Darrin Fresh Water Institute

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Stormwater runoff contributions of Northwest Bay Brook to Lake George.

Prepared for the FUND for Lake George

by

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Executive Summary

Surface runoff of stormwaters has been identified as the primary source of nutrients, bacterial contaminants and pollutants to Lake George. Chemical characterization of stormwater runoff in selected streams has been the subject of a number of studies including the International Biological Program (IBP) in the late 1960's and the National Urban Runoff Program (NURP) in the early 1980's. An ongoing NYS DEC Program monitors stream flow and water chemistry at five locations (Finkle Brook, Marine Village, Sheriff's Dock Culvert, West Brook and Hague Brook). All of these represent urbanized sub-watersheds within the Lake George basin. A long-term stream flow monitoring site within the Lake George basin (NW Bay Brook) was also recently downgraded by the USGS to crest flow measurements only. Operation of this largely forested watershed site was assumed by the Darrin Fresh Water Institute via a grant from the FUND for Lake George in 1997, with both flow and water chemistry recorded.

The Lake George watershed is dissected by more than 140 small streams. The largest tributary to Lake George is Northwest Bay Brook, with a catchment area of 28.1 square miles. Discharge patterns show a seasonal trend, with lowest levels during late summer (August) low-flow conditions and greatest volumes observed during snow melt episodes during the winter months. Stream discharges as low as 1 million gallons per day (mgd) are observed under low-flow conditions. Input of water to Lake George ranged from less than 1 mgd at base-flow to in excess of 970 mgd for peak flow during a storm in January 1998.

Total flow for the 1998 calendar year for Northwest Bay Brook was 9.56 billion gallons per year. March produced the highest volume of water, yielding an average daily discharge of nearly 28 million gallons/day (mgd). The March high average was closely followed by April at 24 mgd. Snowmelt, coupled with spring rain events and saturated soils typically yield maximum runoff volumes in the spring of the year. The 40-year average annual flow, provided by the US Geological Survey, is 8.44 billion gallons/year (bgy). Compared to this value, the calculated total flow for Northwest Bay Brook in 1998 was approximately 12% higher than the 40-year average.

Total loading of phosphorus, nitrogen and total suspended solids from Northwest Bay Brook to Lake George were calculated based on chemical analysis of baseflow and event mean concentrations. Loading rates for phosphorus, nitrogen and total suspended solids were calculated as 0.099, 1.82 and 378.2 kg/h/yr, respectively. With the exception of total suspended solids, these rates are comparable to estimates for forested uplands reported by the Lake Champlain Basin Commission. Suspended solids results are higher than published values for forested watersheds perhaps due to a single year of data collection. We anticipate refining loading estimates with additional data collection.

Background

Runoff of stormwater has been recognized as a primary vehicle for the transport of nutrients and pollutants to Lake George. Chemical characterization of stormwater runoff in selected streams has been the subject of a number of studies including the International Biological Program (IBP) in the late 1960's and the National Urban Runoff Program (NURP) in the early 1980's. An ongoing NYS DEC Program monitors stream flow and water chemistry at five locations (Finkle Brook, Marine Village, Sheriff's Dock Culvert, West Brook and Hague Brook). All of these represent urbanized sub-watersheds within the Lake George basin. A long term stream flow monitoring site within the Lake George basin (NW Bay Brook) was also recently downgraded by the USGS to crest flow measurements only, with total closure of this station anticipated in September of 1999.

In 1997, FUND supported programs established a station for runoff water quality assessment keyed to the continuous monitoring equipment (YSI) and autosampler (ISCO) supplied by a FUND for Lake George equipment grant. The station at NW Bay Brook was established in July 1997 to serve as a baseline station in a relatively unimpacted area. NW Bay Brook is the largest single watershed in the Lake George basin providing a substantial portion of the water inputs to the lake. Stormwater runoff events were collected in August, October and November; keyed to changing forest cover and climatic conditions. Demonstration of the sediment and contaminant loading to Lake George as a result of stormwater runoff can be a powerful tool in design and implementation of control structures. Data collection continued with an extension of the program through 1998.

Watershed Description

The Lake George watershed is part of the St. Lawrence River drainage via the LaChute River and Lake Champlain. Maximum elevation within the Lake George watershed is at Black Mountain, with an elevation of 2646 feet above mean sea level (amsl). The drainage basin is approximately 238 square miles, with approximately one fifth of the watershed occupied by the lake itself. The lake surface is at an elevation of 320 feet (amsl).

Tributary stream-flow comprises 57% of the annual inputs to the hydrologic (water) budget for Lake George (Shuster, 1994). The other components include direct precipitation to the lake (25%) and groundwater influxes (18%). For precipitation falling in the terrestrial portion of the Lake George basin, 52% reaches the lake via streams.

Northwest Bay Brook is the single largest sub-watershed in the Lake George basin. The drainage basin for Northwest Bay Brook has been calculated at 26.1 mi^2 (Fuhs, 1972) or 28.1 mi^2 (Shuster, 1994). Maximum elevation within the NWB watershed is 1500 feet (amsl). Slopes within the watershed are generally steep with numerous areas of exposed bedrock.

Table 1. Station Characteristics.

County	Warren
Latitude	43°39'48"
Longitude	73°36'14"
Elevation (amsl in feet)	423.6
Drainage Area (square miles)	22.0
USGS Code Number	04278300
Discharge Rating Period	29 years
Average Discharge	35.8 ft^3/second
Average Discharge	87597158 l/day

Overburden soil deposits in the Lake George region in general and the Northwest Bay Brook drainage in particular are dominated by glacial tills; a sandy, well drained soil. A major portion (~50%) of the soils in Warren County are generally classified as Bice-Woodstock, as used by the Soil Survey of Warren Co., NY (1989). Bice-Woodstock is a glacial till which consists mainly of well to excessively drained soil with a moderate to coarse texture of granite schist and gneiss bedrock origins. Within the Bice-Woodstock general classification, the Soil Survey has divided the region up into smaller subclasses. More specific to the Northwest Bay Brook drainage basin, a majority of the soils are classified as a Bice very bouldery fine sandy loam or Bice-Woodstock very bouldery fine sandy loam.

The Northwest Bay Brook watershed is forested, with mixed evergreen and deciduous forests. Little commercial or residential land use exists within the watershed. Periodic logging of the upper portions of the watershed is the lone commercial usage. One significant highway, State Route 9N, follows the brook for 2-3 miles above Northwest Bay before veering off over the Tongue Mountain range. There are scattered seasonal homes within the watershed.

Methodology

Water samples were collected with an ISCO 6700 Series autosampler mounted in the US Geological Survey gauging house. This gauging station is located approximately one mile upstream from the point of entry into the lake and has been in near continuous operation since 1958. The ISCO autosampler can collect water samples sequentially based on time or flow, allowing the sampling scheme to be adjusted to each particular storm event. The autosampler was installed in July of 1997. An ISCO, Model 730 Series Bubbler Module was the primary device used to record stream level over the course of the project. This module measures the resistance for an air bubble to be pushed below the surface of the water, and converts that resistance into a measurement in feet. Stream level records were measured at 1 minute intervals, averaged for the 30 minute record and stored electronically. Level information is stored by the autosampler, which retains this information for later use. Level data is downloaded biweekly and plotted to generate a flow chart. As a back-up system, stream level was also recorded continuously on a

Stevens Level Gauge (Model F), maintained by the US Geological Survey. Metallic staff gauges and electronic tape level markers are used for periodic calibration of the recording instruments. All level measurements are referenced to the permanent USGS staff gauge established at the bridge abutment adjacent to the point of sample intake. The USGS Stevens and staff gauges were also used as outside reference points to check the accuracy of the bubbler module, and on occasions when the bubbler module was off-line.

Staging curves were developed using a Marsh-McBirney Flo-Mate™ Model 2000 Portable Flowmeter. Flow and depth were determined at 1 meter intervals across the stream channel, for a minimum of 20 flow measurements at each stage recorded. Staging curves based on flow (total discharge) and water level were developed.

Base-flow samples were collected monthly, at minimum (base) flow (Appendix A). Storm event samples were collected in conjunction with major runoff events. Sampling frequency was keyed to intensity and duration of runoff events. Sample collections ranged from 9 to 72 samples per runoff event, with coverage of both rising and declining flows. A total of 11 stormwater runoff events were sampled in this fashion in 1998 (Appendix B).

Table 2. Northwest Bay Brook event based sampling for 1998.

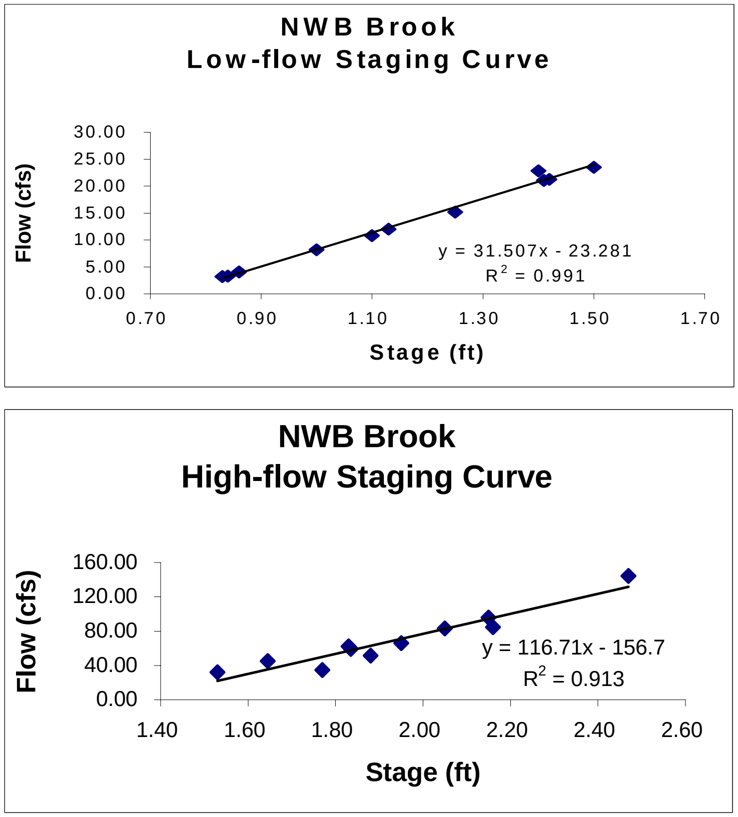
Date	Duration (days)	Peak Stage (feet)	Peak Flow Rate (mgd)	Number of Samples Collected
1/7/98	5	5.02	970	48
2/11/98	3	2.21	118	36
3/9/98	3	4.85	894	42
3/27/98	6	3.72	466	47
4/1/98	2	3.25	328	22
4/20/98	1	2.15	101	9
5/6/98	1	2.15	101	12
5/11/98	4	3.72	466	30
6/14/98	5	3.32	347	72
7/23/98	1	1.20	10.7	24
8/11/98	3	3.18	310	24

