WATER QUALITY IN LOANTAKA BROOK HEADWATERS

1. Introduction

Beginning in 1999, water quality monitoring of the major streams in the Great Swamp Watershed located in Morris and Somerset Counties, NJ has demonstrated that Loantaka Brook is the most impaired of those streams with respect to nutrient and suspended solids levels. In 2003, the Great Swamp Watershed Association (GSWA) initiated supplemental monitoring of the stream's headwaters to identify the major constituents of an anomalously high level of dissolved solids. GSWA's Adopt-a-Stream program enabled a more comprehensive monitoring effort to be mounted in 2005, including measurement of nutrient, suspended solids, and dissolved solids concentrations. This program is aimed at locating point and non-point sources of pollution impacting the stream. This memorandum reviews relevant background information relating to Loantaka Brook and summarizes the current status of the headwaters monitoring study.

2. Background

Water quality in the principal streams flowing in the Great Swamp watershed has been monitored since 1999 under the direction of the Ten Towns Great Swamp Watershed Management Committee, herein referred to as the Ten Towns Committee (TTC). Staff and volunteers from GSWA have participated extensively in this activity, including carrying out the collection and preparation of water samples for analysis by the commercial laboratories designated by the Ten Towns Committee. Water sampling has been, and continues to be, performed on the five major watershed streams: Black Brook, Loantaka Brook, Great Brook, Primrose Brook, and the Passaic River. The sites monitored are several miles from the streams' sources, and are located just prior to where each stream enters the Great Swamp National Wildlife Refuge. Within the Refuge, the five streams merge and a single waterbody, the Passaic River, flows through the watershed outlet, where a sixth sampling site is located. Samples are taken under baseline and storm flow conditions and are analyzed for the concentration of nutrients, specifically soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, nitrates-plus-nitrites, and total nitrogen, as well as total suspended solids.

In June 2002, a report[1] of the results of the monitoring up to that time was prepared for the Ten Towns Committee by F. X. Browne, Inc. of Lansdale, PA, the firm designated by the TTC to design the monitoring program and carry out the chemical analysis. One of the report's principal conclusions was that Loantaka Brook was the most impaired of the five watershed streams with respect to nutrient and suspended solids concentrations, especially under baseline conditions. For example, the charts in Figure 1, taken from the report, show the average total phosphorus and total nitrogen concentrations for 12 baseline samples taken at each of the six sampling sites during the 2-year period beginning in June 1999. The upper chart shows that the Loantaka

[1] Great Swamp Watershed Water Quality Monitoring Report, F. X. Browne, Inc. NJ1356-02, June 2002

Brook phosphorus concentration substantially exceeds that of the other watershed streams; it also exceeds the NJ surface water quality standard (NJSWQS) and the "EPA reference" (a nutrient criterion developed for the geographic region which includes the Great Swamp watershed) for that parameter. Similarly, total nitrogen concentration is significantly larger than that of the other streams. No NJSWQS has been established for this parameter, but the Loantaka Brook concentration is considerably higher than the EPA reference for total nitrogen.

Since the 2002 TTC report was issued, baseline and storm flow monitoring has continued and an additional 14 baseline samples have been collected through the end of 2005. No significant changes in the nutrient data from those covered in the 2002 report have been measured.

The results of monitoring the same watershed streams under storm flow conditions also show Loantaka Brook as having the highest nutrient levels. However, some of the other streams show substantial increases in concentrations of certain nutrients over their baseline levels; an example is Black Brook in which phosphorus and Kjeldahl nitrogen concentrations are comparable with the storm flow values of those parameters for Loantaka Brook.

Average Total Suspended Solids (TSS) baseline concentrations in all the monitored streams meet the NJ Quality Standards, but under storm flow conditions, several streams, including Loantaka Brook, fail these standards.

In late 2002, an unusually high level of Total Dissolved Solids (TDS) in the headwaters of Loantaka Brook was reported. TDS is principally a measure of the concentration of ionic constituents of dissolved inorganic salts; typical TDS constituents in surface waters include calcium, magnesium, sodium, potassium, sulfate, bicarbonate, nitrate and chloride ions. Typically, TDS is found in concentrations ranging from about 100 mg/l to 300 mg/l in unimpaired stream headwaters. The high TDS observations prompted GSWA to undertake a series of measurements on water samples taken from the main stem of Loantaka Brook near where it passes under Woodland Avenue in Morris Township. This site is much closer to the source of the stream than the TTC monitoring site, which is several miles further downstream, fairly close to where Loantaka Brook joins Great Brook. The Integrated Analytical Laboratories, LLC in Randolph, NJ, analyzed the samples taken from the Woodland Avenue site. Table I provides a summary of the results for the five samples taken, beginning on 03/28/03 and ending on 10/07/03. TDS values, obtained by evaporating the water sample and weighing the residue, averaged about 950 mg/l, with the highest value of 1684 mg/l being seen on 04/08/03.

