2007 6:45	75,106	14.1	0.2
Base			*2.0*	*0.040*	*8/19/2007 6:45*	*8/19/2007 10:45*	*26,219*	*3.3*	*0.1*
Storm			*5.0*	*0.089*	*8/19/2007 10:45*	*8/19/2007 14:45*	*28,446*	*8.9*	*0.2*
Storm			*5.0*	*0.089*	*8/19/2007 14:45*	*8/20/2007 11:45*	*281,941*	*88.0*	*1.6*
Base			*2.0*	*0.040*	*8/20/2007 11:45*	*8/21/2007 3:45*	*139,852*	*17.5*	*0.3*
Storm			*5.0*	*0.089*	*8/21/2007 3:45*	*8/21/2007 11:45*	*67,256*	*21.0*	*0.4*
Base			*2.0*	*0.040*	*8/21/2007 11:45*	*8/21/2007 15:45*	*31,358*	*3.9*	*0.1*
Storm			*5.0*	*0.089*	*8/21/2007 15:45*	*8/22/2007 11:45*	*217,601*	*67.9*	*1.2*
Base			*2.0*	*0.040*	*8/22/2007 11:45*	*8/23/2007 11:45*	*130,513*	*16.3*	*0.3*
Storm			*5.0*	*0.089*	*8/23/2007 11:45*	*8/24/2007 3:45*	*92,721*	*28.9*	*0.5*
Base			*2.0*	*0.040*	*8/24/2007 3:45*	*8/27/2007 2:45*	*220,512*	*27.5*	*0.6*
Storm Grab	8/27/07 10:45	8/27/07 10:45	9.0	0.106	8/27/2007 2:45	8/28/2007 3:45	228,940	128.6	1.5
Storm			*5.0*	*0.089*	*8/28/2007 3:45*	*8/29/2007 3:45*	*223,642*	*69.8*	*1.2*
Base			*2.0*	*0.040*	*8/29/2007 3:45*	*9/7/2007 9:45*	*489,612*	*61.1*	*1.2*
Storm			*5.0*	*0.089*	*9/7/2007 9:45*	*9/7/2007 20:45*	*2,239*	*0.7*	*0.0*
Base			*2.0*	*0.040*	*9/7/2007 20:45*	*9/18/2007 18:45*	*1,383*	*0.2*	*0.0*
Storm Composite	9/18/07 20:30	9/20/07 9:29	6.0	0.045	9/18/2007 18:45	9/19/2007 21:45	156,128	58.5	0.4
Base			*2.0*	*0.040*	*9/19/2007 21:45*	*9/20/2007 18:45*	*54,332*	*6.8*	*0.1*
Storm Composite	9/20/07 19:40	9/22/07 12:36	2010.0	0.084	9/20/2007 18:45	9/22/2007 16:45	669,175	83965.8	3.5
Base			*2.0*	*0.040*	*9/22/2007 16:45*	*9/24/2007 17:45*	*143,456*	*17.9*	*0.4*
Storm			*5.0*	*0.089*	*9/24/2007 17:45*	*9/26/2007 19:45*	*204,895*	*64.0*	*1.1*
Storm			*5.0*	*0.089*	*9/26/2007 19:45*	*9/27/2007 20:45*	*146,840*	*45.8*	*0.8*
Base			*2.0*	*0.040*	*9/27/2007 20:45*	*9/29/2007 7:45*	*93,877*	*11.7*	*0.2*
Storm			*5.0*	*0.089*	*9/29/2007 7:45*	*9/29/2007 21:45*	*27,119*	*8.5*	*0.2*
Base			*2.0*	*0.040*	*9/29/2007 21:45*	*9/30/2007 4:45*	*10,671*	*1.3*	*0.0*
Storm			*5.0*	*0.089*	*9/30/2007 4:45*	*9/30/2007 11:45*	*14,880*	*4.6*	*0.1*
Storm			*5.0*	*0.089*	*9/30/2007 11:45*	*10/1/2007 8:45*	*150,286*	*46.9*	*0.8*
Base			*2.0*	*0.040*	*10/1/2007 8:45*	*10/2/2007 7:45*	*145,100*	*18.1*	*0.4*
Storm Grab	10/2/07 10:11	10/2/07 10:11	6.0	0.070	10/2/2007 7:45	10/4/2007 0:45	432,889	162.1	1.9
Base			*2.0*	*0.040*	*10/4/2007 0:45*	*10/5/2007 0:45*	*119,055*	*14.9*	*0.3*
Storm			*5.0*	*0.089*	*10/5/2007 0:45*	*10/7/2007 2:45*	*272,526*	*85.1*	*1.5*
Base			*2.0*	*0.040*	*10/7/2007 2:45*	*10/8/2007 2:45*	*72,744*	*9.1*	*0.2*
Storm Grab	10/9/07 10:37	10/9/07 10:37	2.0	0.064	10/8/2007 2:45	10/9/2007 15:45	231,214	28.9	0.9
Base			*2.0*	*0.040*	*10/9/2007 15:45*	*10/14/2007 21:45*	*345,710*	*43.2*	*0.9*
Storm			*5.0*	*0.089*	*10/14/2007 21:45*	*10/17/2007 3:45*	*49,720*	*15.5*	*0.3*
Base			*2.0*	*0.040*	*10/17/2007 3:45*	*10/17/2007 21:45*	*14,815*	*1.8*	*0.0*
Storm			*5.0*	*0.089*	*10/17/2007 21:45*	*10/21/2007 14:45*	*402,934*	*125.8*	*2.2*
Base			*2.0*	*0.040*	*10/21/2007 14:45*	*10/30/2007 8:45*	*90,394*	*11.3*	*0.2*
Base			*2.0*	*0.040*	*10/30/2007 8:45*	*1/1/2008 0:00*	*2,164,680*	*270.3*	*5.4*
Storm Average			*5.0*	0.089					
Base Average			2.0	0.040					
Snowmelt Average			8.0	0.297					
All Average			*5.0*	0.101					
Total							**11,403,294**	86,377	*50*
SWWD Major Subwatershed Total Acres							8,046		
Total TP/TSS(lb/ac/yr)								10.74	0.01
Total TP/TSS (kg/ha/yr)								12.03	0.01

*Italics indicate estimated concentrations based on average base and storm flow concentrations

** Interval flow values from 1/1/07 to 3/29/07 and 10/30/07 to 1/1/08 were estimated from base flow

Grab samples and flow weighted composite samples were taken at the 100th Street site. The TSS, TKN, TP, VSS, total COD, soluble COD, TOC, TDP, and *E. coli* results from all collected samples are listed in Table 15. The highest TSS concentration of 2010 mg/L was collected in a September 20, 2007 storm composite sample. The highest TP and TKN concentrations were collected from the March 13, 2007 snowmelt grab sample, 0.297 mg/L and 4.30 mg/L, respectively. Metals, chloride, hardness, and other Nitrogen species chemicals are listed in Table 15. Water quality standards were included in Table 16. Other than two samples where water quality standard exceedences were not determinable, all samples were below levels established by the Minnesota Pollution Control Agency.

Table 15. 100th Street 2007 Sample Chemistry Results

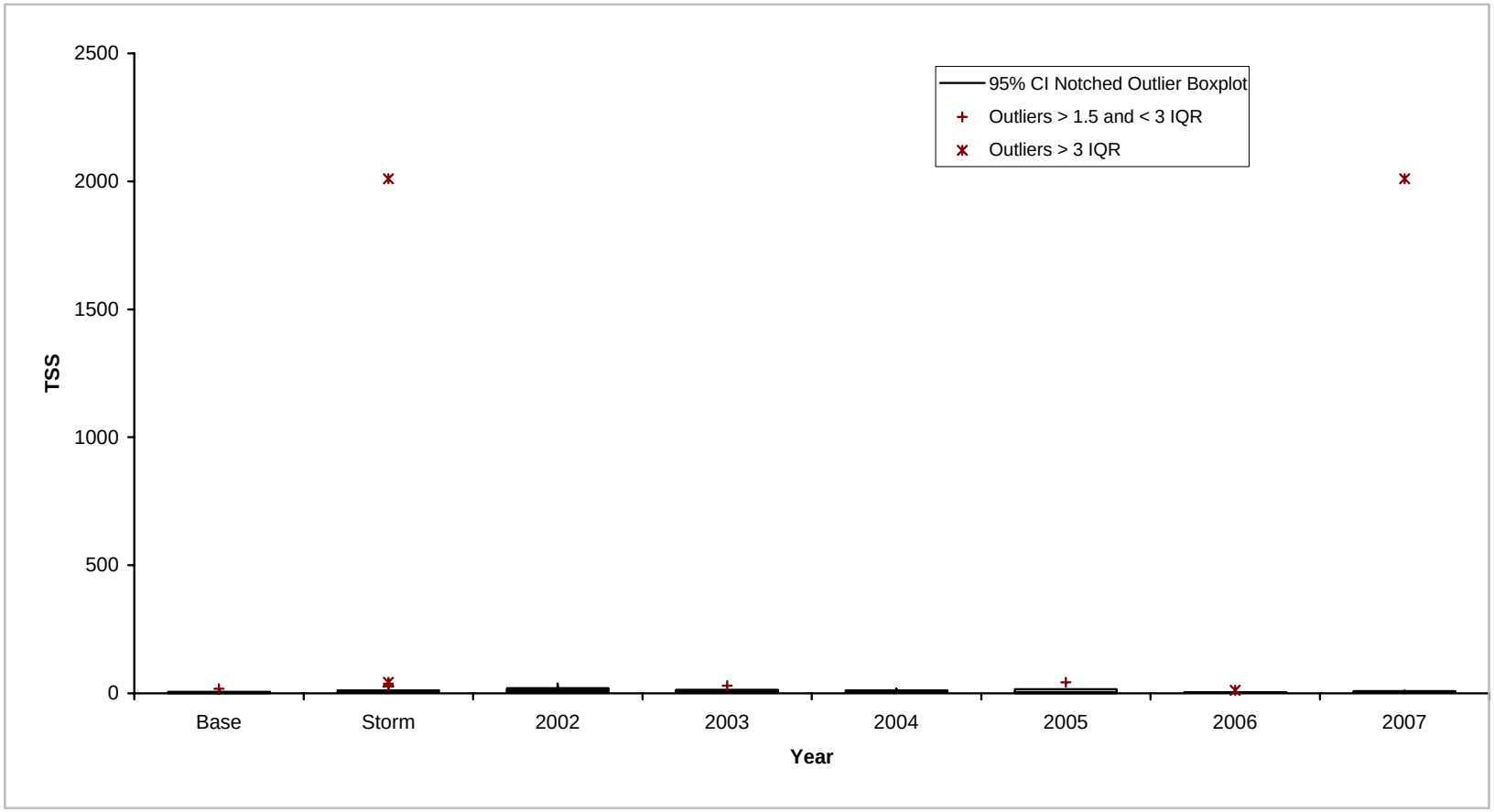
Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	*E. coli* (mpn/100 mL)	COD (mg/L)	TDP (mg/L)	TOC (mg/L)	Soluble COD (mg/L)
Snowmelt Grab	3/13/07 11:00	3/13/07 11:00	8	4	4.30	0.297		51	0.239	17.0	87
Storm Composite	3/30/07 8:52	3/31/07 8:54	9	4	2.40	0.117		31	0.151	7.2	26
Base Grab	4/24/07 11:08	4/24/07 11:08	<2	<2	1.20	~0.040		~13	~0.016	1.8	~13
Storm Composite	5/24/07 10:57	5/24/07 19:54	4	4	2.00	0.186		28	0.120	5.7	21
Storm Composite	5/31/07 3:33	5/31/07 18:48	3	~2	0.89	0.074		20		5.6	18
Storm Composite	6/2/07 15:46	6/2/07 20:42	3	~2	0.81	0.084		22		6.3	21
E. Coli Grab	6/13/07 10:30	6/13/07 10:30					22				
Storm Composite	7/18/07 18:45	7/20/07 9:47	5	4	1.10	0.102		30	<0.010	6.1	26
Storm Composite	8/18/07 21:46	8/19/07 21:08	3	3	0.62	~0.049		26	~0.014	7.5	22
Storm Grab	8/27/07 10:45	8/27/07 10:45	9	8	0.91	0.106		31	~0.014	10.9	23
E. Coli Grab	8/28/07 9:25	8/28/07 9:25					387				
Storm Composite	9/18/07 20:30	9/20/07 9:29	6	~3	0.49	~0.045		37		10.3	34
Storm Composite	9/20/07 19:40	9/22/07 12:36	2010	~5	0.91	0.084		~13	~0.014	5.0	~12
Storm Grab	10/2/07 10:11	10/2/07 10:11	6	3	1.30	0.070		25	~0.029	6.4	30
Storm Grab	10/9/07 10:37	10/9/07 10:37	~2	~1	0.84	0.064		20	~0.044	4.0	15
E. Coli Grab	10/18/07 10:00	10/18/07 10:00					131				

Table 16. 100th Street 2007 Sample Metals and Nitrogen Species Chemical Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start Date	End Date	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/13/07 11:00	3/13/07 11:00	0.0052	0.0017	0.00070	0.0136	<0.00004	0.0014	114	<0.03	0.51	1.00	
Storm Composite	3/30/07 8:52	3/31/07 8:54	0.0056	0.0025	0.00050	0.0109	<0.00004	0.0012	98	0.04	0.94	0.20	136
Base Grab	4/24/07 11:08	4/24/07 11:08	0.0025	0.0030	<0.00007	0.0037	<0.00004	0.0005	151	<0.03	<0.05	~0.04	256
Storm Composite	5/24/07 10:57	5/24/07 19:54	0.0020	0.0024	0.00030	0.0107	<0.00004	0.0008	96	0.05	0.36	0.19	
Storm Composite	5/31/07 3:33	5/31/07 18:48	0.0015	0.0023	0.00030	0.0071	0.00020	0.0006	70	0.03	<0.05	0.09	160
Storm Composite	6/2/07 15:46	6/2/07 20:42	0.0018	0.0019	0.00020	0.0066	<0.00004	0.0009	50	0.03	0.15	0.09	120
E. Coli Grab	6/13/07 10:30	6/13/07 10:30											
Storm Composite	7/18/07 18:45	7/20/07 9:47	0.0019	0.0016	0.00030	0.0220	0.00010	0.0015	34	0.03	0.50	~0.04	102
Storm Composite	8/18/07 21:46	8/19/07 21:08	0.0013	0.0016	0.00020	0.0071	<0.00050	0.0006	25	<0.03	0.07	~0.02	102
Storm Grab	8/27/07 10:45	8/27/07 10:45	0.0014	0.0015	0.00020	0.0045	<0.00050	<0.0005	21	<0.03	<0.05	0.06	96
E. Coli Grab	8/28/07 9:25	8/28/07 9:25											
Storm Composite	9/18/07 20:30	9/20/07 9:29	0.0017	0.0016	0.00030	0.0046	<0.00050	0.0010	38	<0.03	0.36	<0.02	118
Storm Composite	9/20/07 19:40	9/22/07 12:36	0.0019	0.0020	0.00090	0.0053	<0.00050	0.0011	25	0.05	0.43	0.16	94
Storm Grab	10/2/07 10:11	10/2/07 10:11	0.0011	0.0022	0.00020	0.0021	<0.00050	<0.0005	33	0.08	0.56	0.25	122
Storm Grab	10/9/07 10:37	10/9/07 10:37	0.0009	0.0026	0.00010	0.0016	<0.00050	<0.0005	42	0.08	0.56	0.08	166
E. Coli Grab	10/18/07 10:00	10/18/07 10:00											

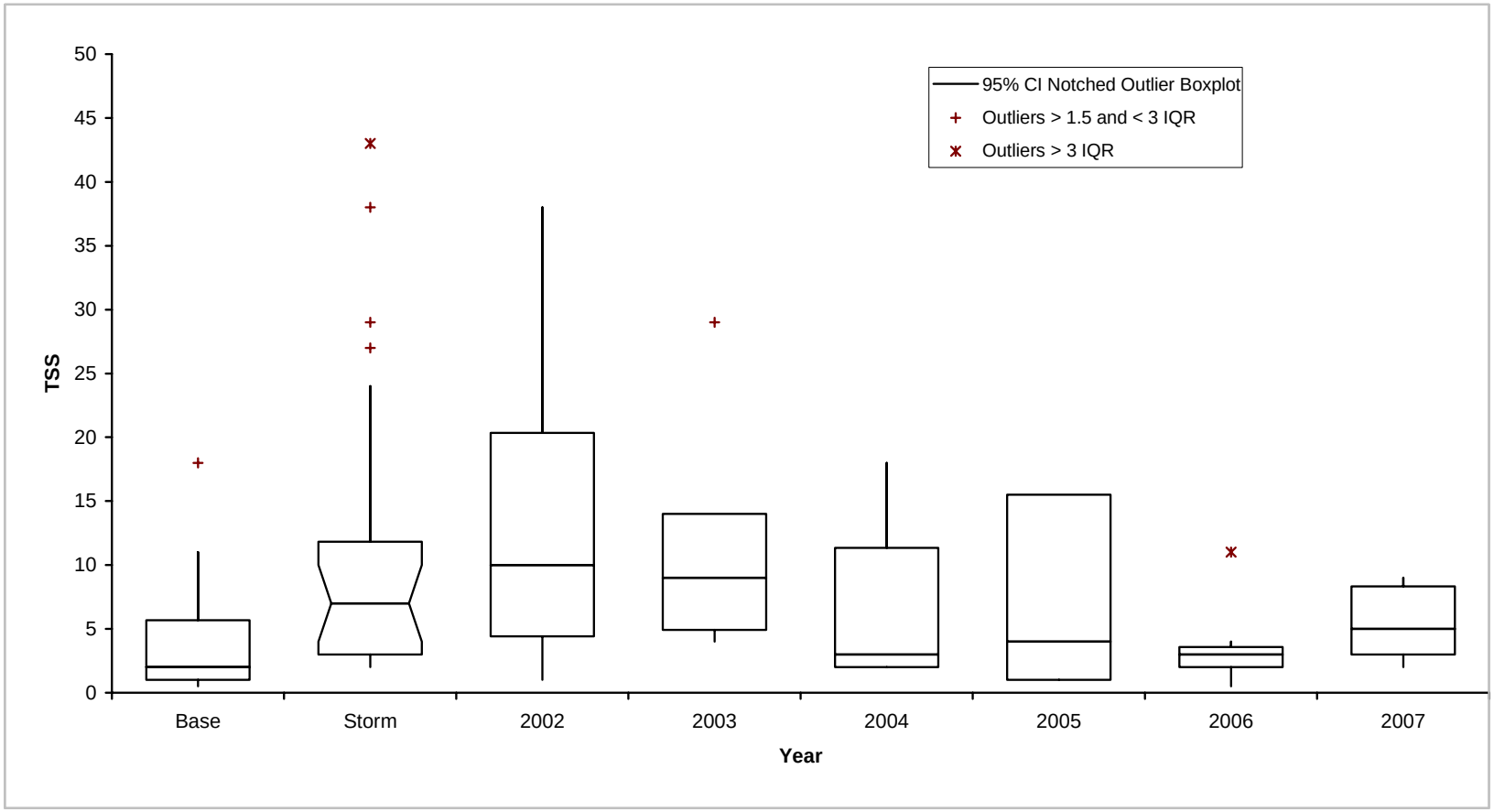
No exceedence determinable
Exceeds Chronic Standard
Exceeds Maximum Standard
Exceeds Final Acute Standard

Statistical summaries for 100th Street are included in figures 34-40 in the form of box plots. Total suspended solids, volatile suspended solids, and total phosphorus have median values that are steady over time. A large increase for these three parameters occurred in 2003, as well as an increase in variability of the box plots. Further analysis of factors or changes in the drainage area would be needed to fully understand the source of this increase. Total chloride ions median values had an increasing trend from 2003 until 2005 and then the median value decreased in 2006. Statistical summaries for fecal coliform were not conducted due to too few samples for each year. Sample tests for 2004, 2005, and 2006 were few for all parameters based on lack of climatological events. These small sample sizes decrease confidence of temporal analysis for each parameter.



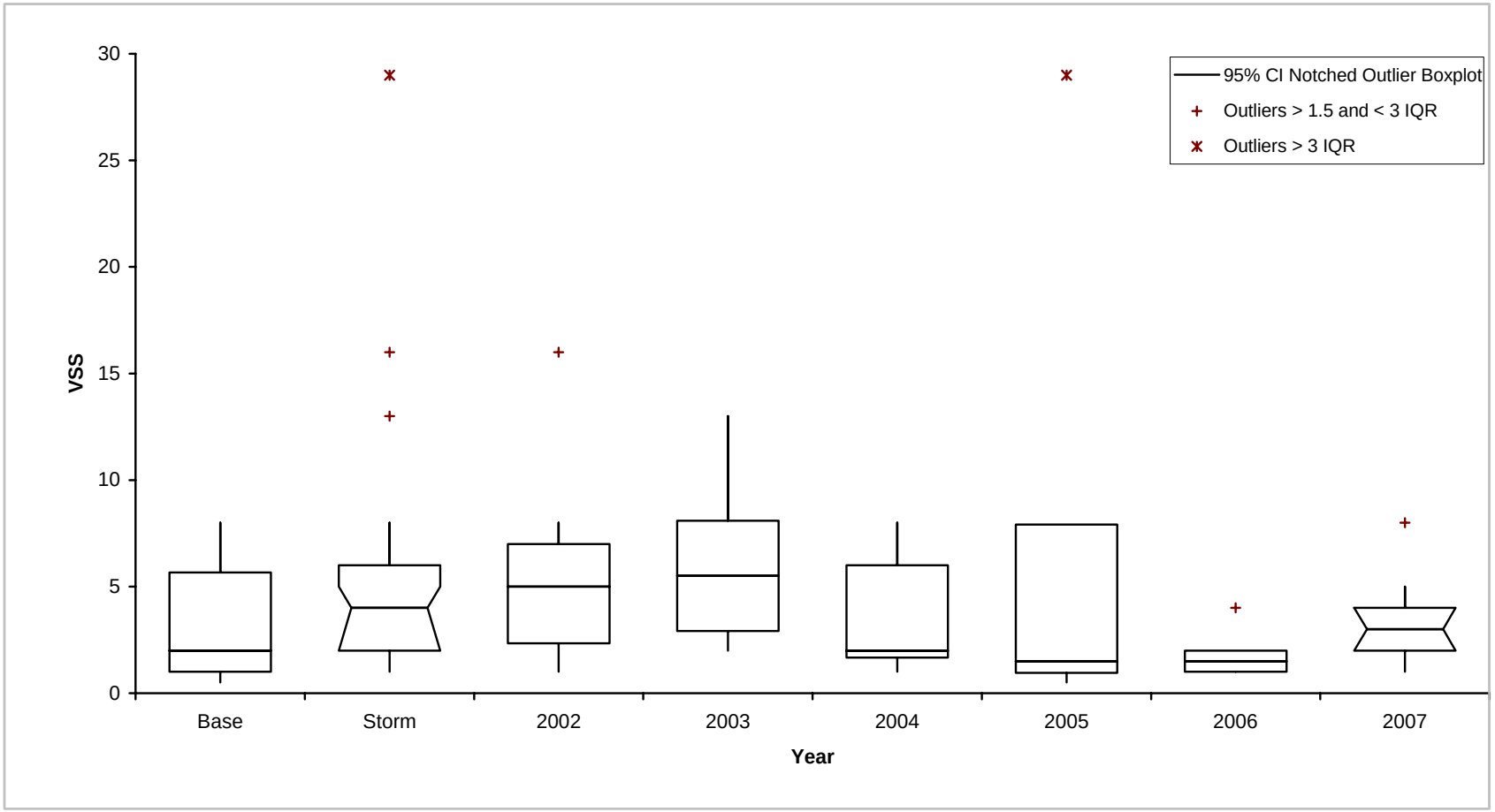
TSS by Year	n	Min	Median	95% CI	Max	IQR
Base	13	0.5	2.00	1.00 to 9.00	18.0	4.67
Storm	43	2.0	7.00	4.00 to 10.00	2010.0	8.83
2002	16	1.0	10.00	4.00 to 22.00	38.0	15.92
2003	10	4.0	9.00	4.00 to 14.00	29.0	9.08
2004	5	2.0	3.00	- to -	18.0	9.33
2005	6	1.0	4.00	1.00 to 43.00	43.0	14.50
2006	8	0.5	3.00	0.50 to 11.00	11.0	1.58
2007	13	2.0	5.00	3.00 to 9.00	2010.0	5.33

Figure 34. 100th Street Total Suspended Solids Box Plot (2002-2007)



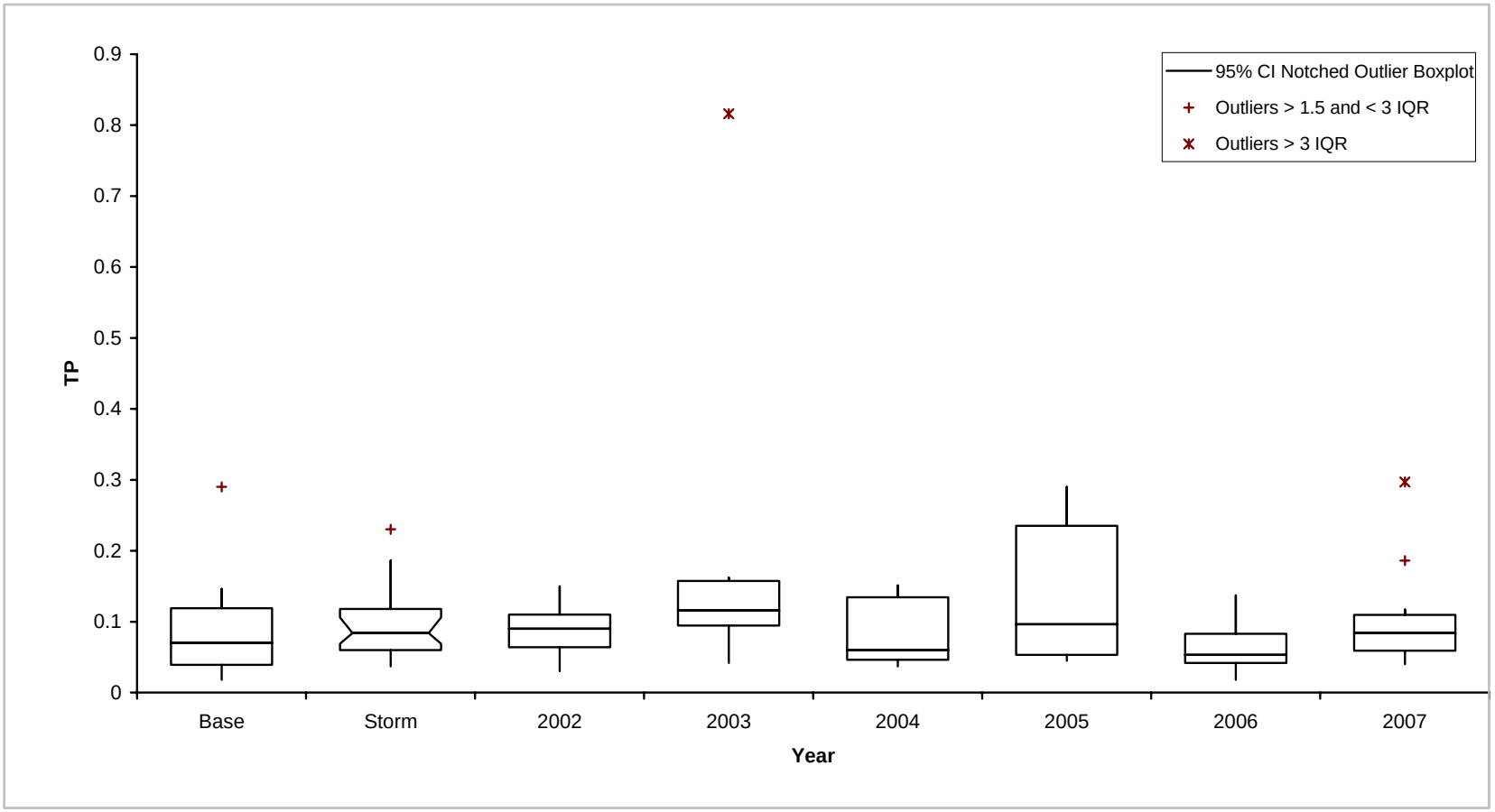
TSS by Year	n	Min	Median	95% CI	Max	IQR
Base	13	0.5	2.00	1.00 to 9.00	18.0	4.67
Storm	43	2.0	7.00	4.00 to 10.00	2010.0	8.83
2002	16	1.0	10.00	4.00 to 22.00	38.0	15.92
2003	10	4.0	9.00	4.00 to 14.00	29.0	9.08
2004	5	2.0	3.00	- to -	18.0	9.33
2005	6	1.0	4.00	1.00 to 43.00	43.0	14.50
2006	8	0.5	3.00	0.50 to 11.00	11.0	1.58
2007	13	2.0	5.00	3.00 to 9.00	2010.0	5.33

Figure 35. 100th Street Total Suspended Solids Box Plot (2002-2007) without Outliers



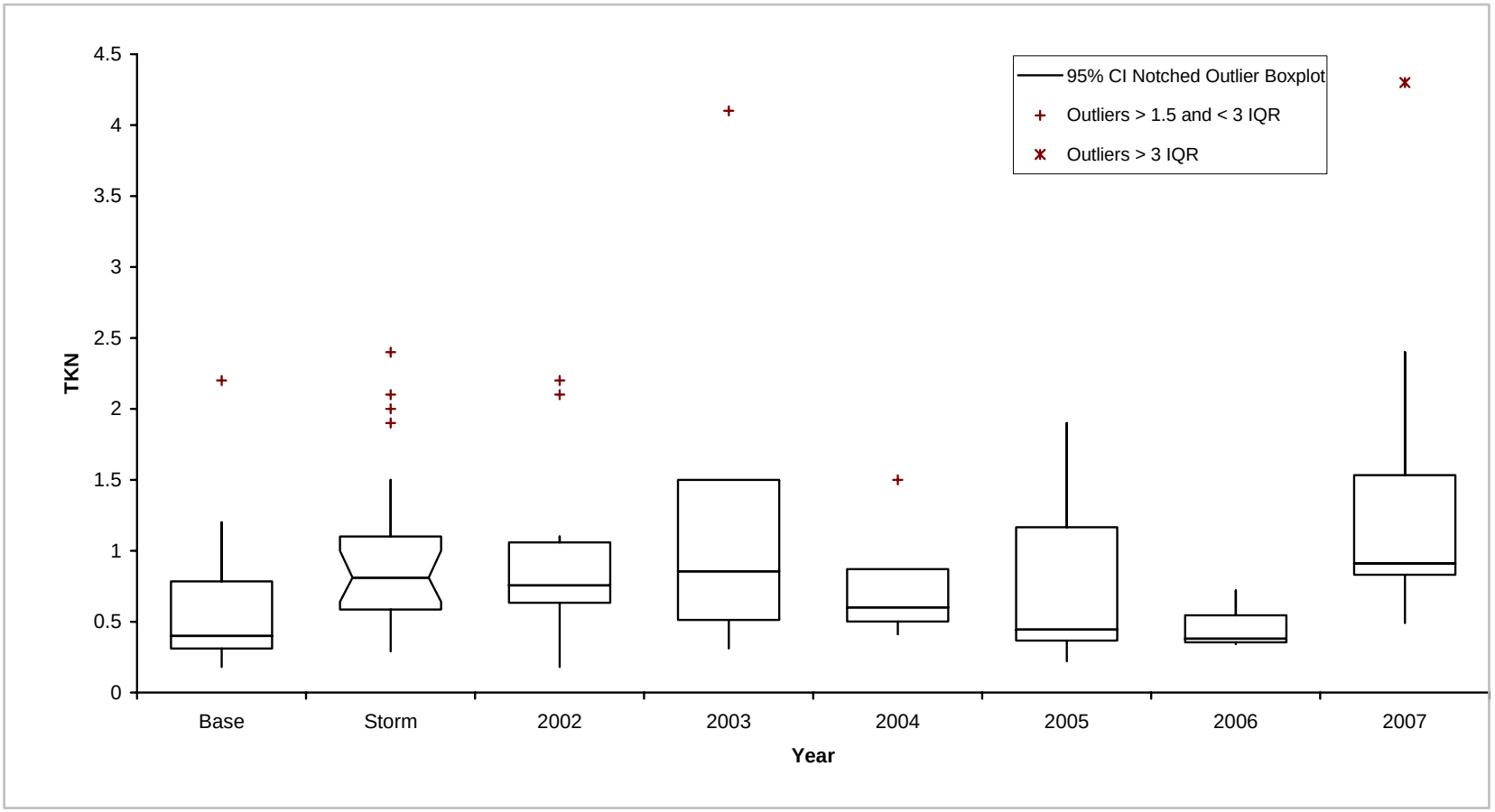
VSS by Year	n	Min	Median	95% CI	Max	IQR
Base	15	0.5	2.00	1.00 to 6.00	8.0	4.67
Storm	40	1.0	4.00	2.00 to 5.00	29.0	4.00
2002	15	1.0	5.00	2.00 to 7.00	16.0	4.67
2003	10	2.0	5.50	2.00 to 9.00	13.0	5.17
2004	5	1.0	2.00	- to -	8.0	4.33
2005	6	0.5	1.50	0.50 to 29.00	29.0	6.96
2006	8	1.0	1.50	1.00 to 4.00	4.0	1.00
2007	13	1.0	3.00	2.00 to 4.00	8.0	2.00

Figure 36. 100th Street Volatile Suspended Solids Box Plot (2002-2007)



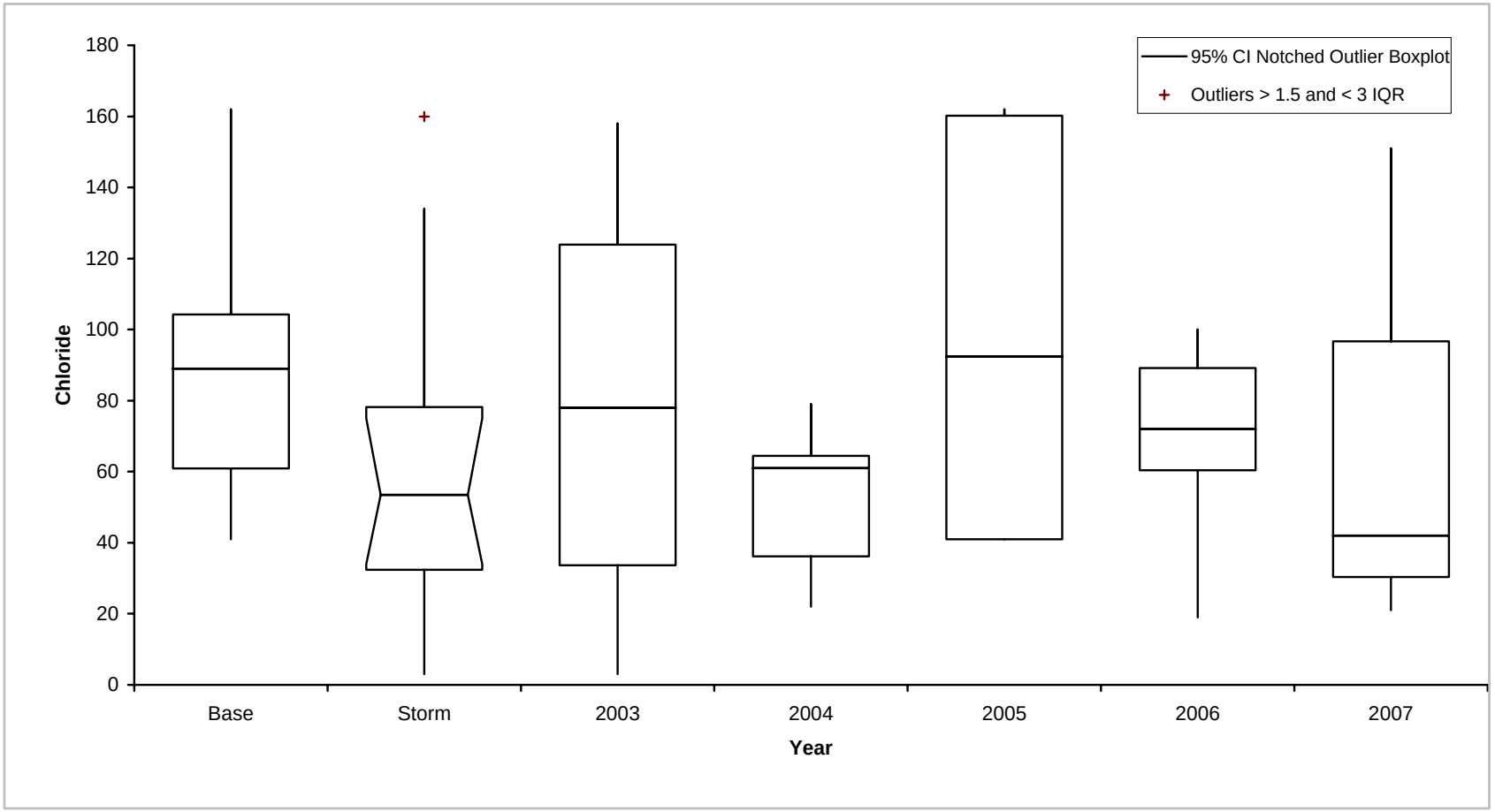
TP by Year	n	Min	Median	95% CI	Max	IQR
Base	13	0.018	0.0700	0.0370 to 0.1370	0.290	0.0800
Storm	45	0.037	0.0840	0.0690 to 0.1060	0.230	0.0580
2002	16	0.030	0.0900	0.0600 to 0.1100	0.150	0.0458
2003	10	0.042	0.1155	0.0680 to 0.1620	0.816	0.0628
2004	7	0.037	0.0600	0.0370 to 0.1510	0.151	0.0882
2005	6	0.045	0.0965	0.0450 to 0.2900	0.290	0.1818
2006	8	0.018	0.0530	0.0180 to 0.1370	0.137	0.0410
2007	13	0.040	0.0840	0.0490 to 0.1170	0.297	0.0507

Figure 37. 100th Street Total Phosphorus Box Plot (2002-2007)



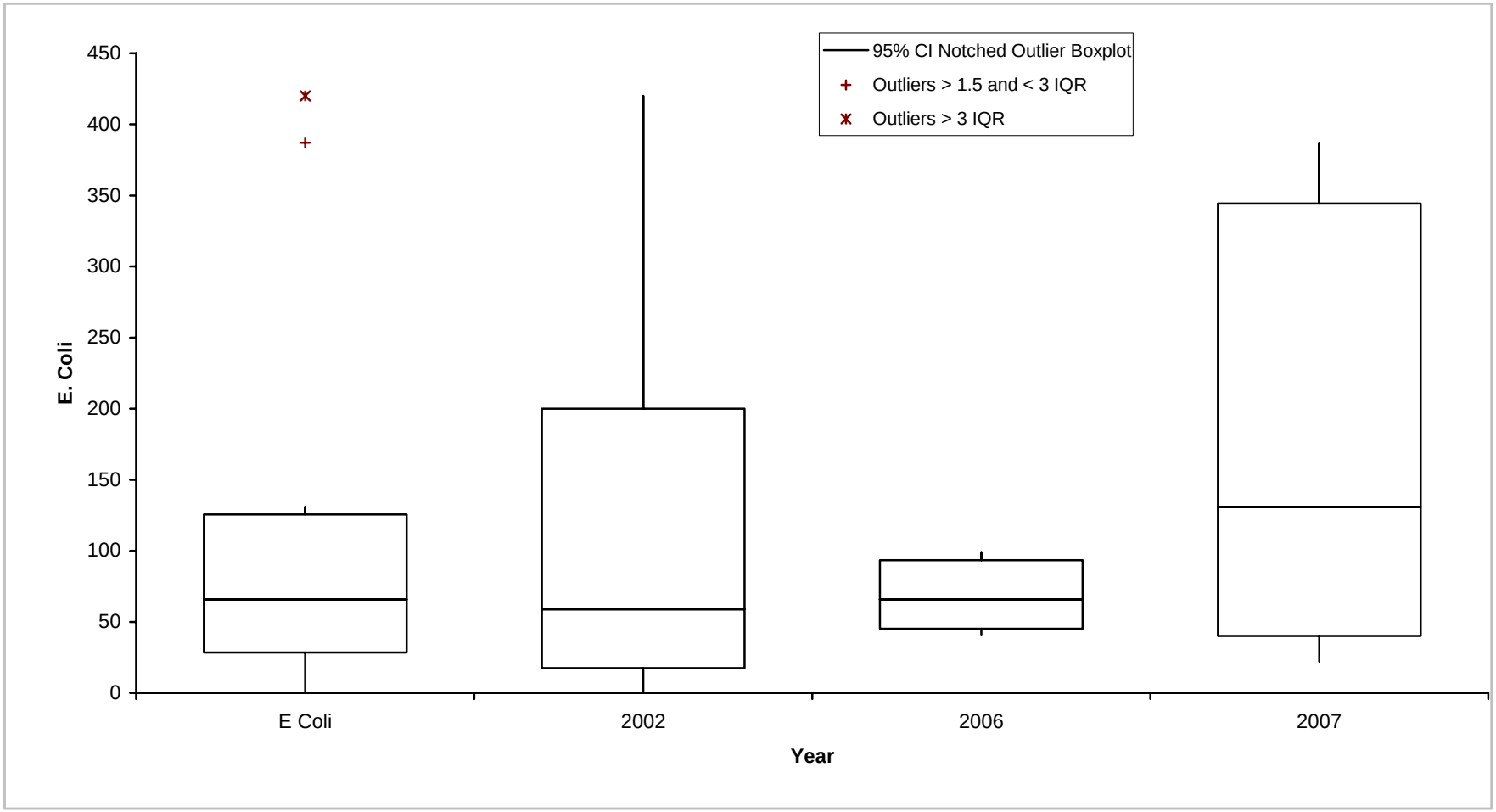
TKN by Year	n	Min	Median	95% CI	Max	IQR
Base	13	0.18	0.400	0.310 to 0.870	2.20	0.473
Storm	45	0.29	0.810	0.640 to 1.000	2.40	0.513
2002	16	0.18	0.755	0.620 to 1.100	2.20	0.426
2003	10	0.31	0.855	0.310 to 1.500	4.10	0.988
2004	7	0.41	0.600	0.410 to 1.500	1.50	0.368
2005	6	0.22	0.445	0.220 to 1.900	1.90	0.800
2006	8	0.34	0.380	0.340 to 0.720	0.72	0.190
2007	13	0.49	0.910	0.810 to 2.000	4.30	0.703

Figure 38. 100th Street Total Kjedahl Nitrogen Box Plot (2002-2007)



Chloride by Year	n	Min	Median	95% CI	Max	IQR
Base	10	41	89.0	60.0 to 151.0	162	43.3
Storm	32	3	53.5	34.0 to 75.0	160	45.8
2003	10	3	78.0	30.0 to 134.0	158	90.3
2004	7	22	61.0	22.0 to 79.0	79	28.3
2005	6	41	92.5	41.0 to 162.0	162	119.2
2006	8	19	72.0	19.0 to 100.0	100	28.8
2007	13	21	42.0	25.0 to 98.0	151	66.3

Figure 39. 100th Street Total Chloride Ions Box Plot (2003-2007)



E. Coli by Year	n	Min	Median	95% CI	Max	IQR
E Coli	11	0.5	66.00	22.00 to 387.00	420.0	97.17
2002	5	0.5	59.00	- to -	420.0	182.50
2006	3	41.0	66.00	- to -	99.0	48.33
2007	3	22.0	131.00	- to -	387.0	304.17

Figure 40. 100th Street *E. coli* Box Plot (2002-2007)

**E. coli* bacteria have been sampled since the 2006 monitoring season. Prior season sampling was for total fecal coliform

* 2003, 2004, and 2005 were not graphed due to inadequate samples

Newport

The 2007 season was the second year where water quality and flow were monitored at the stormwater site in Newport. The hydrograph for the Newport site shows flow from April 10-October 29, 2007 (Figure 41). Total discharge during this period was 3,085,937 cf or 70.8 acre-ft. The peak discharge of 14.66 cfs occurred on July 18, 2007. No precipitation data was collected at this site.

