PRE-CONSTRUCTION MONITORING AT BIOSWALE INSTALLATION SITES ALONG I-294 IN NORTHERN COOK COUNTY, ILLINOIS

James J. Miner
Keith W. Carr
Kathleen E. Bryant

Illinois State Geological Survey
Prairie Research Institute
University of Illinois
615 E. Peabody Drive
Champaign, Illinois 61820

ISGS Open-File Series 2012-3

Submitted under contract #ITHA RR-07-9918 to:

Illinois State Toll Highway Authority
2700 Ogden Ave
Downers Grove, IL 60515

January 2012

EXECUTIVE SUMMARY

The Illinois State Geological Survey monitored the quantity and quality of runoff in roadside ditches for the Illinois State Toll Highway Authority at seven locations along I-294 in northern Cook County between February 2008 and August 2010. The purpose of the study was to develop effective methods for long-term runoff monitoring after bioswale construction in 2010, and to document the baseline surface-water and groundwater conditions for comparison after construction. Monitoring will continue through 2015 to determine the effectiveness of the bioswales at improving runoff quality.

Total discharge measured along each ditch reach ranged from about 185,000 cubic feet at TB7Bout to approximately 4.2 million cubic feet at TB19r, or a yield of respectively about 0.08 to 0.91 ft^3 of discharge per ft^2 of drained pavement area per inch of precipitation. This large range is due to differences in monitoring location within the ditch system relative to inputs, slope and other characteristics of the ditch and roadway, nonpaved areas drained, interactions with groundwater, and differences in the accuracy of the setup of individual monitoring stations. The total load of total dissolved solids transported in the ditch waters ranged from 4,666 kg at TB7Bout to 260,087 kg at TB19r, likely affected by differences in load per roadway segment, ditch erosion or deposition, and the other factors listed above, making meaningful comparisons between sites difficult. These data will be more meaningful when comparing conditions at the same locations before and after construction. Major dissolved ions in runoff were nearly identical at each location and were, in similar order, chloride, sodium, sulfate, calcium, and sulfur. Maximum total load of roadway metals of interest included iron (20.8 kg at TB15B), copper (2.5 kg at TB19r), nickel (1.4 kg at TB19r), zinc (0.8 kg at SandersSW), chromium (0.6 kg at TB19r), and lead (0.2 kg at TB19). The load of total suspended solids ranged from about 125 kg at TB7Bout to 113,782 kg at TB19, likely affected by the factors listed above. Oils and greases were not measured.

Groundwater adjacent to the ditches at TB7B and TB15B showed sodium and chloride levels up to 25 times higher than more distant wells, as well as increases in the following analytes in at least one site: calcium, alkalinity, TDS, sulfate, phosphate, dissolved non-volatile organic carbon, copper, iron, nickel, lead, and altered pH. Some of these analytes were likely transported via airborne deposition and subsequent downward infiltration as well.

Given that the primary purpose of the study was to identify appropriate methods for long-term sampling, improvements identified for post-construction monitoring include the use of refrigerated samplers, use of hardened cross sections for open-channel discharge measurement, application of redundant methods for calculating discharges and masses of analytes in order to cross-check results, measurement of analytes adsorbed to the TSS load, and confirmation of input loadings at all sites. These pre-existing data will be compared to the post-construction conditions at four bioswales to determine the effectiveness of the bioswales at improving the quality and reducing the quantity of runoff. Two examples of each major type of bioswale will be monitored for effectiveness, and design features will be compared for the development of best management practices for runoff quantity and quality improvement.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii

INTRODUCTION 1

PURPOSE AND SCOPE 1

METHODS 4
Precipitation 4
Surface-Water Discharge Volume 4
Surface-Water Discharge Quality 5
Groundwater Levels and Quality 7

DATA AND ANALYSIS 7
Precipitation 7
Surface-Water Discharge 8
Surface-Water Quality 20
Isco Samplers 20
Hydrolabs 23
Gerlach Samplers 28
Groundwater Levels and Quality 28
TB7B Groundwater Levels 37
TB15B Groundwater Levels 37
TB7B Groundwater Quality 37
TB15B Groundwater Quality 39
Comparing Groundwater Quality Between Sites 40
Water Sampling Quality Control 40

FUTURE WORK 42

SUMMARY 43

ACKNOWLEDGMENTS 44

REFERENCES 44

APPENDIX A: Results of Geochemical Analysis of Isco Surface-Water Samples 46

APPENDIX B: Masses of Analytes Measured at All Locations 52

APPENDIX C: Site-Specific Procedures for Calculating Discharge 54

APPENDIX D: Results of Geochemical Analysis of Biweekly Surface-Water Grab Samples . 55

APPENDIX E: Well Construction Information 61

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples 62

APPENDIX G: Results of Geochemical Analysis of Blank Samples 69

APPENDIX H: Results of Geochemical Analysis of Duplicate Samples 71

APPENDIX I: Results of Geochemical Analysis of 4-Week Storage of Surface-Water Samples 79

APPENDIX J: Reproduction of Task List from Appendix B of the ISGS Proposal 80

LIST OF FIGURES

Figure 1. Locations of Tollway bioswales 2
Figure 2. Precipitation 9
Figure 3. TB19 Isco data 10
Figure 4. TB19r Isco data 11
Figure 5. SandersSW Isco data 12
Figure 6. TB15B Isco data 13
Figure 7. TB7Bin Isco data 14
Figure 8. TB7Bout Isco data 15
Figure 9. TB9A Isco data 16
Figure 10. Specific conductivity recorded by Hydrolab dataloggers 24
Figure 11. pH recorded by Hydrolab dataloggers 25
Figure 12. Turbidity recorded by Hydrolab dataloggers 26
Figure 13. Instrument locations at TB7B 29
Figure 14. Instrument locations at TB15B 30
Figure 15. Groundwater levels recorded at TB7B 31
Figure 16. Depth to groundwater in wells at TB7B 32
Figure 17. Specific conductivity of groundwater in wells at TB7B 33
Figure 18. Groundwater levels in wells at TB15B 34
Figure 19. Depth to groundwater in wells at TB15B 35
Figure 20. Specific conductivity of groundwater in wells at TB15B 36

INTRODUCTION

In 2007, ISGS was contracted by the Illinois State Toll Highway Authority (Tollway) to monitor the effectiveness of bioswales to be installed during reconstruction of I-294 in northern Cook County, Illinois, USA. From February 2008 through August 2010, ISGS developed methods for monitoring the quality and quantity of runoff from I-294 in the existing roadside ditch system, and installed monitoring in locations where bioswales were planned (Figure 1) to determine baseline discharge and water quality for comparison to conditions after bioswale construction. In 2010, the bioswales were constructed, and post-construction monitoring began in August 2010. Bioswales are wide, flat ditches that improve the quality of runoff by slowing or infiltrating water and allowing contact with soils and vegetation. This report details the methods, data, and conclusions from all pre-construction monitoring. Annual post-construction reports will be submitted, and a final report that details results of all the post-construction monitoring and includes an analysis of bioswale effectiveness will be prepared after monitoring ends in 2015.

This report was prepared under contract #ITHA RR-07-9918, and is limited to activities regarding bioswale construction and monitoring along the I-294 corridor between Touhy Avenue and Lake-Cook Road, and does not address other activities contained within the above-referenced contract. Purpose and scope, methods, data, and conclusions are discussed.

PURPOSE AND SCOPE

The following is an excerpt from the original summary of tasks related to bioswale monitoring.

> *"ISGS proposes a multi-year study of the effectiveness of ...bioswales. A multi-year study is needed to measure and compare the current runoff quality to future runoff quality after construction of the additional lanes and bioswales, and to document the performance of the bioswales through time as they mature. Proposed tasks include identifying effective methods and measures for continuous and intermittent sampling of runoff quality, documenting runoff quality at the discharge point to the Des Plaines River and from unit areas of roadway under current and post-construction conditions, documenting performance across selected bioswales after construction, and preparation of a report."*

While this scope originally focused on direct discharges to the Des Plaines River, the scope evolved during bioswale planning and construction, as well as during methods development and initial pre-construction sampling. The focus was broadened to include any Tollway runoff through lands owned by the Forest Preserve District of Cook County. This broadening of scope allowed ISGS to choose additional bioswales to monitor and to more selectively choose sites where offsite water sources and other interferences were minimized, thus allowing more accurate determination of bioswale effectiveness. Another objective of the study that developed during the bioswale design process was to compare the effectiveness of the two different designs that were eventually finalized: dry and wet bioswales. Dry bioswales are installed with underdrains that facilitate infiltration; they improve effectiveness by removing almost all suspended solids and their adsorbed metals from infiltrated water via the natural filtration of earth and bioswale materials. Wet bioswales do not have an underdrain, but retain surface water for longer periods than typical roadside ditches, thus facilitating deposition of suspended solids and interaction with biota; removal of dissolved pollutants such as nitrates is assumed to be enhanced in these types

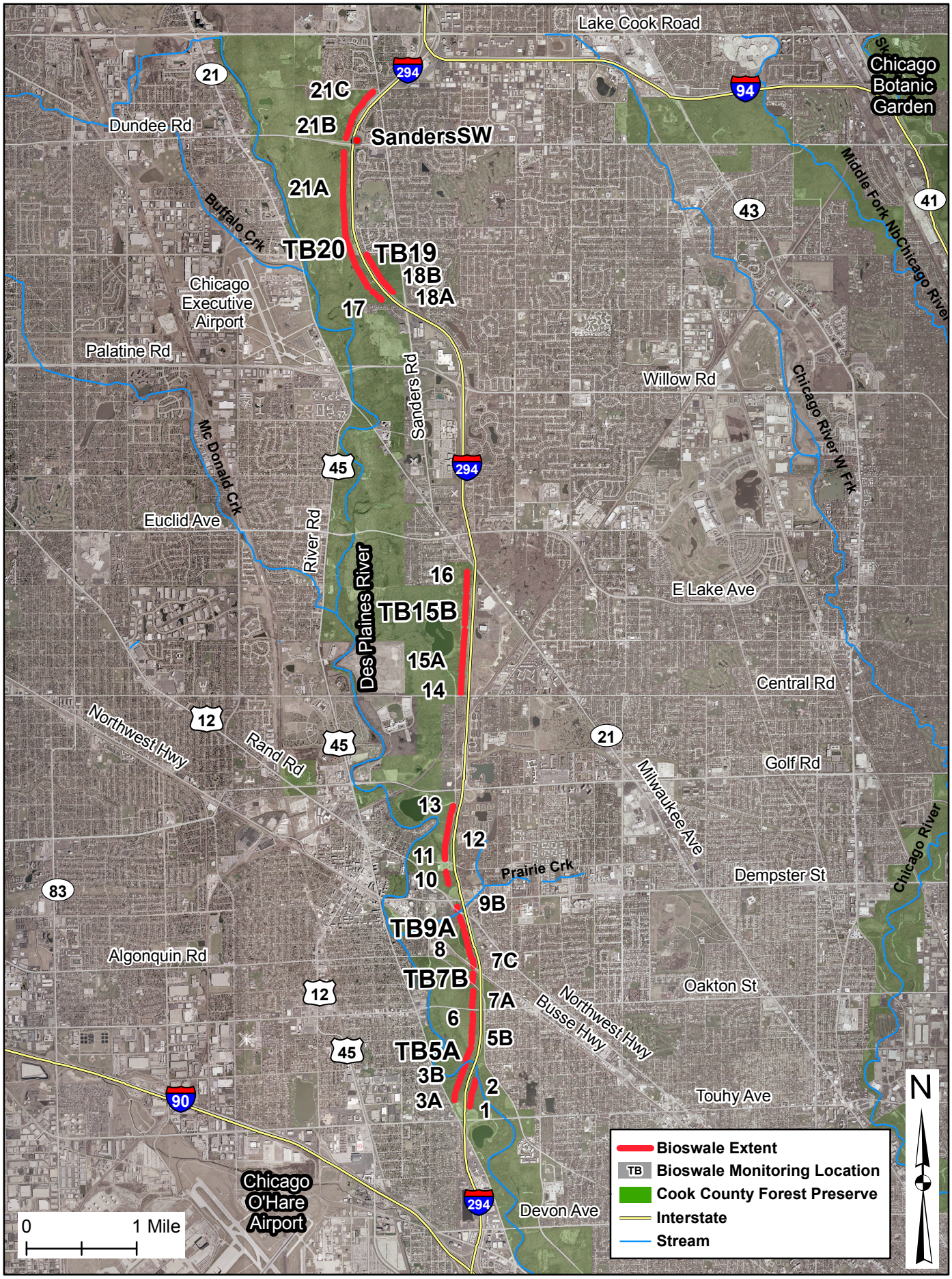


Figure 1. Locations of Tollway bioswales

of bioswales due to denitrification in the reducing wetland conditions, as well as adsorption and transformation of pollutants by extended contact with vegetation and soil bacteria. Examples of each type of bioswale will be monitored for effectiveness after construction, and pre-construction data were collected from all sites selected for post-construction monitoring.

Previous bioswale research has focused on reductions in metals, especially cadmium, chromium, copper, lead, nickel, platinum, and zinc, as well as suspended sediment, nutrients, and hydrocarbons (Crabtree et al. 2006, Mazer et al. 2001, Groves et al. [undated]). While this study does not address hydrocarbons, an extensive suite of metals and other analytes were measured to evaluate the effectiveness of bioswales at improving water quality. The sampling strategy identified by the ISGS for this study was to measure, where possible, the quantity and quality of the runoff that entered the bioswales, and compare that to the output from the bioswales. The differences between inputs and outputs constitutes the removal effectiveness of the bioswales, subject to gains, losses, or storage changes. Most sites did not have point-source inputs, and therefore required different methods to calculate inputs.

Prior to instrumentation, sites were screened to eliminate or minimize any runoff inputs not from the Tollway. Very few sites were found that had no surface-water inputs other than from the Tollway, and those found were additionally screened for backflooding from adjacent creeks, long-term ponding, design variations such as ditch width or depth, roadway features such as curvature or bridges/ramps that add additional lanes or maintenance needs, and sufficient length. Four sites (TB5A, TB19, TB20, and SandersSW) (Figure 1) were chosen for methods development and initial study, and were instrumented in 2008. Monitoring at TB5A and TB20 was ended within a few weeks due to the commencement of construction activities and therefore had little data collected, and are not reported. Pre-construction monitoring at SandersSW and TB19 continued into 2009, when data collection was halted by ditch relocation as part of roadway construction.

By 2010, final bioswale design had been completed. Although the bioswales were not yet constructed, the post-construction monitoring locations were chosen (TB7B [two sites], TB9A, TB15B, and TB19) (Figure 1) and instrumented to collect as much pre-construction data in the pre-existing ditch system as possible. Two examples of each of the two bioswale types ("wet" and "dry") were selected. Construction activities required the eventual removal of all pre-construction monitoring in 2010, but the staged construction caused the beginning and end of pre-construction monitoring at each site to differ. Further, TB7B had been rough graded at the time of installation in August 2009 but not yet constructed, so the baseline data that were collected do not reflect the pre-construction condition. TB9A, TB15B, and TB19 were instrumented prior to grading and bioswale construction, so at least some baseline conditions were documented that reflect the previous ditch configuration. Pre-construction data collected at TB19 are separated into two different periods with two different names due to ditch relocation in 2009. TB19 was monitored from February 2008 through February 2009, and after ditch relocation, the site was instrumented again from September 2009 through May 2010 and relabeled TB19r ("r" for reconstructed), which is considered a separate "site" for the purposes of this study. By August 2010, all bioswales had been constructed and planted, so ISGS concluded pre-construction monitoring and began the post-construction monitoring phase. Data through August 16, 2010, will be included in this report unless otherwise noted. Data and conclusions

will be discussed from the seven sites where long-term pre-construction data were collected: two of the four initial sites (TB19, SandersSW), and the four future bioswales (five total sites) that were selected for post-construction monitoring (TB7Bin, TB7Bout, TB9A, TB15B, and TB19r).

METHODS

Several different datasets were collected to study the mass, concentration, yield, timing, likely transport mechanisms, and fate of contaminants. ISGS collected data on the quality and quantity of runoff at locations in the roadside ditches that roughly corresponded to the future locations of post-construction outputs from the bioswales, as well as at one input location (TB7Bin) that was piped directly from the roadway. Inputs and outputs at site TB7B were the only locations that could be directly compared to determine removal efficiencies in the pre-construction phase. All other locations had runoff inputs that were not point sources, such as roadway reaches where runoff flowed diffusely off the shoulder into the ditches or where the culvert inputs were too numerous for ISGS to monitor in a cost-effective manner. When no input runoff was sampled due to the lack of a single point source, loading data from TB7Bin was used as a substitute. ISGS also collected data on groundwater levels and quality adjacent to the ditches to determine impacts of runoff on adjacent groundwater. Precipitation was measured at one location and obtained from two nearby weather stations. The methods used to collect each of these data sets are discussed below.

Precipitation

Precipitation data were obtained from the Midwestern Regional Climate Center for the Chicago-O'Hare Airport Weather Service Office (WSO) and the Chicago Botanic Garden weather stations (Midwestern Regional Climate Center 2011). The O'Hare station is about 3 miles south of the project area, and the Chicago Botanic Garden (CBG) station is about 3 miles east of the northernmost site, thus bracketing the project area. Hourly and daily precipitation data were obtained from O'Hare, and daily data were obtained from CBG, although daily data were collected at different times at each station and therefore may not align perfectly. In addition, precipitation was collected on site at TB15B between December 2009 and June 2010 using an Isco 674 tipping bucket rain gauge to identify on-site conditions in comparison with the nearest station. The gauge is unheated and therefore is only accurate in nonfreezing conditions. The gauge at O'Hare Airport is maintained and heated so it can be used to determine precipitation regardless of conditions; it is utilized in figures throughout the report. Data from Chicago Botanic Garden and the on-site gauge are used mainly for confirmation of amounts and timing of precipitation, given that they are located closer to the northernmost ditch locations than the O'Hare gauge.

Surface-Water Discharge Volume

The volume of runoff discharge was measured at all locations, including TB7Bin, TB7Bout, TB9A, TB15B, TB19, TB19r, and SandersSW. Isco 6712 automated samplers were installed, equipped with Isco 750 area-velocity modules and sensors, which measured water velocity using Doppler technology and water depth using pressure transducers. The channel shape was determined by measurements of the channel made in the field by ISGS and entered into the Isco 6712 sampler. Discharge was calculated by Isco Flowlink 5.1 software, which utilized the depth and velocity measurements collected every 5 minutes by calculating the cross-sectional area of

the channel based on the depth and channel shape, then multiplying by the velocity, thus calculating total discharge over that period. Measurements for each 5-minute period are summed for total discharge over the 2-week deployment period, and totals for each 2-week period are summed for the period of record. Due to instrument accuracy limitations, velocity measurements were not utilized for flows less than 0.1 ft/s, and depths were not utilized below 0.05 ft. Flowlink calculated estimated discharges under certain conditions, such as when a velocity was not recorded for a particular interval. Some of these estimates were included after a quality control review, and additional discharges were calculated and included at times when Flowlink temporarily was unable to calculate a discharge. The total discharge likely underestimated the actual discharge due to the inability to measure the flows with depths and velocities below those thresholds listed above, and other factors that prevented velocity measurements, such as insufficient particulates in the water for the Isco 750 module to measure velocity, and the presence of ice, large debris, and/or sedimentation that occasionally blocked the Doppler signal.

Surface-Water Discharge Quality

The quality of runoff in the ditches was measured in several different ways. First, an Isco 6712 sampler was installed at each location where water discharge was calculated as discussed above. Measurements of discharge discussed above were made for each 5-minute period, and recorded by the logger. The Isco 6712 samplers collected a 200-milliliter (ml) aliquot of ditch waters for every unit volume of runoff that passed by the sampler, and placed the aliquot into a 10-liter (L) polyethylene (HDPE) composite sample bottle for later analysis. The volume of runoff per aliquot was tailored to individual locations to provide the minimum 1.5 L of sample required to fill all subsample bottles used in the laboratory analysis, but not exceed 10 L, which would end sampling and thus may allow some runoff to pass without being sampled. The normal variability of runoff due to precipitation patterns caused the amount of runoff per aliquot to be too little or too much at times, but attempts were made to minimize these occurrences. The final range of discharge volumes among the various sites was 250 to 2,000 cubic feet (ft^3) per 200 mL aliquot and, for continuity, these values were not altered for seasonality of precipitation once initially optimized for site characteristics. Grab samples of runoff were also collected biweekly at each sampler location in order to check the methods and results of the Isco sampling. In addition, Hydrolab MS5 multiparameter water-quality dataloggers were deployed at certain locations to collect water-quality data (temperature, pH, specific conductivity, and turbidity) hourly at each sample location to determine variability of conditions and timing of events. Finally, Gerlach passive samplers were deployed to collect runoff directly from the pavement edge to determine the concentration of analytes in runoff prior to any contact with the ditch system, although this method was superseded by Isco data collected at TB7Bin, and these data will not be presented. Gerlach data were previously presented in an earlier report (Miner et al. 2009).

Each composite sample bottle was retrieved every two weeks, and subsamples were collected and sent to the Illinois State Water Survey Public Service Laboratory for analysis of metals, anions, total dissolved solids (TDS), total suspended solids (TSS), ortho-phosphate, pH, alkalinity, ammonia-nitrogen, and total and dissolved non-volatile organic carbon (see Appendix A for a complete list of analytes). Subsamples from the Isco 6712 samplers were collected from the composite sample bottle using the methods discussed below. It should be noted that the samplers were unrefrigerated, so that samples were held in ambient climatic conditions for as much as two weeks between retrievals, may lead to certain changes in sample composition in the

sample bottle, especially during warmer months. Sample refrigeration was not possible given the lack of electrical service in the sampling locations, and near-daily site visits to avoid holding time issues were not feasible. Testing was performed to determine if results were obviously affected by the extended holding times. Results are discussed later, along with revised techniques that were developed and are being utilized for improved sampling in the post-construction period. However, to summarize, some of the most important parameters of concern were unaffected, including total suspended solids, chloride, and similar conservative (nonreactive) analytes. Nutrients, organic carbon, and some metals were apparently affected by various processes, likely including adsorption to and desorption from sediment and organic matter, precipitation, bacterial activity, denitrification, and other processes. While magnitude or speciation of analytes may have been affected, trends were mostly unaffected. However, some caution has been exercised in presenting and interpreting the results of Isco sampling for metals and nutrients sampling due to this limitation.

All water samples, including surface water, groundwater, and Isco composite samples, were collected using a peristaltic pump with silicone tubing connected to a flow-through cell. As part of the purging process, a Hydrolab MS5 datalogger was attached to the flow-through cell and used to measure temperature, pH, and specific conductance in samples prior to sampling to insure stabilization of those parameters, and to collect field parameters for future use. The pumping rate was approximately 0.5 liter (l) (0.13 gal) per minute or less in accordance with low-flow sampling procedures (ASTM Standard D6771-02 [ASTM 2002]). Samples collected for analysis of dissolved non-volatile organic carbon, metals, anions, TDS, and phosphate were filtered using a 0.45-micron disposable filter. Samples for metals, total and dissolved non-volatile organic carbon, and ammonia were preserved with acid (0.2% nitric acid, 0.5% phosphoric acid, 0.5% phosphoric acid, and 0.2% sulfuric acid, respectively), and all samples were kept on ice at or below 4°C for transport to the Illinois State Water Survey laboratory for analysis. Grab samples and groundwater samples generally were delivered to the laboratory within the appropriate holding times for each type of sample, although as discussed earlier, some analytes such as nutrients may have slightly exceeded their 48-hour holding times by as much as 24 hours but are not expected to be affected. Blank and duplicate samples were submitted for quality-control purposes and results are discussed later.

Isco samplers were installed in February 2008 at the following locations: TB5A, TB19, TB20, and in May 2008 at SandersSW (Figure 1). The samplers at TB5A and TB20 were removed shortly after installation due to construction activities; no data from these locations is presented. The samplers at SandersSW and TB19 were removed in March 2009, due to impending construction. In order to collect as much pre-construction data as possible, Isco samplers were reinstalled at future bioswale sites TB15B in March 2009, TB7Bin and TB7Bout in August 2009, TB9A in August 2009, and at TB19r in September 2009. Some samplers were again removed during bioswale construction: TB19r on June 1, 2010, and TB15B on July 19, 2010. Samplers at TB7Bin, TB7Bout, and TB9A remained in place through August 16, 2010. Data from all of these deployment periods are presented and discussed. Deployment periods for all locations are shown in Appendix B.

Runoff quality was also measured by collecting grab samples biweekly in the ditch at each Isco sampling station when water was flowing. Ditch samples were collected as discussed below and

complied with all standard sample preservation methods and applicable holding times. Rare exceptions occurred for unfiltered and unacidified samples that have a 48-hour holding time, notably nitrate, which occasionally were held for as long as 72 hours, although no observable alterations are expected. The purpose of this sampling was to provide a redundant method of calculating contaminant load and to double-check the Isco method. Biweekly sampling methods are expected to provide results that reflect average flow conditions because long-interval sampling statistically is more likely to occur during the more common flow conditions such as low to average flows, rather than storm events that are very brief.

Runoff quality was also measured at various times using Hydrolab MS5 multi-parameter water-quality dataloggers, which recorded the water depth, temperature, pH, specific conductivity, and turbidity of the runoff in the ditches hourly. The purpose of the Hydrolab program was to identify timing and levels of spikes in water-quality parameters and to have redundant water-quality data for proxy calculation of solute loads should Isco sampling prove ineffective, although this was not needed. Hydrolabs were serviced monthly, including pre- and post-deployment calibration of all parameters according to manual specifications (Hach Company 2006).

Groundwater Levels and Quality

In November 2009, ISGS began to monitor groundwater adjacent to selected future bioswale locations to determine if infiltrated runoff affected groundwater quality. One monitoring well transect was installed using the methods of Miner and Simon (1997) adjacent to each of TB7B and TB15B, respectively, extending westward from the edge of the ditch. In-Situ AquaTROLL 200 loggers were deployed in each well and were programmed to record specific conductivity, temperature, and water level hourly. Bi-weekly water samples were collected from these wells in addition to the logger parameters using the methods discussed below, and analyzed for the same water-quality parameters as surface water samples, listed in Appendix A. Samples were collected as discussed below.

Isco discharge data discussed above were used to calculate the total masses (loads) of dissolved and suspended solids being transported in runoff. The concentrations (in milligrams per liter) (mg/l) for each analyte in each subsample were multiplied by the total volume of runoff (in l) passing the sampler in each two-week period to calculate the mass (in mg) of each analyte being transported. The masses from each two-week period were summed to determine the total load of each analyte in the runoff at each site for the period of record (Appendix B).

DATA AND ANALYSIS

Data included in this report are 1) precipitation recorded on site and at nearby weather stations, 2) estimates of the surface-water discharge measured at each station and the concentrations of analytes found in the runoff from laboratory analysis, 3) datalogged water-quality parameters in surface water, 4) groundwater levels measured through time, 5) concentrations of analytes found in groundwater, and 6) datalogged water-quality parameters in groundwater.

Precipitation

Precipitation data were obtained from the Midwestern Regional Climate Center (Midwestern Regional Climate Center 2011) at the Illinois State Water Survey for the O'Hare Airport

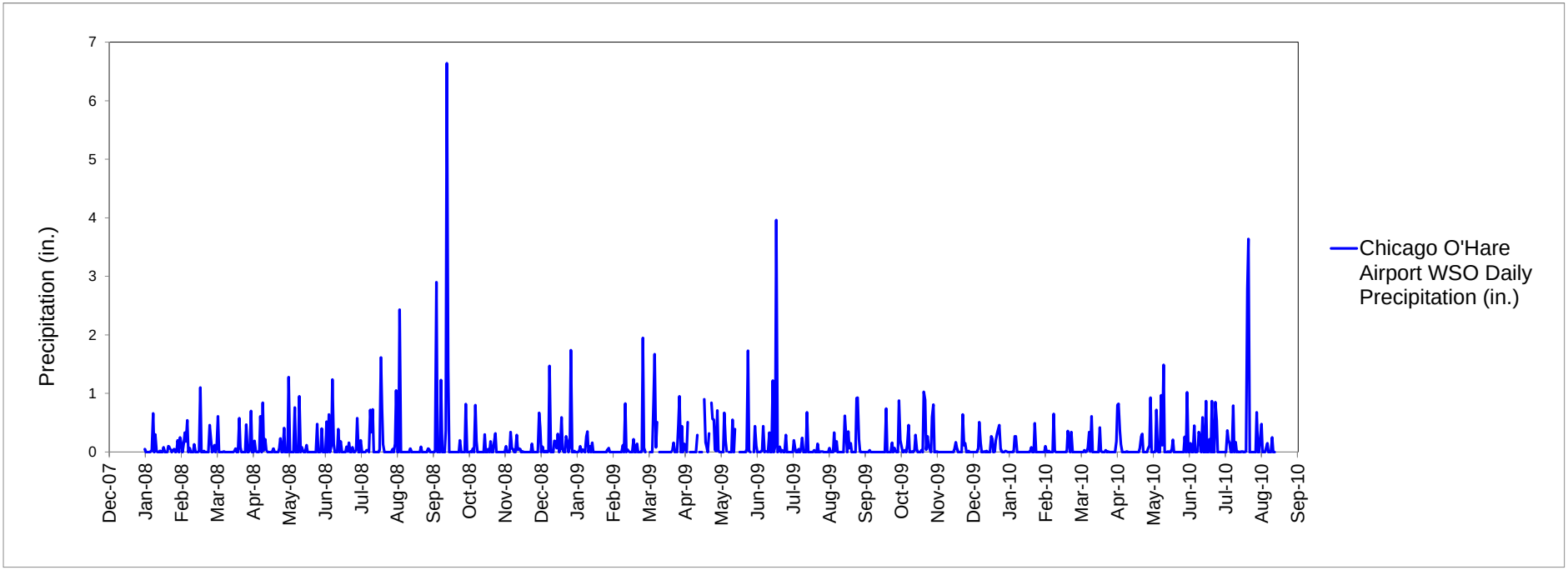
Weather Service Office (WSO) (Figure 1), located approximately 3 miles south of the southernmost site (TB7B) and 11 miles south of the northernmost site (SandersSW). Hourly, daily, and annual data were obtained, and O'Hare daily data are shown in Figure 2 and other figures where precipitation is used. Other precipitation data were also obtained and are presented in Figure 2, including daily data from the gauge at the Chicago Botanic Garden (Figure 1), which is closer to the northern portion of the study area, and on-site data collected between August 12, 2009 and July 19, 2010 at TB15B. Data are summed and shown in Figure 2 as daily totals.

Precipitation data from O'Hare Airport WSO for the period of 1981-2010 show an average of 36.86 inches per year. Total annual precipitation was 50.86 inches (in.) during 2008, 42.57 in. during 2009, and 37.61 in. during 2010. Therefore, precipitation during the study was above average in 2008 and 2009, and near average in 2010. During the study period, there were 22 days with total precipitation greater than 1 in., with the largest daily precipitation events occurring in August 2008 (2.43 in.), September 2008 (6.64 in. and 2.90 in.), June 2009 (3.97 in.), and July 2010 (3.64 in. and 2.79 in.). Of those 22 precipitation events, eight exceeded 2 in., three exceeded 3 in., and one exceeded 6 in. All other precipitation events were less than 1 in. The driest period was between July 2009 and April 2010, when only one precipitation event greater than 1 in. occurred. Precipitation for each deployment period at each Isco station is summed in Appendix B for use in calculating discharge yields and loads.

Surface-Water Discharge

Isco measurements made at each location included water depth and water velocity, which were used by the Isco Flowlink software to calculate discharge based on ditch profile measurements or pipe diameters. Discharges at TB7Bin and TB7Bout were measured in round pipes, and all other locations were open-channel ditches. Figures 3 through 9 show the depth (water level), velocity, and calculated discharge at each location. Data shown are raw (as collected). Prior to summing discharges for each 2-week period, velocity and depth were examined to detect errors, and discharges based on errors were removed or corrected. Errors include negative velocities, which are not possible at any measurement location due to the slope of the ditches and pipes, velocities that are repeated for any length of time resulting from the inability to record a new velocity, depths below the level of accuracy for the pressure transducer (0.05 ft), and velocities below the level of accuracy of the Doppler velocity sensor (0.1 feet per second) (ft/s). Discharges were removed when any of these conditions were found, and when water around the pressure transducer froze (causing a large apparent increase in water depth without any actual discharge), for depths that were below a threshold value due to dams and other ditch obstructions, and similar items. Appendix C lists the specific quality control adjustments in discharge for each measurement location.

Appendix B shows the total discharge at each location, along with other parameters such as deployment period, precipitation recorded during the deployment period, roadway area that drains into the ditch, and similar items. Highest total discharge was measured at TB19r (4,208,437 ft^3) and TB15B (3,477,989 ft^3), slightly less at TB19 (1,782,620 ft^3), SandersSW (1,573,991 ft^3), and TB9A (1,536,930 ft^3), and far less at TB7Bin (211,743 ft^3) and TB7Bout (185,615 ft^3). The results reflect the relative sizes of the catchment areas, the different durations of deployment, and the amount of precipitation that fell during the deployment period. Therefore, in order to



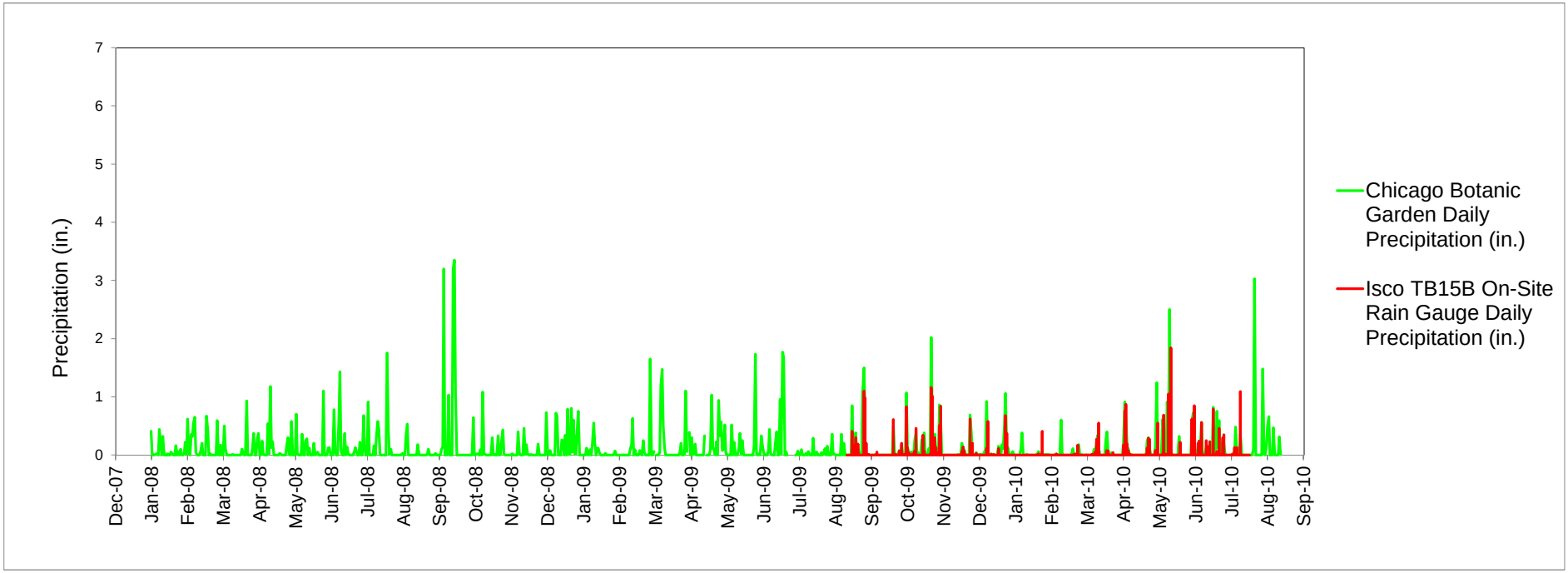


Figure 2. Precipitation recorded at O'Hare International Airport Weather Service Office (WSO), Chicago Botanic Garden, and TB15B

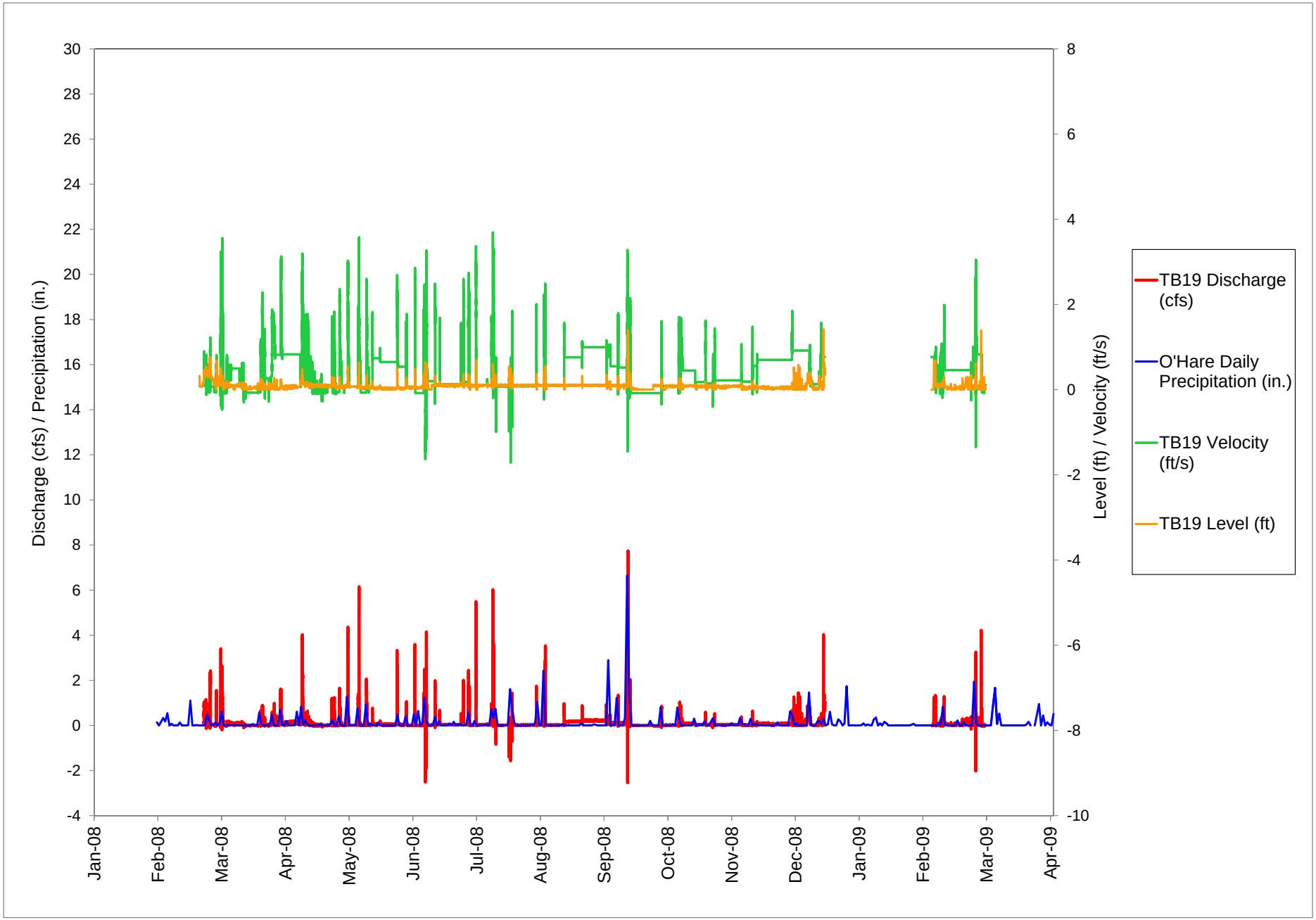


Figure 3. TB19 Isco data

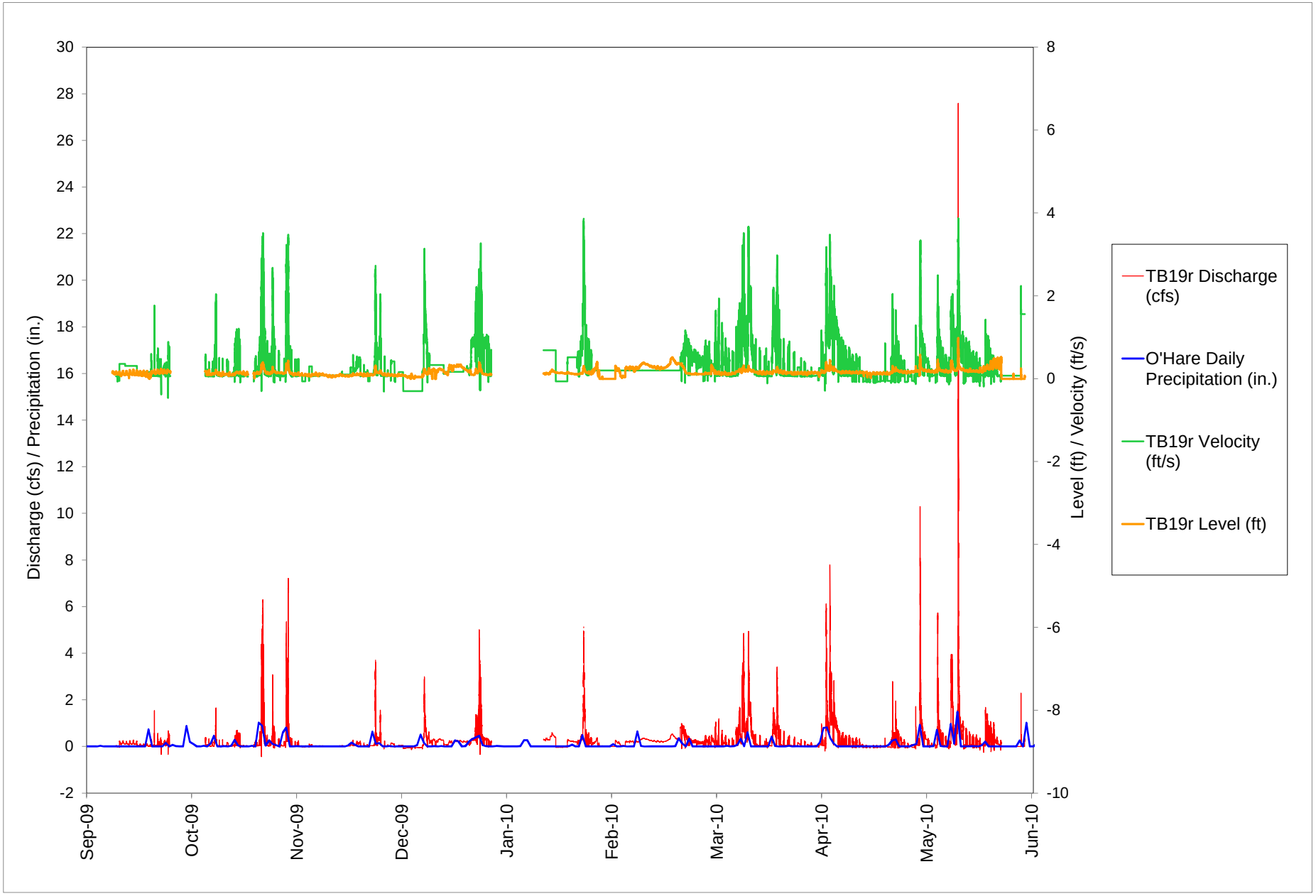


Figure 4. TB19r Isco data

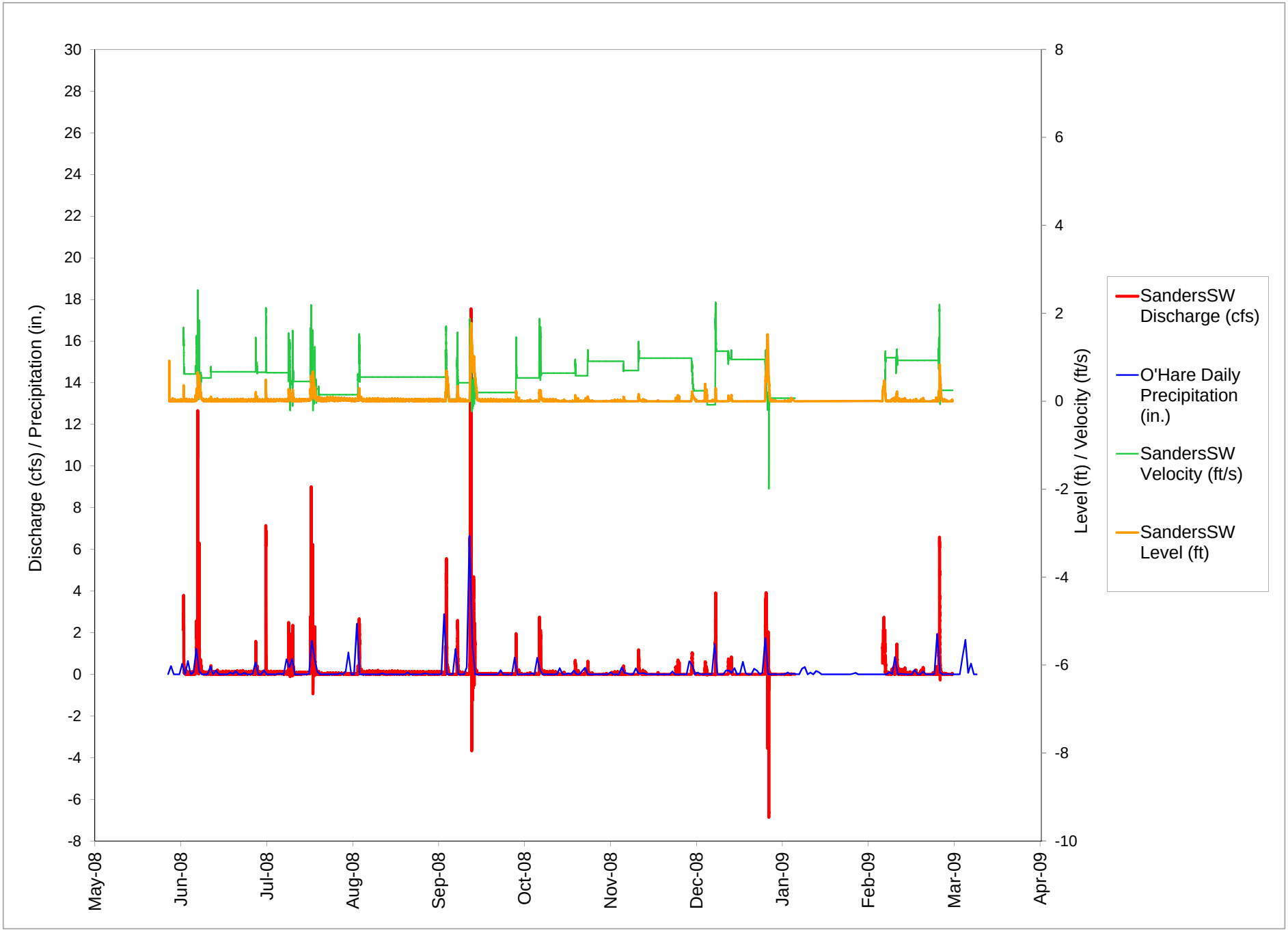


Figure 5. SandersSW Isco data

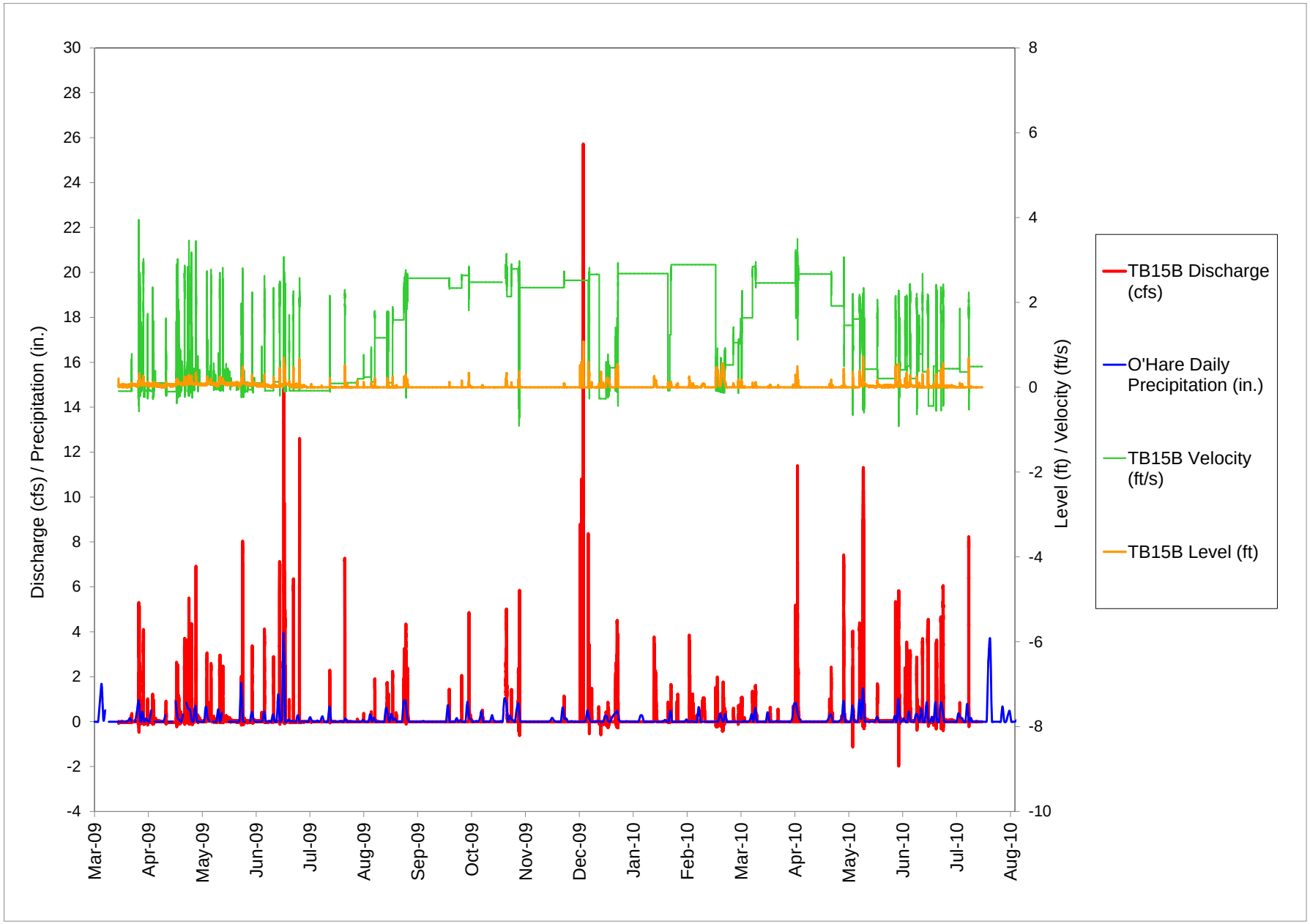


Figure 6. TB15B Isco data

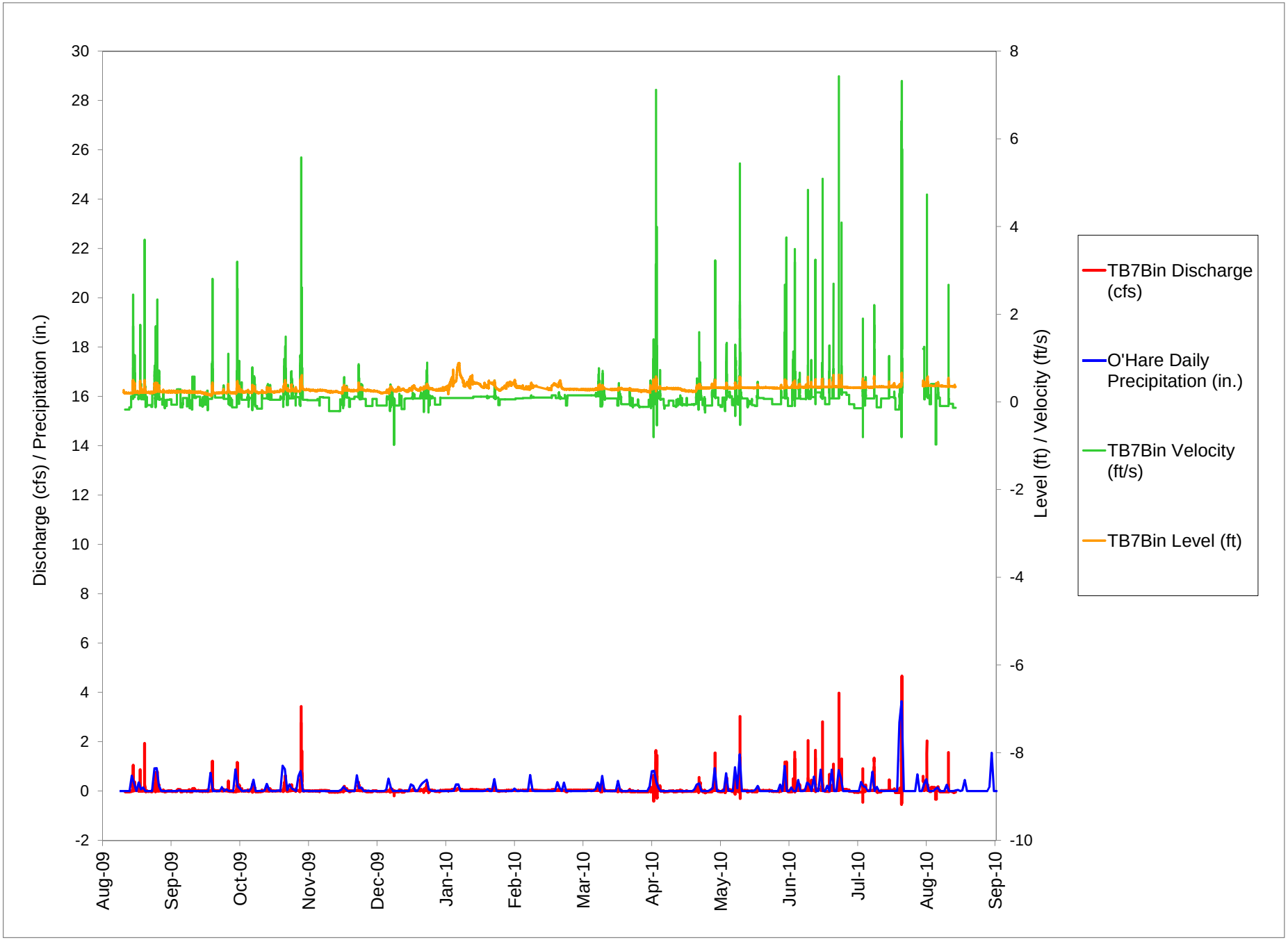


Figure 7. TB7Bin Isco data

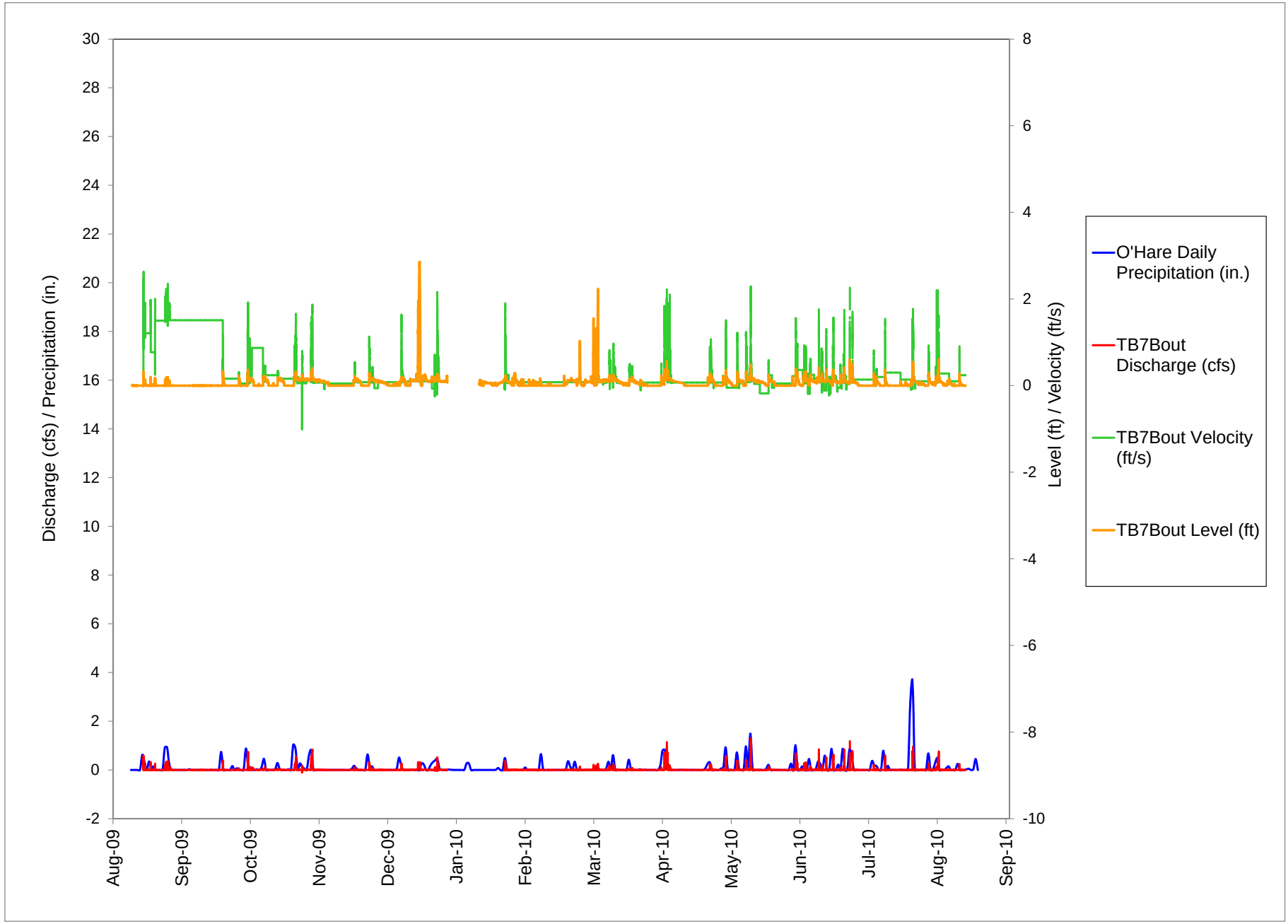


Figure 8. TB7Bout Isco data

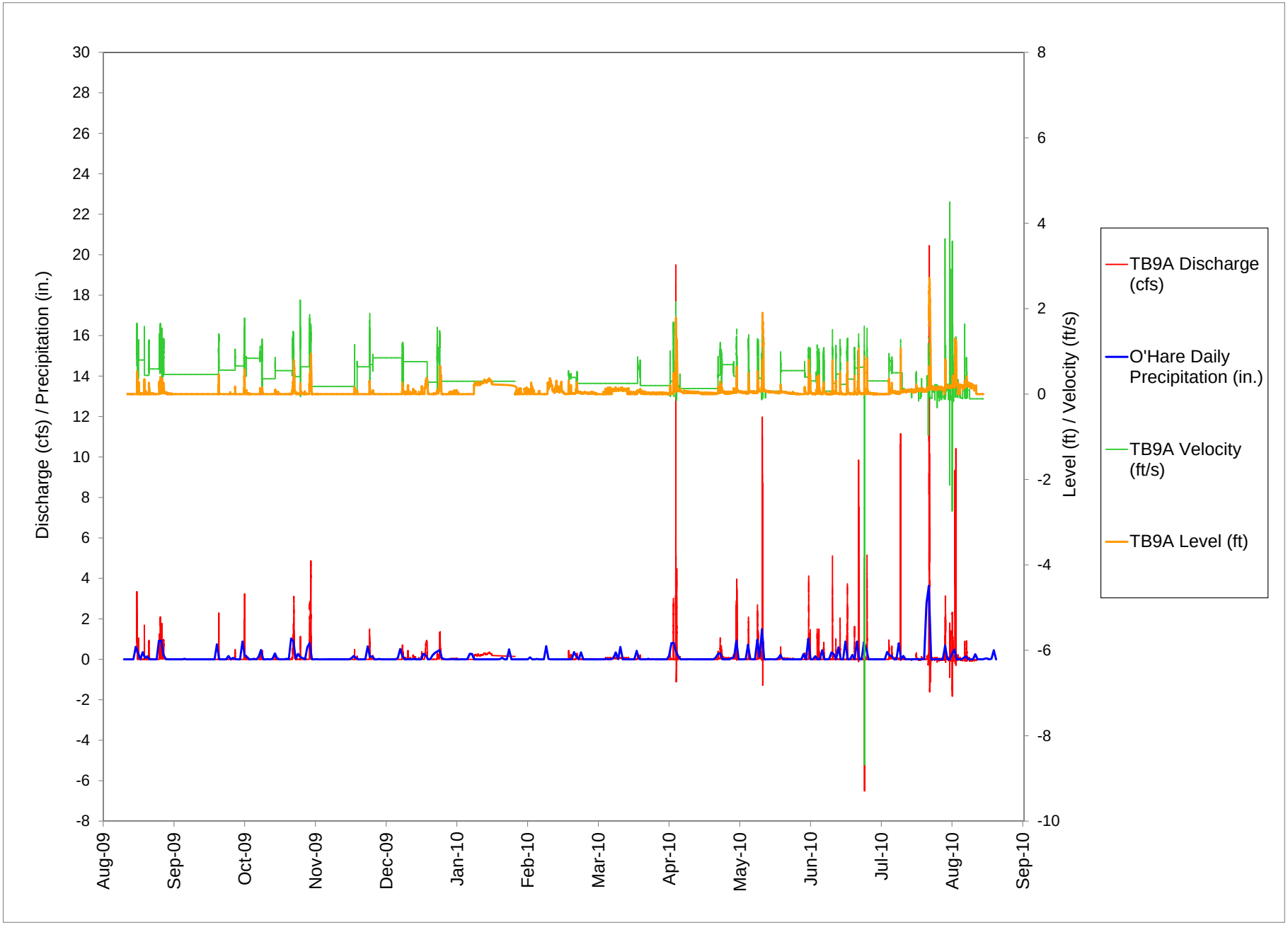


Figure 9. TB9A Isco data

compare sites, it was necessary to standardize the discharges by those factors. Discharge volume was divided by drained area, then divided by precipitation received during the deployment period, producing a discharge yield. Yield (Appendix B) for the ditches was lowest at TB7Bin, TB7Bout, and TB9A, about three times higher at TB19 and TB15B, and more than 10 times higher at TB19r. No yields were calculated for SandersSW because bioswales were not planned in this area. TB19r was almost 4 times higher than TB19 after relocation and regrading of the ditch. Individual locations are discussed below.