Results

Staging Curves/Flow Predictions

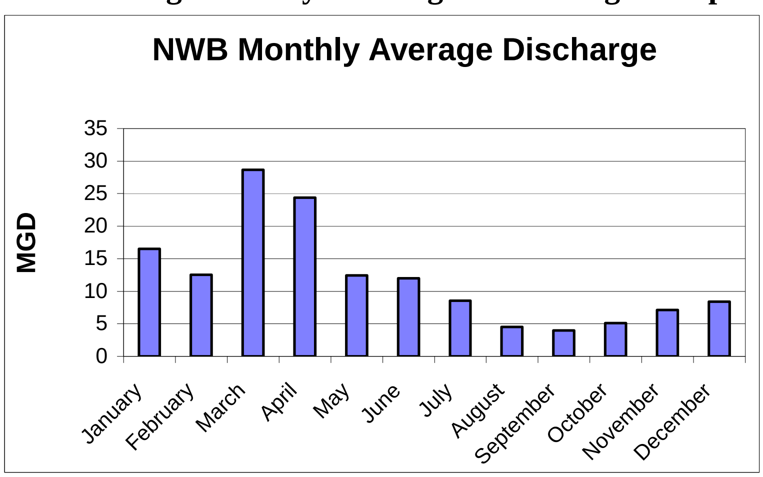
Staging curves depict a two-stage flow pattern – a low-flow curve exists at water levels up to approximately 1.5 ft. At water levels above 1.5 feet, a second, high-flow curve is required to predict discharge rates based on stream levels (Figure 1).

Figure 1. Staging curves for Northwest Bay Brook.



Discharge patterns show a seasonal trend, with lowest levels during late summer (August) low-flow conditions and greatest volumes observed during snow melt episodes during the winter months. Stream discharges as low as 1 million gallons per day (mgd) are observed under low-flow conditions. Input of water to Lake George ranged from less than 1 mgd at base-flow to in excess of 970 mgd for peak flow during a storm in January 1998.

Figure 2. Average monthly discharge in million gallons per day.



Total flow for the 1998 calendar year for Northwest Bay Brook was 9.56 billion gallons per year. March produced the highest volume of water, yielding an average daily discharge of nearly 28 million gallons/day (mgd). The March high average was closely followed by April at 24 mgd. Snowmelt, coupled with spring rain events and saturated soils typically yield maximum runoff volumes in the spring of the year. The 40-year average annual flow, provided by the US Geological Survey, is 8.44 billion gallons/year (bgy). Compared to this value, the calculated total flow for Northwest Bay Brook in 1998 was approximately 12% higher than the 40-year average.

Water Chemistry

Phosphorus and nitrogen levels are typically low during base-flow conditions. Since July 1997, base-flow has averaged 0.9 feet in depth or between 2 and 3 mgd. Orthophosphorus levels are normally at or just above detection limit levels of 1 to 2 ug P/l, and total phosphorus levels average 5 ug P/l. The total phosphorus is most likely higher due to suspended sediments as well as dissolved phosphorus in the water. This is demonstrated by the total soluble phosphorus concentrations that have been measured which are on average somewhat lower than their respective total phosphorus values. Input of water to Lake George ranged from 1.5 mgd at baseflow to more than 340 mgd for peak flow during a storm in January 1998. The brook exports about 5 grams of soluble P per day at baseflow levels. This jumps to over 7 kilograms of soluble P per day at the maximum flow recorded. Similar increases are seen in suspended sediments and particulate phosphorus.

Figure 3. Total Suspended Solids relative to flow in Northwest Bay Brook.

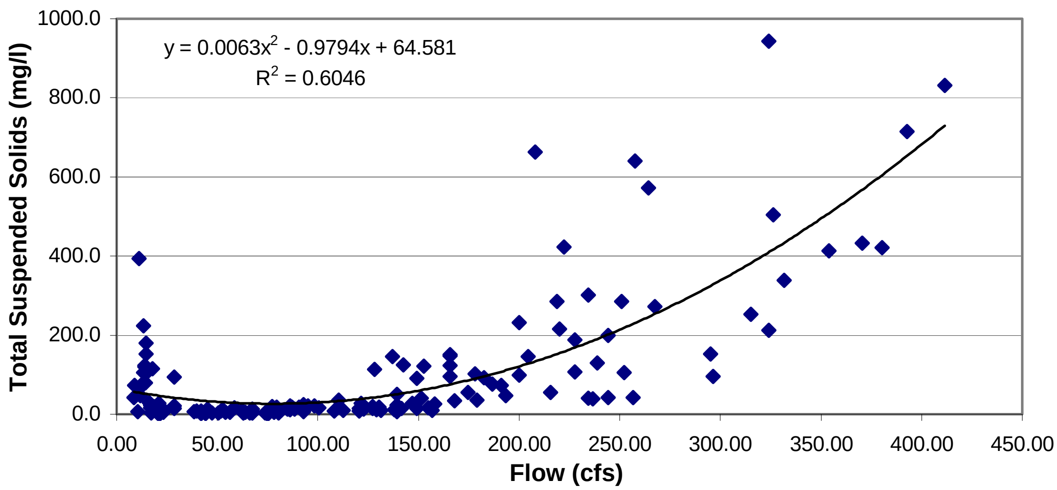
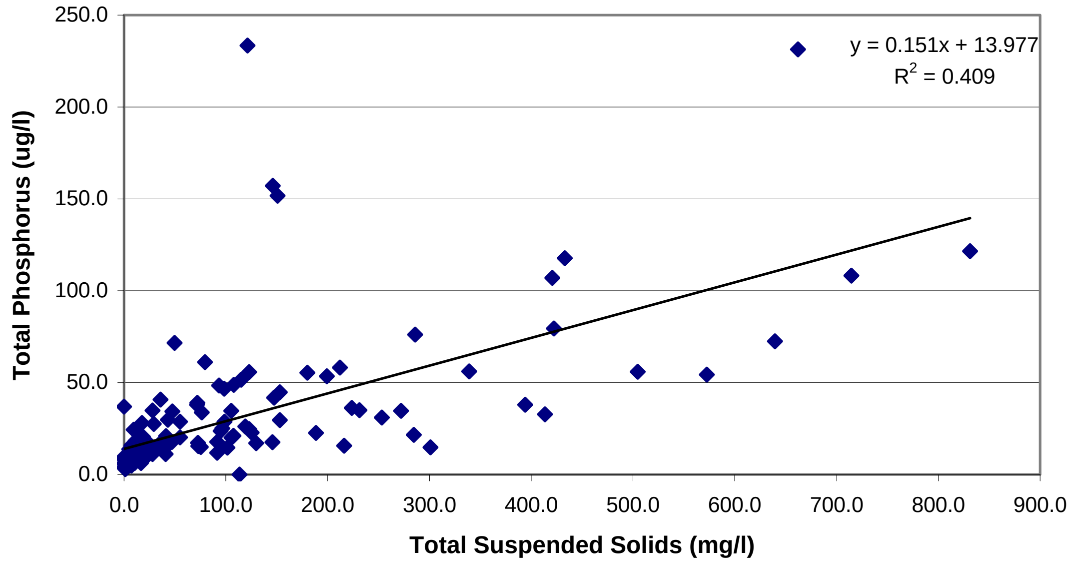


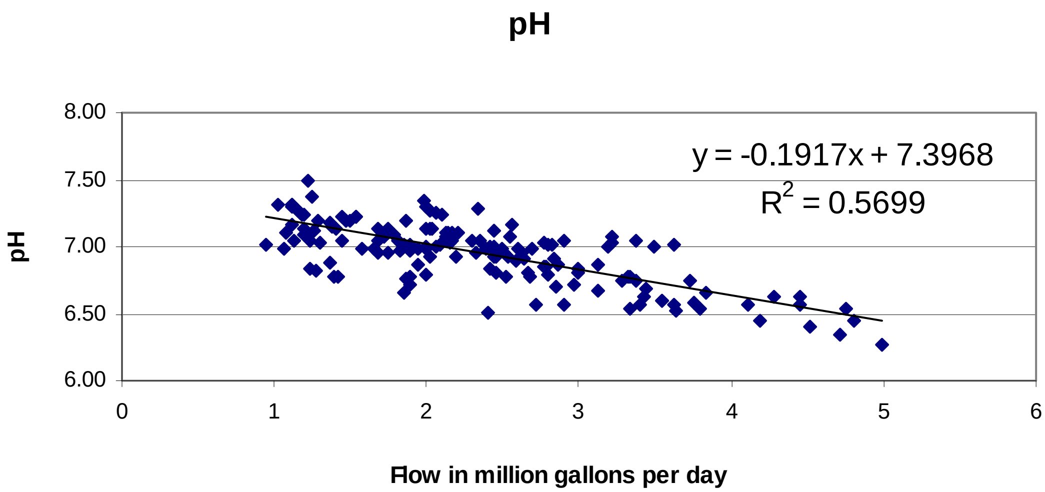
Figure 4 demonstrates the effects suspended materials can have on nutrient loading, particularly total phosphorus levels. The relationship between phosphorus and suspended solids is evident by observing the increase in phosphorus as total suspended solids increase.

Figure 4. Total Phosphorus versus Suspended Solids values.



