

# 23 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) MONITORING

## BACKGROUND

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The Minneapolis Park and Recreation Board (MPRB) and Minneapolis Public Works (MPW) Department are responsible for compliance with the National Pollutant Discharge Elimination System (NPDES) stormwater permit. The MPRB is responsible for monitoring and reporting the data to the City. The purpose of monitoring for the NPDES permit is to characterize the impacts of stormwater discharges. Previously, the MPRB and MPW partnered with the City of St. Paul to fulfill the NPDES permit requirements. Five sites were monitored for 2001 – 2004 located in Minneapolis and St. Paul. In 2005, four new sites were selected for monitoring located in Minneapolis. In 2006 one new recreational/parkland site was selected due to land use changes at the previous recreational/parkland site. The new sites were chosen to comply with the original NPDES permit and to assist MPW with their modeling efforts.

## METHODS

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This summary includes the equipment installation at each site, the parameters monitored, field quality assurance sampling, data handling, validation and reporting.

### Site Installation

The equipment installed at each site included an ISCO 3700 sampler, an area/velocity pressure transducer and ISCO 4150 datalogger. The dataloggers were flow paced and adjusted accordingly throughout the year to collect samples over the entire hydrograph.

Sites 6 (22<sup>nd</sup>/Aldrich) and 8a (Pershing Park) were installed on 5/2/06 and 5/12/06, respectively. Sites 7 (14<sup>th</sup> and Park) and 9 (61<sup>st</sup>/Lyndale) were installed on 5/3/06.

Equipment installation began when freezing temperatures were no longer a concern in the spring to prevent damage to transducers. See Table 23A for site locations and characteristics. See Figure 23A for a map of site locations.

### Monitored Parameters

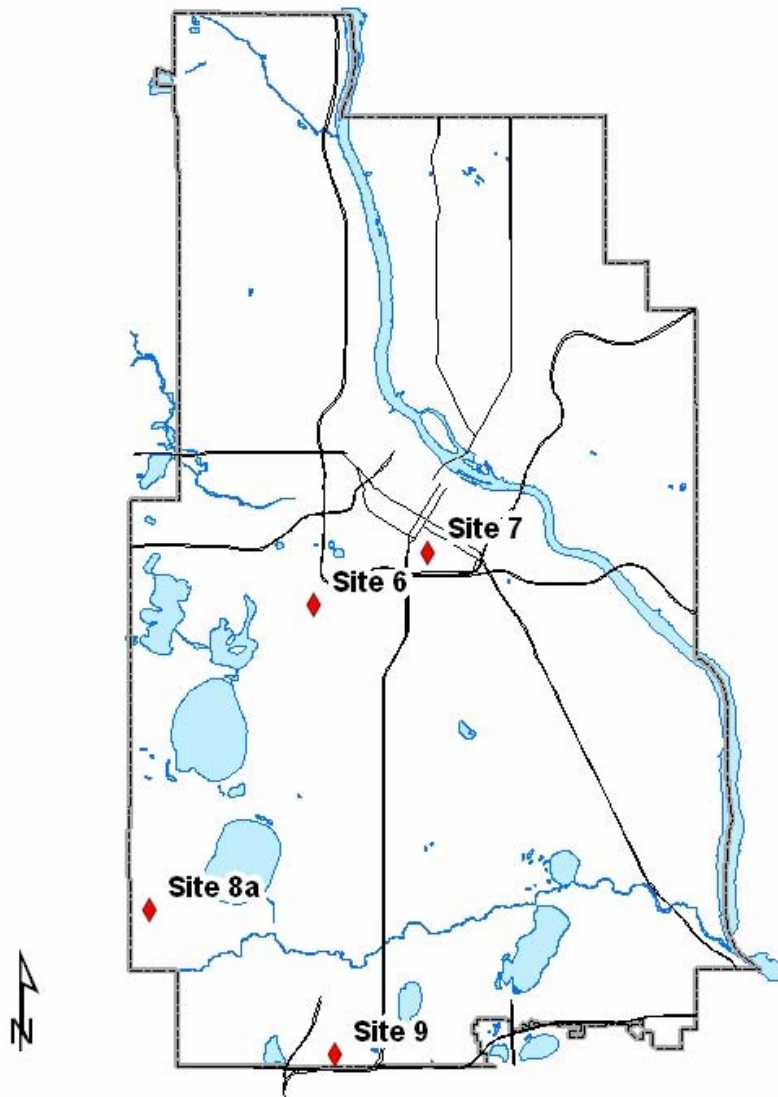
In 2006 storm event samples were collected from May through December. One snowmelt grab sample was collected in February from sites 6, 7 and 9 and in March from site 8a. The target frequency for sample collection was once a month. If a sample was missed one month due to lack of events, then two were taken the next month. Total volume sampled for each site and total recorded volumes in 2006 are given in Table 23B along with the percentage sampled per season. For detailed information on sampling events see Table 23C. Multiple bacteria grab samples were taken throughout the season. All required sampling was successfully accomplished in 2006.

**Table 23A. NPDES stormwater monitoring sites for Minneapolis, MN.**

	<b>SD006</b>	<b>SD007</b>	<b>SD008 (2005)</b>	<b>SD008a</b>	<b>SD009</b>
Location	22 <sup>nd</sup> St. and Aldrich Ave.	E. 14 <sup>th</sup> St. and Park Ave. S.	Kenwood Pkwy – north end of Parade Stadium	Pershing Field east of 49 <sup>th</sup> St. and Chowen Ave.	335 ft east of 61 <sup>st</sup> St. and Harriet Ave.
Land Use	Multi – Family Residential	Commercial/Industrial / High Rise Residential	Recreational/ Parkland	Recreational/ Parkland	Commercial/ Industrial
Area (acres)	8.9	13.1	1.9	2.5	34.9
Pipe Diameter (inches)	18	42	18	10	36
Outfall ID#	10 – 430J	10 – 430D	10 – 430J	57 – 100A/B	71 – 070

**Table 23B. NPDES site volume totals for the sampling period 5/8/06 – 10/16/06.**

	Site 6	Site 7	Site 8a	Site 9
<b>Total volume of sampled events (cf)</b>	71,938	290,366	49,107	370,522
<b>Total volume recorded for 2006 (cf)</b>	92,307	454,172	76,765	809,659
<b>% sampled ANNUAL (April – November)</b>	78%	64%	64%	46%
<b>% sampled SPRING (April – June)</b>	29%	29%	8%	7%
<b>% sampled SUMMER (July – September)</b>	49%	34%	56%	38%
<b>% sampled FALL (October – November)</b>	0.3%	0.3%	0.0%	0.9%



