WATER QUALITY IN LOANTAKA BROOK
2005–2007 Monitoring Results

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1. Introduction

The Great Swamp Watershed Association (GSWA), under its Adopt-a-Stream program[1], conducted quarterly water quality monitoring at several sites in Loantaka Brook during the years 2005 - 2007. Results obtained during the first two years of the program were summarized in a report[2] submitted to the New Jersey Department of Environmental Protection (NJDEP) in April 2007. The following were the principal findings:

- The stream contains high levels of Total Dissolved Solids (TDS), and nitrogen- and phosphorus-bearing nutrients.

- Sodium and chloride are the dominant constituents of TDS. Both of these contaminants can impair the development of many aquatic plants and animals, with consequent reduction in species diversity.

- Sodium, chloride and TDS concentrations are highest in the upper reaches of the stream's headwaters, namely upstream from Morris Township's Woodland Wastewater Pollution Control Facility (WPCU). In this region near its sources, the low-velocity, low-volume brook is vulnerable to contamination by deicing salts deposited on nearby roads and parking lots.

- Downstream from the point where the WPCU discharges into the stream, TDS concentrations are somewhat lower than seen in the upper reaches. A single sampling of the plant effluent contained a relatively high content of TDS, sodium and chloride, although at concentrations less than found at sites located upstream from the plant discharge.

- Nitrogen and phosphorus-bearing nutrients are found at higher levels downstream from the WPCU discharge than upstream. Total nitrogen and phosphorus concentrations significantly exceed the Ten Towns Great Swamp Watershed Management Committee's (TTC) water quality standards[3] for Loantaka Brook. Elevated nutrient levels can cause excessive aquatic plant growth and accelerated eutrophication downstream. In fact, this has been observed on several occasions in the Kitchell Pond area of Loantaka Brook Reservation (a Morris County Park).

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

[2] Water Quality In Loantaka Brook Headwaters 2005–2006 Monitoring Results
Roger Edwards, *Volunteer* and Kelley Curran, *Director of Water Quality Programs*
Great Swamp Watershed Association Stream Team, April 2007

[3] Water Quality Standards for the Great Swamp Watershed, Ten Towns Great Swamp Watershed Management Committee, Prepared by F. X. Browne, Inc., June 2002

2. 2007 Quarterly Sampling Program

Some changes were made in 2007 to the number of sites sampled and the chemical and physical parameters monitored in order to obtain more comprehensive information about the stream's properties. The following are some of the 2007 program features.

- Laboratory analysis was limited to TDS, sodium, chloride, soluble reactive phosphate, total phosphorus, nitrate, nitrite, total Kjeldahl nitrogen and total suspended solids (TSS). All samples were submitted to Environmental Compliance Monitoring, Inc. (ECM) in Hillsborough for analysis. ECM is an NJDEP-certified laboratory. Copies of the laboratory data packages can be found in Attachments 1 through 4.

- Stream samples for laboratory analysis were collected quarterly at the following sites, listed in downstream to upstream order:

LB1	Green Village Road
LB2	Kitchell Road
LB4	Approximately 600 ft downstream from WPCU discharge
LB4P	The WPCU effluent immediately before it enters the stream
LB4S	Adjacent to Ginty Memorial Swimming Pool, Morris Township, upstream from the WPCU discharge
LB5A	Approximately 400 ft upstream from Woodland Avenue bridge

  With the exception of LB4P, all of these sites are located on the main stem of Loantaka Brook, with the most upstream site, LB5A, estimated to be 0.13 miles south of the main source near the Parson's Village apartments on South Street in Morristown; the most downstream site, LB1, is located at the Green Village Road crossing, approximately 4.2 miles from the source and upstream from where the stream flows into the Great Swamp National Wildlife Refuge. Figure 1 contains a map showing the locations of these sites. Figure 2 contains an aerial photo indicating the site locations as well as their geographic coordinates. Figure 3 lists these sites together with other sites referred to in this report, and their distances from the source of the brook's main stem.

- Samples were collected on February 22, May 8, August 21 and November 12. On each of these dates, stream flow rates were determined at sites LB4 and LB4S using the Volunteer Stream Monitoring Partnership protocol. Copies of the completed flow data sheets can be found in Attachment 5.

- 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, turbidity, dissolved oxygen and conductivity. A third estimate of TDS was derived from the conductivity readings. These meter measurements were made on most sampling occasions at all the above sites in addition to a seventh site, LB6, located on a small tributary at the outlet of Turtle Basin (see Figures 1 and 2). Turtle Basin is a detention basin that receives water from Route 124, commercial parking lots, and a condominium development.

- With the exception of the August 21 sampling, all collections were taken under baseflow conditions, as had been the case in all of the 2005 – 2006 collections. On August 21, 2007, sampling was intentionally conducted during a rainstorm event, to compare flow volumes and contaminant levels with those obtained during baseflow conditions.

Copies of the chain of custody reports, field sampling data sheets, and meter calibration logs can be found in Attachments 6, 7, and 8, respectively.

3. 2007 Results

Table I summarizes the TDS, sodium, and chloride concentrations determined by laboratory analysis, together with the Horiba and Oakton meter field measurements. In addition, the table includes stream flow volumes measured at the sampling sites immediately upstream and downstream from the WPCU discharge. Table II shows the laboratory results for nitrogen and phosphorus-bearing nutrients and TSS. Later in this report, some of the chemical data are presented graphically to clarify certain inferences that can be drawn from these results.

3.1 Flow Volumes

The flow volumes under baseflow conditions (February, May and November 2007 measurements) support the argument made in our earlier reports that the low flow volume from upstream normally provides very little dilution of the WPCU discharge. The flow volumes at LB4S and LB4 of approximately 0.5 and 3.5 ft^3/sec respectively imply that about 3.0 ft^3/sec [equivalent to 1.9 million gallons per day (MGD)] were entering the stream between the two sites, which are separated by several hundred yards. Shallow groundwater drainage would be expected to contribute some of this inflow; the daily average volume of the WPCU discharge during 2007, as reported by the plant, was approximately 1.1 MGD, but because of differences between daytime and nighttime flow[4], the discharge rate at the time of these baseflow measurements would have been closer to 1.5 MGD. It is fair to say that the WPCU discharge was contributing the bulk of the downstream flow at the time the flow measurements were made.

[4] Woodland WPCU Plant Foreman, Joe Morrison, Personal Communication

Flow volumes in the stream were substantially higher during the August 21 storm event. At the time of our flow measurements on that occasion, the LB4S and LB4 volumes were approximately 14 and 34 ft^3/sec respectively, so that approximately 20 ft^3/sec was entering the stream between the sites. The measurements were taken during the first few hours of the storm, and it is considered unlikely that any infiltration of storm water into the WPCU influent would have had time to pass through the plant and contribute to the discharge, so it is probable that most of the additional flow came from surface runoff and contributions through storm drains.

3.2 Total Dissolved Solids

The TDS concentrations determined by the laboratory are plotted in Figure 4 as a function of distance from the main source of Loantaka Brook near the Parson's Village apartments. The baseflow samples collected in February, May and November contained elevated levels of TDS, exceeding the New Jersey Surface Water Quality Standard[5] (NJ SWQS) of 500 milligrams per liter (mg/l) in almost all cases. As would be expected from the flow volume discussion above, the stream segment upstream from the WPCU effluent entry point has been found to have different chemical content from the downstream segment. On each baseflow sampling date, the TDS concentrations upstream from the WPCU exceeded 800 mg/l and were higher than those in both the effluent and the downstream segment. The TDS values in the effluent were consistently in the 600 to 750 mg/l range, and downstream from the point where the discharge joins the stream, only relatively minor changes in TDS concentrations were observed. A possible cause for the rise in TDS concentrations seen on February 22 downstream of the discharge entry point will be discussed later in this report.

The August 2007 samples were taken under stormflow conditions and are discussed in Section 3.5 below.

3.3 Baseflow Measurements of Sodium and Chloride

Earlier work in this program, documented in the April 2007 report[2], established that high concentrations of sodium and chloride ions were the major contributors to the elevated TDS levels in Loantaka Brook, and that rock salt used for deicing local roads and parking lots was the probable source of this contamination in the low-flow volume upper headwaters of the stream. Road salt is used only in winter, but it can be retained in soils, slowly leaching into shallow groundwater and seeping into the stream throughout the year. At times of unusually low natural water flow, the diminished amount of dilution can lead to higher than normal sodium and chloride concentrations.

The results of our 2007 baseflow monitoring of sodium and chloride are presented graphically in Figures 5a-c. The data for the three sample sets are shown separately for clarity. The general pattern of the sodium and chloride data is clearly qualitatively similar to that of the TDS data discussed above. The NJ SWQS do not include a sodium criterion, but the Chronic Toxicity Standard for chloride of 230 mg/l is frequently exceeded. In fact, this standard is substantially

[5] Surface Water Quality Standards, NJDEP, October 2006

exceeded in the upper headwaters segment, upstream from the WPCU discharge. One of the February 22 samples, taken following a period of heavy road salt use, also exceeded the NJ Acute Toxicity Standard of 850 mg/l for chloride.

Sodium and chloride concentrations in the WPCU effluent were lower than those measured upstream, but remained relatively high, 100 to 150 mg/l for sodium, and 200 to 250 mg/l for chloride. It seems unlikely that enough deicing agents would infiltrate the wastewater passing through the WPCU to account for this. Potential salt sources might include brine flushed from water softeners, laundry detergent, bleaches, and other household cleaning materials passing through the plant.

Since under normal baseflow conditions, the WPCU discharge provides significantly higher flow volume than the water from upstream with which it mixes, the chemical content of the effluent largely determines the chemical properties of the water flowing downstream. In this principal segment of the brook, the May and November results showed a gradual decrease with flow distance in sodium and chloride concentrations, expected if shallow groundwater draining into the stream provided a degree of progressive dilution by cleaner water. On February 22, both the sodium and the chloride values showed a slight increase downstream from the WPCU, similar to that mentioned above for TDS, which would be consistent with the diluting water, coming both from upstream and additional drainage downstream, containing larger amounts of deicing materials on this date.

The sodium and chloride levels determined for the August 21 storm samples will be discussed later.