To determine the major contributors to the high TDS, the concentrations of several likely constituent ions were also measured using a variety of analytical methods, and these results are also provided in Table I. The sum of the constituent ion concentrations should be comparable with the TDS value if all the major constituents are included. As shown in Table I, the April, May and July sum-of-constituents results amounted to only about 60% of the measured TDS. The consistently high chloride concentrations suggested that sodium and potassium should be included in future measurements; this was done for the 10/07/03 sample and the resulting sum-of-constituents was about 95% of TDS, with the sodium content providing the most significant addition to the total. The fact that the sodium and chloride content accounted for over 70% of the measured TDS suggested the possibility of road salt contamination. The brook's source is

located near both a major highway (Route 124) and parking lots associated with apartment and office buildings. The headwater stream between the source and the Woodland Avenue crossing is slow moving and of low volume, limiting the degree to which contaminants can be flushed downstream. Although road salt use is limited to the winter months, salt may be retained for considerable periods in soils and leach slowly into the stream.

Although the 10/07/03 data indicated that the sum-of-constituents accounted for 95% of TDS, the bicarbonate ion, a common constituent of surface waters, was not included in this series of tests. A calculation of the concentration of total cation positive charge showed it to significantly exceed that of anion negative charge, also indicating that one or more additional anions, should be included in future TDS measurements, bicarbonate being an obvious choice.

3. 2005 Headwaters Monitoring Results

In 2005, supported by its Adopt-a-Stream program, GSWA initiated a comprehensive quarterly monitoring program at four sites in Loantaka Brook's headwaters. These sites are located at approximately half-mile intervals along the main stem of the stream between its source and the outflow from Kitchell Pond. The monitoring sites are designated LB6 (in Turtle Basin, a residential area), LB5 (at the Woodland Avenue crossing, where the 2003 TDS samples were taken), LB4 (just below the discharge from the Woodland Water Pollution Control Facility), and LB2 (just below the outlet from Kitchell Pond.) Figure 2 shows a map of the Loantaka Brook subwatershed showing these four sampling site locations, as well as that for LB1, the downstream TTC monitoring site. An aerial photo of the project location showing the sampling site locations as well as a listing of the geographic coordinates of each can be seen in Figure 3. All water samples were taken under baseline conditions, and samples were analyzed by Environmental Compliance Monitoring, Inc. in Hillsborough, NJ, to determine concentrations of the following parameters: TDS, calcium, magnesium, sodium, potassium, chloride, sulfate, nitrate, nitrite, alkalinity, soluble reactive phosphate, total phosphorus, Kjeldahl nitrogen, and TSS. Nitrate, nitrite and Kjeldahl nitrogen were all reported "as N", and the sum of the three was used for the total nitrogen concentration. The acquired data therefore includes both the nutrients and TSS, which are also monitored downstream under the TTC program, and the TDS and constituent ions, which were the focus of the 2003 headwaters monitoring. Measuring alkalinity enabled a determination of the bicarbonate concentration in solution, as well as the carbonate component[2] of TDS. The laboratory analytical data packages can be found in Attachment A.

3.1 TDS and its Components

Table II summarizes the TDS and constituent ion data acquired during 2005. The following points may be noted.

[2] Carbonates have low solubility in most surface waters, but by reacting with dissolved carbon dioxide and water can form bicarbonate ions, which have a much higher solubility. During a TDS measurement, water is evaporated, the chemical reaction is reversed and carbonates are formed as part of the residue.

1. TDS values are high and consistent with the high values observed in 2003 at the LB5 site.
2. Except for the August 9 results, the sum of constituents generally falls within about 10% of the measured TDS. This is reasonable in view of the analytical lab's measurement error of +/- 12%.
3. The sodium and chloride ions are dominant among the constituent ions, accounting for about 65% of the TDS, on average.
4. On each monitoring date, the LB6 and LB5 results are, with some exceptions, in reasonable agreement with each other, as are those for LB4 and LB2.
5. At each monitoring site, the TDS, sodium and chloride concentrations show a general trend downward through the course of the year, except on August 9 when a small increase in TDS is evident.
6. A significant difference in both TDS and several of the component ions is evident between samples taken above the outlet from the Woodland Water Pollution Control Facility (LB6 and LB5) and those from below it (LB4 and LB2). Notably, TDS, calcium, sodium and chloride levels are lower below this outlet than above it, whereas potassium, sulfate and nitrate levels are higher.

3.2 Nutrients and TSS

The 2005 nitrogen- and phosphorus-bearing nutrients and TSS concentrations are given in Table III.