**Figure 23A. Map of the 2006 NPDES sites located in Minneapolis, MN.**

**Table 23C. Precipitation event data and samples collected for NPDES sites in 2006. A precipitation event is defined as being greater than 0.10 inches and separated by 8 hours. Rain gage located at 3800 Bryant Ave. S., Minneapolis, MN.**

Event	Start Date/Time	End Date/Time	Precip (inches)	Duration (hours)	Intensity (in/hr)	Sample Type	2006 NPDES Events Collected			
							Site 6 22nd/Aldrich	Site 7 14th/Park	Site 8a Pershing	Site 9 61st/Lyndale
1	2/2/2006, n/a	2/2/2006, n/a	n/a	n/a	n/a	grab+	X	X		X
2	3/28/2006 13:15	3/28/2006 13:15	n/a	n/a	n/a	grab+			X	
3	5/8/2006 9:45	5/8/2006 21:50	0.57	12	0.05	composite	X	X		X
4	5/12/2006 3:35	5/13/2006 3:10	0.63	24	0.03	grab	X(Fecal only)	X(Fecal only)		X(Fecal only)
5	5/24/2006 16:20	5/25/2006 20:30	0.18	28	0.01	composite		X		
6	6/5/2006 18:05	6/6/2006 1:45	0.40	8	0.05	composite				X
7	6/16/2006 16:50	6/16/2006 23:20	1.95	6.5	0.30	composite	X(Lmtd)	X(Lmtd)	X(Lmtd)	
8	6/25/2006 4:00	6/25/2006 6:20	0.28	2.5	0.11	composite			X(Lmtd)	
9	7/13/2006 20:15	7/14/2006 1:10	0.30	5	0.06	composite		X(Lmtd)		X(Lmtd)
10	7/16/2006 5:40	7/16/2006 9:45	0.41	4	0.10	composite	X	X		
11	7/19/2006 8:30	7/19/2006 16:50	0.56	8.5	0.07	composite	X	X		X
12	7/24/2006 16:00	7/24/2006 17:25	1.73	1.5	1.15	composite	X		X	X
13	8/1/2006 0:15	8/1/2006 5:15	0.16	5	0.03	composite	X			X(Fecal only)
14	8/1/2006 9:55	8/2/2006 6:05	3.58	20	0.18	composite	X	X	X	X
15	8/10/2006 16:40	8/10/2006 18:30	0.49	2	0.25	composite			X	
16	8/13/2006 9:40	8/13/2006 16:25	0.50	6	0.08	composite			X	
17	8/23/2006 3:00	8/23/2006 8:00	0.92	5	0.18	composite			X	
18	8/24/2006 9:35	8/24/2006 18:20	1.55	9	0.17	composite			X	
19	9/15/2006 23:50	9/16/2006 8:15	0.32	8	0.04	composite				X(Lmtd)
20	9/21/2006 11:05	9/22/2006 18:40	0.88	31	0.03	composite	X (w/Fecal)	X(w/Fecal)	X(Lmtd)	X
21	10/16/2006 4:20	10/16/2006 16:20	0.21	12	0.02	composite	X(Lmtd)	X(Lmtd)		X(Lmtd, w/Fecal)
22	11/28/2006 1:55	11/28/2006 11:25	0.74	10	0.07	grab	X(Fecal only)	X(Lmtd)	X(w/Fecal)	X(w/Fecal)
23	12/11/2006 17:35	12/12/2006 6:15	0.17	13.75	0.01	grab	X	X(Fecal only)		X(w/Fecal)
<b>Totals</b>			<b>16.53</b>				<b>9</b>	<b>7</b>	<b>8</b>	<b>9</b>

+ snowmelt event

n/a= not applicable

X(Lmtd) = event sampled but with limited parameters e.g.sample was >24hrs old, cBOD, TDP, and F. Coli generally were not sampled.

X(w/Fecal) = event sampled with fecal coliform.

X(Fecal only) = Only fecal coliform sampled.

The parameters listed in Table 23D were monitored as part of the NPDES permit for each sample collected. Table 23E gives the method used for analysis, reporting limit and holding time for each parameter as reported by the contract laboratory Instrumental Research, Inc. (IRI).

**Table 23D. List of monitored parameters for the NPDES permit, 2006. BOD is biochemical oxygen demand. The pH was measured in the field using an Oakton Waterproof pHTestr 2. The pH meter was calibrated each sampling trip. Fecal coliform and pH samples were collected from grab samples (spring, summer and fall).**

Parameter	Abbreviation	Units	Sample Type
BOD –carbonaceous, 5 Day	cBOD	mg/L	Composite
Chloride, Total	Cl	mg/L	Composite
Specific Conductivity	Sp. Cond	µmhos/cm	Composite
Copper, Total	Cu	µg/L	Composite
Fecal Coliform	F. Coli	#/100mL	Grab (3X year)
Lead, Total	Pb	µg/L	Composite
Nitrite+Nitrate, Total as N	NO <sub>2</sub> NO <sub>3</sub>	mg/L	Composite
Ammonia, Un-ionized as N	NH <sub>3</sub>	mg/L	Composite
Kjeldahl Nitrogen, Total	TKN	mg/L	Composite
pH	pH	standard unit	Grab (3X year)
Phosphorus, Total Dissolved	TDP	mg/L	Composite
Phosphorus, Total	TP	mg/L	Composite
Solids, Total Dissolved	TDS	mg/L	Composite
Solids, Total Suspended	TSS	mg/L	Composite
Zinc, Total	Zn	µg/L	Composite

**Table 23E. Analysis method, reporting limit and holding times for parameters used by Instrumental Research, Inc.**

Parameter	Method	Reporting Limit	Holding Times
cBOD, carbonaceous, 5 Day (20°C)	SM 5210 B	1.0 mg/L	24 hours
Chloride, Total	SM 4500-Cl <sup>-</sup> B	2.0 mg/L	28 days
Specific Conductivity	SM 2510 B	10 µmhos/cm	28 days
Copper, Total	EPA 200.9	5 µg/L	6 months
Fecal Coliform	SM 9222D	<1 per 100mL	< 24hrs
Lead, Total	SM 3500-Pb B	5 µg/L	6 months
Nitrite+Nitrate, Total as N	SM 4500-NO <sub>3</sub> E	0.030 mg/L	28 days
Ammonia, Un-ionized as N	SM 4500-NH <sub>3</sub> F	0.500 mg/L	7 days
Kjeldahl Nitrogen, Total	SM 4500-Norg B	0.500 mg/L	7 days
Phosphorus, Total Dissolved	SM 4500-P A, B, G	0.010 mg/L	48 hours
Phosphorus, Total	SM 4500-P A, B, E	0.010 mg/L	48 hours
Solids, Total Dissolved	SM 2540 C	10.0 mg/L	7 days
Solids, Total Suspended	SM 2540 D	1.0 mg/L	7 days
Zinc, Total	SM 3500-Zn B	50 µg/L	6 months

## **Field Quality Assurance Samples**

A number of quality assurance samples (10% of samples) were used during the sampling season. The purpose of these samples was to ensure sample integrity. Field blanks consisting of deionized water accompanied samples from the sites to the analytical laboratory. One field blank was used for the four sites each sampling trip for a complete analysis of NPDES parameters. All field blank parameters came back from the laboratory below the minimum detection limits.