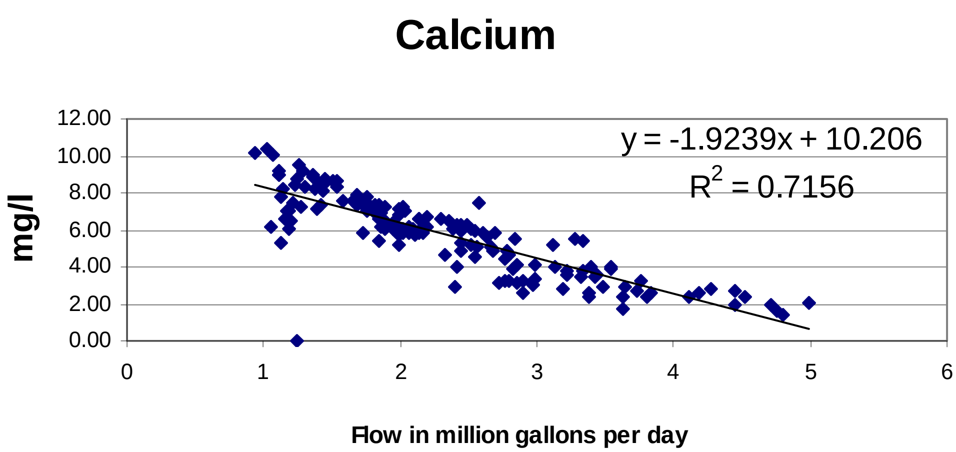
At elevated flow levels, both total phosphorus and dissolved phosphorus demonstrate significant increases in concentrations from the baseline levels. At stage levels of four feet, total phosphorus concentrations increase as much as 140% from average baseline values. This can also be correlated to the amount of suspended sediment at high flows. Total suspended solids in Northwest Bay Brook have been observed to increase as much as 200% during major storm events. This increase of sediment in the water greatly influences the amount of total phosphorus available in the water.

Figure 5. pH versus flow.



Certain chemical characteristics show an inverse relationship to flow, among these are pH, alkalinity, conductivity, and major cations such as calcium, sodium and magnesium. pH depression in streams (Figure 5) is a commonly observed condition due to the acidic

Figure 6. pH versus flow.



nature of rainfall, particularly in the Northeast. At increased flows, a greater proportion of the stream waters are contributed by precipitation or snowmelt, resulting in a pH depression. Major cations, alkalinity and conductivity in forested watersheds are derived primarily from weathering of minerals in the soils, thus greater concentrations are associated with baseflow when groundwater makes a greater contribution to stream flow than surface runoff. Calcium concentrations in Northwest Bay Brook (Figure 6) are comparable to levels in Lake George during baseflow, but drop to relatively low concentrations at times of increased flow.

<u>Nutrient & Sediment Loading</u>

Total loading of phosphorus, nitrogen and total suspended solids were calculated based on chemical analysis of baseflow and event mean concentrations (Table 3). Loading rates for phosphorus were calculated as 0.099 kg/h/yr. Levels of total phosphorus were in the range of those reported for forested sub-watersheds by NURP (0.037 kg/h/yr undeveloped to 0.134 kg/h/yr for 95% forested watersheds – Sutherland et al. 1983). Current estimates were substantially higher than estimates by Fuhs (1972) 0.018 kg/h/yr for Northwest Bay, however those estimates were based primarily on baseflow chemistry. Current estimates were lower than those reported by the Lake Champlain Basin Commission (Budd & Meals 1994) for forested lands of 0.04 to 0.24kg/h/yr.

Loading estimates for total nitrogen were less commonly available in the published literature. Using Fuhs (1972) data we estimate loadings of 0.71 kg/h/yr which is slightly less than half the current estimate of 1.82 kg/h/yr. The Lake Champlain Basin Commission estimated total nitrogen loadings from unfertilized lands of 1.35 kg/h/yr which is more in line with estimates from Northwest Bay Brook.

Loading estimates for suspended sediments from Northwest Bay Brook to Lake George in 1998 were 378 kg/h/yr. This value is substantially higher the typically observed for forested watersheds a may be an artifact of a single year of sample collection. We anticipate refining these results with future data collections.

Table 3. Annual loading of phosphorus, nitrogen and suspended solids to Lake George from Northwest Bay.

	Total Phosphorus (kg)	Total Nitrogen (kg)	Total Suspended Solids (kg)
annual baseflow loading	255	7016	413366
annual event loading	415	5306	2142986
total annual loading	670	12322	2556352

Loading Rates

total loading (kg/h/y)	0.099	1.82	378
total loading (g/h/y)	99.1	1822.7	378157
total loading (g/h/day)	0.27	4.99	1035

References

Budd, L.F. and D.W. Meals. 1994. Lake Champlain non-point source pollution assessment. Prepared for Lake Champlain Management Conference, Lake Champlain Basin Program Technical Report 6B (Appendices A-J). Grand Isle, VT 140 p.

Fuhs, G.W. 1972. The chemistry of streams tributary to Lake George, New York. Environmental Health Report No. 1, New York State Department of Health, Albany, New York. 51 pp. + Appendices.

Shuster, E.L. 1994. Hydrogeology of the Lake George drainage basin, southeastern Adirondack mountains, New York. Ph.D. Thesis. Rensselaer Polytechnic Institute, Troy, New York. 246 pp. + Appendices.

Sutherland, J.W., J.A. Bloomfield and J.M. Swart. 1983. Lake George urban runoff study, Nationwide Urban Runoff Program. Bureau of Water Research, NYS Dept. of Environmental Conservation, Albany, NY.

Water Chemistry Data for 1997 & 1998

Appendix A – Baseflow

Appendix B – Stormflow

Code	**Analyte**	**Units**
Ca	Calcium	mg/L
Cl	Chloride	mg/L
Cond.	Specific Conductance	umhos/cm
Fe	Iron	mg/l
K	Potassium	mg/L
Mg	Magnesium	mg/L
Na	Sodium	mg/L
NO_3	Nitrate	mg N/L
NH_4	Ammonia	mg N/L
pH	pH	S.U.
Si	Soluble Reactive Silica	mg Si/L
SO_4-S	Sulfate	mg S/L
SRP	Soluble Reactive Phosphorus	ug P/L
Stage	Water Level	feet
TN-N	Total Nitrogen	mg N/L
Total P	Total Phosphorus	ug P/L
TSP	Total Soluble Phosphorus	ug P/L
TSS	Total Suspended Solids	mg/L

Appendix A
Northwest Bay Brook Baseflow Chemistry

date	Stage	lab pH	air-eq pH	Alk.	cond.	TSS	SO4-S	MRP	TSP	Total P	NO3	TN	NH4	Si	Cl	Na	Mg	Ca	Fe
2-Jul-97	0.75	7.40	7.48	36.0	89.0	0.2	2.57	1.1	3.8	3.3	0.25	0.40	lt 0.01	2.86	0.97	1.3	2.5	12.9	0.09
24-Jul-97	0.50	7.44	7.51	37.0	84.0	0.2	2.33	1.3	4.3	3.6	0.16	0.31	0.03	2.74	0.92	1.2	2.3	12.3	lt 0.05
21-Aug-97	0.32	7.57	7.54	35.0	89.0	0.4	1.48	1.9	2.5	2.9	0.12	0.21	lt 0.01	2.72	0.70	1.2	2.6	13.4	lt 0.05
23-Sep-97	0.75	7.39	7.42	29.0	90.6	lt 0.1	2.50	2.1	2.1	2.4	0.15	0.27	lt 0.01	2.80	1.42	1.4	2.3	12.2	lt 0.05
22-Oct-97	0.86	7.45	7.31	37.0	97.6	1.9	2.53	1.8	1.1	2.0	0.06	0.16	lt 0.01	2.76	1.12	1.6	2.4	12.0	lt 0.05
1-Nov-97	1.13	6.98	7.24	29.0	73.8	0.7	2.21	1.3	1.4	2.5	0.07	0.21	lt 0.02	2.62	1.79	1.5	2.0	10.2	0.05
4-Dec-97	1.53	6.53	6.62	20.0	61.3	0.0	2.35	lt 1.0	1.4	2.5	0.14	0.29	lt 0.03	2.62	1.61	1.3	1.4	5.7	lt 0.05
22-Jan-98	1.42	6.77	6.50	15.5	64.4	0.4	2.48	2.7	2.2	3.7	0.20	0.34	lt 0.04	2.91	1.39	1.4	1.5	7.3	lt 0.05
11-Feb-98	1.27	6.82	6.86	21.0	65.3	21.9	2.37	3.2	1.7	18.1	0.20	0.38	lt 0.01	2.82	1.74	1.5	1.7	7.3	0.44
25-Feb-98	1.39	6.77	6.73	16.0	60.4	1.4	2.23	1.0	1.9	2.9	0.17	0.30	0.01	2.80	1.78	1.6	1.5	7.2	0.05
9-Mar-98	*1.85*	6.65	6.62	9.0	56.2	9.4	2.05	2.8	1.7	24.5	0.14	0.38	lt 0.01	2.41	1.66	1.5	1.4	5.4	0.59
20-Apr-98	1.98	7.35	7.11	15.0	54.8	lt 0.1	1.931	1.9	2.9	4.0	0.08	0.22	0.02	2.13	1.59	1.4	1.2	6.0	0.10
12-May-98	1.68	7.14	7.01	18.0	59.7	2.1	1.93	1.4	2.7	5.6	0.06	0.22	0.01	1.61	1.97	1.5	1.3	7.4	0.10
4-Jun-98	1.08	7.10	7.10	29.0	69.5	6.3	1.96	3.1	2.4	14.1	0.13	0.40	lt 0.01	2.61	1.29	1.3	1.9	10.0	0.35
24-Jul-98	1.11	7.32	7.35	32.0	76.0	47.4	6.37	2.2	3.4	37.0	3.72	0.51	0.01	2.98	1.72	1.3	2.0	9.2	1.20
11-Aug-98	1.24	7.04	7.14	29.5	73.5	79.6	1.71	2.5	3.8	61.1	0.15	0.66	0.03	2.67	0.50	1.4	2.0	8.8	1.50
22-Oct-98	1.02	7.32	7.43	32.0	74.2	72.8	2.07	2.6	1.7	15.5	0.06	0.31	0.01	2.09	1.47	1.4	2.1	10.4	0.61
30-Nov-98	1.22	7.50	7.31	25.0	61.1	107.7	2.13	3.2	2.1	48.8	0.12	0.43	lt 0.01	2.62	1.56	1.3	1.9	7.5	1.30

Appendix B.

