Town of Plymouth, MA
Department of Marine & Environmental Affairs

Nutrient Management Data Report
Operational Monitoring Program
Data Report for 2012

Portion of restored Eel River at the prior Sawmill Dam site. Photograph courtesy of Alex Hackman, Mass Division of Ecological Restoration.

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Section 1

Introduction of Nutrient Management Plan, WWTF, Town Projects

1.1 Nutrient Management Plan

As part of the Massachusetts Department of Environmental Protection (DEP) approval of Plymouth's Waste Water Treatment Facility (WWTF) Permit, SE# 1-677, a Nutrient Management Plan (NMP) was put in place. This plan was approved by DEP in January of 2001, *Town of Plymouth, Ma Nutrient Management Plan by Camp Dresser & McKee*. As part of the WWTF Permit the NMP consists of surface and groundwater monitoring within the Eel River Watershed in addition to the monitoring required by WWTF plant operations.

The NMP monitoring program consists of three parts; the baseline monitoring which occurred from May 1998 through February 2000; the interim monitoring which occurred from May 2000 through November 2001; the operational monitoring began following the operations of the WWTF in May 2002. As noted in Section 2.1 of the previous monitoring report, the Town and consultants have re-evaluated baseline and monitoring data to accurately represent pre-plant conditions, May 1998 to May 2002, as well as laboratory results which were reported in higher detection limits. Baseline laboratory results were generally reported in lower detection limits as compared with post WWTF results. Data issued Non-Detect (ND) values were numerically assigned half the detection limit for phosphorus and the calculation of Total Nitrogen. With higher detection values the total nitrogen value may appear higher although it was Non-Detect which can be misleading in representation and comparison of data results.

The NMP presents a methodology for monitoring changes in the Eel River system. Table 7-3 within the NMP, also below in Table 3, specifies action levels based on changes in water quality parameters. In addition to the monitoring, the NMP consists of controls and practices, known as the Base Management Plan, which the Town has and will continue to implement to reduce existing nutrient loads to the River and/or help minimize any future increases.

1.2 Purpose of the Nutrient Management Data Report

The purpose of the Nutrient Management Data Report is to present results of the operational monitoring program, compare data results to baseline conditions and defined action levels, evaluate whether changes have occurred and if so set forth a plan remediate the source. Specific action levels can be found in Table 3. The Data Report also allows for public updates on specific projects the Town is implementing within the watershed, Section 1.5.

1.3 Nutrient Management Monitoring

The baseline, interim and operational monitoring was previously conducted by Camp Dresser & McKee, Inc. until 2006. In 2006, the Town of Plymouth's Department of Public Works Environmental Management Division continued with the sampling events. As of October 2012 the Environmental Management Division has merged with Harbor Master and become the Department of Marine & Environmental Affairs. The monitoring program includes the measurement and analysis of multiple parameters for groundwater and surface water quality as well as harbor water quality and aquatic biological health.

The required surface water monitoring sites are listed in Table 1 with additional monitoring locations the Town monitors. Refer to the Surface Water Monitoring Section for further information.

Previous relevant reports include:

- Baseline Monitoring Program for the Eel River Watershed (May 1998), CDM.
- Preliminary Baseline Monitoring Data Report (October 1998), CDM
- Baseline Data Report, May 1990-February 2000, CDM
- Town of Plymouth, Nutrient Management Plan (July 2001), CDM
- Eel River Watershed Monitoring Data Report, May 1998-2001 (June 2002), CDM

- Eel River Watershed Nutrient Management Plan, Program Implementation Draft Update (April 2004), CDM
- Town of Plymouth, Operational Monitoring Program Data Report (March 2006), CDM
- Town of Plymouth, Operational Monitoring Program Data Report for 2006-2007 (August 2008), Town of Plymouth Department of Public Works Environmental Management Division
- Town of Plymouth, Nutrient Management Data Report, Operational Monitoring Program for 2008-2010 (April 2011), Town of Plymouth Department of Public Works Environmental Management Division
- Town of Plymouth, Nutrient Management Data Report, Operational Monitoring Program for 2011 (April 2012), Town of Plymouth Department of Public Works Environmental Management Division

1.4 Waste Water Treatment Facility Discharge

The Town of Plymouth WWTF began operations in May 2002 per the Groundwater Discharge Permit SE#1-677 issued by DEP on June 25, 2000. The permit specifies a maximum 3.45MGD to the infiltration basins with an annual average of 0.75MGD. The maximum day design value of the treatment plant is 5.2MGD of which 1.75MGD is discharged to the ocean outfall. Below are averages per year of total nitrogen, flow to the infiltration basins and flow to the ocean outfall since the operation of the WWTF. The total nitrogen concentrations discharged into the infiltration basins in 2012 are almost half the DEP permitted level of 10mg/L. The flow to the infiltration basins has decreased to approximately 15% of the 0.75MGD from 20% over recent years.

Table 1

Yearly Average of Total Nitrogen (mg/L) to Infiltration Basins											
DATE	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Average	10.76	6.94	4.36	4.26	8.32	7.17	4.95	5.19	6.31	6.36	5.61
Yearly Average of Total Phosphorus (mg/L) to Infiltration Basins											
DATE	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Average	2.98	4.23	5.29	5.33	6.31	6.25	4.21	4.08	3.51	3.84	3.88
Yearly Average Flow (MGD) to Infiltration Basins											
DATE	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Average	0.038	0.174	0.173	0.141	0.173	0.124	0.198	0.108	0.193	0.193	0.117
Yearly Average Flow (MGD) to Ocean Outfall											
DATE	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Average	1.539	1.509	1.330	1.591	1.594	1.574	1.509	1.639	1.556	1.580	1.525

1.5 Department of Public Works and Department of Marine & Environmental Affairs, Base Management Plan and Projects within the Eel River Watershed

In May of 2005, the Environmental Management Division was created under the Department of Public Works to manage the Town's natural resource areas. As part of this management, the Eel River Watershed Nutrient Management Plan was undertaken by this Division. In October of 2012 the Environmental Management Division merged with Harbor Master to form its own Department known as the Department of Marine & Environmental Affairs. The Department of Marine & Environmental Affairs conducts the surface water and groundwater monitoring associated with the NMP and manages the biological monitoring conducted by the Limnologist/Biologist. The Department of Marine & Environmental Affairs reviews, compiles and generates the NMP Operational Monitoring Program Data Reports.

In addition, the Department of Marine & Environmental Affairs implements various projects within the watershed, most of which are part of the NMP Base Management Plan. The Base Management Plan consists of controls and practices the Town has and will continue to implement to reduce existing nutrient loads to the Eel River and/or to help minimize any future increases. The sections of the Plan include; Public Education Program, Buffer Strip, Stormwater BMPs, Source BMPs, Septic System Management, Use of Reclaimed Water, Lot Size and Open Space. The following is an outline of each section of the **Base Management Plan**:

Public Education Program – In response to this plan, the Town has: (a) implemented the Nutrient Management Plan Advisory Committee which consisted of various users, including land owners, farmers, and cranberry growers, to collaborate on the implementation of nutrient reduction techniques within the watershed; (b) involved the public in important watershed protection activities, such as the Eel River Trash Clean Up Day through the American Rivers Program and volunteer/public involvement in activities associated with the Eel River Headwaters River & Wetland Restoration Project; (c) created and updates the Department of Marine & Environmental Affairs website, which educates the public on the importance of protecting water quality and provides recreational links to trails within the Town including the Eel River Preserve.

Buffer Strip – Under this part of the NMP, the Town has protected over 300 acres of conservation land around the Eel River and its watershed. The protected areas include the Hoyt's Pond Conservation Area, the Eel River Preserve, the Russell Mill Pond Conservation Area, the Hayden Pond Conservation Area and the Herries Property. In 2011, the Town protected an additional 10 acres as open space and in 2012 the Town protected an additional 20 acres as open space.

The Town completed a draft of a Watershed Management Program General Bylaw for the Plymouth Harbor Watershed, which includes the Eel River Watershed. This Bylaw would allow for the protection of Plymouth's important natural resources such as water quality, drinking water supply, fish and wildlife habitat, eel grass habitat, shellfish, aesthetics and recreational uses. The goal of the Bylaw is to require mitigation for nutrient loading from land use changes and septic systems within the watershed. Such mitigation would include the use of advanced nutrient removal septic systems, as well as other best management practices. The Town will likely be implementing this or a similar Bylaw following the recommendation of the Department of Environmental Protection's Massachusetts Estuaries Project for the Plymouth Harbor (including the Eel River Watershed) Total Maximum Daily Load Report.

Stormwater BMPs – The Town's Engineering Department has conducted a field inventory of catch basins and outfalls within the Eel River Watershed utilizing a GPS system. This has assisted the Town in implementing solutions to stormwater impacts within the Eel River system. For example, the Town implemented stormwater BMPs at the river crossing on Russell Mill Road to treat and reduce runoff from directly entering the river system. As part of the Eel River Headwaters Restoration Project, completed in 2010, the Town replaced two road crossing culverts, stormwater basin and created wetland infiltration areas for existing stormwater to be treated prior to entering the Eel River. In addition, the development area north of Warren Wells Brook was retrofitted with a constructed wetland stormwater treatment system in 2008-2009 under the Town's direction and oversight. In 2012 the Engineering Department conducted drainage improvements at East Russell Mills Road and cleaning improvements at River Street.

Source BMPs – The Town, with assistance of state and federal project partners, designed, permitted and implemented a 40 acre wetland and 1.75mile river restoration project known as the Eel River Headwaters Restoration Project. The project takes place on the Eel River Preserve where

40 acres of cranberry bogs and upland were acquired as well as on a portion of the Russell Mill Conservation Area. This area was manipulated over time for agricultural purposes, but it has now been taken out of agricultural production under the Towns stewardship. Nutrient loading to the Eel River from this project will be reduced by approximately 600lbs/yr of Nitrogen (CDM, 2005) and 500lbs/yr of Phosphorus (UMASS Amherst Cranberry Station). The Town has acquired over 2.5million dollars in funding and the restoration has been completed as of October 2010. The project has substantially improved fish passage and water quality through the removal of flow control structures and replacement of undersized culverts, restored 40 acres of wetland habitat including Atlantic white cedar swamps and reconfigured the Sawmill Dam to a natural river channel. For additional information on this project, see Eel River Headwaters Restoration Project description in this section below.

Septic System Management - The Town's Engineering Department and Board of Health have been updating a Town-wide septic inventory, which allows for the query and review of onsite septic system plans. The current inventory is available for municipal use in the Geographical Information System linked by parcel Id's. In 2008 the Town conducted a mailing to all residential properties within 100ft. of the Eel River notifying homeowners of the Town's zero interest septic upgrade loan program.

Use of Reclaimed Water – The Town completed a feasibility study, entitled "Plymouth South High/Middle School Water and Wastewater Alternatives Evaluation Final Report" (Sept. 2005, Tighe and Bond), analyzing the use of reclaimed water. Based on the results of the study, the Town has applied for funding sources, such as the State Revolving Fund, working with a developer where reclaimed water would be utilized to irrigate golf courses, ball fields and for toilet flushing within the development. Unfortunately the development fell through due to funding sources thereby eliminating the use of reclaimed water, however, the Town is willing to work with potential developers/partnerships in the future to accomplish this goal.

Lot Size – The Town has maintained the 3 acre lot size for rural residential development. Any development within 200ft. of the river is subject to the MA River Act and any work within 100ft. of the river or resource area is reviewed by the local Conservation Commission and Department of

Environmental Protection. The Conservation Commission has increased the no-touch buffer zone from 25ft to 35ft in the Town's Wetland Protection Act Bylaw.

Open Space – In 2012, the Town protected an additional 20 acres of open space in the Eel River Watershed. In 2011, the Town protected 10 acres neighboring the Herries property. In addition, in 2010 the Town protected over 40acres adjacent to the Eel River Preserve known as the Herries property. In the winter of 2010, an additional 14.5 acres of open space was preserved north of Town Forest within the Eel River Watershed. In 2008 the Town protected 14 acres of land adjacent to Hayden Pond for conservation purposes, habitat and water quality preservation. In 2007 the Town protected 23 acres known as the Hoyt's Pond or College Pond Road property just south and connecting to the Eel River Preserve. The Eel River Preserve is a 130 acre parcel which connects with the 160 acres of the Russell Mill Pond Conservation Area. Through the Eel River Headwaters Restoration Project, and with funding assistance from the Town's Office of Community Development, two informational kiosks on the Sawmill Dam reconfiguration and Cranberry Bog/Wetland Habitat restoration efforts and history have been installed at the project site.

Overall, the work that the Town has performed under the NMP has been widely praised. The Town of Plymouth and project partners for the Eel River Headwaters Restoration received the National Award from Coastal America for preserving and restoring coastal resources and ecosystems. In addition, on January 10, 2008 the Executive Office of Energy and Environmental Affairs issued a press release describing the Town's extraordinary efforts to restore the headwaters of the Eel River. In the press release, Secretary Bowles states, "By providing vision and leadership for numerous open space and restoration projects, the Town of Plymouth continues to set a strong example of municipal action to protect the environment. With ambitious projects such as the Eel River, Plymouth has had extraordinary success pulling together diverse partners and funding sources for projects that benefit the community, the environment, and the region."

While the Base Management Plan will act to reduce and control nutrients in the watershed and prevent ecological harm in the Eel River, the NMP also lists additional control measures to restore the system in the event chemical and physical parameters produce an ecological change as described in Section 2.2.2. To date, there has not been evidence of this ecological change,

however, the Town is committed to protecting the natural resources and has researched the viability of each of the control measures listed in the NMP. In 2007, the Town hired an engineering firm to complete the "Feasibility Study for Constructed Treatment Wetlands at the Plymouth WWTF, Stearns & Wheeler, LLC, June 2007." The Town has pursued funding opportunities for the implementation of the constructed wetlands, however, the current low flow and low input of nitrogen into the infiltration basins will not sustain a wetland community. The Town may actively pursue this option should the flow to the infiltration basins increase.

The following is a brief summary of additional projects in the Eel River Watershed the Town has conducted. For further information please visit the Department of Marine & Environmental Affairs webpage at www.plymouth-ma.gov.

Eel River Headwaters Restoration Project – Wetland & River Restoration

The Eel River Headwaters Restoration site is located within the Eel River Watershed, south of Russell Mill Pond. In 2005, the Town of Plymouth purchased 39.5 acres of bogs and 40 acres of upland at the headwaters of the Eel River, also known as the Eel River Preserve. In 2007 the Town purchased a 44 acre adjacent parcel that connects to Hoyts Pond, a coastal plain pond. The Hoyts Pond parcel, as well as the Eel River Preserve, connects with the additional 100+ acres of Town owned property north of Long Pond Road connecting to Russell Mill Pond.

In October of 2010 the Town of Plymouth, with the assistance of State & Federal Project Partner Agencies, have completed river and wetland restoration activities in the headwaters of the Eel River, the small spring-fed system which drains into historic Plymouth Harbor. This State & Federal Listed Priority Project included dredging to construct a sinuous stream channel 1.7 miles in length to reestablish natural conditions and enhance river continuity, filling of former artificial side channels, reconstruction of a re-connected floodplain, removal of dikes and water control structures, replacement of undersized culverts at Long Pond Road and a driveway to enhance fish passage, extensive wetland plantings including 17,000 Atlantic white cedar (AWC) trees, and re-establishment of rare wetland communities. Sawmill Pond Dam site has been re-configured to allow fish passage, and a restored river channel and floodplain has been reconstructed in the existing impoundment.

(Pre-restoration channel)

(Post-restoration channel)

(Bog 1 pre-restoration)

(Bog 1 post-restoration)

(Bog 2 pre-restoration)

(Bog 2 post-restoration)

Nutrient Management Model: In the early spring of 2006, CDM completed the Nutrient Management Model for the Eel River Watershed. This model calculates the current loadings based off of MA GIS data and defined loading values for the watershed. It takes into account the current data values and calculates the percent reduction needed in each sub-watershed of the Eel River Watershed to reach the appropriated EPA value of 0.48mg/L of total nitrogen. DEP is also required by the Environmental Protection Agency to conduct a Total Maximum Daily Load model for Plymouth Harbor, which includes the Eel River Watershed. This TMDL model will be useful in the decision making process for implementation of projects.

Cumulative Nitrogen Loading Determination for the Plymouth-Duxbury Harbor-Kingston Bay Embayment System in Support of Management and Restoration: The Town of Plymouth has undertaken the responsibility of completing the nitrogen loading determination for the embayment systems pertaining to the seven communities. To date, Tasks 1, 3, 4 & 5 and the first half of Task 2 listed below have been completed as of September 2011. The next step is the completion of Task 2 which will document watershed nitrogen loading targets and point/non-point nitrogen sources for guiding nitrogen reductions within contributing watersheds to the estuary. With the finalized Massachusetts Estuaries Model, the seven communities will have significant information to plan properly for future development and infrastructure needs as well as restoration concepts for current land-use activities.

- Task 1 – Compilation & Review of Previous Studies
  Complete
- Task 2 – Cumulative Nitrogen Loading Determination
  Part 1 Complete, Part 2 Complete
- Task 3 – Stream/River Data Collection
  Complete
- Task 4 – Nitrogen Recycling collection
  Complete
- Task 5 – Assessment of Nutrient Related Health
  Portions Complete
- Task 6 – Hydrodynamic Data Collection & Modeling
  In Progress

- Task 7 – Water Quality Modeling
  Slated for 2013 Based on Funding Resources
- Task 8 – Nitrogen Loading Report
  Slated for 2013 Based on Funding Resources

Plymouth Harbor Watershed By-law: The Division worked with various consultants on a Nutrient Management Mitigation Program for the Plymouth Harbor Watershed which includes the Eel River. The goal of the by-law is to preserve and protect Plymouth Harbor & Eel River by regulating nutrients, and to manage nutrient inputs to protect public health, water quality, and the welfare of the residents of the Town through the preservation of the groundwater and surface water resources. A draft by-law was created by the Division and an article reserved for 2007 Town Meeting. However, preliminary discussions with DEP indicated it would be beneficial to implement the by-law following the release of the TMDL model. The model will specify which areas and what projects would most benefit the reduction in nutrients. Once the Plymouth Harbor Embayment Study is complete the Town will review the best options for the implementation of the watershed by-law.

Eel River Watershed Delineation: In 2006, the Division assigned a consultant to delineate the Eel River Watershed based on the best available groundwater data. The previous watershed delineation was based on surface water and topography data that did not accurately depict the groundwater fed system. The consultant also delineated the entire Plymouth Harbor Watershed based on best available groundwater data. See Map 1 for Eel River & Plymouth Harbor Watershed. As part of the Plymouth Harbor Embayment System study noted above, the watershed for Plymouth Harbor was defined even further.

Constructed Wetlands Feasibility Study at the WWTF Infiltration Basins

The Division has utilized a consultant to conduct a feasibility study for constructing wetlands in the infiltration basin(s) at the WWTF to reduce nutrient loading in the groundwater. The feasibility study was completed in 2007 and consists of various tasks including inventory of site characteristics, evaluation of potential obstructions, wetland concept plans, alternatives analysis and final designs. The Town is evaluating the most appropriate method in reducing nutrient

loading from the WWTF and researching funding for implementation. This project could potentially tie-in with the Reclaimed Water project for as a form of tertiary treatment.

Reclaimed Water from the Wastewater Treatment Facility located in Camelot Park

As part of the Massachusetts Environmental Policy (MEPA) process completed in 1997, which culminated in the construction of the new Town owned WWTF, reclaimed water re-use was evaluated as a means to reduce nutrient loading impacts to the Eel River Watershed from groundwater disposal of treated effluent at the WWTF and also reduce water usage. Two golf courses (Waverly Oaks and Crosswinds), the Plymouth South High School/Middle School campus, and the Forges Fields athletic facility have been identified as potential recipients of reclaimed water from the Town of Plymouth WWTF as part of the feasibility study, entitled "Plymouth South High/Middle School Water and Wastewater Alternatives Evaluation Final Report" (Sept. 2005, Tighe and Bond), analyzing the use of reclaimed water. Based on the results of the study, the Town has applied for funding sources, such as the State Revolving Fund, working with a developer where reclaimed water would be utilized to irrigate golf courses, ball fields and for toilet flushing within the development. Unfortunately the development has been on hold due to funding sources thereby eliminating the use of reclaimed water, however, the Town is willing to work with potential developers/partnerships in the future to accomplish this goal.

Section 2

Data Observations

2.1 Detection Limits and Baseline Averages

The surface and groundwater monitoring program was initiated in 1998 by Camp Dresser & McKee followed in 2006 by the newly created Environmental Management Division that continued the NMP monitoring. An important aspect of the monitoring program, as discovered in 2009, is the level of the detection limits. A detection limit is the laboratories lowest concentration at which an analyte can be detected in a sample and its concentration can be reported with a reasonable degree of accuracy and precision. In some cases a laboratory will utilize drinking water recommended limits as the reporting detection limit when in fact the method detected the analyte at lower limits.

The initial program included very low detection limits (TP 0.05mg/L, TN analytes 0.001-0.2mg/L) and in 2006 the surface water and bi-annual well monitoring event the detection limits were much higher (TP 0.5mg/L, TN analytes 0.05-0.5mg/L). The detection limits are important as non-detect values are numerically assigned to half the detection limit for statistical analyses and analytes reported with higher detection limits would appear to have higher concentrations when in actuality they do not. For example, surface water location S-3A on 4/10/08 initially had a total nitrogen value of 0.723mg/L but with the re-issued lower detection limits the total nitrogen value was reduced substantially to 0.463mg/L. In 2009 the Town requested and received data re-issued with the lowest possible detection limit for nutrients as shown in the surface and groundwater tables in the attached Appendices. As of late 2009, the Town contracted with a laboratory offering the lowest detection limits in the area and therefore the there is an improvement in data representation as compared with baseline values. As noted above adding half the detection limit for non-detect values is important for statistical analysis. It is not common to add half the detection limit for calculating total nitrogen under a groundwater discharge permit (permit wells inner-outer). However, for purposes of statistical analysis and comparison to baseline data the Nutrient Management Data Report calculates total nitrogen for the permit wells using half the detection limit.

As described a memorandum from Horsley Witten Group and attached as Appendix E:

> *Because, in the statistical analyses, non-detect (ND) values are treated numerically as half the detection limit (DL), DL's were identified for each parameter that could be held consistent for both baseline and post-WWTP conditions, in order to allow for a fair and consistent comparison. This involved looking at all detection limits used over the course of the sampling and arriving at a common value that could be numerically applied as half the detection limit to both baseline and post-WWTP data, while including as much as possible of both data sets. The lowest possible "common" DL's were selected that would allow for a consistent analysis from baseline to post WWTP conditions. In general, baseline DL's were lower than post-WWTP DL's and, therefore, baseline DL's had to be artificially raised to match the post-WWTP DL's. In some cases, the post WWTP DL's were simply far too high to provide meaningful data and those values cannot, therefore, be used for statistical*

comparison to baseline data. In some places groundwater DL's differ from surface DL's.

The baseline water quality statistics includes surface water data from nine locations and groundwater data from twenty two monitoring wells. Baseline averages include all available pre-operation data 1998 to May of 2002. When the original baseline values were calculated in the Nutrient Management they did not include all pre-operation data. In most cases only two to three sample dates were utilized for the baseline calculations. These calculated baseline values can be found within this report as well as attached in Appendix E.

2.2 Surface Water Monitoring

Under the NMP, the Town monitors the following surface water locations five times per year: S-1, S-2B, S-3A, S-4A, S-5B, S-6A, however, as of November 2009 access has been denied to S-1. Following the completion of surface water sampling in 2012, access by the homeowner at S-2B has been denied for future sampling. The Town utilized location S-2C, downstream of the dam. Two harbor samples, S-7 & S-10, are collected two times per year in the summer. These locations are described below in surface water sampling locations. The surface water locations are monitored for field parameters, including temperature, specific conductivity, pH, dissolved oxygen and turbidity which are collected with a calibrated YSI 6600 unit. They are also monitored for analytical parameters including boron, chloride, total dissolved solids, ortho-phosphate, total phosphate, ammonia, nitrate, nitrite, total dissolved nitrogen, dissolved inorganic nitrogen and chlorophyll-a. Each sample is analyzed at a certified laboratory. In addition, Harbor locations S-7 and S-10 are monitored for the following analytical parameters: total kjeldahl nitrogen, total dissolved solids, ortho-phosphate, total phosphate, ammonia, nitrate, nitrite, total dissolved nitrogen, dissolved inorganic nitrogen, dissolved organic nitrogen, particulate organic carbon and particulate organic nitrogen which are analyzed at a certified laboratory. The field methodology for collecting surface water samples can be found in Appendix F.

2.2.1 Surface Water Sampling Locations

Table 2

Surface Water Sampling Locations			
Location ID	**Description**	**Required by NMP**	**Schedule**
S-1	Russell Mill Pond Rd – prior to hatchery take left on dirt road. Bear right at fork and follow to water. NOTE: ACCESS DENIED AS OF NOVEMBER 2009	☑	5x/yr
S-2B	24 Russell Mill Pond Rd – Enos Property. From end of dock NOTE: ACCESS DENIED FOR FUTURE SAMPLING The Town has been denied access to sampling location, will utilize downstream location S-2C.	See S-2C	NA
S-2C	Off Russell Mill Pond Rd. Downstream of dam	☑	5x/yr
S-3A	Hayden Pond, upstream of fish ladder	☑	5x/yr
S-4A	Howland Pond, at Clifford Rd Bridge, u/s of dam	☑	5x/yr
S-5B	Downstream of Warren Avenue Bridge	☑	5x/yr
S-6A	The Nature Conservancy – at footbridge (prior to dam removal sample taken in Pond upstream of dam)	☑	5x/yr
S-7	In Harbor near Poverty Point	☑	2x/yr
S-10	In Harbor near jetty	☑	2x/yr
S-17	End of dock at 16 Eel River Circle	Not required	
S-4B	Downstream of Clifford Rd Bridge	Not required	
S-11	Upstream of Howland Pond. At outlet upstream of bridge	Not required	
S-15	At outlet of Forge Pond	Not required	
S-16	Inlet of Forges Pond off Old Sandwich Road near bog	Not required	
S-18	Outlet from lower bog off Old Sandwich Road	Not required	
S-19	Outlet from upper bog off Old Sandwich Road	Not required	
S-20	Pond south of Forge Pond	Not required	
S-3B	Downstream of Hayden Pond, directly downstream of bridge off Sandwich Rd. Across from 128 Sandwich Rd.	Not required	
S-2A	Russell Mill Pond –DEEP Location	Not required	
S-9A	Gilbert fish hatchery, upstream of hatchery near pump house in bog. NOTE: ACCESS DENIED AS OF NOVEMBER 2009	Not required	
S-6B	The Nature Conservancy – downstream of footbridge, between footbridge and outlet to Russell Mill Pond. Note: Dam removed at this location in 2010.	Not required	
S-12	Upstream of Long Pond Rd culvert (prior to 2010 taken at culvert outlet)	Not required	
S-13	Upstream of Bog 2 (as of 2010 restored to wetland) south of Long Pond Rd	Not required	
S-14	At headwaters – near tupelo tree, Bog 6 (as of 2010 restored to wetland)	Not required	

2.2.2 Chemical & Ecological Indicators for Surface Waters and Recommended Actions as described in the NMP 2001

The NMP presents a methodology for monitoring changes in the Eel River system. As described on page 7-3 of the NMP, total nitrogen has been chosen as an indicator of potential change because, like phosphorus, it is important for aquatic growth. As the NMP explains, "because nitrogen is not the limiting nutrient in the Eel River system, addition of nitrogen to surface water

bodies is not expected to cause significant ecological changes. Therefore, nitrogen concentrations will be monitored in the eight wells surrounding the WWTF, but action levels and remedial actions are not defined for this parameter in the groundwater wells." If, however, it is determined that Total Nitrogen has changed in the surface waters (as compared to baseline conditions) and has resulted in a change in the biological system, response actions described in the NMP, and as described below, are required. Below are tables from the NMP describing the chemical and ecological indicators and recommended actions for surface waters.

Chemical Indicators for Surface Waters as Described in the NMP 2001

Table 3

Indicator	**Relevance**	**Expected Change**	**Comparison Level**	**Evaluation**	**Action**
Monitor					
Boron	Indicator of wastewater plume	Increase with no harm	Average baseline conditions	None	None
Monitor and Evaluate					
Total Nitrogen	Required nutrient for aquatic growth	Increase with no harm	Average Baseline Conditions	Check change in ecological indicators	See Recommended Actions
pH	Large changes may cause ecological shift	No change expected			
Monitor and Act					
Total Phosphorus	Limiting nutrient for aquatic growth	No increase expected	Concentrations exceed baseline average & 95% exceedence level ** for 2 months in one season	See Action	See Recommended Actions
Ecological Indicators					
Secchi Depth/ Turbidity	Measure of water clarity		Secchi depth <5% exceedence level for 2 months in one season		

Chlorophyll-a	Measure of algal abundance		Concentrations >95% exceedence level for 2 months in one season	Evaluate parameters to determine whether several indicators have changed systematically together.	See Recommended Actions
Macroinvertebrates (SC/CF ratio)	Indicates the dominant food source available		+/- 50% change in ratio over baseline		
Macrophytes (spatial coverage)	Habitat		+/- 25% change in areal coverage		

Recommended Actions from NMP 2001

Table 4

Indicator	Source	Available Actions
Total Phosphorus	WWTF	• Change Plant Operations • Upgrade plant to include phosphorus removal • Relocate discharge to Site 101
	Pinehills Development	Inform Pinehills Management of change
	Watershed	See Nutrient Management Plan – Possible Actions include: • Reduce P load from cranberry bogs and hatcheries • Identify and remediate failed septic systems • Limit use of fertilizers • Implement BMPs to reduce surface runoff
Total Nitrogen	WWTF	• Change Plant Operations • Upgrade nitrogen removal at plant • Relocate to Site 101
	Pinehills Development	Inform Pinehills Management of change

	Watershed	See NMP. Possible actions include: • Upgrade septics to include nitrogen removal • Limit Use of fertilizers • Implement BMPs to reduce surface runoff
pH	WWTF	Upgrade pH adjustment at plant

Recommended Actions

The Town of Plymouth has been proactive in implementation of projects within the Eel River Watershed as well as other areas in Town. As noted above in Tables 3 & 4, there are recommended actions for chemical and biological indicators based on monitoring results. Although these indicators have not triggered recommended actions, the Town is proactively implementing projects within the watershed to improve water quality as well as a number of other environmental improvements. A description of these projects can be found in Section 1.5.

2.2.3 Surface Water Monitoring Data Comparisons

This section provides a description of locations and summary of monitoring data for the NMP required surface water locations S-1, S-2B, S-3A, S-4A, S-5B, S-6A. As noted in Table 2 as of November 2009 access has been denied to S-1. In addition access has been denied to S-2B, therefore, S-2C located downstream of Russell Mill Dam will replace this location. A summary will be included of the two harbor samples, S-7 & S-10.

Location S-1: This surface water station is located on Warren Wells Brook, a tributary to the Eel River, immediately downstream from a privately owned trout hatchery and approximately 0.5miles Southeast from the nearest WWTF infiltration basin. The trout hatchery also owns the small impoundment upstream from hatchery operations which has likely collected sediment inputs as impoundments do over time. The area upstream from the impoundment was retrofitted in 2008 by a private property owner to include a constructed wetland stormwater treatment system in Camelot

Park. The location S-1 can potentially collect various water quality inputs including stormwater inputs from Camelot Park, trout hatchery operations, horse farm nutrient loading and failed septic systems. Figure II-2 titled "Downgradient Impact Areas from 0.75MGD or 1.25MGD Land Application Site A" in the Technical Advisory Committee (TAC) Report (TAC Committee, 2000) indicates location S-1 is outside of both the 0.75MGD and 1.25MGD influence from the infiltration basins. As shown in Section 1.4, the 2012 average of less than 0.12MGD has been discharged into the infiltration basins.