An equipment blank (1 – 2 L sample) was collected on 12/4/06. To collect the equipment blank, a large bottle of deionized water was placed at the end of the sampler tubing. The intake line was flushed and pumped by pulling deionized water through the sampler, simulating the pre-sample flush. The flush water was back-pumped to waste and then a sample of deionized water was collected. The sample was of sufficient volume to allow analysis of all parameters. All analytes came back from the laboratory below the minimum detection limits.

## **Data Handling, Validation and Reporting**

Manual transcription of data was minimized to reduce the need for data validation. A minimum of 10% of the final data were checked by hand against the raw data sent by the laboratory to ensure there were no errors entering or transferring data. See Section 28, Quality Assurance Assessment Report for details.

Field measurements were recorded on the Field Measurement Form in the Field Log Book and then entered into a computer database. Computerized data from the laboratory were forwarded to the MPRB. Computerized data from the laboratory were checked and passed laboratory quality assurance procedures. Protocols for data validity followed those defined in the Storm Water Monitoring Program Manual (MPRB, 2001). For data reported below the reporting limit, the reporting limit value was divided in half and then used for all calculations.

A Chain of Custody form accompanied each set of sample bottles delivered to the lab. Each sampler tray was labeled indicating the date and time of collection, site location and the field personnel's initials. The time each sample was collected was recorded from the ISCO sampler onto field sheets. A complete description of methods can be found in the Storm Water Monitoring Program Manual (MPRB, 2001).

Statistics for event mean concentrations were calculated using Microsoft Excel spreadsheets. The computer program FLUX and computer model P8 were used to calculate flow-weighted mean concentrations and estimate snowmelt runoff volume respectively.

A description of FLUX as described in the FLUX manual (Walker, 1996):

“FLUX is an interactive program designed for use in estimating the loadings of nutrients or other water quality components passing a tributary sampling station over a given period of time. These estimates can be used in formulating reservoir nutrient balances over annual or seasonal averaging periods appropriate for application of empirical eutrophication models.

Using six calculation techniques, FLUX maps the flow/concentration relationship developed from the sample record onto the entire flow record to calculate total mass discharge and associated error statistics. In many cases, stratifying the data increases the accuracy and precision of loading estimates."

A description of P8 as described in the software's introduction:

"P8 is a model for predicting the generation and transport of stormwater runoff pollutants in small urban catchments...

Simulations are driven by hourly rainfall and daily air-temperature time series..."

## RESULTS & DISCUSSION

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Event mean concentrations are listed in Table 23F. In 2006, where flow was sufficient, *F. coli* grab samples were collected eighteen times at the NPDES sites, Table 23F.

In 2006, limited parameters were collected twelve times, Table 23C. These data were collected after 24 hours and expired parameters were dropped (e.g. cBOD, TDP).

Due to a significant land use change at Site 8 in late summer 2005, a new site was chosen for 2006. The Site 8 land use was dramatically changed from ball fields to impervious artificial turf. This necessitated a new site being chosen for 2006 at Pershing Park. The new site, 8a, is similar in size and has a recreational parkland land use, Table 23A.

Data with questionable usability were underlined. In 2006, three records were flagged. These May TKN data failed the blind monthly performance standard and are marked suspect, but the data were still used because the values were deemed reasonable. Further quality assurance protocols can be found in Section 28.

Table 23G lists the statistical calculations for all measured parameters. Many parameters fluctuate with season. Typically, maximums for most parameters were reached during snowmelt and spring, e.g. TP, NH<sub>3</sub>, NO<sub>2</sub>NO<sub>3</sub>, Cl, TSS, TDS and Zn. Some parameters peaked in fall, e.g. TP, TDP, NO<sub>2</sub>NO<sub>3</sub> and BOD. This was probably due to snowmelt accumulations and leaf litter, respectively.

The event on 6/6/06 also showed increased concentrations for some parameters (TP, TDP, NH<sub>3</sub> and NO<sub>2</sub>NO<sub>3</sub>) which is most likely due to the lack of rain for an extended period of time. The last event prior to 6/5/06 was less than two weeks prior and was on 5/24/06. The last event prior to 7/14/06 was 6/25/06, which could have also allowed a large accumulation of nutrients and pollutants between storms, (TP, TKN, NH<sub>3</sub>, NO<sub>2</sub>NO<sub>3</sub>, TSS and TDS).

Peak phosphorus levels during snowmelt were probably due to an accumulation of animal, lawn, and leaf litter waste in late fall and atmospheric deposition during winter months. The maximum TP of 1.63 mg/L at Site 6 was on 10/16/06. Most snowmelt samples were brown to dark brown and very turbid except Site 8a which was relatively clear. This is most likely due to

the filtering effect of the parkland. High Cl concentrations are typical for stormwater runoff during winter and early spring months when road salt is used. Site 9 showed increased amounts of chloride during the summer months. There are many industries surrounding Site 9 which may be contributing to chloride levels during the summer months. Site 9 also has a small baseflow indicating that there is discharge or infiltration coming from an unknown source. Also, specific conductivity, TDS, and TSS generally tend to be high during winter and spring months, with the exception of Site 9. High TSS values in snowmelt and spring might be attributed to accumulated sand applied to icy roads. A small amount of sand can lead to very high TSS values. Almost all maximum metal values followed the same trend as TSS. Cadmium was below the detection limit for all sites for the single event tested (2/2/06). Zinc was below the detection limit for most of Site 6 and Site 8a events. Fecal coliform values were lowest for the snowmelt event and generally peaked during summer/fall months. This is as expected since bacterial survival is temperature dependent.

