White Rock Creek Watershed Data Report

August 2014

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Introduction

Texas Stream Team is a volunteer-based citizen water quality monitoring program. Citizen scientists collect surface water quality data that may be used in the decision-making process to promote and protect a healthy and safe environment for people and aquatic inhabitants. Citizen scientist water quality monitoring occurs at predetermined monitoring sites, at roughly the same time of day each month. Citizen scientist water quality monitoring data provides a valuable resource of information by supplementing professional data collection efforts where resources are limited. The data may be used by professionals to identify water quality trends, target additional data collection needs, identify potential pollution events and sources of pollution, and to test the effectiveness of water quality management measures.

Texas Stream Team citizen scientist data are not used by the state to assess whether water bodies are meeting the designated surface water quality standards. Texas Stream Team citizen scientists use different methods than the professional water quality monitoring community. These methods are utilized by Texas Stream Team due to higher equipment costs, training requirements, and stringent laboratory procedures that are required of the professional community. As a result, Texas Stream Team data do not have the same accuracy or precision as professional data, and is not directly comparable. However, the data collected by Texas Stream Team provides valuable records, often collected in portions of a water body that professionals are not able to monitor at all, or monitor as frequently. This long-term data set is available, and may be considered by the surface water quality professional community to facilitate management and protection of Texas water resources. For additional information about water quality monitoring methods and procedures, including the differences between professional and volunteer monitoring, please refer to the following sources:

- Texas Stream Volunteer Water Quality Monitoring Manual
- Texas Commission on Environmental Quality (TCEQ) Surface Water Quality Monitoring Procedures

The information that Texas Stream Team citizen scientists collect is covered under a TCEQ approved Quality Assurance Project Plan (QAPP) to ensure that a standard set of methods are used. All data used in watershed data reports are screened by the Texas Stream Team for completeness, precision, and accuracy, in addition to being scrutinized for data quality objectives and with data validation techniques.

The purpose of this report is to provide analysis of data collected by Texas Stream Team citizen scientists. The data presented in this report should be considered in conjunction with other relevant water quality reports in order to provide a holistic view of water quality in this water body. Such sources include, but are not limited to, the following potential resources:

- Texas Surface Water Quality Standards
- Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)
- Texas Clean Rivers Program partner reports, such as Basin Summary Reports and Highlight Reports
- TCEQ Total Maximum Daily Load reports
- TCEQ and Texas State Soil and Water Conservation Board Nonpoint Source Program funded reports, including Watershed Protection Plans

Questions regarding this watershed data report should be directed to the Texas Stream Team at (512) 245-1346.

Watershed Location and Physical Description

Location and Climate

White Rock Creek begins two miles southeast of Frisco and 23 miles later flows into White Rock Lake. The creek joins the Trinity River eight miles south of the lake. (Texas State Historical Association (TSHA)). White Rock Creek is in the Upper White Rock Creek watershed, comprising 66.4 square miles (Vicars) of the Trinity River Basin. The creek is located in parts of Collin and Dallas Counties, flowing through the Dallas, Richardson, Addison, Plano, and Frisco. The sub-tropical climate of the watershed produces about 39 inches of rain a year, primarily in winter and spring. A high rate of evapotranspiration results in a considerable drawdown of surface water in dry months (Jeong).

Physical Description and Land Use

White Rock Creek derives its name from the Austin chalk creek bed, which turns a tan-white color upon weathering. The natural vegetation along the creek has remained largely undisturbed, despite being located in a metropolitan area. White Rock Creek's banks are heavily wooded with cedar elm, pecan, and ash trees (TSHA).

History

White Rock Creek was home to some of the earliest settlements in Dallas County (TSHA). Population growth and water demand led to the construction of a dam on the creek in 1911, forming White Rock Lake (For the Love of the Lake). The watershed is about 95% urbanized currently (Vicars).

Water Quality Parameters

Water Temperature

Water temperature influences the physiological processes of aquatic organisms and each species has an optimum temperature for survival. High water temperatures increase oxygen-demand for aquatic communities and can become stressful for fish and aquatic insects. Water temperature variations are most detrimental when they occur rapidly; leaving the aquatic community no time to adjust. Additionally, the ability of water to hold oxygen in solution (solubility) decreases as temperature increases.

Natural sources of warm water are seasonal, as water temperatures tend to increase during summer and decrease in winter in the Northern Hemisphere. Daily (diurnal) water temperature changes occur during normal heating and cooling patterns. Man-made sources of warm water include power plant effluent after it has been used for cooling or hydroelectric plants that release warmer water. Citizen scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases. While citizen scientist data does not show diurnal temperature fluctuations, it may demonstrate the fluctuations over seasons and years.

Dissolved Oxygen

Oxygen is necessary for the survival of organisms like fish and aquatic insects. The amount of oxygen needed for survival and reproduction of aquatic communities varies according to species composition and adaptations to watershed characteristics like stream gradient, habitat, and available stream flow. The TCEQ Water Quality Standards document lists daily minimum Dissolved Oxygen (DO) criteria for specific water bodies and presumes criteria according to flow status (perennial, intermittent with perennial pools, and intermittent), aquatic life attributes, and habitat. These criteria are protective of aquatic life and can be used for general comparison purposes.

The DO concentrations can be influenced by other water quality parameters such as nutrients and temperature. High concentrations of nutrients can lead to excessive surface vegetation growth and algae, which may starve subsurface vegetation of sunlight, and therefore limit the amount of DO in a water body due to reduced photosynthesis. This process, known as eutrophication, is enhanced when the subsurface vegetation and algae die and oxygen is consumed by bacteria during decomposition. Low DO levels may also result from high groundwater inflows due to minimal groundwater aeration, high temperatures that reduce oxygen solubility, or water releases from deeper portions of dams where DO stratification occurs. Supersaturation typically only occurs underneath waterfalls or dams with water flowing over the top.

Specific Conductivity and Total Dissolved Solids

Specific conductivity is a measure of the ability of a body of water to conduct electricity. It is measured in micro Siemens per cubic centimeter ($\mu S/cm^3$). A body of water is more conductive if it has more dissolved solids such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lower the level of DO, leading to eutrophication. High concentrations of salt can inhibit water absorption and limit root growth for vegetation, leading to an abundance of more drought tolerant plants, and can cause dehydration of fish and amphibians. Sources of Total Dissolved Solids (TDS) can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants. For this report, specific conductivity values have been converted to TDS using a conversion factor of 0.65 and are reported as mg/L.

pH

The pH scale measures the concentration of hydrogen ions on a range of 0 to 14 and is reported in standard units (su). The pH of water can provide useful information regarding acidity or alkalinity. The range is logarithmic; therefore, every 1 unit change is representative of a 10-fold increase or decrease in acidity. Acidic sources, indicated by a low pH level, can include acid rain and runoff from acid-laden soils. Acid rain is mostly caused by coal power plants with minimal contributions from the burning of other fossil fuels and other natural processes, such as volcanic emissions. Soil-acidity can be caused by excessive rainfall leaching alkaline materials out of soils, acidic parent material, crop decomposition creating hydrogen ions, or high-yielding fields that have drained the soil of all alkalinity. Sources of high pH (alkaline) include geologic composition, as in the case of limestone increasing alkalinity and the dissolving of carbon dioxide in water. Carbon dioxide is water soluble, and, as it dissolves it forms carbonic acid. The most suitable pH range for healthy organisms is between 6.5 and 9.

Secchi disk and total depth

The Secchi disk is used to determine the clarity of the water, a condition known as turbidity. The disk is lowered into the water until it is no longer visible, and the depth is recorded. Highly turbid waters pose a risk to wildlife by clogging the gills of fish, reducing visibility, and carrying contaminants. Reduced visibility can harm predatory fish or birds that depend on good visibility to find their prey. Turbid waters allow very little light to penetrate deep into the water, which in turn decreases the density of phytoplankton, algae, and other aquatic plants. This reduces the DO in the water due to reduced photosynthesis. Contaminants are most commonly transported in sediment rather than in the water. Turbid waters can results from sediment washing away from construction sites, erosion of farms, or mining operations. Average Secchi disk transparency (a.k.a. Secchi depth) readings that are less than the total depth readings indicate turbid water. Readings that are equal to total depth indicate clear water. Low total depth observations have a potential to concentrate contaminants.

E. coli Bacteria

E. coli bacteria originate in the digestive tract of endothermic organisms. The EPA has determined *E. coli* to be the best indicator of the degree of pathogens in a water body, which are far too numerous to be tested for directly, considering the amount of water bodies tested. A pathogen is a biological agent that causes disease. The standard for *E. coli* impairment is based on the geometric mean (geomean) of the *E. coli* measurements taken. A geometric mean is a type of average that incorporates the high variability found in parameters such as *E. coli* which can vary from zero to tens of thousands of CFU/100 mL. The standard for contact recreational use of a water body such as White Rock Creek is 126 CFU/100 mL. A water body is considered impaired if the geometric mean is higher than this standard.

Orthophosphate

Orthophosphate is the phosphate molecule all by itself. Phosphorus almost always exists in the natural environment as phosphate, which continually cycles through the ecosystem as a nutrient necessary for the growth of most organisms. Testing for orthophosphate detects the amount of phosphate in the water itself, excluding the phosphate bound up in plant and animal tissue. There are other methods to retrieve the phosphate from the material to which it is bound, but they are too complicated and expensive to be conducted by a volunteer monitors. Testing for orthophosphate gives us an idea of the degree of phosphate in a water body. It can be used for problem identification, which can be followed up with more detailed professional monitoring, if necessary. Phosphorus inputs into a water body may be the weathering of soils and rocks, discharge from wastewater treatment plants, excessive fertilizer use, failing septic systems, livestock and pet waste, disturbed land areas, drained wetlands, water treatment, and some commercial cleaning products. The effect orthophosphate has on a water body is known as eutrophication and is described above under the "Dissolved Oxygen" section.

Nitrate-Nitrogen

Nitrogen is present in terrestrial or aquatic environments as nitrates, nitrites, and ammonia. Nitrate-nitrogen tests are conducted for maximum data compatibility with the TCEQ and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most organisms. Nitrogen inputs into a water body may be livestock and pet waste, excessive fertilizer use, failing septic systems, and industrial discharges that contain corrosion inhibitors. The effect nitrogen has on a water body is known as eutrophication and is described above under the “Dissolved Oxygen” section. Nitrates dissolve more readily than phosphates, which tend to be attached to sediment, and therefore can serve as a better indicator of the possibility of sewage or manure pollution during dry weather.

Texas Surface Water Quality Standards

The Texas Surface Water Quality Standards establish explicit goals for the quality of streams, rivers, lakes, and bays throughout the state. The standards are developed to maintain the quality of surface waters in Texas so that it supports public health and protects aquatic life, consistent with the sustainable economic development of the state.

Water quality standards identify appropriate uses for the state’s surface waters, including aquatic life, recreation, and sources of public water supply (or drinking water). The criteria for evaluating support of those uses include DO, temperature, pH, TDS, toxic substances, and bacteria.

The Texas Surface Water Quality Standards also contain narrative criteria (verbal descriptions) that apply to all waters of the state and are used to evaluate support of applicable uses. Narrative criteria include general descriptions, such as the existence of excessive aquatic plant growth, foaming of surface waters, taste- and odor producing substances, sediment build-up, and toxic materials. Narrative criteria are evaluated by using screening levels, if they are available, as well as other information, including water quality studies, existence of fish kills or contaminant spills, photographic evidence, and local knowledge. Screening levels serve as a reference point to indicate when water quality parameters may be approaching levels of concern.

Data Analysis Methodologies

Data Collection

The field sampling procedures are documented in Texas Stream Team Water Quality Monitoring Manual and its appendices, or the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012). Additionally, all data collection adheres to Texas Stream Team's approved Quality Assurance Project Plan (QAPP).

Table 1: Sample Storage, Preservation, and Handling Requirements

Parameter	Matrix	Container	Sample Volume	Preservation	Holding Time
E. coli	Water	Sterile Polystyrene (SPS)	100	Refrigerate at 4ºC*	6 hours
Nitrate/Nitrogen	Water	Plastic Test Tube	10 mL	Refrigerate at 4ºC*	48 hours
Orthophosphate/Phosphorous	Water	Glass Mixing Bottle	25 mL	Refrigerate at 4ºC*	48 hours
Chemical Turbidity	water	Plastic Turbidity Column	50 mL	Refrigerate at 4ºC*	48 hours

*Preservation performed within 15 minutes of collection.

Processes to Prevent Contamination

Procedures documented in Texas Stream Team Water Quality Monitoring Manual and its appendices, or the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012) outline the necessary steps to prevent contamination of samples, including direct collection into sample containers, when possible. Field Quality Control (QC) samples are collected to verify that contamination has not occurred.

Documentation of Field Sampling Activities

Field sampling activities are documented on the field data sheet. For all field sampling events the following items are recorded: station ID, location, sampling time, date, and depth, sample collector's name/signature, group identification number, conductivity meter calibration information, and reagent expiration dates are checked and recorded if expired.

For all *E. coli* sampling events, station ID, location, sampling time, date, depth, sample collector's name/signature, group identification number, incubation temperature, incubation duration, *E. coli* colony counts, dilution aliquot, field blanks, and media expiration dates are checked and recorded if expired. Values for all measured parameters are recorded. If reagents or media are expired, it is noted and communicated to Texas Stream Team.

