

**WHIPPANY RIVER WATER QUALITY
TREND ANALYSIS STUDY**

**FINAL REPORT
AUGUST 28, 2012**

**PREPARED FOR THE
WHIPPANY RIVER WATERSHED ACTION COMMITTEE**

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THIS PROJECT WAS FUNDED BY THE WHIPPANY RIVER WATERSHED ACTION COMMITTEE

ACKNOWLEDGEMENTS

THE WHIPPANY RIVER WATERSHED ACTION COMMITTEE GRATEFULLY ACKNOWLEDGES THOSE INDIVIDUALS WHO PARTICIPATED IN THE FIELD WORK, SAMPLING, DATA ANALYSIS AND/OR PREPARATION OF THIS REPORT.

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TECHNICAL REPORT

Introduction

Water quality data was collected at selected locations along the Whippany River and compared to historical data collected under similar seasonal and weather conditions. The selected sampling locations included Lake Valley Road in Morris Township (Site 3 - 13.3 miles upstream of the Whippany River confluence with the Rockaway River), Speedwell Avenue in Morristown (Site 5 - 12.4 miles upstream of the confluence), South Jefferson Road in Hanover Township (Site 9 - 7.9 miles upstream of the confluence), Melanie Lane in East Hanover Township (Site 14 - 4.1 miles upstream of the confluence) and Edwards Road in Parsippany (Site 17 - 0.3 miles upstream of the confluence). Diagrams showing sampling locations can be found in [Appendix A](#) of this report. Samples were collected on August 20, 2008, August 11, 2010, June 9, 2011 and October 11, 2011. Samples were collected under dry weather conditions. Water quality parameters analyzed include temperature, dissolved oxygen (DO), pH and specific conductivity which were determined in the field and carbonaceous biochemical oxygen demand (CBOD), total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH₃-N), nitrite nitrogen (NO₂-N), nitrate nitrogen (NO₃-N), orthophosphorus (ortho-P), total phosphorus (Total-P), total suspended solids (TSS), total dissolved solids (TDS), total alkalinity, chlorophyll A, fecal coliform, and enterococcus.

Water quality data collected during 2010/2011 were compared to water quality data, for the same parameters, collected in 1994/1995 and 2001/2002 under similar dry weather conditions. Please note that water quality data collected during the August 20, 2008 sampling date was not included in the 2010/2011 averages. Dry weather conditions generally reflect the river's water quality impacts from point source pollution.

It is important to note that the river flows and river temperatures were higher during the 2010/2011 sampling period when compared to the prior sampling periods. This may have contributed to some extent to the lower dissolved oxygen, total phosphorus, fecal coliform and nitrate concentrations and the increase in suspended solids concentrations observed during this time. With respect to the relatively higher water temperatures, as water temperature increases the dissolved oxygen concentration generally decreases due to a decrease in dissolved oxygen saturation (Henry's Law). The higher base flows observed during 2010/2011 may have diluted the nitrate, fecal coliform and total phosphorus concentrations in the river. The increased flow during the 2010/2011 sampling events (when compared to the prior sampling events) may have contributed to the increase in suspended solids concentration by scouring settled solids from the sediments and into the water column.

Description of Study Area

For a complete description of the study area (Whippany River Watershed) please refer to the "Whippany River Watershed Characterization Report" prepared by the Whippany Watershed Partnership in September of 1995 and "A Cleaner Whippany River Watershed, May 2000," prepared by the New Jersey Department of Environmental Protection and the Whippany Nonpoint Source Work Group, both of which are kept on file with the New Jersey Department of Environmental Protection, Division of Watershed Management, and the Whippany River Watershed Action Committee. A summarized description of the Whippany River Watershed may be found in [Appendix D](#) of this report titled "The Whippany River watershed Action Now Strategy of the Whippany River Watershed Management Plan, January 2000."

