

WATER QUALITY IN GREAT BROOK
Quarterly Monitoring Results
January 2008 - June 2009

Prepared by:

Roger Edwards, *Volunteer* and Kelley Curran, *Director of Water Quality Programs*
Great Swamp Watershed Association Stream Team
New Vernon, NJ 07976

Prepared for:

Debra Hammond, Chief
New Jersey Department of Environmental Protection
Bureau of Water Quality Standards and Assessment
401 East State Street
PO Box 409
Trenton, NJ 08625-0409

July 2009

In early 2008, the Great Swamp Watershed Association (GSWA), under its Adopt-a-Stream program¹, initiated quarterly monitoring of water quality at several sites on Great Brook and two of its tributaries. Great Brook is formed from several smaller streams originating in Morris and Harding Townships, New Jersey. The brook passes through urban, suburban and rural areas, eventually flowing into the Great Swamp National Wildlife Refuge, where it merges with Loantaka and Primrose Brooks before joining the Passaic River. This report documents the results obtained during the first 18 months of this program.

1. Background

Since 1999, the Ten Towns Great Swamp Watershed Management Committee (TTC) has conducted water quality monitoring of the five major streams entering the Great Swamp National Wildlife Refuge (Refuge). GSWA Stream Team staff and volunteers have participated in some phases of this work. The monitoring focused on key nitrogen and phosphorus nutrients and Total Suspended Solids (TSS). Beginning in 2006, some additional parameters, including Total Dissolved Solids (TDS), have been included in the measurements. As part of the TTC program, Great Brook has been sampled at a single site (designated GB1) where the stream crosses Woodland Road, a short distance upstream from the stream's entry into the Refuge. Reports prepared by the TTC's consultants were issued² in 2002 and 2007; more recently, interim reports covering the period May 2006 – April 2008 have been circulated³. Overall, the results for Great Brook have shown it to be somewhat impaired, principally under storm flow conditions, with respect to the New Jersey Surface Water Quality Standards (NJSWQS), though to a lesser extent than two of the other watershed streams, Loantaka Brook and Black Brook.

2. GSWA's 2008-2009 Monitoring Program

To develop a more extensive characterization of the stream's water quality, six sites distributed along Great Brook and its tributaries were selected for our Adopt-a-Stream program. A map showing the locations of the monitoring sites is provided in Figure 1. Four of the sites,

¹GSWA's Adopt-a-Stream program, with the support of local corporations, is aimed at measuring and improving the water quality of streams flowing into the Great Swamp National Wildlife Refuge.

²Great Swamp Watershed Water Quality Monitoring Report, Ten Towns Great Swamp Watershed Management Committee, Prepared by F. X. Browne, June 2002.

Great Swamp Watershed Water Quality Monitoring Report, Ten Towns Great Swamp Watershed Management Committee, Prepared by Princeton Hydro, LLC, March 2007

³Stream Sampling in the Great Swamp Watershed, Interim Reports for Ten Towns Great Swamp Watershed Committee, Prepared by Princeton Hydro, LLC, April 2007, June 2007, October 2007, January 2008 and May 2008.

designated, in upstream to downstream order, GB5, GB4, GB3 and GB1, are on the main stem of Great Brook. A site designated CMA is located in GSWA's Conservation Management Area on one of the headwaters tributaries, Silver Brook (a.k.a. Catfish Brook). Another tributary, Bayne Brook, is monitored at the HLT site on Harding Land Trust property where the brook passes under Wexford Lane. The two tributaries merge and join Great Brook at a point approximately midway between the GB4 and GB3 sites. Figure 2 contains an aerial photo, which also indicates the site locations and a table with their geographic coordinates. The sampling and analytical procedures have been modeled on those followed in our 2005–2007 monitoring⁴ of Loantaka Brook. All monitoring activities are covered under a Quality Assurance Project Plan.

Samples, collected quarterly, were submitted to Environmental Compliance Monitoring, Inc. (ECM) in Hillsborough, NJ for analysis. ECM is a NJDEP-certified laboratory. The concentrations of TDS, sodium, chloride, soluble reactive phosphate, total phosphorus, nitrate, nitrite, total Kjeldahl nitrogen and TSS were determined. Copies of the laboratory data packages can be found in Attachments 1 through 6.

