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# Assessing the Effects of Riverbank Inducement on a Shallow Aquifer in Southeastern Wisconsin

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# ASSESSING THE EFFECTS OF RIVERBANK INDUCEMENT ON A SHALLOW AQUIFER IN SOUTHEASTERN WISCONSIN

by

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ABSTRACT

ASSESSING THE EFFECTS OF RIVERBANK INDUCEMENT ON GROUNDWATER QUALITY IN A SHALLOW AQUIFER IN SOUTHEASTERN WISCONSIN

by
Laura Fields-Sommers

The University of Wisconsin-Milwaukee, 2015
Under the Supervision of Professor Timothy Grundl

The state of Wisconsin is heavily reliant upon groundwater resources. In order to induce river water, implementation of shallow wells with close proximity to river systems is being used as a method to augment groundwater supplies in portions of southeastern Wisconsin. However, river bank wells (RBI) are vulnerable to contamination due to their close interaction with the surface water. The vulnerability increases when induced surface waters contain municipally treated waste water. The objective of this study was to determine the current and potential influences of riverbank inducement, recharge mechanisms of the well field, and to discriminate the sources of sodium and chloride entering the well field. This was accomplished through the use of tracers and groundwater modeling. The tracer suite included major ions, hydrogen and oxygen stable isotopes, bacteria, and personal care products and pharmaceuticals (PPCPs). Inducement of river water into the RBI wells was calculated to be 44-52%. The flow mechanisms were too complex to be explained by dispersivity alone, so the assumption of plug flow was abandoned. Recharge was found to occur in the spring. Sucralose and acesulfame were found to be the most suitable tracers for this system and proved that waste water effluent enters both RBI wells. Waste water effluent was found to be the major source of salt entering the well field with small contribution from road salt runoff. No pathogenic bacteria were entering the well field.

To

Julie Ann Fields,

My eclectic family,

&

All of my teachers

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LIST OF SYMBOLS AND ACRONYMS

δD: ratio of deuterium to hydrogen isotopes in parts per thousand

δO: ratio of oxgen-18 to oxygen-16 in parts per thousand

mMol/L: mili-mole per liter

AS: artificial Sweeteners; A synthetic sugar substitute

DO: dissolved oxygen

FIB: fecal indicator bacterial; sewage fecal tracers

GMWL: Global Meteoric Water Line; used in hydrogen and oxygen stable isotope analysis

LWML: Local Meteoric Water Line; used in hydrogen and oxygen stable isotope analysis

LEL: Local Evaporation Line; used in hydrogen and oxygen stable isotope analysis

PPCPs: personal care products and pharmaceuticals; soap, lotion, sunscreen, dental care products, fragrances, antibacterial products, food additives

RBI: riverbank inducement; draw of river water into an aquifer when a well creates drawdown in that aquifer

VAMPS: The Visualization and Analysis of Microbial Populations Structures; a collection of online tools for research; https://vamps.mbl.edu/index.php

WWTP: waste water treatment plant; aquatic sewage processing plant

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# Chapter 1

## Introduction

Historically, groundwater use has been prevalent in Wisconsin to the point where drawdown has become a concern in many parts of southeastern Wisconsin. In addition to excessive drawdown, the city of Waukesha has high radium concentrations in the deep aquifer it uses for municipal drinking water. To mitigate these issues shallow wells have been placed close to rivers with the intention of inducing water to flow from the river to the aquifer (Figure 1). Such wells are termed riverbank inducement (RBI) wells. By augmenting the aquifer's recharge and lessening the extent of drawdown, the technique can create a more sustainable water supply than can be achieved with normal wells. In addition, when the RBI wells are placed downstream of waste water treatment plant (WWTP) outputs, which are treating the water pumped from the same RBI wells, water is recycled locally and further increases sustainability.

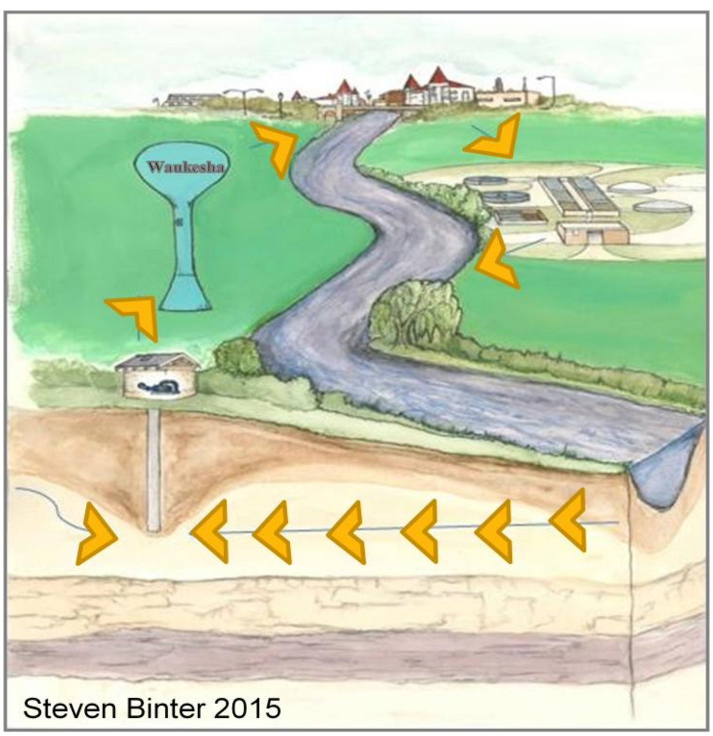


Figure1: Depiction of River Bank Inducement Cycling in Waukesha (Two RBI wells are present in Waukesha).

However the close interaction with surface water bodies poses potential risks of contamination, especially when the outfall from WWTPs enter those surface water bodies directly upstream of the RBI well fields. Recent studies have found micropollutants including pharmaceuticals, personal care products and other emerging contaminants to be commonly present in treated WWTP effluent (Luo et al., 2014; Mompelat et al., 2009; Heberer, 2002;). Additionally, micropollutants were found to be pervasive in surface water and groundwater systems worldwide (Balakrishnan et al. 2008; de Garcia et al. 2013; Farina et al. 2013; Bernot et al. 2013; Lin et al. 2011). This raises the possibility of future contamination in the shallow groundwater systems of the RBI wells.

An existing monitoring network including an RBI well field is located near the city of Waukesha (Figure 4). The RBI wells in the existing monitoring network are located adjacent to an urbanized section of the Fox River. In this section of the river a significant portion of the river consists of treated WWTP effluent from three upstream plants, creating an ideal field site. The monitoring network is well studied and much is known about its hydrology and stratigraphy. The complexity of the glacial till composing a majority of the shallow aquifer matrix in southeastern Wisconsin complicates the flow paths of induced water and makes tracking the induced water difficult. Having a set of reliable tools to trace the flow and identify the presence of WWTP effluent is needed.

The city of Waukesha is currently in the midst of a controversial application for a Lake Michigan diversion under the Great Lakes-St. Lawrence River Basin Water Resources Compact. The diversion would allow the city to discontinue its use of deep aquifer wells, some of which are exceeding EPA radium concentration limits. An alternative to this diversion would be adding more RBI wells. Therefore further study of this particular field site could prove useful to regulators, to the City, and to the public when considering the diversion request.

*History of the City of Waukesha Water Use*

Over the last one-hundred years, a regional drawdown of 500ft has developed within the deep aquifer of southeastern Wisconsin (Thorp, 2013). By 2006 the deepest cone of depression in the region lay under Waukesha (Cape and Grundl, 2006). The influence of this drawdown has reversed the natural flows of groundwater systems lying to the east of Waukesha. The groundwater divide between the Great Lakes Basin and the Mississippi groundwater system was previously to the west of the City and water from there naturally flowed towards Lake Michigan (CH2M HILL, 2013; WDNR, 2015; Figure 2).

Laurentian Great Lakes Boundary in Wisconsin

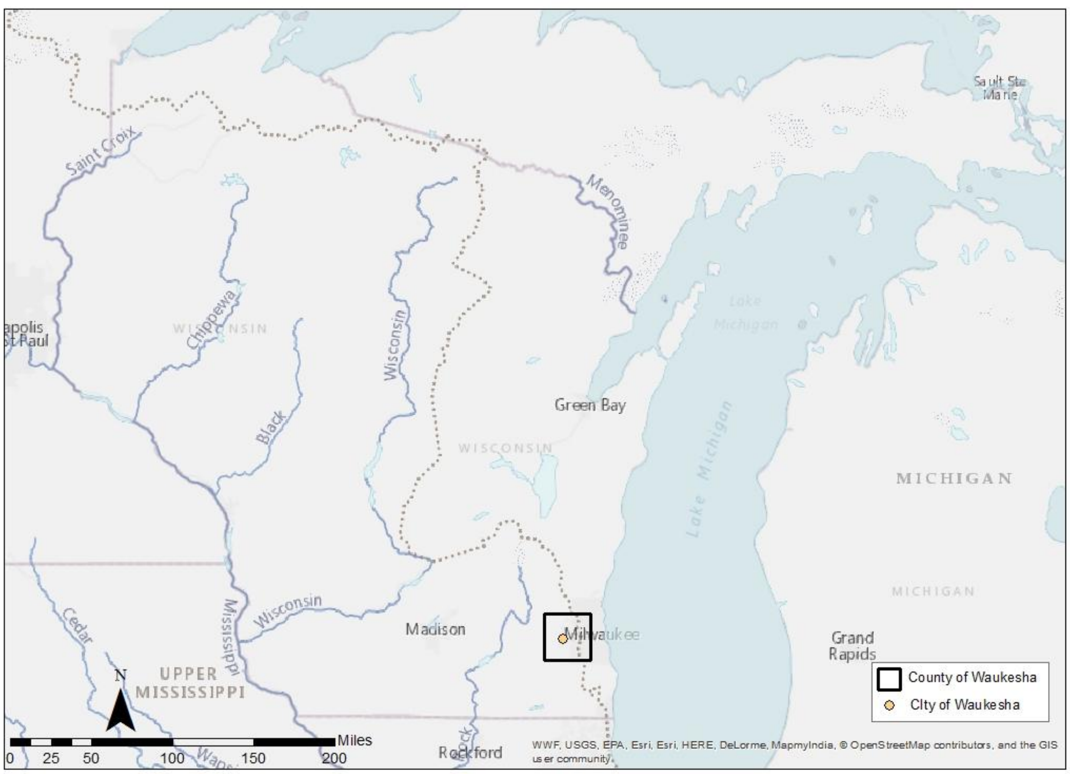


Figure 2. Study Area Location. The divide between the Great Lakes Basin and the Mississippi River Basin indicated by the dotted line. The Waukesha county straddles the divide whereas the city of Waukesha lies in the Mississippi River Basin.

Additionally, the deep aquifer contains dissolved radium and levels in the aquifer have reached up to three times the concentration limits set by the U.S. EPA (CH2M HILL, 2013). World Health Organization limits for $^{226}$Ra and $^{228}$Ra are 27 and 2.7 pCi/L respectively and the U.S. EPA limit is 5 pCi/L of $^{226}$Ra and $^{228}$Ra combined (Cape and Grundl, 2006). These limits were created due to the increased risk of cancer. Waukesha Water Utility currently meets the required limits through removal by hydrous manganese oxide treatment and blending with shallow aquifer well water (Waukesha Water Utility, 2014).


Figure 3.Current proposed diversion and return from Lake Michigan: Waukesha Wisconsin Diversion Application (WDNR 2015)

As of 2013 the City has been treating the water for radium, implementing water conservation, and blending the deep aquifer water with shallow well water, but the City claims these precautions will not be sustainable with predicted growth (CH2M HILL, 2013; WDNR, 2015). Therefore Waukesha has requested a diversion from Lake Michigan to replace the deep groundwater aquifer wells on which the city currently relies. The City is permitted to submit such a request under the Great Lakes-St. Lawrence River Basin Water Resources Compact due to its location within a county which straddles the Great Lakes surface water divide (CH2M

HILL, 2013). If this request is granted the City would be allowed to divert Lake Michigan water to the City. The City is legally bound to return it to the lake with the same or improved quality, which will be accomplished through discharge to the Root River in the Great Lakes Basin (Figure 3). As the first diversion request under the Compact it would set a precedent for other straddling counties and test the strength of the Compact.

# Chapter 2

# Background on Novel Tracers

*Hydrogen and Oxygen Stable Isotope Tracers*

Hydrogen and oxygen isotopes are ideal water flow tracers, as they are constituents of water molecules and not simply dissolved tracers. These isotopes behave conservatively and can differentiate small variability present in systems such as the Fox River in Waukesha (Gat, 1996). They have been commonly used as tracers in surface and groundwater bodies at both local and regional scales (eg. Chen et al., 2012; Athanasopoulos et al., 2011).

The major fractionation processes in the Fox River system, causing enrichment or depletion in isotopic signatures, are seasonal variations in temperature, evaporation and precipitation. In the spring there is higher discharge due to snowmelt and rain in the Wisconsin region. Low temperatures present during snow precipitation lead to low $\delta^{18}O$ values, and these low values are retained until the snow melts. Fractionation can also occur during partial melting of snow due to lighter isotope's preferential melting. In the summer the higher temperatures and evaporation lead to enrichment in $\delta^{18}O$ values in rain and river water (Gibson and Reid, 2010; Smith and Willey, 1977; Kendall, 2004; Bowser et al., 1994; Gat, 1996).

Precipitation falls along a gradient due to fractionation processes. The pattern of precipitation from ocean water has been termed the global meteoric water line (GMWL). The GMWL occurs as a direct result of the consistent fractionation processes occurring with marine evaporation and precipitation. However, local patterns and variations range widely based on the properties of the region resulting in local meteoric water lines (LMWL). A LMWL was defined by Swanson et al., 2006 for Madison, Wisconsin. Another useful tool that can be coupled with an LMWL is a local evaporation line (LEL) which is a function of the environment of a particular surface of water and typically has a slope of 5 (Gat, 1994; Gibson and Reid, 2010; Athanasopoulos et al., 2011).

Stable isotope analysis is convenient at this location due to the fact that water being drawn from deep aquifer for municipal use has a significantly lighter isotopic signature than the shallow wells or the Fox River. The deep aquifer contains old water from the Pleistocene era which was much colder and therefore precipitation and infiltrating water in that time was isotopically much lighter (Klum et al., 2008). The cities of Brookfield, Waukesha, and Sussex use primarily deep aquifer water causing the effluent from their WWTPs to have light isotopic ratios. The shallow aquifer contains modern water, recharged at higher temperatures and therefore has significantly heavier isotopic ratios than the deep aquifer, in accordance with the LMWL.

### *Bacterial Analysis*

<u>16s rRNA sequencing</u>

RNA based bacterial analysis utilizes sections of nucleic acid sequences that are specific to the taxa being analyzed as indicators of that taxa's presence in a sample. Sequencing allows the use multiple RNA indicators through a single technique without needing a known genetic marker for each taxon. Sequencing of the specific 16 strand of RNA is a commonly used method for analysis of taxonomic frequency and distributions because this strand is naturally hypervariable in microbial populations (Logue et al., 2008; Mclellan & Eren, 2014). The Visualization and Analysis of Microbial Population Structure (VAMPS) Project was used for a cloud based storage and visualization of 16s rRNA sequencing data. This method is a broad tool for understanding the scope of the community but more specific methods must be used for reliable quantification of a chosen taxon.

Fecal Bacteria Tracers

Once specific taxa are chosen for quantification indicator sequences may be developed for their quantification by quantitative polymerase chain reaction (qPCR). Polymerase chain reaction (PCR) employs the use of purposefully chosen oligonucleotide primers to copy and amplify source regions of DNA and/or RNA for the chosen indicator sequence. PCR is limited to presence absence analysis. qPCR is a real time reaction that goes a step further and permits quantification of a specific sequence using fluorescent reporter DNA probes (Logue et al., 2008). qPCR is a standard method for quantifying specific bacterial indicators, which are proxy to the quantity of the bacteria itself (such as the sewage tracers mentioned below). The presence of the indicator sequence simply indicates the presence of DNA and/or RNA of the bacteria and does not distinguish between living and dead bacteria.

Fecal indicator bacteria (FIB) are the standard sewage fecal tracers used globally for environmental regulations. The most common FIB are E. coli, enterococcus, and fecal coliforms. Recent research is reaching a consensus that FIB are not source specific and cannot trace human fecal matter specifically (Field & Samadpour, 2007). E. coli and enterococcus are commonly found in many mammals and birds. They also have been found to have poor correlation with human pathogens such as viruses. There is growing evidence that E. coli and entercococci can survive, grow, and establish populations in natural environments such as lakes, streams, algal mats, beach sand, and plant cavities. The 16s rRNA genes in some of these free growing FIB suggest the evolution of unique environmental strains (Mclellan & Eren, 2014).

Lachnospiraceae and Bacteroidales have been singled out as more human specific tracers. Lachnospiraceae has been found to be highly abundant in human sewage in U.S. cities and rich in human related indicators. Bacteroidales have also been found to have a high degree of host specificity rich in human related markers. Specific regions of 16S rRNA strands have been singled out to be used in qPCR (Field & Samadpour, 2007; Mclellan & Eren, 2014).

Aquifer versus River Bacterial Communities

Research suggests that bacteria thriving in WWTP effluent would encounter many obstacles in traveling from a WWTP outfall, through a river, and a two year flow path through aquifer sediment substrate to the wells (Thorp, 2013). WWTP effluent has the most variable aquatic microbial community and is highly dependent on the nature of the sewage and the treatment processing to which it is subjected. The environmental parameters of surface water are vastly different than that of groundwater in regards to sunlight, nutrient availability and concentrations of dissolved oxygen; groundwater being depleted in all three. The soil matrix through which groundwater passes is much more complex than a river system. Soil is known to contain the highest microbial diversity on earth (Barton et al., 2011; Da Rocha et al., 2013). This diversity present in soils will provide competition with which most of the sewage specific bacteria would not be able to compete. Many experiments have shown new organisms experience difficulty when introduced to soil unless that soil is sterilized, likely due to the antimicrobial chemicals released by soil microbes (Gottlieb, 1977).

### *Artificial Sweeteners as Tracers*

Artificial sweeteners (AS) are synthetic compounds used as a replacement for sugar in food, beverages, pharmaceuticals, dental products, and animal feed. They are a portion of a larger grouping of chemicals called pharmaceuticals and personal care products (PPCPs), which represent a wide range of anthropogenic products including: soap, detergent, disinfectants, dental products, insect replants, screen agents and medications (Kahle et al., 2009). PPCPs are high production volume chemicals and are consumed in large quantities across the globe. AS are anthropogenic and xenobiotic, meaning that AS are typically released into aquatic environments through municipal waste waters or industrial agricultural waste. The specific chemicals are highly dependent on local consumption which changes by geographical and cultural location. AS are very persistent in the environment due to stability against environmental degradation. The metabolic stability of AS allows sweeteners to be consumed and excreted unchanged. A handful of AS have been found in treated drinking water. Though some AS such as saccharin are degraded up to 90% in WWTP treatment processes, acesulfame and sucralose pass through the process mainly unchanged. Acesulfame and sucralose are among the most stable AS compounds. Sucralose has been found to be resistant even to ozone (Wolf et al., 2012; Ens et al., 2014). Acesulfame was found to be a dependable sewage tracer in groundwater (Engelhardt, 2013).

# Chapter 3

## Setting

*Study Area*

The head waters of the Fox River watershed are located in Lisbon in southeastern Wisconsin. The entire river basin spans 6,884 square kilometers, delivering water into the Illinois River in northeastern Illinois, which in turn enters the middle Mississippi. The river has a low slope with an average of 0.76 meters per kilometer.

The Upper Fox River basin in Wisconsin spans 2,429 square kilometers. The scope of this study includes the 326 square kilometer section from just below the head waters in Sussex, WI, through Waukesha, and down to Big Bend, WI. The landuse is mostly urban, with some farmland and minor forestland. Approximately a fourth of nutrient loading in this watershed comes from sewage point sources (SPARROW, 2002). The Fox River has two tributaries at this point: Popular Creek at Brookfield and the Pewaukee River at Pewaukee, which drains Pewaukee Lake.

*Topography of Fox River Basin*

The Fox River basin topography has been shaped by the Wisconsin Glaciation, the most recent major advance of the North American ice sheet complex which included the Laurentide ice sheet. The glaciers retreated around 11,000 years ago, leaving moraines, drumlins, kames, outwash planes and lake basin deposits across southeastern Wisconsin. The Fox River developed on glacial till and outwash, characterized by gently rolling hills, and moderate land slopes. The glacial till in the Fox River region in Waukesha consists of a heterogeneous mixture of clays, silts, sands, and gravels (Thorp, 2013).

*Site Location*

An existing monitoring network from previous research was maintained. The network consists of eighteen sampling sites: seven high capacity wells, seven river locations, one artesian spring and three Waste Water Treatment Plants (WWTPs). The sites are located in the Root, Menomonee, and Upper Fox River watersheds of Waukesha and Milwaukee Counties, Wisconsin (Figures 4 & 5). Coordinates can be found in Appendix A.

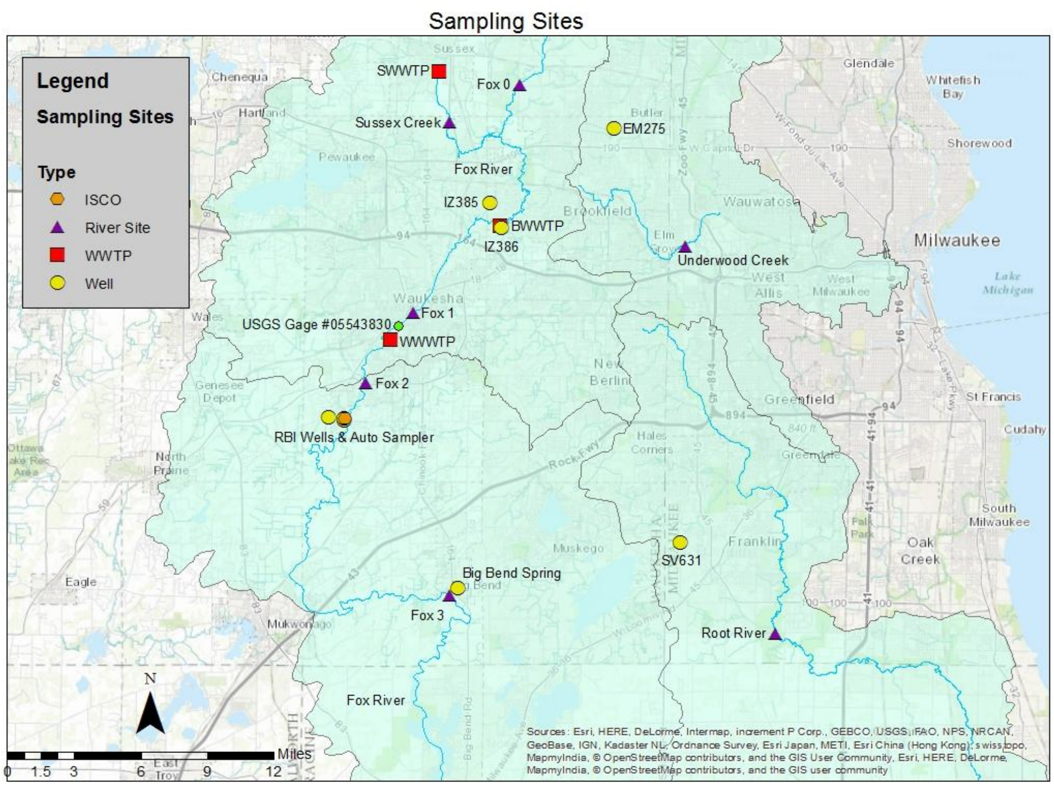


Figure 4. Map of all sampling sites, with light blue indicating the watersheds of the sampling sites.

The main sites used in this study are the WWTPs, Fox River sites, and Waukesha well sites. The WWTPs included the Waukesha, Brookfield and Sussex treatment plants. All four Fox River sites are in the upper Fox River watershed (Fox 0-3). Fox 0 is upstream of all WWTP outfalls, Fox 1 is below two of the outfalls, the Fox 2 is below all three outfalls, and the Fox 3 is much further downstream where groundwater and tributary inputs have diluted the effluent.

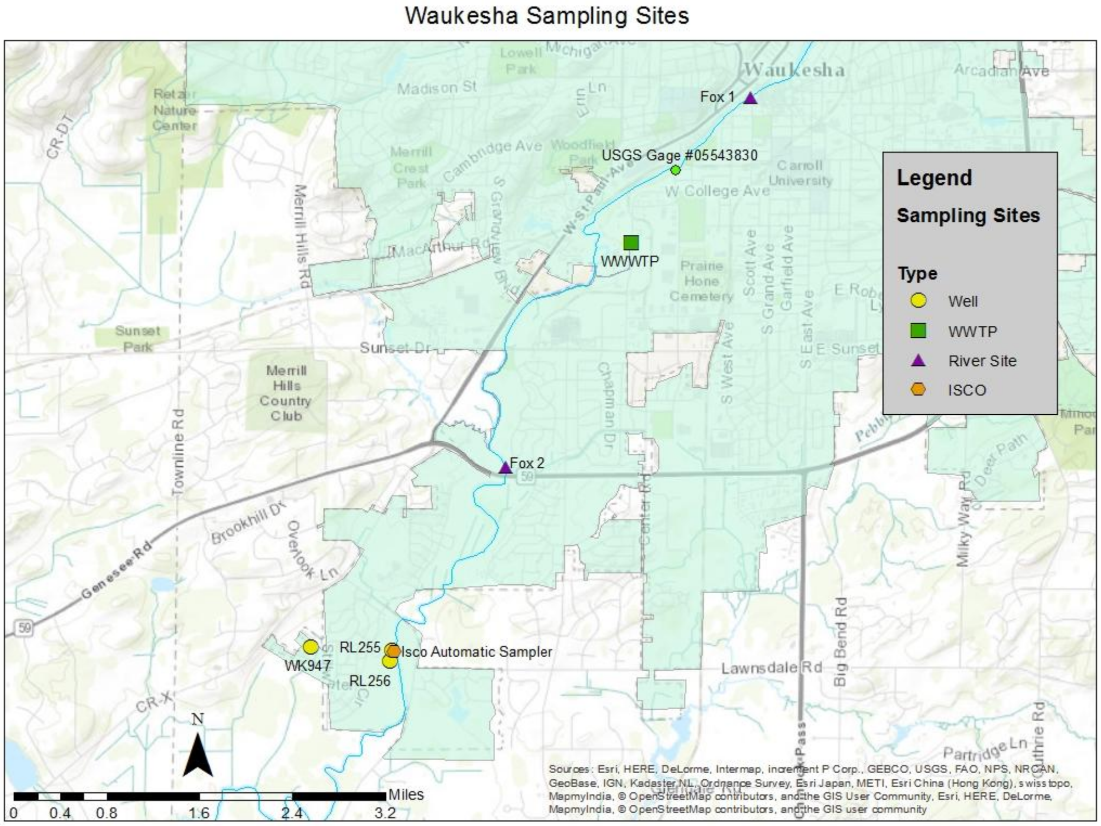


Figure 5. Map of the Waukesha sampling sites, with light blue indicating urban landuse.

The wells maintained by the Waukesha Water Utility are all screened in a gravel layer in the shallow aquifer. The upper portion of the shallow aquifer consists of glacial and alluvial materials laid down during the Pleistocene. The New Berlin Member of southeastern Wisconsin is complex with vertically and horizontally heterogeneous units which have highly variable thickness. It has two distinguishable facies, the upper being a till unit and the lower being a sand and gravel unit. Both units have significant amounts of clay for cation exchange (upper- 17% and lower 13%; Thorp 2013). The lower portion of the shallow aquifer consists of Silurian dolomite and is separated from the deep aquifer by impermeable Maquoketa shale. The RBI wells are RL255 screened from 90 to 125ft, 225 ft from the river and RL256 screened from 62 to

143 ft, 83 ft from the river. WK947 is screened in the same aquifer but with no hydraulic connection to the Fox River, is located 1,500 ft from the riverbank. It is screened from 83 to 105ft just above the Silurian dolomite. Additionally, the Teledyne-Isco Automatic sampler was positioned next to RL255 on the Fox River downstream of Fox 2. Well construction reports can be found in Appendix A.

Background sites include an artesian well, three river sites, and a mixture of four dolomite and standing gravel aquifer wells (Figure 4). They are not used directly in this study, but have been collected for comparison and potential future use. Located in the Fox River Watershed are Big Bend Spring, an artesian well located near Fox 3, and Sussex Creek, located just below the outfall of Sussex WWTP. In the Root River Watershed is the Root River site, hydrologically comparable to Fox 2. In the Menomonee Watershed is Underwood Creek, which has been hydro-modified with cement bedding and channelization. The wells maintained by Brookfield Water Utility are wells: IZ385, IZ386, and EM285; screened in Silurian dolomite. In the city of Franklin is well SV631 which supplies water to a private school and is screened in a shallow sand and gravel aquifer.

# Chapter 4

## Previous Fox River Studies

*Contribution of WWTP Effluent to River Flow*

Holzbauer (2010) determined the contributions of WWTP effluent to the Fox River annually at low flow conditions. The four sites analyzed by Holzbauer were also used in the current study. They are defined in the Setting: Site Location section. The Fox River discharge was determined using USGS gage #05543830 for annual flow conditions (Figures 4&5). Collected samples were extrapolated to annual low flow conditions. Fox 0 effluent contributed 0% of the annual flow because it is upstream of all WWTPS. Effluent contribution increased 28% at Fox 1, downstream of Brookfield WWTP and Sussex WWTP. The maximum effluent contribution of 40% was found further downstream past the outlet for Waukesha WWTP at Fox 2. Fox 3, located far downstream in Big Bend was found to have a decreased contribution of 23% due to dilution (Holzbauer, 2010; Thorp, 2013).

*MODFLOW Numerical Modeling*

Feinstein et al., 2012 used MODFLOW to quantify heterogeneity of subsurface sediments, interactions between groundwater and surface water, and stresses on the aquifer system in order to estimate the percentage of induced river water in the RBI wells. The model domain was broken into three-dimensional, finite-difference cells with layering based on the amount of consolidated deposits. Recharge inputs were approximated from the surface bodies of water expected to act at sinks and water withdrawals were approximated from pumpage out of high capacity wells and discharge to dolomite quarries. Figure 6 shows the hydraulic zonation of the sediments in a model transect containing the RBI wells. The surface sediments between the Fox River and the RBI wells are primarily silts and clays. The sediments were found to be highly heterogeneous with irregular flow paths which were most sensitive to the continuity of coarse grained deposits.

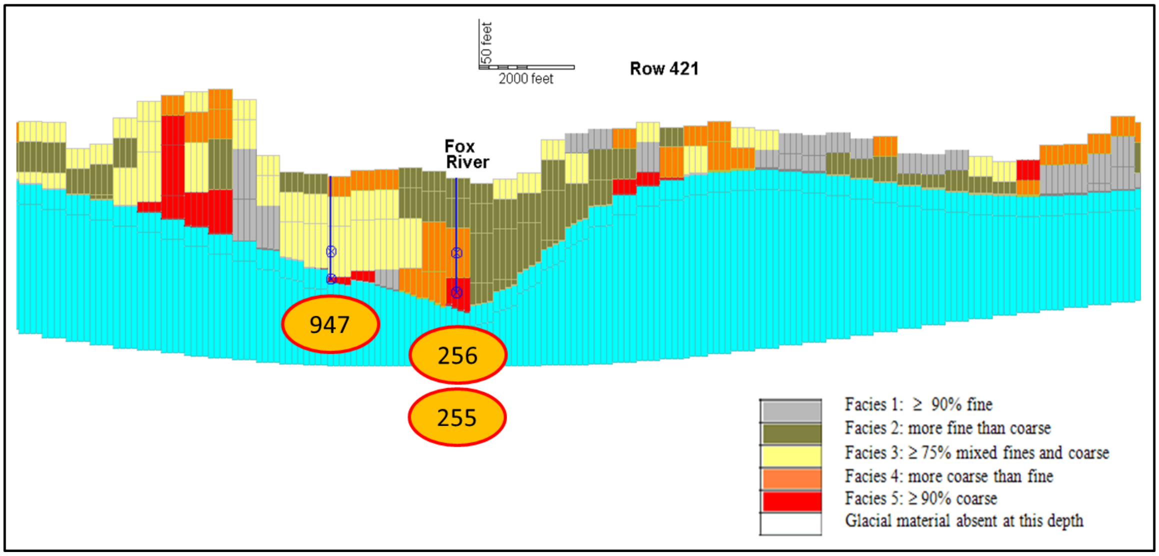


Figure 6. Interpolated stratigraphy from MODFLOW identifying the fine facies material along a crossection containing the wells, perpendicular to the Fox River which crosses the transect was labeled. Transect location is mapped on Figure 5. Modified from Feinstein et al., 2012.

Two models were developed to account for the uncertainty of hydraulic conductivity zones which vary over short distances in this region. One emphasized the connectedness of the fine grain deposits (clay, silt, silty clay, hardpan) and estimated that 31% of the water in the wells came from the River at steady state. The other model emphasized the connectedness of coarse grained deposits (sand, gravel, mix of sand and gravel) and estimated that 41% of the water in the RBI wells came from the River at steady state. No direct hydraulic connection was found between the River and WK947.

A particle tracking routine for water originating in the river was performed to determine the flow paths between the river bed and the RBI wells. . The flow paths were found to originate downstream of the RBI wells. The water does not follow a direct path from the river to the wells. Distances up to 1,000ft for RL255 and 2,000 ft for RL256 were estimated for the flow-paths, along with estimated flow times 0.7-0.9 years for RL255, 1.0-2.5 years RL256. The simulated sources of water entering the RBI well field over time was modeled (Figures 7 & 8). There was a rise in induced stream flow predicted until WK947 came on line four years after pumping began. This was followed by a drop in contribution and another slow rise to a steady state between approximately 10 and 12 years after pumping began (Feinstein et al., 2010).

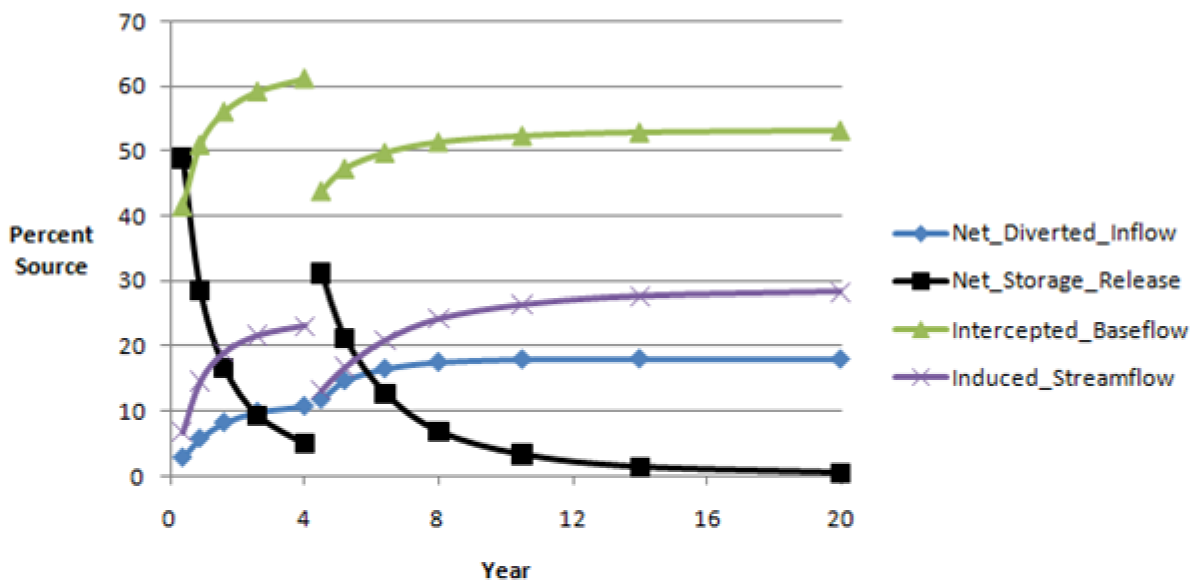


Figure 8. Analysis of source water to Waukesha RBI well field for 2005-2010 pumping rates. Coarse-favored model (Feinstein, 2012). Direct contribution of river water to the RBI wells is shown in purple.

*Chemical Analysis & PHREEQC Modeling*

River Major Ions

Thorp (2013) used chemical analysis of major ions and PHREEQC modeling to investigate the occurrence of RBI. Sodium and chloride concentrations were used as tracers of effluent and the results in the Fox River mirrored the contribution estimated in the Holzbauer in 2010 study (Figure 9). Fox 0 had the lowest concentrations of sodium and chloride. Fox 3 had concentrations slightly higher than Fox 0. Fox 2 had the highest concentrations and Fox 1 had concentrations just below those of Fox 2. The concentration in the WWTP effluent samples had the highest concentrations. Thorp therefore concluded that sodium and chloride increases indicated influence from treatment plant pollution sources and that sodium and chloride would be an adequate tracer of RBI in this system.

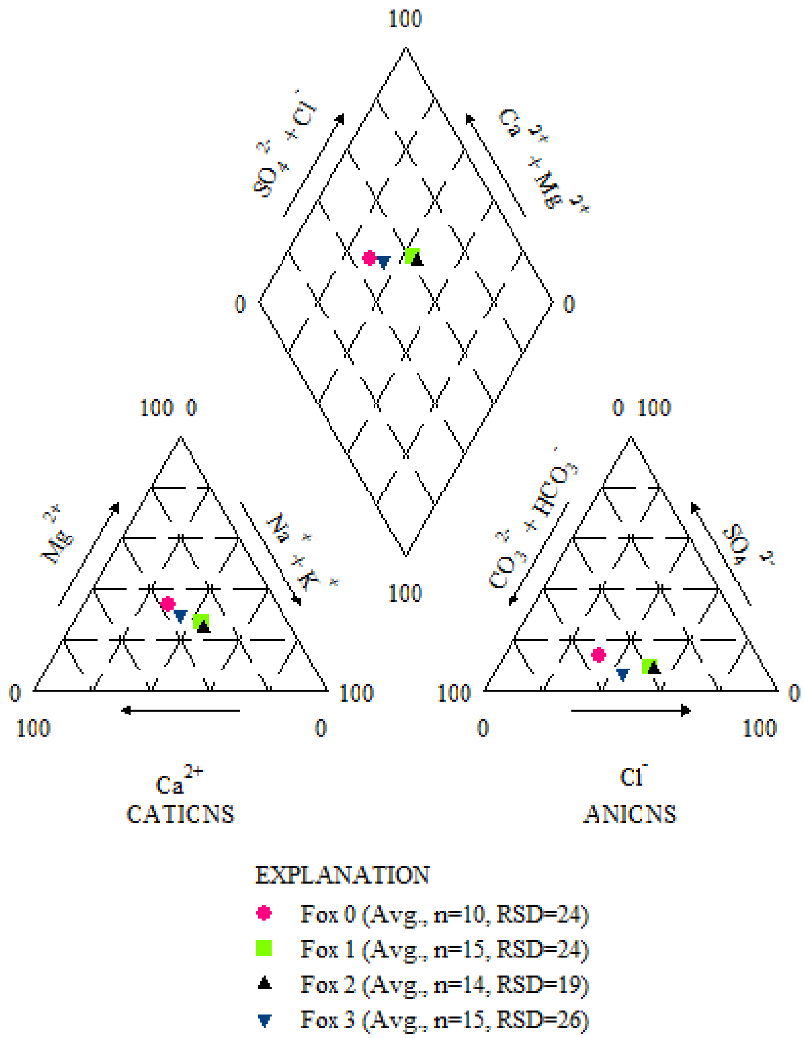


Figure 8. Piper diagram of major ion concentrations in Fox River Sampling Sites, number of samples used and there relative standard deviations are indicated in the legend. (Modified from Thorp, 2013).

Well Major Ions

The well WK947, known to be hydrologically outside of the influence of the river, showed no significant change in either element. Initial monitoring of the two RBI wells (RL255 and RL256) was above the background concentrations of WK947, indicating a connection with the River existed prior to pumping. Records from past show a clear increase in sodium and chloride levels since pumping began, as seen in Figure 10 (Thorp, 2013). The concentrations of sodium and chloride were immediately between the values for WK947 and Fox 2, supporting the occurrence of RBI in RL255 and RL256. The trend of sodium and chloride breakthrough curves indicated the time in which the more saline Fox River water started to enter the well field. The concentrations of sodium and chloride along the Fox River suggested that salt inputs into the river (road salt and WWTP effluent) contributed the majority of sodium and chloride to the RBI wells.

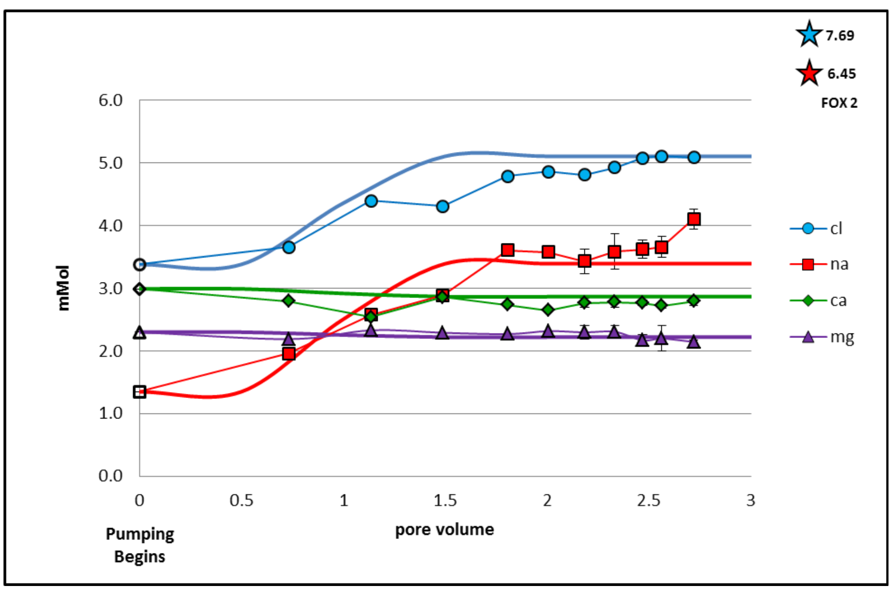


Figure 9. Major ion concentrations in RBI wells RL255 over time. An average of Fox River water sodium and chloride concentrations are depicted to scale in the upper right hand corner (2007-2012; n=12). Thick solid lines represent transport modeling using PHREEQC (Thorp, 2013).

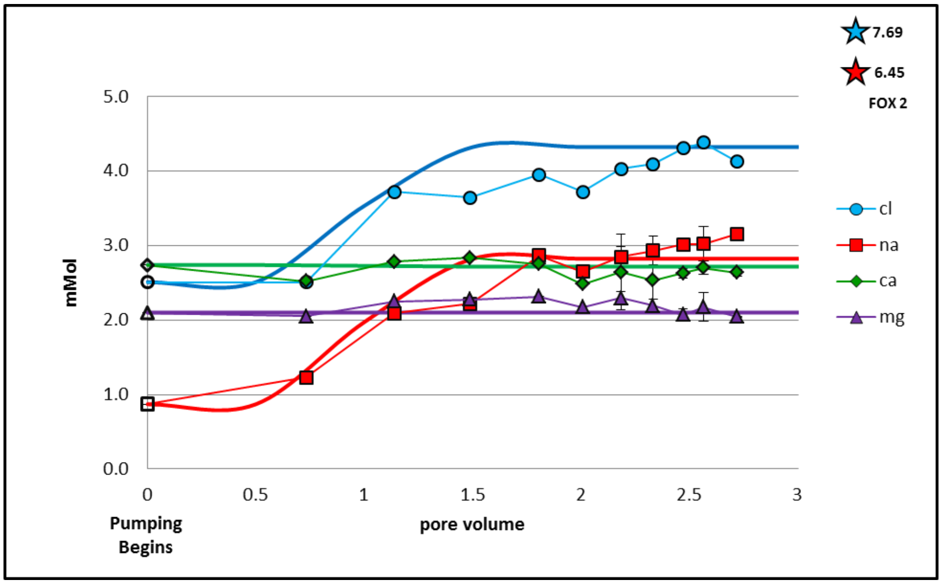

Figure 10. Major ion concentrations in RBI wells RL256 over time. An average of Fox River water sodium and chloride concentrations are depicted to scale in the upper right hand corner (2007-2012; n=12). Thick solid lines represent transport modeling using PHREEQC (Thorp, 2013).