Table 5

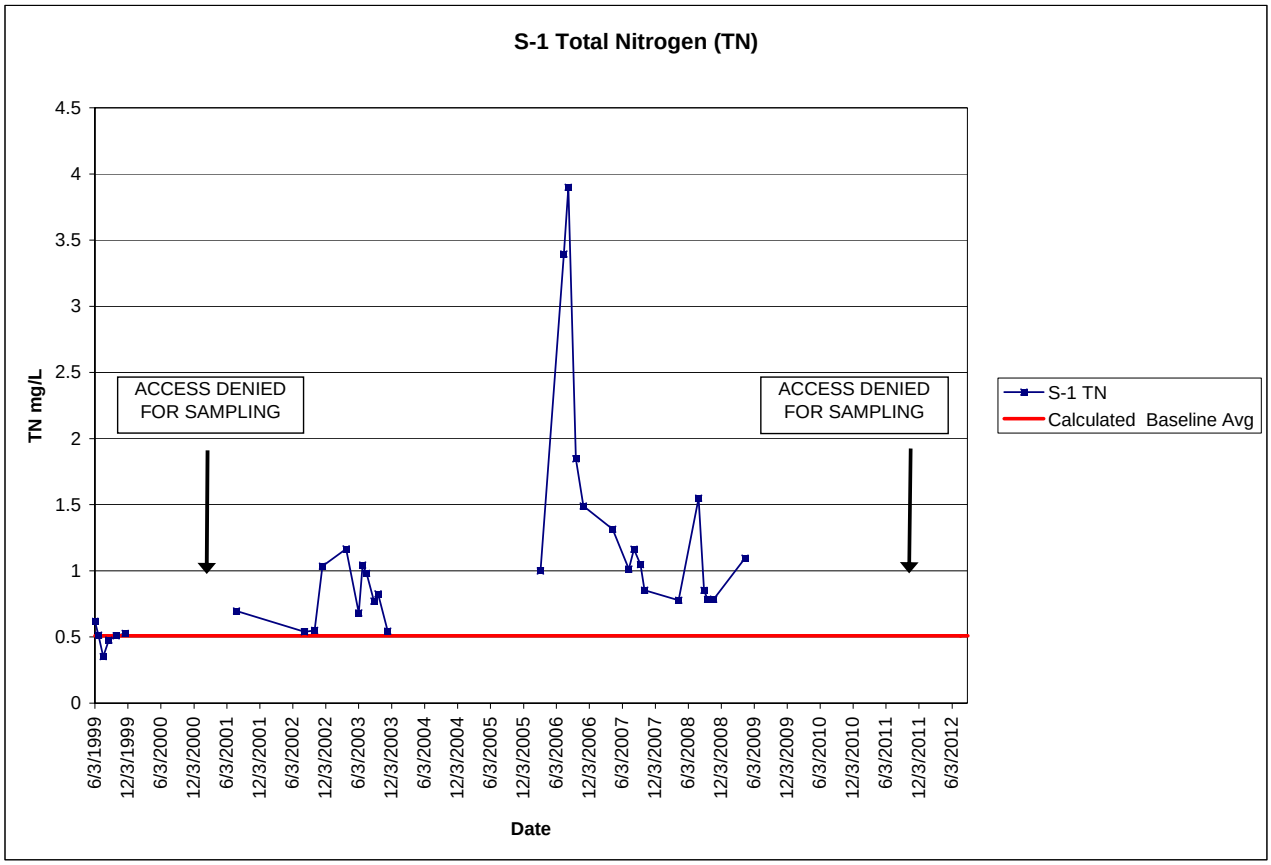
Baseline Average as Described in Appendix E

S-1				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.014	0.023	0.030	10
Total P (mg/L)	0.025	0.029	0.066	11
TKN (mg/L)	0.100	0.291	0.530	4
Ammonia (mg/L)	0.050	0.079	0.145	11
Nitrate (mg/L)	0.143	0.180	0.204	11
Nitrite	NA	NA	NA	0
Total Nitrogen (mg/L)	0.195	0.506	0.697	7
TDN (mg/L)	0.299	0.456	0.635	7
DIN (mg/L)	0.213	0.275	0.320	7
DON (mg/L)	0.065	0.174	0.316	7
PON (mg/L)	0.065	0.081	0.177	7
Boron (mg/L)	0.015	0.022	0.070	10
pH (unitless)	5.600	6.350	7.000	8
Chlorophyll (ug/L)	0.200	0.790	1.600	9

Total Nitrogen

Figure 1 below indicates a peak of TN in 2006 which corresponds respectively to a wetland clearing violation adjacent to Warren Wells Brook on private property as described in the Operational Monitoring Program Data Report (Plymouth, 2008). Water quality data at S-1 following this event shows a quadrupling of total nitrogen and an increase of total phosphorus, as well as an associated increase of total nitrogen at downstream locations S-2B, S-3A and S-5B. Following this incident, the TN value did stabilize for the most part below 1mg/L. Although this is not at the baseline average of 0.51mg/L, there was a downward trend. Further evaluation is not available as access to the site has been denied.

Figure 1



Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L closer to the baseline for this site. The calculated baseline average for S-1 is 0.03mg/L. Excluding the spikes associated with the clearing 8/06,9/06,10/06 as well as 3/06 for the high detection limit and 7/08 for a the data associated with high equipment blank (0.607mg/L) the post WWTF operational average from Aug 02-July 09 is 0.04mg/L, well within range of the baseline average. Further data is not available as access has been denied to the site.

Boron

At this location there were detections prior to WWTF operations during July 99 and Aug 99 with non-detect values until detection in Sept 08 and Oct 08. Following these detections the last three samples were non-detect, however, no further data was acquired due to access being denied. In correlation to this set of samples S-2B and S-3A downstream also had detections in July 99, Aug 99 as well as Sept 99. Upstream from S-1, location S-9A had detections of boron in Sept 08 and

Oct 08 followed by 3 non-detect samples. The Sept 08 field blank had a detection of 0.0360mg/L thereby the boron data during this timeframe has been excluded. Detections in Oct 08 occurred also at S-6A which is outside of the influence of the WWTF and is not on Warren Wells Brook where S-1 is located. The 2008 boron detections do not appear to correlate to any specific event. The calculated boron baseline average for S-1 is 0.022mg/L. Other than the two detections noted above all boron samples were below the detection limit for the operational monitoring period.

pH

As indicated in Table 5 the pre-plant operation average baseline pH is 6.35. From onset of plant operation through 2009, while permission was allowed, the operational average was 6.17. The operational average is within an acceptable range of the baseline average.

Chlorophyll-a

As indicated in Table 5 the pre-plant operation average baseline chlorophyll-a is 0.790 ug/L. From onset of plant operation through 2009, while permission was allowed, the operation average was 2.43ug/L. However, a high count of 24ug/L was detected in August of 2006 the cause is unknown other than input from hatchery operation as the upstream S-9A location was at 0.5ug/L. Excluding the August 2006 value, the average is at 1.49ug/L. In August April and July of 2009 there were unexplained values above average, excluding these two values as well the operational average is at 0.78ug/L. The Town is unable to collect further samples at site due to lack of access from property owner.

Location S-2B/C: S-2B surface water station is located in the Eel River at Russell Mill Pond approximately 0.5miles downstream from S-1 and approximately 1mile Southeast from the nearest WWTF infiltration basin. Russell Mill Pond is now the first impoundment from the headwaters of the Eel River since the removal of Sawmill Pond Dam in 2009-10. Originally CDM collected S-2B prior to the outlet of the Russell Mill Dam and shortly moved the location to the end of the dock at house number 24 on Russell Mills Road. Unfortunately, the owner has denied access for future sampling. The Town has replaced this location with S-2C downstream of the dam as previously sampled. Figure II-2 of the TAC Report (TAC, 2000) indicates this area is outside the area of influence of 0.75MGD from the infiltration basins but with the area of influence of 1.25MGD. As shown in Section 1.4, the 2012 average of less than 0.12MGD has been discharged into the infiltration basins.

Table 6

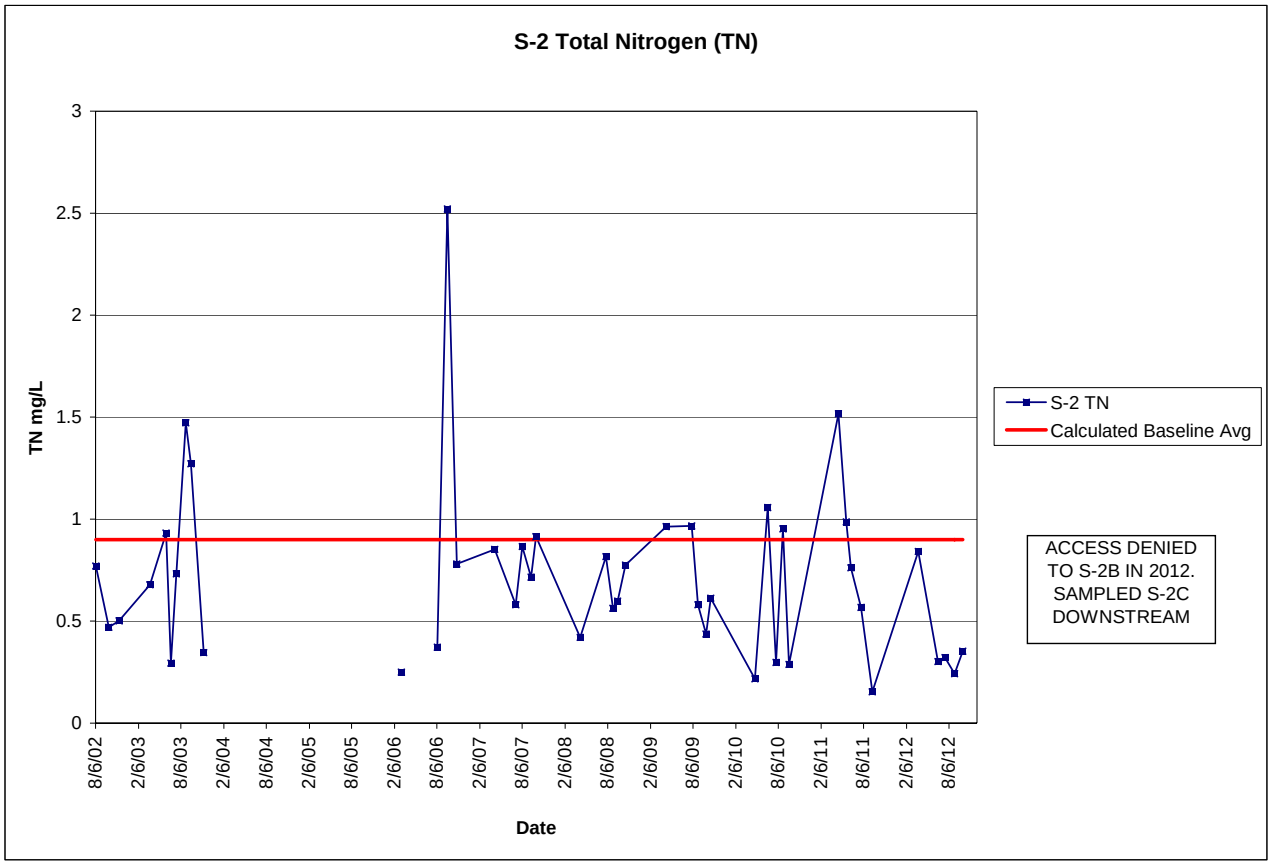
Baseline Average as Described in Appendix E

S-2A				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.005	0.067	0.213	7
Total P (mg/L)	0.025	0.131	0.255	6
TKN (mg/L)	NA	NA	NA	0
Ammonia (mg/L)	0.050	0.050	0.050	7
Nitrate (mg/L)	0.025	0.025	0.025	7
Nitrite	NA	NA	NA	0
Total Nitrogen (mg/L)	0.403	0.900	1.514	7
TDN (mg/L)	0.130	0.335	0.778	7
DIN (mg/L)	0.065	0.116	0.424	7
DON (mg/L)	0.187	0.294	0.556	7
PON (mg/L)	0.151	0.523	0.936	7
Boron (mg/L)	0.015	0.020	0.030	6
pH (unitless)	6.500	6.500	6.500	1
Chlorophyll (ug/L)	3.200	13.980	31.000	6

Total Nitrogen

Figure 2 below indicates a spike in TN in 2006 after the affects of upstream S-1 activity as noted above. It is important to note the baseline data was determined from the S-2A deep location. The location S-2B was then monitored on the surface water from the edge of a dock near Russell Mill dam. As noted above, S-2C will replace S-2B due to denied access. The post WWTF operational average through 2012 is 0.702mg/L, below the calculated baseline average of 0.90mg/L. The average for 2012 is 0.412mg/L, 52% lower than the 2011 average.

Figure 2



Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L. Laboratories have changed since mid summer 2009 with a lower detection limit of 0.005mg/L. The calculated baseline average for S-2B is 0.13mg/L. As noted above, baseline data was determined from the S-2A deep location. The location S-2B was then monitored on the surface water from the edge of a dock near Russell Mill dam. Excluding 6/06 high detection limit as well as the data associated with high equipment blanks in 7/08, 9/09, 10/09 and 6/11 the post WWTF operational average though 2012 is 0.035mg/L, well below the baseline average of 0.13mg/L. The average for 2012 is 0.044 mg/L, 58% lower than the 2011 average.

Boron

At this location there were detections prior to WWTF operations during July 99, Aug 99 and Sept 99 with a brief detection in Jun 04 followed by detections in Jul 10, Aug 10 and Sept 10. Unfortunately, there were detections in the field blank Jul 10 of 0.013mg/L and Aug 10 of

0.022mg/L thereby the boron data during this timeframe has been excluded. The Sept 10 low detected value is consistent throughout the system from upstream at S-6A to the outlet at S-5B. The calculated boron baseline average for S-2 is 0.020mg/L. Other than the detections noted above, and the Sept 10 below the baseline average, all boron samples were below the detection limit for the operational monitoring period.

pH

As indicated in Table 6 the pre-plant operation average baseline pH is 6.50. From onset of plant operation through 2012 the operational average was 6.97. Although half a unit higher than the baseline average, this is well within an acceptable operational average. There were 3 values in 2002-2003 where the pH was 7.7-8.55 which were likely isolated incidents and have potentially skewed the overall average. The average for 2012 is 6.92.

Chlorophyll-a

As indicated in Table 6 the pre-plant operation average baseline chlorophyll-a is 13.98 ug/L. At the new location S-2C there was an unusually high detection of 93.3 ug/L in July of 2012. Without this high reading the operational average through 2012 was 8.95 ug/L, well below the baseline average. With the high reading the operational average through 2012 is 11.1 ug/L, still below baseline average. The average for 2012 without the high detection is 16.05 ug/L.

Location S-3A: This surface water station is located in the Eel River at Hayden Pond approximately 0.65miles downstream from S-2B/C and approximately 1mile east from the nearest WWTF infiltration basin. Hayden Pond is the second and last impoundment along the Eel River other than S-4A site at Howland Pond which is a tributary to the Eel River. The mouth of Hayden Pond receives direct stormwater input from Route 3 via a number of catch basins. To the east of Hayden Pond is 38 acres of agricultural land draining both surface runoff and via underground tile drains to the buffer of Hayden Pond. There is also an additional 13 acres of agricultural land to the west of Hayden, although there is a buffer, this area has been heavily fertilized in the past. Figure II-2 of the TAC Report (TAC, 2000) indicates this area is within either of the two areas of influence 0.75MGD or 1.25MGD from the infiltration basins. As shown in Section 1.4, the 2012 average of less than 0.12MGD has been discharged into the infiltration basins.

Table 7

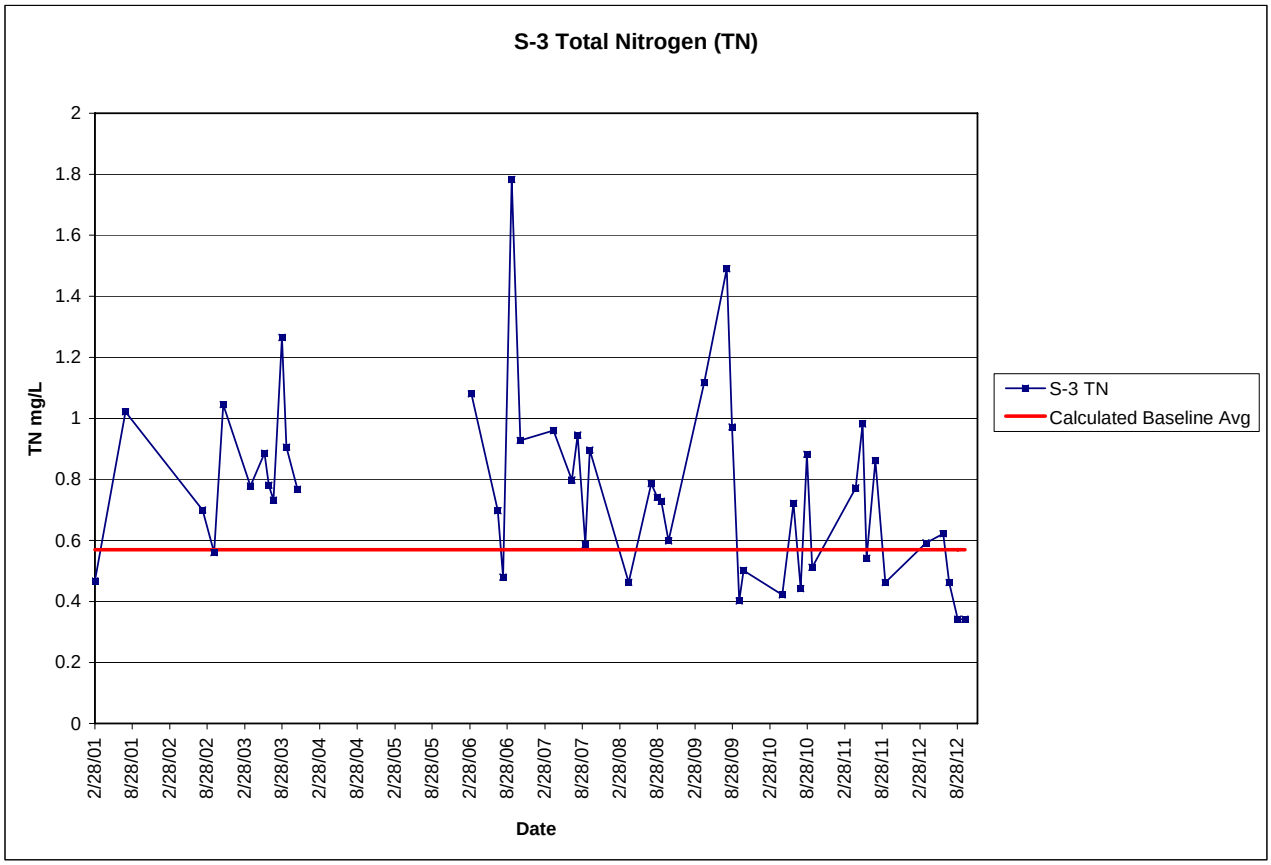
Baseline Average as Described in Appendix E

S-3A				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.005	0.018	0.056	15
Total P (mg/L)	0.025	0.025	0.025	15
TKN (mg/L)	0.100	0.284	0.680	7
Ammonia (mg/L)	0.050	0.060	0.139	15
Nitrate (mg/L)	0.025	0.071	0.233	15
Nitrite	0.025	0.025	0.025	7
Total Nitrogen (mg/L)	0.195	0.570	2.114	15
TDN (mg/L)	0.130	0.593	1.968	8
DIN (mg/L)	0.065	0.131	0.265	8
DON (mg/L)	0.065	0.458	1.847	8
PON (mg/L)	0.065	0.125	0.199	8
Boron (mg/L)	0.015	0.022	0.068	15
pH (unitless)	5.730	6.560	7.150	15
Chlorophyll (ug/L)	0.200	5.080	38.000	15

Total Nitrogen

Figure 3 below indicates a spike in TN after the affects of the upstream S-1 activity in 2006 noted above. The average after the spike from Oct 06 to the end of 2011 was 0.75mg/L. The post WWTF operational average through 2012 is 0.80mg/L. The calculated average from Sept 09 to the end of 2012 was 0.58mg/L, close to the baseline average of 0.57mg/L for this site. The average for 2012 is 0.47mg/L, 65% lower than the 2011 average.

Figure 3



Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L. Laboratories have changed since mid summer 2009 with a lower detection limit of 0.005mg/L. The calculated baseline average for S-3A is 0.025mg/L. Excluding 6/06 high detection limit; the data associated with high equipment blanks in 7/08 and 10/09; the anomaly on 10/06; the 8/08 value when algae bloom was present the post WWTF operational average through 2012 was at 0.039mg/L. The total phosphorus level in 9/08 after the algae growth was <0.02mg/L. The average for 2012 is 0.038 mg/L, 8% lower than 2011.

Boron

At this location there were detections prior to WWTF operations during May 98, June 98, July 99, Aug 99 and Sept 99 followed by detections in Aug 09, Jul 10, Aug 10, Sept 10, July 11 and Sept 11. The Aug 09 value was at the detection level of 0.01mg/L which is the lowest detected value at this location since 1998. The same value was detected downstream at S-5B but not upstream at S-

2B. There were detections in the field blank during Jul 10 of 0.013mg/L and Aug 10 of 0.022mg/L thereby the boron data during this timeframe has been excluded. The Sept 10 low detected value is consistent throughout the system from upstream at S-6A to the outlet at S-5B. The detection in 2011 is approximately the same range as two other sites with detections. S-5 located downstream indicated a detection and S-6 upstream indicated a detection in the same timeframe. However, S-2 is between S-3 and S-6 and did not show any detection. The calculated boron baseline average for S-3A is 0.022mg/L. Other than the detections noted above, some of which are below the baseline average, all boron samples were below the detection limit for the operational monitoring period.

pH

As indicated in Table 7 the pre-plant operation average baseline pH is 6.56. From onset of plant operation through 2012 the operational average was 6.62. The operational average is within an acceptable range of the baseline average. The average for 2012 is 6.80.

Chlorophyll-a

As indicated in Table 7 the pre-plant operation average baseline chlorophyll-a is 5.08 ug/L. From onset of plant operation through 2012 the operation average is 6.92 ug/L, well within an acceptable range of the baseline average. The average for 2012 is 12.29 ug/L.

Location S-4A: This surface water station is located in a tributary to the Eel River at Howland Pond. Downstream approximately 0.25miles is the confluence with the Eel River which is also 0.25miles downstream from location S-3A. This station is approximately 1.5miles east from the nearest infiltration basin and is not influenced by either a 0.75MGD or 1.25MGD discharge as shown in Figure II-2 of the TAC Report (TAC, 2000). Howland Pond is an impoundment bordered by over 60 acres of active agricultural land. This impoundment is subject to influence of agricultural activities discharging sediment as well as stream sediment transport. Figure II-2 of the TAC Report (TAC, 2000) indicates this station is outside of the influence of either 0.75MGD or 1.25MGD from the infiltration basins.

Table 8

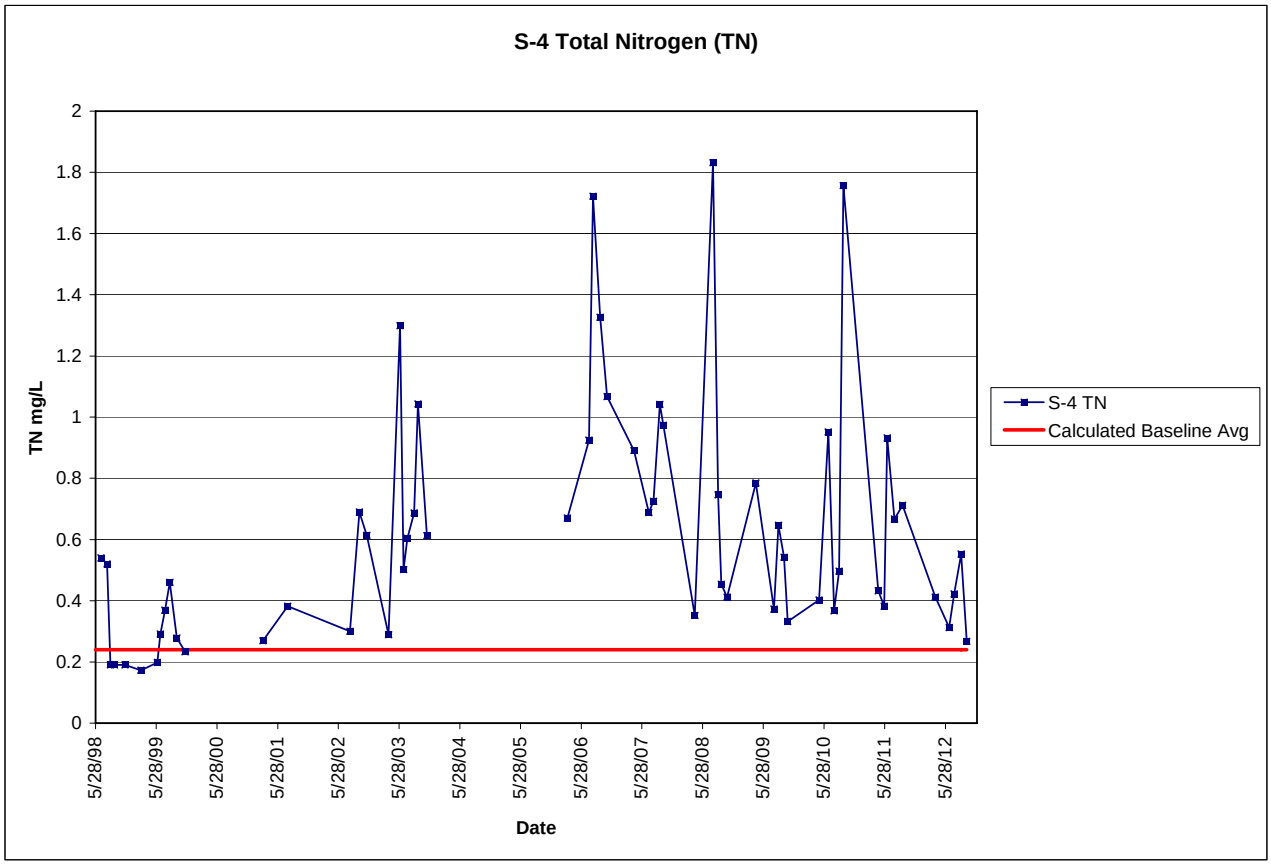
Baseline Average as Described in Appendix E

S-4A				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.005	0.020	0.120	15
Total P (mg/L)	0.025	0.032	0.120	14
TKN (mg/L)	0.100	0.197	0.450	7
Ammonia (mg/L)	0.050	0.050	0.050	15
Nitrate (mg/L)	0.025	0.025	0.025	15
Nitrite	0.025	0.025	0.025	7
Total Nitrogen (mg/L)	0.195	0.243	0.540	14
TDN (mg/L)	0.130	0.154	0.318	8
DIN (mg/L)	0.065	0.065	0.065	8
DON (mg/L)	0.065	0.136	0.297	8
PON (mg/L)	0.065	0.086	0.157	8
Boron (mg/L)	0.015	0.019	0.055	15
pH (unitless)	5.710	6.390	7.000	13
Chlorophyll (ug/L)	0.200	1.400	3.200	15

Total Nitrogen

Figure 4 indicates an upward trend in TN beginning in 2000 with intermittent spikes in TN but decreasing in 2012. This site is not associated with any influence from the WWTF. Increase in TN may be due to wetland clearing in 2005-2006 along the banks of Howland Pond. Another source of nitrogen may be from the quantity of waterfowl such as swans and ducks that utilize the pond. The post WWTF operational average through 2012 is 0.71mg/L. The average in 2012 is 0.39mg/L, 63% lower than the 2011 average. The baseline average is calculated at 0.243mg/L, however, as stated above this site is not associated with any influence from the WWTF and the increase is likely due to a multitude of activities in the surrounding watershed area.

Figure 4



Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L. Laboratories have changed since mid summer 2009 with a lower detection limit of 0.005mg/L. The calculated baseline average for S-4A is 0.032mg/L. A detection in 07/11 was higher than normal but included in the calculated post operational average. Approximately 3 weeks prior to sampling, the owner of Howland Pond treated the pond to remove algae as allowed via permits. Excluding the high detection limit in 3/06 as well as the data associated with high equipment blanks in 7/08, 9/09 and 10/09 the post WWTF operational average through 2012 was at 0.049 mg/L. The average for 2012 is 0.056 mg/L, 52% lower than 2011.

Boron

As similar to other locations there were detections prior to WWTF operations during May 98, Aug 99 and Sept 99 followed by detection in Oct 08, July 09, July 10 and Aug 10. The Oct 2008 detection is at the same time frame as locations S-1, S-9A, S-6A and S-5B which are in a separate

tributary from this location in Howland Pond. There were detections in the field blanks during Jul 10 of 0.013mg/L and Aug 10 of 0.022mg/L t thereby the boron data during this timeframe has been excluded. The following sampling round in Sept 10 was non-detect for boron. The calculated boron baseline average for S-4A is 0.019mg/L. Other than the detections noted above all boron samples were below the detection limit for the operational monitoring period.

pH

As indicated in Table 8 the pre-plant operation average baseline pH is 6.39. From onset of plant operation through 2012 the operational average was 6.62. The operational average is within an acceptable range of the baseline average. The average for 2012 is at 7.10.

Chlorophyll-a

As indicated in Table 8 the pre-plant operation average baseline chlorophyll-a is 1.40 ug/L. From onset of plant operation through 2012 the operational average was 3.12 ug/L. This is calculated without the August 2006 value of 150 ug/L which is likely due to algae noted during sampling. The average for 2012 was 1.96 ug/L.

Location S-5B: This surface water station is located downstream of Eel River Basin and Warren Ave at the mouth of Plymouth Harbor, thereby receiving tidal influence. The station is approximately 1.25miles downstream from the confluence discussed at location S-4A above and 1.25miles Northeast of the nearest infiltration basin. Figure II-2 of the TAC Report (TAC, 2000) indicates this area is within either of the two areas of influence 0.75MGD or 1.25MGD from the infiltration basins. As shown in Section 1.4, the 2012 average of less than 0.12MGD has been discharged into the infiltration basins.