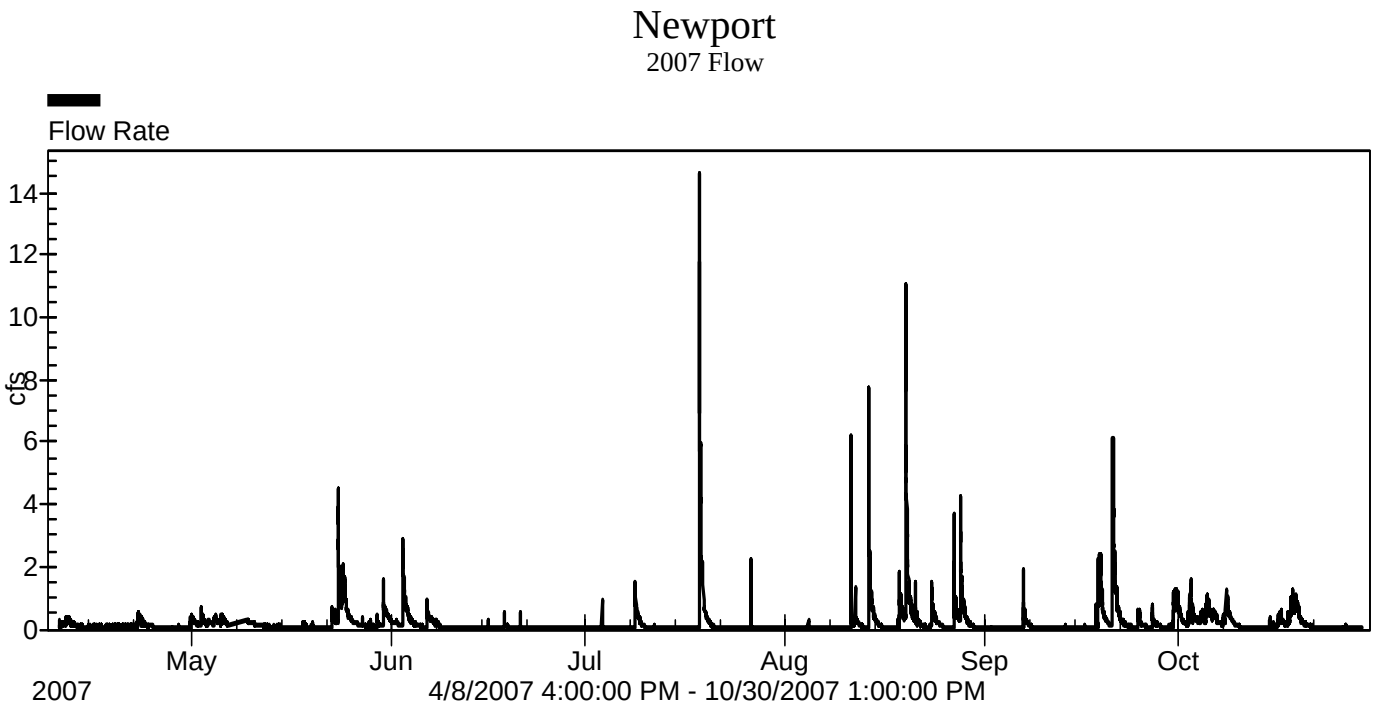


Figure 41. Newport 2007 Continuous Flow

Table 17. Newport Stormwater Total Phosphorus and Total Suspended Solids Loading Table

	Sample Collection Time				Loading Interval				
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval TSS (lb)	Interval TP (lb)
Base			*22*	*0.126*	*1/1/2007 0:00*	*3/12/2007 0:00*	*60,480*	*83.1*	*0.48*
Snowmelt Grab	3/13/07 10:37	3/13/07 10:37	11	0.104	3/12/2007 0:00	3/14/2007 0:00	8,640	5.9	0.06
Base			*22*	*0.126*	*3/14/2007 0:00*	*4/10/2007 13:00*	*23,796*	*32.7*	*0.19*
Base			*22*	*0.126*	*4/10/2007 13:00*	*4/10/2007 20:00*	*1,973*	*2.7*	*0.02*
Storm			*83*	*0.376*	*4/10/2007 20:00*	*4/13/2007 1:00*	*35,101*	*181.9*	*0.82*
Base Composite	4/19/07 10:50	4/24/07 11:57	22	0.126	4/13/2007 1:00	4/22/2007 14:00	50,977	70.0	0.40
Storm			*83*	*0.376*	*4/22/2007 14:00*	*4/24/2007 0:00*	*27,155*	*140.7*	*0.64*
Base			*22*	*0.126*	*4/24/2007 0:00*	*4/30/2007 20:00*	*41,621*	*57.2*	*0.33*
Storm			*83*	*0.376*	*4/30/2007 20:00*	*5/1/2007 14:00*	*18,014*	*93.3*	*0.42*
Base			*22*	*0.126*	*5/1/2007 14:00*	*5/2/2007 14:00*	*13,350*	*18.3*	*0.11*
Storm			*83*	*0.376*	*5/2/2007 14:00*	*5/3/2007 4:00*	*13,516*	*70.0*	*0.32*
Base			*22*	*0.126*	*5/3/2007 4:00*	*5/3/2007 10:00*	*3,671*	*5.0*	*0.03*
Storm			*83*	*0.376*	*5/3/2007 10:00*	*5/4/2007 4:00*	*14,861*	*77.0*	*0.35*
Base			*22*	*0.126*	*5/4/2007 4:00*	*5/4/2007 13:00*	*5,391*	*7.4*	*0.04*
Storm			*83*	*0.376*	*5/4/2007 13:00*	*5/5/2007 5:00*	*14,529*	*75.3*	*0.34*
Base			*22*	*0.126*	*5/5/2007 5:00*	*5/5/2007 14:00*	*5,681*	*7.8*	*0.04*
Storm			*83*	*0.376*	*5/5/2007 14:00*	*5/6/2007 9:00*	*20,889*	*108.2*	*0.49*
Base			*22*	*0.126*	*5/6/2007 9:00*	*5/6/2007 17:15*	*4,943*	*6.8*	*0.04*
No Data					**5/6/2007 17:15**	**5/9/2007 14:00**	**0**	**0.0**	**0.00**
Storm			*83*	*0.376*	*5/9/2007 14:00*	*5/10/2007 9:00*	*15,542*	*80.5*	*0.37*
Base			*22*	*0.126*	*5/10/2007 9:00*	*5/18/2007 8:00*	*45,369*	*62.3*	*0.36*
Storm			*83*	*0.376*	*5/18/2007 8:00*	*5/18/2007 16:00*	*3,167*	*16.4*	*0.07*
Base			*22*	*0.126*	*5/18/2007 16:00*	*5/22/2007 19:00*	*17,670*	*24.3*	*0.14*
Storm			*83*	*0.376*	*5/22/2007 19:00*	*5/23/2007 7:00*	*15,462*	*80.1*	*0.36*
Base			*22*	*0.126*	*5/23/2007 7:00*	*5/23/2007 15:00*	*7,882*	*10.8*	*0.06*
Storm Composite	5/23/07 15:55	5/24/07 19:56	76	0.236	5/23/2007 15:00	5/24/2007 23:00	170,751	810.1	2.52
Base			*22*	*0.126*	*5/24/2007 23:00*	*5/27/2007 11:00*	*77,096*	*105.9*	*0.61*
Storm			*83*	*0.376*	*5/27/2007 11:00*	*5/29/2007 22:00*	*4,671*	*24.2*	*0.11*
Base			*22*	*0.126*	*5/29/2007 22:00*	*5/30/2007 18:00*	*8,815*	*12.1*	*0.07*
Storm			*83*	*0.376*	*5/30/2007 18:00*	*5/31/2007 12:00*	*36,600*	*189.6*	*0.86*
Base			*22*	*0.126*	*5/31/2007 12:00*	*6/1/2007 15:00*	*24,293*	*33.4*	*0.19*
Storm			*83*	*0.376*	*6/1/2007 15:00*	*6/1/2007 17:00*	*1,367*	*7.1*	*0.03*
Base			*22*	*0.126*	*6/1/2007 17:00*	*6/2/2007 16:00*	*12,440*	*17.1*	*0.10*
Storm Composite	6/2/07 17:27	6/3/07 4:06	67	0.188	6/2/2007 16:00	6/3/2007 12:00	87,604	366.4	1.03
Base			*22*	*0.126*	*6/3/2007 12:00*	*6/6/2007 12:00*	*42,683*	*58.6*	*0.34*
Storm			*83*	*0.376*	*6/6/2007 12:00*	*6/7/2007 3:00*	*22,211*	*115.1*	*0.52*
Base			*22*	*0.126*	*6/7/2007 3:00*	*6/7/2007 20:00*	*14,489*	*19.9*	*0.11*
Storm			*83*	*0.376*	*6/7/2007 20:00*	*6/8/2007 8:00*	*7,275*	*37.7*	*0.17*
Base			*22*	*0.126*	*6/8/2007 8:00*	*6/15/2007 23:00*	*13,144*	*18.1*	*0.10*
Storm			*83*	*0.376*	*6/15/2007 23:00*	*6/16/2007 9:00*	*2,038*	*10.6*	*0.05*
Base			*22*	*0.126*	*6/16/2007 9:00*	*6/18/2007 12:00*	*5,037*	*6.9*	*0.04*
Storm			*83*	*0.376*	*6/18/2007 12:00*	*6/19/2007 1:00*	*5,303*	*27.5*	*0.12*
Base			*22*	*0.126*	*6/19/2007 1:00*	*6/20/2007 22:00*	*4,525*	*6.2*	*0.04*
Storm			*83*	*0.376*	*6/20/2007 22:00*	*6/21/2007 11:00*	*3,453*	*17.9*	*0.08*
Base			*22*	*0.126*	*6/21/2007 11:00*	*7/3/2007 14:00*	*5,740*	*7.9*	*0.05*
Storm			*83*	*0.376*	*7/3/2007 14:00*	*7/3/2007 16:00*	*927*	*4.8*	*0.02*
Base			*22*	*0.126*	*7/3/2007 16:00*	*7/8/2007 16:00*	*638*	*0.9*	*0.01*
Storm			*83*	*0.376*	*7/8/2007 16:00*	*7/10/2007 1:00*	*51,105*	*264.8*	*1.20*
Base			*22*	*0.126*	*7/10/2007 1:00*	*7/11/2007 17:00*	*5,410*	*7.4*	*0.04*
Storm			*83*	*0.376*	*7/11/2007 17:00*	*7/11/2007 20:00*	*246*	*1.3*	*0.01*
Base			*22*	*0.126*	*7/11/2007 20:00*	*7/16/2007 3:00*	*601*	*0.8*	*0.00*
Storm			*83*	*0.376*	*7/16/2007 3:00*	*7/16/2007 8:00*	*163*	*0.8*	*0.00*
Base			*22*	*0.126*	*7/16/2007 8:00*	*7/18/2007 15:00*	*372*	*0.5*	*0.00*
Storm Composite	7/18/07 15:49	7/18/07 15:54	2	1.100	7/18/2007 15:00	7/19/2007 4:15	242,571	30.3	16.66
No Data					**7/19/2007 4:15**	**7/19/2007 9:45**	**0**	**0.0**	**0.00**
Base			*22*	*0.126*	*7/19/2007 9:45*	*7/26/2007 15:00*	*46,257*	*63.5*	*0.36*
Storm			*83*	*0.376*	*7/26/2007 15:00*	*7/26/2007 18:00*	*2,691*	*13.9*	*0.06*
Base			*22*	*0.126*	*7/26/2007 18:00*	*8/11/2007 4:00*	*18,102*	*24.9*	*0.14*
Storm			*83*	*0.376*	*8/11/2007 4:00*	*8/11/2007 9:00*	*7,064*	*36.6*	*0.17*
Base			*22*	*0.126*	*8/11/2007 9:00*	*8/11/2007 20:00*	*6,357*	*8.7*	*0.05*
Storm			*83*	*0.376*	*8/11/2007 20:00*	*8/12/2007 0:00*	*6,341*	*32.9*	*0.15*
Base			*22*	*0.126*	*8/12/2007 0:00*	*8/13/2007 23:00*	*17,308*	*23.8*	*0.14*
Storm			*83*	*0.376*	*8/13/2007 23:00*	*8/14/2007 14:00*	*88,757*	*459.9*	*2.08*
Base			*22*	*0.126*	*8/14/2007 14:00*	*8/18/2007 9:00*	*33,962*	*46.6*	*0.27*
Storm			*83*	*0.376*	*8/18/2007 9:00*	*8/19/2007 5:00*	*30,751*	*159.3*	*0.72*
Base			*22*	*0.126*	*8/19/2007 5:00*	*8/19/2007 14:00*	*14,091*	*19.4*	*0.11*
Storm Composite	8/19/07 15:08	8/19/07 23:20	56	0.260	8/19/2007 14:00	8/20/2007 10:00	223,001	779.6	3.62
Base			*22*	*0.126*	*8/20/2007 10:00*	*8/21/2007 3:00*	*28,103*	*38.6*	*0.22*
Storm			*83*	*0.376*	*8/21/2007 3:00*	*8/21/2007 10:00*	*12,482*	*64.7*	*0.29*
Base			*22*	*0.126*	*8/21/2007 10:00*	*8/23/2007 13:00*	*23,285*	*32.0*	*0.18*
Storm			*83*	*0.376*	*8/23/2007 13:00*	*8/24/2007 13:00*	*46,399*	*240.4*	*1.09*
Base			*22*	*0.126*	*8/24/2007 13:00*	*8/27/2007 2:00*	*17,254*	*23.7*	*0.14*
Storm			*83*	*0.376*	*8/27/2007 2:00*	*8/27/2007 15:00*	*43,102*	*223.3*	*1.01*
Base			*22*	*0.126*	*8/27/2007 15:00*	*8/28/2007 3:00*	*16,924*	*23.2*	*0.13*
Storm Composite	8/28/07 3:22	8/28/07 8:56	264	0.572	8/28/2007 3:00	8/28/2007 20:00	81,131	1337.1	1.88
Base			*22*	*0.126*	*8/28/2007 20:00*	*9/6/2007 21:00*	*35,258*	*48.4*	*0.28*
Storm			*83*	*0.376*	*9/6/2007 21:00*	*9/7/2007 10:00*	*15,540*	*80.5*	*0.37*
Base			*22*	*0.126*	*9/7/2007 10:00*	*9/18/2007 4:00*	*18,722*	*25.7*	*0.15*
Storm Composite	9/18/07 12:18	9/18/07 20:50	69	0.276	9/18/2007 4:00	9/19/2007 11:00	101,866	438.8	1.76
Base			*22*	*0.126*	*9/19/2007 11:00*	*9/20/2007 18:00*	*22,382*	*30.7*	*0.18*
Storm Composite	9/20/07 18:52	9/21/07 1:49	47	0.202	9/20/2007 18:00	9/21/2007 13:00	155,954	457.6	1.97
Base			*22*	*0.126*	*9/21/2007 13:00*	*9/24/2007 18:00*	*45,606*	*62.6*	*0.36*
Storm			*83*	*0.376*	*9/24/2007 18:00*	*9/25/2007 2:00*	*9,224*	*47.8*	*0.22*
Base			*22*	*0.126*	*9/25/2007 2:00*	*9/26/2007 19:00*	*13,049*	*17.9*	*0.10*
Storm			*83*	*0.376*	*9/26/2007 19:00*	*9/27/2007 3:00*	*9,833*	*50.9*	*0.23*
Base			*22*	*0.126*	*9/27/2007 3:00*	*9/27/2007 17:00*	*8,286*	*11.4*	*0.07*
Storm			*83*	*0.376*	*9/27/2007 17:00*	*9/27/2007 19:00*	*1,035*	*5.4*	*0.02*
Base			*22*	*0.126*	*9/27/2007 19:00*	*9/29/2007 12:00*	*9,096*	*12.5*	*0.07*
Storm			*83*	*0.376*	*9/29/2007 12:00*	*9/29/2007 18:00*	*1,315*	*6.8*	*0.03*
Base			*22*	*0.126*	*9/29/2007 18:00*	*9/30/2007 2:00*	*880*	*1.2*	*0.01*
Storm			*83*	*0.376*	*9/30/2007 2:00*	*10/1/2007 7:00*	*77,477*	*401.4*	*1.82*
Base			*22*	*0.126*	*10/1/2007 7:00*	*10/2/2007 11:00*	*22,527*	*30.9*	*0.18*
Storm			*83*	*0.376*	*10/2/2007 11:00*	*10/3/2007 7:00*	*55,120*	*285.6*	*1.29*
Base			*22*	*0.126*	*10/3/2007 7:00*	*10/4/2007 11:00*	*29,960*	*41.1*	*0.24*
Storm			*83*	*0.376*	*10/4/2007 11:00*	*10/4/2007 19:00*	*9,150*	*47.4*	*0.21*
Base			*22*	*0.126*	*10/4/2007 19:00*	*10/5/2007 1:00*	*4,681*	*6.4*	*0.04*
Storm			*83*	*0.376*	*10/5/2007 1:00*	*10/6/2007 20:00*	*81,744*	*423.5*	*1.92*
Base			*22*	*0.126*	*10/6/2007 20:00*	*10/7/2007 22:00*	*18,364*	*25.2*	*0.14*
Storm			*83*	*0.376*	*10/7/2007 22:00*	*10/8/2007 20:00*	*44,447*	*230.3*	*1.04*
Base			*22*	*0.126*	*10/8/2007 20:00*	*10/14/2007 22:00*	*41,508*	*57.0*	*0.33*
Storm			*83*	*0.376*	*10/14/2007 22:00*	*10/15/2007 11:00*	*3,334*	*17.3*	*0.08*
Base			*22*	*0.126*	*10/15/2007 11:00*	*10/15/2007 18:00*	*968*	*1.3*	*0.01*
Storm			*83*	*0.376*	*10/15/2007 18:00*	*10/17/2007 7:00*	*24,369*	*126.3*	*0.57*
Base			*22*	*0.126*	*10/17/2007 7:00*	*10/17/2007 22:00*	*8,121*	*11.2*	*0.06*
Storm			*83*	*0.376*	*10/17/2007 22:00*	*10/20/2007 1:00*	*107,989*	*559.5*	*2.54*
Base			*22*	*0.126*	*10/20/2007 1:00*	*10/26/2007 17:00*	*29,597*	*40.6*	*0.23*
Storm			*83*	*0.376*	*10/26/2007 17:00*	*10/27/2007 2:00*	*1,237*	*6.4*	*0.03*
Base			*22*	*0.126*	*10/27/2007 2:00*	*10/29/2007 9:30*	*1,635*	*2.2*	*0.01*
Base			*22*	*0.126*	*10/29/2007 9:30*	*1/1/2008 0:00*	*54,954*	*75.5*	*0.43*
Storm Average			83	0.376					
Base Average			22	0.126					
Snowmelt Average			11	0.104					
All Average			68	0.318					
Total							**3,149,731**	10,861	61
SWWD Major Subwatershed Total Acres							NA		
Total TP/TSS(lb/ac/yr)								NA	NA
Total TP/TSS (kg/ha/yr)								NA	NA

*Italics indicate estimated concentrations based on average base and storm flow concentrations

** Interval flow values from 1/1/07 to 4/10/07 and 10/29/07 to 1/1/08 were estimated from base flow

Grab and flow weighted composite samples were taken at the Newport site to determine water quality. Samples were taken during storm runoff, as well as during base flow conditions. The TSS, TKN, TP, TDP, VSS, soluble COD, total COD, TOC, and *E. coli* concentrations from all collected samples are listed in Table 18. The highest TSS concentrations were collected in a storm composite on August 28, 2007. This storm also produced the highest concentrations of TP. High TKN concentrations were taken from the July 18, 2007 storm composite. Metals, chloride, hardness, and other Nitrogen species chemical results are listed in Table 19. Water quality standards were also included in Table 19, as set by the Minnesota Pollution Control Agency. One sample could not be analyzed due to a missing Hardness value. Copper and zinc had one sample that was above the Final Acute Standard, which is the most severe level. Lead had six samples that were above either the chronic level or the max standard.

Table 18. Newport 2007 Chemical Results

Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	*E. coli* (mpn/100 mL)	COD (mg/L)	TDP (mg/L)	TOC (mg/L)	Soluble COD (mg/L)
Snowmelt Grab	3/13/07 10:37	3/13/07 10:37	11	6	3.7	0.104		30	~0.023	9.5	24
Base Composite	4/19/07 10:50	4/24/07 11:57	22	9	1.8	0.126		40	~0.014	9.6	26
Storm Composite	5/23/07 15:55	5/24/07 19:56	76	36	2.4	0.236		44	<0.010	5.8	22
Storm Composite	6/2/07 17:27	6/3/07 4:06	67	16	1.8	0.188		36	~0.012	6	24
Storm Composite	7/18/07 15:49	7/18/07 15:54	~2		6.3	1.100		230	0.108	12.5	48
Storm Composite	8/19/07 15:08	8/19/07 23:20	56	39	3.3	0.260		83	<0.010	7.1	32
Storm Composite	8/28/07 3:22	8/28/07 8:56	264	81	3.5	0.372		89	<0.010	13.1	51
Storm Composite	9/18/07 12:18	9/18/07 20:50	69	33	3.1	0.276		138	<0.010	10.7	30
Storm Composite	9/20/07 18:52	9/21/07 1:49	47	20	2.6	0.202		46	<0.010	9.8	28
E. coli Grab	10/18/07 10:30	10/18/07 10:30					20				

Table 19. Newport 2007 Sample Metals, Chloride, Hardness, and Nitrogen Species Chemical Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start Date	End Date	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/13/07 10:37	3/13/07 10:37	0.0025	0.0028	0.0008	0.0086	0.00004	0.0010	262	<0.03	0.34	0.65	
Base Composite	4/19/07 10:50	4/24/07 11:57	0.0037	0.0029	0.0015	0.0130	0.00010	0.0015		<0.03	0.09	0.09	130
Storm Composite	5/23/07 15:55	5/24/07 19:56	0.0051	0.0029	0.0035	0.0330	0.00009	0.0014	75	<0.03	0.07	0.03	114
Storm Composite	6/2/07 17:27	6/3/07 4:06	0.0032	0.0027	0.0053	0.0175	0.00008	0.0020	59	<0.03	0.08	0.34	110
Storm Composite	7/18/07 15:49	7/18/07 15:54	0.0470	0.0139	0.0480	0.2370	0.00090	0.0170	2	0.05	0.92	0.05	40
Storm Composite	8/19/07 15:08	8/19/07 23:20	0.0032	0.0019	0.0023	0.0176	<0.0005	0.0014	17	<0.03	<0.05	~0.04	50
Storm Composite	8/28/07 3:22	8/28/07 8:56	0.0069	0.0029	0.0074	0.0400	<0.0005	0.0021	11	<0.03	<0.05	0.07	41
Storm Composite	9/18/07 12:18	9/18/07 20:50	0.0066	0.0027	0.0034	0.0210	<0.0005	0.0015	10	<0.03	<0.05	<0.02	56
Storm Composite	9/20/07 18:52	9/21/07 1:49	0.0036	0.0024	0.0033	0.0180	<0.0005	0.0015	8	<0.03	0.07	0.64	52
E. coli Grab	10/18/07 10:30	10/18/07 10:30											

No exceedence determinable
Exceeds Chronic Standard
Exceeds Maximum Standard
Exceeds Final Acute Standard

No statistical analysis was done for Newport. Analysis is preferably done after a data set has over three years of discrete samples.

Saint Paul Park

The 2007 season was the second year where water quality and flow were monitored at the stormwater site in Saint Paul Park. The hydrograph for the Saint Paul Park site shows flow from April 10-October 29, 2007 (Figure 42). Total discharge during this period was 932,881 cf or 21.4 acre-ft. Peak discharge was 12.57 cfs, which occurred on August 19, 2007. Precipitation was not collect at this site for 2007.

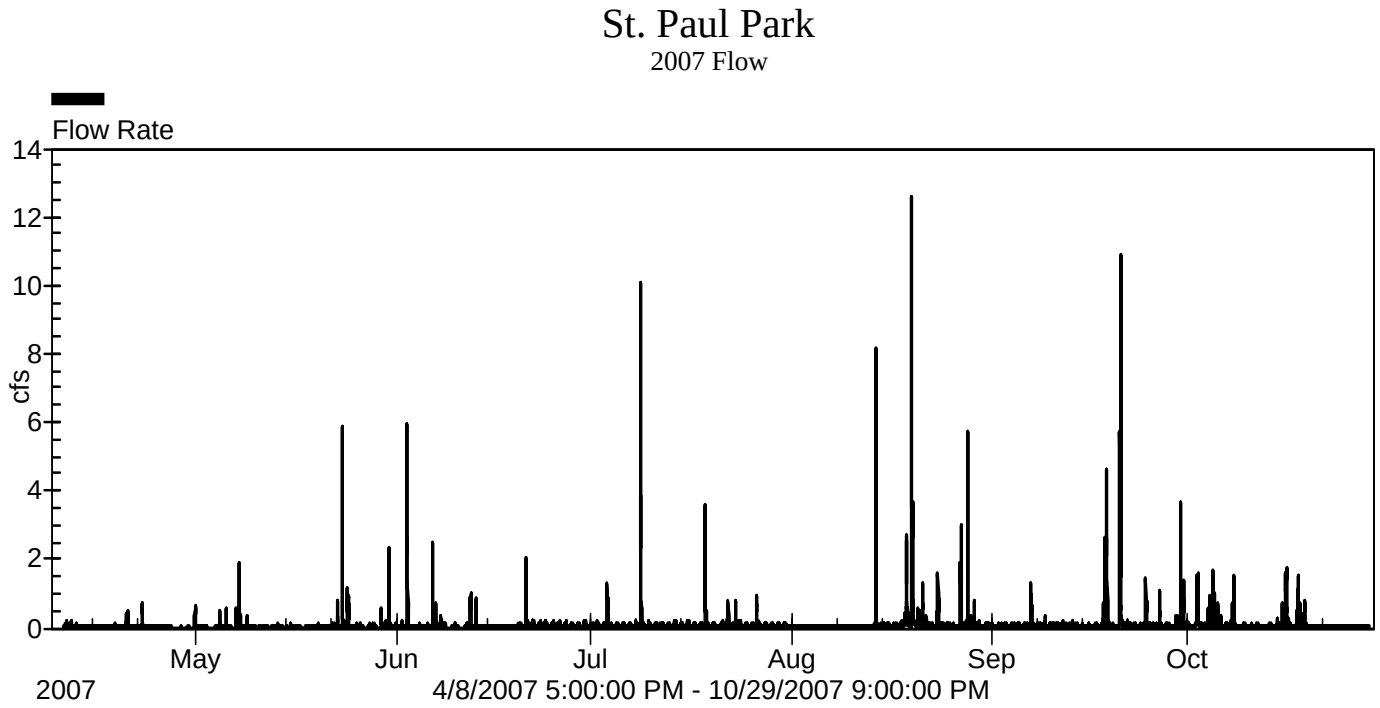


Figure 42. Saint Paul Park 2007 Continuous Flow

Table 20. St Paul Park Stormwater Total Phosphorus and Total Suspended Solids Loading Table

	Sample Collection Time				Loading Interval				
Sample Type	Start	End	TSS (mg/L)	TP (mg/L)	Start	End	Interval Volume (cf)	Interval TSS (lb)	Interval TP (lb)
Base			3	0.205	1/1/2007 0:00	3/12/2007 0:00	6,048	1.1	0.1
Snowmelt Grab	3/13/07 10:46	3/13/07 10:46	78	0.295	3/12/2007 0:00	3/14/2007 0:00	8,640	42.1	0.2
Base			3	0.205	3/14/2007 9:00	4/10/2007 15:30	7,166	1.3	0.1
Storm			147	0.230	4/10/2007 15:30	4/12/2007 1:30	7,375	67.6	0.1
Base			3	0.205	4/12/2007 1:30	4/12/2007 10:30	101	0.0	0.0
Storm			147	0.230	4/12/2007 10:30	4/12/2007 15:30	784	7.2	0.0
Base			3	0.205	4/12/2007 15:30	4/18/2007 12:30	264	0.0	0.0
Storm			147	0.230	4/18/2007 12:30	4/18/2007 16:30	289	2.7	0.0
Base			3	0.205	4/18/2007 16:30	4/20/2007 7:30	17	0.0	0.0
Storm			147	0.230	4/20/2007 7:30	4/20/2007 15:30	1,480	13.6	0.0
Base			3	0.205	4/20/2007 15:30	4/21/2007 18:30	106	0.0	0.0
Storm			147	0.230	4/21/2007 18:30	4/21/2007 22:30	131	1.2	0.0
Base			3	0.205	4/21/2007 22:30	4/22/2007 15:30	163	0.0	0.0
Storm			147	0.230	4/22/2007 15:30	4/23/2007 5:30	5,010	45.9	0.1
Base			3	0.205	4/23/2007 5:30	4/30/2007 19:30	695	0.1	0.0
Storm			147	0.230	4/30/2007 19:30	5/1/2007 4:30	6,183	56.7	0.1
Base			3	0.205	5/1/2007 4:30	5/4/2007 13:30	229	0.0	0.0
Storm			147	0.230	5/4/2007 13:30	5/4/2007 21:30	3,758	34.5	0.1
Base			3	0.205	5/4/2007 21:30	5/5/2007 14:30	80	0.0	0.0
Storm			147	0.230	5/5/2007 14:30	5/5/2007 20:30	2,640	22.4	0.1
Base			3	0.205	5/5/2007 20:30	5/7/2007 5:30	656	0.1	0.0
Storm			147	0.230	5/7/2007 5:30	5/7/2007 12:30	2,385	21.9	0.0
Base			3	0.205	5/7/2007 12:30	5/7/2007 18:30	425	0.1	0.0
Storm Composite**	5/7/07 18:57	5/7/07 18:59	147	0.533	5/7/2007 18:30	5/8/2007 1:30	5,892	54.0	0.2
Base			3	0.205	5/8/2007 1:30	5/8/2007 22:30	601	0.1	0.0
Storm			147	0.230	5/8/2007 22:30	5/9/2007 3:30	1,471	13.5	0.0
Base			3	0.205	5/9/2007 3:30	5/22/2007 19:30	7,265	1.4	0.1
Storm			147	0.230	5/22/2007 19:30	5/23/2007 0:30	4,541	41.6	0.1
Base			3	0.205	5/23/2007 0:30	5/23/2007 15:30	591	0.1	0.0
Storm Composite**	5/23/07 15:49	5/24/07 13:56	147	0.277	5/23/2007 15:30	5/23/2007 20:30	16,473	151.0	0.3
Base			3	0.205	5/23/2007 20:30	5/24/2007 6:30	2,041	0.4	0.0
Storm			147	0.230	5/24/2007 6:30	5/24/2007 18:30	20,330	186.4	0.3
Base			3	0.205	5/24/2007 18:30	5/29/2007 15:30	4,054	0.8	0.1
Storm			147	0.230	5/29/2007 15:30	5/29/2007 21:30	2,359	21.6	0.0
Base			3	0.205	5/29/2007 21:30	5/30/2007 17:30	2,101	0.4	0.0
Storm			147	0.230	5/30/2007 17:30	5/30/2007 23:30	9,083	83.3	0.1
Base			3	0.205	5/30/2007 23:30	6/2/2007 15:30	4,327	0.8	0.1
Storm Composite**	6/2/07 16:04	6/2/07 18:24	147	0.257	6/2/2007 15:30	6/2/2007 23:30	23,188	212.6	0.4
Base			3	0.205	6/2/2007 23:30	6/6/2007 11:30	2,725	0.5	0.0
Storm			147	0.230	6/6/2007 11:30	6/6/2007 16:30	7,577	69.5	0.1
Base			3	0.205	6/6/2007 16:30	6/7/2007 2:30	654	0.1	0.0
Storm			147	0.230	6/7/2007 2:30	6/7/2007 8:30	3,861	35.4	0.1
Base			3	0.205	6/7/2007 8:30	6/7/2007 20:30	471	0.1	0.0
Storm			147	0.230	6/7/2007 20:30	6/8/2007 0:30	1,598	14.6	0.0
Base			3	0.205	6/8/2007 0:30	6/20/2007 21:30	41,933	7.9	0.5
Storm			147	0.230	6/20/2007 21:30	6/21/2007 1:30	7,024	64.4	0.1
Base			3	0.205	6/21/2007 1:30	7/3/2007 13:30	26,202	4.9	0.3
Storm			147	0.230	7/3/2007 13:30	7/3/2007 18:30	4,813	44.1	0.1
Base			3	0.205	7/3/2007 18:30	7/8/2007 15:30	9,492	1.8	0.1
Storm Composite	7/8/07 16:09	7/8/07 17:38	168	0.183	7/8/2007 15:30	7/8/2007 22:30	30,223	317.0	0.3
Base			3	0.205	7/8/2007 22:30	7/18/2007 15:30	25,429	4.8	0.3
Storm Composite	7/18/07 16:28	7/18/07 17:48	132	0.156	7/18/2007 15:30	7/18/2007 22:30	22,341	184.1	0.2
Base			3	0.205	7/18/2007 22:30	7/26/2007 15:30	21,672	4.1	0.3
Storm			147	0.230	7/26/2007 15:30	7/26/2007 20:30	3,962	36.3	0.1
Base			3	0.205	7/26/2007 20:30	7/31/2007 9:15	10,218	1.9	0.1
	No Data				**7/31/2007 9:15**	**8/13/2007 12:30**	**0**	**0.0**	**0.0**
Base			3	0.205	8/13/2007 12:30	8/13/2007 22:30	980	0.2	0.0
Storm			147	0.230	8/13/2007 23:30	8/14/2007 3:30	26,278	240.9	0.4
Base			3	0.205	8/14/2007 3:30	8/18/2007 13:30	9,639	1.8	0.1
Storm			147	0.230	8/18/2007 13:30	8/18/2007 23:30	23,513	215.6	0.3
Base			3	0.205	8/18/2007 23:30	8/19/2007 8:30	3,124	0.6	0.0
Storm			147	0.230	8/19/2007 8:30	8/19/2007 12:30	4,230	38.8	0.1
Base			3	0.205	8/19/2007 12:30	8/19/2007 13:30	511	0.1	0.0
Storm Composite	8/19/07 14:50	8/19/07 17:02	48	0.132	8/19/2007 13:30	8/19/2007 20:30	42,708	128.0	0.4
Base			3	0.205	8/19/2007 20:30	8/20/2007 12:30	6,266	1.2	0.1
Storm			147	0.230	8/20/2007 12:30	8/20/2007 15:30	2,783	25.5	0.0
Base			3	0.205	8/20/2007 15:30	8/21/2007 2:30	2,693	0.5	0.0
Storm			147	0.230	8/21/2007 2:30	8/21/2007 6:30	5,202	47.7	0.1
Base			3	0.205	8/21/2007 6:30	8/21/2007 18:30	3,203	0.6	0.0
Storm			147	0.230	8/21/2007 18:30	8/21/2007 22:30	1,902	17.4	0.0
Base			3	0.205	8/21/2007 22:30	8/23/2007 11:30	4,529	0.8	0.1
Storm			147	0.230	8/23/2007 11:30	8/23/2007 18:30	12,135	111.2	0.2
Base			3	0.205	8/23/2007 18:30	8/27/2007 1:30	7,954	1.5	0.1
Storm Composite**	8/27/07 2:27	8/27/07 4:21	147	0.291	8/27/2007 1:30	8/27/2007 7:30	15,774	144.6	0.3
Base			3	0.205	8/27/2007 7:30	8/28/2007 2:30	3,718	0.7	0.0
Storm Composite	8/28/07 3:40	8/28/07 4:05	180	0.201	8/28/2007 2:30	8/28/2007 6:30	18,133	203.7	0.2
Base			3	0.205	8/28/2007 6:30	8/28/2007 16:30	2,268	0.6	0.0
Storm			147	0.230	8/28/2007 16:30	8/28/2007 19:30	1,803	16.5	0.0
Base			3	0.205	8/28/2007 19:30	9/6/2007 21:30	24,357	4.6	0.3
Storm Composite**	9/7/07 0:17	9/7/07 0:52	147	0.106	9/6/2007 21:30	9/7/2007 4:30	11,348	108.6	0.1
Base			3	0.205	9/7/2007 4:30	9/9/2007 1:30	7,989	1.5	0.1
Storm			147	0.230	9/9/2007 1:30	9/9/2007 5:30	1,950	17.9	0.0
Base Grab	9/12/07 10:44	9/12/07 10:44	3	0.205	9/9/2007 5:30	9/18/2007 4:30	17,062	3.2	0.2
Storm Composite	9/18/07 7:20	9/18/07 18:53	229	0.174	9/18/2007 4:30	9/18/2007 21:30	32,747	468.1	0.4
Base			3	0.205	9/18/2007 21:30	9/20/2007 17:30	5,512	1.0	0.1
Storm Composite	9/20/07 18:30	9/20/07 22:38	54	0.203	9/20/2007 17:30	9/20/2007 23:30	38,384	129.4	0.3
Base			3	0.205	9/20/2007 23:30	9/24/2007 17:30	13,875	2.6	0.2
Storm			147	0.230	9/24/2007 17:30	9/24/2007 20:30	4,454	40.8	0.1
Base			3	0.205	9/24/2007 20:30	9/26/2007 19:30	5,391	1.0	0.1
Storm			147	0.230	9/26/2007 19:30	9/27/2007 0:30	5,266	48.3	0.1
Base			3	0.205	9/27/2007 0:30	9/29/2007 7:30	3,849	0.7	0.0
Storm			147	0.230	9/29/2007 7:30	9/29/2007 15:30	3,476	31.9	0.0
Base			3	0.205	9/29/2007 15:30	9/30/2007 1:30	876	0.2	0.0
Storm Composite	9/30/07 4:41	9/30/07 13:08	217	0.246	9/30/2007 1:30	9/30/2007 8:30	10,623	143.9	0.2
Base			3	0.205	9/30/2007 8:30	9/30/2007 11:30	511	0.1	0.0
Storm			147	0.230	9/30/2007 11:30	9/30/2007 17:30	12,762	117.0	0.2
Base			3	0.205	9/30/2007 17:30	10/2/2007 10:30	5,031	0.9	0.1
Storm			147	0.230	10/2/2007 10:30	10/2/2007 23:30	18,495	169.6	0.3
Base			3	0.205	10/2/2007 23:30	10/5/2007 0:30	10,932	2.0	0.1
Storm			147	0.230	10/5/2007 0:30	10/5/2007 13:30	11,795	108.1	0.2
Base			3	0.205	10/5/2007 13:30	10/5/2007 20:30	734	0.1	0.0
Storm			147	0.230	10/5/2007 20:30	10/6/2007 0:30	3,132	28.7	0.0
Base			3	0.205	10/6/2007 0:30	10/6/2007 5:30	1,020	0.2	0.0
Storm			147	0.230	10/6/2007 5:30	10/6/2007 9:30	1,902	17.4	0.0
Base			3	0.205	10/6/2007 9:30	10/7/2007 22:30	3,811	0.7	0.0
Storm			147	0.230	10/7/2007 22:30	10/8/2007 11:30	13,367	122.5	0.2
Base			3	0.205	10/8/2007 11:30	10/14/2007 22:30	9,337	1.7	0.1
Storm			147	0.230	10/14/2007 22:30	10/15/2007 9:30	2,723	25.0	0.0
Base			3	0.205	10/15/2007 9:30	10/15/2007 17:30	266	0.0	0.0
Storm			147	0.230	10/15/2007 17:30	10/16/2007 22:30	18,890	173.2	0.3
Base			3	0.205	10/16/2007 23:30	10/17/2007 21:30	1,669	0.3	0.0
Storm			147	0.230	10/17/2007 21:30	10/19/2007 10:30	32,889	301.5	0.5
Base			3	0.205	10/19/2007 10:30	10/29/2007 9:00	3,321	0.6	0.0
Base			3	0.205	10/29/2007 9:00	1/1/2008 0:00	10,994	2.1	0.1
Storm Average			147	0.230					
Base Average			3	0.205					
Snowmelt Average			78	0.295					
All Average			132	0.233					
Total							**931,607**	5,163	12
SWWD Major Subwatershed Total Acres							NA		
Total TP/TSS(lb/ac/yr)								NA	NA
Total TP/TSS (kg/ha/yr)								NA	NA

*Italics indicate estimated concentrations based on average base and storm flow concentrations

**TSS concentrations for these storms were based upon storm average

*** Interval flow values from 1/1/07 to 4/10/07 and 10/29/07 to 1/1/08 were estimated from base flow

Grab samples and flow weighted composite samples were taken at the Saint Paul Park site to determine water quality. The TSS, TKN, TP, VSS, total COD, soluble COD, TOC, TDP, and *E. coli* results from all collected samples are listed in Table 21. The highest concentrations for TSS were from the September 18, 2007 storm composite sample. High TP concentrations were from the May 7, 2007 storm composite sample, and high TKN concentrations were collected from the March 13, 2007 snowmelt grab. Metals, chloride, hardness, and other Nitrogen species chemical results are listed in Table 22. Water quality standard exceedences were also included in Table 22. Multiple samples were above chronic, max, and final acute standards for various heavy metals.

Table 21. Saint Paul Park 2007 Sample Chemistry Results

Sample Type	Start Date	End Date	TSS (mg/L)	VSS (mg/L)	TKN (mg/L)	TP (mg/L)	*E. coli* (mpn/100 mL)	COD (mg/L)	TDP (mg/L)	TOC (mg/L)	Soluble COD (mg/L)
Snowmelt Grab	3/13/07 10:46	3/13/07 10:46	78	20	3.8	0.295		90	0.081	23.0	72
Storm Composite	5/7/07 18:57	5/7/07 18:59			3.2	0.533					
Storm Composite	5/23/07 15:49	5/24/07 13:56			1.6	0.277		58	~0.024	3.8	16
Storm Composite	6/2/07 16:04	6/2/07 18:24			2.7	0.257		68	~0.023	5.4	18
Storm Composite	7/8/07 16:09	7/8/07 17:38	168	~26	1.3	0.183		43	0.082	5.2	70
Storm Composite	7/18/07 16:28	7/18/07 17:48	132	23	2.6	0.156		38	~0.013	9.7	46
Storm Composite	8/18/07 18:26	8/18/07 21:05			0.5	0.109		26	~0.011	5.0	18
Storm Composite	8/19/07 14:50	8/19/07 17:02	48	15	0.6	0.132		36	0.061	2.5	~10
Storm Composite	8/27/07 2:27	8/27/07 4:21			1.7	0.291		35	~0.042	7.3	17
Storm Composite	8/28/07 3:40	8/28/07 4:05	180	38	0.9	0.201		38	0.076	6.8	26
Storm Composite	9/7/07 0:17	9/7/07 0:52			0.5	0.106		32			
Base Grab	9/12/07 10:44	9/12/07 10:44	3	~2	1.0	0.205		18	0.066	8.4	15
Storm Composite	9/18/07 7:20	9/18/07 18:53	229	54	1.2	0.174		40	~0.040	3.5	~11
Storm Composite	9/20/07 18:50	9/20/07 22:38	54	13	0.7	0.205		18	0.066	6.0	15
Storm Composite	9/30/07 4:41	9/30/07 13:08	217	61	1.2	0.246		51	~0.041	5.7	29
E. coli Grab	10/18/07 10:50	10/18/07 10:50					441				

Table 22. Saint Paul Park 2007 Sample Metals, Chloride, Hardness, and Nitrogen Species Chemical Results including Exceeded MPCA 7050 Water Quality Standards

Sample Type	Start Date	End Date	Copper (mg/L)	Nickel (mg/L)	Lead (mg/L)	Zinc (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Chloride (mg/L)	Nitrite N (mg/L)	Nitrate N (mg/L)	Ammonia Nitrogen (mg/L)	Hardness (mg/L)
Snowmelt Grab	3/13/07 10:46	3/13/07 10:46	0.0103	0.0049	0.0078	0.0270	0.00090	0.0044	11	0.08	0.39	0.85	113
Storm Composite	5/7/07 18:57	5/7/07 18:59								0.04	0.48	0.91	
Storm Composite	5/23/07 15:49	5/24/07 13:56	0.0169	0.0064	0.0196	0.0770	0.00200	0.0066	3	0.03	0.30	0.38	24
Storm Composite	6/2/07 16:04	6/2/07 18:24	0.0185	0.0071	0.0172	0.0760	0.00010	0.0073	3	<0.03	0.26	0.24	28
Storm Composite	7/8/07 16:09	7/8/07 17:38	0.0090	0.0025	0.0065	0.0300	<0.00004	0.0034	4	<0.03	0.36	0.37	20
Storm Composite	7/18/07 16:28	7/18/07 17:48	0.0080	0.0025	0.0072	0.0450	<0.00004	0.0039	5	0.04	1.33	0.50	30
Storm Composite	8/18/07 18:26	8/18/07 21:05	0.0053	0.0020	0.0037	0.0300	<0.00050	0.0017	3	<0.03	0.57	0.06	22
Storm Composite	8/19/07 14:50	8/19/07 17:02	0.0042	0.0018	0.0047	0.0220	<0.00050	0.0029	2	<0.03	0.18	~0.06	22
Storm Composite	8/27/07 2:27	8/27/07 7:21	0.0114	0.0040	0.0117	0.0510	<0.00050	0.0036	2	0.04	0.41	0.39	23
Storm Composite	8/28/07 3:40	8/28/07 4:05	0.0064	0.0024	0.0084	0.0300	0.00090	0.0022	2	<0.03	<0.05	0.30	20
Storm Composite	9/7/07 0:17	9/7/07 0:52	0.0064	0.0021	0.0023	0.0169	<0.00050	0.0012	5	<0.03	0.66	~0.03	38
Base Grab	9/12/07 10:44	9/12/07 10:44	0.0056	0.0023	0.0058	0.0240	<0.00050	0.0040	2	<0.03	1.27	0.21	28
Storm Composite	9/18/07 7:20	9/18/07 18:53	0.0096	0.0037	0.0100	0.0420	<0.00050	0.0043	3	<0.03	0.31	0.08	32
Storm Composite	9/20/07 18:50	9/20/07 22:38	0.0056	0.0023	0.0058	0.0240	<0.00050	0.0040	2	0.22	0.74	0.21	28
Storm Composite	9/30/07 4:41	9/30/07 13:08	0.0095	0.0035	0.0107	0.0480	<0.00050	0.0030	3	0.08	0.50	~0.03	28
E. coli Grab	10/18/07 10:50	10/18/07 10:50											

No exceedence determinable
Exceeds Chronic Standard
Exceeds Maximum Standard
Exceeds Final Acute Standard

Flow-only Sites: Fox Run, Tamarack Road, 80th Street, 90th Street, Bailey Lake (at Lift Station), West Draw 1 and West Draw 2

Fox Run

The Fox Run stormwater site recorded stage, velocity, and flow between March 26-October 19, 2007 (Figure 43). The total discharge for this period was 508,224 cf or 11.7 acre-ft. The highest recorded flow was 1.27 cfs on March 31, 2007. There was no precipitation gage at this site and no chemistry data was collected at this site.

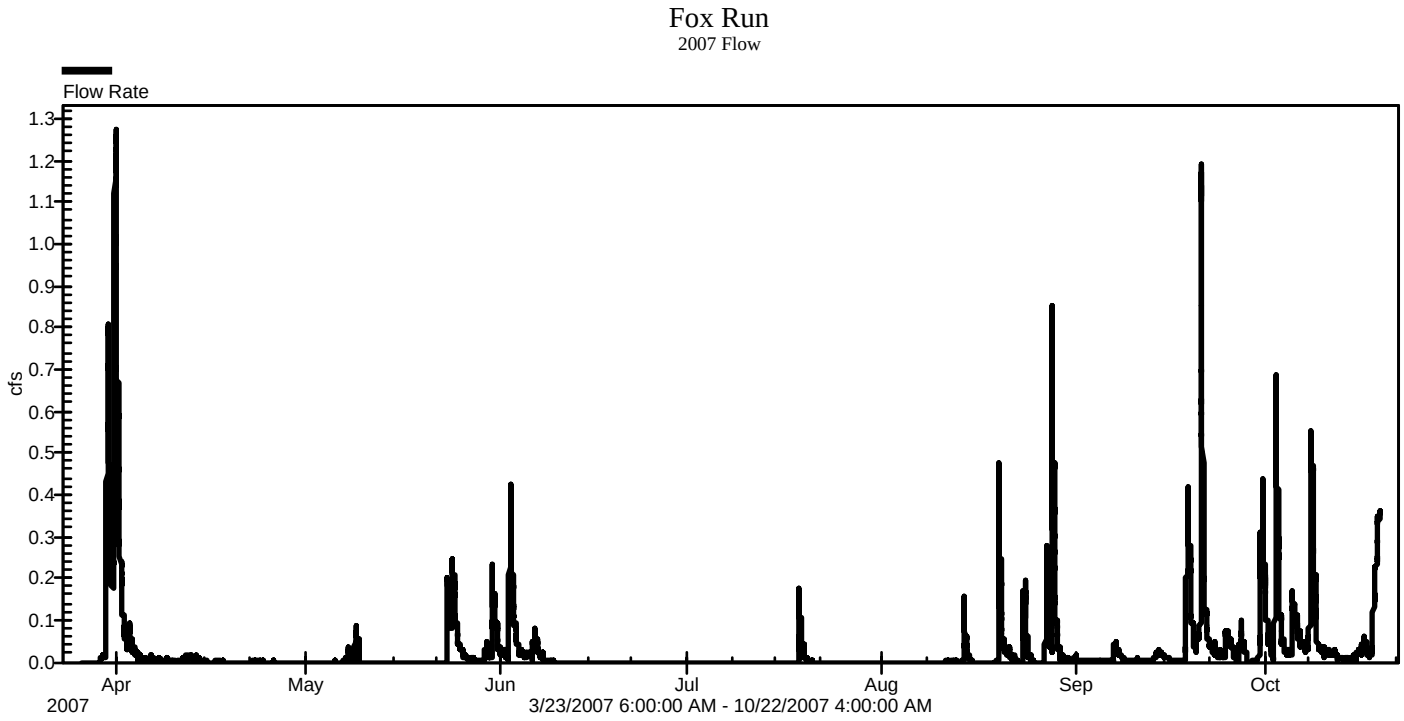


Figure 43. Fox Run 2007 Continuous Flow

Tamarack Road

The Tamarack Road stormwater site recorded stage, velocity, and flow between March 26-July 3, 2007 (Figure 44). Equipment was pulled on July 3, 2007 due to road construction in the area and potential damage to the equipment. The total discharge for this period was 565,632 cf or 12.98 acre-ft. The highest discharge at this site was 19.13 cfs on June 18, 2007. There was no precipitation gage at this site and no chemistry data was collected at this site.

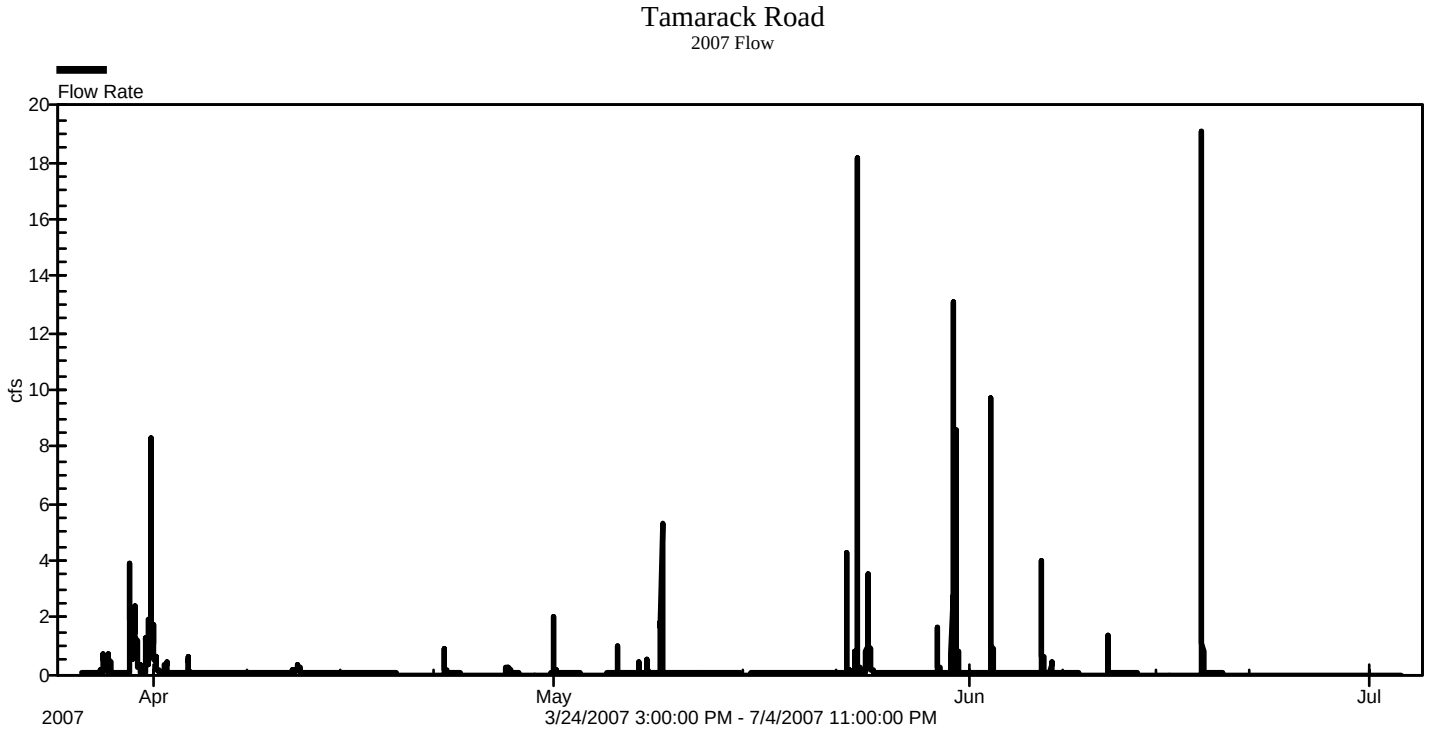


Figure 44. Tamarack Road 2007 Continuous Flow

80th Street

The 80th Street stormwater site recorded stage and flow between April 20-October 30, 2007 (Figure 45). The total discharge for this period was 6,555,994 cf or 151 acre-ft. The high flow at this site—13.83 cfs was on July 19, 2007. There was no precipitation gage at this site and no chemistry data was collected at this site. Staff field visits reported discharges laden with sediment from upstream construction.

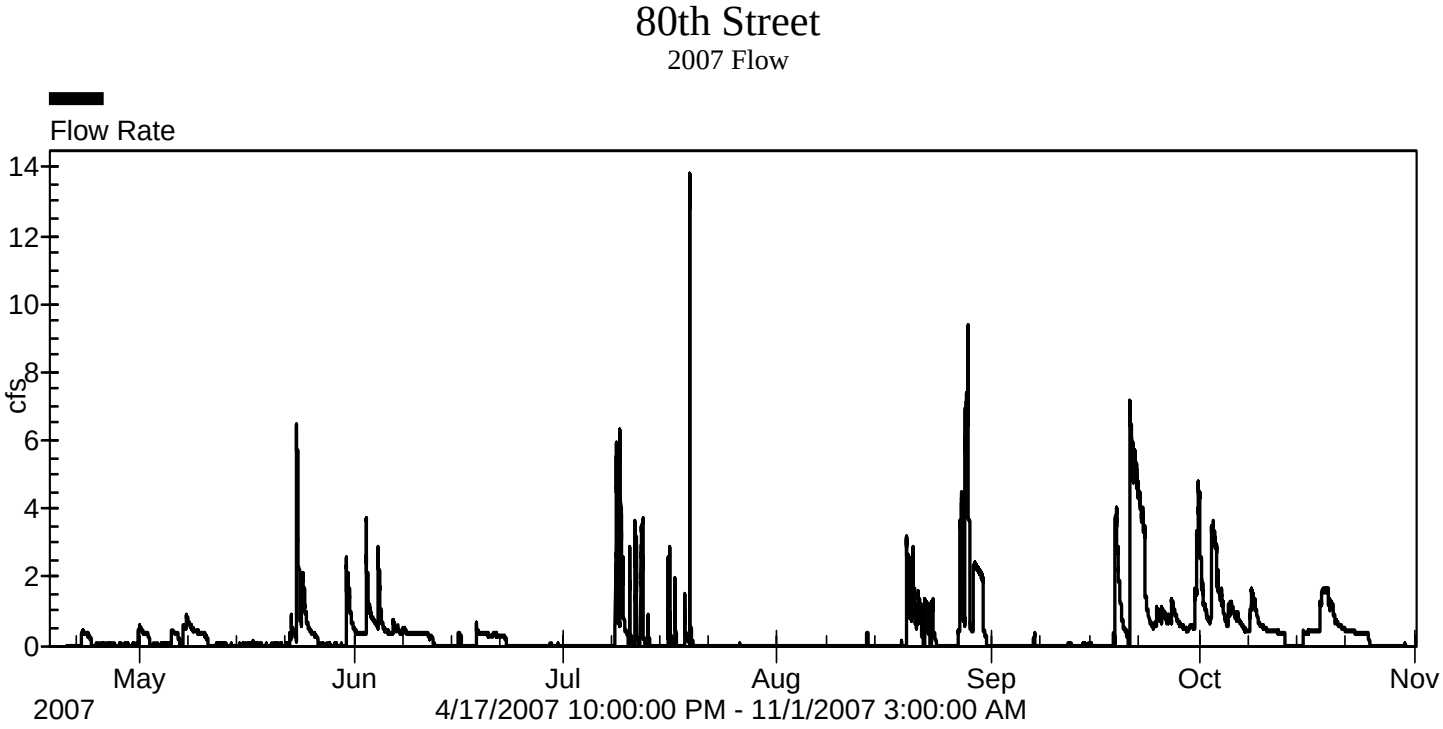


Figure 45. 80th Street 2007 Continuous Flow

90th Street

The 90th Street stormwater site recorded stage and flow between April 18-October 29, 2007 (Figure 46). The total discharge for this period was 4,055,403 cf or 93 acre-ft. The highest discharge at this site was 9.19 cfs on September 20, 2007. There was no precipitation gage at this site. No chemistry data was collected at this site.