3.4 Baseflow Measurements of Nitrogen- and Phosphorus-bearing Nutrients

The 2007 baseflow data for nitrate-N and total nitrogen-N are plotted in Figures 6a-c. Total nitrogen was obtained by summing nitrate-N, nitrite-N and Kjeldahl nitrogen. In contrast to TDS, sodium and chloride results, the nitrogen levels were lowest in the upper headwaters segment and highest in the WPCU effluent. Downstream from the WPCU discharge, the N-bearing nutrient concentrations fell off with flow distance as less-contaminated water drained into the stream or as a result of nitrate uptake by algae or plants[6]. The NJ SWQS do not specify a total nitrogen standard, only a human health standard for nitrates of 10 mg/l. On two out of the three sampling dates nitrates failed to meet this standard in the WPCU effluent and at the LB4 site just downstream from the discharge.

Figures 7a-c show the corresponding baseflow results for soluble reactive phosphate and total phosphorus. Again, the lowest concentrations were seen in the upper headwaters. The downstream pattern of the February and May data was also similar to the nitrogen pattern, with the highest phosphorus levels being observed in the WPCU effluent. An exception to this pattern appeared on November 12, when the Kitchell Road (1.5 miles downstream from the source) sample had a higher concentration than the effluent. The graphs include the NJ Surface Water

[6] Discussed further in Section 4.2

Quality Standard for total phosphorus of 0.1 mg/l, which was exceeded in several of the 2007 samples. Further comment on the baseflow phosphorus results is given later in Section 4.2.

3.5 Stormflow Measurements of TDS, Sodium, Chloride and Nutrients

The concentrations of TDS, sodium, chloride, and N- and P-nutrients, sampled during storm conditions on August 21, 2007, are provided in Figures 8 through 11. The concentrations of all these solutes in the WPCU effluent were similar to the baseflow values, as expected. With the exception of the phosphorus-bearing nutrients, the concentrations observed in all of the samples were not only less than those in the effluent but also less than the corresponding NJ SWQS. These results reflect the strong dilution provided by the stormwater, especially in the upper headwaters and immediately downstream from the WPCU discharge. Further downstream, TDS levels were closer to the baseflow concentrations; this might result from the presence of Kitchell Pond, with its inlet at about 1.4 miles from the source and its outlet immediately upstream from Kitchell Road at 1.5 miles. During a storm, the pond would not be immediately flushed out and would continue to feed its contents downstream for some time.

The phosphorus nutrients, plotted in Figure 11, showed a much different pattern. In the stream, total phosphorus levels tended to be higher than the baseflow values. In addition, concentrations downstream from the WPCU were higher than those measured in the effluent and also exceeded the NJ total-phosphorus standard. An increase in phosphorus nutrients in streams during and after a storm is not unusual. This is often attributed to phosphorus compounds bound to soil particles or plant roots entering the stream water under storm conditions through erosion of banks and disturbance of stream sediment. Stream monitoring performed during the period 1999 to 2005 by the Ten Towns Great Swamp Watershed Management Committee (TTC) and GSWA[7] demonstrated that in the four streams feeding into the Great Swamp National Wildlife Refuge (GSNWR), the average total phosphorus concentrations during storm conditions were at least twice as high as the average baseflow values. In Loantaka Brook at Green Village Road, for example, average total-phosphorus concentrations were about 0.21 and 0.45 mg/l for baseflow and stormflow samples respectively.

4. Overall 2005 – 2007 Perspective

The 2005 – 2006 monitoring results for Loantaka Brook have been previously reported[2], and two sets of data from that report are reproduced here in Table III (TDS and Constituent Ions) and Table IV (N- and P- Nutrients). During those two years, water samples were taken quarterly at the following sites, in downstream to upstream order:

LB2 Kitchell Road
LB4 Approximately 600 ft downstream from WPCU discharge
LB5 Woodland Avenue bridge
LB6 Outlet from Turtle Basin

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

The LB6 site is situated on the upper reaches of a small tributary, which originates near Route 124 and joins the main stem at a point approximately 300 ft upstream from LB5. During 2006, occasional additional samples were taken at LB5A, approximately 400 ft upstream from LB5, and at LB4P, the WPCU effluent. In 2007, sampling was discontinued at the Woodland Avenue bridge site LB5 and carried out instead at LB5A. Sampling at both sites in August 2006 had given very similar results, consistent with the fact that the flow from the Turtle Basin tributary, which joins the stream between these two sites, is normally very small. The choice of LB5A for 2007 sampling, rather than LB5, was part of the plan to comprehensively cover the full length of Loantaka Brook's main stem. In Figures 12 through 17, three years of data for the principal contaminants are plotted as a function of sampling date. For the purpose of these plots, the results obtained at the two Woodland Avenue sites, LB5 and LB5A, have been combined to represent the upper headwaters, the stream segment upstream from the WPCU discharge. The Kitchell Road results represent the downstream segment, south of the Kitchell Pond outlet. The plots also include the effluent data, which were collected only for the last five quarters of the program.

4.1 TDS, Sodium and Chloride

The TDS graph in Figure 12 illustrates that, except for the August 2007 storm sample, the stream consistently failed to meet the NJ TDS water quality standard of 500 mg/l at both the Woodland Avenue and Kitchell Road sites. As already discussed, the highest TDS concentrations were seen in the upper reaches of the stream. The concentration in the WPCU effluent was of similar magnitude to that measured downstream at Kitchell Pond; clearly the properties of the water emerging from the treatment plant usually determine the chemical content downstream, although there is evidence of occasional additional contamination. The plots of sodium and chloride concentrations, Figures 13 and 14, which together account for a substantial portion of the TDS, each show a pattern very much like that of the TDS. All three graphs show surges in February 2005 and February 2007, months when the stream could have been most vulnerable to road salt runoff supplementing the content of the effluent. On those occasions, chloride levels exceeded the NJ Chronic Toxicity standard in several of the downstream samples.

4.2 Total Nitrogen-N and Total Phosphorus-P

N- and P-nutrients (Figures 15-17), in contrast to TDS, sodium and chloride, were found to have their lowest concentrations in the upstream Woodland Avenue samples, and highest values downstream. The Kitchell Road total phosphorus levels were mostly about the same as the concentrations in the WPCU effluent, but the total nitrogen concentrations at the same site were appreciably lower than those observed in the effluent. Figure 15 shows a significant difference between the total nitrogen concentration in the WPCU effluent and that at Kitchell Road. In Figure 16, the total nitrogen measured at all sampling sites downstream from the WPCU discharge are included, showing that on most sampling dates the nitrogen nutrients were depleted progressively as they were transported downstream. The degree to which this depletion occurred was appreciably greater for nitrogen (dominated by nitrate ions) than for the other solutes

measured. The reason for this depletion is not currently known, but it might be associated at least in the warm season with nitrate uptake by plants or algae, or with denitrification. Very few aquatic plants are present in the faster-flowing segments of the stream, but abundant algae and plant growth is often evident during the summer in Kitchell Pond, located immediately upstream from Kitchell Road. Canada geese and other waterfowl that regularly frequent Kitchell Pond might also influence the algal and plant growth.

4.3 Other measured parameters

During 2005 and 2006, considerable effort was given to understanding the composition of the elevated levels of TDS. Table III gives the measured concentrations of several dissolved ionic components and their sum as a percentage of measured TDS. As was stated in the 2007 report[2], the finding that this sum in most cases was within 20% of measured TDS indicated that there were unlikely to be any unmonitored contributors to TDS at significant concentrations. The change in concentrations of TDS, sodium, chloride and nitrate at the point where the WPCU effluent joins the stream has been discussed above. It may also be noted that sulfate concentrations were found to be significantly higher in the downstream segment than in the headwaters. The use of aluminum sulfate in the WPCU's treatment processes to remove phosphorus from the effluent is likely to be at least partially responsible for this.

Tables II and IV include data for Total Suspended Solids (TSS) and water temperature. In almost all cases baseflow TSS values met the NJ standard of 40 mg/l, but frequently failed the 4 mg/l criterion adopted by the Ten Towns Committee in its 2002 objectives[3]. The highest value recorded was 167 mg/l, measured during storm flow at the LB1 site; the TTC stormflow standard for TSS is 40 mg/l. Water temperature measurements show that in the cooler months (February and November) the WPCU effluent temperature measured either directly (LB4P) or shortly after the effluent mixed with the stream water (LB4) was higher than at the other sites. The NJ SWQS for FW2-NT designated streams include a requirement for "no thermal alterations, which would cause temperatures to deviate more than 2.8°C at any time from ambient temperatures." This criterion also requires that temperatures must be measured outside the heat dissipation area, or mixing zone, where the discharge merges with the stream. If the LB4 sampling site, approximately 600 ft downstream from the discharge, is considered to fall outside the mixing zone, this criterion was not being met on the fall and winter dates when water temperatures were recorded.

As stated in Section 2, some additional parameters, pH, dissolved oxygen (DO) and conductivity were measured using a Horiba U-10 multi-parameter water quality meter during 2007. In addition, TDS was measured using an Oakton hand-held meter. These field data and the TDS values derived from conductivity values are included in Table I. In some cases the DO results exceeded the saturation solubility of oxygen in pure water at the recorded temperature. Although this can occur under certain conditions, for example when oxygen generated during photosynthesis becomes trapped in algae, or if the impure stream water has higher oxygen solubility than pure water, the possibility of measurement error cannot be ruled out. The meter measurements of TDS were in fair agreement with the laboratory results, indicating the usefulness of the meters for determining approximate TDS concentrations.

5. Other relevant data

The Ten Towns Committee has been monitoring streams in the Great Swamp Watershed, including Loantaka Brook[7] at the LB1 (Green Village Road) site, since 1999. Until 2005, this program focused on monitoring the principal nitrogen and phosphorus-bearing nutrients and TSS, under both baseflow and stormflow conditions. Recently, laboratory analysis for TDS and ammonia-N, and field measurements of water temperature, conductivity, dissolved oxygen and pH have been added to the program, which is currently carried out by the TTC's environmental consultant Princeton Hydro, LLC. In Princeton Hydro's interim reports[8] covering 2007, it was noted that Loantaka Brook continues to have the poorest quality of all the streams in the Great Swamp Watershed, with total phosphorus-P and TDS concentrations frequently failing to meet NJ state standards.

The United States Geological Survey (USGS) publishes results of its chemical sampling of numerous New Jersey water bodies in annual Water Data Reports. Beginning in October 2004, in collaboration with NJDEP, USGS conducted quarterly sampling of Loantaka Brook at a site near the northeast end of Blue Stone Terrace in Morris Township. This site, designated AN0220 as one of NJDEP's Ambient Biomonitoring Network locations, is approximately 1200 ft downstream from GSWA's LB4 location. The USGS monitored the stream at this site from October 2004 to August 2006; some of the published[9] data, pertaining to the TDS, constituent ions, N- and P- nutrients and TSS, are reproduced in Tables V and VI.