There are many reasons that discharge yield may vary, making it difficult to compare between sites. Indeed, one of the conclusions of this report is that comparisons are likely to be valid only between the pre-construction and post-construction periods at each site. Any loss or gain of discharge after the runoff leaves the roadway will have an impact, such as evaporation, transpiration by plants, infiltration, or groundwater discharge into the ditch. These factors likely varied at each site and could not be quantified given the scope of this study. Factors also include whether the discharge enters the ditch via piping or flows across the shoulder, amount of unvegetated area in the ditch and shoulder, measurement location relative to the beginning or end of the ditch, substrate type, and similar factors. Roadway factors also influence the percentage of runoff generated by precipitation, such as slope, presence of curb and gutter or French drains, and similar features. In addition, differences in the accuracy of the Isco sensor setup may greatly affect accuracy of the discharge measurement, including the precise location of the sensor relative to the ditch bottom and the actual shape of the channel versus the idealized shape that is used in the calculation of cross-sectional area at each depth of flow. Other factors include the characteristics of the flow and the ditch that influence the performance of the sensor, such as the percentage of total discharge that was below the depth or velocity that the sensor could measure, whether sediment was regularly deposited on the sensor, stability of the channel, presence of a thalweg (area of highest flow), and whether the thalweg migrates away from the sensor. Other situations that were noted in the field included trash, ice, or snow that would accumulate and block the sensor. All of these potential impacts on the accuracy of the discharge measurements are not possible to quantify and express as estimated error, preventing detailed comparison of sites to each other. Comparison of pre-construction and post-construction conditions at individual sites will be more meaningful, given that many of the uncertainties listed above will be held constant. Some improvements will be made in the post-construction period, such as the use of stable and uniform ditch cross-sectional areas that were installed during bioswale construction. Finally, calculating discharge yield required that the area of drained pavement be used, and those areas were supplied by others based on construction plans, and may have errors as well.

Discharge yield is by far the highest at TB19r, almost 4 times higher than before the ditch relocation at the same location (TB19). The additional discharge may derive from reconfigured drainage during roadway reconstruction that transferred runoff more efficiently. Also, there may also have been increased groundwater discharge to the ditch after the east bank was excavated to relocate the ditch further eastward. However, the increase may also have been due to the creation of a more uniform ditch cross-section that allowed for more accurate flow calculation, especially regarding the elimination of a thalweg in the ditch that was present at TB19 and often diverted flow away from the sensor. Similarly, the Isco sensor may have been installed slightly deeper relative to the ditch bottom, allowing more of the lower flows to be measured. For example, the mean depth doubled after reconstruction, the mean discharge increased by about 41%, and a valid

discharge occurred 38% of the time at TB19r as opposed to 13% of the time at TB19; all of these could be explained by either an actual increase in discharge, or a change in how the Isco 705 flow module was installed. To minimize inconsistencies in instrument setup and the inaccuracies that are generated, all future monitoring will be performed in pipes or at other hardened, uniform ditch cross-sections, such as concrete channels that were installed in the bioswales during construction. This will improve comparisons between sites.

Discharge yields at TB19 and TB15B are approximately 3 to 4 times higher than TB7Bin, TB7Bout, and TB9A. Limited discussion of this difference is warranted because of the difficulties in comparing between sites, as previously mentioned. However, some of the differences may be due to contributions from offsite areas, which may be larger at TB19 and TB15. TB7Bin is very limited, where much of the paved area that contributes runoff is located on a bridge that is not directly adjacent to the ditch, so that much of the spray or splash that leaves the roadway does not flow into the ditch. Alternatively, given that pipes were utilized for discharge calculations at TB7Bin and TB7Bout and that they had similar results, open-channel discharge measurements generally may have had low accuracy. This will be addressed in the post-construction period by using the hardened cross sections discussed above.

Discharge measurements (Figure 3) were collected at TB19 prior to construction from February 2008 through March 2009. The equipment was removed until September 2009 for ditch reconstruction, and reinstalled as TB19r near the same location from September 2009 into June 2010, when equipment was removed again for subsequent bioswale construction. Discharge at both locations is clearly related to precipitation events, although continuous discharge occurs at low levels for months at a time during late winter through spring, likely due to snowmelt, shallow groundwater discharge into the ditch from adjacent forest preserve areas, and drainage from the roadbed or French drains. Total and maximum discharge rates were respectively 1,782,620 cubic feet (ft^3) and 7.74 cubic feet per second (cfs) at TB19 and 4,208,437 ft^3 and 27.6 cfs at TB19r. The mean discharge rate (measurements of zero discharge were not included in the mean) was 0.38 ft^3 per second at TB19 and 0.54 ft^3 per second at TB19r, and the mean depth for all measuring periods was 0.09 ft at TB19 and 0.16 ft at TB19r. The maximum depth and velocity were respectively 1.42 ft and 3.69 fps at TB19, and 0.98 ft and 3.87 fps at TB19r (Figure 4). One apparent discharge period at TB19 in December 2008 was removed because the ditch had completely frozen at the time, which can cause compression of the pressure transducer and create spurious readings, an uncommon but anticipated wintertime complication. Caution should be applied in comparing these maxima and means for completely different periods due to differing precipitation extremes, as well as the potential differences in Isco setup as discussed earlier. The decrease in maximum depth at TB19r may relate to the wider channel, which can transfer an equal discharge at a lesser depth than before relocation. After grading, TB19r discharge appeared to be more continuous than before, perhaps due to increased infiltration of runoff in the disturbed ditch fill, accompanied by slow release of some discharge, or increased roadway runoff or groundwater discharge into the ditch as previously mentioned. Alternatively, the sensor was also reinstalled deeper relative to the ditch bottom, and may have measured more frequently and for longer periods, recording more discharge after reinstallation. This is likely the case, given that less precipitation fell during the period of record at TB19r.

Discharge was measured at SandersSW prior to construction from May 2008 to March 2009

(Figure 5). Total discharge for this period was 1,573,991 ft^3. Similar to TB19, discharge is episodic and clearly related to precipitation events. Discharge generally was not continuous and there were many dry periods, although continuous discharge occurred for days or weeks during wetter periods as discussed above. The maximum discharge rate was 17.55 ft^3 per second, maximum depth was 1.77 ft, and the maximum velocity was 2.53 fps. The mean discharge rate when discharge was recorded was 1.2 cfs. No bioswales will be installed at this location, and therefore no post-construction comparisons will be made. The frequent periods of no flow are reflected in the mean depth of 0.04 ft. The wide channel at this location likely spread out the flow and lowered the depth, leading to more measurements of zero discharge due to the inability of the flow sensor to measure the shallow water depths.

Discharge was measured at TB15B prior to construction from March 2009 to July 2010 (Figure 6). Total discharge for this period was 3,477,989 ft^3. Similar to TB19, discharge is episodic and clearly related to precipitation events. Discharge was not continuous throughout the monitoring period, although it was continuous for days or weeks during wetter periods, especially from late winter through spring, as discussed above. The maximum discharge rate was about 25.7 ft^3 per second, and the mean discharge rate when discharge was recorded was 0.96 ft^3 per second. Maximum depth and velocity were 1.08 ft and 3.95 fps, respectively. Mean depth was only 0.03 ft, reflecting the many periods of no flow. Monitoring occurred prior to any construction activities, so this data set represents the pre-existing conditions and will be used for post-construction comparison.

Discharge was measured at TB9A prior to construction from August 2009 through August 2010 (Figure 9). Total discharge for this period was 1,536,930 ft^3. Similar to TB19, discharge is episodic and clearly related to precipitation events. Discharge was generally not continuous, although it was seasonally continuous from late winter through spring or for days or weeks during wetter periods. The maximum discharge rate was 23.9 ft^3 per second, and the mean discharge rate when discharge was recorded was 0.63 ft^3 per second. Mean depth was 0.06 ft, reflecting many periods of no flow. Maximum depth was 2.71 ft, which may have occurred during a very rare period of backflooding from the Des Plaines River. Maximum velocity was 4.48 fps. Monitoring occurred prior to any construction activities, so this data set represents the pre-existing conditions and will be used for post-construction comparison.

Site TB7B was already rough graded prior to any monitoring, so none of the data presented here will act as pre-construction baseline. However, the flat profile and culverted input and output locations allowed a higher level of functioning than other roadside ditches in the study. Additionally, comparison of the input and output discharge and chemistry presented later can be used as an estimate of the existing functioning of the "bioswale" prior to emplacement of vegetation and berms, and later comparison to post-construction conditions will be valuable to identify any improvements caused by bioswale features. Finally, the results from TB7Bin after construction may act as a substitute data source for inputs to other bioswales that do not have point-source inputs.

The discharge into and out of TB7B (TB7Bin and TB7Bout, figures 7 and 8) are 211,743 and 185,615 ft^3, respectively. Discharge measurements began in August 2009 and continued through bioswale construction in August 2010. At TB7Bin, maximum discharge was 4.66 ft^3 per second,

maximum depth was 0.89 ft, and maximum velocity was 7.43 fps, which was higher than other locations due to the small pipe diameter and the large vertical drop from the elevated roadway section down to the site. Mean depth was 0.30 ft, mean velocity was 0.06 ft/s, and mean discharge was 0.11 cfs, including only those periods when a discharge was recorded. The larger mean depth reflects the ponding that was nearly always present at the end of the culvert, due to the lack of strong gradient toward the outlet. Discharge was strongly related to precipitation events, starting and stopping within minutes to hours after precipitation began or ended.

At TB7Bout, mean discharge was 0.1 cfs when discharge was recorded, and mean depth was 0.07 ft, reflecting the majority of time that the location was dry. A small dam (about 0.15 ft tall) was installed in September 2009 to elevate depth rapidly to a measurable level when the discharge began, although ponding behind this dam was temporary and dry periods were very common. Discharges were episodic and clearly related to precipitation. Maximum velocity was 2.63 fps. The maximum depth that reflected actual water flow at TB7Bout is 0.61 ft, discounting larger measurements in March and December 2010 that likely reflected freezing conditions around the sensor rather than water flow. As expected, total discharge at TB7Bin was higher than TB7Bout, likely caused by evapotranspiration and surface water infiltrating in the subsurface of the ditch.

Surface-Water Quality

Surface-water quality was measured using 4 methods: ditch runoff was sampled using Isco 6712 flow-integrated samplers, ditch runoff was grab sampled biweekly, runoff was sampled directly from the roadway using Gerlach samplers, and general water-quality parameters in ditch runoff were measured using Hydrolab multi-parameter water-quality dataloggers at selected locations. The purpose of monitoring was to measure water quality at known discharge locations for future comparison to the post-construction conditions, to assess the pre-construction impacts of the ditch system on water quality, and identify the concentrations at input locations for calculations of input loadings.

Isco Samplers

Isco 6712 instruments were used to measure discharge discussed above, and while deployed they also collected ditch samples at each of the locations for the same periods. All samples were flow-integrated composite samples. A small aliquot, or sample, of ditch water (200 mL) was collected for each volume of runoff that passed by the sensor; higher flows caused more frequent sampling, and fewer samples were collected during low flows. Each aliquot was combined in a composite sample bottle, resulting in a sample that was representative of the entire amount of runoff that passed by during the 2-week collection period. Samples were collected from the composite sample bottle using the sampling methods previously described and then analyzed. The concentrations of analytes (in mg/l) were multiplied by the 2-week volume of discharge (in l) measured by the Isco sampler to determine the mass (in mg) of each analyte that was transported by the runoff waters during the 2-week deployment period. The masses for each 2-week period were summed to determine the total masses transported in runoff during the deployment period.

While masses of analytes can also be standardized by dividing by the drained area, duration of monitoring, and discharge in order to make comparisons about sediment or dissolved solids yield between sites, we chose to limit analysis to total mass divided by total discharge, which makes an average concentration. While this may be affected by total precipitation, we determined that, for

long-term deployments such as those in this study, additional analysis beyond average concentration would not be useful given the different sampling locations relative to inputs and the expected major differences in treatment effectiveness. Also, because discharge measurements are utilized to calculate the masses of dissolved and suspended solids, any errors inherent in the discharge measurements carry over into mass calculations and add uncertainty, again making meaningful comparison between sites difficult for the reasons discussed in the discharge section. Comparing pre- and post-construction conditions at the same locations is expected to be more useful, given that many of these site-specific parameters will be held constant. Limited trends and site-specific behaviors are noted below.

Appendix B shows the total volume of discharge for the entire period of record at each site, total precipitation, the number of days in the monitoring period, dates of monitoring, mass of analytes calculated to have passed each location, and average concentration of analytes.

Total suspended solids range from about 113,781 kg of transported sediment at TB19 to 125 kg at TB7Bout. When divided by total discharge, average concentrations range from about 64 g/ft^3 at TB19 to 0.7 g/ft^3 at TB7Bout. Factors affecting this variation in output include whether the ditch is eroding and contributing sediment, such as at TB19, which was cleared not long before sampling began at TB19, but average TSS concentration reduced to about 10 g/ft^3 at TB19r after ditch relocation and bank stabilization. Other factors that affect TSS include the level of water-quality improvement caused by the pre-existing ditch system, which was high at TB7B due to the low slope, wide channel, and ponding in the ditch, which facilitate sediment deposition, as well. Different loadings on the roadway due to construction and other factors may also affect results, but were not possible to evaluate. TSS at TB7Bin was about 6 g/ft^3, and it represents runoff that is delivered directly from the road surface without treatment, assuming no alteration in the pipe. Therefore we assumed that levels above 6 g/ft^3 found at other sites most likely represent situations where the ditch system contributes to the sediment load via erosion, rather than improving water quality by allowing sediment to deposit in the ditch. TB7out was much lower than 6 g/ft^3 (0.2 g/ft^3), suggesting deposition of sediment in the ditch at TB7B caused by the very flat ditch profile and good improvements in water quality prior to bioswale construction. TB15B was roughly equal to TB7Bin, suggesting no net changes in sediment in the ditch and no improvement in water quality in that reach. TB9A was slightly higher at 9.6 g/ft^3, and indeed erosion was seen at several locations on the elevated roadway slope adjacent to TB9A. Scour holes in the ditch were observed at locations where culverts discharge into the ditch at TB9A, which are obvious sources for the additional sediment being transported; therefore, TB9A is contributing sediment to the Tollway runoff and worsening water quality. TB19 was significantly higher as noted above, suggesting ditch erosion and net sediment export from the ditch, and a worsening of water quality. SandersSW had a low sediment concentration (1.4 g/ft^3), but this is likely a spurious result due to the small number of samples collected.

Total dissolved solids (TDS) is the sum of all dissolved ions in the water. The mass (load) of TDS transported by discharge ranged from about 260,000 kg of dissolved solids at TB19r to about 4,700 kg at TB7Bout. These masses of TDS varied according to discharge and duration of monitoring, and were likely influenced by other site-specific factors such as erosion of the ditch, precipitation totals during the period of record, loading rate on the roadway, soil cation exchange capacity, amount of runoff contact with soil, location of sampling point relative to runoff inputs,

and other factors that affect discharge mentioned previously. When divided by discharge, the mean concentrations ranged from 62 g/ft^3 at both TB19 and TB19r to about 15 g/ft^3 at TB9A. A similar value of about 56 g/ft^3 of TDS was found at TB7Bin, suggesting that little reduction in TDS occurred at TB19 and TB19r, and only a modest improvement at SandersSW (46 g/ft^3), although that figure is based on only a few samples. However, average concentrations at TB7Bout, TB9A, and TB15 were about half or less than TB7Bin, suggesting that there was an apparent loss of TDS within the ditch due to adsorption, geochemical precipitation, dilution, or other similar processes, thus showing improvements in the ditch system. Direct precipitation and non-roadway runoff may have diluted levels at the sites with high adjacent slopes, long ditch lengths, or runoff contributed from lands adjacent to the Tollway, such as at TB9A and TB15B. The low concentrations at TB9A suggested that the long ditch provided a long contact time for analytes to adsorb or precipitate, or there was dilution of TDS by low-solute waters, perhaps groundwater discharge through the berm from Belleau Lake or addition of other low-solute sources such as precipitation. Differing loading rates and other factors may have influenced the TDS load as well.

For specific dissolved analytes, the ions that composed the highest masses transported were generally the same at all sites. The dominant analytes at TB7Bin were, in descending order: chloride, sodium, sulfate, calcium, and sulfur. These same 5 ions were present at the other sites in nearly identical order. The next 5 analytes were, in nearly identical order, total non-volatile organic carbon, potassium, magnesium, dissolved non-volatile organic carbon, and silica. Some apparent site-specific factors were responsible for the entire suite of major analytes found and their levels. For example, calcium and alkalinity were low at TB7Bin due to the lack of contact between runoff and soil prior to entering the ditch. After construction at TB19r, increases in potassium occurred and sulfate decreased, perhaps due to exposure or removal of reservoirs in the ditch materials, a change in redox conditions that altered the speciation or availability of analytes for transport, or other materials brought into the site such as seed, mulch, or stabilizing fabric.

Roadway metals of interest (e.g., Maser 2001) at TB7Bin included total masses of iron (0.097 kg), zinc (0.088 kg), copper (0.034 kg), chromium (0.015 kg), and nickel (0.013 kg). This will be considered typical of input loadings at all locations. Other ditches were similar to these results, although there were large disparities in the amounts of metals found, likely due to site specific factors such as the length of the ditch upstream of the sampling location. Of the roadway metals of interest, lowest masses were found at TB7Bin (iron), TB7Bout (chromium), TB9A (copper), and TB15B (zinc, nickel). At these locations, the ditches were long and/or very flat in slope or showed ponding, likely increasing their effectiveness in metals removal. Low iron at TB7Bin may be related to the source concentration, rather than any ditch characteristic. Highest average concentration of iron and lead were at TB19, chromium, copper, and nickel at TB19r, and zinc at SandersSW. Metals may also get transported to the ditches as particulates (dust and shavings) or large masses (e.g., auto parts) rather than being transported dissolved in water, perhaps explaining how the load of iron and other metals may be low in the input waters, but increase in the ditches due to contact with accumulated metal.

TB19 and TB19r have some of the highest TSS values, likely from erosion of the ditch due to the high slopes, which may have prevented significant runoff detention and inhibited water treatment. Metals adsorbed to the soils in the ditches may have been mobilized by erosion and transported to

the samplers, with desorption at some point during transport or sample storage. This suggests that the soils of the ditch may have positive effects on water quality by adsorbing metals, but negative effects if the sediment is eroded and transported. Indeed, the exposure of sediment at land surface may temporarily enhance metals adsorption, but long-term storage may be enhanced by grassed ditches that inhibit erosion. Long- and short-term storage of metals and other ions should be considered. As sediment accumulates in the bioswales through time, there may be a point where the accumulation of sediment and adsorbed metals may be overtaken by erosion of sediment and subsequent transport of metals. This may indicate that maintenance may be needed after a certain amount of sediment accumulates, such as sediment removal and proper disposal. This aspect of bioswale performance will be addressed via soil sampling in the post-construction monitoring.

As noted in the methods section, ISGS collected biweekly grab samples (Appendix D) as a second method to double-check the Isco sampling discussed above, then calculated masses and average concentrations similarly (Appendix B). Comparisons between the two methods suggest that they are not equivalent. TSS is much higher in the Isco samples, but TDS and specific dissolved analytes are higher in the biweekly sampling. From a statistical perspective, biweekly sampling generally collects from the events that occur more frequently, such as average and low-flow events, thereby missing the less frequent peak-flow events where TSS is higher. High flows will tend to erode and transport more sediment, and those are represented better in the Isco composite samples. For dissolved analytes, notably TDS, alkalinity, calcium, sodium, chloride, and potassium, levels are higher in grab samples because there is less dilution during normal flow conditions as compared to storm flows that carry significant low-solute precipitation.

As noted earlier, the current methodology of the Isco sampling is likely to incur some errors. Some analytes may be transformed in the sample bottle prior to sample collection through various processes, such as bacterial action that may utilize nutrients and produce nitrates, and adsorption or desorption of metals to or from sediment that change the Isco sample concentrations relative to the grab samples that conform to standard holding times. Additional discussion of errors attributable to Isco sampling is included later. While these potential alterations are of sufficient concern to alter the post-construction sampling methodology by utilizing refrigerated samplers, there is a clear advantage of flow-integrated sampling over biweekly grab sampling for TSS and other analytes. Analytes that may be impacted by the Isco methodology will be interpreted with care. Future analysis may be warranted to attempt to meld the two data sets to account for their different advantages, for example by utilizing Isco measurements of TSS and other conservative analytes, but utilizing grab samples for other analytes. Alternatively, the masses calculated using Isco and grab samples may act as upper and lower estimates, producing a range of values that bracket the likely actual value.

Hydrolabs

Hydrolab MS5a multiparameter water-quality dataloggers were installed in the ditches at SandersSW, TB15, and TB19 for varying time periods in 2008 through 2010. Parameters such as pH, specific conductivity, and turbidity were measured and are shown in Figures 10 through 12.

Specific conductivity (Figure 10), which is a measure of the electrical conductivity of water and is related to the amount and species of dissolved solids, tended to be highest in winter due to road salt applications and decreased throughout the remainder of the year. Highest readings were

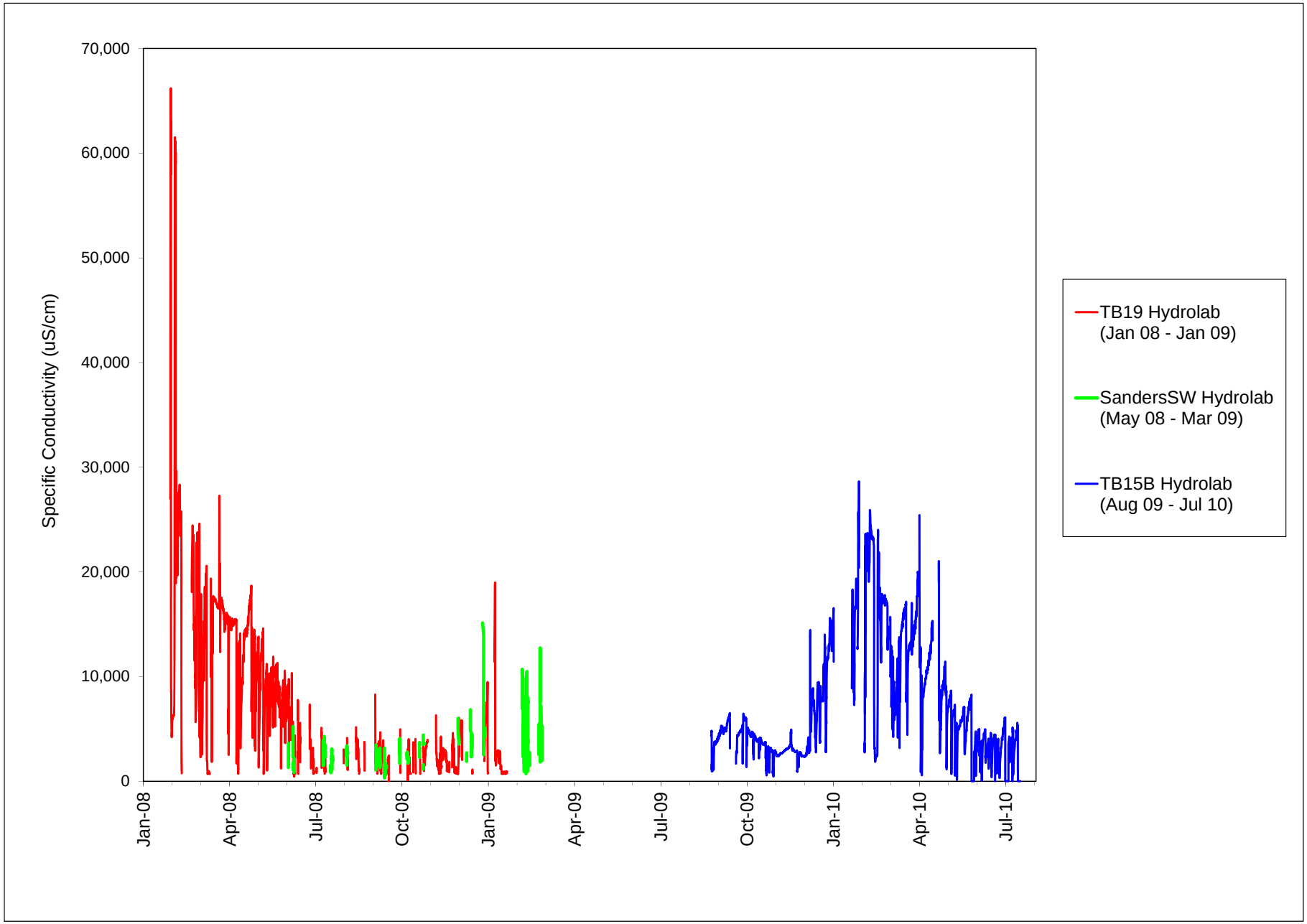


Figure 10. Specific conductivity recorded by Hydrolab dataloggers

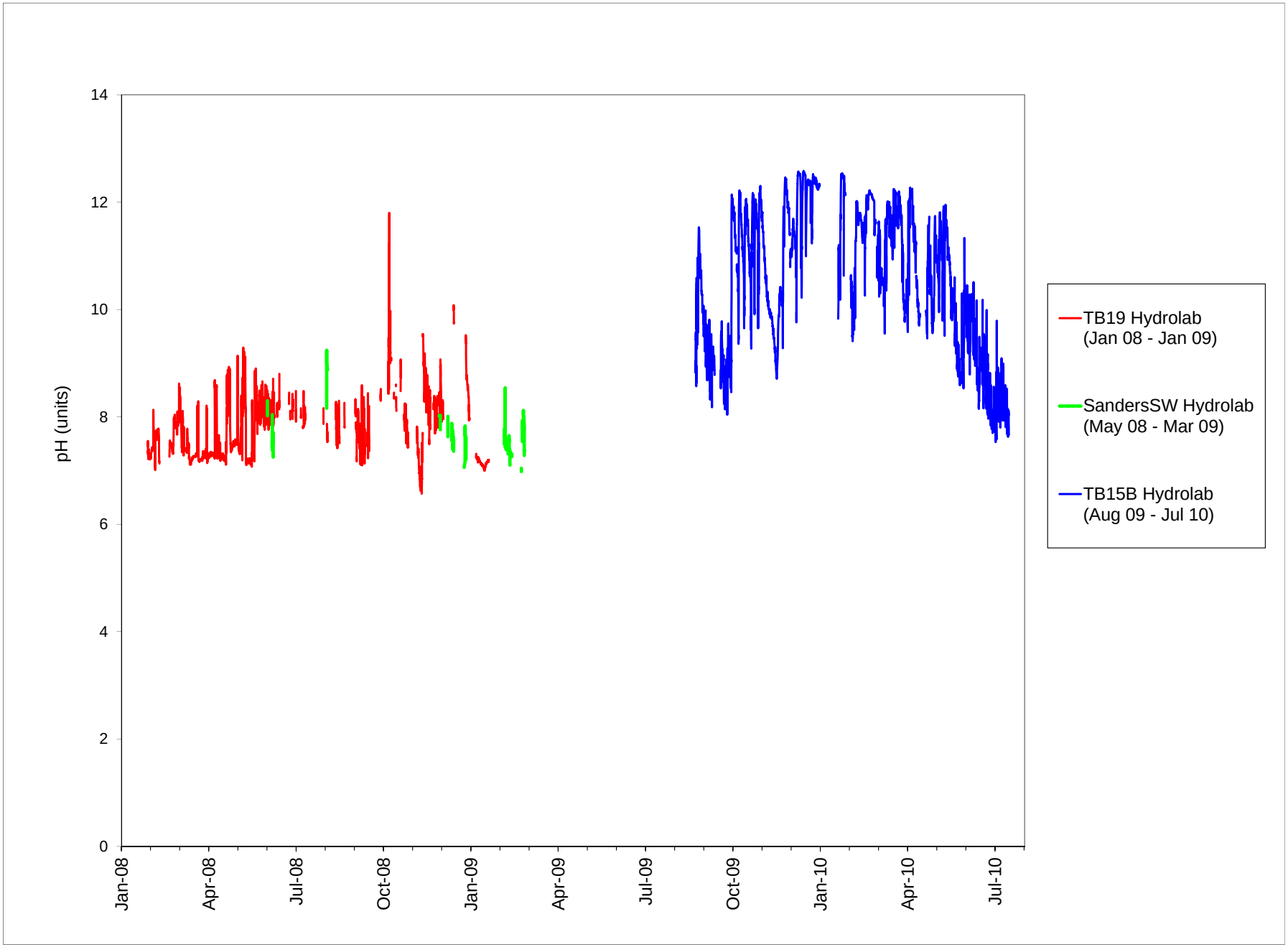


Figure 11. pH recorded by Hydrolab dataloggers

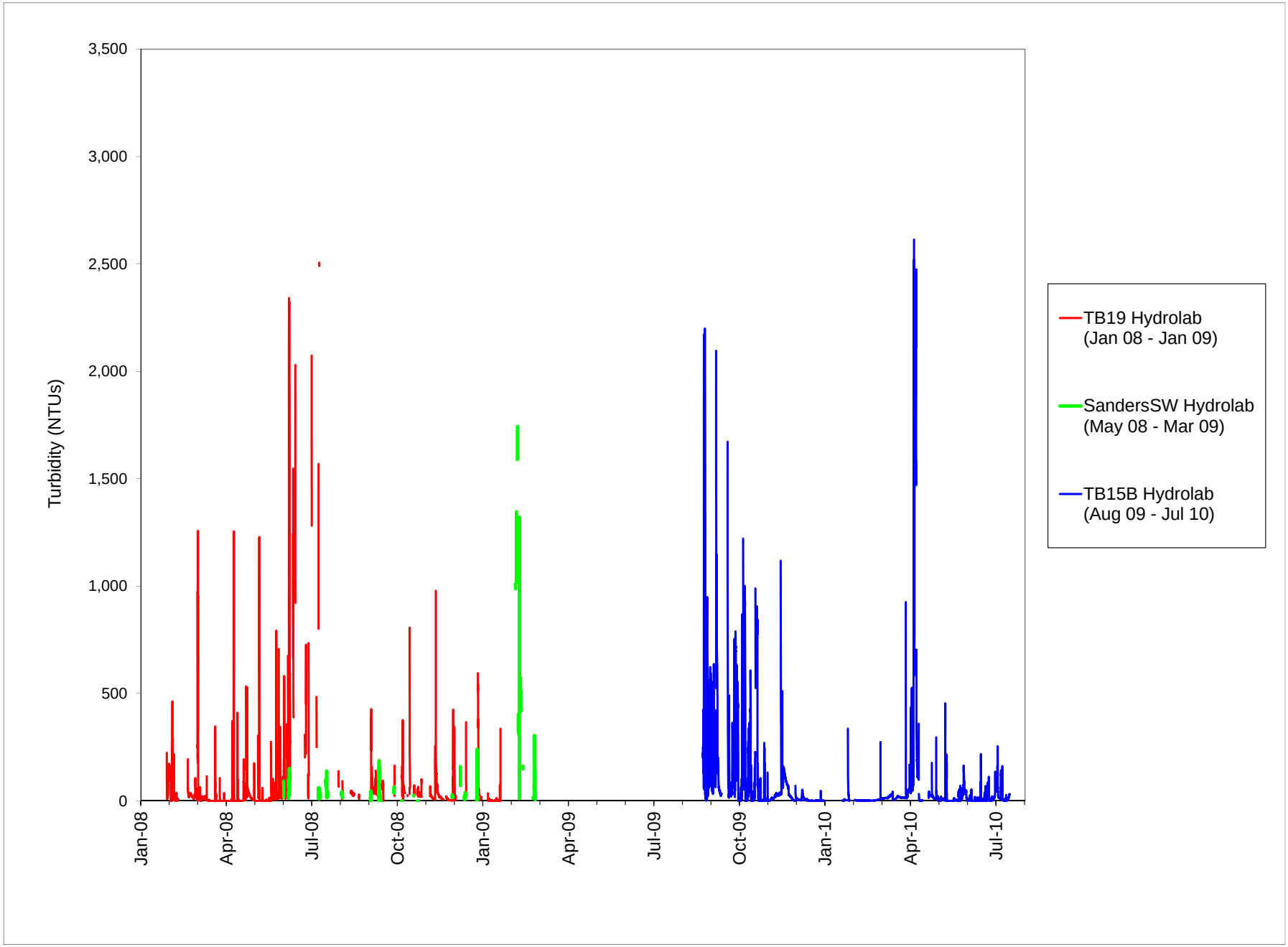


Figure 12. Turbidity recorded by Hydrolab dataloggers

measured at TB19, about 66,000 microSiemens/cm (uS/cm). For comparison, seawater has an approximate specific conductivity of 54,000 (uS/cm). Levels peaked at about 15,000 and 28,000 (uS/cm) at SandersSW and TB15, respectively. Generally, levels remained above 10,000 uS/cm during winter into May, when levels declined rapidly. For the remainder of the year, levels declined to the 1,000-5,000 uS/cm range. Precipitation events tended to cause eventual decreases in specific conductivity after sufficient precipitation occurred to dilute the solute load, although as seen in previous studies (Campbell et al. 2011), precipitation may cause an initial spike in specific conductivity prior to the dilution as the first flush of salt is transported off the roadway and into the ditches and local streams. At SandersSW, dry conditions were common, so that trends were difficult to determine. No minimum level of specific conductivity is presented, because although readings approached zero during dry conditions, readings that occurred when the sensor was less than fully submerged are inaccurate. Specific conductivity levels below 700 uS/cm were disregarded to remove these low-water effects. Chloride levels can be predicted from specific conductivity, and a model from a nearby location in northeastern Illinois (Campbell et al. 2011) showed that when specific conductivity is above 2,164 (uS/cm), then predicted chloride levels would be above 500 ppm, which is the maximum level of chloride allowed under the Illinois Pollution Control Board's General Use Standard for surface water (Illinois Pollution Control Board undated). Using this model, specific conductivity measured in 2008 and 2009 at TB19 and SandersSW exceeded the General Use Standard for chloride almost constantly for winter and spring, decreasing somewhat during precipitation events. For the remainder of the year, the General Use Standard was often exceeded during runoff events, declining in frequency as the year progressed. At TB19, spikes in specific conductivity occurred during precipitation events in spring and summer, although the standard was not always exceeded in every event, especially during the late summer through fall after much of the chloride had been removed from the system. Halite (road salt) granules were seen in roadside sediment late into spring, and it is presumed that halite and brines may be stored in the soil structure and released through groundwater discharge during nonwinter months.

Total dissolved solids can be estimated from specific conductivity data by multiplying by 0.64 (Hach 2006), making maximum TDS approximately 42,000 mg/L at TB19, 10,000 mg/L at SandersSW, and 18,000 mg/L at TB15.

pH is a measure of the acidity of the water, ranging from pH of 1 (very acidic) to 14 (very basic), with pH 7 being neutral. Generally, ditch waters are slightly basic to basic, likely due to generally calcareous ditch sediments (Figure 11). At SandersSW and TB19, waters generally ranged between pH 7 and 9, with some excursions below and above that range. At TB19, the maximum pH was 11.8 and the minimum was 6.6, and at SandersSW the maximum was 9.2 and the minimum was 7.0. At TB15B, waters were more highly alkaline, with waters between pH 7.5 and 12.6, likely affected by runoff of high pH concrete construction dust noted in culverts draining into the ditch. General-use water-quality standards are exceeded when waters exceed pH 9. pH appeared to increase after precipitation events at TB15B and TB19, perhaps suggesting that runoff brought alkaline materials into the ditch, such as concrete dust, or eroded calcareous silt from the surficial sediments in the area. No obvious seasonal pattern was noted. The pH sensor was affected by dry conditions, and significant data loss occurred at sites where the sensor would dry out regularly. Sometimes the sensor would not respond after rewetting until cleaned and serviced by staff, notably at SandersSW, to the extent that no trends or relationships could be

determined at that site.

Turbidity measures the dispersion of light through water, attributed to suspended sediment content and other factors and expressed in nephelometric turbidity units (NTUs), also equivalent to nephelometric formazin units (NFUs) given that the sensors were calibrated with formazin and the sensor used the appropriate light wavelength. Turbidity levels at TB19, SandersSW, and TB15B are shown in Figure 12. Highest turbidity levels recorded were 2,946 NTUs at TB15B, 2,506 NTUs at TB19, and 1,743 NTUs at SandersSW, although these are well above the calibration range of the instruments (0-100 NTUs) and should be considered provisional. Turbidity was episodic and clearly related to precipitation events, especially at SandersSW and TB19, although some turbidity spikes occurred in the absence of precipitation, perhaps caused by on-site disturbance by animals or humans, construction, and similar factors. Also, many precipitation events were not associated with turbidity spikes, suggesting that the rate of precipitation, antecedent moisture conditions, extent of vegetation cover, and other factors may determine if sediment is eroded.

Gerlach Samplers

In order to determine loading rates for ditches that did not have point inputs that were measured and sampled, ISGS installed Gerlach samplers along two sections of tollway to collect runoff directly from the pavement edge. Runoff flowed to the shoulder into a stainless steel trough and was collected into a polyethelyene bottle for later retrieval. The sample is not flow integrated, so it was considered a grab sample. Gerlach samples did not conform to standard holding times. Gerlach sampling became obsolete after the installation at TB7Bin, where a curb and gutter system collected runoff from a specific roadway area and transmitted it via concrete pipes to TB7B. Flow-integrated sampling could be done using Iscos at this site, thus providing a more accurate assessment of the chemistry of input waters. Therefore, there will be no presentation or further use of the Gerlach data.

Groundwater Levels and Quality

Areas adjacent to the ditches were monitored to detect any roadway pollutants in groundwater, which would suggest that groundwater is a sink and perhaps a transport mechanism for runoff. An east-west transect of monitoring wells was installed at each of TB7B and TB15B (figures 13 and 14) beginning adjacent to the ditches and extending westward. Well readings began in November 2009. Wells TB7B-5U, TB7B-5U, TB15B-4U, and TB15B-4L were installed in the footprint of the ditches and are shown on the figures, but they were not installed until 2011 and are not discussed in this report. Each well varied in construction but was installed to screen the uppermost coarse-grained materials, if present. Well construction information is shown in Appendix E.

Each well was equipped with an In-Situ Aquatroll 200, which measured water level, temperature, and specific conductivity every 4 hours. In addition, manual level measurements were made biweekly to check datalogged level measurements. Graphs of water level, depths to water below land surface, and specific conductivity data for each well are shown in Figures 15 through 20.

Groundwater samples were collected biweekly from the wells as discussed previously. Samples were analyzed for the same constituents as the surface-water samples, and results are shown in



Figure 13. Instrument locations at TB7B

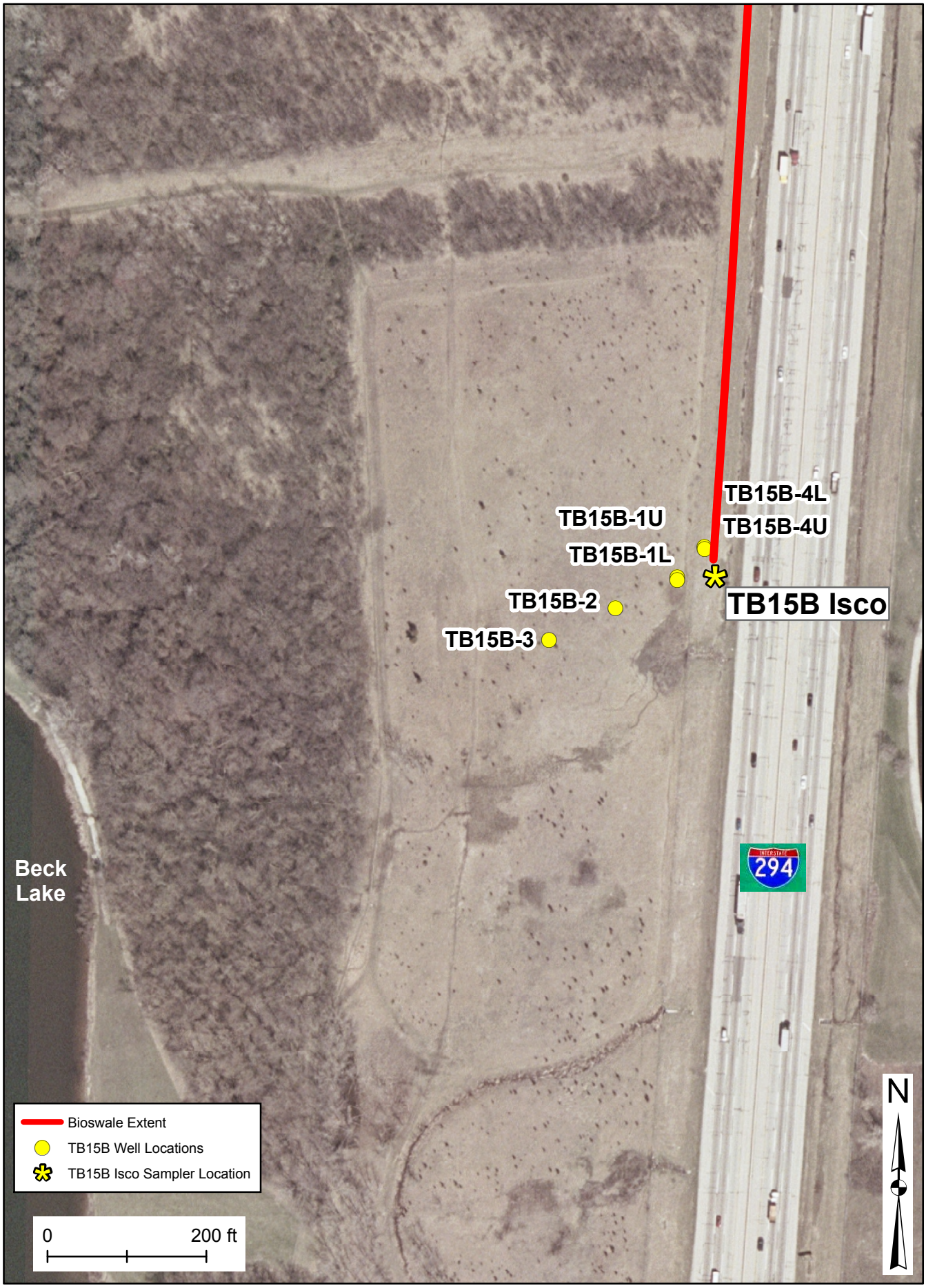


Figure 14. Instrument locations at TB15B

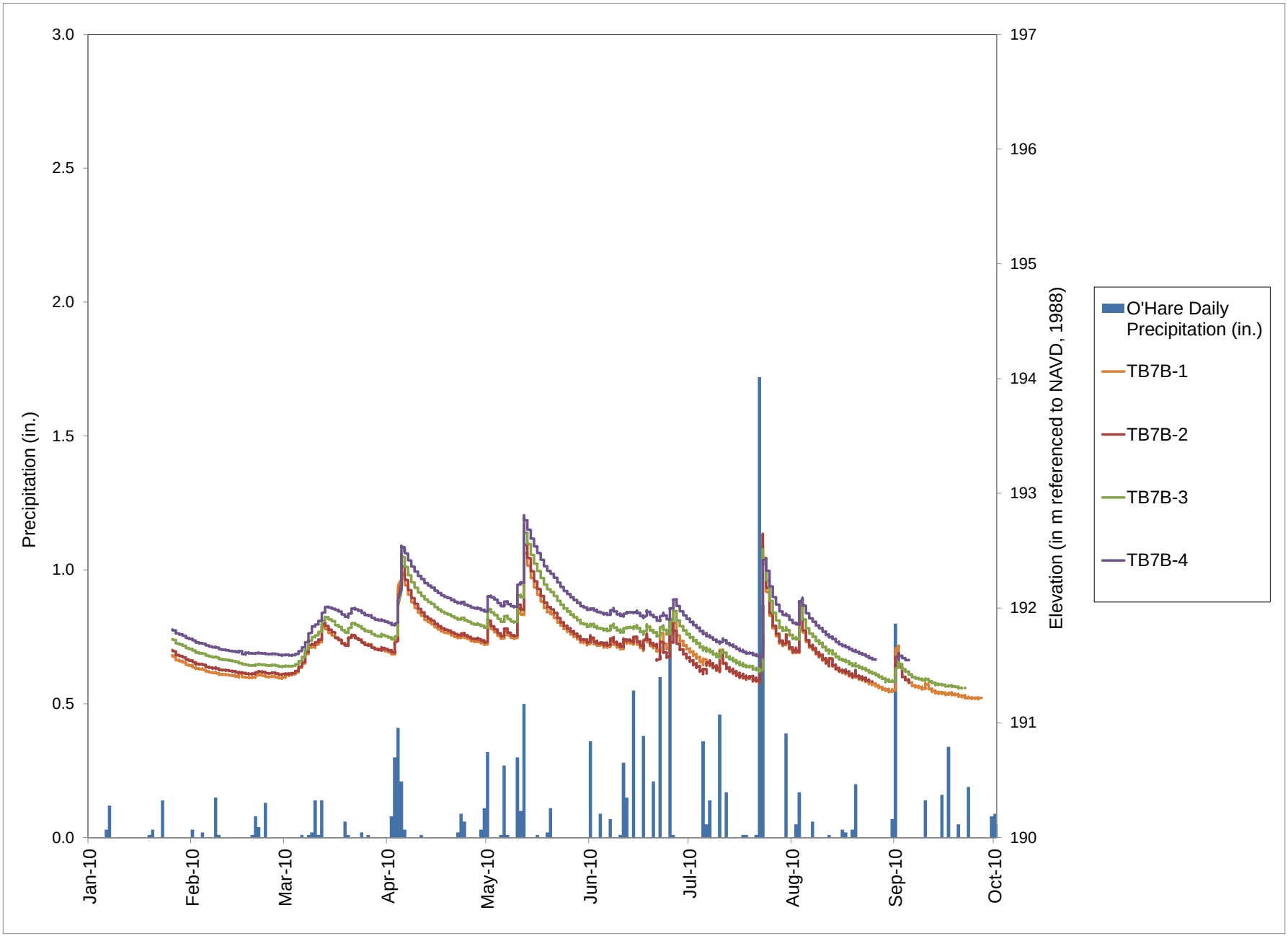


Figure 15. Groundwater levels recorded at TB7B

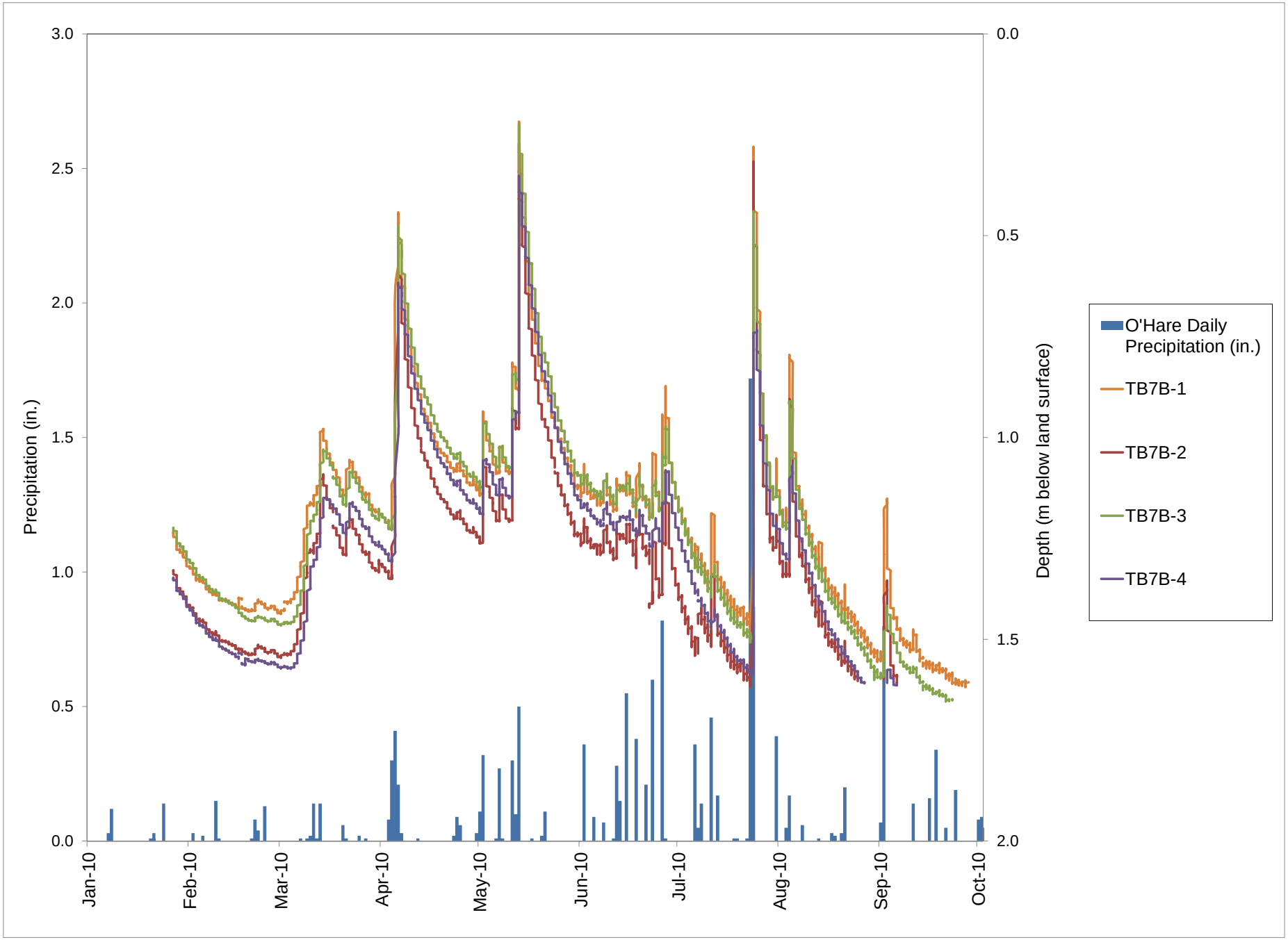


Figure 16. Depth to groundwater in wells at TB7B

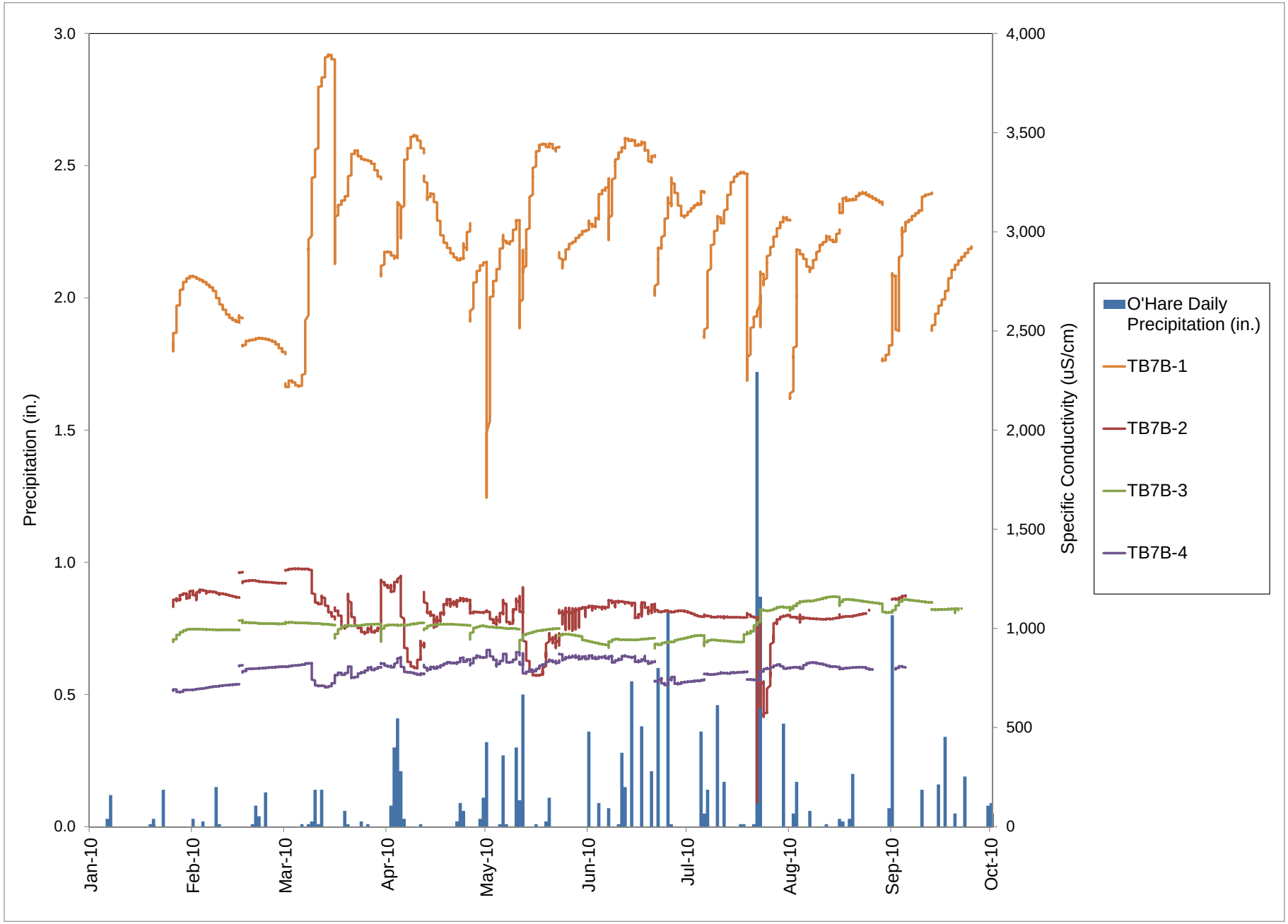


Figure 17. Specific conductivity of groundwater in wells at TB7B

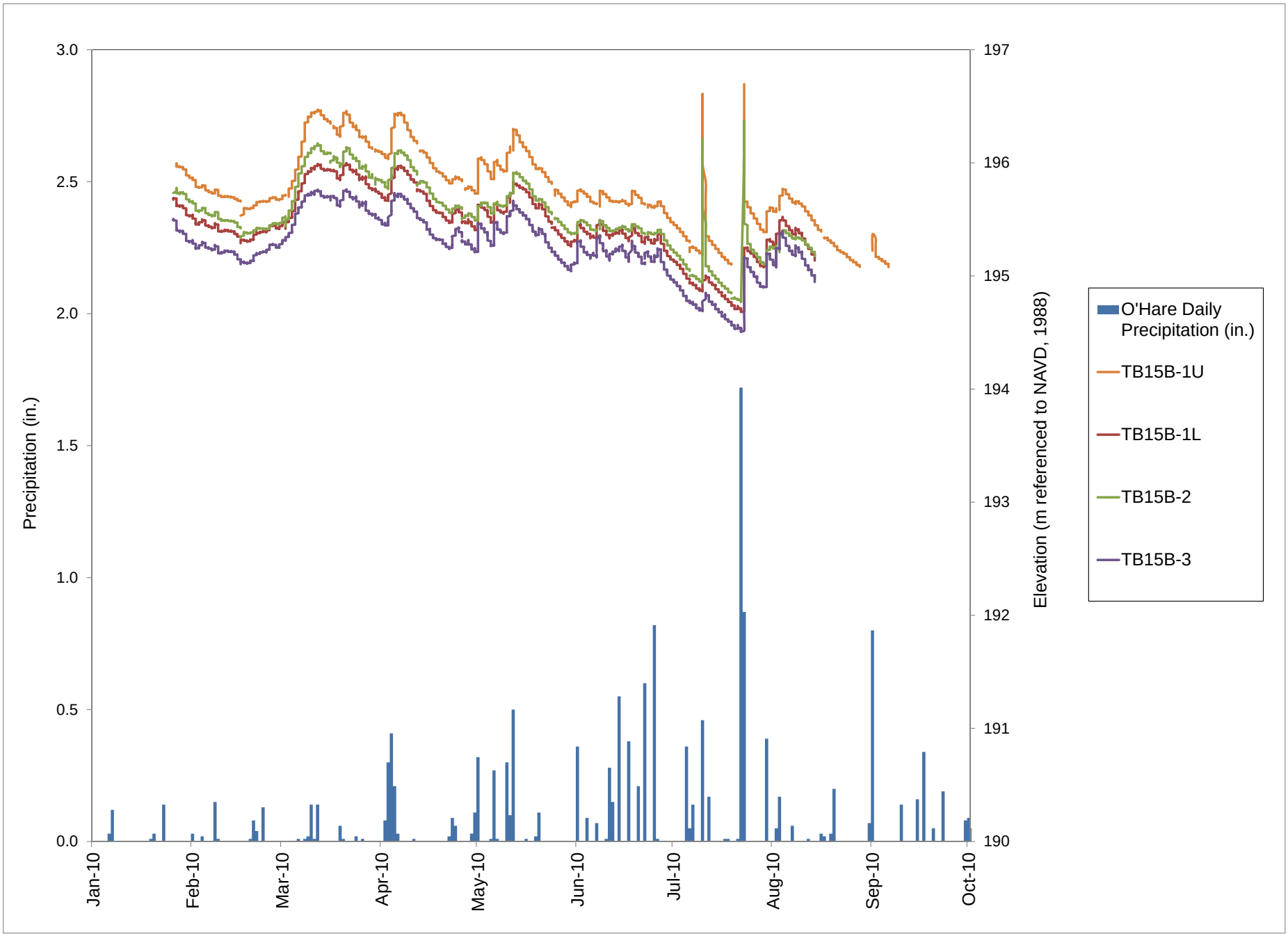


Figure 18. Groundwater levels in wells at TB15B

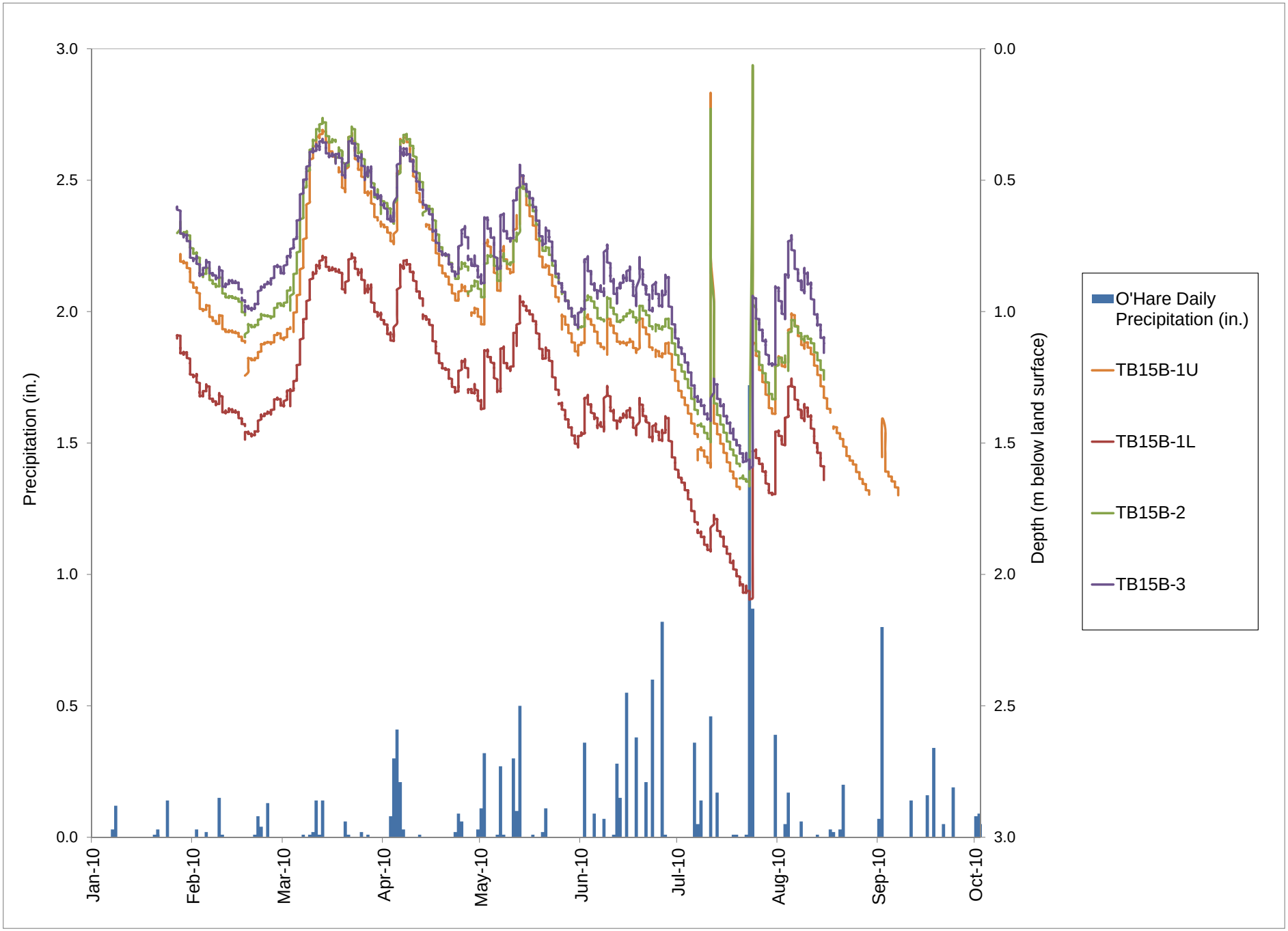


Figure 19. Depth to groundwater in wells at TB15B

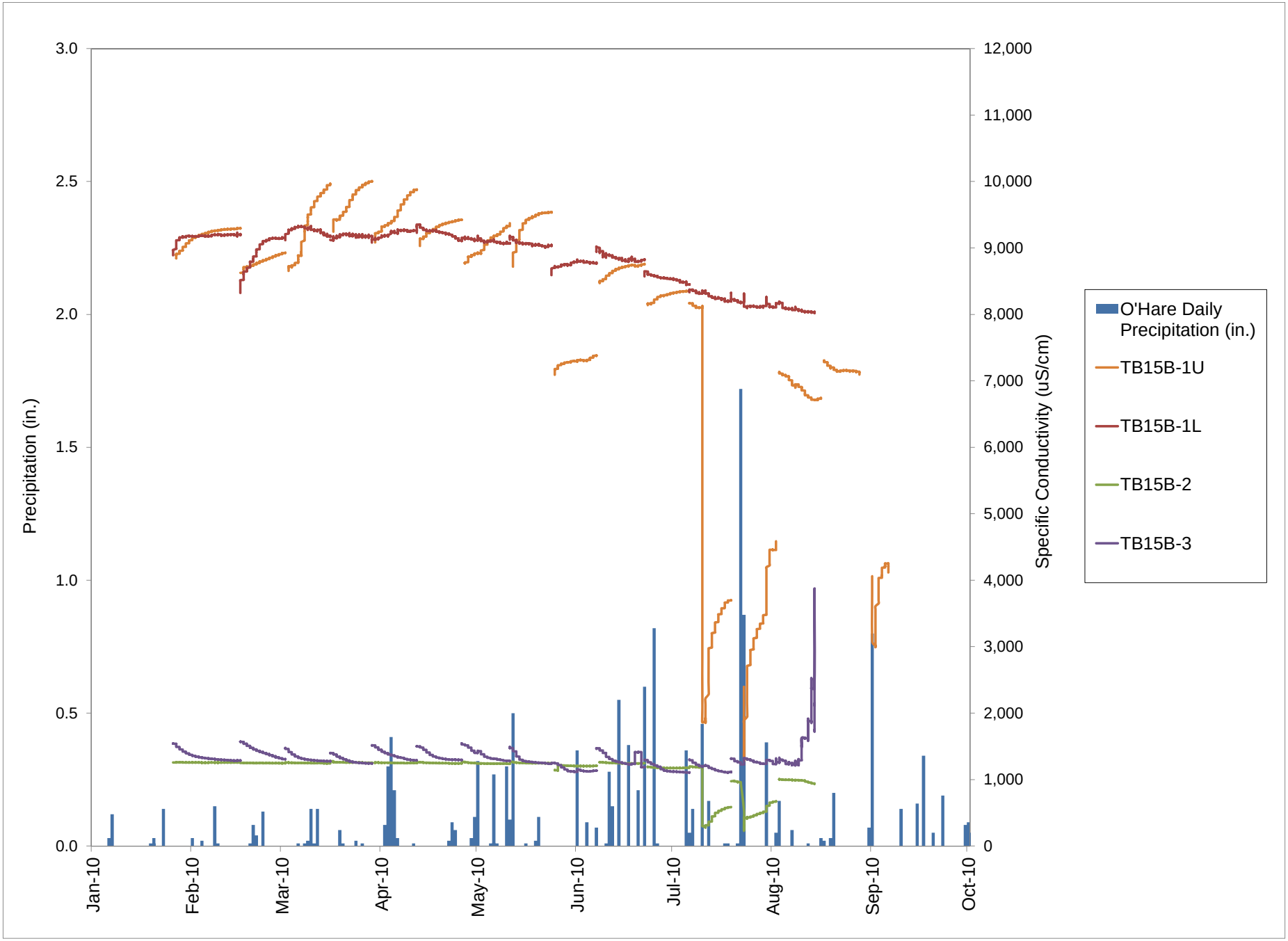


Figure 20. Specific conductivity of groundwater in wells at TB15B

Appendix F. These samples were collected, preserved, and analyzed according to standard practices discussed previously. Also, given that conditions do not fluctuate as rapidly in groundwater as they do in surface water, it is expected that biweekly samples were sufficient to characterize all analytes and their range of concentrations.