PHREEQC Modeling

Thorp used inverse modeling to determine the geochemical processes occurring during RBI in both wells. The inverse model determined that 40% of the water in RL255 came from the River and 35% of the water in RL256 came from the river, consistent with the Feinstein et al., 2012 result of 31% and 41% induced water in RL255 and RL256 respectively. Further explanation for methods can be found in the inverse modeling methods section on page 27.

Further modeling of the RBI flow-path used chemical changes deduced from inverse modeling. The solid lines in Figure 10 represent the best-fit results of a transport modeling system using PHREEQC code. The transport routine in PHREEQC uses a one-dimensional plug flow representation of the flow regime that can include advection-dispersion, cation exchange, and mixing of induced water with original groundwater (Parkhurst, 1995; Thorp, 2013). The modeling and observed data were considered to be similar enough to provide conclusive evidence of inducement in the two wells. The advective front calculated from the breakthrough curve occurred in July 2008, approximately two years after pumping began. The breakthrough curves indicated travel time from the Fox River to the wells to be about two years, matching the Feinstein et al., 2012 results of 0.7-0.9 years for RL255, 1.0-2.5 years RL256.

# Chapter 5

## Relevance and Research Objective

Through the use of RBI wells in southeastern Wisconsin, river water containing WWTP effluent is entering the shallow aquifer that is being pumped for municipal uses. There is a need to develop a set of tracers able to conclusively identify the presence of effluent. The purpose of this proposed research is to determine the current and potential influences of riverbank inducement (RBI) on the shallow aquifer. An existing network of monitoring wells, including two RBI wells in Waukesha County, provides an ideal field site. Six years of background data have already been collected on this site and a plethora of information has been gathered on the local hydrology and geochemistry. The wells also induce water from the Fox River, which contains a significant flow of treated municipal waste water. The specific objectives of this study are twofold:

1. To define recharge mechanisms of the RBI well field using hydrogen and oxygen stable isotope tracking. Further sampling on a time scale pertinent to river flow would allow clearer definition of recharge mechanics.
2. To discriminate the source(s) of salt entering the well field using geochemical tracers. It is important to find a reliable tracer which can conclusively identify the presence of waste water effluent in shallow aquifers.

# Chapter 6

# Methods

*Monitoring Network*

A synopsis of the timing and locations of all of the sampling methods and analysis may be seen in Table 1. The monitoring network was sampled in the spring, summer and fall. This is the same as previous research and is designed to capture information pertinent to groundwater. Sampling was conducted during spring groundwater recharge, late summer baseflow conditions, and late fall groundwater recharge while the river was at baseflow conditions: when the aquifer has the most influence over surface water. Each site type required specific collection techniques and field measurements for selected physical and chemical properties.

Table 1. Synopsis of timing and location of sites sampled for each method of sampling and analysis used.

| Sample Type | Monitoring Network | Spring Melt | Automatic Sampler | Major Ions | Stable Isotopes | Bacteria Analysis | PPCPs |
|---|---|---|---|---|---|---|---|
| Years Collected | 2005-2015 | 2014 & 2015 | 2014-2015 | 2005-2015 | 2009-2015 | 2014 | 2015 |
| Frequency | Once per collection period: Spring, Summer, & Fall | Collected on all known thaw dates: Spring | Daily Samples: April-October, December | All Monitoring Network samples; Auto-sampler: 1per week | All Monitoring Network samples; Auto-sampler: 1per week | Fall Samples: WWTPs (3), Fox 0, Fox 2, RL255, RL256, WK947 | Spring Samples: Sussex & Waukesha WWTPs, Fox 0, Fox 2, RL255, RL256, WK947 |

*Field Methods and Equipment*

For stream sites collection was conducted during base flow conditions as determined by USGS gage station 05543830 Fox River at Waukesha, approximately 0.7 miles downstream from Fox 1 and 5 miles upstream from the Teledyne-Isco automatic sampler (Figures 4 & 5). A Teflon bailer was used to collect water at 5-10 equidistant intervals across the river and composited to ensure a representative sample. At each well house water was collected using YSI

3550 flow-through chamber with tubing connecting raw water tap with the chamber input and outflow hose emptying into a 1L Nalgene bottle. Well pumps ran for 10 minutes prior to collection to ensure that the sample was a representative groundwater sample. At each WWTP a 24 hour composite sample was taken by staff and refrigerated in a 1L Nalgene bottle with as little air as possible to reduce exposure to oxygen. The samples were picked up the next morning.

Once water samples were collected they were kept cool until filtered, within 24hrs using sterile 0.2µm regenerated cellulose filters. Up until July 2014 filtering was conducted in the field using plastic syringes. Following July 2014, a vacuum pump manifold with the vacuum set at -20 kpa was used. Two 125 mL Nalgene bottles of filtrate were kept for major ion analysis. The cations bottle received 1 mL of 4N trace metal grade nitric acid for preservation. One 15 mL polypropylene conical tube of filtrate was kept for isotopic composition. All bottles were capped, sealed with Parafilm and stored at $4^{o}$C until analysis.

Dissolved oxygen, electrical conductivity and temperature were measured for all sites excluding WWTPs. Dissolved oxygen was taken using YSI Model 52 oxygen meter, calibrated to barometric pressure from a standard handheld barometer. CHEMetrics colormetric ampoule kits K-7512 (for high oxygen) and K-7501 (for low oxygen) were used as replicate measurements of dissolved oxygen. Electrical conductivity was measured using a YSI 3500 water quality meter through 2013, then a YSI Pro30 Conductivity Meter was used. River locations were measured with the meters on the bank and the probe as far into the river as possible to ensure the most representative measurement. In the well locations the probes were situated in the collection bottle at the end of the outflow hose. Finally in the artesian spring, the probes were positioned directly in the outflow waters.

Chemical parameters that are subject to rapid change were tested at river and well sites- pH, alkalinity, ferrous iron (often dropped due to its ubiquitous absence), and sulfide. pH was measured using an Accumet 1002 pH meter by Fisher Scientific, calibrated to pH of 4.0 and 7.0. Alkalinity was tested by filtering a 50mL sample and titrating it to 4.50 pH using 0.02N hydrochloric acid. The total acid added was determined by the mass difference between original 50mL sample and mass of sample post titration, using an Ohaus SP402 portable scale. Alkalinity for samples that could not be titrated in the field, i.e. WWTP effluent, were estimated by charge balance. Ferrous was measured with CHEMetrics K-6210 kits and sulfide with CHEMetrics K-9510 kits.

Spring Melt Samples

In addition to the monitoring network samples, hand collected samples were taken on the first warm days of the spring, above $0^{o}C$, when thawing of snow and ice cover was anticipated. The samples were collected with the same methods as river samples in the monitoring network. The sites included were Fox 0 through Fox 3, though sites where ice cover was too thick to break through with a pick-axe were not sampled.

Teledyne-Isco Automatic Sampler

Teledyne-Isco Automatic Sampler, Model 6712, with 720 submerged flow probe module was implemented to collect daily samples from spring 2014-spring 2015. The 720 submerged flow probe module used a differential pressure transducer to measure the level of the flow stream every 30 minutes. The sampler was placed in the field on April 1, 2014 and ran through September 23, 2014, collecting daily samples and storm event triggered samples. Event triggering proved to be problematic and the sampler consistently missed storm events. After September 23rd the sampler was set with a simple daily schedule and no event trigger. However, due to timing no storm event was actually measured. A full listing of the samples can be found in Appendix B. Samples remained in the sampler for a maximum of 24 days and were processed as the WWTP samples were. Weekly samples, chosen on a basis of estimated average discharge for the week, and rainfall event samples were chemically analyzed.

### *Laboratory Analysis*

#### Major Ion Analysis

Anion analytes, $Cl^-$, $SO_4^{2-}$, $NO_3^-$, and $PO_4^{3-}$, were analyzed using ion chromatography on a DIONEX ICS-1000 IC System with Chromeleon version 6.80 SR7 workstation software. Cation analytes, $Ca^{2+}$, $Mg^{2+}$, $Na^+$, $K^+$, were analyzed using atomic absorption spectroscopy on a SOLAAR with version 11.02 workstation software. Anion and cation standards were prepared from commercial 100 mg/L stock solutions. Calibrations were performed at the beginning and end of every analytical run to account for drift. Ion concentrations were calculated independently of the prefore mentioned software, using calibration curves constructed from the averages of the beginning and ending standards. Averages of three to four runs were used for RL255, RL256, and WK947. The standard deviations used to create error bars.

#### Load Calculations

Ion loads were calculated for all of the measured major ions mentioned in the previous section for the Isco Automatic Sampling Site between the months of March and October 2014. Load estimation techniques from U.S. EPA national management measures were used (U.S. EPA, 2003). The defining equation is:

Equation 1.

$$Load\ (\frac{mg}{s}) = \int_t^1 (c_t q_t)\, dt$$

Where k is a constant for unit conversions, $c_t$ is concentration (mg/L) at time t, and $q_t$ is discharge (L/s) at time t. Discharged was calculated by USGS from gage #05543830, which was found to be in direct concert with pressure gages at the Isco automatic sampling site. Loads were calculated for each month in milligrams per second. In 2014 the spring melt was determined to occur between March 7th and March 22nd.The percentage of the spring melt's load contribution during the sampling period was calculated using Equation 2 and is considered to be the load delivered by the spring melt.

Equation 2.

$$\%\, Yearly\ Load\ due\ to\ Spring\ Melt = \frac{\sum Spring\ Melt\ \ Load\ \left(\frac{mg}{s}\right)}{Extrapolated \sum Loads_{Apr-Oct}\ \ \left(\frac{mg}{s}\right)} * 100$$

The road salt load during the spring melt was calculated using equations 3 and 4 for sodium and chloride loads respectively. $Cl_{spring\ melt}$ and $Na_{spring\ melt}$ represent the average of loads calculated for the samples taken during the spring melt as determined for 2014. These spring melt samples were expected to be the high loads for the year. An average of samples taken during non-spring melt (2014) was assumed to reasonably account for the loads over a whole year, excluding the spring melt. Therefore, the average values in the equations were extrapolated from average of all of the loads calculated for the samples actually taken to estimate the average sum load of a month in 2014. The extrapolated average was considered to be the ambient load.

Equation 3.

$$Cl_{road\ salt} = Cl_{spring\ melt} - Cl_{Extrapolated\ Average}$$

Equation 4.

$$Na_{road\ salt} = Na_{March} - Na_{Extrapolated\ Average}$$

Stable Isotope Analysis

A ring-down spectrometer, Picarro AN017 auto analyzer, was used to analyze $\delta^{18}O$ and $\delta D$ stable isotopes. Three calibration standards were chosen within the appropriate span of isotope values. They included KONA water taken from the deep ocean off of Kona, HI, water from well GB bf190 in Green Bay, WI, and water from well DNR BH423 in Pewaukee, WI. The true values of the calibration standards were analyzed against the National Institute of Standards and Technology (NIST) standards. The known calibration standard values were plotted against measured values on separate plots, one for $\delta^{18}O$ and one for $\delta D$. Linear regressions of standards were calculated for each sample run, following the format of the equations 5 and 6. These were used to calibrate the values of each run, see Appendix B. These methods correct for any long-term instrumental drift. There was no significant change in working standards over time.

Equation 5.

$$\delta^{18}O_{calibrated} = m\delta^{18}O_{measured} + b_{\delta^{18}O}$$

Equation 6.

$$\delta D_{calibrated} = m\delta D_{measured} + b_{\delta D}$$

Isotopic signatures were graphed against an LWML defined for Madison, WI (Swanson et al., 2006), as defined below.

Equation 7.

$$\delta D = 7.79\delta^{18}O + 13.1‰$$

LEL were determined as linear regressions of river samples where appropriate. Samples available for isotopic analysis ranged from November 2009 to July 2015.

PHREEQC modeling

In order to determine mixing ratios and model groundwater flow, aqueous geochemical calculations were performed using PHREEQC version 3.1.7.9213 (Parkhurst and Appelo, Jan. 27, 2015) with the *wateqf.dat* database derived from WATEQ4F (Ball and Nordstrom, 1991).

**Inverse Modeling**

Final compositions of the RBI wells were a mix of two end member compositions, the Fox River and pristine groundwater (WK947). Inverse modeling was used to determine extent of mixing and geochemical reactions between the end-members in each RBI well to account for the chemical properties of the water at the end of the measuring period. It was accomplished by quantifying end-member mixing, mineral and gas phase precipitation/ dissolution, and cation exchange reactions responsible for observed changes in chemistry of RL255 and RL256 between initial measurements in 2005 and final measurements in 2015.

The pH value used was an average of Fox 2 samples in 2014. The pristine groundwater used was an average of WK947 between April, 2010 and July 2015 (n=14) . Infilling water was an average of the automatic sampler site taken between April and December of 2014 (n=42). As the automatic samplers were not retrieved immediately, pH measurements were not taken on these samples. The final solution was an average of RL255 samples (n=5) between May 2014 and July 2015 and RL256 samples (n=6)between October 2013 and July 2015. PHREEQC modeling input files may be found in Appendix C.

Cation exchange was calibrated to calculations of sodium loss seen in the wells over time. The amount of sodium lost was calculated using equation 8:

Equation 8.

$$Na_{Lost}(moles) = \left\{\left(Cl\left(\frac{mole}{L}\right) \times Na{:}Cl\right) - Na\left(\frac{mole}{L}\right)\right\} \times \ pumping\ rate\left(\frac{L}{yr}\right) \times yrs\ pumped$$

Where, Cl and Na were the lowest concentrations of chloride and sodium before the sodium to chloride ratios reached a steady state (2005-2012). Na:Cl represents an average of the final sodium to chloride ratio in each well. The sodium lost was calculated in two sections, the first during the rise in (2005-2010) and during the period of consistent sodium to chloride ratios (2010-2012; see Figure 13&14). The totals of the two periods were then summed. The percentage of sodium lost was then calculated using equation 9:

Equation 9.

$$\%Na_{lost} = \left( \frac{Na_{lost}(moles)}{Final\ Na \times pumping\ rate\left(\frac{L}{yr}\right) \times 7\ yrs} \right) \times 100$$

The bottom part of the bracket represents the total sodium that would have come through if there were no cation exchange. Seven years was used for the time pumped because sodium loss occurred between 2005 and 2012. The cation exchange in the inverse modeling was calibrated to the percent of sodium lost from the final solutions of each of the RBI wells.

The program was set to determine the fluxes in the designated solid and gas phases of calcite, dolomite and $CO_{2,}$ and amount of mole transfers of major ions. Parameter selection was based on knowledge of the hydrologic setting. PHREEQC modeled infilling water interacting with initial water, allowing for the fluxes and mixing ratios necessary to conclude with ion concentrations observed in final solution. Uncertainty limits were used to limit the number of possible outcomes: the defined solutions were set a 10% uncertainty (maximum error accepted in major ion analysis data). A few ions were set separately to achieve better calibration with the observed data: chloride, potassium, sulfate and sodium. The specific assignments may be seen in the input modeling input under balance, with each value pertaining to one of the solutions in the order they are defined in the input file (Appendix C).

**Transport Modeling**

The transport model concept is depicted in Figure 11. Interactions in the aquifer as they relate to the model are represented by section (A) and PHREEQC model simulation in a 1-D flow tube is represented by section (B). Initially the entire column was filled with groundwater from the area around the well. At (B1) inducement of the Fox River begins, allowing Fox River water to begin its flow to the wells as pumping is initiated. The point at which geochemical reactions are defined for the flow from the river to the well is (B2). Along the column between (B2) and (B4), advective/dispersive transport and chemical reactions occurring, simulating the (A2) flow path. The constant mixing ratio between pure aquifer water (A1) and induced river water (A2) is denoted as (A3) and is simulated by (B3). The resulting water drawn from the RBI wells is represented by (B4).

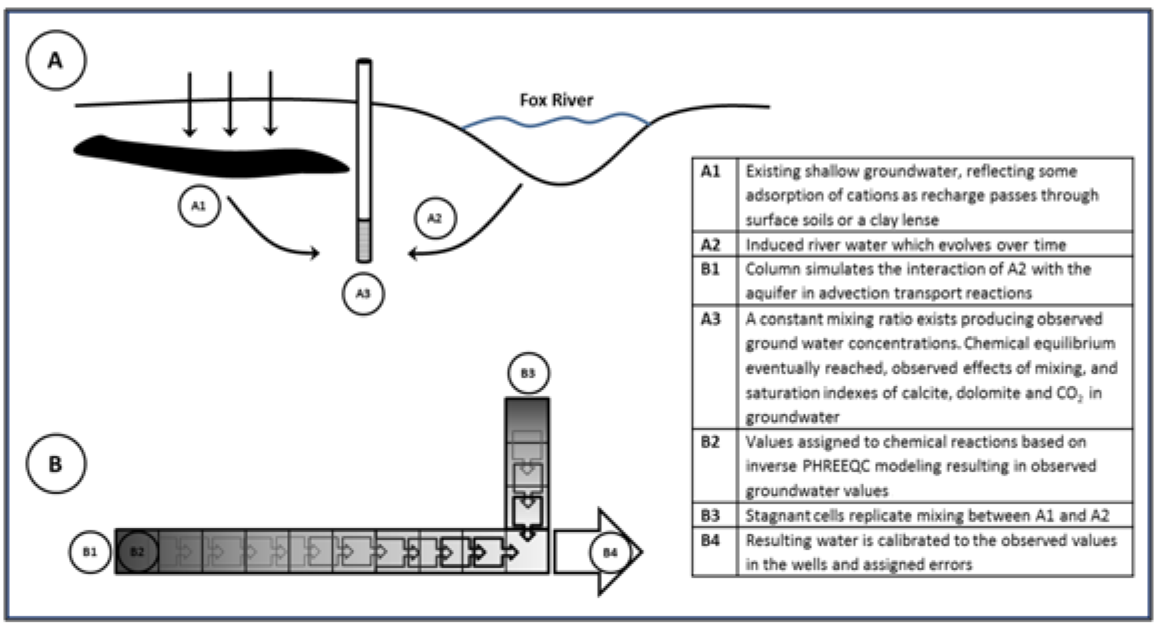


Figure11. Conceptual explanation of PHREEQC transport modeling, Thorp, 2013

The main reactions occurring in the model were mixing of end members and equilibrium phase calibrations. The mixing ratios of Fox River water and pure aquifer water were taken from the results of the inverse modeling. The dissolution values of calcite, dolomite and carbon dioxide indicated by the saturation indexes in the inverse modeling were used to calibrate their equilibrium phases in (B1). Length of flowpath was incorporated into the model using number and length of cells. The model was calibrated by matching the pore volume of the half way point of modeled transport chloride concentration rise with the advection front of the chloride breakthrough curve and stretching the pore volumes to match the time frame.  Plug flow without leaking was assumed.

Bacterial Analysis

During the fall monitoring suite sampling of 2014 an extra 1L sample was taken from the three WWTPs, Fox 0, Fox 2, RL 255, RL 256 and WK 947 sites. The samples were collected in sterile 1L Nalgene bottles with as little air as possible, kept on ice and filtered within 6 hours of collection.  Glassware and associated utensils were prepared using UV sterilization for 15 min. The samples were filtered with 0.22 sterile 47mm EMD Millipore Microbiological Analysis Membrane Filters a vacuum manifold set at 20 kpa.  The filter papers were kept, rolled, and placed in tephlon tubes and frozen -80$^{o}$C until analysis.

**Human Fecal Tracers**

Analysis was completed by the Mclellan lab at the School of Freshwater Science using Ultra Clean Mega Prep soil DNA kit (MoBio Laboratories Inc., Solana Beach, CA) to extract DNA for quantitative polymerase chain reaction (qPCR). Specific sequences present for ruminant, ecoli, enterococcus, lachnospireacie, and bacterioides, were quantified to counts per 100 mL.

**16s rRNA Sequencing**

The  hypervariable 16s RNA region was sequenced and referenced to the Global Alignment for sequence taxonomy, which assigns taxonomy based on 2/3 majority vote of taxonomy of the nearest full length relatives (threshold greater than 80% sequence similarity).

Results were read and analyzed via the Visualization and Analysis of Microbial Population Structures (VAMPS) project (Halliday et al., 2014).

Pharmaceutical and Personal Care Product Tracers

An additional liter of sample was collected from the Sussex and Brookfield WWTPs, Fox 0, Fox 2, RL255, RL256 and WK947 sites during the spring 2015 sampling period for PPCP analysis. The samples were collected in sterile 1L Nalgene bottle, with as little air as possible, kept on ice for a maximum of 4 hours after collection.  The samples were then filtered with 0.2μm sterile regenerated cellulose filter via a vacuum pump set at 20 kpa. Filtered water was poured into amber glass bottles, with Teflon caps, and kept at $4^{o}$C until packed on ice and shipped same day delivery to University of Wisconsin- Steven's Point Water and Environmental Analysis Lab. The lab tested for pharmaceuticals and personal care products (PPCPs), including artificial sweeteners: Acefulfame, Sucralose, Saccharin, Acetaminophen, Cotinine, Caffeine, Paraxanthine, Benzoylecgonine, Carbamazepine, Trimethoprim, Sulfamethazine, Sulfamethoxazole, Venlafaxine, and Triclosan.

# Chapter 7

# Results & Discussion

*Major Ion Analysis & PHREEQC Modeling*

Well Field Major Ions

The major ion chemistry of the pristine aquifer in Figure 12 remained constant, with chloride concentrations at 2.1-2.5 mMol/L (74.9-88.3 mg/L) and sodium concentrations at 1.5-1.7 mMol/L (34.7-39.44 mg/L)..

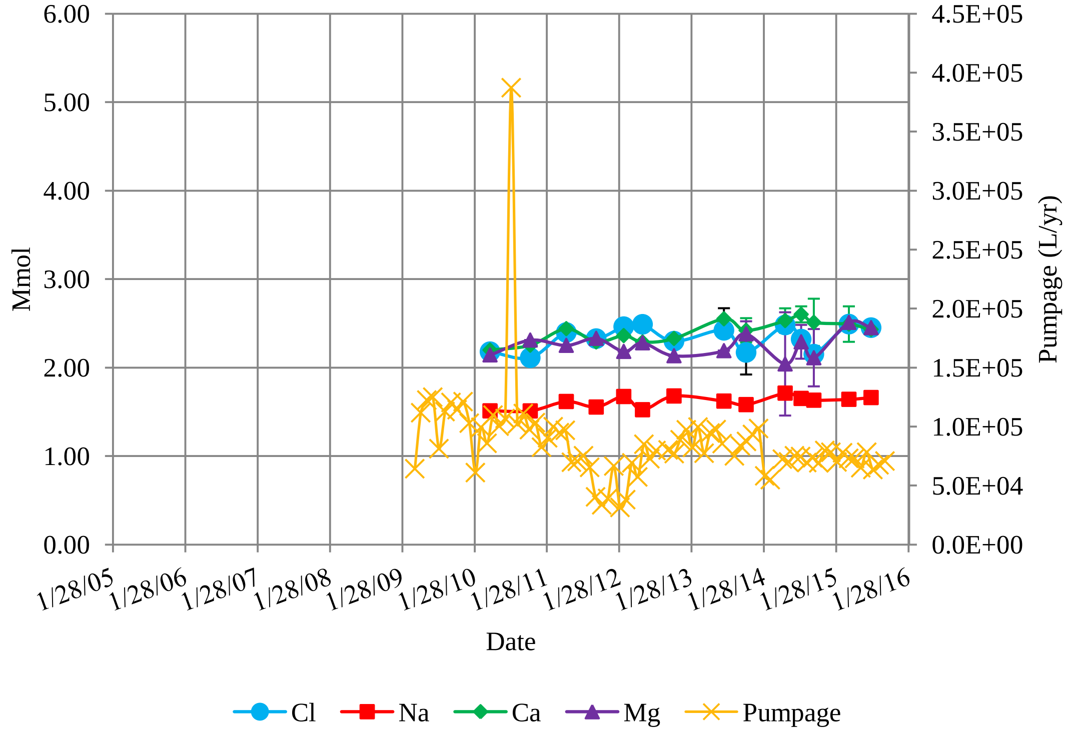


Figure12. Major Ion Chemistry in WK947 from 2008 through 2015. Pumping in this well began April 2009.

Major ion analysis showed that the groundwater chemistry in the two RBI wells did not level off after an initial breakthrough curve as Thorp (2013) predicted. There was a continuing rise of sodium and chloride levels in both wells; with a stepwise increase especially visible in RL255 (Figures 12 and 13). The sodium and chloride concentrations leveled off in a second plateau early in 2014. The first rise occurred in concert with the first rise in induced stream flow into the well field as predicted by Feinstein (2010). The first plateau occurred in concert with the drop in induced stream flow, approximately four years after pumping began, and second rise occurred as induced stream flow was increasing again, approximately six to ten years after pumping began.  After 2015, concentrations level off and the induced stream flow is predicted to level off as well (ten to fourteen years after pumping began), leading to the conclusion of continued stable concentrations (Feinstein et al., 2010).

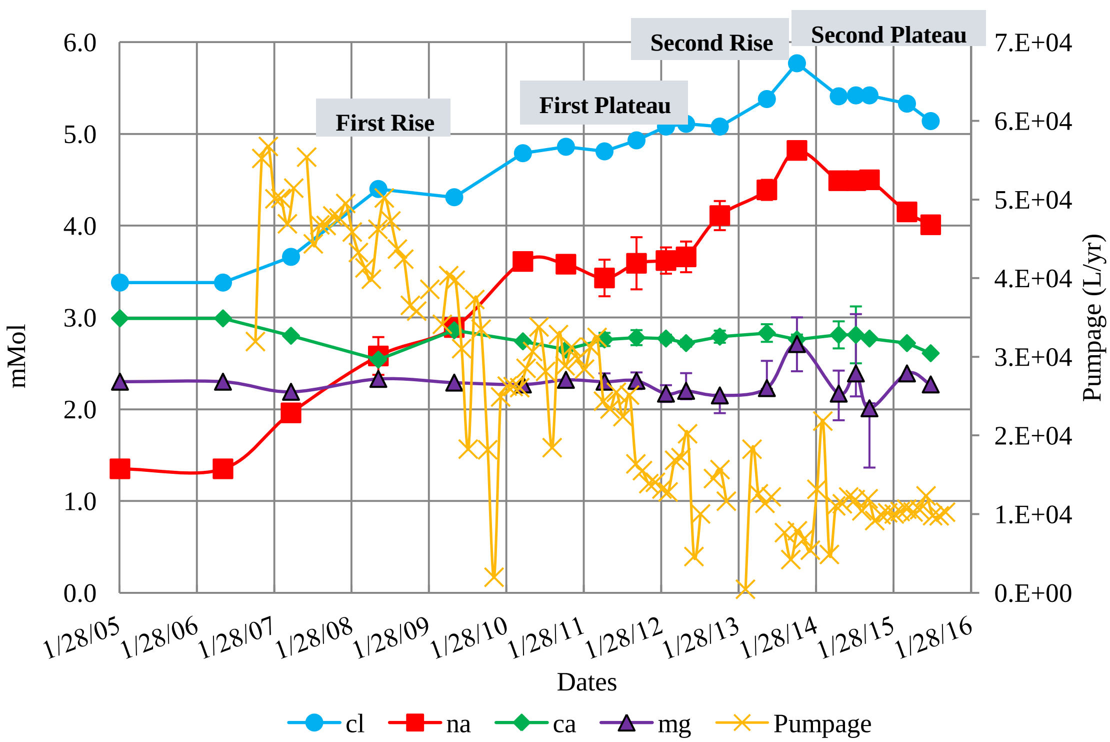


Figure 13.  Major Ion Chemistry in RL255 from 2005 through 2015. Pumping in this well began November 2006

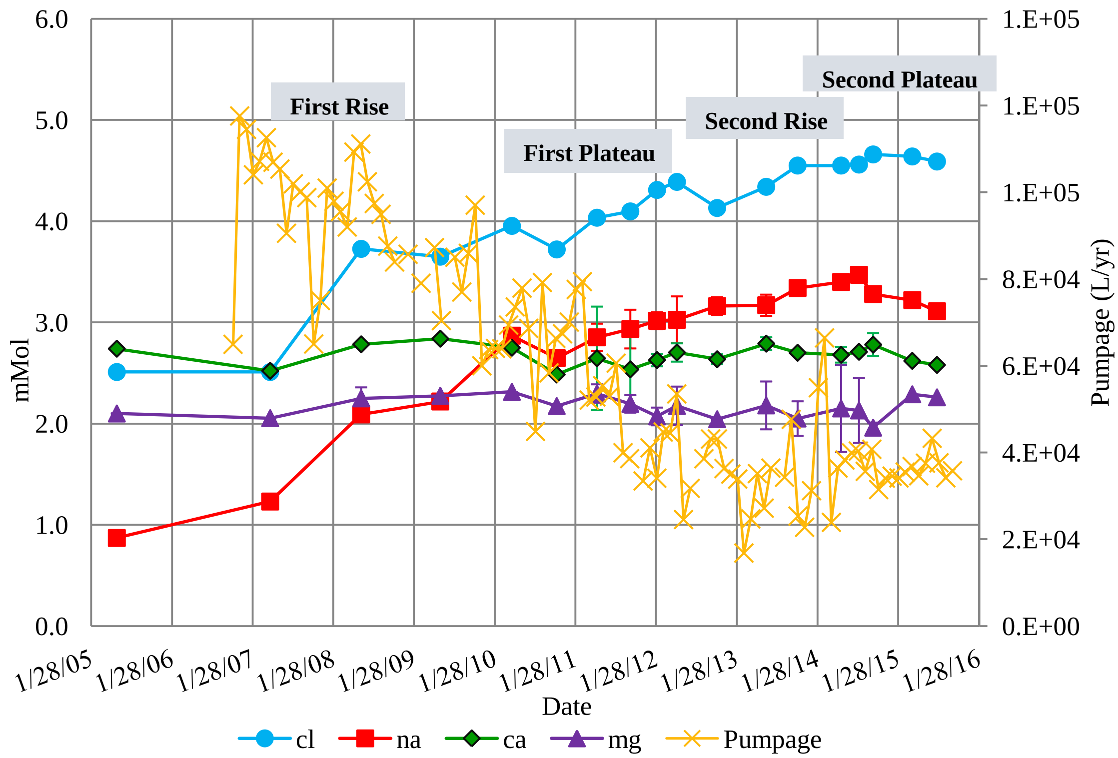


Figure 14. Major Ion Chemistry in RL256 from 2005 through 2015. Pumping in this well began November 2006.

Molar Mismatch

Since sampling begun in 2005, results have shown a large molar mismatch between sodium and chloride molar concentrations starting at a 0.4 sodium to chloride ratio and increasing over time to 0.7. This large mismatch exceeds the mismatch of the Fox River water, providing evidence of sodium for calcium cation exchange during transit from river to well (Figure 15). As pumping began the ratio increased to around 0.7 and leveled off in the first plateau at the end of the breakthrough curve (2010-2012), then increased again to around 0.8 for the remainder of the study. The ratio in both wells leveled off within the standard error range of the ratio of sodium to chloride that has been measured in the Fox River at the Isco site. The ratios in RL256 are closer to those seen in WK947.

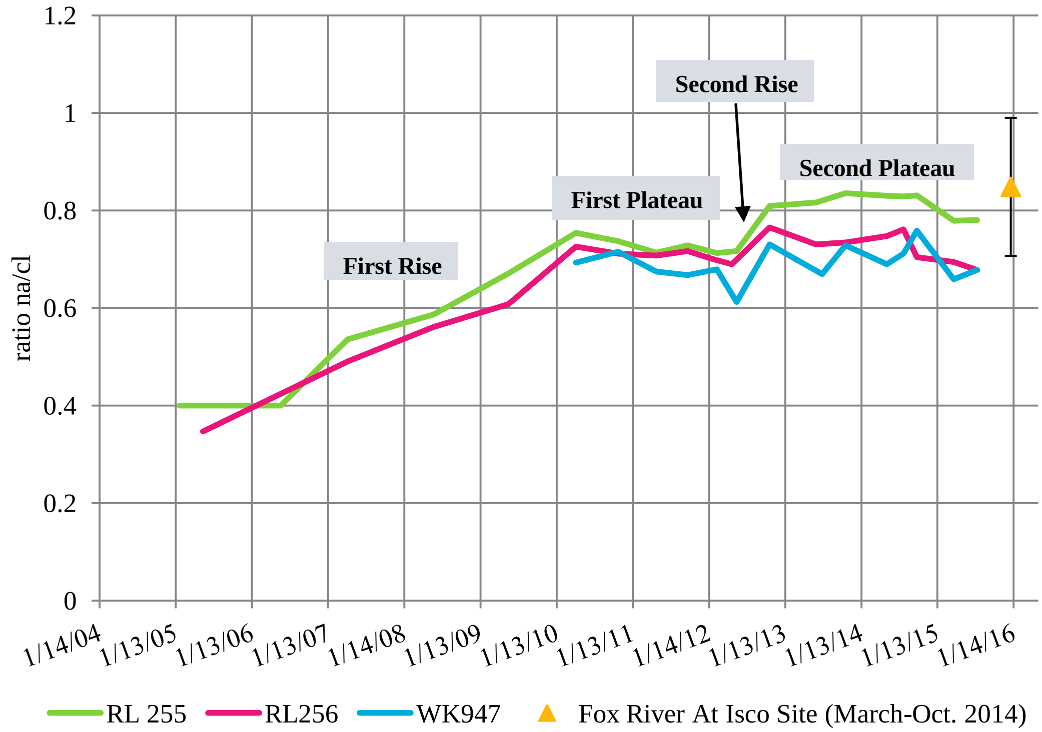


Figure 15. Ratios of sodium to chloride over time in the RBI wells compared to the ratio of WK947 and the average ratio in the Fox River at the Isco Site in 2014.

The first rise in the sodium to chloride ratio occurred as Fox River water, high in sodium and chloride concentrations, was moving into the well field and cation exchange sites responded by exchanging sodium ions for calcium ions causing the large molar mismatch between sodium and chloride. When WK947 came online four years after pumping began in the two RBI wells, there was no new input from the Fox River. Cation exchange capacity was able to reach an equilibrium seen in the first plateau. When the second rise in induced stream flow occurred, additional Fox River water entered the RBI wells, necessitating a new equilibrium with cation exchange sites. Once the induced stream flow reached steady state the cation exchange sites reached the new equilibrium. This equilibrium is essentially the same as pristine groundwater

(WK947) and Fox River water. Therefore further changes in the sodium to chloride ratio is not expected even if the pumping regime changes.

<u>PHREEQC Modeling</u>

Inverse modeling of RL255 determined end member mixing of 59% average Fox River water and 41% pristine groundwater. Sodium loss, due to cation exchange capacity, was found to be 30% of the total sodium entering the well field. Carbonate minerals were under-saturated with saturation indexes of -0.15 for calcite, -0.47 for dolomite, and carbon dioxide was over-saturated with respect to atmospheric levels with a $P_{CO2}$ of $10^{-1.45}$ atm. This model is consistent with the 60% river water contribution of the coarse-grain deposit favored model defined by Feinstein.

Inverse modeling of RL256 quantified mixing at 34% river water and 66% pristine groundwater. Sodium loss due to cation exchange reactions was found to be 20%. Carbonate minerals were also under-saturated with saturation indexes of -0.27 for calcite, -0.71 for dolomite, and carbon dioxide were over-saturated with respect to atmospheric levels with a $P_{CO2}$ of $10^{-1.39}$.

The mixing ratios indicate that RL255 is receiving more river water than RL256, explaining why the breakthrough curve for RL255 is more defined than RL256. It also explains why the final ratios of sodium to chloride in RL255 are closer to the Fox River than RL256. RL256's sodium and chloride ratios closely resemble the pure aquifer water in WK947 due to greater contribution of pure aquifer water.

The PHREEQC transport model was unable to account for double plateau of the breakthrough curve. Fitting the model to the first plateau does not account for the entire rise in sodium and chloride concentrations. If the model were made to fit the second plateau, the dispersivity would be larger than any value measured in the field. In this system the advective front is more complicated than simple plug flow. Simple plug flow cannot be assumed because of changes in the contribution of induced river water over time due to changes in pumping rates. Other possible complications include leakage from the overlying silty layer, and complex flow patterns. The river source is predicted to continue increasing for up to 10 years, meaning that the mixing ratio would increase with time and not be a consistent plug flow (Feinstein et al., 2010). A change in pumping rates would further exacerbate inconsistencies of inducement from the river. Finally it is probable that the flow paths are too complex due to the heterogeneous nature of the glacial till to be considered plug flow.

Fox River Major Ions

The spring melt in Waukesha was determined to occur between March 7th and 22nd in 2014 and March 8th and 20th in 2015. The USGS gage was iced over until March 18th, 2014 and March 9, 2015. Sodium and chloride concentrations in the Fox River, at the Isco site, were the highest in March 2014 during the spring melt; maximum concentration measured at 13.09 mMol/L (301 mg/L) sodium and 11.82 mMol/L(419 mg/L) chloride (Figure 16). The spring melt samples collected in March 2015 had a slightly lower maximum with 9.64 mMol/L (222 mg/L) sodium and 11.39 (404 mg/L) chloride concentration. The concentrations remained fairly constant from April through October with average concentrations of 5.37 ± 1.12 mMol/L (123 ± 26 mg/L) sodium and 6.59 ± 1.08 mMol/L (234 ± 38) mg/L chloride, representing the ambient load. Dips in concentration were directly preceded by increases in discharge due to major precipitation events, representing surface flow, indicating that sodium and chloride concentrations were not due to runoff from the landscape during the majority of the year but rather WWTP effluent input (Figure 15).

Concentrations in December were slightly higher on average at 7.84 ± 0.24 mMol/L (180 ± 6 mg/L) sodium and 9.19 ± 0.42 mMol/L (326 ± 15 mg/L) chloride. In December 2014 the temperature was hovering around freezing with varying mixtures of snow and rain, salting most likely occurred with melting leading to increased sodium and chloride concentrations in the Fox River.

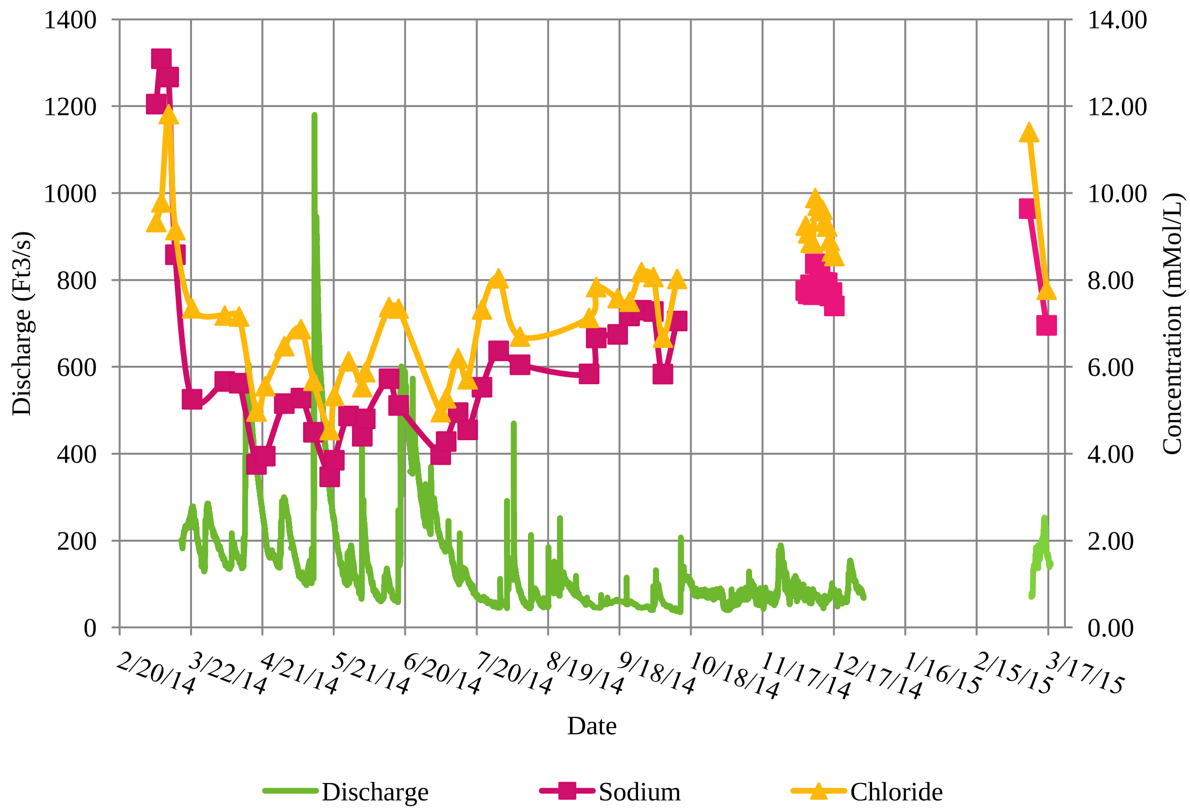


Figure 16. Graph of sodium and chloride concentration in the Fox River at the Isco automatic sampler site in 2014 compared to discharge at USGS gage #05543830.

## <u>Load Calculations</u>

The average load in March is fairly similar to the average load during the remainder of the year, except for sodium and chloride concentrations, which are 10,000 mg/s higher in March (Table 1). Load calculations indicate spring melt runoff and WWTP effluent in March accounted for 11-13% of sodium chloride inputs into the river over a year, extrapolated from the 8 month period from March- October and December 2014 when samples were taken. If all of the months were equal then each month would account for only 8% of the load.

Table 1. Fox River Load March-October 2014 at thIsco automatic- sampling site. The estimated March percent values were calculated by comparing March to the extrapolated average of the full year.

| Spring Melt Load 2014 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ion | Ca | Na | Mg | K | HCO3 | Cl | SO4 | NO3 |
| Avg. March (mg/s) | 10240 | 24980 | 4923 | 110 | 36520 | 41010 | 8162 | 1877 |
| Avg. Month [excluding March] (mg/s) | 10740 | 15690 | 4482 | 500 | 33350 | 30630 | 7683 | 1749 |
| Estimate March % of Full Year {from load ∑s} | 8 | 13 | 9 | 2 | 9 | 11 | 9 | 9 |

Only a portion of the March load consisted of road salt. The load occurring from constant sources of WWTP sodium and chloride was accounted for using equations 3 and 4. The portion of the sodium and chloride loads of in March contributed by road salt were calculated by subtracting the average year load from the average March load, dividing by the average March load and multiplying by 100. The load of road salt entering the Fox River during the spring melt is 3% sodium and 5% chloride of the sodium and chloride yearly load. The road salt coming into the system is minimal compared to the 95-97% originating from the WWTPs flowing through the remainder of the year. This indicates that road salt does not create as much of an impact on this system as sodium and chloride entering the river from the WWTPs. As shown in previous studies, the WWTP effluent accounts for up to 40% of the Fox River flow during annual low flow (Holzbauer, 2010).

*Isotopes*

The variance of WWTP effluent contribution to the Fox River was controlled for by applying a weighted average based on the outflows of each WWTP of the course of the sampling period. No significant trends occurred in the RBI well isotopic signatures. Neither of the RBI wells showed signatures significantly different from WK947. The diversity of signatures for all three wells was so small compared to the diversities seen in the river samples that an average of RL255, RL256 and WK497 was plotted (Figure 17). The LEL was parallel to the LWML and did not directly cross the LWML between the shallow well signature and the WWTP signature.