**Table 23F. NDPEs sampled event data by site for 2006.**

Date	Time	Site ID & Location	Sample Type	TP mg/L	TDP mg/L	TKN mg/L	NH3 mg/L	NO3NO2 mg/L	Cl mg/L	Field pH	Sp.Cond. µmhos/cm	F. Coli cfu/100mL	cBOD mg/L	TSS mg/L	TDS mg/L	Hardness mg/L	Cd µg/L	Cu µg/L	Pb µg/L	Zn µg/L
2/2/2006	13:05	Site #6 22nd & Aldrich	Grab	0.870	0.078	3.72	1.16	0.828	484	8.6	1790	380	13	240	865	76.0	<5.00	61.4	50.8	240
5/8/2006	23:07	Site #6 22nd & Aldrich	Composite	0.529	0.110	<u>3.74</u>	1.60	1.11	2.75		57.7		18	136	58			22.2	66.0	148
5/12/2006	10:55	Site #6 22nd & Aldrich	Grab							7.9		24,000								
*6/16/2006	19:47	Site #6 22nd & Aldrich	Composite	0.532		3.68	1.34	0.494	<2.00		68.0			69	56			18.2	60.6	66.0
7/16/2006	10:07	Site #6 22nd & Aldrich	Composite	0.788	0.201	4.88	2.08	0.567	2.34		92.7		11	134	97			25.3	107	<50.0
7/19/2006	10:31	Site #6 22nd & Aldrich	Composite	0.353	0.173	2.76	1.11	0.697	<2.00		63.5		8	56	47			14.4	30.2	69.0
7/24/2006	18:10	Site #6 22nd & Aldrich	Composite	0.387	0.102	2.21	0.579	0.477	2.30		40.2		6	101	73			18.6	86.4	75.0
8/1/2006	4:23	Site #6 22nd & Aldrich	Composite	0.498	0.106	3.98	1.20	0.700	5.22		76.6		13	82	91			27.3	56.4	93.0
8/2/2006	2:41	Site #6 22nd & Aldrich	Composite	0.250	0.063	1.25	<0.500	0.209	<2.00		29.6		5	54	20			11.3	36.7	<50.0
9/22/2006	8:13	Site #6 22nd & Aldrich	Composite	0.150	0.064	0.918	<0.500	0.383	2.00		48.5		6	17	41			7.10	13.8	<50.0
9/22/2006	11:00	Site #6 22nd & Aldrich	Grab									6,000								
*10/16/2006	6:58	Site #6 22nd & Aldrich	Composite	1.63	1.10	3.44	0.759						113					23.8	13.0	<50.0
11/28/2006	8:50	Site #6 22nd & Aldrich	Grab							8.2		700								
12/12/2006	8:40	Site #6 22nd & Aldrich	Grab	0.140	0.069	2.12	1.50	1.04	40.0	7.2	275	400	11	8	139			10.7	8.00	<50.0
2/2/2006	12:45	Site #7 Park & 14th	Grab	0.769	0.072	2.73	0.699	0.863	532	9.0	2337	200	7	269	909	56.0	<5.00	62.3	39.3	404
5/8/2006	23:04	Site #7 Park & 14th	Composite	0.346	0.051	2.67	1.34	0.798	6.00		67.9		12	127	59			22.3	29.1	131
5/12/2006	11:20	Site #7 Park & 14th	Grab							7.6		6,000								
5/25/2006	21:42	Site #7 Park & 14th	Composite	0.657	0.038	<u>3.51</u>	0.888	0.419	3.25		100		22	284	68			59.9	83.6	270
*6/16/2006	18:55	Site #7 Park & 14th	Composite	0.426		3.36	1.29	0.601	4.82		90.2			119	75			31.8	36.2	85.0
7/14/2006	1:58	Site #7 Park & 14th	Composite	0.613	0.074	4.55	0.586	0.989	11.7		185			153	179			37.5	44.6	82.0
7/16/2006	9:02	Site #7 Park & 14th	Composite	0.311	0.056	2.75	1.57	0.914	<2.00		67.3		4	104	49			26.3	39.7	<50.0
7/19/2006	10:48	Site #7 Park & 14th	Composite	0.225	0.053	2.46	0.985	0.936	3.19		66.8		5	63	82			17.6	13.2	54.0
8/2/2006	1:28	Site #7 Park & 14th	Composite	0.269	0.037	1.07	<0.500	0.378	4.37		70.8		9	117	58			19.9	21.2	68.0
9/22/2006	8:06	Site #7 Park & 14th	Composite	0.122	0.039	0.704	<0.500	0.406	2.00		56.0		5	16	44			7.60	<5.00	<50.0
9/22/2006	11:30	Site #7 Park & 14th	Grab									1,500								
10/16/2006	7:20	Site #7 Park & 14th	Composite	0.799	0.191	2.81	<0.500						50					30.0	29.8	96.0
11/28/2006	9:05	Site #7 Park & 14th	Grab							7.9		275								
12/12/2006	9:00	Site #7 Park & 14th	Grab							6.9		185								
3/28/2006	13:15	Site #8a Pershing Field	Grab	0.754	0.412	2.48	0.572	0.619	<2.00	8.9	113		4	113		108.0	<5.00	8.50	14.4	<50.0
*6/16/2006	21:15	Site #8a Pershing Field	Composite	0.994		6.12	0.750	0.124	<2.00		89.9			181	82			27.0	17.1	62.0
6/25/2006	7:38	Site #8a Pershing Field	Composite	0.209		1.11	0.555	0.253	<2.00		65.7			21	55			11.1	<5.00	<50.0
7/24/2006	18:47	Site #8a Pershing Field	Composite	0.990	0.575	3.61	0.904	0.862	<2.00		104		9	105	74			16.3	16.3	<50.0
8/2/2006	2:53	Site #8a Pershing Field	Composite	0.508	0.138	1.92	<0.500	0.247	5.22		82.7		7	143	46			16.4	18.0	61.0
8/10/2006	18:51	Site #8a Pershing Field	Composite	0.787	0.421	2.81	1.53	0.933	2.54		98.0		10	99	102			12.0	8.85	<50.0
8/13/2006	11:47	Site #8a Pershing Field	Composite	0.316	0.082	2.50	1.17	0.954	<2.00		71		8	76	90			14.8	9.20	<50.0
8/23/2006	6:13	Site #8a Pershing Field	Composite	0.797	0.339	3.39	1.62	1.02	2.50		103		7	107	80			34.7	19.8	52.0
8/24/2006	19:23	Site #8a Pershing Field	Composite	0.289	0.057	2.26	1.13	0.349	<2.00		44		2	123	44			17.2	19.6	<50.0
9/21/2006	19:47	Site #8a Pershing Field	Composite				<0.500						10	55						
11/28/2006	9:30	Site #8a Pershing Field	Grab	0.884	0.286	3.29	<0.500	0.499	2.00	7.2	103	440,000	33	96	75			9.90	6.80	60.0
2/2/2006	12:20	Site #9 61st & Lyndale	Grab	0.501	0.085	9.49	1.38	0.833	724	9.8	2820	60	11	228	1347	92.0	<5.00	50.2	7.00	179
5/9/2006	0:14	Site #9 61st & Lyndale	Composite	0.798	0.090	<u>5.66</u>	3.07	0.720	435		393		19	473	388			67.8	33.3	298
5/12/2006	11:54	Site #9 61st & Lyndale	Grab									3,350								
6/6/2006	2:30	Site #9 61st & Lyndale	Composite	0.826	0.128	4.14	2.81	0.478	40.5		258		13	243	167			65.4	31.9	246
7/14/2006	2:00	Site #9 61st & Lyndale	Composite	0.968	0.097	13.6	11.1	0.977	129		514			330	395			60.5	20.0	274
7/19/2006	11:10	Site #9 61st & Lyndale	Composite	0.576	0.078	3.85	2.23	0.726	27.0		200		7	284	143			41.5	17.8	174
7/24/2006	19:20	Site #9 61st & Lyndale	Composite	0.543	0.045	4.76	2.53	0.773	28.2		208		10	293	159			39.0	17.8	200
8/1/2006	14:25	Site #9 61st & Lyndale	Grab									19000								
8/2/2006	1:16	Site #9 61st & Lyndale	Composite	0.308	0.066	2.43	1.25	0.427	17.9		144		5	177	100			18.8	13.0	70.0
*9/17/2006	18:51	Site #9 61st & Lyndale	Composite	0.483		3.61	2.40	0.409	16.8		159			240	130			32.7	19.9	147
9/22/2006	8:48	Site #9 61st & Lyndale	Composite	0.314	0.133	1.15	<0.500	0.467	9.90		152		7	93	92			17.5	<5.00	<50.0
9/22/2006	10:10	Site #9 61st & Lyndale	Grab									59000								
10/16/2006	12:10	Site #9 61st & Lyndale	Composite	0.741	0.067	24.5	17.6				5500		22					42.0	15.1	178
11/28/2006	12:17	Site #9 61st & Lyndale	Composite	0.697	0.079	2.03	<0.500	0.332	90.5		425		9	386	222			38.8	19.6	230
11/28/2006	10:10	Site #9 61st & Lyndale	Grab							7.9		130								
12/12/2006	9:40	Site #9 61st & Lyndale	Composite	0.232	0.068	2.33	0.503	1.56	240	9.2	906	130	16	96	587			15.2	<5.00	<50.0