Sampling is still encouraged with expired reagents and bacteria media; however, the corresponding values will be flagged in the database. Detailed observational data are recorded, including water appearance, weather, field observations (biological activity and stream uses), algae cover, unusual odors, days since last significant rainfall, and flow severity.

Comments related to field measurements, number of participants, total time spent sampling, and total round-trip distance traveled to the sampling site are also recorded for grant and administrative purposes.

Data Entry and Quality Assurance

Data Entry

The citizen monitors collect field data and report the measurement results on Texas Stream Team approved physical or electronic datasheet. The physical data sheet is submitted to the Texas Stream Team and local partner, if applicable. The electronic datasheet is accessible in the online DataViewer and, upon submission and verification, is uploaded directly to the Texas Stream Team Database.

Quality Assurance & Quality Control

All data are reviewed to ensure that they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to specified monitoring procedures and project specifications. The respective field, data management, and Quality Assurance Officer (QAO) data verification responsibilities are listed by task in the Section D1 of the QAPP, available on the Texas Stream Team website.

Data review and verification is performed using a data management checklist and self-assessments, as appropriate to the project task, followed by automated database functions that will validate data as the information is entered into the database. The data are verified and evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Potential errors are identified by examination of documentation and by manual and computer-assisted examination of corollary or unreasonable data. Issues that can be corrected are corrected and documented. If there are errors in the calibration log, expired reagents used to generate the sampling data, or any other deviations from the field or *E. coli* data review checklists, the corresponding data is flagged in the database.

When the QAO receives the physical data sheets, they are validated using the data validation checklist, and then entered into the online database. Any errors are noted in an error log and the errors are flagged in the Texas Stream Team database. When a monitor enters data electronically, the system will automatically flag data outside of the data limits and the monitor will be prompted to correct the mistake or the error will be logged in the database records. The certified QAO will further review any flagged errors before selecting to validate the data. After validation the data will be formally entered into the database. Once entered, the data can be accessible through the online DataViewer.

Errors, which may compromise the program's ability to fulfill the completeness criteria prescribed in the QAPP, will be reported to the Texas Stream Team Program Manager. If repeated errors occur, the monitor and/or the group leader will be notified via e-mail or telephone.

Data Analysis Methods

Data are compared to state standards and screening levels, as defined in the Surface Water Quality Monitoring Procedures, to provide readers with a reference point for amounts/levels of parameters that may be of concern. The assessment performed by TCEQ and/or designation of impairment involves more complicated monitoring methods and oversight than used by volunteers and staff in this report. The citizen water quality monitoring data are not used in the assessments mentioned above, but are intended to inform stakeholders about general characteristics and assist professionals in identifying areas of potential concern.

Standards & Exceedances

The TCEQ determines a water body to be impaired if more than 10% of samples, provided by professional monitoring, from the last seven years, exceed the standard for each parameter, except for *E. coli* bacteria. When the observed sample value does not meet the standard, it is referred to as an exceedance. At least ten samples from the last seven years must be collected over at least two years with the same reasonable amount of time between samples for a data set to be considered adequate. The 2010 Texas Surface Water Quality Standards report was used to calculate the exceedances for the White Rock Creek Watershed, as seen below in Table 2.

Table 2: Summary of Surface Water Quality Standards for the White Rock Creek Watershed

Parameter	Texas Surface Water Quality Standard 2014
Water Temperature (°C)	33.9
Total Dissolved Solids (mg/L)	400
Dissolved Oxygen (mg/L)	5.0
pH (su)	6.5-9.0
E.coli (CFU/100 mL)	126 (geomean during sampling period)

Methods of Analysis

All data collected from White Rock Creek were exported from the Texas Stream Team database and were then grouped by site. Data was reviewed and, for the sake of data analysis, only one sampling event per month, per site was selected for the entire study duration. If more than one sampling event occurred per month, per site, the most complete, correct, and representative sampling event was selected.

Once compiled, data was sorted and graphed in Microsoft Excel 2010 using standard methods. Trends over time were analyzed using a linear regression analysis in Minitab v 15. Statistically significant trends were added to Excel to be graphed. The cut off for statistical significance was set to a p-value of ≤ 0.05. A p-value of ≤ 0.05 means that the probability that the observed data matches the actual conditions found in nature is 95%. As the p-value decreases, the confidence that it matches actual conditions in nature increases.

For this report, specific conductivity measurements, gathered by volunteers, were converted to TDS using the TCEQ-recommended conversion formula of specific conductivity 0.65. This conversion was made so that volunteer gathered data could be more readily compared to state gathered data. Geomeans were calculated for *E. coli* data for trends and for each monitoring site.

White Rock Creek Watershed Data Analysis

White Rock Creek Maps

Numerous maps were prepared to show spatial variation of the parameters. The parameters mapped include DO, pH, TDS, and *E. coli*. There is also a reference map showing the locations of all active. For added reference points in all maps, layers showing monitoring sites, cities, counties, and major highways were included. All shapefiles were downloaded from reliable federal, state, and local agencies.

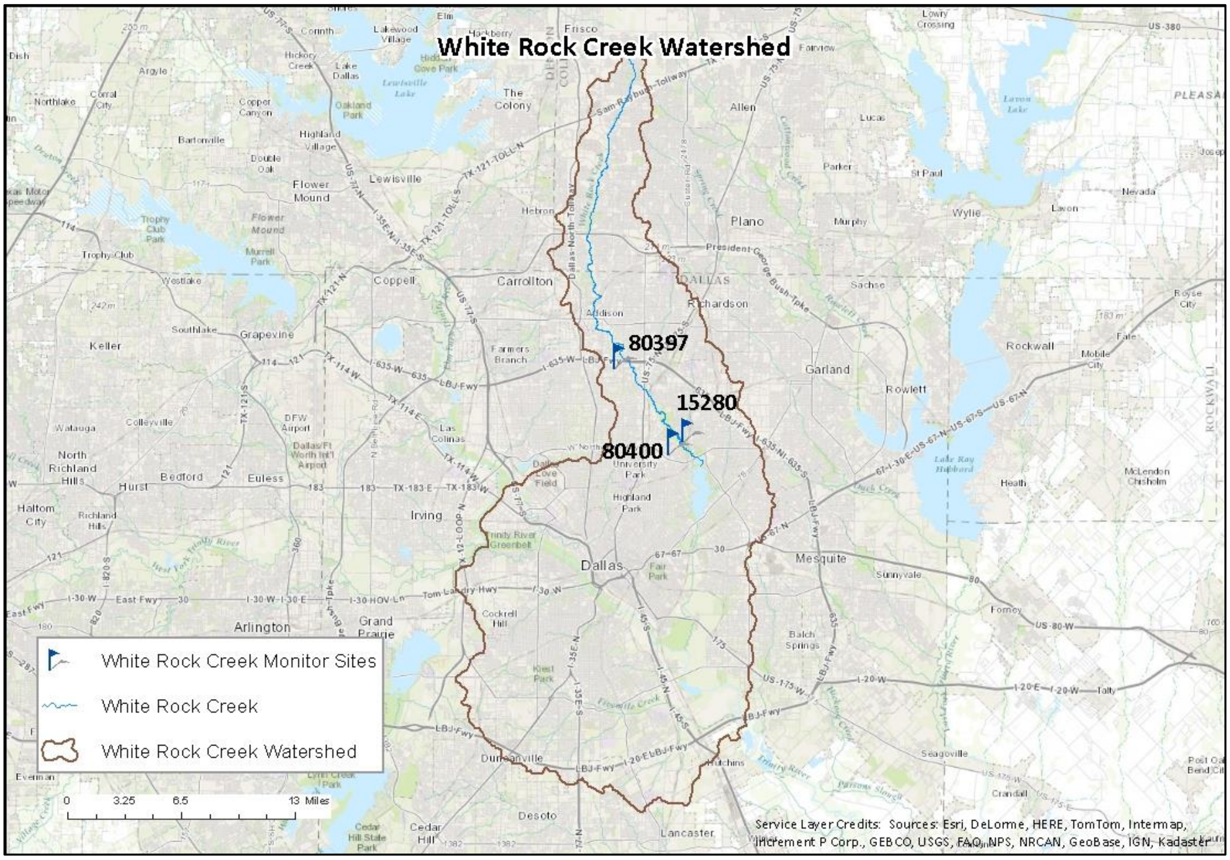

Figure 1: Map of the White Rock Creek Watershed with Texas Stream Team Monitor Sites

White Rock Creek Watershed Trends over Time

Sampling Trends over Time

Sampling in the White Rock Creek Watershed began in May of 2006 and continue to this day. A total of 222 monitoring events from 3 sites were analyzed. Monthly monitoring occurred on a consistent basis, although there was a decline that occurred during the month of August. Sampling was concentrated during the morning hours between 10:00 and 11:00.

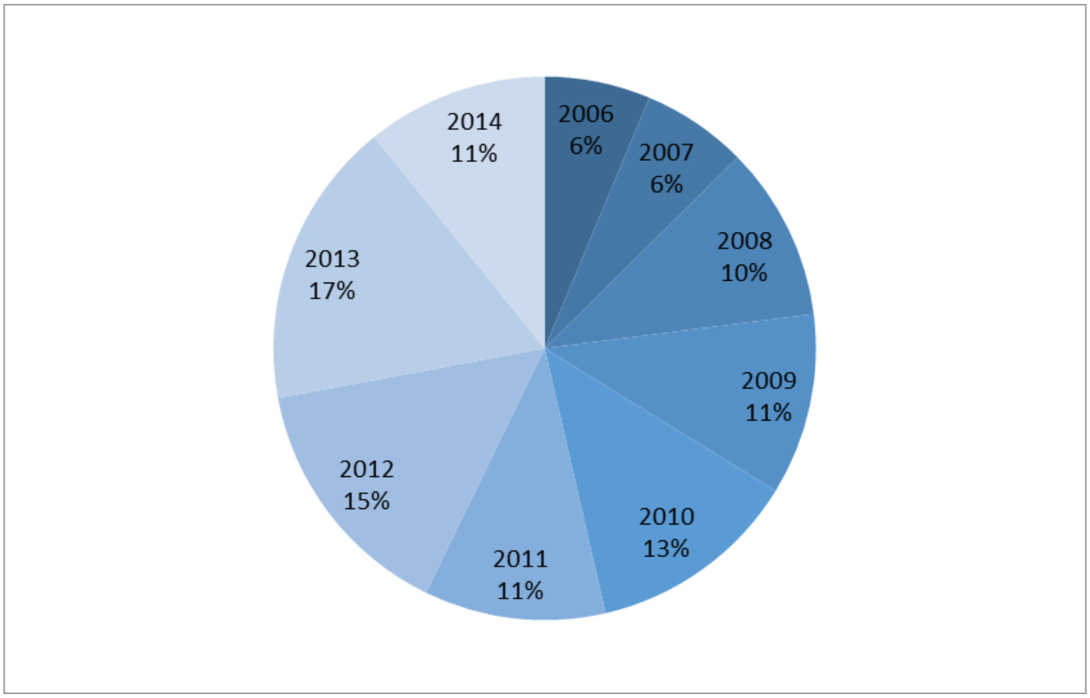

Figure 2: Breakdown of monitoring events by year.

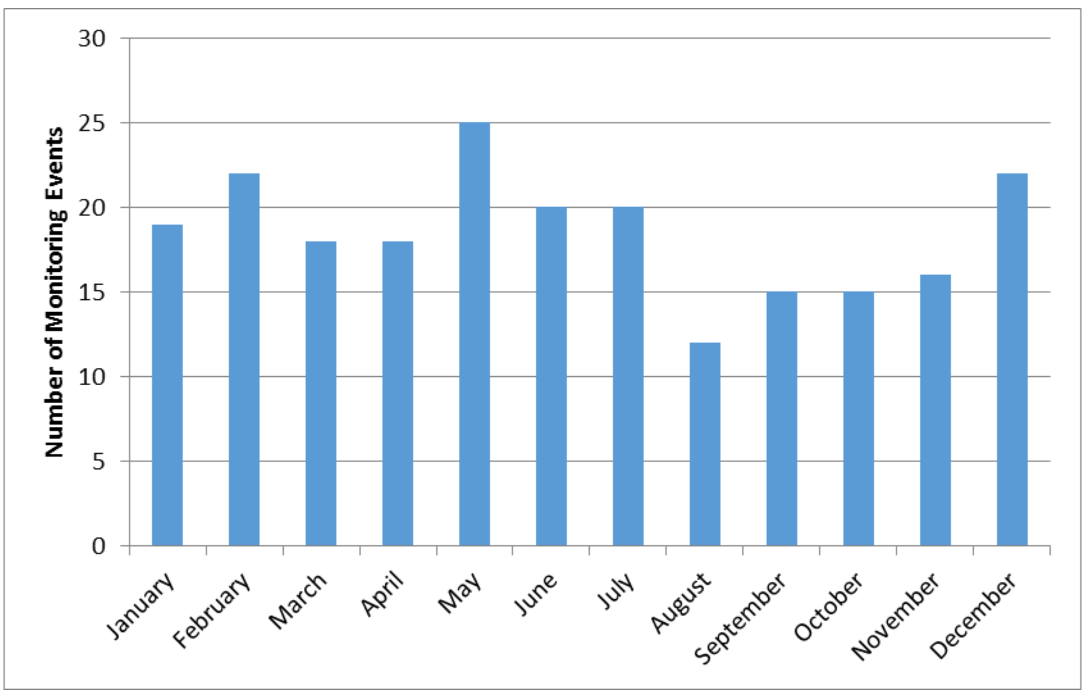

Figure 3: Breakdown of monitoring events by month.