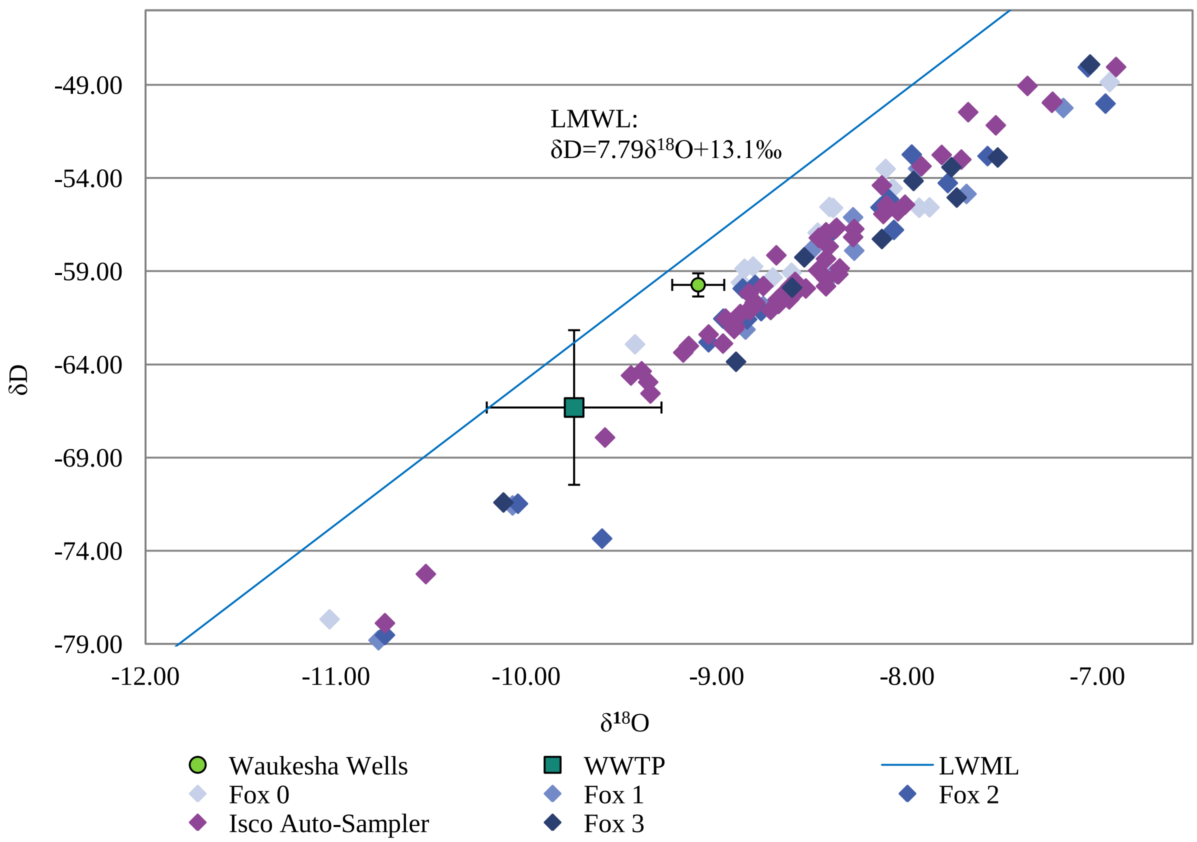


Figure 17. Graph of hydrogen and oxygen stable isotopic signatures of samples collected between 2009 and 2015. Fox River samples in sites 0,1,2, Isco Auto-Sampler, and 3. Waukesha wells RL255, RL256, and WK947 are represented as an average (n=37) with standard error bars. WWTP isotopic signature are represented as a weighted average (n=29) based on percentage of effluent contribution to the Fox River, with standard error bars.

Isotopic signatures in the winter were much lighter than the remainder of the year (Figure 18). In the Fox River, the lightest isotopic signatures occurred during the later portions of the spring melt, below even the signature of the WWTP effluent. The cold conditions of winter form more precipitation as air masses move across the continent from the ocean to Wisconsin than in the summer due to the fact that the maximum amount of moisture the air is capable of holding decreases with temperature. Heavy isotopes condense faster than light isotopes, causing the humid air mass to lose water molecules containing heavy isotopes thereby depleting the humid air mass's isotopic ratio.  This results in isotopically lighter winter precipitation than summer months (Gat, 1996). In addition, during partial melting of ice the lighter isotopes are preferentially melted, creating even lighter isotopic signatures during the initial spring melt. Spring melt is even lighter than WWTP effluent because WWTP effluent is a mixture of light deep aquifer water and heavier shallow aquifer water. On the opposite end of the spectrum, the heaviest isotopic signatures occurred in May, June, and July (Figure 19). The drier conditions between August and December means that the contribution of WWTP effluent was higher and the lighter isotopic signature of the WWTP effluent influenced the isotopic signature of the river more during these months.

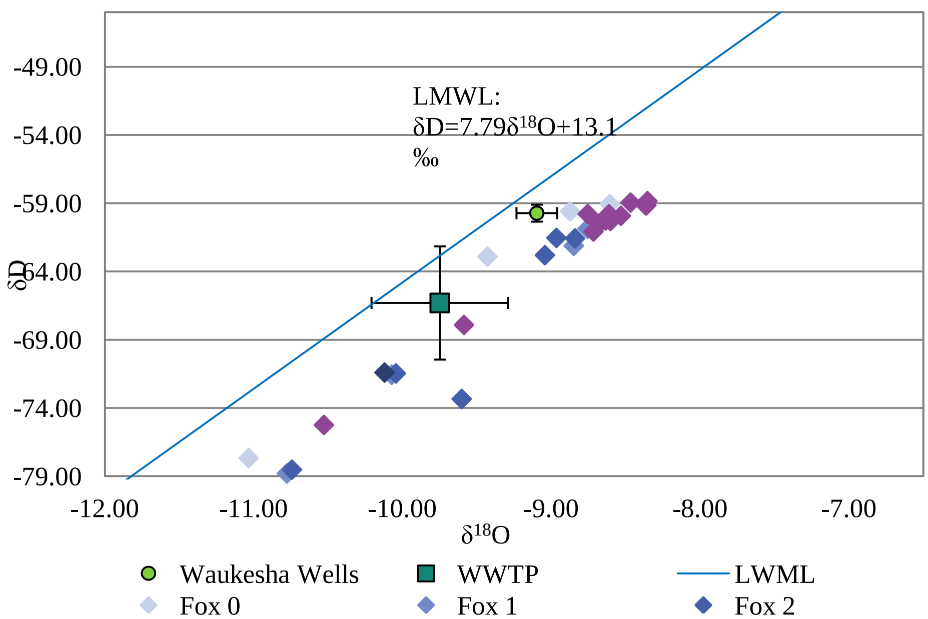


Figure 18. Graph of hydrogen and oxygen stable isotopic signatures of samples collected between 2009 and 2015 between December and March. Fox River samples in sites 0, 1, 2, Isco Auto-Sampler, and 3.

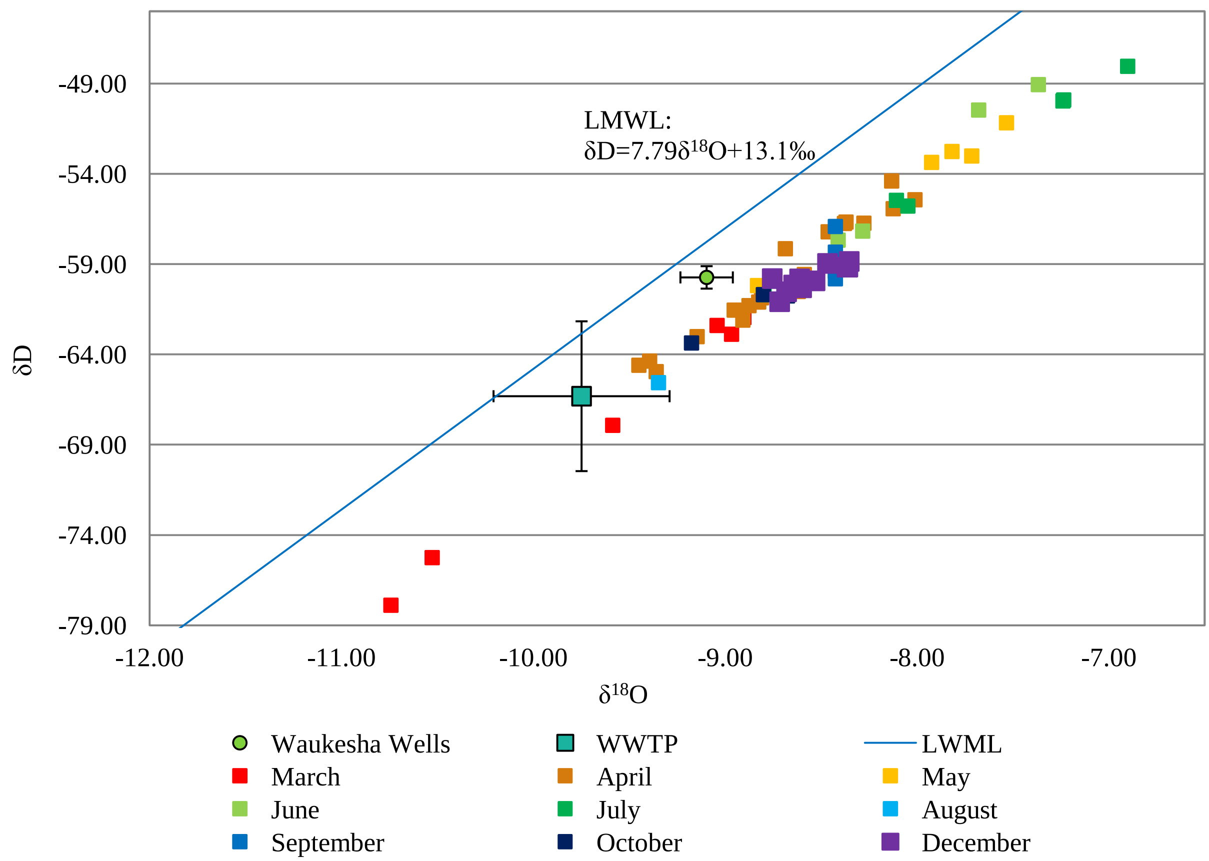


Figure 19. Graph of hydrogen and oxygen stable isotopic signatures of the Fox River at the Isco Automatic Sample Site by month between April 2014 and April 2015.

Upstream of WWTP outputs, Fox 0 signatures (excluding spring melt samples) had an LEL as defined below.

Equation 10.

$$\delta D = 5.35\delta^{18}O + 11.77‰$$

Spring melt signatures were excluded from the LEL calculations because snow melt is isotopically different from meteoric precipitation. The slope of Fox 0 without the influence of spring melt signatures had a slope very close to the slope of 5, which is generally accepted for naturally fed rivers in this time and climate (Gat, 1994; Gibson and Reid, 2010). The LEL, if extended down, crosses the average signature of the shallow wells in Waukesha implying mixing with groundwater as is expected in this region (Figure 20).

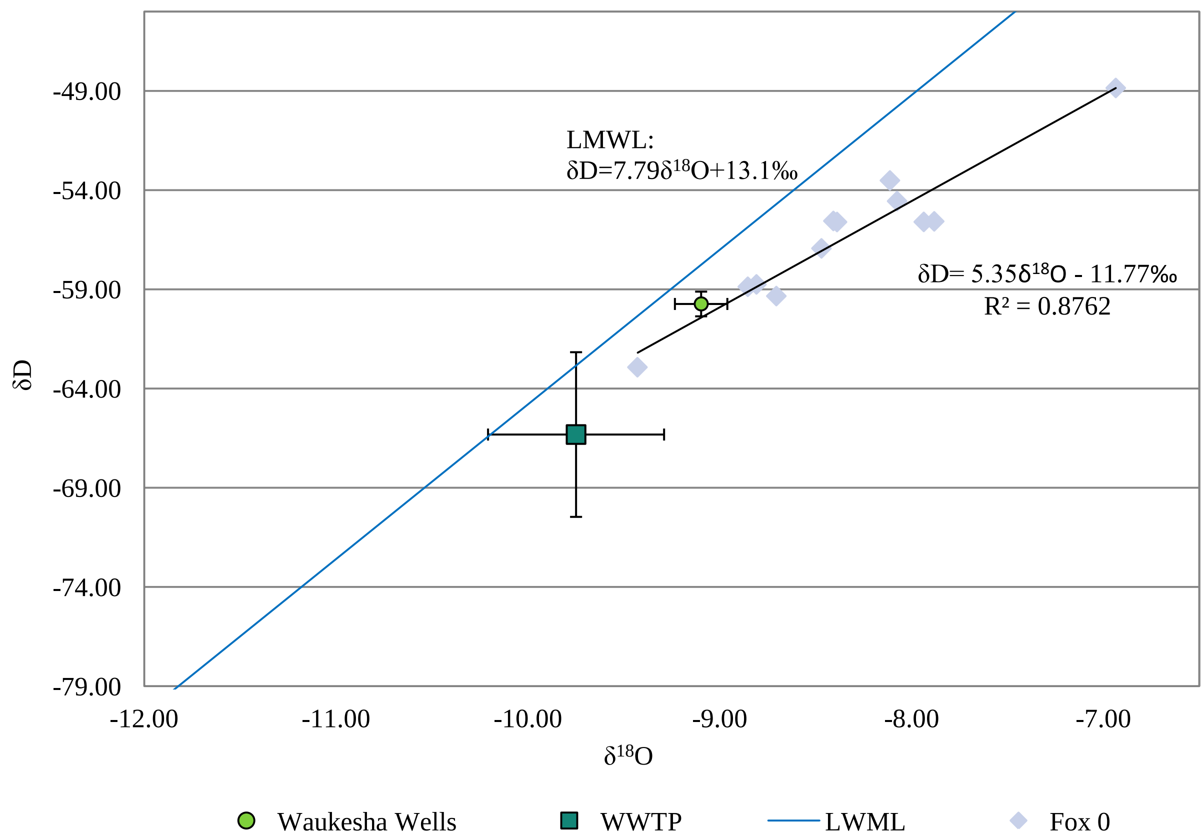


Figure 20. Graph of hydrogen and oxygen stable isotopic signatures of Fox 0, upstream of all WWTP effluent contribution (excluding spring melt samples).

Downstream of WWTP output(s), Fox 1, 2, the Isco Automatic sampler, and Fox 3 (excluding spring melt samples) had a linear regression as defined below.

Equation 11.

$$\delta D = 7.09\delta^{18}O + 1.56‰$$

The slope is greater than that of a naturally fed river in this time and climate. The linear regression downstream of the WWTP outputs crosses the effluent signature and indicates the influence of mixing (Figure 21).

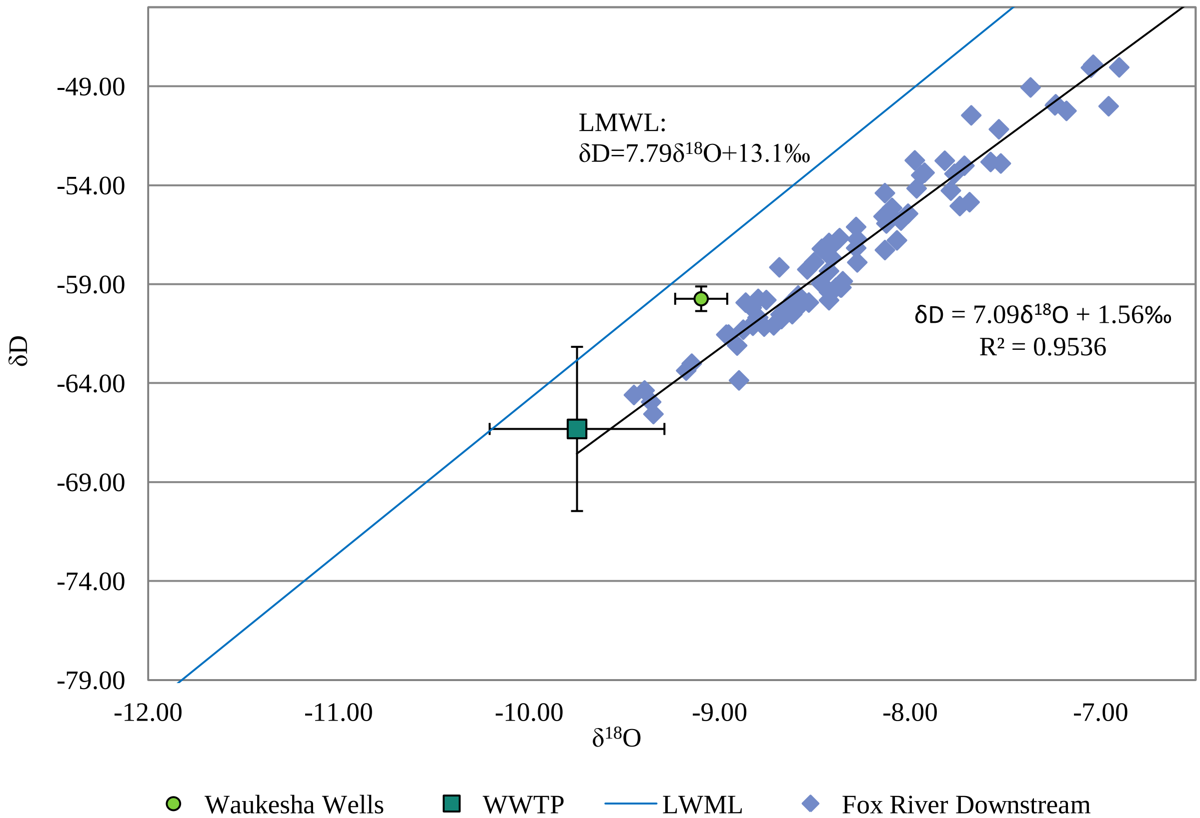


Figure 21. Graph of hydrogen and oxygen stable isotopic signatures of the Fox 1,2, Isco Automatic Sampler, and Fox 3 sites downstream of WWTP effluent contribution (excluding spring melt samples).

<u>Riverbank Inducement Wells</u>

The lack of trends observed in isotopic signatures in the RBI wells stems from two potential causes: a lack of appropriate data and complex groundwater flow patterns. Seasonal fluctuations were apparent in the Fox River, so there was reason to suspect the signatures in the well would fluctuate with the water entering at any given time. If samples were taken at a high enough temporal resolution in the wells and the River there may have been a trend with a delay in isotopic signature directly caused by the travel time between the river and the wells. This has been observed in systems with short (<70m), clearly defined flow paths (Hunt, 2005). This system is not suitable for such a study due its lack of short, clear flow paths. With the complex flow of this system the trend would likely have been so muted that only extreme high water conditions would be observable. The pattern would have been further muted due to the mixing with pristine groundwater which occurs in the RBI wells and is confounded by inconsistent pumping. The amount of stream flow inducement was has not yet reached steady state (Figure 8) which further masks any potential change in the isotopic signatures of the RBI wells.

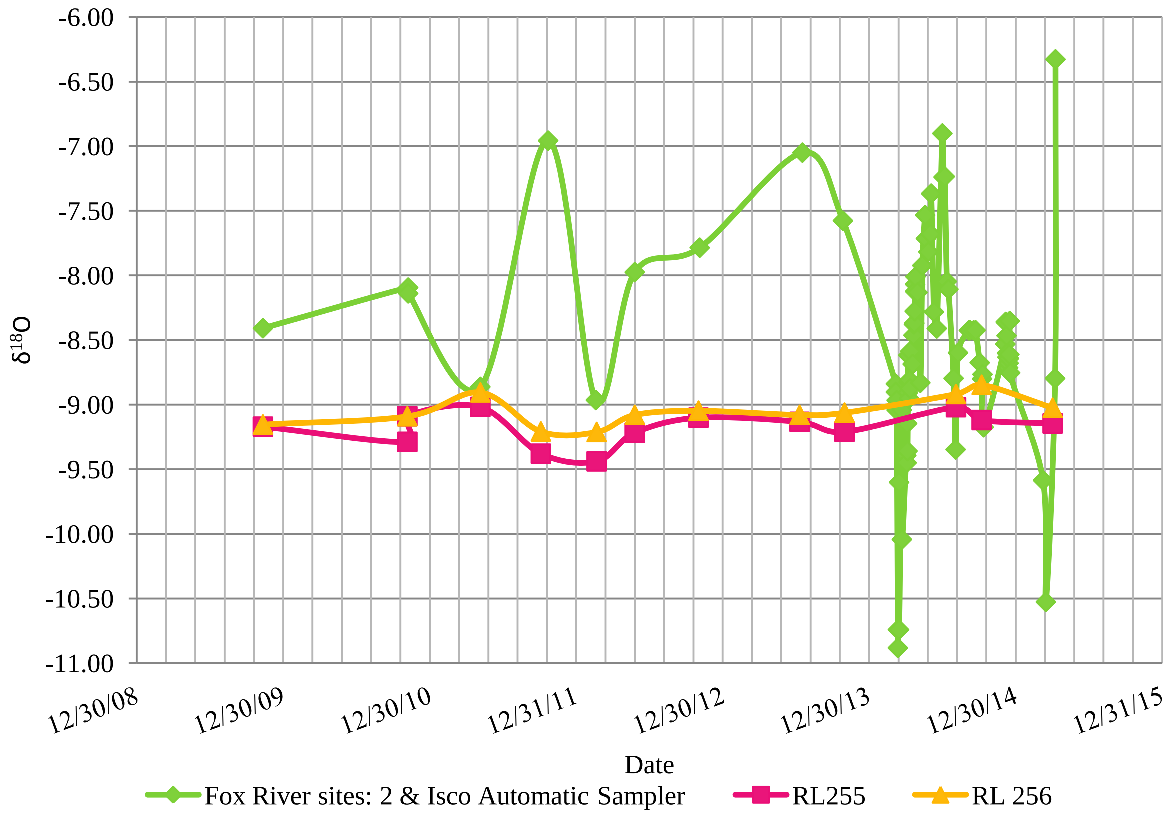


Figure 22. $\delta^{18}O$ in RBI wells and Fox River (2009-2014). Fox 2 samples used from 2009-2014, then Fox Isco Automatic Sampler used for 2014.

Though a pattern mirroring the River was not visible, the average $\delta^{18}O$ of approximately -9 in the two RBI wells over time closely resembled the $\delta^{18}O$ in the Fox River during March and April (Figure 22). This is consistent with the fact that recharging occurs preferentially in the spring.

### *Bacterial Analysis*

Fecal Bacteria Tracers

No fecal tracer bacteria were found in any of the well sites. Ruminant tracers were not found in any of the samples. The general fecal tracers, enterococcus and E. coli were highest in Brookfield and Sussex WWTPs, followed by Fox 0, Fox 2, and then Waukesha WWTP (Table 2). This shows that there is some kind of fecal material in all of these samples though not necessarily human fecal matter. There is a pet lodge directly next to the Fox 0 site, which may be causing the high counts seen in these results.

Table 3. qPCR fecal bacteria counts.

| | bachum cn/100ml | lachno cn/100ml | entero cn/100ml | ecoli cn/100ml | ruminant cn/100ml |
|---|---|---|---|---|---|
| Brookfield WWTP | 431657 | 746381 | 226545 | 20560 | 0 |
| Waukesha WWTP | 8124 | 3623 | 7459 | 566 | 0 |
| Sussex WWTP | 25272 | 27762 | 99718 | 1975 | 0 |
| Fox 0 | 0 | 0 | 9809 | 275 | 0 |
| Fox 2 | 2833 | 2398 | 9697 | 579 | 0 |
| RL 255 | 0 | 0 | 0 | 0 | 0 |
| RL 256 | 0 | 0 | 0 | 0 | 0 |
| WK 947 | 0 | 0 | 0 | 0 | 0 |

The human-specific fecal tracers, Lachnospiraceae and Bacteroidales, found the highest counts in the WWTPs. The highest count was found in Brookfield WWTP, 431657 cn/100mL Bacteroidales and 746381 cn/100mL Lachnospiraceae, which were between the ranges of values measured by the McLellan Lab for Milwaukee WWTPs. Jones Island WWTP had 155118 cn/100mL Bacteroidales and no counts for Lachnospireacie. South Shore WWTP had 5092651 cn/100mL Bacteroidales and 4533106 cn/100mL Lachnospireacie. The counts decreased by an order of magnitude from Brookfield to Sussex and down to Waukesha. No counts were found in

Fox 0, upstream of the treatment plant outlets. Downstream of the WWTP outfalls Fox 2 the counts are almost two-thirds lower than the Waukesha WWTP. These results indicate that human fecal matter is getting into the Fox River downstream of the WWTP outfalls and fecal tracers are not entering into the RBI wells.

16s rRNA Sequencing

The results were inconclusive in regards to tracing bacteria from the WWTPS into the RBI wells (Appendix D). There were bacteria present in the wells which were also present in the WWTP effluent samples, however the similar taxa were bacteria common to aqueous environments and their origin could not be determined. These bacteria could have originated in the wells and then entered the WWTPs, vice versa, or the populations could be unconnected.

Only one of the wells samples had enough RNA for amplification, Brookfield WWTP counts were an order of magnitude lower than the other two WWTPs, and Fox 2 had strangely un-diverse populations which mostly consisted of common aqueous bacteria populations indicating that larger samples should be analyzed in the future (recommend 5L). There were thirteen taxa which were present in all of the samples and this may be interesting to look at with PCR analysis in future studies (Appendix D).

With high precision analysis technology and as knowledge continues to improve, identification to lower taxonomic groups may identify better tracers. If an appropriate tracer is chosen high precision identification and quantification may be achieved through qPCR on a higher volume of samples. It is possible that such methods may show a traceable pattern of effluent through the river and into the wells. However, this may not be the best tracing method for it is quite possible that the differences in environment between WWTPs, the river, and the wells are too drastic to be assured of the same community surviving the flow. The diversity of the soil microbial community alone (Vaz-Moreira et al., 2011; Williams and Vickers, 1986), likely negates the survival of river bacteria on the flow path to the wells.

*Pharmaceuticals and Personal Care Product Tracers*

The majority of PPCPs were not detected in most of the samples at a level above the detection limit (Table 4). Acetaminophen, sulfamethazine and triclosan were not detected in any of the samples. Saccharin, benzoylecgonine, paraxanthine, caffeine, and cotinine were only found in a handful of samples. Carbamazepine, trimethoprim, sulfamethoxazole, and Venlafaxine were detected only in the WWTPs and in Fox 2. Acesulfame and sucralose had the highest concentrations recovered in all of the samples.

Table 4. Chemical characteristics of PPCPs influencing their transport or fate in groundwater (EPI Suite v4.11, 2012).

| Chemical | Log $K_{ow}$ | Water Solubility (mg/L at 25°C) | Henry's Law Constant (atm-m$^3$/mole) |
|---|---|---|---|
| Acesulfame | -1.33 | 91020 | 9.63e$^{-9}$ |
| Sucralose | -1.00 | 2275 | 3.99e$^{-19}$ |
| Caffeine | -0.07 | 2632 | 3.58e$^{-11}$ |
| Benzoylecgonine | -1.32 | 1605 | 1.03e$^{-13}$ |
| Carbamazepine | 2.45 | 17.66 | 1.08e$^{-10}$ |
| Trimethoprim | 0.91 | 2334 | 2.39e$^{-14}$ |
| Sulfamethoxazole | 0.89 | 3942 | 9.56e$^{-13}$ |
| Venlafaxine | 3.28 | 266.7 | 2.04e$^{-11}$ |
| Saccharin | 0.91 | 789.2 | 1.23e$^{-9}$ |
| Cotinine | 0.07 | 99860 | 3.33e$^{-12}$ |
| Paraxanthine | -0.22 | 4149 | 1.75e$^{-12}$ |
| Acetaminophen | 0.24 | 3035 | 6.42e$^{-13}$ |
| Sulfamethazine | 0.76 | 1127 | 1.93e$^{-10}$ |
| Triclosan | 4.66 | 4.621 | 4.99e$^{-9}$ |

There are many reasons the majority of PPCPs were absent in the majority or all of the samples. One reason is that the particular PPCP might not be used enough in the area to have measurable concentrations. The other major reason is the transport behavior of individual PPCP compounds. Table 3 lists the primary environmental constants that govern sorption ($K_{ow}$), solubility and volatility (Henry's Law Constant). Of the PPCPs present in the WWTP effluent, only the ones with environmental constants suitable for transport through porous media are found in the RBI wells. All of the PPCPs are non-volatile, with Henry's Law constants smaller than $1e^{-7}$. Acesulfame and sucralose have among the highest water solubility and the lowest Log $K_{ow}$ values indicating a low propensity to sorb to natural sediments. Benzoylecgonine and paraxanthine have low Log $K_{ow}$s, but they also have low water solubility. Caffeine also has a low Log $K_{ow,}$ but it, along with Cotinine, have been found to degrade with 98% efficiency in WWTPs (Khale et al., 2009). Microbial consumption or co-metabolism, particularly of cyclamate and saccharin, is a large cause of PPCP degradation in aquatic systems (Khale et al., 2009).

Acesulfame was found in amounts above the detection limit in all of the samples. The highest value was Fox 2, followed by the RBI wells, which indicates mixing of river water in the wells. The lowest value was in Fox 0 followed by WK947. The WWTP samples were lower than those of Fox 2 and the RBI wells. This phenomenon is thought to be caused by difficulty recovering acesulfame from WWTP waters due to extraction procedures. Acesulfame is better recovered when the sample is acidified prior to extraction; however recovery of the other analytes is compromised by acidification. As this was the initial study of AS in this system, the aim was to assess the presence of all the analytes (Nikta, 2014).

Sucralose was found above the detection limit in every site except for WK947 with the next lowest concentration found in Fox 0. The highest concentrations are in the WWTP samples. The concentrations decrease by an order of magnitude down to the concentration in Fox 2, and by another order of magnitude down to the concentrations in the RBI wells. Sucralose is a reliable tracer in this context and indicates that WWTP effluent in flowing through the river and into the RBI wells. The mixing ratios indicated by the values of sucralose are 12% and 23% Fox River water in RL255 and RL256 respectively.

Table 4. University of Wisconsin-White Water Environmental Lab 2015.

| **PHARMACEUTICALS AND PERSONAL CARE PRODUCTS**<br>*All sample concentrations and limits of detection (LOD) are reported in parts per trillion (ng/L).*<br>*Adapted from table completed by UWM-White Water Environmental Lab 2015* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| COMPOUND | Lowest limit of detection | Fox River 0 | Waukesha WWTP | Sussex WWTP | Fox River 2 | Well RL 255 | Well RL 256 | Well WK 947 |
| Acesulfame (artificial sweetener) | 5.0 | 9.3 | 36.2 | 47.3 | 238.6 | 171.1 | 83.3 | 16.0 |
| Sucralose (artificial sweetener) | 25 | 175.4 | 31983 | 23316 | 3342 | 416.4 | 774.8 | <LOD |
| Caffeine (stimulant) | 12.0 | 13.1 | <LOD | 19.5 | 87.2 | <LOD | 14.6 | <LOD |
| Benzoylecgonine (cocaine metabolite) | $5^{E}$ | <LOD | <LOD | 31.2 | 5.7 | <LOD | <LOD | <LOD |
| Carbamazepine (anti-epileptic) | 2.0 | <LOD | 98.6 | 452.6 | 57.1 | <LOD | <LOD | <LOD |
| Trimethoprim (human antibiotic) | $5^{E}$ | <LOD | 50.2 | 583.0 | 37.4 | <LOD | <LOD | <LOD |
| Sulfamethoxazole (human antibiotic) | $5^{E}$ | <LOD | 483.9 | 816.2 | 338.4 | <LOD | <LOD | <LOD |
| Venlafaxine (antidepressant) | $5^{E}$ | <LOD | $154.1^{A}$ | 500.6 | 125.6 | <LOD | <LOD | <LOD |
| Saccharin (artificial sweetener) | $25^{E}$ | <LOD | <LOD | <LOD | 31.5 | <LOD | <LOD | <LOD |
| Cotinine (nicotine metabolite) | 3.0 | <LOD | <LOD | 22.1 | 18.8 | 5.1 | <LOD | <LOD |
| Paraxanthine (caffeine metabolite) | 5.0 | <LOD | <LOD | <LOD | 16.9 | <LOD | 10.2 | <LOD |
| Acetaminophen (analgesic) | $35^{E}$ | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD |
| Sulfamethazine (bovine antibiotic) | 1.0 | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD |
| Triclosan (antimicrobial) | 75 | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD | <LOD |
| DATA FLAGS:<br>< LOD = This compound was not detected at a level above limit of detection<br>E = Estimated<br>A = Sample concentration greater than calibrated range | | | | | | | | |

These ratios are similar, but lower than mixing ratios obtained from PHREEQC modeling. These findings may differ from those indicated by PHREEQC modeling due to retardation of sucralose in groundwater and/or inefficiency of recovery in laboratory analysis. Analysis optimized for quantification of acesulfame and sucralose separately may yield better results.

# Chapter 8

## Conclusions

*Unequivocal Evidence of RBI*

The artificial sweetener tracers, acesulfame and sucralose, have proved the occurrence of RBI in both RL255 and RL256. A nuanced picture of recharge mechanisms in the RBI well field is observed. The well RL255 is receiving a higher percentage of Fox River water than RL256 (52% vs. 44%) and more closely mirrors the chemical characteristics of the River; whereas RL256 is more chemically similar to pure aquifer water (WK947).

*Groundwater flow is more nuanced: Not a simple plug flow*

The movement of groundwater is more complicated than simple plug-flow in this system, therefore PHREEQC transport modeling no longer accounts for the sodium and chloride breakthrough curves for the RBI wells. Inducement is instead affected by changes in contribution of induced river water, change in pumping rates, leakage, and complex flow patterns. These more complex flow patterns show signs of having reached a steady state, assuming that pumping rates remain constant.

*Cation Exchange Capacity is at a steady state*

Cation exchange was occurring in the RBI wells during initial inducement, before a steady state level of river inducement was reached. The rises and plateaus of sodium to chloride ratios matched the contribution of river water to the RBI wells as predicted by Feinstein. The cation exchange sites have reached an equilibrium which is essentially the same as both pristine groundwater and Fox River water, therefore this equilibrium is predicted to last even with potential changes in the pumping regime.

At the current pumping levels the concentrations of sodium and chloride appear to have reached a stable level and are predicted to remain so. The U.S. EPA has a drinking water standard for chloride, set at 7 mMol/L. As the chloride concentrations leveled off around 5.5 mMol/L in RL255 and 4.6 mMol/L in RL256, the concentrations are currently not of concern.

*Chloride load in Fox River is effluent dominated*

Maximum pulses of sodium and chloride occurred in March during the spring melt (222 mg/L and 404 mg/L respectively). Their concentrations were consistent the remainder of the year for sodium and chloride (123±26 mg/L and 234±38 mg/L respectively). Rain events caused dips in concentrations, indicating that the sodium and chloride concentrations originated from WWTP effluent contribution. Additionally, the road salt contributed only 3-5% of the annual salt load. As a result waste water effluent was determined the major source of salt entering the well field.

*Isotopic variability in the River is a function of weather and effluent*

The Fox River's isotopic signatures varied by season in accordance with predictable seasonal fractionation processes. The heaviest isotope signatures occurred in the early summer months and winter isotope signatures were comparably lighter. The spring melt isotope signatures were by far the lightest due to the lightness of winter precipitation and fractionation during preferential melting.

The major ion chemistry was also influenced by weather with pulses of high sodium and chloride concentrations during the spring melt from road salt runoff. There were also pulses of low concentrations of sodium and chloride following rain events. The majority of the year the concentrations were consistent and appeared to be maintained by WWTP effluent contribution. The heavy influence of the input of waste water effluent is apparent in the Fox River's isotopic signatures as well. The LELs of the Fox River were pulled down from the LEL upstream with a slope of 5.35, near the generally accepted slope for naturally occurring rivers in this climate, to a slope of 7.09.

*No pathogenic or fecal bacteria are in the RBI wells*

The presence of sucralose and acesulfame provide unambiguous evidence tracing the inflow of WWTP effluent amongst induced Fox River water. However no pathogenic or fecal bacteria were found in either of the RBI wells, when fecal bacteria was found in the River and both were found in WWTP effluent.

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# Appendix A:

# Sample Collection Information

1. Coordinates of Sampling Sites in Decimal Degrees

| Sampling Site | Latitude | Longitude |
|---|---|---|
| RL 255 | 42.959938 | -88.279256 |
| RL 256 | 42.961012 | -88.279063 |
| WK 947 | 42.961236 | -88.289167 |
| Fox 0 | 43.120068 | -88.164715 |
| Fox 1 | 43.011395 | -88.234244 |
| Fox 2 | 42.977690 | -88.264797 |
| Fox 3 | 42.876283 | -88.210559 |
| Auto Sampler | 42.960951 | -88.278707 |
| Brookfield WWTP | 433.052745 | -88.177110 |
| Sussex WWTP | 43.126171 | -88.216985 |
| Waukesha WWTP | 42.998190 | -88.249151 |
| Hygeia Spring | 42.879817 | -88.205125 |
| Sussex Creek | 43.102008 | -88.210367 |
| Root River | 42.858027 | -87.997586 |
| Underwood Creek | 43.042935 | -88.056498 |
| EM275 | 43.099327 | -88.103161 |
| IZ 385 | 43.063351 | -88.183740 |
| IZ 386 | 43.051841 | -88.176827 |
| SV 631 | 42.901237 | -88.059776 |

2. Contacts for sampling sites

<table>
<tr><th>Municipality</th><th>Contact Person</th><th>Contact Number</th><th colspan="3"></th></tr>
<tr><td rowspan="2">Waukesha<br>Water Utility-<br>Wells</td><td rowspan="2">Jeff Detro</td><td rowspan="2">Personal-262.490.4430<br>General-262.521.5272<br>JDetro@waukesha-water.com</td><td>RL255,#11</td><td>RL256,#12</td><td>WK947,#13</td></tr>
<tr><td colspan="3">3103 Saylesville Rd, Waukesha, WI</td></tr>
<tr><td rowspan="3">Bookfield Wells</td><td>Mark Simon</td><td rowspan="3">262.796.6717</td><td>IZ385, #7</td><td>IZ386,#19</td><td>EM275,#28</td></tr>
<tr><td rowspan="2">Mike Terry</td><td>Camelot 2</td><td>Industrial</td><td>Pilgrim Rd</td></tr>
<tr><td colspan="3">19700 Riverview Drive, Brookfield, WI</td></tr>
<tr><td>St. Martins of Tours</td><td>Tom Breedom</td><td>414.333.4700</td><td colspan="3">Available M-Th 5am-1pm<br>7963 S. 116th St, Franklin, WI</td></tr>
<tr><td rowspan="2">Waukesha WWTP</td><td rowspan="2">Randy Thater</td><td>Office: 262.524.3631</td><td colspan="3" rowspan="2">600 Sentry Drive<br>Waukesha, WI</td></tr>
<tr><td>Cell: 414.507.1139</td></tr>
<tr><td rowspan="2">Brookfield WWTP</td><td rowspan="2">Rick Wenzel</td><td>262.787.3809</td><td colspan="3" rowspan="2">21225 Enterprise Ave.<br>Brookfield, WI</td></tr>
<tr><td>For Gate: 262.782.0199</td></tr>
<tr><td>Sussex WWTP</td><td>Jon Baumann</td><td>262.246.5184</td><td colspan="3">N59 W23551 Clover Drive<br>Sussex, WI</td></tr>
<tr><td>City of Waukesha Director of Department of Parks, Recreation and Forestry</td><td>Ron Grall</td><td>262.524.3734<br>www.ci.waukesha.wi.us/parks<br>RGrall@ci.waukesha.wi.us</td><td colspan="3">1900 Aviation Drive<br>Waukesha, WI 53188</td></tr>
<tr><td>Waukesha Park System Manager</td><td>Duane Grimm</td><td>262.548.7807<br>dgrimm@waukeshacounty.gov</td><td colspan="3">Waukesha County Department of Parks and Land Use<br>515 W. Moreland Blv. Room AC230<br>Waukesha, WI 53188</td></tr>
<tr><td>Waukesha- water engineer</td><td>Katie Jelacic, P.E.<br><br>Project Engineer<br><br>262-524-3587<br><br>Cell 262-349-6511</td><td></td><td colspan="3"></td></tr>
<tr><td>Waukesha water utility</td><td>Main # 262-521-5272</td><td></td><td colspan="3"></td></tr>
</table>

## 3. Well Construction Reports

WISCONSIN UNIQUE WELL NUMBER **RL255**

SOURCE: WELL CONSTRUCTION

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A (Rev 12/00)

Depth 127 FT

Property Owner: WAUKESHA WATER UTILITY | Telephone Number: 262 ▬ 521 ▬ 5242

Mailing Address: 115 DELAFIELD ST

City: WAUKESHA | State: WI | Zip Code: 53188

County of Well Location: 68 WAUKESHA 2 | Co Well Permit No: W | Well Completion Date: January 31, 2005

**1. Well Location**
C T=Town C=City V=Village of WAUKESHA | Fire#

Street Address or Road Name and Number: RIVER RD

Subdivision Name | Lot# | Block #

Gov't Lot or SE 1/4 of SW 1/4 of Section 20 T 6 N R 19 E

Latitude Deg. Min.
Longitude Deg Min.

Lat/Long Method GPS009

Well Constructor: WATER WELL | License # 6685

Facility ID (Public): 26802380

Address: N87 W36051 MAPLETON ST

Public Well Plan Approval#: 2003779

City: OCONOMOWOC | State: WI | Zip Code: 53066

Date Of Approval: 12/03/2003

Hicap Well #: 67951 | Common Well #: 11 | 6 gpm/ft

**2. Well Type** 1 — 1=New 2=Replacement (See item 12 below) 3=Reconstruction of previous unique well # ________ constructed in _____

Reason for replaced or reconstructed Well?

1 — 1=Drilled 2=Driven Point 3=Jetted 4=Other

**3. Well Serves** # of homes and or CITY (eg: barn, restaurant, church, school, industry, etc.)
M — M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole

High Capacity: Well? Y Property? Y

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? Y

Well located in floodplain? N

Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: __ units __ in. diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

**5. Drillhole Dimensions and Construction Method**

| Dia.(in.) | From (ft) | To (ft) |
|---|---|---|
| 28.0 | surface | 70 |
| 24.0 | 70 | 127 |

Upper Enlarged Drillhole / Lower Open Bedrock
- 1. Rotary - Mud Circulation
- 2. Rotary - Air
- 3. Rotary - Air and Foam
- 4. Drill-Through Casing Hammer
- 5. Reverse Rotary 28 in. dia
- X 6. Cable-tool Bit
- X 7. Temp. Outer Casing 24 in. dia 70 depth ft. Removed? X

Other

**8. Geology**

| Geology Codes | Type, Caving/Noncaving, Color, Hardness, etc | From (ft.) | To (ft.) |
|---|---|---|---|
| I | TOPSOIL | 0 | 4 |
| YC | SAND, GRAVEL, CLAY | 4 | 10 |
| CG | CLAY W/GRAVEL STONE | 10 | 87 |
| Y | SAND & GRAVEL | 87 | 105 |
| S | SAND | 105 | 127 |

**6. Casing Liner Screen**

| Dia. (in.) | Material, Weight, Specification Manufacturer & Method of Assembly | From (ft.) | To (ft.) |
|---|---|---|---|
| 16.0 | 16 INCH X .375 INCH WALL ERW A53B LONESTAR WELDED 62.64 | surface | 90 |

| Dia.(in.) | Screen type, material & slot size | From | To |
|---|---|---|---|
| 16.0 | 16 INCH PS X .070 INCH SLOT 304 SS | 90 | 125 |

**9. Static Water Level**
1.0 feet B ground surface A=Above B=Below

**10. Pump Test**
Pumping level 83.0 ft. below surface
Pumping at 490.0 GPM 5.0 Hrs

**11. Well Is:** 60 in. A Grade A=Above B=Below
Developed? Y
Disinfected? Y
Capped? Y

**7. Grout or Other Sealing Material**

| Method | Kind of Sealing Material | From (ft.) | To (ft.) | # Sacks Cement |
|---|---|---|---|---|
| TREMIE PUMPED | | | | |

12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property? Y
If no, explain

| | |
|---|---|
| *WISCONSIN UNIQUE WELL NUMBER* SOURCE: WELL CONSTRUCTION | RL256 |

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A (Rev 12/00)

Depth 148 FT

| | | | |
|---|---|---|---|
| Property Owner: WAUKESHA WATER UTILITY | | Telephone Number: 262 - 521 - 5242 | |
| Mailing Address: 115 DELAFIELD ST | | | |
| City: WAUKESHA | State: WI | Zip Code: 53188 | |
| County of Well Location: 68 WAUKESHA 2 | Co Well Permit No: W | Well Completion Date: May 24, 2005 | |

**1. Well Location**

| | |
|---|---|
| C T=Town C=City V=Village of WAUKESHA | Fire# |
| Street Address or Road Name and Number: RIVER RD | |
| Subdivision Name | Lot# / Block # |
| Gov't Lot or SE 1/4 of SW 1/4 of Section 20 T 6 N R 19 E | |
| Latitude Deg. Min. | |
| Longitude Deg Min. | |

| | | |
|---|---|---|
| Well Constructor: WATER WELL | License #: 6685 | Facility ID (Public): 26802380 |
| Address: N87 W36051 MAPLETON ST | | Public Well Plan Approval#: 2003799 |
| City: OCONOMOWOC | State: WI Zip Code: 53066 | Date Of Approval: 12/03/2003 |
| Hicap Well #: 67952 | Common Well #: 12 | 8 gpm/ft |

**2. Well Type** 1 — 1=New 2=Replacement 3=Reconstruction (See item 12 below)
of previous unique well # ________ constructed in ____
Reason for replaced or reconstructed Well?