Methods

Samples were collected at five locations along the Whippany River during dry weather periods. The locations correspond to areas where prior data existed. They included sampling stations located at the Lake Valley Road Bridge in Morris Township (upstream of the Butterworth Wastewater Treatment Plant), Speedwell Avenue bridge in Morristown (immediately downstream of the Speedwell Lake Dam), South Jefferson Road bridge in Hanover Township, Melanie Lane bridge in East Hanover Township and Edwards Road in Parsippany. Maps of the sampling stations along with longitude and latitude information can be found in [Appendix A](#). Sampling was conducted during the spring, summer and fall seasons to account for possible seasonal variability and to be consistent with past sampling events. Sampling months during the 2010/2011 sampling period included June, August and October. Samples were conducted during and were reflective of dry weather conditions (at least five days of dry weather preceded the sampling event). River flow data was collected from the USGS gage station located at Morristown (USGS 01381500 Whippany River at Morristown NJ). River Flow data can be found in [Appendix B](#) attached to this report.

Samples were collected manually from the river either from a bridge or by wading to the center of flow and using clean and rinsed plastic buckets to collect water samples from the center of the water column. Samples were collected in accordance with the "NJDEP Field Sampling Procedures Manual, May 1992." Samples were collected, preserved, refrigerated and delivered to Garden State Laboratory (within 6 hours of collection) by the sampling staff. Sample bottles and preservative was provided by Garden State Laboratory. Quality Control/Quality Assurance (QA/QC) requirements were met as recommended in the NJDEP Field Sampling Procedures Manual and as pre-established by the Whippany River Watershed Action Committee's Technical Advisory Committee (TAC).

Field measurements for Dissolved oxygen, temperature, pH, specific conductivity and salinity were made by sampling staff (during the time of sampling) using a YSI Model 85 handheld oxygen, conductivity, salinity and temperature meter and an Orion model 265A pH meter. Both meters were calibrated immediately prior to each sample run (in accordance with the manufacturer’s instructions) and checked for calibration at the completion of the sample run for drift.

Historical water quality data for trend analysis was collected from the New Jersey Department of Environmental Protection (NJDEP) and from the Township of Hanover Health Department. NJDEP data reflect dry weather water quality conditions during 1994 and 1995. Township of Hanover Health Department data reflect dry weather water quality conditions during the 2001/2002 and 2010/2011 periods. A comparison of the 1994/1995 and 2001/2002 data can be found in a report prepared by the Whippany River Technical Advisory Committee titled “Whippany River Water Quality Trend Analysis Study,” Final Report, March 24, 2003. The water quality data used in this study may be found in Appendix C.

Data

The raw data used in this study may be found in Appendix C of this report. Appendix C also include water quality graphs for the river (average concentration vs. river mile) and for each of the stations (concentration vs. sampling date). Summarized data may be found in Table 1.

TABLE 1 Whippany River Parameter Mean Values for the Periods 1994/1995, 2001/2001 and 2010/2011 – Dry Weather Conditions.

<u>SAMPLE PARAMETER</u>	<u>1994/1995 RIVER MEAN</u>	<u>2001/2002 RIVER MEAN</u>	<u>2010/2011 RIVER MEAN</u>
Temperature (degree C)	15.5	17.9	21.5
Dissolved Oxygen (mg/l)	9.2	9.8	7.9
pH	8.0	7.9	7.7
Specific Conductivity (microsiemens)	456	590	655
CBOD-5 (mg/l)	<1.4	<5.5	<6.0
NH3-N (mg/l)	<0.05	<0.08	0.1
NO2-N (mg/l)	<0.02	<0.02	0.02
NO3-N (mg/l)	2.9	2.8	1.8
TKN (mg/l)	1.4	1.2	<0.6
Ortho-P (mg/l)	<0.4	0.2	<0.1
Total P (mg/l)	0.4	0.2	<0.1
TSS (mg/l)	10.7	3.1	6.7
TDS (mg/l)	283.1	369.8	345
Alkalinity (mg/l)	74.8	85.4	69.5
Chloride (mg/l)	64.8	103.8	NOT MEASURED
Chlorophyll A (ppb)	9.8	2.2	3.7
Fecal coliform (#/100ml)	375.2	237.4	174.5
Flow (cfs) at Morristown gage	22.9	15.3	35.3