Although a rigorous comparison of the USGS and GSWA chemical results cannot be made, since the two sets of samples were collected on different dates and at different locations, examination of the USGS Table V data shows the concentrations of TDS and ionic constituents to generally agree with GSWA's 2005 – 2006 measurements at LB4 (Table III). Similar high values of TDS were seen, with sodium and chloride being the major constituents.

With respect to nutrients, nitrates and total-nitrogen concentrations reported by USGS (Table VI) and GSWA (Table IV) are also generally comparable in magnitude. The Woodland WPCU publishes its own data on the water quality of the plant effluent, and for the limited time period of August 2003 through July 2005, reported nitrate levels. During that period, nitrate-N concentrations ranged from 9.6 to 15.7 mg/l with a mean value of 12.5 mg/l, similar in magnitude to the 2005 – 2006 GSWA LB4 and USGS AN0220 measurements.

In the case of phosphates and total phosphorus concentrations, most of the quarterly USGS results were somewhat higher than those obtained by GSWA. Most USGS samplings showed total phosphorus-P to be in the 0.3 to 0.5 mg/l range, whereas GSWA's concentrations at LB4 rarely exceeded 0.3 mg/l. The WPCU also publishes[10] monthly average total phosphorus-P data for its discharge; these concentrations have averaged between 0.3 to 0.6 mg/l in recent years. The reason for the GSWA's somewhat lower concentrations is not known.

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[8] Stream Sampling in the Great Swamp Watershed, Interim Reports prepared by Princeton Hydro, LLC, April 2007, June 2007 and January 2008

[9] USGS Water Resources Data, New Jersey, Water-Data Reports NJ-05-3 and NJ-06-3

[10] Woodland WPCU NJPDES Discharge Monitoring Reports

6. Summary

Three years of quarterly monitoring of Loantaka Brook under baseflow conditions have demonstrated that two segments of the stream, both having serious water quality problems but for different reasons, can be defined. In the upper headwaters between the brook's sources and a point just upstream of where the WPCU discharge enters the stream, there is a very high level of Total Dissolved Solids, consistently exceeding the NJ Surface Water Quality Standard of 500 mg/l. The dominant contributors to TDS are sodium and chloride ions; the amount of chloride consistently exceeds the NJ Chronic Toxicity Standard of 230 mg/l, and on one occasion exceeded the NJ Acute Toxicity Standard of 850 mg/l. In this segment near its sources, the low-velocity, low-flow stream is vulnerable to contamination by deicing salts deposited on nearby roads and parking lots, and although these materials are used only in winter, their retention in soils and subsequent leaching into shallow groundwater leads to year-round contamination of the stream. Nitrogen and phosphorus nutrients in the main stem of this segment are usually of low concentration, comfortably meeting applicable NJ standards.

A different situation exists downstream from the point of entry of the WPCU effluent. Under normal baseflow conditions, the effluent flow rate is substantially larger than that from the upstream segment. The properties of the downstream segment therefore tend to be determined by the effluent properties, with regard to both flow volume and impurity content.

Nitrate and total nitrogen are found at higher levels downstream from the Woodland WPCU discharge than upstream. Immediately downstream from the plant discharge, nitrate-N concentrations often exceed the human-health based NJ Surface Water Quality Standard of 10 mg/l. The quantity of phosphate and total phosphorus in this segment is also mainly determined by the amount found in the WPCU effluent, with total phosphorus-P usually failing to meet the 0.1 mg/l NJ standard.

The effluent contains a relatively high content of TDS, sodium and chloride, although at concentrations somewhat lower than found upstream from the plant discharge. Salt may enter the influent to the plant in several ways, such as inadvertent infiltration of storm water that could sometimes contain deicing agents, discharge from water softeners, household detergents, bleaches and cleaning agents. Under baseflow conditions, TDS concentrations at the downstream sites fail to meet the 500 mg/l NJ standard most of the time. Sometimes, notably during winter when the downstream segment is vulnerable to road salt runoff supplementing the chloride content of the effluent, the NJ Chronic Toxicity standard for chloride can be exceeded.

During and immediately after significant rainstorms, strong dilution of the stream water substantially reduces the concentrations of TDS, sodium, chloride and the nitrogen nutrients at all sampling sites. Phosphorus nutrient levels, however, can increase during storms as a result of soil erosion transporting bound phosphorus compounds into the stream. A rise in TSS concentrations also often occurs under such conditions.

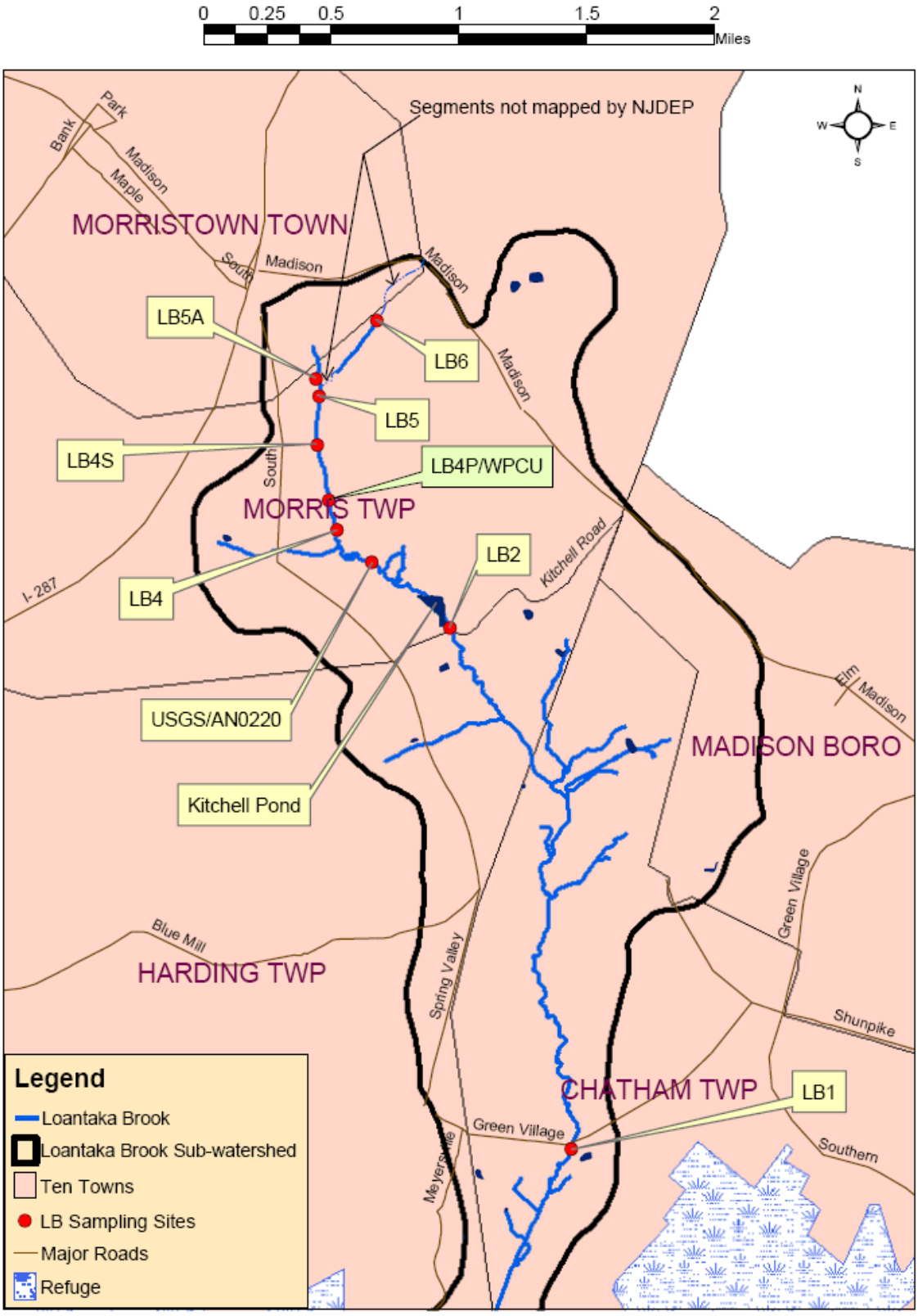
With the completion of the three-year program of monitoring Loantaka Brook, GSWA plans to discontinue quarterly sampling for laboratory analysis, and instead conduct periodic field testing,

using a conductivity meter to monitor TDS at most of the sites monitored during 2007. Should significant departures from recent monitoring history become apparent, additional tests may be initiated.

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, Ellen Drury, Terry Dyben and Al Pawlowski for their enthusiastic participation in this work, and to other Stream Team members for their valued comments and suggestions as the work progressed.

FIGURES



Map created by the Great Swamp Watershed Association using data provided by the NJDEP.
This secondary product has not been authorized or verified by the NJDEP. April 2008.