\* collected after 24 hours

Data with questionable usability are underlined. These data failed the monthly performance standard and are suspect, but the data were still used because the values were reasonable.

**Table 23G. Event mean concentration statistics for 2006. All = includes all 4 sites, STDEV = standard deviation, COV = coefficient of variance**

Site ID	Statistical Function	TP mg/L	TDP mg/L	TKN mg/L	NH3 mg/L	NO3NO2 mg/L	Cl mg/L	Field pH	Sp.Cond. umhos/cm	F. Coli cfu/100mL	cBOD mg/L	TSS mg/L	TDS mg/L	Hardness mg/L	Cd µg/L	Cu µg/L	Pb µg/L	Zn µg/L
6	MEAN (geometric)	0.437	0.126	2.68	0.89	0.589	4.44	7.96	93.4	1726	11.8	63.6	79.3	76.0	2.50	18.6	36.8	54
6	MEAN (arithmetic)	0.557	0.206	2.97	1.08	0.651	54.2	7.98	254	6296	20.3	89.7	149	76.0	2.50	21.8	48.1	74
6	MAX	1.63	1.10	4.88	2.08	1.11	484	8.60	1790	24000	113	240	865	76.0	2.50	61.4	107	240
6	MIN	0.140	0.063	0.918	0.250	0.209	1.00	7.20	29.6	380	4.52	8.40	20.2	76.0	2.50	7.10	8.00	25.0
6	MEDIAN	0.498	0.104	3.44	1.16	0.632	2.32	8.05	65.8	700	10.9	75.4	65.3	76.0	2.50	18.6	50.8	66.0
6	STDEV	0.426	0.316	1.23	0.571	0.285	152	0.591	544	10181	32.8	68.0	254			14.6	31.6	67.4
6	NUMBER	11	10	11	11	10	10	4	10	5	10	10	10	1	1	11	11	11
6	COV	0.765	1.53	0.413	0.532	0.438	2.80	0.074	2.141	1.617	1.618	0.758	1.707			0.671	0.656	0.909
7	MEAN (geometric)	0.391	0.059	2.37	0.658	0.656	6.33	7.81	119	620	9.92	109	92.5	56.0	2.50	27.0	25.7	85.9
7	MEAN (arithmetic)	0.454	0.068	2.66	0.81	0.700	63.1	7.85	338	1632	14.4	139	169	56.0	2.50	31.5	33.9	124
7	MAX	0.799	0.191	4.55	1.57	0.989	532	9.00	2337	6000	49.8	284	909	56.0	2.50	62.3	83.6	404
7	MIN	0.122	0.037	0.704	0.250	0.378	1.00	6.90	56.0	185	4.10	16.4	44.0	56.0	2.50	7.60	2.50	25.0
7	MEDIAN	0.386	0.053	2.74	0.794	0.798	4.37	7.75	70.8	275	7.94	119	68.0	56.0	2.50	28.2	33.0	83.5
7	STDEV	0.239	0.048	1.12	0.487	0.250	176	0.874	751	2504	15.5	87.5	280			17.7	21.8	121
7	NUMBER	10	9	10	10	9	9	4	9	5	8	9	9	1	1	10	10	10
7	COV	0.527	0.709	0.419	0.600	0.357	2.78	0.111	2.22	1.53	1.08	0.629	1.66			0.560	0.642	0.975
8a	MEAN (geometric)	0.576	0.224	2.70	0.664	0.480	1.52	8.00	84.5	440000	7.66	95.11	67.9	108	2.50	15.3	11.5	36.5
8a	MEAN (arithmetic)	0.653	0.289	2.95	0.82	0.586	1.83	8.05	87.4	440000	9.98	106	70.4	108	2.50	16.8	13.3	40.0
8a	MAX	0.99	0.575	6.12	1.62	1.02	5.22	8.90	113	440000	32.9	181	102	108	2.50	34.7	19.8	62.0
8a	MIN	0.491	0.160	2.46	0.524	0.373	1.34	7.96	81.1	440000	5.92	76.8	65.4	108	2.50	14.2	9.0	33.5
8a	MEDIAN	0.771	0.313	2.66	0.750	0.559	1.00	8.05	94.0	440000	8.12	106	74.7	108	2.50	15.6	15.4	25.0
8a	STDEV	0.297	0.184	1.34	0.498	0.337	1.36	1.20	21.6		9.00	41.7	19.4			8.17	6.00	18.01
8a	NUMBER	10	8	10	11	10	10	2	10	1	9	10	10	1	1	10	10	9
8a	COV	0.46	0.64	0.45	0.61	0.58	0.74	0.15	0.25		0.90	0.39	0.28			0.49	0.45	0.45
9	MEAN (geometric)	0.536	0.081	4.48	1.81	0.634	64.5	8.93	345	1544	10.6	232	235	92.0	2.50	36.6	13.0	134
9	MEAN (arithmetic)	0.582	0.085	6.46	3.78	0.700	160	8.97	562	12453	11.8	258	339	92.0	2.50	40.8	16.7	171
9	MAX	0.968	0.133	24.5	17.6	1.56	724	9.80	2820	59000	21.7	473	1347	92.0	2.50	67.8	33.3	298
9	MIN	0.232	0.045	1.15	0.250	0.332	9.90	7.90	144	60	4.59	92.7	92.0	92.0	2.50	15.2	2.50	25.0
9	MEDIAN	0.560	0.079	4.00	2.32	0.720	40.5	9.20	258	3350	10.3	243	167	92.0	2.50	40.3	17.8	179
9	STDEV	0.230	0.026	6.67	5.22	0.352	228	0.97	782	21595	5.59	115	369			18.0	9.78	90.6
9	NUMBER	12	11	12	12	11	11	3	11	7	10	11	11	1	1	12	12	12
9	COV	0.395	0.311	1.03	1.38	0.503	1.42	0.108	1.39	1.73	0.473	0.443	1.09			0.442	0.586	0.531
All	MEAN (geometric)	0.481	0.105	3.01	0.94	0.585	7.7	8.13	138	1692	9.95	113	106	80.6	2.50	23.4	19.3	72
All	MEAN (arithmetic)	0.562	0.156	3.87	1.69	0.659	72.2	8.18	316	31489	14.2	151	186	83.0	2.50	28.2	27.9	106
All	MAX	1.63	1.10	24.5	17.6	1.56	724	9.80	2820	440000	113	473	1347	108	2.50	67.8	107	404
All	MIN	0.122	0.037	0.704	0.250	0.124	1.00	6.90	29.6	60	1.90	8.40	20.2	56.0	2.50	7.10	2.50	25.0
All	MEDIAN	0.529	0.081	2.81	1.12	0.658	3.81	7.90	99.0	1100	9.10	118	81.8	84.0	2.50	22.3	19.6	69
All	STDEV	0.305	0.198	3.92	2.97	0.303	169	0.874	610	102981	18.9	106	276	22.2	0.00	17.5	24.0	95.4
All	NUMBER	43	38	43	44	40	40	13	40	18	37	40	40	4	4	43	43	42
All	COV	0.543	1.27	1.01	1.76	0.460	2.34	0.107	1.93	3.27	1.33	0.698	1.49	0.268	0.000	0.621	0.857	0.898