Discussion

Samples were collected at each of the above mentioned sampling locations on nine (9) separate occasions during 1994/1995, on four (4) separate occasions during 2001/2002 and three separate occasions during 2010/2011. Table 1 lists the parameters which were determined during each sampling period. A mean value and standard deviation

was calculated for each parameter at each sample location for each of the sampling periods. While performing the calculations all values received from the laboratory were included (K descriptor values refer to an actual concentration which is less than the reported concentration, J descriptor values refer to an estimated concentration). However, if a K value or J value was used in the calculation, the mean value calculated was labeled with the appropriate symbol (i.e. if a “K” value was used in the calculation, the final mean value was given a “K” label indicating that the actual mean value is less than the calculated and reported mean value). The geometric mean and geometric standard deviation was used in the bacterial parameter (i.e. fecal coliform, fecal streptococcus and enterococcus) calculations for each location. When determining data points used for graphing, all estimated (J) values remained in the data set as reported and all “less than” (K) data remained in the data set but were changed to a value at the midpoint between the reported value and zero. The calculated mean and standard deviation values for each sampling location may be found in **Appendix C**. A river mean value and standard deviation for each parameter measured was calculated for each of the study periods (1994/1995, 2001/2002 and 2010/2011) using the mean values generated at each of the sampling locations. The river mean value may be used in this study for comparison purposes (comparing the river mean for 1994/1995, 2001/2002 and 2010/2011) since they were generated from the same five sample locations during each sample period. However, the river mean values only include data from five sampling locations (which were not equally spaced) along the river and may not be an accurate representation of an overall spatially weighted river mean. The river standard deviation calculated for each parameter is an estimate of the spatial variability (along the river) of the mean values calculated at the stations along the river. River mean and standard deviations for all test parameters may be found in **Appendix C**.

Dissolved oxygen, nitrate-nitrogen, total phosphorus, chlorophyll A, total suspended solids and fecal coliform data was plotted and may be found in Figures 1, 2, 3, 4, 5 and 6 respectively. These figures provide comparison of the data for each of the parameters mentioned averaged over the 1994/1995, 2001/2002 and 2010/2011 periods. Data was plotted using the average concentration for the reporting period (y-axis) versus sampling station location (mile) on the x-axis. Sampling station locations are located at mile -13.3, -12.4, -7.9, -4.1 and -0.3 for the Lake Valley Road (Morris Township), Speedwell Avenue (Morristown), South Jefferson Road (Hanover Township), Melanie Lane (East Hanover Township) and Edwards Road (Parsippany) stations, respectively. The negative values (-) on the x-axis refer to miles upstream (negative direction) of the Whippany River confluence with the Rockaway River which has a reference point of mile zero (0).

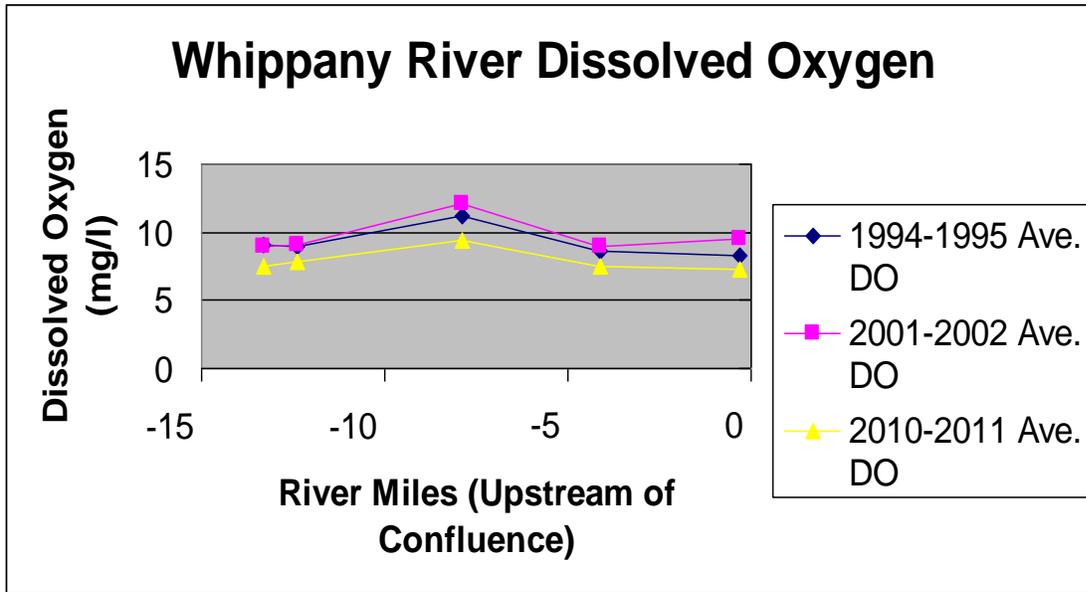
A comparison of 1994/1995, 2001/2002 and 2010/2011 data reveals the following:

Temperature: River temperatures were higher (21.5 C) during the 2010/2011 sampling period when compared to the both the 1994/1995 (15.5 C) and 2001/2002 (17.9 C) sampling periods. Higher water temperature impacts water quality (mostly causing degradation of water quality) by causing a decrease in dissolved oxygen saturation (dissolved oxygen saturation decreases as water temperature increases) and by increasing the rates of carbonaceous and nitrogenous biodegradation.

Dissolved Oxygen : Dissolved oxygen concentrations in the river during the 2010/2011 sampling events were less (7.9 mg/l) than the dissolved oxygen concentrations observed during the 1994/1995 (9.2 mg/l) and 2001/2002 (9.8 mg/l) sampling events. The warmer water temperatures may have contributed to the lower dissolved oxygen values observed during the 2010/2011 sampling events.

Figure 1 Average Dissolved Oxygen concentration for the Whippany River at the Lake Valley Road (mile -13.3), Speedwell Avenue (mile -12.4), S. Jefferson Road (mile -7.9), Melanie Lane (mile - 4.1) and Edwards Road (mile -

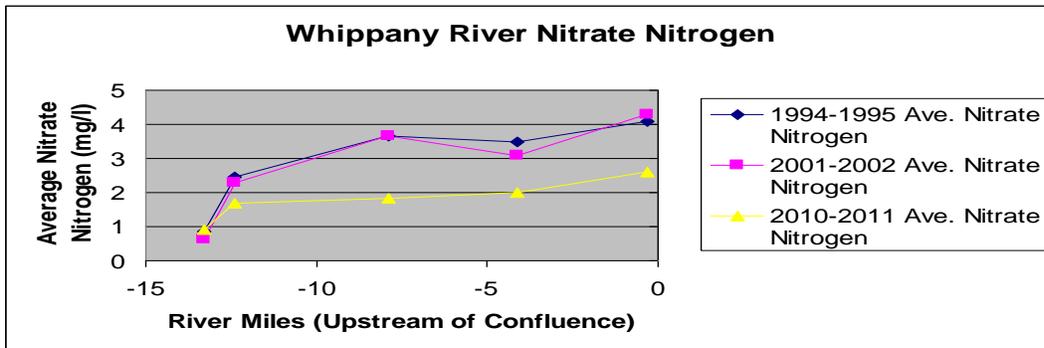
0.3) sampling stations for the periods 1994/1995, 2001/2002 and 2010/2011.



Specific Conductivity, total dissolved solids, Chloride : The specific conductivity, total dissolved solids concentration and chloride concentration did show a significant increase between the 1994/1995 and 2001/2002 sampling periods. This data reflects an increase in the river’s salt concentration between the sampling periods. Increases could be due to an increase in treated effluent flow into the river (wastewater treatment plants do not typically remove salts) and/or a decrease in river dilution (river flows measured at the Morristown gage station were significantly lower during the 2001/2002 sampling period). During 2010/2011 there was a slight increase in specific conductivity and slight decrease in total dissolved solids when compared to 2001/2002 data. The higher river flows during the 2010/2011 period may have influenced the decrease in dissolved solids concentration by creating a dilution effect.