TB7B Groundwater Levels

In the well transect at TB7B, water levels in all wells (Figure 15) were clearly related to precipitation, with levels rising rapidly during and immediately after precipitation events, and falling afterward. Seasonally, water levels peaked at about 1 ft below land surface (Figure 16) in spring or during periods of heavy precipitation (e.g., August 2010), and fell to at least 5 ft below land surface during drier periods in late summer. Water-level elevations show that levels in TB7B-4 were the highest and decreased eastward through TB7B-1. Specific groundwater flow directions were calculated for May 2010 and showed a strong east/northeasterly flow (oriented approximately 70°), perhaps toward the ditch or other unknown drainage east of the Tollway. However, the accuracy of this calculation is somewhat diminished by the linear arrangement of wells in the area.

TB15B Groundwater Levels

In the well transect at TB15B, water levels varied by season (Figure 18), with levels at all wells except the deepest well (TB15B-1L) coming within about 1 ft of land surface (Figure 19) in spring, and falling below 5 ft below land surface in the late summer. Water levels in all wells were clearly related to precipitation, with levels rising rapidly during and immediately after precipitation events. Water-level elevations showed that levels in TB15B-1U were the highest and lowest at TB15B-3. A specific determination of groundwater flow direction was made in May 2010, showing a WNW flow direction oriented approximately 300°, in the direction of Beck Lake, although the linear orientation of wells decreases the accuracy of this determination. A downward gradient was present at TB15B-1 because levels in the upper well (TB15B-1U) were higher than those in the lower well (TB15B-1L), allowing a downward migration of runoff and any dissolved analytes.

TB7B Groundwater Quality

Specific conductivity values were collected with the In-Situ Aquatroll 200 dataloggers, and are shown in Figure 17 for wells adjacent to site TB7B. Well TB7B-1, which is located approximately 10 ft west of the edge of the ditch, had specific conductivity values that were much higher than the remainder of wells located further west along the transect; it was clearly impacted by Tollway runoff that contained high solute loads, likely chloride. Specific conductivity generally remained within the range of about 2,000 to 4,000 microSiemens/cm (uS/cm), with a mean of 2,976 uS/cm and a maximum of about 3,892 uS/cm, as compared to the much lower concentrations found at the remaining wells, which decreased in conductivity westward. The next well, TB7B-2, located approximately 85 ft west of the ditch edge, had a mean of 1,082 uS/cm and a maximum level of less than 1,291 uS/cm, with levels that generally stayed within the range of 800 to 1,300 uS/cm other than during the extreme precipitation in July 2010 when levels decreased due to dilution from infiltration. Well TB7B-3, located approximately 175 ft west of the edge of the ditch, had similar measurements, with a mean of 1,004 and a maximum level of less than 1,200 uS/cm. Finally, well TB7B-4, located approximately 260 ft west of the edge of the ditch, had a mean specific conductivity of 793 uS/cm, a maximum level of 889 uS/cm, and a

minimum level of 685 uS/cm, a small range that may represent unimpacted levels in the area.

Other than well TB7B-1, which appeared to have peaks in specific conductivity related to runoff events that likely added chloride and other solutes to the shallow groundwater system surrounding the ditch, specific conductivities in the other wells generally did not vary with precipitation, although some of the largest rainfall events caused decreases at well TB7B-2, perhaps due to variations in geologic conditions. Because groundwater flow was eastward, the increase in specific conductivity in wells TB7B-2 and TB7B-3 could not have been caused by transport of chloride in groundwater, but more likely by airborne transport of chloride from spray and splash during winter, causing the decreasing trend westward from the Tollway. Any influence from Algonquin Road was not apparent. Because the greatest impact was at the well adjacent to the ditch (TB7B-1), it is possible that very short-term discharges may have overwhelmed the ditch and either flooded the vicinity of the well or temporarily reversed the groundwater flow direction and delivered impacted water to the well area. Some seasonal variations were seen at TB7B-1 and to a lesser extent at TB7B-2, with springtime melting of snow and any subsequent mobilization of wintertime airborne deposition of chloride possibly appearing as a peak in March, and some slight decline may have been observed from spring through summer, possibly due to minor flushing or dilution of chloride.

Groundwater samples were collected from all wells at TB7B to measure water quality, with the goal of identifying whether the ditches were impacting adjacent groundwater. Results of analyses are shown in Appendix F. Differences between the eastern and western ends of the transect suggested impacts, with increases due to solutes being added to the groundwater by runoff that is infiltrating in the ditch, or decreases due to dilution. The eastern end adjacent to the ditch had highest mean and maximum levels of barium, copper, iron, potassium, manganese, sodium, sulfur, alkalinity, total dissolved solids, ammonia, chloride, sulfate, and dissolved non-volatile organic carbon. Analytes that had the highest mean and maximum values west of the edge of the ditch, included aluminum, calcium, zinc, pH, and nitrate. These results suggest that waters high in a wide range of dissolved solids were entering the groundwater system at the east end of the transect via infiltration in the ditch and possibly by aerial deposition on land surface. Many analytes in this list are strongly associated with roadway runoff; the analytes that make up the bulk of the total dissolved solids included, in descending order, chloride, sodium, sulfate, calcium, and sulfur. Nitrate was higher away from the ditch in the forest, which is heavily used by deer, and the nitrate was apparently converted to the high ammonia levels measured in the ponded conditions near the ditch. Calcium was lower adjacent to the ditch likely because of the diluting influence of the low TDS runoff being discharged by the Tollway into the ditch at TB7B. Chloride levels at TB7B-4 likely reflected actual background levels in groundwater, with a mean of 9 mg/l and a maximum of 13 mg/l. The other sites along the transect were increasingly affected by chloride toward the ditch, either directly from the runoff as seen at TB7B-1, or more likely via aerial deposition at the other wells, especially given that groundwater was not likely capable of westward flow except perhaps as far as TB7B-1.

In general, levels of analytes at TB7B did not seem to vary with precipitation or season, although very large precipitation events may have caused slight dilutions, such as the major rainfall event in July 2010 that may have slightly decreased calcium at TB7B-1. Some variations occurred that may have been seasonal, including possible springtime increases in sodium due to snowmelt, and

very large springtime/growing season increases in nitrate. In comparison to TB15B (discussed below), nitrate levels at all TB7B wells were about 2 orders of magnitude higher. This may have been related to the forest environment and/or animal populations as noted above.

TB15B Groundwater Quality

In the east-west well transect at TB15B, specific conductivities (Figure 20) showed a similar pattern as at TB7B. The well nest closest to the edge of the ditch (wells TB15B-1U and TB15B-1L), approximately 35 ft west, had specific conductivity levels apparently impacted by tollway runoff, with mean values of 8,227 and 8,862 uS/cm respectively. Most values were between 6,700 and 9,900 uS/cm except when low water levels in summer caused spurious measurements that were disregarded. Wells further west of the ditch had lower specific conductivities; well TB15B-2 (about 125 ft west) and TB15B-3 (about 210 ft west) had mean values of 1,144 and 1,326 uS/cm, respectively, and levels that were similar in magnitude and behavior. Levels generally remained between 900 and 1,500 uS/cm other than during dry periods that influenced readings. These mean values likely reflected baseline conditions in the area. Specific conductivities in the transect did not clearly vary with precipitation, even the largest rainfall events had little apparent influence. However, precipitation events in March through May increased the conductivity of groundwater in well TB15B-1U, perhaps transporting wintertime airborne chloride deposition from land surface downward into the groundwater, or caused by the lag time required for infiltration in the ditch to flow toward well TB15B-1U. Well TB15B-3 had a slightly higher specific conductivity than TB15B-2 perhaps because it was apparently screened in the same deeper, sandy layer as TB15B-1L, which transmitted groundwater westward from the ditch. Little to no groundwater flow from the ditch was likely carried through the uppermost silty layer in which well TB15B-2 was screened. Airborne transport and deposition of chloride at wells TB15B-2 and TB15B-3 may have been the primary source.

At TB15B, interesting trends in the groundwater samples are as follows. The following analytes (Appendix F) had highest mean and maximum levels in wells TB15B-1U or TB15B-1L (closest to the ditch): barium, calcium, lithium, magnesium, sodium, nickel, lead, sulfur, selenium, strontium, total dissolved solids, sulfate, phosphate, and ammonia. Analytes that had higher mean and maximum levels at the western end of the transect (away from the ditch) are aluminum, chromium, copper, iron, manganese, phosphorous, zinc, pH, and alkalinity. The distribution shows that runoff from the roadway clearly added dissolved ions, notably sodium and chloride, as well as some other roadway metals of interest such as nickel and lead. Similar to TB7B, zinc and the other metals of interest (chromium, copper, iron) may have been more available at the western end of the transect due to unidentified changes in speciation related to pH, redox, or compounding conditions, all of which affect the mobilization of the metals, although mean zinc levels at the western end were influenced by one very large measurement, with the remaining levels near or below those found nearer the tollway. These factors are beyond the scope of this study. Water quality at the western end of the transect reflected the longer flow path and residence time of groundwater that allowed a greater dissolution of analytes and increase in parameters such as alkalinity and pH, although calcium may be higher near the ditch due to other sources of calcium such as concrete dust from construction that was often observed in the ditch.

A few seasonal trends appeared: chloride and sodium were higher in winter at TB15B-1U and declined in summer, although a similar trend is not obvious at TB15B-1L because levels

remained high throughout the year, perhaps affected by the greater depth of that well screen. Calcium appeared to be slightly higher in winter at TB15B-1L, and the following analytes may have been slightly higher at many of the wells in summer: calcium, copper, iron, manganese, and zinc. Precipitation seemed to affect concentrations of some analytes at TB15B, especially large events. For example, the large rainfall event in July 2010 diluted levels of calcium at TB15B-1U and TB15B-1L, chloride at TB15B-1U, sodium at TB1B-1U, sulfate at TB15B-1U, TB15B-2, and TB15B-3, and TDS at TB15B-1U and TB15B-2. Smaller rainfall events did not have identifiable effects at the biweekly sampling rate.

Comparing Groundwater Quality Between Sites

Levels of analytes in groundwater at TB15B and TB7B suggest that different processes occur at each site. Levels of the following analytes were much higher at TB15B at the closest well to the ditch or sitewide: chloride (about 6 times higher next to the ditch), sulfate (about 2 times higher sitewide), calcium (5 times higher next to the ditch), TDS (4 times higher next to the ditch), copper (levels regularly 2 to 10 times higher sitewide), nickel (3 times higher next to the ditch), iron (3 to 6 times higher on average, although highest at TB7B-1 likely due to wetland conditions that reduce iron and liberate it for transport in groundwater), aluminum (levels often 2 to 8 times higher sitewide), and barium (3 times higher sitewide); analytes found at TB15B but not TB7B include lead, chromium, and selenium. Levels of analytes found at TB7B sitewide or next to the ditch at higher concentrations than at TB15B included: manganese (2 to 4 times higher adjacent to the ditch), nitrate (about 5 to 100 times higher sitewide), and ammonia (6 to 20 times higher adjacent to the ditch). As noted above, TDS may have been depressed at TB7B due to the input of runoff that was transported to the ditch in concrete pipes, having had no contact with soil prior to entering the ditch, thus leading to the low calcium observed. Differences in setting (floodplain versus upland), vegetation community, and the large animal presence at TB7B may have lead to the large increases in nitrogen (nitrate, ammonia) found there. Finally, analytes related to roadway runoff were higher at TB15B relative to TB7B, especially at TB15B-1U and TB15B-1L. This may be related to groundwater flow direction, which at TB15B was westward from the tollway through the ditch toward the forest preserve, transporting infiltrated runoff through the groundwater system. At TB7B, groundwater flow was eastward from the forest preserve toward the tollway, slowing or limiting the distance that runoff pollutants travel through the groundwater into the preserve. Airborne pollutants apparently impacted the preserve at TB7B, evidenced by the decline in chloride westward across the entire site, which could only have happened if chloride and other analytes noted above were deposited from the air, given that groundwater flows eastward. Some analytes, like lead and chromium, are transported through the groundwater at TB15B at low levels and at certain times. Given that lead is likely to be greatly reduced over the last few decades, erosion or construction may expose pollutants for transport intermittently. Finally, concentrations of some analytes at TB15B may have been higher due to greater overall load of pollutants into the ditch, which was not analyzed in this study. Further work comparing loading rates is planned.

Water Sampling Quality Control

Blank and duplicate samples were collected during all sampling runs as a quality control measure. Blank samples are shown in Appendix G, and duplicate samples in Appendix H. Generally, no analytes of concern were noted in blank samples, which were collected from distilled/deionized water using the field collection equipment and procedures used for all other samples. On average,

out of 59 blank samples with 42 analytes each, 9 analytes per sample were detected, with calcium, sodium, strontium, total non-volatile organic carbon, and dissolved non-volatile organic carbon appearing in the majority of the samples, and magnesium and chloride appearing in at least 20 samples. Highest levels of detection were made in two blank samples that were collected using an improper method; this practice that was only utilized twice on 4/1/09 and 7/28/09 and was discontinued, and any results presented from those blanks will be disregarded. One detection of silica in February 2010 was 17 mg/l, but it is likely to have been a reporting error. Omitting this instance and the two blanks discussed above, the highest level detected in the blanks was 4.8 mg/l of sodium, and the mean of all detections for all analytes is 0.195 mg/l. Only silica (3.8 mg/l) and sodium (2.4 mg/l) had mean levels of detection that exceed 1.0 mg/l. Roadway metals of interest had no detects for chromium, lead, and zinc, and had 18 detects for iron (maximum 0.13 mg/l), 2 detects for copper (maximum 0.004 mg/l), and 2 detects for nickel (maximum 0.02 mg/l). These results show that no alterations to field techniques were required other than the methodology of the blank discussed above. Distilled and deionized water was used for the blanks, and was derived from municipal water that is of a calcium bicarbonate type. Therefore, it is not surprising that calcium, magnesium, and strontium are among the analytes detected. Similarly, filters contribute organic carbon, sodium, and chloride, which are highly mobile ions that often are detected in blanks.

Duplicate samples, shown in Appendix H, generally indicate concurrence with the initial sample: out of 58 duplicate samples collected with 42 analytes each (2,436 individual analytes), an average percent difference was 5.5%, excluding instances of non-detections. Only 1.6 analytes per sample on average were found with differences greater than 20%, for a total of only 91 out of 2,436 individual analyses; of these, 76% (69 analytes) were at levels less than 10x the detection limit, which makes larger percent differences more likely and is generally considered nonoptimal for analysis. Of the 91 instances where the original and the duplicate differ by more than 20%, iron, nickel, aluminum, and titanium accounting for 46 instances. Only four of 2,436 instances had percent differences larger than 100%, with the largest percent difference being a nitrate sample that was 492% larger, although the total levels were very small, which magnified the size of the percent error. Results of duplicate sampling do not indicate any necessary changes to field or laboratory methods.

As noted earlier, the Isco composite samples were held in ambient conditions in the sampler for as long as two weeks. Nonwinter temperatures in the Isco sampler can be warm during the day, potentially altering the sample, although ditch waters are exposed to those warm conditions prior to sampling, thus lessening the potential impacts. Some analytes are not expected to be influenced by this sampling method, such as TSS, chloride, and similar conservative analytes of primary concern to this study. However, there are analytes and water-quality parameters that may be altered. For example, algae and bacterial activity may utilize nutrients and increase nitrate as a waste product. Redox changes can cause speciation differences. Warming can cause degassing and pH changes that influence the carbonate chemistry, likely causing geochemical precipitation of carbonate. Finally, long-term contact with TSS in the bottle may allow for adsorption or desorption of metals.

In order to test the potential for alterations to influence the results of the study, we collected a grab sample from a flowing ditch at TB9A according to standard methods and properly preserved

and submitted a sample to the laboratory under normal holding times. We also collected a 10-L sample in the same type of polyethylene bottle used for the Isco sampling, and maintained that bottle for 4 weeks at ambient conditions in the office, and another 10-L sample that was kept in refrigeration for 4 weeks. Samples were collected from each bottle after one, two, and four weeks and submitted to the laboratory for analysis. Results (Appendix I) show that, while there are differences between the baseline grab sample and the subsequent samples held at ambient or refrigerated conditions, only a few analytes were significantly altered. A Student's t-test showed that only aluminum, zinc, pH, alkalinity, and nitrate had significant differences between the original baseline sample and the samples collected from the bottle held in ambient conditions. Only magnesium, sodium, alkalinity, total dissolved solids, and nitrate were significantly different between the baseline sample and those samples collected from the bottle kept in refrigeration. Many of the analytes remain within 10% of the original value for the entire 4-week test period, often whether refrigerated or not.

As expected, some of the significant differences were in the metals, which may have been affected by adsorption and desorption. pH and alkalinity were affected by holding at ambient temperatures, which may cause subsequent changes in carbonate chemistry. Nitrates were affected, likely by bacterial activity. In refrigeration, some of these processes were lessened, even if they were still significantly different from the baseline (e.g., nitrate, alkalinity). Some of the analytes that showed significant trends were not actually affected in large magnitude, such as sodium that changed by only 3%. For affected analytes, values often fluctuated in both increasing and decreasing trends over the test period. Those that increased or decreased greater than 10% relative to the original grab sample at some point in the test period include: boron, copper, iron, manganese, molybdenum, nickel, zinc, orthophosphorous, ammonia, and total and dissolved non-volatile organic carbon. Many of these increases, especially boron, copper, molybdenum, and zinc, are not important, given the very small concentrations found or because they only happen toward the end of the 4-week test period, which is much longer than samples were held in ambient conditions during the monitoring. Increasing trends were also found for aluminum, fluorine, and nitrate but percent increase could not be calculated because no levels were found in the original grab sample, presumably due to speciation changes and/or desorption. In many cases, the levels of analytes in week 2 of the test were less than either weeks 1 or 4, suggesting that alterations may not have been related to time the sample spent stored in the bottle, and may have been related to sample collection procedures.

Refrigeration lessened the alteration in many of the analytes and parameters, including barium, calcium, manganese, nickel, sulfur, pH, nitrate, total organic carbon, and dissolved organic carbon. Bacterial action that produces nitrates and utilizes ammonia and organic carbon was likely inhibited by the low temperatures. Reaction rates such as adsorption or desorption may be lowered, thus preserving dissolved metals content. Redox changes and temperature changes may be lessened, thus preserving pH levels and limiting degassing and precipitation. Given these results, refrigerated samplers will be introduced in the post-construction period to improve sample preservation.

FUTURE WORK

This report represents the initial phase of the study, which was to identify appropriate methods for monitoring roadside runoff and adjacent groundwater, and establish initial conditions to compare

against conditions after bioswale construction. The next phase is to monitor the results of the bioswales after construction, including adjacent groundwater. The goal of the monitoring is to identify the loading of pollutants into the bioswales and the fate of those pollutants, including a calculation of the removal efficiency with emphasis on the influence of design factors (e.g., loading rate, retention time, presence of an underdrain, etc.) on efficiency.

As the pre-construction study progressed, the fate of contaminants became a concern, both for long-term maintenance of the bioswales and to identify all transport mechanisms and potential impacts on adjacent forest preserve district properties. Therefore, in the post-construction period, ISGS will include soil sampling in the bioswale, groundwater quality monitoring in the bioswales themselves as well as in the adjacent forest preserves, and measurement of contaminants bound to TSS to inclusively identify sources, sinks, and transport mechanisms for contaminants related to runoff.

One purpose of this study was to develop effective methods of monitoring the quality and quantity of runoff. Some improvements to the methods used in the initial study are as follows. ISGS determined that refrigerated samplers would be used for the post construction monitoring. In the post-construction period, total loads of metals will be additionally assessed by adding extractions of the TSS fraction to determine the total load being transported, whether adsorbed or dissolved. Given that the accuracy of the Isco setups appear to have significant impacts on discharge measurements, discharge calculations will only be done in hardened cross sections and will be cross-checked with a redundant method of calculation using pressure transducers and a rating curve that will be individually generated for each location. Also, various input loadings will be temporarily measured to compare loading rates and verify the accuracy of utilizing loading rates measured at TB7Bin for all locations. No other important alterations to the methodologies are expected.

Bioswale construction was completed by August 2010. ISGS has been contracted to monitor conditions in the bioswales and adjacent groundwater through 2015, and has installed Isco discharge monitoring at seven locations in four bioswales, including two “dry” bioswales, which feature underdrains intended to infiltrate as much runoff as possible, and two “wet” bioswales, which lack underdrains and are not intended to infiltrate the runoff. These seven sites are TB7Bin (input from roadway), TB7Bout (output from bioswale), TB9A (output from bioswale), TB15BSW (surface-water output from bioswale), TB15BGW (discharge from the underdrain), TB19SW (surface-water output from bioswale), and TB19GW (discharge from the underdrain). Some of these have been operating since August 2010, and some were installed as late as August 2011 due to the timing of power sources for refrigerated samplers being made available to ISGS. As of December 2011, all sites were installed and functioning, and monitoring was underway, although fine tuning of monitoring continues. The groundwater monitoring has been performed continuously since August 2010. A final report detailing performance of the bioswales is expected in December 2015.

SUMMARY

ISGS has performed sampling of roadway runoff in the ditches and future bioswale locations along I-294 in northern Cook County, Illinois. Runoff quantity and quality have been measured to identify existing discharge volumes, constituents in runoff and their concentrations, and any

water-quality improvements made by the current ditch system. Measurements of groundwater levels and quality have also been made to identify current impacts on adjacent lands such as forest preserves. Results suggest that there were significant loads of various dissolved and suspended solids in roadway runoff, dominated by sodium chloride but also containing various metals, nutrients, and other analytes. Oils and greases were not measured. At TB7B, the existing ditch system removed significant amounts of these suspended and dissolved analytes due to a low ditch slope that facilitated deposition, infiltration, and evapotranspiration. In other locations, such as TB19, there was an apparent export of sediment and other analytes due to the high slope and eroding channel. These two end members show that some of the removals of analytes from runoff may be temporary, because the ditch sediment and adsorbed metals may remobilize during the lifespan of the ditch due to erosion, state of ditch maintenance, and other factors. Legacy pollutants such as lead are still occasionally found in samples.

Groundwater adjacent to sites TB7B and TB15B showed impacts from roadway operations. The following analytes were found at elevated levels adjacent to the ditches in at least one of the two monitoring sites: sodium, chloride, calcium, alkalinity, TDS, sulfate, phosphate, dissolved non-volatile organic carbon, copper, iron, nickel, lead, and other minor analytes, along with decreased pH. Not all sites have identical impacts, such as calcium that increased at TB15B, likely due to construction debris, but decreased at TB7B, likely due to the runoff having minimal contact with soil before infiltration. Airborne transport of contaminants also likely occurred, causing some of the pattern of decreasing levels away from the roadway, for example chloride at TB7B. Legacy pollutants such as lead were irregularly found dissolved in groundwater, again suggesting that contaminants stored in the roadside sediment may be released to the groundwater via infiltration of ditch waters.

ACKNOWLEDGMENTS

Many ISGS staff assisted with planning and field work on this project, including Jessica Ackerman, Steve Benton, Melinda Campbell, Charles Knight, Eric Plankell, and Geoffrey Pociask. Funding for this report was provided by the Illinois State Toll Highway Authority, contract #ITHA RR-07-9918. Brand names of instruments used were for informational purposes only and do not constitute endorsements. This report reflects the views of the authors, and may not reflect the opinions and policy of the Illinois State Geological Survey, University of Illinois, or the Illinois State Toll Highway Authority. Publication of this report was authorized by the Director, Illinois State Geological Survey, Prairie Research Institute, University of Illinois-Urbana.

REFERENCES

ASTM Standard D6771, 2002, “Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Investigations”, ASTM International, West Conshohocken, PA.

Campbell, M.C., J.J. Miner, and K.W. Carr, 2011, Data and Results of Monitoring At the Unnamed Tributary to the South Branch of Indian Creek (Willowbrook Drain), Il 22, near Long Grove, IL: Illinois State Geological Survey Open-File Report 2011-5, Prairie Research Institute, University of Illinois, Champaign, 34 p.

Crabtree, B., F. Moy, M. Whitehead, and A. Roe, 2006, Monitoring pollutants in highway runoff: Water and Environment Journal 20:287-294.

Groves, W., P. Hammer, K. Knutsen, S. Ryan, and R. Schlipf, undated, Analysis of Bioswale Efficiency for Treating Surface Runoff: undated project report, Donald Bren School of Environmental Science and Management, University of California, Santa Barbara, 175 p.

Hach Company, 2006, Hydrolab DS5X, DS5, and MS5 Water Quality Multiprobes, User Manual, February 2006, Edition 3: Catalog number 003078HY, Loveland, CO, 73 p.

Illinois Pollution Control Board, undated, Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, Part 302 Water Quality Standards, available online at www.ilga.gov/commission/jcar/admincode

Mazer, G., D. Booth, and K. Ewing, 2001, Limitations to vegetation establishment and growth in biofiltration swales: Ecological Engineering 17:429-443.

Midwestern Regional Climate Center, 2011, Midwestern Climate Information System: Illinois State Water Survey, Champaign, Illinois, available online at http://MRCC.sws.uiuc.edu.

Miner, J.J., K.W. Carr, and K.E. Bryant, 2009, Progress Report, Spring 2009: Compilation and Interpretation of Hydrogeologic and Geochemical Data for the Illinois State Toll Highway Authority: unpublished contract report to the Illinois State Toll Highway Authority, Illinois State Geological Survey, Institute of Natural Resource Sustainability, University of Illinois, Champaign, IL, 21 p.

Miner, J.J., and Simon, S.D., 1997, A simplified soil-zone monitoring well: Restoration and Management Notes, v. 15, no. 2, p. 156–160.

APPENDIX A: Results of Geochemical Analysis of Isco Surface-Water Samples

Lab Methodologies

Alkalinity:	Based on SM method 2320B
Anions (F, Cl, NO3, SO4):	Based on US EPA Method 300.0
Metals, normal, with digestion:	Based on US EPA Method 200.7
Ammonia/ammonium:	Based on US EPA Method 350.1
Orthophosphate:	Based on US EPA Method 365.1
Non-volatile organic carbon:	Based on SM method 5310B
Total Dissolved Solids:	Based on SM method 2540C
Total Suspended Solids:	Based on SM method 2540D
pH:	Based on US EPA method 150.1

SM - "Standard Methods for the Examination of Water and Wastewater"
US EPA - methods by the US Environmental Protection Agency

Analytical Results

Date collected	Time collected (cst)	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
					MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
9/8/09	1:42:00 PM	NA*	NA*	TB7Bin Isco	TOLLWAY 261			0.063	0.0447		35.3				0.00609	0.0064	11.0		9.07			287				38.1
10/21/09	7:55:00 AM	NA*	NA*	TB7Bin Isco	TOLLWAY 290			0.060	0.0571		63.0				0.00838	0.0167	10.6		19.0			294		0.092		71.0
11/3/09	10:50:00 AM	510	NA*	TB7Bin Isco	TOLLWAY 296				0.0287		19.5				0.00349	0.0147	3.83		4.28	0.0057		72.6				16.1
12/1/09	10:15:00 AM	NA*	NA*	TB7Bin Isco	TOLLWAY 325			0.035	0.0367		36.9				0.00365	0.0287	4.33		7.66			97.0				31.2
12/29/09	11:15:00 AM	24097	9.10	TB7Bin Isco	TOLLWAY 354	0.045		0.064	0.2269		101			0.0066		0.0371	42.9		23.4	0.0128		5258	0.024			96.6
1/26/10	14:40:00 PM	NA*	NA*	TB7Bin Isco	TOLLWAY 391	0.114		0.061	0.1031		55.0				0.00979	0.0355	24.0		5.86	0.0122		1558	0.016			34.3
4/13/10	13:20:00 PM	4401	8.22	TB7Bin Isco	TOLLWAY 483			0.042	0.0664		42.2			0.0059	0.00947	0.0136	13.3		15.7	0.0379		813				34.4
5/11/10	14:15:00 PM	1734	8.23	TB7Bin Isco	TOLLWAY 520	0.079			0.0375		33.0				0.00520	0.0132	8.82		7.46			311				17.7
5/24/10	14:20:00 PM	2300	6.76	TB7Bin Isco	TOLLWAY 540	0.084		0.026	0.0683		47.6				0.00440	0.0151	10.1		8.99	0.0107		405				26.3
6/7/10	13:50:00 PM	964	7.06	TB7Bin Isco	TOLLWAY 566				0.0506		27.9				0.00422	0.0440	6.27		3.46	0.0197		157				12.3
6/21/10	15:45:00 PM	1345	7.75	TB7Bin Isco	TOLLWAY 586	0.063		0.034	0.0485		34.2				0.00691	0.0160	6.53		5.84	0.0036		226		0.064		21.4
7/6/10	17:10:00 PM	750	8.25	TB7Bin Isco	TOLLWAY 610	0.073		0.023	0.0435		23.6				0.00545	0.0111	3.70		3.51			121				13.8
7/19/10	16:40:00 PM	1297	8.13	TB7Bin Isco	TOLLWAY 624	0.040		0.038	0.0370		26.2			0.0062	0.00771		6.88		6.41	0.0017		224				24.6
8/16/10	13:50:00 PM	300	8.60	TB7Bin Isco	TOLLWAY 661	0.057		0.026	0.0396		16.8			0.0097	0.00643	0.0061	2.27		1.90			41.2				7.16
NA*= not enough sample for field parameters																										
				TB7Bin Isco	min	0.040	NA	0.023	0.0287	NA	16.762	NA	NA	0.00591	0.00349	0.0061	2.275	NA	1.9000	0.0017	NA	41.21	0.016	0.064	NA	7.16
				TB7Bin Isco	max	0.114	NA	0.064	0.227	NA	100.536	NA	NA	0.00970	0.00979	0.0440	42.899	NA	23.3545	0.0379	NA	5258.28	0.024	0.092	NA	96.63
				TB7Bin Isco	mean	0.070	NA	0.043	0.063	NA	40.123	NA	NA	0.00710	0.00624	0.0199	11.038	NA	8.7473	0.0130	NA	704.68	0.020	0.078	NA	31.79
9/8/09	1:15:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 262	0.038		0.041	0.0329		31.0				0.00446	0.0116	4.23		6.98			95.9				26.5
10/6/09	3:25:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 275				0.0202		20.7				0.00389	0.0248	4.25		4.84			70.0				18.4
10/21/09	8:21:00 AM	NA*	NA*	TB7Bout Isco	TOLLWAY 289			0.030	0.0311		31.9				0.00574	0.0235	6.50		7.78			109		0.063		26.9
11/3/09	10:15:00 AM	891	NA*	TB7Bout Isco	TOLLWAY 297			0.044	0.0245		44.1				0.00432	0.0534	5.06		11.1	0.0062		115				40.4
12/1/09	10:00:00 AM	NA*	NA*	TB7Bout Isco	TOLLWAY 324			0.025	0.0271		43.3				0.00468	0.0606	5.05		9.71			102				37.7
12/29/09	10:15:00 AM	5065	9.49	TB7Bout Isco	TOLLWAY 355	0.052		0.042	0.0659		84.2				0.00419	0.0219	18.1		19.3	0.0251		947	0.018			83.3
1/26/10	14:12:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 392	0.066		0.051	0.0701		108					0.0233	16.3		19.2	0.189		1188	0.020			92.7
3/16/10	14:25:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 446	0.065		0.039	0.0507		84.5				0.01155	0.0146	11.5		15.7	0.0369		848				72.7
4/13/10	12:50:00 PM	2859	8.37	TB7Bout Isco	TOLLWAY 484			0.037	0.0418		64.8				0.00872	0.0656	8.55		11.9	0.0026		501				55.3
5/11/10	13:55:00 PM	1707	8.27	TB7Bout Isco	TOLLWAY 521	0.050		0.027	0.0293		43.3				0.00603	0.0395	6.90		9.11	0.0024		293				33.6
5/24/10	12:52:00 PM	890	7.03	TB7Bout Isco	TOLLWAY 541	0.079			0.0264		25.6				0.00411	0.0769	3.88		5.34	0.0036		141				18.1
6/7/10	13:25:00 PM	1099	7.02	TB7Bout Isco	TOLLWAY 567	0.057			0.0368		25.6				0.00539	0.0382	5.92		4.90	0.0025		187				15.3
6/21/10	14:45:00 PM	1043	7.85	TB7Bout Isco	TOLLWAY 587	0.074		0.037	0.0399		32.2				0.00589	0.0323	4.96		6.14			166				22.0
7/6/10	16:46:00 PM	915	8.07	TB7Bout Isco	TOLLWAY 611	0.095		0.064	0.0393		29.9				0.00564	0.105	5.19		6.04	0.0107		149				18.7
7/19/10	16:15:00 PM	798	8.33	TB7Bout Isco	TOLLWAY 625	0.040		0.057	0.0320		29.5				0.00861	0.0193	5.95		5.11			122		0.352		15.9
8/3/10	12:45:00 PM	611	7.28	TB7Bout Isco	TOLLWAY 646			0.049	0.0240		33.2				0.00379	0.025	3.83		6.21	0.002		81.3		0.079		24.7
8/16/10	13:37:00 PM	1051	8.06	TB7Bout Isco	TOLLWAY 662			0.074	0.0451		46.1				0.00927	0.032	6.33		8.65	0.009		160		0.287		32.5
NA*= not enough sample for field parameters																										
				TB7Bout Isco	min	0.038	NA	0.025	0.0202	NA	20.700	NA	NA	NA	0.00379	0.0116	3.830	NA	4.8380	0.0022	NA	70.00	0.018	0.063	NA	15.31
				TB7Bout Isco	max	0.095	NA	0.074	0.0701	NA	108.386	NA	NA	NA	0.01155	0.1051	18.053	NA	19.3189	0.1888	NA	1188.06	0.020	0.352	NA	92.68
				TB7Bout Isco	mean	0.061	NA	0.044	0.0375	NA	45.786	NA	NA	NA	0.00602	0.0393	7.204	NA	9.2938	0.0263	NA	310.31	0.019	0.195	NA	37.33

APPENDIX A: Results of Geochemical Analysis of Isco Surface-Water Samples

Date collected	Time collected (cst)	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as CaC	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
					MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
9/8/09	1:42:00 PM	NA*	NA*	TB7Bin Isco	TOLLWAY 261			2.48		0.394				0.0194	7.60	79	839	no sample		0.27	0.12	355	1.81	110	16.9	8.82
10/21/09	7:55:00 AM	NA*	NA*	TB7Bin Isco	TOLLWAY 290			1.85		0.507				0.0234	7.75	92	1072	22.8	0.007	0.16	0.36	393	0.90	236	18.3	8.61
11/3/09	10:50:00 AM	510	NA*	TB7Bin Isco	TOLLWAY 296			1.10		0.142				0.0181	6.92	47	271	90.0	0.010	0.09	0.17	90.6	0.20	52.4	22.2	2.95
12/1/09	10:15:00 AM	NA*	NA*	TB7Bin Isco	TOLLWAY 325			1.22		0.212				0.0138	7.40	63	396	162	0.005	0.15	0.26	126	0.43	91.4	4.42	4.62
12/29/09	11:15:00 AM	24097	9.10	TB7Bin Isco	TOLLWAY 354			1.98		1.29				0.0093	8.01	132	14372	818		0.81		8768	1.16	246	37.4	10.6
1/26/10	14:40:00 PM	NA*	NA*	TB7Bin Isco	TOLLWAY 391			1.37		0.656				0.0125	8.18	141	4004	976	0.010	0.50	0.11	2410	0.70	97.7	62.8	7.22
4/13/10	13:20:00 PM	4401	8.22	TB7Bin Isco	TOLLWAY 483			1.63		0.487					8.13	185	2365	748		0.56	0.21	1307	0.41	96.9	58.4	6.97
5/11/10	14:15:00 PM	1734	8.23	TB7Bin Isco	TOLLWAY 520			1.33		0.303					8.36	78	911	148	0.004	0.31	0.19	491	0.41	47.4	10.4	5.79
5/24/10	14:20:00 PM	2300	6.76	TB7Bin Isco	TOLLWAY 540			1.18		0.433				0.0123	7.90	97	1213	102	0.013	0.65	0.36	636	0.29	76.1	14.4	4.31
6/7/10	13:50:00 PM	964	7.06	TB7Bin Isco	TOLLWAY 566			1.38		0.225				0.0201	7.52	79	500	169	0.021	1.11	0.13	229	0.13	35.8	28.2	7.22
6/21/10	15:45:00 PM	1345	7.75	TB7Bin Isco	TOLLWAY 586			1.38		0.282				0.0208	7.61	69	707	41.2	0.021	0.13	0.22	344	0.27	61.1	13.9	5.83
7/6/10	17:10:00 PM	750	8.25	TB7Bin Isco	TOLLWAY 610			1.03		0.199				0.0138	7.66	45	395	80.5	0.015	0.19	0.13	172	0.47	39.1	12.9	3.85
7/19/10	16:40:00 PM	1297	8.13	TB7Bin Isco	TOLLWAY 624			1.18		0.277				0.0263	7.59	47	684	61.0	0.021	0.08	0.21	328	0.55	70.3	11.0	5.59
8/16/10	13:50:00 PM	300	8.60	TB7Bin Isco	TOLLWAY 661			1.05		0.117				0.021	7.51	41	161	20.0	0.014		0.20	50.1	0.44	20.8	7.63	4.57
NA*= not enough sample for field parameters																										
				TB7Bin Isco	min	NA	NA	1.03	NA	0.117	NA	NA	NA	0.0093	6.92	41	161	20.00	0.004	0.08	0.11	50.05	0.13	20.75	4.42	2.95
				TB7Bin Isco	max	NA	NA	2.48	NA	1.290	NA	NA	NA	0.0263	8.36	185	14372	976.00	0.021	1.11	0.36	8768.42	1.81	245.67	62.78	10.57
				TB7Bin Isco	mean	NA	NA	1.44	NA	0.395	NA	NA	NA	0.0176	7.72	85	1992	264.48	0.013	0.38	0.20	1121.42	0.58	91.49	22.77	6.21
9/8/09	1:15:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 262			1.69		0.181					7.54	60	370	no sample		0.12	0.22	118	0.19	78.9	10.8	7.10
10/6/09	3:25:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 275			0.771		0.134				0.0077	7.02	40	267	no sample	0.006	<0.06	0.15	91.5	0.33	53.5	7.82	6.64
10/21/09	8:21:00 AM	NA*	NA*	TB7Bout Isco	TOLLWAY 289			1.26		0.197				0.0117	7.49	61	417	no sample	0.004	<0.06	0.28	133	0.34	90.8	6.60	6.39
11/3/09	10:15:00 AM	891	NA*	TB7Bout Isco	TOLLWAY 297			1.46		0.229					7.34	66	489	7.2	0.006	<0.06	0.23	142	0.17	133	7.58	5.25
12/1/09	10:00:00 AM	NA*	NA*	TB7Bout Isco	TOLLWAY 324			1.17		0.214	0.00076			0.0113	7.47	57	434	9.2		0.09	0.28	141	0.45	104	7.45	6.06
12/29/09	10:15:00 AM	5065	9.49	TB7Bout Isco	TOLLWAY 355			1.99		0.693					8.15	71	2815	22	0.004	0.30	0.12	1522	1.56	228	9.08	7.24
1/26/10	14:12:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 392			1.70		0.695				0.0081	8.04	78	3230	19.2	0.004	0.38	0.18	1768	1.95	222	7.97	6.79
3/16/10	14:25:00 PM	NA*	NA*	TB7Bout Isco	TOLLWAY 446			1.06		0.519		0.024		0.0155	7.98	73	2421	18.8		0.14	0.15	1269	1.24	193	10.9	8.06
4/13/10	12:50:00 PM	2859	8.37	TB7Bout Isco	TOLLWAY 484			0.987		0.399	0.00063			0.0140	7.77	62	1568	88.0	0.010	0.33	0.16	785	0.52	146	15.7	7.49
5/11/10	13:55:00 PM	1707	8.27	TB7Bout Isco	TOLLWAY 521			0.856		0.297	0.00064			0.0086	7.76	58	912	10.4	0.017	0.23	0.13	450	0.40	90.1	7.60	7.01
5/24/10	12:52:00 PM	890	7.03	TB7Bout Isco	TOLLWAY 541			1.14		0.157	0.00165			0.0081	7.52	49	471	16.0	0.015	0.57	0.28	206	2.23	54.2	8.20	4.40
6/7/10	13:25:00 PM	1099	7.02	TB7Bout Isco	TOLLWAY 567			0.968		0.188					7.74	58	573	16.8	0.022	0.31	0.12	277	0.21	44.3	11.0	7.78
6/21/10	14:45:00 PM	1043	7.85	TB7Bout Isco	TOLLWAY 587			1.39		0.212					7.80	68	552	25.2	0.009	0.13	0.24	244	0.26	63.1	9.08	7.92
7/6/10	16:46:00 PM	915	8.07	TB7Bout Isco	TOLLWAY 611			2.04		0.196	0.00248				7.94	70	490	70.0	0.031	0.14	0.21	200	0.46	51.8	15.9	8.37
7/19/10	16:15:00 PM	798	8.33	TB7Bout Isco	TOLLWAY 625			1.15		0.182				0.0114	7.51	74	420	59.0	0.276	2.61	0.24	168	0.21	44.2	12.3	9.02
8/3/10	12:45:00 PM	611	7.28	TB7Bout Isco	TOLLWAY 646			1.37		0.154				0.008	7.47	44	335	15.6	0.053	0.08	0.15	112	0.61	69.5	6.03	5.62
8/16/10	13:37:00 PM	1051	8.06	TB7Bout Isco	TOLLWAY 662			1.95		0.257				0.010	7.84	91	591	25.2	0.240	1.58	0.22	218	0.22	94.0	14.9	8.72
NA*= not enough sample for field parameters																										
				TB7Bout Isco	min	NA	NA	0.77	NA	0.134	0.00063	0.024	NA	0.0077	7.02	40	267	7.20	0.004	0.08	0.12	91.51	0.17	44.18	6.03	4.40
				TB7Bout Isco	max	NA	NA	2.04	NA	0.695	0.00248	0.024	NA	0.0155	8.15	91	3230	88.00	0.276	2.61	0.28	1767.96	2.23	227.73	15.89	9.02
				TB7Bout Isco	mean	NA	NA	1.35	NA	0.288	0.00123	0.024	NA	0.0104	7.67	64	962	28.79	0.050	0.50	0.20	461.43	0.67	103.53	9.93	7.05

APPENDIX A: Results of Geochemical Analysis of Isco Surface-Water Samples

Date collected	Time collected (cst)	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
					MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
8/25/09	2:57:00 PM	858	7.95	TB9A Isco	TOLLWAY 252	0.101			0.0399		27.2				0.00385	0.0646	9.88		3.86	0.0033		106				11.5
9/8/09	3:45:00 PM	742	6.96	TB9A Isco	TOLLWAY 259			0.035	0.0419		33.7				0.00362	0.0286	7.31		6.50	0.0063		114		0.067		22.9
10/6/09	3:35:00 PM	NA*	NA*	TB9A Isco	TOLLWAY 276	0.149			0.0271		22.1				0.00243	0.158	3.77		2.76			37.6				7.71
10/20/09	1:50:00 PM	NA*	NA*	TB9A Isco	TOLLWAY 288			0.027	0.0409		31.7				0.00464	0.0231	7.53		6.61			106		0.072		19.2
11/3/09	8:55:00 AM	598	NA*	TB9A Isco	TOLLWAY 298	0.066		0.026	0.0268		26.8				0.00379	0.0445	5.15		6.26			81.4				19.4
12/1/09	9:00:00 AM	NA*	NA*	TB9A Isco	TOLLWAY 323	0.053			0.028		23.2				0.00633	0.0454	5.72		4.65			69.1				14.6
12/29/09	9:00:00 AM	4847	9.68	TB9A Isco	TOLLWAY 353			0.034	0.0869		76.6				0.00554	0.0101	16.6		19.3	0.0062		906	0.020			47.4
4/14/10	8:00:00 AM	1445	8.91	TB9A Isco	TOLLWAY 482	0.094		0.030	0.0414		32.3				0.00428	0.157	5.83		9.21	0.0126		241				19.6
5/11/10	12:50:00 PM	1688	8.16	TB9A Isco	TOLLWAY 522	0.185			0.053		40.3				0.00775	0.206	9.60		8.25	0.123		281				14.6
5/26/10	9:25:00 AM	786	7.30	TB9A Isco	TOLLWAY 544	0.583			0.0343		22.8				0.00435	0.430	4.64		4.26	0.0082		130				10.3
6/7/10	14:35:00 PM	1057	7.25	TB9A Isco	TOLLWAY 565	0.103			0.0632		36.9				0.00351	0.0924	9.10		3.84	0.0409		171				8.44
6/21/10	16:30:00 PM	1001	7.83	TB9A Isco	TOLLWAY 588	0.160		0.025	0.0561		30.9				0.00516	0.134	8.87		3.56	0.0076		163				10.1
7/6/10	15:40:00 PM	730	8.47	TB9A Isco	TOLLWAY 608	0.077		0.028	0.0386		23.1				0.00476	0.0510	6.72		2.53			118				6.71
7/19/10	15:35:00 PM	871	8.15	TB9A Isco	TOLLWAY 626	0.041		0.035	0.0370		21.3			0.0104	0.00521	0.0265	10.2		2.73			150				7.35
8/3/10	15:15:00 PM	259	7.30	TB9A Isco	TOLLWAY 647	0.077		0.027	0.016		11.1				0.00290	0.072	2.10		2.47	0.004		35.9				6.55
8/16/10	13:18:00 PM	953	8.29	TB9A Isco	TOLLWAY 663	0.079		0.043	0.040		19.1			0.009	0.0101	0.035	10.4		4.03	0.002		164				12.7
		NA*= not enough sample for field parameters																								
				TB9A Isco	min	0.041	NA	0.025	0.016	NA	11.114	NA	NA	0.00940	0.00243	0.0101	2.102	NA	2.4676	0.0016	NA	35.87	0.020	0.067	NA	6.55
				TB9A Isco	max	0.583	NA	0.043	0.087	NA	76.645	NA	NA	0.01044	0.01014	0.4298	16.583	NA	19.2969	0.1231	NA	906.05	0.020	0.072	NA	47.37
				TB9A Isco	mean	0.136	NA	0.031	0.042	NA	29.940	NA	NA	0.00992	0.00489	0.0986	7.713	NA	5.6750	0.0213	NA	179.65	0.020	0.070	NA	14.94
4/1/09	11:20:00	5423	10.85	TB15B Isco	TOLLWAY 195			0.026	0.0966		54.0			0.0069	0.0113	0.0225	21.6		1.91	0.0038		1050		0.081		11.9
4/14/09	12:45:00	NA*	NA*	TB15B Isco	TOLLWAY 205	0.089		0.031	0.0748		35.0			0.0086	0.0118	0.0725	22.6		3.31	0.0025		773		0.133		12.4
4/29/09	13:35:00	2275	8.51	TB15B Isco	TOLLWAY 211	0.253		0.038	0.0495		26.5			0.0080	0.0114	0.183	18.4		1.45	0.0100		447		0.131		9.70
5/11/09	14:30:00	1405	NA*	TB15B Isco	TOLLWAY 216	0.317		0.029	0.0469		17.6			0.0067	0.00834	0.221	12.4		1.80	0.0036		274		0.139		7.14
5/27/09	12:35:00	1530	NA*	TB15B Isco	TOLLWAY 220	0.053		0.042	0.0398		18.6				0.00915	0.0415	12.6		2.29			289				9.18
6/10/09	14:15:00	1366	6.98	TB15B Isco	TOLLWAY 225	0.475		0.028	0.0428		16.6				0.00878	0.333	13.1		2.01	0.0124		272				8.95
6/30/09	12:35:00	519	6.79	TB15B Isco	TOLLWAY 228	0.094		0.025	0.0255		16.8				0.00437	0.0658	5.08		1.63			94.9				4.01
7/28/09	8:49:00	826	8.08	TB15B Isco	TOLLWAY 247	0.092			0.0329		20.0			0.0073	0.00589	0.0792	6.21		2.57	0.0021		137		0.065		9.31
8/25/09	10:45:00	998	8.53	TB15B Isco	TOLLWAY 249	0.353		0.051	0.0467		18.6			0.0082	0.0108	0.280	12.4		2.87	0.0187		179				12.5
9/8/09	11:45:00	1385	6.77	TB15B Isco	TOLLWAY 257	0.099		0.062	0.0325		19.2				0.00842	0.115	8.91		3.70			298		0.120		17.0
10/6/09	13:50:00	NA*	NA*	TB15B Isco	TOLLWAY 278	0.564		0.034	0.0393		23.6				0.00765	0.377	19.7		3.75	0.0024	0.026	270		0.065		22.2
11/2/09	14:40:00	823	NA*	TB15B Isco	TOLLWAY 299	0.192		0.037	0.0204		15.9			0.0063	0.00600	0.143	24.1		1.67	0.0025		136				12.5
12/2/09	8:30:00	NA*	NA*	TB15B Isco	TOLLWAY 322	0.471			0.028		19.3				0.00858	0.331	17.9		2.79	0.0038		166		0.105		15.1
12/29/09	12:45:00	4333	10.14	TB15B Isco	TOLLWAY 351				0.0972		46.5				0.00584	0.0121	24.0		3.87			873				15.5
1/26/10	10:55:00	NA*	NA*	TB15B Isco	TOLLWAY 393	0.045		0.044	0.104		44.3				0.0111	0.0281	37.9		2.95		0.024	1639		0.071		25.4
3/17/10	10:15:00	NA*	NA*	TB15B Isco	TOLLWAY 447	0.630			0.0412		31.5				0.0140	0.418	24.6		12.8	0.0347		984				18.9
4/13/10	8:22:00	1576	8.88	TB15B Isco	TOLLWAY 485	1.11		0.020	0.0300		17.3				0.0113	0.769	10.4		2.60	0.0099		290		0.071		7.76
5/11/10	16:00:00 PM	1185	8.27	TB15B Isco	TOLLWAY 523	0.813		0.028	0.029		16.0				0.00741	0.533	10.5		2.70	0.0067		225				7.10
5/25/10	12:20:00	610	7.13	TB15B Isco	TOLLWAY 542	0.674			0.0206		12.4				0.00450	0.419	6.80		1.10	0.0049		113				4.12
6/7/10	12:50:00	1209	7.46	TB15B Isco	TOLLWAY 564	0.223			0.0339		19.3				0.0107	0.198	13.6		3.74	0.0078		208				8.65
6/21/10	13:30:00 PM	1358	7.74	TB15B Isco	TOLLWAY 589	0.263		0.035	0.0454		21.9				0.0125	0.188	17.4		3.22	0.0062		244	0.016			10.7
7/6/10	14:14:00 PM	901	8.41	TB15B Isco	TOLLWAY 609	0.152		0.035	0.0418		22.2				0.00793	0.113	14.1		2.34	0.0050		158				6.58
7/19/10	14:05:00 PM	713	8.30	TB15B Isco	TOLLWAY 627	0.985		0.035	0.0306		15.9			0.0074	0.00547	0.607	6.64		3.02	0.0075		122				7.46
		NA*= not enough sample for field parameters																								
				TB15B Isco	min	0.045	NA	0.020	0.020	NA	12.355	NA	NA	0.0063	0.0044	0.0121	5.080	NA	1.1016	0.0021	0.024	94.90	0.016	0.065	NA	4.01
				TB15B Isco	max	1.111	NA	0.062	0.104	NA	54.000	NA	NA	0.0086	0.0140	0.7687	37.937	NA	12.8063	0.0347	0.026	1638.69	0.016	0.139	NA	25.43
				TB15B Isco	mean	0.378	NA	0.035	0.046	NA	23.865	NA	NA	0.0074	0.0088	0.2413	15.695	NA	3.0475	0.0080	0.025	401.88	0.016	0.098	NA	11.48

APPENDIX A: Results of Geochemical Analysis of Isco Surface-Water Samples

Date collected	Time collected (cst)	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as CaC	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
					MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
8/25/09	2:57:00 PM	858	7.95	TB9A Isco	TOLLWAY 252			1.28		0.226	0.00239				7.74	82	395	481		0.15	0.12	160	0.37	33.8	26.9	7.71
9/8/09	3:45:00 PM	742	6.96	TB9A Isco	TOLLWAY 259			1.60		0.264	0.00088				7.55	72	418	190	0.01	0.10	0.08	145	1.59	66.7	14.9	4.59
10/6/09	3:35:00 PM	NA*	NA*	TB9A Isco	TOLLWAY 276			0.938		0.152	0.00344				7.52	58	169	no sample		0.12	0.09	49.4	0.38	20.8	23.5	5.04
10/20/09	1:50:00 PM	NA*	NA*	TB9A Isco	TOLLWAY 288			1.46		0.242	0.00074				7.94	77	393	no sample	0.004	no sample	0.18	133	0.35	64.6	no sample	no sample
11/3/09	8:55:00 AM	598	NA*	TB9A Isco	TOLLWAY 298			1.25		0.181	0.00104				7.67	66	325	102	0.005		0.16	103	0.29	62.3	10.9	3.55
12/1/09	9:00:00 AM	NA*	NA*	TB9A Isco	TOLLWAY 323			1.03		0.162	0.00130			0.0143	7.54	57	251	73.0	0.010	0.42	0.22	85.2	0.41	41.9	9.12	5.16
12/29/09	9:00:00 AM	4847	9.68	TB9A Isco	TOLLWAY 353			1.69		0.781					7.81	79	2765	223	0.007	0.56	0.12	1527	0.61	134	11.1	6.43
4/14/10	8:00:00 AM	1445	8.91	TB9A Isco	TOLLWAY 482			1.52		0.294	0.00185				8.20	110	786	2240	0.006	0.55	0.14	386	0.43	54.1	13.1	4.93
5/11/10	12:50:00 PM	1688	8.16	TB9A Isco	TOLLWAY 522			1.79		0.315	0.00574			0.0724	6.43	12	933	141	0.009	0.35	0.13	441	24.0	39.3	18.4	7.48
5/26/10	9:25:00 AM	786	7.30	TB9A Isco	TOLLWAY 544			2.23		0.172	0.0195			0.0078	7.88	59	414	189	0.009	0.06	0.20	187	0.57	30.2	15.4	3.44
6/7/10	14:35:00 PM	1057	7.25	TB9A Isco	TOLLWAY 565			1.63		0.321	0.00191				7.90	122	548	1128	0.017	1.06	0.08	255	0.15	23.8	86.4	6.14
6/21/10	16:30:00 PM	1001	7.83	TB9A Isco	TOLLWAY 588			1.61		0.259	0.00452			0.0079	7.90	87	525	304	0.028	0.23	0.19	242	0.83	28.3	19.4	6.32
7/6/10	15:40:00 PM	730	8.47	TB9A Isco	TOLLWAY 608			1.14		0.190	0.00139				7.99	66	377	166	0.030		0.13	170	0.80	19.2	15.8	3.81
7/19/10	15:35:00 PM	871	8.15	TB9A Isco	TOLLWAY 626			1.11		0.197					7.78	57	456	76.5	0.018		0.17	222	0.48	20.3	15.1	6.70
8/3/10	15:15:00 PM	259	7.30	TB9A Isco	TOLLWAY 647			0.733		0.073	0.002			0.009	7.40	27	140	27.6	0.011		0.08	51.9	0.21	19.0	6.33	3.59
8/16/10	13:18:00 PM	953	8.29	TB9A Isco	TOLLWAY 663			1.50		0.192	0.001			0.009	7.85	51	499	50.0	0.008		0.14	235	1.32	36.5	11.9	5.48
NA*= not enough sample for field parameters																										
				TB9A Isco	min	NA	NA	0.73	NA	0.073	0.00074	NA	NA	0.0078	6.43	12	140	27.60	0.004	0.06	0.08	49.45	0.15	18.99	6.33	3.44
				TB9A Isco	max	NA	NA	2.23	NA	0.781	0.01948	NA	NA	0.0724	8.20	122	2765	2240.00	0.030	1.06	0.22	1527.33	23.95	134.36	86.36	7.71
				TB9A Isco	mean	NA	NA	1.41	NA	0.251	0.00338	NA	NA	0.0201	7.69	68	587	385.09	0.013	0.36	0.14	274.56	2.05	43.44	19.88	5.36
4/1/09	11:20:00	5423	10.85	TB15B Isco	TOLLWAY 195			2.24		0.497					10.62	148	2863	307	0.059	0.32	0.20	1712	0.56	30.7	18.4	7.87
4/14/09	12:45:00	NA*	NA*	TB15B Isco	TOLLWAY 205			2.43		0.400	0.0013				8.70	147	1955	562	0.070	0.22	0.18	1076	0.51	34.6	31.4	11.3
4/29/09	13:35:00	2275	8.51	TB15B Isco	TOLLWAY 211			3.00		0.298	0.00579				9.64	152	1206	201	0.067	0.33	0.33	622	0.54	27.8	29.7	11.6
5/11/09	14:30:00	1405	NA*	TB15B Isco	TOLLWAY 216			2.46		0.191	0.00730				7.83	101	735	335	0.101	0.99	0.20	376	0.41	18.9	28.2	8.24
5/27/09	12:35:00	1530	NA*	TB15B Isco	TOLLWAY 220			2.04	0.086	0.209					7.97	97	832	421	0.020	0.33	0.19	411	1.50	24.5	37.8	11.3
6/10/09	14:15:00	1366	6.98	TB15B Isco	TOLLWAY 225			2.76	0.086	0.194	0.0106				7.78	87	731	264	0.012	0.31	0.21	364	0.43	24.5	31.7	11.4
6/30/09	12:35:00	519	6.79	TB15B Isco	TOLLWAY 228			1.51		0.131	0.00178				7.79	78.0	294	461	0.029		0.16	112	0.52	11.1	29.9	6.43
7/28/09	8:49:00	826	8.08	TB15B Isco	TOLLWAY 247			1.43		0.142	0.00200				7.53	83	443	994	0.038	0.28	0.36	189	0.64	26.3	56.5	11.1
8/25/09	10:45:00	998	8.53	TB15B Isco	TOLLWAY 249			2.77		0.158	0.0107				7.58	83	544	182	0.062	0.13	0.28	240	0.64	34.2	24.4	12.0
9/8/09	11:45:00	1385	6.77	TB15B Isco	TOLLWAY 257			3.94		0.170	0.00238				8.06	129	774	237	0.097	0.12	0.24	349	0.34	48.6	21.8	10.3
10/6/09	13:50:00	NA*	NA*	TB15B Isco	TOLLWAY 278			2.93		0.194	0.0143				7.89	90	809	no sample	0.070	0.17	0.29	372	0.32	63.6	35.1	14.4
11/2/09	14:40:00	823	NA*	TB15B Isco	TOLLWAY 299			3.84		0.159	0.00465				9.48	119	478	60.8	0.035	0.16	0.27	149	0.19	39.8	14.4	7.20
12/2/09	8:30:00	NA*	NA*	TB15B Isco	TOLLWAY 322			2.80		0.168	0.0119			0.0091	8.16	111	519	no sample	0.053	0.17	0.26	211	0.52	42.1	no sample	no sample
12/29/09	12:45:00	4333	10.14	TB15B Isco	TOLLWAY 351			1.95		0.463					9.91	46	2489	24	0.013	0.21	0.12	1460	0.45	45.2	8.93	7.05
1/26/10	10:55:00	NA*	NA*	TB15B Isco	TOLLWAY 393			2.84		0.583	0.00103				9.68	60	4189	95.6	0.006	0.37		2448	0.39	62.6	12.3	11.5
3/17/10	10:15:00	NA*	NA*	TB15B Isco	TOLLWAY 447			4.09		0.322	0.0172	0.025		0.0103	8.70	136	2629	557	0.015	0.23		1500	2.02	52.1	18.6	12.7
4/13/10	8:22:00	1576	8.88	TB15B Isco	TOLLWAY 485			4.05		0.142	0.0360			0.0118	9.06	97	831	319	0.058	0.38	0.16	422	0.36	22.6	31.2	10.0
5/11/10	16:00:00 PM	1185	8.27	TB15B Isco	TOLLWAY 523			2.99		0.140	0.0199				7.94	72	640	92.0	0.067	0.51	0.14	322	0.19	18.8	20.0	8.10
5/25/10	12:20:00	610	7.13	TB15B Isco	TOLLWAY 542			2.38		0.0973	0.0130				7.79	66	320	167	0.025	0.18	0.20	142	0.41	11.5	15.6	4.53
6/7/10	12:50:00	1209	7.46	TB15B Isco	TOLLWAY 564			1.94		0.171	0.00563			0.0079	7.54	81	619	38.0	0.081	0.48	0.11	303	0.30	24.3	21.6	14.3
6/21/10	13:30:00 PM	1358	7.74	TB15B Isco	TOLLWAY 589			2.81		0.219	0.00642				7.85	118	732	65.6	0.065	0.65	0.26	334	0.38	29.8	23.2	16.0
7/6/10	14:14:00 PM	901	8.41	TB15B Isco	TOLLWAY 609			2.12		0.185	0.00316				7.98	95	488	120	0.084	0.09	0.20	208	0.13	17.8	15.0	9.56
7/19/10	14:05:00 PM	713	8.30	TB15B Isco	TOLLWAY 627			3.31		0.112	0.0301			0.0092	7.86	60	386	65.0	0.084		0.21	169	0.18	21.7	14.2	7.54
NA*= not enough sample for field parameters																										
				TB15B Isco	min	NA	NA	1.43	0.09	0.097	0.00103	0.025	NA	0.0079	7.53	46	294	24.00	0.006	0.09	0.11	111.69	0.13	11.14	8.93	4.53
				TB15B Isco	max	NA	NA	4.09	0.09	0.583	0.03604	0.025	NA	0.0118	10.62	152	4189	994.00	0.101	0.99	0.36	2448.31	2.02	63.56	56.52	15.96
				TB15B Isco	mean	NA	NA	2.72	0.09	0.232	0.01026	0.025	NA	0.0097	8.41	98	1109	265.13	0.053	0.32	0.22	586.51	0.52	31.88	24.54	10.20