Supplementing the lab analyses, additional TDS measurements were collected using an Oakton TDSTestr 10 meter. In addition, a Horiba U-10 water quality meter was leased for each sampling event and used for taking in-situ measurements of temperature, pH, dissolved oxygen (DO) and conductivity. A third estimate of TDS was derived from the conductivity readings. Water temperature was recorded on each sampling occasion.

Samples were collected on February 12, May 6, August 4 and November 5, 2008 and on February 4, and May 13, 2009. Sampling was performed under baseflow conditions, meaning that no significant precipitation had occurred for at least 48 hours prior to each collection. However, some runoff from snow melting occurred on the days immediately prior to the February 4, 2009 collection; this event will be referred to in Section 3.1. On each sampling date, measurements of stream flow rates were made at some of the sites using the Volunteer Stream Monitoring Partnership protocol.

Copies of the chain of custody reports, field sampling data sheets, and meter calibration logs can be found in Attachments 7, 8 and 9, respectively.

3. Results

Table A summarizes the TDS, sodium, and chloride concentrations determined by laboratory analysis, together with the Horiba and Oakton meter and water temperature field measurements.

⁴ Water Quality in Loantaka Brook, 2005–2007 Monitoring Results, Roger Edwards and Kelley Curran, GSWA Stream Team, May 2008.

In addition, the table includes the measured stream flow volumes, usually taken at GB3, GB4 and GB5, and occasionally at other sites. Table B shows the laboratory results for nitrogen and phosphorus-bearing nutrients and TSS. The data listed as Total Nitrogen “as N” was obtained by summing the quantities in the three preceding columns.

3.1 Total Dissolved Solids, Sodium and Chloride

For completeness, the TDS values derived from meter measurements are included in Table A, but principal weight is given to the more accurate laboratory results. These showed that TDS concentrations, except for those measured on February 4, 2009, ranged from about 220 to 470 mg/l, with sodium and chloride contributing 35% to 55% of the TDS. The NJSWQS for TDS were not exceeded in any of these samples, but the frequently occurring TDS values of 450 mg/l or more at the GB4 and GB5 sites were uncomfortably close to the NJ standard of 500 mg/l. On February 4, 2009, substantially higher values of TDS, ranging from about 570 to 1,830 mg/l, were recorded; on that date between 70% and 87% of these TDS values were contributed by sodium and chloride. These TDS numbers exceeded the NJSWQS at all six sites.

There is no NJSWQS specification for sodium, but on 02/04/09 the chloride chronic toxicity standard of 230 mg/l was also exceeded at all sites, and the chloride acute toxicity standard (860 mg/l) was exceeded at GB5. The large surge in TDS and the associated high sodium and chloride content strongly suggest an influx of road salt, flushed into the stream by recent snowmelt runoff during the days preceding the sampling (note that flow volumes on 02/04/09 were somewhat higher than those usually measured). Very similar behavior was seen during our monitoring of Loantaka Brook⁴. As noted above, at GB4 and GB5 higher levels of TDS than at the other sites were typically seen on other sampling dates. These sites are located in the upper reaches of the main stream channel, where it flows through a more urbanized region of Morris Township near the southern border of Morristown; in this area there is a greater density of roads and parking lots receiving deicing agents during winter than is the case further downstream. Although road salt is used only in winter, it can be retained in soils, slowly leaching into shallow groundwater and seeping into the stream throughout the year.

3.2 Nitrogen and Phosphorus Nutrients, and Total Suspended Solids

Table B summarizes the nutrient and TSS data determined by laboratory analysis. The NJSWQS applicable to these parameters are: Nitrates 10 mg/l, Total Phosphorus 0.1 mg/l and TSS 40 mg/l. The nitrates and TSS standards were consistently met at all the monitored sites. Total phosphorus values also met the standards in most samples but there were some exceptions. Three out of the four exceedances observed during the 18-

month period occurred at the GB4 or the GB5 sites and may be another consequence of the more urban environment of these sites.

3.3 pH and Dissolved Oxygen measurements using a Horiba Meter

Several pH values, tabulated in Table A, fell outside the range specified by the NJSWQS of 6.5 to 8.5. The NJSWQS for dissolved oxygen, 5 mg/l, was met in all cases. However, DO expressed as percent of saturation showed substantially lower values at all sites on November 5 than on the other sampling dates. The reason for this is currently not understood. The Horiba meter was calibrated prior to each sampling round, but to provide confirmation in future monitoring it might be helpful to duplicate the measurements using a second calibrated meter.