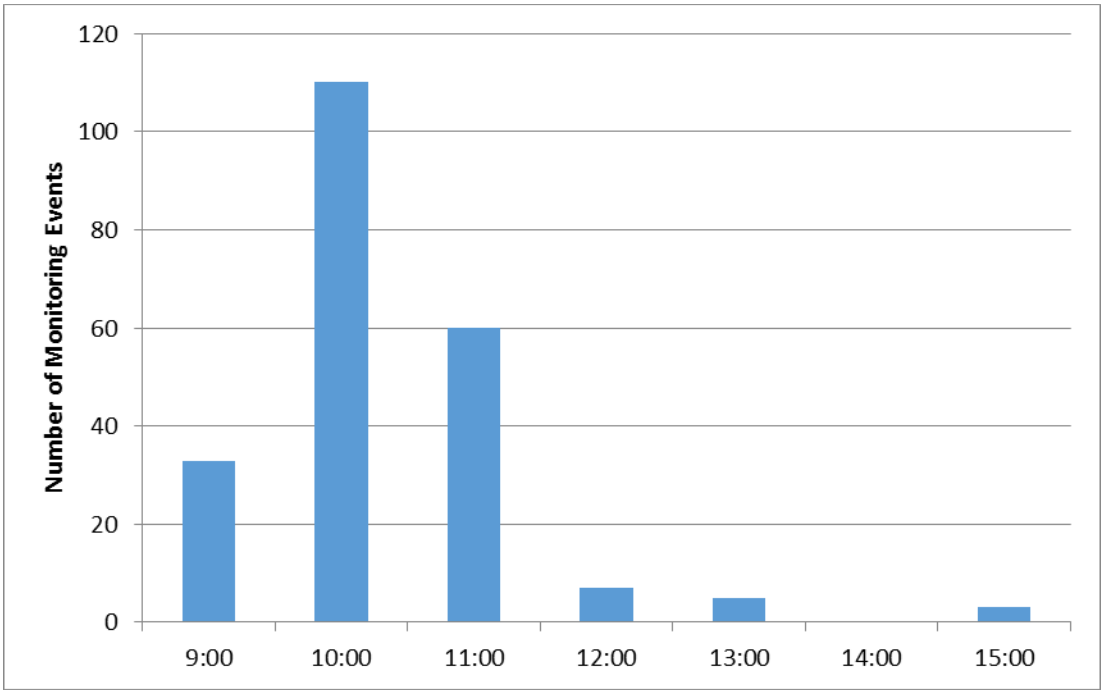

Figure 4: Breakdown of time of monitoring in the White Rock Creek Watershed

Table 3: Descriptive parameters for all sites in the White Rock Creek Watershed

White Rock Creek Watershed May 1996 – July 2014				
Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	216	409 ± 72	182	566
Water Temperature (°C)	219	18.1 ± 7.2	5.0	30.5
Dissolved Oxygen (mg/L)	218	7.3 ± 3.3	2.2	12.8
pH	217	7.4 ± 0.3	6.7	8.3
E. coli	59	276	0	7333
Nitrates	19	1.0 ± 0.0	1	1
Phosphates	18	0.09 ± 0.16	0.02	0.5

There were a total of 222 sampling events between 5/14/2006 and 07/19/2014. Mean is listed for all parameters except for E. coli which is represented as the geomean.

Trend Analysis over Time

Air and water temperature

A total of 219 air and water temperatures were collected in the White Rock Creek Watershed between 2006 and 2014. Water temperatures never exceeded the TCEQ optimal temperature of 33.9°C. Air temperature varied between 5°C and 34°C.

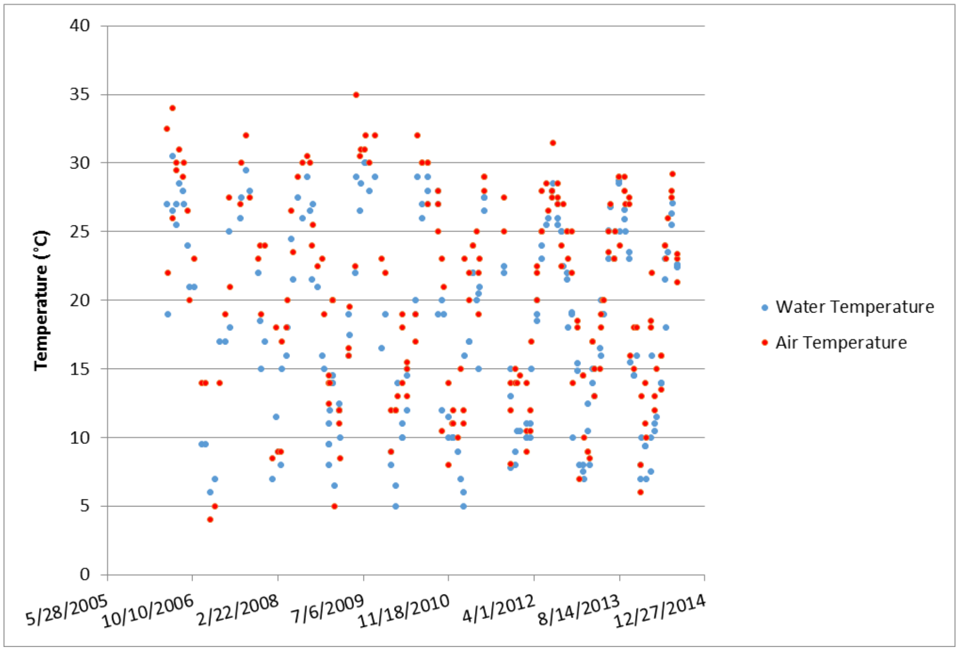

Figure 5: Air and water temperature over time at all sites within the White Rock Creek Watershed

Total Dissolved Solids

Citizen scientists conducted a total of 216 TDS measurements within the watershed. The TDS measurement was completed for 97.3% of all monitoring events. The average TDS measurement for all sites was 409 mg/L. There was a significant decreasing trend in total dissolved solids concentrations observed within the watershed for this time period ($p = 0.015$). The low R^2 value of 0.0274 indicates that this relationship only explains a small amount of the variation in the data.

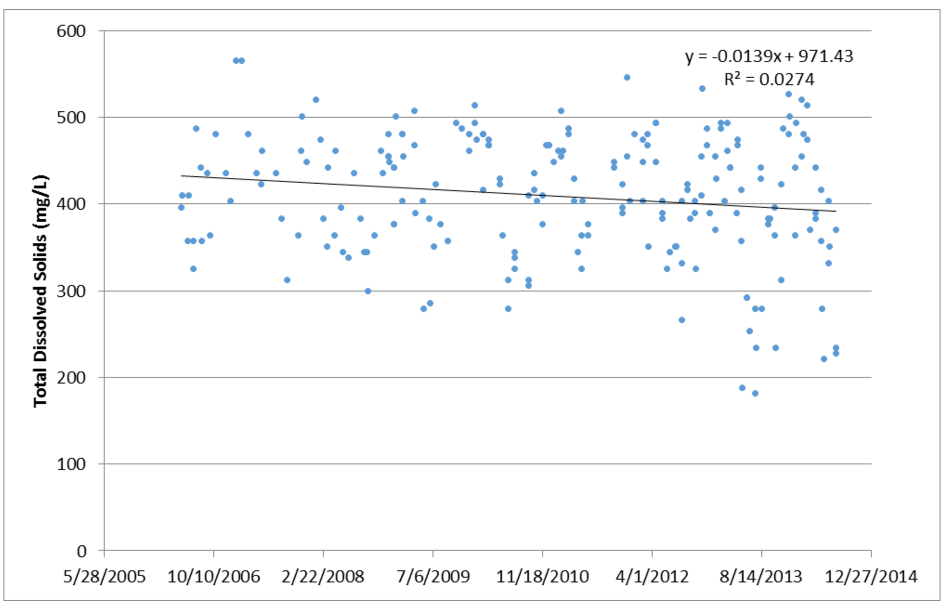

Figure 6: Total dissolved solids over time for all sites within the White Rock Creek Watershed

Dissolved Oxygen

Citizen scientists collected 218 DO samples in the watershed during this time period. The mean DO concentration was 7.3 mg/L. Dissolved oxygen varied from a minimum of 2.2 mg/L in June of 2010, to a maximum of 12.8 mg/L in January of 2012. There was no significant trend in DO concentrations over time observed in this watershed.

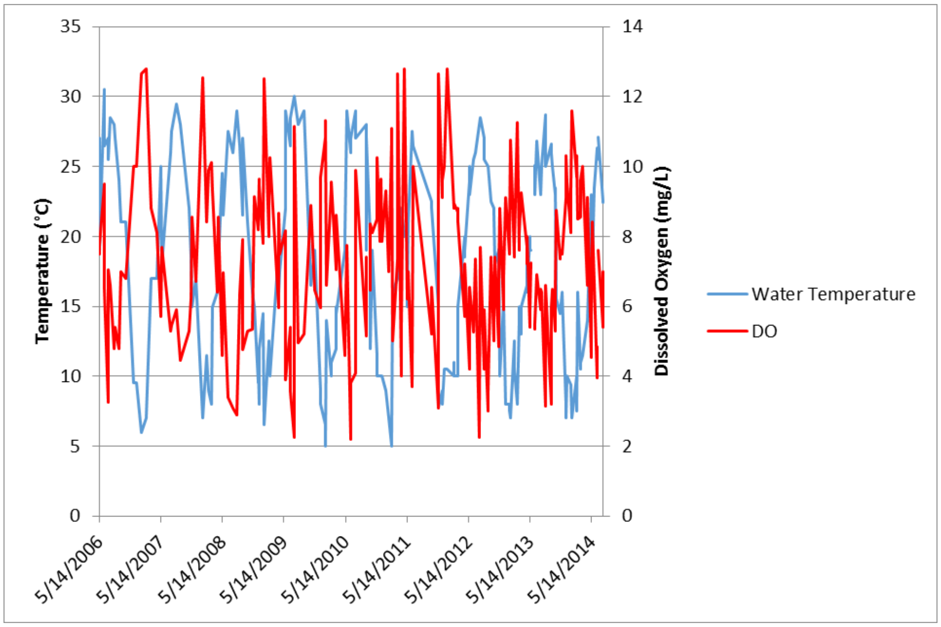

Figure 7: Water temperature and dissolved oxygen over time for all sites within the White Rock Creek Watershed

pH

The pH was measured for 97.7% of all monitoring events in the watershed. The mean pH was 7.4 and it ranged from 6.7 to 8.3 for all sites. There was no significant trend in pH over time observed at this site.

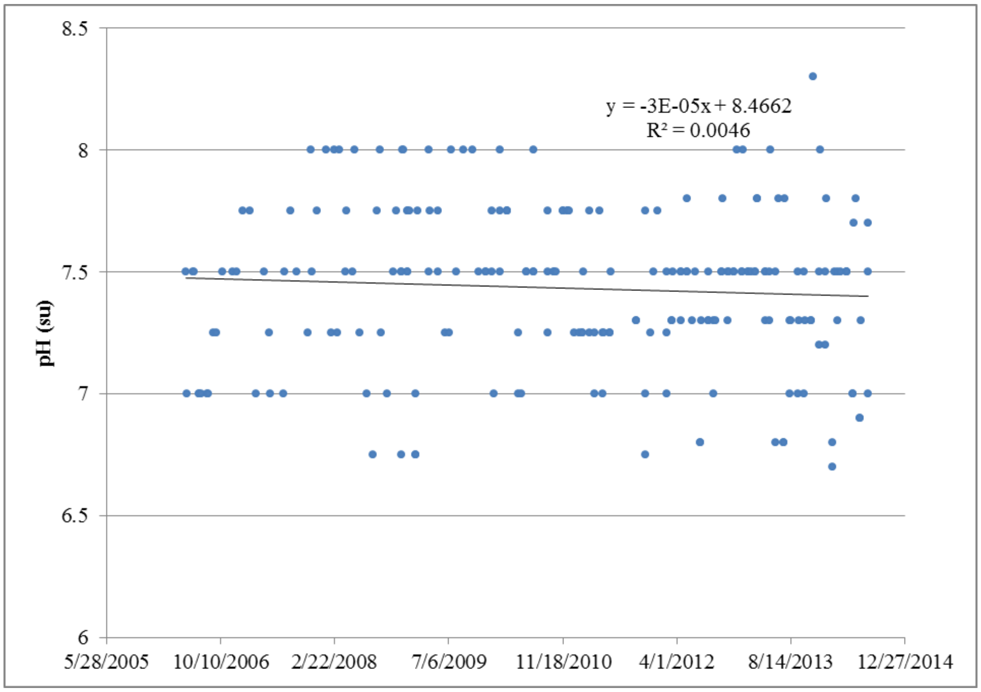

Figure 8: pH for all sites within the White Rock Creek Watershed

E. coli Bacteria

Citizen scientists collected 59 E. coli samples in this watershed. The geomean for E. coli was 276 CFU/100 mL for the watershed. E. coli counts ranged from 0 CFU/100 mL to 7,333 CFU/100 mL in July of 2013. There was no significant trend in E. coli over time observed at this site.