APPENDIX A: Results of Geochemical Analysis of Isco Surface-Water Samples

Date collected	Time collected (cst)	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
					MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
3/5/08	10:30:00	6764	7.70	TB19 Isco	TOLLWAY 25	0.317		0.032	0.0877		58.9				0.00989	0.222	2.87		12.2	0.123		1302	0.021			27.9
3/26/08	11:15:00	NA*	NA*	TB19 Isco	TOLLWAY 32	0.3743		0.058	0.195		114			0.0117	0.00658	0.195	8.17	0.035	26.4	0.1133		3261	0.024			46.4
4/9/08	14:00:00	4695	7.86	TB19 Isco	TOLLWAY 38	0.628		0.049	0.0715		49.4				0.00720	0.438	5.07		16.4	0.0221		915	0.016		0.046	25.5
4/14/08	11:20:00	2406	7.95	TB19 Isco	TOLLWAY 40	0.190		0.044	0.0461		36.1				0.0105	0.171	4.57		13.9	0.0139		440				18.1
5/6/08	10:25:00	5540	7.90	TB19 Isco	TOLLWAY 46	0.275		0.089	0.0989		60.6				0.0195	0.195	4.56		19.4	0.0076		1050				43.4
5/20/08	9:02:00	2146	7.88	TB19 Isco	TOLLWAY 54	0.128		0.053	0.0452		30.9				0.01014	0.126	2.57		8.56	0.0028		408				18.9
5/28/08	14:21:00	1951	7.93	TB19 Isco	TOLLWAY 57	0.100		0.046	0.0450		32.3				0.0122	0.0381	2.01		7.00	0.0087		405	0.020			17.3
6/9/08	15:02:00	1969	7.99	TB19 Isco	TOLLWAY 60	0.198		0.057	0.0443		29.0				0.00935	0.126	3.26		7.27	0.0032		389	0.017			14.8
6/24/08	12:30:00	NA*	NA*	TB19 Isco	TOLLWAY 72	0.0586		0.067	0.0589		35.0				0.0172	0.0445	2.59		7.68	0.0012		461		0.066		23.7
7/9/08	19:10:00	1861	7.76	TB19 Isco	TOLLWAY 80	0.267		0.056	0.0445		31.3			0.0088	0.0125	0.247	2.63		6.39	0.0115		344	0.014			16.8
7/22/08	15:40:00	NA*	NA*	TB19 Isco	TOLLWAY 90	0.261		0.045	0.0340		28.4				0.00796	0.230	1.72		4.48	0.0028		212				11.0
8/6/08	7:45:00	NA*	NA*	TB19 Isco	TOLLWAY 101	0.198		0.0580	0.0398		30.5			0.0075	0.0217	0.201	2.68		5.55	0.0029		251				13.0
9/17/08	10:25:00	549	8.16	TB19 Isco	TOLLWAY 120	0.988		0.039	0.0258		16.3			0.0094	0.00307	0.755	7.02		3.40	0.0064		97.5				7.13
10/15/08	14:47:00	NA*	NA*	TB19 Isco	TOLLWAY 143	0.114		0.040	0.0326		30.5				0.00569	0.0598	7.30		9.57			129				11.5
12/2/08	14:02:00	NA*	NA*	TB19 Isco	TOLLWAY 153	0.144		0.119	0.0619	0.00656	47.9	0.031	0.031	0.0270	0.0158	0.114	9.15	0.022	12.3	0.0236	0.046	535	0.037	0.162	0.069	21.2
12/16/08	15:10:00	3613	7.12	TB19 Isco	TOLLWAY 171	0.694		0.026	0.0640		47.0				0.00722	0.4172	10.3		13.9	0.0261		709				15.9
					*starting with the 12/2/08 sample, MDL for Al = 0.037 mg/L																					
				TB19 Isco	min	0.059	NA	0.026	0.026	0.007	16.300	0.031	0.031	0.008	0.003	0.038	1.720	0.022	3.404	0.001	0.046	97.500	0.014	0.066	0.046	7.130
				TB19 Isco	max	0.988	NA	0.119	0.195	0.007	114.000	0.031	0.031	0.027	0.022	0.755	10.300	0.035	26.400	0.123	0.046	3261.000	0.037	0.162	0.069	46.400
				TB19 Isco	mean	0.308	NA	0.055	0.062	0.007	42.381	0.031	0.031	0.013	0.011	0.224	4.779	0.029	10.900	0.025	0.046	681.781	0.021	0.114	0.058	20.783
10/6/09	11:35:00 AM	NA*	NA*	TB19r Isco	TOLLWAY 277	2.48		0.066	0.108		37.4				0.998	1.48	94.6		35.4	0.0324	0.052	606	0.028	0.122		26.5
10/20/09	11:45:00 AM	1856	7.64	TB19r Isco	TOLLWAY 286			0.036	0.0265		13.2			0.0084	0.00682	0.0300	77.5		17.4	0.0097	0.029	333		0.120		23.0
11/3/09	11:40:00 AM	713	NA*	TB19r Isco	TOLLWAY 295	0.059		0.034	0.0159		10.7			0.0082	0.00457	0.0569	29.2		9.33	0.0029		101	0.020			10.8
12/2/09	2:40:00 PM	831	7.11	TB19r Isco	TOLLWAY 320	0.076		0.034	0.023		19.1			0.0069	0.00511	0.0428	36.8		10.3	0.0016		119				12.5
12/16/09	8:40:00 AM	5908	7.52	TB19r Isco	TOLLWAY 340			0.024	0.125		87.7			0.0127	0.00450	0.0120	51.2		32.3	0.0088		1024	0.028			14.0
12/29/09	12:15:00 PM	13217	10.17	TB19r Isco	TOLLWAY 352			0.023	0.289		163			0.0120	0.00835	0.0093	89.2		49.3			2463	0.041			25.3
1/26/10	15:40:00 PM	8870	9.35	TB19r Isco	TOLLWAY 389			0.026	0.166		116			0.0092	0.0225		71.4		21.4			1803	0.026			17.1
3/16/10	13:46:00 PM	3980	8.03	TB19r Isco	TOLLWAY 444	0.049		0.026	0.0558		53.1				0.00817	0.0284	24.4		35.4	0.0494		752	0.015			13.2
3/31/10	12:04:00 PM	6074	8.80	TB19r Isco	TOLLWAY 465			0.032	0.0407		20.5			0.0100	0.0301		43.2		10.5			1220	0.016			14.0
4/14/10	9:05:00 AM	3070	8.79	TB19r Isco	TOLLWAY 486	1.13		0.057	0.0484		30.5			0.0093	0.0153	0.732	26.1		14.7	0.0125		593				11.9
5/11/10	15:10:00 PM	2989	8.13	TB19r Isco	TOLLWAY 524	0.249		0.038	0.048		30.6				0.0101	0.188	34.1		15.5	0.0074		554		0.291		9.10
5/25/10	16:00:00 PM	1235	7.07	TB19r Isco	TOLLWAY 543	0.168		0.030	0.0322		22.3				0.00566	0.115	16.3		12.0	0.0025		211		0.067		7.04
		NA*= not enough sample for field parameters																								
				TB19r Isco	min	0.049	NA	0.023	0.016	NA	10.679	NA	NA	0.00686	0.00450	0.0093	16.282	NA	9.3333	0.0016	0.029	100.60	0.015	0.067	NA	7.04
				TB19r Isco	max	2.480	NA	0.066	0.289	NA	162.825	NA	NA	0.01266	0.99779	1.4810	94.600	NA	49.3067	0.0494	0.052	2462.55	0.041	0.291	NA	26.50
				TB19r Isco	mean	0.602	NA	0.036	0.082	NA	50.302	NA	NA	0.00959	0.09324	0.2696	49.486	NA	21.9470	0.0141	0.041	814.96	0.025	0.150	NA	15.38
6/10/08	10:30:00	2383	7.56	SandersSW Isco	TOLLWAY 62	0.116		0.038	0.0414		20.4				0.0212	0.0832	2.39		4.41	0.0022		492	0.020			15.6
7/9/08	15:30:00	1628	7.70	SandersSW Isco	TOLLWAY 79	0.242		0.057	0.0320		15.8			0.0087	0.0209	0.216	3.36		3.21	0.0050	0.024	310	0.014	0.067		12.4
7/22/08	11:25:00	2065	7.80	SandersSW Isco	TOLLWAY 84	0.156		0.055	0.0377		22.2			0.0074	0.0241	0.206	3.43		4.60	0.0073		418		0.063		14.3
8/5/08	14:10:00	2502	7.67	SandersSW Isco	TOLLWAY 100	0.0860		0.0640	0.0526		27.7				0.0287	0.115	4.69		6.53	0.0099		469		0.084		17.7
9/17/08	7:20:00	18.78	7.59	SandersSW Isco	TOLLWAY 122	0.564		0.035	0.0348		20.2				0.0202	0.417	3.61		4.76	0.0031		376		0.097		15.9
10/1/08	12:11:00	NA*	NA*	SandersSW Isco	TOLLWAY 141	0.0762		0.030	0.0996		45.6				0.0215	0.0698	6.01		11.8	0.0117		478		0.115		26.1
10/15/08	12:15:00	2431	7.74	SandersSW Isco	TOLLWAY 145	0.119		0.046	0.0547		34.8				0.0148	0.0798	3.60		8.93	0.0016		447	0.015			22.9
11/12/08	12:13:00	NA*	NA*	SandersSW Isco	TOLLWAY 151	0.120		0.032	0.0754		51.5				0.0125	0.0654	5.98		15.0	0.0037		683	0.019			33.9
12/2/08	12:10:00	4148	7.29	SandersSW Isco	TOLLWAY 166	0.049		0.029	0.0820		58.6				0.0112	0.0672	6.05		17.5	0.0050		847		0.074		28.4
12/16/08	12:35:00	2978	7.10	SandersSW Isco	TOLLWAY 170	0.041			0.0723		43.3				0.0130	0.0763	4.94		11.4	0.0129		567		0.085		12.0
1/6/09	11:30:00	7075	6.73	SandersSW Isco	TOLLWAY 175				0.155		88.4				0.00738	0.0344	4.14		19.3	0.0336		1306	0.015	0.076		20.1
					*starting with the 12/2/08 sample, MDL for Al = 0.037 mg/L																					
				SandersSW Isco	min	0.041	NA	0.029	0.032	NA	15.800	NA	NA	0.007	0.007	0.034	2.390	NA	3.211	0.002	0.024	310.000	0.014	0.063	NA	12.000
				SandersSW Isco	max	0.564	NA	0.064	0.155	NA	88.400	NA	NA	0.009	0.029	0.417	6.050	NA	19.310	0.034	0.024	1306.000	0.020	0.115	NA	33.900
				SandersSW Isco	mean	0.157	NA	0.043	0.067	NA	38.955	NA	NA	0.008	0.018	0.130	4.382	NA	9.768	0.009	0.024	581.182	0.017	0.083	NA	19.936

APPENDIX A: Results of Geochemical Analysis of Isco Surface-Water Samples

Date collected	Time collected (cst)	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as CaC	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
					MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
3/5/08	10:30:00	6764	7.70	TB19 Isco	TOLLWAY 25			2.46		0.510	0.00601			0.0267	7.78	84	3642			0.22	0.13	2134	0.59	74.6	15.8	8.03
3/26/08	11:15:00	NA*	NA*	TB19 Isco	TOLLWAY 32			3.64		1.07	0.00963			0.0172	7.77	222	8486		0.017	0.54		5206	1.28	114	39.5	8.62
4/9/08	14:00:00	4695	7.86	TB19 Isco	TOLLWAY 38			4.63		0.424	0.01308				7.91	547	2496	6585		0.06	0.29	1460	0.71	70.9	110	8.89
4/14/08	11:20:00	2406	7.95	TB19 Isco	TOLLWAY 40			3.32		0.245	0.00499			0.0077	7.97	148	1300	526		0.16	0.22	658	0.96	52.3	32.3	11.5
5/6/08	10:25:00	5540	7.90	TB19 Isco	TOLLWAY 46			1.95		0.568	0.00666			0.0153	7.82	133	3033	362.5		0.14	0.32	1699	0.57	123	34.8	18.5
5/20/08	9:02:00	2146	7.88	TB19 Isco	TOLLWAY 54			2.29		0.237	0.00357				7.84	246	1147	570	0.024	0.16	0.23	691	691	691	21.0	9.99
5/28/08	14:21:00	1951	7.93	TB19 Isco	TOLLWAY 57			1.53		0.259	0.00071				8.22	106	1075	459		0.08	0.37	478	478	478	24.5	11.7
6/9/08	15:02:00	1969	7.99	TB19 Isco	TOLLWAY 60			2.53		0.226	0.00307				7.96	123	1072	770			0.37	304	304	304	31.3	11.8
6/24/08	12:30:00	NA*	NA*	TB19 Isco	TOLLWAY 72			2.67		0.291				0.0090	8.01	130	1338		0.018	0.16	0.49	691	0.50	65.6	26.5	
7/9/08	19:10:00	1861	7.76	TB19 Isco	TOLLWAY 80			2.69		0.207	0.00792				7.94	130	1040	965	0.099	0.36	0.43	478	0.42	45.6	33.6	11.0
7/22/08	15:40:00	NA*	NA*	TB19 Isco	TOLLWAY 90			2.30		0.143	0.00587				7.96	136	664	1282			0.31	304	0.60	31.4	39.7	7.37
8/6/08	7:45:00	NA*	NA*	TB19 Isco	TOLLWAY 101			2.05		0.185	0.00582				7.95	117	519	1013		0.12	0.31	244	0.42	27.6	34.3	13.7
9/17/08	10:25:00	549	8.16	TB19 Isco	TOLLWAY 120			4.81		0.0908	0.0370				8.30	156	298	1934	0.011		0.24	112	0.15	19.2	17.9	4.46
10/15/08	14:47:00	NA*	NA*	TB19 Isco	TOLLWAY 143			1.05		0.246	0.00121				8.11	118	463		0.021		0.39	178	0.13	31.3	11.8	8.48
12/2/08	14:02:00	NA*	NA*	TB19 Isco	TOLLWAY 153			3.22		0.360	0.00918	0.033		0.0451	8.13	104	1652	no sample	0.015	0.31	0.27	896	2.31	59.1	no sample	no sample
12/16/08	15:10:00	3613	7.12	TB19 Isco	TOLLWAY 171			4.38		0.380	0.0230			0.0076	8.15	141	1952	1360		0.22	0.25	1148	0.43	45.4	17.9	6.06
				TB19 Isco	min	NA	NA	1.050	NA	0.091	0.001	0.033	NA	0.008	7.772	84.106	298.000	362.500	0.011	0.064	0.127	111.560	0.127	19.246	11.817	4.458
				TB19 Isco	max	NA	NA	4.810	NA	1.073	0.037	0.033	NA	0.045	8.303	546.671	8486.000	6585.000	0.099	0.543	0.488	5206.023	2.307	122.540	109.568	18.532
				TB19 Isco	mean	NA	NA	2.845	NA	0.340	0.009	0.033	NA	0.018	7.988	165.069	1886.063	1438.773	0.029	0.212	0.307	1056.454	0.648	56.321	32.699	10.012
10/6/09	11:35:00 AM	NA*	NA*	TB19r Isco	TOLLWAY 277			8.75		0.674	0.0899			0.0097	8.20	995	2026	no sample	0.061	0.15	0.26	968	0.17	75.4	158	36.9
10/20/09	11:45:00 AM	1856	7.64	TB19r Isco	TOLLWAY 286			2.88		0.334	0.00088				9.21	562	1046	1108	0.012	0.40	0.28	465	0.24	72.3	43.5	16.3
11/3/09	11:40:00 AM	713	NA*	TB19r Isco	TOLLWAY 295			4.06		0.169	0.00196				9.11	167	371	425	0.015	0.16	0.35	135	0.17	34.7	23.3	7.48
12/2/09	2:40:00 PM	831	7.11	TB19r Isco	TOLLWAY 320			3.49		0.234	0.00148				9.08	141	468	230			0.27	163	0.20	34.5	16.8	9.96
12/16/09	8:40:00 AM	5908	7.52	TB19r Isco	TOLLWAY 340			2.76		0.788					8.28	47	3180	115	0.004	0.15	0.11	1868	0.38	39.8	13.2	7.34
12/29/09	12:15:00 PM	13217	10.17	TB19r Isco	TOLLWAY 352			1.50		1.49		0.019			9.62	96	7502	406		0.39		5089	0.58	69.8	20.5	13.4
1/26/10	15:40:00 PM	8870	9.35	TB19r Isco	TOLLWAY 389			2.19		1.20				0.0143	10.3	77	4974	129	0.005	0.66		2974	0.31	46.2	14.5	0.73
3/16/10	13:46:00 PM	3980	8.03	TB19r Isco	TOLLWAY 444			3.35		0.445	0.00103				8.76	148	2172	597	0.010	0.33		1214	0.48	35.4	27.0	12.3
3/31/10	12:04:00 PM	6074	8.80	TB19r Isco	TOLLWAY 465			1.87		0.440		0.021			9.80	86	3265	132	0.005	0.61		1973	0.62	42.0	21.3	14.7
4/14/10	9:05:00 AM	3070	8.79	TB19r Isco	TOLLWAY 486			5.92		0.323	0.0338			0.0084	8.98	151	1652	289	0.014	0.37	0.20	898	0.43	31.8	27.8	16.5
5/11/10	15:10:00 PM	2989	8.13	TB19r Isco	TOLLWAY 524			2.83		0.350	0.00615				8.04	194	1585	340	0.273	0.29	0.20	851	0.08	23.8	33.2	15.3
5/25/10	16:00:00 PM	1235	7.07	TB19r Isco	TOLLWAY 543			2.48		0.217	0.00334				8.17	172	657	273	0.077	0.63	0.29	293	0.17	20.3	21.8	8.53
				TB19r Isco	min	NA	NA	1.50	NA	0.169	0.00088	0.019	NA	0.0084	8.04	47	371	114.80	0.004	0.15	0.11	135.36	0.08	20.26	13.21	0.73
				TB19r Isco	max	NA	NA	8.75	NA	1.494	0.08994	0.021	NA	0.0143	10.34	995	7502	1108.00	0.273	0.66	0.35	5089.49	0.62	75.40	157.74	36.89
				TB19r Isco	mean	NA	NA	3.51	NA	0.556	0.01732	0.020	NA	0.0108	8.97	236	2408	367.55	0.048	0.38	0.24	1407.63	0.32	43.84	35.05	13.29
6/10/08	10:30:00	2383	7.56	SandersSW Isco	TOLLWAY 62			2.13		0.148	0.00198			0.022	7.40	69.5	1259	74.8	0.074	0.18	0.33	677	0.29	45.0	21.37	15.2
7/9/08	15:30:00	1628	7.70	SandersSW Isco	TOLLWAY 79			2.98		0.0947	0.00573			0.0139	7.63	66.0	842	69.0	0.059	0.13	0.34	435	0.28	33.4	19.6	13.2
7/22/08	11:25:00	2065	7.80	SandersSW Isco	TOLLWAY 84			3.94		0.136	0.00454			0.0147	7.78	111	1096	72	0.056	0.25	0.33	553	0.22	37.7	27.63	17.4
8/5/08	14:10:00	2502	7.67	SandersSW Isco	TOLLWAY 100			4.09		0.178	0.00196			0.0166	7.71	92.8	1246	47.0	0.048		0.35	633	0.31	50.1	28.2	24.1
9/17/08	7:20:00	18.78	7.59	SandersSW Isco	TOLLWAY 122			4.41		0.119	0.00904			0.0168	7.66	83.9	1012	25.2	0.099	0.08	0.43	517	0.31	41.9	20.4	16.7
10/1/08	12:11:00	NA*	NA*	SandersSW Isco	TOLLWAY 141			3.63		0.274	0.00122			0.0304	7.87	80.0	1570	7.6	0.076	0.12	0.25	783	0.93	84.3	21.0	21.5
10/15/08	12:15:00	2431	7.74	SandersSW Isco	TOLLWAY 145			3.98		0.208	0.00185			0.0082	8.08	127	1303	24.4	0.041	0.08	0.23	641	0.62	62.2	16.3	16.3
11/12/08	12:13:00	NA*	NA*	SandersSW Isco	TOLLWAY 151			3.41		0.308	0.00118			0.0147	8.14	158	1945	36.5	0.047		0.18	1002	0.65	90.3	18.6	13.3
12/2/08	12:10:00	4148	7.29	SandersSW Isco	TOLLWAY 166			3.21		0.351	0.00172			0.0113	8.14	162	3098	10.8	0.048		0.22	1702	0.62	76.7	17.6	15.8
12/16/08	12:35:00	2978	7.10	SandersSW Isco	TOLLWAY 170			2.47		0.252	0.00169			0.0249	7.54	86	1588	79.5	0.055	0.13	0.22	868	0.54	33.3	16.0	8.06
1/6/09	11:30:00	7075	6.73	SandersSW Isco	TOLLWAY 175			2.33		0.544				0.0295	7.48	77.4	3836	45.2	0.043	0.14	0.11	2300	0.43	54.6	18.9	5.75
				SandersSW Isco	min	NA	NA	2.130	NA	0.095	0.001	NA	NA	0.008	7.400	66.027	842.000	7.600	0.041	0.079	0.114	434.588	0.223	33.279	16.035	5.746
				SandersSW Isco	max	NA	NA	4.410	NA	0.544	0.009	NA	NA	0.030	8.144	161.964	3836.000	79.500	0.099	0.246	0.427	2300.415	0.927	90.333	28.231	24.123
				SandersSW Isco	mean	NA	NA	3.325	NA	0.237	0.003	NA	NA	0.018	7.765	101.218	1708.636	44.727	0.059	0.139	0.271	919.123	0.474	55.416	20.519	15.211

NA*= not enough sample for field parameters

APPENDIX B: Masses of Analytes Measured at All Locations

Masses Calculated from Isco Samples Compiled with Isco Flow Data

Site	TB19	Average Concentration TB19	SandersSW	Average Concentration SandersSW	TB7Bin	Average Concentration TB7Bin	TB7Bout	Average Concentration TB7Bout	TB9A	Average Concentration TB9A	TB15B	Average Concentration TB15B	TB19r	Average Concentration TB19r
Date Range	**2/21/08-03/03/09**		**5/29/08-3/3/09**		**8/12/09-8/16/10**		**8/11/09-8/16/10**		**8/12/09-8/16/10**		**3/17/09-7/19/10**		**9/9/09-6/1/10**	
# of Days	**376**		**278**		**370**		**371**		**370**		**489**		**265**	
Discharge Volume (ft^3)	**1782620**		**1573991**		**211743**		**185615**		**1536930**		**3477989**		**4208437**	
Paved Watershed Area Drained (ft^2)	**127530**		NA		**55757**		**55757**		**368953**		**176418**		**127530**	
Discharge yield (disch./area)	**13.98**		NA		**3.80**		**3.33**		**4.17**		**19.71**		**33.00**	
Discharge yield per day (yield/day)	**0.037**		NA		**0.010**		**0.009**		**0.011**		**0.040**		**0.125**	
Total precipitation during period (in.)	**53.02**		**36.51**		**43.17**		**43.17**		**43.17**		**55.00**		**35.94**	
Standardized yield (discharge yield/ppt)	**0.26364**		NA		**0.08797**		**0.07711**		**0.09649**		**0.35845**		**0.91819**	

Analyte	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	avg. mass	avg. yield	min yield	max yield
Al	20.410	0.011449	11.719	0.007446	0.190	0.000896	0.174	0.000935	4.900	0.003188	29.492	0.008480	30.400	0.007224	13.898	0.005	0.001	0.011
As	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
B	2.495	0.001400	1.419	0.000902	0.191	0.000903	0.185	0.000996	1.012	0.000658	2.564	0.000737	4.067	0.000966	1.705	0.001	0.001	0.001
Ba	3.346	0.001877	2.730	0.001735	0.370	0.001747	0.185	0.000996	1.593	0.001036	4.434	0.001275	8.486	0.002017	3.021	0.001	0.001	0.002
Be	0.004	0.000002	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.001	0.000	0.000	0.000
Ca	2259.482	1.267506	1611.949	1.024116	235.242	1.110978	232.766	1.254029	1133.479	0.737496	2384.350	0.685554	5633.275	1.338567	1927.220	1.066	0.686	1.339
Cd	0.020	0.000011	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.003	0.000	0.000	0.000
Co	0.020	0.000011	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.003	0.000	0.000	0.000
Cr	0.137	0.000077	0.056	0.000035	0.015	0.000072	0.000	0.000000	0.051	0.000033	0.210	0.000060	0.583	0.000138	0.150	0.000	0.000	0.000
Cu	0.492	0.000276	0.788	0.000501	0.034	0.000159	0.029	0.000154	0.203	0.000132	0.835	0.000240	2.515	0.000598	0.699	0.000	0.000	0.001
Fe	14.951	0.008387	9.703	0.006165	0.097	0.000460	0.222	0.001198	4.390	0.002856	20.777	0.005974	20.462	0.004862	10.086	0.004	0.000	0.008
K	258.870	0.145219	162.798	0.103430	63.333	0.299104	35.493	0.191220	282.593	0.183869	1487.369	0.427652	4414.670	1.049005	957.875	0.383	0.145	1.049
Li	0.083	0.000047	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.012	0.000	0.000	0.000
Mg	618.812	0.347136	376.749	0.239359	56.077	0.264833	48.533	0.261470	230.003	0.149651	284.294	0.081741	2529.751	0.601114	592.031	0.284	0.082	0.601
Mn	1.911	0.001072	0.417	0.000265	0.046	0.000217	0.053	0.000283	0.601	0.000391	0.544	0.000156	1.584	0.000376	0.736	0.000	0.000	0.001
Mo	0.030	0.000017	0.037	0.000023	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.058	0.000017	0.128	0.000030	0.036	0.000	0.000	0.000
Na	39689.760	22.264850	25770.364	16.372623	4141.239	19.557826	1462.511	7.879293	7011.360	4.561926	37820.585	10.874269	88856.952	21.114004	29250.396	14.375	4.562	22.265
Ni	0.436	0.000244	0.281	0.000179	0.013	0.000061	0.009	0.000049	0.043	0.000028	0.086	0.000025	1.426	0.000339	0.328	0.000	0.000	0.000
P	0.131	0.000074	2.786	0.001770	0.074	0.000351	0.133	0.000716	0.127	0.000082	3.471	0.000998	6.508	0.001546	1.890	0.001	0.000	0.002
Pb	0.180	0.000101	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.026	0.000	0.000	0.000
S	1131.768	0.634890	770.164	0.489306	195.211	0.921924	192.328	1.036170	589.106	0.383300	1022.451	0.293978	1529.711	0.363487	775.820	0.606	0.294	1.036
Sb	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Se	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Si	163.799	0.091887	156.444	0.099393	8.926	0.042154	6.996	0.037693	56.493	0.036757	263.868	0.075868	396.034	0.094105	150.366	0.063	0.037	0.094
Sn	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.697	0.000201	0.000	0.000000	0.100	0.000	0.000	0.000
Sr	18.372	0.010306	9.752	0.006196	2.309	0.010905	1.457	0.007850	9.403	0.006118	22.993	0.006611	57.219	0.013596	17.358	0.009	0.006	0.014
Ti	0.562	0.000315	0.207	0.000131	0.000	0.000000	0.002	0.000010	0.126	0.000082	0.730	0.000210	0.870	0.000207	0.357	0.000	0.000	0.000
Tl	0.022	0.000012	0.000	0.000000	0.000	0.000000	0.005	0.000025	0.080	0.000052	0.211	0.000061	0.307	0.000073	0.089	0.000	0.000	0.000
V	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Zn	0.477	0.000267	0.830	0.000527	0.088	0.000415	0.029	0.000156	0.405	0.000263	0.136	0.000039	0.237	0.000056	0.314	0.000	0.000	0.000
pH																		
alkalinity	11141.285	6.249951	4088.377	2.597459	508.839	2.403095	322.109	1.735367	2535.17	1.649501	9793.99	2.815991	19512.75	4.636580	6843.217	3.248	1.650	6.250
TDS, 180 C	110642.807	62.067534	72031.236	45.763431	11841.081	55.921870	4665.664	25.136312	22971.967	14.946661	105931.695	30.457745	260087.458	61.801439	84024.558	41.722	14.947	62.068
TSS	113781.627	63.828326	2219.839	1.410325	1274.598	6.019543	124.596	0.671263	14789.455	9.622727	22034.061	6.335288	43726.040	10.390090	28278.602	16.145	0.671	63.828
oPO_4-P	0.394	0.000221	3.075	0.001954	0.051	0.000240	0.143	0.000768	0.496	0.000323	4.970	0.001429	6.821	0.001621	2.279	0.001	0.000	0.002
NH_3-N	7.778	0.004363	5.124	0.003256	1.922	0.009075	1.484	0.007994	7.355	0.004785	28.787	0.008277	44.714	0.010625	13.880	0.008	0.004	0.011
F	12.191	0.006839	14.352	0.009118	1.150	0.005433	0.991	0.005337	5.616	0.003654	19.314	0.005553	19.071	0.004532	10.384	0.005	0.004	0.007
Cl	62406.479	35.008297	39560.466	25.133855	6625.064	31.288189	2190.901	11.803502	10768.285	7.006361	56041.033	16.113057	152723.703	36.289888	47187.990	22.918	7.006	36.290
NO_3-N	32.047	0.017977	16.682	0.010599	3.685	0.017402	3.254	0.017529	95.061	0.061851	51.681	0.014859	37.880	0.009001	34.327	0.023	0.009	0.062
SO_4	3092.755	1.734949	2086.738	1.325762	566.019	2.673139	544.522	2.933616	1704.499	1.109028	2878.993	0.827775	4283.489	1.017834	2165.288	1.716	0.828	2.934
total NVOC	1748.606	0.980919	953.429	0.605740	131.988	0.623341	50.739	0.273355	653.488	0.425190	2245.854	0.645733	3142.202	0.746644	1275.186	0.616	0.273	0.981
dissolved NVOC	489.385	0.274531	647.913	0.411637	37.206	0.175715	35.438	0.190923	208.625	0.135742	938.352	0.269797	1413.809	0.335946	538.676	0.230	0.136	0.336
tot (-alk, tds, tss)=	110227.599	61.835	71223.545	45.250	11938.552	56.382	4757.840	25.633	22115.902	14.390	103313.285	29.705	262024.669	62.262				
tds/discharge (kg/ft^2)=	0.06206753	0.00003482	0.04576343	NA	0.05592187	0.00026410	0.02513631	0.00013542	0.01494666	0.00000973	0.03045774	0.00000876	0.06180144	0.00001469				
tss/discharge (kg/ft^2)=	0.06382833	0.00003581	0.00141032	NA	0.00601954	0.00002843	0.00067126	0.00000362	0.00962273	0.00000626	0.00633529	0.00000182	0.01039009	0.00000247				

APPENDIX B: Masses of Analytes Measured at All Locations

Masses Calculated from Grab Samples Compiled with Isco Flow Data

Site	TB19 Grab	Average Concentration TB19	SandersSW Grab	Average Concentration SandersSW	TB7Bin Grab	Average Concentration TB7Bin	TB7Bout Grab	Average Concentration TB7Bout	TB9A Grab	Average Concentration TB9A	TB15B Grab	Average Concentration TB15B	TB19r Grab	Average Concentration TB19r
Date Range	**2/21/08-03/03/09**		**5/29/08-3/3/09**		**8/12/09-8/16/10**		**8/11/09-8/16/10**		**8/12/09-8/16/10**		**3/17/09-7/19/10**		**9/9/09-6/1/10**	
# of Days	**376**		**278**		**370**		**371**		**370**		**489**		**265**	
Discharge Volume (ft^3)	**1782620**		**1573991**		**211743**		**185615**		**1536930**		**3477989**		**4208437**	
Paved Watershed Area Drained (ft^2)	**127530**		NA		**55757**		**55757**		**368953**		**176418**		**127530**	
Discharge yield (disch./area)	**13.98**		NA		**3.80**		**3.33**		**4.17**		**19.71**		**33.00**	
Discharge yield per day (yield/day)	**0.037**		NA		**0.010**		**0.009**		**0.011**		**0.040**		**0.125**	
Total precipitation during period	**53.02**		**36.51**		**43.17**		**43.17**		**43.17**		**55.00**		**35.94**	
discharge yield/ppt	**0.26364**		NA		**0.08797**		**0.07711**		**0.09649**		**0.35845**		**0.91819**	

Analyte	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	Total mass (kg)	Avg. conc. (g/ft3)	avg. mass	avg. yield	(min yield	max yield
Al	4.526	0.002539	3.657	0.002324	0.448	0.002114	0.381	0.002055	5.550	0.003611	40.566	0.011664	36.874	0.008762	13.143	0.005	0.002	0.012
As	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
B	4.457	0.002500	4.743	0.003014	0.577	0.002725	0.222	0.001198	2.901	0.001887	4.624	0.001330	5.194	0.001234	3.245	0.002	0.001	0.003
Ba	6.087	0.003414	7.053	0.004481	0.633	0.002989	0.194	0.001046	5.133	0.003340	11.181	0.003215	9.911	0.002355	5.742	0.003	0.001	0.003
Be	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Ca	3474.601	1.949155	6351.367	4.035199	924.581	4.366517	253.328	1.364807	2253.975	1.466544	4521.477	1.300026	6698.131	1.591596	3496.780	2.006	1.300	4.367
Cd	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Co	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Cr	0.061	0.000034	0.000	0.000000	0.014	0.000064	0.000	0.000000	0.071	0.000046	0.491	0.000141	0.226	0.000054	0.123	0.000	0.000	0.000
Cu	0.295	0.000166	0.475	0.000302	0.029	0.000135	0.031	0.000165	0.676	0.000440	2.336	0.000672	2.084	0.000495	0.846	0.000	0.000	0.001
Fe	3.072	0.001723	2.433	0.001546	0.209	0.000988	0.398	0.002143	3.524	0.002293	11.171	0.003212	21.084	0.005010	5.984	0.003	0.001	0.005
K	657.725	0.368965	140.445	0.089229	266.859	1.260293	27.987	0.150782	2520.343	1.639856	6429.494	1.848624	5887.464	1.398967	2275.760	1.111	0.151	1.849
Li	0.782	0.000439	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.112	0.000	0.000	0.000
Mg	1672.839	0.938416	2323.873	1.476420	299.303	1.413520	44.399	0.239200	458.308	0.298197	291.978	0.083950	3569.669	0.848217	1237.196	0.637	0.084	1.414
Mn	1.971	0.001106	2.300	0.001461	0.154	0.000727	0.056	0.000301	1.053	0.000685	1.048	0.000301	2.981	0.000708	1.366	0.001	0.000	0.001
Mo	0.061	0.000034	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.823	0.000535	2.964	0.000852	1.021	0.000243	0.696	0.000	0.000	0.001
Na	104367.440	58.547229	43906.095	27.894753	10115.845	47.774096	955.212	5.146213	50219.031	32.674904	105456.306	30.321060	112577.036	26.750320	61085.281	33.536	5.146	58.547
Ni	0.819	0.000460	1.197	0.000760	0.217	0.001026	0.000	0.000000	0.544	0.000354	0.562	0.000162	2.140	0.000508	0.783	0.000	0.000	0.001
P	1.886	0.001058	0.917	0.000583	0.000	0.000000	0.000	0.000000	0.317	0.000206	1.652	0.000475	5.744	0.001365	1.502	0.001	0.000	0.001
Pb	0.263	0.000148	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.038	0.000	0.000	0.000
S	3556.726	1.995225	1967.659	1.250108	815.171	3.849806	175.811	0.947185	1719.673	1.118901	1978.257	0.568793	1953.982	0.464301	1738.183	1.491	0.464	3.850
Sb	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Se	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000	0.000	0.000
Si	110.496	0.061985	263.920	0.167676	20.045	0.094668	8.261	0.044508	120.796	0.078596	364.785	0.104884	371.679	0.088318	179.998	0.079	0.045	0.105
Sn		0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.697	0.000201	0.000	0.000000	0.116	0.000	0.000	0.000
Sr	34.244	0.019210	34.818	0.022121	9.535	0.045031	1.482	0.007984	42.064	0.027369	62.874	0.018078	69.683	0.016558	36.386	0.022	0.008	0.045
Ti	0.044	0.000025	0.022	0.000014	0.003	0.000012	0.006	0.000031	0.107	0.000070	0.298	0.000086	0.964	0.000229	0.206	0.000	0.000	0.000
Tl	0.267	0.000150	0.203	0.000129	0.070	0.000329	0.000	0.000000	0.115	0.000075	0.208	0.000060	0.328	0.000078	0.170	0.000	0.000	0.000
V	0.018	0.000010	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.000	0.000000	0.003	0.000	0.000	0.000
Zn	0.504	0.000283	0.332	0.000211	0.088	0.000414	0.002	0.000009	0.138	0.000090	0.164	0.000047	0.254	0.000060	0.212	0.000	0.000	0.000
pH																		
alkalinity	9467.989	5.311278	13345.074	8.478493	770.177	3.637313	451.957	2.434922	4206.600	2.737015	17625.884	5.067838	19658.270	4.671157	27066.026	3.977	2.435	5.311
TDS, 180 C	297799.13	167.057023	137281.303	87.218598	31984.012	151.050879	3426.173	18.458540	143047.531	93.073568	317151.861	91.188293	307615.331	73.094913	157435.702	98.987	18.459	167.057
TSS	1265.877	0.710122	1025.875	0.651767	100.094	0.472715	44.679	0.240710	430.629	0.280188	3600.954	1.035355	6228.754	1.480064	1667.495	0.703	0.241	1.480
oPO_4-P	0.712	0.000399	1.477	0.000938	0.079	0.000373	0.055	0.000297	0.319	0.000207	1.791	0.000515	7.417	0.001762	1.626	0.001	0.000	0.002
NH_3-N	1.474	0.000827	1.009	0.000641	1.396	0.006594	0.725	0.003907	16.318	0.010617	31.339	0.009011	38.142	0.009063	14.329	0.007	0.001	0.011
F	11.280	0.006328	10.910	0.006931	1.028	0.004855	1.042	0.005614	11.365	0.007395	20.207	0.005810	15.986	0.003799	10240.223	0.006	0.004	0.007
Cl	164511.074	92.286133	71620.651	45.502575	20396.912	96.328488	1351.560	7.281545	81908.469	53.293569	178458.988	51.310972	171661.882	40.789939	88330.443	56.882	7.282	96.328
NO_3-N	33.865	0.018997	24.216	0.015385	7.038	0.033238	1.286	0.006928	16.942	0.011024	50.949	0.014649	24.801	0.005893	769.614	0.015	0.006	0.033
SO_4	9514.723	5.337495	5252.415	3.337004	2565.066	12.114038	500.690	2.697470	4837.986	3.147825	5194.529	1.493544	5368.621	1.275680	4107.355	4.344	1.276	12.114
total NVOC	858.380	0.481527	769.869	0.489119	68.099	0.321611	55.616	0.299630	644.151	0.419116	2475.919	0.711882	2172.376	0.516196	996.661	0.458	0.300	0.712
dissolved NVOC	662.751	0.371785	702.087	0.446055	52.875	0.249711	45.238	0.243721	612.443	0.398485	1921.150	0.552374	1837.986	0.436738	833.504	0.375	0.244	0.552
tot (-alk, tds, tss)=	288635.064	161.916	132624.274	84.260	35478.172	167.553	3368.366	18.147	144758.981	94.187	304862.088	87.655	310171.285	73.702				
tds/discharge (kg/ft^3)=	0.16705702	0.00009371	0.08721860	NA	0.15105088	0.00071337	0.01845854	0.00009945	0.09307357	0.00006056	0.09118829	0.00002622	0.07309491	0.00001737				
tss/discharge (kg/ft^3)=	0.00071012	0.00000040	0.00065177	NA	0.00047271	0.00000223	0.00024071	0.00000130	0.00028019	0.00000018	0.00103536	0.00000030	0.00148006	0.00000035				

Appendix C. Site-specific procedures for calculating discharge

Isco level, velocity, and discharge data adjustments for interpretation

Data interpretation at all sites

1	Only discharges with levels greater than 0.05 ft were included, as 0.05 ft is the lower limit of accuracy of the pressure transducer.
2	Only discharges with velocities greater than 0.1 ft/s were included, as the error of the Doppler velocity sensor is ± 0.1 ft/s.
3	Hourly O'Hare precipitation data or TB15 Rain Gauge data were used to validate discharge events seen in Isco data logs.
4	A discharge event was verified if two or more good velocity readings were obtained within 25 Isco 5-minute data recording intervals.
5	To adjust data within discharge events for a typical hydrograph interpretation, volume calculations using repeated velocities from a previous good reading were included at times of erroneous sensor readings, for up to 25 adjacent data intervals.
6	Discharge calculations at the beginning and ending of discharge events with a level greater than 0.05 ft that were recorded as having repeated velocities, are included in totals for up to 25 repeated intervals by copying nearest good discharge value.
7	If negative velocities occur during discharge events, an adjacent positive discharge volume is copied and included in the total volume.
8	If repeated negative velocities or velocities ≤ 0.1 ft/s occur after a good positive velocity reading, they are considered a continuation, or repeat, of the positive held velocities.
9	When there are frozen temperatures or the ditch is reported frozen in field notes, and/or an anomaly occurs in the record, data are evaluated for removal.
10	Field notes are used to evaluate accuracy of ditch flow conditions and discharge indicated from Isco sensors.

Site-specific conditions and adjustments

Site	Instrument Setup	Data Handling Adjustments	Data Evaluation/Removal
TB7Bin	Standing water at sensor (~0.3 ft)	Beginning and ending of hydrographs were not adjusted to include measurements with repeated velocities. No repeated velocities were counted at the beginning and end of discharge events.	Instrument frozen 12/25/09-2/5/10 - Data removed
TB7Bout	Included 0.15 ft weir after 09/09/2009	Beginning and ending of hydrographs were not adjusted to include measurements with repeated velocities. No repeated velocities were counted at the beginning and end of discharge events.	Instrument frozen 12/29/09-1/23/10 - Data removed
TB9A	No modifications made		Instrument frozen 1/19/10-2/17/10 - Data removed
TB15B	No modifications made		Instrument frozen 12/2/09-12/4/09 - Data removed
TB19	No modifications made		Data missing 9/16/08-9/24/08 Instrument frozen 12/17/08-2/5/09, 2/16/09-3/3/09 - Data removed
TB19r	Sensor set lower in channel, and new channel dimensions greater than at TB19	No adjustments made	Instrument frozen 12/27/09-1/16/10 - Data removed
SandersSW	No modifications made		Instrument frozen 1/6/09-2/7/09 - Data removed

APPENDIX D: Results of Geochemical Analysis of Biweekly Surface-Water Grab Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
				MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
3/5/08	1731	7.56	TB5 Grab	TOLLWAY 3	0.0356		0.055	0.0389		71.0				0.00211	0.0383	4.74		27.2	0.0637		250	0.014	0.179		22.8
3/11/08	NA	NA	TB5 Grab	TOLLWAY 21	0.0328		0.061	0.0446		78.4				0.00155	0.0428	5.14		31.4	0.109		229		0.181		23.6
8/26/09	480	8.52	TB7Bin Grab	TOLLWAY 254	0.134			0.0138		8.07				0.00662	0.0380	3.23		0.969	0.0066		22.8				4.46
12/29/09	18121	8.55	TB7Bin Grab	TOLLWAY 349			0.120	0.181		275					0.0094	88.7		94.1	0.0164		3470	0.070			242
5/11/10	699	10.02	TB7Bin Grab	TOLLWAY 507	0.137		0.038	0.0304		19.3			0.0067	0.00688	0.0448	5.76		2.61	0.0051		133				7.97
6/8/10	309	8.40	TB7Bin Grab	TOLLWAY 551	0.130			0.0241		12.5			0.0064	0.00925	0.105	2.49		1.37	0.0110		49.8				5.77
8/4/10	2575	7.13	TB7Bin Grab	TOLLWAY 645	0.067		0.113	0.051		88.3				0.006	0.019	12.5		25.3	0.050		420	0.018			88.0
			TB7Bin Grab	min	0.067	NA	0.038	0.014	0.00	8.067	NA	NA	0.00642	0.00564	0.0094	2.495	NA	0.9691	0.0051	NA	22.81	0.018	NA	NA	4.46
			TB7Bin Grab	max	0.137	NA	0.120	0.181	0.00	275.008	NA	NA	0.00671	0.00925	0.1047	88.720	NA	94.1217	0.0502	NA	3470.28	0.070	NA	NA	241.55
			TB7Bin Grab	mean	0.117	NA	0.090	0.060	0.00	80.619	NA	NA	0.00656	0.00710	0.0433	22.542	NA	24.8818	0.0178	NA	819.24	0.044	NA	NA	69.55
8/26/09	1326	8.06	TB7Bout Grab	TOLLWAY 255			0.055	0.0592		74.7				0.00482	0.0424	5.80		15.6	0.0170		191				73.6
5/11/10	1080	9.13	TB7Bout Grab	TOLLWAY 506	0.108		0.037	0.0226		34.4				0.00672	0.0760	5.87		6.29	0.0083		166				23.9
6/8/10	1911	8.24	TB7Bout Grab	TOLLWAY 550			0.028	0.0735		83.4				0.00584	0.0191	5.05		13.8	0.0039		295				49.4
6/23/10	842	8.43	TB7Bout Grab	TOLLWAY 585	0.137		0.031	0.0272		25.1				0.00423	0.168	4.43		4.36	0.0064		138				13.8
7/8/10	1130	7.67	TB7Bout Grab	TOLLWAY 606	0.055		0.084	0.0501		45.2				0.00833	0.200	5.99		7.62	0.0655		182				21.8
8/4/10	1145	7.23	TB7Bout Grab	TOLLWAY 644			0.067	0.052		72.2				0.003	0.057	3.68		11.9	0.011		152				57.1
			TB7Bout Grab	min	0.055	NA	0.028	0.023	NA	25.116	NA	NA	NA	0.00271	0.0191	3.675	NA	4.3593	0.0039	NA	138.19	NA	NA	NA	13.81
			TB7Bout Grab	max	0.137	NA	0.084	0.073	NA	83.415	NA	NA	NA	0.00833	0.2001	5.992	NA	15.5854	0.0655	NA	295.17	NA	NA	NA	73.63
			TB7Bout Grab	mean	0.100	NA	0.050	0.047	NA	55.823	NA	NA	NA	0.00544	0.0939	5.137	NA	9.9290	0.0187	NA	187.34	NA	NA	NA	39.94
8/25/09	5552	8.85	TB9A Grab	TOLLWAY 250	0.051		0.077	0.139		36.0				0.0158	0.0178	97.7		13.9	0.0031	0.040	1014	0.022			62.0
9/22/09	3331	8.98	TB9A Grab	TOLLWAY 266	0.057		0.071	0.0990		32.9				0.0132	0.0264	56.9		13.6	0.0065	0.031	591	0.017			50.9
10/7/09	4695	9.22	TB9A Grab	TOLLWAY 272			0.078	0.112		33.7				0.0101	0.0101	86.1		13.7	0.0034	0.055	877	0.026			68.0
10/20/09	4512	9.66	TB9A Grab	TOLLWAY 284	0.047		0.076	0.0947		29.8				0.0153	0.0083	92.0		12.1	0.0027	0.049	806	0.015	0.072		60.7
11/3/09	3721	9.17	TB9A Grab	TOLLWAY 293			0.087	0.0821		40.4				0.0158	0.0135	76.5		16.0	0.0036	0.042	695	0.026			61.2
12/1/09	3793	8.96	TB9A Grab	TOLLWAY 308			0.057	0.089		51.4				0.0108	0.0094	66.2		16.9	0.0032	0.042	674				72.8
12/15/09	7200	8.85	TB9A Grab	TOLLWAY 331			0.067	0.153		131				0.00815	0.0090	53.3		35.5	0.0238		1321	0.031			106
12/29/09	21635	11.37	TB9A Grab	TOLLWAY 348			0.062	0.427		261			0.0116	0.0539	0.0103	125		15.2		0.041	4470	0.039			104
1/26/10	19850	11.58	TB9A Grab	TOLLWAY 379			0.061	0.376		252			0.0107	0.0497	0.0165	112		18.2	0.0015	0.036	4266	0.026	0.095	0.060	93.2
3/2/10	18459	9.86	TB9A Grab	TOLLWAY 414			0.075	0.238		287			0.0092	0.0247	0.0089	69.1		63.2	0.0226		3870	0.041			147
3/16/10	21360	9.88	TB9A Grab	TOLLWAY 435			0.067	0.363		221			0.0097	0.0460		102		25.7	0.0064		4506	0.030	0.065		104
3/30/10	24770	9.77	TB9A Grab	TOLLWAY 458			0.072	0.435		204			0.0069	0.0478		138		20.0	0.0042	0.051	5254	0.030	0.068		83.7
4/14/10	20382	10.28	TB9A Grab	TOLLWAY 479			0.087	0.365		145			0.0080	0.0453		138		12.7		0.043	4126	0.024	0.085		84.0
4/28/10	14156	10.16	TB9A Grab	TOLLWAY 501			0.070	0.214		71.4			0.0077	0.0308	0.0089	113		11.7	0.0043	0.052	3003	0.024			60.6
5/11/10	2183	9.63	TB9A Grab	TOLLWAY 510	0.738		0.041	0.058		49.4			0.006	0.0108	0.503	12.2		12.0	0.0216		384				30.6
5/26/10	13005	7.82	TB9A Grab	TOLLWAY 539			0.091	0.249		43.4				0.0184	0.0288	134		23.8	0.293	0.047	2598	0.037			38.9
6/8/10	6570	8.57	TB9A Grab	TOLLWAY 548	0.086		0.051	0.181		62.9				0.0131	0.0871	65.2		13.3	0.0689	0.026	1284	0.018			42.6
6/22/10	3328	8.68	TB9A Grab	TOLLWAY 578	0.231		0.052	0.0668		22.6				0.0121	0.126	37.1		5.26	0.0070	0.022	618	0.017			18.5
7/8/10	1536	8.05	TB9A Grab	TOLLWAY 607	0.101		0.056	0.0606		31.2				0.00568	0.0810	16.6		5.31	0.0048		270				11.0
8/3/10	2052	9.40	TB9A Grab	TOLLWAY 643	0.152		0.061	0.037		16.3				0.008	0.079	27.3		4.37	0.004		377				16.2
			TB9A Grab	min	0.047	NA	0.041	0.037	NA	16.276	NA	NA	0.00603	0.00568	0.0083	12.220	NA	4.3674	0.0015	0.022	270.37	0.015	0.065	0.060	11.05
			TB9A Grab	max	0.738	NA	0.091	0.435	NA	286.813	NA	NA	0.01163	0.05389	0.5029	138.269	NA	63.2151	0.2932	0.055	5254.18	0.041	0.095	0.060	146.68
			TB9A Grab	mean	0.183	NA	0.068	0.192	NA	101.112	NA	NA	0.00872	0.02275	0.0614	80.851	NA	17.6245	0.0269	0.041	2050.20	0.026	0.077	0.060	65.75

APPENDIX D: Results of Geochemical Analysis of Biweekly Surface-Water Grab Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as CaC	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
				MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
3/5/08	1731	7.56	TB5 Grab	TOLLWAY 3			2.69		0.257		0.024		0.0162	7.79	164	945		0.17	0.21	0.17	421	1.93	63.0	7.67	5.95
3/11/08	NA	NA	TB5 Grab	TOLLWAY 21			3.25		0.277		0.018		0.0097	7.88	210	983		0.15	0.14	0.35	324	2.29	66.4	9.31	5.15
8/26/09	480	8.52	TB7Bin Grab	TOLLWAY 254			1.15		0.0520	0.00117				8.31	39	108	86	0.03	0.13	0.11	26.0	0.33	12.3	16.8	9.52
12/29/09	18121	8.55	TB7Bin Grab	TOLLWAY 349			4.56		3.09		0.027		0.0116	7.93	158	10893	9.2		0.16		7239	1.75	795	9.35	8.99
5/11/10	699	10.02	TB7Bin Grab	TOLLWAY 507			1.24		0.151	0.00070				9.90	58	397	15.2	0.022	0.36	0.16	182	0.36	22.7	10.3	4.82
6/8/10	309	8.40	TB7Bin Grab	TOLLWAY 551			1.23		0.0907	0.00175			0.0205	7.80	38	177	23.6	0.032	0.42	0.27	63.9	0.67	17.0	14.5	9.22
8/4/10	2575	7.13	TB7Bin Grab	TOLLWAY 645			2.75		0.611				0.023	7.78	127	1442	4.8	0.010	0.08	0.31	588	0.72	231	7.25	6.90
			TB7Bin Grab	min	NA	NA	1.15	NA	0.05	0.00070	0.027	NA	0.0116	7.78	38	108	4.80	0.01	0.08	0.11	26.04	0.33	12.28	7.25	4.82
			TB7Bin Grab	max	NA	NA	4.56	NA	3.09	0.00175	0.027	NA	0.0227	9.90	158	10893	86.00	0.03	0.42	0.31	7238.72	1.75	794.57	16.82	9.52
			TB7Bin Grab	mean	NA	NA	2.18	NA	0.80	0.00121	0.027	NA	0.0183	8.34	84	2603	27.76	0.02	0.23	0.21	1619.67	0.77	215.52	11.65	7.89
8/26/09	1326	8.06	TB7Bout Grab	TOLLWAY 255			2.01		0.405					7.70	82	842	45			0.12	269		210	14.3	10.5
5/11/10	1080	9.13	TB7Bout Grab	TOLLWAY 506			1.50		0.204	0.00141				9.36	68	558	12.0	0.016	0.25	0.18	231	0.44	69.7	10.5	7.39
6/8/10	1911	8.24	TB7Bout Grab	TOLLWAY 550			0.676		0.530					8.20	154	1067				0.11	443		137	10.6	10.9
6/23/10	842	8.43	TB7Bout Grab	TOLLWAY 585			1.83		0.176	0.00322				8.47	77	410		0.007		0.35	191		38.5	8.39	10.0
7/8/10	1130	7.67	TB7Bout Grab	TOLLWAY 606			2.98		0.288	0.00205			0.0081	8.06	132	631	3.6	0.010		0.46	231		59.4	17.6	13.5
8/4/10	1145	7.23	TB7Bout Grab	TOLLWAY 644			2.09		0.357					8.04	81	685		0.005		0.24	215		161	9.01	8.48
			TB7Bout Grab	min	NA	NA	0.68	NA	0.18	0.00141	NA	NA	0.0081	7.70	68	410	3.60	0.00	0.25	0.11	191.38	0.44	38.55	8.39	7.39
			TB7Bout Grab	max	NA	NA	2.98	NA	0.53	0.00322	NA	NA	0.0081	9.36	154	1067	44.80	0.02	0.25	0.46	442.87	0.44	210.09	17.55	13.51
			TB7Bout Grab	mean	NA	NA	1.85	NA	0.33	0.00223	NA	NA	0.0081	8.30	99	699	20.13	0.01	0.25	0.24	263.22	0.44	112.63	11.73	10.13
8/25/09	5552	8.85	TB9A Grab	TOLLWAY 250			2.12		1.01					9.21	91	2982	17		0.34	0.10	1638	0.29	169	18.2	16.7
9/22/09	3331	8.98	TB9A Grab	TOLLWAY 266			2.18		0.718		0.019			9.14	112	1805	4.0	0.005	0.08	0.15	927	0.17	139	17.9	14.1
10/7/09	4695	9.22	TB9A Grab	TOLLWAY 272			2.42		0.963					9.53	87	2576	6.8	0.008	0.15	0.22	1338	1.46	183	19.7	20.1
10/20/09	4512	9.66	TB9A Grab	TOLLWAY 284			1.59		0.928					9.63	72	2503	5.6	0.007	0.26	0.24	1319	1.45	191	16.4	17.7
11/3/09	3721	9.17	TB9A Grab	TOLLWAY 293			3.59		0.940					9.44	100	2033	7.2	0.010	0.71	0.23	1032	1.56	207	13.9	12.0
12/1/09	3793	8.96	TB9A Grab	TOLLWAY 308			2.29		0.957					9.04	104	2130	6.4		0.45	0.17	1056	2.44	204	12.4	9.48
12/15/09	7200	8.85	TB9A Grab	TOLLWAY 331			2.96		1.78					8.66	93	4189			0.67	0.24	2213	1.24	295	12.9	13.0
12/29/09	21635	11.37	TB9A Grab	TOLLWAY 348			2.50		3.85		0.035			10.8	93	12722	44		2.28		7457	1.69	285	22.7	21.1
1/26/10	19850	11.58	TB9A Grab	TOLLWAY 379			2.45		3.66		0.037		0.0240	10.6	88	11695	21.2	0.005	1.63		7034	1.26	259	19.3	19.0
3/2/10	18459	9.86	TB9A Grab	TOLLWAY 414			2.87		2.93		0.032		0.0118	9.15	27	10910	13.2	0.009	1.15		6275	0.77	355	12.7	12.9
3/16/10	21360	9.88	TB9A Grab	TOLLWAY 435			2.37		3.21		0.022		0.0086	9.84	39	12304	13.2		1.26		6877	0.72	271	16.9	18.8
3/30/10	24770	9.77	TB9A Grab	TOLLWAY 458			1.37		3.84		0.025		0.0089	9.61	40	14829	15.6	0.009	0.79		8856	0.50	208	20.8	21.4
4/14/10	20382	10.28	TB9A Grab	TOLLWAY 479			0.939		3.07				0.0083	10.0	53	11755	12.8	0.006	1.23		7121	0.43	217	15.1	20.0
4/28/10	14156	10.16	TB9A Grab	TOLLWAY 501			1.27		1.89					9.76	65	8007	6.0	0.004	0.54		4884	0.20	157	19.3	19.3
5/11/10	2183	9.63	TB9A Grab	TOLLWAY 510			3.65		0.434	0.0238			0.0089	9.47	106	1188	40.8	0.014	0.31	0.19	612	0.31	84.9	13.4	9.89
5/26/10	13005	7.82	TB9A Grab	TOLLWAY 539			4.41		1.60				0.0090	8.29	183	7152	25.6	0.009	0.22		4324		106	30.5	21.1
6/8/10	6570	8.57	TB9A Grab	TOLLWAY 548			3.81		1.12	0.00138			0.0082	8.68	157	3609	13.2	0.005	0.77	0.25	2034	0.12	116	15.0	16.0
6/22/10	3328	8.68	TB9A Grab	TOLLWAY 578			2.19		0.478	0.00331			0.0088	9.20	80	1762	16.4	0.021	0.17	0.36	985		50.6	14.4	15.9
7/8/10	1536	8.05	TB9A Grab	TOLLWAY 607			2.19		0.379	0.00212			0.0088	8.51	114	807		0.005		0.40	380		29.8	12.8	10.5
8/3/10	2052	9.40	TB9A Grab	TOLLWAY 643			2.86		0.280	0.002				9.29	86	1055		0.006		0.41	560		45.1	11.5	12.0
			TB9A Grab	min	NA	NA	0.94	NA	0.28	0.00138	0.019	NA	0.0082	8.29	27	807	4.00	0.00	0.08	0.10	379.53	0.12	29.78	11.53	9.48
			TB9A Grab	max	NA	NA	4.41	NA	3.85	0.02376	0.037	NA	0.0240	10.81	183	14829	44.00	0.02	2.28	0.41	8855.94	2.44	355.28	30.49	21.39
			TB9A Grab	mean	NA	NA	2.50	NA	1.70	0.00646	0.028	NA	0.0105	9.40	90	5801	15.84	0.01	0.72	0.25	3346.14	0.91	178.61	16.78	16.05