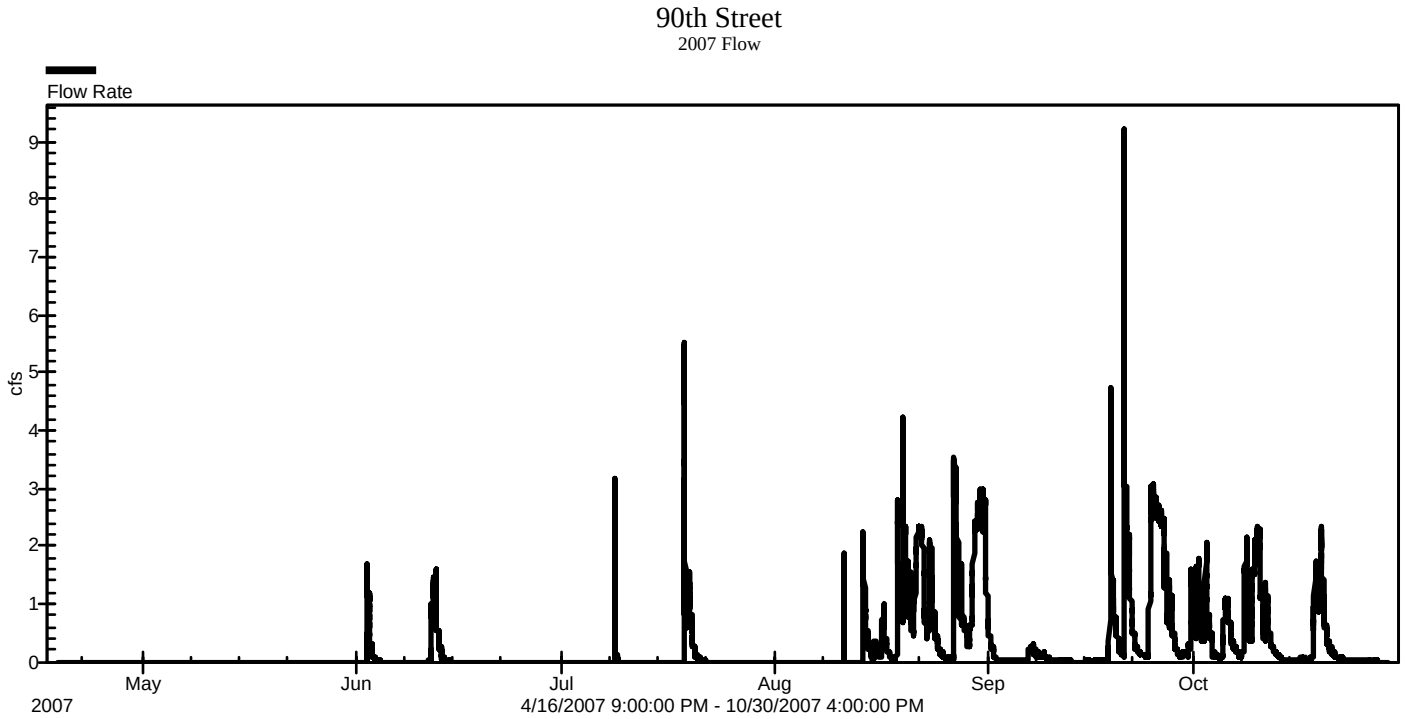


Figure 46. 90th Street 2007 Continuous Flow

Bailey Lift Station

Precipitation measurements were recorded every hour between April 20-October 30, 2007 at this site (Figure 47). Elevation measurements were recorded from October 11-October 30, 2007 due to equipment malfunction. The site did not have water until late in the monitoring season, thusly the equipment malfunction was not identified earlier. The highest recorded Elevation—868.26 ft., was recorded on October 21, 2007. The average stage during the monitoring season was 868.00 ft. The highest recorded daily rainfall —1.46 inches, was recorded July 19, 2007.

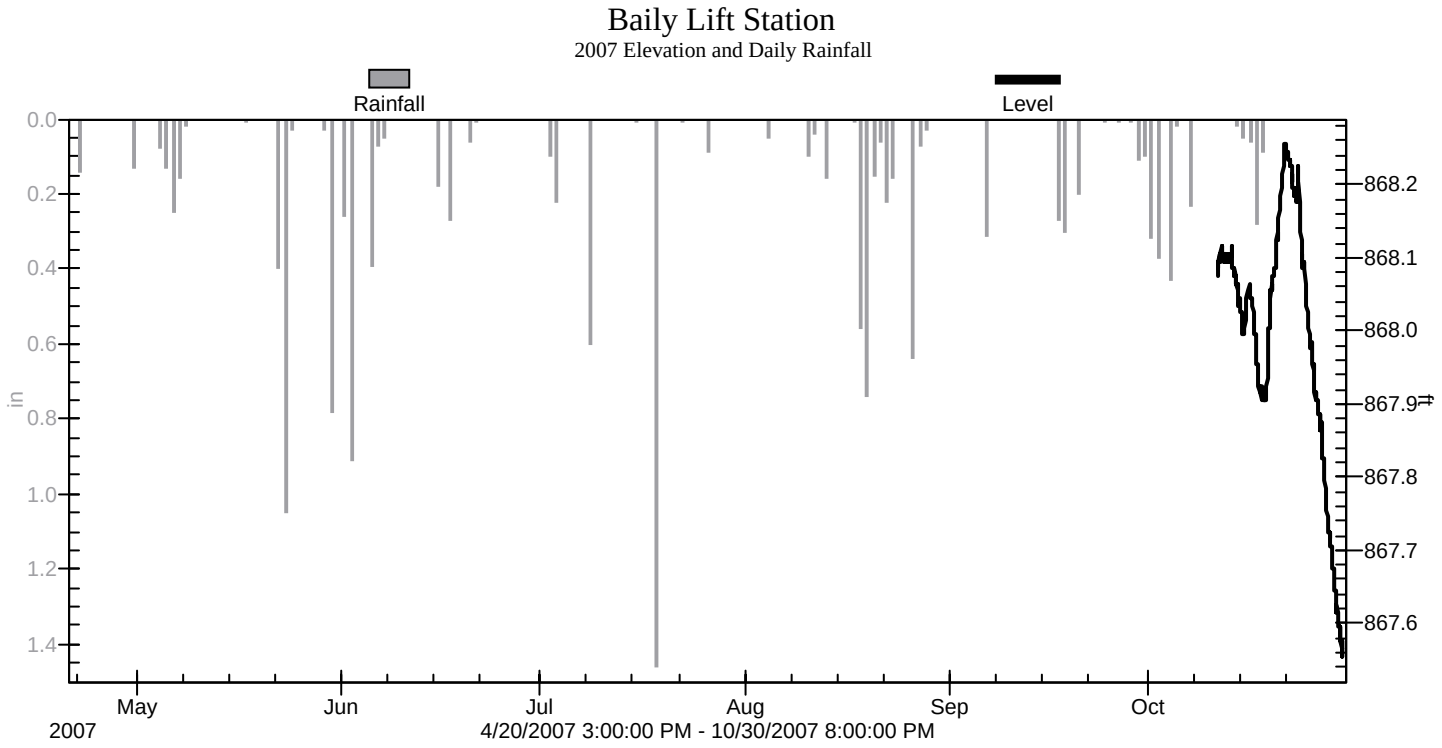


Figure 47. Bailey Lift Station 2007 Elevation and Daily Precipitation

West Draw 1

This was the first year of recording flow at this particular site. West Draw 1 site recorded flow between April 12-October 21, 2007 (Figure 48). The total discharge for this period was 1,569,989 cf or 36 acre-ft. The highest discharge at this site was 2.56 cfs on August 19, 2007. Data were collected at a connected pond to measure bounce associated with storm events to further model calibration (Figure 49). Elevation of this pond has an assumed datum of 100 ft. There was no precipitation gage at this site. No chemistry data was collected at this site.

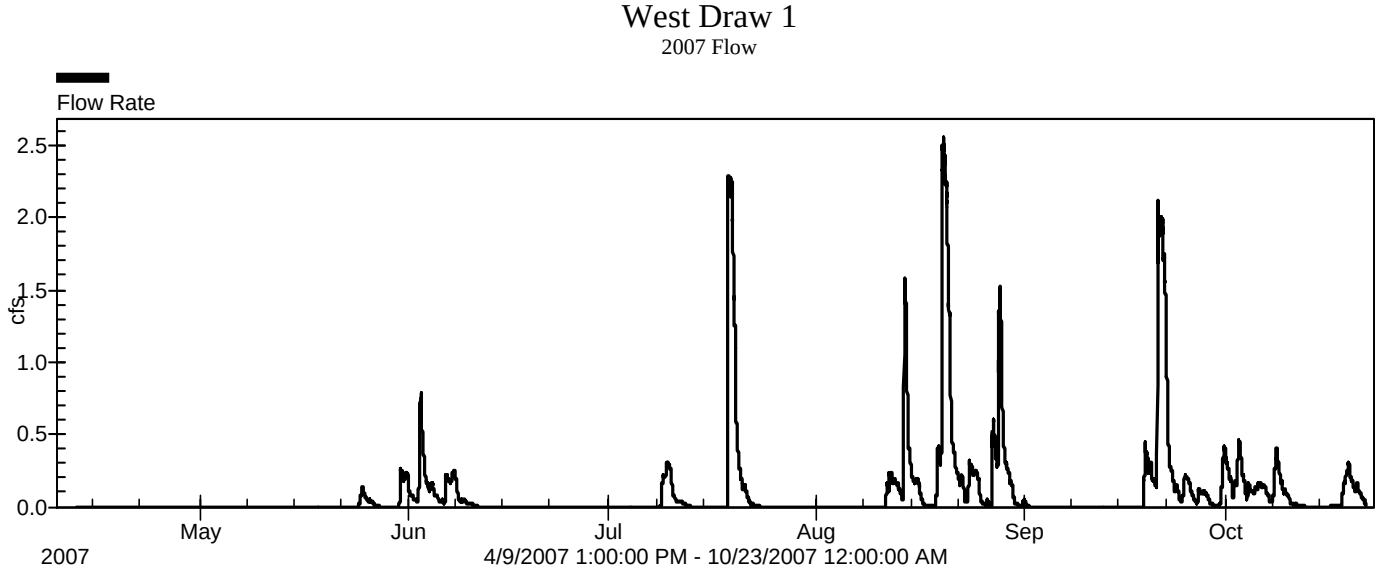


Figure 48. West Draw 1 2007 Continuous Flow

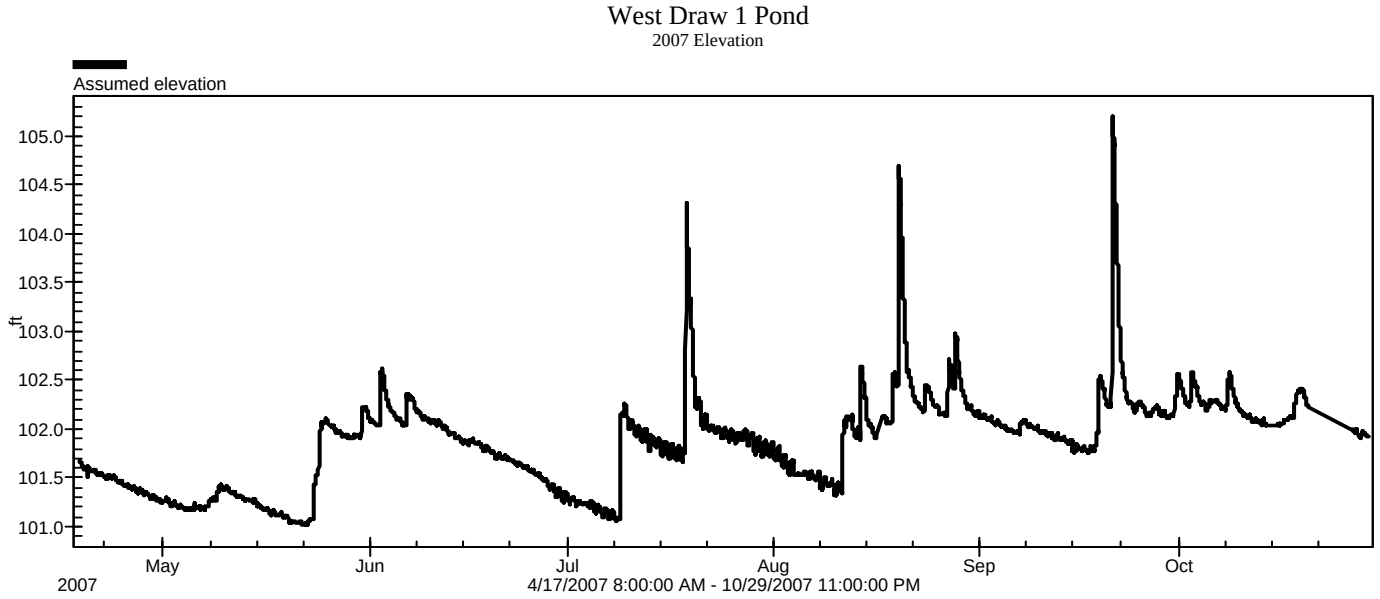


Figure 49. West Draw 1 2007 Elevation

West Draw 2

This was the first year of recording flow at this site. West Draw 1 site recorded flow between May 10-October 29, 2007 (Figure 50). The total discharge for this period was 149,836 cf or 3.44 acre-ft. The highest discharge at this site was 1.74 cfs on September 20, 2007. Data were collected at a connected pond to measure bounce associated with storm events to further model calibration (Figure 51). Elevation of this pond has an assumed datum of 100 ft. There was no precipitation gage at this site. No chemistry data was collected at this site.

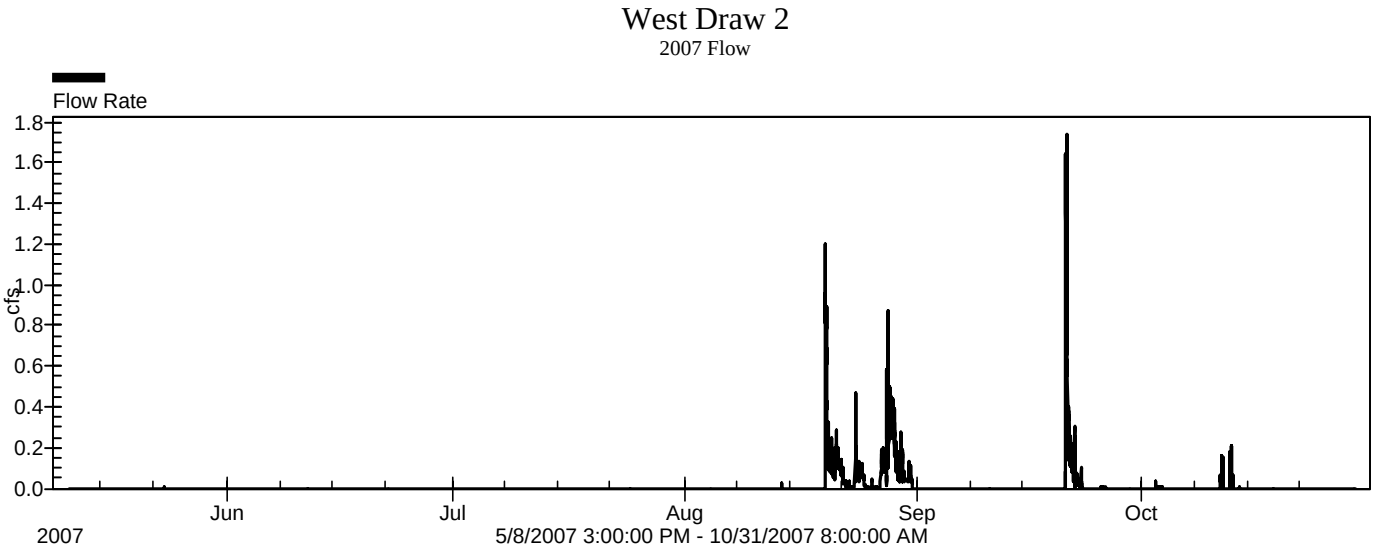


Figure 50. West Draw 2 2007 Continuous Flow

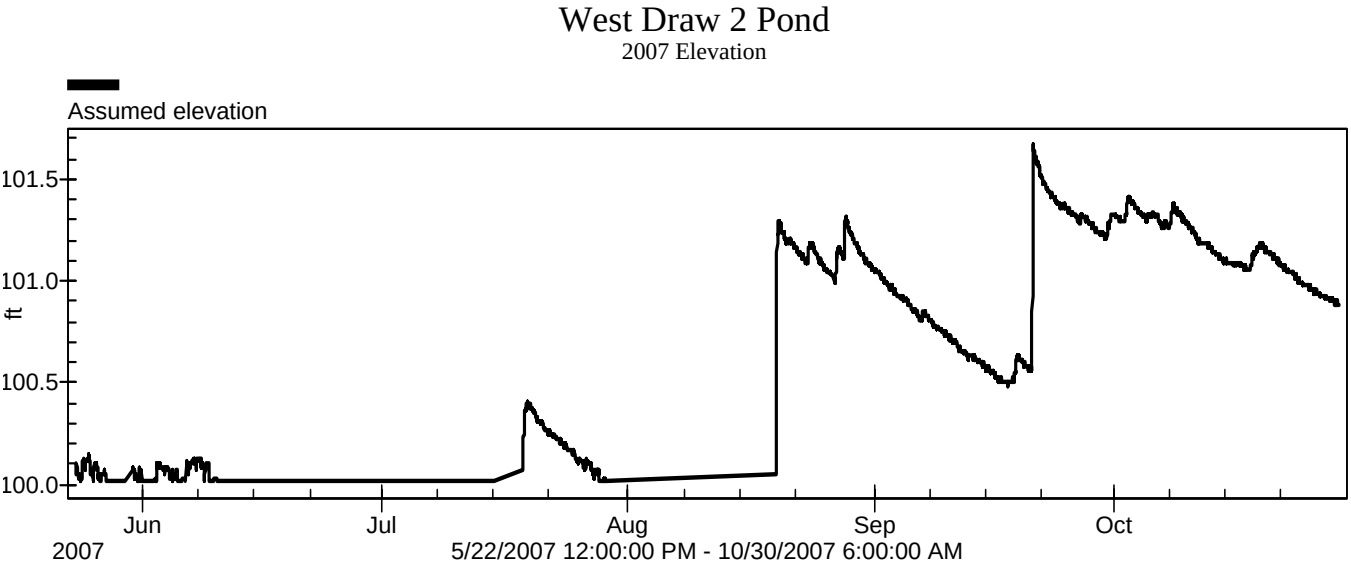
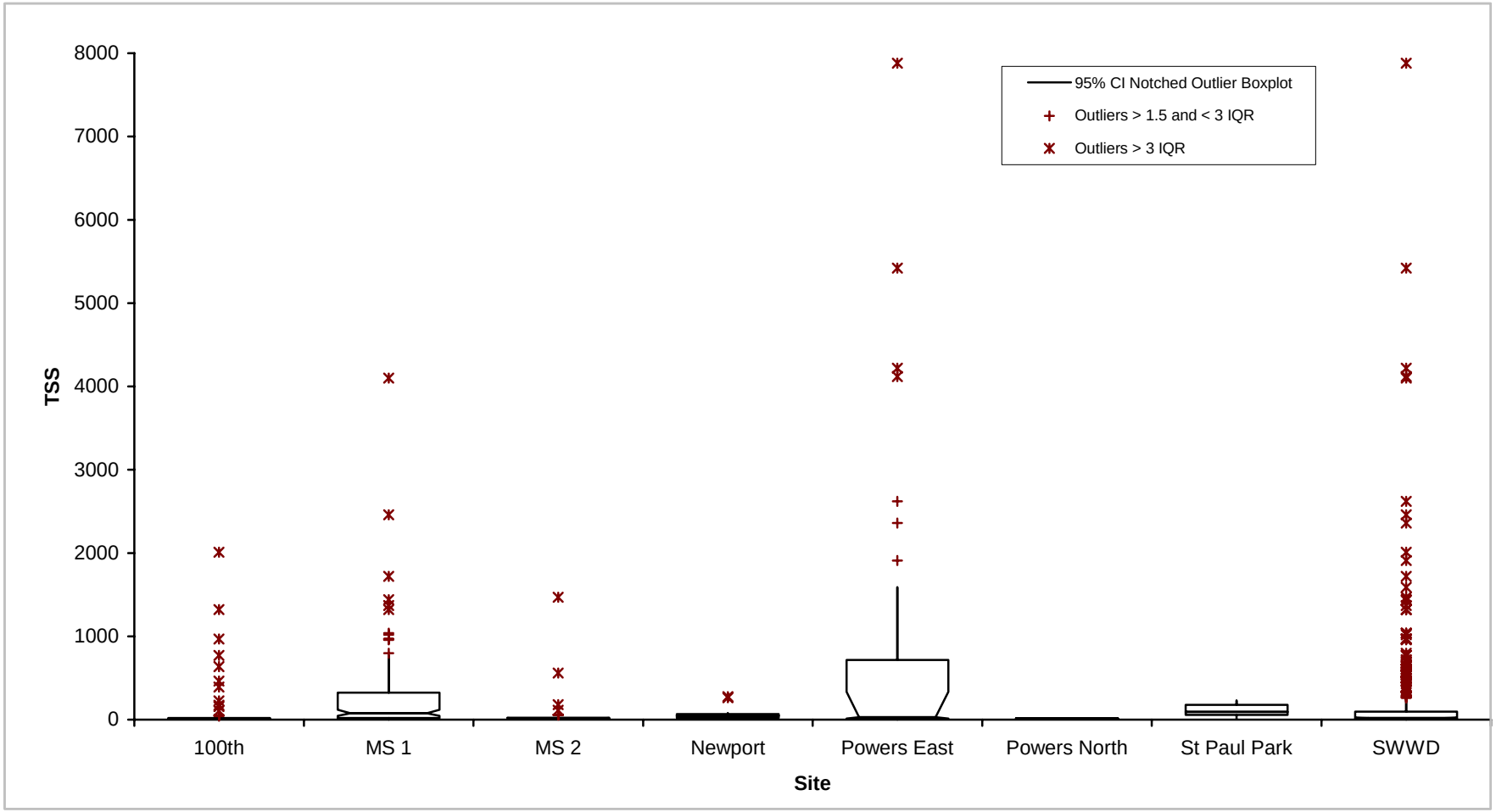


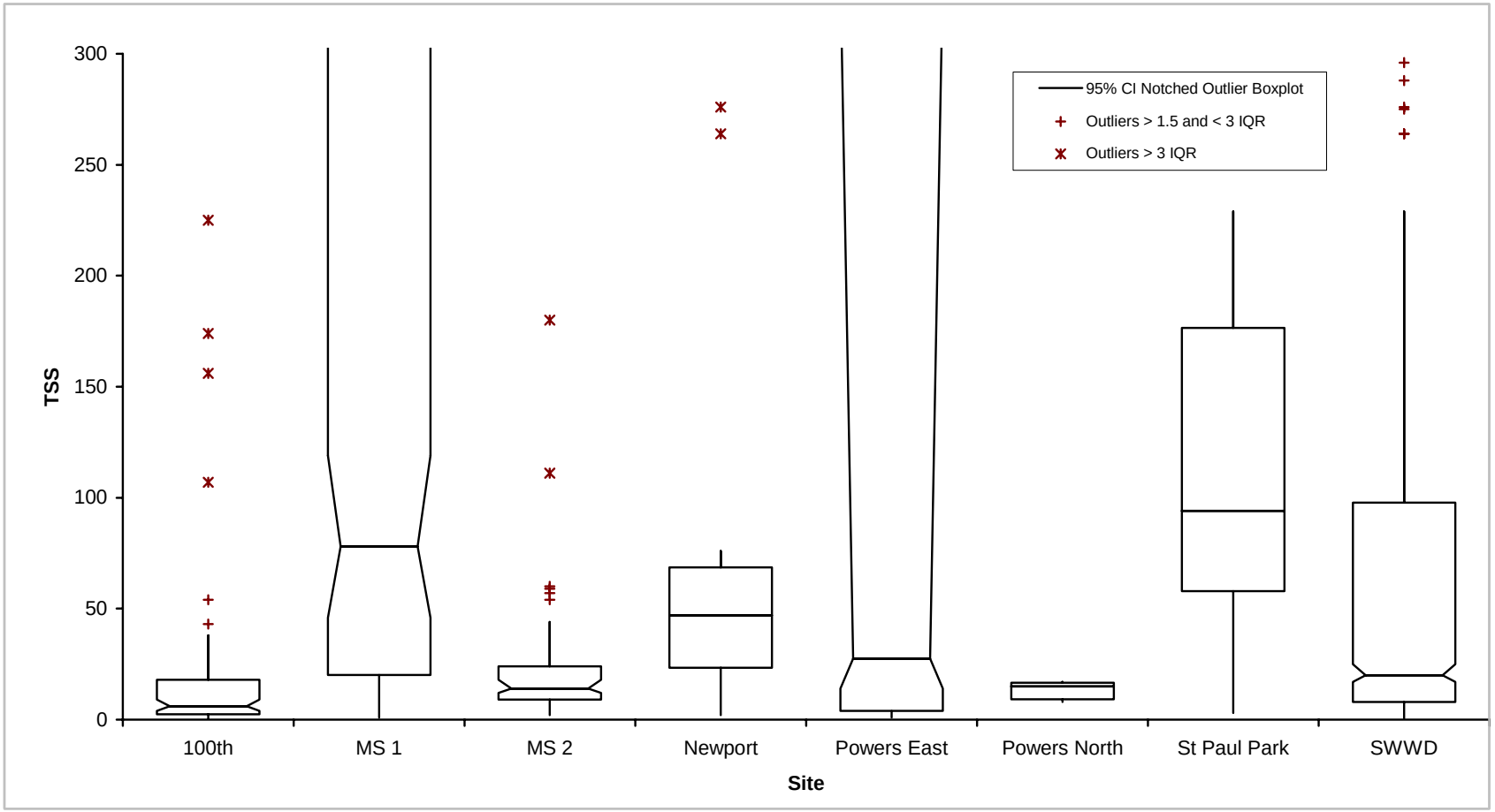
Figure 51. West Draw 2 Pond 2007 Elevation

Figures 52-63 statistically summarize all stream sites for all years, depicted in box plots. Box plots show the benefit of water retention practices at sites MS2, Powers North, and 100th Street. These sites have the lowest median values for total suspended solids, volatile suspended solids, total phosphorus, and total Kjedahl nitrogen. Further analysis of factors within each drainage area would be needed to fully understand the differences between the remaining SWWD sites. Total chloride ions median values had opposite trends when compared to TSS, VSS, TP, and TKN. This chloride trend is probably due to the timing of sample collection, where the used of chloride on streets does not occur during spring, summer, fall months. E. Coli bacteria comparisons could not be done due to small sample sizes. Powers North Tributary site did not have enough TP samples to be included in this analysis.



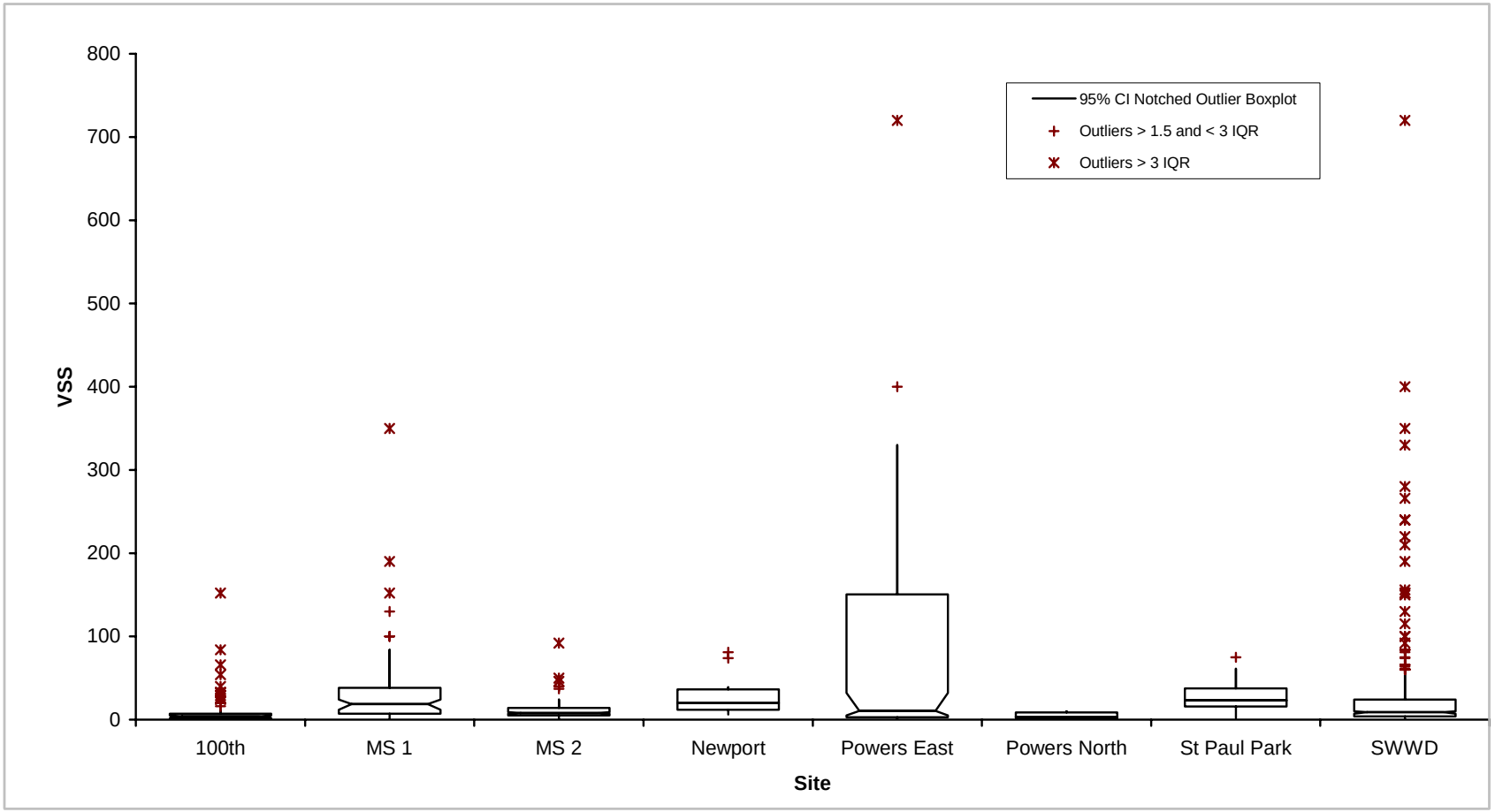
TSS by Site	n	Min	Median	95% CI	Max	IQR
100th	88	0.5	6.00	4.00 to 9.00	2010.0	15.58
MS 1	135	1.0	78.00	46.00 to 119.00	4100.0	303.17
MS 2	109	2.0	14.00	12.00 to 18.00	1470.0	15.00
Newport	15	2.0	47.00	22.00 to 69.00	276.0	45.33
Powers East	42	1.0	27.50	14.00 to 336.00	7880.0	713.33
Powers North	3	8.0	15.00	- to -	17.0	7.50
St Paul Park	15	3.0	94.00	54.00 to 180.00	229.0	118.67
SWWD	407	0.5	20.00	17.00 to 25.00	7880.0	89.83

Figure 52. Total Suspended Solids Box Plot (All Sites)



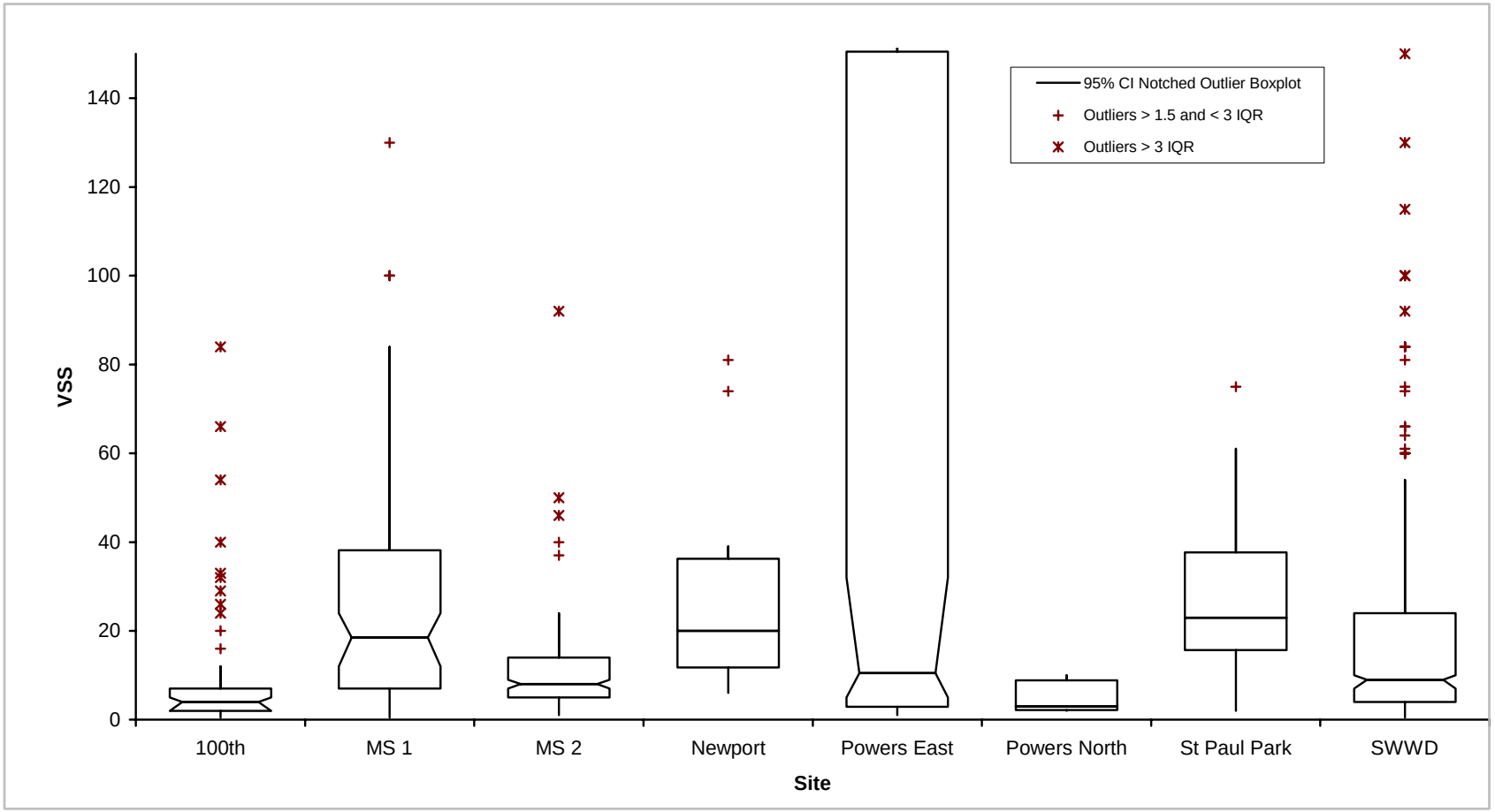
TSS by Site	n	Min	Median	95% CI	Max	IQR
100th	88	0.5	6.00	4.00 to 9.00	2010.0	15.58
MS 1	135	1.0	78.00	46.00 to 119.00	4100.0	303.17
MS 2	109	2.0	14.00	12.00 to 18.00	1470.0	15.00
Newport	15	2.0	47.00	22.00 to 69.00	276.0	45.33
Powers East	42	1.0	27.50	14.00 to 336.00	7880.0	713.33
Powers North	3	8.0	15.00	- to -	17.0	7.50
St Paul Park	15	3.0	94.00	54.00 to 180.00	229.0	118.67
SWWD	407	0.5	20.00	17.00 to 25.00	7880.0	89.83

Figure 53. Total Suspended Solids Box Plot (All Sites) without Outliers



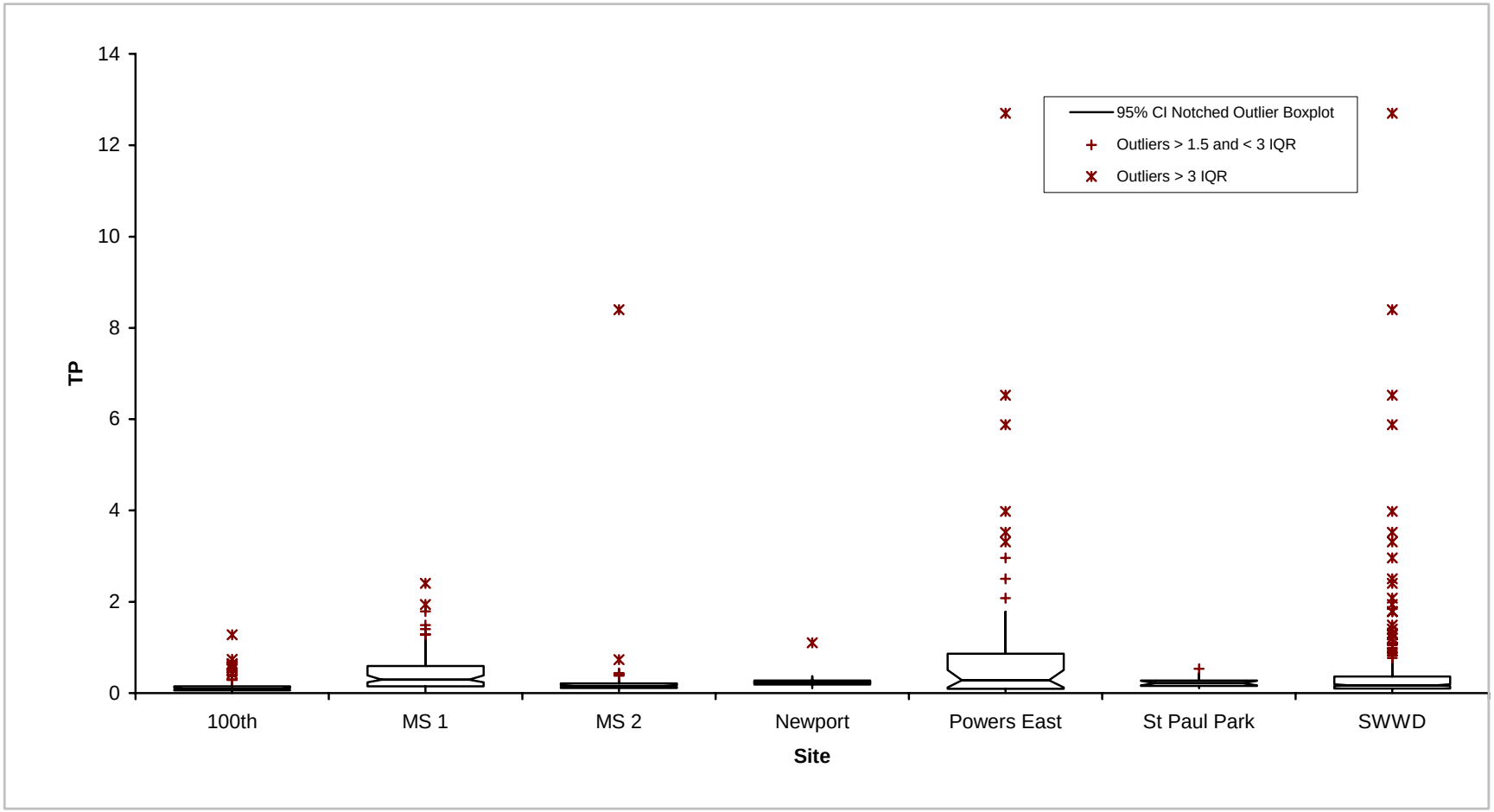
VSS by Site	n	Min	Median	95% CI	Max	IQR
100th	87	0.50	4.000	2.000 to 5.000	152.00	5.000
MS 1	98	0.50	18.500	12.000 to 24.000	350.00	31.167
MS 2	72	1.00	8.000	7.000 to 9.000	92.00	9.000
Newport	14	6.00	20.000	9.000 to 39.000	81.00	24.500
Powers East	42	1.00	10.500	5.000 to 32.000	720.00	147.583
Powers North	3	2.00	3.000	- to -	10.00	6.667
St Paul Park	15	2.00	23.000	15.000 to 38.000	75.00	22.000
SWWD	331	0.50	9.000	7.000 to 10.000	720.00	20.000

Figure 54. Volatile Suspended Solids Box Plot (All Sites)



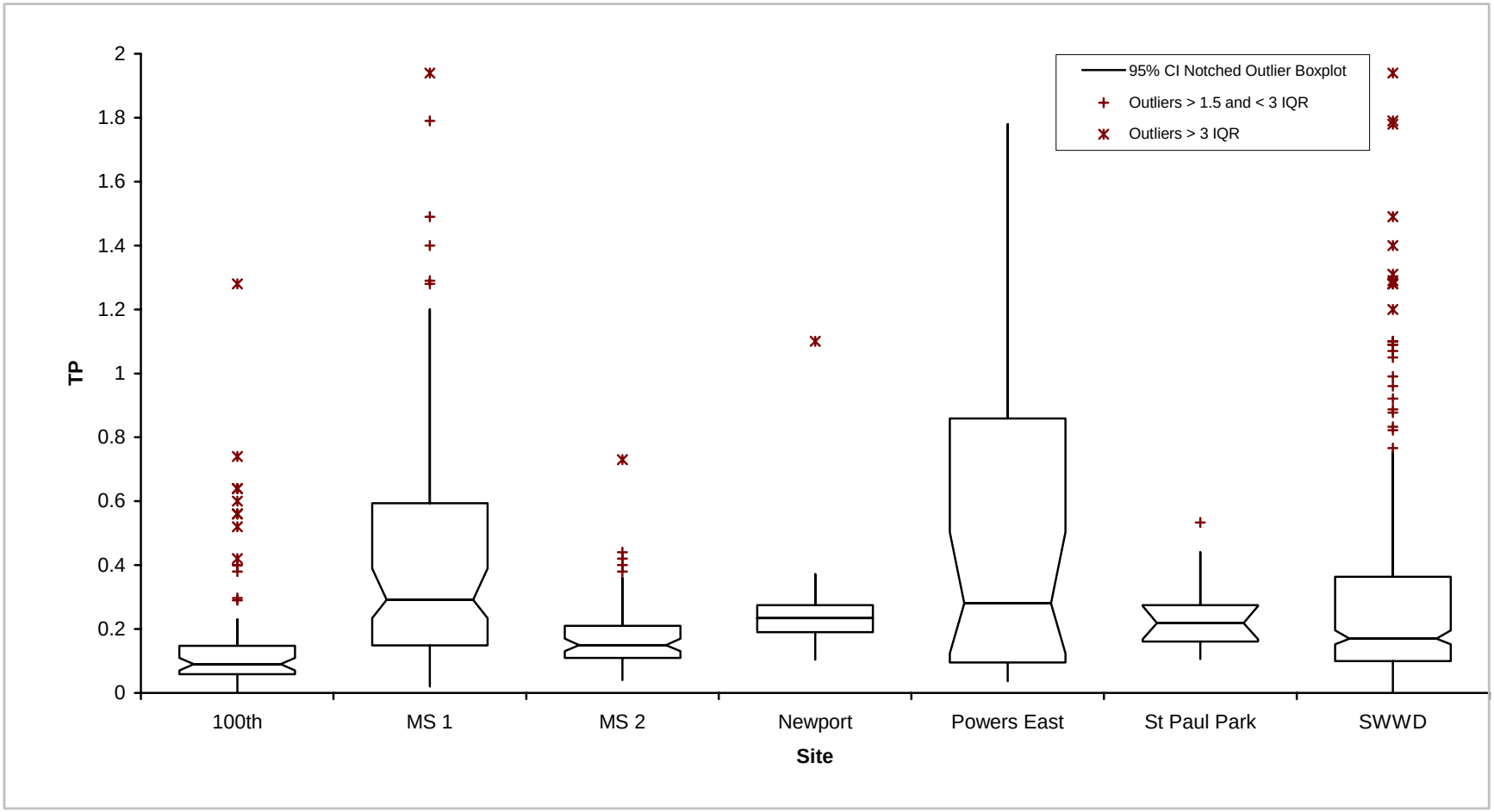
VSS by Site	n	Min	Median	95% CI	Max	IQR
100th	87	0.50	4.000	2.000 to 5.000	152.00	5.000
MS 1	98	0.50	18.500	12.000 to 24.000	350.00	31.167
MS 2	72	1.00	8.000	7.000 to 9.000	92.00	9.000
Newport	14	6.00	20.000	9.000 to 39.000	81.00	24.500
Powers East	42	1.00	10.500	5.000 to 32.000	720.00	147.583
Powers North	3	2.00	3.000	- to -	10.00	6.667
St Paul Park	15	2.00	23.000	15.000 to 38.000	75.00	22.000
SWWD	331	0.50	9.000	7.000 to 10.000	720.00	20.000

Figure 55. Volatile Suspended Solids Box Plot (All Sites) without Outliers



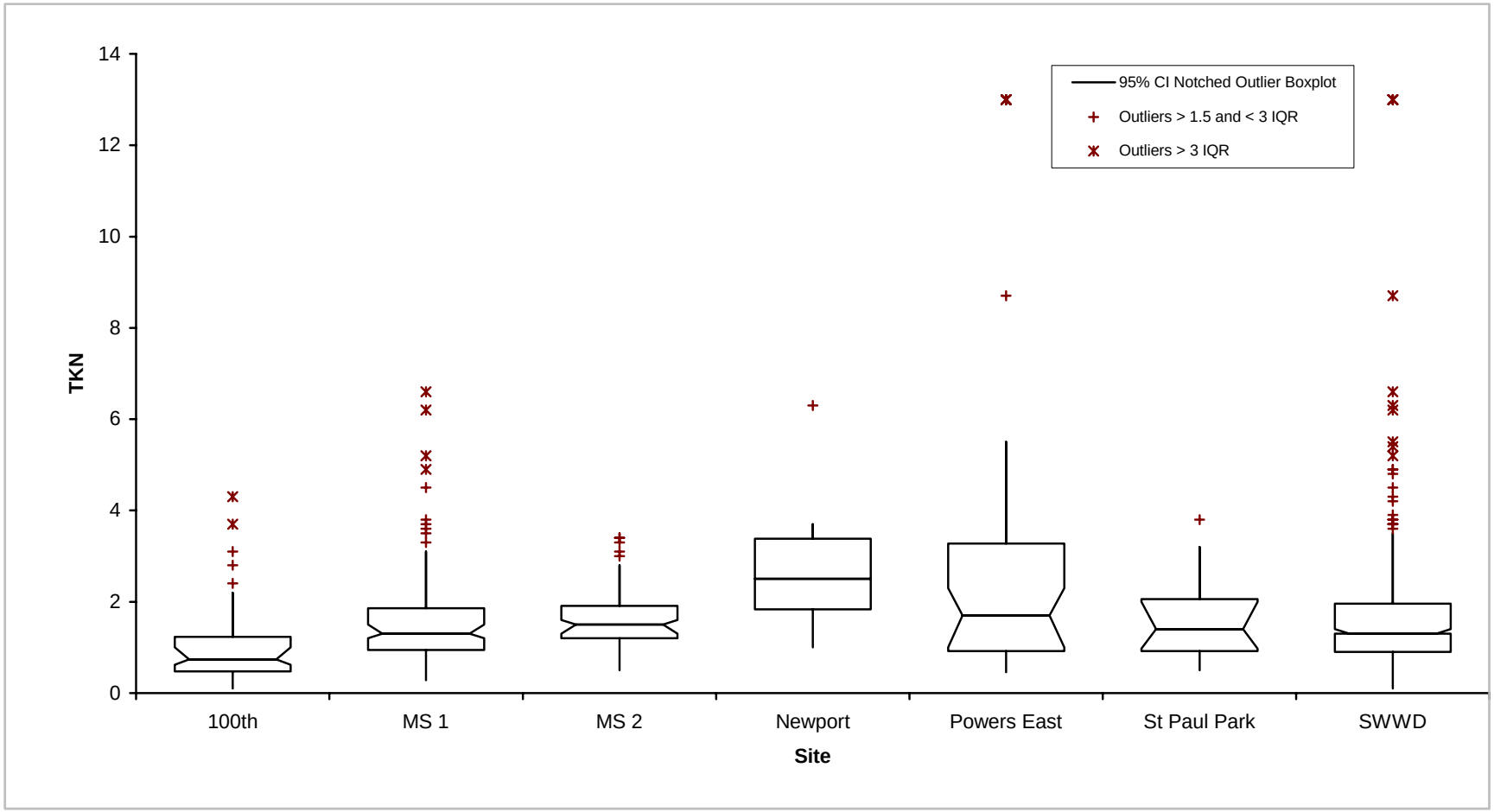
TP by Site	n	Min	Median	95% CI	Max	IQR
100th	89	0.005	0.0900	0.0700 to 0.1100	1.280	0.0883
MS 1	136	0.020	0.2915	0.2340 to 0.3890	2.400	0.4441
MS 2	114	0.040	0.1500	0.1310 to 0.1700	8.400	0.1004
Newport	15	0.104	0.2340	0.1880 to 0.2760	1.100	0.0847
Powers East	48	0.037	0.2805	0.1240 to 0.5030	12.700	0.7628
St Paul Park	24	0.106	0.2185	0.1680 to 0.2720	0.533	0.1139
SWWD	428	0.005	0.1700	0.1520 to 0.1960	12.700	0.2635

Figure 56. Total Phosphorus Box Plot (All Sites)