4. Other relevant data

The TTC monitoring program mentioned earlier has included sampling Great Brook at GB1 since 1999. The concentrations of nitrogen and phosphorus nutrients, and TSS, have been included in reports issued by the TTC consultants^{2, 3}. Our 2008-2009 data for the same suite of parameters, summarized in Table B for the GB1 site, are generally similar to the TTC results. In 2006, Princeton Hydro, TTC's current consultant, began measuring some additional parameters, including TDS. Between September 2006 and April 2008, 20 samples were analyzed³. Usually TDS was found to fall in the 200 to 300 mg/l range, like most of our 2008-2009 results. Some were higher, notably 459 mg/l in December 2007 and 433 mg/l in February 2008. These results are also suggestive of winter road salt runoff.

5. Summary and future monitoring plans

Under its Adopt-a-Stream program, GSWA has initiated quarterly monitoring of water quality in Great Brook with six sampling sites located on the main stem and two headwaters tributaries. The first 18 months of sampling has resulted in the following principal findings.

- No exceedances of NJSWQS were found for the concentrations of nitrogen and phosphorus compounds, and TSS, at the most downstream monitoring site (GB1, located just prior to the brook's entry into the Refuge). These results are consistent with findings at the same site, under baseflow conditions, reported by Ten Towns Committee during its 1999-2008 study.

- In most cases, samples taken at the other Great Brook sites and the two tributaries also met the NJSWQS for nutrients and TSS, but there were a few exceptions, notably four exceedances in the concentration of total phosphorus, three of which occurred at the GB4 or GB5 sites, and might reflect the relatively urbanized environment of the stream segment containing these sites.
- TDS levels met the NJSWQS at all of the monitored sites on five out of the six sampling dates, but usually had higher values in the upper reaches of the main stem (GB4 and GB5) than at the other sites. However, on the sixth date, February 4, 2009, exceptionally high concentrations of TDS were measured and the NJ standards were significantly exceeded at all sites. Sodium and chloride concentrations were also particularly high on this occasion, with the chloride levels failing the NJ chronic toxicity standard at all sites, and failing the more stringent acute toxicity standard at one site. These results are consistent with contamination by road salt and other deicing agents being flushed into the stream by rain or melting snow.
- Comparing these results with those for nearby Loantaka Brook, which flows through a somewhat similar environment, Great Brook is normally the less impaired of the two streams, but on occasion can exhibit a comparable level of impairment with respect to the effects of winter deicing practices.

GSWA intends to continue the quarterly monitoring of Great Brook through 2010. As was done in our 2005–2007 monitoring of Loantaka Brook, we expect to review the range of monitored parameters and sampling sites from time to time, and will make changes in the program if it appears useful in expanding our knowledge of the stream’s health.

Acknowledgements

This work was carried out with the support of members of GSWA’s Corporate Council through the Association’s Adopt-a-Stream program. Thanks are due to Stream Team volunteers Gene Fox, Laura Costello, Dick Barrett and Ellen Drury for their enthusiastic participation in this work, and to other Stream Team members for their valued comments and suggestions as the work progressed.