Nitrogen series (Ammonia, nitrite, nitrate, organic nitrogen): There seemed to be little or no difference in the Ammonia (NH₃-N), Nitrite (NO₂-N) and organic nitrogen (TKN) concentrations between the sampling periods. There was a significant decrease in nitrate nitrogen during the 2010/2011 sampling events (river mean of 1.79 mg/l) when compared to both the 1994/1995 (river mean of 2.9 mg/l) and 2001/2002 (river mean of 2.8 mg/l) sampling events (see Figure 2 below).

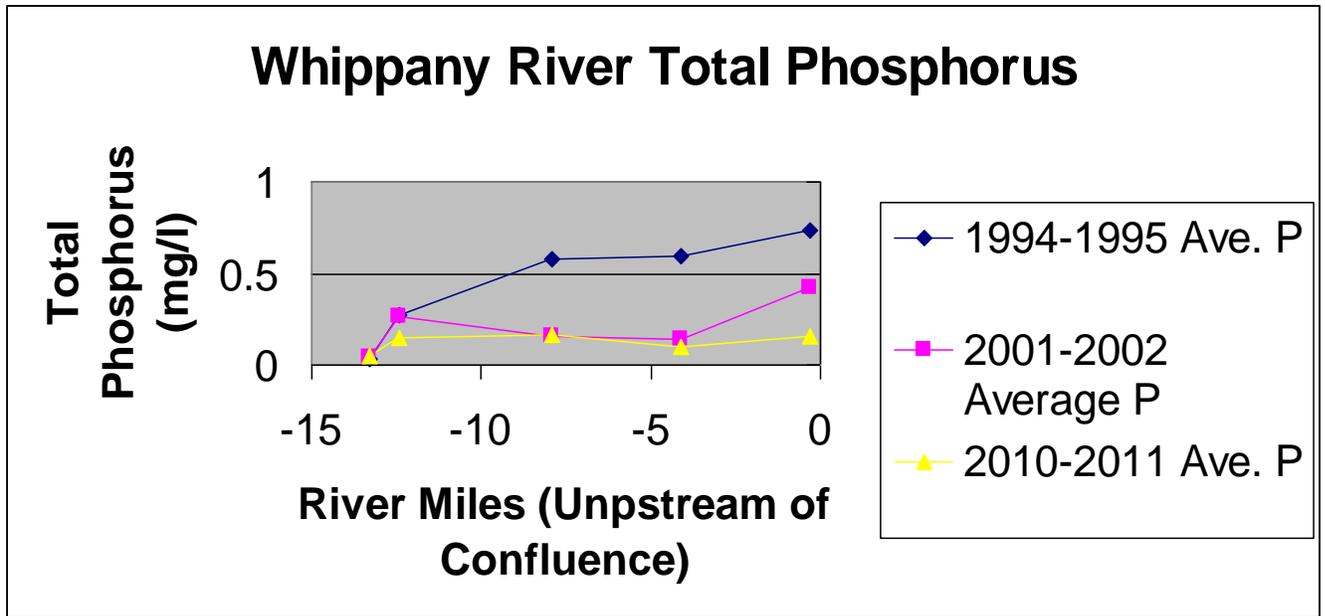
Figure 2 Average Nitrate Nitrogen concentration for the Whippany River at the lake Valley Road (mile -13.3), Speedwell Avenue (mile -12.4), S. Jefferson Road (mile -7.9), Melanie Lane (mile - 4.1) and Edwards Road (mile - 0.3) sampling stations for the periods 1994/1995, 2001/2002 and 2010/2011.



Total Phosphorus : Total phosphorus concentration observed during the 2001/2002 sampling events were significantly lower than the concentrations observed during the 1994/1995 sampling events (see **Figure 3** below).