Table 9

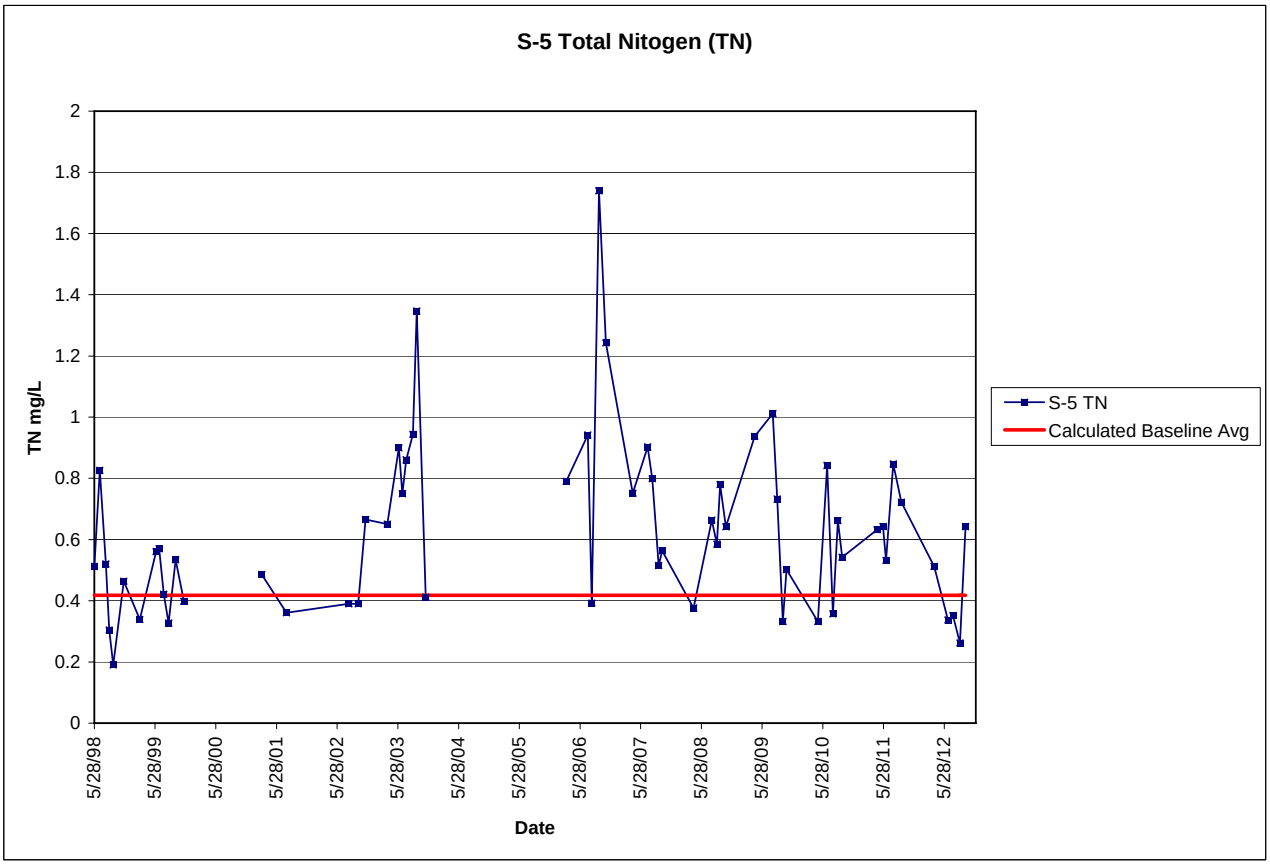
Baseline Average as Described in Appendix E

S-5B				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.005	0.020	0.055	15
Total P (mg/L)	0.025	0.027	0.055	15
TKN (mg/L)	0.100	0.312	0.650	7
Ammonia (mg/L)	0.050	0.050	0.050	15
Nitrate (mg/L)	0.025	0.069	0.203	15
Nitrite	0.025	0.025	0.025	7
Total Nitrogen (mg/L)	0.195	0.418	0.826	15
TDN (mg/L)	0.130	0.207	0.376	8
DIN (mg/L)	0.065	0.117	0.318	8
DON (mg/L)	0.133	0.182	0.318	8
PON (mg/L)	0.065	0.181	0.382	8
Boron (mg/L)	0.015	0.025	0.077	15
pH (unitless)	6.100	6.750	7.400	12
Chlorophyll (ug/L)	0.200	3.700	17.000	15

Total Nitrogen

Figure 5 below indicates an upward trend of TN until 2011 at this station and in 2012 has started a downward trend. This station may be influenced by the increases in Howland Pond and/or any activity occurring with the 1.25miles of river from S-3A/S-4A. The post WWTF operational average through 2012 is 0.68mg/L. The average in 2012 is 0.41mg/L, 63% lower than the 2011 average. The 2012 average is at exactly the calculated baseline average of 0.41mg/L.

Figure 5



Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L. Laboratories have changed since mid summer 2009 with a lower detection limit of 0.005mg/L. The calculated baseline average for S-5B is 0.027 mg/L. A detection in 07/11 was higher than normal but included in the calculated post operational average. Excluding the high detection limit in 3/06; the data associated with high equipment blanks in 7/08, 9/09 ,10/09 and 06/11; and the anomaly in 4/07 the post WWTF operational average through 2012 was at 0.049 mg/L. The average for 2012 is 0.056mg/L, 64% lower than 2011.

Boron

At this location there were detections prior to WWTF operations during May 98, Jun 98, Aug 98, Jun 99, July 99, Aug 99, Nov 99, Feb 00 followed by detections in Aug 07, July 08, Aug 08, Sept 08, Aug 09, Jun 10, July 10, Aug 10, Sept 10, June 11, July 11 and Sept 11. In Aug 07 the

detection was well within the average for the pre-operation values and is likely a localized incident such as septic system input as there have been numerous detections prior to WWTF operations. The July 08 field blank had a detection of 0.0370mg/L and Sept 08 field blank had a detection of 0.0360mg/L thereby the boron data during this timeframe has been excluded. The detection in Aug 08 does not correlate to any of the other sites along the Eel River as they were all non-detect. The Aug 09 value was at the detection level of 0.01mg/L which is the lowest detected value at this location since 1998 followed by the Jun 10 and Sept 10 detection at 0.012mg/L. The Sept 10 low detected value is consistent throughout the system from upstream S-6A downstream to this location. There were detections in the field blanks during Jul 10 of 0.013mg/L and Aug 10 of 0.022mg/L t thereby the boron data during this timeframe has been excluded. The detections in 2012 are below the baseline average other than in June there was a detection of 0.038mg/L. The calculated boron baseline average for S-5B is 0.025mg/L. Other than the detections noted above, which were generally below the baseline average, all boron samples were below the detection limit for the operational monitoring period.

pH

As indicated in Table 9 the pre-plant operation average baseline pH is 6.75. From onset of plant operation through 2012 the operational average was 6.64. The operational average is within an acceptable range of the baseline average. The average for 2012 is 7.15.

Chlorophyll-a

As indicated in Table 9 the pre-plant operation average baseline chlorophyll-a is 3.70ug/L. From onset of plant operation through 2012 the operational average was 5.17 ug/L, above the baseline average, however, within an acceptable range. The average for 2012 is 7.87 ug/L.

Location S-6A: This surface water station is located downstream approximately 1mile from the headwaters of the Eel River. Prior to 2010 this station was located in the Sawmill Impoundment at the headwall of the dam. As of 2010, the dam has been removed and river restored as part of the Eel River Headwaters Restoration described in Section 1.5. The station is located 1 mile south of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is well outside of both the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 10

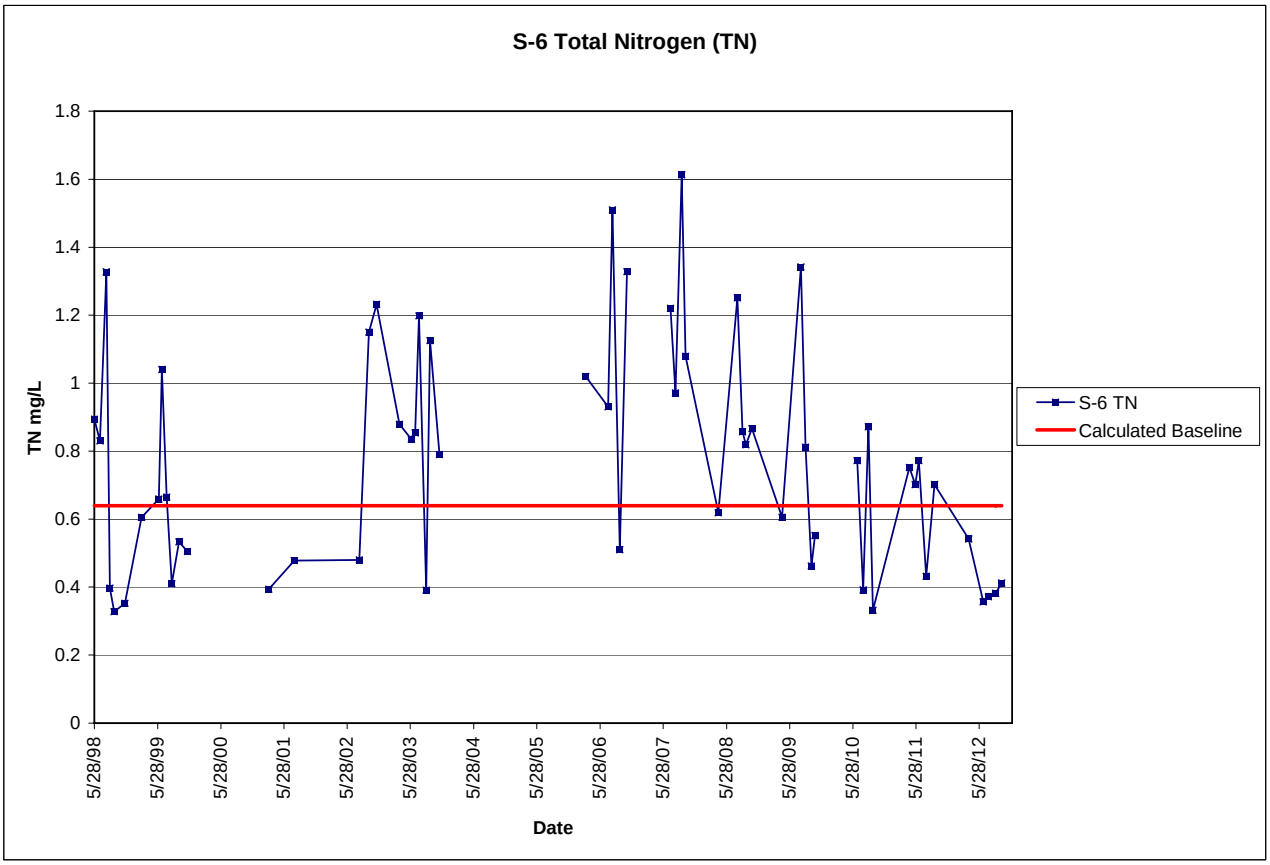
Baseline Average as Described in Appendix E

S-6A				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.005	0.052	0.251	14
Total P (mg/L)	0.025	0.054	0.196	14
TKN (mg/L)	0.100	0.371	1.030	7
Ammonia (mg/L)	0.039	0.056	0.121	14
Nitrate (mg/L)	0.077	0.239	0.434	14
Nitrite	0.025	0.025	0.025	7
Total Nitrogen (mg/L)	0.328	0.639	1.327	14
TDN (mg/L)	0.230	0.464	0.928	7
DIN (mg/L)	0.065	0.248	0.410	7
DON (mg/L)	0.099	0.212	0.518	7
PON (mg/L)	0.069	0.137	0.209	7
Boron (mg/L)	0.015	0.032	0.257	15
pH (unitless)	5.600	6.185	7.110	14
Chlorophyll (ug/L)	0.200	1.690	4.100	15

Total Nitrogen

As shown in Figure 6 below, there has been an overall decrease in TN notably following restoration activities in 2009. With the upstream influence the impoundment, 40 acres of cranberry bogs, ditches, undersized culverts removed and the area restored to natural stream channel and wetland habitat there will be further reductions in nutrient loads to the river system. The post WWTF operational average through 2012 is 0.81mg/L. The average in 2012 is 0.41mg/L, 61% lower than the 2011 average. The 2012 average is well below the calculated baseline average at 0.63mg/L.

Figure 6



Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L. Laboratories have changed since mid summer 2009 with a lower detection limit of 0.005mg/L. The calculated baseline average for S-6A is 0.054 mg/L. Excluding the high detection limit in 3/06 and the data associated with high equipment blanks in 7/08, 9/09, 10/09 and 06/11 the post WWTF operational average through 2012 was at 0.054 mg/L. The average for 2012 is 0.055 mg/L, 63% lower than the average in 2011.

Boron

At this location there were detections prior to WWTF operations during May 98, Jul 99, Aug 99 and Sept 99 followed by detections in Aug 02, July 06, July 08, Oct 08, Aug 09, June 10, July 10, Aug 10, Sept 10, July 11 and Sept 11. Both the Aug 02 and July 06 detections were low and can be compared to pre-operation values. The July 08 field blank had a detection of 0.0370mg/L thereby the boron data during this timeframe has been excluded. The Oct 08 detection was similar to the

detections at S-1 and S-4A which are on separate tributaries to the Eel River. The Aug 09, Jun 10 and Sept 10 value was at the detection level of 0.01mg/L which is the lowest detected value at this location since 1998 and is consistent with detected values at S-5B and S-3A. There were detections in the field blanks during Jul 10 of 0.013mg/L and Aug 10 of 0.022mg/L t thereby the boron data during this timeframe has been excluded. The detections in 2011 are below the calculated baseline average. The calculated boron baseline average for S-6A is 0.032mg/L. Other than the detections noted above all boron samples were below the detection limit for the operational monitoring period.

pH

As indicated in Table 10 the pre-plant operation average baseline pH is 6.19. From onset of plant operation through 2012 the operational average was 6.49. The operational average is within an acceptable range of the baseline average. The average for 2012 is 6.71.

Chlorophyll-a

As indicated in Table 10 the pre-plant operation average baseline chlorophyll-a is 1.69ug/L. From onset of plant operation through 2012 the operational average was 2.14 ug/L, well within an acceptable range of the baseline average. The average for 2012 is 3.26 ug/L.

Location S-7 Harbor: This harbor location is closer to the outlet of the Eel River than S-10 also located in the harbor. The coordinates for this location: 70 38’23.59W 41 57’8.35”N

Table 11

Baseline Average as Described in Appendix E

S-7				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.005	0.018	0.026	7
Total P (mg/L)	0.025	0.025	0.025	3
TKN (mg/L)	0.100	0.313	0.574	7
Ammonia (mg/L)	0.050	0.050	0.050	7
Nitrate (mg/L)	0.025	0.025	0.025	4
Nitrite	NA	NA	NA	0
Total Nitrogen (mg/L)	0.195	0.328	0.615	7
TDN (mg/L)	0.130	0.230	0.414	7
DIN (mg/L)	0.065	0.065	0.065	7
DON (mg/L)	0.065	0.219	0.372	7
PON (mg/L)	0.065	0.098	0.202	7
Boron (mg/L)	NA	NA	NA	NA
pH (unitless)	NA	NA	NA	NA
Chlorophyll (ug/L)	NA	NA	NA	NA

Total Nitrogen

The calculated baseline average for S-7 is 0.328mg/L. The post WWTF operational average through 2012 is 0.49mg/L. The two locations in the harbor had similar averages. The 2012 average is 0.37 mg/L, 78% lower than the 2011 average.

Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L. Laboratories have changed since mid summer 2009 with a lower detection limit of 0.005mg/L. The calculated baseline average for S-7 is 0.025 mg/L. Excluding the data associated with the high equipment blank in 7/08 the post WWTF operational average through 2012 was at 0.043 mg/L. The 2012 average is 0.028 mg/L, 77% lower than the 2011 average.

Location S-10 Harbor:

Located in the harbor close to the jetty. The coordinates for this location: 70 39'12.32"W 41 57'41.86"N

Total Nitrogen

The calculated baseline average for S-10 is 0.32mg/L. The post WWTF operational average through 2012 is 0.49mg/L. The two locations in the harbor had similar total nitrogen averages. The 2012 average is 0.26 mg/L, 56% lower than the 2011 average.

Table 12

Baseline Average as Described in Appendix E

S-10				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Ortho P (mg/L)	0.005	0.018	0.033	8
Total P (mg/L)	0.025	0.025	0.025	3
TKN (mg/L)	0.100	0.328	0.643	8
Ammonia (mg/L)	0.050	0.050	0.050	8
Nitrate (mg/L)	0.025	0.025	0.025	5
Nitrite	NA	NA	NA	0
Total Nitrogen (mg/L)	0.195	0.317	0.696	8
TDN (mg/L)	0.130	0.243	0.578	8
DIN (mg/L)	0.065	0.065	0.065	8
DON (mg/L)	0.065	0.239	0.501	8
PON (mg/L)	0.065	0.093	0.213	8
Boron (mg/L)	NA	NA	NA	NA
pH (unitless)	NA	NA	NA	NA
Chlorophyll (ug/L)	NA	NA	NA	NA

Total Phosphorus

In 2006 the total phosphorus detection limit was at 0.132mg/L which made it difficult to compare to baseline detection limit of 0.05 and 0.003mg/L. The data was re-issued with a detection limit of 0.04mg/L. Laboratories have changed since mid summer 2009 with a lower detection limit of 0.005mg/L. The calculated baseline average for S-10 is 0.025 mg/L. Excluding the data associated with a high equipment blank in 9/09 the post WWTF operational average through 2012 was at 0.039 mg/L. The average for 2012 is 0.051 mg/L, 56% higher than the 2011 average.

2.2.4 Surface Water Nutrient Yearly Averages

Below are two tables depicting the pre and post WWTF operational yearly averages for both total phosphorus and total nitrogen. All data was utilized for total nitrogen averages. Total phosphorus averages excluded values where the field blank had a high detection as noted in Section 2.2.3.

Figure 7

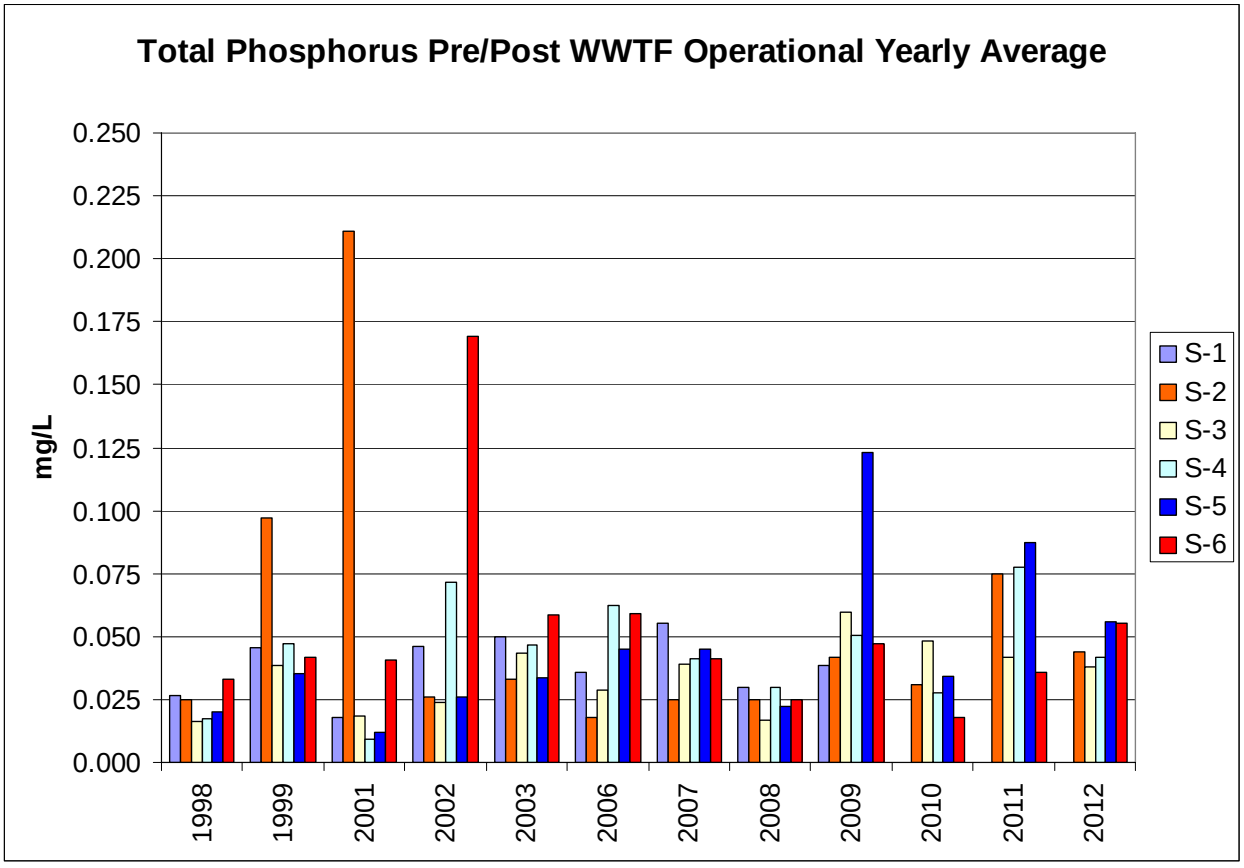
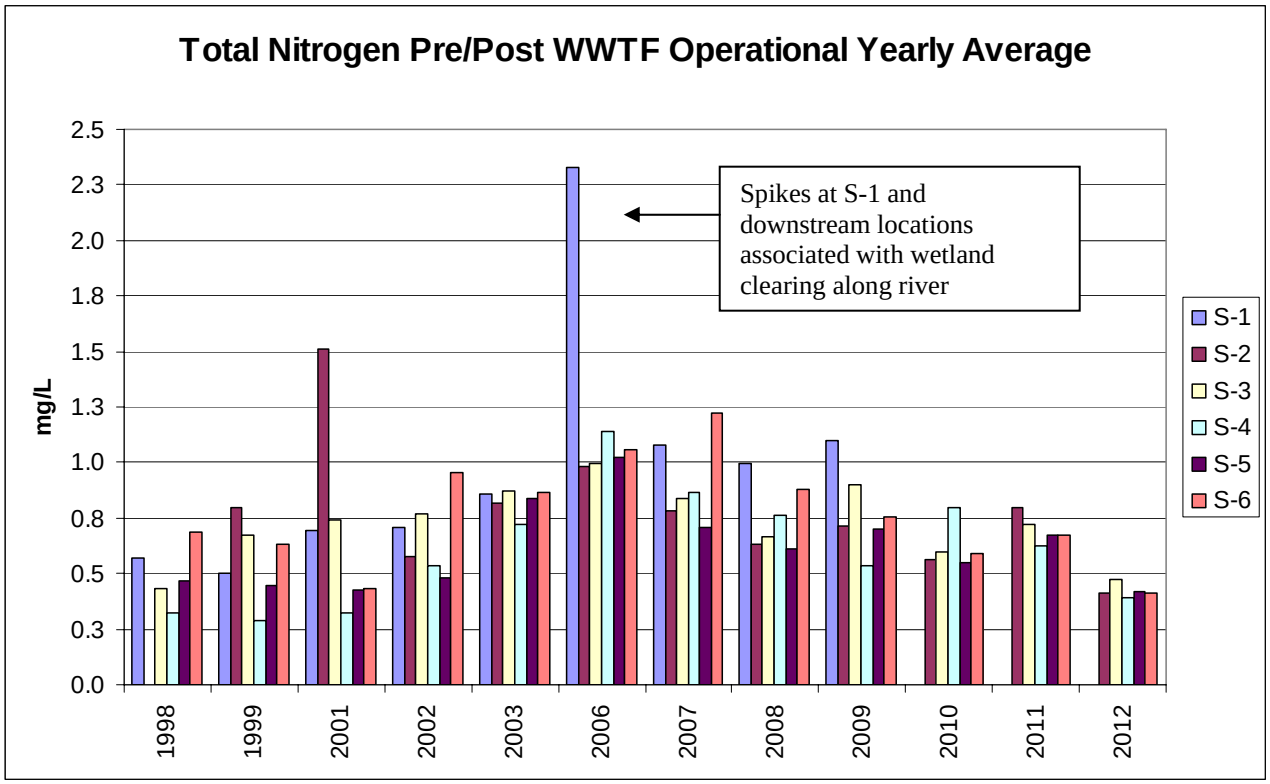


Figure 8



2.3 Groundwater Monitoring

Under the NMP, the Town monitors water levels in thirteen groundwater wells, eleven of which are monitored for field and laboratory analysis. The groundwater monitoring locations monitored two times per year include the following wells: A13, A15, A17, A21, 2SR, 2DR, 3S, 3D, 7SR, 5S and Bradford as described below. As of November 2009 access has been denied to the two well locations 3S & 3D. In the spring of 2011 sampling event an additional well, A19, sampled 2002-2004, will be added to compensate for the wells on private property the Town no longer has access to. A19 is located behind the treatment plant adjacent to the private property of 3S & 3D, thereby allowing the Town to accurately monitor any potential WWTF impacts in the groundwater. The groundwater wells are monitored for field parameters including temperature, specific conductivity, pH, dissolved oxygen and turbidity which are collected with a calibrated YSI 6600 unit. The wells are also monitored for analytical parameters including boron, chloride, copper, iron, mercury, VOC, total dissolved solids, ortho-phosphate, total phosphate, ammonia, nitrate, nitrite, total dissolved nitrogen, dissolved inorganic nitrogen, dissolved organic nitrogen and particulate organic

nitrogen. Each sample is analyzed at a certified laboratory. The field methodology for collecting ground water samples can be found in Appendix G which references the EPA groundwater low stress purging and sampling procedures, EPA July 1996 Rev 2. As noted in the procedure, a two-well volume purge is conducted and sample is collected upon stabilization of field parameters.

2.3.1 Groundwater Monitoring Locations

Table 13

Groundwater Monitoring Locations			
Location ID	**Description**	**Inner/OuterWells/NMP**	**Schedule**
A9	Down gradient of Infiltration site, in wooded area	Inner (Permit)	Monthly
A10	Down gradient of Infiltration site, in wooded area	Inner (Permit)	Monthly
A11	Infiltration Basin Site	Inner (Permit)	Monthly
A16	Infiltration Basin Site	Inner (Permit)	Monthly
6S (R)	Down gradient of infiltration site	Outer (Permit)	Monthly
6D	Down gradient of infiltration site	Outer (Permit)	Monthly
1S	Down gradient of infiltration site	Outer (Permit)	Monthly
USGS 475 (R)	In cul-de-sac of Russell Mill Road	Outer (Permit)	Monthly
A13	DPW Parking Lot	NMP	2x/yr
A15	Before Hayden Hollow subdivision on Sandwich Rd	NMP	2x/yr
A17	Infiltration Basin Site near Odor Control	NMP	2x/yr
A21	On top of Russell Mill Pond Dam	NMP	2x/yr
2SR	Near culvert into Warren Wells Brook (Woods)	NMP	2x/yr
2DR	Near culvert into Warren Wells Brook (Woods)	NMP	2x/yr
3S	At Nickerson Property - near Hatchery NOTE: ACCESS DENIED AS OF NOVEMBER 2009	NMP	2x/yr
3D	At Nickerson Property - near Hatchery NOTE: ACCESS DENIED AS OF NOVEMBER 2009	NMP	2x/yr
A19	As of 2011 Replacement well for 3S/3D located in wooded area behind WWTF	NMP	2x/yr
7SR	In cul-de-sac of East Russell Mill Rd	NMP	2x/yr
5S	Nickerson Property - Off Russell Mills Road	NMP	2x/yr
Bradford	Town water supply well off Long Pond Road	NMP	2x/yr
472	Near Eel River Preserve Parking along Boot Pond Road	NMP (water level only)	WL Only
473	Near Eel River Preserve Parking along Boot Pond Road	NMP (water level only)	WL Only

Note: Locations 7SR & 5S were added to sampling program per DEP approval for 2007 sampling. Location A19 replaces 3S/3D

2.3.2 Groundwater Permit Compliance

Table 14

Groundwater Permit Compliance

Monitoring Group	*Wells*	*Permit Limit*
Adjacent Wells near WWTF site "inner wells"	A8,A9, A10, A11, & A16	Any well >0.2mg/L of total phosphorus for either 3 consecutive months or 4 out of 6 consecutive months
Down-gradient Wells from WWTF site "outer wells"	1S,6SR,6D & USGS 475	Any well total phosphorus increase of >100% over established background concentrations for either 3 consecutive months or 4 out of 6 consecutive months. (Using all baseline data the average background concentration for these four outer wells is 0.07mg/L. The NMP Section 7.3 states 0.084mg/L through July 2001. Therefore an increase of 100% over the established background is 0.14mg/L)

As stated in Table 7-1 of the 2001 Nutrient Management Plan, total phosphorus has an action level while total nitrogen, boron and pH are to be monitored. Total phosphorus was chosen as an indicator because it is generally the limiting nutrient in the freshwater systems. As indicated in the NMP, phosphorus discharged into the infiltration basins is expected to be absorbed by the soil close to the facility and not migrate through the groundwater. To monitor possible phosphorus breakthroughs and prevention from traveling to surface waters, the permit limits were set both in the NMP and the groundwater discharge permit.

2.3.3 Bi-annual Groundwater Monitoring Data Comparisons

A13, A15, A17, A21, 2SR, 2DR, 3S, 3D (and 7SR, 5S as of 2007, A19 as of Nov 2010)

These locations were previously collected by Camp Dresser & McKee Inc. The Environmental Management Division began the monitoring in 2006.

Location A13: This groundwater monitoring well is located in the Towns DPW Facility parking lot off Camelot Park Drive. The monitoring well is located 1,200ft NW of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is outside of both the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 15

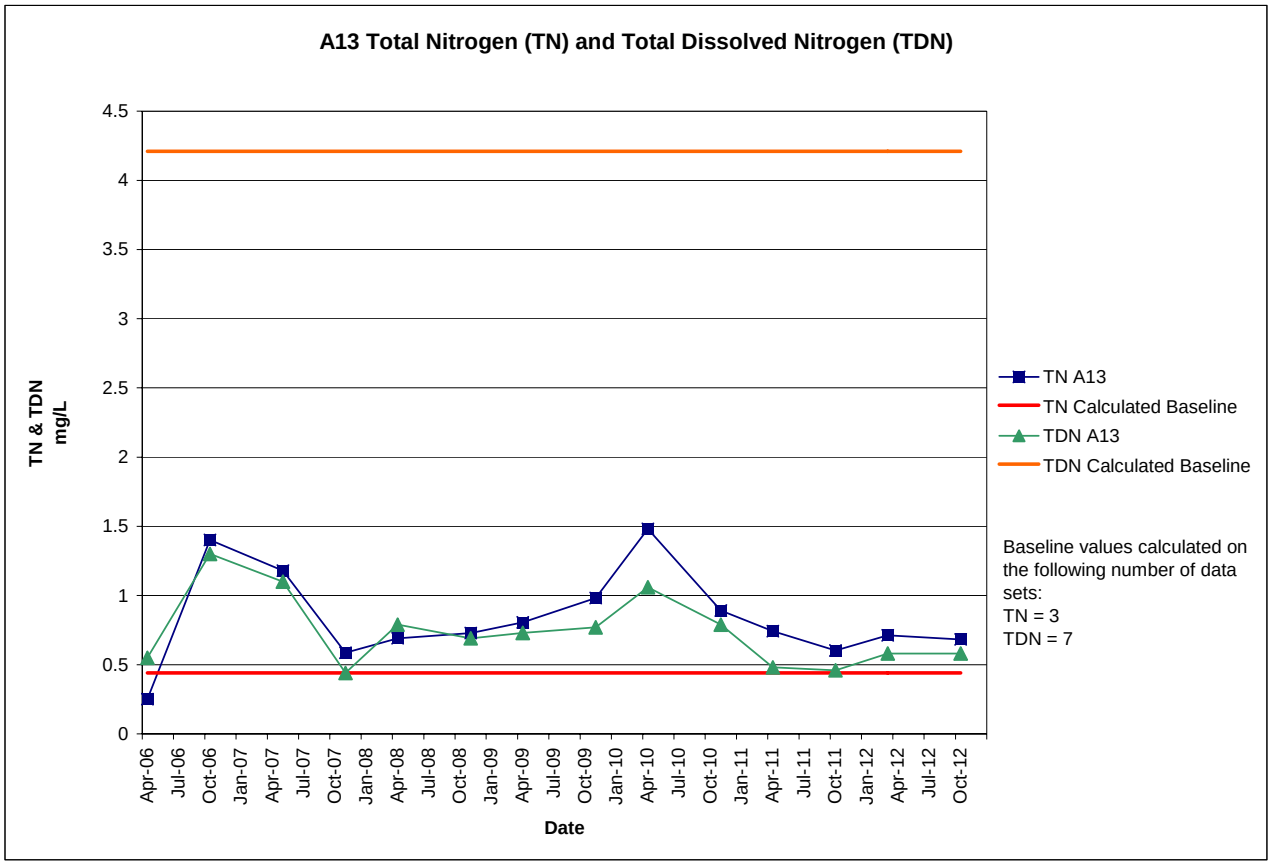
Baseline Average as Described in Appendix E

A13				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.024	0.091	9
Ortho-phosphate (mg/L)	0.05	0.05	0.05	9
Ammonium (mg/L)	0.065	0.091	0.160	9
Nitrate (mg/L)	0.14	0.37	1.68	9
Nitrite (mg/L)	0.065	0.065	0.065	2
Total Nitrogen (mg/L)	0.43	0.44	0.45	3
TDN (mg/L)	0.36	4.21	26.86	7
DIN (mg/L)	0.20	0.50	1.84	7
DON (mg/L)	0.065	3.69	25.03	7
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	2
Boron (mg/L)	0.015	0.016	0.023	9
pH (units)	2.19	4.92	5.60	9

Total Nitrogen

Figure 9 below illustrates total nitrogen and total dissolved nitrogen baseline values as well as 2006-2012 monitoring well data. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data. The number of data sets are listed in the figure as well as the table associated with the monitoring well. For monitoring well A13 the TDN had the higher amount of datasets, however, the baseline values were high due to two sampling periods of well data. Therefore, both TN & TDN will be compared for this monitoring well. The monitoring well data for TDN correlates on the graph appropriately with the TN data. As stated above, the TDN baseline value is high and as the graph indicates all monitoring well data 2006-2012 is well below this level. The TN is above baseline average in most cases but has decreased to just above the baseline average. Without the two spikes in October of 2006 and April of 2010 the operational (2006-2012) average for both TN and TDN is 0.737mg/L, a slight decrease from the 2010 average. This well site is located directly outside of the Eel River Watershed. This well site is out of the influence of the WWTF discharge to the infiltration basins. The groundwater contours indicate the groundwater would not travel in this direction from the infiltration basins. Any nitrogen increase is likely due to watershed impacts.