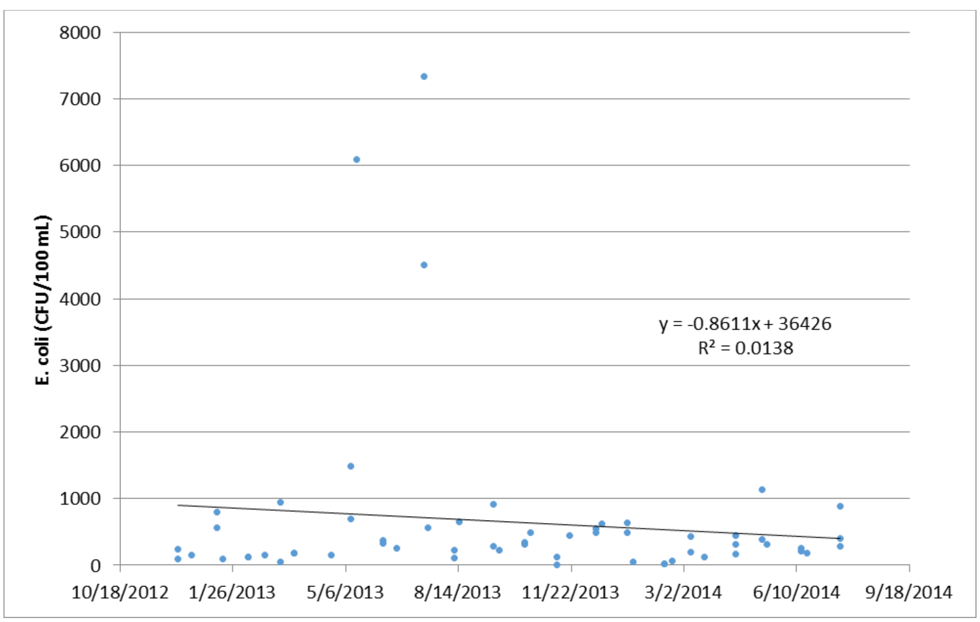

Figure 9: E. coli for all sites within the White Rock Creek Watershed

Orthophosphate

Citizen scientists collected 18 phosphate measurements in this watershed. The mean phosphate concentration in the watershed was 0.09 mg/L. Phosphate concentrations ranged from a low of 0.02 mg/L to a high of 0.50 mg/L. There was no significant trend in phosphate concentrations over time observed in the watershed.

Nitrate-Nitrogen

There were 19 nitrate samples taken in the watershed during this time. The nitrate concentration was 1.0 mg/L for every sample.White Rock Creek Watershed Site by Site Analysis

The following sections will provide a brief summarization of analysis, by site. The average minimum and maximum values recorded in the watershed. These values are reported in order to provide a quick overview of the watershed. The TDS, DO, and pH values are presented as an average, plus or minus the standard deviation from the average. The *E. coli* is presented as a geomean. Please see Table 4, on the following page, for a quick overview of the average results.

As previously mentioned in the 'Water Quality Parameters' section, TDS is an important indicator of turbidity and specific conductivity. The higher the TDS measurement, the more conductive the water is. A high TDS result can indicate increased nutrients present in the water. Site80400 had the highest overall average for TDS, with a result of 413 ± 65 mg/L. Site 80397 had the lowest average TDS, with a result of 405 ± 78 mg/L.

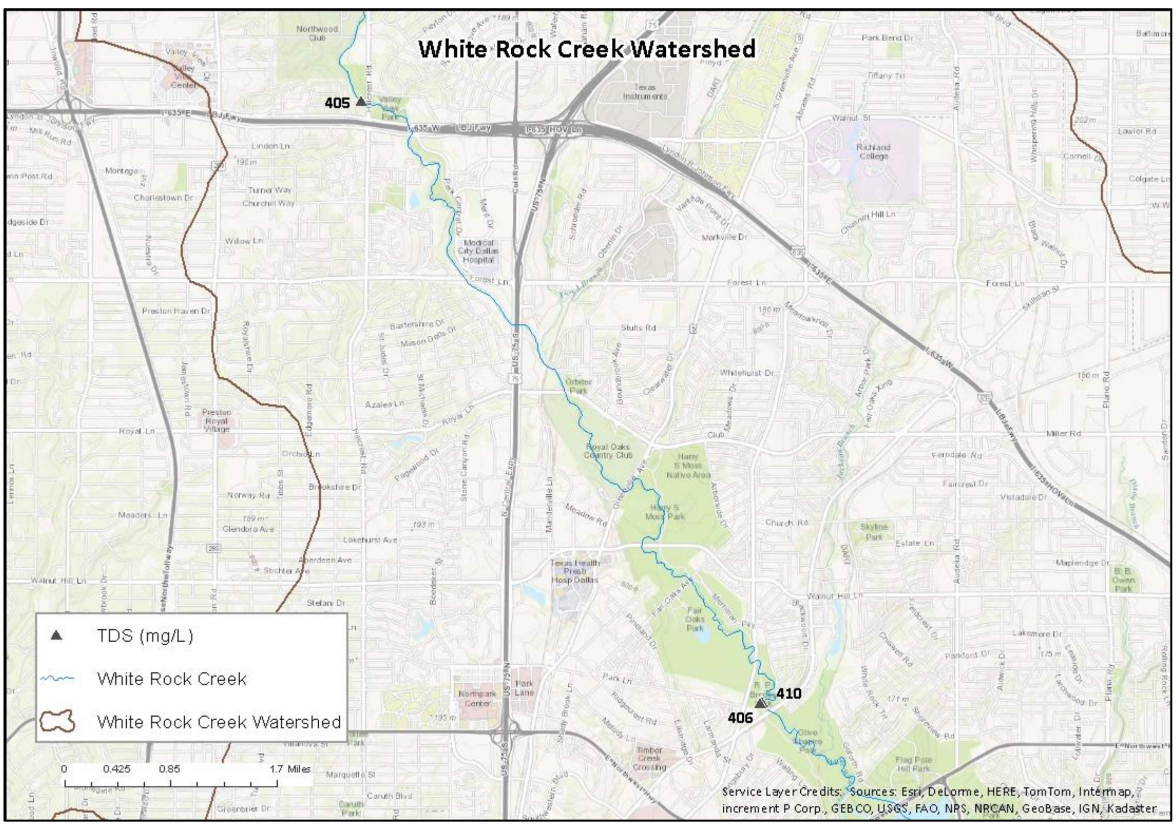

Figure 10: Map of the average total dissolved solids for sites in the White Rock Creek Watershed

The DO measurement can help to understand the overall health of the aquatic community. If there is a large influx of nutrients into the water body than there will be an increase in surface vegetation growth, which can then reduce photosynthesis in the subsurface, thus decreasing the level of DO. Low DO can be dangerous for aquatic inhabitants, which rely upon the dissolved oxygen to breathe. The DO levels can also be impacted by temperature; a high temperature can limit the amount of oxygen solubility, which can also lead to a low DO measurement. Site 15280 had the lowest average DO reading, with a result of 6.4 ± 2.3 mg/L. Site 80397 had the highest average DO reading, with a result of 8.5 ± 2.0 mg/L.

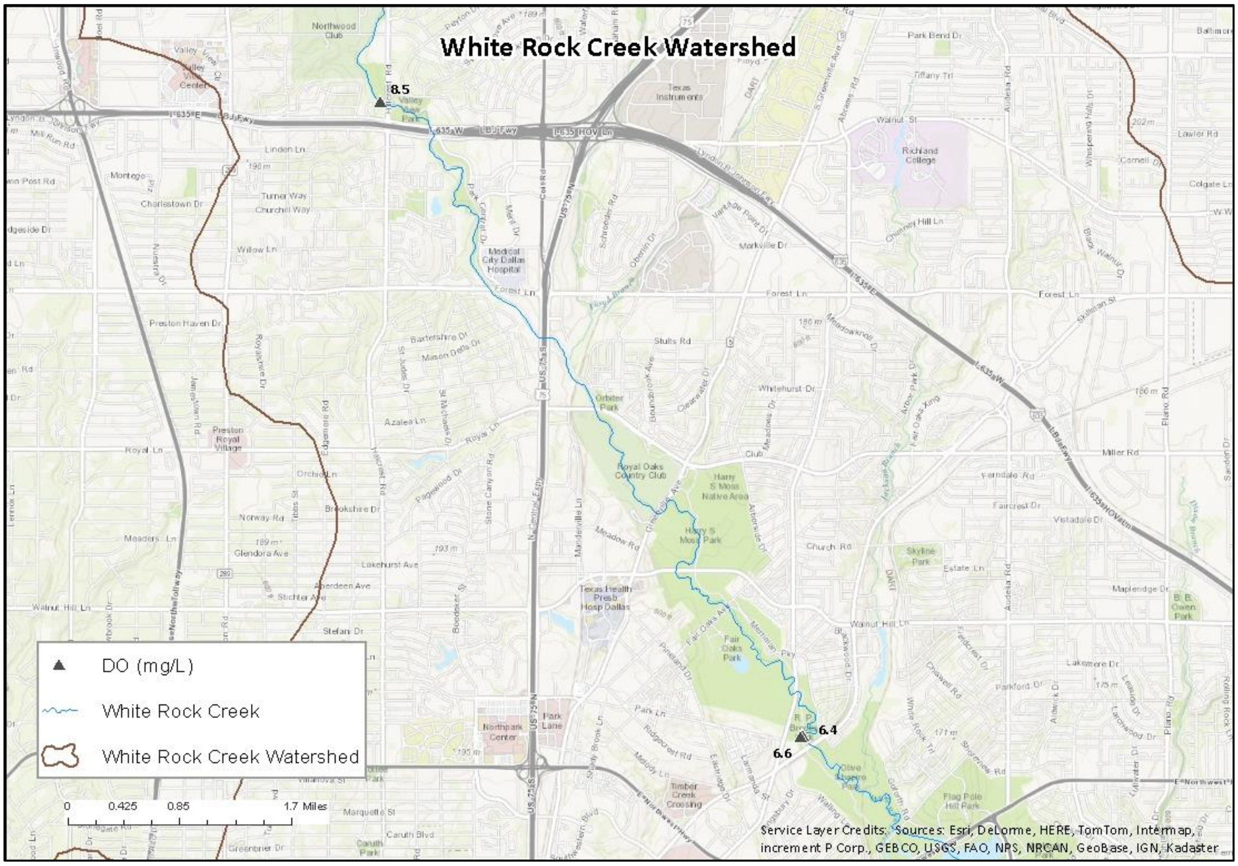

Figure 11: Map of the average dissolved oxygen for sites in the White Rock Creek Watershed

The pH levels are an important indicator for the overall health of the watershed as well. Aquatic inhabitants typically require a pH range between 6.5 and 9 for the most optimum environment. Anything below 6.5 or above 9 can negatively impact reproduction or can result in fish kills. There were no reported pH levels outside of this widely accepted range. Site 80397 had the highest average pH level, with a result of 7.6 ± 0.7. Sites 80400 and 15280 had the lowest average pH levels, with a result of 7.3 ± 0.3 for both sites.