Lat/Long Method: GPS009

**3. Well Serves** # of homes and or CITY (eg: barn, restaurant, church, school, industry, etc.)
M — M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole

High Capacity: Well? Y Property? Y

1 — 1=Drilled 2=Driven Point 3=Jetted 4=Other

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? Y
Well located in floodplain? N
Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: ___ units ___ in . diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

**5. Drillhole Dimensions and Construction Method**

| Dia.(in.) | From (ft) | To (ft) |
|---|---|---|
| 30.0 | surface | 63 |
| 24.0 | 63 | 144 |

Upper Enlarged Drillhole / Lower Open Bedrock
-- 1. Rotary - Mud Circulation
-- 2. Rotary - Air
-- 3. Rotary - Air and Foam
-- 4. Drill-Through Casing Hammer
-- 5. Reverse Rotary 24
X -- 6. Cable-tool Bit ___ in. dia
X -- 7. Temp. Outer Casing 24 in. dia 63 depth ft. Removed? X
Other

**8. Geology**

| Geology Codes | Type, Caving/Noncaving, Color, Hardness, etc | From (ft.) | To (ft.) |
|---|---|---|---|
| __I_ | TOPSOIL | 0 | 3 |
| __CM | CLAY W/SILT | 3 | 23 |
| T_S_ | BROWN SAND | 23 | 27 |
| __P_ | HARDPAN | 27 | 34 |
| __GM | GRAVEL W/SILT | 34 | 39 |
| __GC | GRAVEL W/CLAY | 39 | 54 |
| G_C_ | CLAY-GRAY | 54 | 63 |
| _AG_ | GRAVEL COARSE | 63 | 90 |
| _AS_ | COARSE SAND | 90 | 125 |
| _MS_ | MEDIUM SAND | 125 | 130 |
| _AS_ | COARSE SAND | 130 | 144 |
| _MS | MEDIUM SAND W/SILT | 144 | 147 |

**6. Casing Liner Screen**

| Dia. (in.) | Material, Weight, Specification Manufacturer & Method of Assembly | From (ft.) | To (ft.) |
|---|---|---|---|
| 16.0 | 16 INCH O.D. X .375 INCH WALL ERW | surface | 62 |
| 16.0 | A53-B LONESTAR LONESTAR WELDED 62.64 1 LBS 1 FT | 89 | 102 |

| Dia.(in.) | Screen type, material & slot size | From | To |
|---|---|---|---|
| 16.0 | 16 INCH P.S. X .070 INCH SLOT 304 S.S. DOUBLE SCREEN | 62 | 143 |

**9. Static Water Level**
2.9 feet A ground surface A=Above B=Below

**10. Pump Test**
Pumping level 58.8 ft. below surface
Pumping at 494.0 GPM 24.0 Hrs

**11. Well Is:** A Grade 36 in. A=Above B=Below
Developed? Y
Disinfected? Y
Capped? Y

**7. Grout or Other Sealing Material**
Method: TREMIE PUMPED — Kind of Sealing Material | From (ft.) | To (ft.) | # Sacks Cement

12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property? Y
If no, explain

# Appendix B:

# Field and Analytical Results

## 1. Well Suite Field Analysis

| Well Suite Field Analysis Parameters | | | | | | |
|---|---|---|---|---|---|---|
| Name | Date | pH | Specific Conductivity (mmhos/cm) | Temperature (°C) | Dissolved Oxygen by meter (mg/L) | calculated HCO3 |
| Big Bend Spring | 10/24/2013 | 7.15 | x | 12.15 | 6.51 | 302.96 |
| Big Bend Spring | 4/24/2014 | 7.19 | 0.85 | 9.77 | x | 287.46 |
| Big Bend Spring | 8/5/2014 | 7.13 | 0.88 | 11.60 | 6.06 | 303.24 |
| Big Bend Spring | 10/10/2014 | 7.49 | 0.87 | 12.20 | 9.36 | 319.87 |
| Big Bend Spring | 4/7/2015 | x | 0.86 | 9.90 | 6.95 | x |
| Big Bend Spring | 7/20/2015 | x | 0.87 | 11.40 | 6.68 | x |
| EM 275 | 10/23/2013 | 7.16 | n/a | 10.03 | 0.23 | 303.72 |
| EM 275 | 4/18/2014 | 7.1 | 0.84 | 10.1 | 0.5 | 316.37 |
| EM 275 | 8/6/2014 | 7.09 | 0.77 | 10.3 | 0.41 | 301.66 |
| EM 275 | 10/6/2014 | 6.91 | 0.75 | 15 | 0.31 | 357.53 |
| EM 275 | 4/28/2015 | x | 0.73 | 10.1 | 0.34 | x |
| EM 275 | 7/4/2015 | 5.85 | 0.55 | 10.5 | 0.95 | x |
| IZ 385 | 10/23/2013 | 7.15 | x | 11.57 | 1.18 | 397.22 |
| IZ 385 | 8/6/2014 | 6.72 | 1.38 | 11.4 | 0.56 | 390.16 |
| IZ 385 | 10/2/2014 | 6.65 | 1.35 | 11.4 | 3.25 | 403.98 |
| IZ 385 | 4/28/2015 | x | 1.47 | 11.2 | 0.295 | x |
| IZ 385 | 7/14/2015 | 6.99 | 1.17 | 11.67 | 0.40 | 937.92 |
| IZ 386 | 10/23/2013 | 7.12 | n/a | 11.07 | 0.015 | 403.40 |
| IZ 386 | 4/18/2014 | 7.12 | 1.38 | 11 | 0.26 | 437.21 |
| IZ 386 | 8/6/2014 | 6.45 | 1.37 | 12.23 | 0.34 | n/a |
| IZ 386 | 10/2/2014 | 6.64 | 1.34 | 11.93 | 1.87 | 421.04 |
| IZ 386 | 4/28/2015 | x | 1.32 | 11.20 | 0.13 | x |
| IZ 386 | 7/14/2015 | 6.69 | 1.00 | 11.6 | 0.06 | 676.83 |
| RL 255 | 10/30/2013 | 6.39 | x | 10.43 | 0.06 | 423.09 |
| RL255 | 5/15/2014 | 7.17 | 1.21 | 10.34 | 0 | 443.97 |
| RL255 | 8/4/2014 | 7.22 | 1.19 | 10.77 | 0.22 | 451.61 |
| Rl 255 | 10/7/2014 | 6.74 | 1.16 | 10.30 | 0.33 | 426.03 |
| RL 255 | 4/2/2015 | 6.72 | 1.20 | 10.30 | 0.02 | 454.55 |
| RL 255 | 7/23/2015 | 6.93 | 1.16 | 10.80 | 0.02 | 375.17 |
| RL256 | 10/30/2013 | 7.04 | x | 10.6 | 0.04 | 396.63 |

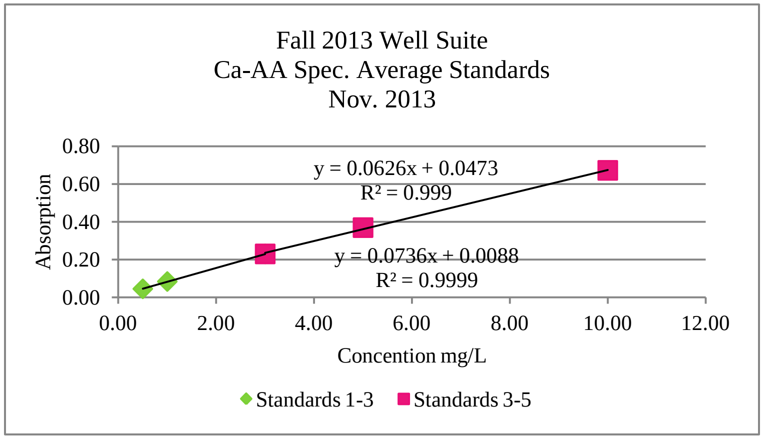
| | | | | | | |
|---|---|---|---|---|---|---|
| RL 256 | 5/15/2014 | 7.22 | 1.07 | 10.80 | 0.03 | 394.57 |
| RL 256 | 8/4/2014 | 7.29 | 1.11 | 10.90 | 0.48 | 318.42 |
| RL 256 | 10/7/2014 | 7.5 | 1.13 | 10.70 | 0.27 | 423.09 |
| RL 256 | 4/2/2015 | 6.76 | 1.13 | 10.80 | 0.03 | 426.03 |
| RL 256 | 7/23/2015 | 6.7 | 4.50 | 10.60 | 1.22 | 400.46 |
| WK 947 | 10/30/2013 | 7.27 | x | 10.4 | 0.03 | 373.99 |
| WK 947 | 5/15/2014 | 7.23 | 0.94 | 10.4 | 0.22 | 395.16 |
| WK 947 | 8/4/2014 | 7.28 | 0.90 | 10.5 | 0.29 | 402.22 |
| WK 947 | 10/7/2014 | 6.82 | 0.90 | 10.40 | 0.07 | 381.05 |
| WK 947 | 4/2/2015 | 6.82 | 0.93 | 10.40 | 0.1 | 399.87 |
| WK 947 | 7/23/2015 | 7.05 | 0.97 | 10.50 | 0.025 | 354.59 |
| SV 631 | 10/24/2013 | 7.53 | n/a | 11.4 | 0.02 | 339.89 |
| Well Suite Field Analysis Parameters (Continued 1) | | | | | | |
| Name | Date | pH | Specific Conductivity (mmhos/cm) | Temperature (°C) | Dissolved Oxygen by meter (mg/L) | calculated HCO3 |
| SV 631 | 4/18/2014 | 7.5 | 0.7095 | 12.125 | 0.31 | 358.12 |
| SV 631 | 8/5/2014 | 7.27 | 0.69 | 11.53 | 0.33 | 339.59 |
| SV 631 | 10/2/2014 | 6.67 | 0.76 | 10.30 | 0.00 | 293.43 |
| SV 631 | 4/7/2015 | 6.56 | 0.78 | 10.50 | 0.04 | x |
| SV 631 | 7/20/2015 | x | 0.28 | 18.10 | 0.08 | x |
| Fox 0 | 10/26/2013 | 7.63 | x | 7.27 | 10.15 | 390.68 |
| Fox 0 | 3/7/2014 | 7.41 | 0.471 | 1.7 | x | 381.34 |
| Fox 0 | 3/9/2014 | 7.84 | 1.052 | 2.67 | 10.50 | 382.81 |
| Fox 0 | 3/12/2014 | 7.47 | 0.85 | 2.67 | 8.44 | 280.50 |
| Fox 0 | 3/15/2014 | 7.55 | 0.81 | 1.13 | 8.97 | 251.39 |
| Fox 0 | 3/22/2014 | 7.52 | 0.83 | 1.77 | x | 256.97 |
| Fox 0 | 8/6/2014 | 7.47 | 0.84 | 15.4 | 6.43 | 280.20 |
| Fox 0 | 10/9/2014 | 7.02 | 0.98 | 8.43 | 8.42 | 326.66 |
| Fox 0 | 4/8/2015 | x | 0.94 | 6.75 | 9.07 | x |
| Fox 1 | 10/26/2013 | 8.12 | x | 6.67 | 10.90 | 296.37 |
| Fox 1 | 3/7/2014 | 7.77 | 1.9 | 0.53 | 8.13 | 335.48 |
| Fox 1 | 3/9/2014 | 8.03 | 2.03 | 0.93 | 13.29 | 336.65 |
| Fox 1 | 3/12/2014 | 7.77 | 2.28 | 1.70 | 10.48 | 236.10 |
| Fox 1 | 3/15/2014 | 7.94 | 1.761 | 1.53 | 15.02 | 267.26 |
| Fox 1 | 3/22/2014 | 7.63 | 1.3 | 2.1 | x | 281.97 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Fox1 | 4/24/2014 | 7.79 | 1.2 | 10.47 | x | 298.14 |
| Fox 1 | 8/9/2014 | 7.87 | 1.4 | 23.80 | 6.75 | 328.42 |
| Fox 1 | 10/9/2014 | 7.51 | 1.5 | 11.60 | 9.39 | 361.94 |
| Fox 1 | 4/8/2015 | x | 1.5 | 8.13 | 10.51 | x |
| Fox 2 | 10/26/2013 | 8.08 | x | 8.57 | 9.3 | 237.57 |
| Fox 2 | 3/7/2014 | 7.71 | 19.43 | 2.43 | 11.13 | 341.95 |
| Fox 2 | 3/9/2014 | 7.91 | 1.82 | 4.53 | 9.77 | 325.19 |
| Fox 2 | 3/12/2014 | 7.82 | 2.10 | 3.93 | 10.12 | n/a |
| Fox 2 | 3/15/2014 | 7.82 | 1.67 | 2.60 | 13.20 | 279.91 |
| Fox 2 | 3/22/2014 | 7.62 | 1.38 | 3.10 | x | 281.67 |
| Fox 2 | 4/24/2014 | 7.75 | 1.24 | 10.80 | x | 305.19 |
| Fox 2 | 8/9/2014 | 7.82 | 1.36 | 23.10 | 10.01 | 349.59 |
| Fox 2 | 10/9/2014 | 7.4 | 1.52 | 11.90 | 14.13 | 354.88 |
| Fox 2 | 4/8/2015 | x | 1.56 | 8.97 | 10.98 | x |
| Fox 2 | 7/23/2015 | 7.4 | 1.39 | 20.67 | 3.66 | 294.90 |
| Fox Isco | 3/7/2014 | 7.77 | 1891/100 | | 1 | 311.37 |
| Fox Isco | 3/9/2014 | 7.73 | 1.81 | 2.20 | 9.32 | 328.71 |
| Fox Isco | 3/12/2014 | 7.85 | 1.89 | 3.50 | 10.13 | 240.80 |
| Fox Isco | 3/15/2014 | 7.77 | 1.48 | 2.47 | 15.35 | 274.32 |
| Fox Isco | 3/22/2014 | 7.53 | 1.32 | 2.93 | x | 295.49 |
| Fox Isco Sampler | 4/9/2015 | 7.57 | 0.80 | 6.83 | 10.75666667 | 150.24 |
| Fox 3 | 7/14/2013 | 7.67 | x | 8.1 | 10.6 | 336.65 |
| Fox 3 | 10/24/2013 | 8.13 | x | 6.73 | 8.14 | 331.65 |
| Fox 3 | 3/15/2014 | 7.56 | 1.68 | 0.23 | 6.99 | 278.44 |
| Fox 3 | 3/22/2014 | 7.72 | 0.986 | 2.33 | 10.95 | 275.20 |
| Well Suite Field Analysis Parameters (Continued 2) | | | | | | |
| Name | Date | pH | Specific Conductivity (mmhos/cm) | Temperature (°C) | Dissolved Oxygen by meter (mg/L) | calculated HCO3 |
| Fox3 | 4/24/2014 | 7.75 | 0.97 | 12.27 | x | 300.49 |
| Fox 3 | 8/5/2014 | 7.59 | 1.00 | 24.1 | 6.25 | 243.15 |
| Fox 3 | 10/10/2014 | 7.6 | 1.09 | 7.04 | 7.27 | 342.24 |
| Fox 3 | 4/7/2015 | x | 1.05 | 9.63 | 8.83 | x |
| Fox 3 | 7/20/2015 | 7.65 | 0.91 | 24.83 | 3.54 | 243.15 |
| Root River | 10/24/2013 | 8.15 | n/a | x | x | 343.42 |
| Root River | 4/22/2014 | 7.71 | 1.13 | 11.07 | x | 313.13 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Root River | 8/5/2014 | 7.47 | 0.87 | 20.40 | 16.21 | 234.63 |
| Root River | 10/6/2014 | 7.23 | 0.97 | 10.80 | 7.93 | 223.16 |
| Root River | 4/7/2015 | x | 1.39 | 7.90 | 9.20 | x |
| Root River | 7/20/2015 | 6.42 | 0.66 | 21.97 | 2.51 | 140.54 |
| Sussex Creek | 10/26/2013 | 8.26 | x | 7.47 | 10.53 | 265.11 |
| Sussex Creek | 8/6/2014 | 8.22 | 0.83 | 20.57 | 9.15 | n/a |
| Sussex Creek | 10/9/2014 | 7.63 | 1.18 | 10.57 | 9.05 | 274.17 |
| Sussex Creek | 4/8/2015 | x | 1.06 | 7.50 | 13.69 | x |
| Underwood Creek | 10/26/2013 | 8.4 | x | x | x | 368.11 |
| Underwood Creek | 8/9/2013 | Construction | x | x | x | x |
| Underwood Creek | 4/8/2015 | x | 1.592 | 6.83 | 6.83 | x |
| Underwood Creek | 7/23/2015 | 7.6 | 4.5 | 18.27 | 7.24 | 356.94 |

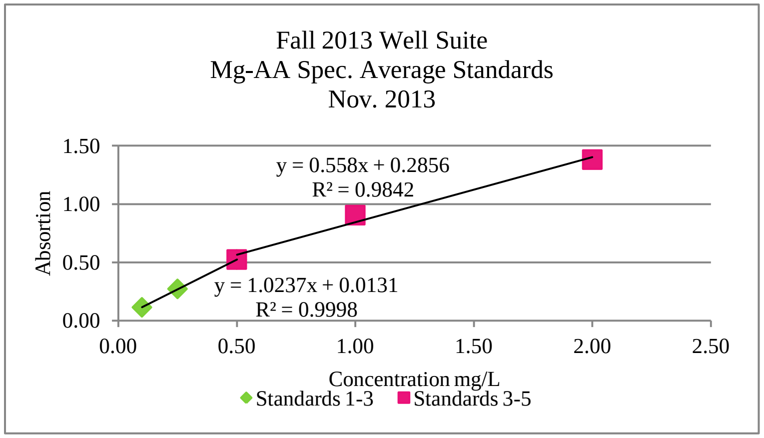
2. Atomic Absorption Spectroscopy with Calibration Curves

## Fall 2013



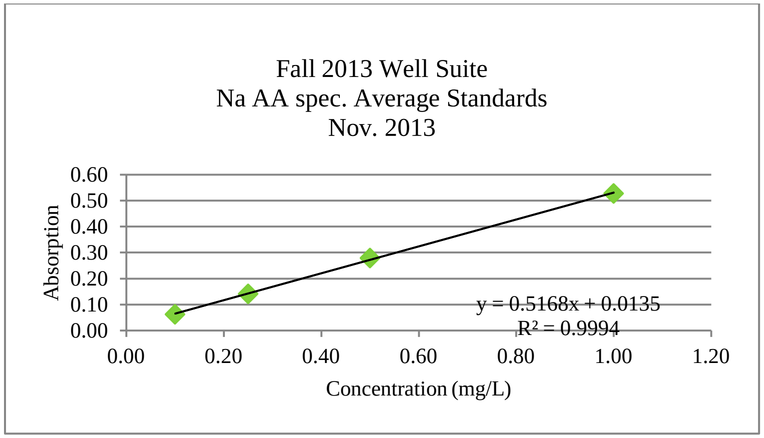

| Fall 2013 Well Suite | | Run Nov. 2013 | | Ca |
|---|---|---|---|---|
| Standard | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.50 | 0.04 | 0.05 | 0.04 |
| Standard 2 | 1.00 | 0.08 | 0.09 | 0.08 |
| Standard 3 | 3.00 | 0.22 | 0.24 | 0.23 |
| Standard 4 | 5.00 | 0.36 | 0.38 | 0.37 |
| Standard 5 | 10.00 | 0.66 | 0.68 | 0.67 |

| Fall 2013 Well Suite | | Run Nov. 2013 | | |
|---|---|---|---|---|
| Ca | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Conc. (mg/L) | Factor | Conc. (mg/L) |
| EM275 10_27_13 | 0.29 | 3.79 | 25.00 | 94.82 |
| SV631 10_24_13 | 0.21 | 2.70 | 25.00 | 67.53 |
| IZ 385 10_21_13 | 0.34 | 4.65 | 25.00 | 116.22 |
| IZ 386 10_21_13 | 0.37 | 5.15 | 25.00 | 128.84 |
| WK 947 10_30_13 | 0.31 | 4.13 | 25.00 | 103.23 |
| RL 255 10_30_13 | 0.33 | 4.45 | 25.00 | 111.19 |
| RL 256 10_30_13 | 0.34 | 4.65 | 25.00 | 116.37 |
| BB Spring 10_24_13 | 0.25 | 3.32 | 25.00 | 82.94 |
| RL 255 7_10_13 | 0.34 | 4.63 | 25.00 | 115.87 |
| RL 256 7_10_13 | 0.33 | 4.58 | 25.00 | 114.57 |
| Fox 0 1-_26_13 | 0.27 | 3.62 | 25.00 | 90.46 |
| Fox 1 10_26_13 | 0.23 | 3.00 | 25.00 | 74.95 |
| Fox 2 10_25_13 | 0.25 | 3.26 | 25.00 | 81.56 |
| Fox 3 10_24_13 | 0.25 | 3.29 | 25.00 | 82.17 |
| Und Crk 10_26_13 | 0.36 | 4.97 | 25.00 | 124.25 |
| Sussex Crk 10_26_13 | 0.25 | 3.18 | 25.00 | 79.38 |
| Roort River 10_24_1 | 0.15 | 1.90 | 25.00 | 47.53 |
| Waukesha WWTP | 0.01 | -0.02 | 25.00 | -0.52 |
| Brookfield WWTP | 0.29 | 3.93 | 25.00 | 98.26 |
| Sussex WWTP | 0.26 | 3.46 | 25.00 | 86.49 |



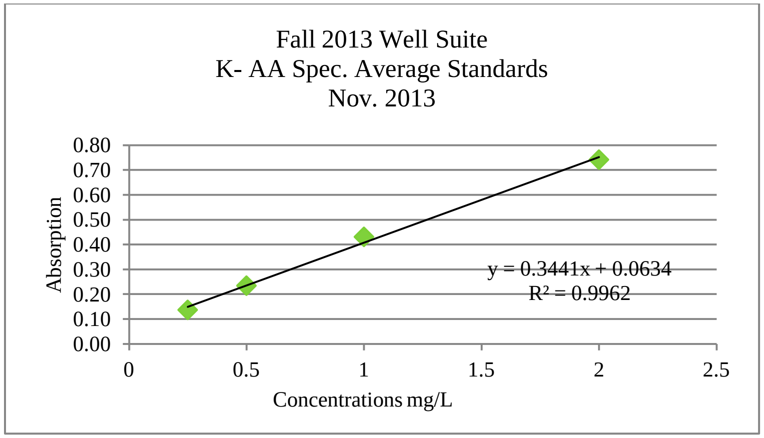

| Fall 2013 Well Suite | | Run Nov. 2013 | | Mg |
|---|---|---|---|---|
| Standard | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.10 | 0.11 | 0.11 | 0.11 |
| Standard 2 | 0.25 | 0.27 | 0.27 | 0.27 |
| Standard 3 | 0.50 | 0.52 | 0.52 | 0.52 |
| Standard 4 | 1.00 | 0.90 | 0.91 | 0.90 |
| Standard 5 | 2.00 | 1.38 | 1.38 | 1.38 |

| Fall 2013 Well Suite | | Run Nov. 2013 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Conc. (mg/L) | Factor | Conc. (mg/L) |
| EM275 10_27_13 | 0.88 | 1.07 | 50.00 | 53.27 |
| SV631 10_24_13 | 1.03 | 1.33 | 50.00 | 66.67 |
| IZ 385 10_21_13 | 0.98 | 1.25 | 50.00 | 62.47 |
| IZ 386 10_21_13 | 1.01 | 1.30 | 50.00 | 64.89 |
| WK 947 10_30_13 | 1.11 | 1.48 | 50.00 | 74.01 |
| RL 255 10_30_13 | 1.07 | 1.40 | 50.00 | 69.93 |
| RL 256 10_30_13 | 1.00 | 1.27 | 50.00 | 63.65 |
| BB Spring 10_24_13 | 0.86 | 1.02 | 50.00 | 51.19 |
| RL 255 7_10_13 | 0.98 | 1.25 | 50.00 | 62.31 |
| RL 256 7_10_13 | 1.08 | 1.42 | 50.00 | 71.22 |
| Fox 0 1-_26_13 | 0.96 | 1.22 | 50.00 | 60.78 |
| Fox 1 10_26_13 | 0.76 | 0.85 | 50.00 | 42.73 |
| Fox 2 10_25_13 | 0.88 | 1.06 | 50.00 | 52.94 |
| Fox 3 10_24_13 | 0.84 | 0.99 | 50.00 | 49.40 |
| Und Crk 10_26_13 | 1.00 | 1.28 | 50.00 | 64.14 |
| Suss Crk 10_26_13 | 0.88 | 1.07 | 50.00 | 53.51 |
| Root R 10_24_1 | 0.85 | 1.01 | 50.00 | 50.51 |
| Waukesha WWTP | 0.76 | 0.86 | 50.00 | 42.83 |
| Brookfield WWTP | 0.84 | 0.99 | 50.00 | 49.68 |
| Sussex WWTP | 0.73 | 0.796 | 50.00 | 39.80 |




| Fall 2013 Well Suite | | Run Nov. 2013 | | Na |
|---|---|---|---|---|
| Standard | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.10 | 0.06 | 0.06 | 0.06 |
| Standard 2 | 0.25 | 0.13 | 0.15 | 0.14 |
| Standard 3 | 0.50 | 0.28 | 0.28 | 0.28 |
| Standard 4 | 1.00 | 0.53 | 0.52 | 0.53 |

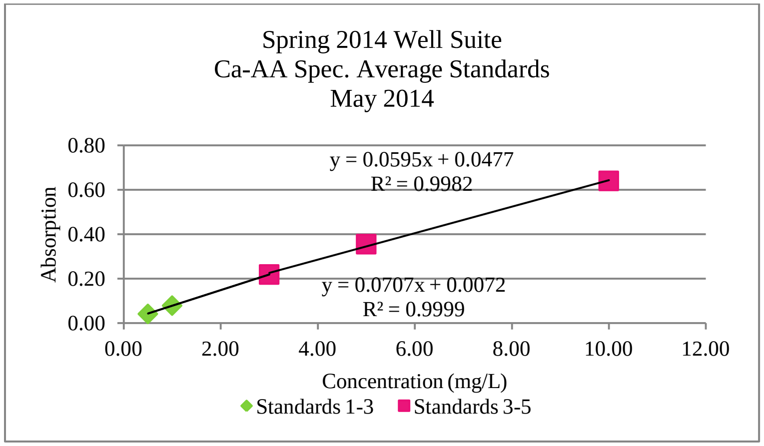
| Fall 2013 Well Suite | | Run Nov. 2013 | | |
|---|---|---|---|---|
| Na | | Dilution | Calculated | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Factor | Conc. (mg/L) | Conc. (mg/L) |
| EM275 10_27_13 | 0.22 | 50.00 | 0.40 | 19.94 |
| SV631 10_24_13 | 0.18 | 50.00 | 0.33 | 16.38 |
| IZ 385 10_21_13 | 0.31 | 100.00 | 0.57 | 56.86 |
| IZ 386 10_21_13 | 0.30 | 100.00 | 0.55 | 54.87 |
| WK 947 10_30_13 | 0.14 | 100.00 | 0.24 | 24.45 |
| standard1ppm | 0.53 | 100.00 | 1.00 | |
| RL 255 10_30_13 | 0.35 | 100.00 | 0.65 | 64.98 |
| RL 256 10_30_13 | 0.28 | 100.00 | 0.52 | 51.57 |
| BB Spring 10_24_13 | 0.27 | 100.00 | 0.49 | 49.45 |
| RL 255 7_10_13 | 0.47 | 100.00 | 0.88 | 87.66 |
| RL 256 7_10_13 | 0.36 | 100.00 | 0.67 | 67.21 |
| Fox 0 1-_26_13 | 0.27 | 100.00 | 0.49 | 49.04 |
| standard 1ppm | 0.53 | | | |
| Fox 1 10_26_13 | 0.30 | 100.00 | 0.56 | 56.15 |
| Fox 2 10_25_13 | 0.10 | 100.00 | 0.17 | 16.55 |
| Fox 3 10_24_13 | 0.29 | 100.00 | 0.54 | 53.61 |
| Und Crk 10_26_13 | 0.20 | 100.00 | 0.35 | 35.28 |
| Sussex Crk 10_26_13 | 0.36 | 100.00 | 0.68 | 67.64 |
| Roort River 10_24_1 | 0.14 | 100.00 | 0.25 | 24.81 |
| standard 1ppm | 0.53 | | | |
| Waukesha WWTP | 0.17 | 500.00 | 0.30 | 149.03 |
| Brookfield WWTP | 0.17 | 500.00 | 0.31 | 156.02 |
| Sussex WWTP | 0.19 | 500.00 | 0.33 | 167.46 |




| Fall 2013 Well Suite | | Run Nov. 2013 | | K |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.25 | 0.15 | 0.12 | 0.14 |
| Standard 2 | 0.5 | 0.25 | 0.22 | 0.23 |
| Standard 3 | 1 | 0.44 | 0.42 | 0.43 |
| Standard 4 | 2 | 0.75 | 0.73 | 0.74 |

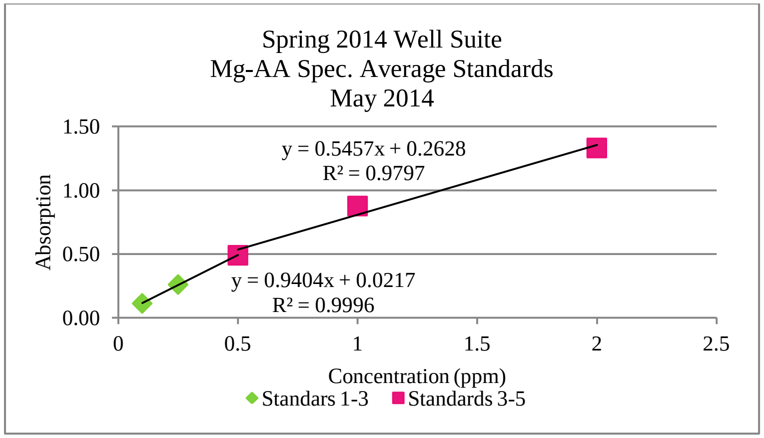
| Fall 2013 Well Suite | | Run Nov. 2013 | | |
|---|---|---|---|---|
| K | | Dilution | Calculated | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Factor | Conc. (mg/L) | Conc. (mg/L) |
| EM275 10_27_13 | 0.57 | 2.00 | 1.46 | 2.92 |
| SV631 10_24_13 | 0.36 | 2.00 | 0.88 | 1.75 |
| IZ 385 10_21_13 | 0.64 | 2.00 | 1.69 | 3.37 |
| IZ 386 10_21_13 | 0.57 | 2.00 | 1.46 | 2.92 |
| WK 947 10_30_13 | 0.54 | 2.00 | 1.39 | 2.78 |
| RL 255 10_30_13 | 0.62 | 2.00 | 1.63 | 3.25 |
| RL 256 10_30_13 | 0.50 | 2.00 | 1.27 | 2.53 |
| BB Spring 10_24_13 | 0.59 | 2.00 | 1.54 | 3.08 |
| RL 255 7_10_13 | 0.54 | 2.00 | 1.39 | 2.78 |
| RL 256 7_10_13 | 0.58 | 2.00 | 1.50 | 2.99 |
| Fox 0 1-_26_13 | 0.33 | 4.00 | 0.79 | 3.16 |
| Fox 1 10_26_13 | 0.55 | 4.00 | 1.40 | 5.60 |
| Fox 2 10_25_13 | 0.66 | 4.00 | 1.72 | 6.88 |
| Fox 3 10_24_13 | 0.54 | 4.00 | 1.39 | 5.57 |
| Und Crk 10_26_13 | 0.54 | 4.00 | 1.40 | 5.59 |
| Sussex Crk 10_26_13 | 0.45 | 4.00 | 1.12 | 4.47 |
| Roort River 10_24_1 | 0.45 | 4.00 | 1.13 | 4.53 |
| Waukesha WWTP | 0.62 | 10.00 | 1.61 | 16.07 |
| Brookfield WWTP | 0.51 | 10.00 | 1.30 | 13.02 |
| Sussex WWTP | 0.49 | 10.00 | 1.23 | 12.26 |

# Spring 2014



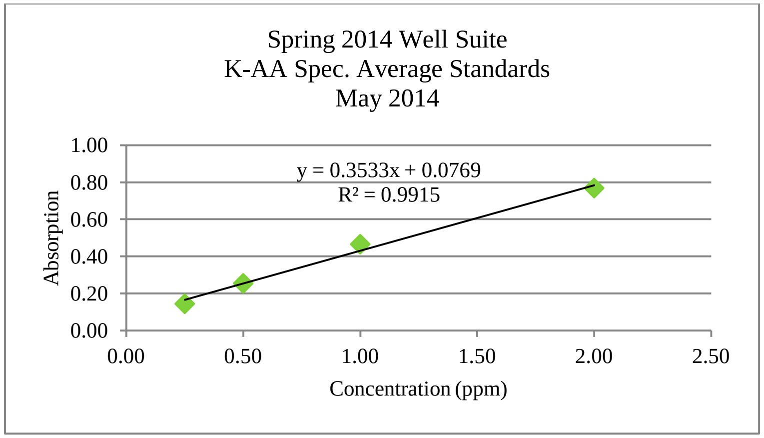

| Spring 2014 Well Suite | | Run May 16, 2014 | | Ca |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.5 | 0.04 | 0.12 | 0.14 |
| Standard 2 | 1 | 0.08 | 0.22 | 0.23 |
| Standard 3 | 3 | 0.22 | 0.42 | 0.43 |
| Standard 4 | 5 | 0.36 | 0.73 | 0.74 |
| Standard 5 | 10 | 0.64 | 0.64 | 0.64 |

| Spring 2014 Well Suite | | Run May 16, 2014 | | |
|---|---|---|---|---|
| Ca | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_4_18_14 | 0.28 | 3.98 | 25.00 | 99.49 |
| SV631_4_22_14 | 0.19 | 2.62 | 25.00 | 65.38 |
| IZ386_4_22_14 | 0.36 | 5.28 | 25.00 | 131.99 |
| WK947_5_15_14 | 0.30 | 4.21 | 25.00 | 105.23 |
| RL255_5_15_14 | 0.31 | 4.46 | 25.00 | 111.60 |
| RL256_15_14 | 0.31 | 4.42 | 25.00 | 110.50 |
| B.B.Spring_4_24_14 | 0.23 | 3.00 | 25.00 | 74.94 |
| RL255_10_30_13 | 0.33 | 4.70 | 25.00 | 117.50 |
| RL256_10_30_13 | 0.31 | 4.35 | 25.00 | 108.86 |
| Fox1_4_24_14 | 0.24 | 3.20 | 25.00 | 80.05 |
| Fox2_4_24_14 | 0.25 | 3.33 | 25.00 | 83.30 |
| Fox3_4_24_14 | 0.22 | 2.92 | 25.00 | 72.94 |
| RootR.4_22_14 | 0.25 | 3.46 | 25.00 | 86.39 |
| W.WWTP_4_24_14 | 0.29 | 4.07 | 25.00 | 101.77 |
| B.WWTP_4_18_14 | 0.31 | 4.48 | 25.00 | 112.11 |
| S.WWTP_4_16_14 | 0.27 | 3.76 | 25.00 | 94.11 |



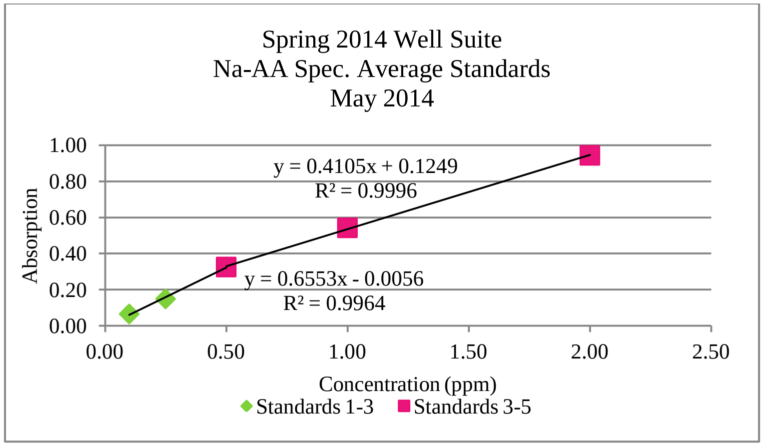

| Spring 2014 Well Suite | | Run May 6, 2014 | | Mg |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.1 | 0.11 | 0.11 | 0.11 |
| Standard 2 | 0.25 | 0.26 | 0.26 | 0.26 |
| Standard 3 | 0.5 | 0.49 | 0.49 | 0.49 |
| Standard 4 | 1 | 0.88 | 0.88 | 0.88 |
| Standard 5 | 2 | 1.33 | 1.33 | 1.33 |

| Spring 2014 Well Suite | | Run May 6, 2014 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | Signal (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_4_18_14 | 0.75 | 0.90 | 50.00 | 45.06 |
| SV631_4_22_14 | 0.84 | 1.06 | 50.00 | 52.79 |
| IZ386_4_22_14 | 1.04 | 1.43 | 50.00 | 71.62 |
| WK947_5_15_14 | 1.07 | 1.47 | 50.00 | 73.60 |
| RL255_5_15_14 | 0.91 | 1.19 | 50.00 | 59.61 |
| RL256_15_14 | 0.96 | 1.28 | 50.00 | 64.14 |
| B.B.Spring_4_24_14 | 0.69 | 0.79 | 50.00 | 39.51 |
| RL255_10_30_13 | 0.91 | 1.18 | 50.00 | 58.97 |
| RL256_10_30_13 | 0.88 | 1.14 | 50.00 | 56.99 |
| Fox1_4_24_14 | 0.59 | 0.61 | 50.00 | 30.34 |
| Fox2_4_24_14 | 0.75 | 0.89 | 50.00 | 44.55 |
| Fox3_4_24_14 | 0.67 | 0.75 | 50.00 | 37.48 |
| RootR.4_22_14 | 0.76 | 0.91 | 50.00 | 45.68 |
| W.WWTP_4_24_14 | 0.78 | 0.94 | 50.00 | 47.19 |
| B.WWTP_4_18_14 | 0.84 | 1.05 | 50.00 | 52.53 |
| S.WWTP_4_16_14 | 0.52 | 0.47 | 50.00 | 23.57 |




| Spring 2014 Well Suite | | Run May 6, 2014 | | K |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.25 | 0.16 | 0.13 | 0.14 |
| Standard 2 | 0.5 | 0.27 | 0.24 | 0.25 |
| Standard 3 | 1 | 0.47 | x | 0.47 |
| Standard 4 | 2 | 0.78 | 0.76 | 0.77 |

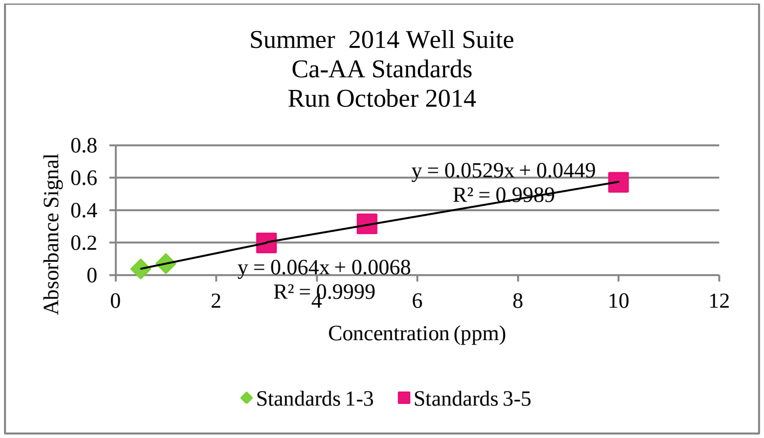
| Spring 2014 Well Suite | | Run May 6, 2014 | | |
|---|---|---|---|---|
| K | | Calculated | Dilution | Corrected |
| SAMPLE ID | Signal (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_4_18_14 | 0.55 | 1.350677 | 2 | 2.70 |
| SV631_4_22_14 | 0.34 | 0.730668 | 2 | 1.46 |
| IZ386_4_22_14 | 0.65 | 1.619442 | 2 | 3.24 |
| WK947_5_15_14 | 0.51 | 1.217053 | 2 | 2.43 |
| RL255_5_15_14 | 0.66 | 1.650402 | 2 | 3.30 |
| RL256_15_14 | 0.59 | 1.439293 | 2 | 2.88 |
| B.B.Spring_4_24_14 | 0.53 | 1.284038 | 2 | 2.57 |
| RL255_10_30_13 | 0.54 | 1.31787 | 2 | 2.64 |
| RL256_10_30_13 | 0.50 | 1.198567 | 2 | 2.40 |
| Fox1_4_24_14 | 0.35 | 0.784948 | 4 | 3.14 |
| Fox2_4_24_14 | 0.40 | 0.906583 | 4 | 3.63 |
| Fox3_4_24_14 | 0.32 | 0.681752 | 4 | 2.73 |
| RootR.4_22_14 | 0.27 | 0.554685 | 4 | 2.22 |
| W.WWTP_4_24_14 | 0.48 | 1.129539 | 10 | 11.30 |
| B.WWTP_4_18_14 | 0.36 | 0.788187 | 10 | 7.88 |
| S.WWTP_4_16_14 | 0.35 | 0.764014 | 10 | 7.64 |




| Spring 2014 Well Suite | | Run May 6, 2014 | | Na |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.10 | 0.07 | 0.07 | 0.07 |
| Standard 2 | 0.25 | 0.15 | 0.15 | 0.15 |
| Standard 3 | 0.50 | 0.32 | 0.33 | 0.33 |
| Standard 4 | 1.00 | 0.54 | 0.54 | 0.54 |
| Standard 5 | 2.00 | 0.94 | 0.95 | 0.94 |

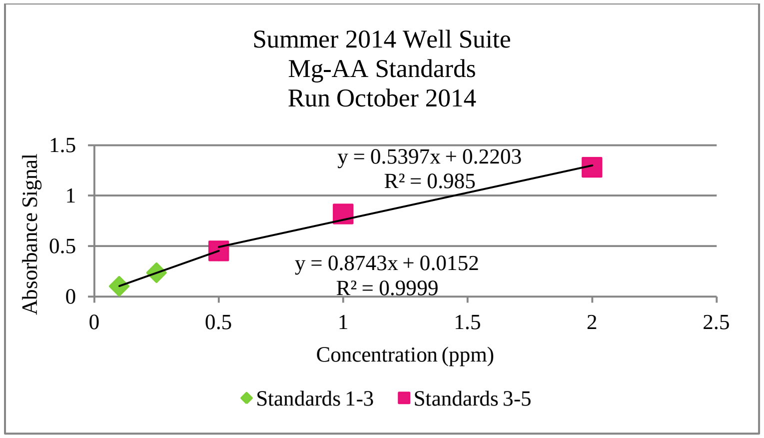
| Spring 2014 Well Suite | | Run May 6, 2014 | | |
|---|---|---|---|---|
| Na | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_4_18_14 | 0.42 | 0.71 | 50.00 | 35.74 |
| SV631_4_22_14 | 0.01 | 0.02 | 50.00 | 0.87 |
| IZ386_4_22_14 | 0.54 | 1.00 | 100.00 | 100.06 |
| WK947_5_15_14 | 0.22 | 0.35 | 100.00 | 34.74 |
| RL255_5_15_14 | 0.51 | 0.93 | 100.00 | 93.02 |
| RL256_15_14 | 0.42 | 0.72 | 100.00 | 71.66 |
| B.B.Spring_4_24_14 | 0.35 | 0.55 | 100.00 | 54.52 |
| RL255_10_30_13 | 0.37 | 0.59 | 100.00 | 59.14 |
| RL256_10_30_13 | 0.23 | 0.36 | 100.00 | 36.47 |
| Fox1_4_24_14 | 0.66 | 1.30 | 100.00 | 130.49 |
| Fox2_4_24_14 | 0.70 | 1.40 | 100.00 | 140.18 |
| Fox3_4_24_14 | 0.49 | 0.88 | 100.00 | 87.82 |
| RootR.4_22_14 | 0.80 | 1.65 | 100.00 | 165.46 |
| W.WWTP_4_24_14 | 0.78 | 1.60 | 500.00 | 799.48 |
| B.WWTP_4_18_14 | 0.77 | 1.56 | 500.00 | 781.63 |
| S.WWTP_4_16_14 | 0.70 | 1.40 | 500.00 | 698.37 |