Northwest Bay Brook Stormflow Chemistry - 1997

Sample #	Time	Stage	lab pH	air-eq pH	Alk.	cond.	TSS	SO4	MRP	TSP	TP	NO3	TN	NH4-N	Si	Cl	Na	Mg	Ca	Fe
29-Aug-97	1:00	0.71	7.36	7.48	36.0	92.5	0.5	2.31	0.7	1.0	4.0	0.17	0.30	lt 0.01	2.76	1.04	1.2	2.3	12.4	0.05
29-Aug-97	3:00	0.71	7.46	7.40	37.0	92.2	0.5	2.29	0.6	1.0	5.2	0.17	0.28	lt 0.01	2.80	1.01	1.2	2.3	12.4	0.06
29-Aug-97	5:00	1.08	7.50	7.30	34.5	92.6	0.4	2.32	0.7	1.0	3.8	0.16	0.29	lt 0.01	2.88	0.98	1.2	2.4	12.6	0.06
29-Aug-97	7:00	1.19	7.51	7.39	36.0	81.2	1.9	2.18	2.6	1.0	7.3	0.17	0.35	lt 0.01	2.62	0.95	1.1	2.2	11.4	0.14
29-Aug-97	9:00	1.39	7.44	7.08	28.0	76.0	32.3	2.06	10.1	3.0	70.6	0.24	1.00	lt 0.01	2.32	0.88	1.1	2.3	8.2	2.83
29-Aug-97	11:00	1.99	7.41	7.20	27.5	74.0	10.7	2.20	5.9	3.0	34.8	0.31	0.81	lt 0.01	2.26	0.95	1.0	1.9	9.0	0.86
29-Aug-97	13:00	3.46	7.13	7.07	27.0	76.5	5.2	2.30	3.2	3.0	21.1	0.30	0.66	lt 0.01	2.34	1.03	1.1	1.8	8.9	0.45
29-Aug-97	15:00	2.72	7.23	7.09	28.0	79.4	0.4	2.34	2.6	3.0	15.4	0.26	0.60	lt 0.01	2.34	1.41	1.4	1.9	9.5	0.35
29-Aug-97	17:00	2.49	7.31	7.25	28.0	81.2	2.8	2.39	2.6	4.0	14.0	0.24	0.57	lt 0.01	2.38	1.73	1.7	2.0	9.7	0.29
29-Aug-97	19:00	2.25	7.26	7.25	28.0	84.5	5.2	2.43	2.3	4.0	12.6	0.23	0.54	lt 0.01	1.36	2.10	2.0	2.0	9.9	0.26
29-Aug-97	21:00	2.35	7.30	7.46	27.5	84.6	2.0	2.44	2.2	4.0	13.4	0.22	0.55	lt 0.01	2.46	2.26	2.0	2.0	10.0	0.23
29-Aug-97	23:00	1.65	7.34	7.34	29.0	86.2	1.4	2.47	1.8	4.0	10.3	0.21	0.49	lt 0.01	2.52	2.19	2.0	2.0	10.1	0.18
28-Oct-97	14:07	1.4	7.19	6.97	29.0	72.1	4.6	2.39	2.5	2.4	8.0	0.10	0.34	lt 0.01	2.56	1.79	1.5	2.2	10.5	0.26
28-Oct-97	16:07	1.51	7.22	7.06	27.0	73.2	4.1	2.38	2.8	2.4	7.5	0.11	0.31	lt 0.01	2.49	2.03	1.6	2.2	9.7	0.19
28-Oct-97	18:07	1.52	7.18	7.09	27.0	71.5	4.4	2.42	2.5	2.4	7.5	0.13	0.33	lt 0.01	2.60	2.19	1.6	2.1	9.5	0.18
28-Oct-97	20:07	1.48	7.23	7.13	26.0	73.2	4.2	2.46	6.6	2.2	9.4	0.14	0.36	lt 0.01	2.58	2.28	1.7	2.1	9.6	0.34
28-Oct-97	22:07	1.45	7.28	7.13	24.5	72.3	3.0	2.59	5.8	2.0	9.5	0.13	0.33	lt 0.01	2.47	2.14	1.7	2.1	9.8	0.25
29-Oct-97	0:07	1.43	7.27	7.09	24.5	73.7	2.5	2.52	4.6	2.2	6.4	0.12	0.31	lt 0.01	2.32	2.07	1.6	2.1	9.6	0.21
29-Oct-97	2:07	1.4	7.32	7.12	25.0	74.4	2.9	2.48	3.2	2.0	6.9	0.12	0.31	lt 0.01	2.49	2.03	1.6	2.1	9.9	0.20
29-Oct-97	4:07	1.39	7.29	7.15	23.5	73.4	3.0	2.52	3.8	5.4	7.3	0.12	0.31	lt 0.01	2.43	2.09	1.6	2.1	9.9	0.23
29-Oct-97	6:07	1.37	7.31	7.09	23.0	74.5	3.4	2.53	4.6	2.4	5.7	0.12	0.31	lt 0.01	2.58	1.99	1.6	2.0	9.8	0.21
29-Oct-97	8:07	1.34	7.41	7.12	22.0	72.2	2.3	2.57	4.0	2.2	6.4	0.11	0.30	lt 0.01	2.56	1.92	1.6	2.1	9.8	0.17
29-Oct-97	10:07	1.32	7.37	7.18	22.0	74.2	2.0	2.57	4.9	2.4	5.9	0.11	0.28	lt 0.01	2.47	1.94	1.6	2.0	9.9	0.16
29-Oct-97	12:07	1.26	7.32	7.21	22.0	74.4	1.2	2.57	2.8	3.4	5.2	0.11	0.29	lt 0.01	2.41	1.92	1.5	2.0	9.8	0.10
1-Nov-97	16:21	1.13	6.98	7.24	29.0	73.8	0.7	2.21	1.3	1.4	2.5	0.07	0.21		2.62	1.79	1.5	2.0	10.2	0.05
1-Nov-97	18:21	1.19	7.14	7.23	27.0	74.7	0.7	2.15	1.1	1.3	2.9	0.08	0.21		2.22	1.69	1.4	1.9	9.8	0.06
1-Nov-97	20:21	1.27	7.24	7.10	27.0	71.9	0.9	2.08	1.3	1.4	3.3	0.07	0.22		2.22	1.65	1.4	1.9	9.6	0.05
1-Nov-97	22:21	1.46	7.20	7.21	26.0	71.3	5.5	2.00	1.6	1.4	4.6	0.07	0.20		2.22	1.55	1.3	1.8	9.3	0.10
2-Nov-97	0:21	1.63	7.20	7.10	24.5	68.5	10.7	1.98	3.7	1.9	14.7	0.06	0.36		2.42	1.50	1.2	1.8	8.0	0.44
2-Nov-97	2:21	1.7	7.19	7.14	24.5	69.3	13.9	2.01	4.0	2.7	16.6	0.07	0.41		1.46	1.57	1.3	1.8	9.3	0.54
2-Nov-97	4:21	1.85	7.17	7.15	25.0	69.0	32.2	2.04	4.2	2.2	25.9	0.09	0.57		1.97	1.52	1.3	1.9	8.5	0.91
2-Nov-97	6:21	1.9	7.21	7.13	23.5	68.0	23.1	2.07	4.5	2.2	33.9	0.09	0.57		2.40	1.36	1.2	1.8	8.1	0.91
2-Nov-97	8:21	1.89	7.22	7.19	23.0	67.7	10.2	2.09	3.2	2.5	15.3	0.10	0.48		2.35	1.43	1.2	1.8	8.5	0.84
2-Nov-97	10:21	1.86	7.09	7.10	22.0	65.4	5.5	2.07	2.7	2.4	10.4	0.10	0.41		2.36	1.40	1.1	1.7	7.6	0.32
2-Nov-97	12:21	1.83	7.21	7.14	22.0	65.5	5.8	2.10	2.4	2.2	9.7	0.11	0.41		1.43	1.42	1.1	1.6	8.1	0.28
2-Nov-97	14:21	1.82	7.34	7.17	22.0	63.6	3.4	2.13	2.2	2.4	7.6	0.11	0.38		2.09	1.43	1.2	1.6	7.3	0.21
3-Nov-97	10:15	2.15	7.09	6.89	13.0	56.3	343.6	3.34	5.5	3.7	21.0	0.15	0.56		2.32	1.50	1.1	1.6		2.84
7-Nov-97	0:00	1.60	7.07	7.02	20.5	63.2	1.9	2.17	5.4	2.4	4.1	0.10	0.36		2.39	1.44	1.2	1.5	7.7	0.10
8-Nov-97	4:00	1.58	7.11	7.51	20.0	64.0	2.0	2.11	4.5	2.4	6.2	0.09	0.29		2.30	1.38	1.2	1.5	7.4	0.10
8-Nov-97	8:00	1.57	7.20	7.11	20.0	63.8	3.2	2.08	4.3	2.4	9.6	0.09	0.33		2.30	1.39	1.2	1.5	5.4	lt 0.05
8-Nov-97	12:00	1.56	7.20	7.08	20.0	63.6	lt 0.1	2.13	4.0	2.6	7.6	0.10	0.32		2.30	1.39	1.2	1.5	7.3	0.10
8-Nov-97	16:00	1.55	7.23	7.05	20.0	63.5	lt 0.1	2.03	5.3	2.4	11.1	0.10	0.43		2.06	1.17	1.2	1.3	5.7	lt 0.05
8-Nov-97	20:00	1.54	7.05	6.97	13.0	53.0	4.0	2.10	4.3	3.4	7.2	0.02	0.38		2.35	1.47	1.1	1.2	5.7	0.14