1. At any particular monitoring site, the results obtained for February 7, May 9 and November 8 are quite similar and self-consistent. However, in most cases, the August 9 samples show significantly higher nutrient levels than those obtained on the other dates. This may arise from more nutrients being available during warm weather, and from especially low stream flow during the summer causing limited flushing and dilution.
2. Except for Kjeldahl nitrogen, all the measured nutrients are found in significantly higher concentrations below the Woodland Facility outlet than above it, again with especially high levels on August 9.
3. TSS results are well within the NJSWQS limit of 25 mg/l. However, these are baseline data and, as stated earlier, significantly higher TSS values have been recorded at the TTC monitoring site under storm flow conditions, frequently exceeding the NJSWQS requirement.

4. Comparison with other watershed streams

The US Geological Survey has conducted quarterly monitoring of two streams in the Great Swamp watershed in recent years[3]. The sites monitored are in headwaters reaches of Primrose Brook (in Jockey Hollow National Historic Park) and the Passaic River (at Tempe Wick Rd). Both of these reaches are substantially less impaired than Loantaka Brook, since they are faster-

[3] USGS Water Resources Data, New Jersey, Volume 3 Reports for Water Years 2000-2004.

moving streams in less-developed environments. Average TDS at these sites, reported by USGS, together with the average 2005 TDS data for Loantaka Brook at the four headwaters monitoring sites are as follows:

Stream	Monitoring site	Sampling years	No. of samples	Avg. TDS mg/l
USGS monitoring				
Primrose Brook	$40^0$46'17"N $74^0$34'12"W	2000 - 2004	20	90
Passaic River	$40^0$45'54"N $74^0$31'48"W	2001 - 2002	8	195
Adopt-a-Stream Loantaka B. headwaters monitoring				
Loantaka Brook	LB6	2005	4	1154
Loantaka Brook	LB5	2005	4	1014
Loantaka Brook	LB4	2005	4	646
Loantaka Brook	LB2	2005	4	651

In the USGS data, sodium and chloride ions constitute relatively smaller fractions of the TDS than found in the 2005 Loantaka Brook data, approximately 12% and 40% in the cases of Primrose Brook and Passaic River, respectively.

Average baseline nutrient levels measured at all watershed sampling sites over 6 years of monitoring under the TTC program are given in the following chart. Concentrations are in mg/l.

Stream or stream site	No. of Samples	Soluble Reactive P	Total Phosph.	Kjeldahl Nitrogen	Nitrates + Nitrites	Total Nitrogen
Black Brook	26	0.040	0.083	0.705	0.359	1.064
Loantaka Brook	26	0.145	0.205	0.691	5.725	6.415
Great Brook	27	0.024	0.058	0.557	0.723	1.259
Primrose Brook	26	0.020	0.039	0.349	0.471	0.806
Passaic River in	26	0.014	0.042	0.392	0.405	0.782
Passaic River out	25	0.044	0.111	0.791	0.251	1.031

Comparing the 2005 Loantaka Brook results given in Table III with the above chart indicates the following:

1. Upstream from the Woodland Facility outlet, the phosphorus-bearing nutrient concentrations found in the February 7, May 9 and November 8 samples are comparable with the averages found in the least-polluted watershed streams. This is also the case for Kjeldahl nitrogen, but nitrates-plus-nitrites, and the resulting total nitrogen, are of somewhat higher concentrations than are found in any of the other streams.
2. On August 9, substantially higher levels of all measured nutrients were seen at all 4 sites.
3. Downstream from the Woodland Facility outlet, Kjeldahl nitrogen concentration has risen only slightly, but all the other nutrient parameters are comparable with the significantly higher concentrations characteristic of the downstream Loantaka

Brook (LB1) averages. It is clear that soluble reactive phosphate and nitrates+nitrites emerging from the Woodland Facility contribute a major part of total phosphorus and nitrogen measured downstream.

5. Discussion

The Woodland Water Pollution Control Facility has reported total phosphorus concentrations in the effluent from its plant for several years. Total phosphorus ("as P") concentrations reported[4] from 2000 to 2005 have ranged from about 0.25 to 0.9 mg/l. Nitrates ("as N") were reported for a 2-year period ending in July 2005, with concentrations ranging from 9 to 16 mg/l. GSWA's 2005 results at the LB4 site immediately downstream from the Woodland Facility are 0.21 to 1.2 mg/l for total phosphorus "as P" (Table III), and 3.2 to 13.8 mg/l for nitrates "as N" (Table II).

At the point where the effluent from the Woodland Facility flows into the principal stem of Loantaka Brook, the nutrient concentrations in the effluent would be expected to be reduced by dilution by the cleaner water. If, for example, the merging flow volumes were equal, the total phosphorus and nitrate levels in the effluent would be reduced by a factor of about two (2). Although a comparison of nutrient concentrations in the Facility effluent with data taken at the LB4 site is not quantitatively meaningful, since the data were taken on different dates, it seems evident that only a modest degree of dilution of the effluent by the cleaner water coming from upstream is taking place, perhaps by a factor of about 2 or 3, and by a substantially smaller amount on August 9.