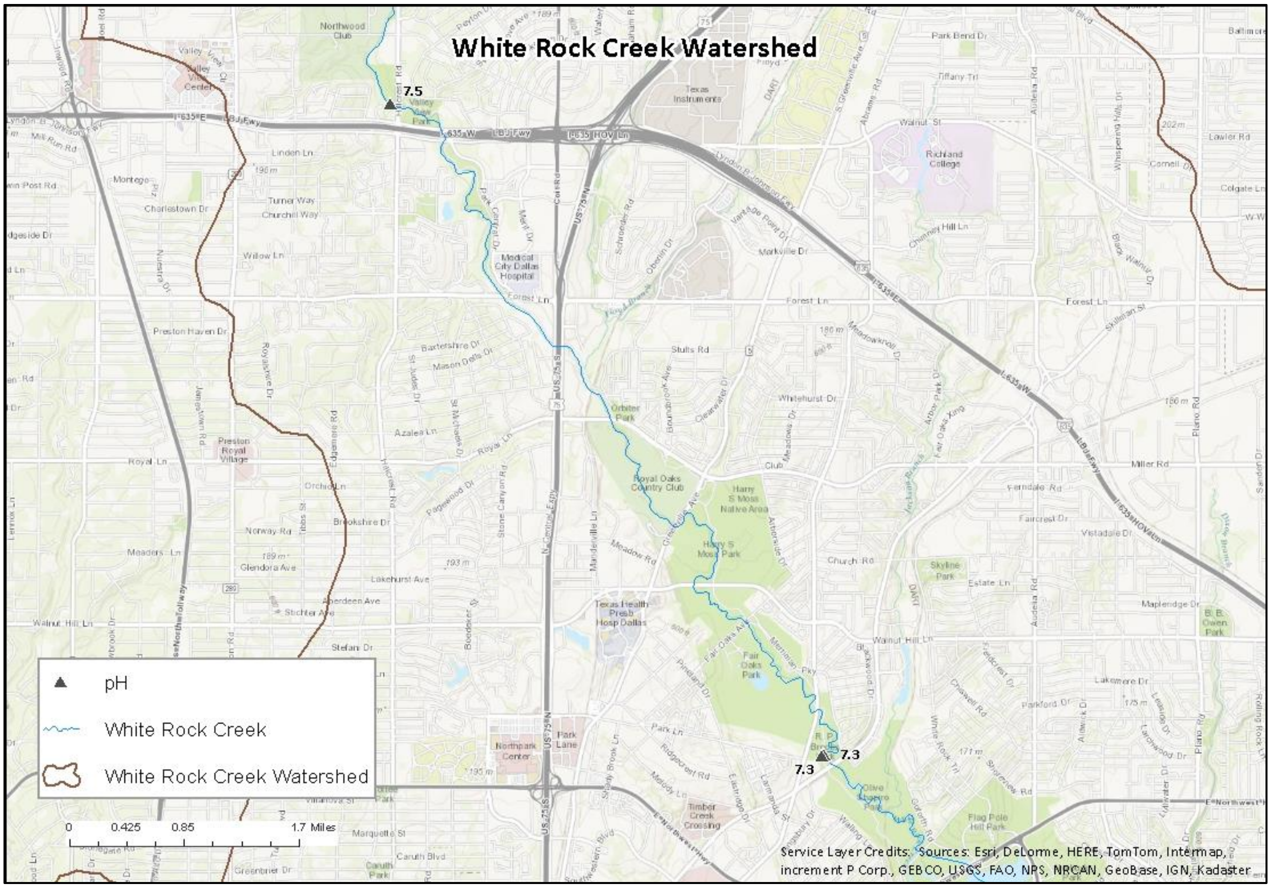

Figure 12: Map of the average pH for sites in the White Rock Creek Watershed

E. coli bacteria originate in the digestive tract of endothermic organisms. The EPA has determined *E. coli* to be the best indicator of the degree of pathogens in a water body, which are far too numerous to be tested for directly, considering the amount of water bodies tested. A pathogen is a biological agent that causes disease. The standard for *E. coli* impairment is based on the geometric mean (geomean) of the *E. coli* measurements taken. A geometric mean is a type of average which takes into account the high variability of parameters such as E. coli which can vary from zero to tens of thousands of CFU/100 mL. Site 80400 had the highest average geomean, with a result of 375 CFU/100mL. Site 15280 had the lowest average geomean, with at result of 223 CFU/100mL.

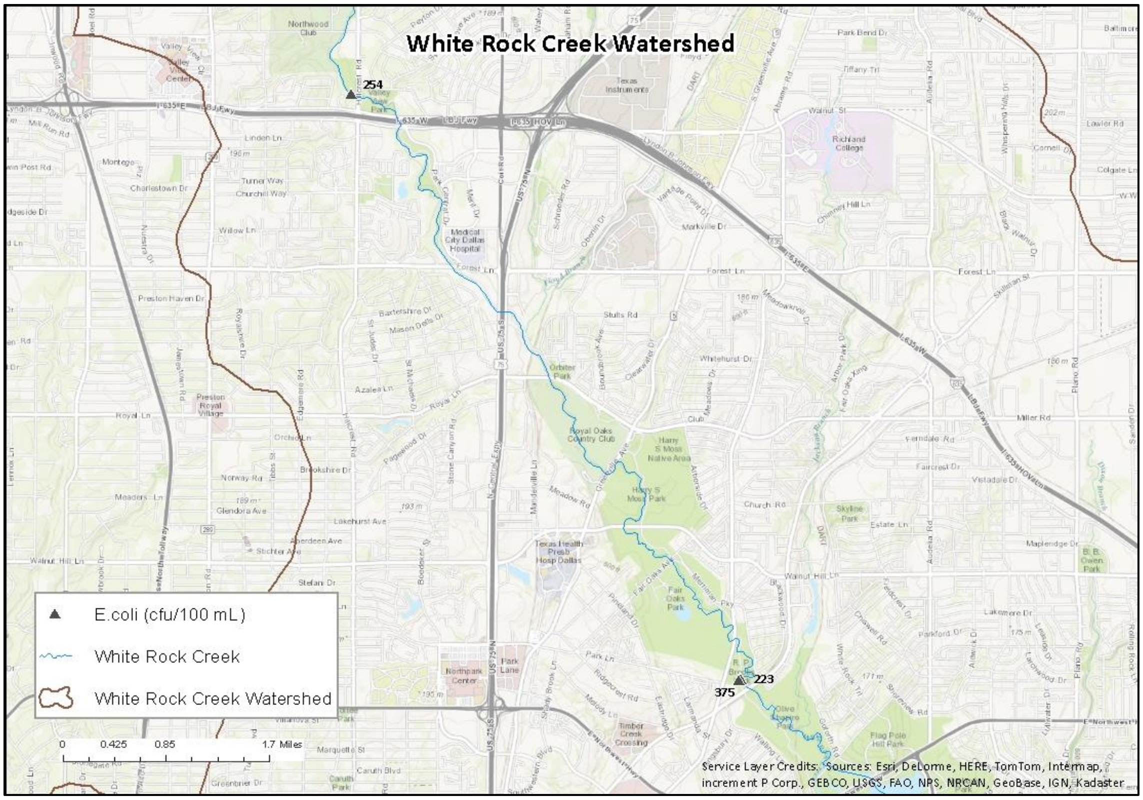

Figure 13: Map of the geomean for E. coli for sites in the White Rock Creek Watershed

Please see Table 4 for a summary of average results at all sites. It is important to note that there was variation in the number of times each site was tested, the time of day at which each site was tested, and the time of month the sampling occurred. While this is a quick overview of the results, it is important to keep in mind that there is natural diurnal and seasonal variation in these water quality parameters. Texas Stream Team citizen scientist data is not used by the state to assess whether water bodies are meeting the designated surface water quality standards.

Table 4: Average Values for all sites in the White Rock Creek Watershed

Site Number	TDS (mg/L)	DO (mg/L)	pH	E. coli (CFU/100 mL)	Nitrates (mg/L)	Phosphates (mg/L)
80397	405 ± 78 (min)	8.5 ± 2.0 (max)	7.6 ± 0.7 (max)	254	1.0 ± 0.0	0.02 ± 0.0 (min)
80400	413 ± 65 (max)	6.6 ± 2.0	7.3 ± 0.3 (min)	375 (max)	1.0 ± 0.0	0.04 ± 0.04
15280	410 ± 69	6.4 ± 2.3 (min)	7.3 ± 0.3 (min)	223 (min)	1.0 ± 0.0	0.29 ± 0.19 (max)

Site 80397– White Rock Creek at Hillcrest

Site Description

This site is located at the Hillcrest Rd. crossing over White Rock Creek. The area is heavily wooded and is the trailhead to the White Rock Creek Trail. A golf course is upstream of the monitoring location. This site is located in a small undeveloped park in between two large residential neighborhoods. Interstate 635 is due south of the monitoring site.

Sampling Information

This site was 86 times between 5/14/2006 and 7/19/2014. The site was monitored in the morning between 09:00 and 11:00.

Table 5: Descriptive parameters for Site 80397

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	83	405 ± 78	189	566
Water Temperature (°C)	85	17.5 ± 7.3	6.0	30.5
Dissolved Oxygen (mg/L)	84	8.5 ± 2.0	5.0	12.8
pH	85	7.6 ± 0.7	7.0	8.3
E. coli	20	254	50	6087
Nitrates	10	1.0 ± 0.0	1.0	1.0
Phosphates	13	0.02 ± 0.0	0.02	0.02

Site was sampled 86 times between 5/14/2006 and 7/19/2014.

Air and water temperature

Citizen scientists collected 85 air and water temperatures at this site during this time. Air temperature varied from a low of 4°C in January of 2007, to a high of 34°C in June of 2006. The mean water temperature was 17.5°C. Water temperature ranged from a low of 6°C in January of 2007, to a high of 30.5°C in June of 2006.

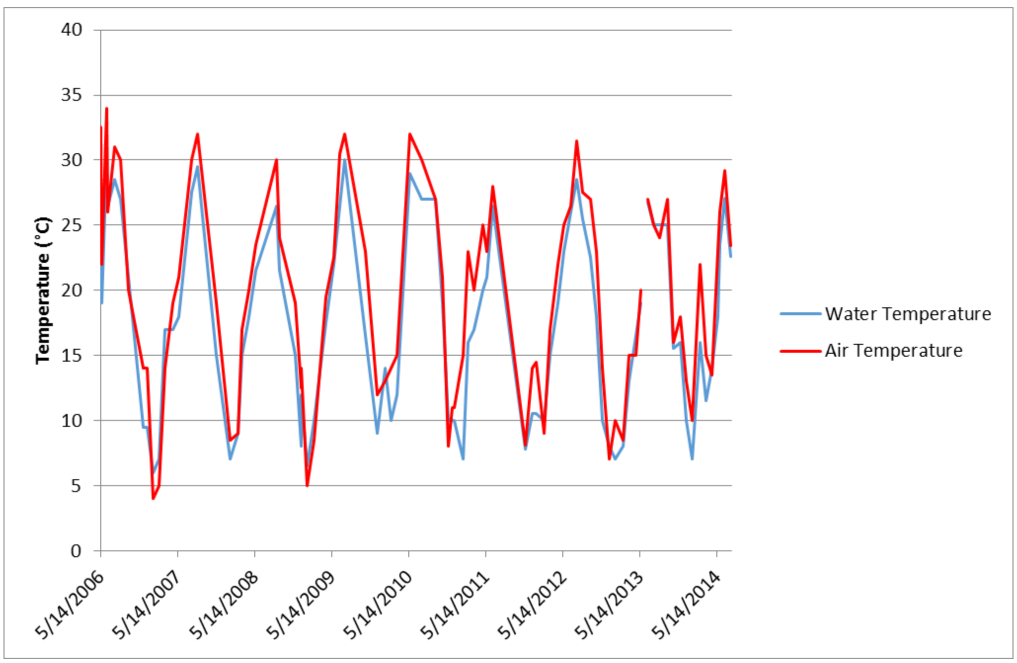

Figure 14: Air and water temperature at site 80397

Total Dissolved Solids

Citizen scientists recorded 83 TDS measurements at this site during this time. The mean TDS concentration was 405 mg/L. The minimum TDS concentration was 189 mg/L and was recorded in May,

2013. The maximum TDS concentration was 566 mg/L and was recorded in February of 2007. There was a significant decrease in TDS concentration over time observed at this site ($p = 0.001$). The R^2 value of 0.1338 indicates that this relationship explains about 13.4% of the variation in the data.

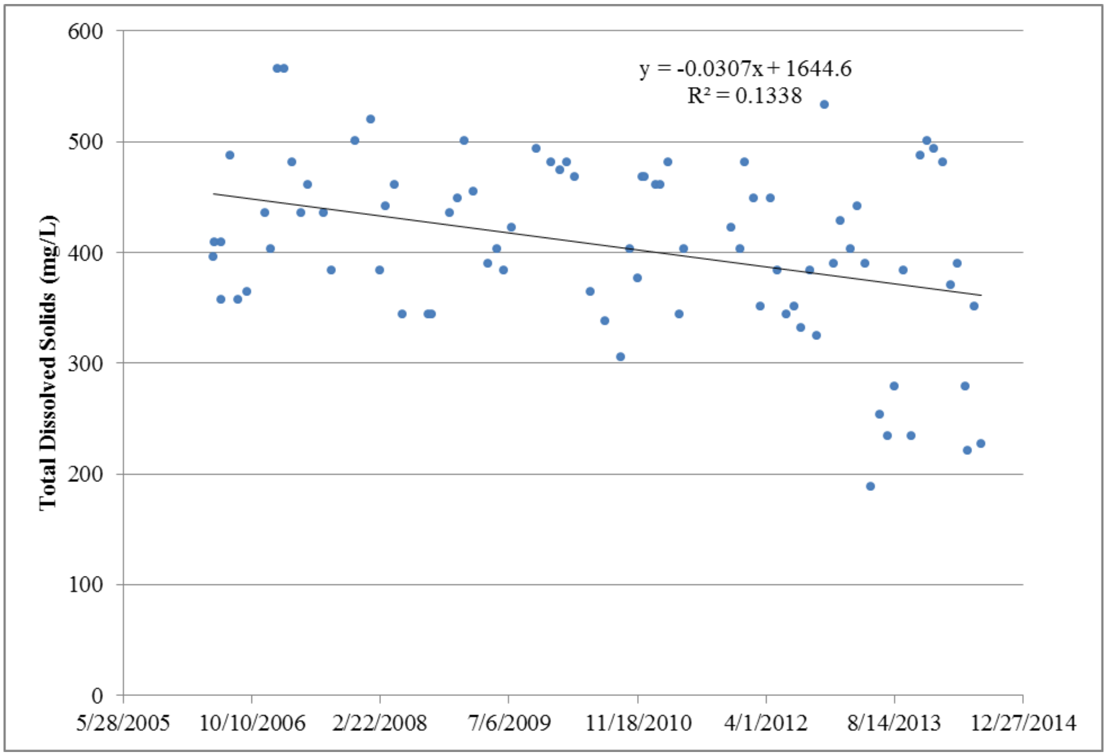

Figure 15: Total dissolved solids at site 80397

Dissolved Oxygen

Citizen scientists collected 84 DO samples at this site. The mean DO concentration was 8.5 mg/L. The minimum DO concentration was 5.0 mg/L in February of 2011. The maximum DO concentration was 12.8 mg/L and was taken on several occasions. There was no significant trend in DO concentrations over time observed at this site.