Appendix B.
Northwest Bay Brook Stormflow Chemistry - 1998

Date	Time	Stage	pH lab	pH	air-eq Alk.	cond.	TSS	SO4	MRP	TSP	Total P	NO3	TN	NH4	Si	Cl	Na	Mg	Ca	Fe
7-Jan-98	14:59	2.40	6.51	6.40	13.0	56.7	146.0	2.18	5.9	2.7	157.1	0.23	0.86		2.24	1.10	1.3	2.1	2.9	4.41
7-Jan-98	18:59	2.72	6.56	6.60	10.0	53.5	150.9	2.16	2.0	2.9	151.6	0.25	0.69		2.26	0.80	1.0	1.5	3.2	2.08
7-Jan-98	22:59	2.90	6.56	6.53	9.0	50.1	422.2	2.14	1.8	3.6	79.5	0.26	0.67		2.18	0.90	1.0	1.6	2.6	2.99
8-Jan-98	2:59	3.64	6.52	6.55	8.0	45.1	943.0	2.02	2.0	3.8	154.5	0.28	1.12		2.08	0.70	1.2	1.6	2.9	3.58
8-Jan-98	6:59	4.71	6.34	6.47	6.0	41.8	831.1	1.87	2.8	4.1	121.6	0.29	1.13		2.00	0.80	1.1	1.4	2.0	3.83
8-Jan-98	10:59	4.99	6.27	6.16	3.0	43.7	420.7	1.84	6.3	4.7	107.0	0.30	0.89		2.05	1.00	1.3	1.5	2.0	3.00
8-Jan-98	14:59	4.52	6.41	6.26	6.0	47.1	212.3	1.84	3.6	5.0	58.3	0.27	0.66		2.03	1.30	1.4	1.2	2.4	1.42
8-Jan-98	18:59	4.19	6.45	6.41	6.0	48.6	253.4	1.91	3.3	4.3	31.0	0.27	0.64		2.05	1.20	1.4	1.1	2.6	0.99
8-Jan-98	22:59	4.45	6.62	6.41	6.0	48.9	413.7	1.89	3.4	4.0	32.7	0.25	0.60		2.05	1.10	1.3	1.0	2.7	0.81
9-Jan-98	2:59	4.28	6.63	6.48	6.5	49.1	94.9	1.86	2.8	4.0	23.7	0.23	0.52		2.10	1.20	1.3	1.0	2.8	0.68
9-Jan-98	6:59	3.76	6.58	6.41	7.0	49.7	105.5	1.94	2.6	4.0	20.1	0.24	0.49		2.15	1.20	1.4	1.0	3.2	0.44
9-Jan-98	10:59	3.44	6.69	6.60	8.0	50.9	41.3	2.00	2.6	4.1	21.0	0.24	0.52		2.19	1.10	1.3	1.0	3.6	0.37
9-Jan-98	14:56	3.40	6.57	6.51	7.0	43.7	38.7	1.93	3.6	3.4	17.1	0.23	0.51		2.18	1.20	1.3	1.0	4.0	0.27
9-Jan-98	18:56	3.54	6.59	6.48	7.0	42.0	41.9	1.94	3.3	3.4	18.5	0.22	0.49		2.05	1.15	1.2	0.9	4.1	0.26
9-Jan-98	22:56	3.54	6.59	6.43	7.0	42.4	129.7	1.98	3.1	3.1	17.1	0.22	0.49		2.17	1.22	1.2	0.9	3.9	0.31
10-Jan-98	2:56	3.34	6.53	6.48	7.0	43.5	55.1	2.00	2.8	3.8	20.3	0.21	0.47		2.19	1.26	1.2	1.0	3.8	0.36
10-Jan-98	6:56	3.13	6.67	6.71	7.0	42.7	47.0	1.97	3.0	3.6	17.8	0.21	0.45		2.01	1.19	1.2	1.0	4.0	0.32
10-Jan-98	10:56	2.99	6.80	6.62	9.0	44.6	36.4	1.98	2.5	3.6	15.4	0.22	0.48		2.24	1.13	1.2	1.0	4.1	0.35
10-Jan-98	14:56	2.86	6.86	6.58	9.0	45.0	33.5	2.02	2.3	3.2	16.1	0.20	0.43		2.10	1.37	1.2	1.0	4.1	0.40
10-Jan-98	18:56	2.77	6.85	6.66	10.0	47.2	26.3	2.02	2.2	3.2	13.0	0.21	0.42		2.07	1.10	1.2	1.0	4.4	0.34
10-Jan-98	22:56	2.68	6.78	6.79	10.0	46.4	27.9	2.03	2.2	2.9	13.2	0.20	0.42		2.08	1.09	1.2	1.0	4.9	0.21
11-Jan-98	2:56	2.58	6.89	6.66	11.0	46.9	22.4	2.07	2.2	3.1	11.3	0.20	0.43		2.25	1.07	1.2	1.0	7.5	0.22
11-Jan-98	6:56	2.52	6.77	6.63	10.5	47.9	17.1	2.07	2.2	3.2	12.3	0.20	0.41		2.22	1.10	1.2	1.0	5.2	0.15
11-Jan-98	10:56	2.45	6.80	6.66	11.0	48.5	14.9	2.10	2.3	3.1	11.1	0.19	0.42		2.27	1.13	1.2	1.1	5.3	0.23
11-Feb-98	23:55	1.23	6.83	6.92	22.5	71.4	3.9	2.34	1.3	2.0	4.3	0.21	0.33		2.89	1.31	1.5	1.7	8.4	0.06
12-Feb-98	1:55	1.30	7.03	6.93	21.5	84.5	3.8	2.29	1.5	2.2	4.3	0.22	0.35		2.66	1.29	1.5	1.7	8.4	0.05
12-Feb-98	3:55	1.44	7.04	7.14	21.0	67.1	5.1	2.27	1.8	2.0	5.7	0.23	0.39		2.72	1.32	1.4	1.6	8.1	0.06
12-Feb-98	5:55	1.58	6.98	6.91	20.0	65.5	6.7	2.18	2.1	2.8	6.6	0.25	0.40		2.62	1.40	1.4	1.5	7.6	0.13
12-Feb-98	7:55	1.68	6.96	6.92	17.0	63.8	8.9	2.14	2.6	2.8	11.5	0.26	0.43		2.57	1.35	1.4	1.5	7.4	0.22
12-Feb-98	9:55	1.82	6.97	6.92	17.0	61.8	12.9	2.12	3.1	3.5	8.4	0.25	0.41		2.52	1.31	1.4	1.5	7.4	0.19
12-Feb-98	10:56	1.89	6.97	7.03	17.5	57.4	18.9	2.14	3.3	2.6	8.1	0.26	0.43	lt 0.01	2.58	1.29	1.4	1.4	7.3	0.17
12-Feb-98	12:56	2.02	7.13	7.01	17.5	61.2	17.2	2.14	3.7	2.8	12.6	0.27	0.46	0.01	2.53	1.25	1.3	1.5	7.2	0.30
12-Feb-98	14:56	2.04	7.13	7.26	16.5	60.8	21.0	2.08	3.7	4.2	11.5	0.28	0.47	0.01	2.46	1.27	1.4	1.4	7.1	0.29
12-Feb-98	16:56	2.13	7.10	6.93	16.0	59.3	21.0	2.10	3.7	2.8	13.8	0.29	0.48	lt 0.01	2.39	1.37	1.4	1.4	6.6	0.42
12-Feb-98	18:56	2.14	7.11	7.05	15.5	58.6	15.7	2.06	3.2	3.7	14.2	0.28	0.45	lt 0.01	2.36	1.50	1.5	1.3	6.6	0.29
12-Feb-98	20:56	2.20	7.11	6.91	14.0	59.0	23.6	2.12	3.6	3.1	17.2	0.28	0.46	lt 0.01	2.39	1.77	1.6	1.4	6.2	0.32
12-Feb-98	22:56	2.17	7.05	6.90	13.5	58.2	20.1	2.07	3.2	2.9	11.5	0.27	0.44	lt 0.01	2.41	1.80	1.7	1.3	6.1	0.30
13-Feb-98	0:56	2.15	7.03	6.88	14.0	57.3	18.3	2.09	2.7	2.8	11.0	0.26	0.46	lt 0.01	2.36	1.86	1.8	1.2	6.0	0.13
13-Feb-98	2:56	2.09	7.02	6.90	14.0	57.7	12.7	2.09	2.7	4.2	9.3	0.25	0.43	0.01	2.42	1.92	1.8	1.3	6.1	0.20
13-Feb-98	4:56	2.06	7.00	6.89	14.0	58.1	11.3	2.09	2.4	3.5	8.3	0.24	0.43	0.01	2.38	2.01	1.8	1.2	6.1	0.13
13-Feb-98	6:56	1.99	7.00	6.88	14.0	58.3	5.6	2.14	2.2	2.8	5.9	0.24	0.35	0.01	2.41	2.10	1.7	1.1	5.2	0.10
13-Feb-98	8:56	2.00	6.98	6.96	14.0	58.7	2.5	2.13	2.2	2.6	7.5	0.24	0.41	0.02	2.41	2.10	1.9	1.3	6.1	0.13
9-Mar-98	0:00	*1.85*	6.65	6.62	9.0	56.2	9.4	2.05	2.8	1.7	24.5	0.14	0.38	lt 0.01	2.41	1.66	1.5	1.4	5.4	0.59
9-Mar-98	2:00	*1.87*	6.76	6.57	13.0	59.4	3.6	2.16	1.5	1.9	6.3	0.15	0.31	lt 0.01	2.44	1.75	1.5	1.3	6.2	0.09
9-Mar-98	4:00	*1.89*	6.72	6.55	14.5	60.0	4.2	2.15	1.7	2.1	6.4	0.15	0.31	0.01	2.46	1.78	1.5	1.3	6.2	0.09