Figure 1. Adopt Loantaka Brook - Water Quality Sampling Sites

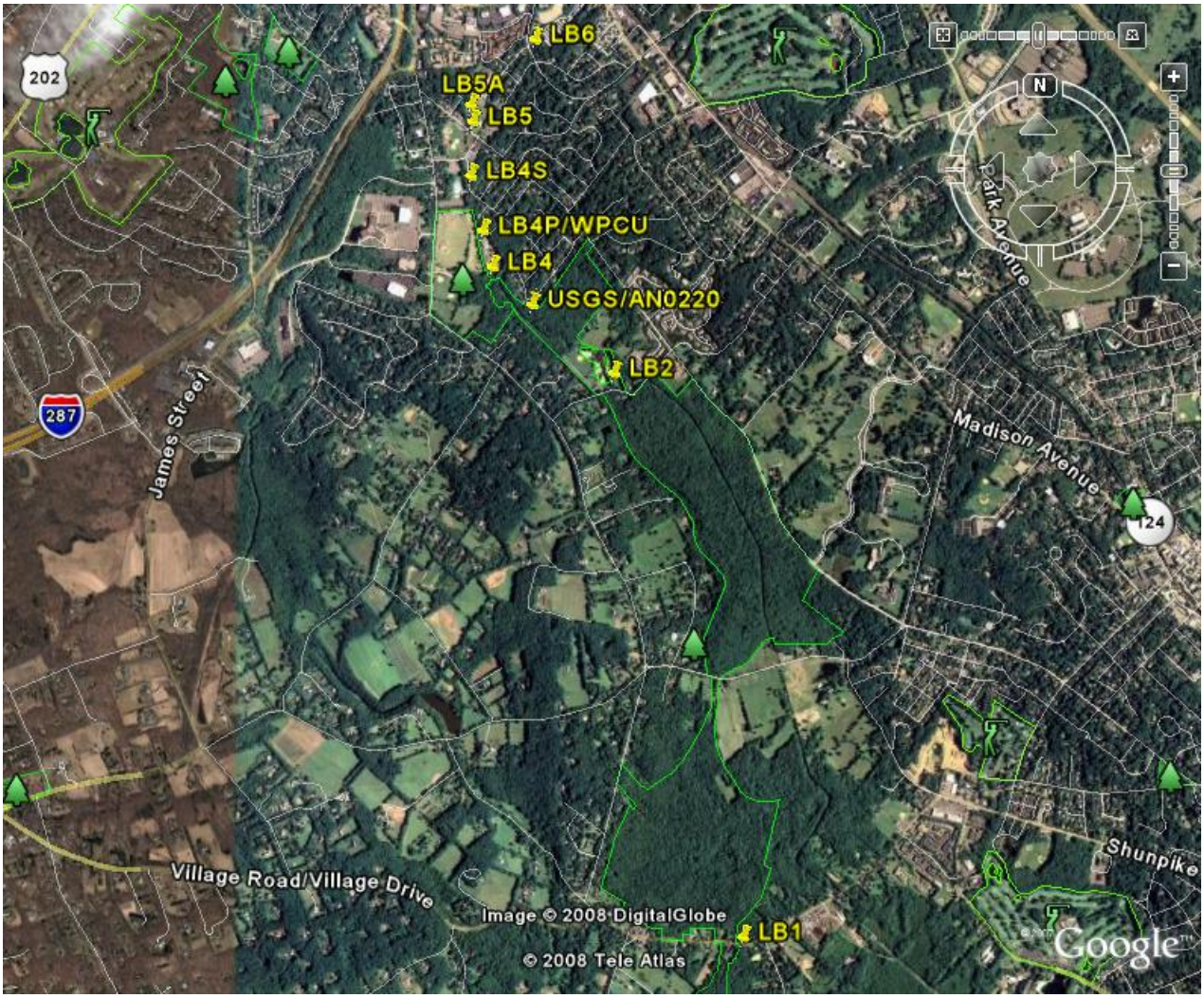


Figure 2. Aerial Photo of Loantaka Brook showing the Sampling Sites

Geographic Coordinates for Sampling Sites on Loantaka Brook
Source: Google Earth software

Site	Description	Latitude	Longitude
LB1	Green Village Road	40°44'18.31"	74°26'45.31"
LB2	Kitchell Pond outlet (Kitchell Road)	40°46'5.01"	74°27'17.60"
USGS/AN0200	USGS/NJDEP Sampling Site	40°46'18"	74°27'38"
LB4	Downstream from WPCU	40°46'25.06"	74°27'47.91"
LB4P	Woodland Water Pollution Control Utility (WPCU)	40°46'31.91"	74°27'50.23"
LB4S	Near Ginty Memorial Swimming Pool	40°46'42.28"	74°27'53.25"
LB5	Woodland Ave bridge (downstream)	40°46'52.50"	74°27'52.79"
LB5A	Upstream from Woodland Ave	40°46'55.61"	74°27'54.07"
LB6	Outlet of Turtle Basin	40°47'7.97"	74°27'37.24"

Designation	Location	Miles from Source (Approx.)
LB1	Green Village Road	4.2
LB2	Kitchell Pond Outlet (Kitchell Road)	1.5
USGS/AN0020	Near Blue Stone Terrace (USGS/NJDEP)	1.0
LB4	600 ft Downstream from WPCU Discharge	0.8
LB4P	WPCU Effluent Discharge	0.65
LB4S	Near Ginty Memorial Swimming Pool	0.4
LB5	Woodland Avenue bridge (downstream)	0.2
LB5A	300 ft Upstream from Woodland Avenue	0.13
LB6	Outlet of Turtle Basin	(NE Tributary)

Figure 3. Sampling Site Locations

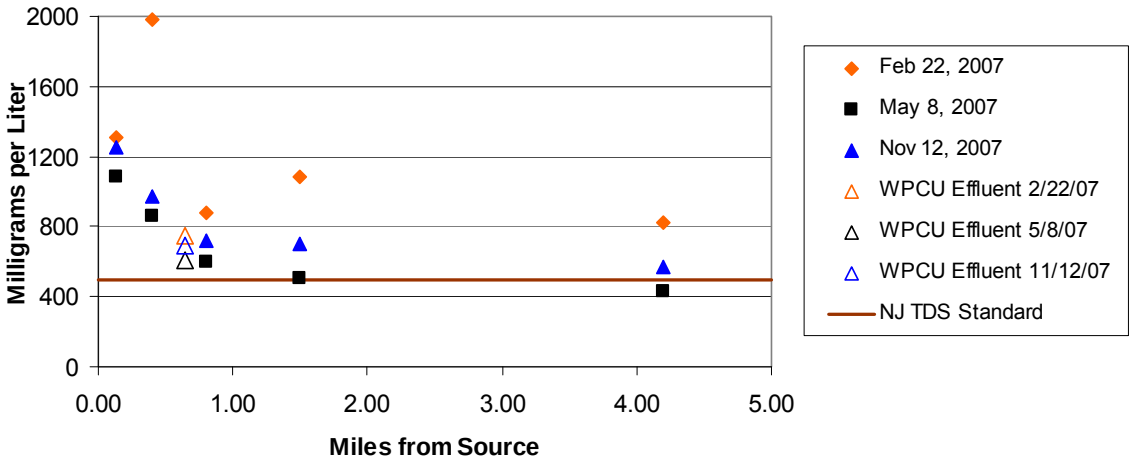


Figure 4. Total Dissolved Solids, Baseflow Conditions

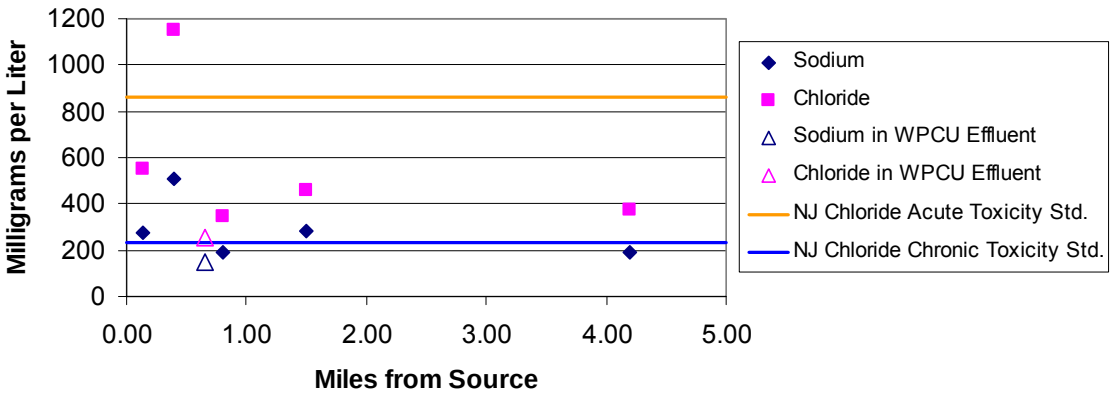


Figure 5a. Sodium and Chloride, Baseflow Conditions, February 22, 2007

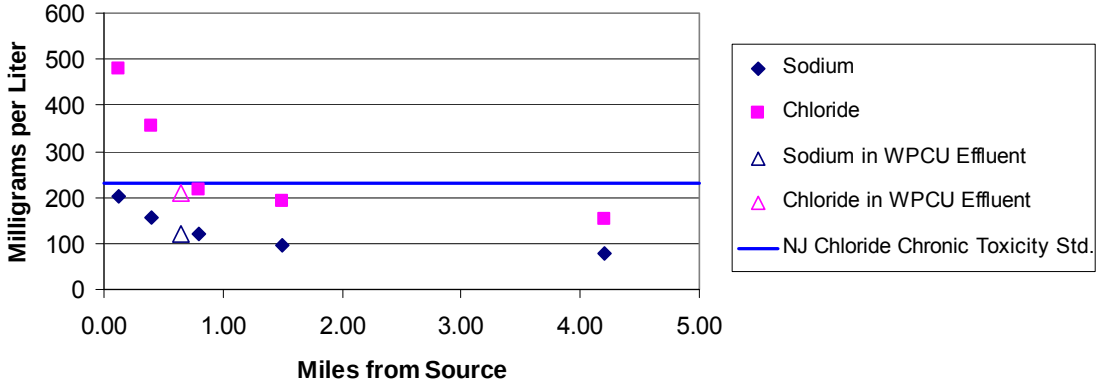


Figure 5b. Sodium and Chloride, Baseflow Conditions, May 8, 2007

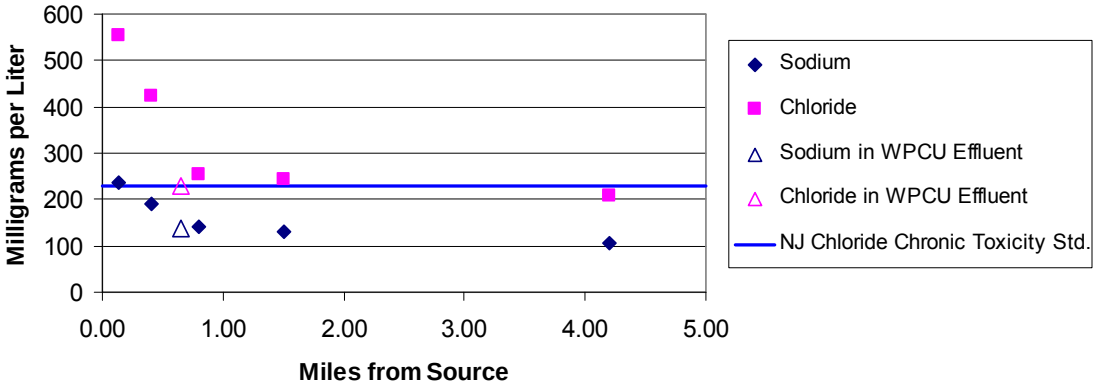


Figure 5c. Sodium and Chloride, Baseflow Conditions, November 12, 2007

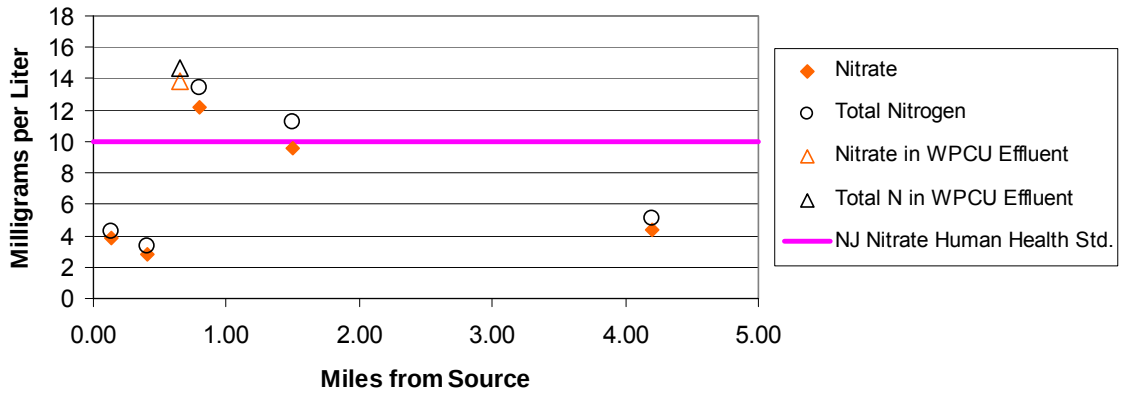


Figure 6a. Nitrate-N and Total nitrogen-N, Baseflow Conditions, February 22, 2007