Dilution is also a factor in the change in TDS seen below the Facility outlet. In this case the plant effluent contains less TDS than the main stream. These relative flow volumes are likely to fluctuate considerably, and more data is needed on the flows, and on the TDS concentration in the plant effluent, to more firmly quantify these water-mixing effects.

The NJ Surface Water Quality Standards for FW2-classified surface waters include an "aquatic life" requirement that total phosphorus (as P) not exceed 0.1 mg/l (or 0.05 mg/l where a tributary enters a lake, pond or reservoir). There is no corresponding nitrogen criterion, only a "human health" requirement that nitrate (as N) not exceed 10 mg/l. The US EPA reference levels for nitrogen, based on the 25th percentile of nutrient levels for streams in the ecoregion, which includes the Great Swamp Watershed, are 1.295 mg/l for total nitrogen (as N), 0.3 mg/l for Kjeldahl nitrogen (as N), and 0.995 mg/l for nitrates+nitrites (as N).

In 2002 the Ten Towns Committee issued a set of quality standards objectives for the major watershed streams[5], and its Loantaka Brook standards are provided at the bottom of Table III. The EPA references and the Ten Towns standards are somewhat more stringent than the NJSWQ Standards for phosphorus, and substantially more stringent for nitrates.

The Woodland Facility is required by the NJDEP to meet a number of criteria for the quality of the effluent water. The Facility reports data from regular evaluations of the effluent, some of

[4] Woodland Facility Discharge Monitoring Report
[5] Water Quality Standards for the Great Swamp Watershed, F. X. Browne, Inc., NJ1356-01, June 2002

which relate to phosphorus- and nitrogen-bearing nutrients. In addition to the total phosphorus and nitrate concentrations mentioned above, the reports include data on nitrogen in the form of ammonia. The State permit, which specifies the upper limits for the nutrient levels, was last renewed in 2003. The following are the limits set at that time for phosphorus and nitrogen concentrations:

Total Phosphorus (as P)	1.0 mg/l	Initial, Interim and Final Phases Jan-Dec Monthly Average
Total Phosphorus (as P)	Report mg/l	Initial, Interim and Final Phases Jan-Dec Weekly Average
Nitrogen, Ammonia (as N)	2 mg/l	All Phases, May-Oct Monthly Average
Nitrogen, Ammonia (as N)	3 mg/l	All Phases, May-Oct Weekly Average
Nitrogen, Ammonia (as N)	5 mg/l	All Phases, Nov-Apr Monthly Average
Nitrogen, Ammonia (as N)	10 mg/l	All Phases, Nov-Apr Weekly Average
Nitrate (as N)	Report mg/l	Initial Phase, Jan-Dec Monthly Average
Nitrate (as N)	Report mg/l	Initial Phase, Jan-Dec Weekly Average

In addition, not listed here, requirements were set on daily loading quantities of the same nutrients expressed as kilograms per day, consistent with the above limits. The Phases refer to intervals in the period covered by the permit, with "Initial" referring to the first two years.

Prior to the 2003 permit renewal, comments submitted, and responded to by NJDEP, included comments from Thomas Borden, Rutgers Environmental Law Clinic, presented on behalf of GSWA and the Sierra Club (NJ Chapter). Regarding the total phosphorus requirement, he argued that because of downstream impoundments, including the Great Swamp, a water quality-based effluent limitation of 0.1 mg/l should be required. NJDEP responded that the 1.0 mg/l limit would be retained until such time as Total Maximum Daily Load for phosphorus is apportioned among the various sources in the Passaic River Basin as a whole. Mr Borden argued that a water quality-based limit should also be required for nitrate. NJDEP's response stated that because of lack of data at the time, such a limit could not be considered until after the nitrate data collected during the permit's initial 2-year phase was available.

6. Concluding Comments

The high concentration of Total Dissolved Solids found in the Loantaka Brook headwaters is largely attributable to the presence in the stream of chloride and sodium ions. While it seems likely that road salt used on nearby highways and parking areas could be responsible, more seasonal data is desirable to verify this. The TDS concentration downstream from the Woodland Facility remains high but is reduced as a result of dilution from the effluent. Of the other major constituent ions, some also show a decrease in concentration below the Facility outlet, but others (specifically potassium, sulfate and nitrate) show an increase. More data on the TDS content of the effluent, as well as more information about the merging flow volumes, is needed to fully evaluate the role of the Facility discharge on the downstream TDS concentration.