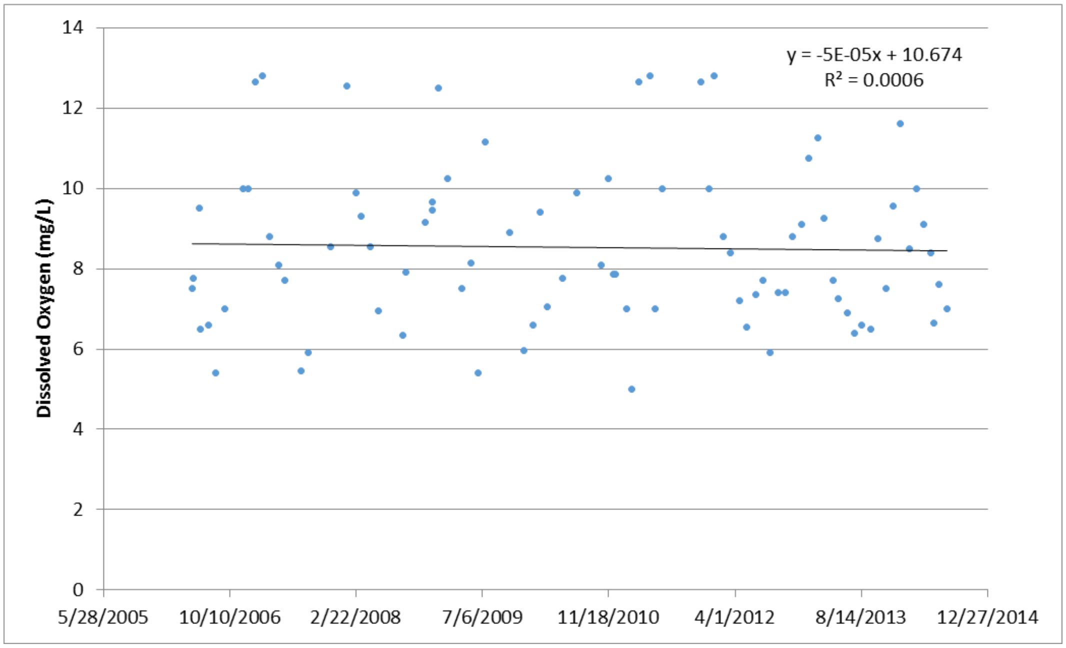

Figure 16: Dissolved oxygen at site 80397

pH

Citizen scientists collected 85 samples of pH at this site. The mean pH was 7.6 and it ranged from a low of 7.0, to a high of 8.3 in November, 2011. There was no significant trend in pH over time observed at this site.

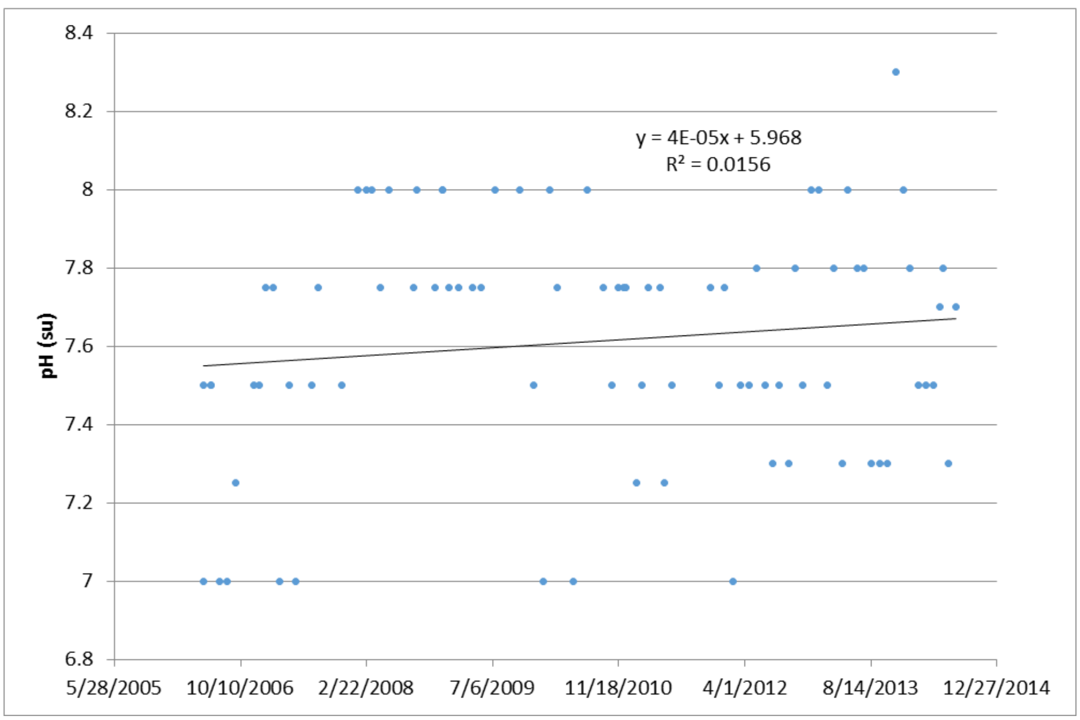

Figure 17: pH at site 80397

Secchi disk and total depth

The Secchi disk depth was recorded as greater than the total depth in all measurements indicating that the bottom of the creek was visible at this site. The mean total depth at this site as 0.36 m.

Field Observations

Flow was recorded as either normal or high. The algae cover was recorded as absent or rare, but became common (26 – 50%) in 2012, and has been recorded as common since then. The water clarity is mostly clear, but was described as cloudy a few times. The water color was clear but was also described as tan on several occasions. The water had no odor.

E. coli Bacteria

Citizen scientists collected 20 E. coli samples at this site. The geomean for E. coli was 254 CFU/100 mL. E. coli counts ranged from 50 CFU/100 mL in January of 2014, to a maximum of 6087 CFU/100 mL in May of 2013. There was no significant trend in E. coli over time observed.

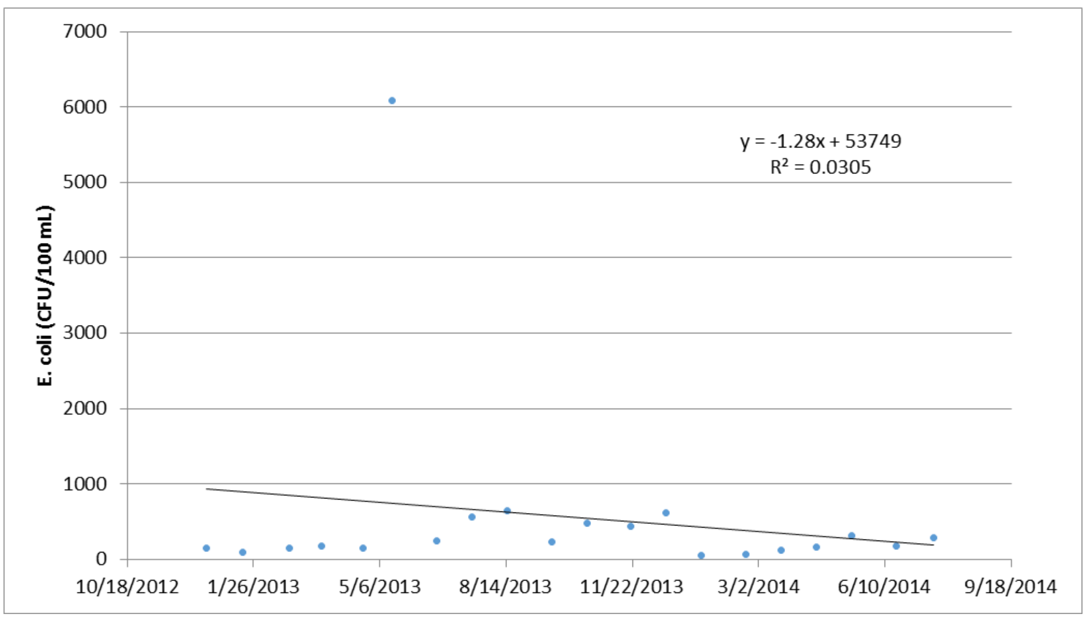

Figure 18: E. coli at site 80397

Orthophosphate

Phosphate samples were taken 13 times at this site. All samples were 0.02 mg/L and there was no variation.

Nitrate-Nitrogen

Citizen scientists took 10 nitrate samples at this site. All samples were recorded as 1.0 mg/L, and there was no variation.

Site 80400– Village Creek at Skillman

Site Description

This site is located at the Village Creek confluence with White Rock Creek near Skillman Road. The site is in the heavily wooded White Rock Creek Greenbelt. There is a large commercial development to the west of the site along with a driving range and apartments.

Sampling Information

This site was sampled 60 times between 7/12/2008 and 7/19/2014. The time of sampling for this site ranged from 09:00 to 11:00.

Table 6: Descriptive parameters for Site 80400

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	59	413 ± 65	182	546
Water Temperature (°C)	59	18.4 ± 7.1	5.0	29.0
Dissolved Oxygen (mg/L)	59	6.6 ± 2.0	2.7	10.9
pH	59	7.3 ± 0.3	6.8	8.0
E. coli	19	375	17	7333
Nitrates	5	1.0 ± 0.0	1.0	1.0
Phosphates	6	0.04 ± 0.04	0.02	0.14

Site was sampled 60 times between 7/12/2008 and 7/19/2014.

Air and water temperature

There were 59 air and water temperatures taken at this site. The air temperature ranged from a low of 8°C in December of 2013, to a high of 35°C in May of 2009. The mean water temperature was 18.4°C. The minimum water temperature was 5°C and was taken in February, 2011. The maximum water temperature was 29°C and was recorded 3 times in 2008 and 2009.

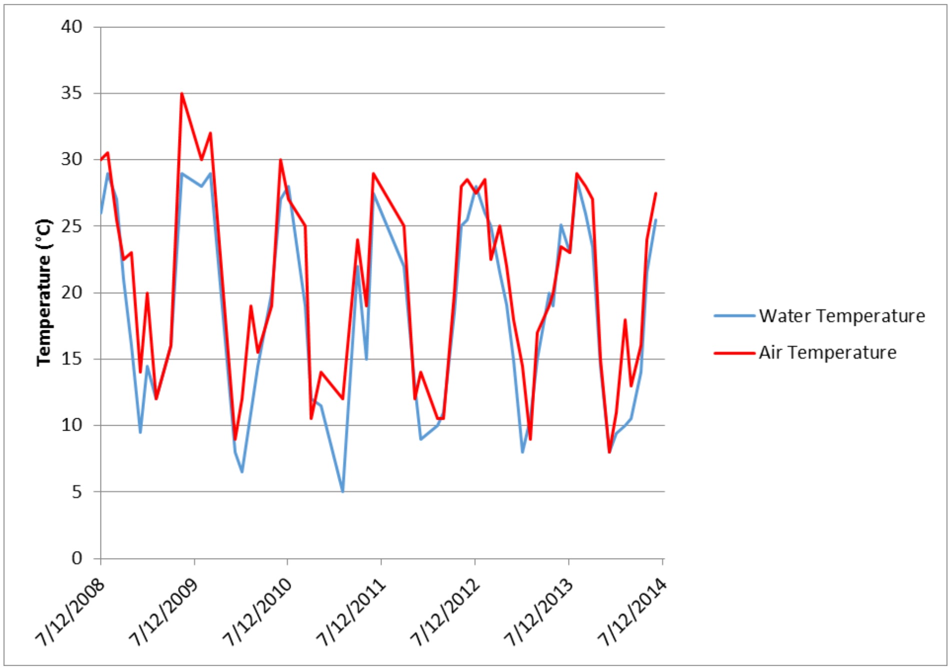

Figure 19: Air and water temperatures at site 80400

Total Dissolved Solids

Citizen scientists took 59 TDS measurements at this site during this time. The mean TDS concentration was 413 mg/L. The minimum TDS concentration was 182 mg/L and was taken in July, 2013. The maximum TDS concentration was 546 mg/L and was taken in June of 2014. There was no significant trend in total dissolved solids over time observed at this site during this time.