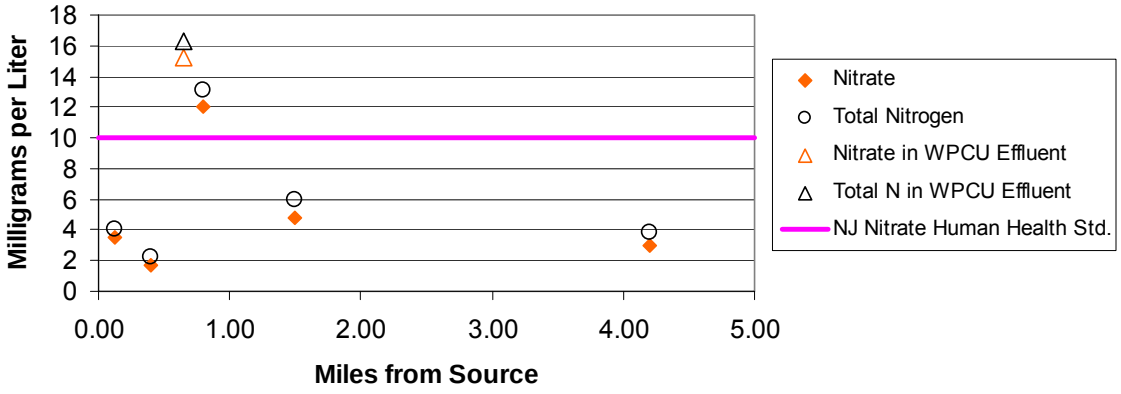


Figure 6b. Nitrate-N and Total nitrogen-N, Baseflow Conditions, May 8, 2007

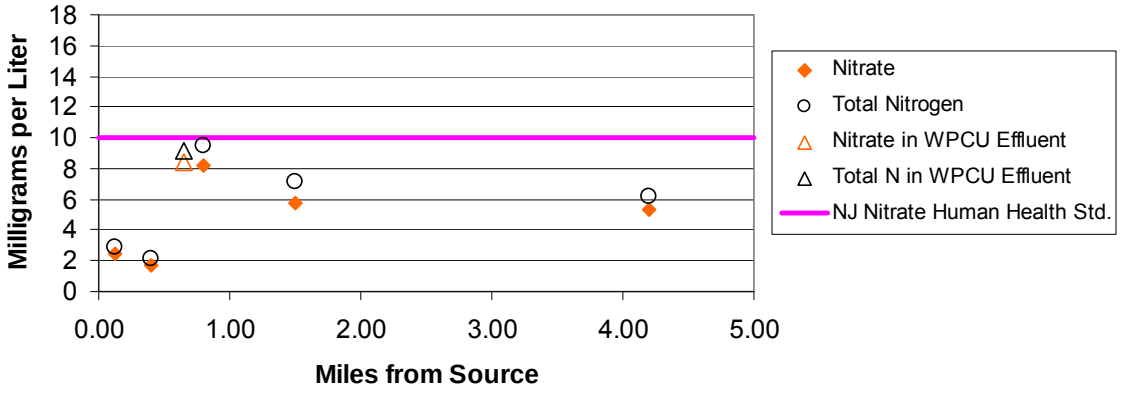


Figure 6c. Nitrate-N and Total nitrogen-N, Baseflow Conditions, November 12, 2007

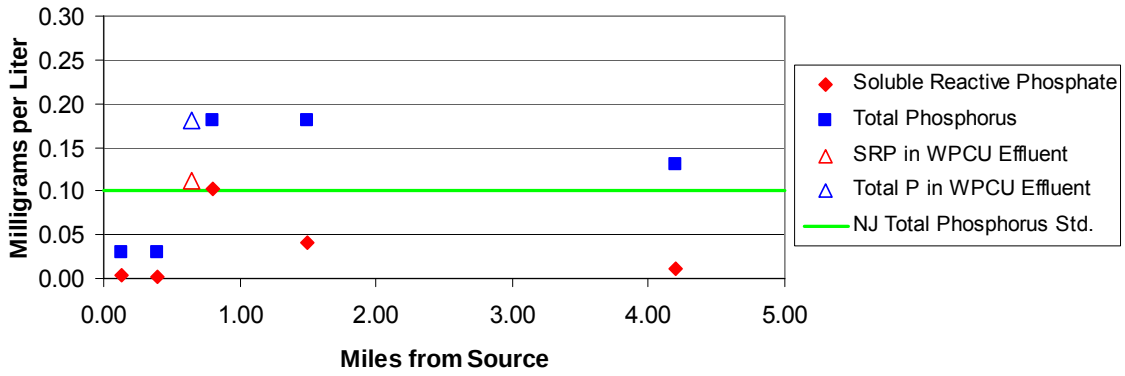


Figure 7a. Soluble Reactive Phosphate-P & Total Phosphorus-P, Baseflow Conditions, February 22, 2007

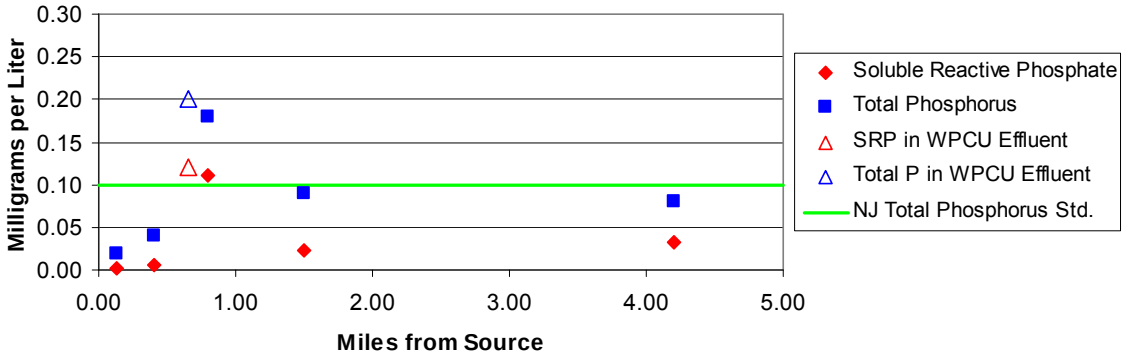


Figure 7b. Soluble Reactive Phosphate-P & Total Phosphorus-P, Baseflow Conditions, May 8, 2007

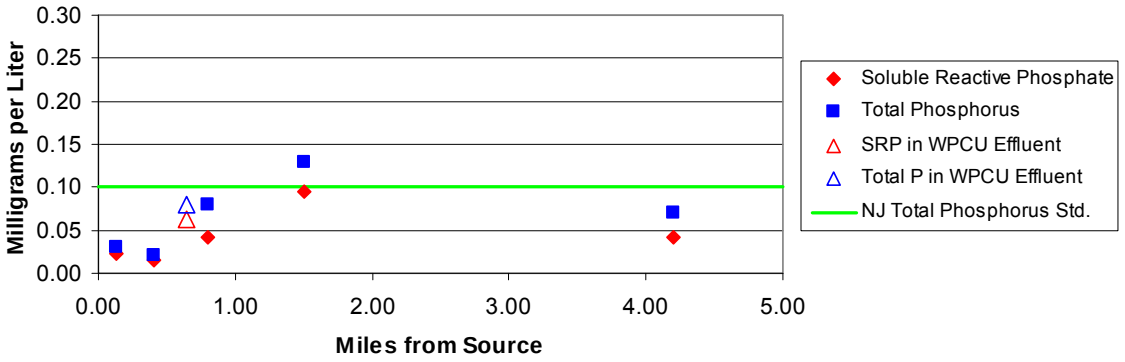


Figure 7c. Soluble Reactive Phosphate-P & Total Phosphorus-P, Baseflow Conditions, November 12, 2007