Regarding nutrient levels, as detailed in Section 4, it is noteworthy that averaged over six years of nutrient monitoring, several of the watershed streams (Black Brook, Great Brook, Primrose Brook and Passaic River "in"), sampled under baseline conditions, not only meet the NJDEP Surface Water Quality Standards for total phosphorus (0.1 mg/l) and nitrates, but also the more stringent EPA reference criteria for nitrates and total nitrogen. (Note that this applies to overall averages, not necessarily to individual samples.) All streams fail to meet the EPA Kjeldahl nitrogen reference. GSWA's 2005 quarterly monitoring has shown that Loantaka Brook downstream from the Woodland Facility outlet fails to meet any of these standards except for the NJSWQS human-health-based nitrate standard of 10 mg/l. Upstream from the Facility outlet, except on August 9, the nutrient levels meet, or come close to meeting, both the Ten Towns Loantaka Brook Standards and the NJSWQ Standards. Below the Facility outlet, the nutrients fail to meet most standards except the NJSWQ "human-health" nitrate standard, and on August 9 at LB4 they even fail to meet that.

According to the Facility's published data, effluent concentrations range from 0.25 to 0.9 mg/l for total phosphorus and 9 to 16 mg/l for nitrates. The headwaters monitoring data taken both above and below the Woodland Facility discharge outlet, as well as the Facility's effluent data, indicate that the effluent is a significant contributor of nitrates and phosphates to a stream having low flow volume and offering minimal dilution of the effluent. During summer months or periods of drought, very low flows make the stream even more vulnerable. More stringent water-quality-based limits on the concentrations of nitrogen- and phosphorus-bearing nutrients are needed to achieve NJ Surface Water Quality (FW2) and Ten Towns Standards in Loantaka Brook.

Figure B1: Baseflow Total Phosphorus Concentrations

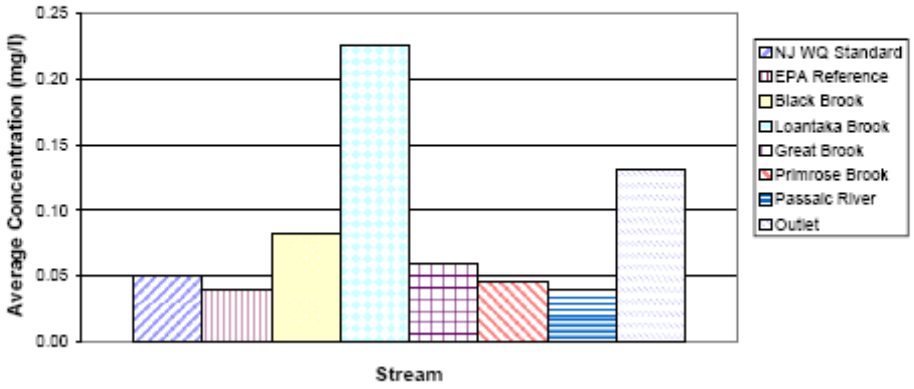
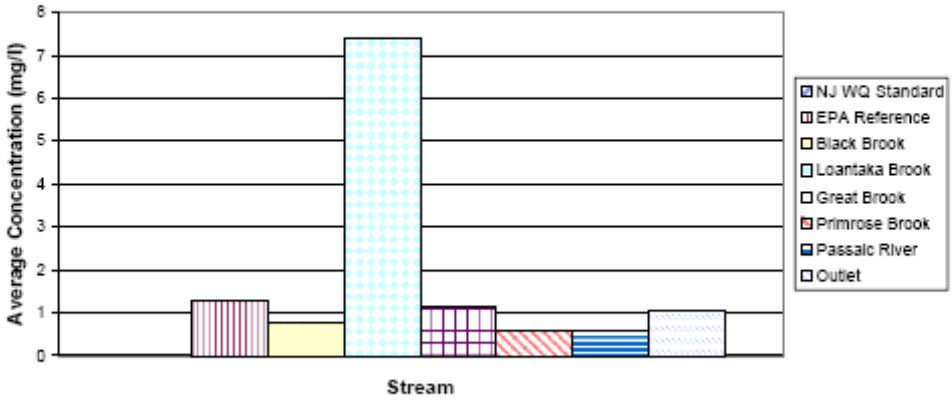


Figure B5: Baseflow Total Nitrogen Concentrations



There is no New Jersey Water Quality Standard for this parameter.

Figure 1. Great Swamp Watershed streams
Baseflow Total Phosphorus and Total Nitrogen
1999 to 2001 Average Concentrations

From Great Swamp Watershed Water Quality Monitoring Report, Ten Towns Committee, June 2002