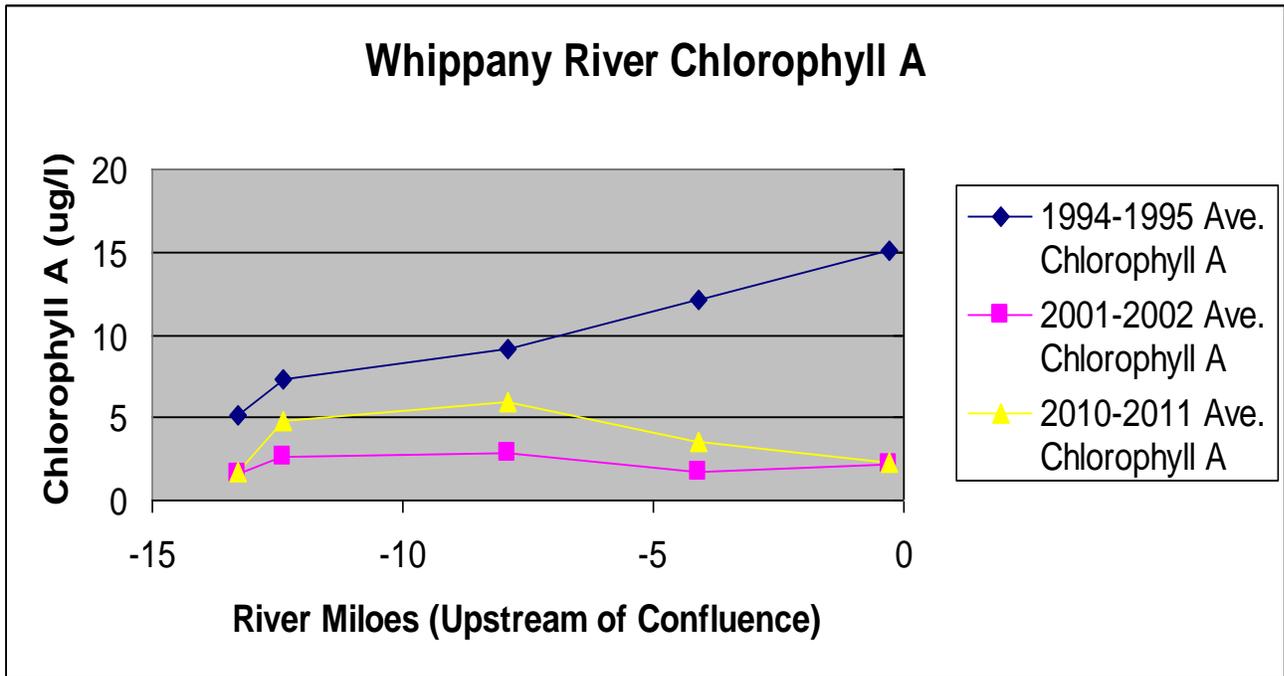
The decrease in river phosphorus concentration between the 1994/1995 and 2001/2002 sampling periods may be due to the Morristown Sewage Treatment Plant (located at mile – 9.3 which is upstream of the South Jefferson Road station) which implemented phosphorus removal in 1996 (total phosphorus concentration in their treated effluent was reduced from approximately 3 mg/l to approximately 0.4 mg/l). This is clearly seen in **Figure 3** where the 2001/2002 total phosphorus concentrations significantly decrease when compared to 1994/1995 concentrations between the Speedwell Avenue and South Jefferson Road stations. A slight decrease in total phosphorus was observed during the 2010/2011 sampling period when compared to the 2001/2002 sampling period. This decrease occurred mostly downstream of the Melanie Road sampling locations and may reflect a current phosphorus removal program implemented by the Hanover Sewerage Treatment plant sometime after the 2001/2002 sampling period.

Figure 3 Average Total Phosphorus concentration for the Whippany River at the lake Valley Road (mile –13.3), Speedwell Avenue (mile –12.4), S. Jefferson Road (mile –7.9), Melanie Lane (mile – 4.1) and Edwards Road (mile – 0.3) sampling stations for the periods 1994/1995, 2001/2002 and 2010/2011.