Sampled data were fairly comparable to typical urban stormwater data, Nationwide Urban Runoff Program (NURP), Center for Watershed Protection (CWP) and Bannerman (Tables 23H and 23I). Table 23H shows median values for MPRB 2006 monitored residential sampled sites which were comparable or less than reported NURP values with the notable exception of TKN values. Most MPRB land use category values were comparable to NURP values, and most metals were well below NURP values. Most parameters were comparable to MPRB 2001 – 2005 data except for residential land use Pb values which are much higher in 2006 and mixed land use TKN, NO<sub>3</sub>NO<sub>2</sub> and TSS values. It is important to note that the new sites monitored in 2005 and 2006 are different watersheds and have similar, but not the same, land uses as previously monitored sites in 2001 – 2004.

**Table 23H. Typical MEDIAN urban stormwater concentrations. NURP = median event mean concentrations as reported by the Nationwide Urban Runoff Program (USEPA, 1996). MPRB = median values calculated by the Minneapolis Parks & Recreation Board for the identified year(s).**

Parameter	Residential			Mixed			Composite of all land use categories		
	MPRB <sup>1</sup>	MPRB <sup>2</sup>	NURP	MPRB <sup>3</sup>	MPRB <sup>4</sup>	NURP	MPRB <sup>5</sup>	MPRB <sup>6</sup>	NURP
	2006	2001 – 2005		2006	2001 – 2005		2006	2001 – 2005	
TP (mg/L)	0.498	0.453	0.383	0.386	0.321	0.263	0.529	0.364	0.33
TKN (mg/L)	3.44	2.38	1.9	2.74	1.62	1.288	2.81	1.90	1.5
NO <sub>3</sub> NO <sub>2</sub> (mg/L)	0.632	0.338	0.736	0.798	0.389	0.558	0.658	0.390	0.68
BOD (mg/L)	10.9	12.2	10	7.94	12.9	7.8	9.1	11.9	9
TSS (mg/L)	75	88	101	119	68	67	118	80	100
Cu (µg/L)	17	16	33	28	18	27	22	17	30
Pb (µg/L)	51	16	144	33	16	114	20	15	140
Zn (µg/L)	66	74	135	84	94	154	68	86	160

<sup>1</sup> Site 6 data

<sup>2</sup> Sites 1 and 2 data, (Site 6, 2005)

<sup>3</sup> Site 7 data

<sup>4</sup> Sites 5 and 5a data, (Site 7, 2005)

<sup>5</sup> Sites 6 – 9 data

<sup>6</sup> Sites 1 – 5a data, (Site 6 – 9, 2005)

Most MPRB mean concentrations were comparable to other studies as listed in Table 23I. TP values are most closely related to those monitored by local agencies. Data from MPRB Sites 1 – 5a (2001 – 2004) and 6 – 9 (2005) were generally similar to the Sites 6 – 9 in 2006. Phosphorus, nitrogen and TSS increased while Cl, BOD, and Zn decreased.

**Table 23I. Typical MEAN urban stormwater concentrations. " -- " = not reported.**

Parameter	NURP <sup>1</sup>	CWP <sup>2</sup>	Bannerman <i>et al.</i> <sup>3</sup>	Mpls PW <sup>4</sup>	St. Paul <sup>5</sup>	MPRB <sup>6</sup> 2001– 2005	MPRB <sup>7</sup> 2006
TP (mg/L)	0.5	0.3	0.66	0.417	0.484	0.471	0.562
TDP (mg/L)	--	--	0.27	0.251	--	0.136	0.156
TKN (mg/L)	2.3	--	--	--	2.46	2.46	3.87
NO3NO2 (mg/L)	0.86	--	--	--	0.362	0.484	0.659
NH3 (mg/L)	--	--	--	0.234	--	1.04	1.69
Cl (mg/L)	--	230 (winter)	--	--	--	227	72.2
BOD (mg/L)	12	--	--	14.9	25	16.6	14.2
TDS (mg/L)	--	--	--	73.3	78	522	186
TSS (mg/L)	239	80	262	77.6	129.2	115	151
Cu (µg/L)	50	10	16	26.7	30	26.8	28.2
Pb (µg/L)	240	18	32	75.5	233	25.6	27.9
Zn (µg/L)	350	140	204	148	194	133	104

<sup>1</sup> USEPA (1996)

<sup>2</sup> Center for Watershed Protection (2000)

<sup>3</sup> Monroe study area of Bannerman *et al.* (1993)

<sup>4</sup> City of Minneapolis Public Works Department (1992) – average from a combination of all land uses

<sup>5</sup> City of St. Paul 1994 stormwater data – average from a combination of land uses

<sup>6</sup> MPRB arithmetic mean calculated from NPDES Sites 1 – 5a (2001 –2004), 6 – 9 (2005)

<sup>7</sup> MPRB arithmetic mean calculated from NPDES Sites 6 – 9 (2006)

The model P8 was used to estimate daily flows for snowmelt events and grab samples from January through mid May. Daily flows were used as input for the interactive program FLUX. Daily temperature and hourly precipitation files obtained from the National Oceanic and Atmospheric Administration (NOAA) National Data Center (NDC) were used as input for P8. The rain gauge is located at the Minneapolis/St. Paul International Airport.