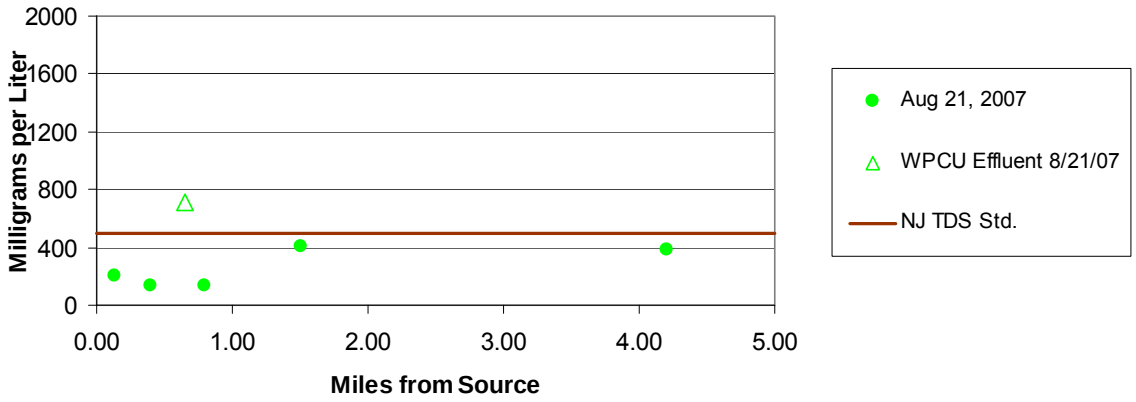


Figure 8. Total Dissolved Solids, Stormflow Conditions, August 21, 2007

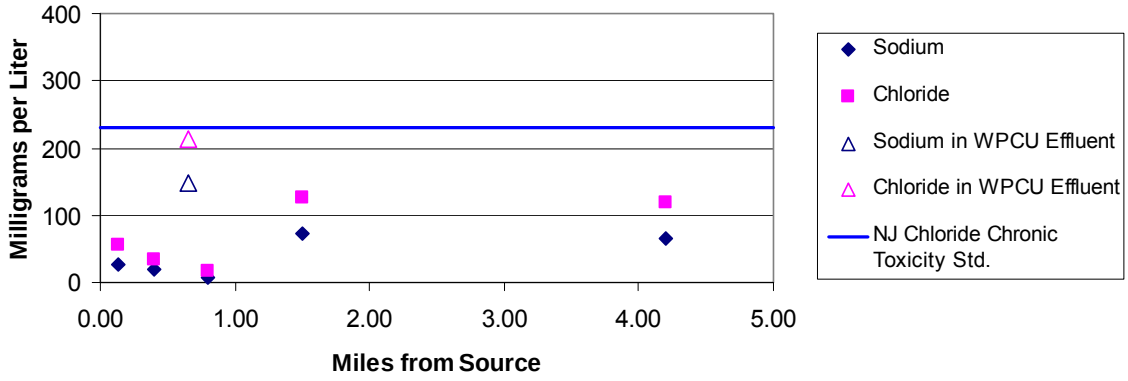


Figure 9. Sodium and Chloride, Stormflow Conditions, August 21, 2007

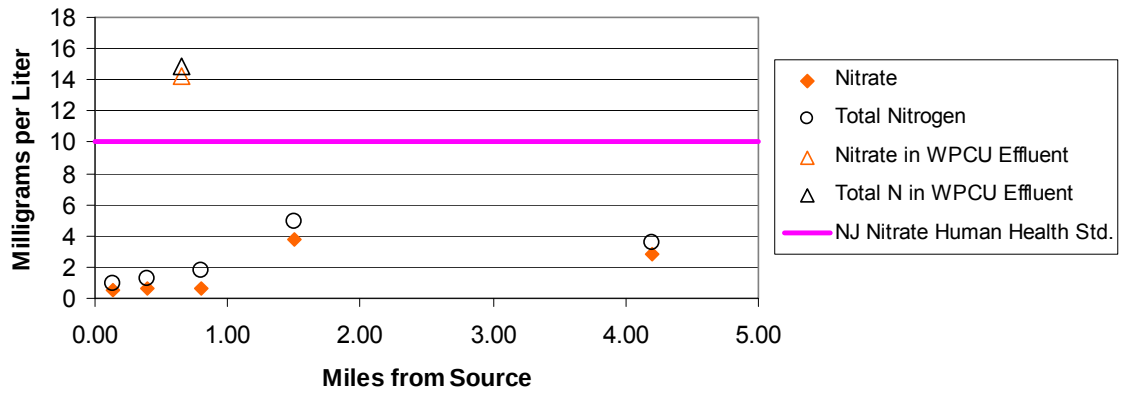


Figure 10. Nitrate-N and Total Nitrogen-N, Stormflow Conditions, August 21, 2007

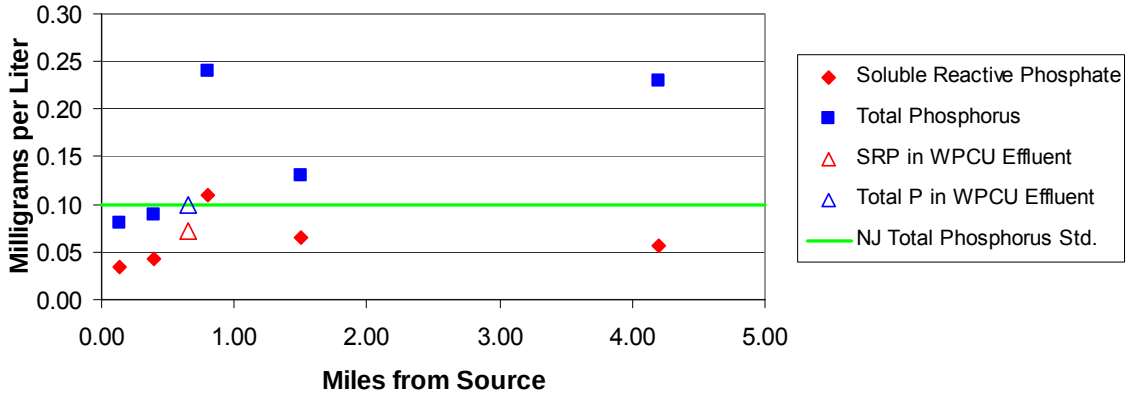


Figure 11. Soluble Reactive Phosphate-P and Total Phosphorus-P, Stormflow Conditions, August 21, 2007