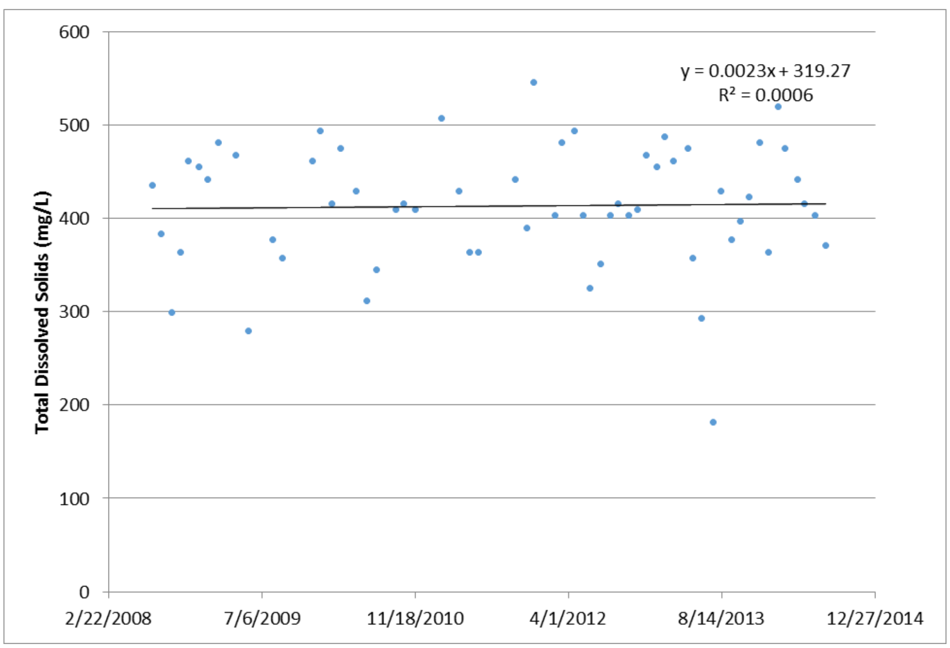

Figure 20: Total Dissolved Solids at site 80400

Dissolved Oxygen

Citizen scientists collected 59 dissolved oxygen samples at this site during this time. The mean DO concentration was 6.6 mg/L. The minimum DO concentration was 2.7 mg/L and was recorded in July of 2012. The maximum DO concentration was 10.9 mg/L and was recorded in January of 2010. There was no significant trend in DO over time observed at this site.

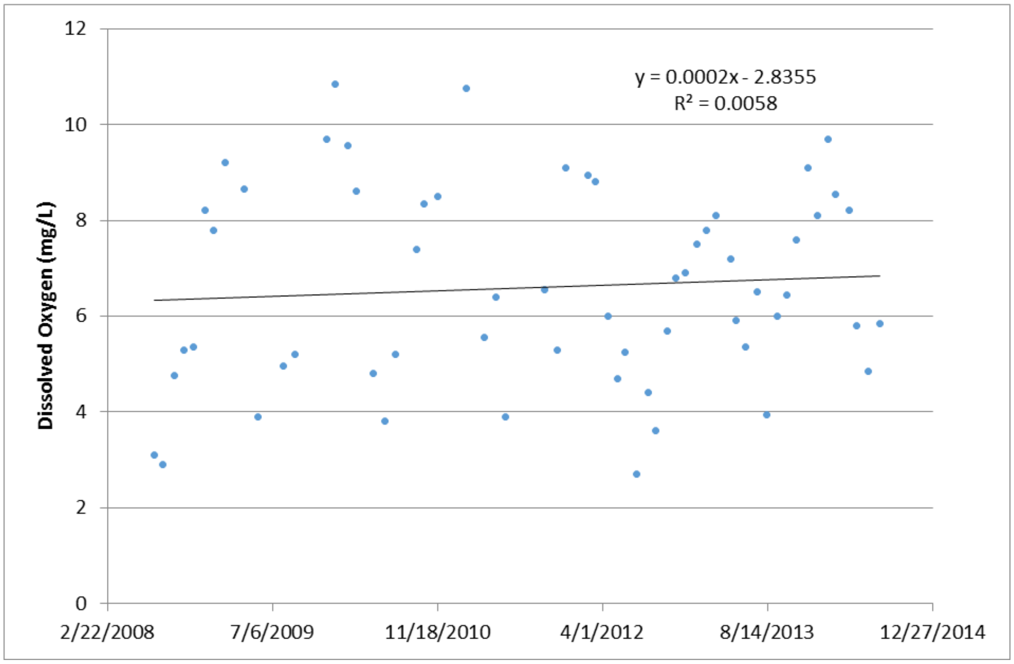

Figure 21: Dissolved Oxygen at site 80400

pH

Citizen scientists took 59 pH measurements at this site during this time. The mean pH was 7.3 and it ranged from a low of 6.8 in August of 2008 and February of 2009, to a high of 8.0 in April and September of 2009. There was no significant trend in pH over time observed at this site.

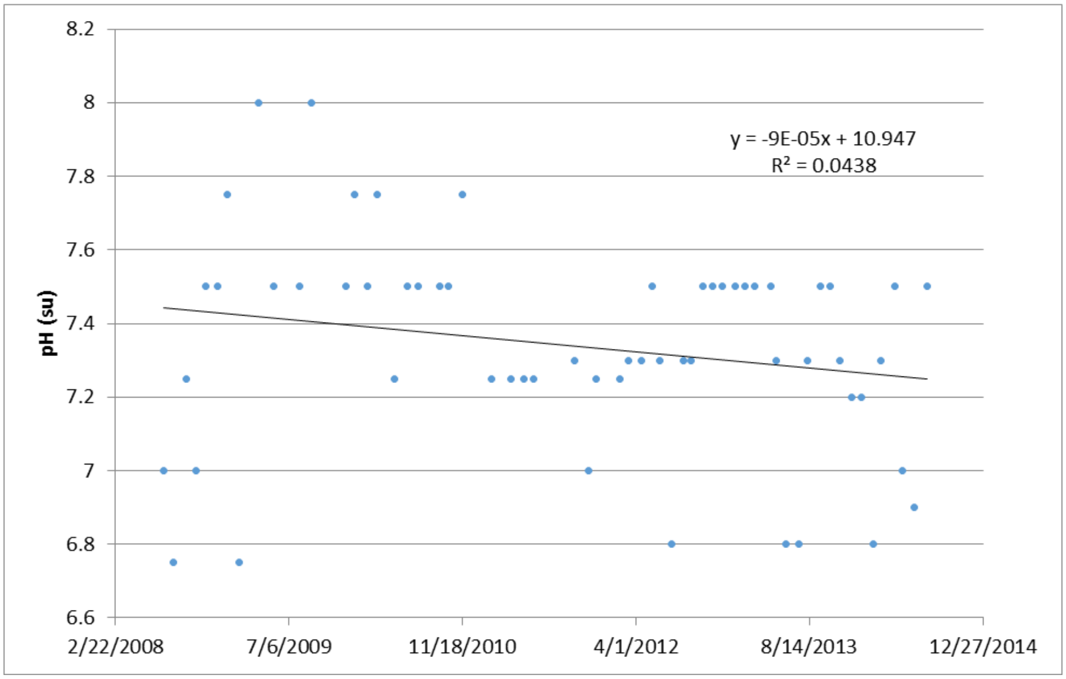

Figure 22: pH at site 80400

Secchi disk and total depth

Secchi disk depth was less than total depth for about 33% of the monitoring events. The mean total depth was 0.73 m. The mean Secchi disk depth was 0.57 m.

Field Observations

Flow was described as normal, but there were a few instances where it was recorded as low. Algae cover was typically absent or rare at this site, but it became increasingly described as common (26 – 50%) beginning in the summer of 2012. Water color was clear to light green. Water clarity was always described as clear. The water at this site had no odor.

E. coli Bacteria

Citizen scientists collected 19 E. coli samples at this site. The geomean for E. coli was 375 CFU/100 mL. The E. coli varied from a minimum of 17 CFU/100 mL in February of 2014, to a maximum of 7333/100 mL in July of 2013. There was no significant trend in E. coli over time observed at this site.

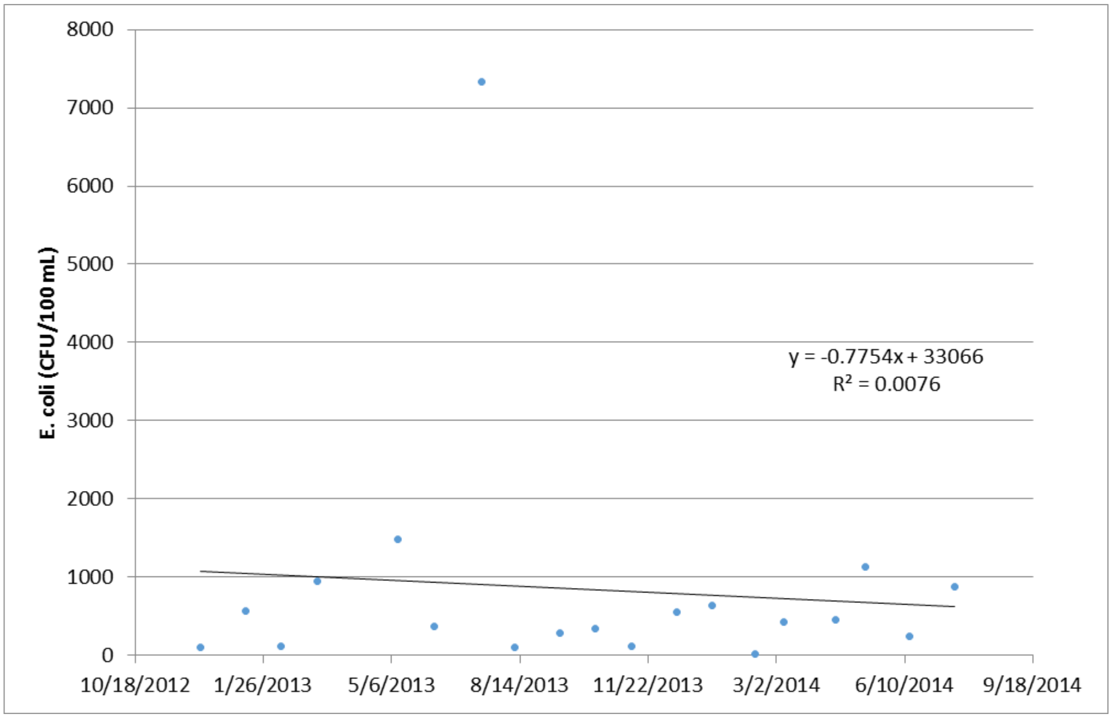

Figure 23: E. coli at site 80400

Orthophosphate

Citizen scientists collected 6 phosphate samples at this site. The mean phosphate concentration was 0.4 mg/L. All samples except one were 0.02 mg/L. The one sample that was not 0.02 mg/L was taken in June of 2014 and was 0.14 mg/L.

Nitrate-Nitrogen

Citizen scientists collected 5 nitrate samples at this site. All samples were recorded as 1.0 mg/L.

Site 15280– White Rock Creek at Skillman Street

Site Description

This site is located in the White Rock Creek Green Belt, under the Skillman St. Bridge. There is a running trail that runs along the creek in the Green Belt. The Green Belt is a strip of wooded land in between a residential area to the northeast, and a commercial area to the southwest.

Sampling Information

This site was sampled 76 times between 7/8/2006 and 7/19/2014. The time of sampling at this site ranged from 10:00 to 12:00.

Table 7: Descriptive parameters for Site 15280

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	74	410 ± 69	234	527
Water Temperature (°C)	75	18.5 ± 7.0	5.0	30.0
Dissolved Oxygen (mg/L)	75	6.4 ± 2.3	2.2	11.3
pH	74	7.3 ± 0.3	6.7	8.0
E. coli	20	223	0	4500
Nitrates	4	1.0 ± 0.0	1.0	1.0
Phosphates	6	0.29 ± 0.20	0.02	0.50

Site was sampled 76 times between 7/8/2006 and 7/19/2014.

Air and water temperature

There were 75 air and water temperatures taken at this site during this time. The air temperature varied from a low of 6°C in December of 2013, to a high of 31°C in July, 2009. The mean water temperature was 18.5°C. Water temperature ranged from a low of 5°C in January, 2010 to a high of 30°C in July of 2009.

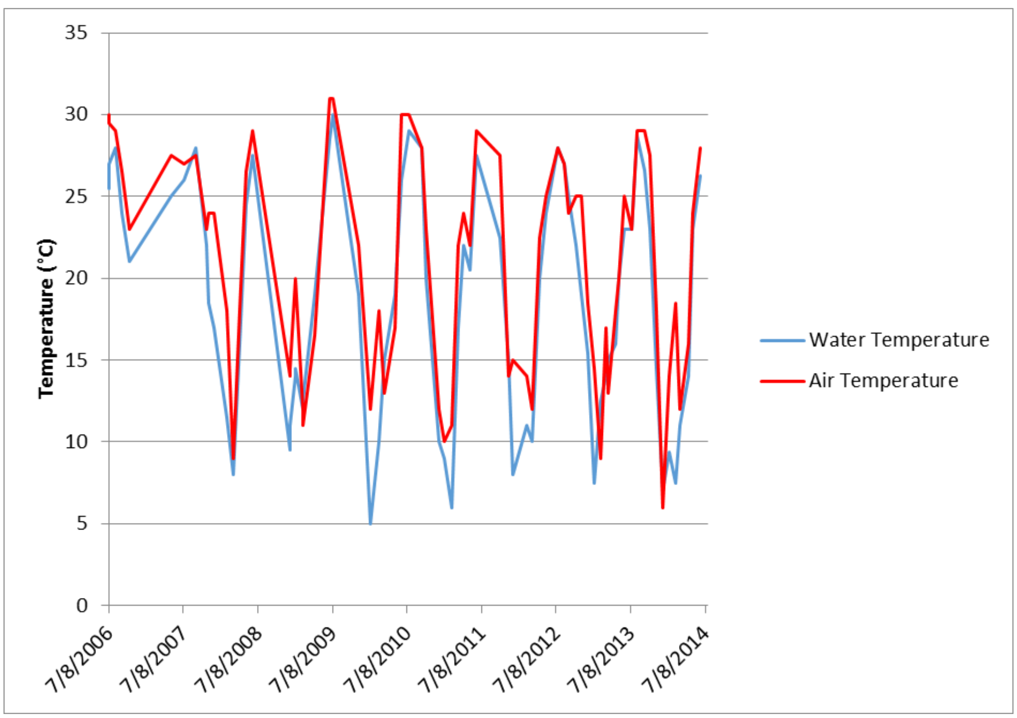

Figure 24: Air and water temperatures at Site 15280

Total Dissolved Solids

Citizen scientists took 74 TDS measurements at this site. The mean TDS concentration was 410 mg/L. The minimum TDS concentration was taken in July of 2014 and was 234 mg/L. The maximum TDS concentration was 527 mg/L and was taken in December of 2013. There was no significant trend in TDS concentration over time observed at this site.