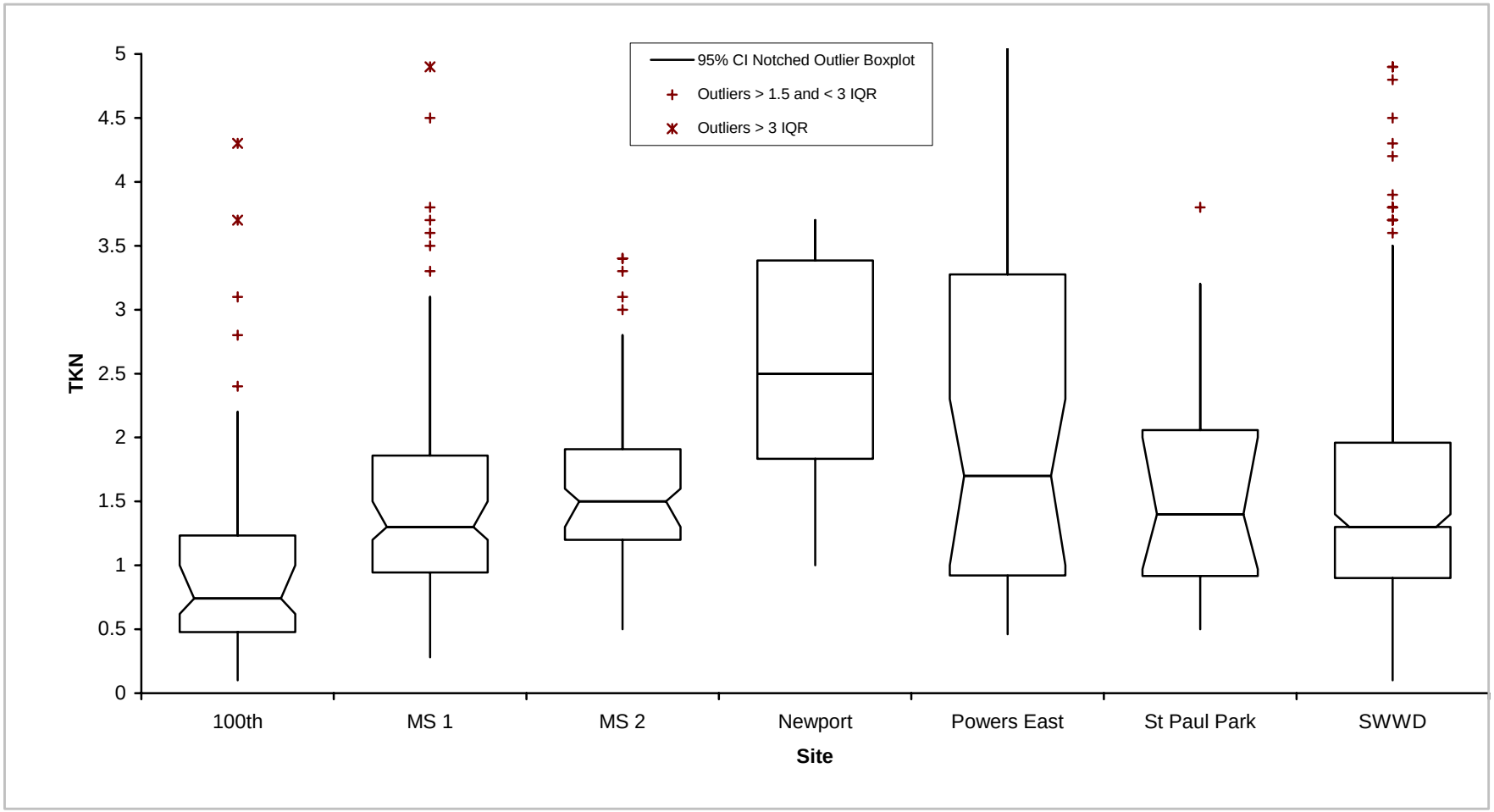
TP by Site	n	Min	Median	95% CI	Max	IQR
100th	89	0.005	0.0900	0.0700 to 0.1100	1.280	0.0883
MS 1	136	0.020	0.2915	0.2340 to 0.3890	2.400	0.4441
MS 2	114	0.040	0.1500	0.1310 to 0.1700	8.400	0.1004
Newport	15	0.104	0.2340	0.1880 to 0.2760	1.100	0.0847
Powers East	48	0.037	0.2805	0.1240 to 0.5030	12.700	0.7628
St Paul Park	24	0.106	0.2185	0.1680 to 0.2720	0.533	0.1139
SWWD	428	0.005	0.1700	0.1520 to 0.1960	12.700	0.2635

Figure 57. Total Phosphorus Box Plot (All Sites) without Outliers



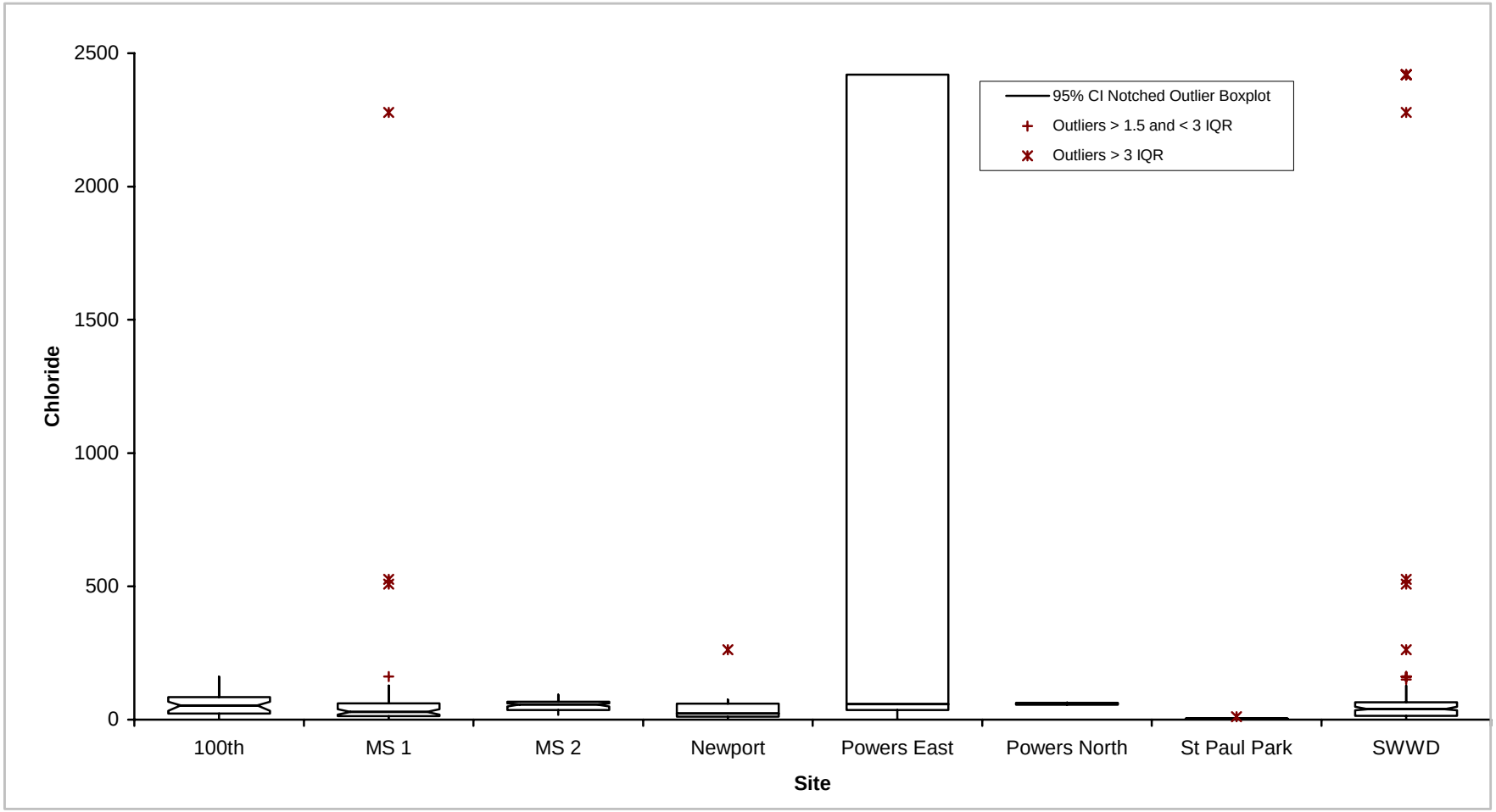
TKN by Site	n	Min	Median	95% CI	Max	IQR
100th	89	0.1	0.74	0.62 to 1.00	4.3	0.76
MS 1	136	0.3	1.30	1.20 to 1.50	6.6	0.91
MS 2	114	0.5	1.50	1.30 to 1.60	3.4	0.71
Newport	15	1.0	2.50	1.80 to 3.40	6.3	1.55
Powers East	48	0.5	1.70	1.00 to 2.30	13.0	2.36
St Paul Park	24	0.5	1.40	0.97 to 2.00	3.8	1.14
SWWD	428	0.1	1.30	1.30 to 1.40	13.0	1.06

Figure 58. Total Kjedahl Nitrogen Box Plot (All Sites)



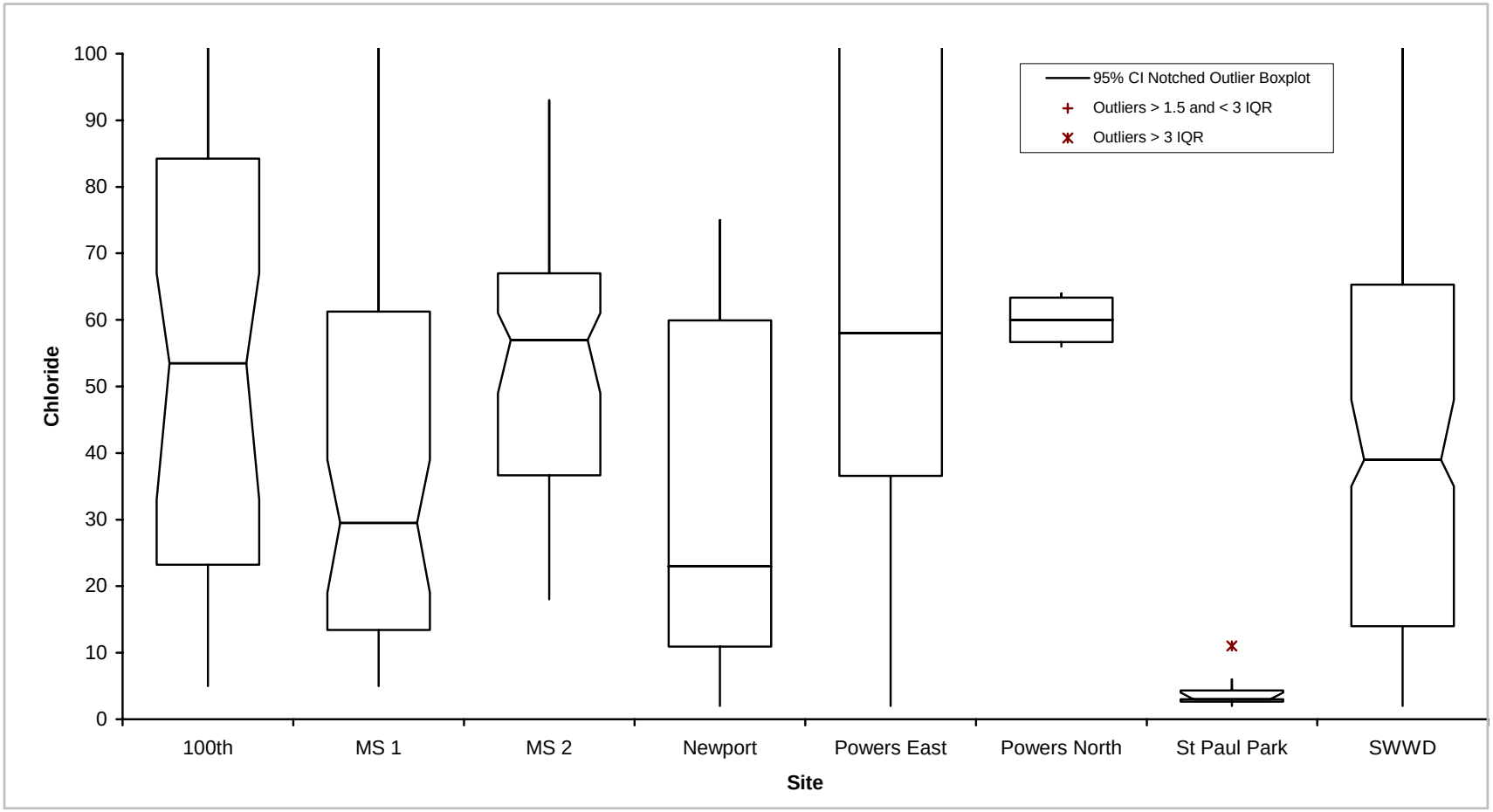
TKN by Site	n	Min	Median	95% CI	Max	IQR
100th	89	0.1	0.74	0.62 to 1.00	4.3	0.76
MS 1	136	0.3	1.30	1.20 to 1.50	6.6	0.91
MS 2	114	0.5	1.50	1.30 to 1.60	3.4	0.71
Newport	15	1.0	2.50	1.80 to 3.40	6.3	1.55
Powers East	48	0.5	1.70	1.00 to 2.30	13.0	2.36
St Paul Park	24	0.5	1.40	0.97 to 2.00	3.8	1.14
SWWD	428	0.1	1.30	1.30 to 1.40	13.0	1.06

Figure 59. Total Kjedahl Nitrogen Box Plot (All Sites) without Outliers



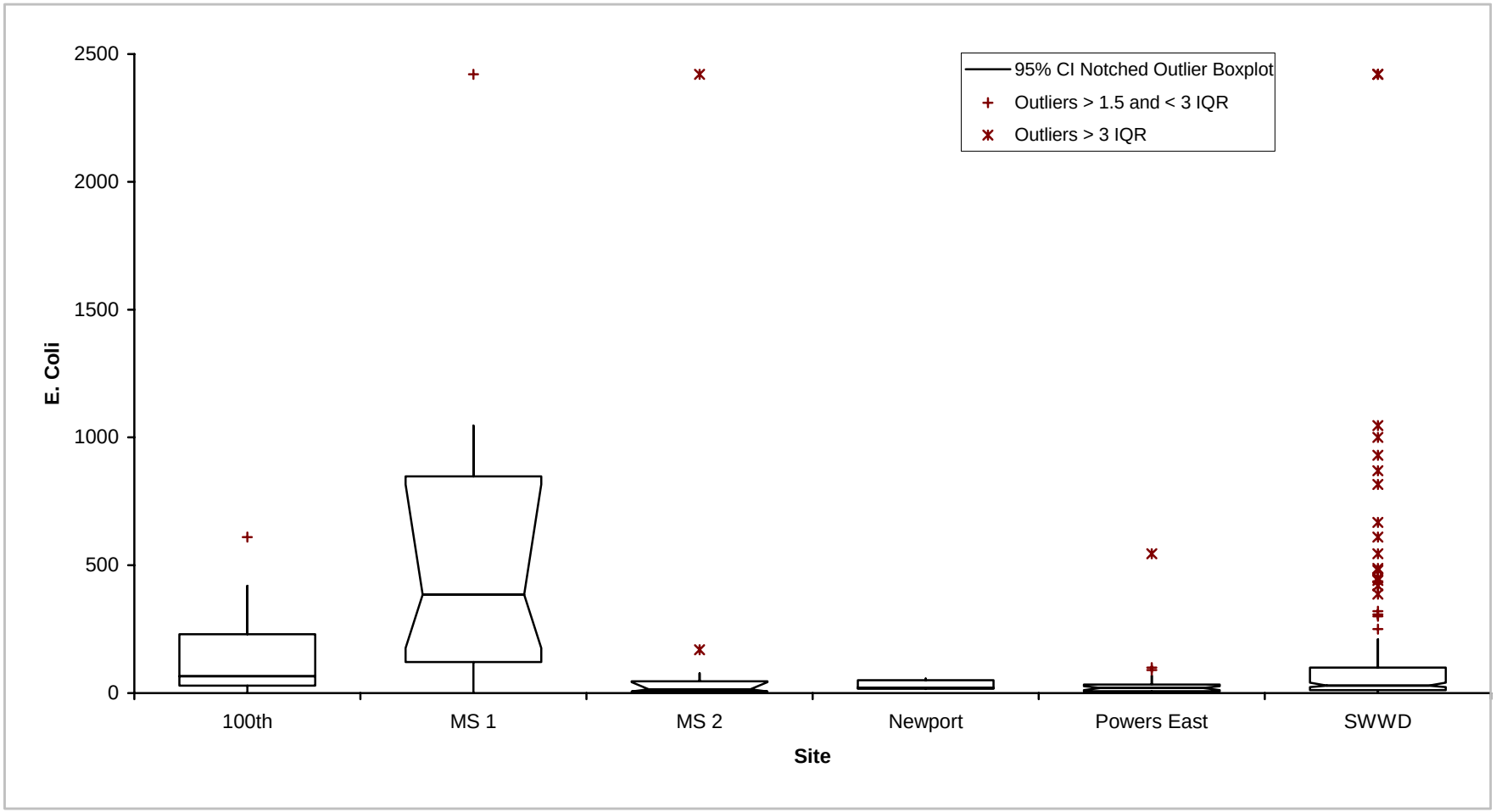
Chloride by Site	n	Min	Median	95% CI	Max	IQR
100th	48	5	53.5	33.0 to 67.0	162	61.0
MS 1	84	5	29.5	19.0 to 39.0	2278	47.8
MS 2	57	18	57.0	49.0 to 61.0	93	30.3
Newport	14	2	23.0	10.0 to 70.0	262	49.0
Powers East	10	2	58.0	10.0 to 2420.0	2420	2383.4
Powers North	3	56	60.0	- to -	64	6.7
St Paul Park	21	2	3.0	3.0 to 4.0	11	1.7
SWWD	237	2	39.0	35.0 to 48.0	2420	51.3

Figure 60. Total Chloride Ions Box Plot (All Sites)



Chloride by Site	n	Min	Median	95% CI	Max	IQR
100th	48	5	53.5	33.0 to 67.0	162	61.0
MS 1	84	5	29.5	19.0 to 39.0	2278	47.8
MS 2	57	18	57.0	49.0 to 61.0	93	30.3
Newport	14	2	23.0	10.0 to 70.0	262	49.0
Powers East	10	2	58.0	10.0 to 2420.0	2420	2383.4
Powers North	3	56	60.0	- to -	64	6.7
St Paul Park	21	2	3.0	3.0 to 4.0	11	1.7
SWWD	237	2	39.0	35.0 to 48.0	2420	51.3

Figure 61. Total Chloride Ions Box Plot (All Sites) without Outliers

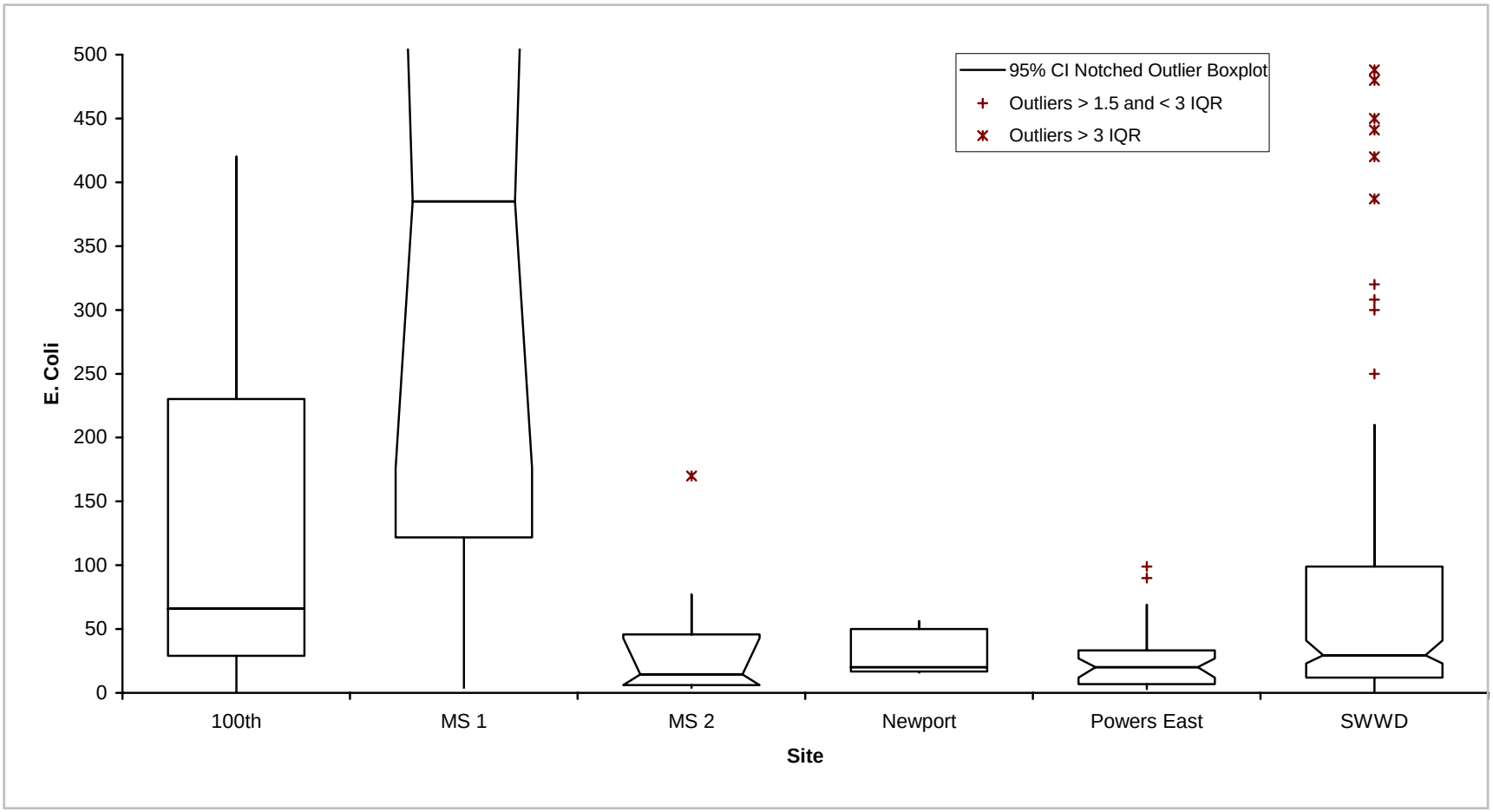


E. Coli by Site	n	Min	Median	95% CI	Max	IQR
100th	15	0.5	66.00	27.00 to 250.00	610.0	201.00
MS 1	20	4.0	385.00	176.00 to 816.00	2420.0	725.75
MS 2	20	4.0	14.50	6.00 to 43.00	2420.0	39.92
Newport	3	16.0	20.00	- to -	56.0	33.33
Powers East	45	3.0	20.00	12.00 to 27.00	545.0	26.33
SWWD	106	0.5	29.50	23.00 to 41.00	2420.0	87.17

Figure 62. *E. coli* Box Plot (All Sites)

*St Paul Park does not have enough samples to be included in this analysis

**E. coli* bacteria has been sampled since the 2006 monitoring season, prior it was total fecal coliform



E. Coli by Site	n	Min	Median	95% CI	Max	IQR
100th	15	0.5	66.00	27.00 to 250.00	610.0	201.00
MS 1	20	4.0	385.00	176.00 to 816.00	2420.0	725.75
MS 2	20	4.0	14.50	6.00 to 43.00	2420.0	39.92
Newport	3	16.0	20.00	- to -	56.0	33.33
Powers East	45	3.0	20.00	12.00 to 27.00	545.0	26.33
SWWD	106	0.5	29.50	23.00 to 41.00	2420.0	87.17

Figure 63. *E. coli* Box Plot (All Sites) without Outliers

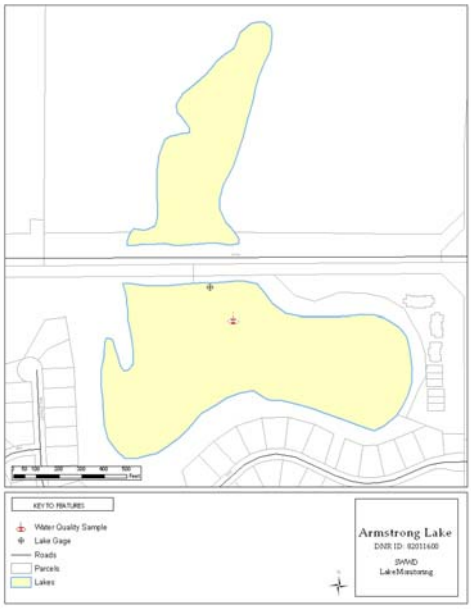
*St Paul Park does not have enough samples to be included in this analysis

***E. coli* bacteria has been sampled since the 2006 monitoring season, prior it was total fecal coliform**

Armstrong Lake

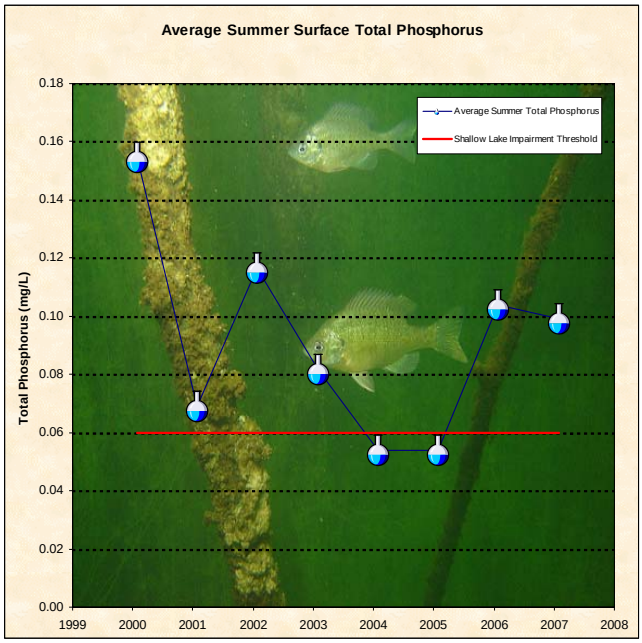
2007 Lake Grade: D+

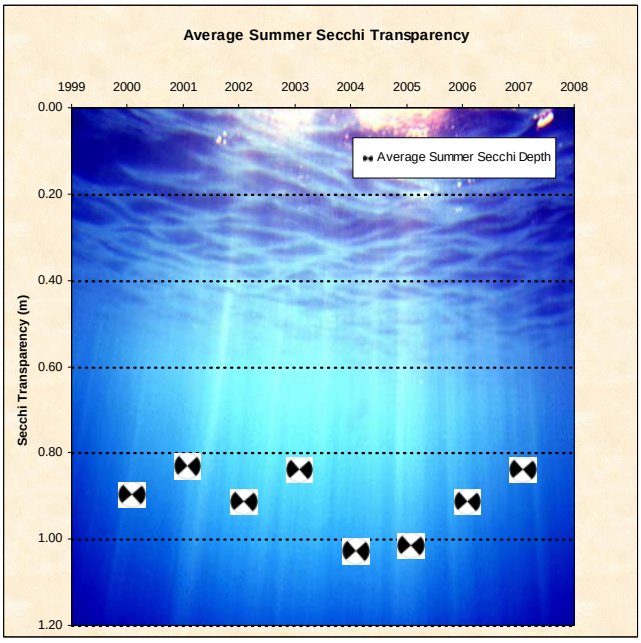
- DNR ID #: 82-0116
- Municipality: City of Lake Elmo
- Location: NW ¼ Sect. 33 T29 – R21
- Lake Size: 28.1 Acres
- Maximum Depth: 5 ft
- Ordinary High Water Mark: 1019.1 ft
- 100%Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Armstrong Lake was considered a eutrophic lake in 2007, based on the Carlson Trophic State Index.
- Secchi disk summer average readings have been relatively stable for the past eight years.
- The major land use is urban.
- Armstrong Lake has the highest amount of chloride ions compared to Powers Lake and Cottage Grove Ravine Park Lake.
- Since this is a shallow lake, stratification did not occur.





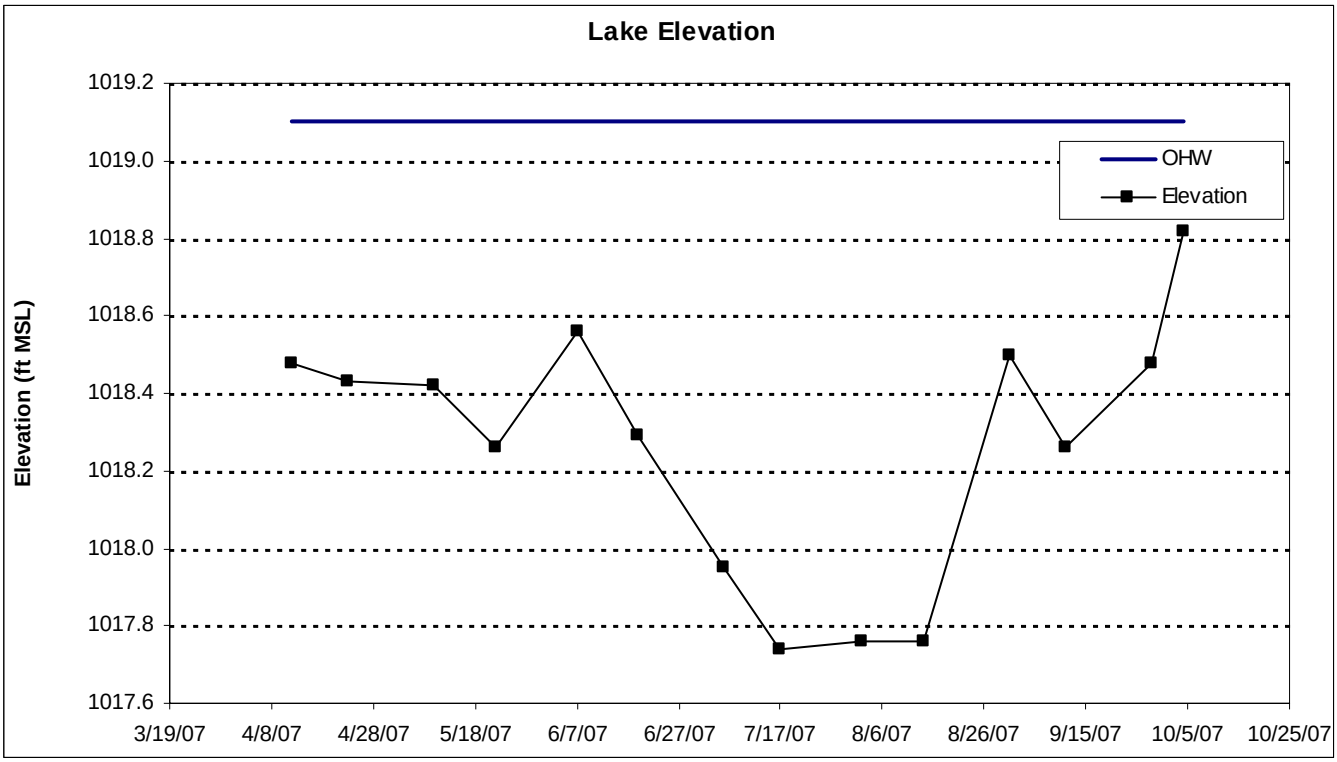
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Total Chloride	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/23/2007	0.023	13	1.20	106	1.22	7.28	15.3
5/22/2007	0.081	36	2.30	118	0.61	10.85	21.1
6/19/2007	0.112	11	2.40	133	0.91	5.30	23.6
7/17/2007	0.062	8	2.00	142	0.76	6.53	30.8
8/14/2007	0.156	69	4.60	158	0.61	6.27	28.4
9/11/2007	0.067	11	2.10	104	1.07	8.39	19.5
10/4/2007	0.043	2	1.60	82	1.22	7.32	18.0
2007 Average	0.078	21	2.31	120	0.91	7.42	22.4
2007 Summer Average	0.099	25	2.78	134	0.84	6.62	25.6

Water quality threshold is 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	1018.82	10/4/2007	1017.74	7/17/2007	1018.27

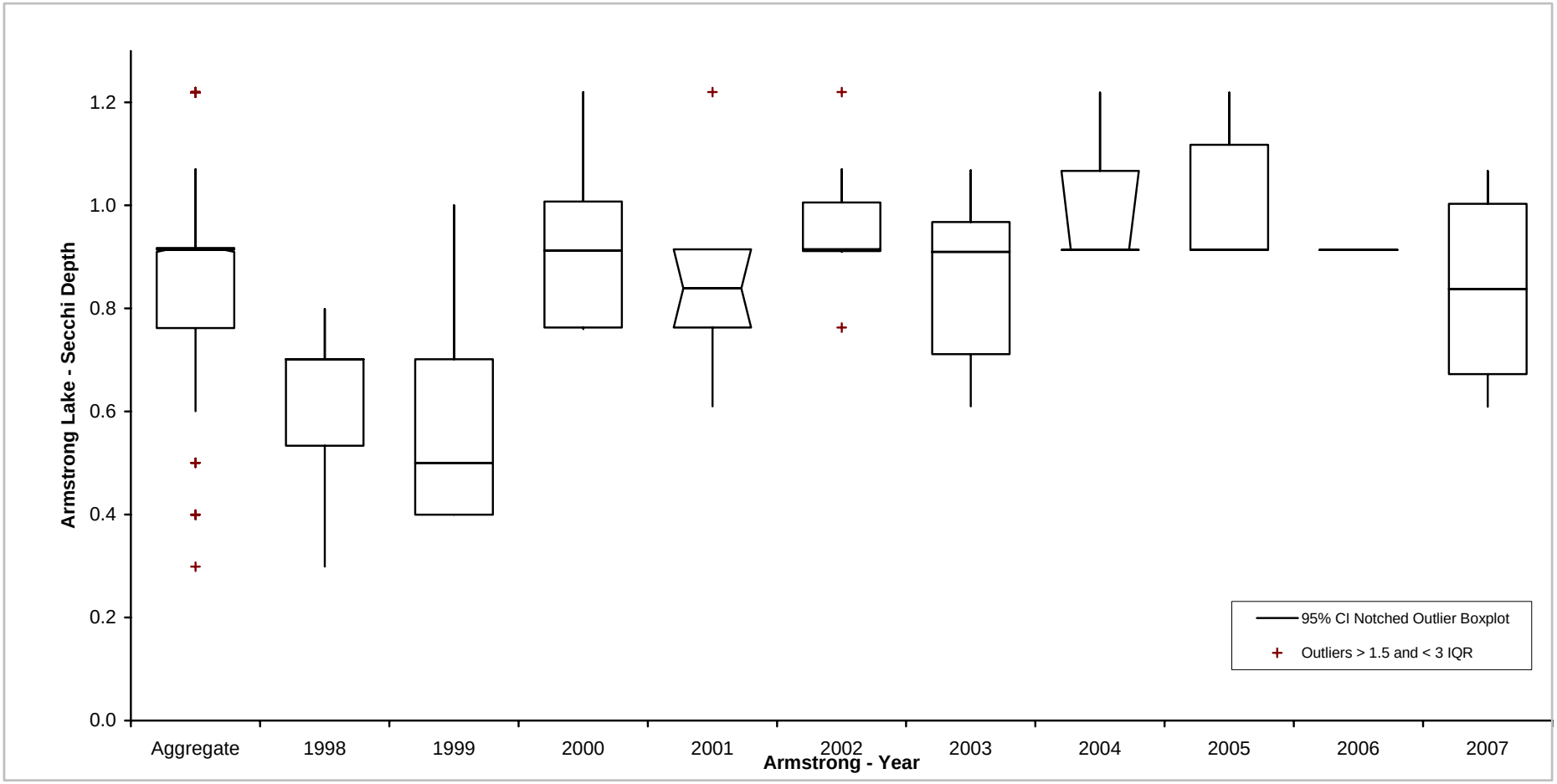
*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over teh course of two summers; however it might aslo reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitroing programs). In addition to exceeding the TP guikeline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. this amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis



Lake Water Quality Summary

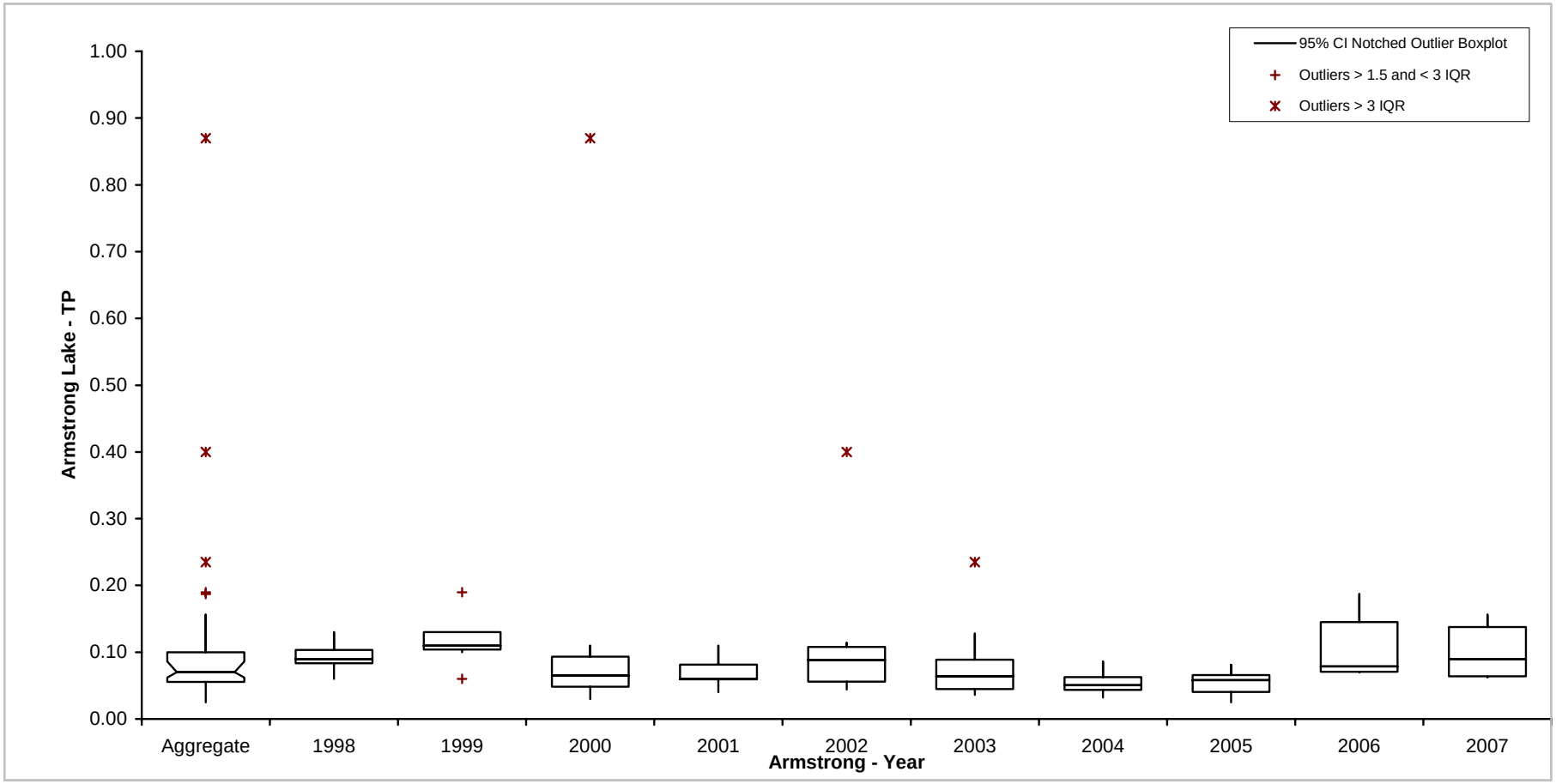
	Trophic Status	Lake Grades							
	2007	2007	2006	2005	2004	2003	2002	2001	2000
Total Phosphorus (mg/l)	Hypereutropic	D	D	C	C	D	D	D	F
Chlorophyll-*a* (ug/l)	Eutrophic	C	B	A	A	B	D	D	F
Secchi depth (ft)	Eutrophic	D	D	D	D	D	D	C	D
Overall	Eutrophic	D+	C-	C+	C+	C-	D	D+	F+

Statistical box plot summaries are included for Armstrong Lake in Figures 64-71. A step shift seems to have occurred for Secchi disk readings between 1999 and 2000. Since that time, Secchi disk values have shown no statistically significant trend and have been holding to the new regime. TKN has shown an increasing trend over the past three years, with the largest one year increase happening between 2006 and 2007.



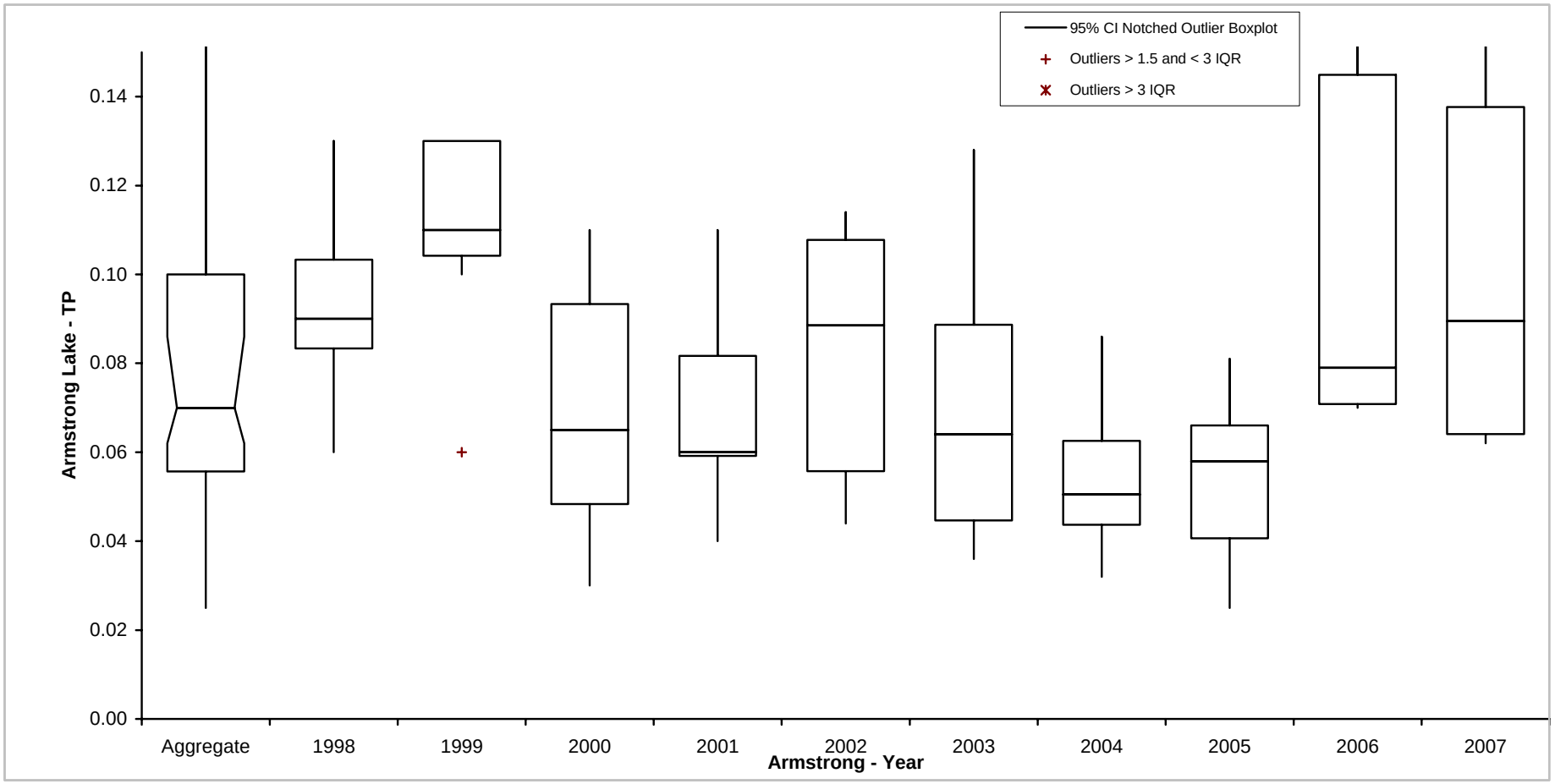
Armstrong Lake - Secchi Depth by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	83	0.30	0.76	0.91	0.91 to 0.91	0.92	1.22	0.16
1998	9	0.30	0.53	0.70	0.40 to 0.70	0.70	0.80	0.17
1999	8	0.40	0.40	0.50	0.40 to 1.00	0.70	1.00	0.30
2000	8	0.76	0.76	0.91	0.76 to 1.22	1.01	1.22	0.24
2001	10	0.61	0.76	0.84	0.76 to 0.92	0.92	1.22	0.15
2002	8	0.76	0.91	0.92	0.76 to 1.22	1.01	1.22	0.09
2003	9	0.61	0.71	0.91	0.61 to 1.07	0.97	1.07	0.26
2004	14	0.91	0.91	0.91	0.91 to 1.07	1.07	1.22	0.15
2005	9	0.91	0.91	0.91	0.91 to 1.22	1.12	1.22	0.20
2006	4	0.91	0.91	0.91	- to -	0.91	0.91	0.00
2007	4	0.61	0.67	0.84	- to -	1.00	1.07	0.33

Figure 64. Secchi Disk box plots for Armstrong Lake (1998-2007)



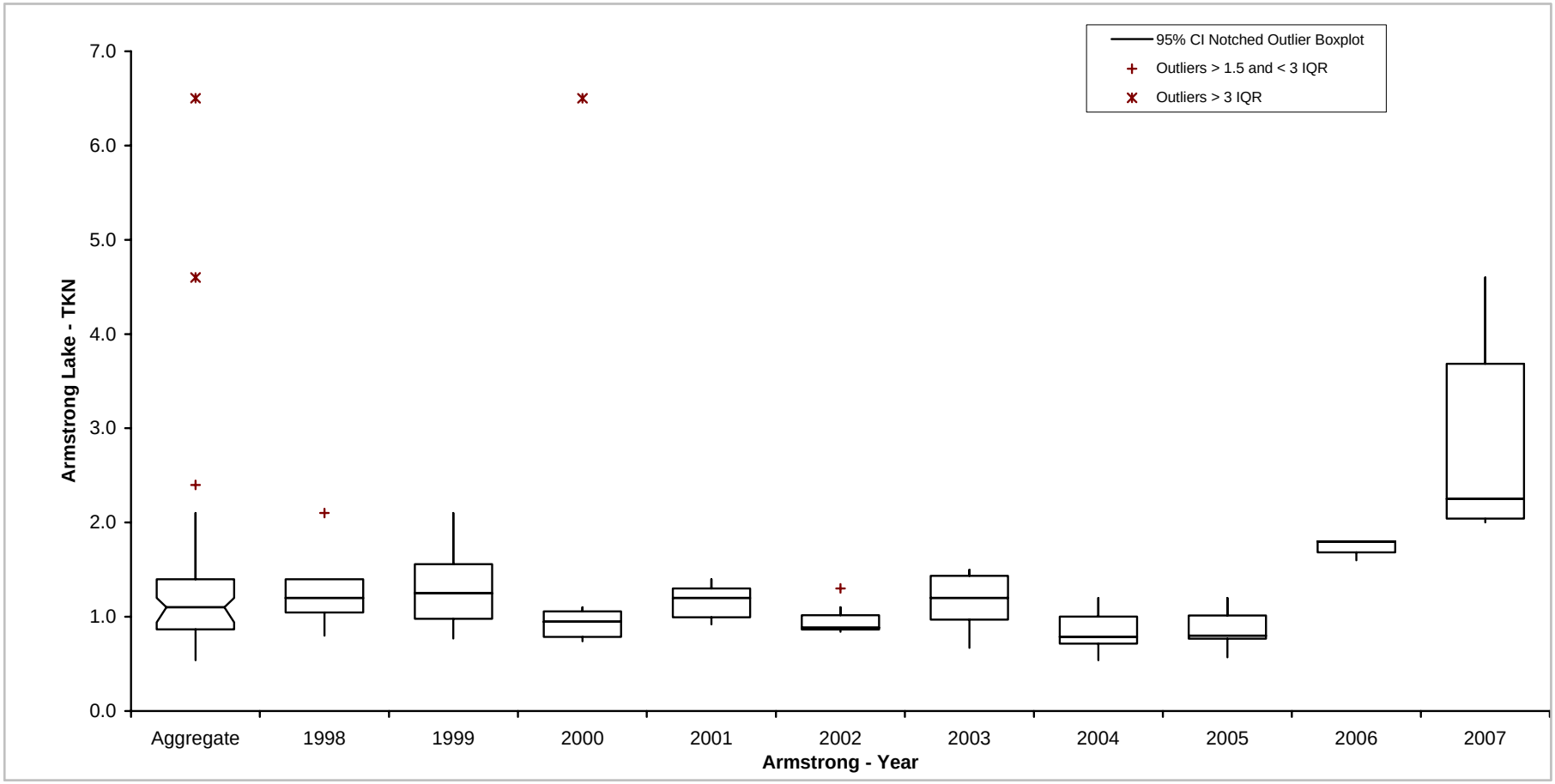
Armstrong Lake - TP by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	77	0.03	0.06	0.07	0.06 to 0.09	0.10	0.87	0.04
1998	9	0.06	0.08	0.09	0.07 to 0.11	0.10	0.13	0.02
1999	8	0.06	0.10	0.11	0.06 to 0.19	0.13	0.19	0.03
2000	8	0.03	0.05	0.07	0.03 to 0.87	0.09	0.87	0.05
2001	10	0.04	0.06	0.06	0.05 to 0.10	0.08	0.11	0.02
2002	8	0.04	0.06	0.09	0.04 to 0.40	0.11	0.40	0.05
2003	9	0.04	0.04	0.06	0.04 to 0.13	0.09	0.24	0.04
2004	8	0.03	0.04	0.05	0.03 to 0.09	0.06	0.09	0.02
2005	9	0.03	0.04	0.06	0.04 to 0.07	0.07	0.08	0.03
2006	4	0.07	0.07	0.08	- to -	0.14	0.19	0.07
2007	4	0.06	0.06	0.09	- to -	0.14	0.16	0.07

Figure 65. Total Phosphorus box plots for Armstrong Lake (1998-2007)



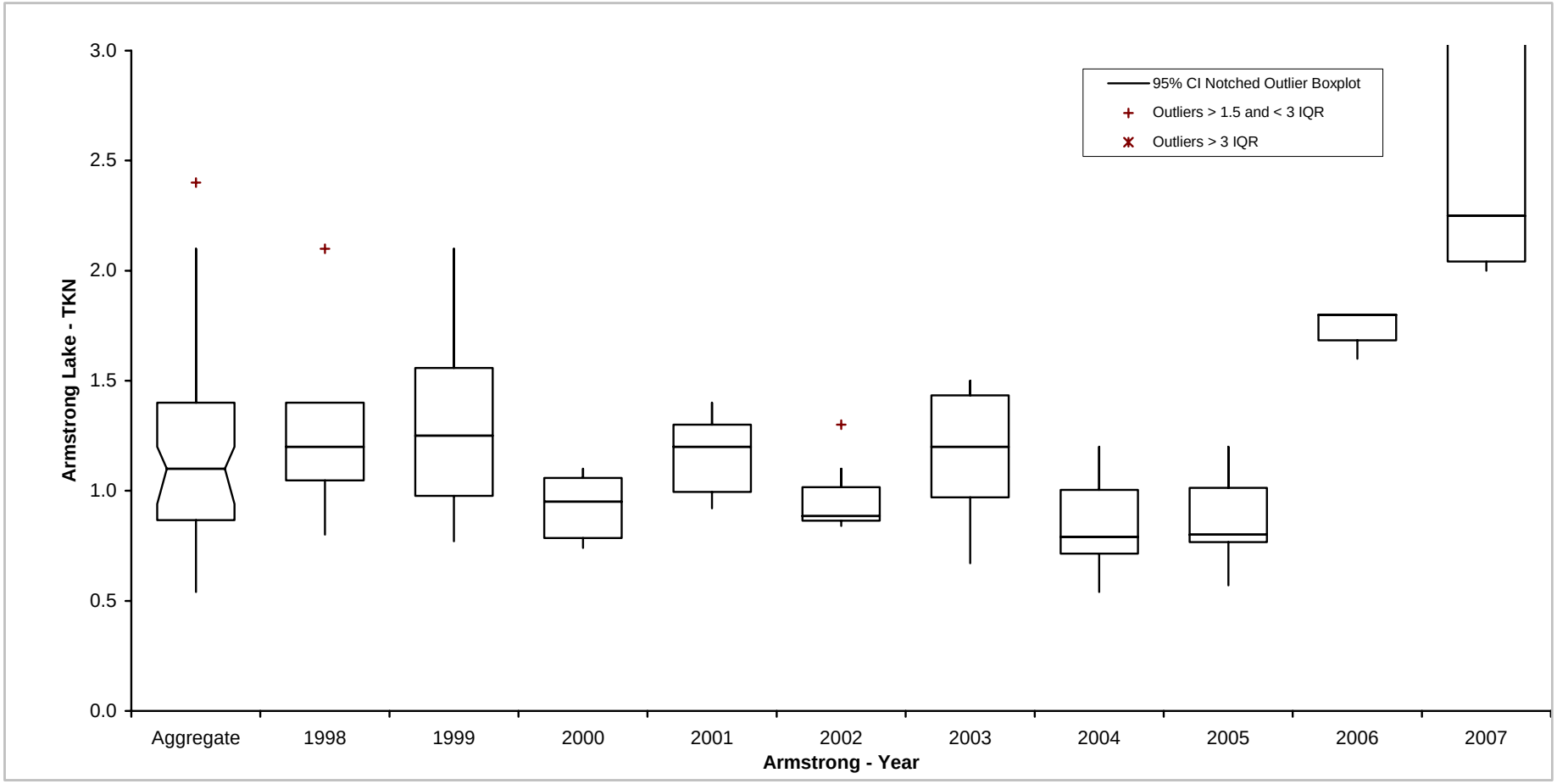
Armstrong Lake - TP by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	77	0.03	0.06	0.07	0.06 to 0.09	0.10	0.87	0.04
1998	9	0.06	0.08	0.09	0.07 to 0.11	0.10	0.13	0.02
1999	8	0.06	0.10	0.11	0.06 to 0.19	0.13	0.19	0.03
2000	8	0.03	0.05	0.07	0.03 to 0.87	0.09	0.87	0.05
2001	10	0.04	0.06	0.06	0.05 to 0.10	0.08	0.11	0.02
2002	8	0.04	0.06	0.09	0.04 to 0.40	0.11	0.40	0.05
2003	9	0.04	0.04	0.06	0.04 to 0.13	0.09	0.24	0.04
2004	8	0.03	0.04	0.05	0.03 to 0.09	0.06	0.09	0.02
2005	9	0.03	0.04	0.06	0.04 to 0.07	0.07	0.08	0.03
2006	4	0.07	0.07	0.08	- to -	0.14	0.19	0.07
2007	4	0.06	0.06	0.09	- to -	0.14	0.16	0.07