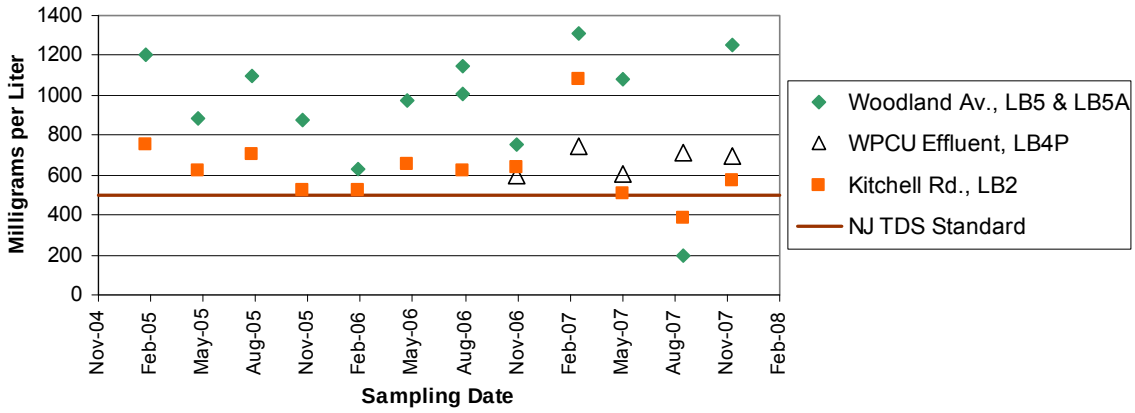


Figure 12. TDS Concentrations, 2005 – 2007*

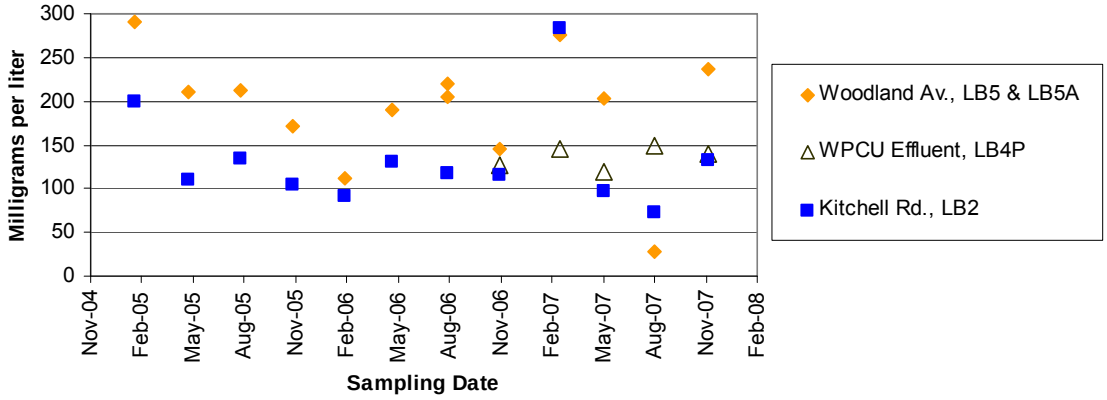


Figure 13. Sodium Concentrations, 2005 – 2007*

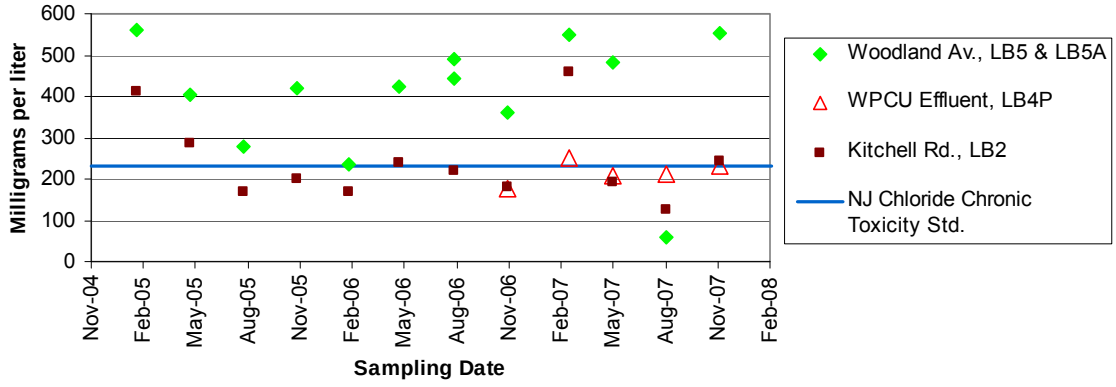


Figure 14. Chloride Concentrations, 2005 – 2007*

***Note: August 2007 results were for stormflow samples, all others were baseflow samples.**

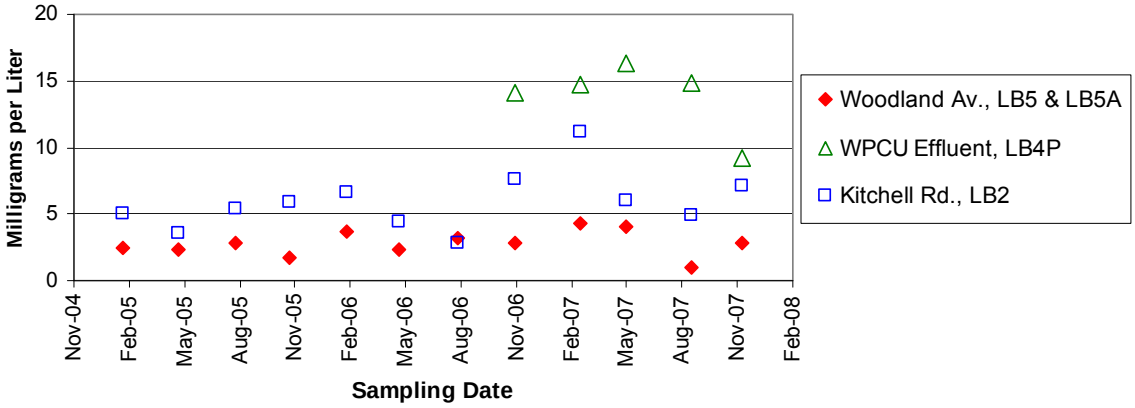


Figure 15. Total Nitrogen-N Concentrations, 2005 – 2007*

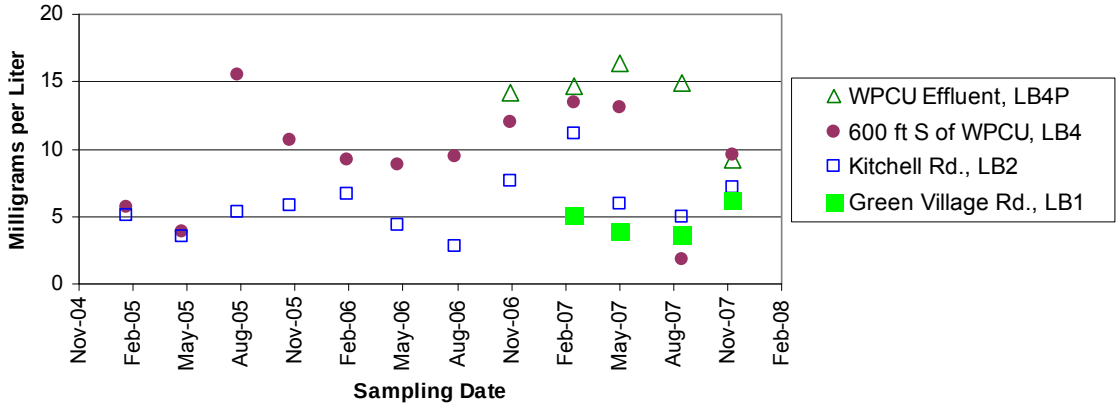


Figure 16. Depletion of Total N During Downstream Transport, 2005 – 2007*

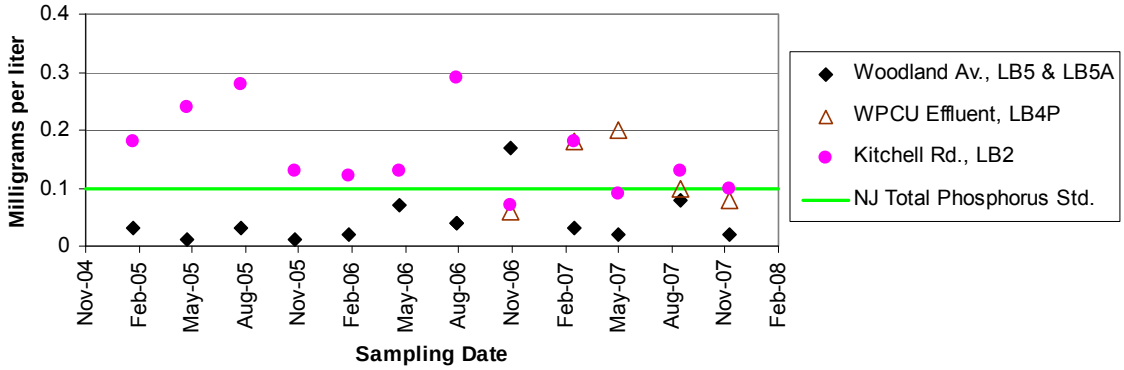


Figure 17. Total Phosphorus-P Concentrations, 2005 – 2007*

***Note: August 2007 results were for stormflow samples, all others were baseflow samples**

TABLES

Table I. TDS, Sodium and Chloride Concentrations, Flow, and In-Situ Meter Measurements
Loantaka Brook, 2007

			Thermometer	Horiba meter				Oakton mtr.	Lab results		
Sampling Site	Sampling Date	Flow*** cf/s	Water Temperature ^{0}C	pH	DO mg/l	Conductivity µS/cm	TDS (0.6 X Cond) mg/l	TDS mg/l	TDS mg/l	Sodium mg/l	Chloride mg/l
LB6 (Turtle Basin)	02/22/07		2.9	7.38	7.42	3700	2220	2400	N/A	N/A	N/A
	05/08/07		12.6	7.21	12.71	1710	1026	801	N/A	N/A	N/A
	08/21/07			----------Not Measured----------					N/A	N/A	N/A
	11/12/07		7.5	7.40	5.93	1680	1008	959	N/A	N/A	N/A
LB5A ca. 400 ft above Woodland Ave Bridge	02/22/07		6.8	7.64	12.70	2460	1476	1770	1310	278	548
	05/08/07		13.6	7.53	10.45	1890	1134	868	1080	204	481
	08/21/07		16.2	7.60	7.90	470	282	156	200	27.5	56.7
	11/12/07		10.0	7.56	8.78	2160	1296	1290	1250	236	553
LB4S Near Ginty Swimming Pool	02/22/07	0.40	4.8	7.45	13.50	3570	2142	2530	1980	511	1150
	05/08/07	0.65	15.3	7.27	16.20	1480	888	697	857	157	354
	08/21/07	14.23	16.3	7.60	7.60	270	162	108	134	19.2	34.8
	11/12/07	0.43	8.7	7.51	9.45	1790	1074	1040	974	189	422
LB4P WPCU effluent	02/22/07		13.2	7.04	8.80	1340	804	770	749	146	252
	05/08/07		15.8	6.82	10.80	1130	678	532	604	119	209
	08/21/07		21.5	----------Not Measured----------				647	716	149	213
	11/12/07		17.8	7.36	7.2	1260.0	756	740	693	139	231
LB4 ca. 600 ft below WPCU discharge	02/22/07	3.8	12.1	7.06	9.63	1600	960	1310	875	189	348
	05/08/07	3.3	15.0	6.85	8.60	1160	696	557	598	119	217
	08/21/07	33.82	16.6	7.50	6.80	190	114	91	136	7.7	17.9
	11/12/07	3.47	16.4	7.18	7.57	1300	780	762	720	141	253
LB2 Kitchell Rd.	02/22/07		5.1	6.98	14.65	2010	1206	1500	1080	283	457
	05/08/07		13.2	7.71	12.00	770	462	583	504	96.6	191
	08/21/07		17.6	7.38	7.93	343	206	339	406	73.5	127
	11/12/07		8.2	7.20	9.80	1260	756	718	699	132	245
LB1 Green Village Rd.	02/22/07		1.2	8.38	17.01	1520	912	762	819	192	371
	05/08/07		14.6	8.51	16.28	570	342	375	428	77.4	151
	08/21/07		17.3	7.25	8.23	266	160	323	384	64.9	120
	11/12/07		5.8	7.63	10.64	1070	642	587	573	107	208

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

08/21/07	STORM FLOW

Table II. N- and P-Bearing Nutrients, and TSS
Loantaka Brook, 2007

Concentrations in mg/liter

	Sampling Site	Sampling Date	Water Temperature ^{0}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
LB5A	ca. 400 ft upstream	02/22/07	6.8	0.34	3.9	0.017	4.26	0.004	0.03	3
	from Woodland Av.	05/08/07	13.6	0.48	3.5	0.018	4.00	< 0.002	0.02	< 3
	STORM --->	08/21/07	16.2	0.46	0.50	0.006	0.97	0.035	0.08	14
		11/12/07	10.0	0.43	2.4	0.023	2.85	0.022	0.03	5
LB4S	Near Ginty	02/22/07	4.8	0.49	2.8	0.026	3.32	< .002	0.03	5
	Swimming Pool	05/08/07	15.3	0.48	1.7	0.013	2.19	0.005	0.04	5
	STORM --->	08/21/07	16.3	0.58	0.64	0.006	1.23	0.043	0.09	12
		11/12/07	8.7	0.40	1.7	0.020	2.12	0.016	0.02	3
LB4P	WPCU effluent	02/22/07	13.2	0.82	13.8	0.102	14.72	0.112	0.18	< 3
		05/08/07	15.8	1.1	15.2	0.024	16.32	0.12	0.2	< 3
	STORM --->	08/21/07	21.5	0.66	14.2	0.005	14.87	0.072	0.10	< 3
		11/12/07	17.8	0.45	8.7	0.009	9.16	0.062	0.08	< 3
LB4	ca. 600 ft below	02/22/07	12.1	1.1	12.2	0.128	13.43	0.103	0.18	< 3
	WPCU Discharge	05/08/07	15.0	1.1	12.0	0.029	13.13	0.11	0.18	< 3
	STORM --->	08/21/07	16.6	1.1	0.66	0.002	1.76	0.11	0.24	26
		11/12/07	16.4	1.3	8.20	0.016	9.52	0.042	0.08	< 3
LB2	Kitchell Rd.	02/22/07	5.1	1.50	9.6	0.086	11.19	0.041	0.18	10
		05/08/07	13.2	1.10	4.8	0.058	5.96	0.023	0.09	< 3
	STORM --->	08/21/07	17.6	1.1	3.8	0.024	4.92	0.065	0.13	9
		11/12/07	8.2	1.3	5.8	0.047	7.15	0.094	0.10	5
LB1	Green Village Rd.	02/22/07	1.2	0.59	4.4	0.057	5.05	0.011	0.13	7
		05/08/07	14.6	0.82	3.0	0.025	3.85	0.032	0.08	< 3
	STORM	08/21/07	17.3	0.79	2.8	0.024	3.61	0.057	0.23	167
		11/12/07	5.8	0.83	5.3	0.022	6.15	0.042	0.07	3

Table III. Total Dissolved Solids and Constituent Ions
Loantaka Brook, 2005 - 2006