Figure 9



Total Phosphorus

As indicated in Table 15 the pre-plant operation average baseline for total phosphorus is 0.024mg/L based on nine sampling rounds. The operational monitoring well data average 2002-2012 is 0.031mg/L, 8% lower than last years average. This average operational concentration is similar to other sampled well sites. This well site is located directly outside of the Eel River Watershed. This well site is out of the influence of the WWTF discharge to the infiltration basins. The groundwater contours indicate the groundwater would not travel in this direction from the infiltration basins.

Boron

As indicated in Table 15 the pre-plant operation average baseline boron is 0.016mg/L. The operational monitoring well data average is 0.019mg/L, majority of values are non-detect. This average is 5% lower than last year's average. The operational average is within an acceptable range of the baseline average.

pH

As indicated in Table 15 the pre-plant operation average baseline pH is 4.92. The operational average is 4.76. The operational average is within an acceptable range of the baseline average.

Location A15: This groundwater monitoring well is located down gradient from the Hayden Hollow Subdivision off of Sandwich Road. The monitoring well is located 3,800ft NE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is within both the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 16

Baseline Average as Described in Appendix E

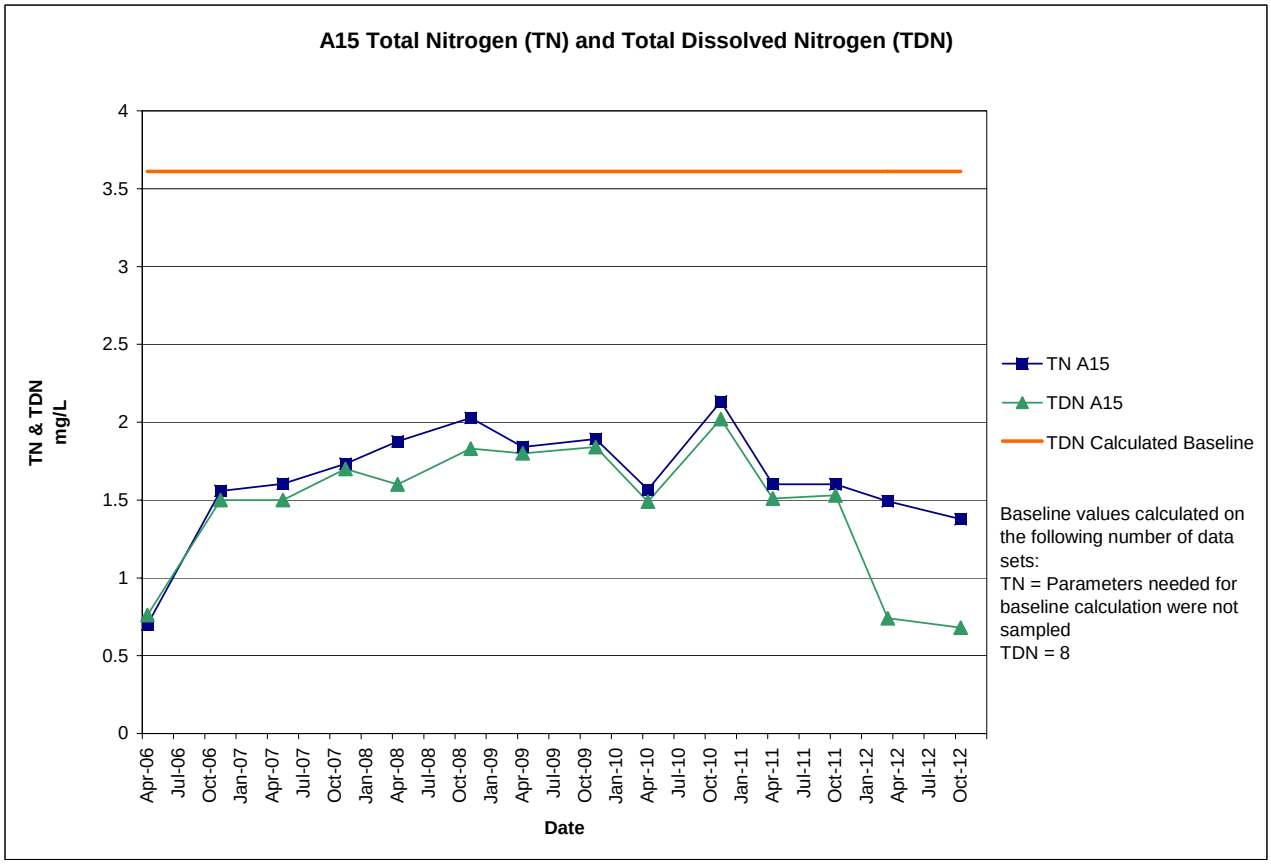
A15				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.031	0.051	8
Ortho-phosphate (mg/L)	0.05	0.05	0.05	8
Ammonium (mg/L)	0.065	0.065	0.065	8
Nitrate (mg/L)	0.065	0.28	1.60	8
Nitrite (mg/L)	NA	NA	NA	0
Total Nitrogen (mg/L)	NA	NA	NA	0
TDN (mg/L)	0.13	3.61	27.55	8
DIN (mg/L)	0.065	0.29	1.61	8
DON (mg/L)	0.065	3.35	25.94	8
PON (mg/L)	NA	NA	NA	0
TKN (mg/L)	NA	NA	NA	0
Boron (mg/L)	0.015	0.038	0.170	7
pH (units)	5.30	6.63	9.60	7

Total Nitrogen

Figure 10 below illustrates total nitrogen and total dissolved nitrogen baseline values as well as 2006-2012 monitoring well data. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data. The number of data sets are listed in the figure as well as the table associated with the monitoring well. For monitoring well A15 the parameters required for TN baseline calculations were not sampled during the pre-operation period. In most cases, nitrite was excluded from the field sampling analysis. Therefore, TDN will be utilized to compare pre and post operational data sets. As with monitoring well A13, A15 also had a high reading during the baseline period for TDN. The monitoring well data for TDN correlates on the graph appropriately with the TN data. As

stated above, the TDN baseline value is high and as the graph indicates all monitoring well data 2006-2012 is below this level. Unfortunately the monitoring well is down gradient of the Hayden Hollow Subdivision with approximately 24 homes built between 1998-2005 with private septic systems. Both the TN & TDN shows a slightly upward trend beginning late 2006 which is likely associated with watershed impacts, specifically private septic systems. In 2011 the trend began to move downward and continues to decrease in 2012. The operational average (2006-2012) for TN and TDN is 1.64mg/L and 1.46mg/L respectively. An upgraded septic system discharges approximately 40mg/L of total nitrogen. The groundwater contours indicate the groundwater would travel from the subdivision intercepting this monitoring well. Comparing this well to up-gradient monitoring well 7SR does not indicate a correlation of the nitrogen with any influence of the WWTF.

Figure 10



Total Phosphorus

As indicated in Table 16 the pre-plant operation average baseline for total phosphorus is 0.031mg/L based on eight sampling rounds. The operational monitoring well data average 2002-

2012 is 0.077mg/L, 8% lower than last years average. As described in the total nitrogen section, this well is down-gradient of a subdivision on private septic systems. Comparing to another up-gradient monitoring well 7SR which has an operational average of 0.0335mg/L does not indicate a correlation of the total phosphorus with any influence of the WWTF.

Boron

As indicated in Table 16 the pre-plant operation average baseline boron is 0.038mg/L. The operational monitoring well data average is 0.013mg/L. This average is the same as last year's average. The operational average is well below the baseline average.

pH

As indicated in Table 16 the pre-plant operation average baseline pH is 6.63. However, in October of 1999 there was a pH value of 9.6 which is likely equipment error. Excluding this value the baseline average is at 6.13. The operational average is 5.74. Slightly lower than the baseline average of 6.13 but well within an acceptable range of the baseline average.

Location A17/MW-7: This groundwater monitoring well is located at the WWTF near odor control. As shown in Figure II-2 of the TAC Report (TAC, 2000) the monitoring well is within the 1.25MGD influence of the infiltration basins and potentially the 0.75MGD influence.

Table 17

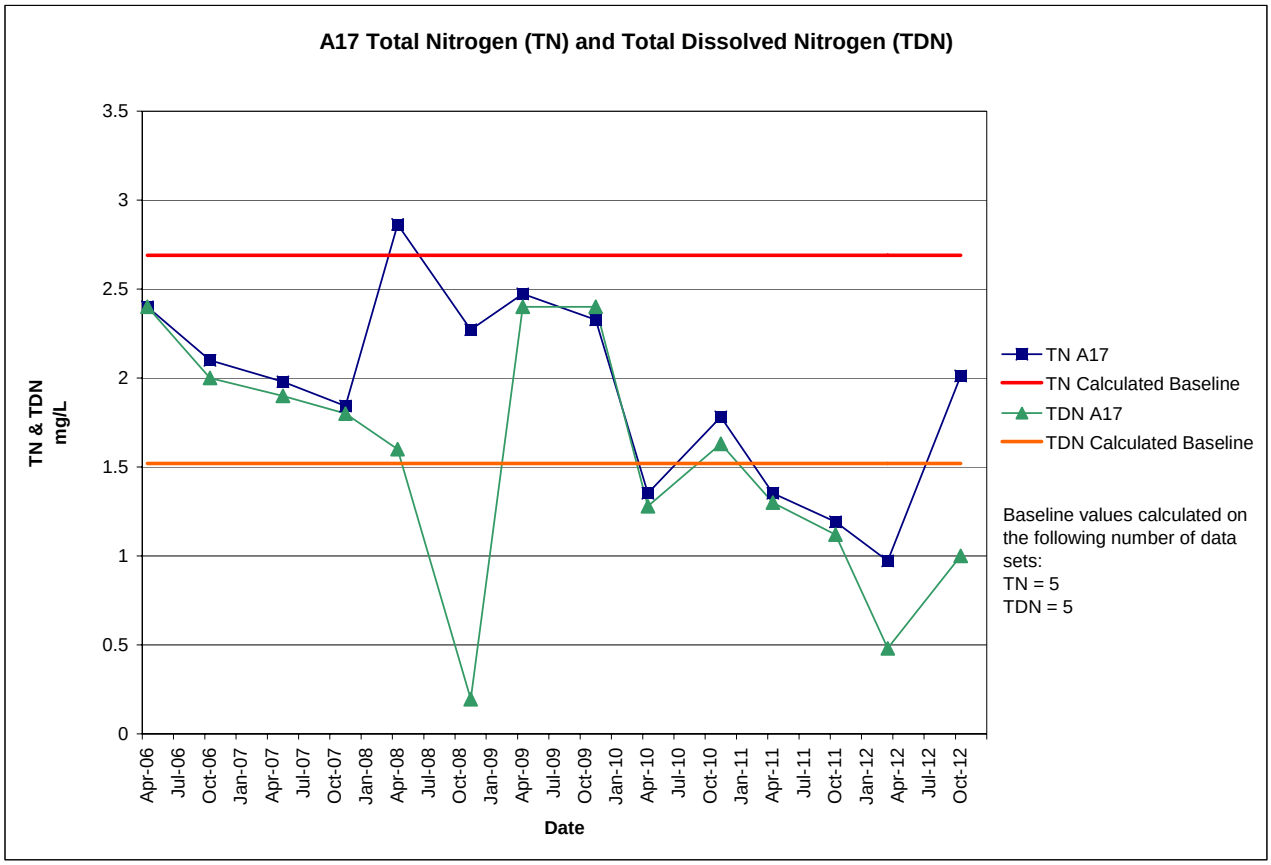
Baseline Average as Described in Appendix E

A17/MW-7				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.008	0.020	8
Ortho-phosphate (mg/L)	0.050	0.050	0.050	7
Ammonium (mg/L)	0.065	0.065	0.065	7
Nitrate (mg/L)	0.49	1.79	3.68	8
Nitrite (mg/L)	0.065	0.065	0.065	3
Total Nitrogen (mg/L)	1.74	2.69	5.59	5
TDN (mg/L)	1.10	1.52	1.73	5
DIN (mg/L)	0.50	1.33	1.63	5
DON (mg/L)	0.065	0.20	0.61	5
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.66	1.84	3
Boron (mg/L)	0.015	0.028	0.059	7
pH (units)	4.40	5.18	5.80	7

Total Nitrogen

Figure 11 below illustrates total nitrogen and total dissolved nitrogen baseline values as well as 2006-2012 monitoring well data. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data. The number of data sets are listed in the figure as well as the table associated with the monitoring well. For monitoring well A17 both the TDN and TN have the same amount of datasets and both can be utilized for baseline comparisons. The monitoring well data for TDN correlates on the graph appropriately with the TN data except for the April and November 2008 data sets. For example, the Total Nitrogen in November was 2.27mg/L while the TDN was non-detect. The average for 2006-2012 monitoring data falls between both the TN and TDN baseline values. In 2012 both TN and TDN were below baseline averages. The operational average (2006-2012) for TN and TDN is 1.92mg/L and 1.53mg/L respectively. Between 1998-1999 the TN values were between 2.35mg/L and 5.5mg/L prior to WWTF operations. Therefore, the 2006-2011 operational data sets do not appear to be impacted from the WWTF operations due to similar pre-operation data rather chemistry in the groundwater.

Figure 11



Total Phosphorus

As indicated in Table 17 the pre-plant operation average baseline for total phosphorus is 0.008mg/L based on eight sampling rounds. The operational monitoring well data average 2002-2012 is 0.053mg/L, 7% lower than last years average without the outlier on October of 2006. The outlier of 1.52mg/L in 2006 is likely a sampling or laboratory error as the previous sample was non-detect and the following sample was at 0.02mg/L.

Boron

As indicated in Table 17 the pre-plant operation average baseline boron is 0.028mg/L. The operational monitoring well data average is 0.023mg/L, 8% lower than last year's average. The operational average is just below the baseline average.

pH

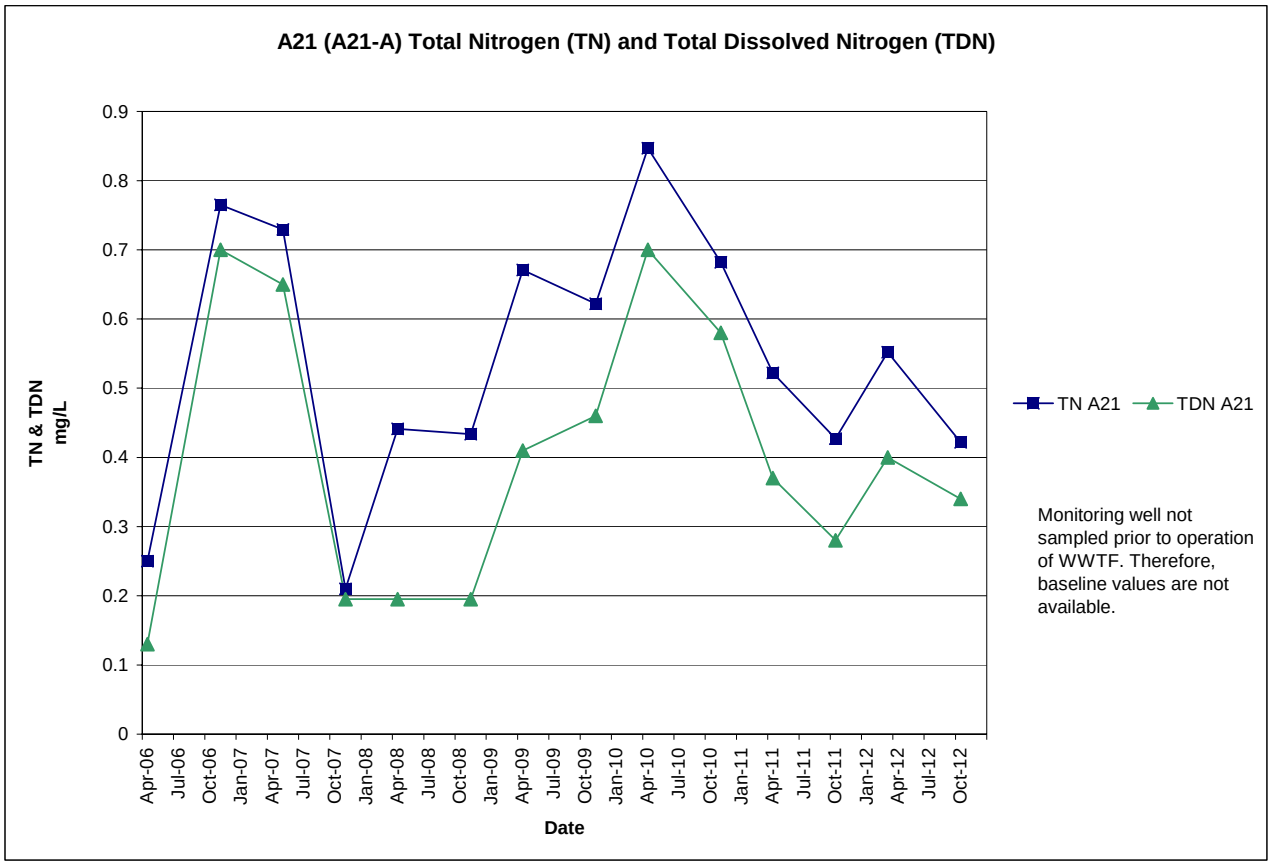
As indicated in Table 17 the pre-plant operation average baseline pH is 5.18. The operational average is 5.22. The operational average is within an acceptable range of the baseline average.

Location A21: This groundwater monitoring well is located off of Russell Mills Road on top of the privately owned dam at Russell Mill Pond. The monitoring well name changed to A21-A when the property owner repaired the dam and the monitoring well was cut flush with the ground level. The monitoring well is located 5,000ft SE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is outside of the 0.75MGD and within the 1.25MGD influence of the infiltration basins. **Monitoring well not sampled prior to plant operation, therefore baseline data is not available.**

Total Nitrogen

Figure 12 below illustrates total nitrogen and total dissolved nitrogen 2006-2012 monitoring well data. This monitoring well was not sampled prior to plant operation therefore baseline values are not available. For monitoring well A21 the parameters required for TN baseline calculations were not sampled during the pre-operation period. The operational average (2006-2012) for TN is 0.54mg/L and TDN is 0.40mg/L. There does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Figure 12



Total Phosphorus

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. The operational monitoring well data average 2002-2012 is 0.041mg/L, 5% lower than last years average. This average operational concentration is similar to other sampled well sites and there does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Boron

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. The operational monitoring well data average is 0.019mg/L, 5% lower than last year's average. This average is consistent with operational values of other monitoring wells.

pH

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. However, the well is monitored for changes in comparison with other monitoring wells and surface water data. The operational average is 6.03. This value is consistent with operational values of other monitoring wells.

Location 2SR: This groundwater monitoring well is located off of Camelot Park near Warren Wells Brook at the privately owned wetland stormwater system. The monitoring well is located 1,200ft SE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is outside of both the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 18

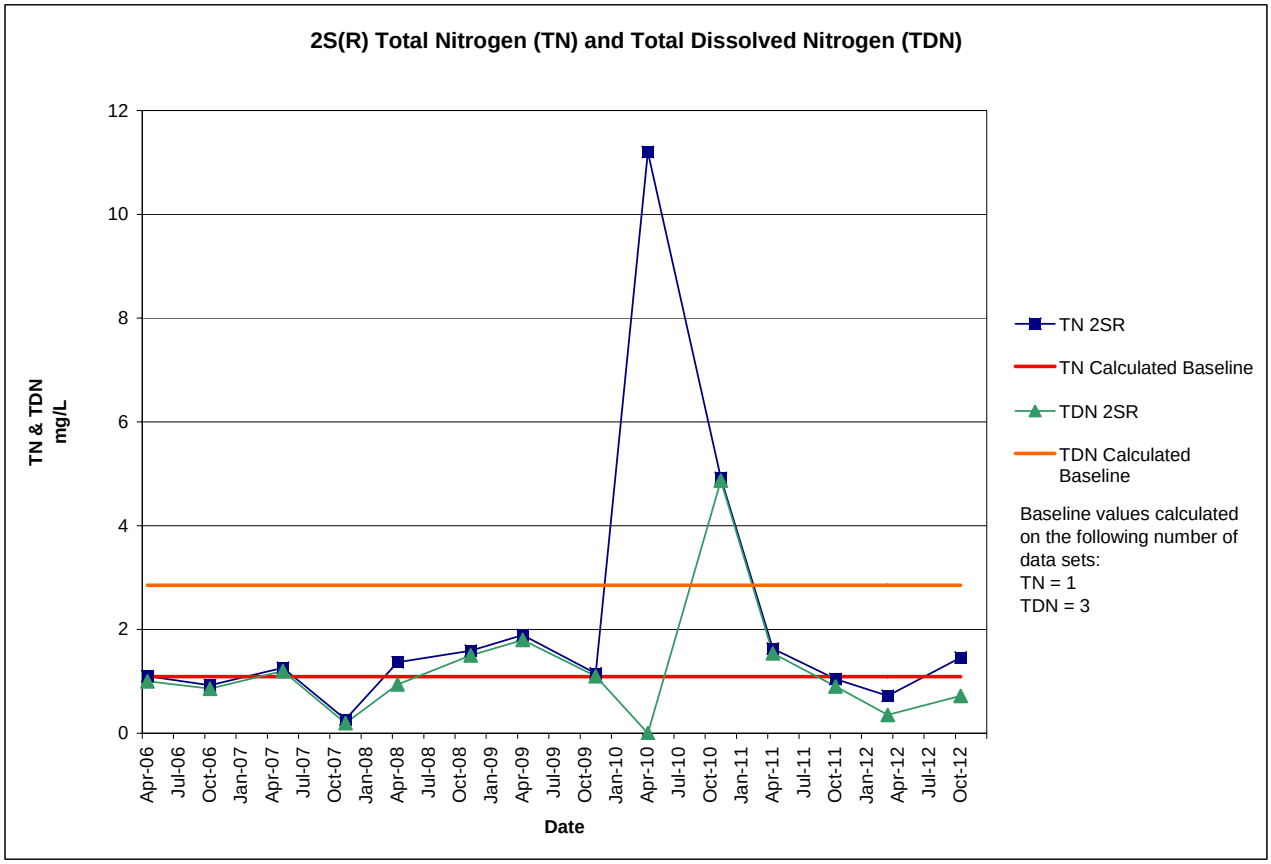
Baseline Average as Described in Appendix E

2SR				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.005	0.013	0.026	3
Ortho-phosphate (mg/L)	0.005	0.005	0.005	3
Ammonium (mg/L)	0.065	0.065	0.065	3
Nitrate (mg/L)	0.923	2.67	4.00	3
Nitrite (mg/L)	NA	NA	NA	0
Total Nitrogen (mg/L)	1.09	1.09	1.09	1
TDN (mg/L)	0.97	2.85	4.22	3
DIN (mg/L)	0.96	2.69	4.02	3
DON (mg/L)	0.065	0.18	0.26	3
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	NA	NA	NA	0
Boron (mg/L)	0.015	0.028	0.044	3
pH (units)	4.80	5.96	8.20	4

Total Nitrogen

Figure 13 below illustrates total nitrogen and total dissolved nitrogen baseline values as well as 2006-2012 monitoring well data. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data. The number of data sets are listed in the figure as well as the table associated with the monitoring well. The monitoring well data for TDN correlates on the graph appropriately with the TN data. There are two spikes in 2010 which are likely correlated to the surface water drainage as in 2010 we experienced two fifty-year storms prior to sampling. Without the two data sets from 2010 included in the average the operational average (2006-2012) for TN and TDN is 1.20mg/ and 0.72mg/L respectively.

Figure 13



Total Phosphorus

As indicated in Table 18 the pre-plant operation average baseline for total phosphorus is 0.013mg/L based on three sampling rounds. The operational monitoring well data average 2002-2012 is 0.032mg/L, 13% lower than last years average. This average operational concentration is similar to other sampled well sites and there does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Boron

As indicated in Table 18 the pre-plant operation average baseline boron is 0.018mg/L. The operational monitoring well data average is 0.018mg/L, 10% lower than last year's average. The operational average is below the baseline average.

pH

As indicated in Table 18 the pre-plant operation average baseline pH is 5.96. However, as with A15 in October of 1999 there was a high pH value of 8.2 which is likely equipment error. Excluding this value the baseline average is at 5.21 averaged between 3 sampling events. The operational average is 4.84. The lower pH was not seen in the adjacent monitoring well 2DR and is likely associated with upstream stormwater basin at Camelot Park. This private stormwater system was retrofitted in 2009 with a constructed wetland treatment system to improve water quality along Warren Wells Brook.

Location 2DR: This groundwater monitoring well is located off of Camelot Park near Warren Wells Brook at the privately owned wetland stormwater system. The monitoring well is located 1,200ft SE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is outside of both the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 19

Baseline Average as Described in Appendix E

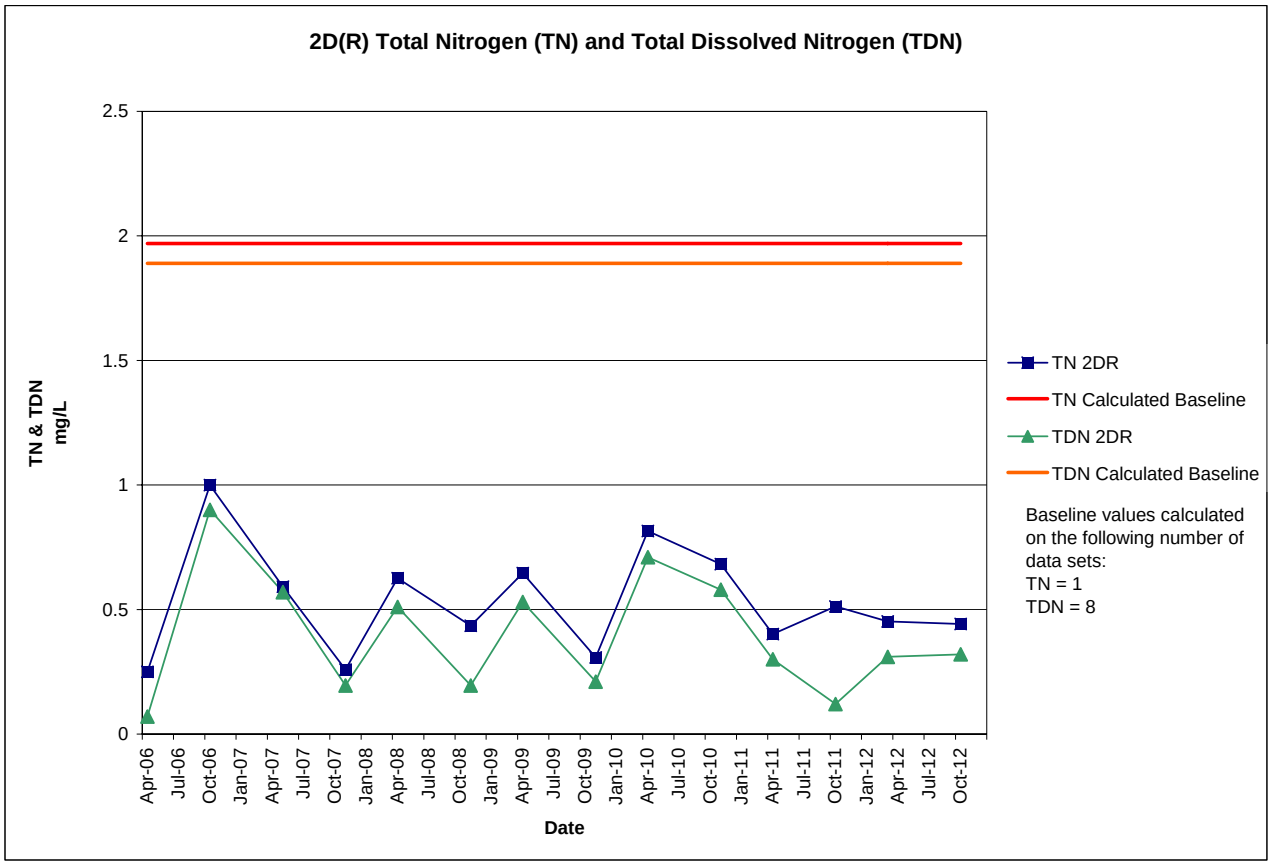
2DR				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.005	0.026	0.080	6
Ortho-phosphate (mg/L)	0.05	0.050	0.050	4
Ammonium (mg/L)	0.065	0.065	0.065	7
Nitrate (mg/L)	0.065	0.94	1.90	8
Nitrite (mg/L)	NA	NA	NA	0
Total Nitrogen (mg/L)	1.97	1.97	1.97	1
TDN (mg/L)	0.13	1.89	8.33	8

DIN (mg/L)	0.065	0.95	1.90	8
DON (mg/L)	0.065	0.95	6.61	8
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	NA	NA	NA	0
Boron (mg/L)	0.015	0.021	0.032	8
pH (units)	4.52	5.62	8.08	7

Total Nitrogen

Figure 14 below illustrates total nitrogen and total dissolved nitrogen baseline values as well as 2006-2012 monitoring well data. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data. The number of data sets are listed in the figure as well as the table associated with the monitoring well. The monitoring well data for TDN correlates on the graph appropriately with the TN data. Both the TDN & TN 2006-2012 operational monitoring datasets are well below the baseline averages. The operational average (2006-2012) for TN and TDN is 0.52mg/L and 0.39mg/L respectively. There does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Figure 14



Total Phosphorus

As indicated in Table 19 the pre-plant operation average baseline for total phosphorus is 0.026mg/L based on six sampling rounds. The operational monitoring well data average 2002-2012 is 0.053mg/L, 15% higher than last years average. This average operational concentration is similar to other sampled well sites and there does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Boron

As indicated in Table 19 the pre-plant operation average baseline boron is 0.021mg/L. The operational monitoring well data average is 0.035mg/L, 6% higher than last year's average. The operational average is just above the baseline average, however, within a reasonable average from the baseline.

pH

As indicated in Table 19 the pre-plant operation average baseline pH is 5.62. However, as with A15 and 2SR, in October of 1999 there was a high pH value of 8.08 which is likely equipment error. Excluding this value the baseline average is at 5.21. The operational average is 5.65, well within an acceptable range of the baseline average.

Location 3S: This groundwater monitoring well is located at the Nickerson Hatchery near Warren Wells Brook. The monitoring well is located 2,100ft SE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is outside of both the 0.75MGD and 1.25MGD influence of the infiltration basins. Between the winter 2006 and spring 2007 sampling event this well was damaged by a vehicle, however, adjacent 3D was able to be sampled. As of Fall 2009 the Town no longer has access to the property.