## Summer 2014



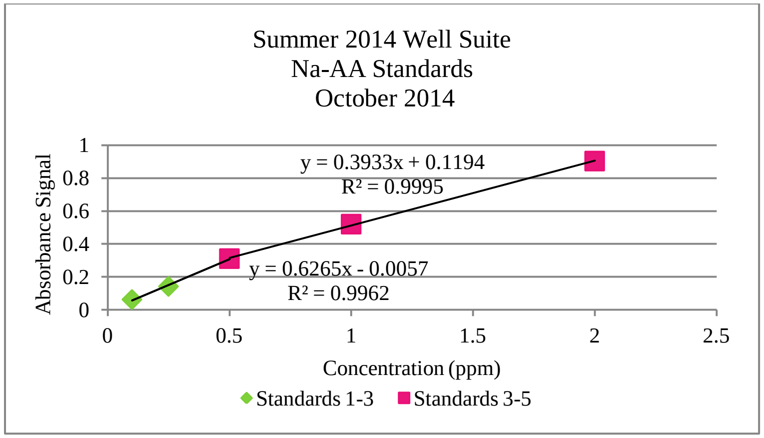

| Summer 2014 Well Suite | | Run October 3, 2014 | | Ca |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.5 | 0.035 | 0.041 | 0.038 |
| Standard 2 | 1 | 0.068 | 0.075 | 0.071488 |
| Standard 3 | 3 | 0.19 | 0.20 | 0.20 |
| Standard 4 | 5 | 0.31 | 0.32 | 0.32 |
| Standard 5 | 10 | 0.56497 | 0.579338 | 0.572154 |

| Summer 2014 Well Suite | | Run October 3, 2014 | | |
|---|---|---|---|---|
| Ca | | Calculated | Dilution | Corrected |
| Sample ID | Signal (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_8_6_14 | 0.283155 | 4.50387 | 25 | 112.60 |
| SV631_8_5_14 | 0.176747 | 2.655425 | 25 | 66.39 |
| IZ385_8_6_14 | 0.324765 | 5.290462 | 25 | 132.26 |
| IZ386_8_6_14 | 0.30042 | 4.830251 | 25 | 120.76 |
| B.B.Spring_8_5_14 | 0.223871 | 3.383186 | 25 | 84.58 |
| RL255_8_4_14 | 0.313053 | 5.069046 | 25 | 126.73 |
| RL256_8_4_14 | 0.275986 | 4.368362 | 25 | 109.21 |
| WK947_8_4_14 | 0.291564 | 4.662843 | 25 | 116.57 |
| Fox0_8_6_14 | 0.209957 | 3.120168 | 25 | 78.00 |
| Fox1_8_9_14 | 0.218738 | 3.286164 | 25 | 82.15 |
| Fox3_8_5_14 | 0.176011 | 2.655425 | 25 | 66.39 |
| SussexCreek_8_6_14 | 0.156898 | 2.655425 | 25 | 66.39 |
| RootR._8_5_14 | 0.158737 | 2.655425 | 25 | 66.39 |
| W.WWTP_8_4_14 | 0.268319 | 4.223412 | 25 | 105.59 |
| B.WWTP_8_6_14 | 0.266952 | 4.197586 | 25 | 104.94 |
| S.WWTP_8_6_14 | 0.239262 | 3.674135 | 25 | 91.85 |



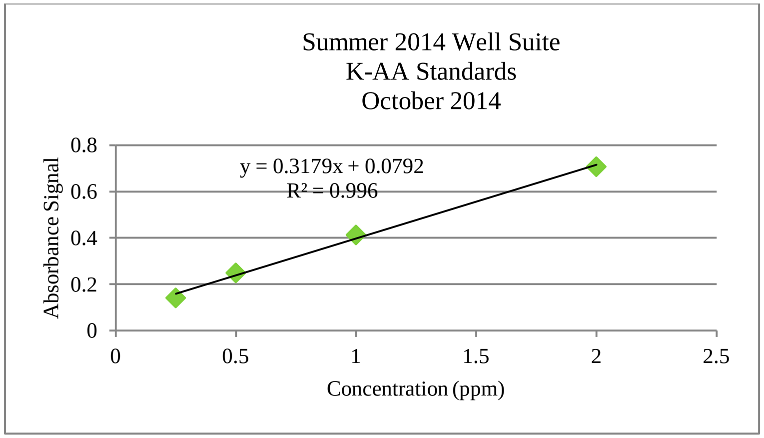

| Summer 2014 Well Suite | | Run October 3, 2014 | | Mg |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.1 | 0.101576 | 0.101576 | 0.101576 |
| Standard 2 | 0.25 | 0.235499 | 0.235499 | 0.235499 |
| Standard 3 | 0.5 | 0.45171 | 0.45171 | 0.45171 |
| Standard 4 | 1 | 0.817808 | 0.817808 | 0.817808 |
| Standard 5 | 2 | 1.28057 | 1.28057 | 1.28057 |

| Summer Well Suite 2014 | | Run October 3, 2014 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_8_6_14 | 0.745587 | 0.973294 | 50 | 48.66 |
| SV631_8_5_14 | 0.91138 | 1.280489 | 50 | 64.02 |
| IZ385_8_6_14 | 0.8604 | 1.18603 | 50 | 59.30 |
| IZ386_8_6_14 | 0.9632 | 1.376506 | 50 | 68.83 |
| B.B>Spring_8_5_14 | 0.720118 | 0.926103 | 50 | 46.31 |
| RL255_8_4_14 | 1.044504 | 1.527152 | 50 | 76.36 |
| RL256_8_4_14 | 0.87636 | 1.215602 | 50 | 60.78 |
| WK947_8_4_14 | 0.918331 | 1.293369 | 50 | 64.67 |
| Fox0_8_6_14 | 0.776777 | 1.031085 | 50 | 51.55 |
| Fox1_8_9_14 | 0.686198 | 0.863254 | 50 | 43.16 |
| Fox3_8_5_14 | 0.567932 | 0.64412 | 50 | 32.21 |
| SussexCreek_8_6_14 | 0.585948 | 0.677502 | 50 | 33.88 |
| RootR._8_5_14 | 0.54339 | 0.598648 | 50 | 29.93 |
| W.WWTP_8_4_14 | 0.66507 | 0.824107 | 50 | 41.21 |
| B.WWTP_8_6_14 | 0.716101 | 0.91866 | 50 | 45.93 |
| S.WWTP_8_6_14 | 0.680583 | 0.85285 | 50 | 42.64 |




| Summer 2014 Well Suite | | Run October 3, 2014 | | Na |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.1 | 0.064144 | 0.061007 | 0.062576 |
| Standard 2 | 0.25 | 0.142603 | 0.1414 | 0.142002 |
| Standard 3 | 0.5 | 0.31108 | 0.310779 | 0.31093 |
| Standard 4 | 1 | 0.524677 | 0.516215 | 0.520446 |
| Standard 5 | 2 | 0.908324 | 0.898489 | 0.903407 |

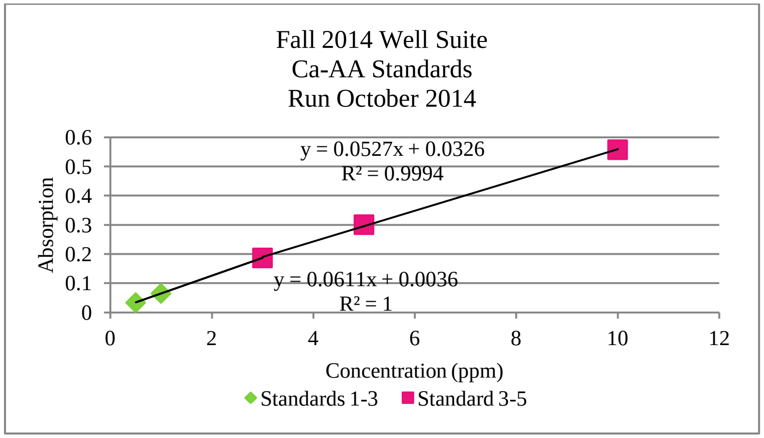
| Summer 2014 Well Suite | | Run October 3, 2014 | | |
|---|---|---|---|---|
| Na | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L0 |
| EM275_8_6_14 | 0.297445 | 0.465675 | 50 | 23.28 |
| SV631_8_5_14 | 0.27699 | 0.400685 | 50 | 20.03 |
| IZ385_8_6_14 | 0.574866 | 1.158063 | 100 | 115.81 |
| IZ386_8_6_14 | 0.514858 | 1.005487 | 100 | 100.55 |
| B.B.Spring_8_5_14 | 0.387063 | 0.680557 | 100 | 68.06 |
| RL255_8_4_14 | 0.570998 | 1.148229 | 100 | 114.82 |
| RL256_8_4_14 | 0.40434 | 0.724486 | 100 | 72.45 |
| WK947_8_4_14 | 0.234373 | 0.365002 | 100 | 36.50 |
| Fox0_8_6_14 | 0.358003 | 0.606669 | 100 | 60.67 |
| Fox1_8_9_14 | 0.764611 | 1.640506 | 100 | 164.05 |
| Fox3_8_5_14 | 0.53432 | 1.05497 | 100 | 105.50 |
| SussexCreek_8_6_14 | 0.404945 | 0.726023 | 100 | 72.60 |
| RootR._8_5_14 | 0.450243 | 0.841198 | 100 | 84.12 |
| W.WWTP_8_4_14 | 0.730095 | 1.552747 | 500 | 776.37 |
| B.WWTP_8_6_14 | 0.706965 | 1.493935 | 500 | 746.97 |
| S.WWTP_8_6_14 | 0.694661 | 1.462652 | 500 | 731.33 |




| Summer 2014 Well Suite | | Run October 3, 2014 | | K |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.25 | 0.143697 | 0.138036 | 0.140867 |
| Standard 2 | 0.5 | 0.253078 | 0.244319 | 0.248699 |
| Standard 3 | 1 | 0.416073 | 0.408868 | 0.412471 |
| Standard 4 | 2 | 0.70579 | 0.708189 | 0.706989 |

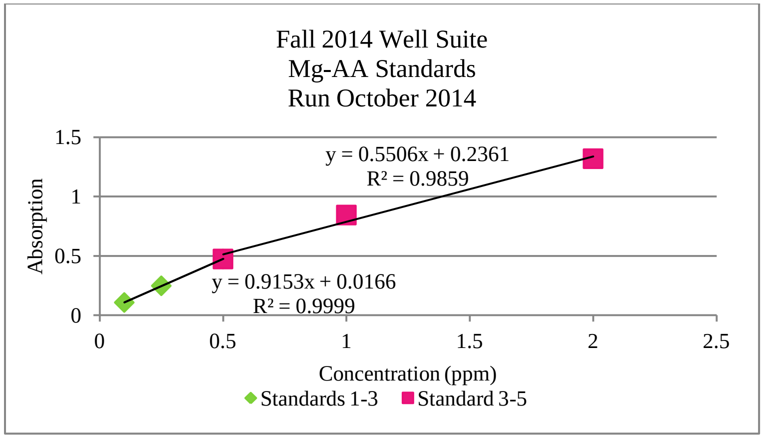
| Summer 2014 Well Suite | | Run October 3, 2014 | | |
|---|---|---|---|---|
| K | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_8_6_14 | 0.297445 | 0.465675 | 50 | 23.28 |
| SV631_8_5_14 | 0.27699 | 0.400685 | 50 | 20.03 |
| IZ385_8_6_14 | 0.574866 | 1.158063 | 100 | 115.81 |
| IZ386_8_6_14 | 0.514858 | 1.005487 | 100 | 100.55 |
| B.B.Spring_8_5_14 | 0.387063 | 0.680557 | 100 | 68.06 |
| RL255_8_4_14 | 0.570998 | 1.148229 | 100 | 114.82 |
| RL256_8_4_14 | 0.40434 | 0.724486 | 100 | 72.45 |
| WK947_8_4_14 | 0.234373 | 0.365002 | 100 | 36.50 |
| Fox0_8_6_14 | 0.358003 | 0.606669 | 100 | 60.67 |
| Fox1_8_9_14 | 0.764611 | 1.640506 | 100 | 164.05 |
| Fox3_8_5_14 | 0.53432 | 1.05497 | 100 | 105.50 |
| SussexCreek_8_6_14 | 0.404945 | 0.726023 | 100 | 72.60 |
| RootR._8_5_14 | 0.450243 | 0.841198 | 100 | 84.12 |
| W.WWTP_8_4_14 | 0.730095 | 1.552747 | 500 | 776.37 |
| B.WWTP_8_6_14 | 0.706965 | 1.493935 | 500 | 746.97 |
| S.WWTP_8_6_14 | 0.694661 | 1.462652 | 500 | 731.33 |

# Fall 2014



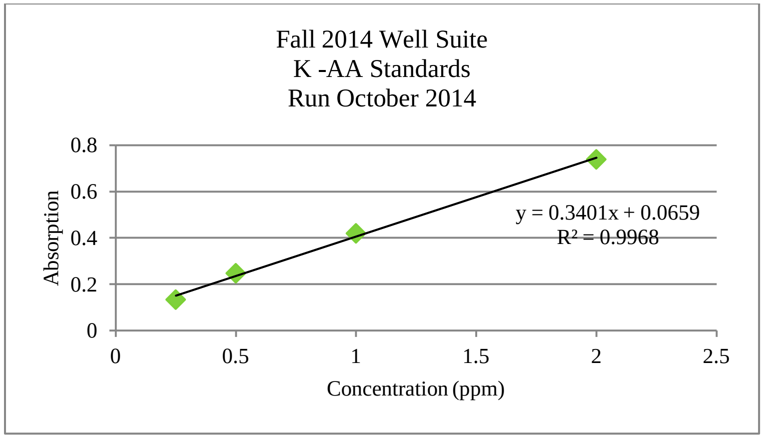

| Fall 2014 Well Suite | Run October 29,2014 | Ca |
|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start |
| Standard 1 | 0.5 | 0.002828 |
| Standard 2 | 1 | 0.033778 |
| Standard 3 | 3 | 0.065139 |
| Standard 4 | 5 | 0.186911 |
| Standard 5 | 10 | 0.300879 |

| Fall 2014 Well Suite | | Run October 29, 2014 | | |
|---|---|---|---|---|
| Ca | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_10_6_14 | 0.180936 | 2.902382 | 25 | 72.55954 |
| SV631_10_2_14 | 0.249842 | 4.122231 | 25 | 103.0558 |
| B.B.Spring_10_10_14 | 0.23131 | 3.770581 | 25 | 94.26452 |
| IZ385_10_2_14 | 0.290604 | 4.895717 | 25 | 122.3929 |
| IZ386_10_2_14 | 0.361912 | 6.248801 | 25 | 156.22 |
| RL255_10_7_14 | 0.266543 | 4.439154 | 25 | 110.9789 |
| RL256_10_7_14 | 0.278305 | 4.662332 | 25 | 116.5583 |
| WK947_10_7_14 | 0.262387 | 4.360277 | 25 | 109.0069 |
| Fox0_10_9_14 | 0.229101 | 3.728673 | 25 | 93.21682 |
| Fox1_10_9_14 | 0.245105 | 4.032355 | 25 | 100.8089 |
| Fox2_10_9_14 | 0.223801 | 3.628102 | 25 | 90.70255 |
| Fox3_10_9_14 | 0.18285 | 2.851044 | 25 | 71.27609 |
| SussexCreek_10_9_14 | 0.254054 | 4.202155 | 25 | 105.0539 |
| RootR._10_6_14 | 0.148412 | 2.197576 | 25 | 54.93941 |
| W.WWTP_10_7_14 | 0.231542 | 3.77499 | 25 | 94.37475 |
| S.WWTP_10_9_14 | 0.212205 | 3.408057 | 25 | 85.20142 |
| B.WWTP_10_2_14 | 0.253148 | 4.184978 | 25 | 104.6244 |
| EM275_10_6_14 | 0.180936 | 2.902382 | 25 | 72.55954 |



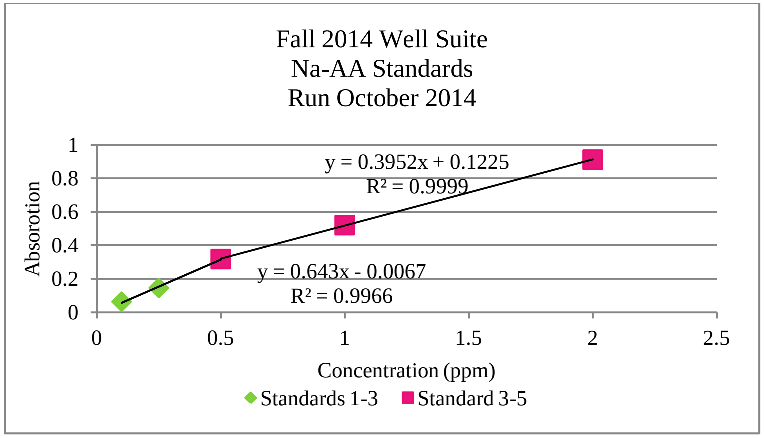

| Fall 2014 Well Suite | | Run October 29, 2014 | | Mg |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.25 | 0.143697 | 0.138036 | 0.140867 |
| Standard 2 | 0.5 | 0.253078 | 0.244319 | 0.248699 |
| Standard 3 | 1 | 0.416073 | 0.408868 | 0.412471 |
| Standard 4 | 2 | 0.70579 | 0.708189 | 0.706989 |

| Fall 2014 Well Suite | | Run October 29, 2014 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_10_6_14 | 0.78707 | 1.000673 | 50 | 50.03363 |
| SV631_10_2_14 | 0.607989 | 0.675426 | 50 | 33.77128 |
| B.B.Spring_10_10_14 | 0.662448 | 0.774334 | 50 | 38.71669 |
| IZ385_10_2_14 | 0.782402 | 0.992194 | 50 | 49.60972 |
| IZ386_10_2_14 | 0.83373 | 1.085415 | 50 | 54.27076 |
| RL255_10_7_14 | 0.77097 | 0.971432 | 50 | 48.57158 |
| RL256_10_7_14 | 0.763067 | 0.957077 | 50 | 47.85385 |
| WK947_10_7_14 | 0.800817 | 1.02564 | 50 | 51.28198 |
| Fox0_10_9_14 | 0.675902 | 0.798769 | 50 | 39.93847 |
| Fox1_10_9_14 | 0.705459 | 0.85245 | 50 | 42.62252 |
| Fox2_10_9_14 | 0.685836 | 0.816811 | 50 | 40.84057 |
| Fox3_10_9_14 | 0.642254 | 0.737658 | 50 | 36.88289 |
| SussexCreek_10_9_14 | 0.718799 | 0.876678 | 50 | 43.83388 |
| RootR._10_6_14 | 0.469638 | 0.494962 | 50 | 24.74808 |
| W.WWTP_10_7_14 | 0.588023 | 0.639162 | 50 | 31.9581 |
| S.WWTP_10_9_14 | 0.620377 | 0.697924 | 50 | 34.89618 |




| Fall 2014 Well Suite | | Run October 29, 2014 | | K |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.25 | 0.139158 | 0.127912 | 0.133535 |
| Standard 2 | 0.5 | 0.249235 | 0.245147 | 0.247191 |
| Standard 3 | 1 | 0.423143 | 0.415533 | 0.419338 |
| Standard 4 | 2 | 0.743188 | 0.734027 | 0.738607 |

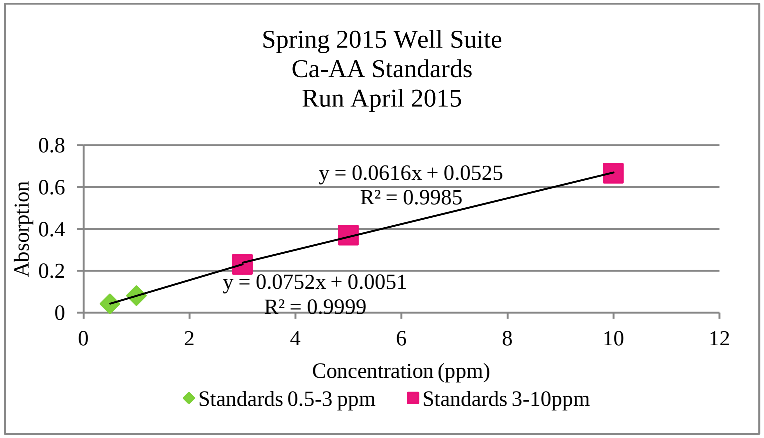
| Fall 2014 Well Suite | | Run October 29, 2014 | | |
|---|---|---|---|---|
| K | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_10_6_14 | 0.290159 | 0.659391 | 2 | 1.318782 |
| SV631_10_2_14 | 0.439012 | 1.097066 | 2 | 2.194132 |
| B.B.Spring_10_10_14 | 0.41571 | 1.028551 | 2 | 2.057103 |
| IZ385_10_2_14 | 0.549744 | 1.422651 | 2 | 2.845303 |
| IZ386_10_2_14 | 0.540948 | 1.396789 | 2 | 2.793577 |
| RL255_10_7_14 | 0.503232 | 1.285891 | 2 | 2.571782 |
| RL256_10_7_14 | 0.46652 | 1.177948 | 2 | 2.355897 |
| WK947_10_7_14 | 0.412648 | 1.019547 | 2 | 2.039093 |
| Fox0_10_9_14 | 0.251532 | 0.545816 | 4 | 2.183264 |
| Fox1_10_9_14 | 0.51115 | 1.309174 | 4 | 5.236697 |
| Fox2_10_9_14 | 0.562424 | 1.459935 | 4 | 5.83974 |
| Fox3_10_9_14 | 0.39516 | 0.968128 | 4 | 3.872514 |
| SussexCreek_10_9_14 | 0.436831 | 1.090654 | 4 | 4.362615 |
| RootR._10_6_14 | 0.395774 | 0.969933 | 4 | 3.87973 |
| W.WWTP_10_7_14 | 0.496223 | 1.265283 | 10 | 12.65283 |
| S.WWTP_10_9_14 | 0.472067 | 1.194257 | 10 | 11.94257 |




| Fall 2014 Well Suite | | Run October 29, 2014 | | Na |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.1 | 0.064185 | 0.061838 | 0.063012 |
| Standard 2 | 0.25 | 0.1470438 | 0.143613 | 0.145329 |
| Standard 3 | 0.5 | 0.3217251 | 0.314356 | 0.318041 |
| Standard 4 | 1 | 0.5252082 | 0.516268 | 0.520738 |
| Standard 5 | 2 | 0.9167099 | 0.906997 | 0.911853 |

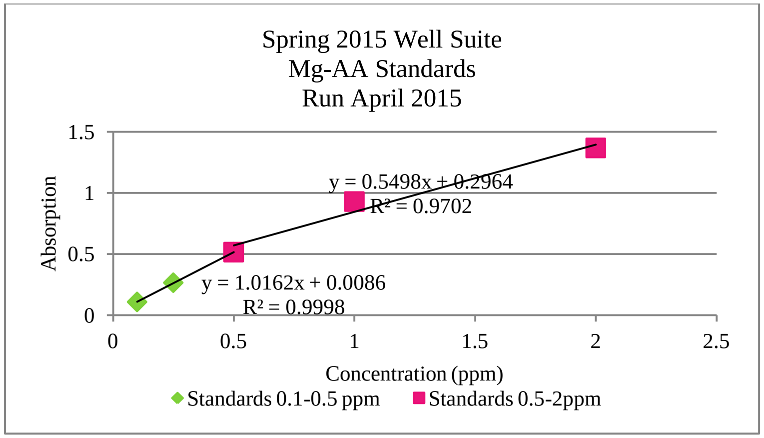
| Fall 2014 Well Suite | | Run October 29, 2014 | | |
|---|---|---|---|---|
| Na | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_10_6_14 | 0.252293348 | 0.381949219 | 50 | 19.09746 |
| SV631_10_2_14 | 0.253169805 | 0.383312294 | 50 | 19.16561 |
| B.B.Spring_10_10_14 | 0.344592154 | 0.561974074 | 100 | 56.19741 |
| IZ385_10_2_14 | 0.557531118 | 1.100787242 | 100 | 110.0787 |
| IZ386_10_2_14 | 0.464708149 | 0.865911308 | 100 | 86.59113 |
| RL255_10_7_14 | 0.455964744 | 0.843787308 | 100 | 84.37873 |
| RL256_10_7_14 | 0.358979583 | 0.598379512 | 100 | 59.83795 |
| WK947_10_7_14 | 0.184460789 | 0.156783373 | 100 | 15.67834 |
| Standard 1ppm | 0.521913171 | 1.010660858 | 100 | 101.0661 |
| Fox0_10_9_14 | 0.384211987 | 0.662226688 | 100 | 66.22267 |
| Fox1_10_9_14 | 0.813259244 | 1.747872581 | 100 | 174.7873 |
| Fox2_10_9_14 | 0.78508687 | 1.67658621 | 100 | 167.6586 |
| Fox3_10_9_14 | 0.455928117 | 0.843694628 | 100 | 84.36946 |
| SussexCreek_10_9_14 | 0.55772841 | 1.101286463 | 100 | 110.1286 |
| RootR._10_6_14 | 0.576371372 | 1.148459949 | 100 | 114.846 |
| W.WWTP_10_7_14 | 0.667883992 | 1.380020223 | 200 | 276.004 |
| S.WWTP_10_9_14 | 0.744831622 | 1.574725764 | 200 | 314.9452 |
| B.WWTP_10_2_14 | 0.78881973 | 1.686031705 | 200 | 337.2063 |

<u>Spring 2015</u>



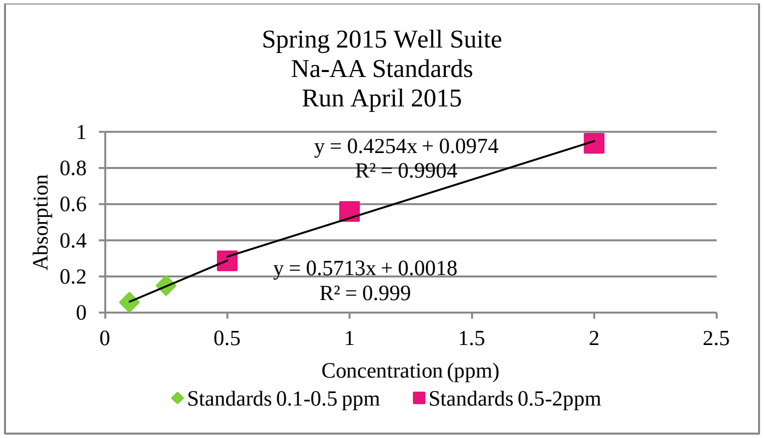

| Spring 2015 Well Suite | | Run April 13, 2015 | | Ca |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.5 | 0.064185 | 0.061838 | 0.063012 |
| Standard 2 | 1 | 0.1470438 | 0.143613 | 0.145329 |
| Standard 3 | 3 | 0.3217251 | 0.314356 | 0.318041 |
| Standard 4 | 5 | 0.5252082 | 0.516268 | 0.520738 |
| Standard 5 | 10 | 0.9167099 | 0.906997 | 0.911853 |

| Spring 2015 Well Suite | | Run April 13, 2015 | | |
|---|---|---|---|---|
| Ca | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| SV631_7April14 | 0.23467 | 2.957302 | 25 | 73.93 |
| BBSpring_7April15 | 0.269971 | 3.530373 | 25 | 88.26 |
| WK947_2April15 | 0.309494 | 4.171979 | 25 | 104.30 |
| RL255_2April15 | 0.335427 | 4.592971 | 25 | 114.82 |
| Rl256_2April15 | 0.325068 | 4.424809 | 25 | 110.62 |
| Fox0_8Arpil15 | 0.248396 | 3.180134 | 25 | 79.50 |
| Fox1_8April15 | 0.265316 | 3.454812 | 25 | 86.37 |
| Fox2_8April15 | 0.280088 | 3.694609 | 25 | 92.37 |
| FoxA_9April15 | 0.137394 | 1.759235 | 25 | 43.98 |
| Fox3_7April15 | 0.255132 | 3.289487 | 25 | 82.24 |
| RR_7April15 | 0.256404 | 3.310137 | 25 | 82.75 |
| UC_8April15 | 0.214971 | 2.790833 | 25 | 69.77 |
| SC_8April15 | 0.231049 | 2.898527 | 25 | 72.46 |
| WWWTP_2April15 | 0.297086 | 3.970547 | 25 | 99.26 |



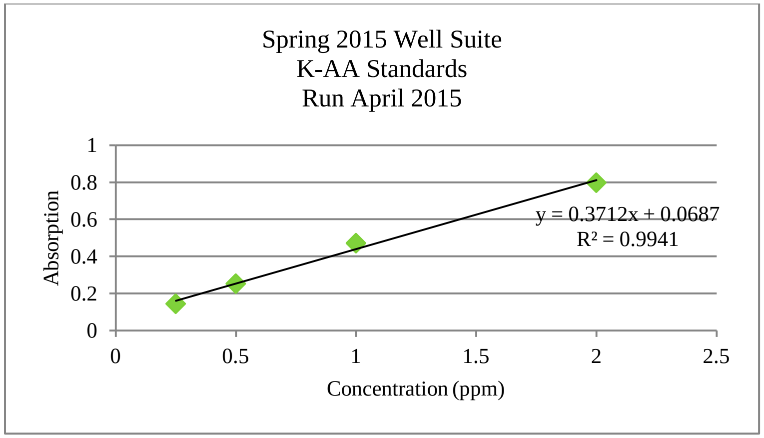

| Spring 2015 Well Suite | | Run April 13, 2015 | | Mg |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.5 | 0.108054 | 0.108791 | 0.108422 |
| Standard 2 | 1 | 0.261792 | 0.26954 | 0.265666 |
| Standard 3 | 3 | 0.5147 | 0.516621 | 0.51566 |
| Standard 4 | 5 | 0.925232 | 0.933876 | 0.929554 |
| Standard 5 | 10 | 1.367743 | 1.368499 | 1.368121 |

| Spring 2015 Well Suite | | Run Aug. 13, 2015 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| SV631_7April14 | 0.843321 | 0.994764 | 50 | 49.74 |
| BBSpring_7April15 | 1.009014 | 1.296133 | 50 | 64.81 |
| WK947_2April15 | 1.001697 | 1.282825 | 50 | 64.14 |
| RL255_2April15 | 0.974586 | 1.233515 | 50 | 61.68 |
| Rl256_2April15 | 0.944581 | 1.17894 | 50 | 58.95 |
| Fox0_8Arpil15 | 0.824269 | 0.960111 | 50 | 48.01 |
| standard1ppm | 0.932153 | | | |
| Fox1_8April15 | 0.841719 | 0.99185 | 50 | 49.59 |
| Fox2_8April15 | 0.831964 | 0.974107 | 50 | 48.71 |
| FoxA_9April15 | 0.418976 | 0.403834 | 50 | 20.19 |
| Fox3_7April15 | 0.824201 | 0.959987 | 50 | 48.00 |
| RR_7April15 | 0.876022 | 1.054241 | 50 | 52.71 |
| standard 1ppm | 0.92362 | | | |
| UC_8April15 | 0.562918 | 0.484754 | 50 | 24.24 |
| SC_8April15 | 0.767296 | 0.856487 | 50 | 42.82 |
| WWWTP_2April15 | 0.786752 | 0.891874 | 50 | 44.59 |
| SWWTP_8April15 | 0.824226 | 0.960033 | 50 | 48.00 |




| Spring 2015 Well Suite | | Run April 13, 2015 | | Na |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.5 | 0.108054 | 0.108791 | 0.108422 |
| Standard 2 | 1 | 0.261792 | 0.26954 | 0.265666 |
| Standard 3 | 3 | 0.5147 | 0.516621 | 0.51566 |
| Standard 4 | 5 | 0.925232 | 0.933876 | 0.929554 |
| Standard 5 | 10 | 1.367743 | 1.368499 | 1.368121 |

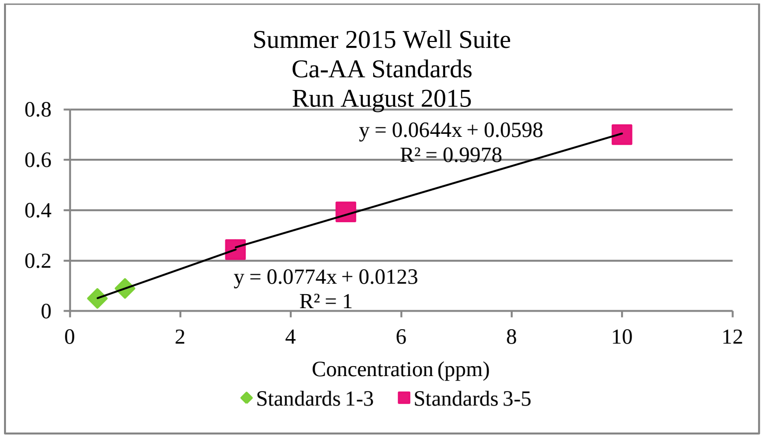
| Spring 2015 Well Suite | | Run April 13, 2015 | | |
|---|---|---|---|---|
| Na | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| SV631_7April14 | 0.255504 | 0.444081 | 50 | 22.20 |
| BBSpring_7April15 | 0.367207 | 0.634244 | 100 | 63.42 |
| WK947_2April15 | 0.221304 | 0.384218 | 100 | 38.42 |
| RL255_2April15 | 0.515697 | 0.983302 | 100 | 98.33 |
| Rl256_2April15 | 0.420299 | 0.759048 | 100 | 75.90 |
| Fox0_8Arpil15 | 0.408954 | 0.732379 | 100 | 73.24 |
| Fox1_8April15 | 0.878969 | 1.837258 | 100 | 183.73 |
| Fox2_8April15 | 0.871997 | 1.820867 | 100 | 182.09 |
| FoxA_9April15 | 0.526101 | 1.00776 | 100 | 100.78 |
| Fox3_7April15 | 0.554578 | 1.074701 | 100 | 107.47 |
| RR_7April15 | 0.83353 | 1.730441 | 100 | 173.04 |
| UC_8April15 | 0.982493 | 2.080614 | 100 | 208.06 |
| SC_8April15 | 0.577003 | 1.127416 | 100 | 112.74 |
| WWWTP_2April15 | 0.807631 | 1.669562 | 500 | 834.78 |
| SWWTP_8April15 | 0.840795 | 1.747521 | 500 | 873.76 |




| Spring 2015 Well Suite | | Run April 13, 2014 | | K |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.25 | 0.14845 | 0.140496 | 0.144473 |
| Standard 2 | 0.5 | 0.253776 | 0.252246 | 0.253011 |
| Standard 3 | 1 | 0.47708 | 0.465862 | 0.471471 |
| Standard 4 | 2 | 0.796863 | 0.798533 | 0.797698 |

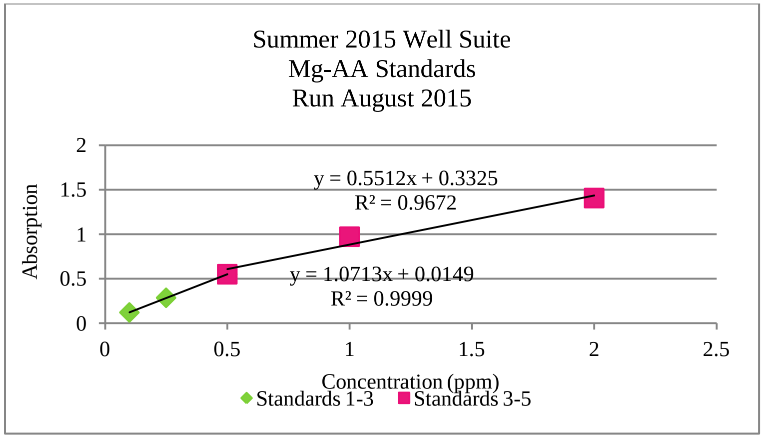
| Spring 2015 Well Suite | | Run April 13, 2015 | | |
|---|---|---|---|---|
| K | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| SV631_7April14 | 0.360483 | 0.786054 | 2 | 1.57 |
| BBSpring_7April15 | 0.463549 | 1.063709 | 2 | 2.13 |
| WK947_2April15 | 0.510079 | 1.18906 | 2 | 2.38 |
| RL255_2April15 | 0.605481 | 1.446069 | 2 | 2.89 |
| Rl256_2April15 | 0.578662 | 1.373819 | 2 | 2.75 |
| Fox0_8Arpil15 | 0.313339 | 0.65905 | 4 | 2.64 |
| Fox1_8April15 | 0.48883 | 1.131815 | 4 | 4.53 |
| Fox2_8April15 | 0.552574 | 1.30354 | 4 | 5.21 |
| FoxA_9April15 | 0.338724 | 0.727437 | 4 | 2.91 |
| Fox3_7April15 | 0.399264 | 0.890529 | 4 | 3.56 |
| RR_7April15 | 0.368639 | 0.808026 | 4 | 3.23 |
| UC_8April15 | 0.388436 | 0.861357 | 4 | 3.45 |
| SC_8April15 | 0.000721 | -0.18313 | 4 | 0.00 |
| WWWTP_2April15 | 0.626677 | 1.50317 | 10 | 15.03 |
| SWWTP_8April15 | 0.539564 | 1.268492 | 10 | 12.68 |

# Summer 2015



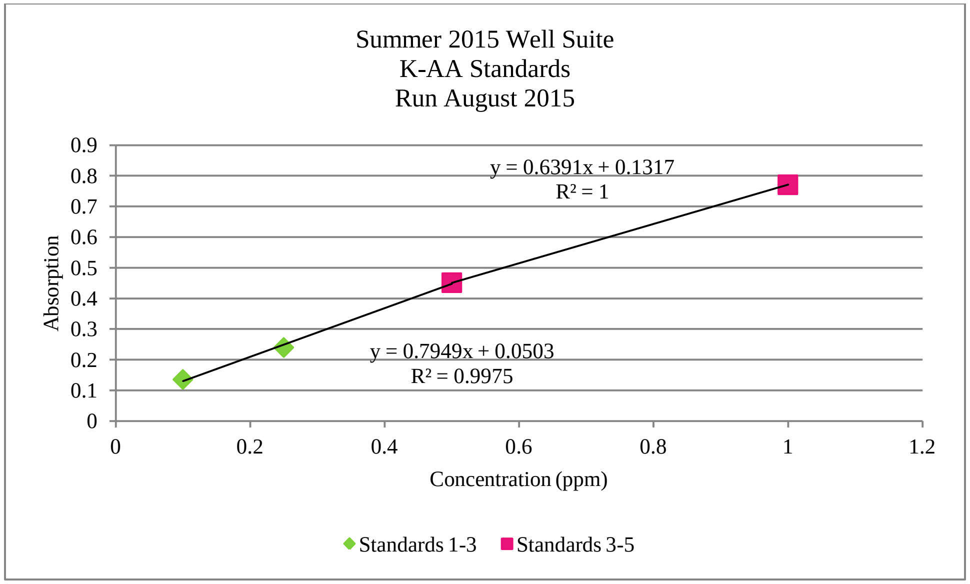

| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | Ca |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.5 | 0.050241 | 0.050817 | 0.050529 |
| Standard 2 | 1 | 0.089971 | 0.090431 | 0.090201 |
| Standard 3 | 3 | 0.242782 | 0.245863 | 0.244323 |
| Standard 4 | 5 | 0.391989 | 0.395801 | 0.393895 |
| Standard 5 | 10 | 0.700254 | 0.700343 | 0.700299 |

| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | |
|---|---|---|---|---|
| Ca | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_jul15 | 0.292135 | 3.61544 | 25 | 90.386 |
| SV631_jul15 | 0.233283 | 2.855071 | 25 | 71.37678 |
| BBSpring_jul15 | 0.252996 | 3.109765 | 25 | 77.74413 |
| IZ385_jul15 | 0.352868 | 4.400097 | 25 | 110.0024 |
| IZ386_jul15 | 0.371862 | 4.645505 | 25 | 116.1376 |
| RL255_Apr15 | 0.336148 | 4.184082 | 25 | 104.6021 |
| RL255_jul15 | 0.333812 | 4.153902 | 25 | 103.8475 |
| RL256_Apr15 | 0.327933 | 4.077949 | 25 | 101.9487 |
| RL256_jul15 | 0.327794 | 4.076154 | 25 | 101.9038 |
| WK947_apr15 | 0.313962 | 3.897442 | 25 | 97.43605 |
| WK947_jul15 | 0.314414 | 3.903276 | 25 | 97.5819 |
| Fox0_jul15 | 0.227583 | 2.781431 | 25 | 69.53579 |
| Fox1_jul15 | 0.24372 | 2.989919 | 25 | 74.74798 |
| Fox2_jul15 | 0.256566 | 3.155893 | 25 | 78.89732 |
| Fox3_jul15 | 0.18674 | 1.971123 | 25 | 49.27807 |
| RR_jul15 | 0.121037 | 0.950891 | 25 | 23.77227 |
| SC_jul15 | 0.253492 | 3.116175 | 25 | 77.90438 |
| UC_jul15 | 0.396115 | 4.958855 | 25 | 123.9714 |
| BWWTP_jul15 | 0.323769 | 4.024147 | 25 | 100.6037 |
| SWWTP_jul15 | 0.286537 | 3.543112 | 25 | 88.57781 |
| WWWTP_jul15 | 0.309878 | 3.844676 | 25 | 96.1169 |