Concentrations in mg/liter

Site	Sampling Date	TDS (meter)	TDS (residue)	Alkalinity as CaCO3	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Chloride Cl	Sulfate SO_4	Carbonate*** CO_3	Nitrate as NO_3	Nitrite as NO_2	Sum of Constituents	Percent of TDS(res)
LB6	02/07/05		1270	134	90	26	360	6.1	549	30.1	80.3	2.88	0.05	1144	90.1%
(Turtle	05/09/05		1110	212	93	26	260	5.6	577	24.0	127.1	1.20	0.05	1114	100.4%
Basin)	08/09/05		1289	250	121	33.7	241	6.11	441	1.2	149.9	15.05	0.07	1009	78.3%
	11/08/05	1090	945	213	99.8	27.4	198	5.96	480	9.0	127.7	2.12	0.01	950	100.5%
	02/07/06	566	631	116	57	16	131	2.88	251	13.0	69.5	8.41	0.02	549	87.0%
	05/03/06	925	1000	172	100	28	220	7.5	448	20.5	103.1	2.12	0.06	929	92.9%
	08/07/06	924	842	160	115	31.6	214	4.73	470	7.0	95.9	0.53	0.01	939	111.5%
	11/07/06	**933**	**956**	**157**	**96.4**	**27.8**	**192**	**4.1**	**365**	**20.4**	**94.1**	**1.24**	**0.15**	**801**	**83.8%**
LB5A*	08/07/06	1330	1150	161	121	38	219	6.47	490	41.0	96.5	11.51	0.11	1024	89.0%
LB5	02/07/05		1200	135	96	27	290	4.4	559	36.0	80.9	9.30	0.05	1103	91.9%
(Woodland	05/09/05		888	151	89	28	210	4.0	404	38.0	90.5	7.97	0.11	872	98.2%
Ave)	08/09/05		1095	184	100	31.6	212	4.73	280	46.0	110.3	6.20	0.09	791	72.2%
	11/08/05	996	873	183	97.2	27.8	171	4.73	420	42.0	109.7	5.31	0.11	878	100.6%
	02/07/06	560	632	145	66.2	17.8	112	2.81	235	33.0	86.9	10.18	0.04	564	89.2%
	05/03/06	1289	977	164	100	29	190	6.7	425	33.4	98.3	8.41	0.09	891	91.2%
	08/07/06	886	1010	148	115	35.7	205	6.3	445	39.0	88.7	11.51	0.10	946	93.7%
	11/07/06	**806**	**756**	**160**	**86.2**	**25.2**	**145**	**3.3**	**361**	**27.8**	**95.9**	**9.30**	**0.03**	**754**	**99.7%**
LB4P**	**11/07/06**	**621**	**594**	**103**	**56.8**	**20.5**	**127**	**10.8**	**178**	**65.2**	**61.8**	**59.76**	**0.04**	**580**	**97.6%**
LB4	02/07/05		750	113	62	21	170	9.2	343	68.0	67.8	23.02	0.42	764	101.9%
(Below	05/09/05		608	125	58	22	140	11	221	78.0	74.9	14.17	0.15	619	101.9%
WPCU	08/09/05		677	146	62.6	23.4	141	11.7	195	79.0	87.5	61.09	0.14	661	97.7%
Outlet)	11/08/05	655	547	87	51.2	16.5	121	10.5	220	70.0	52.2	44.71	0.09	586	107.2%
	02/07/06	564	579	118	57.7	21.1	112	7.66	196	64.0	70.7	39.84	0.08	569	98.3%
	05/03/06	692	713	114	65	23	140	14	243	82.8	68.4	36.74	0.32	673	94.4%
	08/07/06	644	734	130	72.1	25.5	159	10.8	226	86.0	77.9	38.96	0.06	696	94.9%
	11/07/06	**632**	**586**	**110**	**57.3**	**19.7**	**120**	**9.0**	**188**	**58.4**	**66.0**	**50.47**	**0.05**	**569**	**97.1%**
LB2	02/07/05		750	107	63	21	200	7.5	412	55.8	64.2	19.92	0.23	844	112.5%
(Below	05/09/05		622	117	48	18	110	7.4	288	72.0	70.1	13.28	0.23	627	100.8%
Kitchell	08/09/05		707	140	56.4	20.6	134	10.2	169	78.0	83.9	15.49	0.53	568	80.4%
Pond)	11/08/05	271	525	112	49.2	15.9	104	7.98	200	60.0	67.2	23.46	0.18	528	100.5%
	02/07/06	415	521	107	48.5	16.9	91.5	4.69	167	46.0	64.2	23.02	0.08	462	88.6%
	05/03/06	630	659	116	60	23	130	11	240	65.6	69.5	16.38	0.22	616	93.4%
	08/07/06	563	622	140	64.1	23	117	9.73	220	73.0	83.9	5.31	0.72	597	95.9%
	11/07/06	**573**	**636**	**122**	**58.5**	**19.5**	**116**	**7.0**	**179**	**51.8**	73.1	30.54	0.15	536	84.2%

* LB5A is ~400 ft upstream from LB5

*** Carbonate estimated from measured alkalinty

** LB4P is at the plant outlet and the effluent was sampled directly

Table IV. N- and P-Bearing Nutrients
Loantaka Brook, 2005 - 2006

Concentrations in mg/liter

Sampling Site	Sampling Date	Water Temperature ^{0}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
LB6	02/07/05		0.28	0.65	0.015	0.95	< 0.003	0.06	< 3
(Turtle	05/09/05		0.47	0.27	0.015	0.76	< 0.003	0.06	4
Basin)	08/09/05		1.40	3.4	0.021	4.82	0.006	0.38	21
	11/06/05	11.4	0.26	0.48	0.003	0.74	<0.002	0.19	7
	02/07/06	4.5	1.40	1.9	0.005	3.31	0.008	0.02	< 2
	05/03/06	11.9	0.55	0.48	0.018	1.05	<0.002	0.22	41
	08/07/06	21.9	0.42	0.12	0.003	0.54	0.006	0.1	19
	11/07/06	10.0	0.64	0.28	0.047	0.97	<.002	0.02	< 2
LB5A*	08/07/06		0.49	2.6	0.032	3.12	0.01	0.04	12
LB5	02/07/05		0.28	2.1	0.018	2.40	0.004	0.03	3
(Woodland	05/09/05		0.55	1.8	0.033	2.38	0.003	< 0.01	< 3
Ave)	08/09/05		1.40	1.4	0.027	2.83	0.015	0.03	22
	11/06/05	12.2	0.47	1.2	0.035	1.71	0.008	0.01	3
	02/07/06	5.2	1.40	2.3	0.011	3.71	0.002	0.02	< 2
	05/03/06	12.8	0.46	1.9	0.028	2.39	0.002	0.07	2
	08/07/06	21.9	0.62	2.6	0.029	3.25	0.017	0.04	3
	11/07/06	11.5	0.75	2.1	0.01	2.86	< .002	0.17	26
LB4P**	11/07/06	18.1	0.64	13.5	0.011	14.15	0.004	0.06	< 2
LB4	02/07/05		0.37	5.2	0.129	5.70	0.208	0.29	4
(Below	05/09/05		0.68	3.2	0.047	3.93	0.20	0.25	< 3
WPCU	08/09/05		1.70	13.8	0.042	15.54	1.1	1.2	7
Outlet)	11/06/05	18.0	0.52	10.1	0.028	10.65	0.134	0.21	< 3
	02/07/06	10.7	0.16	9.0	0.024	9.18	0.037	0.16	< 2
	05/03/06	15.9	0.49	8.3	0.097	8.89	0.008	0.07	< 2
	08/07/06	23.3	0.67	8.8	0.017	9.49	0.21	0.25	3
	11/07/06	16.4	0.64	11.4	0.018	12.06	0.004	0.04	< 2
LB2	02/07/05		0.47	4.5	0.07	5.04	0.085	0.18	9
(Kitchell	05/09/05		0.49	3.0	0.07	3.56	0.16	0.24	< 3
Road)	08/09/05		1.70	3.5	0.162	5.36	0.2	0.28	11
	11/06/05	13.6	0.52	5.3	0.056	5.88	0.09	0.13	< 3
	02/07/06	4.1	1.40	5.2	0.024	6.62	0.03	0.12	< 2
	05/03/06	16.1	0.65	3.7	0.067	4.42	0.009	0.13	14
	08/07/06	25.0	1.40	1.2	0.22	2.82	0.170	0.29	25
	11/07/06	10.9	0.64	6.9	0.047	7.59	0.015	0.07	< 2

* LB5A is ~400 ft upstream from LB5

** LB4P is at the WPCU outlet and the effluent was sampled directly

Table V. USGS Measurements of Total Dissolved Solids and Constituent Ions
Loantaka Brook, 2004 - 2006

Concentrations in mg/l

Site	Sampling Date	TDS (residue)	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Chloride Cl	Sulfate SO_4	Silica SiO_2	Carbonate CO_3	Nitrate as NO_3	Sum of Constituents	Percent of TDS(res)
AN0220	10/25/04	608	56.3	19.7	129	10.4	202	69.5	14.9	58.2	49.93	611	100.5%
(Blue Stone	02/03/05	696	66.2	24.7	133	10.6	229	78.6	17.6	67.2	57.55	686	98.6%
Terrace,	05/12/05	689	62.4	24.4	120	10.4	211	84.8	17.2	72.5	48.69	654	94.9%
approx	08/11/05	733	68.8	25.4	146	13.1	237	99.1	16.9	64.8	58.88	731	99.7%
1200 ft	11/03/05	594	55.7	20.4	120	10.4	206	67.8	16.9	58.8	52.68	610	102.7%
below LB4)	02/23/06	668	59.8	22.1	134	8.83	228	70.2	16.5	71.9	38.91	650	97.3%
	06/12/06	625	54.8	20.1	116	7.32	208	59.0	6.4	74.9	17.49	565	90.4%
	08/30/06	531	46.7	17.2	99.9	8.85	166	48.1	16.0	66.0	41.52	515	97.0%

Note: Carbonate estimated from Acid Neutralization Capacity

Table VI. USGS Measurements of Nitrogen and Phosphorus Nutrients, and TSS
Loantaka Brook, 2004 - 2006

Concentrations in mg/l

Sampling Site	Sampling Date	Ammonia + organic nitrogen "as N"	Nitrates + Nitrites "as N"	Total Nitrogen "as N"	Ortho-phosphate "as P"	Phosphorus "as P" unfiltered water	Suspended Residue or Sediment
AN0220	10/25/04	0.87	11.28	12	0.495	0.55	3
(Blue Stone	02/03/05	0.91	13	14	0.329	0.59	4
Terrace,	05/12/05	0.95	11	12	0.344	0.47	4
approx	08/11/05	0.68	13.3	14	0.317	0.34	2
1200 ft	11/03/05	0.85	11.9	13	0.255	0.31	5
below LB4)	02/23/06	0.65	8.79	9.4	0.090	0.20	2
	06/12/06	0.82	3.95	4.8	0.085	0.14	2
	08/30/06	0.92	9.38	10	1.07	1.16	1

ATTACHMENTS

1. February 22, 2007 Laboratory Report
2. May 8, 2007 Laboratory Report
3. August 21, 2007 Laboratory Report
4. November 12, 2007 Laboratory Report
5. Flow Data Sheets
6. Chain of Custody Reports
7. Field Sampling Sheets
8. Meter Calibration Log Sheets