Date	Time	Stage	pH lab	pH	air-eq Alk.	cond.	TSS	SO4	MRP	TSP	Total P	NO3	TN	NH4	Si	Cl	Na	Mg	Ca	Fe
9-Mar-98	6:00	1.89	6.77	6.59	14.0	59.3	2.9	2.13	1.3	1.9	5.4	0.15	0.30	lt 0.01	2.39	1.75	1.5	1.3	6.1	0.10
9-Mar-98	8:00	1.94	6.86	6.58	14.0	57.6	2.6	2.14	1.5	1.9	5.9	0.15	0.29	lt 0.01	2.46	1.76	1.5	1.3	6.1	0.08
9-Mar-98	10:00	2.13	7.08	6.62	14.0	58.1	91.4	2.14	2.9	2.9	11.8	0.14	0.31	lt 0.01	2.31	1.73	1.5	1.2	5.8	0.19
9-Mar-98	17:11	2.85	6.70	6.52	11.0	51.2	98.5	1.96	3.2	2.6	46.8	0.14	0.42	lt 0.01	2.22	1.95	1.6	1.4	3.2	1.33
9-Mar-98	19:11	3.38	6.75	6.72	9.0	46.8	285.8	1.84	2.9	2.8	76.1	0.14	0.48	0.01	2.11	1.81	1.5	1.4	2.6	1.42
9-Mar-98	21:11	3.63	6.57	6.60	7.5	44.3	639.4	1.81	4.0	3.3	72.6	0.15	0.58	0.02	2.04	1.64	1.4	1.5	2.4	2.18
9-Mar-98	23:11	3.80	6.54	6.63	8.0	44.6	504.7	1.80	4.7	3.5	56.0	0.17	0.58	0.01	2.06	1.92	1.5	1.3	2.3	1.66
10-Mar-98	1:11	4.75	6.53	6.56	5.5	40.1	714.5	1.68	3.7	4.0	108.3	0.17	0.75	0.01	1.90	1.56	1.3	1.6	1.6	3.02
10-Mar-98	3:11	4.80	6.45	6.38	6.0	39.3	433.0	1.66	2.7	4.4	117.7	0.20	0.97	0.02	1.88	1.52	1.3	1.7	1.4	4.50
10-Mar-98	5:11	4.45	6.56	6.50	5.0	40.0	339.1	1.64	2.9	5.6	56.2	0.21	0.73	0.02	1.88	1.75	1.4	1.1	1.9	1.45
10-Mar-98	7:11	4.11	6.56	6.54	4.0	42.0	153.1	1.73	2.0	4.2	44.8	0.22	0.62	0.02	1.91	1.95	1.5	1.1	2.4	1.01
10-Mar-98	9:11	3.83	6.65	6.65	6.0	42.8	272.1	1.72	2.6	4.4	34.7	0.21	0.57	0.02	1.95	1.88	1.5	1.0	2.6	0.65
10-Mar-98	11:11	3.74	6.74	6.65	7.0	42.6	42.9	1.76	1.7	3.5	29.8	0.20	0.54	0.01	1.97	1.78	1.3	1.0	2.7	0.79
10-Mar-98	13:11	3.43	6.63	6.70	7.0	38.8	107.6	1.81	2.5	3.7	21.1	0.21	0.49	0.01	2.03	1.71	1.4	0.9	3.5	0.38
10-Mar-98	15:11	3.36	6.79	6.70	8.0	41.9		1.79	2.6	4.0	28.8	0.20	0.48	0.01	2.04	1.62	1.2	0.9	3.3	0.49
10-Mar-98	17:11	3.25	6.96	6.68	8.0	40.1	89.8	1.86	2.4	3.3	18.1	0.20	0.47	0.01	2.10	1.63	1.2	0.9	3.7	0.37
10-Mar-98	19:11	3.13	6.99	6.65	8.0	41.5	70.2	2.06	2.6	3.3	19.2	0.21	0.47	0.01	2.32	2.22	1.2	0.9	3.6	0.45
11-Mar-98	16:00	2.57	7.04	6.75	9.0	43.5	6.8	1.94	2.9	3.3	16.5	0.20	0.46	0.01	2.14	1.84	1.2	0.9	4.1	0.33
11-Mar-98	16:00	2.56	7.16	6.83	10.5	47.3		2.02	2.1	2.9	9.6	0.19	0.41	0.01	2.29	1.42	1.1	1.0	5.1	0.18
27-Mar-98	15:28	2.33	6.96	7.10	12.5	47.1	125.5	2.00	3.0	1.5	22.9	0.14	0.41	0.01	2.27	1.57	1.2	1.1	4.6	0.51
27-Mar-98	21:28	2.77	7.03	6.94	9.5	44.9	147.3	1.87	1.9	2.4	41.8	0.15	0.56	0.01	2.15	1.32	1.1	1.1	3.2	0.96
28-Mar-98	3:28	2.80	7.02	6.83	10.0	44.1	96.4	1.88	2.8	2.9	25.2	0.16	0.47	0.02	1.97	1.38	1.2	1.0	3.2	0.76
28-Mar-98	9:28	2.82	7.01	6.95	9.5	43.2	91.6	1.95	3.0	2.4	17.7	0.18	0.40	0.02	2.10	1.43	1.1	0.9	3.9	0.36
28-Mar-98	15:28	3.38	7.04	6.86	8.5	40.9	572.5	1.78	3.0	2.4	54.3	0.17	0.72	0.02	2.01	1.10	1.0	1.2	2.4	1.67
28-Mar-98	21:28	3.63	7.01	6.78	7.5	40.2	199.3	1.69	2.7	3.1	53.5	0.18	0.55	0.02	1.97	1.25	1.1	2.0	1.7	3.66
29-Mar-98	3:28	3.49	7.00	6.87	9.0	40.3	188.6	1.72	2.4	3.1	22.7	0.19	0.48	0.01	1.98	1.26	1.1	0.9	3.0	0.58
29-Mar-98	9:28	3.22	7.03	6.80	8.5	41.6	145.8	1.75	4.8	2.9	17.5	0.18	0.46	0.01	2.03	1.22	1.1	0.9	3.5	0.39
29-Mar-98	15:28	3.22	7.08	6.88	9.0	42.4	216.3	1.78	4.0	3.1	15.6	0.18	0.45	0.02	2.08	1.25	1.1	0.9	3.8	0.37
29-Mar-98	21:28	3.19	7.00	6.84	8.0	42.4	72.7	1.73	3.8	2.9	17.2	0.17	0.46	0.01	2.03	1.33	1.1	1.0	2.8	0.84
30-Mar-98	3:28	2.90	7.04	6.81	10.0	43.2	122.9	1.75	3.0	3.6	24.8	0.16	0.45	0.01	2.03	1.25	1.1	1.0	3.2	0.54
30-Mar-98	9:28	2.71	7.00	7.01	10.5	45.2	59.6	1.81	5.1	2.5	15.6	0.16	0.43	0.01	2.08	1.24	1.1	0.9	3.9	0.34
30-Mar-98	13:30	2.74	6.92	6.98	9.0	40.8	60.0	1.79	1.9	2.2	18.1	0.17	0.42	lt 0.01	2.07	1.15	1.0	1.0	4.0	0.43
30-Mar-98	17:30	3.07	7.02	6.93	8.5	41.2	127.8	1.76	1.9	2.7	29.3	0.17	0.46	lt 0.01	2.09	1.04	0.9	1.0	3.4	0.59
30-Mar-98	21:30	3.1	7.05	6.77	8.5	41.2	100.5	1.72	1.9	2.5	22.1	0.16	0.45	lt 0.01	2.01	1.24	1.1	1.0	3.3	0.53
31-Mar-98	1:30	2.95	7.01	7.07	9.0	41.4	24.6	1.73	1.9	2.5	14.1	0.17	0.43	lt 0.01	1.77	1.30	1.1	0.9	3.7	0.33
31-Mar-98	5:30	2.83	7.03	6.82	9.0	42.3	60.6	1.73	1.9	2.5	16.8	0.17	0.46	lt 0.01	2.01	1.25	1.1	0.9	3.9	0.32
31-Mar-98	9:30	2.73	7.07	6.88	10.5	43.2	39.2	1.74	1.8	2.4	12.9	0.16	0.40	lt 0.01	1.93	1.24	1.1	0.9	4.3	0.23
31-Mar-98	13:30	2.75	7.12	6.85	10.0	42.8	41.3	1.76	1.4	2.5	13.6	0.16	0.40	lt 0.01	2.04	1.21	1.1	0.9	4.1	0.31
31-Mar-98	17:30	2.84	7.12	6.81	11.0	42.1	69.9	1.74	1.9	2.5	14.1	0.16	0.42	lt 0.01	2.07	1.18	1.1	0.9	4.2	0.27
31-Mar-98	21:30	2.73	7.09	6.74	10.0	42.9	29.7	1.73	2.1	2.9	11.5	0.15	0.41	lt 0.01	2.05	1.29	1.1	0.8	4.3	0.25
1-Apr-98	1:30	2.61	7.16	6.81	10.5	45.0	37.9	1.75	1.9	2.9	16.2	0.15	0.40	lt 0.01	2.05	1.28	1.1	0.9	4.3	0.30
1-Apr-98	5:30	2.53	7.18	6.87	11.0	45.3	31.3	1.74	1.9	2.7	15.6	0.15	0.40	lt 0.01	2.05	1.25	1.1	0.9	4.4	0.28
1-Apr-98	10:00	2.45	7.12	6.97	10.5	45.0	-0.1	1.75	1.4	2.5	8.3	0.14	0.34	lt 0.01	2.07	1.19	1.1	0.9	4.9	0.12
1-Apr-98	15:20	2.39	6.99	6.87	12.0	40.9	13.9	1.78	1.0	1.8	9.4	0.14	0.26	lt 0.01	2.10	1.16	1.0	0.9	4.9	0.15
1-Apr-98	17:20	2.62	7.05	6.87	10.5	42.3	41.6	1.73	3.4	2.2	18.2	0.14	0.40	lt 0.01	2.04	1.18	1.0	1.0	4.0	0.45
1-Apr-98	19:20	3.05	7.02	6.94	9.5	40.5	168.9	1.69	3.2	2.5	56.8	0.14	0.60	lt 0.01	2.03	0.97	0.9	1.2	2.7	1.59
1-Apr-98	21:20	3.25	6.99	6.84	8.5	40.2	151.3	1.70	2.9	2.9	29.2	0.14	0.51	lt 0.01	2.03	1.01	1.0	1.0	3.1	0.77