APPENDIX D: Results of Geochemical Analysis of Biweekly Surface-Water Grab Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
				MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
3/4/09	16377	11.96	TB15B Grab	TOLLWAY 130	0.134		0.049	0.301		118			0.0189	0.0865	0.0303	108		0.130		0.045	3263	0.015			35.1
3/31/09	4857	11.10	TB15B Grab	TOLLWAY 194	0.083		0.034	0.0945		50.6			0.0072	0.0264	0.0645	33.4		3.20	0.0047		963	0.022	0.090		18.1
4/14/09	7931	11.96	TB15B Grab	TOLLWAY 203			0.046	0.167		66.5			0.0132	0.0311	0.0177	66.6		0.763		0.030	1550		0.063		19.0
4/29/09	5955	11.19	TB15B Grab	TOLLWAY 209	0.714		0.033	0.123		32.8			0.0142	0.0287	0.0320	67.2		0.0438		0.029	1092				14.5
5/11/09	6400	NA	TB15B Grab	TOLLWAY 214	0.721		0.047	0.0978		16.8			0.0117	0.0310	0.0172	71.9		0.0793	0.0022	0.039	1248		0.067		17.1
5/27/09	3672	10.69	TB15B Grab	TOLLWAY 218	0.401		0.048	0.0956		31.5			0.0078	0.02051	0.0280	43.8		0.179		0.024	655				13.3
6/10/09	5611	9.95	TB15B Grab	TOLLWAY 223	0.771		0.038	0.0862		10.7				0.0281	0.101	77.0		0.323	0.0068	0.036	1119				17.3
6/30/09	2120	9.68	TB15B Grab	TOLLWAY 222	0.517		0.070	0.0509		9.05				0.0173	0.0610	64.4		0.670	0.0041	0.038	989				19.5
7/28/09	4718	9.03	TB15B Grab	TOLLWAY 234	0.240		0.084	0.0898		15.8				0.0110	0.0604	63.0		3.43	0.0047	0.037	953				18.2
8/25/09	4376	9.26	TB15B Grab	TOLLWAY 248	0.522		0.079	0.0685		9.96				0.0111	0.102	62.7		1.20	0.0037	0.104	858				20.3
9/8/09	1385	6.77	TB15B Grab	TOLLWAY 256	0.698		0.106	0.0614		11.3				0.0192	0.255	68.3		2.17	0.0140	0.046	966		0.070		21.4
9/22/09	4386	9.06	TB15B Grab	TOLLWAY 263	0.188		0.082	0.111		21.3				0.0138	0.0602	68.1		3.63	0.0092	0.083	829	0.016			60.5
10/7/09	4565	10.57	TB15B Grab	TOLLWAY 271	0.700		0.046	0.0446		12.1				0.0161	0.239	98.4		0.252	0.0036	0.080	877	0.015			35.6
10/20/09	3524	10.78	TB15B Grab	TOLLWAY 283	0.571		0.033	0.0325		8.46				0.0190	0.184	87.7		0.178	0.0023	0.058	655		0.089		21.7
11/2/09	2492	11.38	TB15B Grab	TOLLWAY 292	0.673		0.030	0.0613		15.7				0.0157	0.0657	66.1		0.048		0.031	396				14.0
12/2/09	2359	10.46	TB15B Grab	TOLLWAY 315	0.564		0.025	0.029		6.61			0.0065	0.0147	0.104	66.3		0.152	0.0028	0.041	428				18.7
12/29/09	15023	12.16	TB15B Grab	TOLLWAY 350			0.031	0.351		176			0.0136	0.0433	0.0147	125		0.586		0.046	2826	0.020			34.2
1/26/10	18717	12.79	TB15B Grab	TOLLWAY 378			0.033	0.369		217			0.0134	0.0775	0.0277	125		0.315		0.055	3880	0.028	0.078		35.5
3/3/10	15354	11.63	TB15B Grab	TOLLWAY 423			0.031	0.283		179			0.0086	0.0375	0.0227	74.5		13.1	0.0114	0.033	48.5				51.3
3/16/10	15297	11.72	TB15B Grab	TOLLWAY 433			0.030	0.196		94.3			0.0148	0.0601		92.7		0.879	0.0020		3217	0.015			31.6
3/30/10	15219	9.96	TB15B Grab	TOLLWAY 453			0.027	0.139		30.6			0.0120	0.0345		100		5.86	0.0136	0.118	3282		0.069		31.0
4/13/10	11197	10.70	TB15B Grab	TOLLWAY 469	0.037		0.023	0.0880		16.5			0.0091	0.0310	0.0113	84.9		0.997		0.046	2207				26.8
4/27/10	8234	11.49	TB15B Grab	TOLLWAY 491			0.039	0.0757		26.0			0.0099	0.0368	0.0161	90.4		0.731		0.055	1662				23.4
5/11/10	946	10.51	TB15B Grab	TOLLWAY 509	1.35			0.030		20.7				0.00797	0.815	9.39		1.92	0.0084		170				6.21
5/25/10	6746	9.51	TB15B Grab	TOLLWAY 534	0.068			0.0771		8.45				0.0265	0.0127	90.6		3.11	0.0054	0.045	1385	0.018			20.7
6/8/10	1803	9.78	TB15B Grab	TOLLWAY 556	0.223		0.025	0.0402		19.6				0.0170	0.161	23.6		3.36	0.0080		324				14.8
6/23/10	2641	9.33	TB15B Grab	TOLLWAY 580	0.175		0.035	0.0559		22.5				0.0115	0.0368	44.0		4.14	0.0137	0.023	475		0.066		15.4
7/8/10	2006	8.10	TB15B Grab	TOLLWAY 605	0.075		0.064	0.0851		31.5				0.00785	0.0749	38.8		8.46	0.0127		349				13.3
8/3/10	2028	7.55	TB15B Grab	TOLLWAY 638	0.062		0.250	0.157		102				0.013	0.090	58.9		35.0	0.172		263	0.032			21.9
			TB15B Grab	min	0.037	NA	0.023	0.029	NA	6.612	NA	NA	0.00647	0.00785	0.0113	9.387	NA	0.0438	0.0020	0.023	48.51	0.015	0.063	NA	6.21
			TB15B Grab	max	1.351	NA	0.250	0.369	NA	216.683	NA	NA	0.01886	0.08653	0.8152	124.994	NA	35.0079	0.1720	0.118	3880.36	0.032	0.090	NA	60.50
			TB15B Grab	mean	0.431	NA	0.053	0.119	NA	47.623	NA	NA	0.01149	0.02739	0.1001	71.411	NA	3.2737	0.0153	0.050	1273.41	0.020	0.074	NA	23.80
3/5/08	11427	7.92	TB19 Grab*	TOLLWAY 16	0.150		0.037	0.116		92.4				0.00470	0.0906	6.93		28.9	0.0819		2279				59.0
3/12/08	19639	8.48	TB19 Grab	TOLLWAY 26	0.0687		0.058	0.232		195				0.00540	0.0127	8.28	0.036	68.3	0.173		4026	0.035			106
3/26/08	6161	9.14	TB19 Grab	TOLLWAY 29	0.0529		0.053	0.0824		79.3				0.00560	0.0361	10.2	0.018	35.6	0.0183		1090	0.024	0.082		34.7
4/9/08	7309	9.52	TB19 Grab	TOLLWAY 36	0.0576		0.077	0.0948		66.6				0.0121	0.0260	8.15	0.023	29.7	0.0159		1455	0.014			54.2
4/23/08	17848	9.22	TB19 Grab	TOLLWAY 43	0.0391		0.129	0.162		67.3				0.00582	0.0328	18.2	0.047	52.7	0.0138		3772	0.041	0.137		135
5/6/08	13655	8.79	TB19 Grab	TOLLWAY 49	0.0404		0.119	0.16775		66.1				0.00637	0.0131	13.3	0.036	40.4	0.0256		2785		0.065	0.057	95.4
5/20/08	10704	8.37	TB19 Grab	TOLLWAY 50	0.0117		0.106	0.131		52.2					0.0372	8.55	0.021	31.7	0.0610		2192	0.025			72.7
5/28/08	10384	8.82	TB19 Grab	TOLLWAY 52	0.108		0.123	0.125		37.2				0.00663		8.45	0.021	23.9	0.0090		2136	0.028	0.119		77.7
6/9/08	4195	8.50	TB19 Grab	TOLLWAY 55	0.397		0.127	0.0715		36.9				0.00681	0.219	5.06		14.8	0.0175		874	0.023			33.2
7/9/08	4824	7.53	TB19 Grab	TOLLWAY 82	0.0530		0.113	0.120		47.3				0.00406	0.0936	3.60		14.2	0.0514		982	0.021			39.3
7/22/08	3622	8.72	TB19 Grab	TOLLWAY 89	0.264		0.099	0.0666		39.3				0.0101	0.182	3.04		13.8	0.0069	0.036	724	0.016			28.6
8/6/08	2790	8.29	TB19 Grab	TOLLWAY 96	0.111		0.0930	0.0835		42.5				0.00707	0.116	2.12		11.1	0.0147		525				16.8
9/3/08	2765	8.47	TB19 Grab	TOLLWAY 106	0.119		0.0920	0.0739		37.5				0.00950	0.118	3.00		10.9	0.0100		535				31.9
9/17/08	2333	8.62	TB19 Grab	TOLLWAY 119	0.119		0.101	0.0694		36.6				0.00290	0.0737	6.79		16.0	0.0029		569				37.7
10/1/08	4133	8.97	TB19 Grab	TOLLWAY 136	0.0849		0.102	0.0657		25.7				0.00739	0.0497	5.06		13.2	0.0031	0.025	832				51.8
10/15/08	3833	8.29	TB19 Grab	TOLLWAY 129	0.195		0.064	0.0956		46.8				0.0129	0.102	18.0		17.7	0.0261		711				41.4
11/12/08	1995	9.66	TB19 Grab	TOLLWAY 149	0.204		0.076	0.0278		16.7			0.0416	0.00855	0.169	57.0		5.99	0.0048	0.024	359				42.2
12/2/08	5271	8.07	TB19 Grab	TOLLWAY 161			0.059	0.0919		82.2			0.0227	0.00465	0.0353	9.53		26.4	0.0206	0.026	1050		0.081		55.8
				*starting with the 12/2/08 sample, MDL for Al = 0.037 mg/L																					
			TB19 Grab	min	0.012	NA	0.037	0.028	NA	16.700	NA	NA	0.023	0.003	0.013	2.120	0.018	5.985	0.003	0.024	359.000	0.014	0.065	0.057	16.800
			TB19 Grab	max	0.397	NA	0.129	0.232	NA	195.000	NA	NA	0.042	0.013	0.219	57.000	0.047	68.290	0.173	0.036	4026.000	0.041	0.137	0.057	135.000
			TB19 Grab	mean	0.122	NA	0.090	0.104	NA	59.311	NA	NA	0.032	0.007	0.083	10.848	0.029	25.294	0.031	0.028	1494.222	0.025	0.097	0.057	56.300

APPENDIX D: Results of Geochemical Analysis of Biweekly Surface-Water Grab Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as CaC	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
				MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
3/4/09	16377	11.96	TB15B Grab	TOLLWAY 130			4.03		1.62					11.5	238	8944	20.0	0.02	1.04	0.36	5210	1.51	81.7	27.9	28.2
3/31/09	4857	11.10	TB15B Grab	TOLLWAY 194			2.97		0.569	0.00107				10.57	187	2692	583	0.07	0.27	0.30	1531	0.73	47.6	55.9	16.9
4/14/09	7931	11.96	TB15B Grab	TOLLWAY 203			3.69		1.02					11.23	202	4147	6.4	0.02	0.33	0.12	2411	0.89	49.2	17.3	16.1
4/29/09	5955	11.19	TB15B Grab	TOLLWAY 209			4.44		0.815					11.5	215	2959	6.8		0.28	0.19	1721	0.91	37.4	14.5	13.9
5/11/09	6400	NA	TB15B Grab	TOLLWAY 214			4.33		0.583					11.07	143	3357	5.2	0.03	0.08	0.20	1920	0.25	46.2	17.1	16.1
5/27/09	3672	10.69	TB15B Grab	TOLLWAY 218			4.84	0.086	0.585					11.3	146	1829	7.2	0.01	0.08	0.20	998	0.43	34.2	15.1	14.8
6/10/09	5611	9.95	TB15B Grab	TOLLWAY 223			5.69	0.086	0.512	0.00327				10.6	126	2983	7	0.01		0.18	1694		44.3	23.4	21.1
6/30/09	2120	9.68	TB15B Grab	TOLLWAY 222			3.84		0.282	0.00115				9.96	148	2627	25.2	0.01	0.18	0.47	1493	0.13	54.0	23.8	19.1
7/28/09	4718	9.03	TB15B Grab	TOLLWAY 234			0.878		0.467	0.00125				9.03	162	2594	29.2	0.02		0.28	760		48.6	28.6	22.0
8/25/09	4376	9.26	TB15B Grab	TOLLWAY 248			1.15		0.333	0.00239				9.71	126	2319	11	0.01		0.16	1572		54.0	18.8	17.2
9/8/09	1385	6.77	TB15B Grab	TOLLWAY 256			2.35		0.296	0.00694				10.2	136	2603	39	0.02		0.28	1473		58.1	36.2	12.1
9/22/09	4386	9.06	TB15B Grab	TOLLWAY 263			3.66		0.481	0.00109				9.18	99	2392	9.6	0.010	0.10	0.17	1282	0.11	162	27.2	21.0
10/7/09	4565	10.57	TB15B Grab	TOLLWAY 271			5.74		0.332	0.00105				10.54	164	2497	9.6	0.018	0.55	0.25	1329	0.17	94.9	29.5	29.2
10/20/09	3524	10.78	TB15B Grab	TOLLWAY 283			4.69		0.256	0.00133				10.63	158	1883	4.8	0.019	0.56	0.26	977	0.31	64.3	18.1	19.7
11/2/09	2492	11.38	TB15B Grab	TOLLWAY 292			4.80		0.507					11.3	155	1164	3.6	0.013	0.42	0.39	581	0.33	41.2	13.4	12.2
12/2/09	2359	10.46	TB15B Grab	TOLLWAY 315			4.87		0.284					10.5	121	1240		0.006	0.42	0.19	624	0.33	49.2	15.6	14.9
12/29/09	15023	12.16	TB15B Grab	TOLLWAY 350			3.31		1.90		0.020			11.5	307	8086	8.0	0.011	1.04		4675	0.91	88.3	23.5	21.4
1/26/10	18717	12.79	TB15B Grab	TOLLWAY 378			3.42		2.04		0.030		0.0242	11.8	445	10066	14.0	0.008	1.29		5923	0.78	85.4	24.2	20.1
3/3/10	15354	11.63	TB15B Grab	TOLLWAY 423			1.58		1.63	0.00057			0.0154	10.8	108	8782	12.0	0.010	0.88		5157	0.51	121	16.5	17.0
3/16/10	15297	11.72	TB15B Grab	TOLLWAY 433			3.10		1.26					11.6	255	8289	5.6	0.010	0.64		4878	0.79	73.6	26.8	20.5
3/30/10	15219	9.96	TB15B Grab	TOLLWAY 453			2.66		0.817					10.0	96	8504	5.2	0.012	0.40		5015	0.56	71.8	25.7	25.5
4/13/10	11197	10.70	TB15B Grab	TOLLWAY 469			4.20		0.545					10.7	163	6215	6.0	0.016	0.46		3573	0.49	67.8	17.7	21.7
4/27/10	8234	11.49	TB15B Grab	TOLLWAY 491			3.89		0.529				0.0080	10.9	179	4389		0.013	0.42		2518	0.47	57.5	22.3	20.8
5/11/10	946	10.51	TB15B Grab	TOLLWAY 509			4.55		0.164	0.0300			0.0087	10.20	110	520	16.0	0.027	0.13	0.18	213	0.19	16.3	15.0	10.9
5/25/10	6746	9.51	TB15B Grab	TOLLWAY 534			1.14		0.371					9.87	174	3633	2.8	0.006			2038		54.4	46.7	28.4
6/8/10	1803	9.78	TB15B Grab	TOLLWAY 556			3.09		0.251	0.00416			0.0080	9.65	123	954	7.2	0.011	0.23	0.16	452	0.36	41.7	30.6	31.7
6/23/10	2641	9.33	TB15B Grab	TOLLWAY 580			3.20		0.342	0.00063				9.61	133	1384	9.2	0.021	0.42	0.34	718	0.31	40.8	26.3	25.4
7/8/10	2006	8.10	TB15B Grab	TOLLWAY 605			2.88		0.428	0.00069				8.40	170	1083	3.2	0.014		0.33	481		33.9	34.5	28.8
8/3/10	2028	7.55	TB15B Grab	TOLLWAY 638			6.70		0.251	0.002				7.85	370	1171	4.8	0.069	0.14	0.25	385	3.41	58.6	43.5	40.4
			TB15B Grab	min	NA	NA	0.88	0.09	0.16	0.00057	0.020	NA	0.0080	7.85	96	520	2.80	0.01	0.08	0.12	213.33	0.11	16.32	13.37	10.91
			TB15B Grab	max	NA	NA	6.70	0.09	2.04	0.03000	0.030	NA	0.0242	11.77	445	10066	583.00	0.07	1.29	0.47	5923.44	3.41	162.48	55.88	40.42
			TB15B Grab	mean	NA	NA	3.64	0.09	0.67	0.00382	0.025	NA	0.0129	10.40	178	3769	31.90	0.02	0.45	0.25	2124.28	0.65	61.30	25.37	20.94
3/5/08	11427	7.92	TB19 Grab*	TOLLWAY 16			2.72		0.751	0.00147			0.0358	8.00	149	6338		0.02	0.08		3668	1.62	157	10.6	6.27
3/12/08	19639	8.48	TB19 Grab	TOLLWAY 26			1.03		1.66		0.024		0.0216	8.42	150	11240		0.02			6583	0.25	272	11.3	7.48
3/26/08	6161	9.14	TB19 Grab	TOLLWAY 29			1.51		0.582				0.0125	9.06	167	3265		0.01		0.25	1831	0.68	95.9	13.1	12.0
4/9/08	7309	9.52	TB19 Grab	TOLLWAY 36			0.847		0.667					9.52	110	7952	8			0.16	2278	0.07	138	15.6	14.2
4/23/08	17848	9.22	TB19 Grab	TOLLWAY 43			0.319		0.969		0.02			9.39	121	10136	18	0.02			6099	0.08	355	28.3	20.2
5/6/08	13655	8.79	TB19 Grab	TOLLWAY 49			0.477		0.775					8.78	232	7622	25	0.02			4371	0.47	279	18.5	15.9
5/20/08	10704	8.37	TB19 Grab	TOLLWAY 50			0.520		0.615					7.72	269	6058	30.4	0.02			3353	1.76	188	13.5	11.8
5/28/08	10384	8.82	TB19 Grab	TOLLWAY 52			0.414		0.494				0.0127	8.94	283	5687	11.2	0.02		0.60	3123	2.38	221	13.9	12.1
6/9/08	4195	8.50	TB19 Grab	TOLLWAY 55			5.69		0.327	0.00811			0.0115	8.46	253	2320	282	0.02	0.06	0.59	1160	1.75	95.1	21.0	11.8
7/9/08	4824	7.53	TB19 Grab	TOLLWAY 82			5.35		0.369	0.00085			0.0097	7.89	284	2620	36.0	0.01		0.53	1326		104	20.1	17.7
7/22/08	3622	8.72	TB19 Grab	TOLLWAY 89			5.72		0.325	0.00648				8.74	211	1949	119			0.78	1014	0.17	74.9	25.2	13.7
8/6/08	2790	8.29	TB19 Grab	TOLLWAY 96			3.82		0.328	0.00332				8.23	254	1497	10.0	0.02		0.53	712		52.5	10.4	9.29
9/3/08	2765	8.47	TB19 Grab	TOLLWAY 106			1.85		0.321	0.00196			0.0087	8.32	146	1488	15.2	0.02		0.87	723	0.08	96.8	25.1	21.6
9/17/08	2333	8.62	TB19 Grab	TOLLWAY 119			4.22		0.265					8.66	278	1566	19.6			0.60	696	0.11	99.4	13.0	9.66
10/1/08	4133	8.97	TB19 Grab	TOLLWAY 136			2.47		0.238	0.00074				8.93	273	2257	10.4			0.63	1099	0.16	131	10.8	9.18
10/15/08	3833	8.29	TB19 Grab	TOLLWAY 129			3.01		0.524	0.00214				8.32	148	2052	19.6		0.08	0.29	1091	0.38	111	16.9	16.1
11/12/08	1995	9.66	TB19 Grab	TOLLWAY 149			12.6		0.158	0.00354		0.049	0.0173	9.67	178	1125	12.4	0.02		0.52	451	0.72	120	14.8	13.5
12/2/08	5271	8.07	TB19 Grab	TOLLWAY 161			3.63		0.635				0.0493	8.28	157	2927				0.32	1614	0.61	141	9.96	9.21
			TB19 Grab	min	NA	NA	0.319	NA	0.158	0.001	0.020	0.049	0.009	7.723	110.437	1125.000	8.400	0.011	0.062	0.160	451.288	0.074	52.507	9.957	6.267
			TB19 Grab	max	NA	NA	12.600	NA	1.659	0.008	0.024	0.049	0.049	9.670	284.264	11240.000	282.000	0.024	0.081	0.872	6583.052	2.382	354.697	28.311	21.617
			TB19 Grab	mean	NA	NA	3.122	NA	0.556	0.003	0.022	0.049	0.020	8.630	203.499	4338.833	44.086	0.018	0.074	0.513	2288.535	0.705	151.678	16.218	12.877

APPENDIX D: Results of Geochemical Analysis of Biweekly Surface-Water Grab Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
				MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
9/22/09	3605	9.98	TB19r Grab	TOLLWAY 267	0.050		0.056	0.0549		23.8				0.0101	0.0189	91.0		17.1	0.0048	0.061	625	0.029			31.1
10/6/09	1716	10.42	TB19r Grab	TOLLWAY 270	0.055		0.037	0.0446		23.5				0.00942	0.0181	85.5		7.81	0.0023	0.043	454				21.6
10/20/09	2249	10.54	TB19r Grab	TOLLWAY 280			0.031	0.0215		14.5			0.0065	0.00792		88.5		7.36		0.032	399				21.5
11/3/09	1379	10.19	TB19r Grab	TOLLWAY 294	0.042		0.045	0.0176		10.4			0.0073	0.0580	0.0438	63.3		9.85	0.0027		227	0.015	0.064		16.9
12/1/09	1351	9.66	TB19r Grab	TOLLWAY 314	0.059		0.035	0.019		15.1				0.00537	0.0177	55.2		16.2	0.0019		208				19.0
12/28/09	8936	9.94	TB19r Grab	TOLLWAY 342	0.041		0.038	0.194		114			0.0080	0.00766	0.0129	73.3		35.1	0.0174		1705	0.033			23.4
1/26/10	9665	11.95	TB19r Grab	TOLLWAY 380			0.026	0.164		106				0.0248	0.0081	89.7		34.8		0.027	2097	0.027			22.7
3/3/10	10786	9.43	TB19r Grab	TOLLWAY 424	0.187		0.025	0.261		188				0.0131	0.112	50.7		86.9	0.135		3122	0.045			30.5
3/16/10	5303	9.28	TB19r Grab	TOLLWAY 434	0.085		0.048	0.0845		52.4				0.0138	0.0555	40.6		46.0	0.0233		1003	0.024			19.9
3/31/10	8622	8.94	TB19r Grab	TOLLWAY 463			0.063	0.0939		36.2				0.0164		72.1		53.2	0.0268	0.033	1738	0.029			23.8
4/14/10	6125	9.39	TB19r Grab	TOLLWAY 478	0.059		0.055	0.0684		45.5				0.0179	0.0290	67.8		46.2	0.0589	0.029	1105	0.026	0.306		17.1
4/27/10	6124	10.83	TB19r Grab	TOLLWAY 500			0.060	0.0562		29.0				0.0192	0.0169	84.2		7.52	0.0045	0.027	1189	0.015			12.7
5/11/10	653	9.79	TB19r Grab	TOLLWAY 508	0.996		0.042	0.030		34.8				0.00577	0.562	8.11		9.42	0.0083		98.3				4.95
			TB19r Grab	min	0.041	NA	0.025	0.018	NA	10.376	NA	NA	0.00650	0.00079	0.0081	8.106	NA	7.3640	0.0019	0.027	98.34	0.015	0.064	NA	4.95
			TB19r Grab	max	0.996	NA	0.063	0.261	NA	187.511	NA	NA	0.00800	0.05804	0.5619	91.000	NA	86.8764	0.1355	0.061	3122.25	0.045	0.306	NA	31.10
			TB19r Grab	mean	0.175	NA	0.043	0.085	NA	53.242	NA	NA	0.00727	0.01611	0.0813	66.930	NA	29.0357	0.0260	0.036	1074.60	0.027	0.185	NA	20.39
6/10/08	3200	6.98	SandersSW Grab	TOLLWAY 61	0.186		0.128	0.0863		97.5				0.0157	0.199	1.27		44.5	0.0229		539	0.025			28.4
8/5/08	5399	8.61	SandersSW Grab	TOLLWAY 95	0.0678		0.125	0.127		69.2				0.0419	0.137	5.85		18.2	0.0690		989		0.114		34.6
9/17/08	2464	6.97	SandersSW Grab	TOLLWAY 117	0.0954		0.162	0.0897		131						1.55		65.2	0.0859		303	0.041			43.0
11/12/08	4233	7.32	SandersSW Grab	TOLLWAY 158	0.130		0.040	0.0884		69.6				0.0125	0.0455	4.24		22.9	0.0088		794	0.016			40.2
12/2/08	5516	7.19	SandersSW Grab	TOLLWAY 160			0.039	0.123		111				0.00658	0.0153	4.70		38.1	0.0157		1060	0.016			49.8
12/16/08	2560	6.79	SandersSW Grab	TOLLWAY 174	0.045		0.111	0.0831		165				0.00182	0.0271	0.585		86.7	0.0610		301	0.031			44.4
			SandersSW Grab	min	0.045	NA	0.039	0.083	NA	69.200	NA	NA	NA	0.002	0.015	0.585	NA	18.240	0.009	NA	301.000	0.016	0.114	NA	28.400
			SandersSW Grab	max	0.186	NA	0.162	0.127	NA	165.000	NA	NA	NA	0.042	0.199	5.850	NA	86.690	0.086	NA	1060.000	0.041	0.114	NA	49.800
			SandersSW Grab	mean	0.105	NA	0.101	0.099	NA	107.217	NA	NA	NA	0.016	0.085	3.033	NA	45.935	0.044	NA	664.333	0.026	0.114	NA	40.067
3/5/08	8576	8.26	TB20 Grab	TOLLWAY 17	0.0592			0.116		81.8				0.00625	0.0993	10.4		15.0	0.214		1699				29.4
3/12/08	4154	7.83	TB20 Grab	TOLLWAY 27	0.0461			0.0700		47.8				0.00598	0.1217	3.90		10.4	0.377		784				15.2
3/26/08	9140	7.75	TB20 Grab	TOLLWAY 30	0.0530		0.042	0.216		132				0.00872	0.0427	7.67	0.024	34.1	0.0625		1784	0.030			42.3
4/9/08	7467	8.05	TB20 Grab	TOLLWAY 34	0.0456		0.041	0.147		86.5				0.00772	0.0387	7.45	0.019	27.0	0.0727		1477				39.2

*starting with the 12/2/08 sample, MDL for Al = 0.037 mg/L

APPENDIX D: Results of Geochemical Analysis of Biweekly Surface-Water Grab Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as CaC	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
				MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
9/22/09	3605	9.98	TB19r Grab	TOLLWAY 267			3.33		0.482					9.98	149	1946	31.2	0.010	0.17	0.25	1023	0.09	84.7	33.9	24.3
10/6/09	1716	10.42	TB19r Grab	TOLLWAY 270			2.25		0.510					10.46	125	1408	27.6	0.003	0.15	0.20	714		60.7	19.9	19.1
10/20/09	2249	10.54	TB19r Grab	TOLLWAY 280			2.24		0.342					10.64	165	1205	66.0	0.008	0.23	0.25	566	0.11	67.8	14.9	14.8
11/3/09	1379	10.19	TB19r Grab	TOLLWAY 294			2.96		0.264				0.0075	10.3	144	749	24.8	0.009	0.16	0.25	322	0.11	51.3	12.4	10.3
12/1/09	1351	9.66	TB19r Grab	TOLLWAY 314			2.13		0.300					9.74	151	761	39.2	0.008	0.08	0.19	310	0.10	52.7	10.1	9.25
12/28/09	8936	9.94	TB19r Grab	TOLLWAY 342			2.44		1.05					9.08	59	4881	180		0.24	0.17	2987	0.35	64.0	13.1	10.5
1/26/10	9665	11.95	TB19r Grab	TOLLWAY 380			2.22		1.26		0.025		0.0123	10.7	139	5798	53.2	0.003	1.07		3459	0.75	62.2	15.5	16.3
3/3/10	10786	9.43	TB19r Grab	TOLLWAY 424			3.04		1.36	0.00370	0.023		0.0082	8.64	114	6118	115	0.008	0.61		3510	0.19	78.8	17.0	13.8
3/16/10	5303	9.28	TB19r Grab	TOLLWAY 434			3.72		0.619	0.00132				9.11	200	2891	8.4	0.006	0.33		1596	0.59	54.1	15.9	16.9
3/31/10	8622	8.94	TB19r Grab	TOLLWAY 463			0.831		0.742					9.12	149	4701	3.2	0.005	0.38		2704		61.9	22.6	22.6
4/14/10	6125	9.39	TB19r Grab	TOLLWAY 478			0.806		0.678					9.32	313	3328	7.6	0.285	0.83		1854		46.5	18.5	24.1
4/27/10	6124	10.83	TB19r Grab	TOLLWAY 500			1.30		0.598					10.6	168	3264	12.0	0.025	0.18		1857		34.5	22.9	22.6
5/11/10	653	9.79	TB19r Grab	TOLLWAY 508			5.31		0.188	0.0287				9.65	152	424	53.6	0.079		0.27	122	0.10	13.2	24.5	13.8
			TB19r Grab	min	NA	NA	0.81	NA	0.19	0.00132	0.023	NA	0.0075	8.64	59	424	3.20	0.00	0.08	0.17	122.02	0.09	13.17	10.10	9.25
			TB19r Grab	max	NA	NA	5.31	NA	1.36	0.02867	0.025	NA	0.0123	10.74	313	6118	180.00	0.28	1.07	0.27	3509.78	0.75	84.66	33.88	24.28
			TB19r Grab	mean	NA	NA	2.50	NA	0.65	0.01123	0.024	NA	0.0094	9.80	156	2883	47.85	0.04	0.37	0.23	1617.16	0.27	56.32	18.55	16.79
6/10/08	3200	6.98	SandersSW Grab*	TOLLWAY 61			6.70		0.562	0.00195			0.0171	7.32	405	1780	4.4	0.02		0.29	758	0.52	83.5	19.8	19.1
8/5/08	5399	8.61	SandersSW Grab	TOLLWAY 95			8.64		0.451	0.00080			0.0148	8.44	188	2910	65.0	0.07	0.13	0.58	1540	0.08	108	40.3	37.5
9/17/08	2464	6.97	SandersSW Grab	TOLLWAY 117			6.38		0.663					7.26	365	1393	22.0	0.03		0.22	532	1.01	110	10.5	9.36
11/12/08	4233	7.32	SandersSW Grab	TOLLWAY 158			4.29		0.395	0.00081				7.70	259	2328	4.4	0.03		0.17	1161	0.10	115	16.0	14.9
12/2/08	5516	7.19	SandersSW Grab	TOLLWAY 160			4.08		0.592					7.76	293	3118	4.0	0.02		0.15	1994	0.23	126	10.6	9.95
12/16/08	2560	6.79	SandersSW Grab	TOLLWAY 174			5.43		0.758	0.00079				7.25	494	1490	23.2			0.18	494	1.38	118	11.3	6.31
			SandersSW Grab	min	NA	NA	4.080	NA	0.395	0.001	NA	NA	0.015	7.247	187.812	1393.000	4.000	0.016	0.125	0.153	493.952	0.083	83.484	10.530	6.308
			SandersSW Grab	max	NA	NA	8.640	NA	0.758	0.002	NA	NA	0.017	8.436	494.155	3118.000	65.000	0.074	0.125	0.576	1994.020	1.384	126.365	40.281	37.548
			SandersSW Grab	mean	NA	NA	5.920	NA	0.570	0.001	NA	NA	0.016	7.621	334.126	2169.833	20.500	0.035	0.125	0.265	1079.910	0.555	110.258	18.108	16.194
3/5/08	8576	8.26	TB20 Grab	TOLLWAY 17			3.11		0.712		0.020		0.0341	8.26	134	4776		0.02	0.12		2693	0.20	76.1	8.27	7.73
3/12/08	4154	7.83	TB20 Grab	TOLLWAY 27			2.41		0.381				0.0435	7.82	96	2225		0.01		0.64	1254	0.09	40.6	9.61	6.13
3/26/08	9140	7.75	TB20 Grab	TOLLWAY 30			2.51		1.22				0.0616	7.92	160	5160		0.01			2932		107	11.3	10.2
4/9/08	7467	8.05	TB20 Grab	TOLLWAY 34			1.90		0.817				0.0339	8.07	145	4086	10				2320		106	13.0	10.5

APPENDIX E: Well Construction Information

Well ID	Installation date	Land surface elevation (m)	Well top elevation (m)	Screened interval (m)	Screen length (m)	Top of sand pack (m)	Bentonite seal extent (m)
Site TB7B							
TB7B-1	11/18/2009	192.825	194.042	0.415 to 1.728	1.313	0.365	0.365 to surface
TB7B-2	11/18/2009	192.965	194.123	0.448 to 1.755	1.307	0.300	0.300 to surface
TB7B-3	11/18/2009	192.955	194.135	0.444 to 1.750	1.306	0.300	0.300 to surface
TB7B-4	11/18/2009	193.161	194.290	0.547 to 1.855	1.308	0.300	0.300 to surface
Site TB15B							
TB15B-1U	11/19/2009	196.777	197.973	0.549 to 1.857	1.308	0.300	0.300 to surface
TB15B-1L	11/19/2009	196.777	197.930	1.589 to 2.896	1.307	1.740	1.740 to surface
TB15B-2	11/19/2009	196.435	197.525	0.564 to 1.869	1.305	0.300	0.300 to surface
TB15B-3	11/19/2009	196.105	197.105	0.714 to 2.021	1.307	0.300	0.300 to surface

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
				MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
12/1/09	2629	7.10	TB7B-1	TOLLWAY 310			0.131	0.036		64.5				0.00322	0.846	3.97		22.1	0.733		531	0.021			39.9
12/15/09	2825	7.25	TB7B-1	TOLLWAY 332			0.119	0.0406		57.5					4.36	3.03		22.6	0.479		543	0.035			38.9
1/13/10	2488	6.96	TB7B-1	TOLLWAY 366			0.114	0.0348		48.3				0.00082	6.07	2.65		19.9	0.313		499	0.017			33.6
1/27/10	2482	7.04	TB7B-1	TOLLWAY 381	0.046		0.107	0.0380		50.0				0.00080	3.57	2.63		19.0	0.361		494	0.041			35.1
2/17/10	2292	7.46	TB7B-1	TOLLWAY 399			0.103	0.0353		57.6					4.31	2.27		21.5	0.395		496	0.018			35.6
3/2/10	2078	7.62	TB7B-1	TOLLWAY 415			0.107	0.0322		52.9					3.70	2.18		19.9	0.341		463	0.022			33.9
3/17/10	3101	7.40	TB7B-1	TOLLWAY 436	0.049		0.097	0.0488		74.0				0.00152	4.59	2.75		27.6	0.489		614	0.017			58.2
3/31/10	2871	7.66	TB7B-1	TOLLWAY 459			0.106	0.0407		64.4					4.72	2.32		26.1	0.400		573	0.025			48.5
4/13/10	2939	7.19	TB7B-1	TOLLWAY 474			0.113	0.0427		68.2				0.00123	5.78	2.86		25.2	0.415		545	0.020	0.064		48.2
4/27/10	2662	7.40	TB7B-1	TOLLWAY 496	0.038		0.103	0.0396		58.4					5.70	2.93		21.5	0.381		526				48.9
5/12/10	2665	7.53	TB7B-1	TOLLWAY 512	0.048		0.123	0.041		64.8					5.59	3.26		22.9	0.423		511	0.020			50.5
5/24/10	2530	6.99	TB7B-1	TOLLWAY 526			0.119	0.0362		59.4					6.35	3.08		22.1	0.363		476	0.021			40.5
6/8/10	3121	7.20	TB7B-1	TOLLWAY 552	0.038		0.122	0.0497		67.8					6.76	3.31		24.9	0.423		587	0.022			53.7
6/22/10	3009	6.83	TB7B-1	TOLLWAY 574	0.038		0.141	0.0475		67.8					6.55	4.64		24.7	0.401		575	0.032	0.081		46.4
7/7/10	2642	7.12	TB7B-1	TOLLWAY 597			0.155	0.0464		62.1					5.38	3.75		24.9	0.347		507		0.069		39.7
7/20/10	2584	6.97	TB7B-1	TOLLWAY 617			0.152	0.0453		49.1					4.94	3.40		19.4	0.302		516	0.014	0.078		42.4
8/2/10	2487	7.08	TB7B-1	TOLLWAY 630	0.041		0.170	0.040		58.9					4.60	3.52		21.1	0.324		462	0.014	0.121		39.2
8/17/10	3017	7.36	TB7B-1	TOLLWAY 657	0.040		0.162	0.052		60.8					5.85	3.36		22.0	0.376		581	0.028	0.097		47.8
			TB7B-1	min	0.038	NA	0.097	0.032	NA	48.266	NA	NA	0.00000	0.00080	0.8455	2.180	NA	18.9923	0.3018	NA	462.20	0.014	0.064	NA	33.61
			TB7B-1	max	0.049	NA	0.170	0.052	NA	73.984	NA	NA	0.00000	0.00322	6.7554	4.637	NA	27.6047	0.7331	NA	614.13	0.041	0.121	NA	58.17
			TB7B-1	mean	0.042	NA	0.125	0.042	NA	60.357	NA	NA	0.00000	0.00152	4.9812	3.106	NA	22.6272	0.4036	NA	527.70	0.023	0.085	NA	43.39
12/1/09	1296	7.17	TB7B-2	TOLLWAY 311			0.284	0.035		101				0.00129	1.04	0.702		93.4	0.647		82.5	0.053			23.7
12/15/09	1320	7.29	TB7B-2	TOLLWAY 333			0.285	0.0339		88.8					1.35	0.608		96.5	0.549		78.0	0.049			24.5
1/13/10	1249	7.09	TB7B-2	TOLLWAY 367	0.117		0.266	0.0342		85.5				0.00161	0.246	0.669		92.8	0.328		73.6	0.054			27.6
1/27/10	1232	7.44	TB7B-2	TOLLWAY 382	0.047		0.256	0.0330		83.1				0.00139	0.207	0.603		89.7	0.211		72.5	0.050			26.6
2/17/10	1252	7.54	TB7B-2	TOLLWAY 400	0.666		0.248	0.0350		101					0.884	0.906		104	0.434		79.1	0.054			31.2
3/2/10	1216	7.36	TB7B-2	TOLLWAY 416			0.234	0.0315		94.9				0.00143	0.237	0.509		110	0.342		74.7	0.042			27.6
3/17/10	1129	7.38	TB7B-2	TOLLWAY 437	0.457		0.229	0.0335		89.6				0.00214	0.512	0.723		97.7	0.170		65.1	0.028			25.7
3/31/10	1120	7.47	TB7B-2	TOLLWAY 460	0.334		0.225	0.0356		91.0				0.00179	0.481	0.620		99.7	0.198		59.2	0.034			24.5
4/13/10	1020	7.39	TB7B-2	TOLLWAY 475			0.189	0.0299		81.9				0.00149	0.0181	0.685		76.9	0.0823		46.3	0.033			24.3
4/27/10	1105	7.26	TB7B-2	TOLLWAY 497	0.050		0.217	0.0319		80.9				0.00231	0.0970	0.542		80.0	0.161		55.6	0.033			22.0
5/12/10	1083	7.49	TB7B-2	TOLLWAY 513			0.259	0.030		85.7				0.00175	0.0237	0.551		88.1	0.270		59.9	0.046			23.0
5/24/10	1030	7.14	TB7B-2	TOLLWAY 527			0.231	0.0306		81.6				0.00189	0.0070	0.525		75.0	0.102		51.9	0.035			20.1
6/8/10	1088	7.24	TB7B-2	TOLLWAY 553			0.261	0.0312		81.3				0.00162	0.0169	0.598		80.6	0.199		59.2	0.050			19.7
6/22/10	1102	7.10	TB7B-2	TOLLWAY 575			0.291	0.0317		86.1				0.00099	0.0271	0.629		84.3	0.264		57.7	0.044			18.8
7/7/10	1088	7.25	TB7B-2	TOLLWAY 599			0.318	0.0316		81.2				0.00182	0.0783	0.688		83.2	0.445		59.0	0.039			16.4
7/20/10	1082	7.13	TB7B-2	TOLLWAY 618			0.318	0.0307		78.8				0.00123	0.0603	0.657		79.1	0.505		55.6	0.048			13.1
8/2/10	1088	7.24	TB7B-2	TOLLWAY 632			0.297	0.032		94.3				0.001	0.196	0.750		79.0	0.228		53.2	0.048			15.2
8/17/10	1078	7.42	TB7B-2	TOLLWAY 658			0.270	0.029		79.5					0.169	0.708		74.4	0.431		65.1	0.041			13.4
			TB7B-2	min	0.047	NA	0.189	0.029	NA	78.805	NA	NA	NA	0.00099	0.0070	0.509	NA	74.4148	0.0823	NA	46.27	0.028	NA	NA	13.09
			TB7B-2	max	0.666	NA	0.318	0.036	NA	100.914	NA	NA	NA	0.00231	1.3489	0.906	NA	109.8040	0.6466	NA	82.51	0.054	NA	NA	31.20
			TB7B-2	mean	0.278	NA	0.260	0.032	NA	86.993	NA	NA	NA	0.00162	0.3139	0.649	NA	88.0357	0.3093	NA	63.80	0.043	NA	NA	22.08
12/1/09	1215	7.30	TB7B-3	TOLLWAY 312			0.125	0.025		114				0.00143	0.166	0.583		80.8	0.0348		70.0	0.038	0.071		12.9
12/15/09	1138	7.44	TB7B-3	TOLLWAY 334	0.217		0.122	0.0257		97.8				0.00163	0.403	0.633		75.5	0.0436		58.7	0.048			12.1
1/13/10	1034	7.23	TB7B-3	TOLLWAY 368			0.108	0.0191		87.2				0.00135	0.0228	0.403		69.8	0.0034		46.5	0.035			10.6
1/27/10	944	7.51	TB7B-3	TOLLWAY 383			0.114	0.0195		86.6				0.00139	0.0155	0.397		65.0			37.9	0.030			9.70
2/17/10	974	7.67	TB7B-3	TOLLWAY 401			0.113	0.0172		102					0.0363	0.381		72.3	0.0080		38.9	0.037			11.8
3/2/10	960	7.48	TB7B-3	TOLLWAY 417			0.085	0.0155		94.1				0.00121	0.0598	0.359		68.4	0.0038		36.1	0.026			12.3
3/17/10	870	7.53	TB7B-3	TOLLWAY 438			0.089	0.0160		91.4				0.00104		0.291		61.1			25.6	0.020			11.1
3/31/10	883	7.54	TB7B-3	TOLLWAY 461			0.104	0.0160		95.1						0.295		69.1	0.0018		23.5	0.031			12.0
4/13/10	845	7.29	TB7B-3	TOLLWAY 476			0.103	0.0168		86.7				0.00118	0.0132	0.273		60.8			19.2	0.022			11.6
4/27/10	880	7.41	TB7B-3	TOLLWAY 498			0.096	0.0165		89.1				0.00184	0.0949	0.340		61.2	0.0112		21.5	0.028			10.1
5/12/10	862	7.56	TB7B-3	TOLLWAY 514			0.126	0.017		90.1				0.00144	0.0073	0.289		60.7			16.9	0.030			9.25
5/24/10	845	7.30	TB7B-3	TOLLWAY 528			0.129	0.0160		88.3				0.00150		0.297		59.4			17.7	0.025			9.32
6/8/10	860	7.35	TB7B-3	TOLLWAY 554			0.118	0.0171		88.6				0.00090	0.0103	0.322		59.1			19.9	0.035			8.07
6/22/10	873	7.15	TB7B-3	TOLLWAY 576			0.130	0.0172		91.0				0.00177		0.342		59.3	0.0022		18.5	0.028			7.26
7/7/10	902	7.31	TB7B-3	TOLLWAY 600			0.138	0.0173		94.1				0.00137		0.369		64.3	0.0021		20.4	0.026			7.62
7/20/10	966	7.33	TB7B-3	TOLLWAY 619			0.119	0.0171		95.8				0.00158	0.0513	0.388		65.2	0.0108		22.8	0.040			8.53
8/2/10	1083	7.28	TB7B-3	TOLLWAY 633			0.161	0.023		119				0.002	0.011	0.428		76.0			24.3	0.033			9.39
8/17/10	1105	7.45	TB7B-3	TOLLWAY 659			0.137	0.022		116				0.001	0.012	0.443		78.5	0.002		28.8	0.036			10.0
			TB7B-3	min	0.217	NA	0.085	0.016	NA	86.642	NA	NA	NA	0.00090	0.0073	0.273	NA	59.1075	0.0018	NA	16.95	0.020	0.071	NA	7.26
			TB7B-3	max	0.217	NA	0.161	0.026	NA	118.744	NA	NA	NA	0.00184	0.4031	0.633	NA	80.7515	0.0436	NA	69.99	0.048	0.071	NA	12.87
			TB7B-3	mean	0.217	NA	0.118	0.019	NA	95.945	NA	NA	NA	0.00140	0.0695	0.380	NA	67.0161	0.0113	NA	30.41	0.032	0.071	NA	10.21

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as $CaCO_3$	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
				MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
12/1/09	2629	7.10	TB7B-1	TOLLWAY 310			4.89		0.131				0.0098	7.31	678	1520	no sample	0.004	0.44	0.21	405		104	14.4	9.88
12/15/09	2825	7.25	TB7B-1	TOLLWAY 332			5.16		0.133					7.60	681	1604	no sample	0.008	0.76	0.28	445		112	8.33	7.83
1/13/10	2488	6.96	TB7B-1	TOLLWAY 366			4.87		0.108				0.0101	7.53	699	1460	no sample	0.014	0.86	0.27	356		96.7	9.13	8.15
1/27/10	2482	7.04	TB7B-1	TOLLWAY 381			4.62		0.107	0.00153	0.026		0.0085	7.42	628	1411	no sample	0.011	0.80	0.24	368		99.4	9.06	7.75
2/17/10	2292	7.46	TB7B-1	TOLLWAY 399			7.18		0.106					7.40	644	1373	no sample	0.015	0.76	0.23	333		93.7	8.37	8.15
3/2/10	2078	7.62	TB7B-1	TOLLWAY 415			5.00		0.0955					7.44	627	1236	no sample	0.016	0.55	0.22	273	0.08	88.3	7.76	8.47
3/17/10	3101	7.40	TB7B-1	TOLLWAY 436			5.15		0.136	0.00190				7.31	734	1774	no sample	0.016	0.81	0.14	475		150	14.7	13.0
3/31/10	2871	7.66	TB7B-1	TOLLWAY 459			5.17		0.115		0.020			7.46	769	1615	no sample	0.023	0.78	0.18	383		126	10.7	9.94
4/13/10	2939	7.19	TB7B-1	TOLLWAY 474			5.43		0.123	0.00082				7.35	781	1690	no sample	0.008	1.17	0.27	1125		129	13.2	11.7
4/27/10	2662	7.40	TB7B-1	TOLLWAY 496			5.45		0.117	0.00103				7.39	674	1532	no sample	0.033	1.07	0.24	383		128	13.5	12.2
5/12/10	2665	7.53	TB7B-1	TOLLWAY 512			5.58		0.124	0.00117				7.48	677	1533	no sample	0.023	1.06	0.15	366		138	14.7	13.1
5/24/10	2530	6.99	TB7B-1	TOLLWAY 526			5.54		0.118					7.25	734	1478	no sample	0.040	1.15	0.37	318		118	11.1	9.94
6/8/10	3121	7.20	TB7B-1	TOLLWAY 552			6.19		0.137					7.18	733	1788	no sample	0.019	1.37	0.13	489		151	15.0	16.0
6/22/10	3009	6.83	TB7B-1	TOLLWAY 574			6.43		0.133					7.16	771	1669	no sample	0.018	1.52	0.25	417	0.07	131.2	13.8	15.5
7/7/10	2642	7.12	TB7B-1	TOLLWAY 597			6.00		0.125					7.33	776	1524	no sample	0.020	1.53	0.31	328		108	10.4	8.17
7/20/10	2584	6.97	TB7B-1	TOLLWAY 617			6.02		0.108					7.34	713	1457	no sample	0.024	1.44	0.33	326		118.7	14.3	10.5
8/2/10	2487	7.08	TB7B-1	TOLLWAY 630			6.05		0.106	0.001				7.31	724	1438	no sample	0.073	1.58	0.35	289		113	15.5	12.7
8/17/10	3017	7.36	TB7B-1	TOLLWAY 657			6.77		0.125	0.001				7.28	779	1642	no sample	0.045	1.49	0.31	387		131	14.8	14.2
			TB7B-1	min	NA	NA	4.62	NA	0.10	0.00059	0.020	NA	0.0085	7.16	627	1236	NA	0.00	0.44	0.13	272.56	0.07	88.33	7.76	7.75
			TB7B-1	max	NA	NA	7.18	NA	0.14	0.00190	0.026	NA	0.0101	7.60	781	1788	NA	0.07	1.58	0.37	1124.68	0.08	151.49	15.47	15.97
			TB7B-1	mean	NA	NA	5.64	NA	0.12	0.00111	0.023	NA	0.0095	7.36	712	1541	NA	0.02	1.06	0.25	414.67	0.08	118.74	12.15	10.95
12/1/09	1296	7.17	TB7B-2	TOLLWAY 311			6.59		0.126				0.0110	7.38	575	774	no sample	0.005	0.07	0.15	95.5		67.7	6.13	5.89
12/15/09	1320	7.29	TB7B-2	TOLLWAY 333			6.30		0.130				0.0078	7.68	586	781	no sample	0.008	0.11	0.21	89.0		74.8	6.03	5.30
1/13/10	1249	7.09	TB7B-2	TOLLWAY 367			5.67		0.118	0.00358			0.0086	7.56	605	760	no sample	0.007	0.07	0.19	68.1	0.64	81.5	20.2	4.07
1/27/10	1232	7.44	TB7B-2	TOLLWAY 382			5.28		0.114		0.024			7.51	587	762	no sample	0.008		0.20	63.5	0.81	79.6	6.14	3.97
2/17/10	1252	7.54	TB7B-2	TOLLWAY 400			8.31		0.115	0.0244				7.41	596	775	no sample	0.010		0.18	63.5	0.42	82.3	7.27	5.18
3/2/10	1216	7.36	TB7B-2	TOLLWAY 416			5.73		0.108				0.0075	7.45	589	751	no sample	0.010		0.17	63.9	0.68	78.3	5.19	5.15
3/17/10	1129	7.38	TB7B-2	TOLLWAY 437			6.25		0.105	0.0152			0.0075	7.51	541	714	no sample	0.014		0.17	51.2	2.68	74.1	5.16	5.06
3/31/10	1120	7.47	TB7B-2	TOLLWAY 460			5.96		0.100					7.52	550	759	no sample	0.021		0.17	47.9	3.68	79.6	5.70	4.23
4/13/10	1020	7.39	TB7B-2	TOLLWAY 475			4.94		0.0953					7.52	433	617	no sample	0.009		0.18	41.4	7.00	68.8	4.00	3.74
4/27/10	1105	7.26	TB7B-2	TOLLWAY 497			5.20		0.0994	0.00102				7.55	515	659	no sample	0.012		0.19	41.6	5.65	65.7	4.90	4.09
5/12/10	1083	7.49	TB7B-2	TOLLWAY 513			5.43		0.107					7.63	514	663	no sample	0.011		0.18	38.4	5.41	57.6	5.62	4.68
5/24/10	1030	7.14	TB7B-2	TOLLWAY 527			5.42		0.0973					7.40	485	643	no sample	0.008		0.17	37.7	4.62	62.6	3.68	3.82
6/8/10	1088	7.24	TB7B-2	TOLLWAY 553			5.55		0.101					7.41	528	648	no sample	0.008		0.16	38.5	2.47	58.9	5.40	4.41
6/22/10	1102	7.10	TB7B-2	TOLLWAY 575			5.90		0.103					7.43	546	647	no sample	0.010		0.22	37.2	0.80	53.7	4.32	4.88
7/7/10	1088	7.25	TB7B-2	TOLLWAY 599			6.09		0.105					7.48	544	631	no sample	0.010		0.22	37.7		46.6	4.17	3.50
7/20/10	1082	7.13	TB7B-2	TOLLWAY 618			6.13		0.102					7.40	516	626	no sample	0.010		0.23	50.1		37.5	5.73	4.16
8/2/10	1088	7.24	TB7B-2	TOLLWAY 632			6.57		0.102					7.48	511	625	no sample	0.012	0.00	0.21	48.0	0.17	43.3	6.23	5.12
8/17/10	1078	7.42	TB7B-2	TOLLWAY 658			6.09		0.097				0.009	7.39	495	628	no sample	0.008		0.26	57.5		41.2	4.35	3.94
			TB7B-2	min	NA	NA	4.94	NA	0.10	0.00102	0.024	NA	0.0075	7.38	433	617	NA	0.00	0.00	0.15	37.23	0.17	37.47	3.68	3.50
			TB7B-2	max	NA	NA	8.31	NA	0.13	0.02444	0.024	NA	0.0110	7.68	605	781	NA	0.02	0.11	0.26	95.46	7.00	82.34	20.19	5.89
			TB7B-2	mean	NA	NA	5.97	NA	0.11	0.01106	0.024	NA	0.0086	7.48	540	692	NA	0.01	0.06	0.19	53.94	2.69	64.11	6.12	4.51
12/1/09	1215	7.30	TB7B-3	TOLLWAY 312			9.76		0.0871					7.48	528	694	no sample	0.008		0.16	92.3	0.65	35.8	4.84	2.79
12/15/09	1138	7.44	TB7B-3	TOLLWAY 334			9.55		0.0848				0.0078	7.87	523	665	no sample	0.013		0.18	73.2	1.29	35.5	8.27	3.08
1/13/10	1034	7.23	TB7B-3	TOLLWAY 368			7.73		0.0670					7.66	507	606	no sample	0.009		0.16	52.9	1.24	31.5	3.12	2.50
1/27/10	944	7.51	TB7B-3	TOLLWAY 383			7.20		0.0651		0.025			7.61	473	561	no sample	0.008		0.17	33.1	8.18	28.3	3.23	3.00
2/17/10	974	7.67	TB7B-3	TOLLWAY 401			15.5		0.0662					7.58	476	572	no sample	0.010		0.16	47.3	2.61	31.2	4.10	3.04
3/2/10	960	7.48	TB7B-3	TOLLWAY 417			8.08		0.0615		0.030			7.55	459	571	no sample	0.012		0.16	44.1	4.55	35.0	3.62	3.36
3/17/10	870	7.53	TB7B-3	TOLLWAY 438			7.00		0.0587					7.62	414	506	no sample	0.009		0.16	23.2	11.5	30.9	3.38	3.02
3/31/10	883	7.54	TB7B-3	TOLLWAY 461			7.20		0.0581					7.68	425	550	no sample	0.013		0.16	27.9	7.42	34.0	3.42	2.81
4/13/10	845	7.29	TB7B-3	TOLLWAY 476			6.80		0.0555					7.62	402	506	no sample	0.010		0.17	19.1	9.88	32.7	2.78	2.74
4/27/10	880	7.41	TB7B-3	TOLLWAY 498			7.34		0.0676					7.65	400	525	no sample	0.013		0.19	17.3	11.9	27.0	3.61	3.79
5/12/10	862	7.56	TB7B-3	TOLLWAY 514			7.17		0.0661					7.74	395	567	no sample	0.011		0.17	16.0	16.2	27.9	5.15	3.39
5/24/10	845	7.30	TB7B-3	TOLLWAY 528			7.25		0.0668		0.018			7.49	393	534	no sample	0.009		0.16	18.5	13.1	28.2	3.02	2.77
6/8/10	860	7.35	TB7B-3	TOLLWAY 554			7.70		0.0679					7.50	401	515	no sample	0.009		0.15	16.7	13.7	23.9	2.99	2.85
6/22/10	873	7.15	TB7B-3	TOLLWAY 576			7.80		0.0662					7.53	412	521	no sample	0.011		0.18	17.9	10.9	22.7	2.95	2.97
7/7/10	902	7.31	TB7B-3	TOLLWAY 600			8.50		0.0716					7.54	430	550	no sample	0.010		0.21	20.5	10.4	21.3	2.90	2.37
7/20/10	966	7.33	TB7B-3	TOLLWAY 619			8.79		0.0743					7.48	426	627	no sample	0.012		0.20	59.9	5.42	24.4	4.06	3.99
8/2/10	1083	7.28	TB7B-3	TOLLWAY 633			9.38		0.084					7.46	503	676	no sample	0.014		0.21	56.2	5.00	27.6	3.73	4.05
8/17/10	1105	7.45	TB7B-3	TOLLWAY 659			9.92		0.088				0.008	7.47	527	685	no sample	0.013		0.22	44.8	5.60	29.5	3.59	3.19
			TB7B-3	min	NA	NA	6.80	NA	0.06	NA	0.018	NA	0.0077	7.46	393	506	NA	0.01	NA	0.15	16.02	0.65	21.31	2.78	2.37
			TB7B-3	max	NA	NA	15.49	NA	0.09	NA	0.030	NA	0.0078	7.87	528	694	NA	0.01	NA	0.22	92.33	16.19	35.81	8.27	4.05
			TB7B-3	mean	NA	NA	8.48	NA	0.07	NA	0.025	NA	0.0078	7.58	449	580	NA	0.01	NA	0.18	37.83	7.75	29.30	3.82	3.10

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
				MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
12/1/09	750	7.50	TB7B-4	TOLLWAY 313			0.083	0.014		95.3				0.00110	0.0095	1.49		52.7			11.7	0.023			8.58
12/15/09	814	7.71	TB7B-4	TOLLWAY 335			0.085	0.0134		81.8				0.00134	0.0257	1.49		52.0	0.0037		11.3	0.038			7.58
1/13/10	696	7.45	TB7B-4	TOLLWAY 369			0.107	0.0123		72.4				0.00112	0.0367	0.851		49.4			7.95	0.026			3.88
1/27/10	1071	7.74	TB7B-4	TOLLWAY 384			0.101	0.0114		70.8				0.00089	0.0259	0.731		46.3			7.97	0.025			3.74
2/17/10	704	7.77	TB7B-4	TOLLWAY 402			0.094	0.00913		84.0					0.0063	0.795		54.3			7.73	0.027			5.01
3/2/10	734	7.65	TB7B-4	TOLLWAY 418	0.048		0.084	0.0107		90.5					0.107	1.04		57.0	0.0033		9.43	0.020			6.04
3/17/10	733	7.57	TB7B-4	TOLLWAY 439			0.079	0.0131		81.8					0.0757	0.622		47.6	0.0019		7.18				4.96
3/31/10	704	7.51	TB7B-4	TOLLWAY 462	0.207		0.099	0.0102	0.00056	88.3				0.00125	0.603	0.749		55.1	0.0201		7.48	0.028			5.30
4/13/10	690	7.41	TB7B-4	TOLLWAY 477			0.082	0.0176		78.5				0.00079	0.0201	0.610		47.6			6.50				5.76
4/27/10	695	7.45	TB7B-4	TOLLWAY 499			0.108	0.00989		82.6				0.00121	0.0093	0.688		49.8			7.01	0.022			4.60
5/12/10	734	7.56	TB7B-4	TOLLWAY 515			0.106	0.010		86.5					0.0062	0.711		52.8			7.38	0.021			5.02
5/24/10	724	7.33	TB7B-4	TOLLWAY 529			0.099	0.0105		82.4				0.00082	0.0212	0.634		49.1			7.32	0.028			4.29
6/8/10	749	7.38	TB7B-4	TOLLWAY 555			0.089	0.00905		85.1					0.0132	0.724		50.2			8.19	0.030			4.34
6/22/10	742	7.24	TB7B-4	TOLLWAY 577			0.114	0.00866		87.0				0.00106	0.0087	0.747		49.7			7.42	0.024			4.34
7/7/10	757	7.27	TB7B-4	TOLLWAY 601			0.113	0.00812		84.9				0.00124	0.0105	0.880		51.3			7.70	0.021			4.10
7/20/10	783	7.29	TB7B-4	TOLLWAY 620			0.107	0.00981		81.7				0.00101	0.0116	1.17		50.2			8.97	0.033			4.46
8/2/10	811	7.40	TB7B-4	TOLLWAY 634			0.136	0.011		101				0.001	0.009	0.895		53.7			8.33	0.021			4.25
8/17/10	788	7.53	TB7B-4	TOLLWAY 660			0.121	0.010		89.1					0.023	1.06		51.3			8.49	0.018			4.21
			TB7B-4	min	0.048	NA	0.079	0.008	NA	70.769	NA	NA	NA	0.00079	0.0062	0.610	NA	46.2956	0.0019	NA	6.50	0.018	NA	NA	3.74
			TB7B-4	max	0.207	NA	0.136	0.018	NA	101.282	NA	NA	NA	0.00134	0.6031	1.493	NA	57.0283	0.0201	NA	11.67	0.038	NA	NA	8.58
			TB7B-4	mean	0.127	NA	0.100	0.011	NA	84.661	NA	NA	NA	0.00108	0.0568	0.883	NA	51.1154	0.0072	NA	8.23	0.025	NA	NA	5.02
12/2/09	8396	7.07	TB15B-1U	TOLLWAY 318			0.130	0.162		481				0.00154	0.0142	5.85	0.107	392	0.0210		702	0.148	0.083		82.1
12/16/09	8648	7.05	TB15B-1U	TOLLWAY 336			0.112	0.151		448					0.0074	4.64	0.107	402	0.0098		735	0.150			82.7
1/13/10	8985	7.16	TB15B-1U	TOLLWAY 364			0.105	0.138		503				0.00232	0.0256	4.19	0.100	400	0.0026		779	0.126	0.093		78.1
1/27/10	8882	7.30	TB15B-1U	TOLLWAY 388			0.095	0.137		502					0.0084	3.25	0.094	417	0.0019		920	0.128			82.5
2/17/10	8823	7.27	TB15B-1U	TOLLWAY 403	0.079		0.099	0.141		483					0.141	3.76	0.100	407	0.0074		760	0.159			89.2
3/3/10	8558	6.97	TB15B-1U	TOLLWAY 419			0.100	0.134		520				0.00128	0.0244	4.26	0.119	442			735	0.128			85.3
3/17/10	9573	7.19	TB15B-1U	TOLLWAY 440			0.085	0.134		490				0.00162		2.27	0.082	424	0.0017		969	0.111			92.4
3/30/10	9517	7.80	TB15B-1U	TOLLWAY 454			0.089	0.139		514					0.0090	3.13	0.092	415	0.0031		908	0.114			95.9
4/13/10	9590	8.16	TB15B-1U	TOLLWAY 470	0.062		0.100	0.135		504				0.00132	0.419	2.89	0.091	410	0.0051		941	0.132			96.9
4/27/10	9245	7.10	TB15B-1U	TOLLWAY 495			0.087	0.132		497					0.0287	4.52	0.127	419	0.0021		785	0.146			86.2
5/12/10	9361	7.10	TB15B-1U	TOLLWAY 518			0.102	0.141		515					0.0229	3.89	0.168	426			853	0.144	0.066		94.1
5/25/10	9619	6.91	TB15B-1U	TOLLWAY 536			0.114	0.140		481					0.0238	4.56		397	0.0015		878	0.134	0.096		92.5
6/8/10	8814	7.04	TB15B-1U	TOLLWAY 560			0.109	0.138		492					0.0145	4.88	0.138	405			775	0.147		0.041	86.7
6/23/10	8670	7.88	TB15B-1U	TOLLWAY 581	0.043		0.120	0.136		463					0.0418	5.43		380	0.0043		691	0.138			79.0
7/7/10	8771	7.50	TB15B-1U	TOLLWAY 593			0.149	0.145		495				0.00491	0.0093	6.04	0.156	400	0.0044		727	0.138			88.7
7/20/10	NA*	NA*	TB15B-1U	TOLLWAY 614	4.61		0.127	0.170		285				0.00389	2.52	6.02	0.087	217	0.0991		482	0.103	0.081		52.1
8/3/10	4044	8.26	TB15B-1U	TOLLWAY 639	2.39		0.126	0.166		215				0.004	1.42	3.67		164	0.017		484	0.067	0.072		37.9
8/17/10	6368	7.49	TB15B-1U	TOLLWAY 653	1.71		0.151	0.202		371				0.002	1.01	4.61		286	0.017		641	0.117	0.083		67.2
			TB15B-1U	min	0.043	NA	0.085	0.132	NA	214.592	NA	NA	NA	0.00128	0.0074	2.268	0.08	164.4426	0.0015	NA	481.82	0.067	0.066	0.04	37.85
			TB15B-1U	max	4.606	NA	0.151	0.202	NA	520.183	NA	NA	NA	0.00491	2.5247	6.043	0.17	441.8010	0.0991	NA	969.09	0.159	0.096	0.04	96.86
			TB15B-1U	mean	1.482	NA	0.111	0.147	NA	458.890	NA	NA	NA	0.00251	0.3375	4.326	0.11	378.0193	0.0132	NA	764.74	0.130	0.082	0.04	81.63
12/2/09	8332	6.93	TB15B-1L	TOLLWAY 319			0.121	0.113		498					0.0386	6.11	0.111	400	0.0275		713	0.151	0.073		89.6
12/16/09	8762	6.98	TB15B-1L	TOLLWAY 337	0.073		0.115	0.115		483					0.0887	5.86	0.115	415	0.0144		725	0.145			91.1
1/13/10	8786	7.04	TB15B-1L	TOLLWAY 365	0.981		0.108	0.113		537				0.00172	0.800	5.95	0.119	410	0.0206		730	0.139			83.0
1/27/10	8493	7.05	TB15B-1L	TOLLWAY 387	0.129		0.108	0.111		545				0.00087	0.143	6.26	0.136	433	0.0118		802	0.121			85.6
2/17/10	8789	7.18	TB15B-1L	TOLLWAY 404			0.090	0.108		526						4.99	0.105	445	0.0086		779	0.173			90.7
3/3/10	8838	6.40	TB15B-1L	TOLLWAY 420	0.789		0.116	0.113		574			0.0059	0.00136	0.725	5.67	0.128	457	0.0162	0.028	823	0.125			95.9
3/17/10	8776	6.92	TB15B-1L	TOLLWAY 441	2.06		0.089	0.124		542			0.0072	0.00437	1.99	5.94	0.115	451	0.0398		769	0.112			92.0
3/30/10	8829	6.93	TB15B-1L	TOLLWAY 455	0.118		0.089	0.108		559					0.159	4.68	0.115	445	0.0100		774	0.120			92.2
4/13/10	8841	7.36	TB15B-1L	TOLLWAY 471			0.089	0.104		515				0.00182	0.0188	4.77	0.111	409	0.0086		771	0.138			90.0
4/27/10	8767	7.13	TB15B-1L	TOLLWAY 494	0.107		0.085	0.110		537				0.00118	0.132	6.00	0.148	440	0.0099		772	0.163	0.109		90.1
5/12/10	8655	7.05	TB15B-1L	TOLLWAY 519			0.101	0.121		538				0.00117	0.0171	6.02	0.188	436	0.0049		782	0.141			93.7
5/25/10	8633	6.93	TB15B-1L	TOLLWAY 535	0.079		0.099	0.115		527					0.128	6.63		429	0.0104		793	0.138			91.1
6/8/10	8637	6.98	TB15B-1L	TOLLWAY 559			0.093	0.114		519					0.0238	6.72		415	0.0072		731	0.141			87.4
6/23/10	8675	7.06	TB15B-1L	TOLLWAY 582	0.047		0.110	0.115		495				0.00125	0.0280	6.74		400	0.0077		747	0.131	0.072		84.5
7/7/10	8638	6.96	TB15B-1L	TOLLWAY 594			0.132	0.120		533					0.0547	7.31	0.164	421	0.0078		792	0.121			87.9
7/20/10	8535	6.52	TB15B-1L	TOLLWAY 613	0.398		0.139	0.121		527				0.00197	0.406	7.57	0.165	394	0.0177		729	0.150	0.150	0.050	84.9
8/3/10	8039	7.01	TB15B-1L	TOLLWAY 640	6.81		0.165	0.151		524			0.010	0.009	5.55	10.8	0.184	398	0.099		738	0.148	0.100		85.2
8/17/10	8301	7.06	TB15B-1L	TOLLWAY 654	0.049		0.161	0.119		493					0.043	7.68		374	0.013		738	0.140		0.061	83.9
			TB15B-1L	min	0.047	NA	0.085	0.104	NA	483.207	NA	NA	0.00594	0.00087	0.0171	4.683	0.11	373.9233	0.0049	0.028	713.18	0.112	0.072	0.05	83.01
			TB15B-1L	max	6.813	NA	0.165	0.151	NA	573.987	NA	NA	0.00960	0.00913	5.5531	10.801	0.19	457.0836	0.0995	0.028	822.87	0.173	0.150	0.06	95.88
			TB15B-1L	mean	0.970	NA	0.112	0.116	NA	526.384	NA	NA	0.00759	0.00249	0.6087	6.427	0.14	420.8130	0.0187	0.028	761.58	0.139	0.101	0.06	88.81