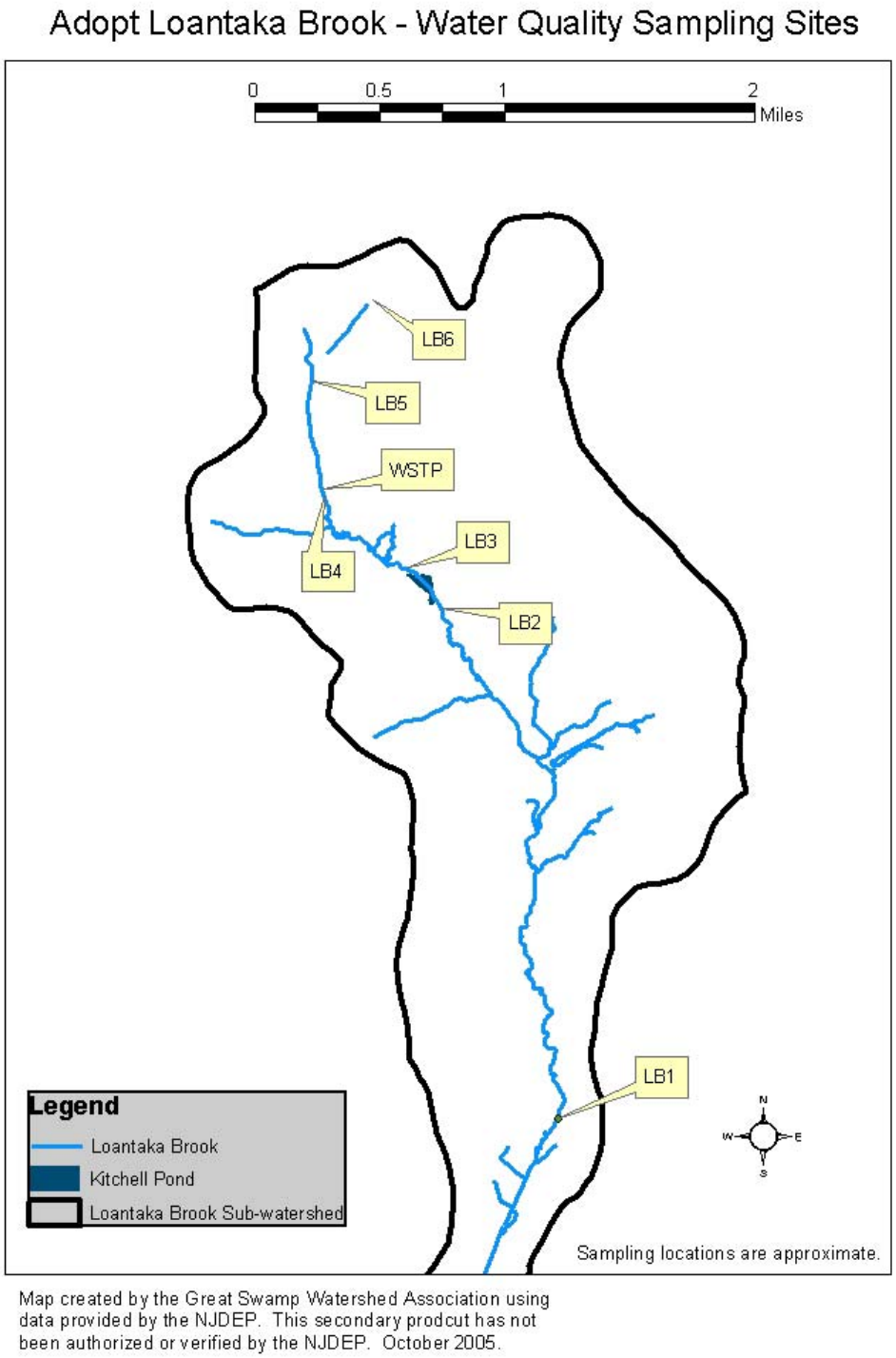
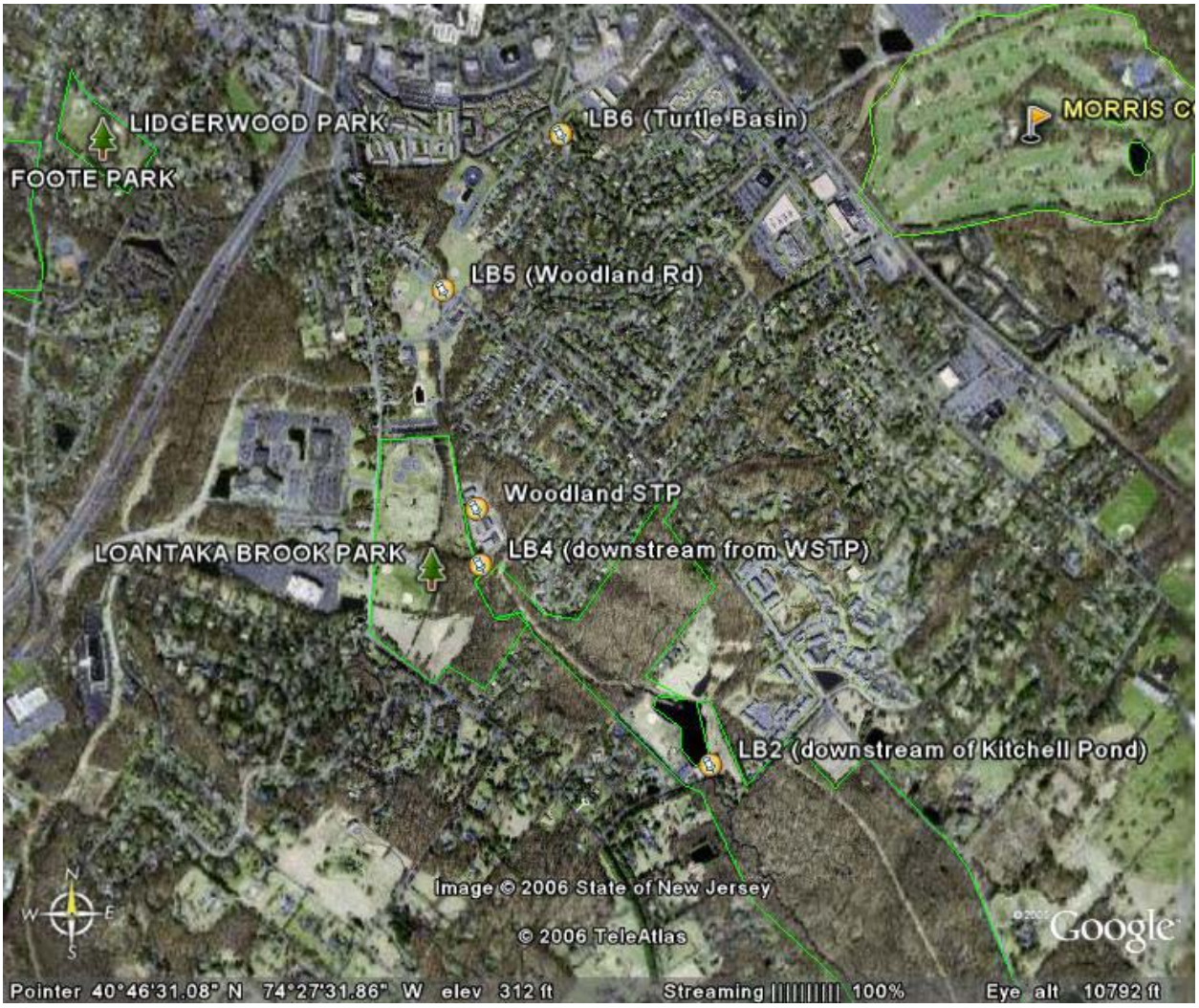