Date	Time	Stage	pH lab	pH	air-eq Alk.	cond.	TSS	SO4	MRP	TSP	Total P	NO3	TN	NH4	Si	Cl	Na	Mg	Ca	Fe
1-Apr-98	23:20	3.17	6.73	6.84	9.5	39.8	157.2	1.70	2.4	2.7	20.8	0.13	0.42	lt 0.01	2.03	1.09	1.0	0.9	3.4	0.47
2-Apr-98	1:20	3.06	7.00	6.86	8.0	39.7	153.8	1.70	1.8	2.4	16.0	0.13	0.37	lt 0.01	2.01	1.12	1.0	0.8	3.8	0.29
2-Apr-98	3:20	2.93	6.95	6.80	9.0	39.8	54.9	1.72	1.7	2.5	11.3	0.13	0.37	lt 0.01	2.06	1.12	1.1	0.9	3.7	0.36
2-Apr-98	5:20	2.88	7.00	6.80	10.0	40.9	82.0	1.73	1.5	2.2	10.9	0.13	0.36	lt 0.01	2.12	1.14	1.1	0.8	4.3	0.21
2-Apr-98	7:20	2.8	7.04	6.90	9.5	41.5	26.1	1.72	1.5	2.2	10.3	0.13	0.36	lt 0.01	2.07	1.12	1.0	0.9	3.9	0.30
2-Apr-98	9:20	2.75	7.06	6.87	9.5	41.3	27.5	1.75	1.5	2.2	13.9	0.13	0.33	lt 0.01	2.15	1.10	1.0	0.9	4.3	0.18
2-Apr-98	11:20	2.7	7.08	6.88	10.0	41.7	26.0	1.74	1.5	2.2	7.8	0.13	0.34	lt 0.01	2.09	1.10	1.0	0.8	4.4	0.10
20-Apr-98	10:24	2.10	7.24	7.06	14.0	50.3	12.6	1.923	2.7	3.2	11.6	0.10	0.30	0.01	2.26	1.54	1.3	1.2	5.7	0.37
20-Apr-98	12:24	2.06	7.25	7.03	13.5	53.6	10.3	1.9	2.2	2.9	7.7	0.10	0.32	0.03	2.22	1.57	1.5	1.2	5.9	0.14
20-Apr-98	14:24	2.02	7.27	7.08	14.0	53.8	10.4	1.904	2.4	2.7	6.3	0.10	0.28	0.03	2.24	1.65	1.4	1.1	5.9	0.12
20-Apr-98	16:24	1.99	7.30	7.05	13.5	53.9		1.903	2.2	3.1	6.2	0.09	0.28	0.02	2.22	1.65	1.4	1.1	5.8	0.13
20-Apr-98	17:24	1.98	7.35	7.11	15.0	54.8	lt 0.1	1.931	1.9	2.9	4.0	0.08	0.22	0.02	2.13	1.59	1.4	1.2	6.0	0.10
6-May-98	10:00	2.1	7.70	6.92	15.5	49.1	14.0	1.85	1.7	3.4	12.0	0.05	0.36	0.02	2.07	1.18	1.1	1.2	6.2	0.35
6-May-98	12:00	2.07	6.97	6.99	14.5	50.7	6.9	1.82	1.5	2.9	8.9	0.05	0.31	0.01	2.12	1.17	1.1	1.2	6.2	0.21
6-May-98	14:00	2.05	7.08	6.93	14.5	51.1	5.7	1.85	1.7	3.1	8.8	0.05	0.26	0.01	2.25	1.23	1.1	1.1	6.1	0.17
6-May-98	16:00	2.03	7.15	6.87	15.5	52.5	7.4	1.85	1.7	3.2	10.7	0.05	0.35	0.01	2.29	1.24	1.2	1.2	6.2	0.15
10-May-98	10:07	1.65	6.99	7.13	18.5	55.6	8.8	1.90	1.1	2.6	8.8	0.06	0.25	0.02	2.15	1.26	1.2	1.4	7.6	0.13
10-May-98	14:06	1.75	7.14	6.92	18.0	53.8	4.9	1.86	1.5	2.7	13.8	0.05	0.36	0.01	2.26	1.21	1.2	1.4	7.1	0.35
10-May-98	18:06	1.86	7.19	7.07	18.5	53.3	7.2	1.87	1.5	2.9	4.8	0.05	0.26	0.01	2.17	1.12	1.1	1.3	6.9	0.13
10-May-98	22:06	1.99	7.14	6.92	17.0	50.6	10.9	1.84	1.5	2.9	9.3	0.05	0.30	0.01	2.31	1.12	1.1	1.3	6.8	0.19
11-May-98	2:06	2.17	7.07	6.87	16.0	49.5	20.3	1.83	1.8	3.3	17.9	0.05	0.29	0.01	2.30	1.16	0.7	1.3	5.8	0.47
11-May-98	6:06	2.17	7.10	6.90	15.5	48.3	7.0	1.87	1.6	3.3	14.2	0.05	0.31	0.01	2.33	1.32	1.3	1.2	6.1	0.26
11-May-98	14:57	2.02	6.92	6.91	14.0	46.3	3.2	1.91	1.2	3.0	8.3	0.04	0.23	0.01	2.27	1.58	1.5	1.2	6.1	0.15
11-May-98	18:57	1.94	6.98	7.00	15.5	50.9	3.1	1.90	1.0	2.8	8.5	0.04	0.22	0.01	2.35	1.55	1.4	1.2	6.4	0.13
11-May-98	22:57	1.89	7.01	6.96	16.0	53.9	3.3	1.93	0.9	3.0	7.2	0.05	0.22	0.01	2.27	1.72	1.4	1.2	6.5	0.12
12-May-98	2:57	1.85	7.01	6.92	17.0	56.8	16.5	1.91	0.9	2.5	6.3	0.06	0.24	0.01	1.72	1.88	1.5	1.1	6.6	0.07
12-May-98	6:57	1.81	7.04	6.94	17.5	57.1	5.2	1.94	1.2	2.7	5.8	0.06	0.23	0.02	2.39	1.87	1.4	1.2	7.0	0.06
12-May-98	10:57	1.78	7.09	6.95	17.5	59.3	2.5	1.93	1.0	2.5	6.2	0.06	0.21	0.01	2.42	2.05	1.5	1.3	7.2	0.08
12-May-98	14:57	1.75	7.10	7.00	17.0	61.3	3.4	1.97	1.4	2.7	6.2	0.06	0.23	0.03	1.61	2.53	1.8	1.3	7.4	0.08
12-May-98	18:57	1.71	7.09	6.96	18.0	60.7	2.3	1.93	1.2	2.7	5.3	0.06	0.22	0.01	1.70	2.37	1.7	1.3	7.5	0.08
12-May-98	22:57	1.68	7.14	7.01	18.0	59.7	1.8	1.93	1.4	2.7	5.6	0.06	0.22	0.01	1.61	1.97	1.5	1.3	7.4	0.10
12-Jun-98	11:53	0.94	7.02	7.24	31.0	73.2	41.7	2.06	2.1	2.3	15.3	0.18	0.43	0.02	2.45	1.35	1.3	2.1	10.1	0.46
12-Jun-98	15:53	1.11	7.16	7.25	30.0	71.4	29.2	1.95	2.5	2.5	27.6	0.18	0.51	0.03	2.43	1.22	1.2	2.0	9.0	0.83
12-Jun-98	19:53	1.38	7.15	7.21	28.0	68.4	27.9	1.72	2.7	3.7	34.8	0.16	0.50	0.03	2.41	1.36	1.3	1.8	8.2	0.86
12-Jun-98	23:53	1.41	7.14	7.23	27.0	69.0	18.4	2.32	2.5	4.0	20.2	0.15	0.47	0.01	2.45	1.25	1.2	1.8	8.5	0.65
13-Jun-98	3:53	1.36	7.18	7.18	27.0	69.9	18.7	1.79	2.2	3.9	20.6	0.16	0.47	0.01	2.37	1.49	1.4	1.8	8.8	0.75
13-Jun-98	7:53	1.29	7.19	7.16	27.0	71.5	17.0	1.80	2.2	3.7	17.8	0.16	0.46	0.01	2.45	1.75	1.5	1.8	9.2	0.57
13-Jun-98	11:53	1.25	7.38	7.20	27.0	71.1	11.3	1.82	2.1	3.3	18.3	0.15	0.43	0.02	2.53	1.65	n/a	n/a	n/a	n/a
13-Jun-98	15:53	1.45	7.22	7.17	27.0	68.9	13.3	1.75	2.1	3.7	16.9	0.15	0.42	lt 0.01	2.41	1.55	1.4	1.7	8.8	0.50
13-Jun-98	19:53	1.53	7.22	7.12	26.0	65.7	14.5	1.69	2.2	4.0	18.3	0.12	0.40	lt 0.01	2.34	1.46	1.4	1.7	8.3	0.64
13-Jun-98	23:53	1.53	7.22	7.13	24.0	67.7	8.9	1.75	2.2	3.9	15.0	0.14	0.40	0.02	2.50	1.61	1.8	1.7	8.6	0.51
14-Jun-98	3:53	1.47	7.19	7.10	25.0	68.3	11.9	1.77	2.7	4.2	16.4	0.13	0.40	0.02	2.44	1.58	1.4	1.7	8.6	0.54
14-Jun-98	7:53	1.50	7.20	7.17	25.0	66.8	20.4	1.75	1.9	3.7	13.9	0.12	0.39	0.02	2.23	1.47	1.4	1.6	8.6	0.41
14-Jun-98	12:12	1.72	7.07			45.3	10.4	1.07	2.4	4.4	15.5	0.05	0.35	0.01	2.09	1.54	1.1	1.0	5.9	0.32
14-Jun-98	20:12	2.55	7.07	6.97	16.0	52.4	101.4	1.88	3.2	5.2	14.6	0.08	0.61	0.01	2.34	1.60	1.6	1.3	4.6	1.33
15-Jun-98	0:12	3.33	6.77	6.93	12.0	45.1	301.2	1.38	4.6	7.5	14.8	0.06	0.36	0.01	2.27	1.57	1.2	1.0	5.5	0.28
15-Jun-98	4:12	3.28	6.75	6.75	10.0	44.7	284.7	1.34	3.7	8.1	21.6	0.04	0.32	lt 0.01	2.09	1.57	1.2	0.9	5.5	0.26