Table 20

Baseline Average as Described in Appendix E

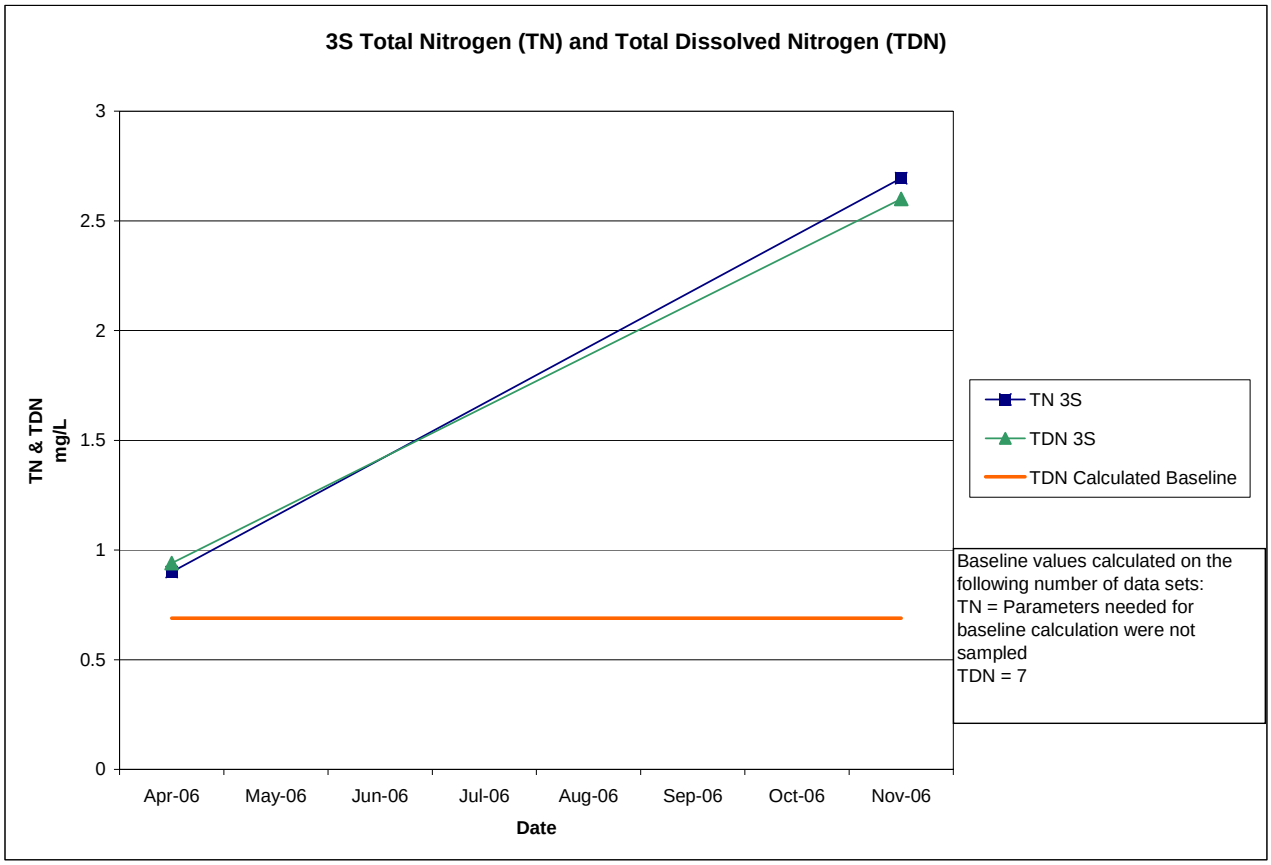
3S				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.009	0.012	6
Ortho-phosphate (mg/L)	0.05	0.05	0.05	5
Ammonium (mg/L)	0.065	0.065	0.065	6
Nitrate (mg/L)	0.29	0.63	0.95	7
Nitrite (mg/L)	NA	NA	NA	0
Total Nitrogen (mg/L)	NA	NA	NA	0
TDN (mg/L)	0.31	0.69	0.99	7
DIN (mg/L)	0.29	0.63	0.95	7
DON (mg/L)	0.065	0.087	0.155	7
PON (mg/L)	NA	NA	NA	0
TKN (mg/L)	NA	NA	NA	0
Boron (mg/L)	0.015	0.031	0.110	6
pH (units)	5.27	5.62	5.90	6

Total Nitrogen

Figure 15 below illustrates total dissolved nitrogen baseline values as well as 2006 monitoring well data. Between the winter 2006 and spring 2007 sampling event this well was damaged by a vehicle, however, adjacent 3D was able to be sampled. As of Fall 2009 the Town no longer has access to the property. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data. The number of data sets are listed in the figure as well as the table associated with the monitoring

well. The monitoring well data for TDN correlates on the graph appropriately with the TN data. There are only two datasets to compare to baseline, one value is at the baseline while the other is above baseline. While there is not any further data to compare, the adjacent well site shows an increase at this same time and then decreases. It is appropriate to note there is a cesspool up-gradient from the monitoring wells.

Figure 15



Total Phosphorus

As indicated in Table 20 the pre-plant operation average baseline for total phosphorus is 0.009mg/L based on six sampling rounds. The operational monitoring well data average has remained the same at 0.028mg/L due to well damage and access denial. This average operational concentration is similar to other sampled well sites and there does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Boron

As indicated in Table 20 the pre-plant operation average baseline boron is 0.031mg/L. The operational monitoring well data average through 2006 is 0.024mg/L where 100% of the values

were non-detect. As of 2010 access to the well has since been denied as described above. The operational average is below the baseline average.

pH

As indicated in Table 20 the pre-plant operation average baseline pH is 5.62. The operational average in 2006 prior to the monitoring well being damaged and now without access is 5.49. The operational average is within an acceptable range of the baseline average.

Location 3D: This groundwater monitoring well is located at the Nickerson Hatchery near Warren Wells Brook. The monitoring well is located 2,100ft SE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is outside of both the 0.75MGD and 1.25MGD influence of the infiltration basins. As of Fall 2009 the Town no longer has access to the property.

Table 21

Baseline Average as Described in Appendix E

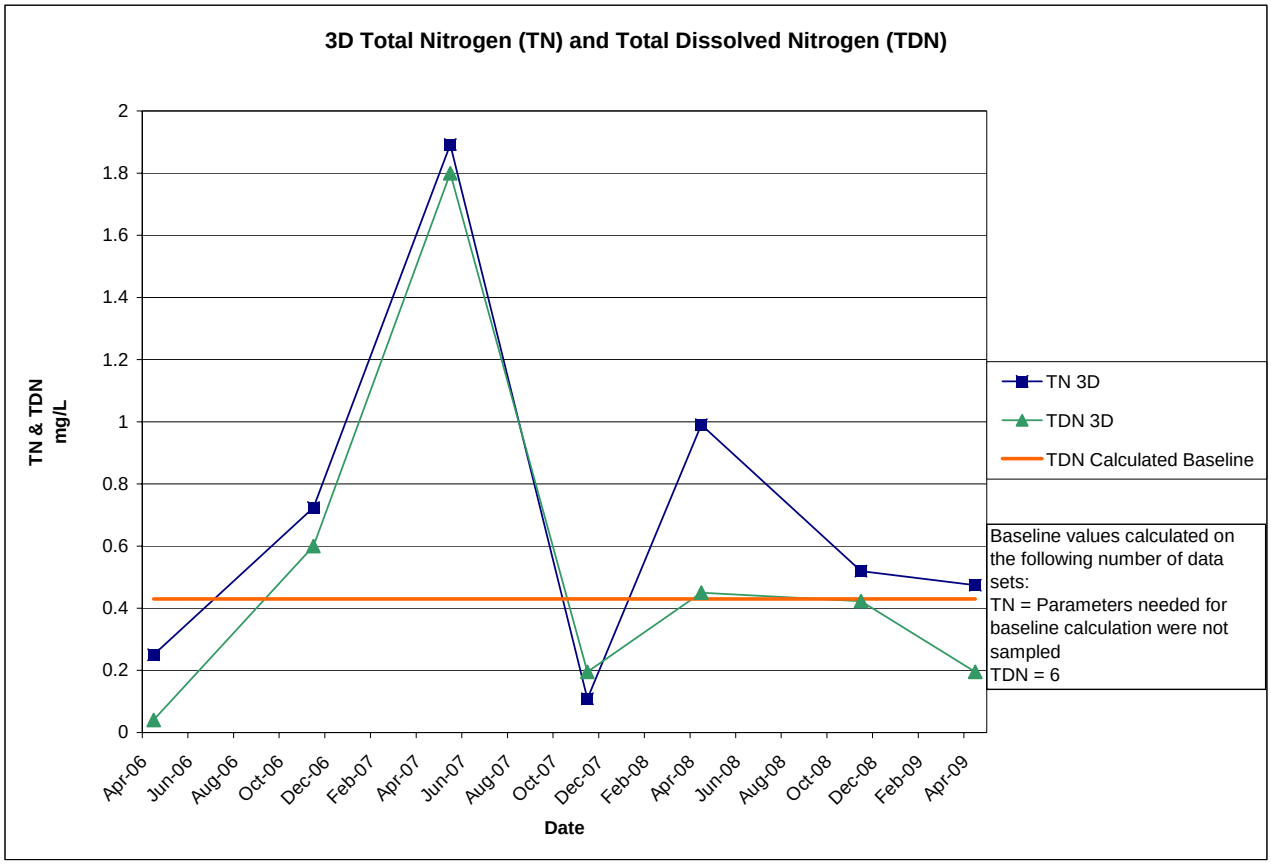
3D				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.021	0.061	5
Ortho-phosphate (mg/L)	0.0015	0.050	0.050	6
Ammonium (mg/L)	0.065	0.065	0.065	5
Nitrate (mg/L)	0.065	0.295	0.689	6
Nitrite (mg/L)	NA	NA	NA	0
Total Nitrogen (mg/L)	NA	NA	NA	0
TDN (mg/L)	0.13	0.43	0.79	6
DIN (mg/L)	0.065	0.30	0.69	6
DON (mg/L)	0.065	0.14	0.37	6
PON (mg/L)	NA	NA	NA	0
TKN (mg/L)	NA	NA	NA	0
Boron (mg/L)	0.015	0.015	0.015	6
pH (units)	4.94	5.49	5.93	6

Total Nitrogen

Figure 16 below illustrates total dissolved nitrogen baseline values as well as 2006-2010 monitoring well data. As of Fall 2009 the Town no longer has access to the property. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data, in this case TDN. The number of data sets are listed in the figure as well as the table associated with the monitoring well. The monitoring

well data for TDN correlates on the graph appropriately with the TN data other than one data point. The TDN 2006-2009 monitoring data for TDN is below the baseline value other than two datasets which have a following 4 datasets at baseline. It is appropriate to note there is a cesspool up-gradient from the monitoring wells.

Figure 16



Total Phosphorus

As indicated in Table 21 the pre-plant operation average baseline for total phosphorus is 0.021mg/L based on five sampling rounds. The operational monitoring well data average has remained the same at 0.048mg/L since 2009 as the Town is no longer allowed to access the well. This average operational concentration is similar to other sampled well sites and there does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Boron

As indicated in Table 21 the pre-plant operation average baseline boron is 0.015mg/L. The operational monitoring well data average through 2009 is 0.021mg/L where 91% of the values were non-detect. As of 2010 access to the well has since been denied as described above. The

operational average is just above the baseline average, however, only one of the eleven readings were detected.

pH

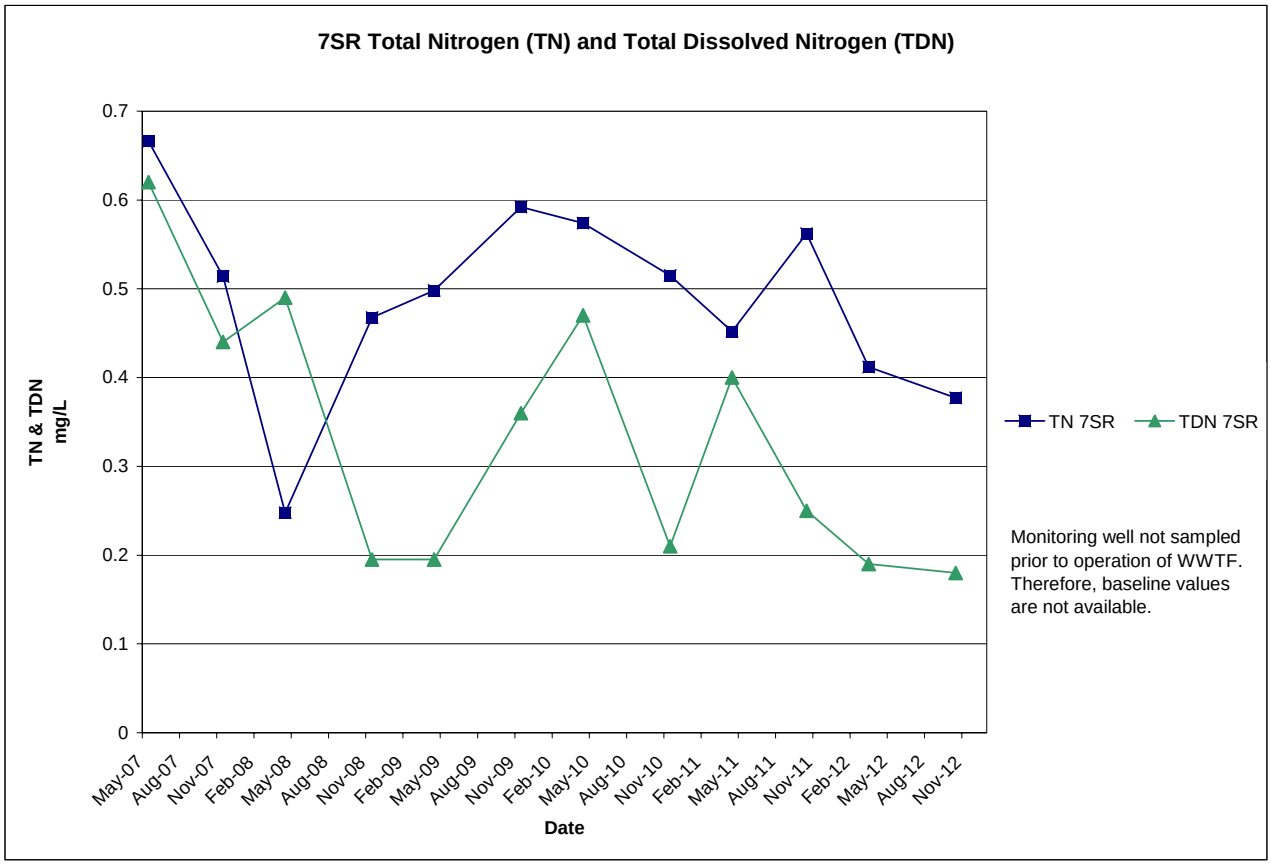
As indicated in Table 21 the pre-plant operation average baseline pH is 5.49. The operational average, while permission to the well was granted, was 5.94. The operational average is within an acceptable range of the baseline average.

Location 7SR: This groundwater monitoring well is located at the end of Old Russell Mills Road near Route 3. The monitoring well is located 2,100ft NE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is within both the 0.75MGD and 1.25MGD influence of the infiltration basins. **Monitoring well not sampled prior to plant operation, therefore baseline data is not available.** This monitoring well was added to the sampling program in 2007.

Total Nitrogen

Figure 17 below illustrates total nitrogen and total dissolved nitrogen 2007-2012 monitoring well data. 7SR monitoring well not sampled prior to plant operation, therefore baseline data is not available. The monitoring well data for TDN and TN do not in all cases correlate on the graph. The operational average (2007-2012) for TN and TDN is 0.412mg/L and 0.18mg/L respectively. These values are very low and there does not appear to be any watershed impacts from WWTF operations.

Figure 17



Total Phosphorus

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. The operational monitoring well data average 2007-2012 is 0.033mg/L, 18% lower than last years average. This average operational concentration is similar to other sampled well sites and there does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Boron

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. However, the well is monitored for changes in comparison with other monitoring wells and surface water data. The operational monitoring well data average is 0.009mg/L, 10% lower than last year's average.

pH

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. However, the well is monitored for changes in comparison with other monitoring wells and

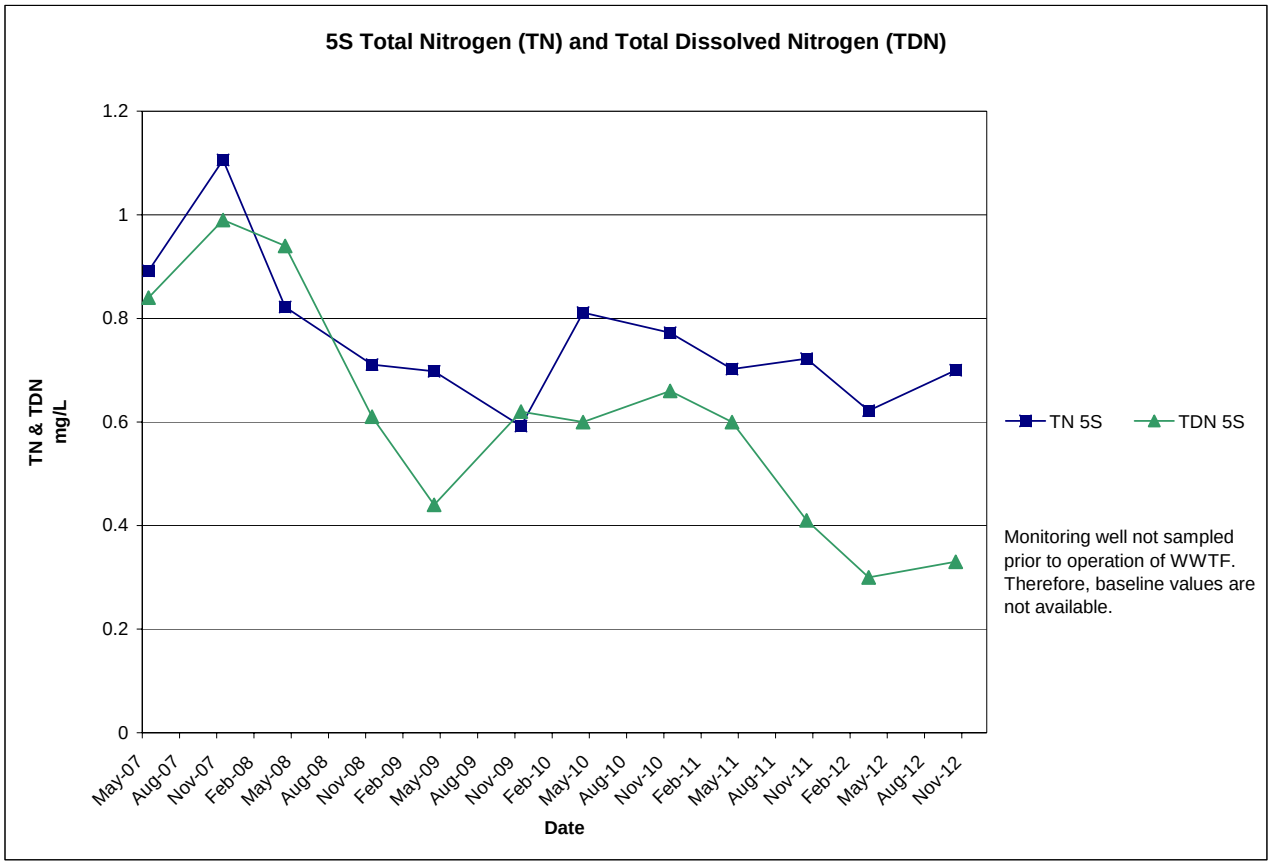
surface water data. The operational average is 5.11. This value is consistent with baseline values of other monitoring wells that are near Route 3 and other nearby monitoring wells.

Location 5S: This groundwater monitoring well is located off of Russell Mills Road heading toward the Nickerson Hatchery. The monitoring well is located 2,200ft SE of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is within the 1.25MGD influence and potentially either outside or just within the 0.75MGD influence of the infiltration basins. **Monitoring well not sampled prior to plant operation, therefore baseline data is not available.** This monitoring well was added to the sampling program in 2007.

Total Nitrogen

Figure 18 below illustrates total nitrogen and total dissolved nitrogen 2007-2012 monitoring well data. 5S monitoring well not sampled prior to plant operation, therefore baseline data is not available. The water column in the monitoring well is very shallow and seems to be experiencing breakthrough of sediment in the well screen. Even after purging the water to three-well volumes the sample water is quite turbid. The monitoring well data for TDN correlates on the graph appropriately with the TN data. The 2007-2012 monitoring average for TN and TDN is 0.76mg/L and 0.61mg/L respectively. There does not appear to be any impacts in the groundwater at this well site from the watershed or WWTF.

Figure 18



Total Phosphorus

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. The operational monitoring well data average 2007-2012 is 0.590mg/L, 18% lower than last years average. Higher values due to the ongoing high amount of siltation in the monitoring well, although data prior to 2007 is not available. The water column in the monitoring well is very shallow and seems to be experiencing breakthrough of sediment in the well screen. After purging the water to three-well volumes the sample water has been quite turbid but clearing over the last few years.

Boron

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. However, the well is monitored for changes in comparison with other monitoring wells and surface water data. The operational monitoring well data average is 0.019mg/L, 10% lower than last year's average.

pH

This monitoring well was not sampled prior to plant operation, therefore baseline values do not exist. However, the well is monitored for changes in comparison with other monitoring wells and surface water data. The operational average is 5.09. This value is consistent with baseline values of other nearby monitoring wells.

Bradford Well: This municipal well site is located approximately 5,000ft SW of the nearest infiltration basin and as shown in Figure II-2 of the TAC Report (TAC, 2000) is not within the 1.25MGD or 0.75MGD influence of the infiltration basins. This site was chosen to reflect changes in the groundwater system on a watershed scale which are not associated with the WWTF.

Table 22

Baseline Average as Described in Appendix E

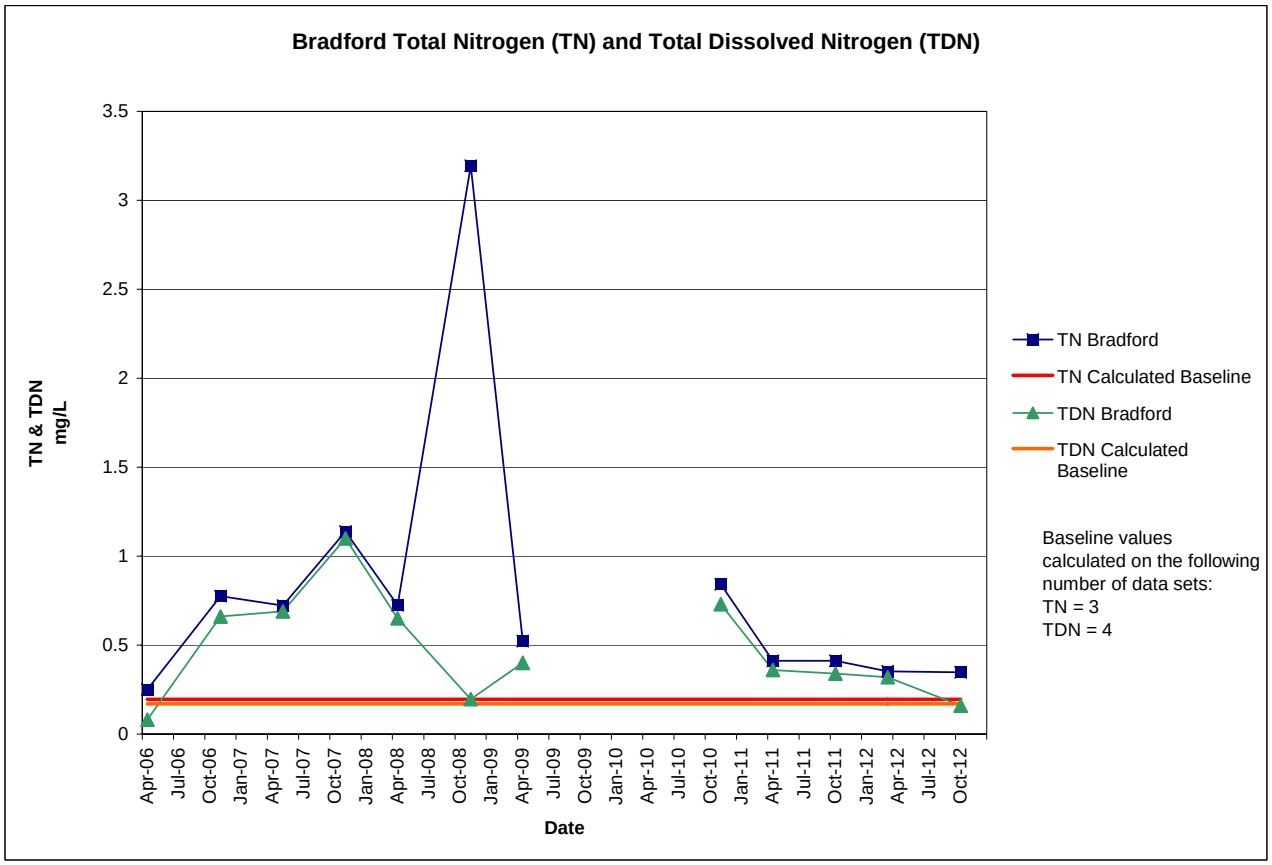
Bradford				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.013	0.028	6
Ortho-phosphate (mg/L)	0.050	0.050	0.050	6
Ammonium (mg/L)	0.065	0.065	0.065	6
Nitrate (mg/L)	0.065	0.065	0.065	6
Nitrite (mg/L)	0.065	0.065	0.065	2
Total Nitrogen (mg/L)	0.195	0.195	0.195	3
TDN (mg/L)	0.13	0.17	0.29	4
DIN (mg/L)	0.065	0.065	0.065	4
DON (mg/L)	0.065	0.13	0.21	4
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	2
Boron (mg/L)	0.015	0.016	0.020	5
pH (units)	5.40	5.93	6.40	6

Total Nitrogen

Figure 19 below illustrates total nitrogen and total dissolved nitrogen baseline values as well as 2006-2012 monitoring well data. With the bi-annual groundwater monitoring wells baseline TN & TDN can be compared to operational results. However, it would be appropriate to use the baseline comparison with the highest number of data sets to get an accurate comparison to operational data. The number of data sets are listed in the figure as well as the table associated with the monitoring well. For the Bradford well TDN has a greater number of baseline datasets for comparison. However, both parameters have a similar baseline datasets and therefore both baseline averages

will be compared. The 2006-2012 monitoring well data for TDN correlates on the graph appropriately with the TN data other than one data point in November 2008 where the TN was 3.19mg/L while TDN was non-detect. Both the TN & TDN show a downward trend since 2011. The operational average (2006-2012) for TN and TDN are 0.80mg/L and 0.47mg/L respectively. As stated above this site was chosen to reflect changes in the groundwater system on a watershed scale which are not associated with the WWTF as it is outside of the WWTF area of influence.

Figure 19



Total Phosphorus

As indicated in Table 22 the pre-plant operation average baseline for total phosphorus is 0.013mg/L based on six sampling rounds. The operational monitoring well data average 2002-2012 is 0.05mg/L, 13% lower than last years average. This average operational concentration is similar to other sampled well sites and there does not appear to be any impacts in the groundwater. As stated above this site was chosen to reflect changes in the groundwater system on a watershed scale which are not associated with the WWTF as it is outside of the WWTF area of influence.

Boron

As indicated in Table 22 the pre-plant operation average baseline boron is 0.016mg/L. The operational monitoring well data average is 0.016mg/L, 6% lower than last year's average.

pH

Field data is not collected at this location as the raw water is collected from the spigot at the potable water supply building.

2.3.4 Inner and Outer Groundwater Monitoring Data Comparisons

A8, A9, A10, A11, A16, 1S, 6S(R), 6D, USGS 475(R)

> *As stated in the July 2001 Nutrient Management Plan Section 7.3: Eight monitoring wells are located near the WWTF for observing changes in the groundwater. The "inner wells" – A9, A10, A11 and A16 – are sited closest to the facility and would be the first to show any change caused by the treatment facility. The "outer wells" – 6SR, 6D, 1S and USGS 475(R)- are located further from the WWTF (down gradient of the property line) and would show a change later than the inner wells.*
>
> *Four parameters, total phosphorus, total nitrogen, boron, and pH, were identified for monitoring groundwater changes proximal to the WWTF.*

As noted in Section 2.1 adding half the detection limit for non-detect values is important for statistical analysis. It is not common to add half the detection limit for calculating total nitrogen under a groundwater discharge permit (permit wells inner-outer). However, for purposes of statistical analysis and comparison to baseline data the Nutrient Management Data Report calculates total nitrogen for the permit wells using half the detection limit.

Location A8/MW-11: This groundwater monitoring well is in the center of the existing group of infiltration basins and is therefore as shown in Figure II-2 of the TAC Report (TAC, 2000) within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 23

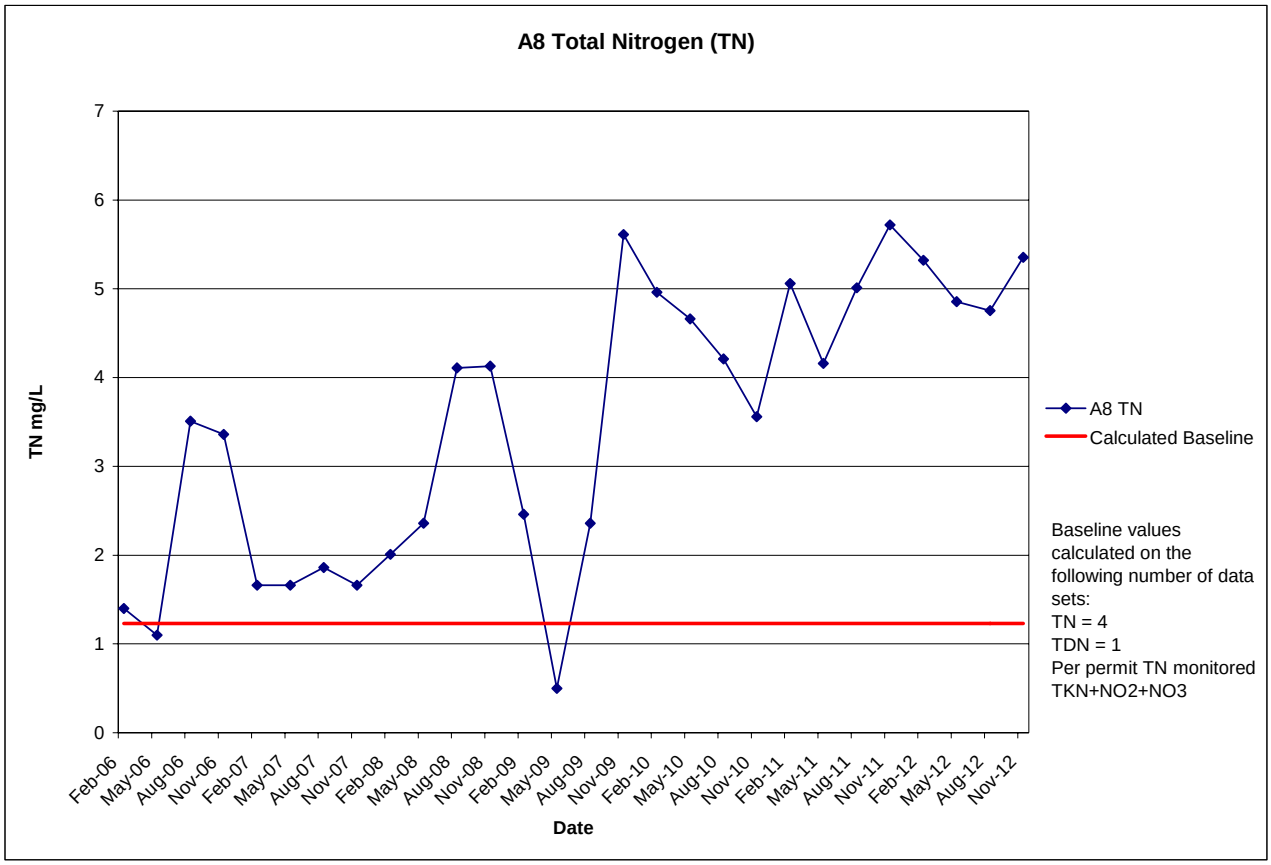
Baseline Average as Described in Appendix E

A8/MW-11				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.003	0.003	4
Ortho-phosphate (mg/L)	0.050	0.050	0.050	4
Ammonium (mg/L)	0.065	0.065	0.065	4
Nitrate (mg/L)	0.77	1.08	1.31	4
Nitrite (mg/L)	0.065	0.065	0.065	3
Total Nitrogen (mg/L)	0.98	1.23	1.44	4
TDN (mg/L)	0.92	0.92	0.92	1
DIN (mg/L)	0.79	0.79	0.79	1
DON (mg/L)	0.13	0.13	0.13	1
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	3
Boron (mg/L)	0.015	0.024	0.039	4
pH (units)	5.56	5.66	5.80	3

Total Nitrogen

Figure 20 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well A8 is located within the infiltration basins, therefore, fluctuations of nitrogen are likely associated with wastewater disposal and monitoring well sample timing. Wells A8, A9 & A10 indicate an increase in TN concentration, however, the down gradient wells 6S, 1S, 7SR and A15 have low TN concentrations. As stated above this well is directly impacted from the infiltration basins and fluctuations are expected.