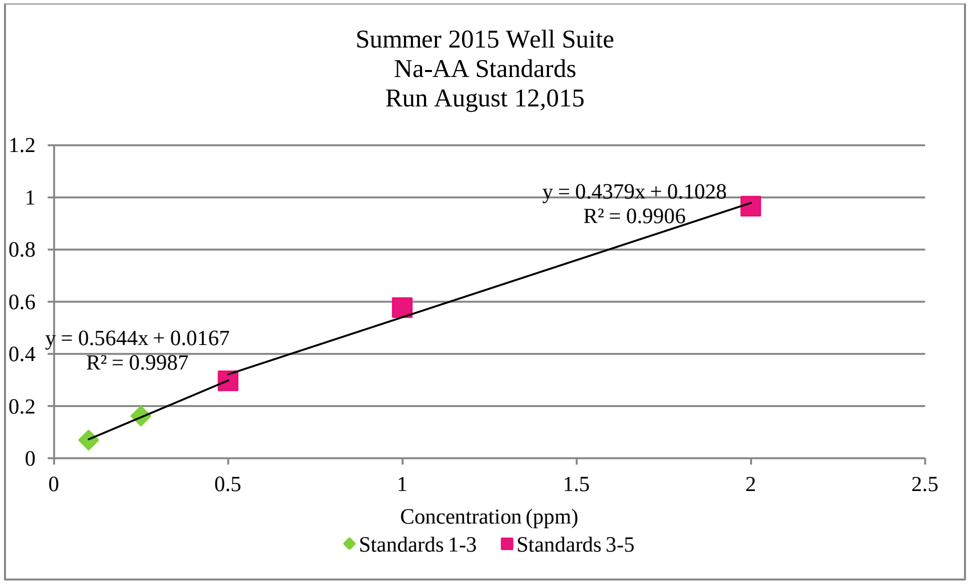

| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | Mg |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.1 | 0.119995 | 0.120848 | 0.120422 |
| Standard 2 | 0.25 | 0.281428 | 0.28894 | 0.285184 |
| Standard 3 | 0.5 | 0.550872 | 0.548241 | 0.549556 |
| Standard 4 | 1 | 0.960303 | 0.982898 | 0.971601 |
| Standard 5 | 2 | 1.401807 | 1.409466 | 1.405637 |

| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_jul15 | 0.772565 | 0.798376 | 50 | 39.9188 |
| SV631_jul15 | 0.957352 | 1.133621 | 50 | 56.68107 |
| BBSpring_jul15 | 0.758534 | 0.772921 | 50 | 38.64606 |
| IZ385_jul15 | 0.96819 | 1.153284 | 50 | 57.66418 |
| RL255_Apr15 | 0.961725 | 1.141555 | 50 | 57.07776 |
| RL255_jul15 | 0.9443 | 1.109942 | 50 | 55.49711 |
| RL256_Apr15 | 0.925263 | 1.075405 | 50 | 53.77025 |
| RL256_jul15 | 0.935693 | 1.094327 | 50 | 54.71633 |
| Standard1ppm | 0.983601 | 1.181243 | 50 | 59.06216 |
| WK947_apr15 | 0.985915 | 1.185441 | 50 | 59.27204 |
| WK947_jul15 | 0.989204 | 1.191408 | 50 | 59.57041 |
| Fox0_jul15 | 0.797145 | 0.84297 | 50 | 42.14848 |
| Fox1_jul15 | 0.779637 | 0.811207 | 50 | 40.56034 |
| Fox2_jul15 | 0.77274 | 0.798694 | 50 | 39.9347 |
| Fox3_jul15 | 0.635979 | 0.550578 | 50 | 27.5289 |
| RR_jul15 | 0.365952 | 0.327687 | 50 | 16.38437 |
| standard 1ppm | 0.983023 | 1.180195 | 50 | 59.00974 |
| SC_jul15 | 0.851647 | 0.941848 | 50 | 47.09241 |
| UC_jul15 | 0.982197 | 1.178696 | 50 | 58.93482 |
| BWWTP_jul15 | 0.916283 | 1.059112 | 50 | 52.95561 |
| SWWTP_jul15 | 0.796036 | 0.840958 | 50 | 42.04792 |
| WWWTP_jul15 | 0.787053 | 0.824661 | 50 | 41.23303 |




| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | Mg |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.1 | 0.160428 | 0.135594 | 0.135594 |
| Standard 2 | 0.25 | 0.26615 | 0.239876 | 0.239876 |
| Standard 3 | 0.5 | 0.464961 | 0.451265 | 0.451265 |
| Standard 4 | 1 | 0.797024 | 0.770812 | 0.770812 |
| Standard 5 | 2 | 0.160428 | 0.135594 | 0.135594 |

| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_Jul15 | 0.483714 | 0.545244 | 2 | 1.090488 |
| SV631_Jul15 | 0.337148 | 0.36086 | 2 | 0.721721 |
| BBSpring_Jul15 | 0.423778 | 0.469843 | 2 | 0.939686 |
| IZ385_Jul15 | 0.636679 | 0.790141 | 2 | 1.580282 |
| IZ386_Jul15 | 0.561284 | 0.67217 | 2 | 1.34434 |
| WK947_Apr15 | 0.475812 | 0.535302 | 2 | 1.070605 |
| WK947_Jul15 | 0.482422 | 0.543617 | 2 | 1.087235 |
| RL255_April15 | 0.535154 | 0.631285 | 2 | 1.26257 |
| RL255_Jul15 | 0.535596 | 0.631977 | 2 | 1.263953 |
| Rl256_April15 | 0.555183 | 0.662624 | 2 | 1.325248 |
| RL256_Jul15 | 0.54599 | 0.64824 | 2 | 1.29648 |
| Fox0_Jul15 | 0.273256 | 0.221492 | 4 | 0.885969 |
| Fox1_Jul15 | 0.53243 | 0.627023 | 4 | 2.508091 |
| Fox2_Jul15 | 0.562339 | 0.673822 | 4 | 2.695287 |
| Fox3_Jul15 | 0.365895 | 0.397025 | 4 | 1.588099 |
| RR_Jul15 | 0.327512 | 0.348738 | 4 | 1.394951 |
| SC_Jul15 | 0.498573 | 0.563937 | 4 | 2.255747 |
| UC_Jul15 | 0.462346 | 0.518362 | 4 | 2.07345 |
| BWWTP_Jul15 | 0.46796 | 0.525424 | 10 | 5.254242 |
| SWWTP_Jul15 | 0.463709 | 0.520077 | 10 | 5.200767 |
| WWWTP_Jul15 | 0.598774 | 0.73083 | 10 | 7.308302 |

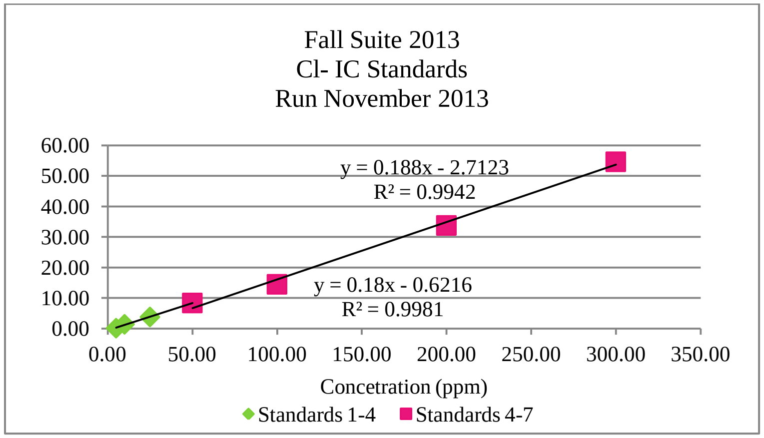



| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | Mg |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.1 | 0.070331 | 0.069989 | 0.07016 |
| Standard 2 | 0.25 | 0.165735 | 0.159146 | 0.162441 |
| Standard 3 | 0.5 | 0.298833 | 0.295339 | 0.297086 |
| Standard 4 | 1 | 0.589916 | 0.565262 | 0.577589 |
| Standard 5 | 2 | 0.973547 | 0.958895 | 0.966221 |

| Summer 2015 Well Suite | | Run Aug. 5, 2015 | | |
|---|---|---|---|---|
| Mg | | Calculated | Dilution | Corrected |
| SAMPLE ID | SIGNAL (Absorption) | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_Jul15 | 0.253056 | 0.418774 | 50 | 20.93872 |
| SV631_Jul15 | 0.352738 | 0.570765 | 50 | 28.53827 |
| BBSpring_Jul15 | 0.286493 | 0.478017 | 100 | 47.80166 |
| IZ385_Jul15 | 0.61565 | 1.171158 | 100 | 117.1158 |
| IZ386_Jul15 | 0.468332 | 0.834739 | 100 | 83.47388 |
| WK947_Apr15 | 0.225564 | 0.370064 | 100 | 37.00645 |
| WK947_Jul15 | 0.232592 | 0.382516 | 100 | 38.2516 |
| RL255_April15 | 0.508273 | 0.925948 | 100 | 92.59478 |
| RL255_Jul15 | 0.416353 | 0.716038 | 100 | 71.60377 |
| Rl256_April15 | 0.418369 | 0.720642 | 100 | 72.06418 |
| RL256_Jul15 | 0.507045 | 0.923144 | 100 | 92.31445 |
| Fox0_Jul15 | 0.359083 | 0.585255 | 100 | 58.52547 |
| Fox1_Jul15 | 0.841717 | 1.68741 | 100 | 168.741 |
| Fox2_Jul15 | 0.82406 | 1.647087 | 100 | 164.7087 |
| Fox3_Jul15 | 0.489962 | 0.884134 | 100 | 88.41337 |
| RR_Jul15 | 0.437616 | 0.764594 | 100 | 76.45945 |
| SC_Jul15 | 0.61065 | 1.159739 | 100 | 115.9739 |
| UC_Jul15 | 0.996978 | 2.041969 | 100 | 204.1969 |
| BWWTP_Jul15 | 0.842183 | 1.688475 | 200 | 337.6949 |
| SWWTP_Jul15 | 0.757202 | 1.494409 | 200 | 298.8818 |
| WWWTP_Jul15 | 0.779941 | 1.546338 | 200 | 309.2676 |

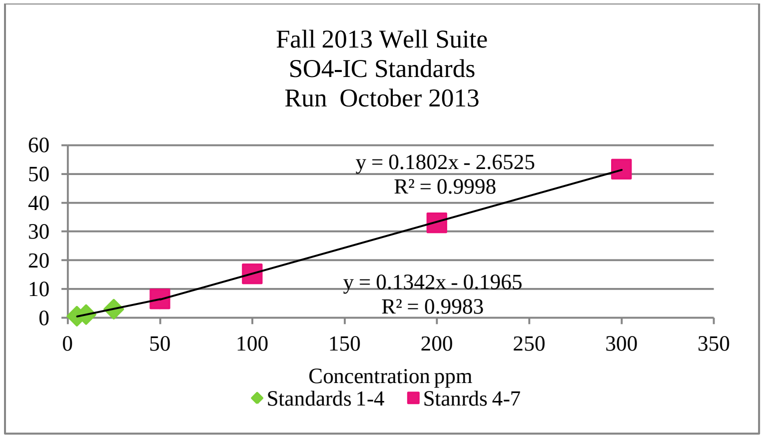
## 3. Ion Chromatography with Calibration Curves

## Fall 2013



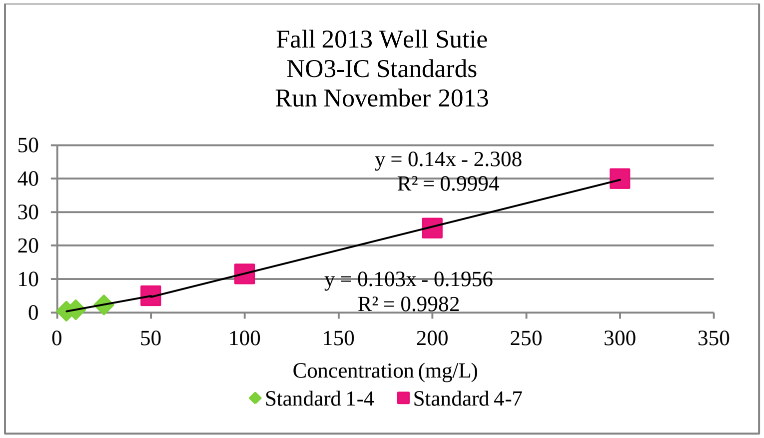

| Fall 2013 Well Suite | Run Nov. 2013 | Cl |
|---|---|---|
| Standards | Concentration (mg/L) | Area Start |
| Standard 1 | 5 | 0.13 |
| Standard 2 | 10 | 1.40 |
| Standard 3 | 25 | 3.80 |
| Standard 4 | 50 | 8.39 |
| Standard 5 | 100 | 14.50 |
| Standard 6 | 200 | 33.79 |
| Standard 7 | 300 | 54.65 |

| Fall 2013 Well Suite | Run Nov. 2013 | |
|---|---|---|
| Cl | Area (µs*m) | Concentration (mg/L) |
| EM275 | 7.77 | 43.22 |
| SV 631 | 8.27 | 45.76 |
| IZ 385 | 45.28 | 254.66 |
| IZ 386 | 36.46 | 210.74 |
| WK 947 | 14.10 | 74.88 |
| RL 255 | 41.01 | 233.39 |
| RL 256 | 31.91 | 188.07 |
| BB Spring | 20.88 | 133.08 |
| R-R RL 255 | 38.54 | 221.10 |
| R-R RL 256 | 30.57 | 181.37 |
| Fox 0 | 25.59 | 156.57 |
| Fox 1 | 53.12 | 293.76 |
| Fox 2 | 62.83 | 342.13 |
| Fox 3 | 35.86 | 207.72 |
| Und. Crk | 75.26 | 404.06 |
| Sussex Crk | 38.36 | 220.22 |
| Root River | 36.79 | 212.35 |
| WK WWTP | 105.24 | 553.41 |
| BK WWTP | 125.59 | 654.84 |
| Sussex WWTP | 105.73 | 555.86 |




| Fall 2013 Well Suite | Run Nov. 2013 | SO4 |
|---|---|---|
| Standards | Concentration (mg/L) | Area Start |
| Standard 1 | 5 | 0.09 |
| Standard 2 | 10 | 0.95 |
| Standard 3 | 25 | 2.48 |
| Standard 4 | 50 | 5.28 |
| Standard 5 | 100 | 11.74 |

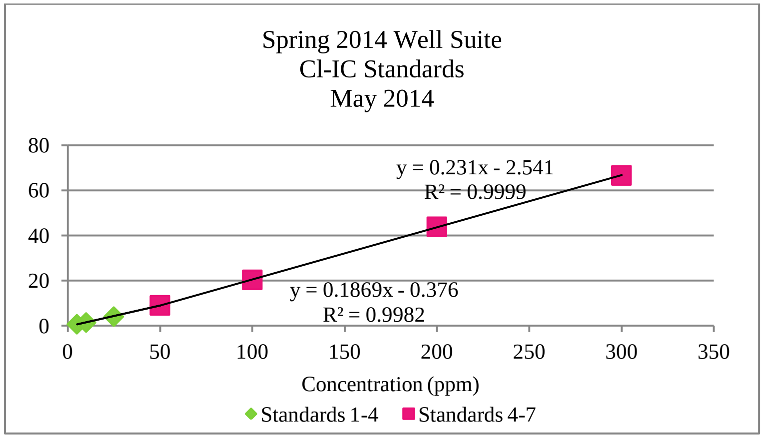
| Fall 2013 Well Suite | Run Nov. 2013 | |
|---|---|---|
| $SO_4$ | Area (µs*m) | Concentration (mg/L) |
| EM275 | 16.48 | 132.15 |
| SV 631 | 6.23 | 47.46 |
| IZ 385 | 8.20 | 63.74 |
| IZ 386 | 10.96 | 86.56 |
| WK 947 | 13.33 | 106.16 |
| RL 255 | 8.19 | 63.61 |
| RL 256 | 9.86 | 77.43 |
| BB Spring | 3.61 | 25.83 |
| R-R RL 255 | 8.11 | 63.02 |
| R-R RL 256 | 11.83 | 93.75 |
| Fox 0 | 8.31 | 64.65 |
| Fox 1 | 6.86 | 52.64 |
| Fox 2 | 7.78 | 60.29 |
| Fox 3 | 5.27 | 39.56 |
| Und. Crk | 21.69 | 175.19 |
| Sussex Crk | 8.84 | 69.01 |
| Root River | 6.24 | 47.54 |
| WK WWTP | 12.53 | 99.48 |
| BK WWTP | 12.33 | 97.88 |
| Sussex WWTP | 10.48 | 82.54 |




| Fall 2013 Well Suite | Run Nov. 2013 | NO3 |
|---|---|---|
| Standards | Concentration (mg/L) | Area Start |
| Standard 1 | 5 | 0.3952 |
| Standard 2 | 10 | 0.825 |
| Standard 3 | 25 | 2.2575 |
| Standard 4 | 50 | 5.0089 |
| Standard 5 | 100 | 11.529 |
| Standard 6 | 200 | 25.2195 |
| Standard 7 | 300 | 40.0028 |

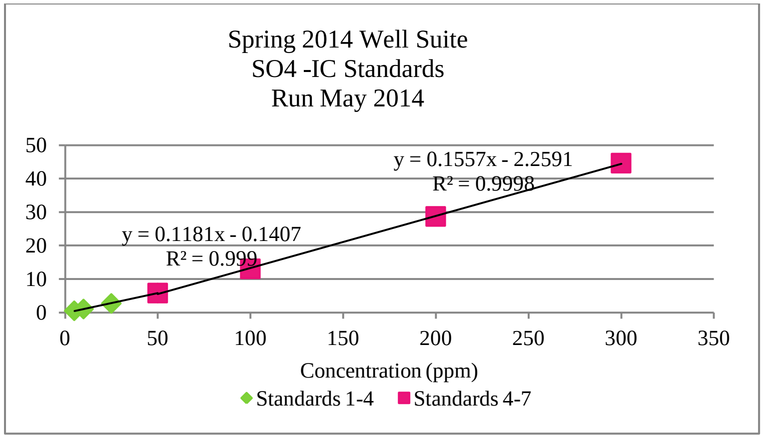
| Fall 2013 Well Suite | Run Nov. 2013 | |
|---|---|---|
| $NO_3$ | Area (µs*m) | Concentration (mg/L) |
| EM275 | 0.02 | 4.23 |
| SV 631 | n.a. | 0.00 |
| IZ 385 | 0.22 | 0.65 |
| IZ 386 | n.a. | 0.00 |
| WK 947 | 0.06 | 4.70 |
| RL 255 | 0.03 | 4.32 |
| RL 256 | n.a. | 0.00 |
| BB Spring | 1.09 | 16.21 |
| R-R RL 255 | 0.04 | 4.43 |
| R-R RL 256 | n.a. | 0.00 |
| Fox 0 | 0.27 | 7.02 |
| Fox 1 | 0.63 | 11.03 |
| Fox 2 | 1.51 | 20.81 |
| Fox 3 | 1.02 | 15.44 |
| Und. Crk | 0.02 | 4.23 |
| Sussex Crk | 0.88 | 13.82 |
| Root River | n.a. | 0.00 |
| WK WWTP | 9.75 | 112.68 |
| BK WWTP | 3.69 | 45.17 |
| Sussex WWTP | 1.15 | 16.81 |

# Spring 2014




| Spring 2014 Well Suite | Run May 16, 2014 | Cl |
|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start |
| Standard 1 | 5 | 0.3719 |
| Standard 2 | 10 | 0.7652 |
| Standard 3 | 25 | 2.0182 |
| Standard 4 | 50 | 4.3866 |
| Standard 5 | 100 | 10.0133 |
| Standard 6 | 200 | 22.1924 |
| Standard 7 | 300 | 34.4487 |

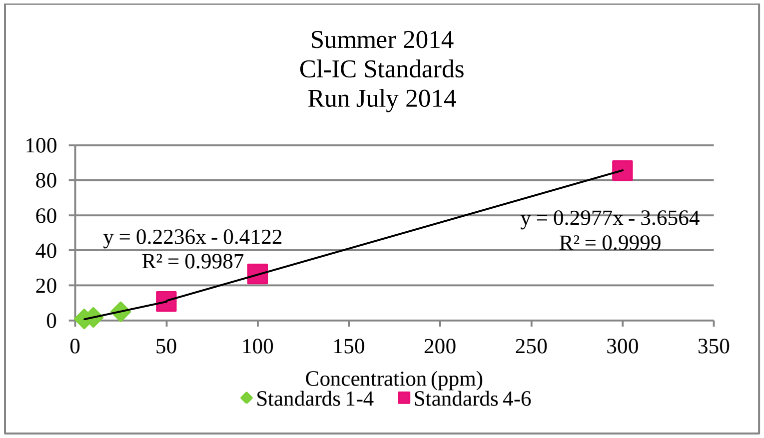
| Spring 2014 Well Suite | Run May 16, 2014 | |
|---|---|---|
| Cl | Area | Calculated |
| Sample Name | µS*min | Concentration (mg/L) |
| EM275 | 9.4837 | 52.05498 |
| SV 631 | 11.5871 | 61.16061 |
| IZ 386 | 57.9948 | 262.0597 |
| WK 947 | 17.6121 | 87.24286 |
| RL 255 | 41.7885 | 191.9026 |
| RL 256 | 35.0633 | 162.7892 |
| BB Spring | 26.1527 | 124.2152 |
| Fox 1 | 52.9855 | 240.3745 |
| Fox 2 | 56.259 | 254.5455 |
| Fox 3 | 35.5968 | 165.0987 |
| Root River | 71.8322 | 321.9619 |
| WK WWTP | 130.2842 | 575.0009 |
| BK WWTP | 126.7856 | 559.8554 |
| Sussex WWTP | 105.6286 | 468.2667 |




| Spring 2014 Well Suite | | Run May 16, 2014 | | SO4 |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 0.25 | 0.07 | 0.07 | 0.07 |
| Standard 2 | 0.5 | 0.15 | 0.15 | 0.15 |
| Standard 3 | 1 | 0.32 | 0.33 | 0.33 |
| Standard 4 | 2 | 0.54 | 0.54 | 0.54 |

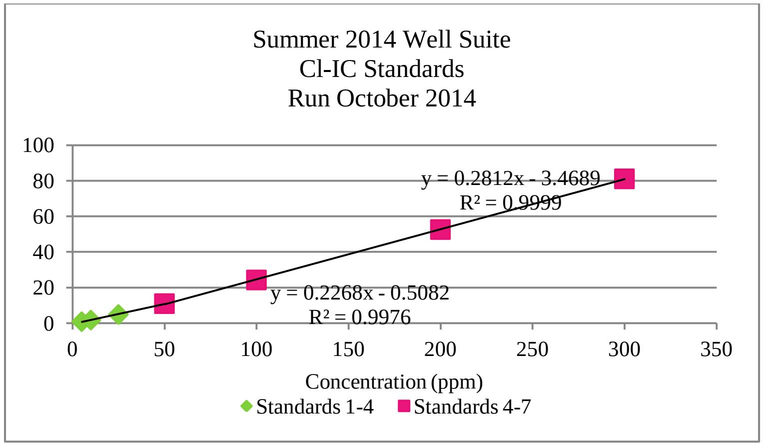
| Spring 2014 Well Suite | Run May 16, 2014 | |
|---|---|---|
| SO4 | Area | Calculated |
| Sample Name | µS*min | Concentration (mg/L) |
| EM275 | 6.7467 | 28.82209 |
| SV 631 | 22.6775 | 193.2108 |
| IZ 386 | 10.5838 | 53.46628 |
| WK 947 | 17.088 | 95.24021 |
| RL 255 | 8.8365 | 42.24406 |
| RL 256 | 10.0388 | 49.96596 |
| BB Spring | 3.9404 | 10.79833 |
| Fox 1 | 7.2135 | 31.82017 |
| Fox 2 | 7.6688 | 34.74438 |
| Fox 3 | 5.6001 | 21.45793 |
| Root River | 6.65 | 28.20103 |
| WK WWTP | 13.2315 | 70.47142 |
| BK WWTP | 10.7344 | 54.43353 |
| Sussex WWTP | 8.4872 | 40.00064 |

## Summer 2014



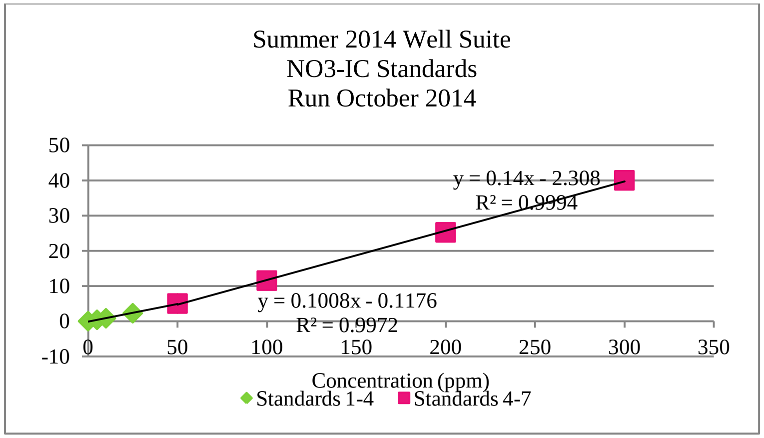

| Summer 2014 Well Suite | | Run July 29, 2014 | | |
|---|---|---|---|---|
| Cl | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| 8/9/14Fox1_1:5 | 10.3955 | 48.33497 | 5 | 241.6749 |
| 8/14BWWTP1:5 | 21.441 | 84.30433 | 5 | 421.5217 |
| 8/14SWWTP1:5 | 19.4583 | 77.64427 | 5 | 388.2214 |

| Summer 2014 Well Suite | | Run July 29, 2014 | | Cl |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.8629 | 0.8759 | 0.8694 |
| Standard 2 | 10 | 1.7634 | 1.7681 | 1.76575 |
| Standard 3 | 25 | 4.9424 | 5.0115 | 4.97695 |
| Standard 4 | 50 | 10.808 | 10.9212 | 10.8646 |
| Standard 5 | 100 | 26.4108 | 26.7255 | 26.56815 |
| Standard 6 | 200 | 84.9719 | 85.6581 | 85.315 |
| Standard 7 | 300 | 85.1518 | 85.9718 | 85.5618 |



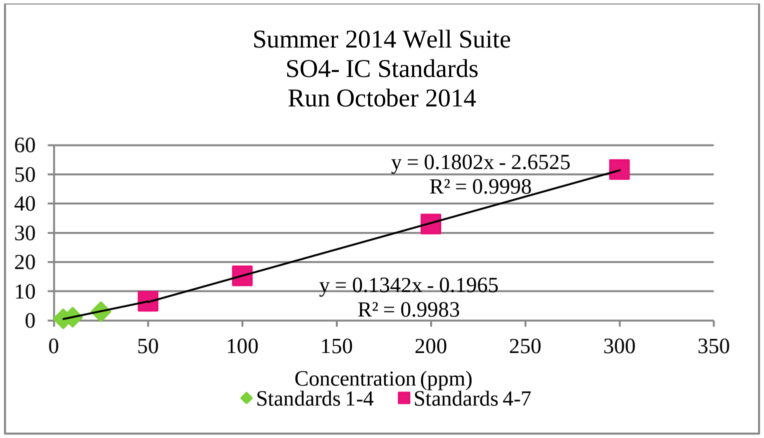

| Summer 2014 Well Suite | Run Oct. 3, 2014 | Cl |
|---|---|---|
| Standards | Concentration (mg/L) | Absorption |
| Standard 1 | 5 | 0.8263 |
| Standard 2 | 10 | 1.7214 |
| Standard 3 | 25 | 4.8601 |
| Standard 4 | 50 | 10.9675 |
| Standard 5 | 100 | 24.2636 |
| Standard 6 | 200 | 52.5817 |
| Standard 7 | 300 | 81.0626 |

| Summer 2014 Well Suite | Run Oct. 3, 2014 | |
|---|---|---|
| SO4 | Area | Calculated |
| Sample Name | µS*min | Concentration (mg/L) |
| EM275_Jul14 | 7.3187 | 34.51014 |
| SV 631_Jul14 | 10.7 | 49.41887 |
| IZ 385_Jul14 | 57.1848 | 215.6959 |
| IZ 386_Jul14 | 61.3302 | 230.4378 |
| RL255_Jul14 | 46.3023 | 176.9957 |
| RL 256_Jul14 | 40.0967 | 154.9275 |
| WK 947_Jul14 | 19.1449 | 80.41892 |
| Fox 0_Jul14 | 27.8729 | 111.4573 |
| Fox 2_Jul14 | 73.3251 | 273.0939 |
| Fox 3_Jul14 | 45.2217 | 173.1529 |
| Sussex Crk_Jul14 | 32.4986 | 127.9072 |
| Root River_Jul14 | 34.7801 | 136.0206 |




| Summer 2014 Well Suite | Run Oct. 3, 2014 | NO3 |
|---|---|---|
| Standards | Concentration (mg/L) | Absorption |
| Standard 1 | 5 | 0.3952 |
| Standard 2 | 10 | 0.825 |
| Standard 3 | 25 | 2.2575 |
| Standard 4 | 50 | 5.0089 |
| Standard 5 | 100 | 11.529 |
| Standard 6 | 200 | 25.2195 |
| Standard 7 | 300 | 40.0028 |

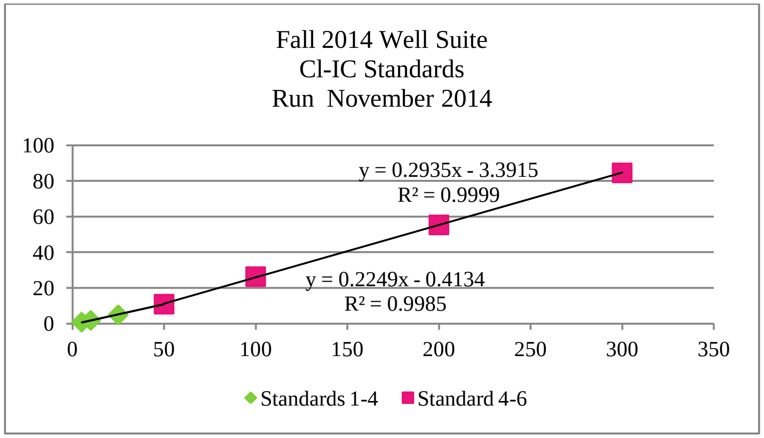
| Summer 2014 Well Suite | Run Oct. 3, 2014 | |
|---|---|---|
| NO3 | Area | Calculated |
| Sample Name | μS*min | Concentration (mg/L) |
| EM275 | 0 | 0 |
| SV 631 | 0 | 0 |
| IZ 385 | 0.2082 | 3.232143 |
| IZ 386 | 0.0162 | 1.327381 |
| RL255 | 0.0644 | 1.805556 |
| RL 256 | 0.0149 | 1.314484 |
| WK 947 | 0.042 | 1.583333 |
| Fox 0 | 0.1567 | 2.72123 |
| Fox 2 | 1.3284 | 14.34524 |
| Fox 3 | 0.5179 | 6.304563 |
| Sussex Crk | 0.754 | 8.646825 |
| Root River | 0.1734 | 2.886905 |
| WK WWTP | 9.5811 | 84.92214 |
| BK WWTP | 5.4163 | 54.8998 |
| Sussex WWTP | 1.1882 | 12.95437 |




| Summer 2014 Well Suite | Run Oct. 3, 2014 | SO4 |
|---|---|---|
| Standards | Concentration (mg/L) | Absorption |
| Standard 1 | 5 | 0.5721 |
| Standard 2 | 10 | 1.1291 |
| Standard 3 | 25 | 3.0099 |
| Standard 4 | 50 | 6.5824 |
| Standard 5 | 100 | 15.2807 |
| Standard 6 | 200 | 33.0108 |
| Standard 7 | 300 | 51.661 |

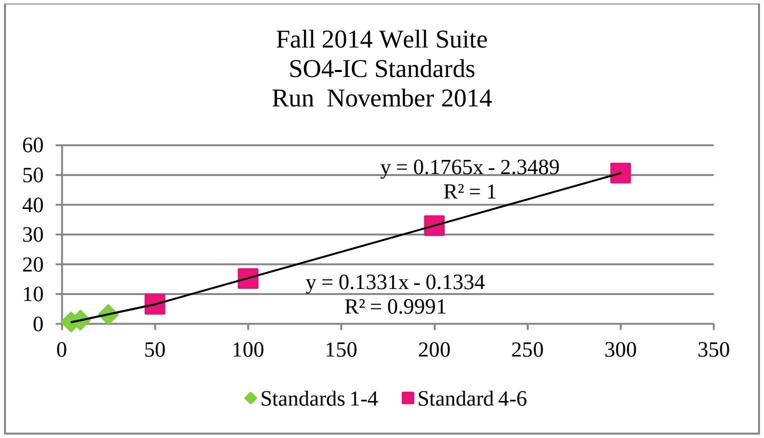
| Summer 2014 Well Suite | Run Oct. 3, 2014 | |
|---|---|---|
| SO4 | Area | Calculated |
| Sample Name | µS*min | Concentration (mg/L) |
| EM275 | 29.3849 | 177.788 |
| SV 631 | 7.5725 | 56.74251 |
| IZ 385 | 10.1957 | 71.29967 |
| IZ 386 | 12.3787 | 83.41398 |
| RL255 | 10.0582 | 70.53663 |
| RL 256 | 13.3445 | 88.77358 |
| WK 947 | 19.4259 | 122.5216 |
| Fox 0 | 7.6717 | 57.29301 |
| Fox 2 | 7.7551 | 57.75583 |
| Fox 3 | 5.1415 | 39.77645 |
| Sussex Crk | 8.2831 | 60.6859 |
| Root River | 7.7049 | 57.47725 |
| WK WWTP | 14.0683 | 92.79023 |
| BK WWTP | 13.4487 | 89.35183 |
| Sussex WWTP | 11.6331 | 79.27636 |

# Fall 2014



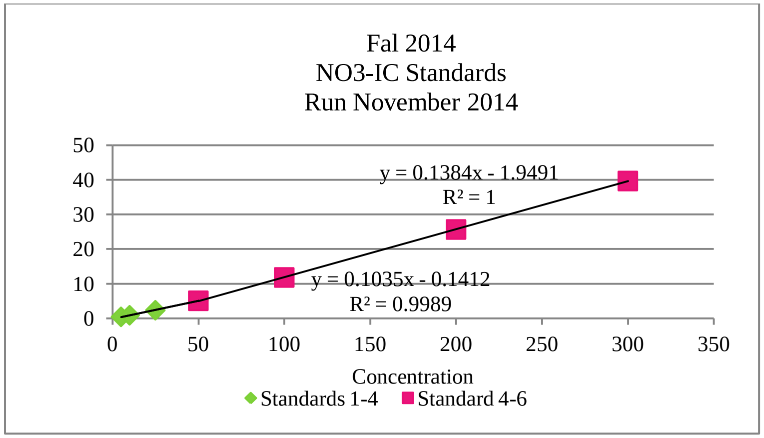

| Fall 2014 Well Suite | | Run Nov. 13, 2014 | | Cl |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.8389 | 0.8647 | 0.8518 |
| Standard 2 | 10 | 1.8184 | 1.8483 | 1.83335 |
| Standard 3 | 25 | 4.919 | 4.997 | 4.958 |
| Standard 4 | 50 | 10.8858 | 10.9974 | 10.9416 |
| Standard 5 | 100 | 26.1872 | 26.5355 | 26.36135 |
| Standard 6 | 200 | 54.997 | 55.7583 | 55.37765 |
| Standard 7 | 300 | 84.1242 | 84.9823 | 84.55325 |

| Fall 2014 Well Suite | | Run Nov. 13, 2014 | | |
|---|---|---|---|---|
| Cl | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275 | 12.2633 | 53.33833 | 1 | 53.33833 |
| SV 631 | 6.0051 | 28.53935 | 1 | 28.53935 |
| B.B.Spring | 31.132 | 117.6269 | 1 | 117.6269 |
| IZ 385 | 58.1351 | 209.6307 | 1 | 209.6307 |
| IZ 386 | 56.5827 | 204.3414 | 1 | 204.3414 |
| RL255 | 45.4061 | 166.261 | 1 | 166.261 |
| RL 256 | 38.5947 | 143.0535 | 1 | 143.0535 |
| WK 947 | 18.9455 | 76.10562 | 1 | 76.10562 |
| Fox 0 | 32.8473 | 123.4712 | 1 | 123.4712 |
| Fox 1 | 76.6447 | 272.6957 | 1 | 272.6957 |
| Fox 2 | 77.0576 | 274.1026 | 1 | 274.1026 |
| Fox 3 | 43.6729 | 160.3557 | 1 | 160.3557 |
| Sussex Crk | 48.2039 | 175.7935 | 1 | 175.7935 |
| Root River | 47.4496 | 173.2235 | 1 | 173.2235 |
| WK WWTP_1:5 | 19.4812 | 77.93083 | 5 | 389.6542 |
| BK WWTP_1:5 | 21.477 | 84.73083 | 5 | 423.6542 |
| Sussex WWTP_1:5 | 23.9704 | 93.22624 | 5 | 466.1312 |
| Summer14B.B.Spring | 29.5826 | 112.3479 | 1 | 112.3479 |




| Fall 2014 Well Suite | | Run Nov. 13, 2014 | | SO4 |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.581 | 0.5878 | 0.5844 |
| Standard 2 | 10 | 1.2026 | 1.224 | 1.2133 |
| Standard 3 | 25 | 3.0517 | 3.0947 | 3.0732 |
| Standard 4 | 50 | 6.5466 | 6.5964 | 6.5715 |
| Standard 5 | 100 | 15.0923 | 15.2735 | 15.1829 |
| Standard 6 | 200 | 32.7362 | 33.1702 | 32.9532 |
| Standard 7 | 300 | 50.4004 | 50.8538 | 50.6271 |

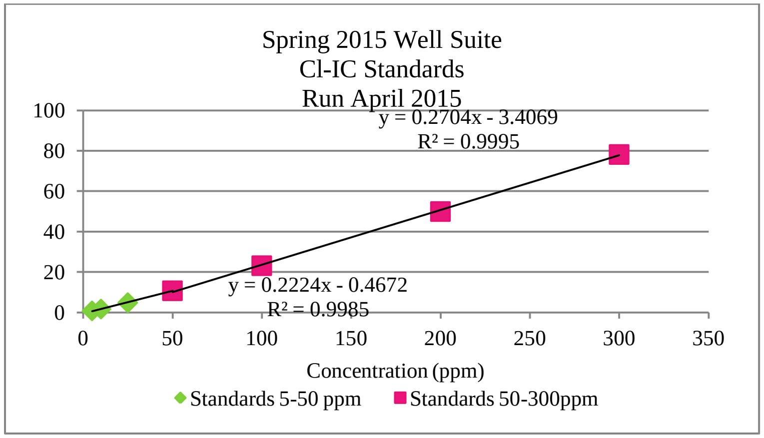
| Fall 2014 Well Suite | | Run Nov. 13, 2104 | | |
|---|---|---|---|---|
| SO4 | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275 | 8.8024 | 63.18017 | 1 | 63.18017 |
| SV 631 | 26.9273 | 165.8708 | 1 | 165.8708 |
| B.B.Spring | 6.7307 | 51.44249 | 1 | 51.44249 |
| IZ 385 | 10.3698 | 72.06062 | 1 | 72.06062 |
| IZ386 | 11.9275 | 80.88612 | 1 | 80.88612 |
| RL255 | 9.85 | 69.11558 | 1 | 69.11558 |
| RL256 | 11.3983 | 77.88782 | 1 | 77.88782 |
| WK 947 | 17.4552 | 112.2045 | 1 | 112.2045 |
| Fox 0 | 11.9993 | 81.29292 | 1 | 81.29292 |
| Fox 1 | 9.3919 | 66.52011 | 1 | 66.52011 |
| Fox 2 | 9.3927 | 66.52465 | 1 | 66.52465 |
| Fox 3 | 5.9372 | 45.60932 | 1 | 45.60932 |
| Sussex Crk | 12.2354 | 82.63059 | 1 | 82.63059 |
| Root River | 4.3139 | 33.41322 | 1 | 33.41322 |
| WK WWTP | 2.13 | 17.00526 | 5 | 85.0263 |
| BK WWTP | 1.917 | 15.40496 | 5 | 77.02479 |
| Sussex WWTP | 2.1745 | 17.33959 | 5 | 86.69797 |




| Fall 2014 Well Suite | | Run Nov. 13, 2014 | | NO3 |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.43 | 0.4345 | 0.43225 |
| Standard 2 | 10 | 0.8858 | 0.8985 | 0.89215 |
| Standard 3 | 25 | 2.3247 | 2.3667 | 2.3457 |
| Standard 4 | 50 | 5.0576 | 5.0937 | 5.07565 |
| Standard 5 | 100 | 11.8333 | 11.7799 | 11.8066 |
| Standard 6 | 200 | 25.6704 | 25.6398 | 25.6551 |
| Standard 7 | 300 | 39.4674 | 39.8281 | 39.64775 |

| Fall 2014 Well Suite | | Run Nov. 13, 2014 | | |
|---|---|---|---|---|
| NO3 | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275 | n.a. | 0 | 1 | 0 |
| SV 631 | n.a. | 0 | 1 | 0 |
| B.B.Spring | 0.5772 | 6.941063 | 1 | 6.941063 |
| IZ 385 | 0.2174 | 3.464734 | 1 | 3.464734 |
| IZ 386 | 0.0186 | 1.543961 | 1 | 1.543961 |
| RL255 | 0.0396 | 1.74686 | 1 | 1.74686 |
| RL 256 | n.a. | 0 | 1 | 0 |
| WK 947 | 0.0251 | 1.606763 | 1 | 1.606763 |
| Fox 0 | 0.1473 | 2.78744 | 1 | 2.78744 |
| Fox 1 | 0.9563 | 10.60386 | 1 | 10.60386 |
| Fox 2 | 1.5245 | 16.09372 | 1 | 16.09372 |
| Fox 3 | 0.9118 | 10.17391 | 1 | 10.17391 |
| Sussex Crk | 0.9852 | 10.88309 | 1 | 10.88309 |
| Root River | 0.032 | 1.67343 | 1 | 1.67343 |
| WK WWTP_1:5 | 1.3125 | 14.04541 | 5 | 70.22705 |
| BK WWTP_1:5 | 0.3045 | 4.30628 | 5 | 21.5314 |
| Sussex WWTP_1:5 | 0.8508 | 9.584541 | 5 | 47.92271 |
| Sprig14B.B.Spring | 1.0866 | 11.8628 | 1 | 11.8628 |
| Spring14WK WWTP_1:5 | 0.914 | 10.19517 | 5 | 50.97585 |
| Spring14BK WWTP_1:5 | 0.5903 | 7.067633 | 5 | 35.33816 |
| Spring14Sussex WWTP_1:5 | 0.487 | 6.069565 | 5 | 30.34783 |

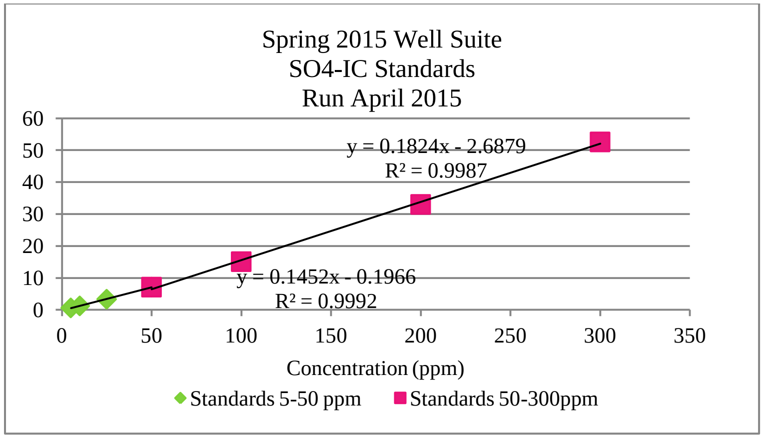
# Spring 2015





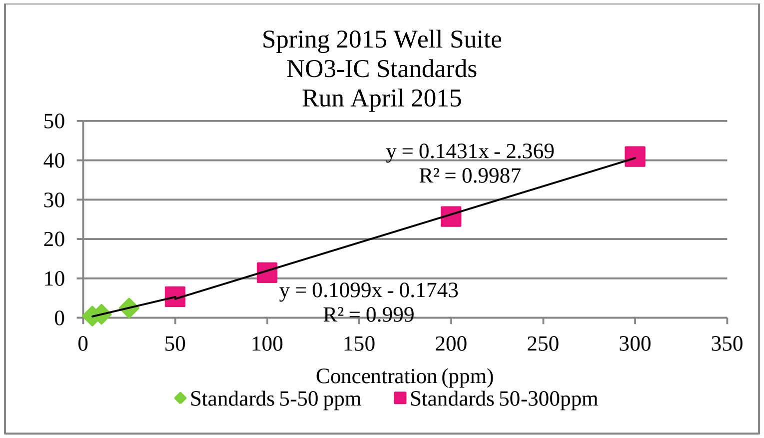

| Spring 2015 2014 Well Suite | | Run May. 13, 2014 | | Cl |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.812 | 0.8156 | 0.8138 |
| Standard 2 | 10 | 1.6925 | 1.7246 | 1.70855 |
| Standard 3 | 25 | 4.8365 | 4.8991 | 4.8678 |
| Standard 4 | 50 | 10.7136 | 10.8079 | 10.76075 |
| Standard 5 | 100 | 23.0486 | 23.3039 | 23.17625 |
| Standard 6 | 200 | 49.743 | 50.211 | 49.977 |
| Standard 7 | 300 | 78.0737 | 78.3863 | 78.23 |

| Spring 2015 Well Suite | | Run May 13, 2014 | | |
|---|---|---|---|---|
| Cl | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| SV631_4.7.15 | 12.5609 | 59.05251 | 1 | 59.05 |
| BBSpring_4.7.15 | 30.8268 | 126.6039 | 1 | 126.60 |
| WK947_4.2.15 | 20.4781 | 88.3321 | 1 | 88.33 |
| RL255_4.2.15 | 47.6911 | 188.9719 | 1 | 188.97 |
| RL256_4.2.15 | 41.0744 | 164.5018 | 1 | 164.50 |
| Fox0_4.8.15 | 5.061 | 24.85701 | 5 | 124.29 |
| Fox1_4.8.15 | 12.6738 | 59.47004 | 5 | 297.35 |
| Fox2_4.8.15 | 12.229 | 57.82507 | 5 | 289.13 |
| FoxA_4.9.15 | 6.0962 | 29.51169 | 5 | 147.56 |
| Fox3_4.7.15 | 6.6258 | 31.89299 | 5 | 159.46 |
| RR_4.7.15 | 11.9092 | 56.64238 | 5 | 283.21 |
| UC_4.8.15 | 14.6306 | 66.70673 | 5 | 333.53 |
| SC_4.8.15 | 6.8378 | 32.84622 | 5 | 164.23 |
| WWWTP_4.8.15 | 22.8009 | 96.92234 | 5 | 484.61 |
| SWTTP_4.2.15 | 23.4613 | 99.36464 | 5 | 496.82 |




| Spring 2015 Well Suite | | Run May 13, 2014 | | SO4 |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.6117 | 0.606 | 0.60885 |
| Standard 2 | 10 | 1.2203 | 1.2407 | 1.2305 |
| Standard 3 | 25 | 3.3169 | 3.3462 | 3.33155 |
| Standard 4 | 50 | 7.0842 | 7.1423 | 7.11325 |
| Standard 5 | 100 | 15.0152 | 15.1638 | 15.0895 |
| Standard 6 | 200 | 32.9017 | 33.1258 | 33.01375 |
| Standard 7 | 300 | 52.5505 | 52.6318 | 52.59115 |