Figure 1 ADOPT-GREAT-BROOK MONITORING SITES

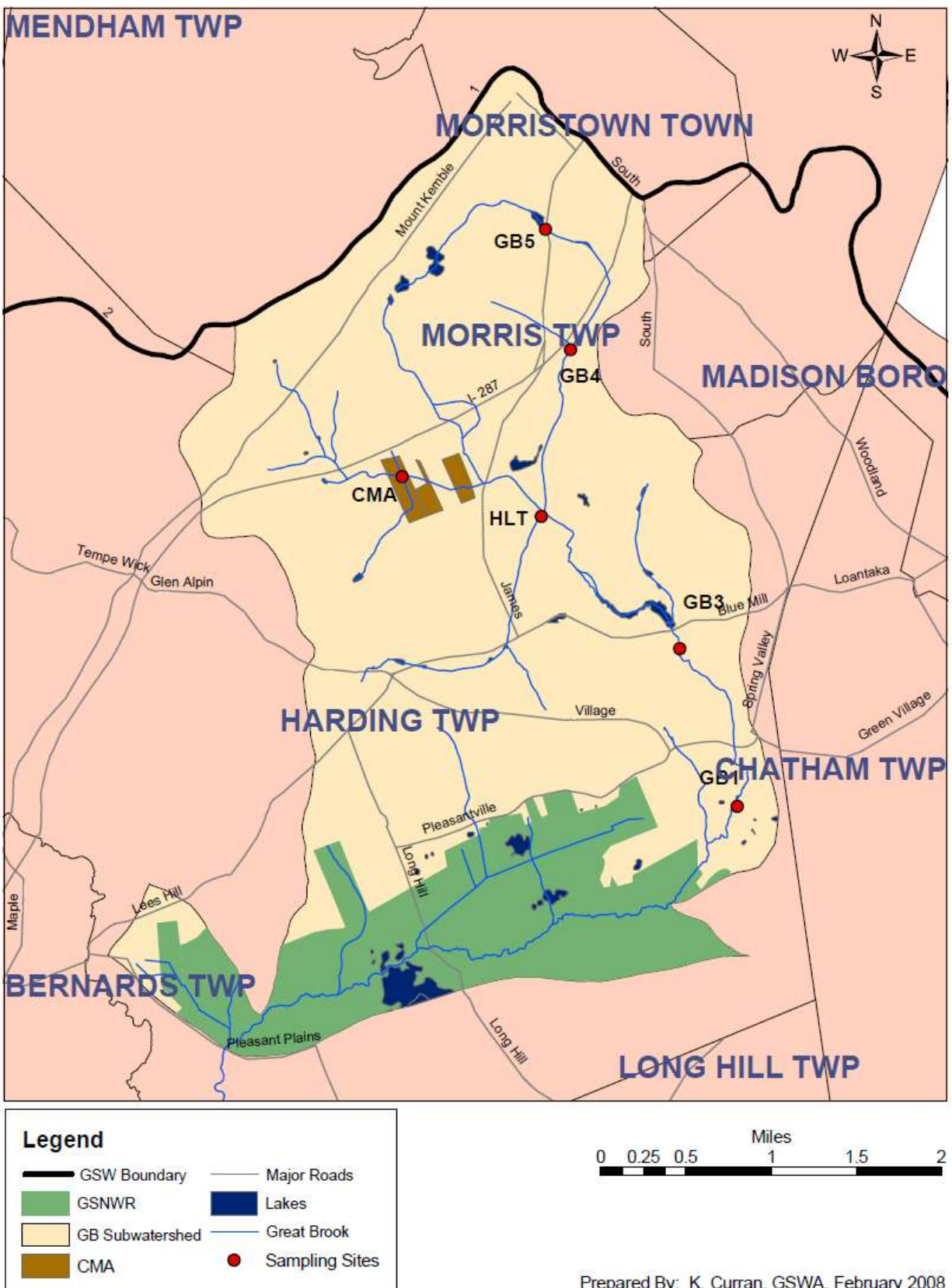
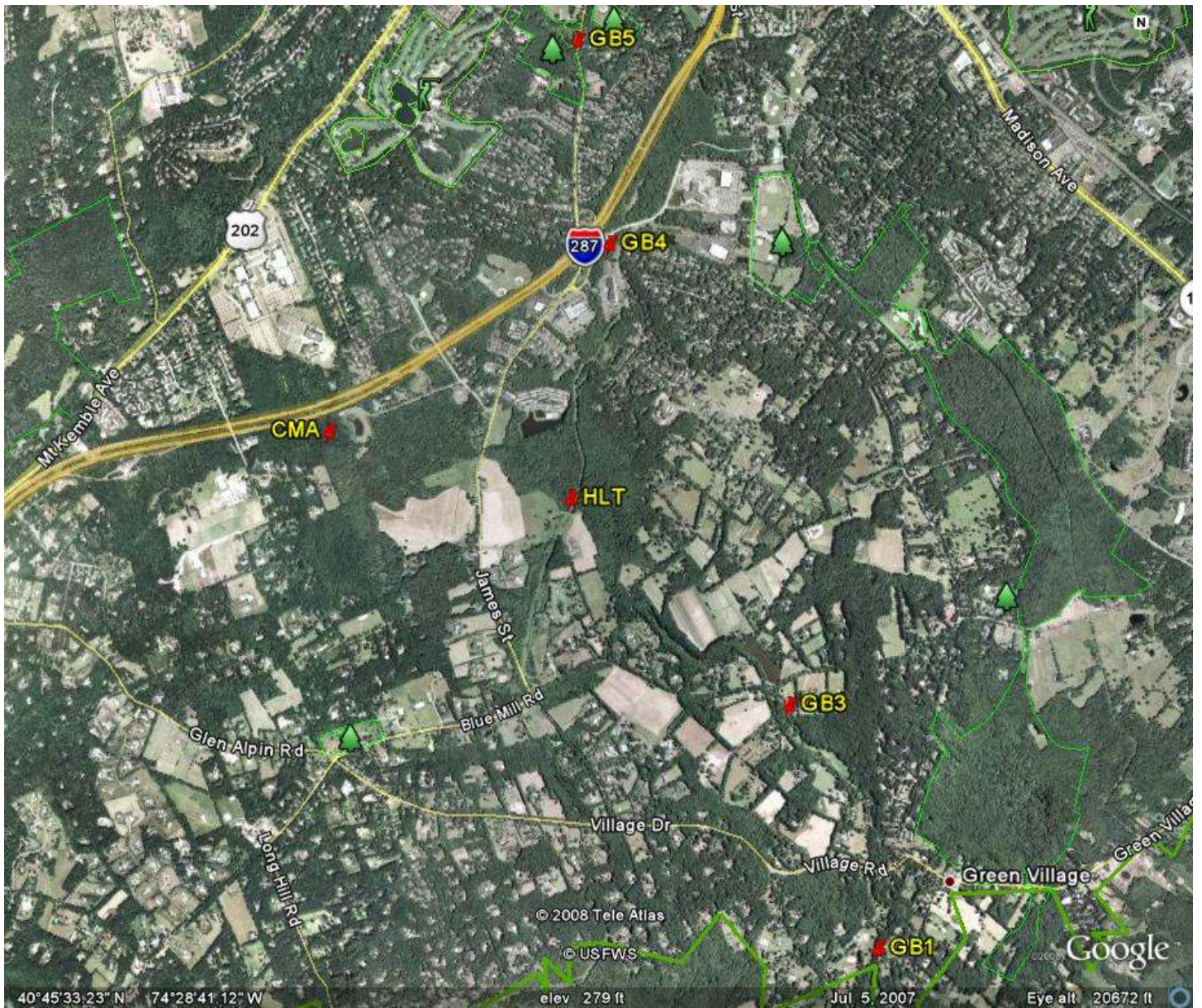