Figure 20



Total Phosphorus

As indicated in Table 23 the pre-plant operation average baseline for total phosphorus is 0.003mg/L based on four sampling rounds. The operational monitoring well data average 2006-2012 is 0.509mg/L, slight increase from 2011 operational average. There is not a permit limit for this groundwater monitoring well as it is within the infiltration basins. The inner and outer wells did not exceed any permit limits as discussed below.

Boron

As indicated in Table 23 the pre-plant operation average baseline for boron is 0.024mg/L. The operational monitoring well data average 2006-2012 is 0.147mg/L without the Feb 2006 value of 4.8 which is likely a technical error as it is 43 times the average. 29% of the operational average samples were non-detect. The operational average is above the baseline average, however, the down gradient well A9 just outside of the infiltration basin has a low operational average of 0.09mg/L.

pH

As indicated in Table 23 the pre-plant operation average baseline pH is 5.66. The operational average 2006 through 2012 was 5.99 well within an acceptable range of the baseline average. The pH operational average did not change from the previous year.

Location A9: This groundwater monitoring well is in the area of proposed future infiltration basins and approximately 400ft NE from existing infiltration basins. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 24

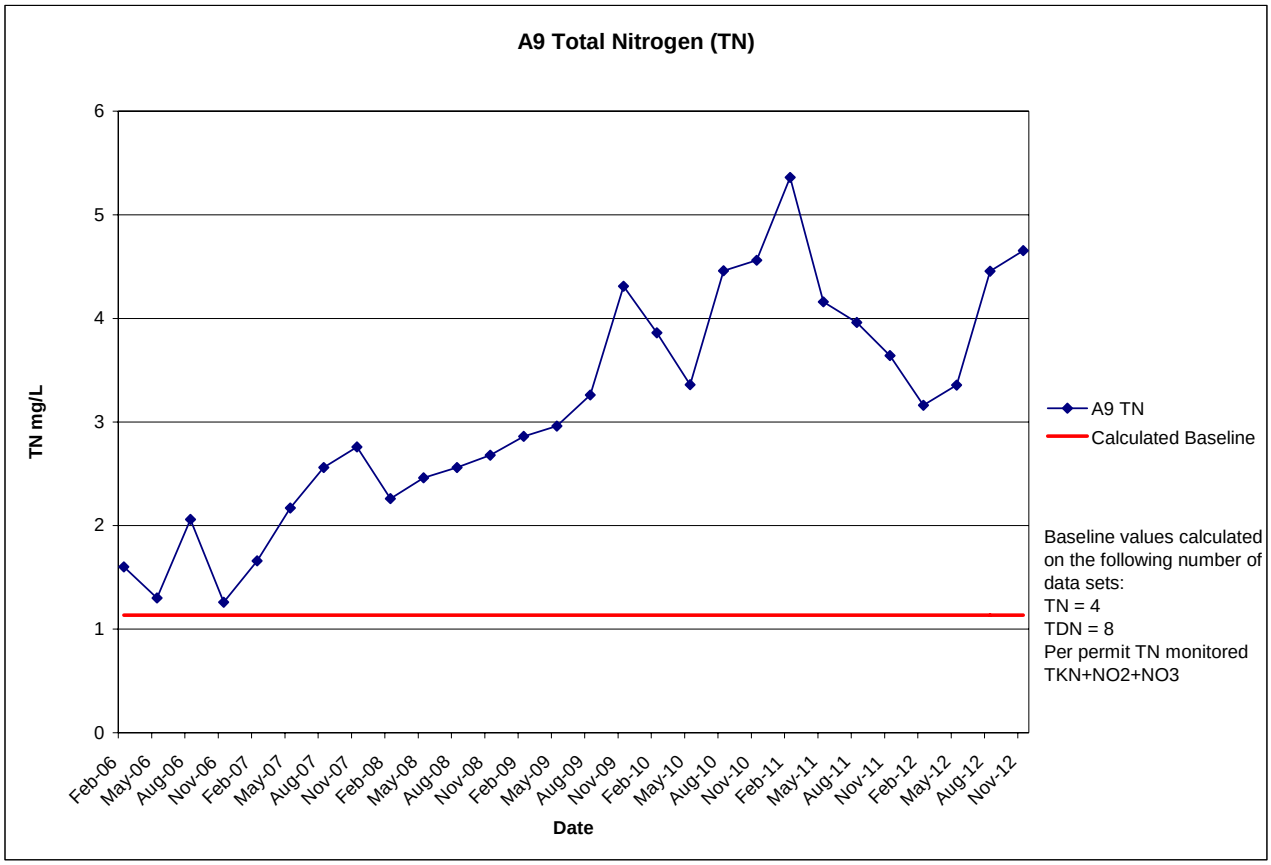
Baseline Average as Described in Appendix E

A9				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.009	0.022	11
Ortho-phosphate (mg/L)	0.05	0.05	0.05	11
Ammonium (mg/L)	0.065	0.065	0.065	10
Nitrate (mg/L)	0.32	0.65	1.27	11
Nitrite (mg/L)	0.065	0.065	0.065	3
Total Nitrogen (mg/L)	0.911	1.135	1.427	4
TDN (mg/L)	0.46	0.71	1.36	8
DIN (mg/L)	0.32	0.58	1.30	8
DON (mg/L)	0.065	0.14	0.21	8
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.12	0.22	3
Boron (mg/L)	NA	NA	NA	0
pH (units)	5.28	6.00	6.75	11

Total Nitrogen

Figure 21 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well A9 is located approximately 400ft down gradient of the infiltration basins. There is a steady increase of TN concentrations from 2006 at this well without the major fluctuations the up-gradient well A8 indicates. Well USGS475R, down gradient showed an increase in TN during the winter months.

Figure 21



Total Phosphorus

As indicated in Table 24 the pre-plant operation average baseline for total phosphorus is 0.009mg/L. The operational monitoring well data average 2006-2012 is 0.029mg/L, slightly higher than last year's average. This well did not exhibit a total phosphorus concentration of 0.2mg/L or greater for either three consecutive monthly samplings or four out of six consecutive monthly sampling periods as written in the permit.

Boron

This well was sampled prior to plant operation, however, boron data is not available during the baseline period. 63% of the operational average samples were non-detect. The operational monitoring well data average 2006-2012 is 0.09mg/L.

pH

As indicated in Table 24 the pre-plant operation average baseline pH is 6.00. The operational average 2006 through 2012 was 5.28 which is lower than expected, however, it does not appear to be associated with groundwater discharge as well A8 in the infiltration bed is not showing this

change. Monitoring wells A16, A11 and USGS475R have lower baseline averages that are similar to this wells operational average. The pH operational average did not change from the previous year.

Location A10: This groundwater monitoring well is approximately 400ft SE from existing infiltration basins. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 25

Baseline Average as Described in Appendix E

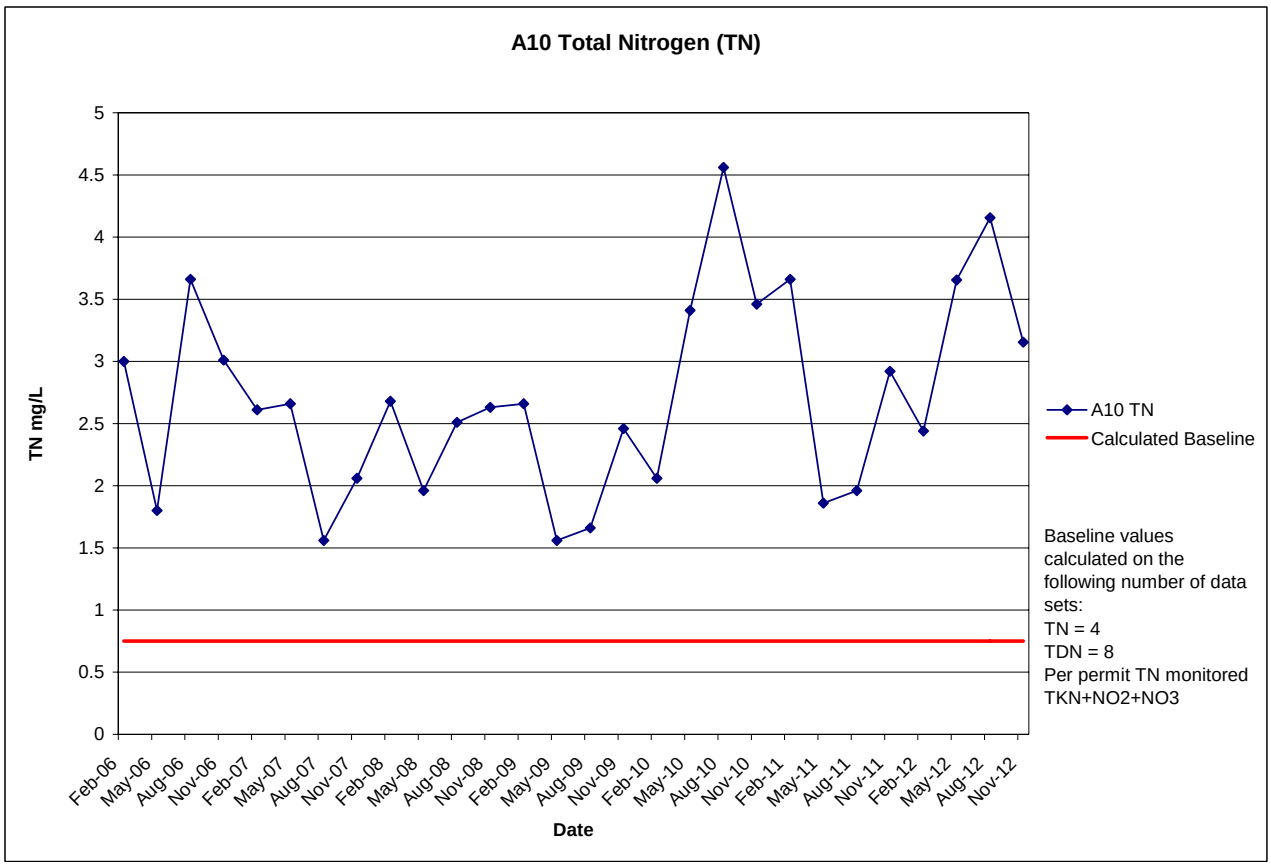
A10				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.006	0.010	8
Ortho-phosphate (mg/L)	0.05	0.05	0.05	10
Ammonium (mg/L)	0.065	0.065	0.065	10
Nitrate (mg/L)	0.35	1.84	14.68	11
Nitrite (mg/L)	0.065	0.065	0.065	3
Total Nitrogen (mg/L)	0.52	0.75	0.96	4
TDN (mg/L)	0.43	2.43	15.24	8
DIN (mg/L)	0.39	2.27	14.68	8
DON (mg/L)	0.065	0.14	0.56	8
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	3
Boron (mg/L)	0.015	0.016	0.023	11
pH (units)	4.99	5.63	6.20	11

Total Nitrogen

Figure 22 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well A10 is located approximately 400ft south of the infiltration basins. The 2006-2012 monitoring data indicate fluctuations above the TN baseline value, however, there are only four TN baseline values to compare. TDN baseline consists of eight values with a broad fluctuation between 0.52 mg/L to 15.24 mg/L. The down gradient well, 6S, is below or at baseline value for most of 2006-2011 monitoring and started

increasing in 2012. Monitoring well 1S also has minimal levels which were frequently below the baseline average of 0.36mg/L.

Figure 22



Total Phosphorus

As indicated in Table 25 the pre-plant operation average baseline for total phosphorus is 0.006mg/L based on eight sampling rounds. The operational monitoring well data average 2006-2012 is 0.012mg/L, slight increase from last years average. This well did not exhibit a total phosphorus concentration of 0.2mg/L or greater for either three consecutive monthly samplings or four out of six consecutive monthly sampling periods as written in the permit.

Boron

As indicated in Table 25 the pre-plant operation average baseline boron is 0.016mg/L. The operational monitoring well data average 2006-2012 is 0.07mg/L where 77% of the values were non-detect. The operational average is above the baseline average, however, 83% of the readings

were non-detect. For average calculations half the detection limits are utilized for non-detect values.

pH

As indicated in Table 25 the pre-plant operation average baseline pH is 5.63. The operational average 2006 through 2012 was 4.91 which is lower than expected, however, it does not appear to be associated with groundwater discharge as well A8 in the infiltration bed is not showing this change. Monitoring wells A16, A11 and USGS475R have lower baseline averages that are similar to this wells operational average.

Location A11: This groundwater monitoring well is slightly south of existing infiltration basins in the southwest corner. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 26

Baseline Average as Described in Appendix E

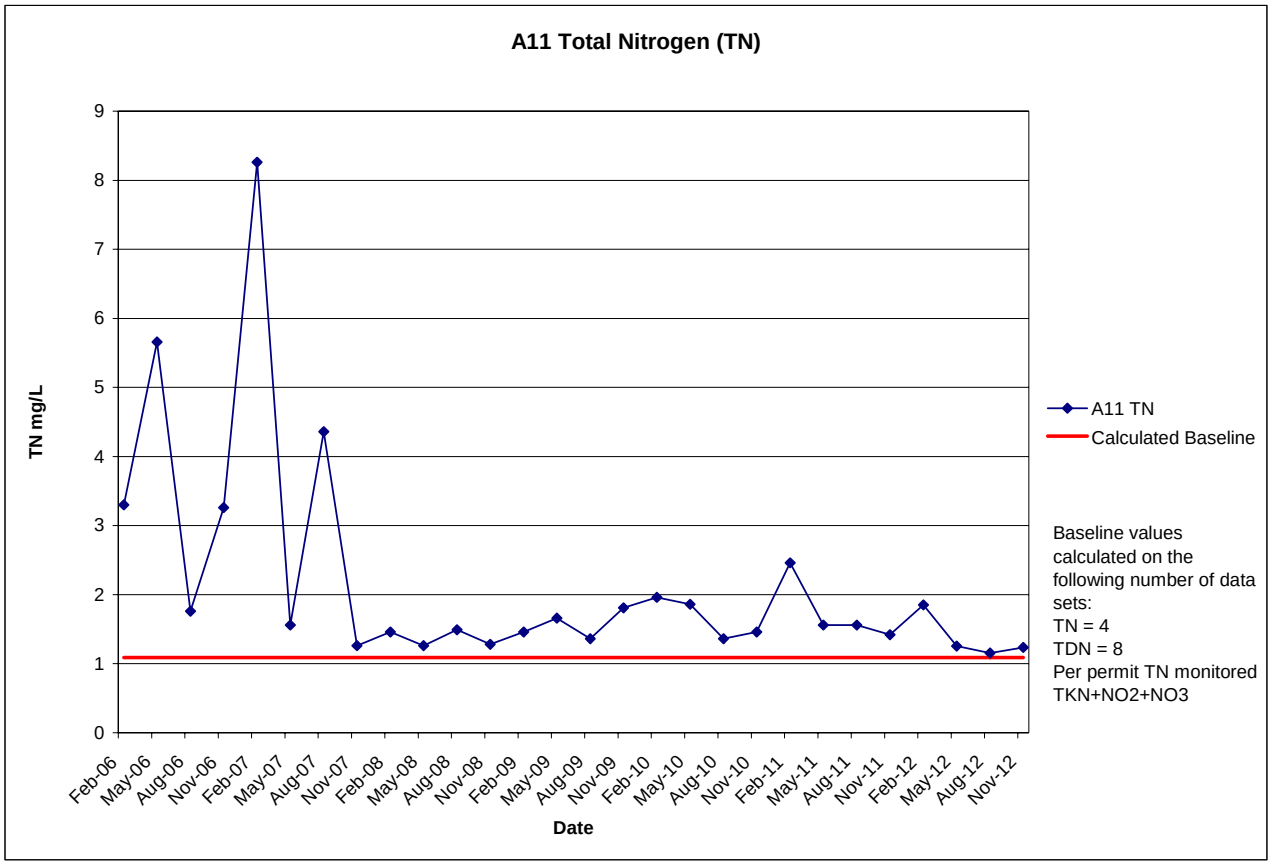
A11				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.008	0.020	10
Ortho-phosphate (mg/L)	0.05	0.05	0.05	11
Ammonium (mg/L)	0.065	0.065	0.065	9
Nitrate (mg/L)	0.32	0.84	1.06	11
Nitrite (mg/L)	0.065	0.065	0.065	3
Total Nitrogen (mg/L)	1.020	1.09	1.19	4
TDN (mg/L)	0.87	1.06	1.70	8
DIN (mg/L)	0.32	0.80	0.97	8
DON (mg/L)	0.065	0.26	1.37	8
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	3
Boron (mg/L)	0.015	0.017	0.025	11
pH (units)	3.78	5.39	6.00	11

Total Nitrogen

Figure 23 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well A11 is located within the

existing infiltration basins southwest of monitoring well A8, therefore, fluctuations of nitrogen may be associated with wastewater disposal and monitoring well sample timing. During 2006-2007 fluctuations in TN are apparent, however, the following years show steady values close to the baseline average. In 2012 the TN values decreased from previous operational years.

Figure 23



Total Phosphorus

As indicated in Table 26 the pre-plant operation average baseline for total phosphorus is 0.008mg/L based on ten sampling rounds. The operational monitoring well data average 2006-2012 is 0.022mg/L, slight increase from last years average. This well did not exhibit a total phosphorus concentration of 0.2mg/L or greater for either three consecutive monthly samplings or four out of six consecutive monthly sampling periods as written in the permit.

Boron

As indicated in Table 26 the pre-plant operation average baseline boron is 0.017mg/L. The operational monitoring well data average 2006-2012 is 0.06mg/L where 88% of the values were

non-detect. The operational average is above the baseline average, however, 92% of the readings were non-detect. For average calculations half the detection limits are utilized for non-detect values.

pH

As indicated in Table 26 the pre-plant operation average baseline pH is 5.39. The operational average 2006 through 2012 was 5.22 well within an acceptable range of the baseline average.

Location A16: This groundwater monitoring well is slightly south of route 3 and approximately 170ft from existing northeast infiltration bed. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 27

Baseline Average as Described in Appendix E

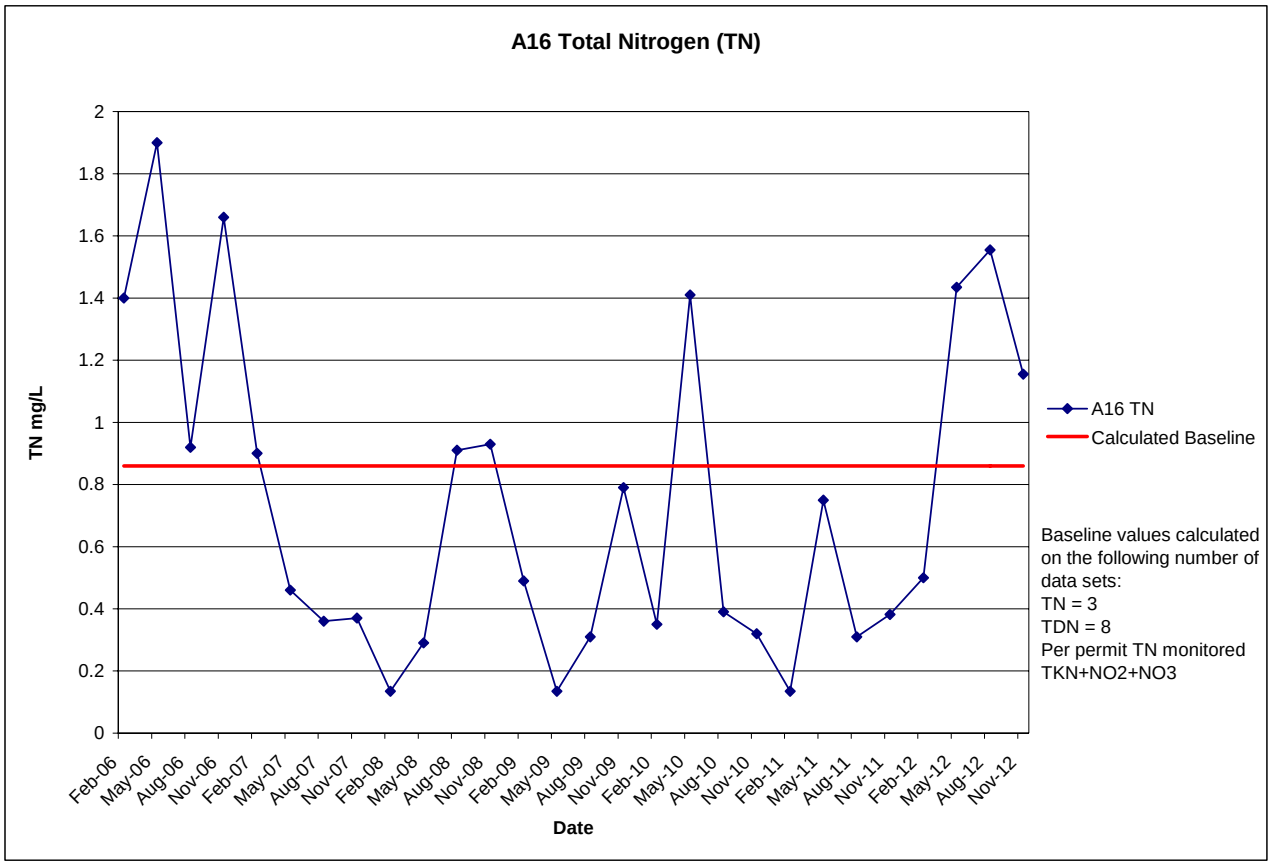
A16				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.006	0.012	9
Ortho-phosphate (mg/L)	0.05	0.05	0.05	9
Ammonium (mg/L)	0.065	0.065	0.065	10
Nitrate (mg/L)	0.50	0.91	1.37	11
Nitrite (mg/L)	0.065	0.065	0.065	3
Total Nitrogen (mg/L)	0.77	0.86	0.93	3
TDN (mg/L)	0.85	1.44	2.11	8
DIN (mg/L)	0.50	1.02	1.43	8
DON (mg/L)	0.065	0.42	1.60	8
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	3
Boron (mg/L)	0.015	0.016	0.022	11
pH (units)	4.90	5.27	5.67	6

Total Nitrogen

Figure 24 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well A16 is approximately 170ft north of the infiltration basins. During the 2006-2012 monitoring, there are fluctuations in the TN

values, however, most are well below the baseline average of 0.86mg/L. In the spring and summer of 2012 the TN values increased above the baseline average.

Figure 24



Total Phosphorus

As indicated in Table 27 the pre-plant operation average baseline for total phosphorus is 0.006mg/L based on nine sampling rounds. The operational monitoring well data average 2006-2012 is 0.017mg/L, slightly higher than last year's average. This well did not exhibit a total phosphorus concentration of 0.2mg/L or greater for either three consecutive monthly samplings or four out of six consecutive monthly sampling periods as written in the permit.

Boron

As indicated in Table 27 the pre-plant operation average baseline boron is 0.016mg/L. The operational monitoring well data average 2006-2012 is 0.05mg/L where 88% of the values were non-detect. The operational average is above the baseline average, however, 88% of the readings were non-detect. For average calculations half the detection limits are utilized for non-detect values.

pH

As indicated in Table 27 the pre-plant operation average baseline pH is 5.27. The operational average 2006 through 2012 was 5.07 well within an acceptable range of the baseline average.

Location 1S: This groundwater monitoring well is approximately 1000ft southeast from existing infiltration bed. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 28

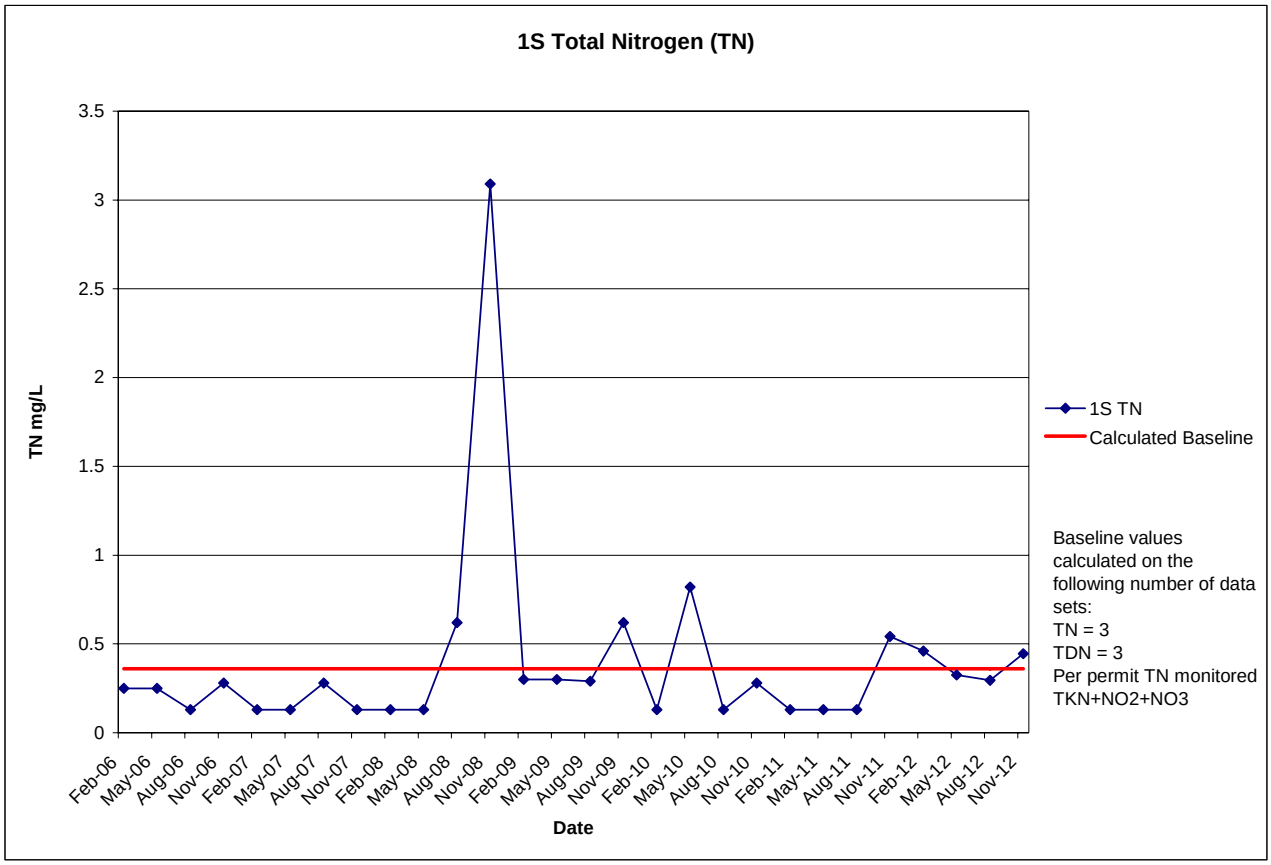
Baseline Average as Described in Appendix E

1S				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.007	0.017	4
Ortho-phosphate (mg/L)	0.05	0.05	0.05	4
Ammonium (mg/L)	0.065	0.065	0.065	4
Nitrate (mg/L)	0.065	0.065	0.065	4
Nitrite (mg/L)	0.065	0.065	0.065	3
Total Nitrogen (mg/L)	0.20	0.36	0.68	3
TDN (mg/L)	0.13	0.13	0.13	1
DIN (mg/L)	0.065	0.065	0.065	1
DON (mg/L)	0.065	0.065	0.065	1
PON (mg/L)	NA	NA	NA	0
TKN (mg/L)	0.065	0.23	0.55	3
Boron (mg/L)	0.015	0.029	0.057	3
pH (units)	4.49	5.46	6.35	4

Total Nitrogen

Figure 25 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well 1S is southeast of A10 and southwest of 6D/6S. The 2006-2012 monitoring data is below the baseline average at 0.28mg/L excluding the one spike in the winter of 2008 (3.09mg/L).

Figure 25



Total Phosphorus

As indicated in Table 28 the pre-plant operation average baseline for total phosphorus is 0.007mg/L based on four sampling rounds. The operational monitoring well data average 2006-2012 is 0.021mg/L, slightly higher than last year's average. The down-gradient wells have a permit limit of 100% over the established background concentration for the four wells. This average concentration utilizing all baseline data prior to plant operation is 0.07mg/L. The value of 0.14mg/L signifies the increase of 100% over established background as stated in the permit. During the operational monitoring period this well site remained below the permit limit.

Boron

As indicated in Table 28 the pre-plant operation average baseline boron is 0.029mg/L. The operational monitoring well data average 2006-2012 is 0.05mg/L where 96% of the values were non-detect. The operational average is above the baseline average, however, 96% of the readings were non-detect. For average calculations half the detection limits are utilized for non-detect values.

pH

As indicated in Table 28 the pre-plant operation average baseline pH is 5.46. The operational average 2006 through 2012 was 5.36 well within an acceptable range of the baseline average.