Figure 2. Map of Loantaka subwatershed showing sampling sites



Site	Description	Latitude	Longitude
LB2	downstream from Kitchell Pond	40°46'5.01"	74°27'17.60"
LB4	downstream from WSTP	40°46'25.06"	74°27'47.91"
WSTP	Woodland Treatment Plant	40°46'30.66"	74°27'48.45"
LB5	Woodland Rd	40°46'52.50"	74°27'52.79"
LB6	Turtle Basin	40°47'7.97"	74°27'37.24"

Figure 3. Aerial Photo of Loantaka Brook showing sampling sites

Sampling Date	TDS (Residue)	Nitrate plus Nitrite (as N)	Calcium	Magnesium	Sodium	Potassium	Iron	Chloride	Ortho-phosphate	Sulfate	Nitrate plus Nitrite (as NO3)	Sum of Constituents mg/l	Sum of Constituents % of TDS
3/28/2003	620							200				200	32.3%
4/8/2003	1684		71.8	16.3				944	0.8	29.2		1062.1	63.1%
5/13/2003	844		99	24.3				314	0.3	40.1		477.7	56.6%
7/15/2003	892		100	32.7				371	ND	45.4		549.1	61.6%
10/7/2003	745	1.97	104	31	162	3.92	0.98	368	ND	34.6	8.72	713.2	95.7%

Note: Blank cells indicate no measurement was taken
ND = Not detected
On 10/7/2003, analysis was made for arsenic and mercury, but neither was detected.