All flow-weighted mean concentrations were calculated using FLUX (Table 23J). FLUX calculates flow-weighted mean concentrations and associated error statistics based on six different calculation methods. Calculation methods 1-Direct Mean Loading and 5-Regression, Second-Order were ignored because they are inappropriate for storm sewer applications where the daily

flow file contains a significant number of zero flows (Bruce Wilson, MPCA Research Scientist, personal communication, 2001). In general, calculation methods 2- Flow-Weighted Concentration and 6- Regression Applied to Individual Daily Flows were used. Sample concentrations and associated daily average flows were used as input for these calculations. The data were often stratified by flow or season to achieve the most accurate and precise results.

**Table 23J. Flow-weighted mean concentrations and related statistics for NPDES parameters in 2006. STDEV= standard deviation.**

Site	TP (mg/L)	TDP (mg/L)	TKN (mg/L)	NO3NO2 (mg/L)	NH3 (mg/L)	Cl* (mg/L)	cBOD (mg/L)	TSS (mg/L)	TDS* (mg/L)	Cu (µg/L)	Pb (µg/L)	Zn (µg/L)
6	0.649	0.144	3.68	0.714	1.39	174	12	142	328	32	59	120
7	0.384	0.051	2.82	0.699	1.06	36.2	9	122	124	29	31	129
8a	0.659	0.249	3.32	0.606	0.96	2.03	7	128	70	19	16	32
9	0.501	0.096	4.33	0.532	3.14	150	9	231	210	35	19	96
<b>MEAN</b>	<b>0.548</b>	<b>0.135</b>	<b>3.54</b>	<b>0.638</b>	<b>1.64</b>	<b>91</b>	<b>9</b>	<b>156</b>	<b>183</b>	<b>28.8</b>	<b>31.3</b>	<b>94</b>
<b>MEDIAN</b>	<b>0.575</b>	<b>0.120</b>	<b>3.50</b>	<b>0.653</b>	<b>1.48</b>	<b>93</b>	<b>9</b>	<b>135</b>	<b>167</b>	<b>30.5</b>	<b>25.0</b>	<b>108</b>
<b>STANDEV</b>	<b>0.131</b>	<b>0.085</b>	<b>0.64</b>	<b>0.085</b>	<b>1.019</b>	<b>84</b>	<b>2</b>	<b>51</b>	<b>113</b>	<b>6.95</b>	<b>19.6</b>	<b>44</b>

\* Flow-weighted mean concentrations for Cl and TDS were difficult to estimate using FLUX due to large outliers from the one snowmelt sample, these estimates should be used with discretion.

Large rain events can lead to pipe surcharges. Surcharges, where the water backs up vertically and creates a pressurized head, result in inaccurate daily flow calculations and should be considered when evaluating flow-weighted mean concentrations. These events included high precipitation totals or high intensity. The following surcharges occurred at the NPDES sites in 2006:

- **Site 6:** 6/16/06, 7/24/06, 8/2/06, 8/24/06
- **Site 7:** 6/16/06, 8/22/06
- **Site 8a:** 6/6/06, 6/16/06, 7/16/06, 7/25/06, 8/1/06, 8/2/06, 8/6/06, 8/10/06, 8/13/06, 8/23/06, 8/24/06, 9/2/06
- **Site 9:** 6/16/06, 8/24/06

Site 8a had twelve surcharges in 2006. They are likely due to two pipes and overland flow coming into a manhole basin and a 10 inch PVC pipe outlet at the bottom. The outlet is unable to discharge the water fast enough and it surcharges.

The highest and lowest TP concentrations were estimated at Site 6 and 7, respectively. Site 6 is multi-family residential. Site 7 is mostly high rise residential. Site 7 had the lowest estimated TP, TDP, TKN and TSS. This was probably due to the lack of vegetation inputs (seeds, leaves, grass clippings, etc.) within the Site 7 watershed.

Site 9 had the highest estimated concentrations of TKN, NH<sub>3</sub>, TSS and Cu. Site 9 is located adjacent to a large cement aggregate mixing facility which may explain the higher TSS values. Site 9 is mainly commercial/industrial. This site sometimes had a small baseflow which could be sampled during future monitoring to distinguish high concentrations from storm events or baseflow.

Site 8a had the highest estimated concentrations of TDP and lowest estimated NH<sub>3</sub>, Cl, cBOD, TDS, Cu, Pb, and Zn. Low concentrations of TSS and metals would be expected for an open parkland watershed as there should be minimal inputs of these parameters.

For comparison purposes, Table 23K includes flow-weighted mean pollutant concentrations reported by the U.S. Geological Survey (USGS) for various sites within the Twin Cities (as cited in MPCA, 2000). The Yates watershed was a stabilized residential area. Iverson was a residential watershed under development while Sandberg was predominantly light industrial land use as reported by the USGS (as cited in MPCA, 2000). Site 6 is more closely related to the Yates watershed land use characteristics. Sites 7 and 9 are most comparable to the Sandberg watershed land use characteristics. When comparing the flow-weighted mean concentrations for these sites, Site 6 has lower concentrations than Yates for all parameters with the exception of Pb. Sites 7 and 9 also have lower flow-weighted mean concentrations than Sandberg for almost all parameters and are well within the ranges shown. The 2006 water quality of Sites 6, 7, and 9 was better than the study sites of 1980.

Flow-weighted mean concentrations for Cl and TDS were difficult to estimate using FLUX due to large outliers from the single snowmelt sample. These estimates should be used with discretion. When samples were below the MDL, half of the MDL was used for calculations. Concentrations for Cd sampled in 2006 were all below the MDL for each site. Cadmium was discontinued from monitoring in 2006 because Cd concentrations have typically been below detection for the Minneapolis/St. Paul area (Table 23L), as seen in previous years data. The detection limit for Cd has changed over time, in 2002 it was <0.500 µg/L, in 2003 it was <2.00 µg/L and in 2004 it was <5.00 µg/L (IRI).