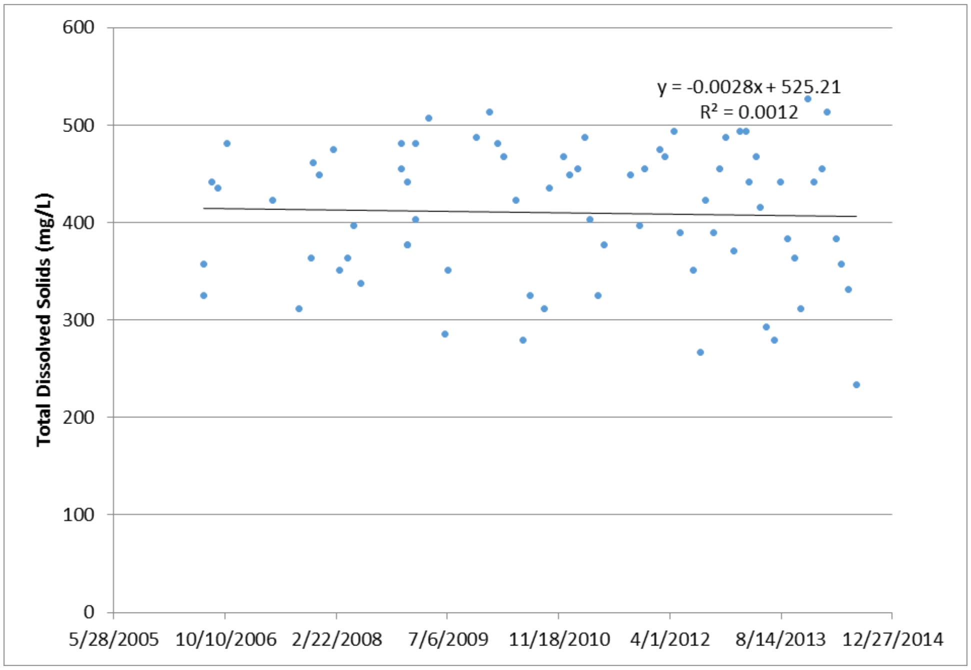

Figure 25: Total dissolved solids at Site 15280

Dissolved Oxygen

Citizen scientists collected 75 dissolved oxygen samples at this site during this time. The mean DO concentration was 6.4 mg/L. DO concentration ranged from a low of 2.2 mg/L in June of 2010, to a high of 11.3 mg/L in January of 2010. There was no significant trend in DO over time observed at this site.

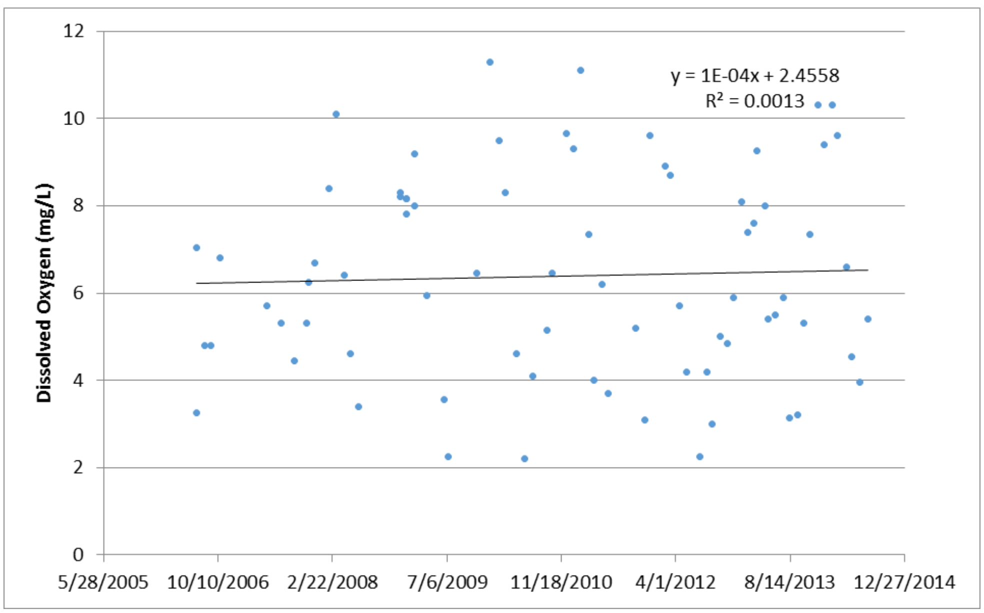

Figure 26: Dissolved oxygen at Site 15280

pH

There were 74 pH measurements taken at this site during this time. The mean pH was 7.3 and it ranged from a minimum of 6.7 in February of 2014 to a maximum of 8.0 in November of 2007. There was no significant trend in pH over time observed at this site.

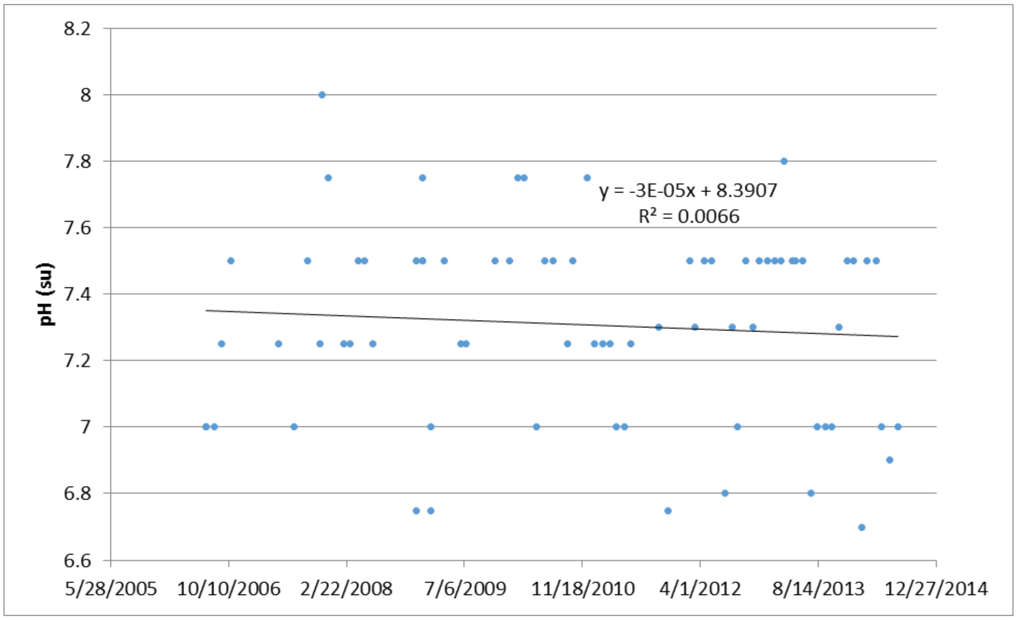

Figure 27: Dissolved oxygen at Site 15280

Secchi disk and total depth

The Secchi disk depth was less than total depth for about 50% of the monitoring events. The mean total depth at this site was 0.79m. The mean Secchi disk depth was 0.55 m. Secchi disk depth, when less than total depth, ranged from 0.27m to 0.61m.

Field Observations

Flow was usually recorded as normal. Algae cover was absent until March of 2011, after which it was recorded as common (26 – 50%). Water color was usually clear to light green. The water clarity was recorded as clear. The water had no odor at this site.

E. coli Bacteria

Citizen scientists collected 20 E. coli samples at this site. The geomean for E. coli was 223 CFU/100 mL. E. coli ranged from 0 CFU/100 mL in November of 2013 to 4500 CFU/100 mL in July of 2013. There was no significant trend in E. coli observed at this site.

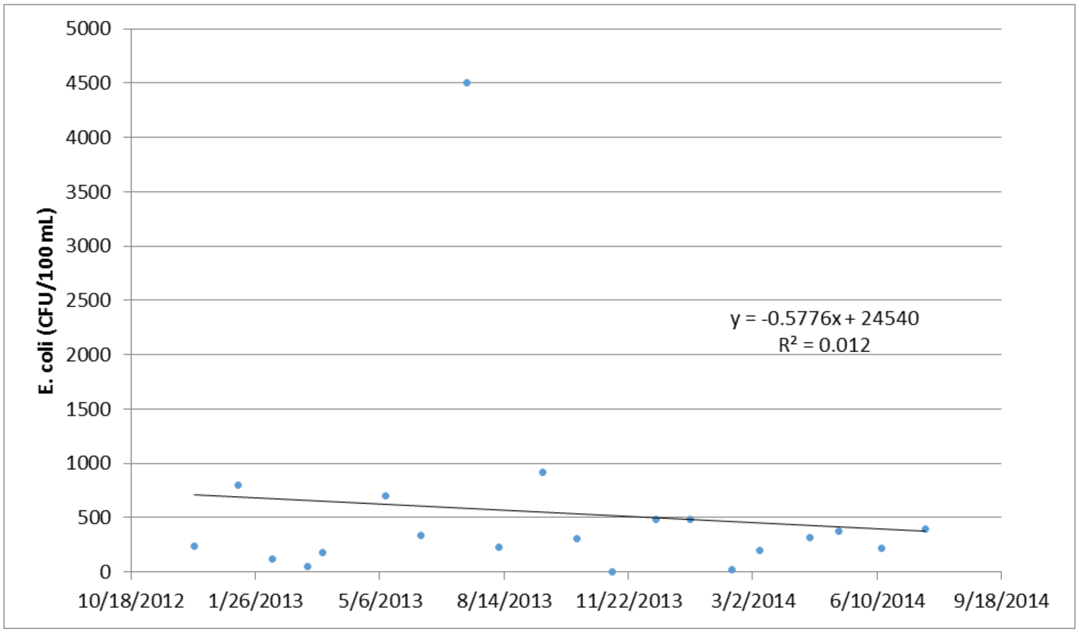

Figure 28: E. coli at Site 15280

Orthophosphate

Citizen scientists collected 6 phosphate samples at this site. The mean phosphate concentration was 0.29 mg/L. Phosphate concentrations varied between 0.02 mg/L to 0.5 mg/L

Nitrate-Nitrogen

Citizen scientists collected 4 nitrate samples at this site. The concentration of nitrate for all samples was 1.0 mg/L.

Get Involved with Texas Stream Team!

Once trained, citizen monitors can directly participate in monitoring by communicating their data to various stakeholders. Some options include: participating in the Clean Rivers Program (CRP) Steering Committee Process, providing information during “public comment” periods, attending city council and advisory panel meetings, developing relations with local Texas Commission on Environmental Quality (TCEQ) and river authority water specialists, and, if necessary, filing complaints with environmental agencies, contacting elected representatives and media, or starting organized local efforts to address areas of concern.

The Texas Clean Rivers Act established a way for the citizens of Texas to participate in building the foundation for effective statewide watershed planning activities. Each CRP partner agency has established a steering committee to set priorities within its basin. These committees bring together the diverse stakeholder interests in each basin and watershed. Steering committee participants include representatives from the public, government, industry, business, agriculture, and environmental groups. The steering committee is designed to allow local concerns to be addressed and regional solutions to be formulated. For more information about participating in these steering committee meetings, please contact the appropriate

CRP partner agency for your river basin at:
http://www.tceq.state.tx.us/compliance/monitoring/crp/partners.html.

Currently, Texas Stream Team is working with various public and private organizations to facilitate data and information sharing. One component of this process includes interacting with watershed stakeholders at CRP steering committee meetings. A major function of these meetings is to discuss water quality issues and to obtain input from the general public. While participation in this process may not bring about instantaneous results, it is a great place to begin making institutional connections and to learn how to become involved in the assessment and protection system that Texas agencies use to keep water resources healthy and sustainable.

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Vicars, Julie Anne Groening. Hydrological Impacts of Urbanization: White Rock Creek, Dallas Texas. Denton, Texas. UNT Digital Library. http://digital.library.unt.edu/ark:/67531/metadc5583/. Accessed August 28, 2014.

Appendix A- List of Maps, Tables, and Figures

Tables

Figures