NA*= not enough water for field parameters

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as $CaCO_3$	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
				MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
12/1/09	750	7.50	TB7B-4	TOLLWAY 313			6.40		0.0603					7.59	394	430	no sample	0.004			12.9	2.15	22.8	5.04	1.96
12/15/09	814	7.71	TB7B-4	TOLLWAY 335			6.00		0.0609					7.91	393	427	no sample	0.007		0.10	12.0	2.11	21.6	2.36	2.15
1/13/10	696	7.45	TB7B-4	TOLLWAY 369			5.29		0.0505				0.0012	7.77	375	394	no sample	0.007		0.11	7.07	5.16	11.7	11.8	2.07
1/27/10	1071	7.74	TB7B-4	TOLLWAY 384			5.18		0.0471		0.018			7.69	343	392	no sample	0.007		0.11	5.84	10.3	10.9	2.06	1.79
2/17/10	704	7.77	TB7B-4	TOLLWAY 402			7.20		0.0467					7.66	380	420	no sample	0.007		0.11	7.53	7.95	13.8	4.28	2.47
3/2/10	734	7.65	TB7B-4	TOLLWAY 418			6.04		0.0496	0.00176				7.65	393	432	no sample	0.011		0.11	9.50	7.27	16.3	7.33	3.45
3/17/10	733	7.57	TB7B-4	TOLLWAY 439			5.37		0.0478					7.66	321	393	no sample	0.008		0.12	7.29	14.3	13.5	2.74	2.48
3/31/10	704	7.51	TB7B-4	TOLLWAY 462			5.94		0.0500	0.00720	0.023			7.77	344	458	no sample	0.016		0.10	7.37	14.4	13.6	1.86	2.21
4/13/10	690	7.41	TB7B-4	TOLLWAY 477			5.47		0.0490					7.65	317	401	no sample	0.009		0.12	9.00	15.1	15.7	1.74	1.88
4/27/10	695	7.45	TB7B-4	TOLLWAY 499			5.58		0.0545					7.67	337	428	no sample	0.011		0.14	9.00	14.4	13.4	2.37	2.91
5/12/10	734	7.56	TB7B-4	TOLLWAY 515			5.94		0.0575					7.71	337	472	no sample	0.010		0.12	9.27	15.6	14.8	3.07	2.35
5/24/10	724	7.33	TB7B-4	TOLLWAY 529			6.02		0.0554					7.48	327	446	no sample	0.009		0.12	9.79	16.1	13.0	2.38	2.18
6/8/10	749	7.38	TB7B-4	TOLLWAY 555			6.33		0.0577					7.48	344	310	no sample	0.009		0.11	9.02	16.0	12.6	2.13	2.01
6/22/10	742	7.24	TB7B-4	TOLLWAY 577			6.53		0.0573					7.43	348	444	no sample	0.010		0.13	8.78	14.9	12.3	1.60	1.95
7/7/10	757	7.27	TB7B-4	TOLLWAY 601			6.48		0.0580				0.0936	7.52	347	462	no sample	0.010		0.13	8.84	15.7	11.9	1.81	1.50
7/20/10	783	7.29	TB7B-4	TOLLWAY 620			6.54		0.0581					7.47	347	462	no sample	0.009		0.12	9.55	17.1	12.7	9.00	4.07
8/2/10	811	7.40	TB7B-4	TOLLWAY 634			7.47		0.064					7.48	381	491	no sample	0.012		0.14	10.4	12.6	11.9	2.19	2.65
8/17/10	788	7.53	TB7B-4	TOLLWAY 660			7.08		0.061					7.45	368	492	no sample	0.009		0.15	11.3	14.6	12.5	4.77	1.84
			TB7B-4	min	NA	NA	5.18	NA	0.05	0.00176	0.018	NA	0.0012	7.43	317	310	NA	0.00	NA	0.10	5.84	2.11	10.94	1.60	1.50
			TB7B-4	max	NA	NA	7.47	NA	0.06	0.00720	0.023	NA	0.0936	7.91	394	492	NA	0.02	NA	0.15	12.88	17.05	22.83	11.85	4.07
			TB7B-4	mean	NA	NA	6.16	NA	0.05	0.00448	0.020	NA	0.0474	7.61	355	431	NA	0.01	NA	0.12	9.13	11.98	14.17	3.81	2.33
12/2/09	8396	7.07	TB15B-1U	TOLLWAY 318		0.160	8.77		4.14		0.025		0.0272	7.30	352	5257	no sample	0.012			2691	0.14	224	4.15	3.07
12/16/09	8648	7.05	TB15B-1U	TOLLWAY 336		0.159	7.87		4.06				0.0143	7.67	327	5332	no sample	0.012		0.31	2745	0.16	225	3.56	3.51
1/13/10	8985	7.16	TB15B-1U	TOLLWAY 364		0.143	7.43		3.85		0.026		0.0217	7.44	313	5330	no sample	0.012		0.18	2788	0.14	221	3.78	3.43
1/27/10	8882	7.3	TB15B-1U	TOLLWAY 388			6.54		3.82		0.032		0.0140	7.52	316	5571	no sample	0.013			2994	0.14	235	2.33	2.66
2/17/10	8823	7.27	TB15B-1U	TOLLWAY 403			7.97		3.99				0.0103	7.53	331	4782	no sample	0.011			2751	0.14	222	4.98	3.14
3/3/10	8558	6.97	TB15B-1U	TOLLWAY 419		0.137	8.52		4.03		0.041		0.0121	7.45	342	4334	no sample	0.016			2438	0.11	206	3.38	2.96
3/17/10	9573	7.19	TB15B-1U	TOLLWAY 440			6.11		3.69		0.031		0.0091	7.44	309	5343	no sample	0.012			3130	0.11	245	3.67	3.32
3/30/10	9517	7.8	TB15B-1U	TOLLWAY 454		0.134	7.01		3.91		0.030		0.0076	7.40	330	5541	no sample	0.016			3193	0.08	252	3.52	3.11
4/13/10	9590	8.16	TB15B-1U	TOLLWAY 470		0.149	7.02		3.76				0.0103	7.26	342	5339	no sample	0.011			3185	0.09	256	3.30	3.52
4/27/10	9245	7.1	TB15B-1U	TOLLWAY 495			7.27		3.92					7.28	355	5157	no sample	0.015			3172	0.10	232	3.18	4.26
5/12/10	9361	7.1	TB15B-1U	TOLLWAY 518		0.158	7.44		4.02					7.41	342	5517	no sample	0.016		0.32	2884	0.13	239	3.92	3.33
5/25/10	9619	6.91	TB15B-1U	TOLLWAY 536		0.155	7.57		3.86		0.026		0.0074	7.33	347	6100	no sample	0.014		0.30	2967		255	3.54	3.18
6/8/10	8814	7.04	TB15B-1U	TOLLWAY 560			7.96		3.96				0.0188	7.28	357	4644	no sample	0.012		0.26	2764		223	4.64	5.94
6/23/10	8670	7.88	TB15B-1U	TOLLWAY 581		0.141	8.66		3.87				0.0122	7.24	360	5935	no sample	0.015		0.29	2576		218	2.96	2.93
7/7/10	8771	7.5	TB15B-1U	TOLLWAY 593			9.29		4.10				0.0228	7.14	365	5990	no sample	0.015		0.31	2712	0.07	223	3.20	4.94
7/20/10	NA*	NA*	TB15B-1U	TOLLWAY 614		0.148	18.4		2.30	0.156			0.0183	7.40	293	3546	no sample	0.099	0.39	0.42	1667	0.07	136	34.6	5.54
8/3/10	4044	8.26	TB15B-1U	TOLLWAY 639			12.4		1.60	0.080			0.015	7.45	244	2744	no sample	0.049		0.47	1375	0.08	117	10.8	7.11
8/17/10	6368	7.49	TB15B-1U	TOLLWAY 653			13.0		3.00	0.057			0.016	7.31	332	4267	no sample	0.287		0.34	2097	0.08	178	10.7	5.35
NA*= not enough water for field parameters																									
			TB15B-1U	min	NA	0.13	6.11	NA	1.60	0.05661	0.025	NA	0.0074	7.14	244	2744	NA	0.01	0.39	0.18	1374.73	0.07	117.01	2.33	2.66
			TB15B-1U	max	NA	0.16	18.40	NA	4.14	0.15550	0.041	NA	0.0272	7.67	365	6100	NA	0.29	0.39	0.47	3193.02	0.16	255.75	34.64	7.11
			TB15B-1U	mean	NA	0.15	8.85	NA	3.66	0.09723	0.030	NA	0.0148	7.38	331	5041	NA	0.04	0.39	0.32	2673.80	0.11	217.07	6.13	3.96
12/2/09	8332	6.93	TB15B-1L	TOLLWAY 319			8.96		4.04		0.022		0.0168	7.26	379	4673	no sample	0.010			2682		251	3.45	2.70
12/16/09	8762	6.98	TB15B-1L	TOLLWAY 337		0.132	8.70		4.18				0.0100	7.42	373	5433	no sample	0.014		0.31	2771	0.10	248	2.11	2.68
1/13/10	8786	7.040	TB15B-1L	TOLLWAY 365		0.143	10.3		3.94	0.0329	0.021		0.0147	7.23	373	4855	no sample	0.037		0.18	2860	0.08	240	4.08	2.97
1/27/10	8493	7.050	TB15B-1L	TOLLWAY 387		0.157	8.38		4.05	0.00072	0.027		0.0115	7.25	375	5448	no sample	0.016			2950	0.07	239	3.48	1.98
2/17/10	8789	7.180	TB15B-1L	TOLLWAY 404		0.134	8.32		3.90		0.042			7.25	373	5324	no sample	0.011			2869		237	4.62	2.69
3/3/10	8838	6.400	TB15B-1L	TOLLWAY 420		0.148	10.8		4.13	0.0227	0.046		0.0108	7.26	372	5465	no sample	0.021			2877		237	3.89	2.98
3/17/10	8776	6.920	TB15B-1L	TOLLWAY 441			12.8		4.00	0.0678	0.034		0.0128	7.26	370	5447	no sample	0.031			2855		239	5.17	4.13
3/30/10	8829	6.930	TB15B-1L	TOLLWAY 455			8.13		4.00		0.042			7.13	369	6042	no sample	0.017			2972		235	2.80	2.44
4/13/10	8841	7.360	TB15B-1L	TOLLWAY 471		0.179	7.73		3.83		0.022		0.0077	7.14	374	4961	no sample	0.011			2910		234	8.26	3.04
4/27/10	8767	7.130	TB15B-1L	TOLLWAY 494			8.00		4.05					7.13	372	5498	no sample	0.020			3005		235	2.64	2.26
5/12/10	8655	7.050	TB15B-1L	TOLLWAY 519			8.33		4.11					7.30	368	5718	no sample	0.014		0.30	2921	0.10	236	4.21	3.05
5/25/10	8633	6.930	TB15B-1L	TOLLWAY 535			8.60		4.11		0.023		0.0110	7.19	370	6138	no sample	0.014			2856		235	3.74	3.48
6/8/10	8637	6.98	TB15B-1L	TOLLWAY 559			8.51		4.07		0.018			7.20	369	5407	no sample	0.012		0.28	2792		232	7.36	5.24
6/23/10	8675	7.060	TB15B-1L	TOLLWAY 582			8.67		3.95		0.020		0.0087	7.13	370	5752	no sample	0.014		0.26	2804		233	3.01	3.23
7/7/10	8638	6.960	TB15B-1L	TOLLWAY 594		0.193	9.31		4.03				0.0097	7.08	374	5757	no sample	0.013		0.28	2811		222	2.46	2.07
7/20/10	8535	6.52	TB15B-1L	TOLLWAY 613		0.156	10.2		3.92	0.0112			0.0124	7.20	378	5375	no sample	0.015		0.24	2641		218	7.59	3.12
8/3/10	8039	7.01	TB15B-1L	TOLLWAY 640			26.0		3.89	0.253	0.022		0.022	7.07	367	5110	no sample	0.023		0.19	2636		211	4.05	3.02
8/17/10	8301	7.06	TB15B-1L	TOLLWAY 654			9.92		3.93		0.024		0.012	7.13	368	5146	no sample	0.013		0.21	2672		218	3.18	3.06
			TB15B-1L	min	NA	0.13	7.73	NA	3.83	0.00072	0.018	NA	0.0077	7.07	367	4673	NA	0.01	NA	0.18	2635.81	0.07	210.59	2.11	1.98
			TB15B-1L	max	NA	0.19	25.95	NA	4.18	0.25286	0.046	NA	0.0225	7.42	379	6138	NA	0.04	NA	0.31	3004.80	0.10	251.25	8.26	5.24
			TB15B-1L	mean	NA	0.16	10.10	NA	4.01	0.06469	0.028	NA	0.0124	7.20	372	5419	NA	0.02	NA	0.25	2826.86	0.09	233.47	4.23	3.01

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
				MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
12/2/09	1143	7.37	TB15B-2	TOLLWAY 317			0.136	0.057		131				0.00099	0.0086	1.74		83.7	0.0035		31.0	0.036	0.069		62.9
12/16/09	1173	7.63	TB15B-2	TOLLWAY 338	0.041		0.130	0.0576		113				0.00110	0.0292	1.24		85.5	0.0023		29.2	0.053			62.3
1/13/10	1154	7.71	TB15B-2	TOLLWAY 363			0.123	0.0497		102						1.20		76.7			29.2	0.042			58.5
1/27/10	1128	7.68	TB15B-2	TOLLWAY 386			0.118	0.0505		105				0.00122	0.0259	1.02		81.8			33.2	0.051			59.3
2/17/10	1143	7.88	TB15B-2	TOLLWAY 405			0.105	0.0481		124					0.0465	1.26		88.0	0.0023		28.6	0.044	0.080		61.9
3/3/10	1149	7.46	TB15B-2	TOLLWAY 421			0.119	0.0488		121				0.00088	0.0107	1.47		87.2			30.7	0.043			65.6
3/17/10	1137	7.49	TB15B-2	TOLLWAY 442	0.038		0.095	0.0466		114				0.00097	0.0449	0.978		84.0			29.1	0.037			62.9
3/30/10	1133	7.35	TB15B-2	TOLLWAY 456			0.108	0.0468		121					0.0071	1.32		88.5		0.023	27.0	0.033			64.9
4/13/10	1144	7.61	TB15B-2	TOLLWAY 472	0.475		0.105	0.0494		116					0.530	1.34		87.7	0.0068		25.5	0.026			64.8
4/27/10	1143	7.47	TB15B-2	TOLLWAY 493	0.044		0.106	0.0521		116				0.00101	0.102	1.59		82.4	0.0056		25.4	0.037			62.7
5/12/10	1160	7.40	TB15B-2	TOLLWAY 517			0.123	0.053		123					0.0503	1.58		87.4	0.0224		25.7	0.035			64.9
5/25/10	1178	7.44	TB15B-2	TOLLWAY 537			0.128	0.0519		119				0.00090	0.0837	1.56		85.1	0.0186		27.4	0.045			63.5
6/8/10	1157	7.41	TB15B-2	TOLLWAY 558			0.117	0.0542		118					0.0766	1.65		84.7	0.0194		27.8	0.047			62.2
6/23/10	1128	7.47	TB15B-2	TOLLWAY 583	0.042		0.137	0.0535		120					0.0	1.65		84.0	0.0096		26.3	0.034			60.3
7/7/10	2762	7.60	TB15B-2	TOLLWAY 595			0.181	0.0538		117				0.00656	0.0093	1.29		87.6		0.024	28.4	0.039			62.8
7/20/10	978	7.45	TB15B-2	TOLLWAY 615	15.0		0.124	0.110		66.0			0.0140	0.00756	7.83	5.87		38.3	0.0613		28.3	0.037	0.083		22.6
8/3/10	285	7.94	TB15B-2	TOLLWAY 641	0.346		0.103	0.048		62.0				0.004	0.247	0.825		29.7	0.005		30.2				20.3
8/17/10	1956	7.48	TB15B-2	TOLLWAY 655	1.06		0.155	0.072		89.1				0.003	0.680	1.43		59.5	0.013		28.9	0.030	0.072		37.8
			TB15B-2	min	0.038	NA	0.095	0.047	NA	62.007	NA	NA	0.01397	0.00088	0.0071	0.825	NA	29.6703	0.0023	0.023	25.45	0.026	0.069	NA	20.33
			TB15B-2	max	14.999	NA	0.181	0.110	NA	131.139	NA	NA	0.01397	0.00756	7.8286	5.872	NA	88.4907	0.0613	0.024	33.22	0.053	0.083	NA	65.64
			TB15B-2	mean	2.131	NA	0.123	0.056	NA	109.764	NA	NA	0.01397	0.00256	0.5775	1.612	NA	77.8726	0.0142	0.023	28.44	0.040	0.076	NA	56.70
12/2/09	452	8.13	TB15B-3	TOLLWAY 316			0.030	0.021		35.7				0.00280	0.0351	0.874		16.6	0.0125	0.109	25.1				9.09
12/16/09	834	7.65	TB15B-3	TOLLWAY 339			0.078	0.0639		83.1				0.00206	0.0302	0.889		53.6	0.0053		28.9	0.029			17.5
1/13/10	1103	7.660	TB15B-3	TOLLWAY 362	0.040		0.133	0.0834		123				0.00135	0.0871	1.68		83.0	0.0087	0.022	48.2	0.044			40.9
1/27/10	1094	7.740	TB15B-3	TOLLWAY 385			0.102	0.0676		103				0.00117	0.0314	1.07		70.3	0.0017		37.0	0.028			25.7
2/17/10	1157	7.690	TB15B-3	TOLLWAY 406	7.62		0.122	0.119		168			0.0120	0.00979	15.1	4.71		105	0.154		42.5	0.059	0.160		37.5
3/3/10	1119	7.400	TB15B-3	TOLLWAY 422	0.126		0.095	0.0650		117				0.00153	0.157	0.891		76.0	0.0038		38.2	0.028			27.2
3/17/10	1061	7.360	TB15B-3	TOLLWAY 443	0.932		0.095	0.0742		121				0.00181	1.24	1.46		80.3	0.0147		39.4	0.031			31.7
3/30/10	1158	7.420	TB15B-3	TOLLWAY 457			0.111	0.0725		129					0.0165	1.38		85.6	0.0030		41.2	0.034			37.4
4/13/10	1112	7.440	TB15B-3	TOLLWAY 473			0.091	0.0667		113				0.00097	0.0506	0.930		75.2	0.0018	0.023	32.4	0.029			28.2
4/27/10	1165	7.770	TB15B-3	TOLLWAY 492	0.343		0.117	0.0761		129				0.00120	0.512	2.03		85.9	0.0146		38.7	0.042			44.9
5/12/10	1149	7.490	TB15B-3	TOLLWAY 516			0.129	0.068		128				0.00091	0.0509	1.77		85.8	0.0037		37.0	0.036			40.8
5/25/10	1079	7.390	TB15B-3	TOLLWAY 538			0.123	0.0751		119				0.00106	0.0400	1.47		80.0	0.0054		37.3	0.040			36.2
6/8/10	1109	7.790	TB15B-3	TOLLWAY 557			0.116	0.0748		123					0.0261	1.77		83.1	0.0022		37.4	0.041			37.1
6/23/10	1107	7.560	TB15B-3	TOLLWAY 584	15.2		0.165	0.143		238			0.0206	0.0378	31.6	6.80		136	0.583	0.028	38.0	0.076	0.271		39.6
7/7/10	1115	7.300	TB15B-3	TOLLWAY 596			0.159	0.0699		105				0.00181	0.0114	1.12		69.9	0.0023		35.0	0.029			23.1
7/20/10	1242	7.360	TB15B-3	TOLLWAY 616	0.937		0.163	0.0796		106				0.00332	1.44	1.86		69.5	0.0166		31.5	0.038			26.2
8/3/10	1285	8.130	TB15B-3	TOLLWAY 642			0.175	0.079		128				0.001		1.94		82.9	0.014		37.6	0.032			38.0
8/17/10	1188	7.780	TB15B-3	TOLLWAY 656	0.066		0.174	0.077		115				0.002	0.081	1.37		76.1	0.002		37.6	0.036	0.072		30.3
			TB15B-3	min	0.040	NA	0.030	0.021	NA	35.735	NA	NA	0.01200	0.00091	0.0114	0.874	NA	16.6075	0.0017	0.022	25.14	0.028	0.072	NA	9.09
			TB15B-3	max	15.203	NA	0.175	0.143	NA	238.351	NA	NA	0.02064	0.03785	31.5702	6.800	NA	136.2778	0.5825	0.109	48.18	0.076	0.271	NA	44.88
			TB15B-3	mean	3.159	NA	0.121	0.076	NA	121.241	NA	NA	0.01632	0.00441	2.9698	1.889	NA	78.5874	0.0472	0.046	36.83	0.038	0.167	NA	31.75

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples

Date collected	Field conductivity	Field pH	Sample location	Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as $CaCO_3$	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
				MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
12/2/09	1143	7.37	TB15B-2	TOLLWAY 317			8.12		1.36				0.0087	7.62	375	747	no sample	0.008		0.45	73.9	0.12	187	4.89	3.19
12/16/09	1173	7.63	TB15B-2	TOLLWAY 338			7.56		1.29					7.86	388	746	no sample	0.016		0.47	75.9		177	2.62	2.22
1/13/10	1154	7.71	TB15B-2	TOLLWAY 363			6.72		1.22					7.76	386	740	no sample	0.012		0.45	81.0		181	3.48	2.01
1/27/10	1128	7.68	TB15B-2	TOLLWAY 386			6.68		1.20		0.030			7.77	384	729	no sample	0.013		0.43	78.4		175	2.46	1.59
2/17/10	1143	7.88	TB15B-2	TOLLWAY 405			7.07		1.18	0.00063				7.81	387	745	no sample	0.012		0.44	79.6		177	4.50	2.10
3/3/10	1149	7.46	TB15B-2	TOLLWAY 421			7.38		1.20					7.70	386	728	no sample	0.014		0.46	82.4	0.09	179	2.59	2.03
3/17/10	1137	7.49	TB15B-2	TOLLWAY 442			6.65		1.14	0.00065	0.028			7.71	372	728	no sample	0.012		0.39	81.1		178	3.21	2.79
3/30/10	1133	7.35	TB15B-2	TOLLWAY 456			7.02		1.23					7.71	385	818	no sample	0.016		0.43	79.3		176	2.21	1.65
4/13/10	1144	7.61	TB15B-2	TOLLWAY 472			8.44		1.20	0.0137				7.59	390	842	no sample	0.023		0.43	74.8		171	2.00	2.30
4/27/10	1143	7.47	TB15B-2	TOLLWAY 493			7.19		1.29					7.53	390	760	no sample	0.035		0.46	79.0		173	3.43	2.20
5/12/10	1160	7.40	TB15B-2	TOLLWAY 517			7.62		1.32					7.69	393	749	no sample	0.034	0.07	0.44	83.7		175	5.01	2.41
5/25/10	1178	7.44	TB15B-2	TOLLWAY 537			7.75		1.32					7.69	392	867	no sample	0.019		0.42	113		261	2.89	2.01
6/8/10	1157	7.41	TB15B-2	TOLLWAY 558			7.94		1.32					7.53	394	754	no sample	0.014		0.42	73.7		169	4.40	1.93
6/23/10	1128	7.47	TB15B-2	TOLLWAY 583			8.12		1.27					7.58	398	770	no sample	0.184		0.51	80.4		176	2.47	2.82
7/7/10	2762	7.60	TB15B-2	TOLLWAY 595			8.34		1.23				0.0186	7.48	395	770	no sample	0.016		0.52	75.0		173	2.47	1.67
7/20/10	978	7.45	TB15B-2	TOLLWAY 615			43.3		0.554	0.397			0.0331	7.61	224	761	no sample	0.009		0.57	43.7	0.11	82.2	8.10	6.32
8/3/10	285	7.94	TB15B-2	TOLLWAY 641			6.89		0.417	0.011			0.011	7.79	228	409	no sample	0.029		0.61	33.4		62.1	12.5	7.92
8/17/10	1956	7.48	TB15B-2	TOLLWAY 655			10.4		0.853	0.037			0.017	7.51	335	610	no sample	0.071		0.59	53.0	0.09	116	5.19	5.19
			TB15B-2	min	NA	NA	6.65	NA	0.42	0.00063	0.028	NA	0.0087	7.48	224	409	NA	0.01	0.07	0.39	33.40	0.09	62.11	2.00	1.59
			TB15B-2	max	NA	NA	43.29	NA	1.36	0.39745	0.030	NA	0.0331	7.86	398	867	NA	0.18	0.07	0.61	112.88	0.12	260.84	12.48	7.92
			TB15B-2	mean	NA	NA	9.62	NA	1.14	0.07675	0.029	NA	0.0176	7.66	367	737	NA	0.03	0.07	0.47	74.51	0.10	166.08	4.13	2.91
12/2/09	452	8.13	TB15B-3	TOLLWAY 316			5.40		0.303					7.96	152	221	no sample			0.72	17.0		24.7	24.1	4.75
12/16/09	834	7.65	TB15B-3	TOLLWAY 339			7.05		0.845				0.0126	7.92	334	507	no sample	0.010		0.44	93.0		60.0	6.31	2.45
1/13/10	1103	7.66	TB15B-3	TOLLWAY 362			8.22		1.38					7.63	440	924	no sample	0.009		0.37	167		108	16.2	2.37
1/27/10	1094	7.74	TB15B-3	TOLLWAY 385			7.05		1.08		0.038		0.0091	7.64	420	641	no sample	0.009		0.36	105		67.7	3.86	1.85
2/17/10	1157	7.69	TB15B-3	TOLLWAY 406					1.30	0.211			0.0830	7.61	470	1023	no sample	0.155		0.36	126	0.08	86.2	22.1	4.99
3/3/10	1119	7.40	TB15B-3	TOLLWAY 422			7.63		1.04	0.00371			0.0121	7.67	411	708	no sample	0.014		0.35	116		75.6	4.15	1.96
3/17/10	1061	7.36	TB15B-3	TOLLWAY 443			9.78		1.11	0.0301	0.021		0.0148	7.59	427	732	no sample	0.040		0.33	122		83.6	9.51	2.47
3/30/10	1158	7.42	TB15B-3	TOLLWAY 457			8.09		1.24					7.51	432	823	no sample	0.014		0.36	137		99.3	5.38	2.07
4/13/10	1112	7.44	TB15B-3	TOLLWAY 473			7.24		1.07				0.0074	7.49	428	726	no sample	0.011		0.37	126		90.5	2.98	2.03
4/27/10	1165	7.77	TB15B-3	TOLLWAY 492			9.44		1.41	0.0100			0.0077	7.55	399	853	no sample	0.018		0.35	155		120	3.68	1.65
5/12/10	1149	7.49	TB15B-3	TOLLWAY 516			8.97		1.36					7.63	412	770	no sample	0.013		0.39	143		114	4.47	2.26
5/25/10	1079	7.39	TB15B-3	TOLLWAY 538			8.48		1.26					7.51	410	822	no sample	0.011		0.37	135		109	4.54	1.78
6/8/10	1109	7.79	TB15B-3	TOLLWAY 557			9.11		1.34					7.52	406	893	no sample	0.012		0.35	143		116	5.76	1.76
6/23/10	1107	7.56	TB15B-3	TOLLWAY 584			40.2		1.35	0.523			0.180	7.51	402	1283	no sample	0.021		0.46	134		110	5.57	5.60
7/7/10	1115	7.30	TB15B-3	TOLLWAY 596			8.45		1.00				0.0139	7.44	407	674	no sample	0.011		0.48	90.9		66.9	2.61	1.90
7/20/10	1242	7.36	TB15B-3	TOLLWAY 616			11.4		1.12	0.0303			0.0186	7.47	407	772	no sample	0.035		0.45	97.8		70.7	3.65	3.38
8/3/10	1285	8.13	TB15B-3	TOLLWAY 642			9.88		1.31				0.011	7.60	392	813	no sample	0.016		0.50	128		105	2.52	2.23
8/17/10	1188	7.78	TB15B-3	TOLLWAY 656			9.64		1.16	0.001			0.015	7.56	414	881	no sample	0.019		0.51	114		90.1	3.60	3.06
			TB15B-3	min	NA	NA	5.40	NA	0.30	0.00073	0.021	NA	0.0074	7.44	152	221	NA	0.01	NA	0.33	17.00	0.08	24.73	2.52	1.65
			TB15B-3	max	NA	NA	40.22	NA	1.41	0.52306	0.038	NA	0.1801	7.96	470	1283	NA	0.15	NA	0.72	166.77	0.08	120.39	24.14	5.60
			TB15B-3	mean	NA	NA	10.36	NA	1.15	0.11553	0.030	NA	0.0322	7.60	398	781	NA	0.02	NA	0.42	119.30	0.08	88.83	7.28	2.70

APPENDIX F: Results of Geochemical Analysis of Groundwater Samples
Comparison of Mean/Max at All Wells

Sample location		Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
	MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
TB7B-1	mean	0.042	NA	0.125	0.042	NA	60.357	NA	0.00	NA	0.00152	4.9812	3.106	NA	22.6272	0.4036	NA	527.70	0.023	0.085	NA	43.39
TB7B-2	mean	0.278	NA	0.260	0.032	NA	86.993	NA	0.00	NA	0.00162	0.3139	0.649	NA	88.0357	0.3093	NA	63.80	0.043	0.000	NA	22.08
TB7B-3	mean	0.217	NA	0.118	0.019	NA	95.945	NA	0.00	NA	0.00140	0.0695	0.380	NA	67.0161	0.0113	NA	30.41	0.032	0.071	NA	10.21
TB7B-4	mean	0.127	NA	0.100	0.011	NA	84.661	NA	0.00	NA	0.00108	0.0568	0.883	NA	51.1154	0.0072	NA	8.23	0.025	0.000	NA	5.02
	trend	low East		mid High	high East		low East				high East	high East	high East		mid High	high East		high East				high East
TB7B-1	max	0.049	NA	0.170	0.052	NA	73.984	NA	NA	NA	0.00322	6.7554	4.637	NA	27.6047	0.7331	NA	614.13	0.041	0.121	NA	58.17
TB7B-2	max	0.666	NA	0.318	0.036	NA	100.914	NA	NA	NA	0.00231	1.3489	0.906	NA	109.8040	0.6466	NA	82.51	0.054	0.000	NA	31.20
TB7B-3	max	0.217	NA	0.161	0.026	NA	118.744	NA	NA	NA	0.00184	0.4031	0.633	NA	80.7515	0.0436	NA	69.99	0.048	0.071	NA	12.87
TB7B-4	max	0.207	NA	0.136	0.018	NA	101.282	NA	NA	NA	0.00134	0.6031	1.493	NA	57.0283	0.0201	NA	11.67	0.038	0.000	NA	8.58
	trend	low East		mid High	high East		low East				high East	high East	high East		low East	high East		high East		high East		high East
TB15B-1U	max	4.606464	NA	0.151466	0.202307	NA	520.1828	NA	NA	0	0.004908	2.524667	6.0428329	0.168381	441.801	0.099068	0	969.0932	0.159267	0.095628	0.041125	96.86214447
TB15B-1L	max	6.812948	NA	0.165149	0.150921	NA	573.9868	NA	NA	0.009603	0.009129	5.553141	10.800678	0.187627	457.0836	0.099466	0.028274	822.872	0.172564	0.149537	0.061156	95.88297272
TB15B-2	max	14.99912	NA	0.181407	0.109728	NA	131.1389	NA	NA	0.01397	0.007557	7.828569	5.8723617	0	88.49073	0.0613	0.023526	33.22087	0.053447	0.0835	0	65.64246368
TB15B-3	max	15.20344	NA	0.175349	0.143191	NA	238.3506	NA	NA	0.020642	0.037849	31.57018	6.8000808	0	136.2778	0.582506	0.108961	48.17942	0.075983	0.27056	0	44.88493729
	trend	high West			high East		high East			high West	high West	high West		high East	high East	high West	high West	high East	high East	high West	high East	high East
TB15B-1U	mean	1.482465	NA	0.111012	0.146764	NA	458.8899	NA	NA	0	0.002505	0.337481	4.3256685	0.111939	378.0193	0.013209	0	764.7373	0.12951	0.081806	0.041125	81.63273303
TB15B-1L	mean	0.970239	NA	0.111662	0.116296	NA	526.3838	NA	NA	0.007595	0.002485	0.608746	6.4273062	0.135951	420.813	0.018655	0.028274	761.5791	0.138727	0.100639	0.05568	88.81005859
TB15B-2	mean	2.130706	NA	0.123037	0.055699	NA	109.7639	NA	NA	0.01397	0.002558	0.577456	1.6124828	0	77.87262	0.014201	0.023396	28.44326	0.039542	0.076077	0	56.69607099
TB15B-3	mean	3.158939	NA	0.121039	0.076408	NA	121.2408	NA	NA	0.016319	0.004412	2.969825	1.889096	0	78.58742	0.047174	0.045669	36.83111	0.038263	0.167492	0	31.7522165
	trend	high West			high East		high East			high West	high West	high West	high East	high East	high East	high West	high West	high East	high East	high West	high East	high East

Sample location		Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as CaC	TDS mg/L	TSS mg/L	oPO$_4$-P mg/L	NH$_3$-N mg/L	F mg/L	Cl mg/L	NO$_3$-N mg/L	SO$_4$ mg/L	t NVOC mg/L	d NVOC mg/L
	MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
TB7B-1	mean	NA	NA	5.64	NA	0.12	0.00111	0.023	NA	0.0095	7.36	712	1541	NA	0.02	1.06	0.25	414.67	0.08	118.74	12.15	10.95
TB7B-2	mean	NA	NA	5.97	NA	0.11	0.01106	0.024	NA	0.0086	7.48	540	692	NA	0.01	0.06	0.19	53.94	2.69	64.11	6.12	4.51
TB7B-3	mean	NA	NA	8.48	NA	0.07	0.00000	0.025	NA	0.0078	7.58	449	580	NA	0.01	0.00	0.18	37.83	7.75	29.30	3.82	3.10
TB7B-4	mean	NA	NA	6.16	NA	0.05	0.00448	0.020	NA	0.0474	7.61	355	431	NA	0.01	0.00	0.12	9.13	11.98	14.17	3.81	2.33
	trend			mid High		high East	mid High			high West	high West	high East	high East			high East		high East	high West	high East	high East	high East
TB7B-1	max	NA	NA	7.18	NA	0.14	0.00190	0.026	NA	0.0101	7.60	781	1788	NA	0.07	1.58	0.37	1124.68	0.08	151.49	15.47	15.97
TB7B-2	max	NA	NA	8.31	NA	0.13	0.02444	0.024	NA	0.0110	7.68	605	781	NA	0.02	0.11	0.26	95.46	7.00	82.34	20.19	5.89
TB7B-3	max	NA	NA	15.49	NA	0.09	0.00000	0.030	NA	0.0078	7.87	528	694	NA	0.01	0.00	0.22	92.33	16.19	35.81	8.27	4.05
TB7B-4	max	NA	NA	7.47	NA	0.06	0.00720	0.023	NA	0.0936	7.91	394	492	NA	0.02	0.00	0.15	12.88	17.05	22.83	11.85	4.07
	trend			mid High		high East	mid High			high West	low East	high East	high East		high East	high East	high East	high East	low East	high East	mid High	high East
TB15B-1U	max	NA	0.160142	18.39814	NA	4.144035	0.155501	0.041181	NA	0.027242	7.671	364.544	6100	NA	0.287155	0.39267	0.470605	3193.023	0.164978	255.7493	34.63634	7.105216829
TB15B-1L	max	NA	0.192668	25.95366	NA	4.17588	0.252857	0.046481	NA	0.022463	7.421	378.636	6138	NA	0.036898	0	0.30879	3004.797	0.099968	251.2531	8.263729	5.238560517
TB15B-2	max	NA	0	43.29146	NA	1.357092	0.397447	0.029807	NA	0.03308	7.86	397.647	867	NA	0.183543	0.070562	0.610915	112.8763	0.120472	260.8357	12.48025	7.917573974
TB15B-3	max	NA	0	40.22156	NA	1.414885	0.523059	0.037835	NA	0.180099	7.963	469.59	1283	NA	0.154815	0	0.721015	166.7675	0.077945	120.3909	24.13802	5.601098182
	trend		high East	high West		high East	high West	high East		high West	high West	high West	high East		high East	high East	high West	high East	high East	high East	high East	
TB15B-1U	mean	NA	0.148528	8.847991	NA	3.660262	0.097231	0.030241	NA	0.014839	7.380556	330.7979	5040.5	NA	0.035497	0.39267	0.320864	2673.796	0.109723	217.0714	6.126953	3.961413945
TB15B-1L	mean	NA	0.155278	10.09686	NA	4.007307	0.064691	0.027928	NA	0.012377	7.201056	371.9061	5419.3889	NA	0.016914	0	0.250984	2826.856	0.086389	233.4658	4.227678	3.008760986
TB15B-2	mean	NA	0	9.623571	NA	1.143563	0.076746	0.028682	NA	0.017619	7.662111	366.7801	737.38889	NA	0.029874	0.070562	0.472553	74.50998	0.103061	166.0753	4.132921	2.907788145
TB15B-3	mean	NA	0	10.35933	NA	1.149134	0.115529	0.029658	NA	0.032161	7.601056	397.9661	781.44444	NA	0.024505	0	0.417306	119.2975	0.077945	88.82911	7.283672	2.698047679
	trend		high East			high East				high West	high West	high West	high East		high East	high East		high East		high East		high East

Appendix G: Results of Geochemical Analysis of Blank Samples

Date collected	Sample location	Sample ID	Aluminum Al mg/L	Arsenic As mg/L	Boron B mg/L	Barium Ba mg/L	Beryllium Be mg/L	Calcium Ca mg/L	Cadmium Cd mg/L	Cobalt Co mg/L	Chromium Cr mg/L	Copper Cu mg/L	Iron Fe mg/L	Potassium K mg/L	Lithium Li mg/L	Magnesium Mg mg/L	Manganese Mn mg/L	Molybdenum Mo mg/L	Sodium Na mg/L	Nickel Ni mg/L	Phosphorus P mg/L	Lead Pb mg/L	Sulfur S mg/L
		MDL:	0.037	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
3/6/08	blank	TOLLWAY 23	0.0611					0.812					0.0415	0.067		0.153			1.32				
3/13/08	blank	TOLLWAY 28						0.015															
3/27/08	blank	TOLLWAY 33			0.043			0.065					0.0060	0.021					0.516				
4/10/08	blank	TOLLWAY JM 37						0.013											0.45				
4/23/08	blank	TOLLWAY JM 45						0.054								0.0187	0.0016		1.81				
5/28/08	blank	TOLLWAY 58	0.0263					0.763						0.134		0.133			1.21		0.077		
6/11/08	blank	TOLLWAY 63			0.024			0.018								0.0067			0.039				
7/8/08	blank	TOLLWAY 75						0.123								0.0536	0.0039		0.033				
7/23/08	blank	TOLLWAY 88			0.028			0.027								0.0032		0.061	0.031				
8/7/08	blank	TOLLWAY 102						0.019						0.018		0.0045							
8/20/08	blank	TOLLWAY 105			0.026								0.012										
9/4/08	blank	TOLLWAY 110			0.0330																		
9/16/08	blank	TOLLWAY 113																					
10/2/08	blank	TOLLWAY 138						0.072								0.0163							
10/16/08	blank	TOLLWAY 147	0.0097			0.00167		0.188						0.030		0.0414			0.209				
10/28/08	blank	TOLLWAY 157						0.013								0.0036			0.027				
11/13/08	blank	TOLLWAY 152						0.028								0.0053			0.031				
12/3/08	blank	TOLLWAY 164						0.034															
12/17/08	blank	TOLLWAY 172						0.049						0.017		0.0041							
1/8/09	blank	TOLLWAY 182						0.068								0.0033	0.0018		0.034				
2/18/09	blank	TOLLWAY 186						0.048															
3/5/09	blank	TOLLWAY 133						0.116								0.0084	0.0045						
4/1/09	blank	TOLLWAY 197	0.214			0.00322		1.69				0.00092	0.134	1.20		0.123	0.0016		44.1				0.483
4/30/09	blank	TOLLWAY 212						0.064											0.495				
5/12/09	blank	TOLLWAY 217						0.039						0.016			0.0022		0.618				
5/28/09	blank	TOLLWAY 221						0.035										0.043					
6/11/09	blank	TOLLWAY 226						0.104						0.016		0.0202			0.042				
7/1/09	blank	TOLLWAY 229						0.020															
7/8/09	blank	TOLLWAY 240						0.495								0.178			0.041				
7/14/09	blank	TOLLWAY 244						0.281						0.020		0.108			0.072				
7/28/09	blank	TOLLWAY 245	0.115			0.00321		0.902					0.0561	3.41		0.154	0.0017		36.9				0.596
8/25/09	blank	TOLLWAY 253						0.032											0.078				
9/10/09	blank	TOLLWAY 260						0.051									0.0017		0.032				
9/22/09	blank	TOLLWAY 265	0.045					0.244					0.0342	0.214		0.052			1.03				
10/8/09	blank	TOLLWAY 274						0.080				0.00388	0.0228	0.043			0.0027		0.229				
10/21/09	blank	TOLLWAY 287						0.043					0.0068	0.028			0.0021		0.102		0.065		
11/4/09	blank	TOLLWAY 300						0.052															
11/17/09	blank	TOLLWAY 303						0.037					0.0064										
12/3/09	blank	TOLLWAY 321						0.017															
12/17/09	blank	TOLLWAY 341						0.133					0.0109	0.028					0.149				
12/30/09	blank	TOLLWAY 356						0.026											0.032				
1/14/10	blank	TOLLWAY 370						0.150					0.0077						0.052	0.015			
1/28/10	blank	TOLLWAY 390						0.117					0.0107						0.214				
2/18/10	blank	TOLLWAY 407						0.489								0.128			0.039				
2/18/10	blank 2	TOLLWAY 408						0.289					0.0097	0.037		0.032			0.107				
3/4/10	blank	TOLLWAY 425						0.085															
3/4/10	blank 2	TOLLWAY 426						0.139					0.0077						0.043				
3/18/10	blank	TOLLWAY 445						0.175								0.046			0.113				0.217
4/1/10	blank	TOLLWAY 464						0.072						0.094		0.087			1.38	0.017			
4/15/10	blank	TOLLWAY 487						0.119								0.029			0.109				
4/28/10	blank	TOLLWAY 502						0.081						0.069					0.436				
5/13/10	blank	TOLLWAY 525						0.138					0.0138			0.031							
5/27/10	blank	TOLLWAY 545						0.121											0.036				
6/10/10	blank	TOLLWAY 570						0.095					0.0078	0.039									
6/24/10	blank	TOLLWAY 590						0.061					0.0123										
7/8/10	blank	TOLLWAY 612						0.111															
7/22/10	blank	TOLLWAY 629						0.133					0.0092										
8/5/10	blank	TOLLWAY 648						0.141								0.032			0.072				
8/18/10	blank	TOLLWAY 664						0.129											0.060				
		# detects	6.00	0.00	5.00	3.00	0.00	56.00	0.00	0.00	0.00	2.00	18.00	19.00	0.00	27.00	10.00	2.00	38.00	2.00	2.00	0.00	3.00
		min	0.010	0.000	0.024	0.002	0.000	0.013	0.000	0.000	0.000	0.001	0.006	0.016	0.000	0.003	0.002	0.043	0.027	0.015	0.065	0.000	0.217
		max	0.214	0.000	0.043	0.003	0.000	1.690	0.000	0.000	0.000	0.004	0.134	3.410	0.000	0.178	0.004	0.061	44.100	0.017	0.077	0.000	0.596
		mean	0.079	0.000	0.031	0.003	0.000	0.170	0.000	0.000	0.000	0.002	0.023	0.290	0.000	0.055	0.002	0.052	2.429	0.016	0.071	0.000	0.432

Appendix G: Results of Geochemical Analysis of Blank Samples

Date collected	Sample location	Sample ID	Antimony Sb mg/L	Selenium Se mg/L	Silicon Si mg/L	Tin Sn mg/L	Strontium Sr mg/L	Titanium Ti mg/L	Thalium Tl mg/L	Vanadium V mg/L	Zinc Zn mg/L	pH	alkalinity mg/L as $CaCO_3$	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L
		MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3.0	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31
3/6/08	blank	TOLLWAY 23			0.134		0.00315	0.00110				5.65							0.72			0.45	0.47
3/13/08	blank	TOLLWAY 28										5.55							0.10				
3/27/08	blank	TOLLWAY 33										6.49							0.099			0.33	
4/10/08	blank	TOLLWAY JM 37										5.68											
4/23/08	blank	TOLLWAY JM 45					0.00063					5.72							1.18			0.39	
5/28/08	blank	TOLLWAY 58					0.00371	0.00057				6.49	4						0.52			0.47	
6/11/08	blank	TOLLWAY 63					0.00040					5.73										0.43	0.31
7/8/08	blank	TOLLWAY 75					0.00044					5.97										0.92	0.82
7/23/08	blank	TOLLWAY 88										5.48										1.00	0.82
8/7/08	blank	TOLLWAY 102						0.00095				5.62											0.45
8/20/08	blank	TOLLWAY 105										5.51										0.43	0.48
9/4/08	blank	TOLLWAY 110										5.41										0.77	0.80
9/16/08	blank	TOLLWAY 113										5.51											
10/2/08	blank	TOLLWAY 138										5.56										0.52	1.00
10/16/08	blank	TOLLWAY 147					0.00132					5.65											0.46
10/28/08	blank	TOLLWAY 157										5.64										0.64	0.53
11/13/08	blank	TOLLWAY 152										5.63										0.65	0.64
12/3/08	blank	TOLLWAY 164										5.71										1.02	0.55
12/17/08	blank	TOLLWAY 172										5.95											
1/8/09	blank	TOLLWAY 182										6.22											
2/18/09	blank	TOLLWAY 186										5.91							0.10				
3/5/09	blank	TOLLWAY 133					0.00039					6.01										0.50	0.90
4/1/09	blank	TOLLWAY 197			0.580		0.0143	0.00526				5.94				0.03			2.74			0.63	7.07
4/30/09	blank	TOLLWAY 212					0.00040					6.03										0.47	0.65
5/12/09	blank	TOLLWAY 217										5.99								0.16			
5/28/09	blank	TOLLWAY 221				0.086						5.74										0.63	
6/11/09	blank	TOLLWAY 226				0.086	0.00080					5.79							0.10			0.51	
7/1/09	blank	TOLLWAY 229										5.82				0.01							0.57
7/8/09	blank	TOLLWAY 240					0.00049					5.74							0.17				0.41
7/14/09	blank	TOLLWAY 244					0.00062					5.71							0.21		0.34		0.56
7/28/09	blank	TOLLWAY 245			0.212		0.0210	0.00125				5.66				0.01			1.33			0.47	0.35
8/25/09	blank	TOLLWAY 253										6.18											1.04
9/10/09	blank	TOLLWAY 260										5.98										0.47	0.73
9/22/09	blank	TOLLWAY 265			0.089		0.00378	0.00067				5.68							0.64			0.44	0.97
10/8/09	blank	TOLLWAY 274					0.00078					5.89							0.23			0.44	0.80
10/21/09	blank	TOLLWAY 287										6.04							0.23			0.81	0.46
11/4/09	blank	TOLLWAY 300					0.00048					5.76							0.18				0.46
11/17/09	blank	TOLLWAY 303										5.39							0.14			1.04	0.95
12/3/09	blank	TOLLWAY 321										5.55										0.65	0.78
12/17/09	blank	TOLLWAY 341					0.00067					5.47							0.65			0.59	0.44
12/30/09	blank	TOLLWAY 356										5.69							0.09			0.54	0.64
1/14/10	blank	TOLLWAY 370					0.00045					6.01							0.13			0.37	0.73
1/28/10	blank	TOLLWAY 390							0.021			6.68											0.62
2/18/10	blank	TOLLWAY 407					0.00200					6.34											
2/18/10	blank 2	TOLLWAY 408			17.9		0.00065	0.00073				6.32							0.20			0.72	0.42
3/4/10	blank	TOLLWAY 425										6.35										0.48	0.42
3/4/10	blank 2	TOLLWAY 426					0.00049					6.21										0.48	
3/18/10	blank	TOLLWAY 445					0.00089					6.91	5									0.45	0.61
4/1/10	blank	TOLLWAY 464					0.00120					6.18							0.46				0.62
4/15/10	blank	TOLLWAY 487					0.00088					6.06										0.61	0.52
4/28/10	blank	TOLLWAY 502					0.00100					5.89							0.20			0.70	1.14
5/13/10	blank	TOLLWAY 525					0.00096					5.61										1.53	1.96
5/27/10	blank	TOLLWAY 545					0.00071					6.15										1.19	0.78
6/10/10	blank	TOLLWAY 570					0.00096					6.18										0.62	0.55
6/24/10	blank	TOLLWAY 590										5.73				0.002						0.83	1.20
7/8/10	blank	TOLLWAY 612					0.00057					5.81										0.78	1.17
7/22/10	blank	TOLLWAY 629					0.00064					5.80										1.00	0.88
8/5/10	blank	TOLLWAY 648					0.001					5.76										1.07	1.20
8/18/10	blank	TOLLWAY 664					0.001					5.49										0.83	0.94
		# detects	0.00	0.00	5.00	2.00	32.00	7.00	1.00	0.00	0.00		2.00	0.00	0.00	4.00	0.00	0.00	22.00	1.00	1.00	42.00	45.00
		min	0.000	0.000	0.089	0.086	0.000	0.001	0.021	0.000	0.000		4.281	0.000	0.000	0.002	0.000	0.000	0.091	0.164	0.343	0.334	0.313
		max	0.000	0.000	17.922	0.086	0.021	0.005	0.021	0.000	0.000		4.859	0.000	0.000	0.035	0.000	0.000	2.743	0.164	0.343	1.534	7.073
		mean	0.000	0.000	3.787	0.086	0.002	0.002	0.021	0.000	0.000		4.570	0.000	0.000	0.016	0.000	0.000	0.473	0.164	0.343	0.664	0.864

8.707 avg #
0.000 min of mins
44.100 max of maxes
0.357 mean of means

Appendix H: Results of Geochemical Analysis of Duplicate Samples

		Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
		MDL:	0.0061	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
3/26/08	TB20 Grab	Tollway 30	0.0530	<0.108	0.042	0.216	<0.00055	132	<0.012	<0.013	<0.0058	0.00872	0.0427	7.67	0.024	34.1	0.0625	<0.022	1784	0.030	<0.063	<0.041	42.3
3/26/08	TB20 Grab dupe	Tollway 31	0.0519	<0.108	0.039	0.210	<0.00055	131	<0.012	<0.013	<0.0058	0.00847	0.0371	7.49	0.023	34.1	0.0630	<0.022	1764	0.019	0.075	<0.041	39.4
		difference	0.00110	<MDL	0.00300	0.00646	<MDL	1.00000	<MDL	<MDL	<MDL	0.00025	0.00560	0.18000	0.00090	0.00000	0.00050	<MDL	20.00000	0.01100	<MDL	<MDL	2.90000
		% difference	2.08	<MDL	7.14	2.98	<MDL	0.76	<MDL	<MDL	<MDL	2.87	13.11	2.35	3.83	0.00	0.80	<MDL	1.12	36.67	<MDL	<MDL	6.86
		> 20% ?																		36.67			
4/9/08	TB20 Grab	TOLLWAY JM 34	0.0456	<0.108	0.041	0.147	<0.00055	86.5	<0.012	<0.013	<0.0058	0.00772	0.0387	7.45	0.019	27.0	0.0727	<0.022	1477	<0.014	<0.063	<0.041	39.2
4/9/08	TB20 Grab dupe	TOLLWAY JM 35	0.0472	<0.108	0.042	0.147	<0.00055	84.7	<0.012	<0.013	<0.0058	0.00809	0.0406	7.57	0.018	26.9	0.0722	<0.022	1463	0.017	0.085	0.042	38.6
		difference	0.00160	<MDL	0.00100	0.00019	<MDL	1.80000	<MDL	<MDL	<MDL	0.00037	0.00190	0.12000	0.00120	0.14000	0.00050	<MDL	14.00000	<MDL	<MDL	<MDL	0.60000
		% difference	3.51	<MDL	2.44	0.13	<MDL	2.08	<MDL	<MDL	<MDL	4.79	4.91	1.61	6.22	0.52	0.69	<MDL	0.95	<MDL	<MDL	<MDL	1.53
		> 20% ?																					
4/14/08	TB20 Isco	TOLLWAY JM 41	0.0973	<0.108	0.026	0.0698	<0.00055	49.2	<0.012	<0.013	<0.0058	0.0101	0.0831	5.81	<0.018	13.2	0.0297	<0.022	741	<0.014	0.08	<0.041	22.2
4/14/08	TB20 Isco dupe	TOLLWAY JM 42	0.140	<0.108	0.032	0.0699	<0.00055	49.0	<0.012	<0.013	<0.0058	0.00994	0.124	5.90	<0.018	13.1	0.0295	<0.022	742	<0.014	<0.063	<0.041	22.0
		difference	0.04270	<MDL	0.00600	0.00011	<MDL	0.20000	<MDL	<MDL	<MDL	0.00014	0.04120	0.09000	<MDL	0.07000	0.00020	<MDL	1.00000	<MDL	<MDL	<MDL	0.20000
		% difference	43.88	<MDL	23.08	0.16	<MDL	0.41	<MDL	<MDL	<MDL	1.39	49.58	1.55	<MDL	0.53	0.67	<MDL	0.13	<MDL	<MDL	<MDL	0.90
		> 20% ?	43.88		23.08								49.58										
4/23/08	TB19 Grab	TOLLWAY JM 43	0.0391	<0.108	0.129	0.162	<0.00055	67.3	<0.012	<0.013	<0.0058	0.00582	0.0328	18.2	0.047	52.7	0.0138	<0.022	3772	0.041	0.137	<0.041	135
4/23/08	TB19 Grab dupe	TOLLWAY JM 44	0.0461	<0.108	0.128	0.161	<0.00055	63.1	<0.012	<0.013	<0.0058	0.00725	0.0303	18.9	0.042	50.3	0.0118	<0.022	3776	0.024	0.097	<0.041	133
		difference	0.00700	<MDL	0.00100	0.00062	<MDL	4.20000	<MDL	<MDL	<MDL	0.00143	0.00250	0.70000	0.00450	2.41000	0.00200	<MDL	4.00000	0.01700	0.04000	<MDL	2.00000
		% difference	17.90	<MDL	0.78	0.38	<MDL	6.24	<MDL	<MDL	<MDL	24.57	7.62	3.85	9.68	4.57	14.49	<MDL	0.11	41.46	29.20	<MDL	1.48
		> 20% ?										24.57								41.46	29.20		
5/6/08	TB19 Grab	TOLLWAY 49	0.0404	<0.108	0.119	0.16775	<0.00055	66.1	<0.012	<0.013	<0.0058	0.00637	0.0131	13.3	0.036	40.4	0.0256	<0.022	2785	<0.014	0.065	0.057	95.4
5/6/08	TB19 Grab dupe	TOLLWAY 47	0.0597	<0.108	0.123	0.168	<0.00055	67.8	<0.012	<0.013	<0.0058	0.00606	0.0399	13.2	0.038	39.9	0.0277	<0.022	2832	0.023	<0.063	0.044	98.1
		difference	0.01930	<MDL	0.00400	0.00051	<MDL	1.70000	<MDL	<MDL	<MDL	0.00031	0.02680	0.10000	0.00190	0.54000	0.00210	<MDL	47.00000	<MDL	<MDL	0.01300	2.70000
		% difference	47.77	<MDL	3.36	0.30	<MDL	2.57	<MDL	<MDL	<MDL	4.87	204.58	0.75	5.26	1.34	8.20	<MDL	1.69	<MDL	<MDL	22.81	2.83
		> 20% ?	47.77										204.58									22.81	
5/20/08	TB19 Grab	TOLLWAY 50	0.0117	<0.108	0.106	0.131	<0.00055	52.2	<0.012	<0.013	<0.0058	<0.00079	0.0372	8.55	0.021	31.7	0.0610	<0.022	2192	0.025	<0.063	<0.041	72.7
5/20/08	TB19 Grab dupe	TOLLWAY 51	0.0106	<0.108	0.106	0.134	<0.00055	53.0	<0.012	<0.013	<0.0058	<0.00079	0.0441	8.67	0.022	31.5	0.0609	<0.022	2226	<0.014	0.087	<0.041	74.2
		difference	0.00110	<MDL	0.00000	0.00229	<MDL	0.80000	<MDL	<MDL	<MDL	<MDL	0.00690	0.12000	0.00090	0.15000	0.00010	<MDL	34.00000	<MDL	<MDL	<MDL	1.50000
		% difference	9.40	<MDL	0.00	1.74	<MDL	1.53	<MDL	<MDL	<MDL	<MDL	18.55	1.40	4.31	0.47	0.16	<MDL	1.55	<MDL	<MDL	<MDL	2.06
		> 20% ?																					
5/28/08	TB19 Grab	TOLLWAY 52	0.108	<0.108	0.123	0.125	<0.00055	37.2	<0.012	<0.013	<0.0058	0.00663	<0.0059	8.45	0.021	23.9	0.0090	0.026	2136	0.028	0.119	<0.041	77.7
5/28/08	TB19 Grab dupe	TOLLWAY 56	0.115	<0.108	0.131	0.129	<0.00055	37.7	<0.012	<0.013	<0.0058	0.00664	<0.0059	9.73	0.022	26.0	0.0084	0.025	2182	0.018	<0.063	<0.041	78.7
		difference	0.00780	<MDL	0.00800	0.00350	<MDL	0.50000	<MDL	<MDL	<MDL	0.00001	<MDL	1.28000	0.00100	2.02000	0.00060	0.00100	46.00000	0.01000	<MDL	<MDL	1.00000
		% difference	7.26	<MDL	6.50	2.80	<MDL	1.34	<MDL	<MDL	<MDL	0.15	<MDL	15.15	4.81	8.44	6.67	3.85	2.15	35.71	<MDL	<MDL	1.29
		> 20% ?																		35.71			
6/9/08	TB19 Grab	TOLLWAY 55	0.397	<0.108	0.127	0.0715	<0.00055	36.9	<0.012	<0.013	<0.0058	0.00681	0.219	5.06	<0.018	14.8	0.0175	<0.022	874	0.023	<0.063	<0.041	33.2
6/9/08	TB19 Grab dupe	TOLLWAY 59	0.491	<0.108	0.118	0.0743	<0.00055	37.3	<0.012	<0.013	<0.0058	0.00611	0.279	5.27	<0.018	15.3	0.0178	<0.022	917	0.018	<0.063	<0.041	34.2
		difference	0.09440	<MDL	0.00900	0.00284	<MDL	0.40000	<MDL	<MDL	<MDL	0.00070	0.05990	0.21000	<MDL	0.46000	0.00030	<MDL	43.00000	0.00500	<MDL	<MDL	1.00000
		% difference	23.78	<MDL	7.09	3.97	<MDL	1.08	<MDL	<MDL	<MDL	10.28	27.39	4.15	<MDL	3.11	1.71	<MDL	4.92	21.74	<MDL	<MDL	3.01
		> 20% ?	23.78										27.39							21.74			
7/9/08	TB19 Grab	TOLLWAY 82	0.0530	<0.108	0.113	0.120	<0.00055	47.3	<0.012	<0.013	<0.0058	0.00406	0.0936	3.60	<0.018	14.2	0.0514	<0.022	982	0.021	<0.063	<0.041	39.3
7/9/08	TB19 Grab dupe	TOLLWAY 81	0.0546	<0.108	0.114	0.121	<0.00055	47.7	<0.012	<0.013	<0.0058	0.00425	0.0973	3.64	<0.018	15.3	0.0514	<0.022	998	<0.014	<0.063	<0.041	39.9
		difference	0.00160	<MDL	0.00100	0.00116	<MDL	0.40000	<MDL	<MDL	<MDL	0.00019	0.00370	0.04000	<MDL	1.12000	0.00000	<MDL	16.00000	<MDL	<MDL	<MDL	0.60000
		% difference	3.02	<MDL	0.88	0.97	<MDL	0.85	<MDL	<MDL	<MDL	4.68	3.95	1.11	<MDL	7.90	0.00	<MDL	1.63	<MDL	<MDL	<MDL	1.53
		> 20% ?																					
7/22/08	TB19 Gerlach	TOLLWAY 86	0.0199	<0.108	0.031	0.113	<0.00055	19.0	<0.012	<0.013	<0.0058	0.00536	0.538	1.78	<0.018	2.82	0.106	<0.022	20.9	<0.014	<0.063	<0.041	6.02
7/22/08	TB19 Gerlach dupe	TOLLWAY 87	0.0173	<0.108	0.035	0.114	<0.00055	19.1	<0.012	<0.013	<0.0058	0.00448	0.514	1.79	<0.018	2.82	0.106	<0.022	20.9	0.019	<0.063	<0.041	6.02
		difference	0.00260	<MDL	0.00400	0.00089	<MDL	0.10000	<MDL	<MDL	<MDL	0.00088	0.02400	0.01000	<MDL	0.00400	0.00050	<MDL	0.00000	<MDL	<MDL	<MDL	0.00000
		% difference	13.07	<MDL	12.90	0.79	<MDL	0.53	<MDL	<MDL	<MDL	16.42	4.46	0.56	<MDL	0.14	0.47	<MDL	0.00	<MDL	<MDL	<MDL	0.00
		> 20% ?																					
8/6/08	TB19 Grab	TOLLWAY 96	0.111	<0.108	0.0930	0.0835	<0.00055	42.5	<0.012	<0.013	<0.0058	0.00707	0.116	2.12	<0.018	11.1	0.0147	<0.022	525	<0.014	<0.063	<0.041	16.8
8/6/08	TB19 Grab dupe	TOLLWAY 97	0.0742	<0.108	0.0910	0.0844	<0.00055	44.3	<0.012	<0.013	<0.0058	0.00732	0.0857	2.13	<0.018	11.4	0.0142	<0.022	533	<0.014	<0.063	<0.041	17.0
		difference	0.03690	<MDL	0.00200	0.00090	<MDL	1.80000	<MDL	<MDL	<MDL	0.00025	0.03010	0.01000	<MDL	0.28000	0.00050	<MDL	8.00000	<MDL	<MDL	<MDL	0.20000
		% difference	33.21	<MDL	2.15	1.08	<MDL	4.24	<MDL	<MDL	<MDL	3.54	25.99	0.47	<MDL	2.52	3.40	<MDL	1.52	<MDL	<MDL	<MDL	1.19
		> 20% ?	33.21										25.99										
8/19/08	TB19 Gerlach	TOLLWAY 91	0.0455	<0.108	0.068	0.116	<0.00055	16.2	<0.012	<0.013	0.0065	0.00845	1.09	1.72	<0.018	2.54	0.123	0.027	18.3	<0.014	<0.063	<0.041	5.23
8/19/08	TB19 Gerlach dupe	TOLLWAY 103	0.0436	<0.108	0.051	0.115	<0.00055	16.0	<0.012	<0.013	<0.0058	0.00722	1.09	1.70	<0.018	2.53	0.121	<0.022	18.6	<0.014	<0.063	<0.041	5.24
		difference	0.00190	<MDL	0.01700	0.00101	<MDL	0.20000	<MDL	<MDL	<MDL	0.00123	0.00400	0.02000	<MDL	0.00800	0.00130	<MDL	0.30000	<MDL	<MDL	<MDL	0.01000
		% difference	4.18	<MDL	25.00	0.87	<MDL	1.23	<MDL	<MDL	<MDL	14.56	0.37	1.16	<MDL	0.31	1.06	<MDL	1.64	<MDL	<MDL	<MDL	0.19
		> 20% ?			25.00																		
9/3/08	TB19 Grab	TOLLWAY 106	0.119	<0.108	0.0920	0.0739	<0.00055	37.5	<0.012	<0.013	<0.0058	0.00950	0.118	3.00	<0.018	10.9	0.0100	<0.022	535	<0.014	<0.063	<0.041	31.9
9/3/08	TB19 Grab dupe	TOLLWAY 107	0.0616	<0.108	0.0930	0.0745	<0.00055	37.5	<0.012	<0.013	<0.0058	0.0100	0.0536	2.96	<0.018	11.0	0.0085	<0.022	539	0.015	<0.063	<0.041	32.1
		difference	0.05730	<MDL	0.00100	0.00054	<MDL	0.00000	<MDL	<MDL	<MDL	0.00052	0.06460	0.04000	<MDL	0.04000	0.00150	<MDL	4.00000	<MDL	<MDL	<MDL	0.20000
		% difference	48.19	<MDL	1.09	0.73	<MDL	0.00	<MDL	<MDL	<MDL	5.47	54.65	1.33	<MDL	0.37	15.00	<MDL	0.75	<MDL	<MDL	<MDL	0.63
		> 20% ?	48.19										54.65										
9/17/08	SandersSW Grab	TOLLWAY 117	0.0954	<0.108	0.162	0.0897	<0.00055	131	<0.012	<0.013	<0.0058	<0.00079	<0.0059	1.55	<0.018	65.2	0.0859	<0.022	303	0.041	<0.063	<0.041	43.0
9/17/08	SandersSW Grab dupe	TOLLWAY 118	0.120	<0.108	0.163	0.0899	<0.00055	132	<0.012	<0.013	<0.0058	0.00122	0.0218	1.55	<0.018	66.7	0.0786	<0.022	304	0.043	<0.063	<0.041	43.6
		difference	0.02460	<MDL	0.00100	0.00022	<MDL	1.00000	<MDL	<MDL	<MDL	<MDL	<MDL	0.00000	<MDL	1.50000	0.00730	<MDL	1.00000	0.00200	<MDL	<MDL	0.60000
		% difference	25.79	<MDL	0.62	0.25	<MDL	0.76	<MDL	<MDL	<MDL	<MDL	<MDL	0.00	<MDL	2.30	8.50	<MDL	0.33	4.88	<MDL	<MDL	1.40
		> 20% ?	25.79																				
10/1/08	TB19 Grab	TOLLWAY 136	0.0849	<0.108	0.102	0.0657	<0.00055	25.7	<0.012	<0.013	<0.0058	0.00739	0.0497	5.06	<0.018	13.2	0.0031	0.025	832	<0.014	<0.063	<0.041	51.8
10/1/08	TB19 Grab dupe	TOLLWAY 137	0.0663	<0.108	0.094	0.0640	<0.00055	26.3	<0.012	<0.013	<0.0058	0.00704	0.0368	4.95	<0.018	13.0	0.0021	0.022	815	<0.014	<0.063	<0.041	42.1
		difference	0.01860	<MDL	0.00800	0.00167	<MDL	0.60000	<MDL	<MDL	<MDL	0.00035	0.01290	0.11000	<MDL	0.21000	0.00100	0.00300	17.00000	<MDL	<MDL	<MDL	9.70000
		% difference	21.91	<MDL	7.84	2.54	<MDL	2.33	<MDL	<MDL	<MDL	4.74	25.96	2.17	<MDL	1.59	32.26	12.00	2.04	<MDL	<MDL	<MDL	18.73
		> 20% ?	21.91										25.96				32.26						
10/15/08	TB19 Grab	TOLLWAY 129	0.195	<0.108	0.064	0.0956	<0.00055	46.8	<0.012	<0.013	<0.0058	0.0129	0.102	18.0	<0.018	17.7	0.0261	<0.022	711	<0.014	<0.063	<0.041	41.4
10/15/08	TB19 Grab dupe	TOLLWAY 142	0.183	<0.108	0.061	0.0968	<0.00055	46.9	<0.012	<0.013	<0.0058	0.0133	0.0937	18.4	<0.018	17.0	0.0258	<0.022	722	<0.014	<0.063	<0.041	41.6
		difference	0.01120	<MDL	0.00300	0.00117	<MDL	0.10000	<MDL	<MDL	<MDL	0.00038	0.00850	0.40000	<MDL	0.67000	0.00030	<MDL	11.00000	<MDL	<MDL	<MDL	0.20000
		% difference	5.76	<MDL	4.69	1.22	<MDL	0.21	<MDL	<MDL	<MDL	2.94	8.32	2.22	<MDL	3.79	1.15	<MDL	1.55	<MDL	<MDL	<MDL	0.48
		> 20% ?																					