Most parameters fell within the range of estimated flow-weighted mean concentration of previous years as seen in Table 23L. In 2006 the parameters TP, TKN, NO<sub>2</sub>NO<sub>3</sub> and TSS had higher concentrations than previous years. Specifically TKN and NO<sub>2</sub>NO<sub>3</sub> show a rather marked increase. TKN (NH<sub>3</sub> + organic nitrogen) sources in urban stormwater can be from anthropogenic activities (fertilizer) and animal waste, but is likely in this case to be from the decay of organic material such as vegetation. NO<sub>2</sub>NO<sub>3</sub> sources can be formed from the nitrification of TKN, and thus share similar sources. 2006 also shows the highest recorded flow weighted mean concentration of TP for the six years monitored. This result is probably from the decay of organic material. In 2006 sites 8a and 9 had mean TP concentrations of 0.653 and 0.582 mg/L, respectively.

While the land use designation characteristics (commercial, residential, etc.) for the NPDES stormwater sites have remained the same, the watersheds for the sites are different as sites have needed to be changed from year-to-year. Also the timing of street sweeping and sampling may have had an effect. These may have been the greatest influence on the concentration differences.

Event mean concentration seasonal statistics (snowmelt, spring, summer and fall) for a combination of all sites were calculated and are listed in Table 23M. Seasonal patterns are evident with snowmelt having the highest mean TP, TKN, CI, TSS, TDS and Zn. Summer had the highest F. Coli. geometric mean. Fall had the highest mean concentrations of TDP, and also shows an increase in many of the other pollutants.



**Table 23M. Statistical summary for event mean concentrations by season in 2006. Statistics were calculated from all sites (6 –9).  
STDEV= standard deviation, COV= coefficient of variance**

2006 Season	Statistical Function	TP mg/L	TDP mg/L	TKN mg/L	NH3 mg/L	NO3NO2 mg/L	Cl mg/L	Field pH	Sp.Cond. µmhos/cm	F. Coli cfu/100mL	cBOD mg/L	TSS mg/L	TDS mg/L	Hardness mg/L	Cd µg/L	Cu µg/L	Pb µg/L	Zn µg/L
SNOWMELT (February)	MEAN (geometric)	0.695	0.078	4.58	1.04	0.841	571	9.12	2276	166	9.78	245	1019	73.2	2.5	57.7	24.1	259
	MEAN (arithmetic)	0.713	0.078	5.31	1.08	0.841	580	9.13	2316	213	10.1	246	1040	74.7	2.5	58.0	32.4	274
	MAX	0.870	0.085	9.49	1.38	0.863	724	9.80	2820	380	12.5	269	1347	92.0	2.5	62.3	50.8	404
	MIN	0.501	0.072	2.73	0.699	0.828	484	8.60	1790	60	6.92	228	865	56.0	2.5	50.2	7.00	179
	MEDIAN	0.769	0.078	3.72	1.16	0.833	532	9.00	2337	200	10.8	240	909	76.0	2.5	61.4	39.3	240
	STDEV	0.191	0.007	3.65	0.349	0.019	127	0.611	515	160	2.86	21	266	18.0	0.0	6.74	22.7	116
	NUMBER	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
COV	0.267	0.083	0.687	0.323	0.022	0.219	0.067	0.223	0.752	0.284	0.086	0.256	0.242	0.000	0.116	0.702	0.424	
SPRING (April-May)	MEAN (geometric)	0.557	0.066	3.75	1.55	0.719	12.4	7.75	111	7843	17.5	219	97.5			37.6	48.1	199
	MEAN (arithmetic)	0.583	0.072	3.90	1.72	0.763	112	7.75	155	11117	17.9	255	143			43.0	53.0	212
	MAX	0.799	0.110	5.66	3.05	1.11	435	7.90	393	24000	22.4	473	388			67.8	83.6	298
	MIN	0.346	0.038	2.67	0.888	0.419	2.75	7.60	57.7	3350	12.3	127	58.0			22.0	29.1	131
	MEDIAN	0.593	0.071	3.63	1.47	0.759	4.63	7.75	84.0	6000	18.5	210	63.5			41.1	49.7	209
	STDEV	0.193	0.033	1.27	0.934	0.285	216	0.212	160	11236	4.24	162	163			24.3	26.2	84.5
	NUMBER	4	4	4	4	4	4	2	4	3	4	4	4			4	4	4
COV	0.330	0.464	0.325	0.543	0.374	1.928	0.027	1.034	1.011	0.237	0.636	1.139			0.565	0.495	0.399	
SUMMER (June-August)	MEAN (geometric)	0.474	0.106	3.04	1.10	0.551	3.73		94.3	19000	7.01	114	81.8			22.9	23.3	59.6
	MEAN (arithmetic)	0.532	0.145	3.56	1.63	0.629	12.3		118	19000	7.68	135	98.5			26.0	31.0	80
	MAX	0.994	0.575	13.6	11.1	1.02	129		514	19000	13.2	330	395			65.4	107	274
	MIN	0.209	0.037	1.07	0.250	0.124	1.00		29.6	19000	1.90	20.8	20.2			11.1	2.50	25.0
	MEDIAN	0.503	0.090	3.09	1.19	0.649	2.52		86.3	19000	7.57	112	80.8			19.4	19.9	64.0
	STDEV	0.258	0.142	2.48	2.13	0.283	27.0		102		3.04	80.4	75.1			14.5	25.1	70.9
	NUMBER	24	20	24	24	24	24		24	1	18	24	24			24	24	24
COV	0.485	0.980	0.696	1.309	0.450	2.19		0.86		0.395	0.597	0.763			0.558	0.810	0.881	
FALL (Sept-Nov)	MEAN (geometric)	0.409	0.117	2.47	0.58	0.547	12.5	7.75	171	1684	15.7	60.9	105			17.8	11.8	62
	MEAN (arithmetic)	0.563	0.209	4.26	2.04	0.637	50.3	7.79	266	46711	25.6	119	154			21.4	14.3	90
	MAX	1.631	1.10	24.5	17.6	1.56	240	9.20	906	440000	113	386	587			42.0	29.8	230
	MIN	0.122	0.039	0.704	0.250	0.332	1.00	6.90	48.5	130	5.00	8.40	41.0			7.10	2.50	25.0
	MEDIAN	0.483	0.074	2.33	0.25	0.438	13.4	7.90	156	700	10.6	94.4	92.0			17.5	13.8	60
	STDEV	0.455	0.321	6.78	4.94	0.435	82.4	0.782	287	131586	32.0	131	172			12.8	8.20	77.8
	NUMBER	11	10	11	12	8	8	7	8	11	11	8	9			11	9	9
COV	0.808	1.53	1.59	2.42	0.68	1.64	0.10	1.081	2.82	1.253	1.103	1.120			0.597	0.574	0.863	