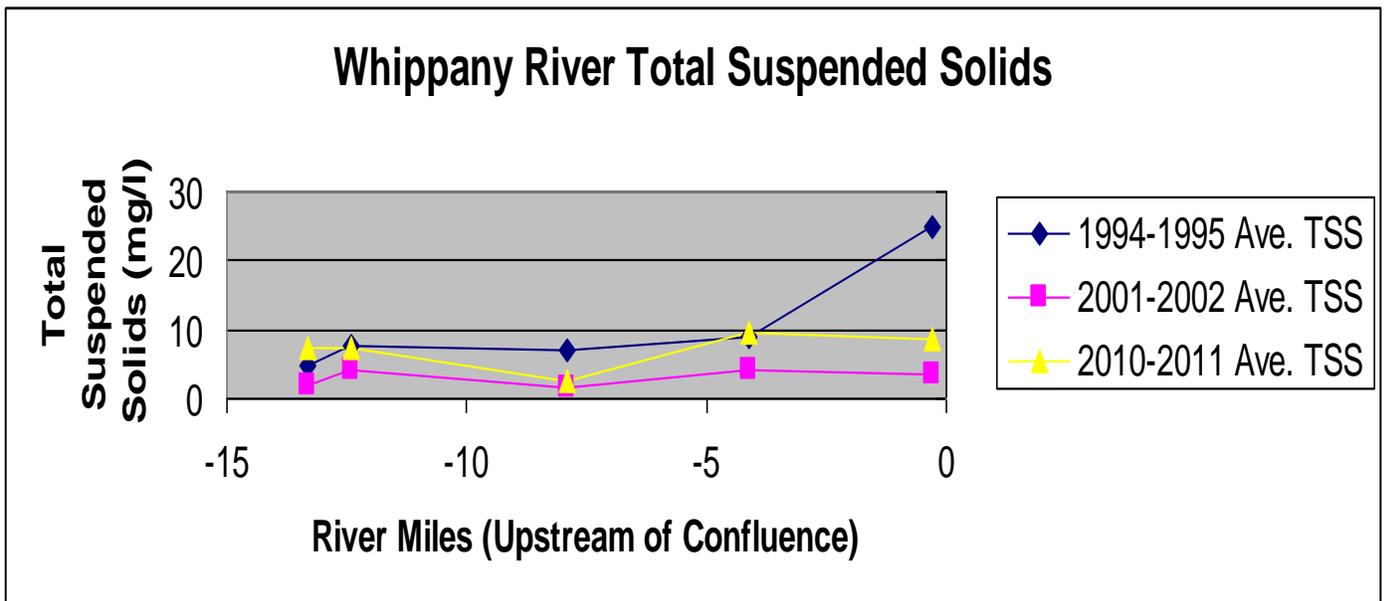
Chlorophyll A : Chlorophyll A concentrations (planktonic Chlorophyll A) observed during the 2001/2002 sampling events were significantly lower than concentrations observed during the 1994/1995 sampling events. Chlorophyll A concentrations during the 2010/2011 sampling events were either similar or slightly higher than the 2001/2002 sampling events (see **Figure 4** below).

Figure 4 Average Chlorophyll A concentration for the Whippany River at the lake Valley Road (mile –13.3), Speedwell Avenue (mile –12.4), S. Jefferson Road (mile –7.9), Melanie Lane (mile – 4.1) and Edwards Road (mile – 0.3) sampling stations for the periods 1994/1995, 2001/2002 and 2010/2011.



Total Suspended Solids (TSS): The total suspended solids concentrations decreases from 1994/1995 to 2010/2011. The calculated river mean TSS concentration decrease from 10.7 mg/l to 3.1 mg/l between 1994/1995 and 2002/2002. The suspended solids concentrations during the 2010/2011 sampling period was slightly higher (river mean concentration of 6.7 mg/l) than the concentrations observed during the 2001/2002 period (see Figure 5).