Date	Time	Stage	pH lab	pH	air-eq Alk.	cond.	TSS	SO4	MRP	TSP	Total P	NO3	TN	NH4	Si	Cl	Na	Mg	Ca	Fe
15-Jun-98	8:12	3.12	6.86	6.79	11.0	42.6	75.4	1.23	3.0	7.3	15.0	0.05	0.31	lt 0.01	2.05	1.56	1.1	0.9	5.2	0.23
15-Jun-98	12:12	2.84	6.91	6.90	12.0	44.0	9.2	1.62	2.9	7.8	11.1	0.04	0.29	lt 0.01	2.23	1.17	1.1	0.9	5.5	0.24
15-Jun-98	16:12	2.63	6.96	6.89	11.0	45.6	40.8	1.63	2.7	5.4	11.1	0.04	0.31	lt 0.01	2.23	1.14	1.2	0.9	5.6	0.18
15-Jun-98	20:12	2.69	6.98	6.88	12.0	46.8	14.2	1.64	2.4	5.7	10.0	0.04	0.29	0.01	2.52	1.11	1.2	1.0	5.8	0.18
16-Jun-98	0:12	2.60	6.98	6.84	13.0	47.2	11.4	1.70	2.2	4.9	9.0	0.04	0.28	lt 0.01	2.48	1.11	1.2	1.0	5.9	0.18
16-Jun-98	4:12	2.51	6.95	6.86	14.0	48.5	19.6	1.66	2.1	4.7	13.4	0.04	0.28	lt 0.01	2.36	1.10	1.2	1.0	6.1	0.18
16-Jun-98	8:12	2.45	6.92	6.84	13.0	48.9		1.64	2.2	4.5	10.6	0.04	0.27	lt 0.01	2.36	1.03	1.1	1.0	6.0	0.17
17-Jun-98	12:00	3.32	6.78	6.50	10.5	41.4	231.2	1.69	2.9	4.5	35.0	0.02	0.41	lt 0.01	2.27	1.17	1.2	1.1	3.5	1.00
17-Jun-98	16:00	2.99	6.83	6.69	12.0	44.8	55.1	1.68	2.3	4.5	28.7	0.03	0.38	lt 0.01	2.42	1.25	1.3	1.2	3.4	1.41
17-Jun-98	20:00	2.78	6.85	6.71	11.0	47.1	15.9	1.72	2.1	4.5	16.7	0.03	0.38	lt 0.01	2.42	1.37	1.3	1.0	4.9	0.55
18-Jun-98	0:00	2.64	6.91	6.80	13.0	49.2	14.4	1.74	2.1	4.4	13.2	0.03	0.32	lt 0.01	2.48	1.32	1.4	1.0	5.6	0.41
18-Jun-98	4:00	2.54	6.93	6.81	13.0	49.3	11.9	1.74	2.1	3.9	11.6	0.04	0.31	lt 0.01	2.61	1.25	1.3	1.0	5.9	0.30
18-Jun-98	8:00	2.44	6.93	6.86	15.0	52.4	12.4	1.75	2.1	4.0	14.1	0.04	0.31	lt 0.01	2.50	1.36	1.4	1.1	5.9	0.36
18-Jun-98	12:00	2.39	6.98	6.97	14.0	52.3	27.8	1.75	2.0	4.2	11.1	0.04	0.27	lt 0.01	2.52	1.32	1.3	1.1	6.1	0.29
18-Jun-98	16:00	2.44	7.00	6.90	15.0	51.4	9.0	1.72	2.2	4.4	12.5	0.04	0.27	lt 0.01	2.48	1.21	1.2	1.1	6.3	0.37
18-Jun-98	20:00	2.49	6.99	6.87	16.0	52.7	14.2	1.74	2.1	4.4	11.3	0.03	0.25	0.03	2.45	1.43	1.3	1.1	6.3	0.31
19-Jun-98	0:00	2.42	7.00	7.15	16.0	54.1	8.9	1.74	2.0	4.4	12.7	0.04	0.26	lt 0.01	2.48	1.55	1.5	1.1	6.3	0.41
19-Jun-98	4:00	2.35	7.05	6.91	16.0	54.8	10.5	1.75	2.1	4.5	11.3	0.04	0.28	lt 0.01	2.48	1.55	1.5	1.1	6.5	0.30
19-Jun-98	8:00	2.30	7.05	7.00	17.0	56.5	8.6	1.75	2.2	4.5	12.7	0.04	0.30	lt 0.01	2.48	1.65	1.5	1.1	6.6	0.32
23-Jul-98	10:57	1.06	6.99	7.29	33.0	76.8	394.0	1.69	2.4	3.1	38.1	0.15	0.74	0.03	3.01	1.06	0.9	2.6	6.2	4.38
23-Jul-98	12:57	1.13	7.04	7.35	32.0	74.6	223.7	1.66	5.7	2.9	36.2	0.15	1.25	0.03	2.89	1.04	1.2	2.8	5.3	5.76
23-Jul-98	14:57	1.19	7.09	7.58	33.0	74.9	180.2	1.61	2.2	2.4	55.4	0.14	0.92	0.02	2.86	1.02	1.0	2.5	6.1	3.83
23-Jul-98	16:57	1.20	7.14	7.39	32.0	74.6	153.0	1.59	2.2	2.4	29.7	0.14	0.73	0.01	2.86	1.04	1.3	2.3	6.5	3.38
23-Jul-98	18:57	1.19	7.24	7.32	32.0	74.5	123.0	1.57	2.2	2.7	55.7	0.13	0.81	0.02	2.86	1.03	1.2	2.3	6.5	2.36
23-Jul-98	20:57	1.18	7.24	7.61	34.0	75.8	119.3	1.59	2.4	3.1	26.2	0.14	0.73	0.01	2.98	1.01	1.2	2.2	7.0	2.57
23-Jul-98	22:57	1.17	7.26	7.35	32.0	75.5	105.2	1.60	2.1	2.6	34.7	0.14	0.67	0.01	2.95	0.96	1.2	2.2	7.1	2.72
24-Jul-98	0:57	1.15	7.27	7.34	32.0	75.1	76.5	1.58	1.9	2.6	33.9	0.14	0.67	0.01	2.89	1.00	1.2	2.1	6.6	2.21
24-Jul-98	2:57	1.14	7.28	7.57	32.0	75.2	72.1	1.64	2.1	2.4	39.0	0.14	0.51	0.01	3.01	1.06	1.2	2.1	8.3	1.71
24-Jul-98	4:57	1.12	7.30	7.35	33.0	76.1	71.6	1.61	2.1	2.4	37.9	0.14	0.51	0.01	2.92	1.09	1.1	2.0	7.8	1.44
24-Jul-98	6:57	1.11	7.31	7.36	32.0	75.8	47.4	1.65	2.2	2.9	34.4	0.15	0.42	0.02	2.80	1.20	1.2	2.0	8.9	1.35
24-Jul-98	8:57	1.11	7.32	7.35	32.0	76.0	lt 0.1	1.64	2.2	3.4	37.0	0.14	0.51	0.01	2.98	1.11	1.3	2.0	9.2	1.20
11-Aug-98	10:00	1.36	6.88	7.05	28.0	75.2	115.1	1.62	4.7	4.2	51.6	0.15	0.72	0.03	2.67	0.31	1.2	1.9	8.9	1.37
11-Aug-98	13:59	1.24	7.04	7.14	29.5	73.5	79.6	1.71	2.5	3.8	61.1	0.15	0.66	0.03	2.67	0.50	1.4	2.0	8.8	1.50
11-Aug-98	17:59	1.26	7.12	7.16	29.0	75.0	93.4	1.63	2.8	4.0	48.4	0.14	0.52	0.02	2.80	0.61	1.4	1.8	9.5	0.92
11-Aug-98	21:59	2.97	6.72	6.70	17.0	51.8	662.1	1.46	11.2	6.1	231.4	0.13	1.30	0.02	2.24	0.55	0.8	2.0	3.0	6.29
12-Aug-98	1:59	2.80	6.79	6.75	14.5	52.8	121.3	1.57	8.6	7.9	233.5	0.15	1.57	0.01	2.27	0.43	1.2	1.9	4.6	4.65
12-Aug-98	5:59	2.67	6.81	6.79	13.0	51.4	49.8	1.64	5.0	6.5	71.6	0.12	0.74	0.01	2.27	0.30	1.1	1.2	5.1	1.18
12-Aug-98	9:59	2.42	6.84	6.80	14.0	53.3	35.7	1.70	3.6	6.3	40.8	0.10	0.59	0.01	2.48	0.46	1.1	1.2	4.0	0.62
12-Aug-98	13:59	2.19	6.93	6.78	16.0	55.4	17.4	1.74	3.2	5.8	28.1	0.09	0.50	0.01	2.48	0.54	1.3	1.2	6.7	0.36
12-Aug-98	17:59	1.99	6.79	6.92	16.5	57.4	13.2	1.78	3.1	5.4	22.9	0.09	0.49	0.01	2.70	0.49	1.3	1.2	7.2	0.41
12-Aug-98	21:59	1.84	6.99	6.94	17.5	60.5	10.6	1.83	2.8	4.7	15.8	0.09	0.43	0.02	2.80	0.49	1.3	1.3	7.3	0.26
13-Aug-98	1:59	1.75	6.95	6.93	21.5	63.9	13.2	1.85	2.5	4.9	17.6	0.10	0.45	0.01	2.73	0.44	1.4	1.3	7.8	0.33
13-Aug-98	5:59	1.68	7.04	7.01	21.0	63.4	7.3	1.87	2.8	4.5	15.8	0.09	0.41	0.02	2.39	0.42	1.2	1.4	7.9	0.27