Figure 66. Total Phosphorus box plots for Armstrong Lake (1998-2007) without Outliers



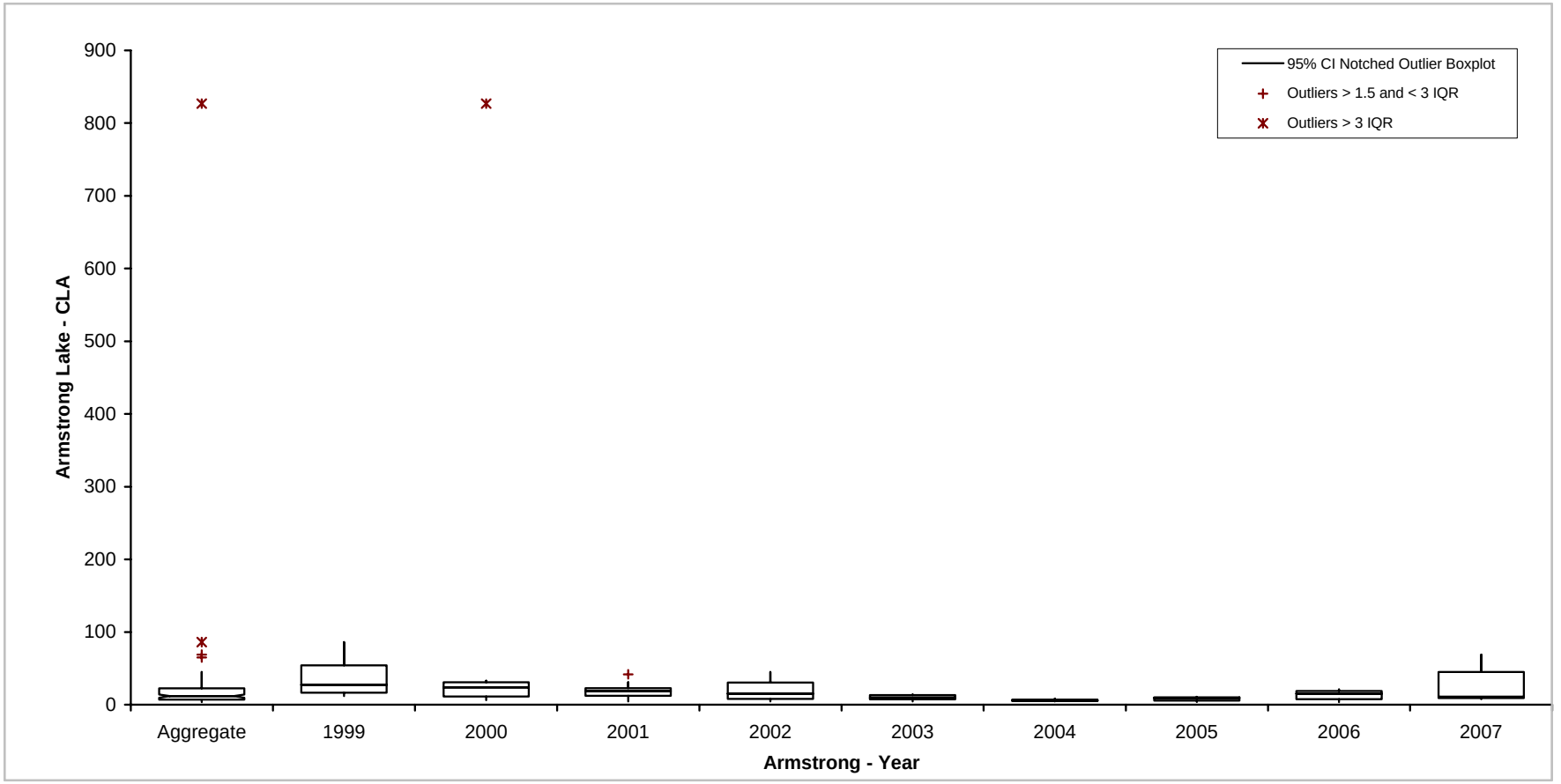
Armstrong Lake - TKN by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	77	0.54	0.87	1.10	0.94 to 1.20	1.40	6.50	0.53
1998	9	0.80	1.05	1.20	0.94 to 1.40	1.40	2.10	0.35
1999	8	0.77	0.98	1.25	0.77 to 2.10	1.56	2.10	0.58
2000	8	0.74	0.79	0.95	0.74 to 6.50	1.06	6.50	0.27
2001	10	0.92	1.00	1.20	0.94 to 1.30	1.30	1.40	0.31
2002	8	0.84	0.86	0.89	0.84 to 1.30	1.02	1.30	0.15
2003	9	0.67	0.97	1.20	0.91 to 1.50	1.43	1.50	0.46
2004	8	0.54	0.72	0.79	0.54 to 1.20	1.00	1.20	0.29
2005	9	0.57	0.77	0.80	0.76 to 1.20	1.01	1.20	0.25
2006	4	1.60	1.68	1.80	- to -	1.80	1.80	0.12
2007	4	2.00	2.04	2.25	- to -	3.68	4.60	1.64

Figure 67. Total Kjedahl Nitrogen box plots for Armstrong Lake (1998-2007)



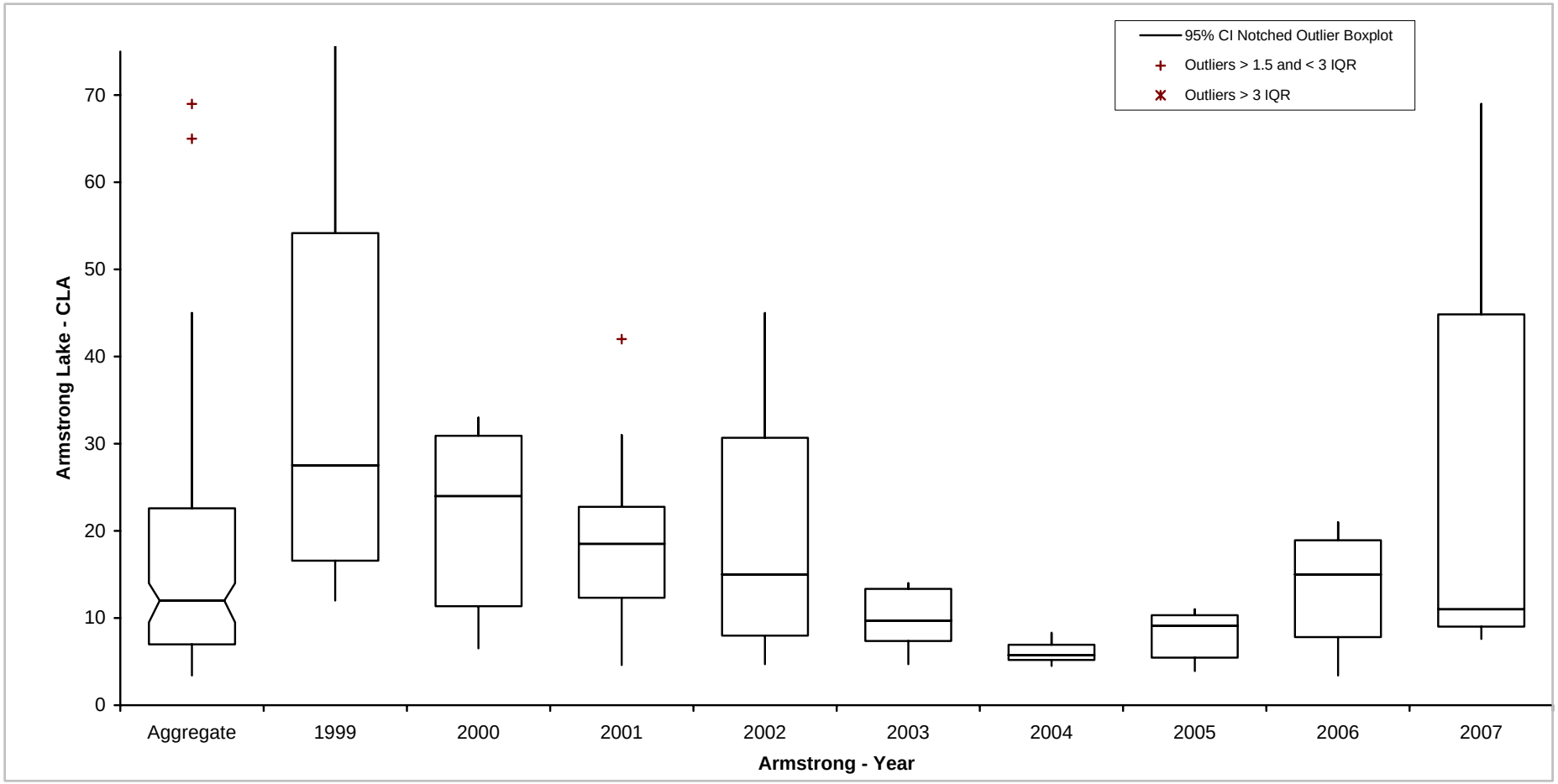
Armstrong Lake - TKN by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	77	0.54	0.87	1.10	0.94 to 1.20	1.40	6.50	0.53
1998	9	0.80	1.05	1.20	0.94 to 1.40	1.40	2.10	0.35
1999	8	0.77	0.98	1.25	0.77 to 2.10	1.56	2.10	0.58
2000	8	0.74	0.79	0.95	0.74 to 6.50	1.06	6.50	0.27
2001	10	0.92	1.00	1.20	0.94 to 1.30	1.30	1.40	0.31
2002	8	0.84	0.86	0.89	0.84 to 1.30	1.02	1.30	0.15
2003	9	0.67	0.97	1.20	0.91 to 1.50	1.43	1.50	0.46
2004	8	0.54	0.72	0.79	0.54 to 1.20	1.00	1.20	0.29
2005	9	0.57	0.77	0.80	0.76 to 1.20	1.01	1.20	0.25
2006	4	1.60	1.68	1.80	- to -	1.80	1.80	0.12
2007	4	2.00	2.04	2.25	- to -	3.68	4.60	1.64

Figure 68. Total Kjedahl Nitrogen box plots for Armstrong Lake (1998-2007) without Outliers



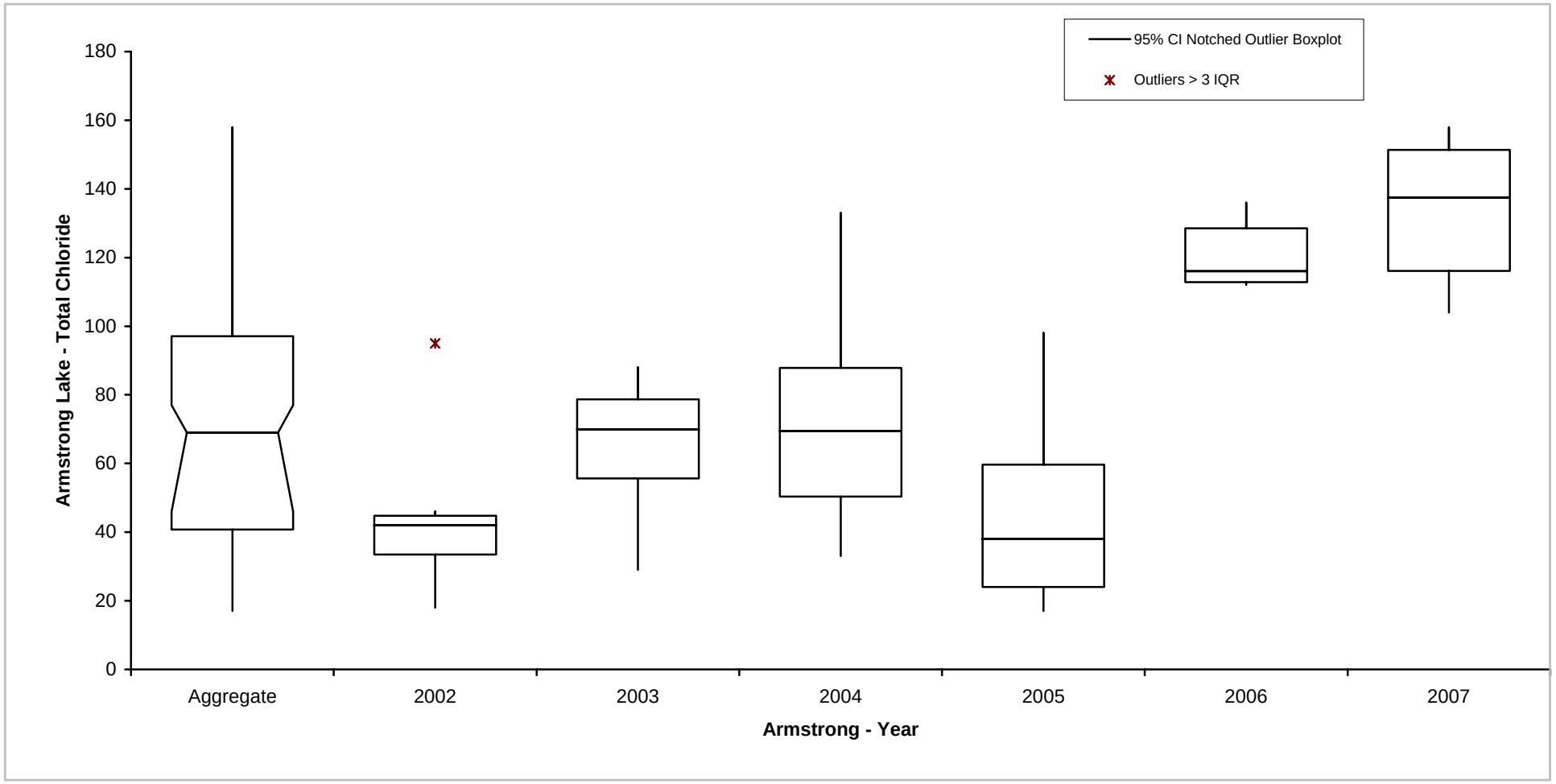
Armstrong Lake - CLA by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	68	3.40	6.98	12.00	9.50 to 14.00	22.58	827.00	15.60
1999	8	12.00	16.58	27.50	12.00 to 86.00	54.17	86.00	37.58
2000	8	6.50	11.34	24.00	6.50 to 827.00	30.92	827.00	19.58
2001	10	4.60	12.31	18.50	4.70 to 31.00	22.75	42.00	10.44
2002	8	4.70	7.98	15.00	4.70 to 45.00	30.67	45.00	22.68
2003	9	4.70	7.37	9.70	6.10 to 14.00	13.33	14.00	5.97
2004	8	4.50	5.19	5.75	4.50 to 8.30	6.93	8.30	1.74
2005	9	3.90	5.47	9.10	4.40 to 11.00	10.33	11.00	4.87
2006	4	3.40	7.82	15.00	- to -	18.92	21.00	11.10
2007	4	7.60	9.02	11.00	- to -	44.83	69.00	35.82

Figure 69. Chlorophyll-a box plots for Armstrong Lake (1999-2007)



Armstrong Lake - CLA by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	68	3.40	6.98	12.00	9.50 to 14.00	22.58	827.00	15.60
1999	8	12.00	16.58	27.50	12.00 to 86.00	54.17	86.00	37.58
2000	8	6.50	11.34	24.00	6.50 to 827.00	30.92	827.00	19.58
2001	10	4.60	12.31	18.50	4.70 to 31.00	22.75	42.00	10.44
2002	8	4.70	7.98	15.00	4.70 to 45.00	30.67	45.00	22.68
2003	9	4.70	7.37	9.70	6.10 to 14.00	13.33	14.00	5.97
2004	8	4.50	5.19	5.75	4.50 to 8.30	6.93	8.30	1.74
2005	9	3.90	5.47	9.10	4.40 to 11.00	10.33	11.00	4.87
2006	4	3.40	7.82	15.00	- to -	18.92	21.00	11.10
2007	4	7.60	9.02	11.00	- to -	44.83	69.00	35.82

Figure 70. Chlorophyll-a box plots for Armstrong Lake (1999-2007) without Outliers



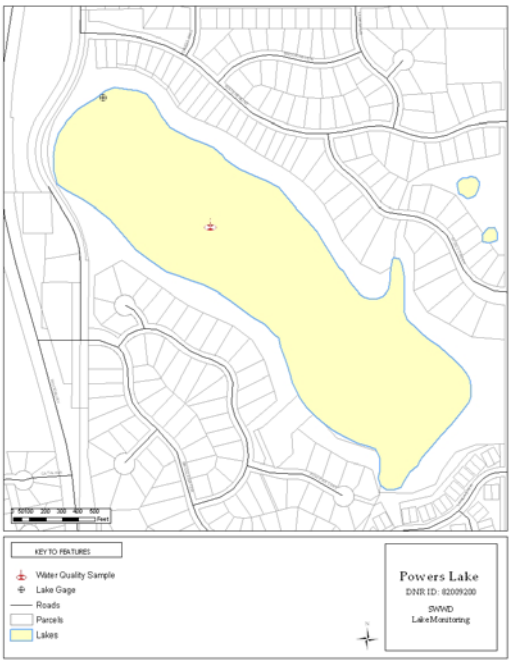
Chloride by Armstrong - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	42	17.00	40.75	69.00	46.00 to 77.00	97.08	158.00	56.33
2002	8	18.00	33.50	42.00	18.00 to 95.00	44.75	95.00	11.25
2003	9	29.00	55.67	70.00	47.00 to 82.00	78.67	88.00	23.00
2004	8	33.00	50.33	69.50	33.00 to 133.00	87.83	133.00	37.50
2005	9	17.00	24.00	38.00	22.00 to 69.00	59.67	98.00	35.67
2006	4	112.00	112.83	116.00	- to -	128.50	136.00	15.67
2007	4	104.00	116.08	137.50	- to -	151.33	158.00	35.25

Figure 71. Total Chloride box plots for Armstrong Lake (1998-2007)

Powers Lake

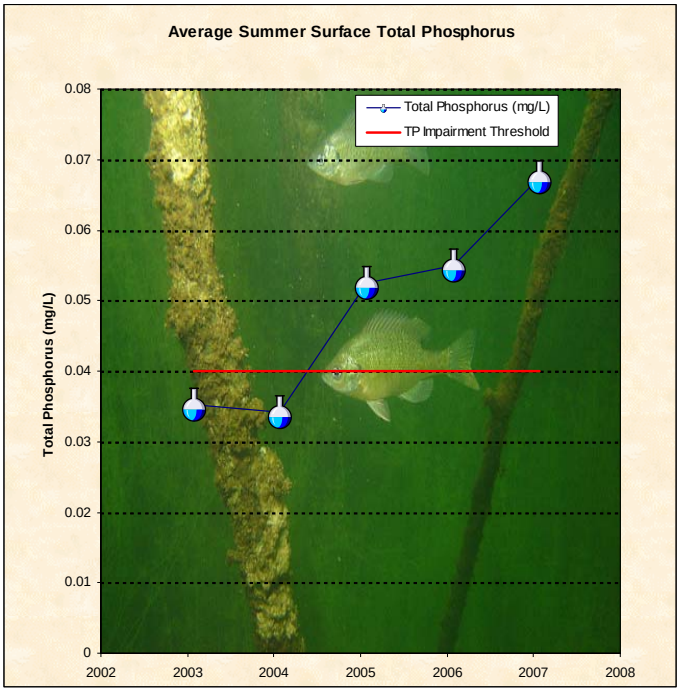
2007 Lake Grade: C

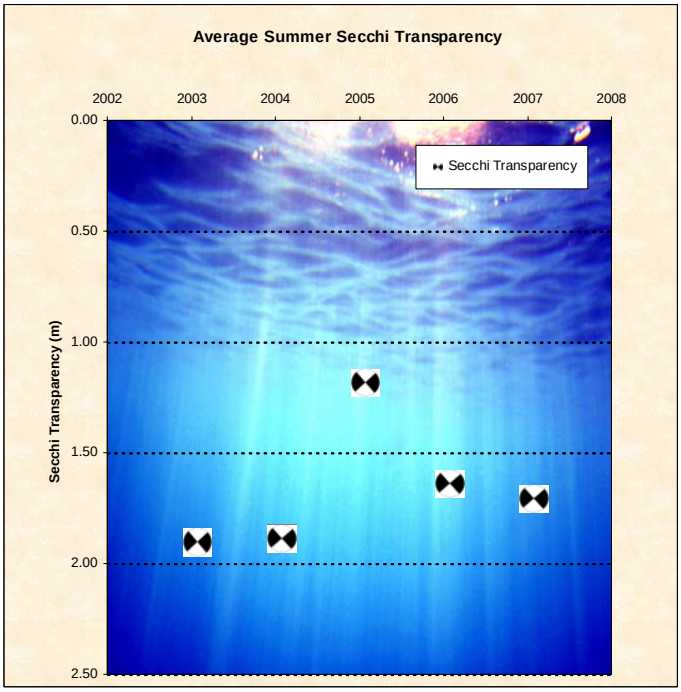
- DNR ID #: 82-0092
- Municipality: City of Woodbury
- Location: SW ¼ Sect. 11 T28 – R21
- Lake Size: 60 Acres
- Maximum Depth: 40 ft
- Ordinary High Water Mark: 891.3 ft
- 48%Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Powers Lake was considered a eutrophic lake in 2007, based on the Carlson Trophic State Index.
- There is an increasing trend in the average total phosphorus, and Secchi disk transparency (water clarity) is declining, indicating declining water quality.
- The major land use is urban/residential.
- **Eurasian Water Milfoil (an invasive aquatic plant) is present.**
- The lake stratified from June 19th to October 11th, 2007 and the average depth of the thermocline was 1.68 m





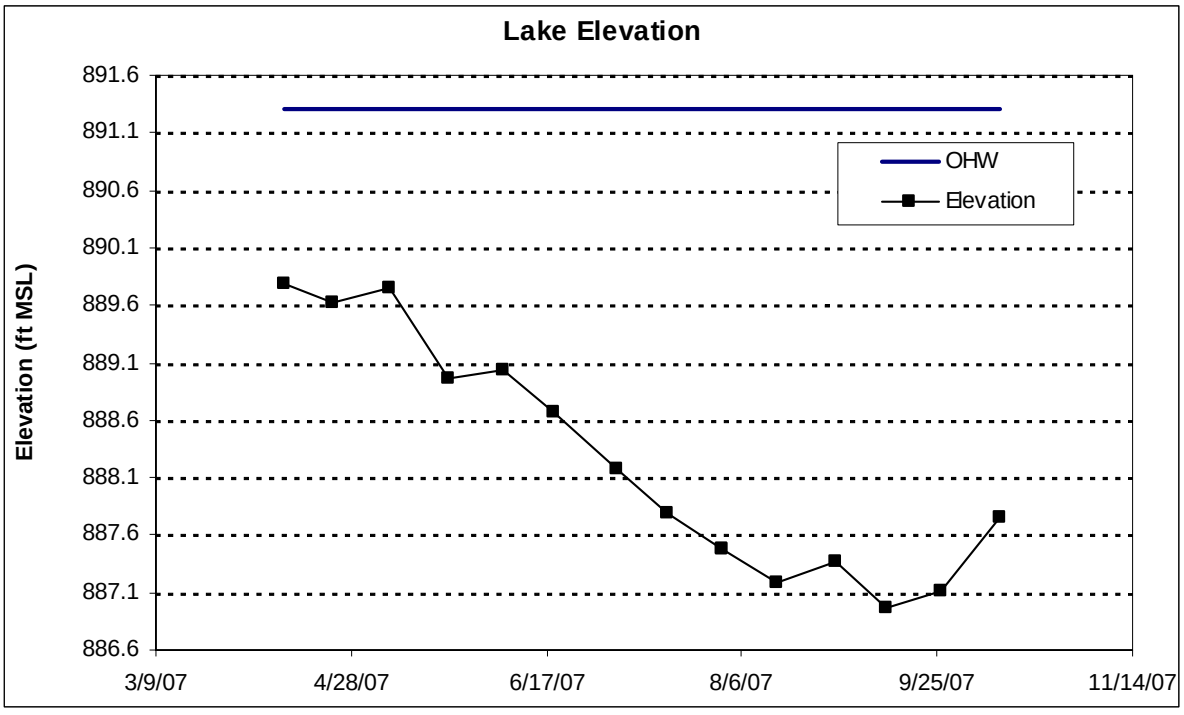
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Total Chloride	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/13/2007	0.023	9	0.51	37	1.98	12.42	5.0
4/25/2007	0.030	8	0.83	38	2.59	11.53	13.3
5/7/2007	0.022	21	1.00	38	2.13	13.31	17.2
5/22/2007	0.043	8	1.20	NA	2.90	9.11	20.4
6/5/2007	0.035	14	0.54	26	2.59	9.84	21.9
6/20/2007	0.037	16	1.20	38.5	1.98	7.44	26.9
7/3/2007	0.030	24	1.30	40	1.68	9.17	27.7
7/16/2007	0.228	41	2.90	38	1.22	9.70	29.8
8/1/2007	0.030	10	1.60	38	2.29	7.90	31.6
8/13/2007	0.031	26	1.20	39	1.37	9.03	28.3
8/28/2007	0.039	25	1.70	NA	1.07	8.88	24.6
9/10/2007	0.027	13	1.80	NA	1.37	7.66	23.2
9/25/2007	0.047	20	1.40	37	1.52	8.21	21.7
10/11/2007	0.027	14	1.10	37	1.83	6.13	17.8
2007 Average	0.046	18	1.31	37	1.89	9.31	22.1
2007 Summer Average	0.056	21	1.52	37	1.68	8.65	26.2

Water quality threshold is 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

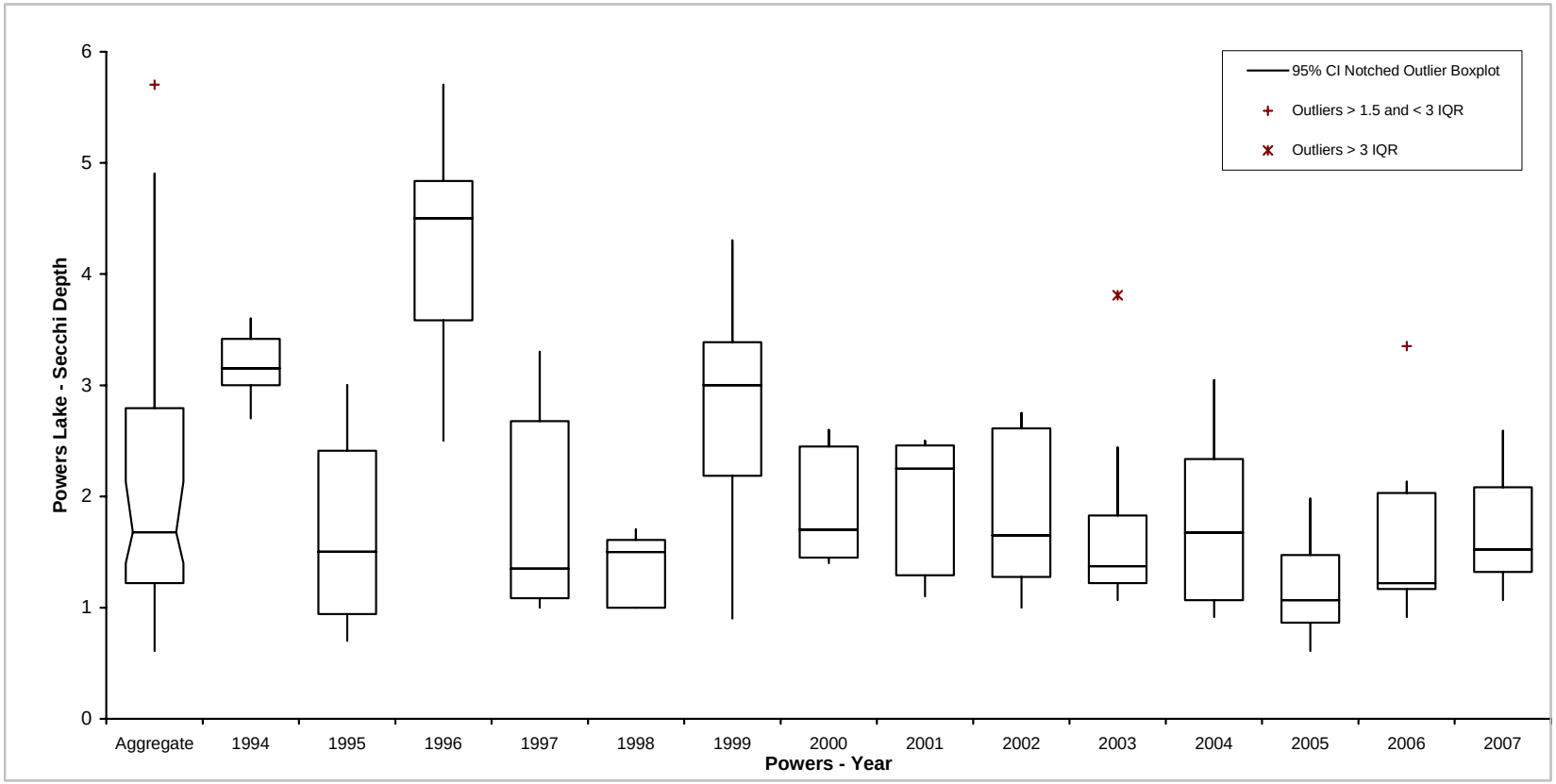
	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	889.79	4/11/2007	886.97	9/12/2007	888.21

*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over teh course of two summers; however it might aslo reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitroing programs). In addition to exceeding the TP guikeline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. this amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



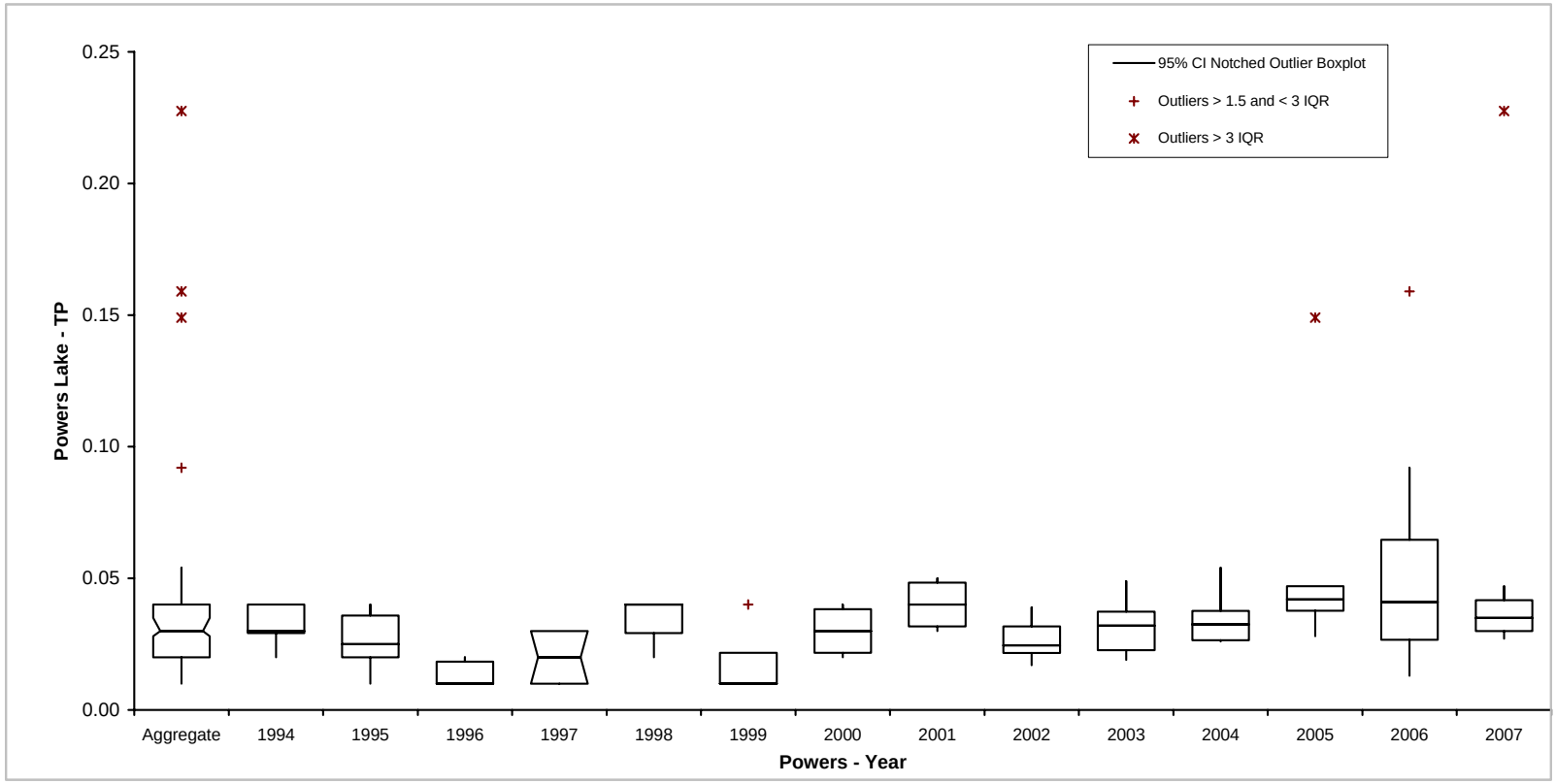
Lake Water Quality Summary	Trophic Status	Lake Grades				
	2007	2007	2006	2005	2004	2003
Total Phosphorus (mg/l)	Eutrophic	C	C	F	C	C
Chlorophyll-*a* (ug/l)	Eutrophic	C	C	C	C	C
Secchi depth (ft)	Eutrophic	C	C	D	C	C
Overall	Eutrophic	C	C	D	C	C

Box plot statistical summaries for Powers Lake are included in Figures 72-77. Secchi disk values do not show a statistically significant trend in either direction. Of note, the monitoring seasons of 1996 and 1999 had the highest Secchi disk median values were correlated with the lowest median values of both total phosphorus and chlorophyll-a. There is a moderate statistically significant increasing trend in total phosphorus median values over the sampling period.



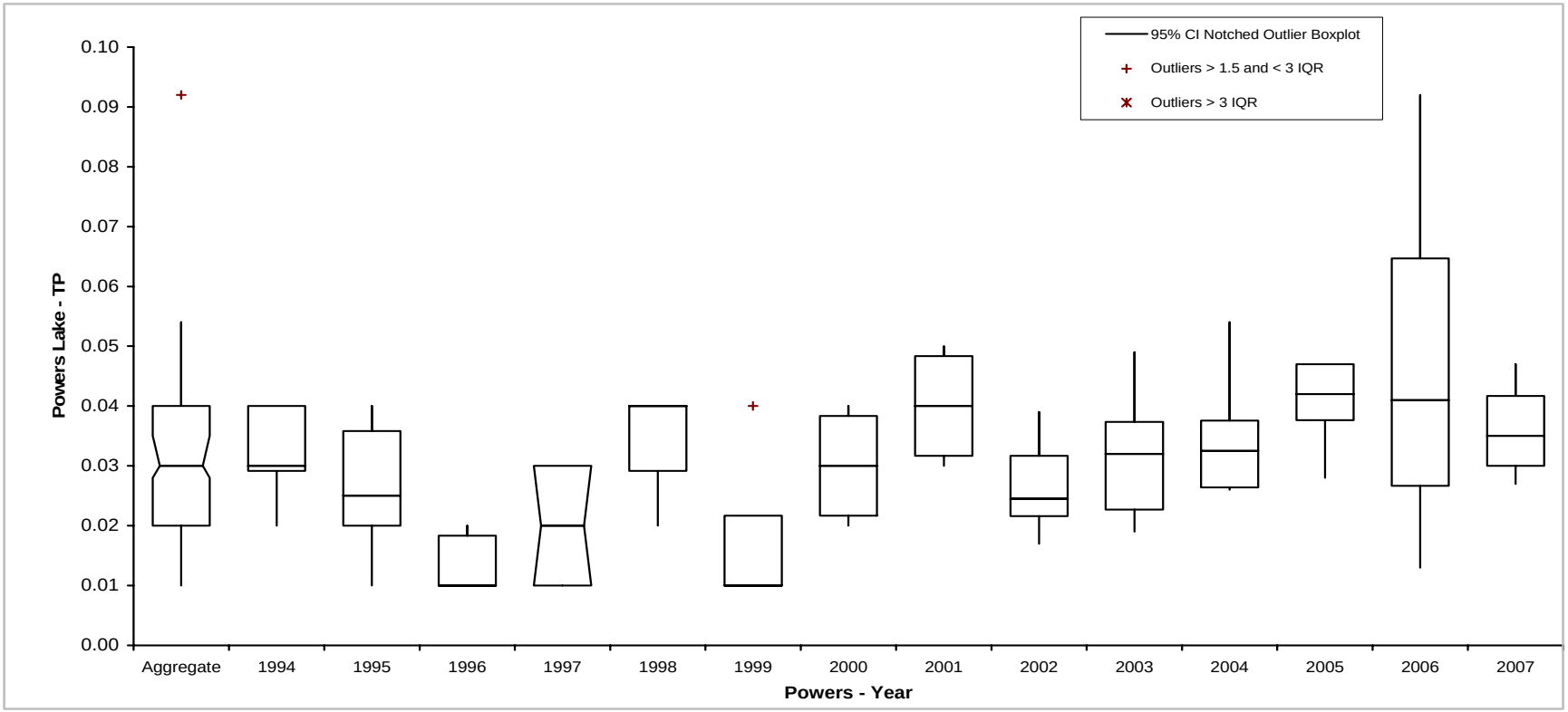
Powers Lake - Secchi Depth by Powers - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	107	0.61	1.22	1.68	1.40 to 2.13	2.79	5.70	1.57
1994	10	2.70	3.00	3.15	3.00 to 3.60	3.42	3.60	0.42
1995	8	0.70	0.94	1.50	0.70 to 3.00	2.41	3.00	1.47
1996	7	2.50	3.58	4.50	2.50 to 5.70	4.84	5.70	1.25
1997	8	1.00	1.08	1.35	1.00 to 3.30	2.68	3.30	1.59
1998	6	1.00	1.00	1.50	1.00 to 1.70	1.61	1.70	0.61
1999	6	0.90	2.19	3.00	0.90 to 4.30	3.39	4.30	1.20
2000	3	1.40	1.45	1.70	- to -	2.45	2.60	1.00
2001	3	1.10	1.29	2.25	- to -	2.46	2.50	1.17
2002	6	1.00	1.28	1.65	1.00 to 2.75	2.61	2.75	1.34
2003	9	1.07	1.22	1.37	1.22 to 2.44	1.83	3.81	0.61
2004	14	0.91	1.07	1.68	1.07 to 2.90	2.34	3.05	1.27
2005	9	0.61	0.86	1.07	0.76 to 1.68	1.47	1.98	0.61
2006	9	0.91	1.17	1.22	1.07 to 2.13	2.03	3.35	0.86
2007	9	1.07	1.32	1.52	1.22 to 2.29	2.08	2.59	0.76

Figure 72. Secchi Disk box plots for Powers Lake (1994-2007)



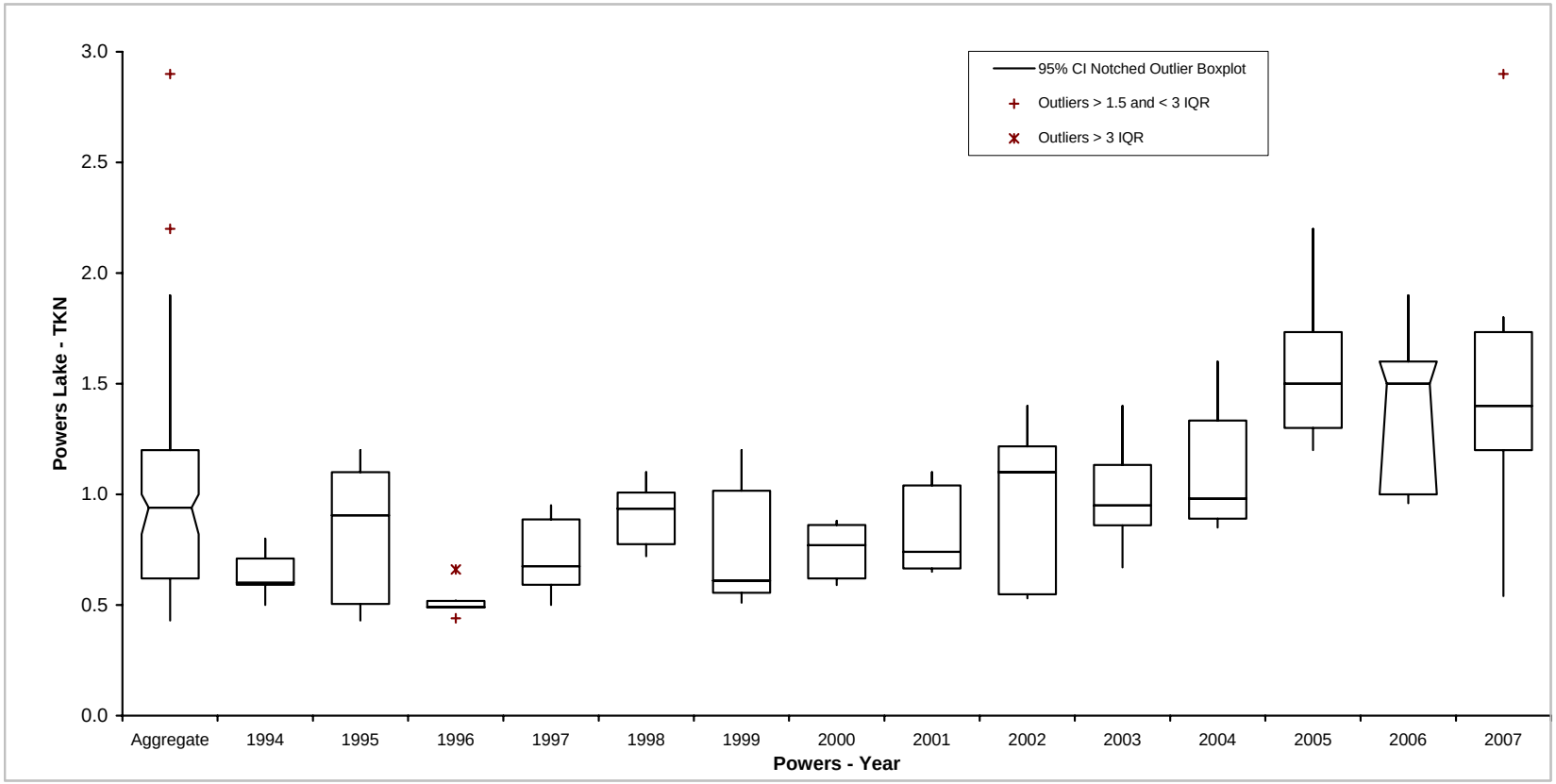
Powers Lake - TP by Powers - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	101	0.01	0.02	0.03	0.03 to 0.04	0.04	0.23	0.02
1994	10	0.02	0.03	0.03	0.02 to 0.04	0.04	0.04	0.01
1995	8	0.01	0.02	0.03	0.01 to 0.04	0.04	0.04	0.02
1996	7	0.01	0.01	0.01	0.01 to 0.02	0.02	0.02	0.01
1997	8	0.01	0.01	0.02	0.01 to 0.03	0.03	0.03	0.02
1998	6	0.02	0.03	0.04	0.02 to 0.04	0.04	0.04	0.01
1999	6	0.01	0.01	0.01	0.01 to 0.04	0.02	0.04	0.01
2000	3	0.02	0.02	0.03	- to -	0.04	0.04	0.02
2001	3	0.03	0.03	0.04	- to -	0.05	0.05	0.02
2002	6	0.02	0.02	0.02	0.02 to 0.04	0.03	0.04	0.01
2003	9	0.02	0.02	0.03	0.02 to 0.04	0.04	0.05	0.01
2004	8	0.03	0.03	0.03	0.03 to 0.05	0.04	0.05	0.01
2005	9	0.03	0.04	0.04	0.04 to 0.05	0.05	0.15	0.01
2006	9	0.01	0.03	0.04	0.02 to 0.09	0.06	0.16	0.04
2007	9	0.03	0.03	0.04	0.03 to 0.05	0.04	0.23	0.01

Figure 73. Total Phosphorus box plots for Powers Lake (1994-2007)



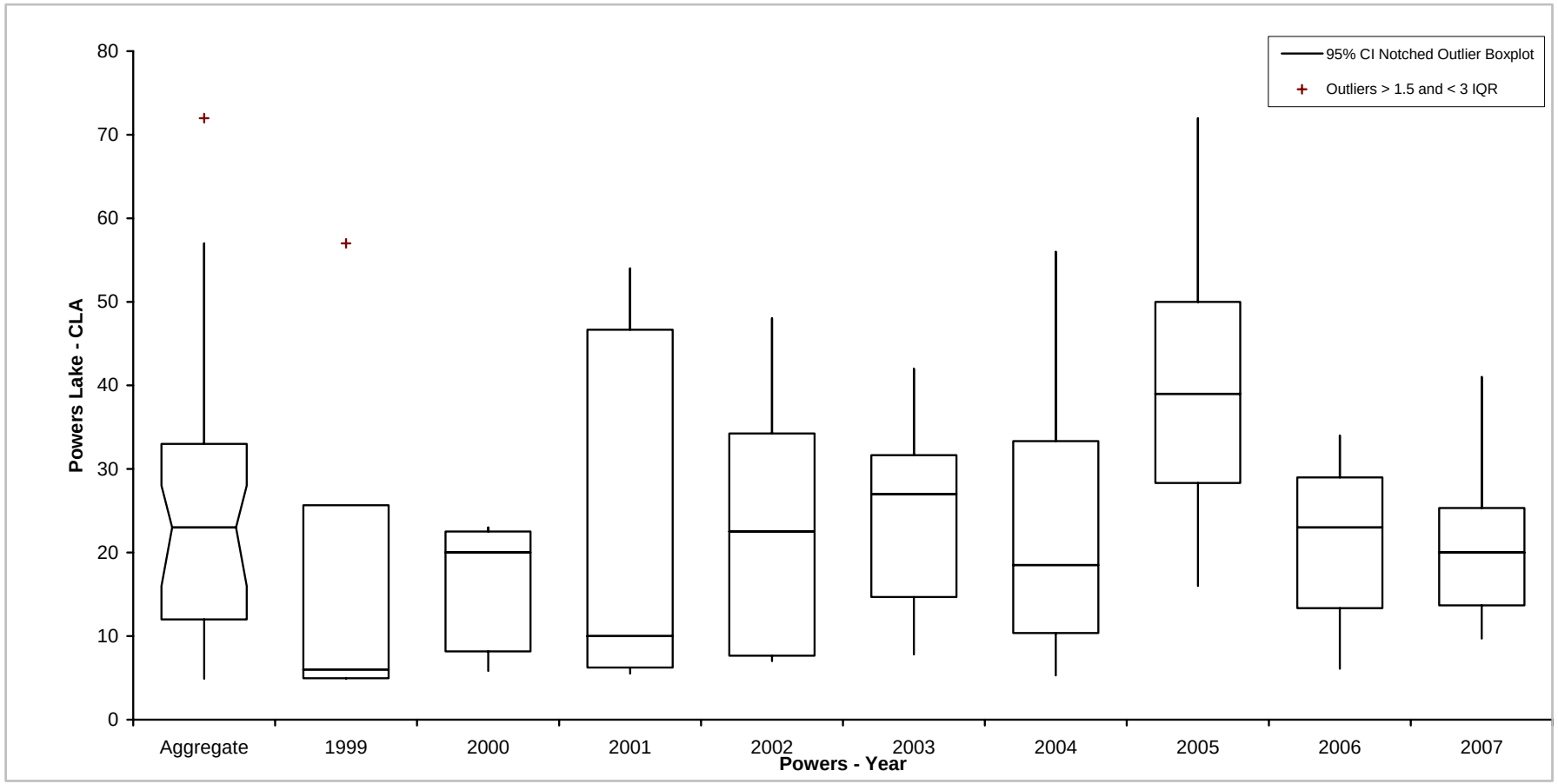
Powers Lake - TP by Powers - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	101	0.01	0.02	0.03	0.03 to 0.04	0.04	0.23	0.02
1994	10	0.02	0.03	0.03	0.02 to 0.04	0.04	0.04	0.01
1995	8	0.01	0.02	0.03	0.01 to 0.04	0.04	0.04	0.02
1996	7	0.01	0.01	0.01	0.01 to 0.02	0.02	0.02	0.01
1997	8	0.01	0.01	0.02	0.01 to 0.03	0.03	0.03	0.02
1998	6	0.02	0.03	0.04	0.02 to 0.04	0.04	0.04	0.01
1999	6	0.01	0.01	0.01	0.01 to 0.04	0.02	0.04	0.01
2000	3	0.02	0.02	0.03	- to -	0.04	0.04	0.02
2001	3	0.03	0.03	0.04	- to -	0.05	0.05	0.02
2002	6	0.02	0.02	0.02	0.02 to 0.04	0.03	0.04	0.01
2003	9	0.02	0.02	0.03	0.02 to 0.04	0.04	0.05	0.01
2004	8	0.03	0.03	0.03	0.03 to 0.05	0.04	0.05	0.01
2005	9	0.03	0.04	0.04	0.04 to 0.05	0.05	0.15	0.01
2006	9	0.01	0.03	0.04	0.02 to 0.09	0.06	0.16	0.04
2007	9	0.03	0.03	0.04	0.03 to 0.05	0.04	0.23	0.01