Figure 2 AERIAL PHOTO SHOWING GREAT BROOK MONITORING SITES



Geographic Coordinates for Sampling Sites on Great Brook

Source: Google Earth software

SITE	LOCATION	LATITUDE	LONGITUDE
GB1	Woodland Road	40°44'4.83"N	74°27'30.41"W
GB3	Dickson's Mill Rd	40°44'52.38"N	74°27'53.40"W
GB4	Laura Lane	40°46'22.06"N	74°28'39.67"W
GB5	Footes Pond James St	40°47'1.63"N	74°28'47.87"W
CMA	GSWA's Conservation Mgt. Area	40°45'45.63"N	74°29'51.84"W
HLT	Harding Land Trust property/Wexford Ln	40°45'32.57"N	74°28'49.67"W

A. TDS, Sodium and Chloride Concentrations, Flow, and Other On-site Measurements, Great Brook

					Horiba meter				Oakton mtr.	0.6 X Cond.	Lab results		
Site	Sampling Date	Flow*** cf/s	Water Temperature °F °C		pH	DO mg/l	DO (approx. % of Saturation)	Conductivity µS/cm	TDS mg/l	TDS mg/l	TDS mg/l	Sodium mg/l	Chloride mg/l
GB5 Great Brook at James St. below Foote's Pond	02/12/08	0.78	36.6	2.6	7.37	12.00	88.9%	698	--	419	450	63.1	147.1
	05/06/08	1.20	69.6	20.9	7.63	8.76	99.5%	645	362	387	432	50.5	118.6
	08/04/08	0.87	79.0	26.1	7.97	8.65	108.1%	570	244	342	313	40.0	91.5
	11/05/08		57.0	13.9	7.14	6.55	64.2%	756	345	454	434	55.8	142.0
	02/04/09	1.74	35.0	1.7	8.30	12.40	89.9%	3500	1720	2100	1830	570	1015
	05/13/09	0.62	65.8	18.8	7.64	8.74	95.0%	681	485	409	454	58.4	144.0
GB4 Great Brook near Laura Lane	02/12/08	1.66	34.7	1.5	7.17	12.83	92.3%	760	--	456	472	82.9	179.4
	05/06/08	2.40	59.7	15.4	7.53	10.92	110.3%	730	402	438	446	66.4	143.1
	08/04/08	2.08	71.2	21.8	7.38	7.22	83.0%	705	296	423	382	53.2	115.1
	11/05/08	1.34	54.6	12.6	6.78	5.45	51.9%	858	389	515	466	76.9	171.0
	02/04/09	2.63	36.1	2.3	8.20	15.80	116.2%	2800	1380	1680	1480	419	735
	05/13/09	1.12	59.2	15.1	7.42	8.65	86.5%	789	574	473	483	82.6	180.0
CMA Silver Brook near Tiger Lily Lane	02/12/08	1.98	35.0	1.7	6.23	13.50	97.8%	423	--	254	273	30.7	96.1
	05/06/08		57.2	14.0	7.45	10.34	101.4%	461	252	277	285	28.3	74.5
	08/04/08		67.1	19.5	6.30	7.60	83.5%	481	187	289	260	27.6	67.9
	11/05/08		53.2	11.8	6.30	5.52	51.6%	464	208	278	259	26.2	79.3
	02/04/09		35.6	2.0	7.00	13.40	97.8%	1600	739	960	1220	392	657
	05/13/09		53.6	12.0	6.59	10.32	96.4%	440	325	264	286	36.6	89.4
HLT Bayne Brook at Wexford Ln.	02/12/08	1.94	34.1	1.2	6.58	12.55	89.6%	436	--	262	276	52.0	100
	05/06/08		60.8	16.0	7.30	9.87	100.7%	391	216	235	221	37.3	66.7
	08/04/08		68.9	20.5	6.63	7.45	83.7%	548	225	329	303	45.9	61.3
	11/05/08	0.70	53.6	12.0	6.52	7.75	72.4%	447	212	268	241	38.7	59.8
	02/04/09		33.6	0.9	6.90	12.10	85.8%	1100	508	660	572	133	265
	05/13/09	2.54	57.4	14.1	6.71	10.67	104.6%	386	282	232	241	37.9	75.0
GB3 Great Brook near Dickson's Mill Rd	02/12/08	-----Not measured-----											
	05/06/08	12.60	62.0	16.7	7.54	10.51	109.5%	505	279	303	294	43.4	91.2
	08/04/08	5.94	77.5	25.3	7.17	7.35	90.7%	494	209	296	253	34.8	69.8
	11/05/08	4.68	52.8	11.6	6.02	5.30	49.1%	396	169	238	221	30.5	62.0
	02/04/09	19.88	36.1	2.3	7.60	14.20	104.4%	2100	983	1260	1050	319	564
	05/13/09	9.25	61.5	16.4	7.20	10.39	107.1%	417	302	250	278	41.0	83.6
GB1 Great Brook at Woodland Road	02/12/08		36.8	2.7	7.73	14.58	108.8%	435	--	261	279	47.6	93.1
	05/06/08		51.1	10.6	6.96	9.55	86.8%	484	249	290	274	40.2	88.2
	08/04/08	4.51	72.0	22.2	7.41	6.62	77.0%	485	200	291	282	33.1	61.3
	11/05/08		52.3	11.3	6.58	5.25	48.6%	386	273	232	228	28.4	52.2
	02/04/09		34.1	1.2	7.50	16.00	114.3%	1600	730	960	751	221	387
	05/13/09		59.5	15.3	7.49	10.29	103.9%	399	289	239	256	35.5	78.8

*** Flow estimated using float travel time & stream X-section (Volunteer Stream Monitoring Partnership method)

Red entries indicate failure to meet the applicable NJ Surface Water Quality Standard