Location 6S(R): This groundwater monitoring well is approximately 300ft north of 1S and 1000ft southeast from existing infiltration basins. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 29

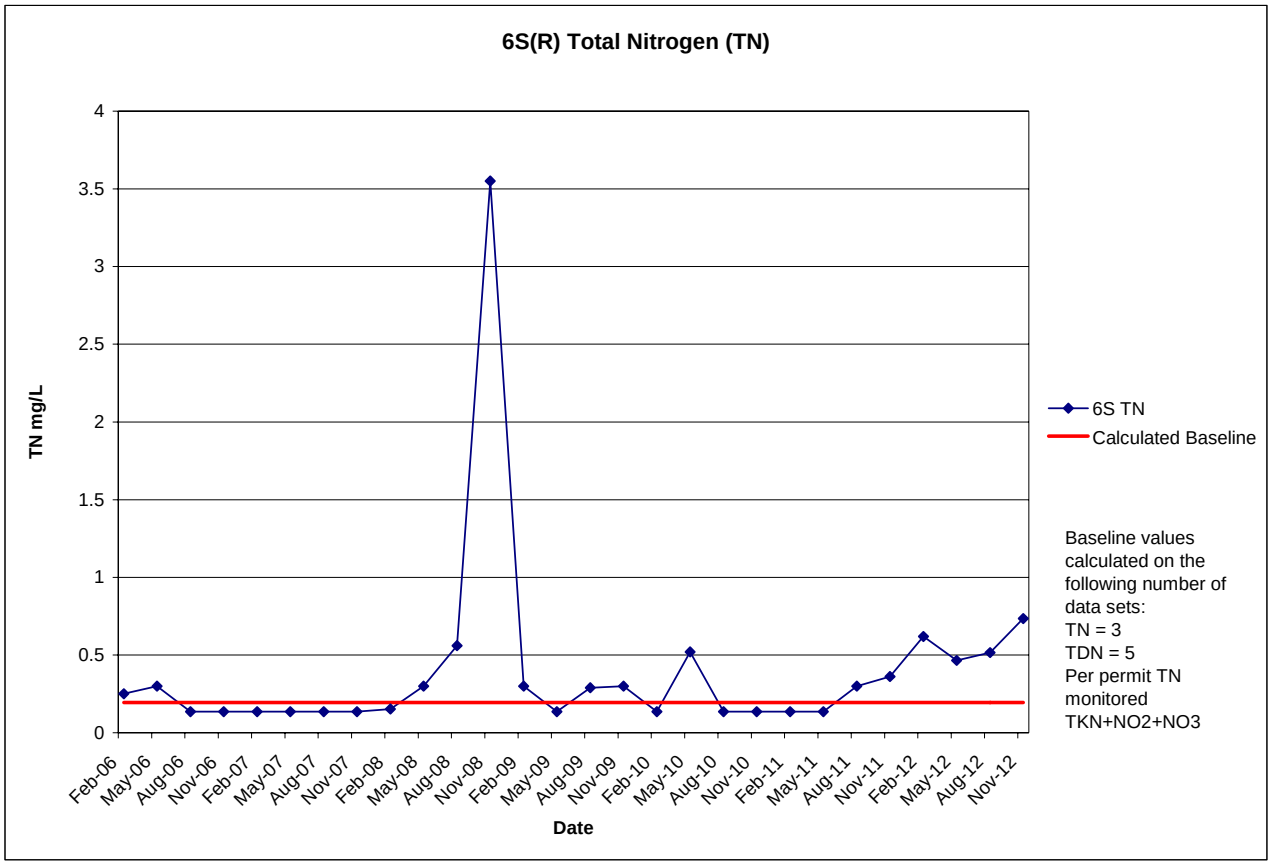
Baseline Average as Described in Appendix E

6SR				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.007	0.02	7
Ortho-phosphate (mg/L)	0.05	0.05	0.05	7
Ammonium (mg/L)	0.065	0.065	0.065	7
Nitrate (mg/L)	0.065	0.065	0.065	7
Nitrite (mg/L)	0.065	0.065	0.065	2
Total Nitrogen (mg/L)	0.195	0.195	0.195	3
TDN (mg/L)	0.13	0.20	0.50	5
DIN (mg/L)	0.065	0.065	0.065	5
DON (mg/L)	0.065	0.15	0.47	5
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	1
Boron (mg/L)	0.015	0.015	0.015	6
pH (units)	4.70	5.42	6.00	7

Total Nitrogen

Figure 26 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well 6S(R) is located southeast of the infiltration basins. The 2006-2012 monitoring data is just above the baseline average at 0.28mg/L excluding the one spike in the winter of 2008 (3.55mg/L). The TN values increased in 2012 in correlation to increases at adjacent well 6D.

Figure 26



Total Phosphorus

As indicated in Table 29 the pre-plant operation average baseline for total phosphorus is 0.006mg/L based on seven sampling rounds. The operational monitoring well data average 2006-2012 is 0.021mg/L, slightly higher than last year's average. The down-gradient wells have a permit limit of 100% over the established background concentration for the four wells. This average concentration utilizing all baseline data prior to plant operation is 0.07mg/L. The value of 0.14mg/L signifies the increase of 100% over established background as stated in the permit. During the operational monitoring period this well site remained below the permit limit.

Boron

As indicated in Table 29 the pre-plant operation average baseline boron is 0.015mg/L. The operational monitoring well data average 2006-2012 is 0.05mg/L where 96% of the values were non-detect. The operational average is above the baseline average, however, 96% of the readings were non-detect. For average calculations half the detection limits are utilized for non-detect values.

pH

As indicated in Table 29 the pre-plant operation average baseline pH is 5.42. The operational average 2006 through 2012 was 5.26 well within an acceptable range of the baseline average.

Location 6D: This groundwater monitoring well is approximately 300ft north of 6S and 1000ft from existing infiltration basins. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 30

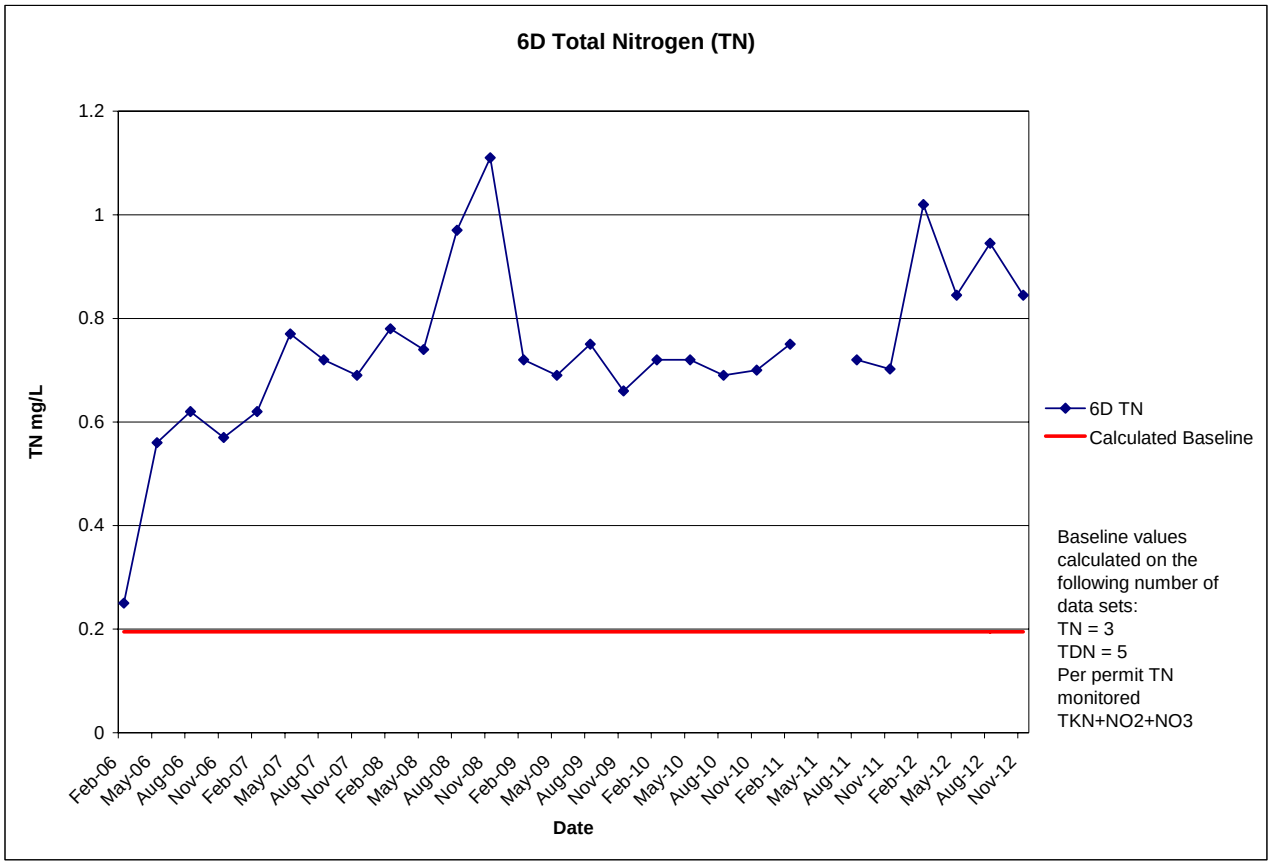
Baseline Average as Described in Appendix E

6D				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.006	0.020	7
Ortho-phosphate (mg/L)	0.05	0.05	0.05	7
Ammonium (mg/L)	0.065	0.065	0.065	7
Nitrate (mg/L)	0.065	0.065	0.065	7
Nitrite (mg/L)	0.065	0.065	0.065	2
Total Nitrogen (mg/L)	0.195	0.195	0.195	3
TDN (mg/L)	0.13	0.13	0.13	5
DIN (mg/L)	0.065	0.065	0.065	5
DON (mg/L)	0.065	0.08	0.15	5
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	2
Boron (mg/L)	0.015	0.017	0.029	7
pH (units)	5.80	6.50	9.68	7

Total Nitrogen

Figure 27 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well 6D(R) is located south of 6S(R). The average TN for the 2006-2012 monitoring data is at 0.736 mg/L, though, this is above the baseline average but does not appear to be correlated to the infiltration basins when compared to surrounding well data.

Figure 27



Total Phosphorus

As indicated in Table 30 the pre-plant operation average baseline for total phosphorus is 0.006mg/L based on seven sampling rounds. The operational monitoring well data average 2006-2012 is 0.028mg/L, same as last year's average. The down-gradient wells have a permit limit of 100% over the established background concentration for the four wells. This average concentration utilizing all baseline data prior to plant operation is 0.07mg/L. The value of 0.14mg/L signifies the increase of 100% over established background as stated in the permit. During the operational monitoring period this well site remained below the permit limit.

Boron

As indicated in Table 30 the pre-plant operation average baseline boron is 0.017mg/L. The operational monitoring well data average 2006-2012 is 0.05mg/L where 100% of the values were non-detect. The operational average is above the baseline average, however, 100% of the readings were non-detect. For average calculations half the detection limits are utilized for non-detect values.

pH

As indicated in Table 30 the pre-plant operation average baseline pH is 6.50. However, as with in September of 2001 there was a high pH value of 9.68 which is likely equipment error. Excluding this value the baseline average is at 5.98. The operational average 2006 through 2012 was 5.47 well within an acceptable range of the baseline average.

Location USGS475(R): This groundwater monitoring well is slightly south of route 3 and approximately 1,350ft from existing northeast infiltration bed. As shown in Figure II-2 of the TAC Report (TAC, 2000) it is within the 0.75MGD and 1.25MGD influence of the infiltration basins.

Table 31

Baseline Average as Described in Appendix E

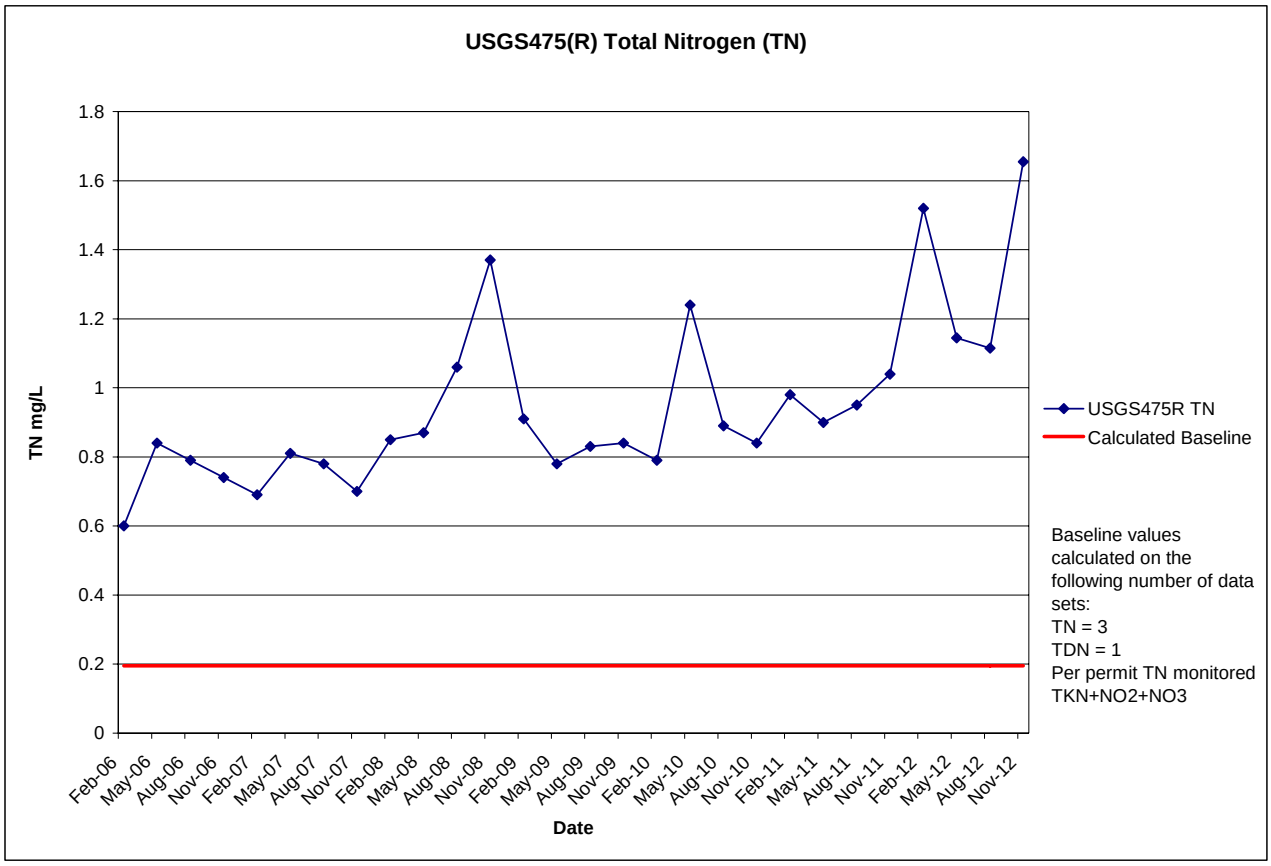
USGS475(R)				
Parameter	**Minimum**	**Mean**	**Maximum**	**Count**
Total Phosphorous (mg/L)	0.003	0.039	0.075	3
Ortho-phosphate (mg/L)	0.050	0.050	0.050	3
Ammonium (mg/L)	0.065	0.065	0.065	3
Nitrate (mg/L)	0.065	0.065	0.065	3
Nitrite (mg/L)	0.065	0.065	0.065	2
Total Nitrogen (mg/L)	0.195	0.195	0.195	3
TDN (mg/L)	0.13	0.13	0.13	1
DIN (mg/L)	0.065	0.065	0.065	1
DON (mg/L)	0.065	0.065	0.065	1
PON (mg/L)	0.065	0.065	0.065	1
TKN (mg/L)	0.065	0.065	0.065	2
Boron (mg/L)	0.015	0.024	0.032	2
pH (units)	5.10	5.32	5.60	4

Total Nitrogen

Figure 28 below illustrates total nitrogen baseline values as well as 2006-2012 monitoring well data. The inner and outer groundwater monitoring wells baseline TN can be compared to operational TN results. The permit requires the parameters TKN, NO3 and NO2 for analytical computation of TN on a quarterly basis for the monitoring wells. Therefore, a comparison of TN baseline value with the operational TN data will be performed. The monitoring wells are analyzed to monitor potential transport of infiltration from the WWTF. Well USGS475 is located just south of Route 3 and approximately 1,350ft from existing northeast infiltration bed. The average TN for

the 2006-2012 monitoring data is at 0.95 mg/L, though, this is above the baseline average but does not appear to be correlated to the infiltration basins when compared to surrounding well data.

Figure 28



Total Phosphorus

As indicated in Table 31 the pre-plant operation average baseline for total phosphorus is 0.039mg/L based on three sampling rounds. The operational monitoring well data average 2006-2012 is 0.042mg/L, same as last year's average. In August of 2006 there was a high value of 0.76mg/L which is likely a laboratory or sampling error as the prior concentration was 0.029mg/L and then followed by 0.027mg/L. Without this value the operational is 0.033mg/L. The down-gradient wells have a permit limit of 100% over the established background concentration for the four wells. This average concentration utilizing all baseline data prior to plant operation is 0.07mg/L. The value of 0.14mg/L signifies the increase of 100% over established background as stated in the permit. As noted above, there was one high value in August of 2006 but the prior and following month were at 0.02mg/L.

Boron

As indicated in Table 31 the pre-plant operation average baseline boron is 0.024mg/L. The operational monitoring well data average 2006-2012 is 0.047mg/L where 92% of the values were non-detect. The operational average is above the baseline average, however, 92% of the readings were non-detect. For average calculations half the detection limits are utilized for non-detect values.

pH

As indicated in Table 31 the pre-plant operation average baseline pH is 5.32. The operational average 2006 through 2010 was 5.51 well within an acceptable range of the baseline average.

2.4 Biological Monitoring

The baseline biomonitoring program was performed in 1998, 1999 and 2001. Four pond stations were established and monitored during those years: Russell Mill Pond, Hayden Pond, Howland Pond and Eel River Pond (basin). All four ponds are man-made impoundments along the Eel River. The memoranda presenting the biomonitoring data and findings were presented as Appendix D of the June 2002 Eel River Watershed Monitoring Data Report.

The results of the operational biomonitoring of periphyton, macroinvertebrates, and plankton that was completed in 2008, 2009, 2010, 2011 and 2012 are attached in Appendix C. The following is a brief discussion of the data results compiled by the Town's Professional Consultant Limnologist/Biologist.

2.4.1 Biological Monitoring Locations

Table 32

Biological Monitoring Locations			
Location ID	**Description**	**Macrophyte/ Phytoplankton**	**Macroinvertebrate/ Periphyton**
BM-1	Downstream of Russell Mill Pond, near hatchery		☑
BM-2	Downstream of Hayden Pond, near Sandwich Road		☑
BM-3	Near Forge Drive		☑
BM-4	Downstream of Sawmill Pond Dam		☑
Russell Mill Pond		☑	

Hayden Pond		☑	
Howland Pond		☑	
Eel River Basin		☑	

2.4.2 Macroinvertebrate Data, 2008

Macroinvertebrate sampling was conducted on September 20 and 21, 2008 at the four stations selected for previous biomonitoring of lotic (running water) habitats composing the Eel River ecosystem. These stations consist of the following: BM-1 located downstream of Russell Millpond adjacent to a fish hatchery, BM-2 located upstream of the Old Sandwich Road Bridge crossing, BM-3a located upstream of the Forge Road crossing, and BM-4 located upstream of Russell Millpond and below the spillway of an impoundment known as "Sawmill Pond" (adjacent to the Nature Conservancy Office). Habitat characteristics of these sampling stations remain essentially unchanged from those detailed in previous reports.

Methods

Sampling was conducted according to the multihabitat method of the Massachusetts DEP (December 1995) using an aquatic dip net. Substrates and instream structure providing microhabitat for aquatic invertebrates (cobble/gravel, submerged plants, woody debris/snags, etc) were sampled in proportion to their representation to form a composite sample at each sampling station. Analysis of the sample collected at each station entailed laboratory identification and enumeration of all organisms without subsampling. Collected organisms were identified to the lowest practical taxon, generally family or genus.

Data Analysis

Quantification of community structure observed in the sampling program is necessary if potential impacts to the system are to be detected in the future. Features of community structure quantified in this program consist of the following: richness (number of taxa), evenness (relative importance of taxa), number of EPT taxa (representatives of the pollution sensitive orders Ephemeroptera, Plecoptera and Trichoptera), relative abundance of major taxa (percent composition of the total community) and the relative abundance of functional feeding groups.

Community diversity has two components: richness and evenness. Richness is the most obvious component of diversity. The larger the number of taxa (species or genera) in a community, the greater the diversity. Evenness is the pattern of importance or dominance of taxa within a community. The more even or equitable the abundance of taxa are relative to each other, the greater is the diversity. Conversely, a community dominated by one or a few taxa, with other taxa being relatively rare, is less diverse. Evenness is quantified using the scaled standard deviation (scaled SD) value of Fager (1972) which uses the formula for that statistic to measure the variability in numbers of individuals per taxa. Scaled SD is a direct measure of the evenness component of diversity and allows comparison of samples with different numbers of taxa and individuals. Scaled SD values range from 0 to 1.0, with 0 representing extreme skew or unevenness in community structure (low diversity) and 1.0 representing complete evenness (maximum diversity).

Community measures involving tolerance values assigned to taxa, such as the Hilsenhoff Biotic Index and Lenat's Biotic Index, were omitted from analysis of the Eel River data due to their derivation from studies of communities inhabiting riffle habitat (stream reaches characterized by turbulent water flow). These measures are of questionable appropriateness for the Eel River which is a low-gradient system lacking riffles (as pointed out in previous reports). Additionally, tolerance values were developed as measures of the response of various taxa to diminished concentrations of dissolved oxygen resulting from organic pollution. Increased loading of organics to the Eel River, such as from a sewerage discharge, is not an impact anticipated in the design of this study.

Results

Results of macroinvertebrate sampling in 2008 reinforce previous findings that show community composition corresponding predictably to the habitat characteristics of each sampling station (Appendix C). Some changes are evident in community composition in comparison to last year or to historical data, the most notable being the reappearance of blackfly larvae at stations BM-2 and 3a where they were curiously absent in 2007 and three new taxa observed for the first time in the Eel River. These findings and other details of the macroinvertebrate communities observed at each station in 2008 are discussed in the following paragraphs.

The community at station BM-1 continued to be dominated by hydropsychid caddisflies (*Hydropsyche* and *Cheumatopsyche*) that specialize in building particle-filtering nets and retreats among gravel and cobble. Also important were pea clams (Pisidiidae) that inhabit these substrates and that are also common among the submerged roots of bank vegetation. Both the caddisflies and clams are filter-feeders and their great abundance attests to a steady supply of fine particulate organic matter (FPOM) discharged from Russell Millpond located upstream.

Measurements of community richness and EPT taxa at BM-1 register within the ranges documented in the historical database. However, evenness was lower than recorded previously due to disproportionate representation by *Hydropsyche* as opposed to the relative scarcity of other taxa in the community. This organism has consistently dominated the community at BM-1 and the decrease in the value of evenness reflects coincidences of sampling rather than a change in water quality.

At stations BM-2 and BM-3a, where submerged aquatic plants provide most of the substrate inhabited by macroinvertebrates, the communities were dominated by amphipods (*Gammarus*) that are detritivores commonly associated with plants and, especially at BM-2, by mayfly nymphs (*Baetis* and *Stenonema*) that graze on periphyton associated with aquatic plants.

As discussed above, blackfly larvae (Simuliidae) reappeared at these stations, with their distinctive habit of attachment to aquatic vegetation. Their absence in 2007 remains perplexing, but obviously represents only a localized and temporary loss. At station BM-3a, the caddisfly *Hydropsyche* had built retreats appearing as small, coarse "tufts" attached to the ribbon-like leaves of Bur-reed (*Sparganium*) bent over in the current. *Hydropsyche* more typically builds its retreats among gravel and cobble substrates such as at station BM-1.

The three taxa representing new records for the Eel River were all collected at Station BM-3a. These consisted of the damselfly *Argia,* the caddisfly *Pycnopsyche*, and the caddisfly *Triaenodes* (this latter genus has also been recorded in the Headwaters monitoring project). Measurements of community richness, evenness, and EPT taxa at stations BM-2 and BM-3a were within the ranges documented in the historical database.

The community at station BM-4 was dominated by the caddisfly *Hydropsyche* and by isopods (*Caecidotea*). Additionally, the mayfly *Stenonema* has increased its representation since first appearing at this station in 2006. Specimens of dragonfly nymphs of the genus *Boyeria* were again observed at BM-4 after appearing at this station for the first time in 2007. *Boyeria* has been previously observed at station BM-3a in 2006.

Also at BM-4, the stonefly *Leuctra* was represented by three specimens this year compared to one specimen each in 2006 and 2007. *Leuctra* is the only stonefly genus documented in the Eel River to date and only at BM-4. Measurements of community richness, evenness, and EPT taxa at station BM-4 were within the ranges documented in the historical database.

Changes in composition and structure of the Eel River macroinvertebrate community between 2008 and historical data reflect fluctuations in populations that are typical of macroinvertebrate communities. Numerous factors contribute to population dynamics within macroinvertebrate communities with extremes of flow, from drought conditions to flooding torrents, being the overriding factor. Other factors include competition, predation, type and availability of submerged substrates, and the dispersal of taxa through the oviposition behavior of aerial adult forms and by downstream "drift" of immature forms.

Reference Cited: Fager, E.W. 1972. Diversity: a sampling study. American Naturalist 106: 293 – 310.

2.4.3 Periphyton Data, 2008

The following has been compiled from information provided by the Town's Consultant Limnologist/Biologist:

Periphyton data at locations BM-1, BM-2, BM-3a & BM-4 were collected in the spring and fall of 2008. Results of the data can be found in Appendix C. The artificial substrates collected in the Spring were richly colonized with periphytic growth composed generally of diatoms as observed in previous years. Additionally, the green alga Coleochaete was common at BM-4 and bacteria

coated extensive areas of the slides incubated at BM-1. The artificial substrates collected in the Fall supported periphytic growth composed generally of diatoms as observed in previous years. Bacteria coated extensive areas of the slides incubated at BM-1 and BM-4, but this has occurred occasionally at other locations and is likely a coincidence of colonization patterns rather than an indication of any change in water quality. Slides at BM-1 also supported many retreats of Hydropsychid caddisflies.

2.4.4 Secchi Transparency and Dominant Phytoplankton, 2008

Spring 2008: Results of multiprobe measurements recorded on May 20, 2008 are located in Appendix C. Results of Eel River Plankton sampling conducted on May 20, 2008 are located in Appendix C. Similar to previous years, there is generally an increase in specific conductance from headwater locations (BM-4 and BM-3a) downstream throughout the system eventually to Eel River Basin. The water level in Russell Mill Pond appeared to be about one meter lower than usual and the western end of the pond, normally shallow, is completely dewatered except for a small channel carrying Eel River flow through exposed mudflats. Despite this loss of depth, the pond is thermally stratified and the hypolimnion is becoming anoxic as it does each summer. Secchi transparency was limited to 3.5 feet which is typical of this very productive pond. Identical to May of last year, the diatom Asterionella was the dominant organism among the phytoplankton in all ponds of the Eel River system.

Fall 2008: Results of multiprobe measurements recorded on September 28, 2008 are located in Appendix C. Results of Eel River Plankton sampling conducted on September 28,2008 are located in Appendix C. Water levels were high in all ponds due to two days of heavy rains that preceded the monitoring effort. Also, Russell Mill Pond was restored to its normal elevation through action of the dam owner to impound water and raise the level approximately one meter higher than the dewatered condition observed earlier in the year. The diluting influence of abundant rainfall is evident in the generally reduced values of specific conductance, especially in Howland Pond and Eel River Basin where values usually range around 95 and 105 us/cm respectively.

Russell Mill Pond was thermally stratified and the hypolimnion was nearly anoxic consistent with measurements recorded in previous summers. Secchi transparency had improved slightly from 3.5 feet in May to 4.5 feet. Low transparency resulting from very high densities of phytoplankton is typical of this very fertile pond.

In agreement with historical records, the dominant organism among the phytoplankton in all ponds of the Eel River system was the diatom Tabellaria. In May of 2007 it was Asterionella and the previous September it was both Tabellaria and Asterionella. Organisms other than these two diatoms do contribute significantly to the pond phytoplankton communities on occasion, but generally Tabellaria and/or Asterionella predominate. The last time these diatoms were supplanted as a major component of the phytoplankton communities was September 2003 when the cyanophyte Anabaena was dominant in all ponds at that time.

Eel River Basin exhibited the richest community (greatest number of taxa) compared to the other ponds, but this is understandable because of its position downstream of the other three ponds and therefore receiving phytoplankton exported from them via the western and eastern branches of the Eel River. Russell Mill Pond delivers a tremendous amount of plankton biomass to Hayden Pond and Eel River Basin located downstream and these ponds usually reflect this influence. Howland Pond, located on the east branch of the system, is not influenced by Russell Mill Pond and sometimes has a plankton community of different composition, but it also contributes to the rich community observed in Eel River Basin.

2.4.5 Macrophyte and Biomass Survey, 2008

The following information has been compiled from information provided by the Town's Consultant Limnologist/Biologist:

Observations of macrophytes in the four ponds were conducted throughout the summer of 2008 in conjunction with other monitoring activities. The macrophyte communities of the three shallow ponds (Hayden Pond, Howland Pond, and Eel River Basin) have remained essentially unchanged since 2006. These ponds are perennially choked with vegetative biomass from one or two dominant species. Fanwort (Cabomba caroliniana) dominates in Hayden Pond and is co-dominant

with Waterweed (Elodea nuttallii) in Eel River Basin. In Howland Pond, the floating pads (leaves) of White Waterlily (Nymphaea odorata) form a dense canopy over most of the surface each year.

Russell Millpond supports the greatest diversity of macrophytes among the ponds being monitored due to its greater size and depth in contrast to the shallow and plant-clogged character of the other three. Changes did occur in the macrophyte community of Russell Mill Pond due to the one-meter drawdown in water level that persisted during the summer. This drawdown dewatered extensive areas of pond bottom at the shallow western end and thereby prevented the growth of White Waterlily (Nymphaea odorata) and Yellow Waterlily (Nuphar variegata) that usually form extensive areas of floating pads in this area of the basin. The rhizomes (roots) of these plants likely survived the dewatering and will again produce floating pads and flowers if water levels remain near the usual elevation next year. The generally turbid and sometimes murky water resulting from productivity by phytoplankton in Russell Mill Pond limits observations of submerged macrophytes, but no significant changes were evident in this component of the community.

Fanwort (Cabomba caroliniana) remains the only invasive alien macrophyte present in the system and is still restricted to Hayden Pond and Eel River Basin as discussed above. There is no sign of other problematic aliens such as Hydrilla (Hydrilla verticillata), Eurasian Water-milfoil (Myriophyllum spicatum), or Water Chestnut (Trapa natans) in any of the ponds.

2.4.6 Macroinvertebrate Data, 2009

The following information has been compiled from information provided by the Town's Consultant Limnologist/Biologist:

Macroinvertebrate sampling was conducted on September 26, 2009 at the four stations selected for previous biomonitoring of lotic (running water) habitats composing the Eel River ecosystem. Habitat characteristics of these sampling stations remain essentially unchanged from those detailed in previous reports. Consistent with previous efforts, sampling was conducted according to the multihabitat method of the Massachusetts DEP (December, 1995) using an aquatic dip net. Quantification of community structure was also consistent with previous efforts.

Results of macroinvertebrate sampling in 2009 reinforce previous findings that show community composition corresponding predictably to the habitat characteristics of each sampling station Appendix C. Some changes are evident in community composition in comparison to last year or to historical data, the most notable being the absence of hydropsychid caddisflies at station BM-3a where they are often numerous. These findings and other details of the macroinvertebrate communities observed at each station in 2009 are discussed in the following paragraphs.

The community at station BM-1 continued to be dominated by hydropsychid caddisflies (Hydropsyche and Cheumatopsyche) that specialize in building particle-filtering nets and retreats among gravel and cobble. Also important were pea clams (Pisidiidae) that are common among the submerged roots of bank vegetation at this station. Both the caddisflies and clams are filter-feeders and their great abundance attests to a steady supply of fine particulate organic matter (FPOM) discharged from Russell Millpond located upstream. Measurements of community richness, evenness, and EPT taxa at station BM-1 register within the ranges documented in the historical database.

At stations BM-2 and BM-3a, where submerged aquatic plants provide most of the substrate inhabited by macroinvertebrates, the communities were dominated by amphipods (Gammarus and Hyalella) that are detritivores commonly associated with plants and by mayfly nymphs (Baetis at BM-2 and Stenonema at BM-3a) that graze on periphyton associated with aquatic plants. Blackfly larvae (Simuliidae) and isopods (Caecidotea) were also represented significantly at these stations. The lack of hydropsychid caddisflies at BM-3a, mentioned above, is due to a coincidence of sampling and future efforts will undoubtedly confirm their persistence at this station. Community richness at BM-2 registered a new high of 13 taxa in 2009. All other measurements of community richness, evenness, and EPT taxa at BM-2 and BM-3a were within the ranges documented in the historical database.

The community at station BM-4 was dominated by blackfly larvae (Simuliidae) and the mayfly Stenonema. Since first appearing at this station in 2006, Stenonema has steadily increased its representation in the community. As usual, the caddisfly Hydropsyche and isopods (Caecidotea) were also important at BM-4. Specimens of dragonfly nymphs of the genus Boyeria were again

observed at BM-4 since first appearing at this station in 2007. Also at BM-4, the stonefly Leuctra was represented by one specimen this year compared to three in 2008 and one specimen each in 2006 and 2007. Leuctra is the only stonefly genus documented in the Eel River to date and only at BM-4. Measurements of community richness, evenness, and EPT taxa at BM-4 were within the ranges documented in the historical database.