Appendix H: Results of Geochemical Analysis of Duplicate Samples

			Sb	Se	Si	Sn	Sr	Ti	Tl	V	Zn	pH	alkalinity	TDS, 180 C	TSS	oPO_4-P	NH_3-N	F	Cl	NO_3-N	SO_4	total NVOC	dissolved NVOC	mean relative % difference between dupe and sample
		Sample ID	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L as $CaCO_3$	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
		MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31	
3/26/08	TB20 Grab	Tollway 30	<0.059	<0.131	2.51	<0.086	1.22	<0.00056	<0.017	<0.047	0.0616	7.92	160	5160		0.01	<0.06	<0.08	2932	<0.07	107	11.3	10.2	
3/26/08	TB20 Grab dupe	Tollway 31	<0.059	<0.131	2.38	<0.086	1.12	<0.00056	0.017	<0.047	0.0614	7.94	159	5118		<0.01	<0.06	<0.08	2978	<0.07	103	11.7	10.5	
		difference	<MDL	<MDL	0.13000	<MDL	0.10310	<MDL	<MDL	<MDL	0.00020	0.02400	0.66300	42.00000	NA	<MDL	<MDL	<MDL	46.31167	<MDL	3.70461	0.39389	0.30292	
		% difference	<MDL	<MDL	5.18	<MDL	8.42	<MDL	<MDL	<MDL	0.32	0.30	0.41	0.81	NA	<MDL	<MDL	<MDL	1.58	<MDL	3.46	3.49	2.98	4.68
		> 20% ?																						
4/9/08	TB20 Grab	TOLLWAY JM 34	<0.059	<0.131	1.90	<0.086	0.817	<0.00056	<0.017	<0.047	0.0339	8.07	145	4086		<0.01	<0.06	<0.08	2320	<0.07	106	13.0	10.5	
4/9/08	TB20 Grab dupe	TOLLWAY JM 35	<0.059	<0.131	1.88	<0.086	0.820	<0.00056	<0.017	<0.047	0.0344	8.09	145	4074		<0.01	<0.06	<0.08	2347	<0.07	107	12.3	10.6	
		difference	<MDL	<MDL	0.02000	<MDL	0.00329	<MDL	<MDL	<MDL	0.00050	0.01600	0.73200	12.00000	NA	<MDL	<MDL	<MDL	27.75018	<MDL	0.41728	0.60931	0.02796	
		% difference	<MDL	<MDL	1.05	<MDL	0.40	<MDL	<MDL	<MDL	1.47	0.20	0.50	0.29	NA	<MDL	<MDL	<MDL	1.20	<MDL	0.39	4.70	0.27	1.81
		> 20% ?																						
4/14/08	TB20 Isco	TOLLWAY JM 41	<0.059	<0.131	2.88	<0.086	0.378	0.00122	<0.017	<0.047	0.0080	7.92	109	2090	294	<0.01	0.09	0.15	1145	0.38	62.9	38.0	10.1	
4/14/08	TB20 Isco dupe	TOLLWAY JM 42	<0.059	<0.131	2.99	<0.086	0.380	0.00205	0.017	<0.047	0.0083	7.92	110	2095	270	<0.01	0.08	0.15	1130	0.37	62.9	36.3	10.9	
		difference	<MDL	<MDL	0.11000	<MDL	0.00210	0.00083	<MDL	<MDL	0.00030	0.00700	0.27400	5.00000	24.00000	<MDL	0.01083	0.00508	15.11624	0.00393	0.02059	1.69208	0.72991	
		% difference	<MDL	<MDL	3.82	<MDL	0.56	68.03	<MDL	<MDL	3.75	0.09	0.25	0.24	8.16	<MDL	12.17	3.48	1.32	1.04	0.03	4.45	7.21	9.11
		> 20% ?						68.03																
4/23/08	TB19 Grab	TOLLWAY JM 43	<0.059	<0.131	0.319	<0.086	0.969	<0.00056	0.02	<0.047	<0.0073	9.39	121	10136	18	0.02	<0.06	<0.08	6099	0.08	355	28.3	20.2	
4/23/08	TB19 Grab dupe	TOLLWAY JM 44	<0.059	<0.131	0.321	<0.086	0.963	<0.00056	0.021	<0.047	<0.0073	9.38	119	10209	17	0.02	<0.06	<0.08	5915	0.08	329	28.1	18.6	
		difference	<MDL	<MDL	0.00200	<MDL	0.00518	<MDL	0.00100	<MDL	<MDL	0.00400	2.83500	73.00000	1.00000	0.00631	<MDL	<MDL	184.22210	0.00026	25.25609	0.23755	1.61195	
		% difference	<MDL	<MDL	0.63	<MDL	0.53	<MDL	5.00	<MDL	<MDL	0.04	2.34	0.72	5.56	26.33	<MDL	<MDL	3.02	0.34	7.12	0.84	7.97	8.25
		> 20% ?														26.33								
5/6/08	TB19 Grab	TOLLWAY 49	<0.059	<0.131	0.477	<0.086	0.775	<0.00056	<0.017	<0.047	<0.0073	8.78	232	7622	25	0.02	<0.06	<0.08	4371	0.47	279	18.5	15.9	
5/6/08	TB19 Grab dupe	TOLLWAY 47	<0.059	<0.131	0.535	<0.086	0.776	<0.00056	0.026	<0.047	<0.0073	8.78	231	7558		0.02	<0.06	<0.08	4452	0.47	259	19.5	16.4	
		difference	<MDL	<MDL	0.05800	<MDL	0.00178	<MDL	<MDL	<MDL	<MDL	0.00200	0.42500	64.00000	NA	0.00160	<MDL	<MDL	81.25879	0.00443	20.49456	0.99423	0.52687	
		% difference	<MDL	<MDL	12.16	<MDL	0.23	<MDL	<MDL	<MDL	<MDL	0.02	0.18	0.84	NA	10.27	<MDL	<MDL	1.86	0.94	7.34	5.38	3.31	14.54
		> 20% ?																						
5/20/08	TB19 Grab	TOLLWAY 50	<0.059	<0.131	0.520	<0.086	0.615	<0.00056	<0.017	<0.047	<0.0073	7.72	269	6058	30.4	0.02	<0.06	<0.08	3353	1.76	188	13.5	11.8	
5/20/08	TB19 Grab dupe	TOLLWAY 51	<0.059	<0.131	0.526	<0.086	0.624	<0.00056	<0.017	<0.047	<0.0073	7.77	276	6005		0.02	<0.06	<0.08	3321	1.76	185	13.8	12.4	
		difference	<MDL	<MDL	0.00600	<MDL	0.00924	<MDL	<MDL	<MDL	<MDL	0.04900	7.70200	53.00000	NA	0.00120	<MDL	<MDL	32.36334	0.00542	2.77510	0.35372	0.59903	
		% difference	<MDL	<MDL	1.15	<MDL	1.50	<MDL	<MDL	<MDL	<MDL	0.63	2.87	0.87	NA	7.72	<MDL	<MDL	0.97	0.31	1.48	2.63	5.06	3.02
		> 20% ?																						
5/28/08	TB19 Grab	TOLLWAY 52	<0.059	<0.131	0.414	<0.086	0.494	<0.00056	<0.017	<0.047	0.0127	8.94	283	5687	11.2	0.02	<0.06	0.60	3123	2.38	221	13.9	12.1	
5/28/08	TB19 Grab dupe	TOLLWAY 56	<0.059	<0.131	0.417	<0.086	0.510	<0.00056	<0.017	<0.047	<0.0073	8.94	281	5678		0.02	<0.06	0.60	3124	2.40	219	14.0	12.2	
		difference	<MDL	<MDL	0.00300	<MDL	0.01602	<MDL	<MDL	<MDL	<MDL	0.00200	2.35900	9.00000	NA	0.00311	<MDL	0.00275	0.48266	0.01857	2.25799	0.14952	0.08018	
		% difference	<MDL	<MDL	0.72	<MDL	3.24	<MDL	<MDL	<MDL	<MDL	0.02	0.83	0.16	NA	16.87	<MDL	0.46	0.02	0.78	1.02	1.08	0.66	4.88
		> 20% ?																						
6/9/08	TB19 Grab	TOLLWAY 55	<0.059	<0.131	5.69	<0.086	0.327	0.00811	<0.017	<0.047	0.0115	8.46	253	2320	282	0.02	0.06	0.59	1160	1.75	95.1	21.0	11.8	
6/9/08	TB19 Grab dupe	TOLLWAY 59	<0.059	<0.131	6.06	<0.086	0.337	0.0115	<0.017	<0.047	0.0078	8.45	258	2379	327	0.01	0.07	0.61	1231	1.93	97.0	21.1	12.5	
		difference	<MDL	<MDL	0.37000	<MDL	0.00977	0.00343	<MDL	<MDL	0.00370	0.00700	5.41300	59.00000	45.00000	0.00165	0.00742	0.01700	71.00000	0.17887	1.91540	0.06300	0.70300	
		% difference	<MDL	<MDL	6.50	<MDL	2.99	42.29	<MDL	<MDL	32.17	0.08	2.14	2.54	15.96	10.20	12.05	2.88	6.12	10.21	2.01	0.30	5.94	9.52
		> 20% ?						42.29			32.17													
7/9/08	TB19 Grab	TOLLWAY 82	<0.059	<0.131	5.35	<0.086	0.369	0.00085	<0.017	<0.047	0.0097	7.89	284	2620	36.0	0.01	<0.06	0.53	1326	<0.07	104	20.1	17.7	
7/9/08	TB19 Grab dupe	TOLLWAY 81	<0.059	<0.131	5.46	<0.086	0.372	0.00083	<0.017	<0.047	0.0100	7.88	284	2607	30.0	0.02	<0.06	0.55	1337	<0.07	104	19.8	17.8	
		difference	<MDL	<MDL	0.11000	<MDL	0.00364	0.00002	<MDL	<MDL	0.00030	0.01100	0.10100	13.00000	6.00000	0.00648	<MDL	0.02056	11.45859	<MDL	0.45886	0.38989	0.07103	
		% difference	<MDL	<MDL	2.06	<MDL	0.99	2.35	<MDL	<MDL	3.09	0.14	0.04	0.50	16.67	58.12	<MDL	3.87	0.86	<MDL	0.44	1.94	0.40	4.72
		> 20% ?														58.12								
7/22/08	TB19 Gerlach	TOLLWAY 86	<0.059	<0.131	1.85	<0.086	0.135	<0.00056	<0.017	<0.047	0.0205	6.90	45.9	123	190	<0.01	0.07	0.39	23.5	<0.07	16.0	45.4	15.9	
7/22/08	TB19 Gerlach dupe	TOLLWAY 87	<0.059	<0.131	1.87	<0.086	0.135	<0.00056	<0.017	<0.047	0.0196	6.91	45.9	132	198	<0.01	0.08	0.40	23.5	<0.07	16.1	48.7	15.7	
		difference	<MDL	<MDL	0.02000	<MDL	0.00024	<MDL	<MDL	<MDL	0.00090	0.00900	0.00750	9.00000	8.00000	<MDL	0.00465	0.00849	0.01743	<MDL	0.07689	3.28940	0.21751	
		% difference	<MDL	<MDL	1.08	<MDL	0.18	<MDL	<MDL	<MDL	4.39	0.13	0.02	7.32	4.21	<MDL	6.40	2.16	0.07	<MDL	0.48	7.25	1.37	3.52
		> 20% ?																						
8/6/08	TB19 Grab	TOLLWAY 96	<0.059	<0.131	3.82	<0.086	0.328	0.00332	<0.017	<0.047	<0.0073	8.23	254	1497	10.0	0.02	<0.06	0.53	712	<0.07	52.5	10.4	9.29	
8/6/08	TB19 Grab dupe	TOLLWAY 97	<0.059	<0.131	3.78	<0.086	0.331	0.00108	<0.017	<0.047	<0.0073	8.24	255	1491	8.0	<0.01	<0.06	0.54	707	<0.07	52.4	9.88	9.39	
		difference	<MDL	<MDL	0.04000	<MDL	0.00353	0.00224	<MDL	<MDL	<MDL	0.00300	0.55200	6.00000	2.00000	<MDL	<MDL	0.00280	4.47013	<MDL	0.09500	0.54048	0.10532	
		% difference	<MDL	<MDL	1.05	<MDL	1.08	67.47	<MDL	<MDL	<MDL	0.04	0.22	0.40	20.00	<MDL	<MDL	0.52	0.63	<MDL	0.18	5.19	1.13	7.71
		> 20% ?						67.47																
8/19/08	TB19 Gerlach	TOLLWAY 91	<0.059	<0.131	1.77	<0.086	0.100	0.00067	0.018	<0.047	0.0397	6.89	41	126	179	0.02	0.32	0.68	20.8	<0.07	14.5	23.5	16.4	
8/19/08	TB19 Gerlach dupe	TOLLWAY 103	<0.059	<0.131	1.77	<0.086	0.100	0.00077	<0.017	<0.047	0.0384	6.89	42	125	144	0.01	0.33	0.68	20.9	<0.07	14.5	28.0	16.6	
		difference	<MDL	<MDL	0.00000	<MDL	0.00008	0.00010	<MDL	<MDL	0.00130	0.00500	0.10770	1.00000	35.00000	0.00407	0.00250	0.00254	0.01079	<MDL	0.00295	4.43016	0.20102	
		% difference	<MDL	<MDL	0.00	<MDL	0.08	14.93	<MDL	<MDL	3.27	0.07	0.26	0.79	19.55	26.19	0.77	0.38	0.05	<MDL	0.02	18.83	1.22	5.27
		> 20% ?														26.19								
9/3/08	TB19 Grab	TOLLWAY 106	<0.059	<0.131	1.85	<0.086	0.321	0.00196	<0.017	<0.047	0.0087	8.32	146	1488	15.2	0.02	<0.06	0.87	723	0.08	96.8	25.1	21.6	
9/3/08	TB19 Grab dupe	TOLLWAY 107	<0.059	<0.131	1.66	<0.086	0.325	<0.00056	<0.017	<0.047	<0.0073	8.32	147	1490	16.0	0.01	<0.06	0.86	727	0.08	96.8	26.0	25.5	
		difference	<MDL	<MDL	0.19000	<MDL	0.00411	<MDL	<MDL	<MDL	<MDL	0.00400	0.97600	2.00000	0.80000	0.00845	<MDL	0.00777	3.55644	0.00157	0.09402	0.96780	3.88796	
		% difference	<MDL	<MDL	10.27	<MDL	1.28	<MDL	<MDL	<MDL	<MDL	0.05	0.67	0.13	5.26	43.38	<MDL	0.89	0.49	2.09	0.10	3.86	17.99	8.94
		> 20% ?														43.38								
9/17/08	SandersSW Grab	TOLLWAY 117	<0.059	<0.131	6.38	<0.086	0.663	<0.00056	<0.017	<0.047	<0.0073	7.26	365	1393	22.0	0.03	<0.06	0.22	532	1.01	110	10.5	9.36	
9/17/08	SandersSW Grab dupe	TOLLWAY 118	<0.059	<0.131	6.40	<0.086	0.671	<0.00056	<0.017	<0.047	<0.0073	7.29	364	1448	24.4	0.05	<0.06	0.21	528	1.01	110	12.4	9.47	
		difference	<MDL	<MDL	0.02000	<MDL	0.00829	<MDL	<MDL	<MDL	<MDL	0.02800	1.33300	55.00000	2.40000	0.01776	<MDL	0.00791	4.86912	0.00245	0.15864	1.91041	0.10684	
		% difference	<MDL	<MDL	0.31	<MDL	1.25	<MDL	<MDL	<MDL	<MDL	0.39	0.36	3.95	10.91	52.08	<MDL	3.59	0.91	0.24	0.14	18.14	1.14	6.01
		> 20% ?														52.08								
10/1/08	TB19 Grab	TOLLWAY 136	<0.059	<0.131	2.47	<0.086	0.238	0.00074	<0.017	<0.047	<0.0073	8.93	273	2257	10.4	<0.01	<0.06	0.63	1099	0.16	131	10.8	9.18	
10/1/08	TB19 Grab dupe	TOLLWAY 137	<0.059	<0.131	2.36	<0.086	0.233	<0.00056	<0.017	<0.047	<0.0073	8.93	273	2258	11.2	<0.01	<0.06	0.63	1107	0.16	132	11.2	9.50	
		difference	<MDL	<MDL	0.11000	<MDL	0.00549	<MDL	<MDL	<MDL	<MDL	0.00000	0.31300	1.00000	0.80000	<MDL	<MDL	0.00303	7.79630	0.00104	0.07974	0.41474	0.32165	
		% difference	<MDL	<MDL	4.45	<MDL	2.30	<MDL	<MDL	<MDL	<MDL	0.00	0.11	0.04	7.69	<MDL	<MDL	0.48	0.71	0.67	0.06	3.85	3.50	6.58
		> 20% ?																						
10/15/08	TB19 Grab	TOLLWAY 129	<0.059	<0.131	3.01	<0.086	0.524	0.00214	<0.017	<0.047	<0.0073	8.32	148	2052	19.6	<0.01	0.08	0.29	1091	0.38	111	16.9	16.1	
10/15/08	TB19 Grab dupe	TOLLWAY 142	<0.059	<0.131	3.01	<0.086	0.534	0.00212	<0.017	<0.047	<0.0073	8.33	148	2096	20.8	<0.01	0.07	0.29	1042	0.37	110	17.4	16.0	
		difference	<MDL	<MDL	0.00000	<MDL	0.00980	0.00002	<MDL	<MDL	<MDL	0.00600	0.08800	44.00000	1.20000	<MDL	0.00362	0.00566	48.70566	0.00749	1.11509	0.47748	0.09332	
		% difference	<MDL	<MDL	0.00	<MDL	1.87	0.93	<MDL	<MDL	<MDL	0.07	0.06	2.14	6.12	<MDL	4.61	1.96	4.46	1.98	1.00	2.83	0.58	2.44
		> 20% ?																						

Appendix H: Results of Geochemical Analysis of Duplicate Samples

		Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
		MDL:	0.0061	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
10/28/08	SandersSW Gerlach	TOLLWAY 155	0.0494	<0.108	0.033	0.0921	<0.00055	13.6	<0.012	<0.013	<0.0058	0.0158	0.0333	1.41	<0.018	2.03	0.0125	<0.022	27.1	<0.014	<0.063	<0.041	4.69
10/28/08	SandersSW Gerlach dupe	TOLLWAY 156	0.0616	<0.108	0.033	0.0941	<0.00055	13.8	<0.012	<0.013	0.0060	0.0159	0.0417	1.44	<0.018	2.06	0.0130	<0.022	27.6	<0.014	<0.063	<0.041	4.78
		difference	0.01220	<MDL	0.00000	0.00201	<MDL	0.20000	<MDL	<MDL	<MDL	0.00014	0.00840	0.03000	<MDL	0.02200	0.00050	<MDL	0.50000	<MDL	<MDL	<MDL	0.09000
		% difference	24.70	<MDL	0.00	2.18	<MDL	1.47	<MDL	<MDL	<MDL	0.89	25.23	2.13	<MDL	1.08	4.00	<MDL	1.85	<MDL	<MDL	<MDL	1.92
		> 20% ?	24.70										25.23										
11/12/08	SandersSW Grab	TOLLWAY 158	0.130	<0.108	0.040	0.0884	<0.00055	69.6	<0.012	<0.013	<0.0058	0.0125	0.0455	4.24	<0.018	22.9	0.0088	<0.022	794	0.016	<0.063	<0.041	40.2
11/12/08	SandersSW Grab dupe	TOLLWAY 159	0.129	<0.108	0.038	0.0872	<0.00055	68.1	<0.012	<0.013	<0.0058	0.0123	0.0426	4.14	<0.018	21.7	0.0084	<0.022	774	<0.014	<0.063	<0.041	39.4
		difference	0.00090	<MDL	0.00200	0.00122	<MDL	1.50000	<MDL	<MDL	<MDL	0.00018	0.00290	0.10000	<MDL	1.23000	0.00040	<MDL	20.00000	<MDL	<MDL	<MDL	0.80000
		% difference	0.69	<MDL	5.00	1.38	<MDL	2.16	<MDL	<MDL	<MDL	1.44	6.37	2.36	<MDL	5.36	4.55	<MDL	2.52	<MDL	<MDL	<MDL	1.99
		> 20% ?																					
12/2/08	TB19 Gerlach	TOLLWAY 162	<0.037	<0.108	0.056	0.674	<0.00055	77.0	<0.012	<0.013	<0.0058	0.0194	0.0563	7.86	0.021	8.83	0.145	<0.022	4960	<0.014	0.162	0.071	24.7
12/2/08	TB19 Gerlach dupe	TOLLWAY 163	<0.037	<0.108	0.055	0.675	<0.00055	78.4	<0.012	<0.013	0.0070	0.0214	0.0526	7.80	0.021	9.00	0.145	<0.022	4900	0.014	0.077	0.047	24.6
		difference	<MDL	<MDL	0.00100	0.00064	<MDL	1.40000	<MDL	<MDL	<MDL	0.00208	0.00370	0.06000	0.00000	0.17000	0.00030	<MDL	60.00000	<MDL	0.08500	0.02400	0.10000
		% difference	<MDL	<MDL	1.79	0.09	<MDL	1.82	<MDL	<MDL	<MDL	10.75	6.57	0.76	0.00	1.93	0.21	<MDL	1.21	<MDL	52.47	33.80	0.40
		> 20% ?																			52.47	33.80	
12/16/08	SandersSW Gerlach	TOLLWAY 167	<0.037	<0.108	0.051	0.390	<0.00055	66.6	<0.012	<0.013	<0.0058	0.0237	0.0371	7.27	<0.018	6.16	0.170	<0.022	3440	<0.014	0.089	0.047	25.9
12/16/08	SandersSW Gerlach dupe	TOLLWAY 168	<0.037	<0.108	0.050	0.395	<0.00055	67.7	<0.012	<0.013	<0.0058	0.0244	0.0368	7.39	0.018	6.37	0.173	<0.022	3570	<0.014	<0.063	0.043	26.1
		difference	<MDL	<MDL	0.00100	0.00501	<MDL	1.10000	<MDL	<MDL	<MDL	0.00068	0.00030	0.12000	<MDL	0.20300	0.00300	<MDL	130.00000	<MDL	<MDL	0.00400	0.20000
		% difference	<MDL	<MDL	1.96	1.29	<MDL	1.65	<MDL	<MDL	<MDL	2.87	0.81	1.65	<MDL	3.29	1.76	<MDL	3.78	<MDL	<MDL	8.51	0.77
		> 20% ?																					
1/6/09	SandersSW Isco	TOLLWAY 175	<0.037	<0.108	<0.023	0.155	<0.00055	88.4	<0.012	<0.013	<0.0058	0.00738	0.0344	4.14	<0.018	19.3	0.0336	<0.022	1306	0.015	0.076	<0.041	20.1
1/6/09	SandersSW Isco dupe	TOLLWAY 179	<0.037	<0.108	<0.023	0.158	<0.00055	88.1	<0.012	<0.013	<0.0058	0.00741	0.0351	4.18	<0.018	19.6	0.0327	<0.022	1341	0.019	0.112	<0.041	20.4
		difference	<MDL	<MDL	<MDL	0.00347	<MDL	0.30000	<MDL	<MDL	<MDL	0.00003	0.00070	0.04000	<MDL	0.25000	0.00090	<MDL	35.00000	0.00400	0.03600	<MDL	0.30000
		% difference	<MDL	<MDL	<MDL	2.24	<MDL	0.34	<MDL	<MDL	<MDL	0.41	2.03	0.97	<MDL	1.29	2.68	<MDL	2.68	26.67	47.37	<MDL	1.49
		> 20% ?																		26.67	47.37		
2/17/09	TB19 Grab	TOLLWAY 183	<0.037	<0.108	0.050	0.146	<0.00055	115	<0.012	<0.013	0.0095	0.00732	0.0220	34.4	<0.018	45.1	0.105	<0.022	2162	0.030	<0.063	<0.041	59.9
2/17/09	TB19 Grab dupe	TOLLWAY 184	<0.037	<0.108	0.053	0.153	<0.00055	119	<0.012	<0.013	0.0093	0.00701	0.0219	35.7	<0.018	47.0	0.109	0.024	2248	0.034	0.071	<0.041	62.1
		difference	<MDL	<MDL	0.00263	0.00675	<MDL	3.79818	<MDL	<MDL	0.00017	0.00031	0.00012	1.39700	<MDL	1.88963	0.00425	<MDL	86.00000	0.00364	<MDL	<MDL	2.18190
		% difference	<MDL	<MDL	5.24	4.61	<MDL	3.29	<MDL	<MDL	1.74	4.18	0.55	4.07	<MDL	4.19	4.06	<MDL	3.98	12.00	<MDL	<MDL	3.64
		> 20% ?																					
3/3/09	TB19 Grab	TOLLWAY 189	<0.037	<0.108	0.068	0.103	<0.00055	91.3	<0.012	<0.013	<0.0058	0.00717	0.0145	34.2	<0.018	51.2	0.0431	<0.022	1398	0.026	<0.063	<0.041	49.6
3/3/09	TB19 Grab dupe	TOLLWAY 234	<0.037	<0.108	0.068	0.105	<0.00055	93.6	<0.012	<0.013	<0.0058	0.00760	0.0147	34.7	<0.018	52.1	0.0451	<0.022	1421	0.027	<0.063	<0.041	51.1
		difference	<MDL	<MDL	0.00008	0.00160	<MDL	2.30725	<MDL	<MDL	<MDL	0.00043	0.00027	0.52700	<MDL	0.87835	0.00203	<MDL	23.00000	0.00131	<MDL	<MDL	1.43703
		% difference	<MDL	<MDL	0.12	1.55	<MDL	2.53	<MDL	<MDL	<MDL	6.03	1.87	1.54	<MDL	1.72	4.70	<MDL	1.65	5.04	<MDL	<MDL	2.90
		> 20% ?																					
4/1/09	TB15B Isco	TOLLWAY 195	<0.037	<0.108	0.026	0.0966	<0.00055	54.0	<0.012	<0.013	0.0069	0.0113	0.0225	21.6	<0.018	1.91	0.0038	<0.022	1050	<0.014	0.081	<0.041	11.9
4/1/09	TB15B Isco dupe	TOLLWAY 196	<0.037	<0.108	0.025	0.0964	<0.00055	54.3	<0.012	<0.013	0.0069	0.0121	0.0270	21.7	<0.018	1.93	<0.0015	<0.022	1050	<0.014	0.085	<0.041	11.8
		difference	<MDL	<MDL	0.00100	0.00019	<MDL	0.30000	<MDL	<MDL	0.00000	0.00085	0.00450	0.10000	<MDL	0.01600	<MDL	<MDL	0.00000	<MDL	0.00400	<MDL	0.10000
		% difference	<MDL	<MDL	3.85	0.20	<MDL	0.56	<MDL	<MDL	0.00	7.56	20.00	0.46	<MDL	0.84	<MDL	<MDL	0.00	<MDL	4.94	<MDL	0.84
		> 20% ?																					
4/14/09	TB15B Grab	TOLLWAY 203	<0.037	<0.108	0.046	0.167	<0.00055	66.5	<0.012	<0.013	0.0132	0.0311	0.0177	66.6	<0.018	0.763	<0.0015	0.030	1550	<0.014	0.063	<0.041	19.0
4/14/09	TB15B Grab dupe	TOLLWAY 204	<0.037	<0.108	0.042	0.168	<0.00055	65.6	<0.012	<0.013	0.0134	0.0311	0.0146	66.0	<0.018	0.702	<0.0015	0.026	1514	<0.014	0.091	<0.041	18.6
		difference	<MDL	<MDL	0.00400	0.00099	<MDL	0.90000	<MDL	<MDL	0.00020	0.00001	0.00310	0.60000	<MDL	0.06090	<MDL	0.00400	35.92493	<MDL	0.02800	<MDL	0.40000
		% difference	<MDL	<MDL	8.70	0.59	<MDL	1.35	<MDL	<MDL	1.52	0.03	17.51	0.90	<MDL	7.98	<MDL	13.33	2.32	<MDL	44.44	<MDL	2.11
		> 20% ?																			44.44		
4/29/09	WRP1-W	TOLLWAY 206	0.044	<0.108	0.138	0.0288	<0.00055	72.9	<0.012	<0.013	<0.0058	0.0130	0.0788	3.69	<0.018	26.3	0.0724	0.026	27.1	0.024	0.567	<0.041	61.8
4/29/09	WRP1 dupe	TOLLWAY 207	<0.037	<0.108	0.139	0.0294	<0.00055	74.1	<0.012	<0.013	<0.0058	0.0135	0.0388	3.71	<0.018	26.9	0.0613	0.025	27.4	0.025	0.534	<0.041	61.5
		difference	<MDL	<MDL	0.00100	0.00061	<MDL	1.20000	<MDL	<MDL	<MDL	0.00051	0.04000	0.02000	<MDL	0.53000	0.01110	0.00100	0.30000	0.00100	0.03300	<MDL	0.30000
		% difference	<MDL	<MDL	0.72	2.12	<MDL	1.65	<MDL	<MDL	<MDL	3.93	50.76	0.54	<MDL	2.01	15.33	3.85	1.11	4.17	5.82	<MDL	0.49
		> 20% ?											50.76										
4/29/09	TB15B Grab	TOLLWAY 209	0.714	<0.108	0.033	0.123	<0.00055	32.8	<0.012	<0.013	0.0142	0.0287	0.0320	67.2	<0.018	0.0438	<0.0015	0.029	1092	<0.014	<0.063	<0.041	14.5
4/29/09	TB15B Grab dupe	TOLLWAY 210	0.725	<0.108	0.045	0.124	<0.00055	33.0	<0.012	<0.013	0.0148	0.0298	0.0323	68.7	<0.018	0.0429	0.0015	0.030	1104	<0.014	<0.063	<0.041	14.5
		difference	0.01100	<MDL	0.01200	0.00055	<MDL	0.20000	<MDL	<MDL	0.00060	0.00113	0.00030	1.50000	<MDL	0.00090	<MDL	0.00100	11.55908	<MDL	<MDL	<MDL	0.00000
		% difference	1.54	<MDL	36.36	0.45	<MDL	0.61	<MDL	<MDL	4.23	3.94	0.94	2.23	<MDL	2.05	<MDL	3.45	1.06	<MDL	<MDL	<MDL	0.00
		> 20% ?			36.36																		
5/11/09	TB15B Grab	TOLLWAY 214	0.721	<0.108	0.047	0.0978	<0.00055	16.8	<0.012	<0.013	0.0117	0.0310	0.0172	71.9	<0.018	0.0793	0.0022	0.039	1248	<0.014	0.067	<0.041	17.1
5/11/09	TB15B Grab dupe	TOLLWAY 215	0.698	<0.108	0.046	0.0989	<0.00055	17.1	<0.012	<0.013	0.0111	0.0316	0.0185	72.6	<0.018	0.0793	0.0044	0.040	1246	<0.014	0.065	<0.041	17.1
		difference	0.02300	<MDL	0.00100	0.00107	<MDL	0.30000	<MDL	<MDL	0.00060	0.00054	0.00130	0.70000	<MDL	0.00000	0.00220	0.00100	1.76196	<MDL	0.00200	<MDL	0.00000
		% difference	3.19	<MDL	2.13	1.09	<MDL	1.79	<MDL	<MDL	5.13	1.74	7.56	0.97	<MDL	0.00	100.00	2.56	0.14	<MDL	2.99	<MDL	0.00
		> 20% ?															100.00						
5/27/09	TB15B Grab	TOLLWAY 218	0.401	<0.108	0.048	0.0956	<0.00055	31.5	<0.012	<0.013	0.0078	0.02051	0.0280	43.8	<0.018	0.179	<0.0015	0.024	655	<0.014	<0.063	<0.041	13.3
5/27/09	TB15B Grab dupe	TOLLWAY 219	0.417	<0.108	0.047	0.0958	<0.00055	32.5	<0.012	<0.013	0.0092	0.0211	0.0264	45.2	<0.018	0.179	0.0018	<0.022	674	<0.014	<0.063	<0.041	13.7
		difference	0.01580	<MDL	0.00042	0.00016	<MDL	0.97152	<MDL	<MDL	0.00145	0.00060	0.00162	1.34012	<MDL	0.00075	<MDL	<MDL	18.86237	<MDL	<MDL	<MDL	0.45536
		% difference	3.94	<MDL	0.88	0.16	<MDL	3.08	<MDL	<MDL	18.64	2.93	5.79	3.06	<MDL	0.42	<MDL	<MDL	2.88	<MDL	<MDL	<MDL	3.43
		> 20% ?																					
6/10/09	TB15B Grab	TOLLWAY 223	0.771	<0.108	0.038	0.0862	<0.00055	10.7	<0.012	<0.013	<0.0058	0.0281	0.101	77.0	<0.018	0.323	0.0068	0.036	1119	<0.014	<0.063	<0.041	17.3
6/10/09	TB15B Grab dupe	TOLLWAY 224	0.756	<0.108	0.048	0.0861	<0.00055	10.5	<0.012	<0.013	<0.0058	0.0278	0.106	77.6	<0.018	0.265	0.0071	0.042	1107	<0.014	<0.063	<0.041	17.2
		difference	0.01422	<MDL	0.00967	0.00004	<MDL	0.18890	<MDL	<MDL	<MDL	0.00029	0.00516	0.61529	<MDL	0.05780	0.00035	0.00675	12.00000	<MDL	<MDL	<MDL	0.08549
		% difference	1.85	<MDL	25.39	0.05	<MDL	1.77	<MDL	<MDL	<MDL	1.03	5.12	0.80	<MDL	17.91	5.16	19.00	1.07	<MDL	<MDL	<MDL	0.49
		> 20% ?			25.39																		
6/30/09	TB15B Grab	TOLLWAY 222	0.517	<0.108	0.070	0.0509	<0.00055	9.05	<0.012	<0.013	<0.0058	0.0173	0.0610	64.4	<0.018	0.670	0.0041	0.038	989	<0.014	<0.063	<0.041	19.5
6/30/09	TB15B Grab dupe	TOLLWAY 227	0.486	<0.108	0.067	0.0507	<0.00055	8.92	<0.012	<0.013	<0.0058	0.0171	0.0327	63.6	<0.018	0.653	0.0032	0.035	980	<0.014	<0.063	<0.041	19.5
		difference	0.03100	<MDL	0.00300	0.00028	<MDL	0.13000	<MDL	<MDL	<MDL	0.00016	0.02830	0.80000	<MDL	0.01740	0.00090	0.00300	9.00000	<MDL	<MDL	<MDL	0.00000
		% difference	6.00	<MDL	4.29	0.55	<MDL	1.44	<MDL	<MDL	<MDL	0.93	46.39	1.24	<MDL	2.60	21.95	7.89	0.91	<MDL	<MDL	<MDL	0.00
		> 20% ?											46.39				21.95						
7/14/09	WRP1-W	TOLLWAY 241	<0.037	<0.108	0.538	0.0727	<0.00055	141	<0.012	<0.013	<0.0058	0.00999	0.0305	14.3	<0.018	62.6	0.308	0.032	102	0.043	0.936	<0.041	108
7/14/09	WRP1 dupe	TOLLWAY 242	<0.037	<0.108	0.528	0.0724	<0.00055	137	<0.012	<0.013	<0.0058	0.0100	0.0301	14.0	<0.018	61.5	0.290	0.034	101	0.036	0.948	<0.041	107
		difference	<MDL	<MDL	0.01000	0.00030	<MDL	4.00000	<MDL	<MDL	<MDL	0.00001	0.00040	0.30000	<MDL	1.09000	0.01760	0.00200	1.00000	0.00700	0.01200	<MDL	1.00000
		% difference	<MDL	<MDL	1.86	0.41	<MDL	2.84	<MDL	<MDL	<MDL	0.10	1.31	2.10	<MDL	1.74	5.72	6.25	0.98	16.28	1.28	<MDL	0.93
		> 20% ?																					

Appendix H: Results of Geochemical Analysis of Duplicate Samples

		Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as $CaCO_3$	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L	mean relative % difference between dupe and sample
		MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31	
10/28/08	SandersSW Gerlach	TOLLWAY 155	<0.059	<0.131	1.36	<0.086	0.0885	0.00064	<0.017	<0.047	0.0507	6.91	34.9	121	7.2	0.01	0.29	0.45	36.7	0.55	12.2	10.6	7.14	
10/28/08	SandersSW Gerlach dupe	TOLLWAY 156	<0.059	<0.131	1.40	<0.086	0.0899	0.00071	<0.017	<0.047	0.0501	6.90	34.8	123	6.4	0.01	0.26	0.46	36.7	0.56	12.3	10.8	7.59	
		difference	<MDL	<MDL	0.04000	<MDL	0.00137	0.00007	<MDL	<MDL	0.00060	0.01600	0.06390	2.00000	0.80000	0.00066	0.03116	0.00815	0.00445	0.00307	0.07058	0.16575	0.45663	
		% difference	<MDL	<MDL	2.94	<MDL	1.55	10.94	<MDL	<MDL	1.18	0.23	0.18	1.65	11.11	4.94	10.81	1.82	0.01	0.55	0.58	1.56	6.40	4.51
		> 20% ?																						
11/12/08	SandersSW Grab	TOLLWAY 158	<0.059	<0.131	4.29	<0.086	0.395	0.00081	<0.017	<0.047	<0.0073	7.70	259	2328	4.4	0.03	<0.06	0.17	1161	0.10	115	16.0	14.9	
11/12/08	SandersSW Grab dupe	TOLLWAY 159	<0.059	<0.131	4.19	<0.086	0.386	0.00083	<0.017	<0.047	0.0075	7.71	259	2336	4.4	0.03	<0.06	0.18	1164	0.10	114	15.3	14.9	
		difference	<MDL	<MDL	0.10000	<MDL	0.00957	0.00002	<MDL	<MDL	<MDL	0.01800	0.32800	8.00000	0.00000	0.00107	<MDL	0.00105	2.77693	0.00073	1.19819	0.75126	0.06116	
		% difference	<MDL	<MDL	2.33	<MDL	2.42	2.47	<MDL	<MDL	<MDL	0.23	0.13	0.34	0.00	3.30	<MDL	0.60	0.24	0.71	1.04	4.68	0.41	2.11
		> 20% ?																						
12/2/08	TB19 Gerlach	TOLLWAY 162	<0.059	<0.131	1.45	<0.086	1.42	<0.00056	<0.017	<0.047	0.180	7.25	45	13223	184	0.04	2.32	<0.8 *	7234	0.85	45.4	54.1	17.7	
12/2/08	TB19 Gerlach dupe	TOLLWAY 163	<0.059	<0.131	1.43	<0.086	1.42	<0.00056	<0.017	<0.047	0.184	7.25	45	13234	189	0.05	2.42	<0.8 *	8066	0.85	45.4	53.1	20.0	
		difference	<MDL	<MDL	0.02000	<MDL	0.00140	<MDL	<MDL	<MDL	0.00420	0.00200	0.15880	11.00000	5.30000	0.00201	0.10477	<MDL	832.06996	0.00151	0.02109	1.02028	2.37199	
		% difference	<MDL	<MDL	1.38	<MDL	0.10	<MDL	<MDL	<MDL	2.33	0.03	0.36	0.08	2.88	4.52	4.52	<MDL	11.50	0.18	0.05	1.89	13.44	5.74
		> 20% ?																						
12/16/08	SandersSW Gerlach	TOLLWAY 167	<0.059	<0.131	1.85	<0.086	0.601	<0.00056	<0.017	<0.047	0.133	7.24	56	9045	119	0.02	0.86	<0.8 *	5808	0.41	63.9	54.2	9.94	
12/16/08	SandersSW Gerlach dupe	TOLLWAY 168	<0.059	<0.131	1.89	<0.086	0.611	<0.00056	<0.017	<0.047	0.136	7.29	56	9028	115	0.02	0.87	<0.8 *	5404	0.40	63.7	32.0	10.1	
		difference	<MDL	<MDL	0.04000	<MDL	0.01016	<MDL	<MDL	<MDL	0.00380	0.04600	0.21390	17.00000	4.00000	0.00092	0.00831	<MDL	403.85012	0.00959	0.21091	22.20910	0.12899	
		% difference	<MDL	<MDL	2.16	<MDL	1.69	<MDL	<MDL	<MDL	2.87	0.64	0.38	0.19	3.36	3.69	0.96	<MDL	6.95	2.32	0.33	40.95	1.30	3.85
		> 20% ?																				40.95		
1/6/09	SandersSW Isco	TOLLWAY 175	<0.059	<0.131	2.33	<0.086	0.544	<0.00056	<0.017	<0.047	0.0295	7.48	77.4	3836	45.2	0.04	0.14	0.11	2300	0.43	54.6	18.9	5.75	
1/6/09	SandersSW Isco dupe	TOLLWAY 179	<0.059	<0.131	2.37	<0.086	0.549	<0.00056	<0.017	<0.047	0.0315	7.52	77.0	3857	48.0	0.04	0.13	0.10	2256	0.44	54.6	11.1	6.23	
		difference	<MDL	<MDL	0.04000	<MDL	0.00550	<MDL	<MDL	<MDL	0.00200	0.04400	0.41590	21.00000	2.80000	0.00119	0.00503	0.01679	44.60022	0.00530	0.01075	7.85003	0.48340	
		% difference	<MDL	<MDL	1.72	<MDL	1.01	<MDL	<MDL	<MDL	6.78	0.59	0.54	0.55	6.19	2.77	3.63	14.75	1.94	1.23	0.02	41.47	8.41	6.91
		> 20% ?																				41.47		
2/17/09	TB19 Grab	TOLLWAY 183	<0.059	<0.131	1.63	<0.086	0.954	<0.00056	0.017	<0.047	0.0151	8.71	169	6038	8.4	0.01	0.13	0.40	3500	0.41	154	10.8	11.5	
2/17/09	TB19 Grab dupe	TOLLWAY 184	<0.059	<0.131	1.69	<0.086	0.996	<0.00056	<0.017	<0.047	0.0182	8.72	168	6015	8.0	0.01	<0.06	0.41	3480	0.41	155	11.3	10.2	
		difference	<MDL	<MDL	0.05491	<MDL	0.04173	<MDL	<MDL	<MDL	0.00305	0.01300	1.38400	23.00000	0.40000	0.00006	<MDL	0.01164	19.92625	0.00642	0.91476	0.50260	1.30269	
		% difference	<MDL	<MDL	3.36	<MDL	4.37	<MDL	<MDL	<MDL	20.18	0.15	0.82	0.38	4.76	0.58	<MDL	2.92	0.57	1.58	0.59	4.64	11.31	4.15
		> 20% ?									20.18													
3/3/09	TB19 Grab	TOLLWAY 189	<0.059	<0.131	1.75	<0.086	0.736	<0.00056	<0.017	<0.047	<0.0073	8.64	224	4070	6.8	0.02	<0.06	0.38	2261	1.52	133	16.3	17.0	
3/3/09	TB19 Grab dupe	TOLLWAY 234	<0.059	<0.131	1.80	<0.086	0.746	<0.00056	<0.017	<0.047	<0.0073	8.66	227	4112	6.8	0.02	<0.06	0.37	2276	1.50	133	19.5	16.7	
		difference	<MDL	<MDL	0.04950	<MDL	0.00981	<MDL	<MDL	<MDL	<MDL	0.01700	2.59700	42.00000	0.00000	0.00096	<MDL	0.00702	15.37913	0.02065	0.40700	3.12839	0.28439	
		% difference	<MDL	<MDL	2.82	<MDL	1.33	<MDL	<MDL	<MDL	<MDL	0.20	1.16	1.03	0.00	5.70	<MDL	1.85	0.68	1.36	0.31	19.16	1.67	2.79
		> 20% ?																						
4/1/09	TB15B Isco	TOLLWAY 195	<0.059	<0.131	2.24	<0.086	0.497	<0.00056	<0.017	<0.047	<0.0073	10.62	148	2863	307	0.06	0.32	0.20	1712	0.56	30.7	18.4	7.87	
4/1/09	TB15B Isco dupe	TOLLWAY 196	<0.059	<0.131	2.24	<0.086	0.499	<0.00056	0.019	<0.047	<0.0073	10.60	148	2880		0.06	0.33	0.18	1693	3.33	30.7	15.4	7.45	
		difference	<MDL	<MDL	0.00000	<MDL	0.00256	<MDL	<MDL	<MDL	<MDL	0.02000	0.55500	17.00000	NA	0.00152	0.00896	0.02586	19.43910	2.76600	0.00530	2.99435	0.41232	
		% difference	<MDL	<MDL	0.00	<MDL	0.52	<MDL	<MDL	<MDL	<MDL	0.19	0.38	0.59	NA	2.56	2.82	12.73	1.14	492.03	0.02	16.25	5.24	23.90
		> 20% ?																		492.03				
4/14/09	TB15B Grab	TOLLWAY 203	<0.059	<0.131	3.69	<0.086	1.02	<0.00056	<0.017	<0.047	<0.0073	11.23	202	4147	6.4	0.02	0.33	0.12	2411	0.89	49.2	17.3	16.1	
4/14/09	TB15B Grab dupe	TOLLWAY 204	<0.059	<0.131	3.63	<0.086	1.01	<0.00056	<0.017	<0.047	<0.0073	11.22	206	4155		0.02	0.32	0.14	2402	0.90	49.1	19.1	15.5	
		difference	<MDL	<MDL	0.06000	<MDL	0.01040	<MDL	<MDL	<MDL	<MDL	0.01200	4.19000	8.00000	NA	0.00124	0.01399	0.02548	8.95447	0.00504	0.04835	1.85998	0.56981	
		% difference	<MDL	<MDL	1.63	<MDL	1.02	<MDL	<MDL	<MDL	<MDL	0.11	2.08	0.19	NA	5.47	4.24	21.58	0.37	0.56	0.10	10.76	3.54	6.10
		> 20% ?																21.58						
4/29/09	WRP1-W	TOLLWAY 206	<0.059	<0.131	2.45	<0.086	0.166	0.00164	<0.017	<0.047	<0.0073	7.37	110	499	176	0.48	2.00	0.35	32.5	6.84	186	26.7	21.2	
4/29/09	WRP1 dupe	TOLLWAY 207	<0.059	<0.131	2.50	<0.086	0.169	<0.00056	<0.017	<0.047	<0.0073	7.40	112	516	155	0.46	2.08	0.38	32.2	6.77	185	28.0	21.6	
		difference	<MDL	<MDL	0.05000	<MDL	0.00231	<MDL	<MDL	<MDL	<MDL	0.02500	1.81400	17.00000	21.30000	0.01369	0.07993	0.03809	0.33698	0.07428	1.23923	1.21913	0.43272	
		% difference	<MDL	<MDL	2.04	<MDL	1.39	<MDL	<MDL	<MDL	<MDL	0.34	1.65	3.41	12.10	2.87	3.99	11.03	1.04	1.09	0.67	4.56	2.04	5.21
		> 20% ?																						
4/29/09	TB15B Grab	TOLLWAY 209	<0.059	<0.131	4.44	<0.086	0.815	<0.00056	<0.017	<0.047	<0.0073	11.5	215	2959	6.8	<0.01	0.28	0.19	1721	0.91	37.4	14.5	13.9	
4/29/09	TB15B Grab dupe	TOLLWAY 210	<0.059	<0.131	4.50	<0.086	0.826	<0.00056	<0.017	<0.047	<0.0073	11.4	215	3036	8.8	<0.01	0.28	0.19	1631	0.92	37.3	15.4	14.0	
		difference	<MDL	<MDL	0.06000	<MDL	0.01137	<MDL	<MDL	<MDL	<MDL	0.01900	0.46600	77.00000	2.00000	<MDL	0.00066	0.00472	90.15088	0.00764	0.02105	0.90117	0.10851	
		% difference	<MDL	<MDL	1.35	<MDL	1.40	<MDL	<MDL	<MDL	<MDL	0.17	0.22	2.60	29.41	<MDL	0.24	2.52	5.24	0.84	0.06	6.22	0.78	4.32
		> 20% ?													29.41									
5/11/09	TB15B Grab	TOLLWAY 214	<0.059	<0.131	4.33	<0.086	0.583	<0.00056	<0.017	<0.047	<0.0073	11.07	143	3357	5.2	0.03	0.08	0.20	1920	0.25	46.2	17.1	16.1	
5/11/09	TB15B Grab dupe	TOLLWAY 215	<0.059	<0.131	4.34	<0.086	0.586	<0.00056	<0.017	<0.047	<0.0073	11.07	143	3346	4.4	0.02	0.09	0.20	1911	0.25	46.0	17.5	16.1	
		difference	<MDL	<MDL	0.01000	<MDL	0.00298	<MDL	<MDL	<MDL	<MDL	0.00500	0.47300	11.00000	0.80000	0.00472	0.01257	0.00070	8.66663	0.00032	0.25380	0.35726	0.00337	
		% difference	<MDL	<MDL	0.23	<MDL	0.51	<MDL	<MDL	<MDL	<MDL	0.05	0.33	0.33	15.38	16.44	15.62	0.36	0.45	0.13	0.55	2.09	0.02	6.49
		> 20% ?																						
5/27/09	TB15B Grab	TOLLWAY 218	<0.059	<0.131	4.84	0.086	0.585	<0.00056	<0.017	<0.047	<0.0073	11.3	146	1829	7.2	0.01	0.08	0.20	998	0.43	34.2	15.1	14.8	
5/27/09	TB15B Grab dupe	TOLLWAY 219	<0.059	<0.131	5.00	0.086	0.600	<0.00056	<0.017	<0.047	<0.0073	11.3	146	1831	6.8	<0.01	0.07	0.19	983	0.42	34.1	15.4	14.2	
		difference	<MDL	<MDL	0.15269	0.00000	0.01523	<MDL	<MDL	<MDL	<MDL	0.02400	0.38400	2.00000	0.40000	<MDL	0.00560	0.00156	15.04884	0.01063	0.06004	0.30598	0.59142	
		% difference	<MDL	<MDL	3.15	0.00	2.60	<MDL	<MDL	<MDL	<MDL	0.21	0.26	0.11	5.56	<MDL	7.37	0.80	1.51	2.47	0.18	2.02	3.99	3.02
		> 20% ?																						
6/10/09	TB15B Grab	TOLLWAY 223	<0.059	<0.131	5.69	0.086	0.512	0.00327	<0.017	<0.047	<0.0073	10.6	126	2983	7	0.01	<0.06	0.18	1694	<0.07	44.3	23.4	21.1	
6/10/09	TB15B Grab dupe	TOLLWAY 224	<0.059	<0.131	5.67	0.086	0.512	0.00309	<0.017	<0.047	<0.0073	10.5	125	2990	8	0.02	0.08	0.18	1670	<0.07	44.6	23.9	21.0	
		difference	<MDL	<MDL	0.01893	0.00000	0.00037	0.00018	<MDL	<MDL	<MDL	0.03700	0.39000	7.00000	0.40000	0.00275	<MDL	0.00112	24.11028	<MDL	0.31323	0.49954	0.09196	
		% difference	<MDL	<MDL	0.33	0.00	0.07	5.42	<MDL	<MDL	<MDL	0.35	0.31	0.23	5.56	21.96	<MDL	0.63	1.42	<MDL	0.71	2.13	0.44	4.59
		> 20% ?														21.96								
6/30/09	TB15B Grab	TOLLWAY 222	<0.059	<0.131	3.84	<0.086	0.282	0.00115	<0.017	<0.047	<0.0073	9.96	148	2627	25.2	0.01	0.18	0.47	1493	0.13	54.0	23.8	19.1	
6/30/09	TB15B Grab dupe	TOLLWAY 227	<0.059	<0.131	3.77	<0.086	0.280	<0.00056	<0.017	<0.047	<0.0073	9.95	147	2612	22.8	0.01	0.20	0.49	1453	0.14	53.9	24.0	19.0	
		difference	<MDL	<MDL	0.07000	<MDL	0.00137	<MDL	<MDL	<MDL	<MDL	0.00600	0.47200	15.00000	2.40000	0.00088	0.01994	0.01800	40.58447	0.00358	0.08063	0.19732	0.12602	
		% difference	<MDL	<MDL	1.82	<MDL	0.49	<MDL	<MDL	<MDL	<MDL	0.06	0.32	0.57	9.52	6.30	11.21	3.83	2.72	2.72	0.15	0.83	0.66	5.21
		> 20% ?																						
7/14/09	WRP1-W	TOLLWAY 241	<0.059	<0.131	3.85	<0.086	0.354	<0.00056	<0.017	<0.047	<0.0073	7.71	264	1230	59.6	0.78	0.84	0.41	161	1.48	300	49.7	38.6	
7/14/09	WRP1 dupe	TOLLWAY 242	<0.059	<0.131	3.80	<0.086	0.351	<0.00056	<0.017	<0.047	<0.0073	7.74	263	1205	104	0.79	0.84	0.40	159	1.46	298	42.2	39.2	
		difference	<MDL	<MDL	0.05000	<MDL	0.00314	<MDL	<MDL	<MDL	<MDL	0.02500	1.11800	25.00000	44.80000	0.01078	0.00066	0.00720	2.07342	0.02859	2.35622	7.47451	0.65892	
		% difference	<MDL	<MDL	1.30	<MDL	0.89	<MDL	<MDL	<MDL	<MDL	0.32	0.42	2.03	75.17	1.37	0.08	1.77	1.29	1.93	0.79	15.04	1.71	5.40
		> 20% ?													75.17									