Figure 74. Total Phosphorus box plots for Powers Lake (1994-2007) without Outliers



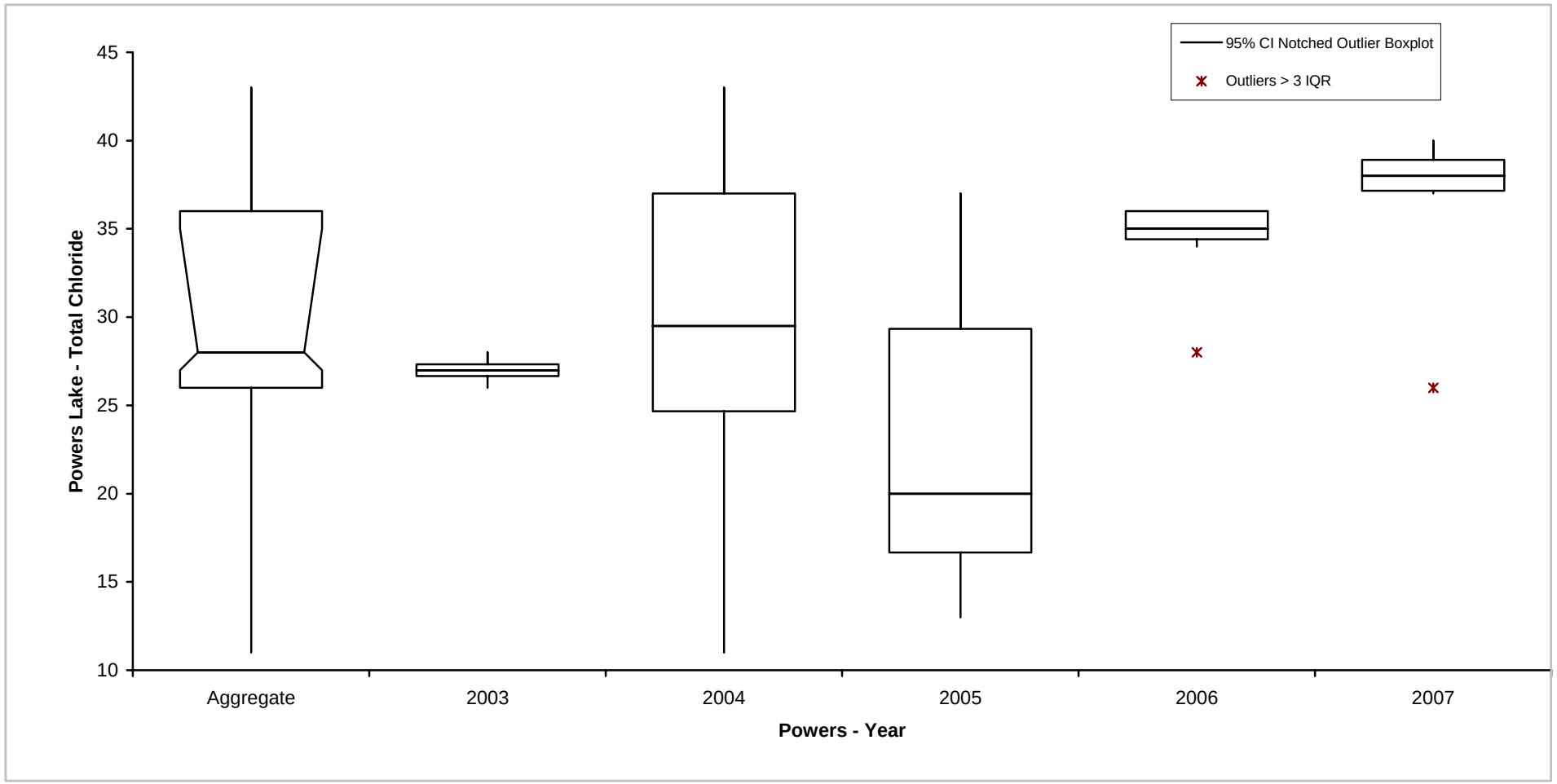
Powers Lake - TKN by Powers - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	101	0.43	0.62	0.94	0.82 to 1.00	1.20	2.90	0.58
1994	10	0.50	0.59	0.60	0.50 to 0.71	0.71	0.80	0.12
1995	8	0.43	0.51	0.91	0.43 to 1.20	1.10	1.20	0.60
1996	7	0.44	0.49	0.49	0.44 to 0.66	0.52	0.66	0.03
1997	8	0.50	0.59	0.68	0.50 to 0.95	0.89	0.95	0.30
1998	6	0.72	0.78	0.94	0.72 to 1.10	1.01	1.10	0.23
1999	6	0.51	0.56	0.61	0.51 to 1.20	1.02	1.20	0.46
2000	3	0.59	0.62	0.77	- to -	0.86	0.88	0.24
2001	3	0.65	0.67	0.74	- to -	1.04	1.10	0.38
2002	6	0.53	0.55	1.10	0.53 to 1.40	1.22	1.40	0.67
2003	9	0.67	0.86	0.95	0.82 to 1.20	1.13	1.40	0.27
2004	8	0.85	0.89	0.98	0.85 to 1.60	1.33	1.60	0.44
2005	9	1.20	1.30	1.50	1.30 to 1.80	1.73	2.20	0.43
2006	9	0.96	1.00	1.50	1.00 to 1.60	1.60	1.90	0.60
2007	9	0.54	1.20	1.40	1.20 to 1.80	1.73	2.90	0.53

Figure 75. Total Kjedahl Nitrogen box plots for Powers Lake (1994-2007)



Powers Lake - CLA by Powers - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	61	4.90	12.00	23.00	16.00 to 28.00	33.00	72.00	21.00
1999	5	4.90	4.97	6.00	- to -	25.67	57.00	20.70
2000	3	5.80	8.17	20.00	- to -	22.50	23.00	14.33
2001	3	5.50	6.25	10.00	- to -	46.67	54.00	40.42
2002	6	7.00	7.64	22.50	7.00 to 48.00	34.25	48.00	26.61
2003	9	7.80	14.67	27.00	14.00 to 33.00	31.67	42.00	17.00
2004	8	5.30	10.37	18.50	5.30 to 56.00	33.33	56.00	22.97
2005	9	16.00	28.33	39.00	21.00 to 56.00	50.00	72.00	21.67
2006	9	6.10	13.33	23.00	12.00 to 29.00	29.00	34.00	15.67
2007	9	9.70	13.67	20.00	13.00 to 26.00	25.33	41.00	11.67

Figure 76. Chlorophyll-a box plots for Powers Lake (1999-2007)



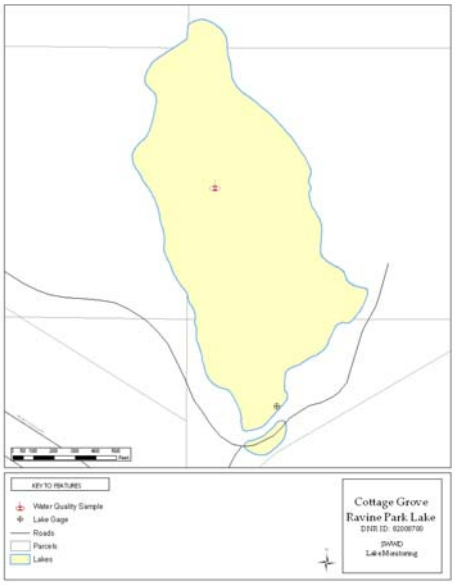
Powers Lake - Total Chloride by Powers - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	41	11.00	26.00	28.00	27.00 to 35.00	36.00	43.00	10.00
2003	9	26.00	26.67	27.00	26.00 to 28.00	27.33	28.00	0.67
2004	8	11.00	24.67	29.50	11.00 to 43.00	37.00	43.00	12.33
2005	9	13.00	16.67	20.00	16.00 to 34.00	29.33	37.00	12.67
2006	8	28.00	34.42	35.00	28.00 to 36.00	36.00	36.00	1.58
2007	7	26.00	37.17	38.00	26.00 to 40.00	38.92	40.00	1.75

Figure 77. Total Chloride box plots for Powers Lake (2003-2007)

Cottage Grove Ravine Regional Park Lake

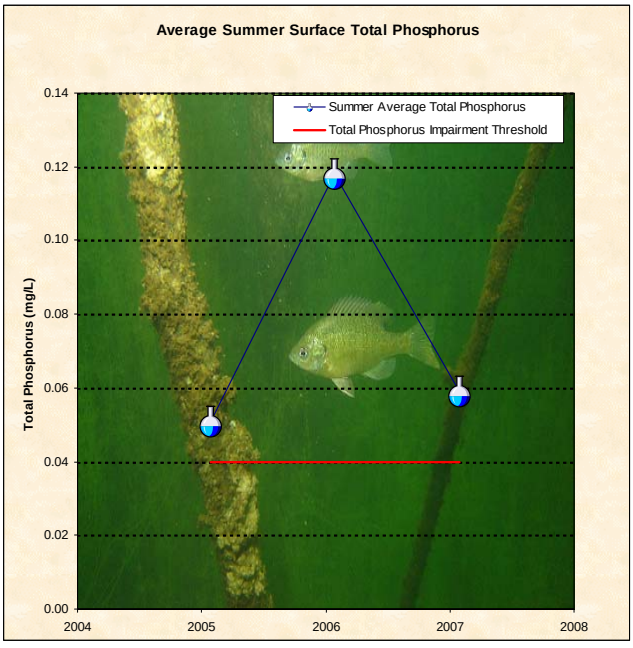
2007 Lake Grade: C+

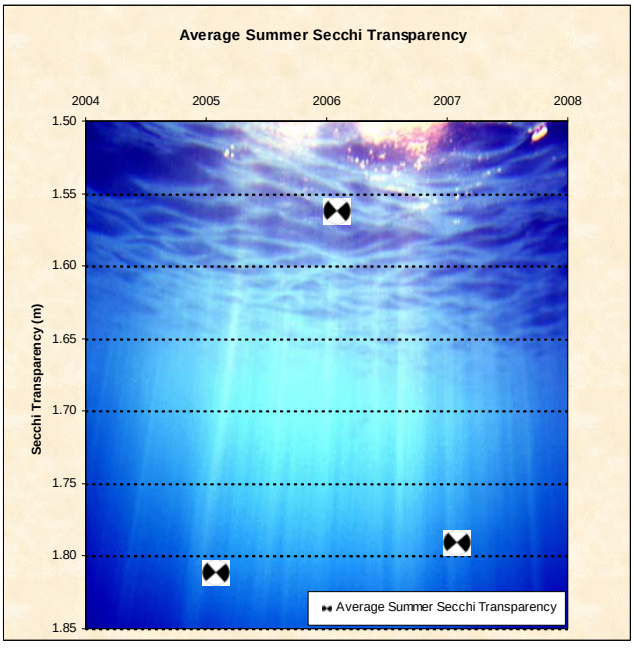
- DNR ID #: 820087
- Municipality: City of Cottage Grove
- Location: SW ¼ Sect. 23 T26&27 – R21
- Lake Size: 19.4 Acres
- Maximum Depth: 16 ft
- Ordinary High Water Mark: 770.7 ft
- Littoral area not known



Summary Points

- Cottage Grove Ravine Regional Park Lake was considered a eutrophic lake in 2007, based on the Carlson Trophic State Index.
- Statistical trends could not be determined for Cottage Grove Ravine Regional Park Lake due to insufficient data points.
- The major land use is open space, forest, and agriculture.
- The lake was stratified from June 19th to September 11th, 2007 and the average depth of the thermocline was 1.16 meters.





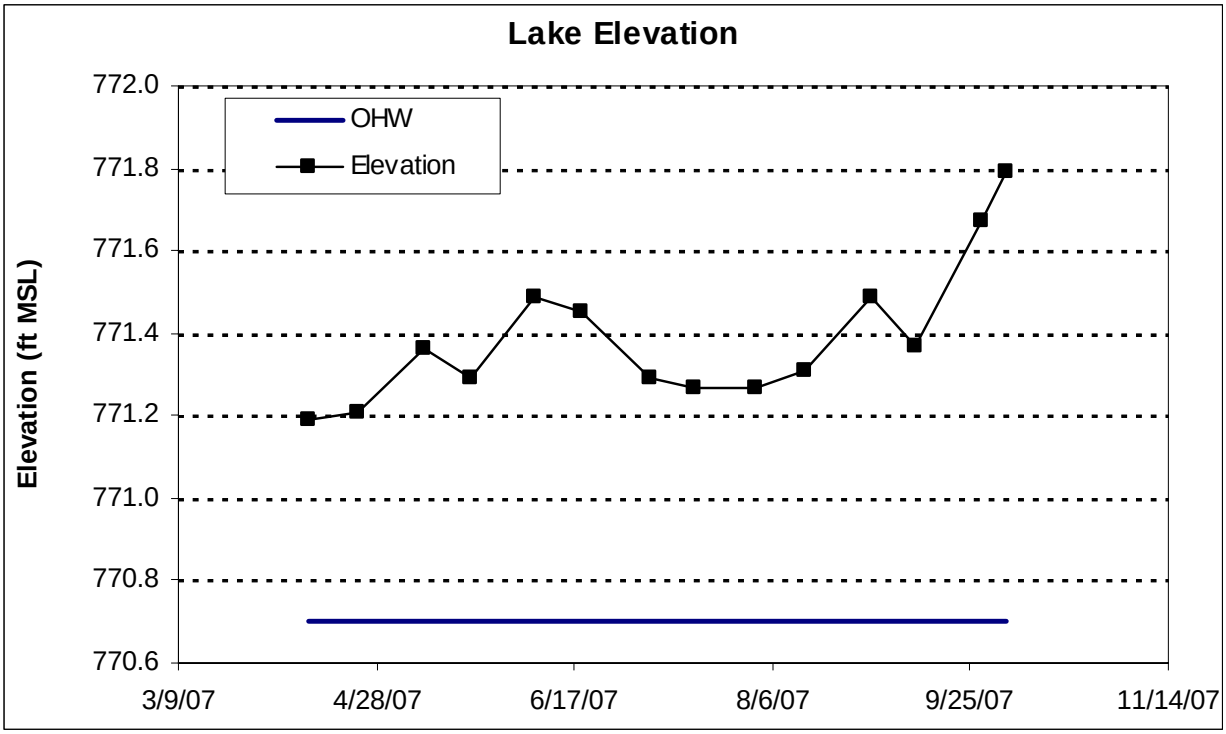
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Total Chloride	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/23/2007	0.059	14	0.86	16	1.68	10.25	15.4
5/22/2007	0.049	9	0.76	NA	2.13	9.00	20.6
6/19/2007	0.054	14	0.83	18	1.98	4.67	27.3
7/17/2007	0.067	20	0.96	17	1.83	10.02	30.3
8/14/2007	0.058	28	0.97	18	1.52	9.25	29.0
9/11/2007	0.057	8	1.30	NA	1.83	3.63	22.7
10/4/2007	0.061	8	1.10	17	1.07	4.92	19.1
2007 Average	0.058	14	0.97	17	1.72	7.39	23.5
2007 Summer Average	0.059	17	1.02	18	1.79	6.89	27.3

Water quality threshold is 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

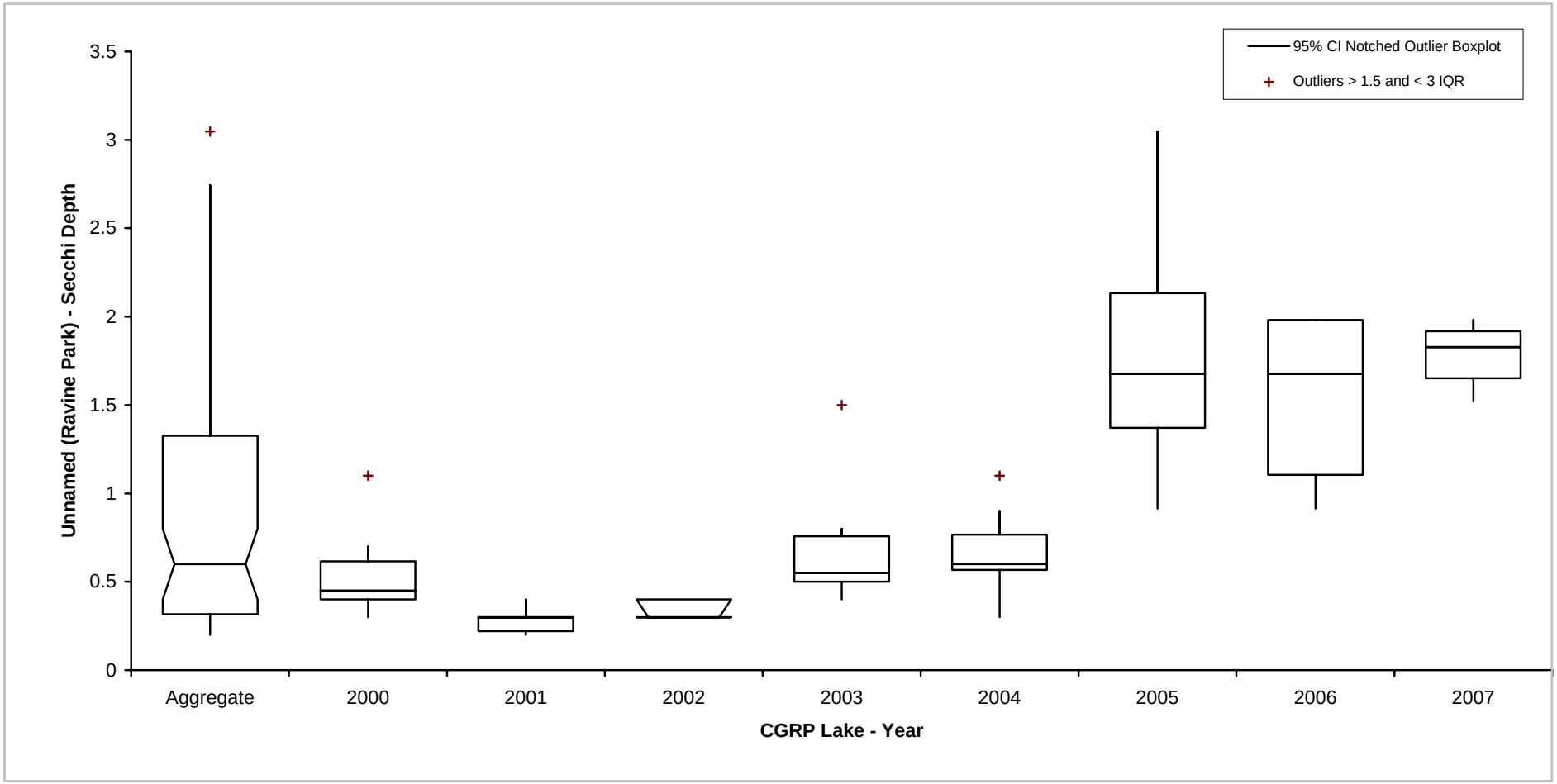
	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	771.79	10/4/2007	771.19	4/11/2007	771.39

*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over teh course of two summers; however it might aslo reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitroing programs). In addition to exceeding the TP guikeline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. this amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



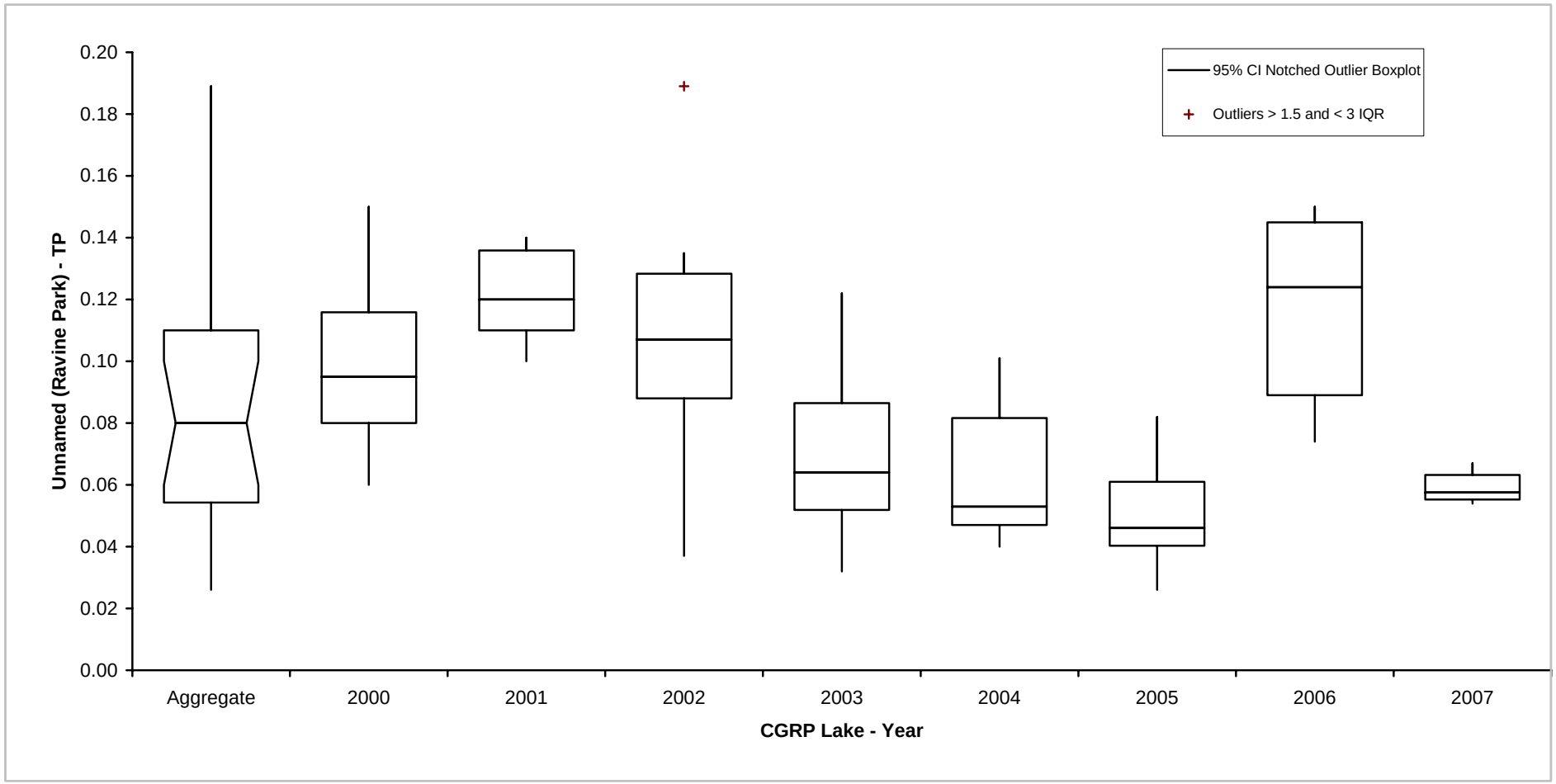
Lake Water Quality Summary	Trophic Status	Lake Grades		
	2007	2007	2006	2005
Total Phosphorus (mg/l)	Eutrophic	C	D	F
Chlorophyll-*a* (ug/l)	Eutrophic	B	C	C
Secchi depth (ft)	Mesotrophic	C	C	C
Overall	Eutrophic	C+	C-	D+

Statistical box plot summaries for Cottage Grove Regional Ravine Park Lake are included in Figures 78-82. Similar to Armstrong Lake, a step increase in Secchi disk median values was evident between the years 2004 and 2005. This step was more dramatic then Armstrong Lake and the Secchi disk median values are holding at the new regime at a stable condition over the past three years. Other than the 2006 sampling season, total phosphorus, total Kjedahl nitrogen, and chlorophyll-a median values appears to have a decreasing trend.



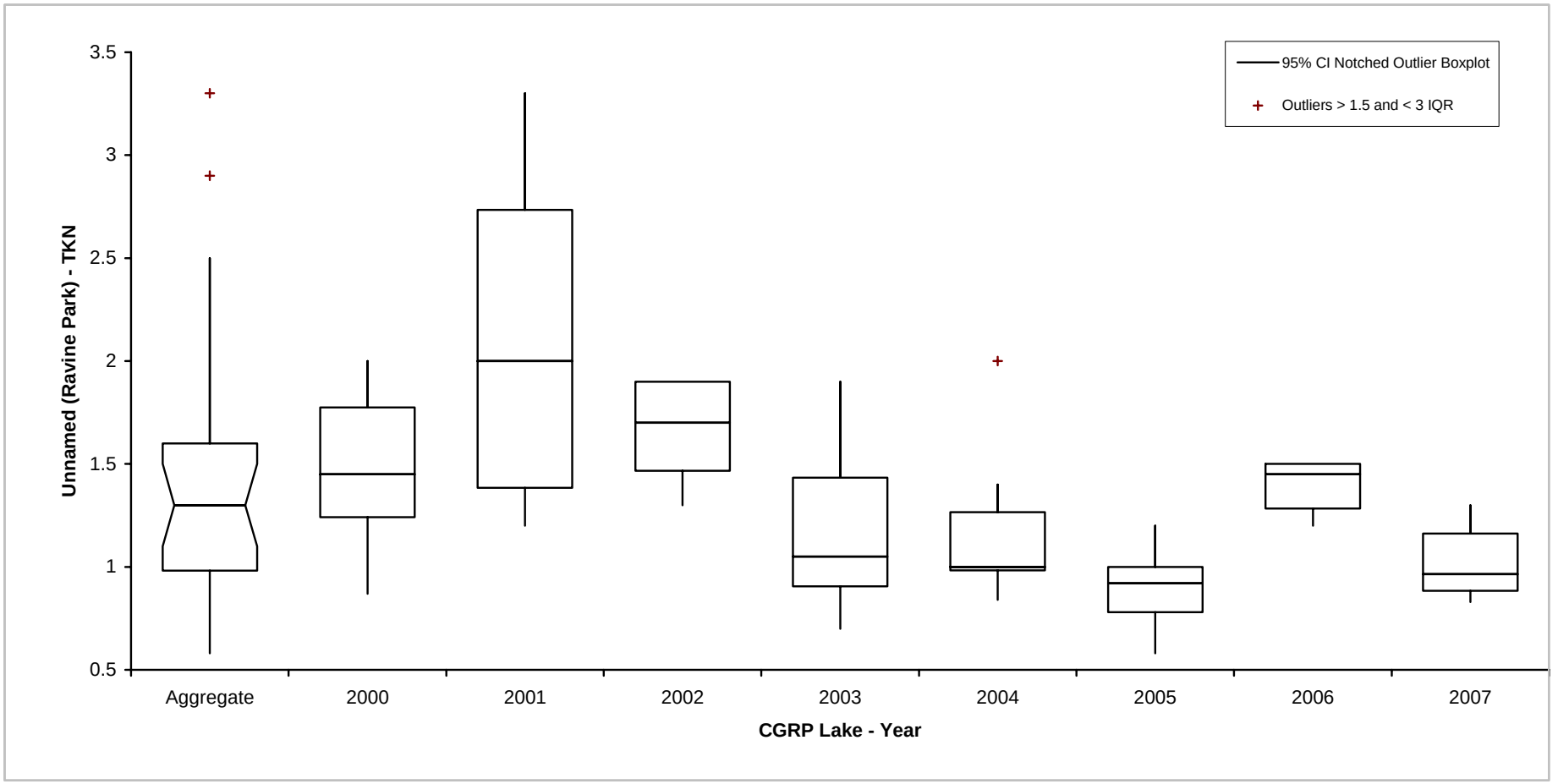
Secchi Depth by CGRP Lake - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	59	0.20	0.32	0.60	0.40 to 0.80	1.33	3.05	1.01
2000	8	0.30	0.40	0.45	0.30 to 1.10	0.62	1.10	0.22
2001	8	0.20	0.22	0.30	0.20 to 0.40	0.30	0.40	0.08
2002	9	0.30	0.30	0.30	0.30 to 0.40	0.40	0.40	0.10
2003	8	0.40	0.50	0.55	0.40 to 1.50	0.76	1.50	0.26
2004	9	0.30	0.57	0.60	0.50 to 0.90	0.77	1.10	0.20
2005	9	0.91	1.37	1.68	1.07 to 2.74	2.13	3.05	0.76
2006	4	0.91	1.10	1.68	- to -	1.98	1.98	0.88
2007	4	1.52	1.65	1.83	- to -	1.92	1.98	0.27

Figure 78. Secchi Disk Depth box plots for Cottage Grove Ravine Lake (2000-2007)



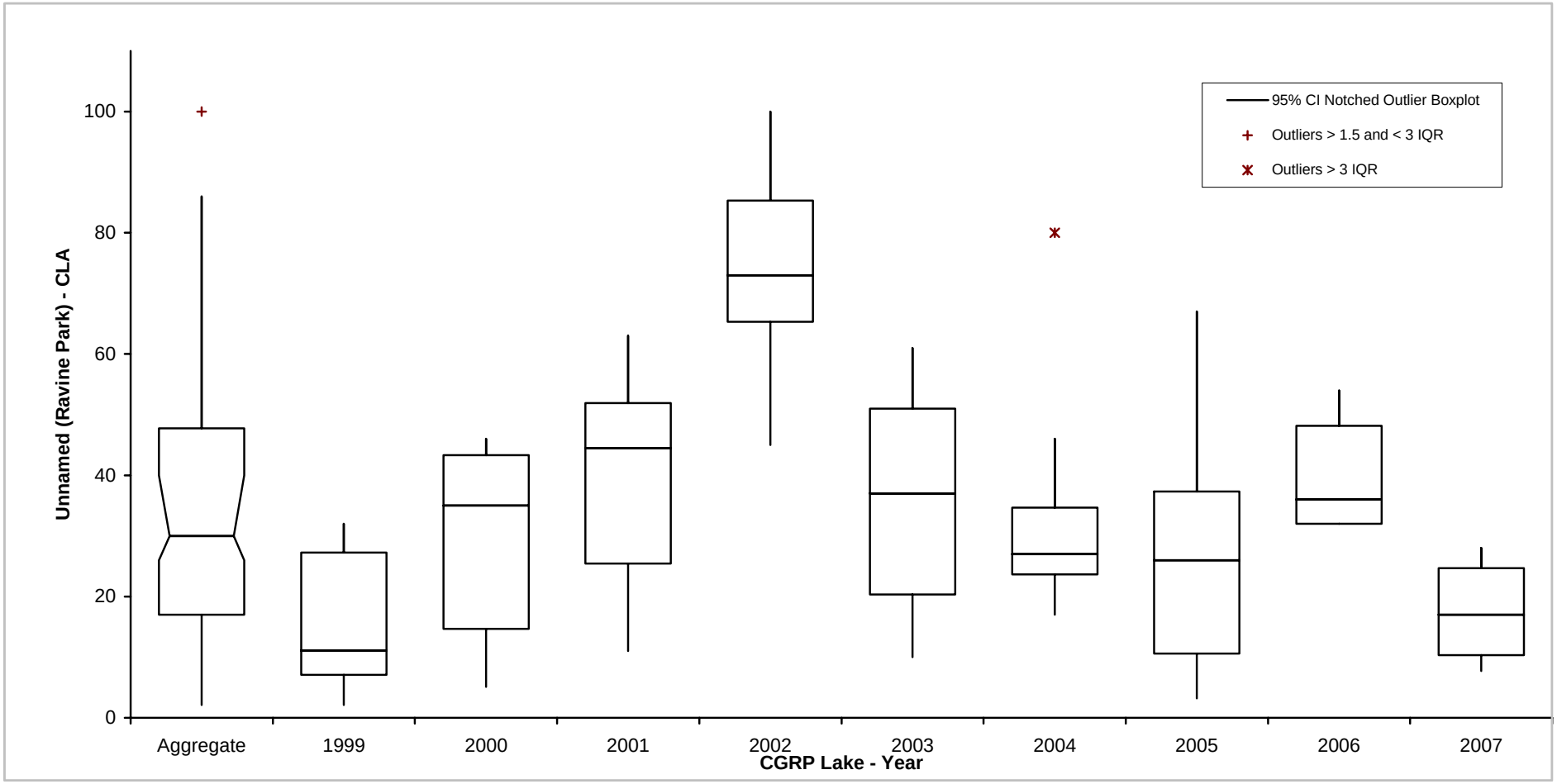
Unnamed (Ravine Park) - TP by CGRP Lake - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	59	0.03	0.05	0.08	0.06 to 0.10	0.11	0.19	0.06
2000	8	0.06	0.08	0.10	0.06 to 0.15	0.12	0.15	0.04
2001	8	0.10	0.11	0.12	0.10 to 0.14	0.14	0.14	0.03
2002	9	0.04	0.09	0.11	0.08 to 0.14	0.13	0.19	0.04
2003	8	0.03	0.05	0.06	0.03 to 0.12	0.09	0.12	0.03
2004	9	0.04	0.05	0.05	0.05 to 0.09	0.08	0.10	0.03
2005	9	0.03	0.04	0.05	0.04 to 0.07	0.06	0.08	0.02
2006	4	0.07	0.09	0.12	- to -	0.15	0.15	0.06
2007	4	0.05	0.06	0.06	- to -	0.06	0.07	0.01

Figure 79. Total Phosphorus box plots for Cottage Grove Ravine Lake (2000-2007)



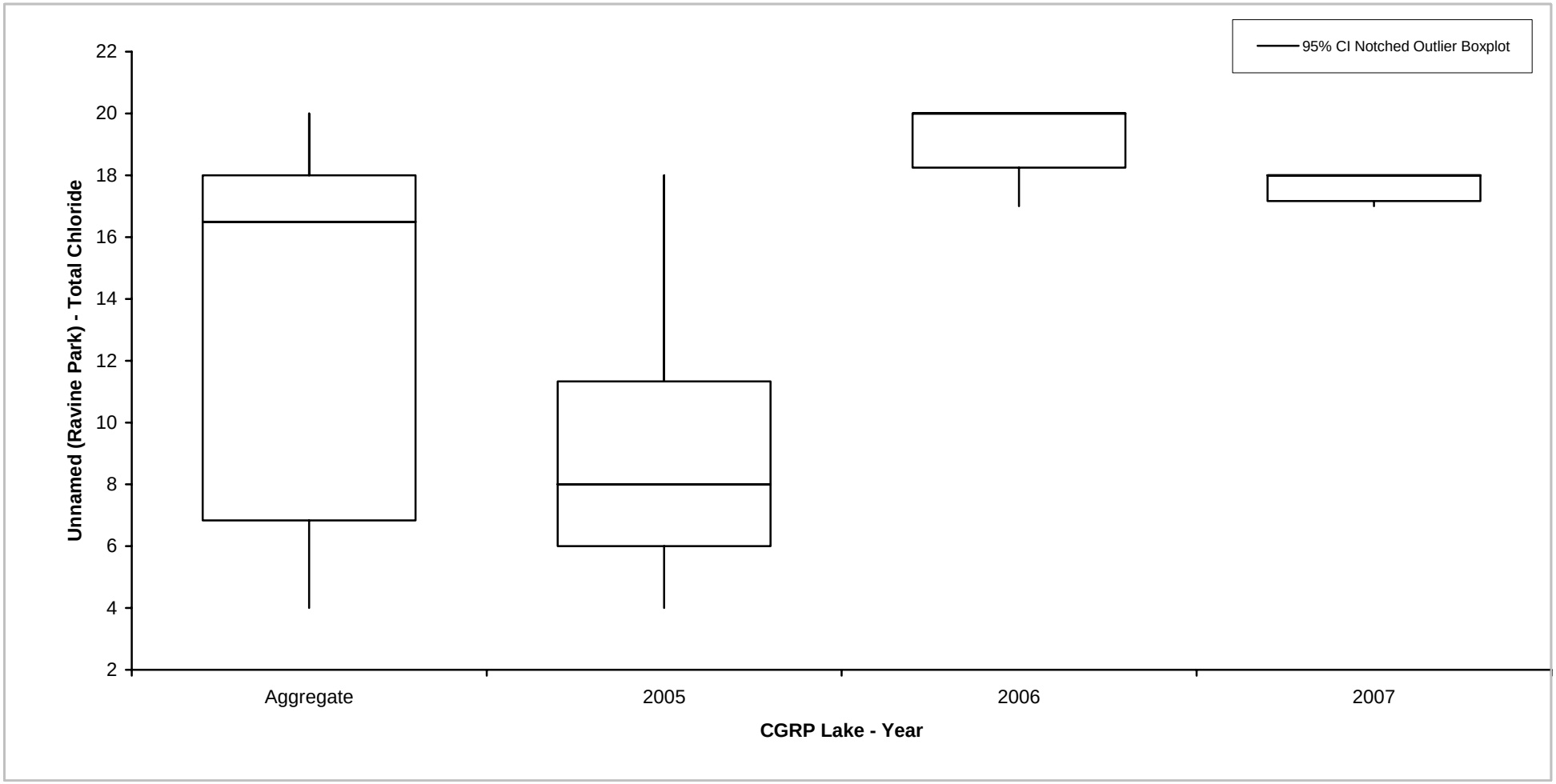
Unnamed (Ravine Park) - TKN by CGRP Lake - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	59	0.58	0.98	1.30	1.10 to 1.50	1.60	3.30	0.62
2000	8	0.87	1.24	1.45	0.87 to 2.00	1.78	2.00	0.53
2001	8	1.20	1.38	2.00	1.20 to 3.30	2.73	3.30	1.35
2002	9	1.30	1.47	1.70	1.40 to 1.90	1.90	1.90	0.43
2003	8	0.70	0.91	1.05	0.70 to 1.90	1.43	1.90	0.53
2004	9	0.84	0.98	1.00	0.97 to 1.40	1.27	2.00	0.28
2005	9	0.58	0.78	0.92	0.74 to 1.00	1.00	1.20	0.22
2006	4	1.20	1.28	1.45	- to -	1.50	1.50	0.22
2007	4	0.83	0.88	0.97	- to -	1.16	1.30	0.28

Figure 80. Total Kjedahl Nitrogen box plots for Cottage Grove Ravine Lake (2000-2007)



Unnamed (Ravine Park) - CLA by CGRP Lake - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	68	2.10	17.00	30.00	26.00 to 40.00	47.75	100.00	30.75
1999	10	2.10	7.07	11.10	5.60 to 30.00	27.25	32.00	20.18
2000	8	5.10	14.67	35.00	5.10 to 46.00	43.33	46.00	28.67
2001	8	11.00	25.42	44.50	11.00 to 63.00	51.92	63.00	26.50
2002	9	45.00	65.33	73.00	64.00 to 86.00	85.33	100.00	20.00
2003	7	10.00	20.33	37.00	10.00 to 61.00	51.00	61.00	30.67
2004	9	17.00	23.67	27.00	23.00 to 46.00	34.67	80.00	11.00
2005	9	3.20	10.60	26.00	9.80 to 50.00	37.33	67.00	26.73
2006	4	32.00	32.00	36.00	- to -	48.17	54.00	16.17
2007	4	7.70	10.33	17.00	- to -	24.67	28.00	14.34

Figure 81. Chlorophyll-a box plots for Cottage Grove Ravine Lake (1999-2007)



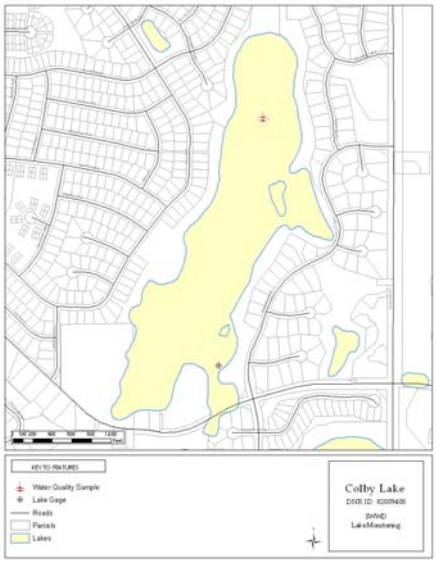
Total Chloride by CGRP Lake - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	16	4.00	6.83	16.50	6.00 to 18.00	18.00	20.00	11.17
2005	9	4.00	6.00	8.00	6.00 to 16.00	11.33	18.00	5.33
2006	4	17.00	18.25	20.00	- to -	20.00	20.00	1.75
2007	3	17.00	17.17	18.00	- to -	18.00	18.00	0.83

Figure 82. Total Chloride box plots for Cottage Grove Ravine Lake (2005-2007)

Colby Lake

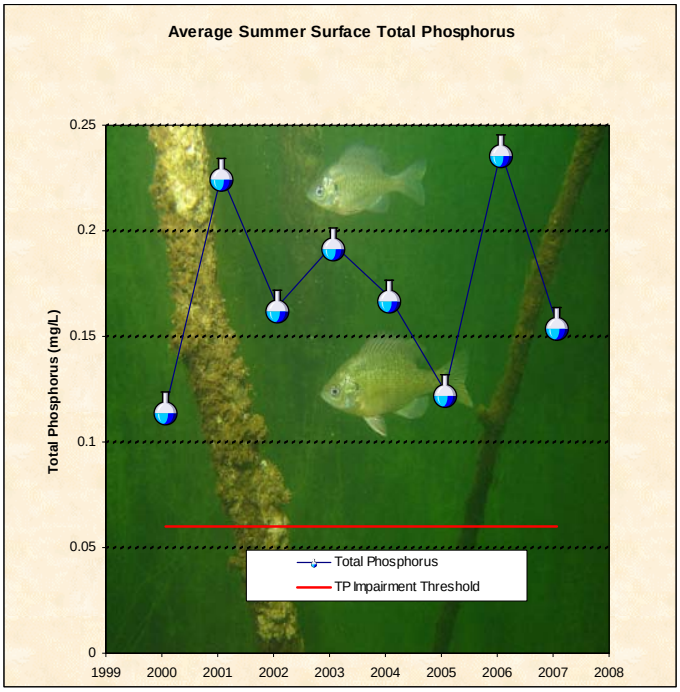
2007 Lake Grade: F+

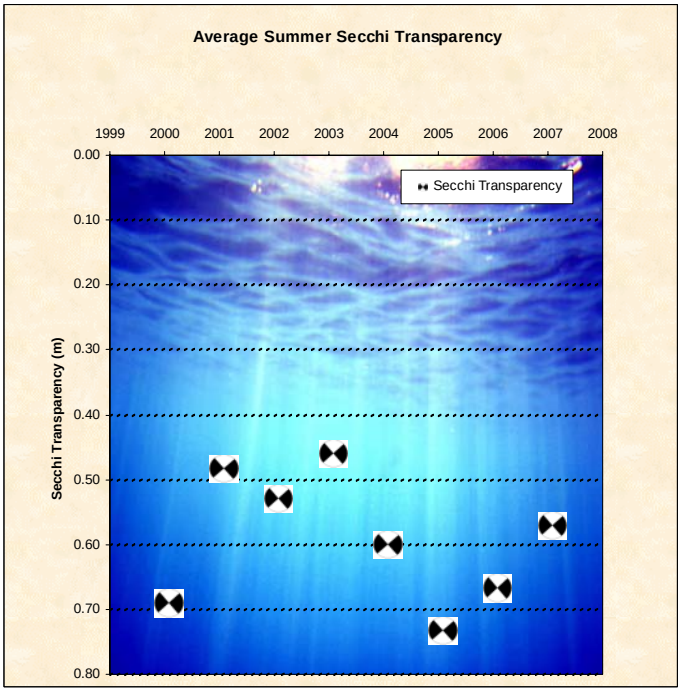
- DNR ID #: 82-0094
- Municipality: City of Woodbury
- Location: SE ¼ Sect. 15 T28 – R21
- Lake Size: 70 Acres
- Maximum Depth: 11 ft
- Ordinary High Water Mark: 891.8 ft
- 100%Littoral
  Note: Littoral area is the portion of the lake <15 ft and dominated by aquatic vegetation.



Summary Points

- Colby Lake was considered a hypereutrophic lake in 2007, based on the Carlson Trophic State Index.
- Statistical analysis shows an increasing trend in Secchi disk readings, correlating to a possible improvement in water quality
- The major land use is urban/residential.
- The lake stratified from July 18th to August 14th, 2007 and the average depth of the thermocline was 0.61 meters.





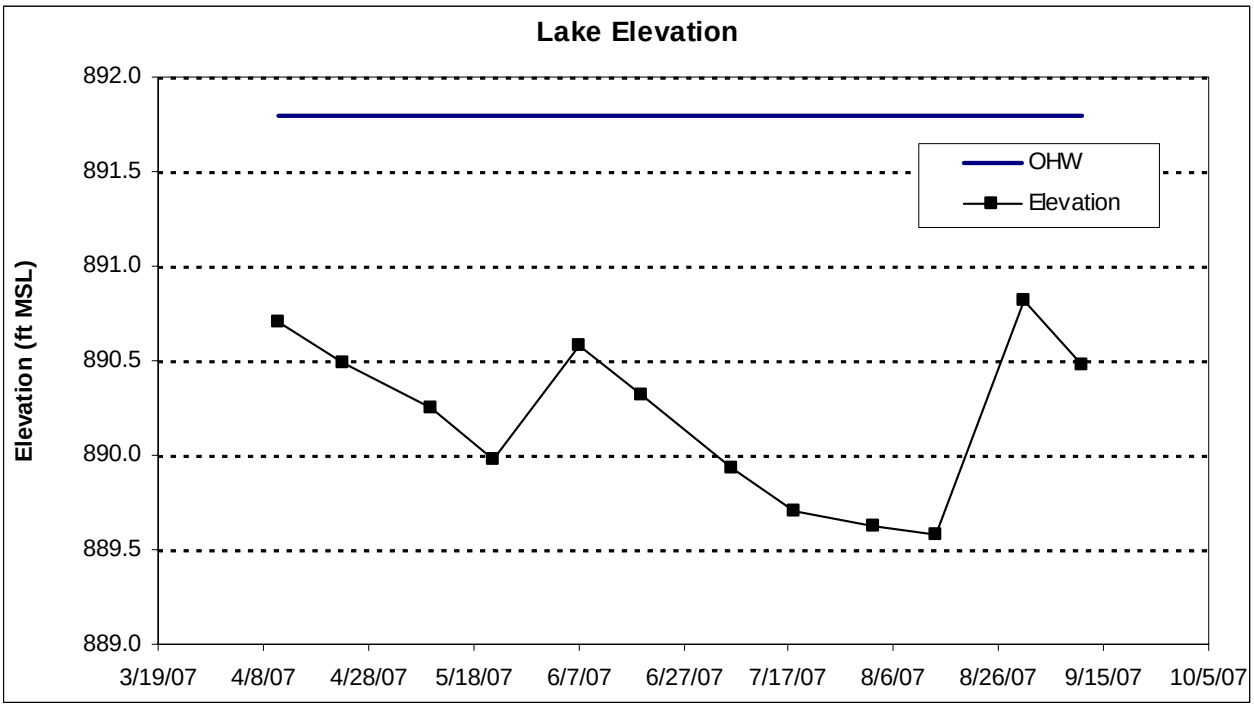
Date	Total Phosphorus (mg/L)	Chlorophyll-a (ug/L)	Total Kjeldahl Nitrogen (mg/L)	Secchi Disk Depths (m)	Surface Dissolved Oxygen Levels (mg/L)	Surface Temperature Levels (Celsius)
4/23/2007	0.061	22	1.50	1.37	9.62	15.5
5/22/2007	0.089	35	1.60	0.76	8.92	20.5
6/19/2007	0.134	31	2.50	0.61	5.99	27.3
7/18/2007	0.136	46	3.10	0.91	12.55	30.6
8/14/2007	0.139	51	3.10	0.46	9.44	29.1
9/11/2007	0.215	100	2.80	0.30	8.03	23.0
10/4/2007	0.188	92	2.50	0.30	8.30	19.0
2007 Average	0.137	54	2.44	0.67	8.98	23.6
2007 Summer Average	0.156	57	2.88	0.57	9.00	27.5

Water quality threshold is 0.04 mg/L TP or higher*

Shallow lake water quality threshold is 0.06 mg/L TP or higher*

	High	High Date	Low	Low Date	Average
2007 Elevation (ft)	889.79	4/11/2007	886.97	9/12/2007	888.21

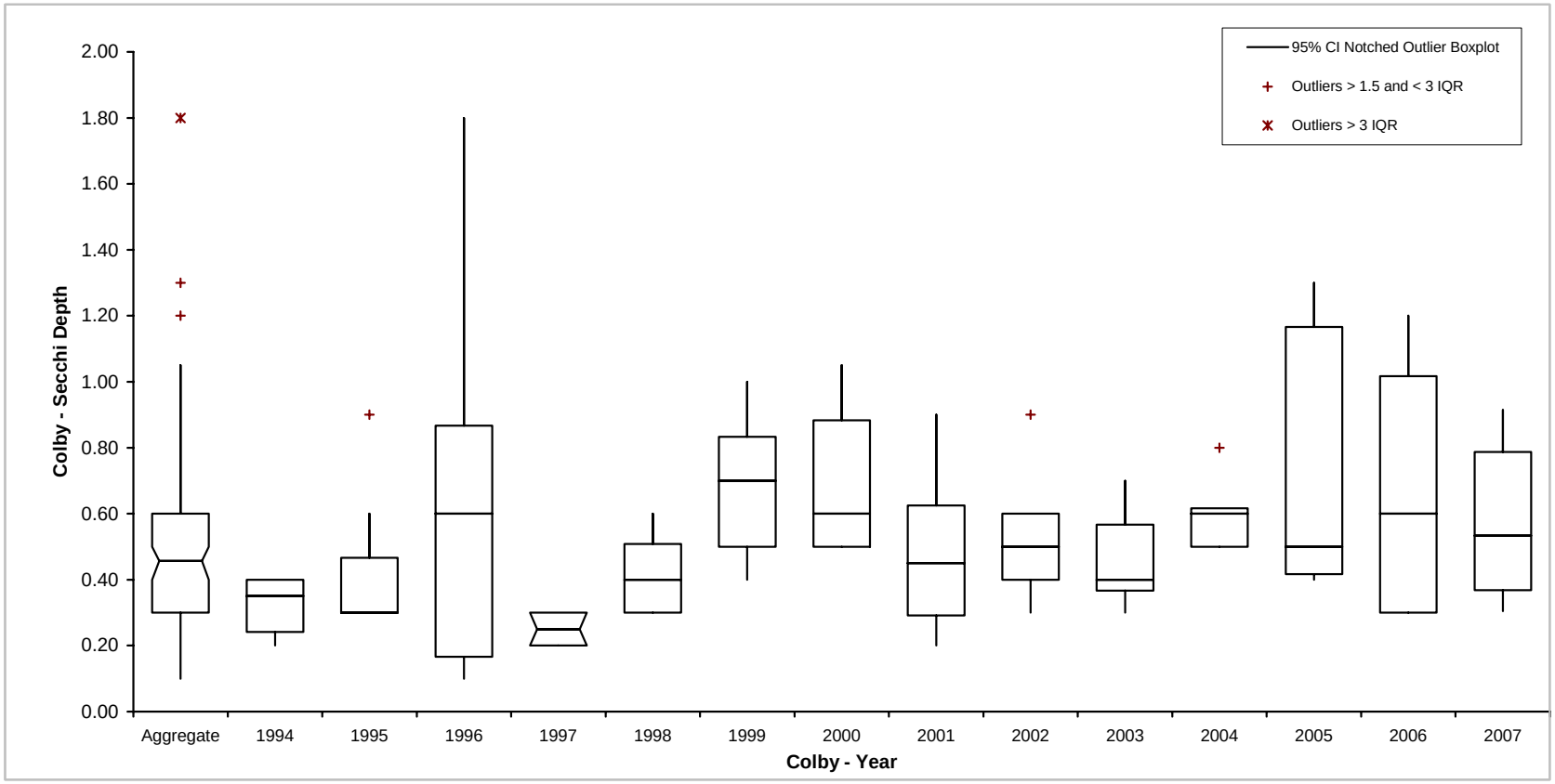
*MPCA description of Impaired Lake's Listing criteria: "At a minimum, a decision that a given lake is impaired for the 303(d) list due to excessive nutrients will be supported by data for both causal and response factors. Data requirements for 303(d) listing consist of 12 or more TP measurements collected from June through September over the most recent 10-year period. Ideally this should represent 12 separate visits to the lake over teh course of two summers; however it might aslo reflect four monthly samples over the course of three years (a typical sampling regimen for many lake monitroing programs). In addition to exceeding the TP guikeline thresholds, lakes to be considered for 303(d) listing should have at least 12 Secchi measurements and 12 chlorophyll-a measurements. this amount of data will allow for at least one season (preferably more) of paired TP, chlorophyll-a, and Secchi disk data and provide a basis for evaluating their interrelationships and hence the trophic status of the lake."