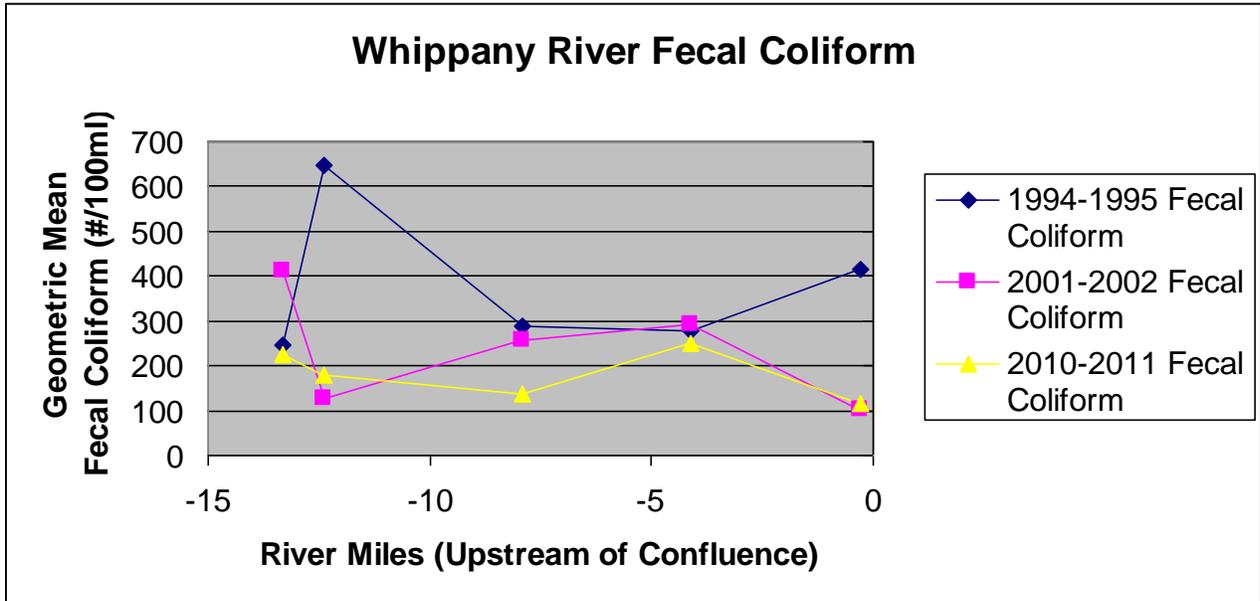
Figure 5 Average Total Suspended Solids concentration for the Whippany River at the lake Valley Road (mile – 13.3), Speedwell Avenue (mile –12.4), S. Jefferson Road (mile –7.9), Melanie Lane (mile – 4.1) and Edwards Road (mile – 0.3) sampling stations for the periods 1994/1995, 2001/2002 and 2010/2011.



Fecal Coliform: Fecal Coliform concentrations decreased from a 1994/1995 river mean of 375.2 per 100ml to a 2001/2002 river mean of 237.4 per 100ml. This represents a 37% decrease in fecal coliform from 1994/1995 to 2001/2002. Fecal coliform concentrations further decreases during the 2010/2011 sampling period (river mean concentration of 174.5 per 100ml) which represents an overall decrease in fecal coliform (calculated from the river mean values) of 53% from 1994/1995 to 2010/2011. The observed decrease over time may be due to an active

watershed management program which is aimed at reducing fecal coliform in runoff, goose management and the proper disposal of pet feces.

Figure 6 Average Fecal Coliform concentration for the Whippany River at the lake Valley Road (mile -13.3), Speedwell Avenue (mile -12.4), S. Jefferson Road (mile -7.9), Melanie Lane (mile - 4.1) and Edwards Road (mile - 0.3) sampling stations for the periods 1994/1995 and 2001/2002.



Conclusions:

Based on the data collected during this study, Whippany River water quality (as measured using total phosphorus, total suspended solids, fecal coliform and nitrate nitrogen parameters) under dry weather conditions improved from 1994/1995 to 2010/2011. When comparing the 2001/2002 and 2010/2011 sampling data, nitrate nitrogen, total phosphorus and fecal coliform concentrations all decreased over time while total suspended solids increased. Dissolve oxygen during the 2010/2011 sampling period was slightly lower than the concentrations observed during the 1994/1995 and 2001/2002 sampling periods. Some of the decrease may be due to water temperatures being higher during the 2010/2011 sampling events when compared to the prior sampling periods. Specific conductivity and total dissolved solids both increased from 1994/1995 to 2010/2011.

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D