Table I. TDS and Constituent Ion Concentration in milligrams/liter

Loantaka Brook at Woodland Avenue, 2003

Sampling Site	Sampling Date	TDS (Residue)	Alkalinity as $CaCO_3$	Nitrate as N	Nitrite as N	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulfate	Carbonate (from Alk)	Nitrate as NO_3	Nitrite as NO_2	Sum of Constituents mg/l	Sum of Constituents % of TDS
LB6	02/07/05	1270	134	0.65	0.015	90	26	360	6.1	549	30.1	80.3	2.88	0.05	1144	90.1%
	05/09/05	1110	212	0.27	0.015	93	26	260	5.6	577	24.0	127.1	1.20	0.05	1114	100.4%
	08/09/05	1289	250	3.4	0.021	121	33.7	241	6.11	441	1.2	149.9	15.05	0.07	1009	78.3%
	11/08/05	945	213	0.48	0.003	99.8	27.4	198	5.96	480	9.0	127.7	2.12	0.01	950	100.5%
LB5	02/07/05	1200	135	2.1	0.016	96	27	290	4.4	559	36.0	80.9	9.30	0.05	1103	91.9%
	05/09/05	888	151	1.8	0.033	89	28	210	4.0	404	38.0	90.5	7.97	0.11	872	98.2%
	08/09/05	1095	184	1.4	0.027	100	31.6	212	4.73	280	46.0	110.3	6.20	0.09	791	72.2%
	11/08/05	873	183	1.2	0.035	97.2	27.8	171	4.73	420	42.0	109.7	5.31	0.11	878	100.6%
LB4	02/07/05	750	113	5.2	0.129	62	21	170	9.2	343	68.0	67.8	23.02	0.42	764	101.9%
	05/09/05	608	125	3.2	0.047	58	22	140	11	221	78.0	74.9	14.17	0.15	619	101.9%
	08/09/05	677	146	13.8	0.042	62.6	23.4	141	11.7	195	79.0	87.5	61.09	0.14	661	97.7%
	11/08/05	547	87	10.1	0.028	51.2	16.5	121	10.5	220	70.0	52.2	44.71	0.09	586	107.2%
LB2	02/07/05	750	107	4.5	0.07	63	21	200	7.5	412	55.8	64.2	19.92	0.23	844	112.5%
	05/09/05	622	117	3.0	0.07	48	18	110	7.4	288	72.0	70.1	13.28	0.23	627	100.8%
	08/09/05	707	140	3.5	0.162	56.4	20.6	134	10.2	169	78.0	83.9	15.49	0.53	568	80.4%
	11/08/05	525	112	5.3	0.056	49.2	15.9	104	7.98	200	60.0	67.2	23.46	0.18	528	100.5%

LB6 Turtle Basin
LB5 Woodland Avenue
LB4 Below Woodland Facility Outlet
LB2 Below Kitchell Pond

Note: The carbonate contribution to TDS was derived from the alkalinity measurement, assuming that in solution the bicarbonate ion is the predominant contributor to alkalinity. During evaporation, the bicarbonate dissociates and carbonate forms part of the residue.

Table II. TDS and Constituent Ion Concentrations in milligrams/liter
Loantaka Brook Headwaters, 2005

Sampling Site	Sampling Date	Total Kjeldahl Nitrogen "as N"	Nitrates "as N"	Nitrites "as N"	Total Nitrogen "as N"	Soluble Reactive Phosphate "as P"	Total Phosphorus "as P"	Total Suspended Solids
LB6 (Turtle Basin)	02/07/05	0.28	0.65	0.015	0.95	< 0.003	0.06	< 3
	05/09/05	0.47	0.27	0.015	0.76	< 0.003	0.06	4
	08/09/05	1.40	3.4	0.021	4.82	0.006	0.38	21
	11/06/05	0.26	0.48	0.003	0.74	<0.002	0.19	**7**
LB5 (Woodland Avenue)	02/07/05	0.28	2.1	0.016	2.40	0.004	0.03	3
	05/09/05	0.55	1.8	0.033	2.38	0.003	< 0.01	< 3
	08/09/05	1.40	1.4	0.027	2.83	0.015	0.03	22
	11/06/05	0.47	1.2	0.035	1.71	0.008	0.01	**3**
LB4 (Below Woodland Facility)	02/07/05	0.37	5.2	0.129	5.70	0.208	0.29	4
	05/09/05	0.68	3.2	0.047	3.93	0.20	0.25	< 3
	08/09/05	1.70	13.8	0.042	15.54	1.1	1.2	7
	11/06/05	0.52	10.1	0.028	10.64	0.134	0.21	**< 3**
LB2 (Below Kitchell Pond)	02/07/05	0.47	4.5	0.07	5.04	0.085	0.18	9
	05/09/05	0.49	3.0	0.07	3.56	0.16	0.24	< 3
	08/09/05	1.70	3.5	0.162	5.36	0.2	0.28	11
	11/06/05	0.52	5.3	0.056	5.88	0.09	0.13	**< 3**

LB1 (Green Village Road)			(Nitrates + nitrites)				
Ten Towns Monitoring 1999 - 2005	Average	0.65	5.77	6.42	0.15	0.21	10.1
	Range	0.21 - 1.30	1.96 - 8.89	2.53 - 9.41	0.02 - 0.48	0.11 - 0.53	1.2 - 44
Ten Towns 2002 Loantaka Brook Standards		0.4	2.0	2.40	0.02	0.05	4

Table III. N- and P-Bearing Nutrients in milligrams/liter
Loantaka Brook Headwaters, 2005

ATTACHMENT A

LABORATORY DATA PACKAGES

1. February 7, 2005 Sampling Report
2. May 9, 2005 Sampling Report
3. August 9, 2005 Sampling Report
4. November 8, 2005 Sampling Report