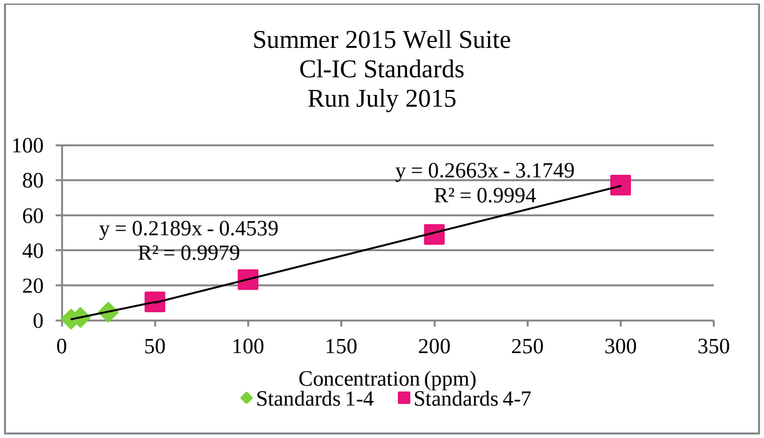
| Spring 2015 Well Suite | | Run May 13, 2014 | | |
|---|---|---|---|---|
| SO4 | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| SV631_4.7.15 | 9.4204 | 66.38322 | 1 | 66.38 |
| BBSpring_4.7.15 | 6.8157 | 48.29408 | 1 | 48.29 |
| WK947_4.2.15 | 18.3443 | 115.3081 | 1 | 115.31 |
| RL255_4.2.15 | 10.1035 | 70.12829 | 1 | 70.13 |
| RL256_4.2.15 | 10.7161 | 73.48684 | 1 | 73.49 |
| Fox0_4.8.15 | 1.1387 | 9.196281 | 5 | 45.98 |
| Fox1_4.8.15 | 1.4358 | 11.24242 | 5 | 56.21 |
| Fox2_4.8.15 | 1.511 | 11.76033 | 5 | 58.80 |
| FoxA_4.9.15 | 0.6822 | 6.052342 | 5 | 30.26 |
| Fox3_4.7.15 | 1.064 | 8.681818 | 5 | 43.41 |
| RR_4.7.15 | 1.7378 | 13.32231 | 5 | 66.61 |
| UC_4.8.15 | 1.3695 | 10.78581 | 5 | 53.93 |
| SC_4.8.15 | 1.3946 | 10.95868 | 5 | 54.79 |
| WWWTP_4.8.15 | 2.3007 | 17.19904 | 5 | 86.00 |
| SWTTP_4.2.15 | 1.9898 | 15.05785 | 5 | 75.29 |




| Spring 2015 Well Suite | | Run May 13, 2014 | | NO3 |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.4433 | 0.4433 | 0.4433 |
| Standard 2 | 10 | 0.8987 | 0.9126 | 0.90565 |
| Standard 3 | 25 | 2.4681 | 2.4954 | 2.48175 |
| Standard 4 | 50 | 5.3372 | 5.391 | 5.3641 |
| Standard 5 | 100 | 11.4189 | 11.5277 | 11.4733 |
| Standard 6 | 200 | 25.5122 | 25.9343 | 25.72325 |
| Standard 7 | 300 | 41.0618 | 40.8505 | 40.95615 |

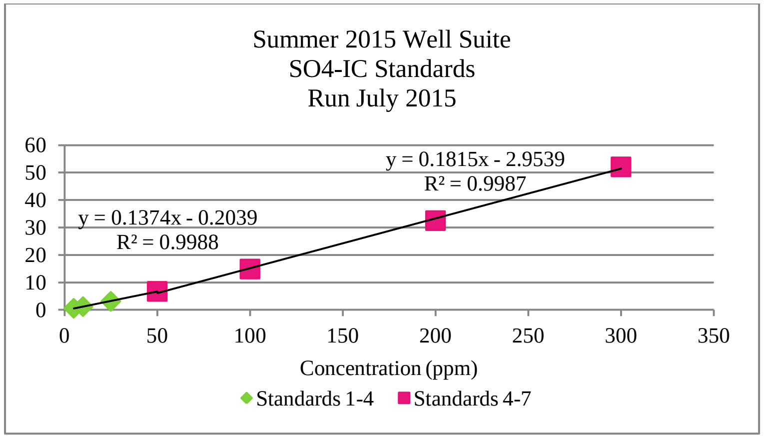
| Spring 2015 Well Suite | | Run May 13, 2014 | | |
|---|---|---|---|---|
| NO3 | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| SV631_4.7.15 | n.a. | | | 0.00 |
| BBSpring_4.7.15 | 0.5527 | 6.615105 | 1 | 6.62 |
| WK947_4.2.15 | n.a. | | | 0.00 |
| RL255_4.2.15 | 0.0317 | 1.874431 | 1 | 1.87 |
| RL256_4.2.15 | n.a. | | | 0.00 |
| Fox0_4.8.15 | n.a. | | | 0.00 |
| Fox1_4.8.15 | 0.1356 | 2.819836 | 5 | 14.10 |
| Fox2_4.8.15 | 0.2816 | 4.148317 | 5 | 20.74 |
| FoxA_4.9.15 | 0.114 | 2.623294 | 5 | 13.12 |
| Fox3_4.7.15 | 0.1414 | 2.872611 | 5 | 14.36 |
| RR_4.7.15 | n.a. | | | 0.00 |
| UC_4.8.15 | 0.0493 | 2.034577 | 5 | 10.17 |
| SC_4.8.15 | 0.1236 | 2.710646 | 5 | 13.55 |
| WWWTP_4.8.15 | 1.652 | 16.61783 | 5 | 83.09 |
| SWTTP_4.2.15 | 0.21 | 3.496815 | 5 | 17.48 |

# Summer 2015



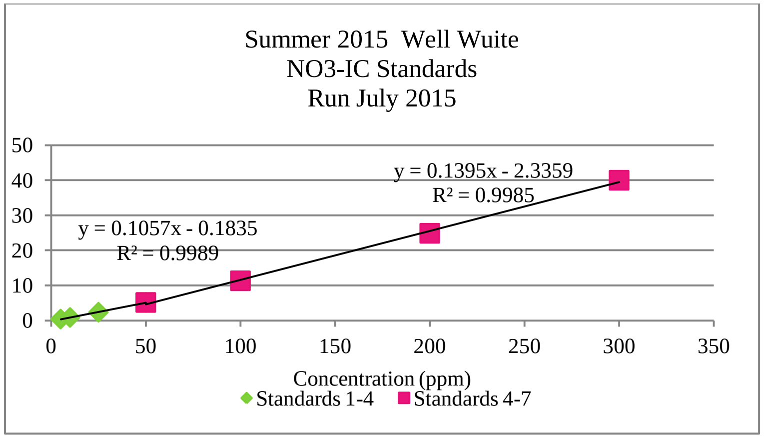

| Summer 2015 Well Suite | | Run Jul. 29, 2014 | | Cl |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.8067 | 0.8118 | 0.80925 |
| Standard 2 | 10 | 1.7213 | 1.7237 | 1.7225 |
| Standard 3 | 25 | 4.7205 | 4.7464 | 4.73345 |
| Standard 4 | 50 | 10.5661 | 10.6679 | 10.617 |
| Standard 5 | 100 | 23.1135 | 23.5422 | 23.32785 |
| Standard 6 | 200 | 48.5769 | 49.6698 | 49.12335 |
| Standard 7 | 300 | 76.8932 | 77.702 | 77.2976 |

| Summer 2015 Well Suite | | Run Jul. 29, 2014 | | |
|---|---|---|---|---|
| Cl | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_7.14.15 | 5.5019 | 27.20786 | 1 | 27.20786 |
| SV631_7.20.15 | 13.0063 | 60.76305 | 1 | 60.76305 |
| BBSpring_7.20.15 | 23.0612 | 98.52084 | 1 | 98.52084 |
| IZ385_7.14.15 | 64.3002 | 253.38 | 1 | 253.38 |
| IZ386_7.14.15 | 52.8497 | 210.3815 | 1 | 210.3815 |
| WK947_7.23.15 | 19.9312 | 86.76718 | 1 | 86.76718 |
| RL255_7.23.15 | 40.1857 | 162.8261 | 1 | 162.8261 |
| RL256_7.23.15 | 45.3837 | 182.3455 | 1 | 182.3455 |
| Fox0_7.16.15 | 4.2708 | 21.58383 | 5 | 107.9191 |
| Fox1_7.16.15 | 13.011 | 60.7807 | 5 | 303.9035 |
| Fox2_7.23.15 | 11.7945 | 56.21254 | 5 | 281.0627 |
| Fox3_7.20.15 | 5.9234 | 29.13339 | 5 | 145.667 |
| RR_7.20.15 | 4.7516 | 23.78026 | 5 | 118.9013 |
| UC_7.23.15 | 18.0589 | 79.73639 | 5 | 398.6819 |
| SC_7.26.15 | 8.3902 | 40.40247 | 5 | 202.0123 |
| BWWTP_7.14.15 | 27.2025 | 114.0721 | 5 | 570.3605 |
| WWWTP_7.16.15 | 24.6872 | 104.6267 | 5 | 523.1337 |
| SWTTP_7.16.15 | 21.8344 | 93.91401 | 5 | 469.57 |




| Summer 2015 Well Suite | | Run Jul. 29, 2014 | | SO4 |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.565 | 0.5495 | 0.55725 |
| Standard 2 | 10 | 1.1721 | 1.1736 | 1.17285 |
| Standard 3 | 25 | 3.0915 | 3.0958 | 3.09365 |
| Standard 4 | 50 | 6.6901 | 6.7651 | 6.7276 |
| Standard 5 | 100 | 14.7637 | 14.9758 | 14.86975 |
| Standard 6 | 200 | 32.1719 | 32.8107 | 32.4913 |
| Standard 7 | 300 | 51.7483 | 52.415 | 52.08165 |

| Summer 2015 Well Suite | | Run Jul. 29, 2014 | | |
|---|---|---|---|---|
| SO4 | Area | Calculated | Dilution | Corrected |
| Sample Name | μS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_7.14.15 | 23.4503 | 145.4777 | 1 | 145.4777 |
| SV631_7.20.15 | 9.8008 | 70.27383 | 1 | 70.27383 |
| BBSpring_7.20.15 | 5.0768 | 38.43304 | 1 | 38.43304 |
| IZ385_7.14.15 | 10.1142 | 72.00055 | 1 | 72.00055 |
| IZ386_7.14.15 | 12.7903 | 86.7449 | 1 | 86.7449 |
| WK947_7.23.15 | 19.1682 | 121.8848 | 1 | 121.8848 |
| RL255_7.23.15 | 12.2386 | 83.70523 | 1 | 83.70523 |
| RL256_7.23.15 | 9.4197 | 68.1741 | 1 | 68.1741 |
| Fox0_7.16.15 | 1.2987 | 10.93595 | 5 | 54.67977 |
| Fox1_7.16.15 | 1.3329 | 11.18486 | 5 | 55.92431 |
| Fox2_7.23.15 | 1.2691 | 10.72052 | 5 | 53.60262 |
| Fox3_7.20.15 | 0.7587 | 7.005822 | 5 | 35.02911 |
| RR_7.20.15 | 0.3697 | 4.174672 | 5 | 20.87336 |
| UC_7.23.15 | 3.3094 | 25.56987 | 5 | 127.8493 |
| SC_7.26.15 | 1.771 | 14.37336 | 5 | 71.86681 |
| BWWTP_7.14.15 | 2.4601 | 19.38865 | 5 | 96.94323 |
| WWWTP_7.16.15 | 2.5017 | 19.69141 | 5 | 98.45706 |




| Summer 2015 Well Suite | | Run Jul. 29, 2014 | | NO3 |
|---|---|---|---|---|
| Standards | Concentration (mg/L) | Absorption Start | Absorption Final | Average |
| Standard 1 | 5 | 0.565 | 0.5495 | 0.55725 |
| Standard 2 | 10 | 1.1721 | 1.1736 | 1.17285 |
| Standard 3 | 25 | 3.0915 | 3.0958 | 3.09365 |
| Standard 4 | 50 | 6.6901 | 6.7651 | 6.7276 |
| Standard 5 | 100 | 14.7637 | 14.9758 | 14.86975 |
| Standard 6 | 200 | 32.1719 | 32.8107 | 32.4913 |
| Standard 7 | 300 | 51.7483 | 52.415 | 52.08165 |

| Summer 2015 Well Suite | | Run Jul. 29, 2014 | | |
|---|---|---|---|---|
| SO4 | Area | Calculated | Dilution | Corrected |
| Sample Name | µS*min | Concentration (mg/L) | Factor | Concentration (mg/L) |
| EM275_7.14.15 | 0.0714 | 2.411542 | 1 | 2.411542 |
| SV631_7.20.15 | 0.1192 | 2.863765 | 1 | 2.863765 |
| BBSpring_7.20.15 | 0.8344 | 9.630085 | 1 | 9.630085 |
| IZ385_7.14.15 | 0.1502 | 3.157048 | 1 | 3.157048 |
| IZ386_7.14.15 | 0.149 | 3.145695 | 1 | 3.145695 |
| WK947_7.23.15 | 0.121 | 2.880795 | 1 | 2.880795 |
| RL255_7.23.15 | 0.1286 | 2.952696 | 1 | 2.952696 |
| RL256_7.23.15 | 0.156 | 3.211921 | 1 | 3.211921 |
| Fox0_7.16.15 | 0.0181 | 1.907285 | 5 | 9.536424 |
| Fox1_7.16.15 | 0.1466 | 3.12299 | 5 | 15.61495 |
| Fox2_7.23.15 | 0.3716 | 5.251656 | 5 | 26.25828 |
| Fox3_7.20.15 | 0.1191 | 2.862819 | 5 | 14.3141 |
| RR_7.20.15 | 0.0334 | 2.052034 | 5 | 10.26017 |
| UC_7.23.15 | 0.0191 | 1.916746 | 5 | 9.583728 |
| SC_7.26.15 | 0.1649 | 3.296121 | 5 | 16.48061 |
| BWWTP_7.14.15 | 0.6402 | 7.79281 | 5 | 38.96405 |
| WWWTP_7.16.15 | 1.734 | 18.14096 | 5 | 90.70482 |
| SWTTP_7.16.15 | 0.2031 | 3.657521 | 5 | 18.28761 |

4. Averages and Standard Deviations for Each Site

## RL255

Calcium
RL255

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 11/19/2013 | 115.87 | 2.89 | 11/19/2013 | 113.00 | 2.82 |
| 10/29/2014 | 115.75 | 2.89 | 10/29/2014 | 109.27 | 2.72 |
| 11/22/2014 | 109.15 | 2.72 | 1/22/2014 | 109.50 | 2.73 |
| AVE | 113.59 | 2.83 | AVE | 110.59 | 2.76 |
| STD | | 0.10 | STD | | 0.05 |
| RSD | | 3.39 | RSD | | 1.93 |



Calcium
RL255

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | Ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 111.60 | 2.78 | 9/25/2014 | 126.73 | 3.16 | 10/29/2014 | 110.98 | 2.77 |
| 10/29/2014 | 119.06 | 2.97 | 10/29/2014 | 103.50 | 2.58 | 10/29/2014 | 111.81 | 2.79 |
| 11/22/2014 | 107.39 | 2.68 | 11/22/2014 | 107.51 | 2.68 | 11/22/2014 | 110.28 | 2.75 |
| AVE | 112.68 | 2.81 | AVE | 112.58 | 2.81 | AVE | 111.02 | 2.77 |
| STD | | 0.15 | STD | | 0.31 | STD | | 0.02 |
| RSD | | 5.25 | RSD | | 11.03 | RSD | | 0.69 |

Calcium

RL255

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/13/2015 | 114.82 | 2.86 | 8/5/2015 | 103.85 | 2.59 |
| 8/5/2015 | 104.60 | 2.61 | 8/12/15 | 105.47 | 2.63 |
| 8/12/15 | 107.62 | 2.68 | | | 0.00 |
| | | | | | |
| AVE | 109.02 | 2.72 | AVE | | |
| STD | | 0.13 | STD | | |
| RSD | | 4.82 | RSD | | |

Magnesium

RL255

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 11/19/2013 | 62.31 | 2.56 | 5/16/2014 | 58.97 | 2.43 |
| 10/29/2014 | 51.35 | 2.11 | 10/29/2014 | 51.37 | 2.11 |
| 11/22/2014 | 48.72 | 2.01 | 11/22/2014 | 47.91 | 1.97 |
| | | | | | |
| AVE | 54.13 | 2.23 | AVE | 52.75 | 2.17 |
| STD | | 0.30 | STD | | 0.23 |
| RSD | | 13.31 | RSD | | 10.73 |

| Magnesium RL255 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Spring 2014** | | | **Summer 2014** | | | **Fall 2014** | |
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 59.61 | 2.45 | 9/25/2014 | 76.36 | 3.14 | 10/29/2014 | 48.57 | 2.00 |
| 10/29/2014 | 50.83 | 2.09 | 10/29/2014 | 50.17 | 2.06 | 10/29/2014 | 50.40 | 2.07 |
| 11/22/2014 | 47.90 | 1.97 | 11/22/2014 | 48.13 | 1.98 | 11/22/2014 | 47.83 | 1.97 |
| AVE | 52.78 | 2.17 | AVE | 58.22 | 2.39 | AVE | 48.93 | 2.01 |
| STD | | 0.25 | STD | | 0.65 | STD | | 0.05 |
| RSD | | 11.55 | RSD | | 27.04 | RSD | | 2.70 |

| Magnesium RL255 | | | | | |
|---|---|---|---|---|---|
| | **Spring 2015** | | | **Summer 2015** | |
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/13/2015 | 61.68 | 2.54 | 8/5/2015 | 55.50 | 2.28 |
| 8/5/2015 | 57.08 | 2.35 | 8/12/15 | 54.91 | 2.26 |
| 8/12/15 | 55.54 | 2.28 | | | 0.00 |
| AVE | 58.10 | 2.39 | AVE | | |
| STD | | 0.13 | STD | | |
| RSD | | 5.49 | RSD | | |

Sodium
RL255

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 2/14/2015 | 100.34 | 4.36 | 2/14/2015 | 110.34 | 4.80 |
| 2/19/2015 | 99.38 | 4.32 | 2/19/2015 | 111.99 | 4.87 |
| 2/21/2015 | 102.93 | 4.48 | 2/21/2015 | 110.18 | 4.79 |
| AVE | 100.88 | 4.39 | AVE | 110.84 | 4.82 |
| STD | | 0.11 | STD | | 0.04 |
| RSD | | 2.49 | RSD | | 0.90 |

Sodium
RL255

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 2/14/2015 | 105.25 | 4.58 | 2/14/2015 | 103.25 | 4.49 | 2/14/2015 | 102.84 | 4.47 |
| 2/19/2015 | 102.56 | 4.46 | 2/19/2015 | 101.79 | 4.43 | 2/19/2015 | 102.77 | 4.47 |
| 2/21/2015 | 102.13 | 4.44 | 2/21/2015 | 104.78 | 4.56 | 2/21/2015 | 105.15 | 4.57 |
| AVE | 103.31 | 4.49 | AVE | 103.27 | 4.49 | AVE | 103.59 | 4.50 |
| STD | | 0.07 | STD | | 0.07 | STD | | 0.06 |
| RSD | | 1.64 | RSD | | 1.45 | RSD | | 1.31 |

Sodium
RL255

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 4/12/15 | 98.33 | 4.28 | 8/12/15 | 92.31 | 4.01 |
| 8/12/15 | 92.59 | 4.03 | | | |
| AVE | | | AVE | | |
| STD | | | STD | | |
| RSD | | | RSD | | |

Potassium
RL255

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 11/19/2013 | 2.78 | 0.07 | 11/19/2013 | 3.25 | 0.08 |
| 10/29/2014 | 4.97 | 0.13 | 10/29/2014 | 4.96 | 0.13 |
| 11/22/2014 | 5.27 | 0.13 | 11/22/2014 | 5.22 | 0.13 |
| AVE | 4.34 | 0.11 | AVE | 4.48 | 0.11 |
| STD | | 0.03 | STD | | 0.03 |
| RSD | | 31.38 | RSD | | 25.74 |

Potassium

RL255

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 3.30 | 0.08 | 9/25/2014 | 3.24 | 0.08 | 10/29/2014 | 2.57 | 0.07 |
| 10/29/2014 | 4.96 | 0.13 | 10/29/2014 | 5.10 | 0.13 | 10/29/2014 | 5.16 | 0.13 |
| 11/22/2014 | 5.39 | 0.14 | 11/22/2014 | 5.07 | 0.13 | 11/22/2014 | 5.26 | 0.13 |
| | | | | | | | | |
| AVE | 4.55 | 0.12 | AVE | 4.47 | 0.11 | AVE | 4.33 | 0.11 |
| STD | | 0.03 | STD | | 0.03 | STD | | 0.04 |
| RSD | | 24.26 | RSD | | 23.85 | RSD | | 35.17 |

Potassium

RL255

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 4/13/15 | 1.34 | 0.03 | 8/12/15 | 1.09 | 0.03 |
| 8/12/15 | 1.26 | 0.03 | | | |
| | | | | | |
| AVE | | | AVE | | |
| STD | | | STD | | |
| RSD | | | RSD | | |

# RL256

| Calcium RL256 | | | | | |
|---|---|---|---|---|---|
| **Summer 2013** | | | **Fall 2013** | | |
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 11/19/2013 | 114.57 | 2.86 | 5/16/2014 | 108.86 | 2.71 |
| 10/29/2014 | 109.69 | 2.74 | 10/29/2014 | 107.30 | 2.68 |
| 11/22/2014 | 110.98 | 2.77 | 11/22/2014 | 109.17 | 2.72 |
| AVE | 111.75 | 2.79 | AVE | 108.44 | 2.70 |
| STD | | 0.06 | STD | | 0.02 |
| RSD | | 2.26 | RSD | | 0.92 |

| Calcium RL256 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Spring 2014** | | | **Summer 2014** | | | **Fall 2014** | | |
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 110.50 | 2.76 | 9/25/2014 | 109.21 | 2.72 | 10/29/2014 | 116.56 | 2.91 |
| 10/29/2014 | 104.41 | 2.60 | 10/29/2014 | 107.33 | 2.68 | 10/29/2014 | 110.87 | 2.76 |
| 11/22/2014 | 107.02 | 2.67 | 11/22/2014 | 108.91 | 2.72 | 11/22/2014 | 107.57 | 2.68 |
| AVE | 107.31 | 2.68 | AVE | 108.48 | 2.71 | AVE | 111.67 | 2.78 |
| STD | | 0.08 | STD | | 0.03 | STD | | 0.11 |
| RSD | | 2.85 | RSD | | 0.93 | RSD | | 4.07 |

Calcium
RL256

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/13/2015 | 110.62 | 2.76 | 8/5/2015 | 101.90 | 2.54 |
| 8/5/2015 | 101.95 | 2.54 | 8/12/15 | 105.01 | 2.62 |
| 8/12/15 | 102.87 | 2.57 | | | 0.00 |
| | | | | | |
| AVE | 105.15 | 2.62 | AVE | | |
| STD | | 0.12 | STD | | |
| RSD | | 4.53 | RSD | | |

Magnesium
RL256

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 10/9/2013 | 59.39 | 2.45 | 11/19/2013 | 63.65 | 2.22 |
| 10/29/2014 | 51.19 | 2.11 | 10/29/2014 | 49.58 | 2.04 |
| 11/22/2014 | 48.34 | 1.99 | 11/22/2014 | 45.69558 | 1.88 |
| | | | | | |
| AVE | 52.98 | 2.18 | AVE | 52.97 | 2.05 |
| STD | | 0.24 | STD | | 0.17 |
| RSD | | 10.85 | RSD | | 8.32 |

Magnesium
RL256

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 64.14 | 2.64 | 9/25/2014 | 60.78 | 2.50 | 10/29/2014 | 47.85 | 1.97 |
| 10/29/2014 | 48.35 | 1.99 | 10/29/2014 | 48.71 | 2.00 | 10/29/2014 | 48.60 | 2.00 |
| 11/22/2014 | 44.38 | 1.83 | 11/22/2014 | 46.21 | 1.90 | 11/22/2014 | 46.23 | 1.90 |
| | | | | | | | | |
| AVE | 52.29 | 2.15 | AVE | 51.90 | 2.13 | AVE | 47.56 | 1.96 |
| STD | | 0.43 | STD | | 0.32 | STD | | 0.05 |
| RSD | | 19.99 | RSD | | 15.01 | RSD | | 2.55 |

Magnesium
RL256

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/13/2015 | 58.95 | 2.42 | 8/5/2015 | 54.72 | 2.25 |
| 8/5/2015 | 53.77 | 2.21 | 8/12/15 | 55.14 | 2.27 |
| 8/12/15 | 53.97 | 2.22 | | | 0.00 |
| | | | | | |
| AVE | 55.56 | 2.29 | AVE | | |
| STD | | 0.12 | STD | | |
| RSD | | 5.28 | RSD | | |

Sodium
RL256

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 2/14/2015 | 75.51 | 3.28 | 2/14/2015 | 77.20 | 3.36 |
| 2/19/2015 | 72.51 | 3.15 | 2/19/2015 | 77.37 | 3.36 |
| 2/21/2015 | 70.74 | 3.08 | 2/21/2015 | 76.04 | 3.31 |
| | | | 2/21/2015 | 79.39 | 3.45 |
| AVE | 72.92 | 3.17 | AVE | 77.28 | 3.34 |
| STD | | 0.10 | STD | | 0.03 |
| RSD | | 3.30 | RSD | | 0.94 |

Sodium
RL256

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 2/14/2015 | 79.58 | 3.46 | 2/14/2015 | 80.84 | 3.51 | 2/14/2015 | 76.32 | 3.32 |
| 2/19/2015 | 77.57 | 3.37 | 2/19/2015 | 79.90 | 3.47 | 2/19/2015 | 74.83 | 3.25 |
| 2/21/2015 | 77.72 | 3.38 | 2/21/2015 | 78.43 | 3.41 | 2/21/2015 | 74.92 | 3.26 |
| | | | | | | | | |
| AVE | 78.29 | 3.40 | AVE | 79.72 | 3.47 | AVE | 75.57 | 3.28 |
| STD | | 0.05 | STD | | 0.05 | STD | | 0.04 |
| RSD | | 1.44 | RSD | | 1.52 | RSD | | 1.11 |

Sodium

RL256

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 4/12/15 | 75.90 | 3.30 | 8/12/15 | 71.60 | 3.11 |
| 8/12/15 | 72.06 | 3.13 | | | |
| AVE | 73.98 | 3.22 | AVE | | |
| STD | | 0.12 | STD | | |
| RSD | | 3.67 | RSD | | |

Potassium

RL256

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 11/19/2013 | 2.99 | 0.08 | 10/29/2014 | 4.83 | 0.12 |
| 10/29/2014 | 4.90 | 0.13 | 11/22/2014 | 4.75 | 0.12 |
| 11/22/2014 | 4.73 | 0.12 | | | |
| AVE | 4.21 | 0.11 | AVE | 4.79 | 0.12 |
| STD | | 0.03 | STD | | 0.00 |
| RSD | | 25.05 | RSD | | 1.27 |

Potassium

RL256

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 2.88 | 0.07 | 9/25/2014 | 2.98 | 0.08 | 10/29/2014 | 2.36 | 0.06 |
| 10/29/2014 | 4.83 | 0.12 | 10/29/2014 | 5.12 | 0.13 | 10/29/2014 | 4.92 | 0.13 |
| 11/22/2014 | 4.70 | 0.12 | 11/22/2014 | 4.79 | 0.12 | 11/22/2014 | 4.88 | 0.12 |
| | | | | | | | | |
| AVE | 4.13 | 0.11 | AVE | 4.30 | 0.11 | AVE | 4.05 | 0.10 |
| STD | | 0.03 | STD | | 0.03 | STD | | 0.04 |
| RSD | | 26.36 | RSD | | 26.76 | RSD | | 36.28 |

Potassium

RL256

| Spring 2014 | | | Summer 2014 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 4/13/15 | 2.75 | 0.07 | 8/12/15 | 1.30 | 0.03 |
| 8/12/15 | 1.33 | 0.03 | | | 0.00 |
| | | 0.00 | | | 0.00 |
| | | | | | |
| AVE | | | AVE | | |
| STD | | | STD | | |
| RSD | | | RSD | | |

# WK947

Calcium
WK947

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| | 108.67 | 2.71 | 11/19/2013 | 103.23 | 2.57 |
| 10/29/2014 | 98.23 | 2.45 | 10/29/2014 | 92.71 | 2.31 |
| 11/22/2014 | 100.40 | 2.50 | 11/22/2014 | 94.94 | 2.37 |
| | | | | | |
| AVE | 102.43 | 2.55 | AVE | 96.96 | 2.42 |
| STD | | 0.14 | STD | | 0.14 |
| RSD | | 5.38 | RSD | | 5.72 |



Calcium
WK947

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 105.23 | 2.62 | 9/25/2014 | 116.57 | 2.91 | 10/29/2014 | 109.01 | 2.72 |
| 10/29/2014 | 97.96 | 2.44 | 10/29/2014 | 96.18 | 2.40 | 10/29/2014 | 92.93 | 2.32 |
| 11/22/2014 | 101.75 | 2.54 | 11/22/2014 | 100.62 | 2.51 | 11/22/2014 | 100.28 | 2.50 |
| | | | | | | | | |
| AVE | 101.65 | 2.53 | AVE | 104.46 | 2.60 | AVE | 100.74 | 2.51 |
| STD | | 0.09 | STD | | 0.27 | STD | | 0.20 |
| RSD | | 3.58 | RSD | | 10.26 | RSD | | 7.99 |

Calcium

WK947

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/13/2015 | 104.30 | 2.60 | 8/5/2015 | 97.58 | 2.43 |
| 8/5/2015 | 97.44 | 2.43 | 8/12/15 | 97.21 | 2.42 |
| 8/12/15 | 97.72 | 2.44 | | | |
| | | | | | |
| AVE | 99.82 | 2.49 | AVE | | |
| STD | | 0.10 | STD | | |
| RSD | | 3.89 | RSD | | |

Magnesium

WK947

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| | 56.83 | 2.34 | 11/19/2013 | 74.01 | 3.04 |
| 10/29/2014 | 52.53 | 2.16 | 10/29/2014 | 51.38 | 2.11 |
| 11/22/2014 | 50.03 | 2.06 | 11/22/2014 | 47.95 | 1.97 |
| | | | | | |
| AVE | 53.13 | 2.19 | AVE | 57.78 | 2.38 |
| STD | | 0.14 | STD | | 0.58 |
| RSD | | 6.47 | RSD | | 24.51 |

Magnesium
Wk947

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 44.55 | 1.83 | 9/25/2014 | 64.67 | 2.66 | 10/29/2014 | 51.28 | 2.11 |
| 10/29/2014 | 53.69 | 2.21 | 10/29/2014 | 52.94 | 2.18 | 10/29/2014 | 52.61 | 2.16 |
| 11/22/2014 | 50.68 | 2.08 | 11/22/2014 | 49.67 | 2.04 | 11/22/2014 | 50.28 | 2.07 |
| | | | | | | | | |
| AVE | 49.64 | 2.04 | AVE | 55.76 | 2.29 | AVE | 51.39 | 2.11 |
| STD | | 0.19 | STD | | 0.32 | STD | | 0.05 |
| RSD | | 9.38 | RSD | | 14.14 | RSD | | 2.28 |

Magnesium
WK947

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/13/2015 | 64.14 | 2.64 | 8/5/2015 | 59.57 | 2.45 |
| 8/5/2015 | 59.27 | 2.44 | 8/12/15 | 59.75 | 2.46 |
| 8/12/15 | 59.71 | 2.46 | | | |
| | | | | | |
| AVE | 61.04 | 2.51 | AVE | | |
| STD | | 0.11 | STD | | |
| RSD | | 4.41 | RSD | | |

Sodium
WK947

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 2/14/2015 | 37.06878 | 1.61 | 2/14/2015 | 36.69145 | 1.60 |
| 2/19/2015 | 37.28964 | 1.62 | 2/19/2015 | 36.05962 | 1.57 |
| 2/21/2015 | 37.58996 | 1.63 | 2/21/2015 | 36.2506 | 1.58 |
| | | | | | |
| AVE | 37.32 | 1.62 | AVE | 36.33 | 1.58 |
| STD | | 0.01 | STD | | 0.01 |
| RSD | | 0.70 | RSD | | 0.89 |

Sodium
WK947

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 2/14/2015 | 40.422 | 1.76 | 2/14/2015 | 38.33799 | 1.67 | 2/14/2015 | 38.31145 | 1.67 |
| 2/19/2015 | 39.19788 | 1.70 | 2/19/2015 | 37.93486 | 1.65 | 2/19/2015 | 37.02761 | 1.61 |
| 2/21/2015 | 38.71087 | 1.68 | 2/21/2015 | 37.71262 | 1.64 | 2/21/2015 | 36.81062 | 1.60 |
| | | | | | | | | |
| AVE | 39.44 | 1.71 | AVE | 38.00 | 1.65 | AVE | 37.38 | 1.63 |
| STD | | 0.04 | STD | | 0.01 | STD | | 0.04 |
| RSD | | 2.24 | RSD | | 0.83 | RSD | | 2.17 |

Sodium

WK947

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 4/13/15 | 38.42 | 1.67 | 8/12/15 | 38.25 | 1.66 |
| 8/12/15 | 37.01 | 1.61 | | | |
| | | 0.00 | | | |
| AVE | 37.71 | 1.64 | AVE | | |
| STD | | 0.04 | STD | | |
| RSD | | 2.65 | RSD | | |

Potassium

WK947

| Summer 2013 | | | Fall 2013 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| | 0.75 | 0.02 | 11/19/2013 | 2.78 | 0.06 |
| 10/29/2014 | 4.15 | 0.11 | 10/29/2014 | 4.01 | 0.10 |
| 11/22/2014 | 4.33 | 0.11 | 11/22/2014 | 4.08 | 0.10 |
| AVE | 3.08 | 0.08 | AVE | 3.62 | 0.09 |
| STD | | 0.05 | STD | | 0.03 |
| RSD | | 65.50 | RSD | | 28.20 |

Potassium
WK947

| Spring 2014 | | | Summer 2014 | | | Fall 2014 | | |
|---|---|---|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L | test date | ppm | mMol/L |
| 5/16/2014 | 2.43 | 0.06 | 9/25/2014 | 2.87 | 0.07 | 10/29/2014 | 2.04 | 0.05 |
| 10/29/2014 | 4.41 | 0.11 | 10/29/2014 | 4.19 | 0.11 | 10/29/2014 | 4.52 | 0.12 |
| 11/22/2014 | 4.20 | 0.11 | 11/22/2014 | 4.23 | 0.11 | 11/22/2014 | 4.12 | 0.11 |
| AVE | 3.68 | 0.09 | AVE | 3.76 | 0.10 | AVE | 3.56 | 0.09 |
| STD | | 0.03 | STD | | 0.02 | STD | | 0.03 |
| RSD | | 29.49 | RSD | | 20.51 | RSD | | 37.43 |

Potassium
WK947

| Spring 2015 | | | Summer 2015 | | |
|---|---|---|---|---|---|
| test date | ppm | mMol/L | test date | ppm | mMol/L |
| 4/13/15 | 1.09 | 0.03 | 8/12/15 | 1.09 | 0.03 |
| 8/12/15 | 1.07 | 0.03 | | | |
| AVE | | | AVE | | |
| STD | | | STD | | |
| RSD | | | RSD | | |

## 5. Stable Isotope Results

# Data

| Run November 11, 2014 Well Suite | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date of Sample | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| GB bf190-1 | Standard 1 | -16.905 | 0.181 | -124.477 | 0.442 |
| GB bf190-2 | | -16.954 | 0.192 | -124.644 | 0.41 |
| GB bf190-3 | | -17.008 | 0.208 | -124.868 | 0.444 |
| GB bf190-Avg. | | -16.9557 | - | -124.663 | - |
| DNR BH423-1 | Standard 2 | -10.904 | 0.186 | -76.286 | 0.38 |
| DNR BH423-2 | | -10.886 | 0.18 | -76.294 | 0.354 |
| DNR BH423-3 | | -10.873 | 0.192 | -75.967 | 0.447 |
| DNR BH423-Avg. | | -10.8877 | - | -76.1823 | - |
| Kona Water-1 | Standard 3 | 0.247 | 0.197 | 1.558 | 0.433 |
| Kona Water-2 | | 0.252 | 0.184 | 1.589 | 0.454 |
| Kona Water-3 | | 0.261 | 0.203 | 1.741 | 0.409 |
| Kona Water-Avg. | | 0.253333 | - | 1.629333 | - |
| EM275-1 | Fall 2014 | -8.963 | 0.198 | -60.189 | 0.433 |
| EM275-2 | | -8.904 | 0.197 | -60.023 | 0.477 |
| EM275-3 | | -8.898 | 0.207 | -59.98 | 0.408 |
| EM275-Avg. | | -8.92167 | 0.200667 | -60.064 | 0.439333 |
| SV631-1 | Fall 2014 | -8.891 | 0.197 | -59.171 | 0.409 |
| SV631-2 | | -8.887 | 0.171 | -59.258 | 0.389 |
| SV631-3 | | -8.801 | 0.194 | -58.941 | 0.404 |
| SV631-Avg. | | -8.85967 | 0.187333 | -59.1233 | 0.400667 |
| IZ385-1 | Fall 2014 | -8.704 | 0.201 | -58.544 | 0.364 |
| IZ385-2 | | -8.661 | 0.191 | -58.575 | 0.34 |
| IZ385-3 | | -8.728 | 0.183 | -58.662 | 0.392 |
| IZ385-Avg. | | -8.69767 | 0.191667 | -58.5937 | 0.365333 |
| IZ386-1 | Fall 2014 | 0.195 | -8.758 | 0.371 | -58.934 |
| IZ386-2 | | 0.183 | -8.767 | 0.371 | -58.814 |
| IZ386-3 | | 0.195 | -8.782 | 0.436 | -59.035 |
| IZ386-Avg. | | 0.191 | -8.769 | 0.392667 | -58.9277 |
| B.B.Spring-1 | Fall 2014 | -7.555 | 0.195 | -52.006 | 0.424 |
| B.B.Spring-2 | | -7.521 | 0.176 | -52.039 | 0.431 |
| B.B.Spring-3 | | -7.41 | 0.194 | -51.939 | 0.452 |
| B.B.Spring-Avg. | | -7.49533 | 0.188333 | -51.9947 | 0.435667 |
| RL255-1 | Fall 2014 | 0.205 | -8.882 | 0.419 | -58.994 |

| | | | | | |
|---|---|---|---|---|---|
| RL255-2 | | 0.183 | -8.929 | 0.437 | -59.324 |
| RL255-3 | | 0.214 | -8.831 | 0.447 | -59.25 |
| RL255-Avg. | | 0.200667 | -8.88067 | 0.434333 | -59.1893 |
| RL256-1 | Fall 2014 | -8.645 | 0.2 | -57.669 | 0.417 |
| RL256-2 | | -8.643 | 0.182 | -57.516 | 0.372 |
| RL256-3 | | -8.534 | 0.203 | -57.508 | 0.435 |
| RL256-Avg. | | -8.60733 | 0.195 | -57.5643 | 0.408 |
| WK947-1 | Fall 2014 | -8.682 | 0.175 | -57.757 | 0.403 |
| WK947-2 | | -8.751 | 0.205 | -57.979 | 0.413 |
| WK947-3 | | -8.602 | 0.191 | -57.624 | 0.372 |
| WK947-Avg. | | -8.67833 | 0.190333 | -57.7867 | 0.396 |
| Fox0-1 | Fall 2014 | -8.682 | 0.218 | -57.757 | 0.456 |
| Fox0-2 | | -8.751 | 0.207 | -57.979 | 0.369 |
| Fox0-3 | | -8.602 | 0.187 | -57.624 | 0.399 |
| Fox0-Avg. | | -8.67833 | 0.204 | -57.7867 | 0.408 |
| Fox1-1 | Fall 2014 | -8.2 | 0.191 | -57.984 | 0.414 |
| Fox1-2 | | -8.187 | 0.194 | -57.993 | 0.4 |
| Fox1-3 | | -8.063 | 0.211 | -57.61 | 0.465 |
| Fox1-Avg. | | -8.15 | 0.198667 | -57.8623 | 0.426333 |
| Fox2-1 | Fall 2014 | -8.486 | 0.198 | -59.535 | 0.401 |
| Fox2-2 | | -8.531 | 0.181 | -59.978 | 0.363 |
| Fox2-3 | | -8.565 | 0.207 | -59.983 | 0.441 |
| Fox2-Avg. | | -8.52733 | 0.195333 | -59.832 | 0.401667 |
| Fox3-1 | Fall 2014 | -7.846 | 0.188 | -55.831 | 0.364 |
| Fox3-2 | | -7.922 | 0.217 | -56.054 | 0.469 |
| Fox3-3 | | -7.911 | 0.172 | -56.005 | 0.409 |
| Fox3-Avg. | | -7.893 | 0.192333 | -55.9633 | 0.414 |
| Sus.Crk-1 | Fall 2014 | -7.846 | 0.188 | -55.831 | 0.364 |
| Sus.Crk-2 | | -7.922 | 0.217 | -56.054 | 0.469 |
| Sus.Crk-3 | | -7.911 | 0.172 | -56.005 | 0.409 |
| Sus.Crk-Avg. | | -7.893 | 0.192333 | -55.9633 | 0.414 |
| R.River-1 | Fall 2014 | -8.509 | 0.194 | -61.352 | 0.419 |
| R.River-2 | | -8.575 | 0.227 | -61.426 | 0.402 |
| R.River-3 | | -8.62 | 0.192 | -61.545 | 0.413 |
| R.River-Avg. | | -8.568 | 0.204333 | -61.441 | 0.411333 |
| B.WWTP-1 | Fall 2014 | -9.517 | 0.211 | -64.707 | 0.379 |
| B.WWTP-2 | | -9.557 | 0.189 | -65.025 | 0.419 |
| B.WWTP-3 | | -9.489 | 0.219 | -64.811 | 0.418 |
| B.WWTP-Avg. | | -9.521 | 0.206333 | -64.8477 | 0.405333 |
| S.WWTP-1 | Fall 2014 | -9.572 | 0.185 | -67.074 | 0.391 |
| S.WWTP-2 | | -9.531 | 0.211 | -66.857 | 0.377 |
| S.WWTP-3 | | -9.502 | 0.192 | -66.556 | 0.39 |
| S.WWTP-Avg. | | -9.535 | 0.196 | -66.829 | 0.386 |
| W.WWTP-1 | Fall 2014 | -10.425 | 0.192 | -73.041 | 0.384 |
| W.WWTP-2 | | -10.393 | 0.183 | -73.119 | 0.419 |
| W.WWTP-3 | | -10.41 | 0.193 | -73.142 | 0.412 |
| W.WWTP-Avg. | | -10.4093 | 0.189333 | -73.1007 | 0.405 |
| EM275-1 | Summer 2014 | -8.888 | 0.194 | -59.408 | 0.431 |