B. N- and P-Bearing Nutrients, and TSS, Great Brook

Concentrations in mg/liter

Sampling Site	Sampling Date	Water Temperature ° F ° C		Total Kjeldahl Nitrogen "as N"	Nitrate "as N"	Nitrite "as N"	Total Nitrogen "as N"	Soluble Reactive Phosphate "as P"	Total Phosphorus "as P"	Total Suspended Solids
GB5 Great Brook at James St. below Foote's Pond	02/12/08	36.6	2.6	0.22	2.3	0.018	2.54	0.004	0.04	3
	05/06/08	69.6	20.9	0.38	1.4	0.045	1.83	0.008	0.06	9
	08/04/08	79.0	26.1	0.80	0.97	0.047	1.82	0.004	0.16	27
	11/05/08	57.0	13.9	0.28	1.5	0.029	1.81	0.018	0.04	17
	02/04/09	35.0	1.7	0.61	2.2	0.015	2.83	< 0.002	0.03	< 3
	05/13/09	65.8	18.8	0.57	1.6	0.041	2.21	0.005	0.06	7
GB4 Great Brook near Laura Lane	02/12/08	34.7	1.5	0.22	2.0	0.009	2.23	0.050	0.16	< 3
	05/06/08	59.7	15.4	0.32	1.3	0.024	1.64	0.013	0.04	< 3
	08/04/08	71.2	21.8	0.33	0.87	0.011	1.21	0.024	0.15	3
	11/05/08	54.6	12.6	0.23	1.4	0.010	1.64	0.026	0.04	< 3
	02/04/09	36.1	2.3	0.37	1.2	0.010	1.58	< .002	0.05	4
	05/13/09	59.2	15.1	0.57	1.3	0.032	1.90	0.015	0.05	3
CMA Silver Brook near Tiger Lily Lane	02/12/08	35.0	1.7	0.12	1.4	0.003	1.52	0.011	0.05	< 3
	05/06/08	57.2	14.0	0.38	0.93	0.006	1.32	0.029	0.07	6
	08/04/08	67.1	19.5	0.26	0.98	0.009	1.25	0.037	0.10	11
	11/05/08	53.2	11.8	0.25	0.77	0.005	1.03	0.034	0.07	18
	02/04/09	35.6	2.0	0.17	1.1	0.007	1.28	0.018	0.06	< 3
	05/13/09	53.6	12.0	0.38	1.0	0.007	1.39	0.020	0.06	7
HLT Bayne Brook at Wexford Lane	02/12/08	34.1	1.2	0.26	1.6	0.004	1.86	0.007	0.03	9
	05/06/08	60.8	16.0	0.32	0.59	0.019	0.93	0.021	0.07	11
	08/04/08	68.9	20.5	0.19	0.65	0.008	0.85	0.026	0.07	5
	11/05/08	53.6	12.0	0.25	0.73	0.006	0.99	0.015	0.03	3
	02/04/09	33.6	0.9	0.33	1.0	0.005	1.34	0.002	0.07	22
	05/13/09	57.4	14.1	0.34	0.90	0.013	1.25	0.017	0.02	4
GB3 Great Brook near Dickson's Mill Rd.	02/12/08	<-----Not Measured----->								
	05/06/08	62.0	16.7	0.11	0.77	0.013	0.89	0.006	0.06	6
	08/04/08	77.5	25.3	0.19	0.20	0.010	0.40	0.030	0.07	< 3
	11/05/08	52.8	11.6	0.43	0.7	0.008	1.15	0.015	0.11	8
	02/04/09	36.1	2.3	0.61	0.98	0.010	1.60	0.005	0.06	6
	05/13/09	61.5	16.4	0.62	0.91	0.016	1.55	0.026	0.06	4
GB1 Great Brook at Woodland Road	02/12/08	36.8	2.7	0.09	1.2	0.006	1.30	0.012	0.04	< 3
	05/06/08	51.1	10.6	0.35	0.72	0.014	1.08	0.014	0.05	< 3
	08/04/08	72.0	22.2	0.23	0.38	0.005	0.62	0.033	0.07	5
	11/05/08	52.3	11.3	0.20	0.70	0.005	0.91	0.033	0.06	3
	02/04/09	34.1	1.2	0.61	0.89	0.007	1.51	0.006	0.05	6
	05/13/09	59.5	15.3	0.34	0.94	0.014	1.29	0.024	0.06	< 3

Red entries indicate failure to meet the applicable NJ Surface Water Quality Standard