Lake Water Quality Summary

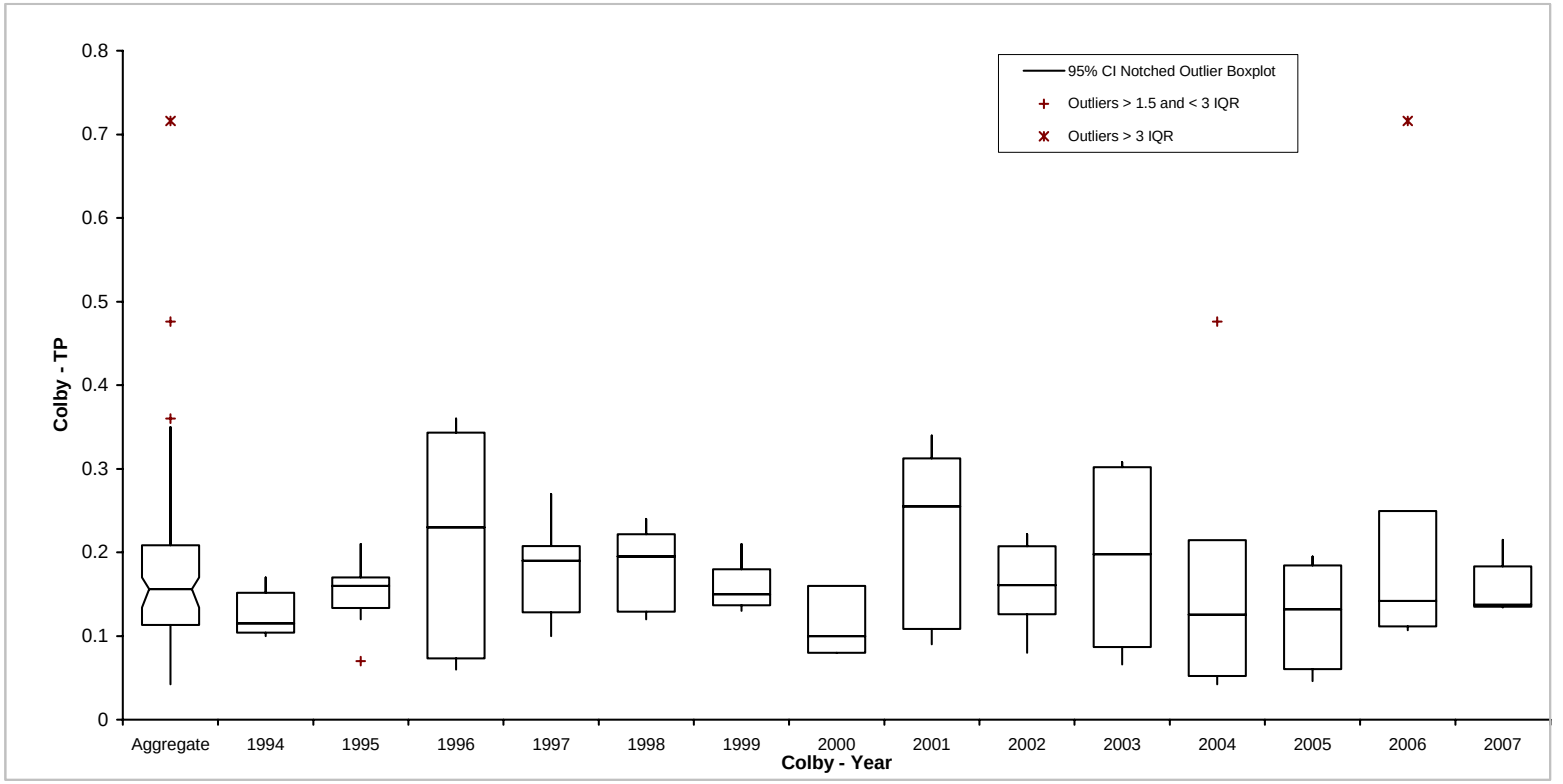
	Trophic Status	Lake Grades						
	2007	2007	2006	2005	2004	2003	2002	2001
Total Phosphorus (mg/l)	Hypereutrophic	F	F	D	F	F	F	F
Chlorophyll-*a* (ug/l)	Hypereutrophic	D	F	F	C	D	C	F
Secchi depth (ft)	Hypereutrophic	F	F	D	F	F	F	F
Overall	Hypereutrophic	F+	F	D-	D-	F+	D-	F

Statistical box plot summaries for Colby Lake are included in Figures 83-86. Secchi disk median values do not have a significant trend. Total Kjedahl nitrogen median values have been fluctuating greatly over the past fourteen years, ranging from a low of 1.30 mg/L to 2.95 mg/L. The median TKN values for Colby Lake are roughly two times higher then any other lake in South Washington Watershed District.



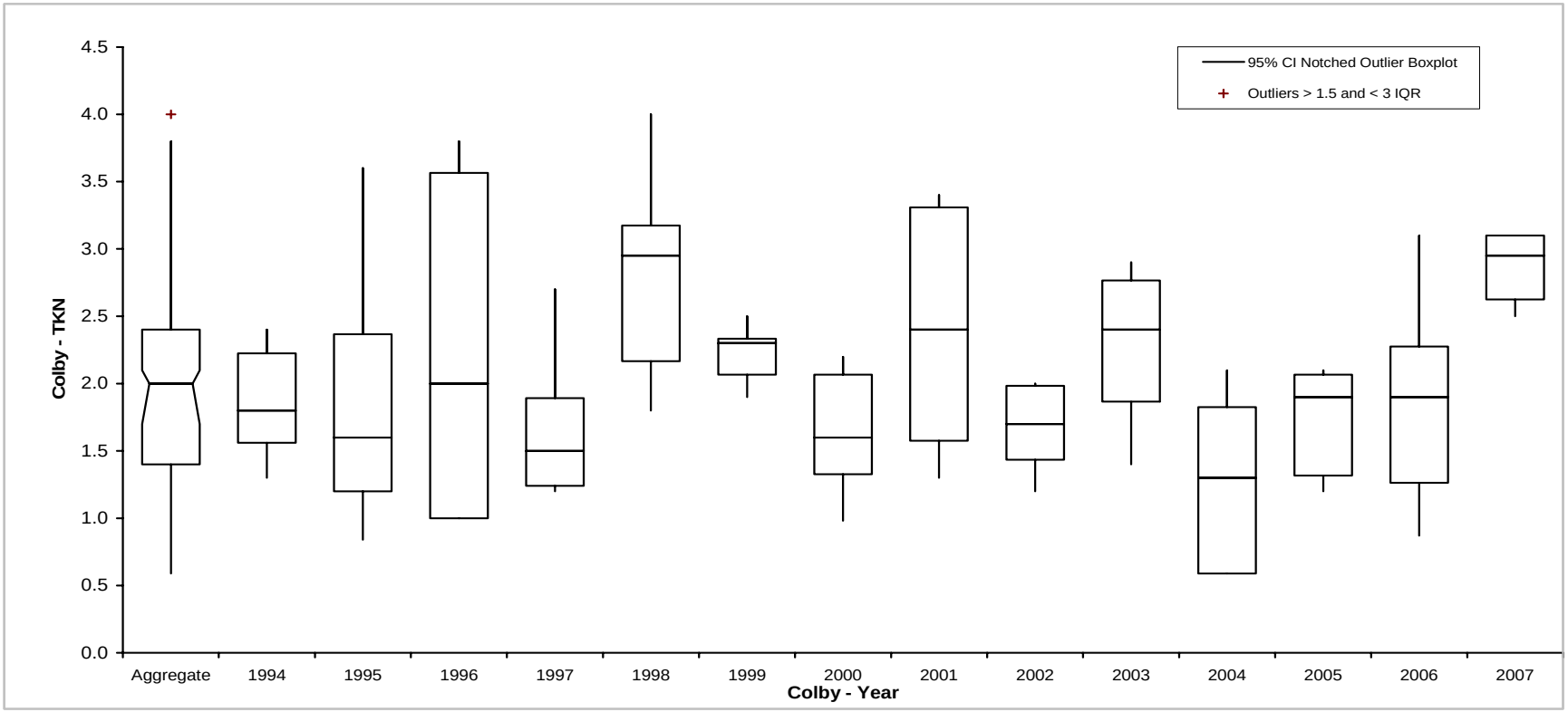
Colby - Secchi Depth by Colby - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	91	0.10	0.30	0.46	0.40 to 0.50	0.60	1.80	0.30
1994	8	0.20	0.24	0.35	0.20 to 0.40	0.40	0.40	0.16
1995	9	0.30	0.30	0.30	0.30 to 0.60	0.47	0.90	0.17
1996	9	0.10	0.17	0.60	0.10 to 1.00	0.87	1.80	0.70
1997	8	0.20	0.20	0.25	0.20 to 0.30	0.30	0.30	0.10
1998	6	0.30	0.30	0.40	0.30 to 0.60	0.51	0.60	0.21
1999	9	0.40	0.50	0.70	0.50 to 0.90	0.83	1.00	0.33
2000	5	0.50	0.50	0.60	- to -	0.88	1.05	0.38
2001	6	0.20	0.29	0.45	0.20 to 0.90	0.63	0.90	0.33
2002	7	0.30	0.40	0.50	0.30 to 0.90	0.60	0.90	0.20
2003	5	0.30	0.37	0.40	- to -	0.57	0.70	0.20
2004	6	0.50	0.50	0.60	0.50 to 0.80	0.62	0.80	0.12
2005	3	0.40	0.42	0.50	- to -	1.17	1.30	0.75
2006	6	0.30	0.30	0.60	0.30 to 1.20	1.02	1.20	0.72
2007	4	0.30	0.37	0.53	- to -	0.79	0.91	0.42

Figure 83. Secchi Disk Depth box plots for Colby Lake (1994-2007)



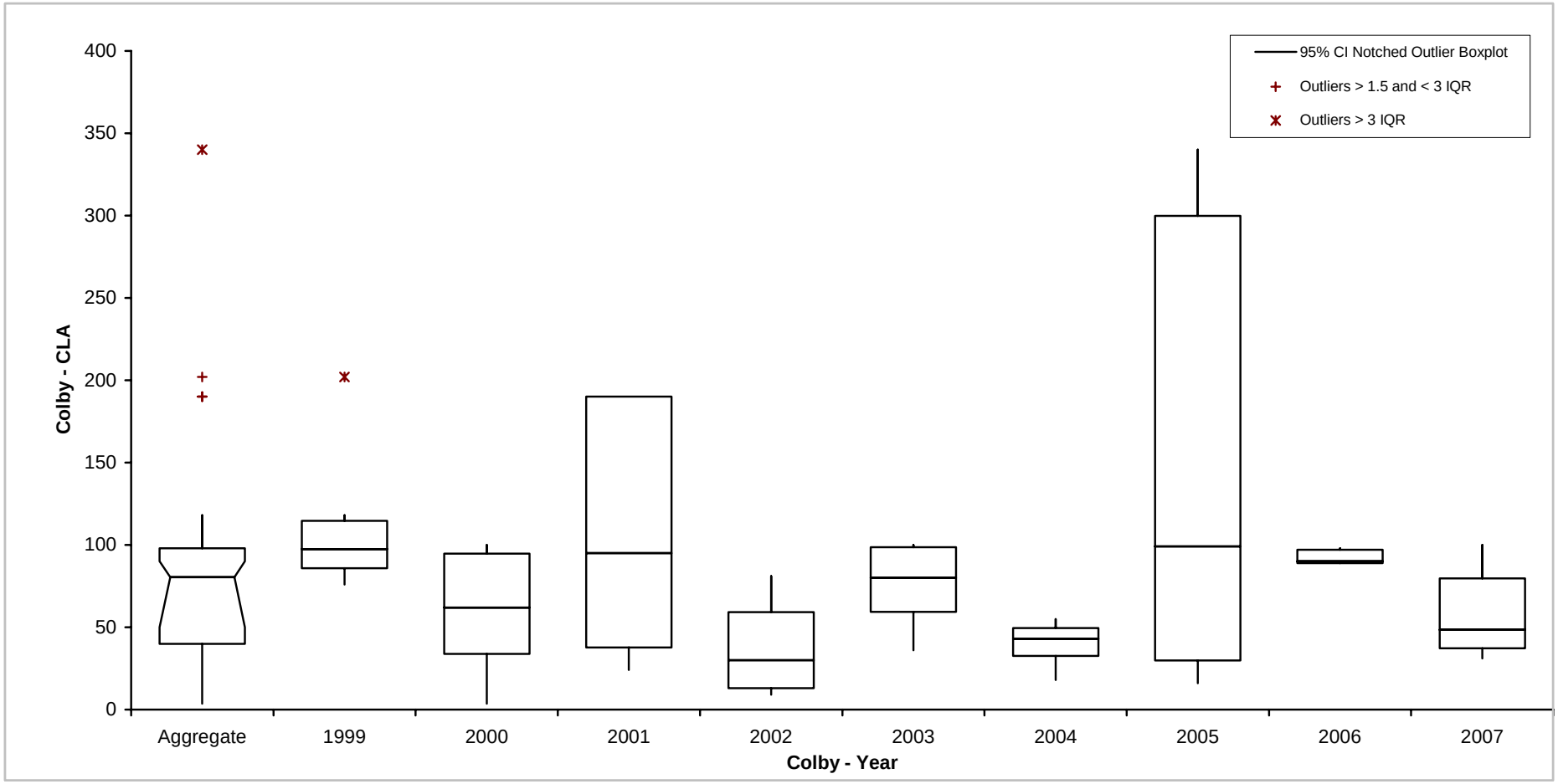
Colby - TP by Colby - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	91	0.04	0.11	0.16	0.13 to 0.17	0.21	0.72	0.10
1994	8	0.10	0.10	0.12	0.10 to 0.17	0.15	0.17	0.05
1995	9	0.07	0.13	0.16	0.12 to 0.17	0.17	0.21	0.04
1996	9	0.06	0.07	0.23	0.06 to 0.35	0.34	0.36	0.27
1997	8	0.10	0.13	0.19	0.10 to 0.27	0.21	0.27	0.08
1998	6	0.12	0.13	0.20	0.12 to 0.24	0.22	0.24	0.09
1999	9	0.13	0.14	0.15	0.13 to 0.20	0.18	0.21	0.04
2000	5	0.08	0.08	0.10	- to -	0.16	0.16	0.08
2001	6	0.09	0.11	0.26	0.09 to 0.34	0.31	0.34	0.20
2002	7	0.08	0.13	0.16	0.08 to 0.22	0.21	0.22	0.08
2003	5	0.07	0.09	0.20	- to -	0.30	0.31	0.22
2004	6	0.04	0.05	0.13	0.04 to 0.48	0.21	0.48	0.16
2005	3	0.05	0.06	0.13	- to -	0.18	0.20	0.12
2006	6	0.11	0.11	0.14	0.11 to 0.72	0.25	0.72	0.14
2007	4	0.13	0.13	0.14	- to -	0.18	0.22	0.05

Figure 84. Total Phosphorus box plots for Colby Lake (1994-2007)



Colby - TKN by Colby - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	91	0.59	1.40	2.00	1.70 to 2.10	2.40	4.00	1.00
1994	8	1.30	1.56	1.80	1.30 to 2.40	2.23	2.40	0.67
1995	9	0.84	1.20	1.60	1.00 to 2.90	2.37	3.60	1.17
1996	9	1.00	1.00	2.00	1.00 to 3.70	3.57	3.80	2.57
1997	8	1.20	1.24	1.50	1.20 to 2.70	1.89	2.70	0.65
1998	6	1.80	2.17	2.95	1.80 to 4.00	3.18	4.00	1.01
1999	9	1.90	2.07	2.30	2.00 to 2.40	2.33	2.50	0.27
2000	5	0.98	1.33	1.60	- to -	2.07	2.20	0.74
2001	6	1.30	1.58	2.40	1.30 to 3.40	3.31	3.40	1.73
2002	7	1.20	1.43	1.70	1.20 to 2.00	1.98	2.00	0.55
2003	5	1.40	1.87	2.40	- to -	2.77	2.90	0.90
2004	6	0.59	0.59	1.30	0.59 to 2.10	1.83	2.10	1.24
2005	3	1.20	1.32	1.90	- to -	2.07	2.10	0.75
2006	6	0.87	1.26	1.90	0.87 to 3.10	2.28	3.10	1.01
2007	4	2.50	2.63	2.95	- to -	3.10	3.10	0.48

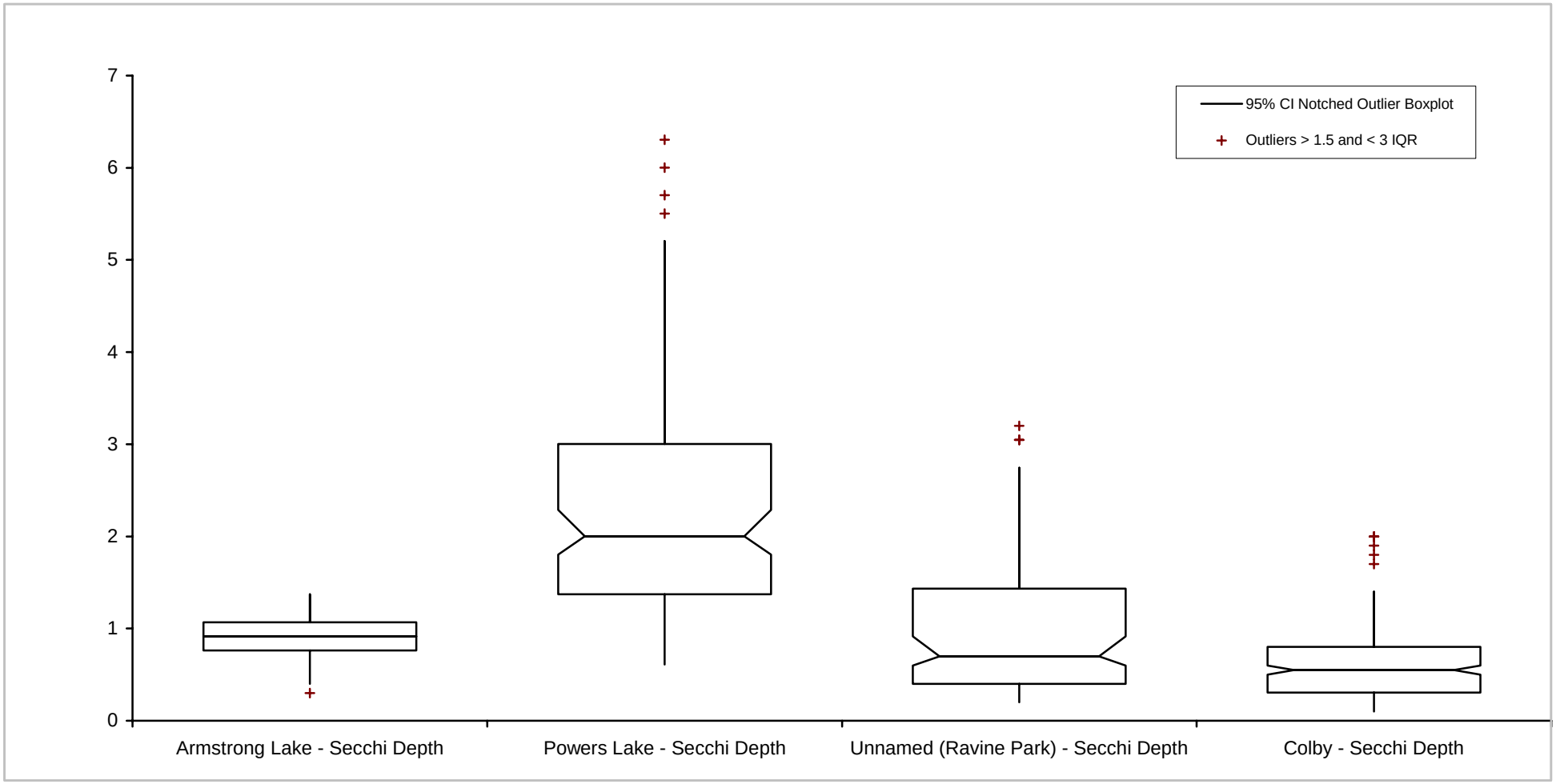
Figure 85. Total Kjedahl Nitrogen box plots for Colby Lake (1994-2007)



Colby - CLA by Colby - Year	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Aggregate	50	3.50	39.92	80.50	50.00 to 90.00	98.00	340.00	58.08
1999	8	76.00	85.83	97.50	76.00 to 202.00	114.67	202.00	28.83
2000	5	3.50	33.83	62.00	- to -	94.67	100.00	60.83
2001	6	24.00	37.75	95.00	24.00 to 190.00	190.00	190.00	152.25
2002	7	9.00	13.00	30.00	9.00 to 81.00	59.17	81.00	46.17
2003	5	36.00	59.33	80.00	- to -	98.67	100.00	39.33
2004	6	18.00	32.67	43.00	18.00 to 55.00	49.50	55.00	16.83
2005	3	16.00	29.83	99.00	- to -	299.83	340.00	270.00
2006	6	89.00	89.00	90.00	89.00 to 98.00	97.08	98.00	8.08
2007	4	31.00	37.25	48.50	- to -	79.58	100.00	42.33

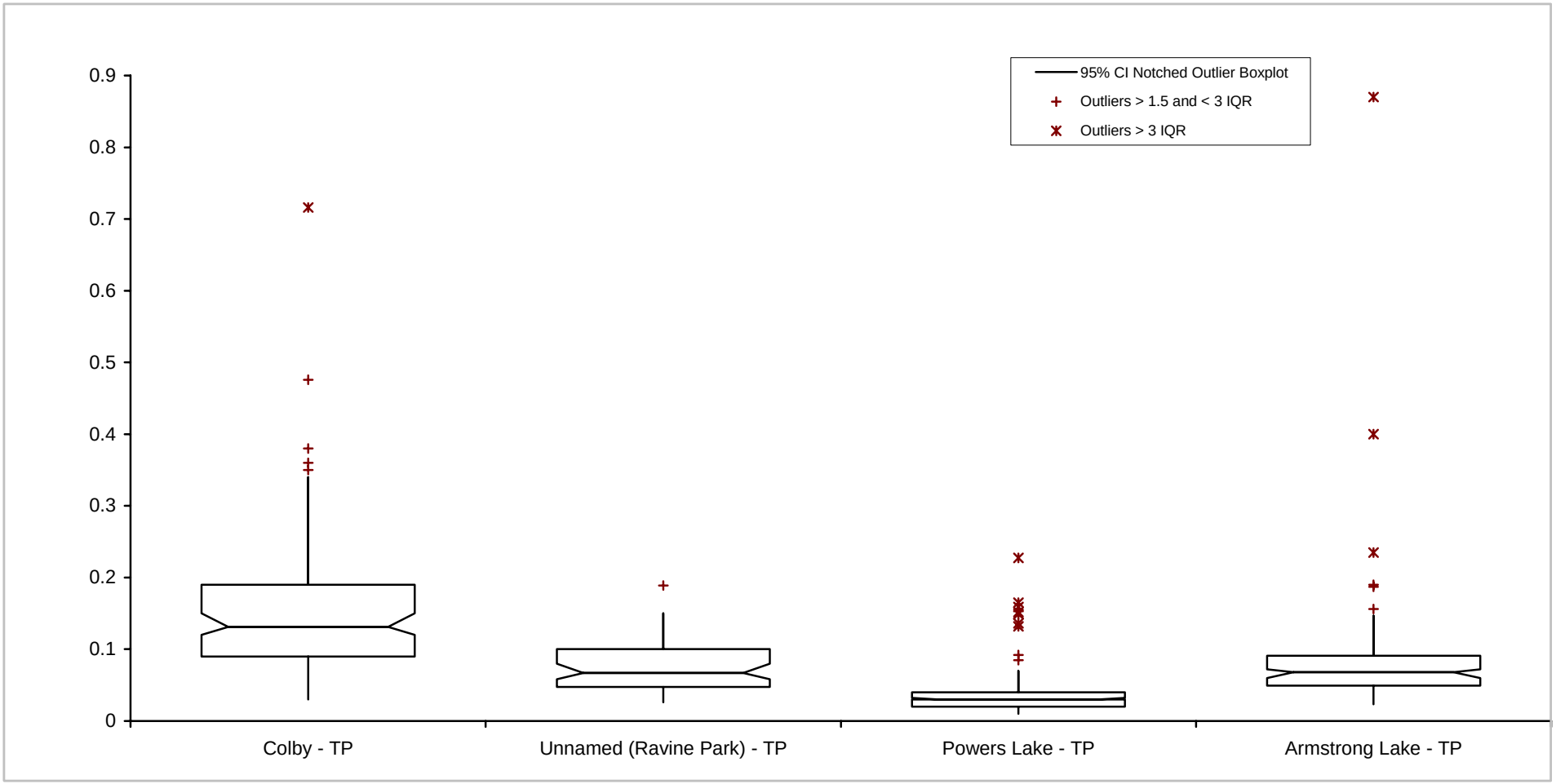
Figure 86. Chlorophyll-a box plots for Colby Lake (1994-2007)

Figures 87-94 are box plot summaries showing relationships between four lakes monitored in South Washington Watershed District. Powers Lake has the highest Secchi disk readings in the district. Armstrong Lake has limited variability in Secchi disk readings due to the shallow nature of the lake. Powers Lake also has the lowest total phosphorus median values and total Kjedahl nitrogen median values, correlating to the higher Secchi disk readings. Both Cottage Grove Ravine Park Lake and Armstrong Lake have similar medians for total phosphorus, once again correlating towards similar median values for Secchi disk readings. Armstrong Lake has the highest outlier for chlorophyll-a, which is matched to the highest total phosphorus outlier. Colby Lake had the lowest readings for Secchi disk, with the highest values of TKN, TP, and CLA. Total chloride ions box plots have interesting summaries. Armstrong has the highest median value, with Powers Lake and then Cottage Grove Ravine Park Lake with the mid and low median values, respectively. Hypothesis for such an outcome would be the difference in land use and the connection of roads to the water bodies. Further investigation is needed to confirm this hypothesis.



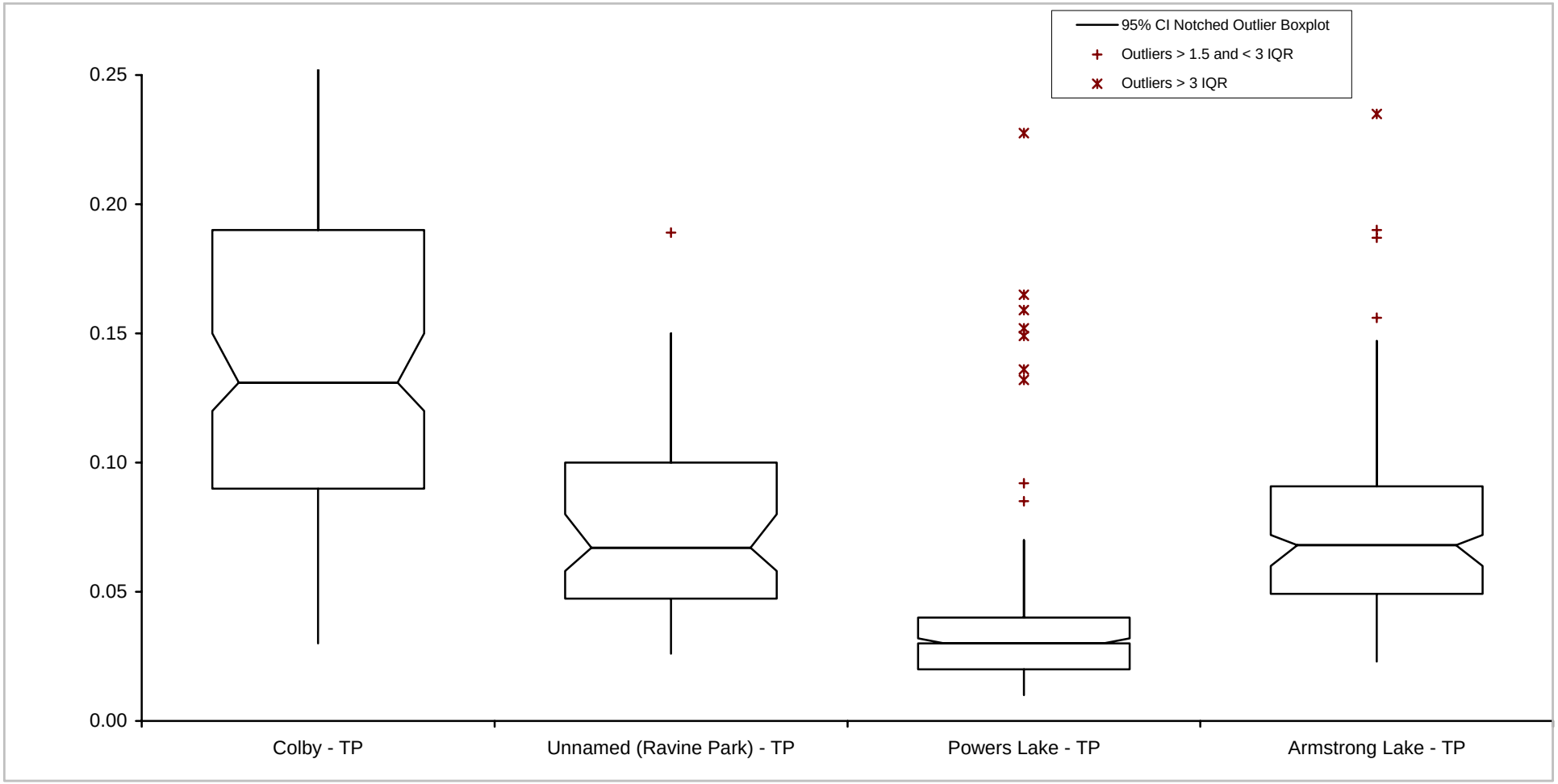
	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Armstrong Lake - Secchi Depth	130	0.30	0.76	0.91	0.91 to 0.91	1.07	1.37	0.30
Powers Lake - Secchi Depth	170	0.61	1.37	2.00	1.80 to 2.29	3.00	6.30	1.63
Unnamed (Ravine Park) - Secchi Depth	97	0.20	0.40	0.70	0.60 to 0.91	1.43	3.20	1.03
Colby - Secchi Depth	146	0.10	0.30	0.55	0.50 to 0.60	0.80	2.00	0.50

Figure 87. Secchi Disk Depth box plots for Armstrong, Powers, Cottage Grove Ravine Lakes, and Colby Lake



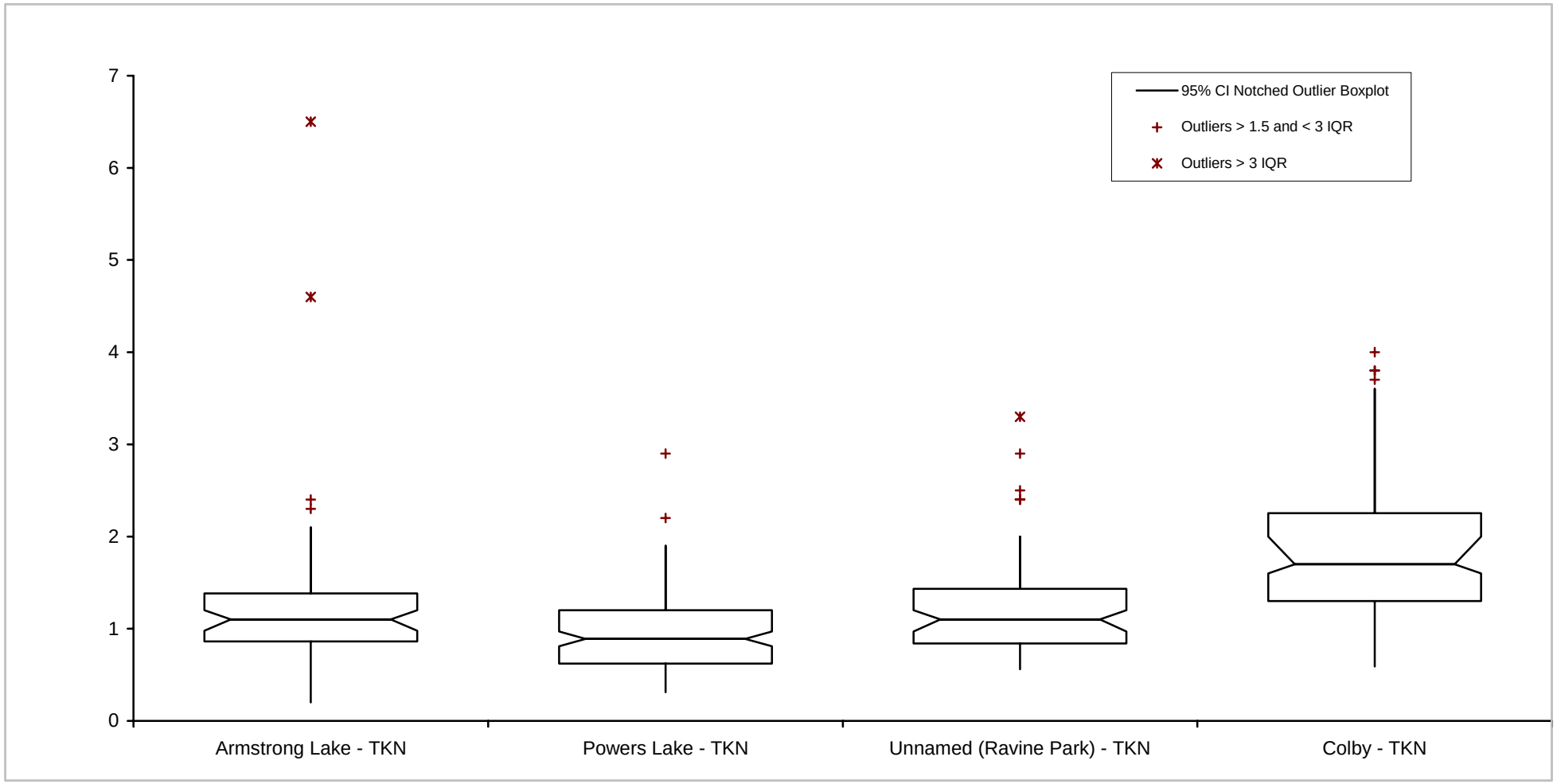
	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Colby - TP	146	0.03	0.09	0.13	0.12 to 0.15	0.19	0.72	0.10
Unnamed (Ravine Park) - TP	97	0.03	0.05	0.07	0.06 to 0.08	0.10	0.19	0.05
Powers Lake - TP	159	0.01	0.02	0.03	0.03 to 0.03	0.04	0.23	0.02
Armstrong Lake - TP	119	0.02	0.05	0.07	0.06 to 0.07	0.09	0.87	0.04

Figure 88. Total Phosphorus box plots for Armstrong, Powers, and Cottage Grove Ravine Lakes



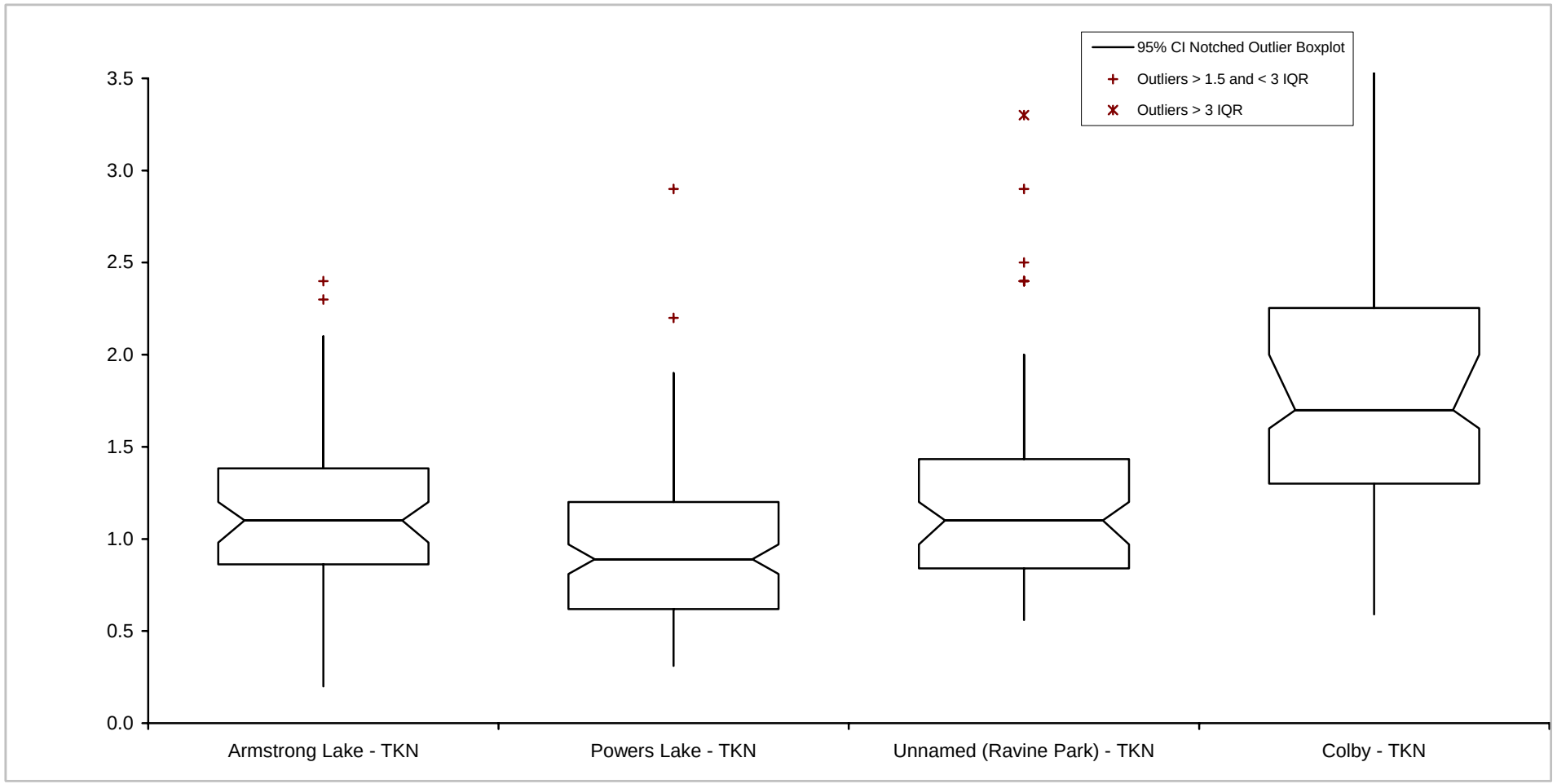
	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Colby - TP	146	0.03	0.09	0.13	0.12 to 0.15	0.19	0.72	0.10
Unnamed (Ravine Park) - TP	97	0.03	0.05	0.07	0.06 to 0.08	0.10	0.19	0.05
Powers Lake - TP	159	0.01	0.02	0.03	0.03 to 0.03	0.04	0.23	0.02
Armstrong Lake - TP	119	0.02	0.05	0.07	0.06 to 0.07	0.09	0.87	0.04

Figure 89. Total Phosphorus box plots for Armstrong, Powers, Cottage Grove Ravine Lakes, and Colby without Outliers



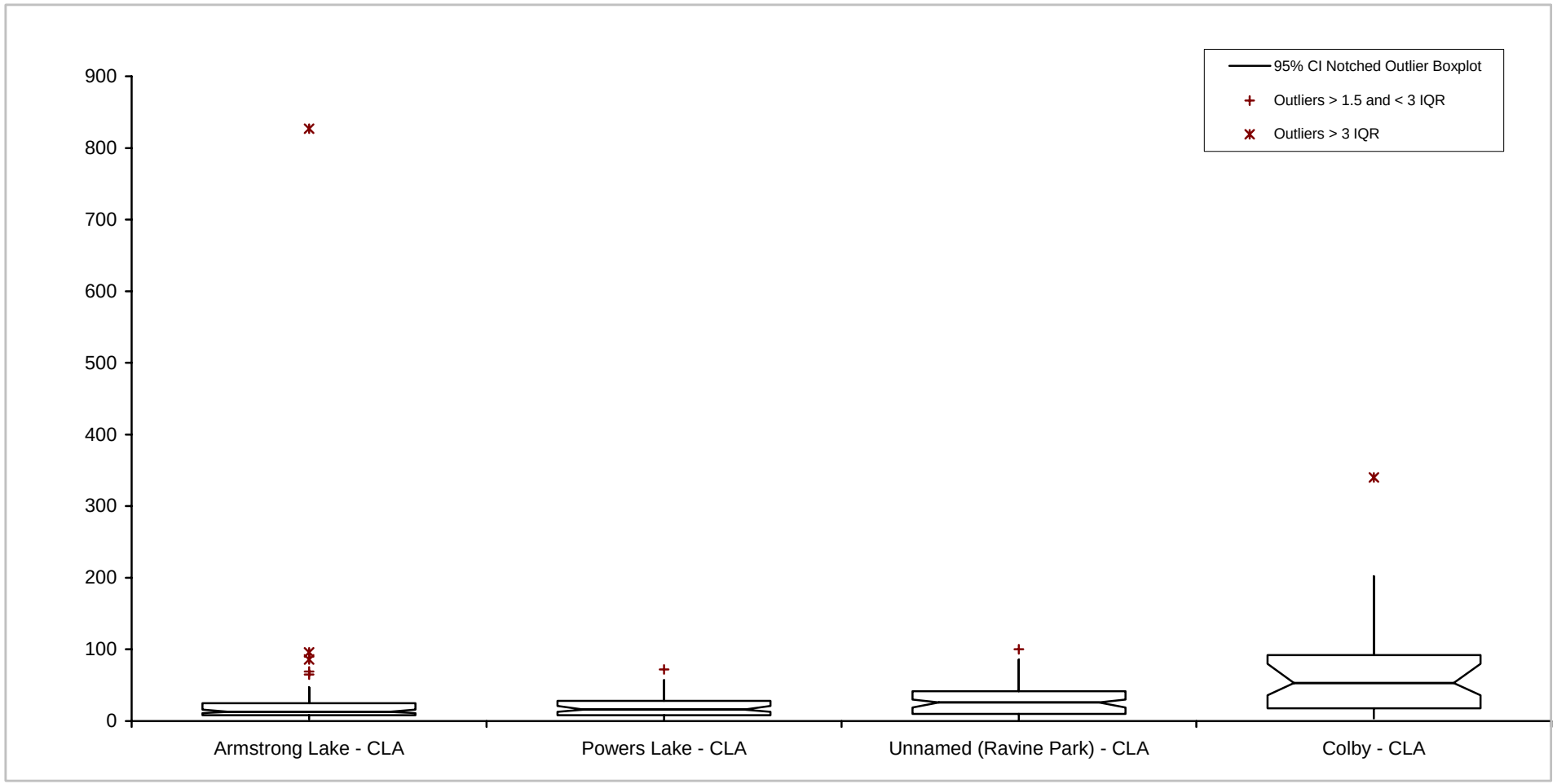
	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Armstrong Lake - TKN	119	0.20	0.86	1.10	0.98 to 1.20	1.38	6.50	0.52
Powers Lake - TKN	159	0.31	0.62	0.89	0.81 to 0.97	1.20	2.90	0.58
Jnnamed (Ravine Park) - TKN	97	0.56	0.84	1.10	0.97 to 1.20	1.43	3.30	0.59
Colby - TKN	146	0.59	1.30	1.70	1.60 to 2.00	2.25	4.00	0.95

Figure 90. Total Kjedahl Nitrogen box plots for Armstrong, Powers, Cottage Grove Ravine Lakes, and Colby Lake



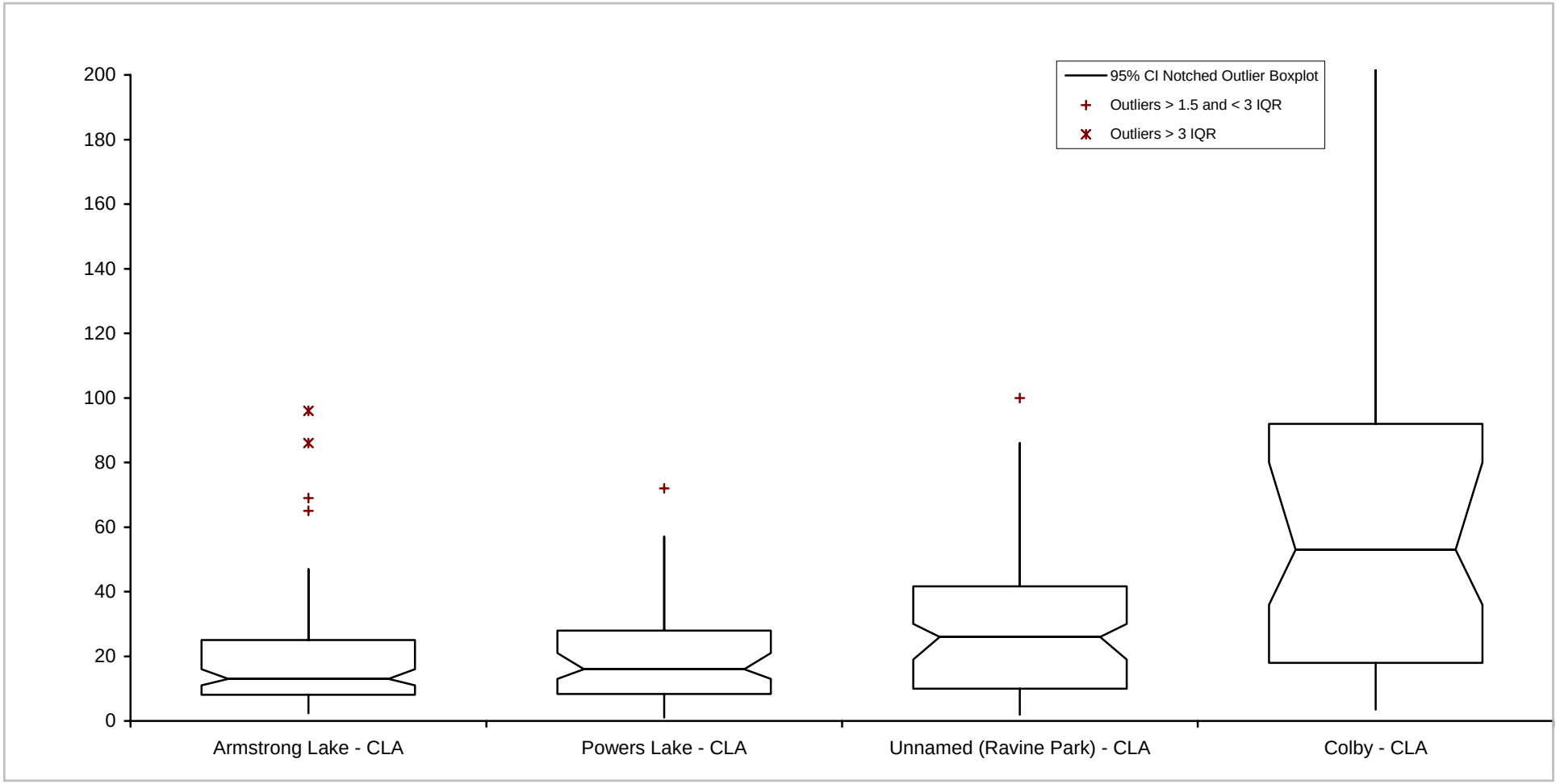
	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Armstrong Lake - TKN	119	0.20	0.86	1.10	0.98 to 1.20	1.38	6.50	0.52
Powers Lake - TKN	159	0.31	0.62	0.89	0.81 to 0.97	1.20	2.90	0.58
Jnnamed (Ravine Park) - TKN	97	0.56	0.84	1.10	0.97 to 1.20	1.43	3.30	0.59
Colby - TKN	146	0.59	1.30	1.70	1.60 to 2.00	2.25	4.00	0.95

Figure 91. Total Kjedahl Nitrogen box plots for Armstrong, Powers, Cottage Grove Ravine Lakes, and Colby Lake without Outliers



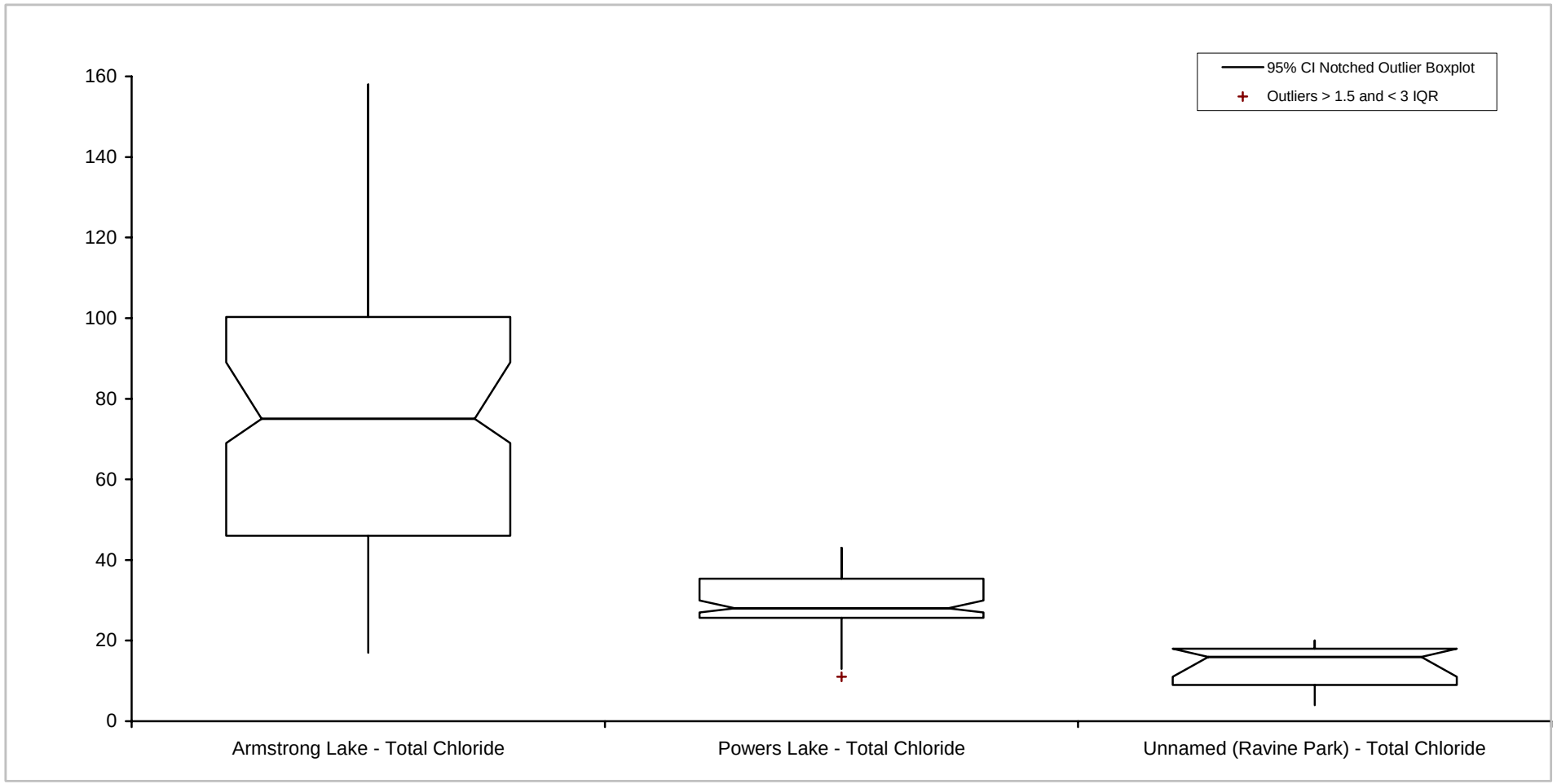
	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Armstrong Lake - CLA	108	2.40	8.08	13.00	11.00 to 16.00	25.00	827.00	16.92
Powers Lake - CLA	99	1.00	8.33	16.00	13.00 to 21.00	28.00	72.00	19.67
Jnnamed (Ravine Park) - CLA	109	1.90	10.00	26.00	19.00 to 30.00	41.67	100.00	31.67
Colby - CLA	78	3.50	18.00	53.00	36.00 to 80.00	92.00	340.00	74.00

Figure 92. Chlorophyll-a box plots for Armstrong, Powers, Cottage Grove Ravine Lakes, and Colby Lake



	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
Armstrong Lake - CLA	108	2.40	8.08	13.00	11.00 to 16.00	25.00	827.00	16.92
Powers Lake - CLA	99	1.00	8.33	16.00	13.00 to 21.00	28.00	72.00	19.67
Jnnamed (Ravine Park) - CLA	109	1.90	10.00	26.00	19.00 to 30.00	41.67	100.00	31.67
Colby - CLA	78	3.50	18.00	53.00	36.00 to 80.00	92.00	340.00	74.00

Figure 93. Chlorophyll-a box plots for Armstrong, Powers, Cottage Grove Ravine Lakes, and Colby Lake without Outliers



	n	Min	1st Quartile	Median	95% CI	3rd Quartile	Max	IQR
mstrong Lake - Total Chloride	70	17.00	46.00	75.00	69.00 to 89.00	100.33	158.00	54.33
Powers Lake - Total Chloride	65	11.00	25.67	28.00	27.00 to 30.00	35.33	43.00	9.67
(Ravine Park) - Total Chloride	26	4.00	9.00	16.00	11.00 to 18.00	18.00	20.00	9.00

Figure 94. Total Chloride box plots for Armstrong, Powers, and Cottage Grove Ravine Lakes

Lake Gages

Lake gages were read biweekly on twelve lakes in SWWD from April 11-October 11, 2007. Table 22 lists the high, low, range and average elevations for each lake monitored in 2007. Figure 95-106 shows the fluctuation in elevation for each lake monitored in 2007. For historical lake elevations visit the Lake Finder page on the MN DNR website http://www.dnr.state.mn.us/lakefind/index.html.