Appendix H: Results of Geochemical Analysis of Duplicate Samples

		Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
		MDL:	0.0061	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
7/28/09	TB15B Grab	TOLLWAY 234	0.240	<0.108	0.084	0.0898	<0.00055	15.8	<0.012	<0.013	<0.0058	0.0110	0.0604	63.0	<0.018	3.43	0.0047	0.037	953	<0.014	<0.063	<0.041	18.2
7/28/09	TB15B Grab-dupe	TOLLWAY 246	0.211	<0.108	0.070	0.0895	<0.00055	13.7	<0.012	<0.013	<0.0058	0.0102	0.0348	60.6	<0.058	2.82	0.0037	<0.022	929	<0.014	<0.063	<0.041	18.1
		difference	0.02878	<MDL	0.01395	0.00026	<MDL	2.11717	<MDL	<MDL	<MDL	0.00083	0.02565	2.38820	<MDL	0.60419	0.00096	<MDL	23.61957	<MDL	<MDL	<MDL	0.13838
		% difference	11.99	<MDL	16.61	0.29	<MDL	13.40	<MDL	<MDL	<MDL	7.50	42.46	3.79	<MDL	17.62	20.52	<MDL	2.48	<MDL	<MDL	<MDL	0.76
		> 20% ?											42.46				20.52						
8/25/09	TB9A Grab	TOLLWAY 250	0.051	<0.108	0.077	0.139	<0.00055	36.0	<0.012	<0.013	<0.0058	0.0158	0.0178	97.7	<0.058	13.9	0.0031	0.040	1014	0.022	<0.063	<0.041	62.0
8/25/09	TB9A Grab dupe	TOLLWAY 251	<0.037	<0.108	0.073	0.134	<0.00055	34.9	<0.012	<0.013	<0.0058	0.0150	0.0115	96.2	<0.058	12.3	0.0032	0.031	990	0.020	<0.063	<0.041	59.3
		difference	<MDL	<MDL	0.00465	0.00495	<MDL	1.08244	<MDL	<MDL	<MDL	0.00084	0.00632	1.41445	<MDL	1.53958	0.00013	0.00981	23.72968	0.00178	<MDL	<MDL	2.69764
		% difference	<MDL	<MDL	6.02	3.55	<MDL	3.00	<MDL	<MDL	<MDL	5.32	35.58	1.45	<MDL	11.09	4.23	24.22	2.34	8.06	<MDL	<MDL	4.35
		> 20% ?											35.58					24.22					
9/8/09	TB15B Isco	TOLLWAY 257	0.099	<0.108	0.062	0.0325	<0.00055	19.2	<0.012	<0.013	<0.0058	0.00842	0.115	8.91	<0.058	3.70	<0.0015	<0.022	298	<0.014	0.120	<0.041	17.0
9/8/09	TB15B Isco dupe	TOLLWAY 258	0.047	<0.108	0.062	0.0319	<0.00055	19.2	<0.012	<0.013	<0.0058	0.0101	0.0550	8.90	<0.058	3.70	<0.0015	<0.022	296	<0.014	0.084	<0.041	17.0
		difference	0.05200	<MDL	0.00000	0.00057	<MDL	0.00000	<MDL	<MDL	<MDL	0.00163	0.06010	0.01000	<MDL	0.00100	<MDL	<MDL	2.00000	<MDL	0.03600	<MDL	0.00000
		% difference	52.53	<MDL	0.00	1.75	<MDL	0.00	<MDL	<MDL	<MDL	19.36	52.22	0.11	<MDL	0.03	<MDL	<MDL	0.67	<MDL	30.00	<MDL	0.00
		> 20% ?	52.53										52.22								30.00		
9/22/09	TB15B Grab	TOLLWAY 263	0.188	<0.108	0.082	0.111	<0.00055	21.3	<0.012	<0.013	<0.0058	0.0138	0.0602	68.1	<0.058	3.63	0.0092	0.083	829	0.016	<0.063	<0.041	60.5
9/22/09	TB15B Grab dupe	TOLLWAY 264	0.170	<0.108	0.082	0.113	<0.00055	21.6	<0.012	<0.013	<0.0058	0.0142	0.0477	68.6	<0.058	3.66	0.0084	0.082	839	0.015	<0.063	<0.041	60.9
		difference	0.01800	<MDL	0.00000	0.00154	<MDL	0.30000	<MDL	<MDL	<MDL	0.00040	0.01250	0.50000	<MDL	0.02400	0.00080	0.00100	10.00000	0.00100	<MDL	<MDL	0.40000
		% difference	9.57	<MDL	0.00	1.39	<MDL	1.41	<MDL	<MDL	<MDL	2.89	20.76	0.73	<MDL	0.66	8.70	1.20	1.21	6.25	<MDL	<MDL	0.66
		> 20% ?											20.76										
10/6/09	TB19r Grab dupe	TOLLWAY 269	0.048	<0.108	0.031	0.0441	<0.00055	23.5	<0.012	<0.013	<0.0058	0.00720	0.0212	83.4	<0.058	7.62	0.0027	0.035	449	<0.014	<0.063	<0.041	21.7
10/6/09	TB19r Grab	TOLLWAY 270	0.055	<0.108	0.037	0.0446	<0.00055	23.5	<0.012	<0.013	<0.0058	0.00942	0.0181	85.5	<0.058	7.81	0.0023	0.043	454	<0.014	<0.063	<0.041	21.6
		difference	0.00700	<MDL	0.00600	0.00043	<MDL	0.00000	<MDL	<MDL	<MDL	0.00222	0.00310	2.10000	<MDL	0.19300	0.00040	0.00800	5.00000	<MDL	<MDL	<MDL	0.10000
		% difference	14.58	<MDL	19.35	0.97	<MDL	0.00	<MDL	<MDL	<MDL	30.83	14.62	2.52	<MDL	2.53	14.81	22.86	1.11	<MDL	<MDL	<MDL	0.46
		> 20% ?										30.83						22.86					
10/20/09	TB15B Grab	TOLLWAY 283	0.571	<0.108	0.033	0.0325	<0.00055	8.46	<0.012	<0.013	<0.0058	0.0190	0.184	87.7	<0.058	0.178	0.0023	0.058	655	<0.014	0.089	<0.041	21.7
10/20/09	TB15B Grab dupe	TOLLWAY 282	0.559	<0.108	0.034	0.0310	<0.00055	8.11	<0.012	<0.013	<0.0058	0.0180	0.173	86.5	<0.058	0.171	0.0022	0.061	646	<0.014	0.096	<0.041	21.1
		difference	0.01200	<MDL	0.00100	0.00155	<MDL	0.35000	<MDL	<MDL	<MDL	0.00100	0.01080	1.20000	<MDL	0.00700	0.00010	0.00300	9.00000	<MDL	0.00700	<MDL	0.60000
		% difference	2.10	<MDL	3.03	4.77	<MDL	4.14	<MDL	<MDL	<MDL	5.25	5.89	1.37	<MDL	3.94	4.35	5.17	1.37	<MDL	7.87	<MDL	2.76
		> 20% ?																					
11/2/09	TB15B Grab dupe	TOLLWAY 291	0.681	<0.108	0.031	0.0612	<0.00055	15.8	<0.012	<0.013	<0.0058	0.0156	0.0701	65.5	<0.058	0.049	<0.0015	0.035	393	<0.014	<0.063	<0.041	14.2
11/2/09	TB15B Grab	TOLLWAY 292	0.673	<0.108	0.030	0.0613	<0.00055	15.7	<0.012	<0.013	<0.0058	0.0157	0.0657	66.1	<0.058	0.048	<0.0015	0.031	396	<0.014	<0.063	<0.041	14.0
		difference	0.00757	<MDL	0.00062	0.00012	<MDL	0.13033	<MDL	<MDL	<MDL	0.00015	0.00442	0.65095	<MDL	0.00138	<MDL	0.00449	3.12650	<MDL	<MDL	<MDL	0.22148
		% difference	1.11	<MDL	2.02	0.19	<MDL	0.82	<MDL	<MDL	<MDL	0.99	6.31	0.99	<MDL	2.82	<MDL	12.69	0.80	<MDL	<MDL	<MDL	1.56
		> 20% ?																					
11/16/19	WRP1-W	TOLLWAY 301	<0.037	<0.108	0.258	0.0499	<0.00055	149	<0.012	<0.013	<0.0058	0.00367	0.0167	7.06	<0.058	63.0	0.155	<0.022	76.2	0.047	0.189	<0.041	77.1
11/16/09	WRP1 dupe	TOLLWAY 302	<0.037	<0.108	0.263	0.0510	<0.00055	152	<0.012	<0.013	<0.0058	0.00387	0.0175	7.26	<0.058	63.8	0.154	<0.022	78.8	0.066	0.172	<0.041	77.9
		difference	<MDL	<MDL	0.00474	0.00114	<MDL	2.66718	<MDL	<MDL	<MDL	0.00020	0.00084	0.20261	<MDL	0.77998	0.00049	<MDL	2.62567	0.01847	0.01775	<MDL	0.79181
		% difference	<MDL	<MDL	1.83	2.28	<MDL	1.79	<MDL	<MDL	<MDL	5.53	5.06	2.87	<MDL	1.24	0.32	<MDL	3.45	39.02	9.38	<MDL	1.03
		> 20% ?																		39.02			
12/1/09	TB9A Grab	TOLLWAY 308	<0.037	<0.108	0.057	0.089	<0.00055	51.4	<0.012	<0.013	<0.0058	0.0108	0.0094	66.2	<0.058	16.9	0.0032	0.042	674	<0.014	<0.063	<0.041	72.8
12/1/09	TB9A Grab dupe	TOLLWAY 309	<0.037	<0.108	0.057	0.089	<0.00055	51.0	<0.012	<0.013	<0.0058	0.0110	0.0125	66.9	<0.058	16.4	0.0034	0.040	675	<0.014	<0.063	<0.041	72.5
		difference	<MDL	<MDL	0.00028	0.00060	<MDL	0.44932	<MDL	<MDL	<MDL	0.00015	0.00311	0.72391	<MDL	0.52126	0.00020	0.00154	0.88354	<MDL	<MDL	<MDL	0.32404
		% difference	<MDL	<MDL	0.50	0.68	<MDL	0.87	<MDL	<MDL	<MDL	1.43	33.14	1.09	<MDL	3.08	6.18	3.69	0.13	<MDL	<MDL	<MDL	0.45
		> 20% ?											33.14										
12/14/09	OR-1	TOLLWAY 326	<0.037	<0.108	0.035	0.0459	<0.00055	76.6	<0.012	<0.013	<0.0058	0.00094	0.402	9.76	<0.058	33.7	0.888	<0.022	62.5	0.027	0.235	<0.041	9.65
12/14/09	OR-1 dupe	TOLLWAY 327	<0.037	<0.108	0.033	0.0461	<0.00055	77.2	<0.012	<0.013	<0.0058	<0.00079	0.403	9.85	<0.058	34.8	0.883	<0.022	63.5	0.027	0.249	<0.041	9.51
		difference	<MDL	<MDL	0.00179	0.00014	<MDL	0.66939	<MDL	<MDL	<MDL	<MDL	0.00098	0.09366	<MDL	1.06063	0.00437	<MDL	0.96207	0.00060	0.01321	<MDL	0.13615
		% difference	<MDL	<MDL	5.16	0.30	<MDL	0.87	<MDL	<MDL	<MDL	<MDL	0.24	0.96	<MDL	3.14	0.49	<MDL	1.54	2.24	5.61	<MDL	1.41
		> 20% ?																					
12/28/09	OR-2	TOLLWAY 346	0.067	<0.108	0.034	0.0333	<0.00055	53.0	<0.012	<0.013	<0.0058	0.00096	0.339	8.69	<0.058	24.4	0.360	<0.022	56.7	0.021	0.201	<0.041	10.8
12/28/09	OR-2 dupe	TOLLWAY 347	0.068	<0.108	0.034	0.0338	<0.00055	55.4	<0.012	<0.013	<0.0058	0.00124	0.314	8.81	<0.058	25.5	0.363	<0.022	57.6	0.016	0.213	<0.041	11.0
		% difference	2.06	<MDL	1.39	1.44	<MDL	4.54	<MDL	<MDL	<MDL	30.14	7.30	1.41	<MDL	4.49	0.87	<MDL	1.54	26.78	6.31	<MDL	1.61
		> 20% ?										30.14								26.78			
1/11/10	OR-1	TOLLWAY 357	0.051	<0.108	0.039	0.0467	<0.00055	68.7	<0.012	<0.013	<0.0058	<0.00079	1.01	8.25	<0.058	32.3	0.672	<0.022	77.2	0.015	0.436	<0.041	11.3
1/11/10	OR-1 dupe	TOLLWAY 358	0.040	<0.108	0.037	0.0451	<0.00055	66.5	<0.012	<0.013	<0.0058	<0.00079	0.970	7.99	<0.058	30.0	0.658	<0.022	74.7	0.020	0.394	<0.041	11.0
		difference	0.01061	<MDL	0.00205	0.00162	<MDL	2.25105	<MDL	<MDL	<MDL	<MDL	0.04018	0.26001	<MDL	2.26439	0.01405	<MDL	2.51878	0.00497	0.04200	<MDL	0.23587
		% difference	20.79	<MDL	5.32	3.47	<MDL	3.28	<MDL	<MDL	<MDL	<MDL	3.98	3.15	<MDL	7.02	2.09	<MDL	3.26	33.69	9.63	<MDL	2.09
		> 20% ?	20.79																	33.69			
1/25/10	WRP1-W	TOLLWAY 371	0.151	<0.108	0.141	0.0284	<0.00055	89.1	<0.012	<0.013	<0.0058	0.00654	0.167	6.59	<0.058	38.5	0.257	<0.022	43.0	0.027	0.498	<0.041	72.5
1/25/10	WRP1 dupe	TOLLWAY 372	0.167	<0.108	0.139	0.0290	<0.00055	88.1	<0.012	<0.013	<0.0058	0.00669	0.186	6.89	<0.058	37.3	0.258	<0.022	44.8	0.018	0.460	<0.041	73.5
		difference	0.01675	<MDL	0.00167	0.00059	<MDL	0.99642	<MDL	<MDL	<MDL	0.00015	0.01935	0.29561	<MDL	1.17237	0.00049	<MDL	1.84944	0.00862	0.03788	<MDL	1.00508
		% difference	11.12	<MDL	1.18	2.09	<MDL	1.12	<MDL	<MDL	<MDL	2.28	11.58	4.48	<MDL	3.05	0.19	<MDL	4.30	32.03	7.61	<MDL	1.39
		> 20% ?																		32.03			
2/15/10	OR-2	TOLLWAY 394	<0.037	<0.108	0.042	0.0528	<0.00055	85.0	<0.012	<0.013	<0.0058	<0.00079	0.808	7.02	<0.058	35.4	0.745	<0.022	110	0.020	0.466	<0.041	11.2
2/15/10	OR-2 dupe	TOLLWAY 395	<0.037	<0.108	0.040	0.0524	<0.00055	84.8	<0.012	<0.013	<0.0058	<0.00079	0.831	7.06	<0.058	37.3	0.738	<0.022	110	0.032	0.451	<0.041	11.1
		difference	<MDL	<MDL	0.00215	0.00044	<MDL	0.17295	<MDL	<MDL	<MDL	<MDL	0.02234	0.03658	<MDL	1.88340	0.00653	<MDL	0.23549	0.01266	0.01476	<MDL	0.13377
		% difference	<MDL	<MDL	5.10	0.84	<MDL	0.20	<MDL	<MDL	<MDL	<MDL	2.76	0.52	<MDL	5.31	0.88	<MDL	0.21	64.29	3.17	<MDL	1.19
		> 20% ?																		64.29			
3/1/10	OR-1	TOLLWAY 409	<0.037	<0.108	0.040	0.0540	<0.00055	89.2	<0.012	<0.013	<0.0058	<0.00079	0.677	7.27	<0.058	37.9	0.790	<0.022	119	0.017	0.550	<0.041	8.09
3/1/10	OR-1 dupe	TOLLWAY 410	<0.037	<0.108	0.039	0.0539	<0.00055	89.2	<0.012	<0.013	<0.0058	<0.00079	0.687	7.21	<0.058	34.7	0.787	<0.022	118	0.020	0.523	<0.041	8.04
		difference	<MDL	<MDL	0.00145	0.00007	<MDL	0.02618	<MDL	<MDL	<MDL	<MDL	0.01066	0.05637	<MDL	3.14370	0.00326	<MDL	1.03405	0.00270	0.02769	<MDL	0.05645
		% difference	<MDL	<MDL	3.62	0.13	<MDL	0.03	<MDL	<MDL	<MDL	<MDL	1.58	0.78	<MDL	8.30	0.41	<MDL	0.87	15.70	5.03	<MDL	0.70
		> 20% ?																					
3/15/10	OR-2	TOLLWAY 427	0.046	<0.108	<0.023	0.0243	<0.00055	41.4	<0.012	<0.013	<0.0058	0.00103	0.206	4.72	<0.058	17.4	0.172	<0.022	42.0	<0.014	<0.063	<0.041	8.39
3/15/10	OR-2 dupe	TOLLWAY 428	0.047	<0.108	<0.023	0.0240	<0.00055	41.0	<0.012	<0.013	<0.0058	<0.00079	0.201	4.69	<0.058	17.0	0.169	<0.022	41.6	<0.014	<0.063	<0.041	8.33
		difference	0.00095	<MDL	<MDL	0.00024	<MDL	0.34840	<MDL	<MDL	<MDL	<MDL	0.00483	0.02349	<MDL	0.34972	0.00262	<MDL	0.41115	<MDL	<MDL	<MDL	0.05963
		% difference	2.07	<MDL	<MDL	1.00	<MDL	0.84	<MDL	<MDL	<MDL	<MDL	2.35	0.50	<MDL	2.02	1.52	<MDL	0.98	<MDL	<MDL	<MDL	0.71
		> 20% ?																					

Appendix H: Results of Geochemical Analysis of Duplicate Samples

		Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as $CaCO_3$	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NOVC mg/L	mean relative % difference between dupe and sample
		MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31	
7/28/09	TB15B Grab	TOLLWAY 234	<0.059	<0.131	0.878	<0.086	0.467	0.00125	<0.017	<0.047	<0.0073	9.03	162	2594	29.2	0.02	<0.06	0.28	760	<0.07	48.6	28.6	22.0	
7/28/09	TB15B Grab-dupe	TOLLWAY 246	<0.059	<0.131	0.703	<0.086	0.444	0.00064	<0.017	<0.047	<0.0073	9.03	162	2555		0.01	0.06	0.28	759	<0.07	48.5	28.5	20.5	
		difference	<MDL	<MDL	0.17517	<MDL	0.02279	0.00061	<MDL	<MDL	<MDL	0.00400	0.66800	39.00000	NA	0.01014	<MDL	0.00584	1.03003	<MDL	0.01298	0.11111	1.50686	
		% difference	<MDL	<MDL	19.95	<MDL	4.88	48.62	<MDL	<MDL	<MDL	0.04	0.41	1.50	NA	45.12	<MDL	2.11	0.14	<MDL	0.03	0.39	6.84	11.63
		> 20% ?						48.62								45.12								
8/25/09	TB9A Grab	TOLLWAY 250	<0.059	<0.131	2.12	<0.086	1.01	<0.00056	<0.017	<0.047	<0.0073	9.21	91	2982	17	<0.01	0.34	0.10	1638	0.29	169	18.2	16.7	
8/25/09	TB9A Grab dupe	TOLLWAY 251	<0.059	<0.131	2.03	<0.086	0.975	<0.00056	<0.017	<0.047	<0.0073	9.19	91	3007		<0.01	0.34	0.09	1645	0.29	171	18.0	17.5	
		difference	<MDL	<MDL	0.08672	<MDL	0.02967	<MDL	<MDL	<MDL	<MDL	0.02000	0.56080	25.00000	NA	<MDL	0.00082	0.00544	6.80841	0.00295	1.23878	0.13155	0.81884	
		% difference	<MDL	<MDL	4.10	<MDL	2.95	<MDL	<MDL	<MDL	<MDL	0.22	0.61	0.84	NA	<MDL	0.24	5.52	0.42	1.03	0.73	0.72	4.89	5.48
		> 20% ?																						
9/8/09	TB15B Isco	TOLLWAY 257	<0.059	<0.131	3.94	<0.086	0.170	0.00238	0.018	<0.047	<0.0073	8.06	129	774	237	0.10	0.12	0.24	349	0.34	48.6	21.8	10.3	
9/8/09	TB15B Isco dupe	TOLLWAY 258	<0.059	<0.131	3.83	<0.086	0.170	0.00110	<0.017	<0.047	<0.0073	8.06	129	775		0.09	0.13	0.23	348	0.33	48.5	22.5	9.82	
		difference	<MDL	<MDL	0.11000	<MDL	0.00060	0.00128	<MDL	<MDL	<MDL	0.00100	0.07700	1.00000	NA	0.00826	0.00195	0.00769	0.84484	0.00486	0.07887	0.74603	0.48949	
		% difference	<MDL	<MDL	2.79	<MDL	0.35	53.78	<MDL	<MDL	<MDL	0.01	0.06	0.13	NA	8.56	1.58	3.22	0.24	1.43	0.16	3.43	4.75	9.49
		> 20% ?						53.78																
9/22/09	TB15B Grab	TOLLWAY 263	<0.059	<0.131	3.66	<0.086	0.481	0.00109	<0.017	<0.047	<0.0073	9.18	99	2392	9.6	0.010	0.10	0.17	1282	0.11	162	27.2	21.0	
9/22/09	TB15B Grab dupe	TOLLWAY 264	<0.059	<0.131	3.66	<0.086	0.485	0.00060	<0.017	<0.047	<0.0073	9.19	99	2379		0.010	0.09	0.16	1277	0.12	161	27.3	21.1	
		difference	<MDL	<MDL	0.00000	<MDL	0.00443	0.00049	<MDL	<MDL	<MDL	0.01000	0.10160	13.00000	NA	0.00008	0.00583	0.00232	4.99763	0.00312	1.54806	0.04903	0.09741	
		% difference	<MDL	<MDL	0.00	<MDL	0.92	44.95	<MDL	<MDL	<MDL	0.11	0.10	0.54	NA	0.77	5.82	1.41	0.39	2.73	0.95	0.18	0.46	4.25
		> 20% ?						44.95																
10/6/09	TB19r Grab dupe	TOLLWAY 269	<0.059	<0.131	2.23	<0.086	0.508	<0.00056	<0.017	<0.047	<0.0073	10.46	125	1422		<0.003	0.18	0.21	725	0.08	60.4	19.7	19.7	
10/6/09	TB19r Grab	TOLLWAY 270	<0.059	<0.131	2.25	<0.086	0.510	<0.00056	<0.017	<0.047	<0.0073	10.46	125	1408	27.6	0.003	0.15	0.20	714	<0.07	60.7	19.9	19.1	
		difference	<MDL	<MDL	0.02000	<MDL	0.00203	<MDL	<MDL	<MDL	<MDL	0.00100	0.51200	14.00000	NA	<MDL	0.02711	0.01126	10.29870	<MDL	0.26082	0.14428	0.56367	
		% difference	<MDL	<MDL	0.90	<MDL	0.40	<MDL	<MDL	<MDL	<MDL	0.01	0.41	0.98	NA	<MDL	14.99	5.25	1.42	<MDL	0.43	0.73	2.87	6.65
		> 20% ?																						
10/20/09	TB15B Grab	TOLLWAY 283	<0.059	<0.131	4.69	<0.086	0.256	0.00133	<0.017	<0.047	<0.0073	10.63	158	1883	4.8	0.019	0.56	0.26	977	0.31	64.3	18.1	19.7	
10/20/09	TB15B Grab dupe	TOLLWAY 282	<0.059	<0.131	4.53	<0.086	0.248	0.00104	<0.017	<0.047	<0.0073	10.66	158	1871		0.018	0.56	0.23	977	0.31	63.9	18.1	19.5	
		difference	<MDL	<MDL	0.16000	<MDL	0.00833	0.00029	<MDL	<MDL	<MDL	0.03700	0.21200	12.00000	NA	0.00023	0.00152	0.03344	0.17571	0.00044	0.35103	0.03951	0.17986	
		% difference	<MDL	<MDL	3.41	<MDL	3.25	21.80	<MDL	<MDL	<MDL	0.35	0.13	0.64	NA	1.22	0.27	12.64	0.02	0.14	0.55	0.22	0.91	3.61
		> 20% ?						21.80																
11/2/09	TB15B Grab dupe	TOLLWAY 291	<0.059	<0.131	4.78	<0.086	0.505	<0.00056	<0.017	<0.047	<0.0073	11.3	154	1164		0.013	0.41	0.23	570	0.35	42.0	13.8	12.3	
11/2/09	TB15B Grab	TOLLWAY 292	<0.059	<0.131	4.80	<0.086	0.507	<0.00056	<0.017	<0.047	<0.0073	11.3	155	1164	3.6	0.013	0.42	0.39	581	0.33	41.2	13.4	12.2	
		difference	<MDL	<MDL	0.01966	<MDL	0.00159	<MDL	<MDL	<MDL	<MDL	0.00800	0.39700	0.00000	NA	0.00007	0.00842	0.16024	11.97181	0.02185	0.75781	0.45150	0.03569	
		% difference	<MDL	<MDL	0.41	<MDL	0.31	<MDL	<MDL	<MDL	<MDL	0.07	0.26	0.00	NA	0.50	2.06	68.31	2.10	6.29	1.81	3.27	0.29	4.83
		> 20% ?																68.31						
11/16/19	WRP1-W	TOLLWAY 301	<0.059	<0.131	4.14	<0.086	0.294	<0.00056	<0.017	<0.047	<0.0073	7.76	339	933	6.0	0.130	<0.06	0.25	123	0.21	272	12.0	11.2	
11/16/09	WRP1 dupe	TOLLWAY 302	<0.059	<0.131	4.21	<0.086	0.301	<0.00056	<0.017	<0.047	<0.0073	7.77	339	939		0.131	<0.06	0.26	120	0.23	267	11.7	11.4	
		difference	<MDL	<MDL	0.07059	<MDL	0.00685	<MDL	<MDL	<MDL	<MDL	0.01200	0.71700	6.00000	NA	0.00016	<MDL	0.00541	2.41864	0.01207	4.75506	0.26446	0.16640	
		% difference	<MDL	<MDL	1.71	<MDL	2.33	<MDL	<MDL	<MDL	<MDL	0.15	0.21	0.64	NA	0.13	<MDL	2.12	1.97	5.63	1.75	2.20	1.48	3.92
		> 20% ?																						
12/1/09	TB9A Grab	TOLLWAY 308	<0.059	<0.131	2.29	<0.086	0.957	<0.00056	<0.017	<0.047	<0.0073	9.04	104	2130	6.4	<0.003	0.45	0.17	1056	2.44	204	12.4	9.48	
12/1/09	TB9A Grab dupe	TOLLWAY 309	<0.059	<0.131	2.29	<0.086	0.963	<0.00056	<0.017	<0.047	<0.0073	9.03	104	2136		<0.003	0.46	0.18	1026	2.41	204	9.57	9.55	
		difference	<MDL	<MDL	0.00079	<MDL	0.00600	<MDL	<MDL	<MDL	<MDL	0.01000	0.13000	6.00000	NA	<MDL	0.00753	0.00257	29.78208	0.02158	0.32229	2.86514	0.07225	
		% difference	<MDL	<MDL	0.03	<MDL	0.63	<MDL	<MDL	<MDL	<MDL	0.11	0.12	0.28	NA	<MDL	1.66	1.48	2.82	0.89	0.16	23.04	0.76	3.62
		> 20% ?																				23.04		
12/14/09	OR-1	TOLLWAY 326	<0.059	<0.131	3.58	<0.086	0.233	<0.00056	<0.017	<0.047	<0.0073	7.72	260	577	7.2	0.172	<0.06	0.15	134	<0.07	26.7	17.6	16.1	
12/14/09	OR-1 dupe	TOLLWAY 327	<0.059	<0.131	3.56	<0.086	0.234	<0.00056	<0.017	<0.047	<0.0073	7.65	262	580		0.175	<0.06	0.15	135	<0.07	26.8	18.0	15.7	
		difference	<MDL	<MDL	0.02556	<MDL	0.00092	<MDL	<MDL	<MDL	<MDL	0.06600	2.19300	3.00000	NA	0.00298	<MDL	0.00320	0.79617	<MDL	0.12604	0.37838	0.35121	
		% difference	<MDL	<MDL	0.71	<MDL	0.39	<MDL	<MDL	<MDL	<MDL	0.86	0.84	0.52	NA	1.73	<MDL	2.18	0.59	<MDL	0.47	2.15	2.19	1.57
		> 20% ?																						
12/28/09	OR-2	TOLLWAY 346	<0.059	<0.131	3.20	<0.086	0.174	0.00201	<0.017	<0.047	<0.0073	7.32	190	423	10	0.172	0.11	0.15	106	0.45	32.4	13.3	12.1	
12/28/09	OR-2 dupe	TOLLWAY 347	<0.059	<0.131	3.24	<0.086	0.177	0.00261	<0.017	<0.047	<0.0073	7.39	190	446		0.179	0.10	0.13	108	0.43	32.5	13.6	12.4	
		% difference	<MDL	<MDL	1.16	<MDL	1.54	30.30	<MDL	<MDL	<MDL	0.90	0.08	5.44	NA	3.82	9.64	8.84	2.34	4.10	0.20	2.67	2.30	6.04
		> 20% ?						30.30																
1/11/10	OR-1	TOLLWAY 357	<0.059	<0.131	3.90	<0.086	0.214	0.00176	<0.017	<0.047	<0.0073	7.16	247	540	4.4	0.309	0.27	0.16	141	<0.07	32.1	15.3	14.7	
1/11/10	OR-1 dupe	TOLLWAY 358	<0.059	<0.131	3.80	<0.086	0.209	0.00141	<0.017	<0.047	<0.0073	7.16	247	543		0.311	0.27	0.15	143	<0.07	32.7	14.7	14.3	
		difference	<MDL	<MDL	0.09557	<MDL	0.00516	0.00035	<MDL	<MDL	<MDL	0.00300	0.09100	3.00000	NA	0.00214	0.00254	0.00234	2.15723	<MDL	0.61776	0.57639	0.37510	
		% difference	<MDL	<MDL	2.45	<MDL	2.42	20.13	<MDL	<MDL	<MDL	0.04	0.04	0.56	NA	0.69	0.93	1.50	1.53	<MDL	1.92	3.77	2.55	5.45
		> 20% ?						20.13																
1/25/10	WRP1-W	TOLLWAY 371	<0.059	<0.131	3.84	<0.086	0.181	0.00505	<0.017	<0.047	0.0092	7.21	170	628	20.0	0.379	0.22	0.21	64.1	1.26	226	16.1	14.7	
1/25/10	WRP1 dupe	TOLLWAY 372	<0.059	<0.131	3.94	<0.086	0.183	0.00608	<0.017	<0.047	0.0088	7.23	170	635		0.385	0.22	0.20	62.3	1.25	223	15.0	15.0	
		difference	<MDL	<MDL	0.10216	<MDL	0.00250	0.00103	<MDL	<MDL	0.00036	0.02200	0.36700	7.00000	NA	0.00574	0.00590	0.00371	1.75626	0.01034	2.58457	1.13302	0.31494	
		% difference	<MDL	<MDL	2.66	<MDL	1.38	20.33	<MDL	<MDL	3.90	0.31	0.22	1.11	NA	1.51	2.66	1.79	2.74	0.82	1.14	7.03	2.15	4.72
		> 20% ?						20.33																
2/15/10	OR-2	TOLLWAY 394	<0.059	<0.131	4.72	<0.086	0.246	0.00092	<0.017	<0.047	<0.0073	7.07	269	681	17.6	0.309	0.46	0.12	190	<0.07	31.0	17.7	16.3	
2/15/10	OR-2 dupe	TOLLWAY 395	<0.059	<0.131	4.70	<0.086	0.244	0.00083	<0.017	<0.047	<0.0073	7.07	267	644		0.311	0.46	0.12	191	<0.07	31.6	16.9	16.5	
		difference	<MDL	<MDL	0.01826	<MDL	0.00177	0.00009	<MDL	<MDL	<MDL	0.00700	1.18000	37.00000	NA	0.00135	0.00147	0.00021	0.45898	<MDL	0.60678	0.80114	0.19527	
		% difference	<MDL	<MDL	0.39	<MDL	0.72	9.95	<MDL	<MDL	<MDL	0.10	0.44	5.43	NA	0.44	0.32	0.17	0.24	<MDL	1.96	4.52	1.20	4.60
		> 20% ?																						
3/1/10	OR-1	TOLLWAY 409	<0.059	<0.131	5.28	<0.086	0.244	0.00136	<0.017	<0.047	<0.0073	6.98	282	669	9.2	0.408	0.66	<0.08	211	<0.07	25.6	21.3	19.6	
3/1/10	OR-1 dupe	TOLLWAY 410	<0.059	<0.131	5.25	<0.086	0.242	0.00163	<0.017	<0.047	<0.0073	7.02	280	692		0.412	0.65	<0.08	211	<0.07	25.7	21.2	19.0	
		difference	<MDL	<MDL	0.02470	<MDL	0.00148	0.00027	<MDL	<MDL	<MDL	0.03200	1.75400	23.00000	NA	0.00345	0.01899	<MDL	0.00916	<MDL	0.14654	0.11112	0.56254	
		% difference	<MDL	<MDL	0.47	<MDL	0.61	20.10	<MDL	<MDL	<MDL	0.46	0.62	3.44	NA	0.84	2.86	<MDL	0.00	<MDL	0.57	0.52	2.88	3.07
		> 20% ?						20.10																
3/15/10	OR-2	TOLLWAY 427	<0.059	<0.131	2.66	<0.086	0.102	0.00188	<0.017	<0.047	<0.0073	7.18	130	299	7.2	0.049	<0.06	0.12	76.4	0.28	23.0	10.8	9.83	
3/15/10	OR-2 dupe	TOLLWAY 428	<0.059	<0.131	2.65	<0.086	0.101	0.00195	<0.017	<0.047	<0.0073	7.22	130	297		0.047	<0.06	0.11	76.1	0.28	22.9	11.0	9.73	
		difference	<MDL	<MDL	0.01321	<MDL	0.00102	0.00008	<MDL	<MDL	<MDL	0.04700	0.17900	2.00000	NA	0.00166	<MDL	0.00707	0.23927	0.00166	0.04797	0.21419	0.09677	
		% difference	<MDL	<MDL	0.50	<MDL	1.00	4.02	<MDL	<MDL	<MDL	0.65	0.14	0.67	NA	3.40	<MDL	6.01	0.31	0.60	0.21	1.98	0.98	1.48
		> 20% ?																						

Appendix H: Results of Geochemical Analysis of Duplicate Samples

		Sample ID	Al mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	K mg/L	Li mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	P mg/L	Pb mg/L	S mg/L
		MDL:	0.0061	0.108	0.023	0.00085	0.00055	0.012	0.012	0.013	0.0058	0.00079	0.0059	0.016	0.018	0.0025	0.0015	0.022	0.026	0.014	0.063	0.041	0.217
3/29/10	OR-4	TOLLWAY 448	<0.037	<0.108	0.063	0.0300	<0.00055	92.2	<0.012	<0.013	<0.0058	<0.00079	0.0233	4.21	<0.058	42.9	0.108	<0.022	102	0.018	<0.063	<0.041	45.2
3/29/10	OR-4 dupe	TOLLWAY 449	<0.037	<0.108	0.059	0.0285	<0.00055	86.5	<0.012	<0.013	<0.0058	<0.00079	0.0172	3.99	<0.058	42.6	0.103	<0.022	95.5	0.018	<0.063	<0.041	42.9
		difference	<MDL	<MDL	0.00440	0.00158	<MDL	5.70431	<MDL	<MDL	<MDL	<MDL	0.00609	0.21543	<MDL	0.22049	0.00467	<MDL	6.45505	0.00017	<MDL	<MDL	2.26855
		% difference	<MDL	<MDL	6.94	5.25	<MDL	6.19	<MDL	<MDL	<MDL	<MDL	26.17	5.12	<MDL	0.51	4.34	<MDL	6.33	0.94	<MDL	<MDL	5.02
		> 20% ?											26.17										
4/14/10	TB9A Grab	TOLLWAY 479	<0.037	<0.108	0.087	0.365	<0.00055	145	<0.012	<0.013	0.0080	0.0453	<0.0059	138	<0.058	12.7	<0.0015	0.043	4126	0.024	0.085	<0.041	84.0
4/14/10	TB9A Grab dupe	TOLLWAY 480	<0.037	<0.108	0.078	0.361	<0.00055	146	<0.012	<0.013	0.0070	0.0446	<0.0059	136	<0.058	12.9	<0.0015	0.048	4076	0.022	0.078	0.043	83.2
		difference	<MDL	<MDL	0.00895	0.00376	<MDL	1.48784	<MDL	<MDL	0.00096	0.00070	<MDL	1.67281	<MDL	0.17674	<MDL	0.00465	49.25586	0.00261	0.00769	<MDL	0.85019
		% difference	<MDL	<MDL	10.30	1.03	<MDL	1.03	<MDL	<MDL	12.02	1.54	<MDL	1.22	<MDL	1.39	<MDL	10.78	1.19	10.81	9.00	<MDL	1.01
		> 20% ?																					
5/11/10	TB9A Grab	TOLLWAY 510	0.738	<0.108	0.041	0.058	<0.00055	49.4	<0.012	<0.013	0.006	0.0108	0.503	12.2	<0.058	12.0	0.0216	<0.022	384	<0.014	<0.063	<0.041	30.6
5/11/10	TB9A Grab dupe	TOLLWAY 511	0.965	<0.108	0.041	0.062	<0.00055	50.3	<0.012	<0.013	0.006	0.0116	0.641	12.7	<0.058	12.3	0.0240	<0.022	395	<0.014	<0.063	<0.041	31.6
		difference	0.22766	<MDL	0.00016	0.00434	<MDL	0.91621	<MDL	<MDL	0.00040	0.00079	0.13854	0.44782	<MDL	0.22149	0.00242	<MDL	10.75650	<MDL	<MDL	<MDL	0.97715
		% difference	30.86	<MDL	0.40	7.47	<MDL	1.86	<MDL	<MDL	6.56	7.31	27.55	3.66	<MDL	1.84	11.22	<MDL	2.80	<MDL	<MDL	<MDL	3.20
		> 20% ?	30.86										27.55										
5/25/10	OR-1	TOLLWAY 530	<0.037	<0.108	0.031	0.0374	<0.00055	53.3	<0.012	<0.013	<0.0058	<0.00079	0.257	6.02	<0.058	23.8	1.57	<0.022	72.7	<0.014	0.077	<0.041	6.84
5/25/10	OR-1 dupe	TOLLWAY 531	<0.037	<0.108	0.028	0.0371	<0.00055	52.4	<0.012	<0.013	<0.0058	0.00117	0.257	5.97	<0.058	23.4	1.55	<0.022	71.9	<0.014	0.075	<0.041	6.73
		difference	<MDL	<MDL	0.00243	0.00032	<MDL	0.85056	<MDL	<MDL	<MDL	<MDL	0.00028	0.04344	<MDL	0.38074	0.02176	<MDL	0.79855	<MDL	0.00157	<MDL	0.11444
		% difference	<MDL	<MDL	7.90	0.85	<MDL	1.60	<MDL	<MDL	<MDL	<MDL	0.11	0.72	<MDL	1.60	1.39	<MDL	1.10	<MDL	2.04	<MDL	1.67
		> 20% ?																					
6/8/10	TB9A Grab	TOLLWAY 548	0.086	<0.108	0.051	0.181	<0.00055	62.9	<0.012	<0.013	<0.0058	0.0131	0.0871	65.2	<0.058	13.3	0.0689	0.026	1284	0.018	<0.063	<0.041	42.6
6/8/10	TB9A Grab dupe	TOLLWAY 549	0.103	<0.108	0.051	0.185	<0.00055	63.4	<0.012	<0.013	<0.0058	0.0133	0.0914	66.5	<0.058	13.7	0.0700	0.028	1309	<0.014	<0.063	<0.041	43.1
		difference	0.01726	<MDL	0.00021	0.00362	<MDL	0.54003	<MDL	<MDL	<MDL	0.00027	0.00434	1.32626	<MDL	0.41018	0.00116	0.00168	24.80713	<MDL	<MDL	<MDL	0.47163
		% difference	20.08	<MDL	0.41	2.00	<MDL	0.86	<MDL	<MDL	<MDL	2.07	4.98	2.03	<MDL	3.08	1.68	6.40	1.93	<MDL	<MDL	<MDL	1.11
		> 20% ?	20.08																				
6/22/10	TB9A Grab	Tollway 578	0.231	<0.108	0.052	0.0668	<0.00055	22.6	<0.012	<0.013	<0.0058	0.0121	0.126	37.1	<0.058	5.26	0.0070	0.022	618	0.017	<0.063	<0.041	18.5
6/22/10	TB9A Grab dupe	Tollway 579	0.208	<0.108	0.053	0.0687	<0.00055	23.2	<0.012	<0.013	<0.0058	0.0124	0.114	38.2	<0.058	5.47	0.0087	<0.022	638	0.016	<0.063	<0.041	19.0
		difference	0.02289	<MDL	0.00093	0.00198	<MDL	0.67121	<MDL	<MDL	<MDL	0.00037	0.01145	1.07544	<MDL	0.21053	0.00177	<MDL	20.10492	0.00111	<MDL	<MDL	0.52621
		% difference	9.89	<MDL	1.78	2.96	<MDL	2.98	<MDL	<MDL	<MDL	3.04	9.11	2.90	<MDL	4.01	25.42	<MDL	3.26	6.46	<MDL	<MDL	2.85
		> 20% ?															25.42						
7/7/10	TB7B-1	Tollway 597	<0.037	<0.108	0.155	0.0464	<0.00055	62.1	<0.012	<0.013	<0.0058	<0.00079	5.38	3.75	<0.058	24.9	0.347	<0.022	507	<0.014	0.069	<0.041	39.7
7/7/10	TB7B-1 dupe	Tollway 598	<0.037	<0.108	0.151	0.0462	<0.00055	60.7	<0.012	<0.013	<0.0058	<0.00079	5.36	3.77	<0.058	23.3	0.341	<0.022	507	<0.014	<0.063	<0.041	39.4
		difference	<MDL	<MDL	0.00387	0.00025	<MDL	1.44382	<MDL	<MDL	<MDL	<MDL	0.01691	0.01055	<MDL	1.56256	0.00608	<MDL	0.43768	<MDL	<MDL	<MDL	0.33978
		% difference	<MDL	<MDL	2.49	0.53	<MDL	2.32	<MDL	<MDL	<MDL	<MDL	0.31	0.28	<MDL	6.28	1.75	<MDL	0.09	<MDL	<MDL	<MDL	0.86
		> 20% ?																					
7/19/10	TB15B Isco	TOLLWAY 627	0.985	<0.108	0.035	0.0306	<0.00055	15.9	<0.012	<0.013	0.0074	0.00547	0.607	6.64	<0.058	3.02	0.0075	<0.022	122	<0.014	<0.063	<0.041	7.46
7/19/10	TB15B Isco dupe	TOLLWAY 628	1.06	<0.108	0.034	0.0312	<0.00055	16.1	<0.012	<0.013	0.0081	0.00588	0.661	6.67	<0.058	3.12	0.0085	<0.022	122	<0.014	0.084	<0.041	7.57
		difference	0.07338	<MDL	0.00129	0.00065	<MDL	0.19292	<MDL	<MDL	0.00071	0.00041	0.05392	0.02707	<MDL	0.09652	0.00100	<MDL	0.29977	<MDL	<MDL	<MDL	0.11439
		% difference	7.45	<MDL	3.69	2.13	<MDL	1.21	<MDL	<MDL	9.58	7.55	8.88	0.41	<MDL	3.19	13.35	<MDL	0.25	<MDL	<MDL	<MDL	1.53
		> 20% ?																					
8/2/10	TB7B-1	TOLLWAY 630	0.041	<0.108	0.170	0.040	<0.00055	58.9	<0.012	<0.013	<0.0058	<0.00079	4.60	3.52	<0.058	21.1	0.324	<0.022	462	0.014	0.121	<0.041	39.2
8/2/10	TB7B-1 dupe	TOLLWAY 631	<0.037	<0.108	0.162	0.040	<0.00055	57.8	<0.012	<0.013	<0.0058	<0.00079	5.13	3.45	<0.058	21.0	0.328	<0.022	467	<0.014	0.105	<0.041	40.0
		difference	<MDL	<MDL	0.00750	0.00016	<MDL	1.08384	<MDL	<MDL	<MDL	<MDL	0.52418	0.07131	<MDL	0.15646	0.00409	<MDL	4.57034	<MDL	0.01560	<MDL	0.86067
		% difference	<MDL	<MDL	4.42	0.39	<MDL	1.84	<MDL	<MDL	<MDL	<MDL	11.39	2.03	<MDL	0.74	1.26	<MDL	0.99	<MDL	12.93	<MDL	2.20
		> 20% ?																					
8/16/10	OR-1	TOLLWAY 649	<0.037	<0.108	0.053	0.037	<0.00055	55.6	<0.012	<0.013	<0.0058	<0.00079	0.199	7.33	<0.058	23.3	0.548	<0.022	64.6	<0.014	0.082	<0.041	4.79
8/16/10	OR-1 dupe	TOLLWAY 650	<0.037	<0.108	0.052	0.037	<0.00055	54.7	<0.012	<0.013	<0.0058	<0.00079	0.191	7.17	<0.058	23.9	0.536	<0.022	63.1	<0.014	0.098	<0.041	4.73
		difference	<MDL	<MDL	0.00097	0.00081	<MDL	0.90289	<MDL	<MDL	<MDL	<MDL	0.00809	0.15722	<MDL	0.60453	0.01206	<MDL	1.54872	<MDL	0.01679	<MDL	0.06049
		% difference	<MDL	<MDL	1.85	2.17	<MDL	1.62	<MDL	<MDL	<MDL	<MDL	4.07	2.15	<MDL	2.59	2.20	<MDL	2.40	<MDL	20.57	<MDL	1.26
		> 20% ?																			20.57		

Appendix H: Results of Geochemical Analysis of Duplicate Samples

		Sample ID	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Ti mg/L	Tl mg/L	V mg/L	Zn mg/L	pH	alkalinity mg/L as $CaCO_3$	TDS, 180 C mg/L	TSS mg/L	oPO_4-P mg/L	NH_3-N mg/L	F mg/L	Cl mg/L	NO_3-N mg/L	SO_4 mg/L	total NVOC mg/L	dissolved NVOC mg/L	mean relative % difference between dupe and sample
		MDL:	0.059	0.131	0.066	0.086	0.00037	0.00056	0.017	0.047	0.0073		4	12	3	0.01	0.06	0.08	0.09	0.07	0.31	0.31	0.31	
3/29/10	OR-4	TOLLWAY 448	<0.059	<0.131	2.37	<0.086	0.276	<0.00056	0.030	<0.047	<0.0073	8.21	236	714	3.2	0.012	<0.06	0.14	161	<0.07	121	7.34	6.42	
3/29/10	OR-4 dupe	TOLLWAY 449	<0.059	<0.131	2.24	<0.086	0.261	<0.00056	<0.017	<0.047	<0.0073	8.23	234	719		0.012	<0.06	0.14	161	<0.07	121	7.45	6.54	
		difference	<MDL	<MDL	0.13890	<MDL	0.01445	<MDL	<MDL	<MDL	<MDL	0.02000	1.77500	5.00000	NA	0.00018	<MDL	0.00010	0.28662	<MDL	0.06822	0.10176	0.12133	
		% difference	<MDL	<MDL	5.85	<MDL	5.24	<MDL	<MDL	<MDL	<MDL	0.24	0.75	0.70	NA	1.53	<MDL	0.08	0.18	<MDL	0.06	1.39	1.89	4.03
		> 20% ?																						
4/14/10	TB9A Grab	TOLLWAY 479	<0.059	<0.131	0.939	<0.086	3.07	<0.00056	<0.017	<0.047	0.0083	10.0	53	11755	12.8	0.006	1.23	<0.8 *	7121	0.43	217	15.1	20.0	
4/14/10	TB9A Grab dupe	TOLLWAY 480	<0.059	<0.131	0.940	<0.086	3.05	<0.00056	<0.017	<0.047	0.0073	10.0	54	11806		0.006	1.24	<0.8 *	7424	0.48	216	14.2	20.7	
		difference	<MDL	<MDL	0.00095	<MDL	0.02203	<MDL	<MDL	<MDL	0.00095	0.01700	0.82440	51.00000	NA	0.00001	0.01612	<MDL	302.66571	0.05263	1.25775	0.87336	0.75082	
		% difference	<MDL	<MDL	0.10	<MDL	0.72	<MDL	<MDL	<MDL	11.43	0.17	1.55	0.43	NA	0.20	1.31	<MDL	4.25	12.25	0.58	5.80	3.76	4.15
		> 20% ?																						
5/11/10	TB9A Grab	TOLLWAY 510	<0.059	<0.131	3.65	<0.086	0.434	0.0238	<0.017	<0.047	0.0089	9.47	106	1188	40.8	0.014	0.31	0.19	612	0.31	84.9	13.4	9.89	
5/11/10	TB9A Grab dupe	TOLLWAY 511	<0.059	<0.131	4.29	<0.086	0.444	0.0326	<0.017	<0.047	0.0107	9.44	106	1190		0.015	0.29	0.17	605	0.33	84.9	13.6	9.74	
		difference	<MDL	<MDL	0.64091	<MDL	0.01055	0.00879	<MDL	<MDL	0.00180	0.02500	0.20400	2.00000	NA	0.00129	0.01657	0.01479	7.18000	0.01813	0.05865	0.25511	0.14690	
		% difference	<MDL	<MDL	17.55	<MDL	2.43	37.01	<MDL	<MDL	20.13	0.26	0.19	0.17	NA	9.40	5.36	7.80	1.17	5.82	0.07	1.91	1.49	7.98
		> 20% ?						37.01			20.13													
5/25/10	OR-1	TOLLWAY 530	<0.059	<0.131	0.489	<0.086	0.175	<0.00056	<0.017	<0.047	<0.0073	7.50	174	475	3.6	0.055	<0.06	0.17	135	<0.07	19.3	14.0	12.2	
5/25/10	OR-1 dupe	TOLLWAY 531	<0.059	<0.131	0.485	<0.086	0.173	<0.00056	<0.017	<0.047	<0.0073	7.52	174	493		0.056	0.07	0.16	135	<0.07	19.3	13.6	11.9	
		difference	<MDL	<MDL	0.00355	<MDL	0.00161	<MDL	<MDL	<MDL	<MDL	0.02000	0.42400	18.00000	NA	0.00142	<MDL	0.01025	0.37085	<MDL	0.02209	0.32975	0.24094	
		% difference	<MDL	<MDL	0.73	<MDL	0.92	<MDL	<MDL	<MDL	<MDL	0.27	0.24	3.79	NA	2.61	<MDL	6.04	0.27	<MDL	0.11	2.36	1.98	1.82
		> 20% ?																						
6/8/10	TB9A Grab	TOLLWAY 548	<0.059	<0.131	3.81	<0.086	1.12	0.00138	<0.017	<0.047	0.0082	8.68	157	3609	13.2	0.005	0.77	0.25	2034	0.12	116	15.0	16.0	
6/8/10	TB9A Grab dupe	TOLLWAY 549	<0.059	<0.131	3.85	<0.086	1.13	0.00190	<0.017	<0.047	0.0077	8.67	156	3617		0.005	0.73	0.25	2000	0.12	116	15.6	16.2	
		difference	<MDL	<MDL	0.04332	<MDL	0.01556	0.00052	<MDL	<MDL	0.00046	0.00900	0.80700	8.00000	NA	0.00031	0.03236	0.00475	34.18286	0.00218	0.15207	0.55580	0.14110	
		% difference	<MDL	<MDL	1.14	<MDL	1.40	37.51	<MDL	<MDL	5.62	0.10	0.51	0.22	NA	6.12	4.22	1.92	1.68	1.86	0.13	3.69	0.88	4.21
		> 20% ?						37.51																
6/22/10	TB9A Grab	Tollway 578	<0.059	<0.131	2.19	<0.086	0.478	0.00331	<0.017	<0.047	0.0088	9.20	80	1762	16.4	0.021	0.17	0.36	985	<0.07	50.6	14.4	15.9	
6/22/10	TB9A Grab dupe	Tollway 579	<0.059	<0.131	2.23	<0.086	0.493	0.00328	<0.017	<0.047	0.0082	9.21	81	1776		0.020	0.17	0.36	978	<0.07	50.7	13.5	15.1	
		difference	<MDL	<MDL	0.03645	<MDL	0.01474	0.00002	<MDL	<MDL	0.00054	0.00600	0.72770	14.00000	NA	0.00043	0.00300	0.00114	6.71914	<MDL	0.09801	0.85721	0.88141	
		% difference	<MDL	<MDL	1.66	<MDL	3.08	0.61	<MDL	<MDL	6.15	0.07	0.91	0.79	NA	2.10	1.75	0.31	0.68	<MDL	0.19	5.97	5.53	4.02
		> 20% ?																						
7/7/10	TB7B-1	Tollway 597	<0.059	<0.131	6.00	<0.086	0.125	<0.00056	<0.017	<0.047	<0.0073	7.33	776	1524		0.020	1.53	0.31	328	<0.07	108	10.4	8.17	
7/7/10	TB7B-1 dupe	Tollway 598	<0.059	<0.131	5.95	<0.086	0.124	<0.00056	<0.017	<0.047	<0.0073	7.33	775	1519		0.016	1.52	0.31	330	0.11	109	10.6	8.33	
		difference	<MDL	<MDL	0.05016	<MDL	0.00091	<MDL	<MDL	<MDL	<MDL	0.00100	1.41800	5.00000	NA	0.00377	0.01516	0.00118	1.57278	<MDL	0.93056	0.14909	0.15951	
		% difference	<MDL	<MDL	0.84	<MDL	0.73	<MDL	<MDL	<MDL	<MDL	0.01	0.18	0.33	NA	18.80	0.99	0.38	0.48	<MDL	0.86	1.43	1.95	2.00
		> 20% ?																						
7/19/10	TB15B Isco	TOLLWAY 627	<0.059	<0.131	3.31	<0.086	0.112	0.0301	<0.017	<0.047	0.0092	7.86	60	386	65.0	0.084	<0.06	0.21	169	0.18	21.7	14.2	7.54	
7/19/10	TB15B Isco dupe	TOLLWAY 628	<0.059	<0.131	3.52	<0.086	0.112	0.0335	<0.017	<0.047	0.0087	7.87	60	386		0.086	0.07	0.20	169	0.17	21.6	14.8	12.6	
		difference	<MDL	<MDL	0.21166	<MDL	0.00033	0.00342	<MDL	<MDL	0.00052	0.00600	0.01800	0.00000	NA	0.00273	<MDL	0.00113	0.11468	0.00976	0.07287	0.53220	5.05022	
		% difference	<MDL	<MDL	6.40	<MDL	0.30	11.38	<MDL	<MDL	5.65	0.08	0.03	0.00	NA	3.27	<MDL	0.55	0.07	5.57	0.34	3.74	66.94	6.29
		> 20% ?																					66.94	
8/2/10	TB7B-1	TOLLWAY 630	<0.059	<0.131	6.05	<0.086	0.106	0.001	<0.017	<0.047	<0.0073	7.31	724	1438		0.073	1.58	0.35	289	<0.07	113	15.5	12.7	
8/2/10	TB7B-1 dupe	TOLLWAY 631	<0.059	<0.131	6.06	<0.086	0.108	0.001	<0.017	<0.047	<0.0073	7.34	702	1392		0.047	1.36	0.33	281	<0.07	112	13.7	12.8	
		difference	<MDL	<MDL	0.01339	<MDL	0.00131	0.00004	<MDL	<MDL	<MDL	0.03000	21.98900	46.00000	NA	0.02645	0.21921	0.01388	7.80003	<MDL	0.86946	1.74190	0.08090	
		% difference	<MDL	<MDL	0.22	<MDL	1.23	6.00	<MDL	<MDL	<MDL	0.41	3.04	3.20	NA	36.20	13.86	4.01	2.70	<MDL	0.77	11.26	0.64	5.29
		> 20% ?														36.20								
8/16/10	OR-1	TOLLWAY 649	<0.059	<0.131	3.69	<0.086	0.202	<0.00056	<0.017	<0.047	<0.0073	7.21	188	467	6.0	0.039	<0.06	0.17	123	<0.07	12.7	19.5	19.3	
8/16/10	OR-1 dupe	TOLLWAY 650	<0.059	<0.131	3.59	<0.086	0.197	<0.00056	<0.017	<0.047	<0.0073	7.23	187	463		0.040	<0.06	0.17	122	<0.07	12.6	19.4	19.6	
		difference	<MDL	<MDL	0.09651	<MDL	0.00452	<MDL	<MDL	<MDL	<MDL	0.01400	0.80000	4.00000	NA	0.00046	<MDL	0.00156	0.87012	<MDL	0.08022	0.08798	0.31891	
		% difference	<MDL	<MDL	2.62	<MDL	2.24	<MDL	<MDL	<MDL	<MDL	0.19	0.42	0.86	NA	1.17	<MDL	0.91	0.71	<MDL	0.63	0.45	1.65	2.51
		> 20% ?																						
																							mean RPD of all samples	5.48

APPENDIX I: Results of Geochemical Analysis of 4-Week Storage of Surface-Water Samples

Analyte		Original grab sample	Ambient sample Week 1		Refrigerated sample Week 1		Ambient sample Week 2		Refrigerated sample Week 2		Ambient sample Week 4		Refrigerated sample Week 4		TB9 4-week hold-time experiment #2 Ambient (room temp)		Refrigerated	
															% change	Significance	% change	Significance
		TOLLWAY 539	TOLLWAY	% change	TOLLWAY	% change	TOLLWAY	% change	TOLLWAY	% change	TOLLWAY	% change	TOLLWAY	% change				
Aluminum	Al	<0.037	<0.037		0.050	n/a	0.038	n/a	<0.037		0.041	n/a	0.078	n/a	119.79	Yes	320.79	
Arsenic	As	<0.108	<0.108		<0.108		<0.108		<0.108		<0.108		<0.108		<MDL		<MDL	
Boron	B	0.091	0.093	2.038	0.091	0.204	0.082	-9.561	0.081	-10.954	0.090	-0.736	0.099	8.981	-0.74		8.98	
Barium	Ba	0.249	0.250	0.483	0.252	1.116	0.241	-3.117	0.251	0.927	0.240	-3.652	0.250	0.258	-3.65		0.26	
Beryllium	Be	<0.00055	<0.00055		<0.00055		<0.00055		<0.00055		<0.00055		<0.00055		<MDL		<MDL	
Calcium	Ca	43.4	44.8	3.371	43.4	0.124	43.4	0.141	42.3	-2.434	45.7	5.355	44.1	1.651	5.35		1.65	
Cadmium	Cd	<0.012	<0.012		<0.012		<0.012		<0.012		<0.012		<0.012		<MDL		<MDL	
Cobalt	Co	<0.013	<0.013		<0.013		<0.013		<0.013		<0.013		<0.013		<MDL		<MDL	
Chromium	Cr	<0.0058	<0.0058		<0.0058		<0.0058		<0.0058		<0.0058		<0.0058		<MDL		<MDL	
Copper	Cu	0.0184	0.0184	0.076	0.0176	-4.173	0.0174	-5.311	0.0191	3.525	0.0176	-4.475	0.0205	11.204	-4.47		11.2	
Iron	Fe	0.0288	0.0353	22.603	0.0780	171.292	0.0313	8.802	0.0406	41.082	0.0069	-75.851	0.0721	150.870	-75.85		150.87	
Potassium	K	134	134	-0.148	133	-0.481	134	0.061	137	1.958	138	2.930	139	3.669	2.93		3.67	
Lithium	Li	<0.058	<0.058		<0.058		<0.058		<0.058		<0.058		<0.058		<MDL		<MDL	
Magnesium	Mg	23.8	24.6	3.485	23.7	-0.481	22.9	-3.492	23.1	-2.975	23.7	-0.420	23.4	-1.575	-0.42		-1.58	Yes
Manganese	Mn	0.293	0.157	-46.494	0.277	-5.630	0.0364	-87.572	0.266	-9.300	<0.0015	n/a	0.263	-10.352	-99.74		-10.35	
Molybdenum	Mo	0.047	0.043	-7.321	0.042	-10.163	0.047	1.664	0.049	4.039	0.052	11.149	0.049	5.613	11.15		5.61	
Sodium	Na	2598	2650	1.997	2641	1.654	2606	0.286	2652	2.072	2669	2.708	2679	3.123	2.71		3.12	Yes
Nickel	Ni	0.037	0.027	-28.491	0.040	8.470	0.033	-10.379	0.029	-23.301	0.026	-30.592	0.040	8.035	-30.59		8.03	
Phosphorus	P	<0.063	<0.063		<0.063		<0.063		<0.063		<0.063		<0.063		<MDL		<MDL	
Lead	Pb	<0.041	<0.041		<0.041		<0.041		<0.041		<0.041		<0.041		<MDL		<MDL	
Sulfur	S	38.9	40.3	3.777	39.3	1.018	38.0	-2.114	38.0	-2.258	40.6	4.467	40.1	3.083	4.47		3.08	
Antimony	Sb	<0.059	<0.059		<0.059		<0.059		<0.059		<0.059		<0.059		<MDL		<MDL	
Selenium	Se	<0.131	<0.131		<0.131		<0.131		<0.131		<0.131		<0.131		<MDL		<MDL	
Silicon	Si	4.41	4.44	0.640	4.44	0.781	4.34	-1.660	4.36	-1.071	4.40	-0.172	4.53	2.791	-0.17		2.79	
Tin	Sn	<0.086	<0.086		<0.086		<0.086		<0.086		<0.086		<0.086		<MDL		<MDL	
Strontium	Sr	1.60	1.61	0.345	1.60	-0.468	1.58	-1.188	1.61	0.144	1.59	-0.923	1.59	-0.687	-0.92		-0.69	
Titanium	Ti	<0.00056	<0.00056		0.00094		<0.00056		<0.00056		<0.00056		0.00141		<MDL		402.51	
Thalium	Tl	<0.017	<0.017		<0.017		<0.017		<0.017		<0.017		<0.017		<MDL		<MDL	
Vanadium	V	<0.047	<0.047		<0.047		<0.047		<0.047		<0.047		<0.047		<MDL		<MDL	
Zinc	Zn	0.0090	0.0113	26.312	0.0090	0.539	0.0107	19.035	0.0082	-8.262	0.0114	26.974	0.0129	44.184	26.97	Yes	44.18	
pH		8.29	7.92	-4.500	8.24	-0.555	7.96	-4.017	8.23	-0.712	7.87	-5.031	8.06	-2.811	-5.03	Yes	-2.81	
alkalinity		183	182	-0.718	181	-1.095	181	-1.166	182	-0.901	180	-1.546	182	-0.668	-1.55	Yes	-0.67	Yes
TDS, 180 C		7152	7214	0.867	7200	0.671	7151	-0.014	7198	0.643	7194	0.587	7180	0.391	0.59		0.39	Yes
TSS		25.6													not analyzed		not analyzed	
ortho P	oPO4-P	0.009	0.008	-17.344	0.006	-31.778	0.008	-10.106	<0.003	n/a	0.003	-63.229	0.011	20.081	-63.23		20.08	
Ammonia	NH3 -N	0.22	0.38	75.664	0.27	23.883	0.11	-49.734	0.27	24.208	0.07	-65.430	0.37	70.166	-65.43		70.17	
Fluorine	F	<0.8 *	<0.8 *		<0.8 *		0.27	n/a	0.26		0.21	n/a	0.20		-48.22		-48.83	
Chlorine	Cl	4324	4228	-2.233	4480	3.588	4411	1.995	4178	-3.380	4240	-1.954	4223	-2.347	-1.95		-2.35	
Nitrate	NO3 -N	<0.07	0.62	n/a	0.32		0.55	n/a	0.25		0.72	n/a	0.30		1968.60	Yes	744.07	Yes
sulfate	SO4	106	107	0.913	104	-1.253	105	-0.382	105	-0.330	106	0.053	106	0.109	0.05		0.11	
organic carbon	total NVOC	30.5	26.1	-14.506	25.2	-17.439	23.8	-22.060	27.5	-9.798	17.2	-43.669	20.9	-31.512	-43.67		-31.51	
	dissolved NVOC	21.1	22.6	7.260	24.3	15.100	20.8	-1.251	24.7	17.052	16.3	-22.731	21.4	1.431	-22.73		1.43	

APPENDIX J: Reproduction of Task List from Appendix B of the ISGS Proposal

"Appendix B. Task 2: Characterization of Runoff to the Des Plaines River at I-294

Reconstruction and addition of lanes on I-294 north near Des Plaines, Illinois, has raised issues regarding the quality of runoff to the Des Plaines River, which is the receiving water for runoff from portions of I-294. Environmental considerations raised during reconstruction planning have suggested the inclusion of a runoff treatment system that uses bioswales, which are wide, low-slope, vegetated ditches that detain and transmit runoff, that cause improvements of water quality through sedimentation of suspended solids and their load of adsorbed materials such as metals, uptake of nutrients by the plants and microbes, and breakdown of petroleum products in soil and the vegetative mat. ISTHA has requested that ISGS quantify the performance of the bioswales through time.

In order to properly assess the performance of the bioswales, it is important to quantify the current quality of runoff being discharged to the Des Plaines and compare to conditions after bioswale installation. By sampling and monitoring the current runoff, both directly from the road as well as the final discharge point at the Des Plaines River, it will be possible to identify the constituents that should be monitored after construction, identify the levels of constituents in the current discharge for comparison to future conditions, and assess the current treatment system effectiveness. Sampling is likely to include regular and grab samples, automatic sampling using composite and interval sampling methods, and automatic measurement of multiple water-quality parameters using dataloggers. Datalogged parameters are more limited in nature, and will likely act as proxy indicators of levels of constituents in the runoff, but the automatic sampling will be necessary to identify runoff events that occur between manual samplings. In previous studies, levels of constituents of concern have been calibrated to these proxy indicators, and a model has been used to predict the actual levels of the constituents of concern. Sampling in year 1 will help determine which constituents and sampling methods are the most cost effective and reliable, and those results will be used in determining the sampling strategy for the post-construction situation.

In addition, the effectiveness of individual bioswales will be investigated through sampling inputs versus outputs, and by measuring hydraulic parameters such as the Hydraulic Loading Rate (HLR) and the Hydraulic Residence Time (HRT), which have been shown to predict bioswale performance. Vegetation parameters may also be measured to help determine characteristics such as total vegetation cover, which also affect bioswale performance.

Item 1(Years 1-3): ISGS will quantify discharge volume to the Des Plaines River and selected dissolved and suspended constituents. Key points along the current and future runoff handling system will be monitored, currently expected to be two separate locations of future bioswale installation. Direct runoff from the roadway at an appropriate location will also be measured and sampled. Equipment required to sample runoff water and measure water-quality parameters will be purchased and installed. Water samples will be collected and analyzed. Costs for this task include purchase of automatic water samplers,

composite water samplers, multiparameter water-quality dataloggers, discharge measurement loggers, and field installation equipment, field installation and sampling costs, and sample analysis costs.

Item 2 (Year 1): ISGS will identify selected geochemical parameters that can effectively and efficiently be monitored to compare pre- and post-construction conditions. Parameters that can be measured using water-quality dataloggers will be utilized if possible.

Item 3 (Year 1): ISGS will measure hydraulic parameters of current runoff system.

Item 4 (Years 2 and 3): ISGS will measure volume and selected geochemistry of inputs and outputs to selected bioswales that have been constructed, and calculate removal efficiencies for selected parameters. Current plans include monitoring two different bioswales with differing parameters.

Item 5 (Years 2 and 3): ISGS will measure the hydraulic parameters once for each selected bioswale above after construction.

Item 6 (Years 2 and 3): Vegetation parameters will be measured annually for each selected bioswale above, including percent cover.

Item 7 (Year 3): By June 30, 2010, ISGS will submit a final report that contains data and conclusions. If additional monitoring is necessary, additional funding will be sought, and the report may be delayed until sufficient data are available."