Changes in composition and structure of the Eel River macroinvertebrate community between 2009 and historical data reflect fluctuations in populations that are typical of macroinvertebrate communities. Numerous factors contribute to population dynamics within macroinvertebrate communities with extremes of flow, from drought conditions to flooding torrents, being the overriding factor. Other factors include competition, predation, type and availability of submerged substrates, and the dispersal of taxa through the oviposition behavior of aerial adult forms and by downstream "drift" of immature forms.

2.4.7 Periphyton Data, 2009

The following has been compiled from information provided by the Town's Consultant Limnologist/Biologist:

Periphyton data at locations BM-1, BM-2, BM-3a & BM-4 were collected in the spring and fall of 2009. Results of the data can be found in Appendix C. The artificial substrates collected in the Spring were richly colonized with periphytic growth composed generally of diatoms as observed in previous years. Additionally, bacteria coated extensive areas of the slides incubated at BM-1. The artificial substrates collected in the Fall were colonized with periphytic growth composed generally of diatoms as observed in previous years. The influence of phytoplankton discharged from Russell Mill Pond (especially Asterionella) is evident at BM-1 located immediately downstream of this very productive pond. Bacteria coated extensive areas of the slides incubated at BM-3a and BM-4. Bacterial coverage of slides has been observed intermittently at each of the four sampling locations in previous years, generally accompanied by rust-colored deposits of iron precipitates.

2.4.8 Secchi Transparency and Dominant Phytoplankton, 2009

Spring 2009: Results of multiprobe measurements recorded on May 10, 2009 are given in Appendix C. The water elevation in Russell Mill Pond was discovered to be extremely low, appearing to be 10 to 12 feet below its normal level. This is much lower than observed last May when the water level was about 3 or 4 feet lower than usual.

The exposed northern shoreline in the vicinity of the Enos property was littered with old bricks, rusted pieces of metal and machinery, fragments of old glass bottles and porcelain, and lots of shoe leather that appeared to be in various stages of construction suggesting that the area is the site of the old mill and this was once involved in the manufacture of footwear. The exposed shoreline was steep and hazardous and so little water remained in the basin that multiprobe measurements and plankton sampling were conducted from shore instead of canoe. Similar to previous years, there is generally an increase in specific conductance from headwater locations (BM-4 and BM-3a) downstream throughout the system eventually to Eel River Basin.

The dominant organism among the phytoplankton in all the ponds, except Howland Pond, was the colonial chrysophyte *Synura*. This contrasts with results from the two previous years when the diatom *Asterionella* was the dominant organism in all ponds of the Eel River system in May. The ascendancy of *Synura* likely originated in Russell Mill Pond, possibly triggered by factors related to its altered, drawn-down condition, and then exported to Hayden Pond and Eel River Basin located downstream. The phytoplankton communities observed in the latter two ponds often reflect the influence of very high productivity by phytoplankton in Russell Mill Pond and subsequent delivery of organisms downstream via the outflow.

Howland Pond, located on the southern branch of the Eel River, is not subject to this influence and often supports a different phytoplankton community compared to the other ponds as it did this May. Most of the important organisms in Howland Pond (*Spirogyra*, *Eunotia*, and *Closterium*) are usually associated with substrates rather than found floating in the plankton. This is to be expected in this very shallow basin where algae growing attached to substrates gets dislodged and swept up

by currents and wind-induced turbulence and, thereby, suspended in the water column where it can be captured in a plankton net.

Fall 2009: Results of multiprobe measurements recorded on September 7, 2009 are given in Appendix C. The water elevation in Russell Mill Pond was found to be restored to its normal level. The water column exhibited pronounced hypoxia in the hypolimnion as is typical of this pond during thermal stratification. In contrast, the epilimnion had supersaturated values of dissolved oxygen due to photosynthetic activity by high densities of phytoplankton . The other ponds had undersaturated values of dissolved oxygen due to the senescent condition of their lush macrophyte communities and the associated demand for oxygen by microbial decomposers.
The dominant organism among the phytoplankton in all ponds was *Asterionella*; a diatom that is often prominent in the Eel River system see Appendix C. High densities of *Asterionella* in Russell Mill Pond reduced water transparency to only 3.5 feet (1.1 meters) and export of this organism via the outflow was evident in the phytoplankton communities of Hayden Pond and Eel River Basin located downstream. The phytoplankton communities observed in the latter two ponds often reflect the influence of very high productivity by phytoplankton in Russell Mill Pond. Howland Pond, located on the southern branch of the Eel River, is not subject to this influence and often supports a different phytoplankton community compared to the other ponds. However, on this date, conditions in Howland Pond were such that *Asterionella* became dominant in this pond as well.

2.4.9 Macrophyte and Biomass Survey, 2009

There were no changes from the 2008 Macrophyte survey. Hayden Pond, Howland Pond and Eel River Pond have accumulated deposits of sediment that have filled them almost to capacity in the decades since being impounded and are, therefore, extremely shallow. These organic-rich sediments support profuse growth by macrophytes in each pond. The initial macrophyte surveys recorded in 2001 showed them to be dominated by one or two species and this condition has remained essentially unchanged. In Hayden Pond and Eel River Pond, the invasive alien Fanwort (*Cabomba caroliniana)* and the native Waterweed (*Elodea nuttallii*) have remained co-dominated since 2001. In both ponds, Fanwort grows nearly to the surface in a dense accumulation of biomass each year. Most of the surface of Howland Pond becomes covered by the floating pads of White Waterlily (*Nymphaea odorata*) each year. The macrophyte community of Russell Pond is

more diverse, but has also remained relatively unchanged since 2001. Limitation of light penetration by high densities of phytoplankton in Russell Mill Pond likely restricts macrophyte growth to the shallowest portions of this pond.

2.4.10 Macroinvertebrate Data, 2010

Macroinvertebrate sampling was conducted on September 5, 2010 at the four stations selected for biomonitoring of lotic (running water) habitats composing the Eel River ecosystem. Habitat characteristics of three of these sampling stations remain essentially unchanged from those detailed in previous reports, but removal of the dam at "Sawmill Pond" has radically changed station BM-4. Consistent with previous efforts, sampling was conducted according to the multihabitat method using an aquatic dip net. Quantification of community structure was also consistent with previous efforts.

Station BM-4 was located in the area below the former dam (now the location of a new footbridge) and was characterized by non-turbulent flow in a channel having a minor gradient typical of the Eel River. This area now has the steepest gradient of the entire system and features a series of five plunging steps where water drops from a few inches up to a foot in elevation at each step. Water flows turbulently throughout this series of steps which comprise approximately 50 feet (15 meters) of the river channel. This section of river was retained as station BM-4 in order to monitor post-restoration development of a macroinvertebrate community in this unique habitat.

Results of macroinvertebrate sampling in 2010 reinforce previous findings that show community composition corresponding predictably to the habitat characteristics of each sampling station as shown in Appendix C. The community at station BM-1 continued to be dominated by hydropsychid caddisflies that specialize in building particle-filtering nets and retreats among gravel and cobble. Measurements of community richness, evenness, and EPT taxa at station BM-1 register within the ranges documented in the historical database.

Submerged aquatic plants provide most of the substrate inhabited by macroinvertebrates at stations BM-2 and BM-3a. Mayfly nymphs (*Baetis*) that graze on periphyton associated with aquatic plants

dominated at BM-2. The native waterweed (*Elodea*) appears to have displaced some beds of the non-indigenous fanwort (*Cabomba*) which was previously more widespread at this station. Measurements of community richness, evenness, and EPT taxa at station BM-2 were within the ranges documented in the historical database. Blackfly larvae (Simuliidae) dominated at BM-3a where they covered the submerged leaves of bur-reed (*Sparganium*). Disproportionate representation by these larvae resulted in community richness and evenness registering below the minimum historical values recorded at this station. This result is due to population fluctuations that are typical of macroinvertebrate communities and does not indicate any long-term trend in water quality.

Organisms collected at station BM-4 represent pioneer specimens colonizing this newly created habitat. Hydropsychid caddisflies and isopods (*Caecidotea*) were important components of the community prior to dam removal and restoration and they are already significant in the post-restoration community.

2.4.11 Periphyton Data, 2010

Spring 2010: The artificial substrates collected on May 25, 2010 were richly colonized with periphytic growth composed generally of diatoms as observed in previous years. Additionally, bacteria coated extensive areas of the slides. At station BM-1, near the small Hatchery downstream of Russell Mill Dam, the discharge of plankton from highly productive Russell Mill Pond located upstream is evident from the presence of *Asterionella* colonies that were observed enmeshed among the periphyton.

Fall 2010: The artificial substrates collected in the Eel River on September 25, 2010 were richly colonized with periphytic growth dominated by diatoms as observed in previous years.

2.4.12 Secchi Transparency and Dominant Phytoplankton, 2010

Spring 2010: Results of multiprobe measurements recorded in the four ponds on May 21, 2010 are given in Appendix C. The water column of Russell Mill Pond exhibited pronounced hypoxia in the hypolimnion as is typical of this pond during thermal stratification. Also evident in the hypolimnion is a gradient of increasing conductivity extending from a depth of two meters down to

the bottom of the pond. This gradient results from "internal loading" of nutrients mobilized from the sediment and will intensify as anoxia and reducing conditions persist during the stratification period. These processes recur each year in the hypolimnion of Russell Mill Pond. In contrast, the epolimnion had supersaturated values of dissolved oxygen due to photosynthetic activity by high densities of phytoplankton. The other ponds had undersaturated values of dissolved oxygen due to demand for oxygen by microbes that are decomposing senescent macrophytes and the lush coating of periphyton associated with them.

The phytoplankton community of Russell Mill Pond was dominated by three taxa: the diatom *Asterionella* and the chrysophytes *Synura* and *Diniobryon* as shown in Appendix C. High densities of these organisms in Russell Mill Pond reduced water transparency to only 5 feet (1.5meters) and their export via the outflow was strongly evident in the phytoplankton communities of Hayden Pond and Eel River Basin located downstream. The phytoplankton communities observed in the latter two ponds often reflect the influence of very high productivity by phytoplankton in Russell Mill Pond.

Howland Pond, located on the eastern branch of the Eel River, is not subject to this influence and usually supports a phytoplankton community different from the other ponds. Conditions in Howland Pond on the sample date were such that *Asterionella* dominated the community exclusively without representation by *Synura* and *Dinobryon* that distinguished Russell Mill Pond as noted above. *Asterionella* is commonly a dominant organism among all ponds of the Eel River system, but last year *Synura* was ascendant in Russell Mill Pond and, consequently, in the ponds located downstream.

Fall 2010: Results of multiprobe measurements recorded in the four ponds on September 24, 2010 are given in Appendix C. The water column of Russell Mill Pond exhibited pronounced hypoxia in the hypolimnion as is typical of this pond during thermal stratification. Also evident in the hypolimnion is a gradient of increasing conductivity extending from a depth of 2.5 meters down to the bottom of the pond. This gradient results from "internal loading" of nutrients mobilized from the sediment and will intensify as anoxia and reducing conditions persist during the stratification period. These processes recur each year in the hypolimnion of Russell Mill Pond. In contrast, the epilimnion had supersaturated values of dissolved oxygen due to photosynthetic activity by high densities of phytoplankton. As similar to the spring, the other ponds had undersaturated values of

dissolved oxygen due to demand for oxygen by microbes that are decomposing senescent macrophytes and the abundant coating of periphyton associated with them.

The phytoplankton community of Russell Mill Pond was dominated by the chrysophyte *Dinobryon* with significant representation by the diatom *Tabellaria* and the ciliate protozoan *Climacostomum.* High densities of these organisms reduced water transparency to only 5.5 feet (1.7 meters) in Russell Mill Pond. This pond typically appears greenish-brown and murky due to very high productivity by phytoplankton. This was the first time that *Climaacostomum* has been observed in the Eel River ponds (it was also common in Eel River Basin), but it has been observed previously in other Plymouth ponds including Gallows Pond and the south basin of Bloody Pond.

Dinobryon was also very common in Hayden Pond along with the diatoms *Melosira* and *Nitzschia* and the filamentous green alga *Zygnema*. In Howland Pond, the phytoplankton community was dominated by the diatoms *Melosira* and *Tabellaria* and the filamentous green alga *Mougeotia.* Lastly, Eel River Basin was dominated by *Nitzchia, Mougeotia* and *Climacostomum.* The diversity evident in all ponds this September is atypical because usually the ponds are dominated by either *Asterionella* or *Tabellaria* or both of these diatoms together. The filamentous algae ascendant in these plankton samples are likely derived from periphytic growth on the copious macrophyte biomass that occupies the three downstream ponds.

2.4.13 Macrophyte and Biomass Survey, 2010

Results of recent macrophytes surveys of the Eel River ponds are generally consistent with observations recorded since 2001. The recent drawdowns of Russell Mill Pond have resulted in changes at the shallow western end of that pond where floating pads of Yellow Waterlily (*Nuphar variegata*) have disappeared and been replaced by emergent patches of Bur-reed (*Sparganium*). Also in Russell Mill Pond, the alien Yellow Iris (*Iris pseudacorus*) has recently made an appearance in many locations along the shoreline. Limitation of light penetration by high densities of phytoplankton in Russell Mill Pond favors Bladderwort (*Utricularia*), a plant that lacks roots and floats as a mass of branching stems. Submerged growth by rooted macrophytes is restricted to the shallowest portions of this pond.

The invasive alien Fanwort (*Cabomba caroliniana*) remains dominant in Hayden Pond and Eel River Basin. Fanwort appears to be in the process of displacing native Waterweed (*Elodea nuttallii*) in the western half of Hayden Pond which was once occupied almost exclusively by Waterweed, but now supports a mixture of both species. Throughout all the years of the monitoring program, Fanwort has been observed to grow to the surface in a dense accumulation of vegetative biomass in both Hayden Pond and Eel River Basin.

Lastly, most of the surface of Howland Pond was again covered by the floating pads of White Waterlily (*Nymphaea odorata*). This has been observed each year since the start of the monitoring program in 2001.

2.4.14 Macroinvertebrate Data, 2011

Macroinvertebrate sampling was conducted on October 2, 2011 at the four stations selected for biomonitoring of lotic (running water) habitats composing the Eel River ecosystem. Habitat characteristics of these sampling stations remain essentially unchanged from those detailed in previous reports, including the recent changes at BM-4 (TNC) involving the removal of the dam at "Sawmill Pond" documented in previous years report. Consistent with previous efforts, sampling was conducted according to the multihabitat method using an aquatic dip net. Quantification of community structure was also consistent with previous efforts.

Results of macroinvertebrate sampling in 2011 reinforce previous findings that show community composition corresponding predictably to the habitat characteristics of each sampling station. However, macroinvertebrates were relatively sparse at every station (especially at BM-3a) and it may be that the high flows generated by Hurricane Irene dislodged many macroinvertebrates and carried them downstream. Measurements of community richness and EPT taxa at most stations were near the minimum value documented in the historical database or established a new record low value. In contrast, measurements of community evenness registered near the center of the historical range documented for each station, except for station BM-3a where a new record high value of 0.77 was observed.

As usual, cobble and gravel substrates at station BM-1 (fish hatchery) were encrusted with the retreats of hydropsychid caddisflies. The glass slides deployed as artificial substrates for periphyton were also encrusted with hydropsychid retreats on this date (this is the only location were periphyton slides were found and recovered for analysis). These caddisfilies specialize in building particle-filtering nets and retreats on hard substrates.

Fingernail clams were common along the northern bank of the channel in micro-habitat created where the bank is steep and roots of bank vegetation protrude into the channel and form a submerged network of biomass along the side of the channel. Sponges were also common in this micro-habitat. This is the only station where rooted aquatic plants were absent from the channel.

As documented in previous years, submerged aquatic plants provide most of the substrate inhabited by macroinvertebrates at station BM-2 (Old Sandwich Rd). Channel vegetation at BM-2 consisted of *Elodea, Potamogeton,* and *Sparganium.* Fragments of the alien invasive plant Fanwort (*Cabomba caroliniana)* were also observed here having originated from the infestation established in Hayden Pond located a short distance upstream. The fauna at station BM-2 was dominated by amphipods and, secondarily, by hydropsychid caddisflies and blackfly larvae. Periphyton slides could not be found at BM-2, so periphyton was collected by squeezing and washing pieces of aquatic fern.

Habitat and substrates available for macroinvertebrates at station BM-3a consists mostly of submerged aquatic vegetation similar to station BM-2 above. Numerous plant species grow in the channel including *Callitriche, Elodea,* and *Sparganium.* Bladderwort (*Utricularia)* is also prevalent at this location and is found tangled up with the other plants.

Fauna was very sparse at BM-3a, likely due to Hurricane Irene as stated above, but additionally, riparian vegetation along the eastern bank at Station BM-3a, ,adjacent to the horse pasture, appeared to have been cleared and removed recently (this has been observed numerous times over the years of monitoring).

The community was limited almost exclusively to blackfly larvae (Simuliidae), hydropsychid caddisflies, amphipods, and isopods. Only two nymphs of the damselfly *Calopteryx* contributed additionally to the fauna at this station. Glass slides deployed as artificial substrates for periphyton at BM-3a could not be located, so pieces of bladderwort and other submerged vegetation were squeezed and periphyton washed into a sample bottle for analysis as an alternative to the slides.

Results from station BM-4 (TNC) show colonization of this recently created habitat to be a relatively slow process. Hydropsychid caddisflies and isopods (*Caecidotea)* were important components of the community prior to dam removal and restoration and they were among the first organisms to re-establish themselves in the new habitat last year. They remain significant in the community sampled this year along with increasing representation by diptera (flies and midges) and the mayfly *Stenonema.*

Aquatic vegetation growing in the channel at BM-4 (TNC) consisted of *Callitriche, Potamogeton,* and *Sparganium.* Glass slides deployed as artificial substrates for periphyton could not be found at this location, put prominent filamentous forms of algae growing along the banks and on submerged vegetation were collected as a substitute.

2.4.15 Periphyton Data, 2011

Spring 2011: The artificial substrates collected on May 30, 2011 were richly colonized with periphytic growth composed generally of diatoms as observed in previous years. Similar to May of 2010, the export of plankton from highly productive Russell Mill Pond is evident from the presence of *Asterionella* colonies that were observed enmeshed among the periphyton on substrates located downstream. Russell Mill Pond generally supports a "bloom" of this diatom each spring.

Fall 2011: Station BM-1 (fish hatchery) is the only station where the slides deployed as artificial substrate for periphyton were recovered. It is likely that high flows generated by Hurricane Irene in late August washed deployment apparatus at the other stations downstream. The slides at BM-1 were rusty-red with iron precipitates and bacteria that covered most of the slides. A few diatoms typical of periphyton communities were observed on the slides as well as some algal taxa that are typically planktonic observed entangled with fungal hyphae on the slides. These latter organisms

were discharged from Russell Mill Pond, a system that produces high densities of phytoplankton located just upstream.

Periphyton at Station BM-2 was collected from aquatic fern growing in the channel and this natural substrate supported a typical periphyton community dominated by diatoms. At Station BM-3a, periphyton was collected from submerged vegetation, especially bladderwort (*Utricularia*). These natural substrates supported a periphyton community dominated by diatoms similar to Station BM-2.

At Station BM-4 (new TNC footbridge), filamentous forms of algae were growing prominently along the sides of the channel and on submerged vegetation. Microscopic inspection of collected filaments revealed them to be composed of the two very common taxa.

2.4.16 Secchi Transparency and Dominant Phytoplankton, 2011

Spring 2011: Results of multiprobe measurements recorded in the four ponds on May 7, 2011 are given in Appendix C. Measurements of Russell Mill Pond conformed predictably to previous years of profile data with the hypolimnion becoming anoxic and internal loading evident. Also, the epilimnion of this pond had supersaturated values of dissolved oxygen due to photosynthetic activity by high densities of phytoplankton. These processes recur annually in Russell Mill Pond during the stratification period. The unstratified ponds had undersaturated values of dissolved oxygen due to demand for oxygen by microbes that are decomposing senescent macrophytes and other organic material in these shallow basins.

The phytoplankton community of Russell Mill Pond was again dominated by the diatom *Asterionella*. High densities of this organism in Russell Mill Pond reduced water transparency to 7 feet (2.1 meters) and its export via the outflow was strongly evident in the phytoplankton communities of Hayden Pond and Eel River Basin located downstream. The phytoplankton communities observed in the latter two ponds often reflect the influence of very high productivity by phytoplankton in Russell Mill Pond.

Howland Pond, located on the eastern branch of the Eel River, is not subject to this influence and usually supports a phytoplankton community different from the other ponds. On this sampling day, the phytoplankton community of Howland Pond was dominated by the diatoms *Tabellaria* and *Synedra* and the chrysophyte *Dinobryon.*

Fall 2011: Measurements of temperature and dissolved oxygen recorded in the four ponds on September 11, 2011 are given in Appendix C. Measurements of Russell Mill Pond conformed predictably to previous years of profile data with anoxic conditions in the hypolimnion and, conversely, supersaturated values of dissolved oxygen in the epilimnion due to photosynthetic activity by high densities of phytoplankton. These processes recur annually in Russell Mill Pond during the stratification period. The unstratified ponds had undersaturated values of dissolved oxygen due to demand for oxygen by microbes that are decomposing senescent macrophytes and other organic material in these shallow basins.

The diatoms *Tabellaria* and *Asterionella* were important in the phytoplankton communities of all four ponds which is typical for Fall monitoring results. In addition to these diatoms, the phytoplankton community of Russell Mill Pond was dominated by thin filaments of the cyanophyte *Oscillatoria* and the ciliate protozoan *Climacostomum.* High densities of these organisms reduced water transparency to only 4.4 feet (1.3 meters) in Russell Mill Pond. This pond typically appears greenish-brown and murky due to very high productivity by phytoplankton.

Hayden Pond supported a phytoplankton community very similar to Russell Mill Pond except that the cyanophyte *Anabaena* supplanted *Oscillatoria.* Howland Pond, located on the eastern branch of the Eel River, supported by phytoplankton community somewhat different from the other ponds in that the filamentous diatom *Melosira* and the chrysophyte *Synura* were numerically prominent.

2.4.17 Macrophyte and Biomass Survey, 2011

Macrophyte surveys of the Eel River ponds document almost no change from observations reported last year. One exception is that specimens of Yellow Waterlily (*Nuphar variegate)* have reappeared at the shallow western end of Russell Mill Pond where they were formerly prevalent prior to being suppressed as a result of drawdowns of this pond. As noted in previous reports, limitation of light penetration by high densities of phytoplankton in Russell Mill Pond restricts growth by rooted macrophytes to the shallowest portions of this basin. Bladderwort (*Utricularia*), a plant lacking roots, is commonly observed floating on or near the surface of Russell Mill Pond as a tangled mass of branching stems.

The invasive alien Fanwort (*Cabomba caroliniana*) remains dominant in Hayden Pond and Eel River Basin. Throughout all the years of monitoring, Fanwort has been observed to grow to the surface in a dense accumulation of vegetative biomass in both Hayden Pond and Eel River Basin. In Howland Pond most of the surface was again covered by the floating pads of White Waterlily (*Nymphaea odorata*). This has been observed each year since the start of the monitoring program in 2001.

2.4.18 Macroinvertebrate Data, 2012

Macroinvertebrate sampling was conducted on September 23, 2912 at the four stations selected for biomonitoring of lotic (running water) habitats composing the Eel River ecosystem. Habitat characteristics of these sampling stations remain essentially unchanged from those detailed in previous reports, including the recent changes at BM-4 (TNC) involving the removal of the dam at "Sawmill Pond" documented in previous years report. Consistent with previous efforts, sampling was conducted according to the multihabitat method using an aquatic dip net. Quantification of community structure was also consistent with previous efforts.

Results of macroinvertebrate sampling in 2012 reinforce previous findings that show community composition corresponding predictably to the habitat characteristics of each sampling station. As usual, cobble and gravel substrates at station BM-1 (fish hatchery) were encrusted with the retreats of larval hydropsychid caddisfiles. These caddisflies specialize in building particle-filtering nets and retreats on hard substrates.

Fingernail claims were encountered along the left (northern) bank of the channel at BM-1, but were abundant in similar habitat along the right (southern) bank that is located slightly upstream and had not been previously sampled. This micro-habitat exists where the bank is steep and roots of bank vegetation protrude into the channel and form a submerged network of biomass along the side of the channel. Sponges were also common in this micro-habitat. A few scattered specimens of *Sparaganium* were the only aquatic plants rooted in the channel at this location.

As documented in previous years, submerged aquatic plants provide most of the substrate inhabited by macroinvertebrates at station BM-2 (Old Sandwich Rd). Channel vegetation at BM-2 consisted

of *Elodea, Potamogeton, Sparganuim,* and the alien invasive plant Fanwort (*Cabomba caroliniana*). This last one is derived from the infestation that is established in Hayden Pond located a short distance upstream. The fauna at station BM-2 was dominated by amphipods and, secondarily, by nymphs of the mayfly *Baetis*. Blackfly larvae (Simuliidae) was not found during this sampling event.

Habitat and substrates available for macroinvertebrates at station BM-3a consists mostly of submerged aquatic vegetation similar to station BM-2 described above. Numerous plant species grow in the channel including *Callitriche, Elodea,* and *Sparganuim*. Blackfly larvae and hydropsychid (caddisfly) larvae were especially prevalent on the broad leaves of *Sparaganuim*. Mayfly nymphs (*Baetis* and *Stenoema*) and amphipods composed most of the remainder of the community at this location. Community richness rebounded dramatically from a low of 5 in 2011 to reach 11 in the 2012 sampling effort.

Results from station BM-4 (TNC) show colonization of this recently created habitat to be progressing such that a community now has fairly balanced representation by midges (Chironomidae), blackflies, mayflies (*Baetis* and *Stenonema*) and hydropsychid caddisflies. Aquatic vegetation growing in the channel at BM-4 consisted of *Callitriche, Eoldea, Potamogeton,* and *Sparaganuim* As at other locations (except BM-2), *Sparaganuim* was heavily colonized by blackfly larvae.

2.4.19 Periphyton Data, 2012

Fall 2012: The artificial substrates collected on September 23, 2012 were richly colonized with periphytic growth composed generally of diatoms as observed in previous years. The export of plankton from highly productive Russell Mill Pond is again evident from the presence of *Tabellaria* colonies that were observed enmeshed among the periphyton on substrates located downstream. *Tabellaria* was evident at high densities in a net sample of phytoplankton collected from Russell Mill Pond on September 16, 2013.

2.4.20 Secchi Transparency and Dominant Phytoplankton, 2012

Spring 2012: Results of temperature and dissolved oxygen measurements recorded in the four ponds on May 12, 2012 can be found in Appendix C. Russell Mill Pond appeared particularly brown and turbid due to a bloom of the diatom *Asterionella.* Absorption of solar radiation by high densities of this organism caused a rapid gain of heat near the surface and a very steep thermocline below the depth of light penetration between 3 and 4 meters where the temperature decreased 2.5'C. Below the thermocline, the hypolimnion was already close to being anoxic due to intense microbial demand for oxygen. This has been observed consistently each spring during monitoring since 2006.

In contrast to the hypolimnion, the epilimnion of Russell Mill Pond has supersaturated values of dissolved oxygen due to photosynthetic activity by high densities of *Asterionella.* These processes recur annually in Russell Mill Pond during the stratification period.

The shallow, unstratified ponds had undersaturated values of dissolved oxygen due to demand for oxygen by microbes that are decomposing senescent macrophytes and other organic material in these basins.

Results of phytoplankton sampling are given in Appendix C. As stated above, *Asterionella* was present at such high densities in Russell Mill Pond that the water appeared brown and turbid. This diatom commonly dominates the phytoplankton community of Russell Mill Pond, but this bloom was exceptional in that it reduced water transparency to a remarkable 2.5 feet (0.76meters) as measured with the Secchi Disk. This is the lowest value on record for Russell Mill Pond since Secchi transparency measurements were initiated in 2006 (historical range is usually 3 to 7 feet).

As observed in previous years of monitoring, the outflow from Russell Mill Pond discharges tremendous amounts of *Asterionella* biomass and this was strongly evident in the phytoplankton communities of Hayden Pond and Eel River Basin located downstream. The water of these latter two ponds, especially Hayden Pond, had the same murky, brown appearance and microscopic analysis of samples showed *Asterionella* to be the dominant organism in both ponds. The

phytoplankton communities observed in these two ponds often reflect the influence of very high productivity by phytoplankton in Russell Mill Pond and subsequent export of phytoplankton biomass downstream.

Howland Pond, located on the eastern branch of the Eel River, is not subject to this influence and usually supports a phytoplankton community different from the other ponds. On the monitoring event, the phytoplankton community of Howland Pond was dominated by the chrysophyte *Dinobryon* and, secondarily, by the diatoms *Asterionella* (not derived from Russell Mill Pond) and *Tabellaria*.

Fall 2012: Results of temperature and dissolved oxygen measurements recorded in the four ponds on September 15 & 16, 2012 can be found in Appendix C. The unstratified ponds had undersaturated values of dissolved oxygen due to demand for oxygen by microbes that are decomposing senescent macrophytes and other organic material in these shallow basins.

Measurements of Russell Mill Pond conformed predictably to previous years of profile data with hypoxic conditions near the top of the thermocline at a depth of 2 meters intensifying with depth to anoxia in the hypolimnion. Conversely, supersaturated values of dissolved oxygen were attained in the epilimnion due to photosynthetic activity by high densities of phytoplankton. These processes recur annually in Russell Mill Pond during the stratification period.

The diatom *Tabellaria* was important in the phytoplankton communities of all four ponds which is typical for September monitoring results. In addition to this diatom, filaments of the cyanophyte *Oscillatoria* were prevalent in the phytoplankton community of Russell Mill Pond. High densities of these organisms reduced water transparency to only 5 feet (1.5meters) in Russell Mill Pond. This pond typically appears greenish-brown and murky due to very high productivity by phytoplankton.

Hayden Pond supported a phytoplankton community very similar to Russell Mill Pond being dominated by *Tabellaria*, but differed in that *Oscillatoria* was absent. In Eel River Basin, the diatoms *Asterionella* and *Synedra* joined *Tabellaria* in dominating the phytoplankton community.

Howland Pond, located on the eastern branch of the Eel River, supported a phytoplankton community somewhat different from the other ponds in that the diatoms *Fragilaria* and *Eunotia* were numerically prominent in addition to *Tabellaria*.

2.4.21 Macrophyte and Biomass Survey, 2012

Results of recent macrophytes surveys of the Eel River ponds document almost no change from observation reported in 2011. The invasive alien Fanwort (*Cabomba caroliniana*) remains dominant in Hayden Pond and Eel River Basin. Throughout all the years of the monitoring program, Fanwort has been observed to grow to the surface in a dense accumulation of vegetative biomass in both Hayden Pond and Eel River Basin. In Howland Pond, most of the surface was again covered by the floating pads of White Waterlily (*Nymphaea odorata*), especially around the perimeter. This has been observed each year since the start of monitoring program in 2001.

As noted in previous reports, limitation of light penetration by high densities of phytoplankton in Russell Mill Pond restricts growth by rooted macrophytes to the shallowest portions of this basin. Bladderwort (*Utricularia*), a plant lacking roots, is commonly observed floating on or near the surface of Russell Mill Pond as a tangled mass of branching stems. Another plant lacking roots, Coontail (*Ceratophyllum echinatum*), has become more prevalent and is evident in shallow areas along with Bladderwort. Waterweed (*Elodea nuttalli*) and Tape-grass (*Vallisneria Americana*) persist at scattered locations in the littoral zone. A species of Pondweed (*Potamogeton*) with floating leaves is more prevalent in deeper areas of the littoral zone (2 to 3 feet deep) where its floating leaves enable it to compensate for the biogenic turbidity and limited light penetration characteristic of this pond. Another plant with floating leaves, Yellow Waterlily (*Nuphar variegate*), persists at scattered locations including the shallow western end of the pond and in protective covers.

2.5 References

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