Table 22. SWWD 2007 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	4/11/07-10/4/07	14	771.19 4/11/2007	771.79 10/4/2007	0.60	771.39	770.70
Markgrafs	82-0089	4/11/07-10/10/07	15	923.32 8/2/2007	924.52 10/10/2007	1.20	923.88	925.30
Wilmes	82-0090	4/11/07-10/10/07	12	900.49 8/17/2007	903.13 8/31/2007	2.64	901.99	902.60
Powers	82-0092	4/11/07-10/11/07	14	886.97 9/12/2007	889.79 4/11/2007	2.82	888.26	891.30
Colby	82-0094	4/11/07-10/4/07	14	889.58 8/14/2007	891.28 10/4/2007	1.70	890.33	891.80
Bailey	82-0456	4/11/07-10/10/07	15	864.02 8/17/2007	868.98 10/9/2007	4.96	866.54	NA
Armstrong	82-0116-02	4/12/07-10/10/07	14	1017.74 7/17/2007	1018.82 10/4/2007	1.08	1018.27	1019.10
Vandeberg	82-0084	4/11/07-10/10/07	16	834.51 9/14/2007	836.48 4/11/2007	1.97	835.31	NA
Fish	82-0093	4/11/07-10/10/07	15	914.73 5/10/2007	917.13 6/20/2007	2.40	915.75	916.40
Ria	82-0098	4/11/07-10/10/07	14	949.00 8/16/2007	950.50 4/11/2007	1.50	949.64	NA
La	82-0097	4/11/07-10/10/07	14	997.79 8/16/2007	998.94 4/11/2007	1.15	998.32	1000.60
Shepard's Pond	82-0083	4/11/07-10/10/07	14	920.24 8/16/2007	922.08 4/11/2007	1.84	920.86	NA

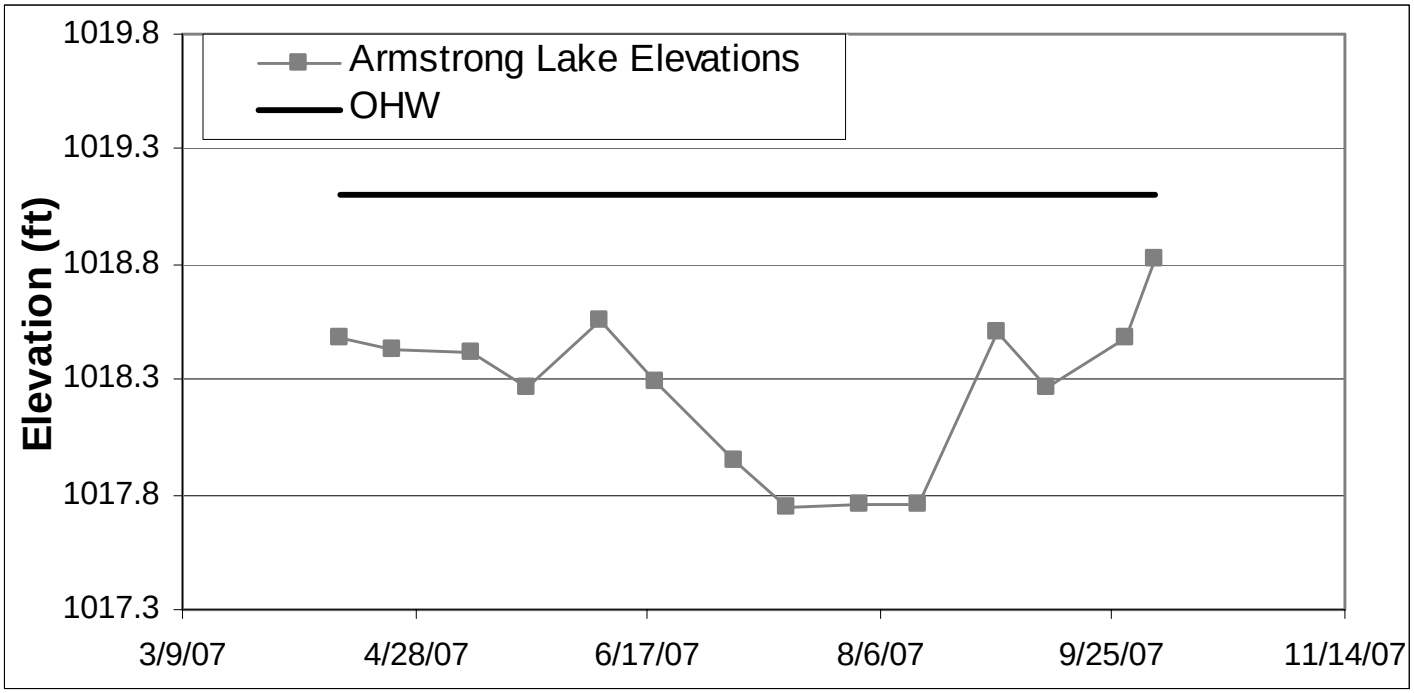


Figure 95. Armstrong Lake Elevations and Ordinary High Water (OHW)

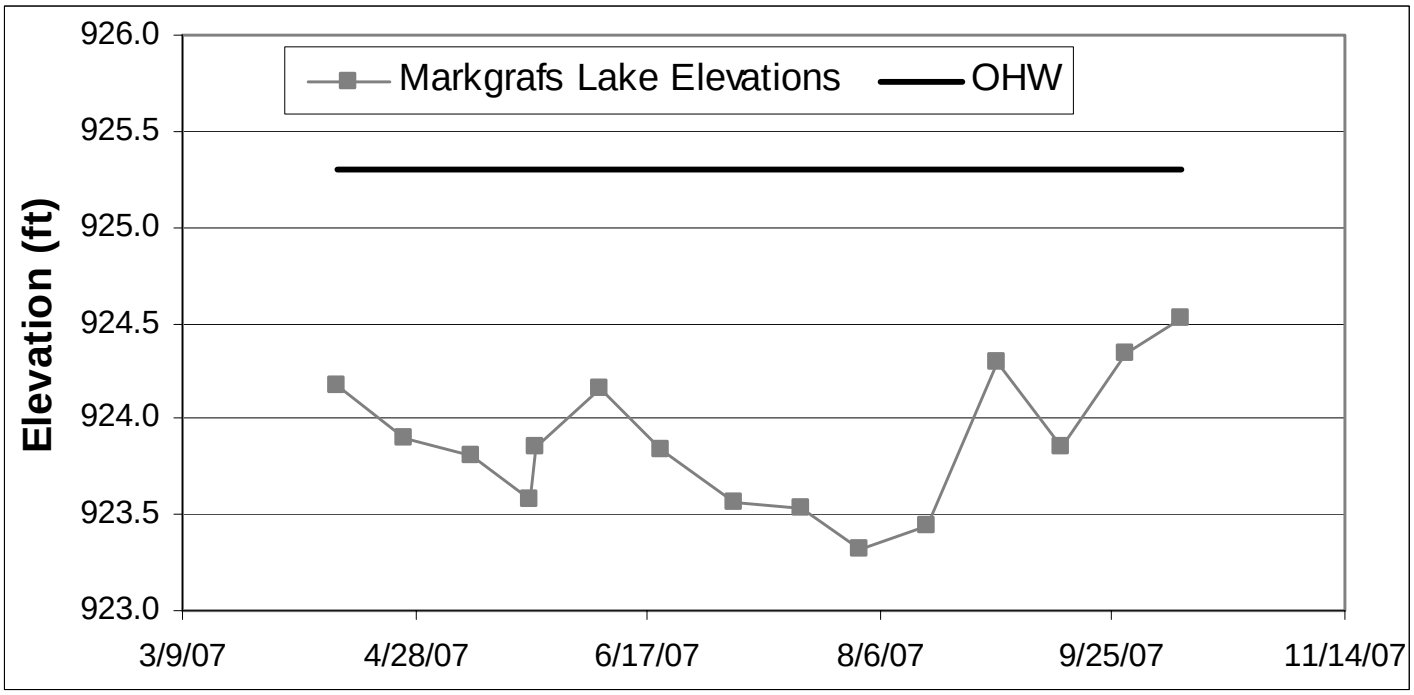


Figure 96. Markgrafs Lake Elevations and Ordinary High Water (OHW)

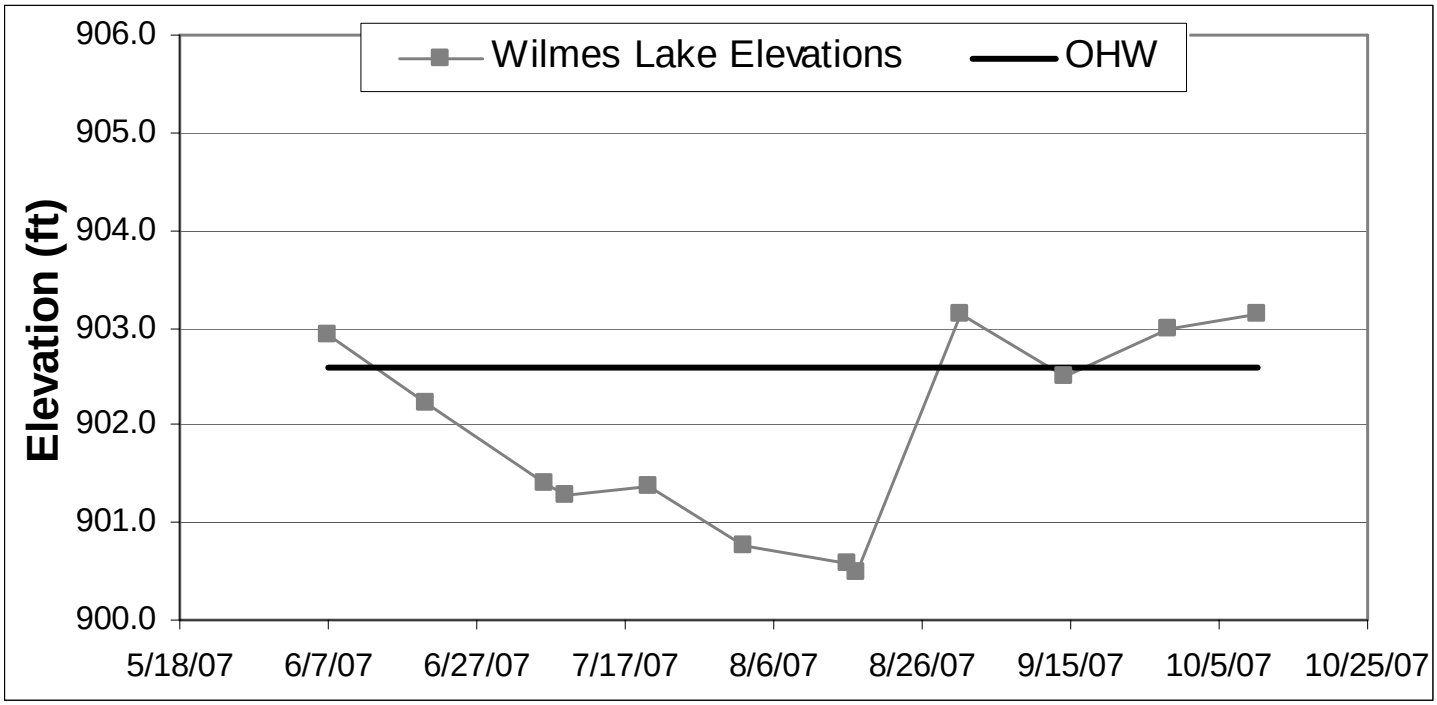


Figure 97. Wilmes Lake Elevations and Ordinary High Water (OHW)

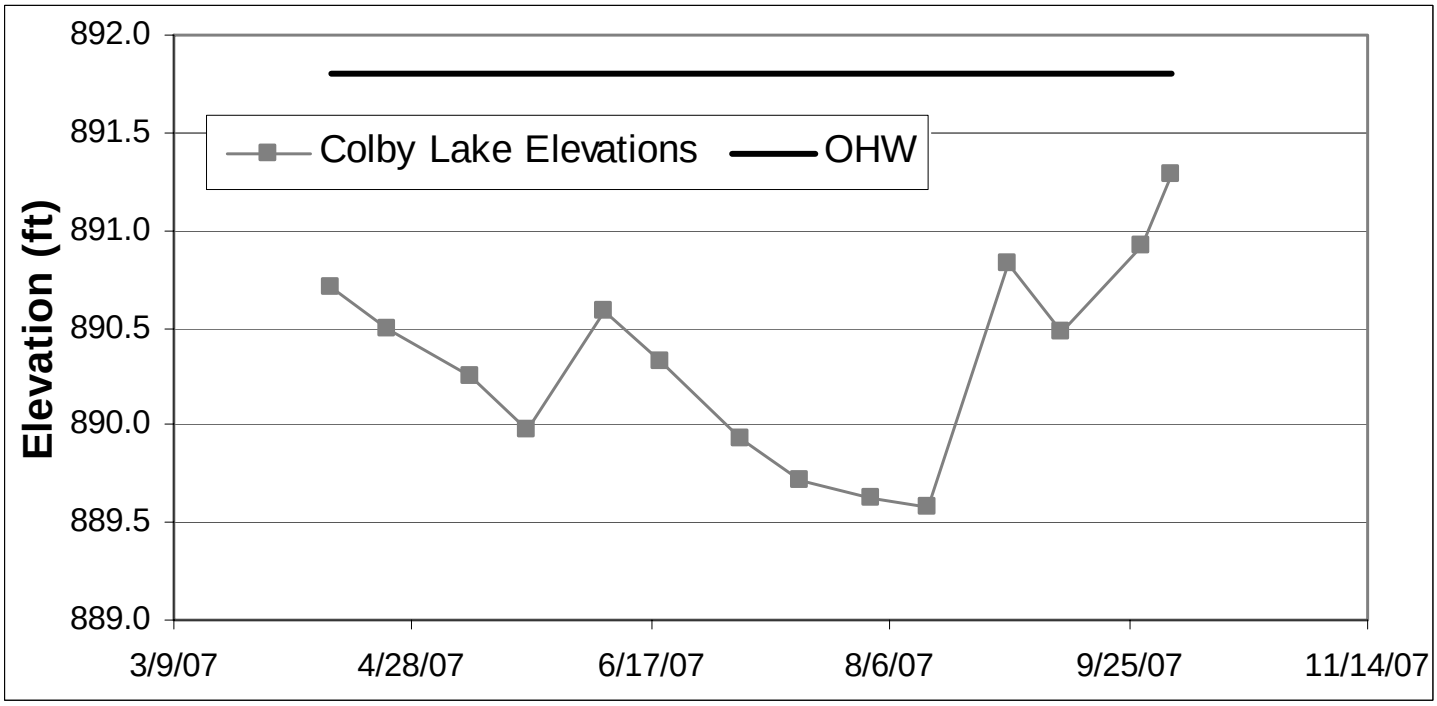


Figure 98. Colby Lake Elevations and Ordinary High Water (OHW)

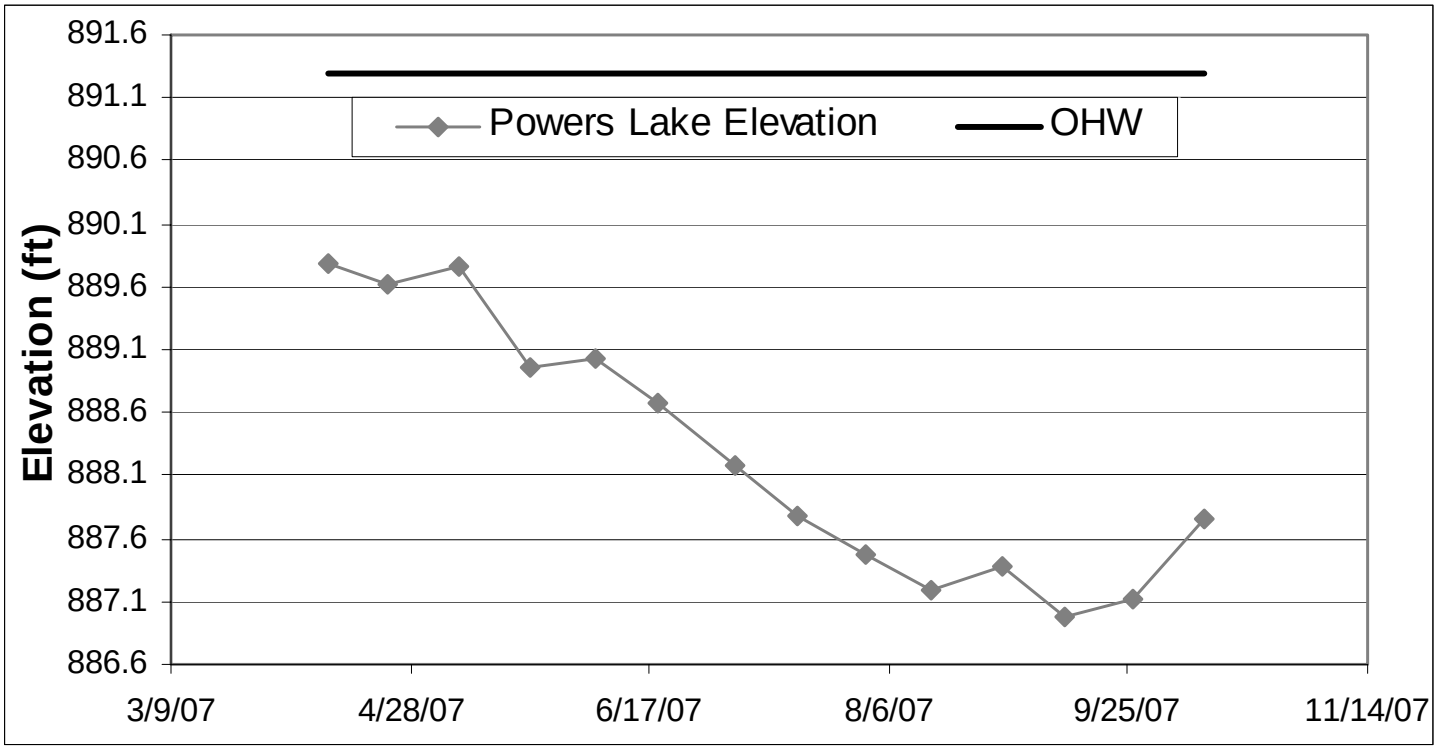


Figure 99. Powers Lake Elevations and Ordinary High Water (OHW)

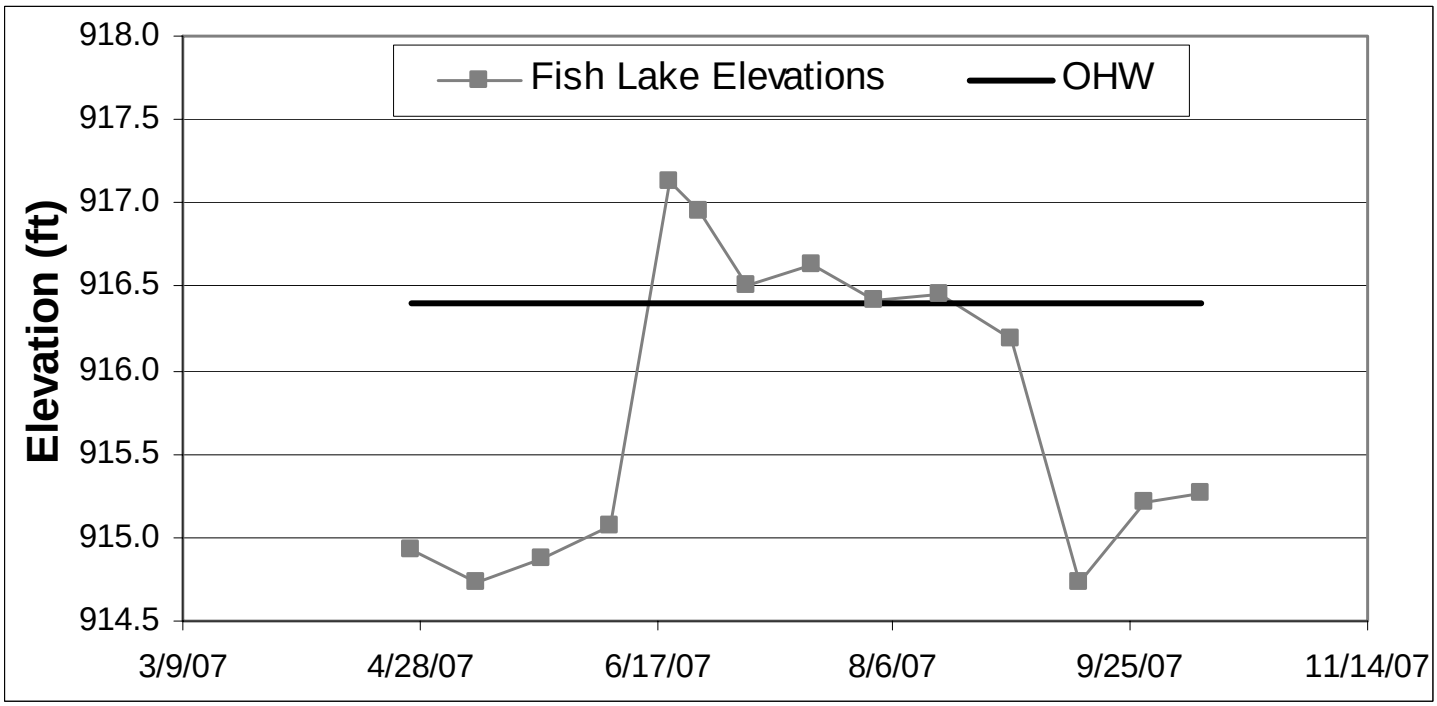


Figure 100. Fish Lake Elevations

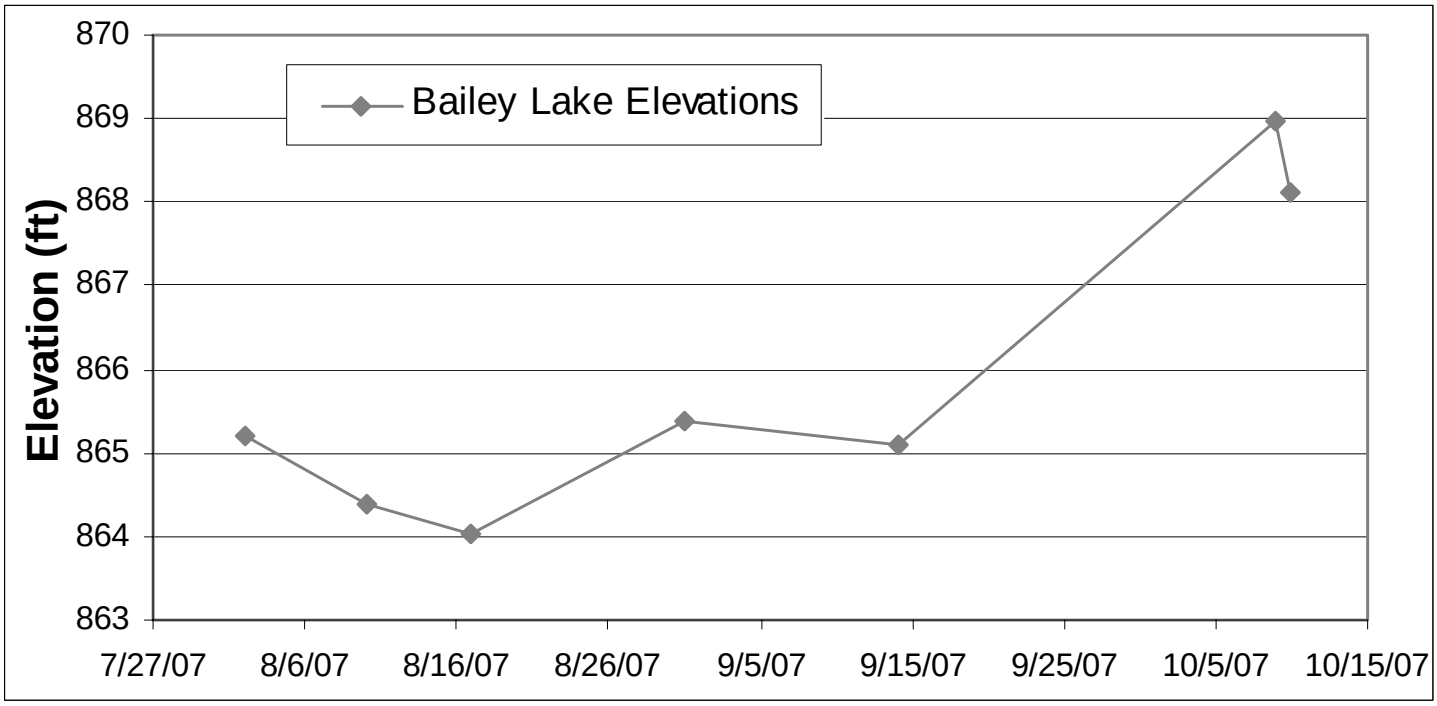


Figure 101. Bailey Lake Elevations

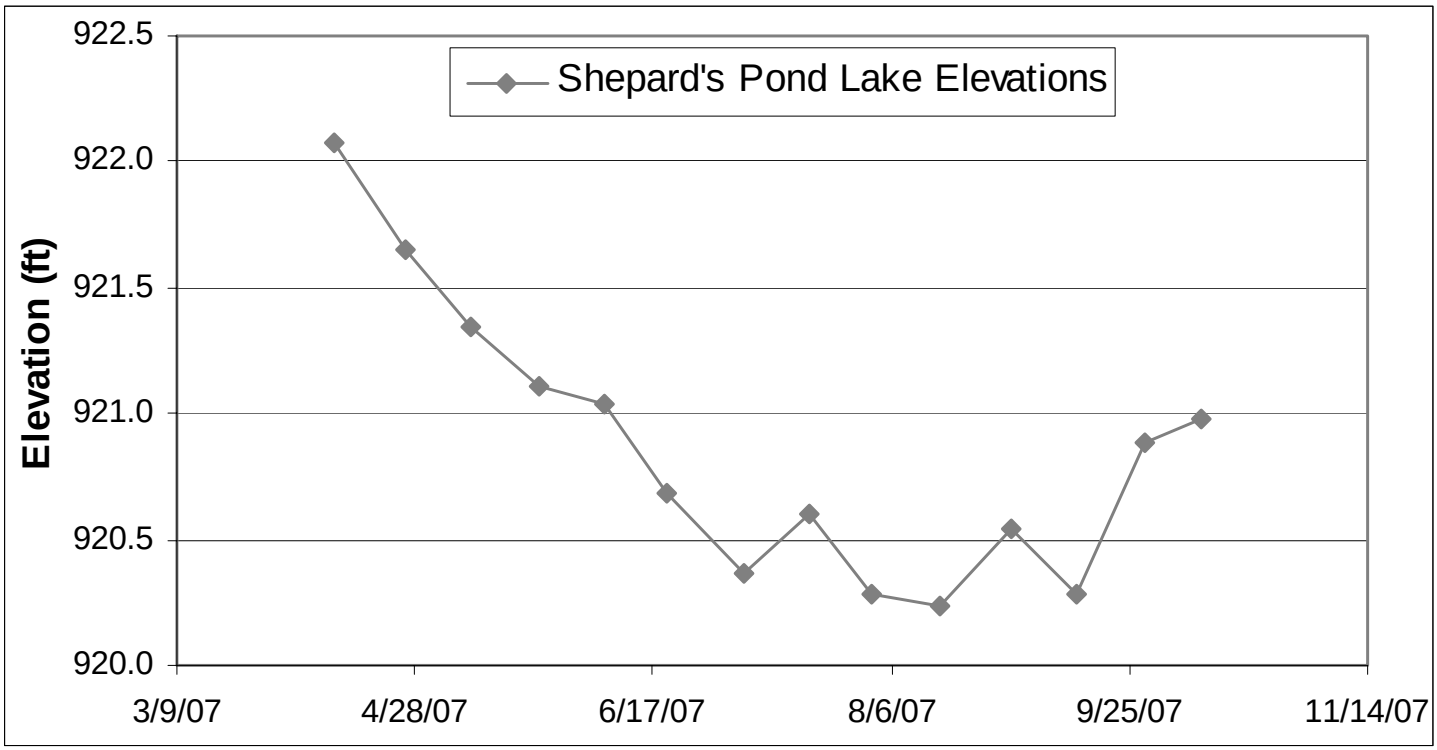


Figure 102. Shepard's Pond Elevations

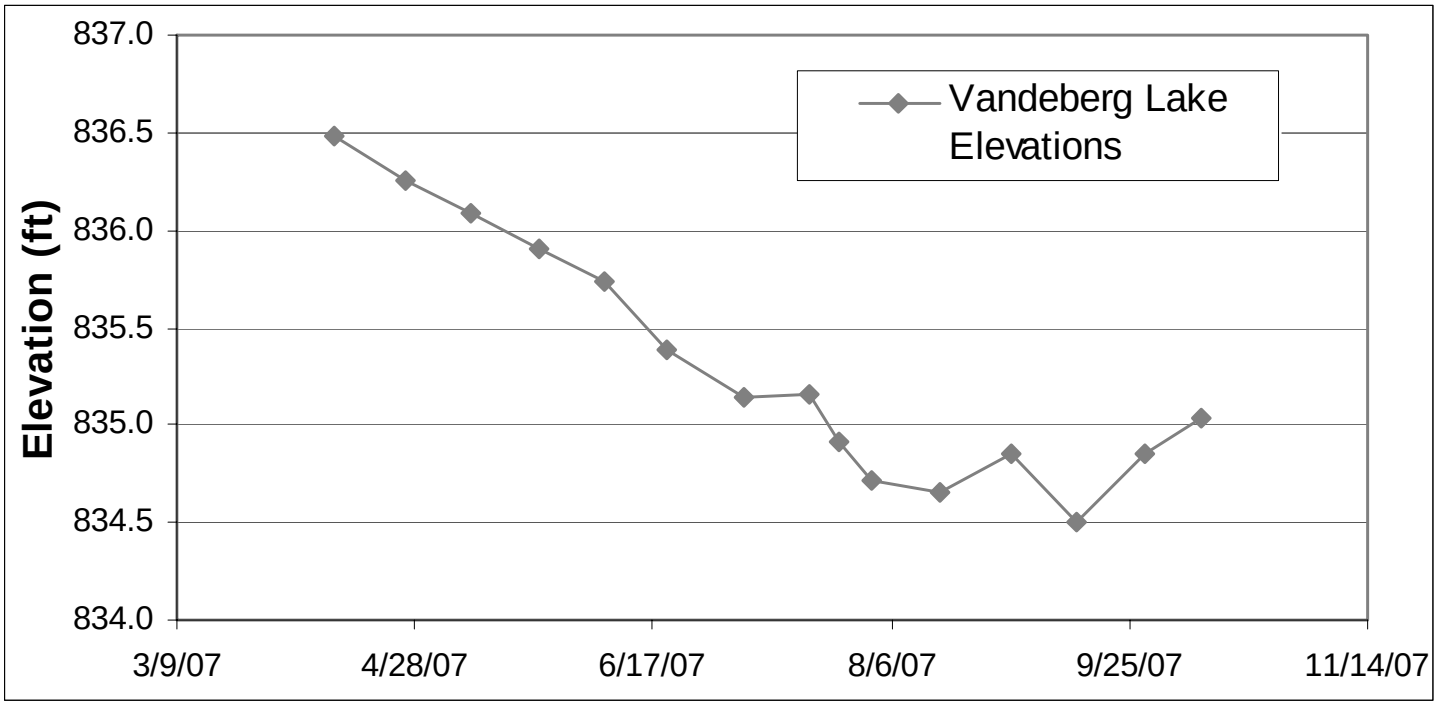


Figure 103. Vandeberg Lake Elevations

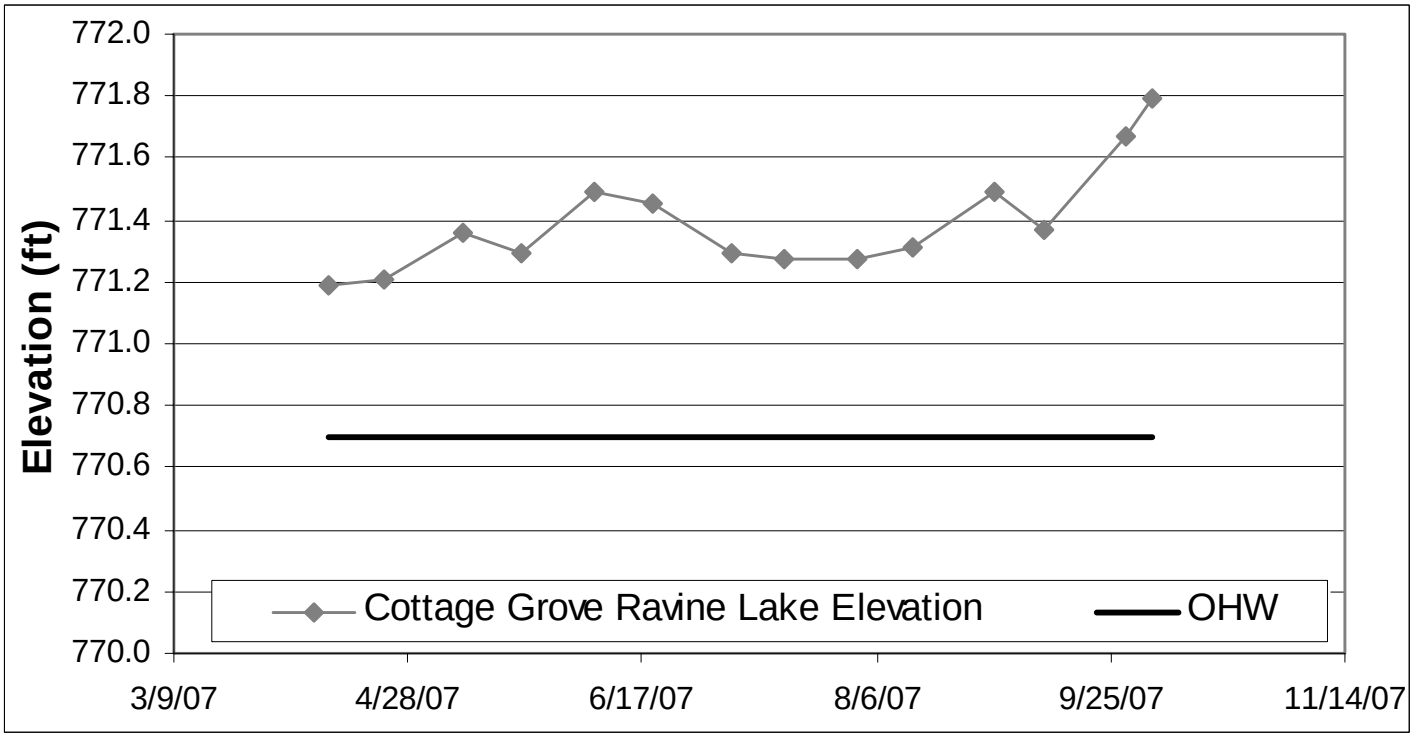


Figure 104. Cottage Grove Ravine Park Lake Elevations and Ordinary High Water (OHW)

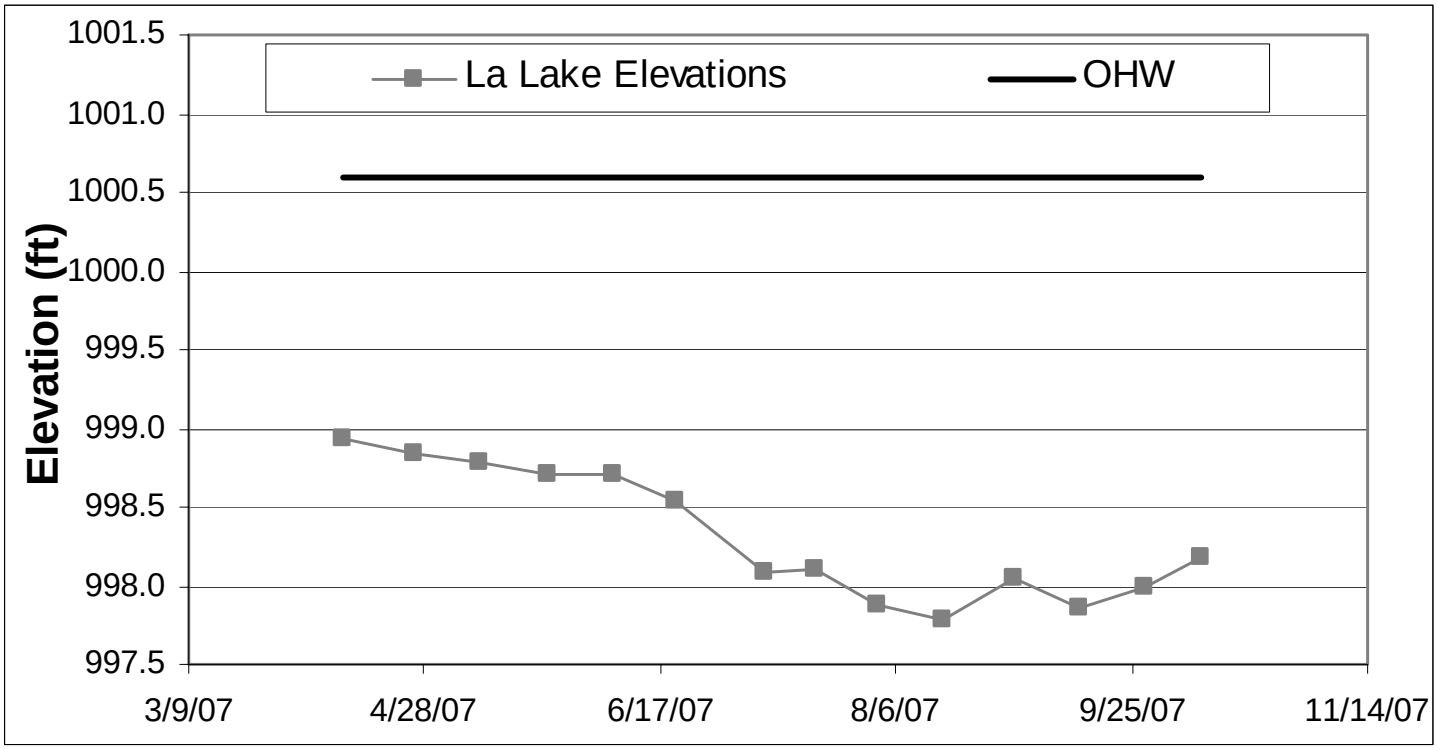


Figure 105. La Lake Elevations and Ordinary High Water (OHW)

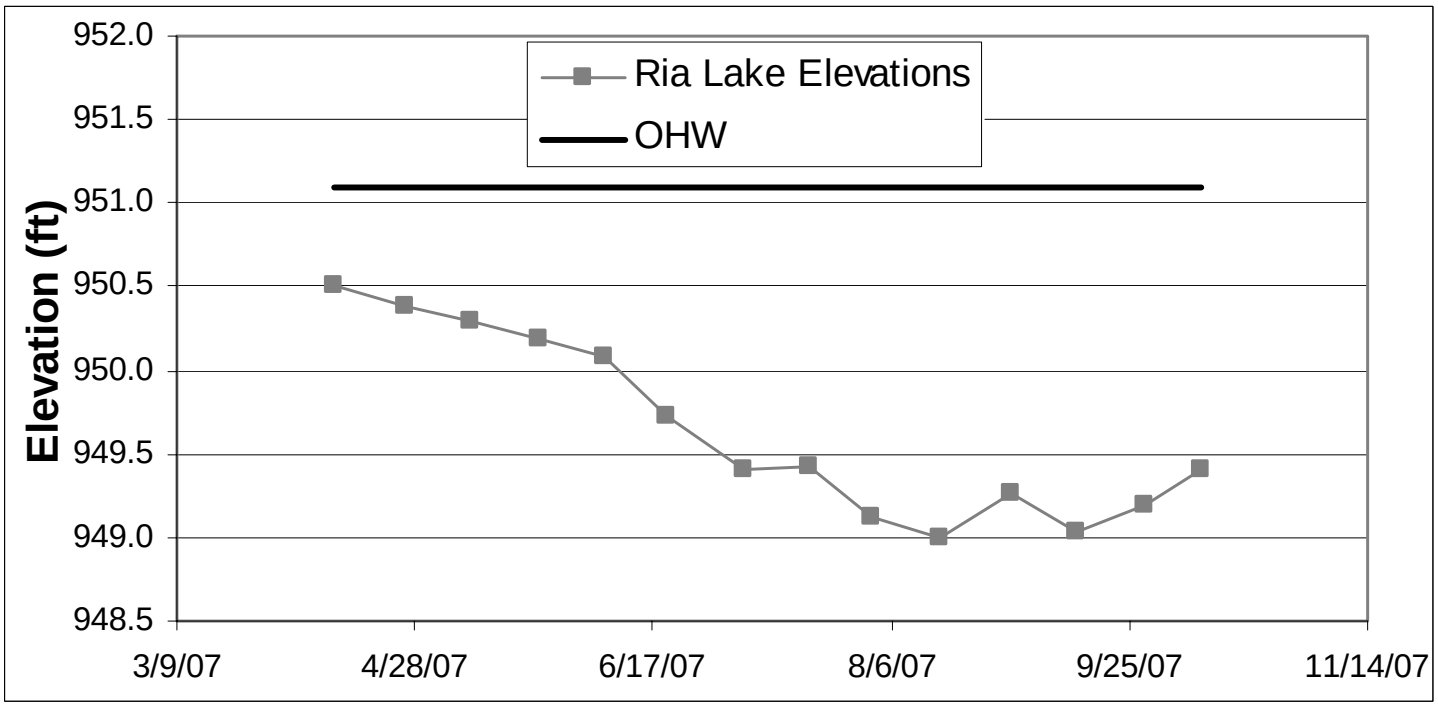


Figure 106. Ria Lake Elevations and Ordinary High Water (OHW)

Observation Wells

Six observation wells were monitored for elevation concurrently by the Washington Conservation District from January 25-December 19, 2007. Table 23 shows the high, low, range and average groundwater observations during the 2007 monitoring season. Figure 107 shows the fluctuation of the groundwater elevations for each well during the 2007 monitoring season. Water levels for observation wells were highest mostly during either in late fall or late spring. Observation well #545604 had the highest recorded level in October. Low groundwater elevations occurred in September for all wells except for well # 545602 and well # 616497, which occurred in October and December respectively.

Table 23. SWWD 2007 Observation Well Elevations

Well #	Dates Monitored	# Readings	Monitoring Point Elevation (ft)	Lowest Reading (ft)	Lowest Reading Date	Highest Reading (ft)	Highest Reading Date	Range (ft)	Average Elevation (ft)
545602	1-25-07 to 12-19-07	12	889.25	814.25	10/24/2007	816.03	1/25/2007	1.78	815.10
545603	1-25-07 to 12-19-07	12	909.15	846.65	9/27/2007	855.68	11/13/2007	9.03	850.28
545604	1-25-07 to 12-19-07	12	906.70	859.68	9/27/2007	868.65	10/24/2007	8.97	863.37
616493	1-25-07 to 12-19-07	12	916.75	799.75	-	799.75	-	0	799.75
616494	1-25-07 to 12-19-07	12	916.95	836.95	-	836.95	-	0	836.95
616497	1-25-07 to 12-19-07	12	913.53	862.08	12/19/2007	863.09	6/22/2007	1.01	862.19

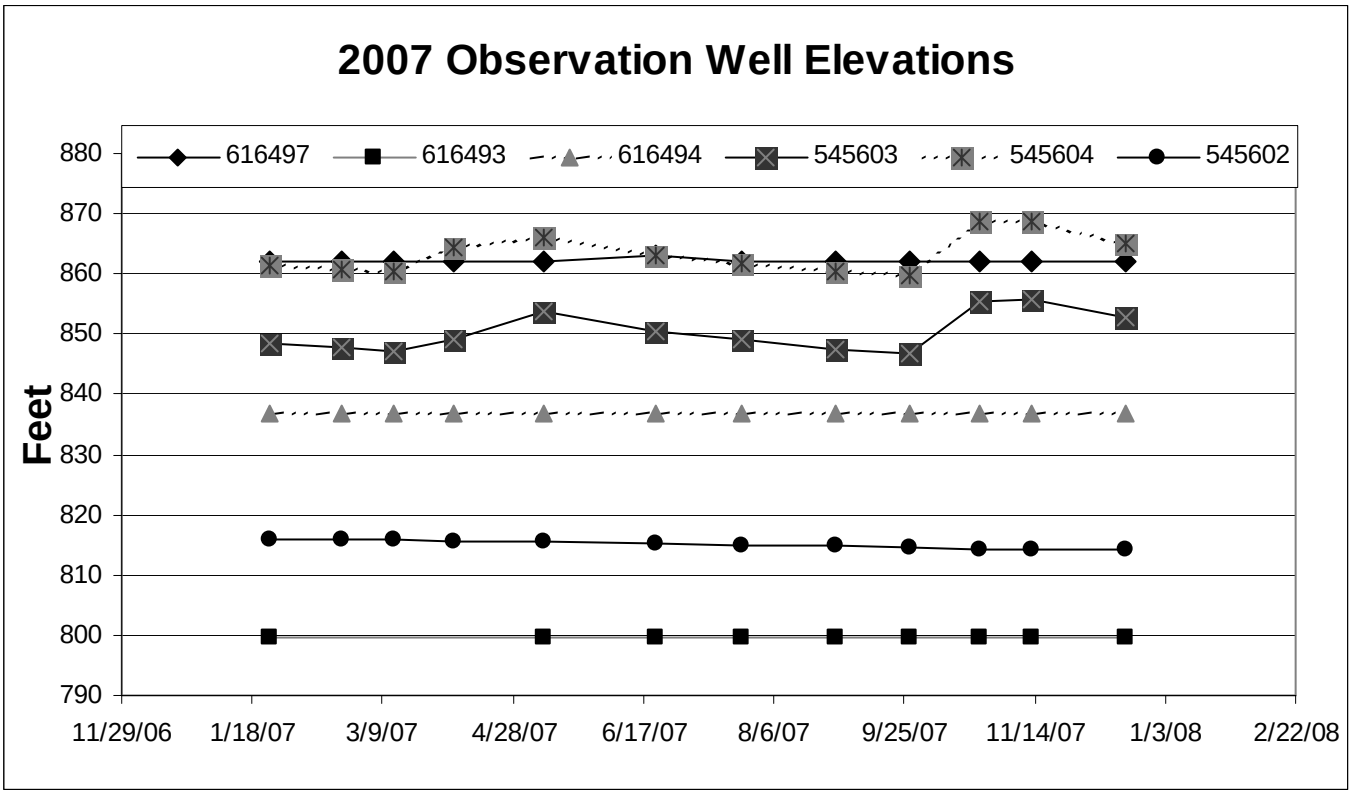


Figure 107. SWWD 2007 Observation Well Elevations