| | | | | | |
|---|---|---|---|---|---|
| EM275-2 | | -8.881 | 0.183 | -59.149 | 0.45 |
| EM275-3 | | -8.904 | 0.198 | -59.4 | 0.392 |
| EM275-Avg. | | -8.891 | 0.191667 | -59.319 | 0.424333 |
| SV631-1 | Summer 2014 | -9.022 | 0.171 | -60.244 | 0.356 |
| SV631-2 | | -8.969 | 0.216 | -60.019 | 0.372 |
| SV631-3 | | -9.072 | 0.208 | -60.465 | 0.414 |
| SV631-Avg. | | -9.021 | 0.198333 | -60.2427 | 0.380667 |
| IZ385-1 | Summer 2014 | -8.892 | 0.199 | -58.998 | 0.428 |
| IZ385-2 | | -8.861 | 0.198 | -58.811 | 0.42 |
| IZ385-3 | | -8.865 | 0.196 | -58.705 | 0.446 |
| IZ385-Avg. | | -8.87267 | 0.197667 | -58.838 | 0.431333 |
| IZ386-1 | Summer 2014 | -8.85 | 0.188 | -59.137 | 0.393 |
| IZ386-2 | | -8.894 | 0.184 | -59.317 | 0.378 |
| IZ386-3 | | -8.891 | 0.203 | -59.298 | 0.404 |
| IZ386-Avg. | | -8.87833 | 0.191667 | -59.2507 | 0.391667 |

| December 9, 2014 Well Suite | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date of Sample | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| GB bf190-1 | Standard 1 | -16.943 | 0.197 | -124.41 | 0.395 |
| GB bf190-2 | | -17.022 | 0.21 | -124.609 | 0.474 |
| GB bf190-3 | | -16.948 | 0.19 | -124.259 | 0.413 |
| GB bf190-Avg. | | -16.971 | - | -124.426 | - |
| DNR BH423-1 | Standard 2 | -10.864 | 0.191 | -76.203 | 0.424 |
| DNR BH423-2 | | -10.876 | 0.19 | -76.114 | 0.417 |
| DNR BH423-3 | | -10.892 | 0.185 | -76.041 | 0.386 |
| DNR BH423-Avg. | | -10.8773 | - | -76.1193 | - |
| Kona Water-1 | Standard 3 | 0.235 | 0.172 | 1.56 | 0.451 |
| Kona Water-2 | | 0.301 | 0.191 | 2.056 | 0.448 |
| Kona Water-3 | | 0.316 | 0.191 | 2.322 | 0.405 |
| Kona Water-Avg. | | 0.284 | - | 1.979333 | - |
| RL255-1 | Summer 2014 | -8.758 | 0.186 | -58.831 | 0.432 |
| RL255-2 | | -8.781 | 0.194 | -58.88 | 0.443 |
| RL255-3 | | -8.705 | 0.201 | -58.704 | 0.409 |
| RL255-Avg. | | -8.748 | 0.193667 | -58.805 | 0.428 |
| RL256-1 | Summer 2014 | -8.572 | 0.183 | -57.399 | 0.409 |
| RL256-2 | | -8.675 | 0.181 | -57.645 | 0.41 |
| RL256-3 | | -8.692 | 0.191 | -57.802 | 0.414 |
| RL256-Avg. | | -8.64633 | 0.185 | -57.6153 | 0.411 |
| WK947-1 | Summer 2014 | -8.529 | 0.22 | -57.507 | 0.38 |
| WK947-2 | | -8.63 | 0.21 | -57.76 | 0.42 |
| WK947-3 | | -8.704 | 0.191 | -57.917 | 0.386 |
| WK947-Avg. | | -8.621 | 0.207 | -57.728 | 0.395333 |
| Fox0-1 | Summer 2014 | -7.706 | 0.232 | -54.144 | 0.413 |

| | | | | | |
|---|---|---|---|---|---|
| Fox0-2 | | -7.641 | 0.187 | -53.978 | 0.406 |
| Fox0-3 | | -7.646 | 0.204 | -53.864 | 0.406 |
| Fox0-Avg. | | -7.66433 | 0.207667 | -53.9953 | 0.408333 |
| Fox1-1 | | -8.018 | 0.177 | -56.324 | 0.386 |
| Fox1-2 | Summer 2014 | -7.967 | 0.202 | -56.066 | 0.424 |
| Fox1-3 | | -8.031 | 0.209 | -56.489 | 0.457 |
| Fox1-Avg. | | -8.00533 | 0.196 | -56.293 | 0.422333 |
| Fox2-1 | | -8.393 | 0.188 | -58.683 | 0.412 |
| Fox2-2 | Summer 2014 | -8.287 | 0.189 | -58.503 | 0.377 |
| Fox2-3 | | -8.302 | 0.183 | -58.299 | 0.404 |
| Fox2-Avg. | | -8.32733 | 0.186667 | -58.495 | 0.397667 |
| Fox3-1 | | -8.585 | 0.201 | -62.169 | 0.414 |
| Fox3-2 | Summer 2014 | -8.653 | 0.218 | -62.302 | 0.408 |
| Fox3-3 | | -8.641 | 0.184 | -62.299 | 0.418 |
| Fox3-Avg. | | -8.62633 | 0.201 | -62.2567 | 0.413333 |
| Sus.Crk-1 | Summer 2014 | -7.887 | 0.192 | -54.643 | 0.424 |
| Sus.Crk-2 | | -7.929 | 0.221 | -54.682 | 0.41 |
| Sus.Crk-3 | | -7.959 | 0.201 | -55.042 | 0.407 |
| Sus.Crk-Avg. | | -7.925 | 0.204667 | -54.789 | 0.413667 |
| R.River-1 | | -7.698 | 0.181 | -56.531 | 0.418 |
| R.River-2 | Summer 2014 | -7.574 | 0.188 | -56.25 | 0.393 |
| R.River-3 | | -7.779 | 0.193 | -56.618 | 0.396 |
| R.River-Avg. | | -7.68367 | 0.187333 | -56.4663 | 0.402333 |
| B.WWTP-1 | | -9.192 | 0.189 | -63.565 | 0.406 |
| B.WWTP-2 | Summer 2014 | -9.121 | 0.189 | -63.416 | 0.406 |
| B.WWTP-3 | | -9.21 | 0.198 | -63.583 | 0.413 |
| B.WWTP-Avg. | | -9.17433 | 0.192 | -63.5213 | 0.408333 |
| S.WWTP-1 | | -9.372 | 0.192 | -64.759 | 0.409 |
| S.WWTP-2 | Summer 2014 | -9.281 | 0.195 | -64.341 | 0.402 |
| S.WWTP-3 | | -9.295 | 0.181 | -64.395 | 0.368 |
| S.WWTP-Avg. | | -9.316 | 0.189333 | -64.4983 | 0.393 |
| W.WWTP-1 | | -10.296 | 0.225 | -71.412 | 0.39 |
| W.WWTP-2 | Summer 2014 | -10.37 | 0.207 | -71.918 | 0.476 |
| W.WWTP-3 | | -10.313 | 0.209 | -71.716 | 0.438 |
| W.WWTP-Avg. | | -10.3263 | 0.213667 | -71.682 | 0.434667 |
| EM275-1 | | -8.794 | 0.197 | -58.702 | 0.414 |
| EM275-2 | Spring 2014 | -8.86 | 0.193 | -58.789 | 0.404 |
| EM275-3 | | -8.777 | 0.209 | -58.676 | 0.392 |
| EM275-Avg. | | -8.81033 | 0.199667 | -58.7223 | 0.403333 |
| IZ386-1 | | -8.757 | 0.17 | -59.392 | 0.432 |
| IZ386-2 | Spring 2014 | -8.693 | 0.19 | -59.088 | 0.515 |
| IZ386-3 | | -8.682 | 0.183 | -59.086 | 0.456 |
| IZ386-Avg. | | -8.71067 | 0.181 | -59.1887 | 0.467667 |
| B.B.Spring-1 | | -7.025 | 0.191 | -50.056 | 0.452 |
| B.B.Spring-2 | Spring 2014 | -7.041 | 0.188 | -50.27 | 0.445 |
| B.B.Spring-3 | | -7.063 | 0.188 | -50.329 | 0.462 |
| B.B.Spring-Avg. | | -7.043 | 0.189 | -50.2183 | 0.453 |

| | | | | | |
|---|---|---|---|---|---|
| RL255-1 | Spring 2014 | -8.971 | 0.182 | -59.628 | 0.512 |
| RL255-2 | | -8.573 | 0.194 | -58.326 | 0.423 |
| RL255-3 | | -5.276 | 0.178 | -49.755 | 0.437 |
| RL255-Avg. | | -7.60667 | 0.184667 | -55.903 | 0.457333 |
| RL256-1 | Spring 2014 | -8.266 | 0.214 | -57.005 | 0.419 |
| RL256-2 | | -8.372 | 0.184 | -57.098 | 0.4 |
| RL256-3 | | -8.367 | 0.201 | -57.152 | 0.451 |
| RL256-Avg. | | -8.335 | 0.199667 | -57.085 | 0.423333 |
| WK947-1 | Spring 2014 | -8.256 | 0.201 | -56.793 | 0.416 |
| WK947-2 | | -8.596 | 0.195 | -57.461 | 0.416 |
| WK947-3 | | -8.51 | 0.211 | -57.309 | 0.434 |
| WK947-Avg. | | -8.454 | 0.202333 | -57.1877 | 0.422 |
| Fox1-1 | Spring 2014 | -7.397 | 0.194 | -53.195 | 0.363 |
| Fox1-2 | | -7.432 | 0.181 | -53.23 | 0.386 |
| Fox1-3 | | -7.418 | 0.207 | -53.328 | 0.397 |
| Fox1-Avg. | | -7.41567 | 0.194 | -53.251 | 0.382 |
| Fox2-1 | Spring 2014 | -7.804 | 0.196 | -55.302 | 0.428 |
| Fox2-2 | | -7.8 | 0.194 | -55.122 | 0.425 |
| Fox2-3 | | -7.787 | 0.193 | -55.114 | 0.496 |
| Fox2-Avg. | | -7.797 | 0.194333 | -55.1793 | 0.449667 |
| Fox3-1 | Spring 2014 | -7.135 | 0.188 | -52.633 | 0.399 |
| Fox3-2 | | -7.624 | 0.187 | -53.878 | 0.385 |
| Fox3-3 | | -7.642 | 0.196 | -53.825 | 0.392 |
| Fox3-Avg. | | -7.467 | 0.190333 | -53.4453 | 0.392 |

| December 11, 2014 Isco Automatic Sampler | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date Sampled | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| GB bf190-1 | Standard 1 | -16.743 | 0.192 | -123.496 | 0.471 |
| GB bf190-2 | | -16.783 | 0.193 | -123.449 | 0.515 |
| GB bf190-3 | | -16.828 | 0.194 | -123.531 | 0.498 |
| GB bf190-Avg. | | -16.7847 | - | -123.492 | - |
| DNR BH423-1 | Standard 2 | -10.78 | 0.197 | -75.758 | 0.398 |
| DNR BH423-2 | | -10.764 | 0.186 | -75.756 | 0.518 |
| DNR BH423-3 | | -10.68 | 0.184 | -75.245 | 0.472 |
| DNR BH423-Avg. | | -10.7413 | - | -75.5863 | - |
| Kona Water-1 | Standard 3 | 0.372 | 0.216 | 1.87 | 0.49 |
| Kona Water-2 | | 0.362 | 0.18 | 2.064 | 0.458 |
| Kona Water-3 | | 0.348 | 0.211 | 2.176 | 0.463 |
| Kona Water-Avg. | | 0.360667 | - | 2.036667 | - |
| I2-1 | 4/3/14 | -9.083 | 0.183 | -62.764 | 0.406 |
| I2-2 | | -9.138 | 0.185 | -63.057 | 0.468 |
| I2-3 | | -9.131 | 0.187 | -63.041 | 0.473 |

| | | | | | |
|---|---|---|---|---|---|
| I2-Avg. | | -9.11733 | 0.185 | -62.954 | 0.449 |
| I10-1 | 4/3/14 | -8.543 | 0.183 | -59.615 | 0.493 |
| I10-2 | | -8.506 | 0.209 | -59.733 | 0.474 |
| I10-3 | | -8.541 | 0.19 | -59.609 | 0.457 |
| I10-Avg. | | -8.53 | 0.194 | -59.6523 | 0.474667 |
| I22-1 | 4/18/14 Composite Flow | -8.392 | 0.201 | -56.727 | 0.453 |
| I22-2 | | -8.367 | 0.205 | -56.492 | 0.486 |
| I22-3 | | -8.362 | 0.2 | -56.519 | 0.442 |
| I22-Avg. | | -8.37367 | 0.202 | -56.5793 | 0.460333 |
| I23-1 | 4/18/15 Composite Flow | -8.268 | 0.203 | -56.417 | 0.429 |
| I23-2 | | -8.311 | 0.196 | -56.376 | 0.44 |
| I23-3 | | -8.283 | 0.184 | -56.447 | 0.448 |
| I23-Avg. | | -8.28733 | 0.194333 | -56.4133 | 0.439 |
| I24-1 | 4/18/14 Composite Flow | -8.346 | 0.178 | -56.51 | 0.457 |
| I24-2 | | -8.369 | 0.178 | -56.413 | 0.452 |
| I24-3 | | -8.368 | 0.183 | -56.591 | 0.406 |
| I24-Avg. | | -8.361 | 0.179667 | -56.5047 | 0.438333 |
| I5-1 | 4/30/14 | -7.797 | 0.201 | -52.8 | 0.437 |
| I5-2 | | -7.758 | 0.206 | -52.572 | 0.427 |
| I5-3 | | -7.804 | 0.188 | -52.874 | 0.425 |
| I5-Avg. | | -7.78633 | 0.198333 | -52.7487 | 0.429667 |
| I12-1 | 5/7/14 | -8.484 | 0.201 | -58.161 | 0.402 |
| I12-2 | | -8.484 | 0.189 | -58.298 | 0.454 |
| I12-3 | | -8.489 | 0.189 | -58.107 | 0.517 |
| I12-Avg. | | -8.48567 | 0.193 | -58.1887 | 0.457667 |
| I17-1 | 5/12/14 Composite Flow | -7.914 | 0.169 | -54.966 | 0.438 |
| I17-2 | | -7.955 | 0.189 | -55.102 | 0.371 |
| I17-3 | | -7.915 | 0.182 | -54.963 | 0.462 |
| I17-Avg. | | -7.928 | 0.18 | -55.0103 | 0.423667 |
| I21-1 | 5/12/14 Composite Flow | -7.243 | 0.2 | -47.711 | 0.431 |
| I21-2 | | -7.243 | 0.212 | -47.68 | 0.425 |
| I21-3 | | -7.199 | 0.186 | -47.773 | 0.387 |
| I21-Avg. | | -7.22833 | 0.199333 | -47.7213 | 0.414333 |
| I21-1 | 5/19/14 Composite Flow | -7.111 | 0.182 | -48.929 | 0.412 |
| I21-2 | | -7.191 | 0.192 | -48.958 | 0.427 |
| I21-3 | | -7.164 | 0.192 | -48.955 | 0.409 |
| I21-Avg. | | -7.15533 | 0.188667 | -48.9473 | 0.416 |
| I22-1 | 5/19/14 Composite Flow | -7.225 | 0.19 | -49.322 | 0.415 |
| I22-2 | | -7.206 | 0.202 | -49.516 | 0.413 |
| I22-3 | | -7.23 | 0.194 | -49.357 | 0.492 |
| I22-Avg. | | -7.22033 | 0.195333 | -49.3983 | 0.44 |
| I2-1 | 5/21/14 | -7.377 | 0.184 | -50.999 | 0.38 |
| I2-2 | | -7.381 | 0.187 | -51.086 | 0.44 |
| I2-3 | | -7.349 | 0.191 | -50.951 | 0.461 |
| I2-Avg. | | -7.369 | 0.187333 | -51.012 | 0.427 |
| I8-1 | 5/27/14 | -7.456 | 0.208 | -50.698 | 0.464 |
| I8-2 | | -7.464 | 0.19 | -50.858 | 0.395 |

| | | | | | |
|---|---|---|---|---|---|
| I8-3 | | -7.496 | 0.206 | -50.73 | 0.411 |
| I8-Avg. | | -7.472 | 0.201333 | -50.762 | 0.423333 |
| I23-1 | 6/1/14 Composite Flow | -7.483 | 0.204 | -49.412 | 0.434 |
| I23-2 | | -7.449 | 0.188 | -49.347 | 0.421 |
| I23-3 | | -7.45 | 0.162 | -49.293 | 0.436 |
| I23-Avg. | | -7.46067 | 0.184667 | -49.3507 | 0.430333 |
| I24-1 | 6/1/14-6/2/14 Composite Flow | -7.193 | 0.197 | -47.724 | 0.414 |
| I24-2 | | -7.206 | 0.181 | -47.5 | 0.423 |
| I24-3 | | -7.217 | 0.21 | -47.532 | 0.382 |
| I24-Avg. | | -7.20533 | 0.196 | -47.5853 | 0.406333 |
| I15-1 | 6/3/14 | -6.982 | 0.187 | -46.85 | 0.424 |
| I15-2 | | -7.052 | 0.173 | -47.125 | 0.426 |
| I15-3 | | -7.031 | 0.174 | -47.2 | 0.439 |
| I15-Avg. | | -7.02167 | 0.178 | -47.0583 | 0.429667 |
| I6-1 | 6/10/14 | -7.908 | 0.205 | -55.13 | 0.394 |
| I6-2 | | -7.971 | 0.19 | -55.294 | 0.371 |
| I6-3 | | -7.933 | 0.193 | -55.094 | 0.425 |
| I6-Avg. | | -7.93733 | 0.196 | -55.1727 | 0.396667 |
| I13-1 | 6/17/14 | -8.107 | 0.195 | -56.224 | 0.411 |
| I13-2 | | -8.105 | 0.199 | -56.215 | 0.404 |
| I13-3 | | -8.141 | 0.208 | -56.386 | 0.449 |
| I13-Avg. | | -8.11767 | 0.200667 | -56.275 | 0.421333 |
| I21-1 | 6/17/14-6/18/14 Composite Flow | -8.048 | 0.205 | -55.237 | 0.461 |
| I21-2 | | -8.011 | 0.19 | -55.06 | 0.486 |
| I21-3 | | -7.98 | 0.177 | -54.92 | 0.454 |
| I21-Avg. | | -8.013 | 0.190667 | -55.0723 | 0.467 |
| Fox0-1 | 3/22/2014 Hand Collection | -10.674 | 0.188 | -75.947 | 0.406 |
| Fox0-2 | | -10.665 | 0.185 | -75.977 | 0.469 |
| Fox0-3 | | -10.723 | 0.206 | -76.176 | 0.466 |
| Fox0-Avg. | | -10.6873 | 0.193 | -76.0333 | 0.447 |
| Fox1-1 | 3/22/2014 Hand Collection | -9.725 | 0.207 | -69.932 | 0.448 |
| Fox1-2 | | -9.735 | 0.204 | -69.937 | 0.441 |
| Fox1-3 | | -9.718 | 0.165 | -69.906 | 0.415 |
| Fox1-Avg. | | -9.726 | 0.192 | -69.925 | 0.434667 |
| Fox2-1 | 3/22/2014 Hand Collection | -9.685 | 0.178 | -69.663 | 0.381 |
| Fox2-2 | | -9.707 | 0.195 | -69.888 | 0.43 |
| Fox2-3 | | -9.702 | 0.194 | -69.941 | 0.505 |
| Fox2-Avg. | | -9.698 | 0.189 | -69.8307 | 0.438667 |

| November 12, 2014 Isco Automatic Sampler | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date Sampled | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| GB bf190-1 | Standard 1 | -16.784 | 0.203 | -122.972 | 0.474 |
| GB bf190-2 | | -16.769 | 0.19 | -122.963 | 0.503 |
| GB bf190-3 | | -16.805 | 0.198 | -123.083 | 0.505 |
| GB bf190-Avg. | | -16.786 | - | -123.006 | - |
| DNR BH423-1 | Standard 2 | -10.747 | 0.195 | -75.571 | 0.436 |
| DNR BH423-2 | | -10.74 | 0.188 | -75.315 | 0.422 |
| DNR BH423-3 | | -10.775 | 0.19 | -75.354 | 0.436 |
| DNR BH423-Avg. | | -10.754 | - | -75.4133 | - |
| Kona Water-1 | Standard 3 | 0.355 | 0.152 | 1.975 | 0.496 |
| Kona Water-2 | | 0.391 | 0.177 | 2.385 | 0.449 |
| Kona Water-3 | | 0.391 | 0.179 | 2.319 | 0.473 |
| Kona Water-Avg. | | 0.379 | - | 2.226333 | - |
| I21-1 | 7/1/14-7/4/14 Composite Flow | -6.539 | 0.189 | -45.944 | 0.416 |
| I21-2 | | -6.557 | 0.173 | -46.076 | 0.453 |
| I21-3 | | -6.531 | 0.184 | -46.112 | 0.434 |
| I21-Avg. | | -6.54233 | 0.182 | -46.044 | 0.434333 |
| I22-1 | 7/4/14 | -6.868 | 0.211 | -47.691 | 0.419 |
| I22-2 | | -6.862 | 0.181 | -47.729 | 0.463 |
| I22-3 | Composite Flow | -6.852 | 0.196 | -47.76 | 0.474 |
| I22-Avg. | | -6.86067 | 0.196 | -47.7267 | 0.452 |
| I23-1 | 7/4/14 | -6.854 | 0.201 | -47.61 | 0.416 |
| I23-2 | | -6.887 | 0.199 | -48.033 | 0.467 |
| I23-3 | Composite Flow | -6.872 | 0.195 | -47.906 | 0.433 |
| I23-Avg. | | -6.871 | 0.198333 | -47.8497 | 0.438667 |
| I24-1 | 7/4/14 | -6.917 | 0.191 | -48.251 | 0.415 |
| I24-2 | | -6.909 | 0.181 | -48.457 | 0.525 |
| I24-3 | Composite Flow | -6.897 | 0.196 | -48.233 | 0.462 |
| I24-Avg. | | -6.90767 | 0.189333 | -48.3137 | 0.467333 |
| I3-1 | 7/7/14 | -6.879 | 0.199 | -47.944 | 0.398 |
| I3-2 | | -6.855 | 0.191 | -47.882 | 0.406 |
| I3-3 | | -6.893 | 0.188 | -47.896 | 0.432 |
| I3-Avg. | | -6.87567 | 0.192667 | -47.9073 | 0.412 |
| I7-1 | 7/12/14 | -7.682 | 0.196 | -53.656 | 0.414 |
| I7-2 | | -7.689 | 0.17 | -53.926 | 0.514 |
| I7-3 | | -7.693 | 0.189 | -53.775 | 0.515 |
| I7-Avg. | | -7.688 | 0.185 | -53.7857 | 0.481 |
| I10-1 | 7/16/14 | -7.744 | 0.199 | -53.441 | 0.463 |
| I10-2 | | -7.714 | 0.216 | -53.318 | 0.474 |
| I10-3 | | -7.785 | 0.199 | -53.645 | 0.444 |
| I10-Avg. | | -7.74767 | 0.204667 | -53.468 | 0.460333 |
| I11-1 | 7/29/14 | -8.465 | 0.195 | -58.741 | 0.448 |
| I11-2 | | -8.423 | 0.172 | -58.634 | 0.443 |
| I11-3 | | -8.425 | 0.174 | -58.689 | 0.43 |
| I11-Avg. | | -8.43767 | 0.180333 | -58.688 | 0.440333 |

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|---|---|---|---|---|---|
| I16-1 | 8/3/14 | -8.968 | 0.18 | -63.441 | 0.473 |
| I16-2 | | -9.039 | 0.197 | -63.626 | 0.47 |
| I16-3 | | -8.957 | 0.194 | -63.627 | 0.486 |
| I16-Avg. | | -8.988 | 0.190333 | -63.5647 | 0.476333 |
| I2-1 | 9/5/14 | -7.929 | 0.189 | -54.794 | 0.495 |
| I2-2 | | -7.921 | 0.208 | -54.959 | 0.472 |
| I2-3 | | -7.926 | 0.223 | -54.995 | 0.531 |
| I2-Avg. | | -7.92533 | 0.206667 | -54.916 | 0.499333 |
| I5-1 | 9/8/14 | -8.084 | 0.187 | -56.375 | 0.409 |
| I5-2 | | -8.053 | 0.191 | -56.255 | 0.443 |
| I5-3 | | -8.063 | 0.185 | -56.383 | 0.405 |
| I5-Avg. | | -8.06667 | 0.187667 | -56.3377 | 0.419 |
| I14-1 | 9/17/14 | -8.134 | 0.211 | -57.168 | 0.461 |
| I14-2 | | -8.224 | 0.206 | -57.754 | 0.419 |
| I14-3 | | -8.15 | 0.193 | -57.272 | 0.476 |
| I14-Avg. | | -8.16933 | 0.203333 | -57.398 | 0.452 |
| I19-1 | 9/22/14 | -8.249 | 0.192 | -58.013 | 0.462 |
| I19-2 | | -8.17 | 0.186 | -57.617 | 0.502 |
| I19-3 | | -8.245 | 0.187 | -57.803 | 0.454 |
| I19-Avg. | | -8.22133 | 0.188333 | -57.811 | 0.472667 |
| I9-1 | 10/2/14 | -8.293 | 0.188 | -58.589 | 0.482 |
| I9-2 | | -8.296 | 0.21 | -58.542 | 0.477 |
| I9-3 | | -8.358 | 0.208 | -59.153 | 0.473 |
| I9-Avg. | | -8.31567 | 0.202 | -58.7613 | 0.477333 |
| I15-1 | 10/8/14 | -8.438 | 0.192 | -58.687 | 0.471 |
| I15-2 | | -8.45 | 0.183 | -58.726 | 0.448 |
| I15-3 | | -8.436 | 0.195 | -58.659 | 0.518 |
| I15-Avg. | | -8.44133 | 0.19 | -58.6907 | 0.479 |
| I19-1 | 10/12/14 | -8.83 | 0.202 | -61.385 | 0.432 |
| I19-2 | | -8.773 | 0.196 | -61.191 | 0.433 |
| I19-3 | | -8.845 | 0.202 | -61.526 | 0.513 |
| I19-Avg. | | -8.816 | 0.2 | -61.3673 | 0.459333 |
| FoxIsco-1 | 3/22/2014 Hand Sampled | -8.704 | 0.197 | -60.57 | 0.439 |
| FoxIsco-2 | | -8.732 | 0.198 | -60.84 | 0.551 |
| FoxIsco-3 | | -8.612 | 0.171 | -60.422 | 0.588 |
| FoxIsco-Avg. | | -8.68267 | 0.188667 | -60.6107 | 0.526 |
| Fox3-1 | 3-22-14 Hand Sampled | -9.742 | 0.189 | -69.416 | 0.463 |
| Fox3-2 | | -9.755 | 0.174 | -69.58 | 0.403 |
| Fox3-3 | | -9.784 | 0.167 | -69.885 | 0.455 |
| Fox3-Avg. | | -9.76033 | 0.176667 | -69.627 | 0.440333 |

| December 12, 2014 Isco Automatic Sampler | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date Sampled | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| GB bf190-1 | Standard 1 | -16.78 | 0.188 | -122.875 | 0.531 |
| GB bf190-2 | | -16.828 | 0.206 | -123.063 | 0.507 |
| GB bf190-3 | | -16.78 | 0.175 | -122.998 | 0.565 |
| GB bf190-Avg. | | -16.796 | - | -122.979 | - |
| DNR BH423-1 | Standard 2 | -10.798 | 0.195 | -75.699 | 0.394 |
| DNR BH423-2 | | -10.829 | 0.202 | -75.607 | 0.451 |
| DNR BH423-3 | | -10.803 | 0.189 | -75.416 | 0.403 |
| DNR BH423-Avg. | | -10.81 | - | -75.574 | - |
| Kona Water-1 | Standard 3 | 0.381 | 0.19 | 1.731 | 0.519 |
| Kona Water-2 | | 0.352 | 0.185 | 1.824 | 0.505 |
| Kona Water-3 | | 0.346 | 0.192 | 1.823 | 0.455 |
| Kona Water-Avg. | | 0.359667 | - | 1.792667 | - |
| RL255-1 | 10/30/2013 | -8.849 | 0.191 | -58.61 | 0.459 |
| RL255-2 | | -8.897 | 0.199 | -58.803 | 0.564 |
| RL255-3 | | -8.897 | 0.18 | -59.005 | 0.525 |
| RL255-Avg. | | -8.881 | 0.19 | -58.806 | 0.516 |
| RL256-1 | 10/30/2013 | -8.721 | 0.201 | -58.055 | 0.465 |
| RL256-2 | | -8.74 | 0.184 | -58.064 | 0.497 |
| RL256-3 | | -8.737 | 0.194 | -58.16 | 0.546 |
| RL256-Avg. | | -8.73267 | 0.193 | -58.093 | 0.502667 |
| WK947-1 | 10/30/2013 | -8.696 | 0.206 | -57.684 | 0.442 |
| WK947-2 | | -8.666 | 0.189 | -57.602 | 0.424 |
| WK947-3 | | -8.723 | 0.205 | -57.942 | 0.391 |
| WK947-Avg. | | -8.695 | 0.2 | -57.7427 | 0.419 |
| Fox0-1 | 10/26/2013 | -8.093 | 0.194 | -55.061 | 0.435 |
| Fox0-2 | | -8.08 | 0.208 | -54.7 | 0.449 |
| Fox0-3 | | -8.098 | 0.198 | -54.792 | 0.391 |
| Fox0-Avg. | | -8.09033 | 0.2 | -54.851 | 0.425 |
| Fox1-1 | 10/26/2013 | -6.626 | 0.18 | -47.663 | 0.373 |
| Fox1-2 | | -6.572 | 0.18 | -47.404 | 0.428 |
| Fox1-3 | | -6.619 | 0.191 | -47.44 | 0.425 |
| Fox1-Avg. | | -6.60567 | 0.183667 | -47.5023 | 0.408667 |
| Fox2-1 | 10/26/2013 | -7.22 | 0.188 | -51.521 | 0.458 |
| Fox2-2 | | -7.264 | 0.189 | -51.511 | 0.468 |
| Fox2-3 | | -7.258 | 0.194 | -51.385 | 0.481 |
| Fox2-Avg. | | -7.24733 | 0.190333 | -51.4723 | 0.469 |
| Fox3-1 | 10/24/2013 | -7.457 | 0.192 | -52.014 | 0.431 |
| Fox3-2 | | -7.435 | 0.192 | -52.021 | 0.478 |
| Fox3-3 | | -7.419 | 0.166 | -52.174 | 0.524 |
| Fox3-Avg. | | -7.437 | 0.183333 | -52.0697 | 0.477667 |
| WWWTP-1 | October 2013 | -10.102 | 0.212 | -69.989 | 0.446 |
| WWWTP-2 | | -10.117 | 0.195 | -69.959 | 0.454 |
| WWWTP-3 | | -10.134 | 0.174 | -70.035 | 0.501 |
| WWWTP-Avg. | | -10.1177 | 0.193667 | -69.9943 | 0.467 |

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|---|---|---|---|---|---|
| SWWTP-1 | October 2013 | -9.403 | 0.189 | -64.591 | 0.436 |
| SWWTP-2 | | -9.405 | 0.184 | -64.589 | 0.503 |
| SWWTP-3 | | -9.442 | 0.191 | -64.778 | 0.437 |
| SWWTP-Avg. | | -9.41667 | 0.188 | -64.6527 | 0.458667 |
| BWWTP-1 | October2013 | -9.246 | 0.187 | -63.376 | 0.485 |
| BWWTP-2 | | -9.285 | 0.17 | -63.609 | 0.484 |
| BWWTP-3 | | -9.214 | 0.195 | -63.222 | 0.43 |
| BWWTP-Avg. | | -9.24833 | 0.184 | -63.4023 | 0.466333 |
| RL255-1 | July 2013 | -8.785 | 0.204 | -58.683 | 0.474 |
| RL255-2 | | -8.793 | 0.205 | -58.659 | 0.491 |
| RL255-3 | | -8.834 | 0.198 | -58.773 | 0.437 |
| RL255-Avg. | | -8.804 | 0.202333 | -58.705 | 0.467333 |
| RL256-1 | July 2013 | -8.745 | 0.169 | -58.085 | 0.487 |
| RL256-2 | | -8.761 | 0.185 | -57.903 | 0.471 |
| RL256-3 | | -8.744 | 0.198 | -57.89 | 0.416 |
| RL256-Avg. | | -8.75 | 0.184 | -57.9593 | 0.458 |
| WK947-1 | July 2013 | -8.815 | 0.191 | -58.505 | 0.483 |
| WK947-2 | | -8.804 | 0.196 | -58.475 | 0.524 |
| WK947-3 | | -8.83 | 0.215 | -58.476 | 0.478 |
| WK947-Avg. | | -8.81633 | 0.200667 | -58.4853 | 0.495 |
| Fox0-1 | July 2013 | -7.562 | 0.206 | -51.819 | 0.5 |
| Fox0-2 | | -7.501 | 0.198 | -51.668 | 0.43 |
| Fox0-3 | | -7.526 | 0.198 | -51.596 | 0.425 |
| Fox0-Avg. | | -7.52967 | 0.200667 | -51.6943 | 0.451667 |
| Fox1-1 | July 2013 | -7.932 | 0.196 | -54.688 | 0.448 |
| Fox1-2 | | -7.937 | 0.186 | -54.718 | 0.468 |
| Fox1-3 | | -7.992 | 0.214 | -54.865 | 0.476 |
| Fox1-Avg. | | -7.95367 | 0.198667 | -54.757 | 0.464 |
| Fox2-1 | July 2013 | -6.739 | 0.203 | -46.812 | 0.433 |
| Fox2-2 | | -6.744 | 0.192 | -46.82 | 0.495 |
| Fox2-3 | | -6.679 | 0.213 | -46.49 | 0.5 |
| Fox2-Avg. | | -6.72067 | 0.202667 | -46.7073 | 0.476 |
| Fox3-1 | July 2013 | -6.776 | 0.182 | -46.701 | 0.481 |
| Fox3-2 | | -6.701 | 0.171 | -46.522 | 0.497 |
| Fox3-3 | | -6.649 | 0.195 | -46.449 | 0.486 |
| Fox3-Avg. | | -6.70867 | 0.182667 | -46.5573 | 0.488 |
| WWWTP-1 | July 2013 | -9.696 | 0.184 | -66.318 | 0.445 |
| WWWTP-2 | | -9.74 | 0.214 | -66.391 | 0.434 |
| WWWTP-3 | | -9.711 | 0.193 | -66.476 | 0.47 |
| WWWTP-Avg. | | -9.71567 | 0.197 | -66.395 | 0.449667 |
| SWWTP-1 | July 2013 | -8.941 | 0.192 | -60.023 | 0.448 |
| SWWTP-2 | | -8.936 | 0.205 | -60.114 | 0.461 |
| SWWTP-3 | | -8.96 | 0.21 | -60.067 | 0.411 |
| SWWTP-Avg. | | -8.94567 | 0.202333 | -60.068 | 0.44 |
| BWWTP-1 | July 2013 | -8.106 | 0.187 | -53.696 | 0.416 |
| BWWTP-2 | | -8.073 | 0.203 | -53.57 | 0.444 |
| BWWTP-3 | | -8.077 | 0.197 | -53.525 | 0.467 |
| BWWTP-Avg. | | -8.08533 | 0.195667 | -53.597 | 0.442333 |

| March 3,2015 Isco Automatic Sampler | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date Sampled | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| BF190 water-1 | | -16.694 | 0.183 | -123.843 | 0.431 |
| BF190 water-2 | Standard 1 | -16.723 | 0.187 | -124.063 | 0.41 |
| BF190 water-3 | | -16.699 | 0.19 | -124.025 | 0.416 |
| BF190 water-Avg. | | -16.7053 | 0.186667 | -123.977 | 0.419 |
| BH423 water-1 | | -10.953 | 0.169 | -77.157 | 0.522 |
| BH423 water-2 | Standard 2 | -10.902 | 0.194 | -76.816 | 0.448 |
| BH423 water-3 | | -10.893 | 0.195 | -76.762 | 0.429 |
| BH423 water-Avg. | | -10.916 | 0.186 | -76.9117 | 0.466333 |
| KONA water-1 | | 0.321 | 0.168 | 1.024 | 0.456 |
| KONA water-2 | Standard 3 | 0.277 | 0.181 | 1.25 | 0.434 |
| KONA water-3 | | 0.327 | 0.188 | 1.559 | 0.486 |
| KONA water-Avg. | | 0.308333 | 0.179 | 1.277667 | 0.458667 |
| I13-1 | | -8.031 | 0.177 | -56.104 | 0.42 |
| I13-2 | 4/4/14 | -8.02 | 0.194 | -56.144 | 0.487 |
| I13-3 | | -8.039 | 0.176 | -56.207 | 0.401 |
| I13-Avg. | | -8.03 | 0.182333 | -56.1517 | 0.436 |
| I1-1 | | -9.136 | 0.183 | -63.641 | 0.435 |
| I1-2 | 4/2/14 | -9.144 | 0.202 | -63.629 | 0.417 |
| I1-3 | | -9.175 | 0.197 | -63.746 | 0.357 |
| I1-Avg. | | -9.15167 | 0.194 | -63.672 | 0.403 |
| I2-1 | | -9.165 | 0.195 | -63.804 | 0.441 |
| I2-2 | 4/3/14 | -9.236 | 0.199 | -63.956 | 0.428 |
| I2-3 | | -9.222 | 0.16 | -63.941 | 0.418 |
| I2-Avg. | | -9.20767 | 0.184667 | -63.9003 | 0.429 |
| I3-1 | | -8.932 | 0.206 | -62.302 | 0.424 |
| I3-2 | 4/4/14 | -8.888 | 0.194 | -62.332 | 0.467 |
| I3-3 | | -8.892 | 0.177 | -62.316 | 0.429 |
| I3-Avg. | | -8.904 | 0.192333 | -62.3167 | 0.44 |
| I5-1 | | -8.705 | 0.19 | -61.526 | 0.416 |
| I5-2 | 4/6/14 | -8.654 | 0.201 | -61.402 | 0.425 |
| I5-3 | | -8.638 | 0.196 | -61.278 | 0.41 |
| I5-Avg. | | -8.66567 | 0.195667 | -61.402 | 0.417 |
| I6-1 | 4/7/14 | -8.381 | 0.168 | -59.845 | 0.351 |
| I6-2 | | -8.386 | 0.186 | -59.826 | 0.384 |
| I6-3 | | -8.362 | 0.185 | -59.777 | 0.368 |
| I6-Avg. | | -8.37633 | 0.179667 | -59.816 | 0.367667 |
| I7-1 | | -8.544 | 0.188 | -60.19 | 0.364 |
| I7-2 | 4/8/14 | -8.551 | 0.206 | -60.222 | 0.35 |
| I7-3 | | -8.654 | 0.196 | -60.789 | 0.511 |
| I7-Avg. | | -8.583 | 0.196667 | -60.4003 | 0.408333 |

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|---|---|---|---|---|---|
| I8-1 | 4/9/14 | -8.735 | 0.178 | -60.925 | 0.408 |
| I8-2 | | -8.672 | 0.203 | -60.727 | 0.421 |
| I8-3 | | -8.725 | 0.212 | -60.891 | 0.391 |
| I8-Avg. | | -8.71067 | 0.197667 | -60.8477 | 0.406667 |
| I9-1 | 4/10/14 | -8.517 | 0.189 | -59.93 | 0.411 |
| I9-2 | | -8.586 | 0.19 | -60.399 | 0.368 |
| I9-3 | | -8.602 | 0.181 | -60.163 | 0.415 |
| I9-Avg. | | -8.56833 | 0.186667 | -60.164 | 0.398 |
| I11-1 | 4/12/14 | -8.271 | 0.193 | -58.619 | 0.416 |
| I11-2 | | -8.416 | 0.193 | -59.303 | 0.414 |
| I11-3 | | -8.349 | 0.213 | -58.706 | 0.342 |
| I11-Avg. | | -8.34533 | 0.199667 | -58.876 | 0.390667 |
| I12-1 | 4/13/14 | -8.197 | 0.178 | -57.685 | 0.391 |
| I12-2 | | -8.213 | 0.191 | -57.921 | 0.469 |
| I12-3 | | -8.205 | 0.191 | -57.965 | 0.427 |
| I12-Avg. | | -8.205 | 0.186667 | -57.857 | 0.429 |
| I14-1 | 4/20/14 | -8.24 | 0.196 | -56.575 | 0.39 |
| I14-2 | | -8.277 | 0.18 | -56.615 | 0.433 |
| I14-3 | | -8.146 | 0.187 | -56.342 | 0.386 |
| I14-Avg. | | -8.221 | 0.187667 | -56.5107 | 0.403 |
| I15-1 | 4/21/14 | -8.189 | 0.192 | -56.244 | 0.422 |
| I15-2 | | -8.084 | 0.178 | -55.897 | 0.355 |
| I15-3 | | -8.135 | 0.192 | -56.004 | 0.389 |
| I15-Avg. | | -8.136 | 0.187333 | -56.0483 | 0.388667 |
| I16-1 | 4/22/14 | -8.041 | 0.199 | -55.693 | 0.432 |
| I16-2 | | -8.162 | 0.182 | -56.087 | 0.398 |
| I16-3 | | -8.18 | 0.194 | -56.135 | 0.381 |
| I16-Avg. | | -8.12767 | 0.191667 | -55.9717 | 0.403667 |
| I17-1 | 4/23/14 | -8.092 | 0.19 | -56.393 | 0.578 |
| I17-2 | | -8.078 | 0.208 | -56.372 | 0.628 |
| I17-3 | | -7.934 | 0.196 | -55.337 | 0.381 |
| I17-Avg. | | -8.03467 | 0.198 | -56.034 | 0.529 |
| I18-1 | 4/24/14 | -7.868 | 0.171 | -55.068 | 0.411 |
| I18-2 | | -7.887 | 0.205 | -55.269 | 0.443 |
| I18-3 | | -7.891 | 0.194 | -55.359 | 0.397 |
| I18-Avg. | | -7.882 | 0.19 | -55.232 | 0.417 |
| I19-1 | 4/25/14 | -7.8 | 0.178 | -54.897 | 0.38 |
| I19-2 | | -7.76 | 0.193 | -54.636 | 0.437 |
| I19-3 | | -7.745 | 0.188 | -54.676 | 0.464 |
| I19-Avg. | | -7.76833 | 0.186333 | -54.7363 | 0.427 |
| FA-1 | 3/9/15 | -9.199 | 0.19 | -66.256 | 0.418 |
| FA-2 | | -9.219 | 0.198 | -66.372 | 0.446 |
| FA-3 | | -9.23 | 0.194 | -66.531 | 0.435 |
| FA-Avg. | | -9.216 | 0.194 | -66.3863 | 0.433 |
| FA-1 | 3/16/15 | -10.13 | 0.187 | -73.469 | 0.4 |
| FA-2 | | -10.174 | 0.195 | -73.828 | 0.359 |
| FA-3 | | -10.167 | 0.198 | -73.846 | 0.433 |
| FA-Avg. | | -10.157 | 0.193333 | -73.7143 | 0.397333 |

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|---|---|---|---|---|---|
| I1-1 | 12/5/14 | -8.292 | 0.202 | -59.314 | 0.359 |
| I1-2 | | -8.314 | 0.199 | -59.27 | 0.402 |
| I1-3 | | -8.262 | 0.191 | -59.102 | 0.369 |
| I1-Avg. | | -8.28933 | 0.197333 | -59.2287 | 0.376667 |
| I2-1 | 12/6/14 | -8.131 | 0.175 | -58.523 | 0.302 |
| I2-2 | | -8.092 | 0.198 | -58.44 | 0.382 |
| I2-3 | | -8.132 | 0.206 | -58.438 | 0.347 |
| I2-Avg. | | -8.11833 | 0.193 | -58.467 | 0.343667 |
| I3-1 | 12/7/14 | -8.124 | 0.191 | -58.187 | 0.389 |
| I3-2 | | -8.121 | 0.202 | -58.277 | 0.397 |
| I3-3 | | -8.123 | 0.179 | -58.22 | 0.341 |
| I3-Avg. | | -8.12267 | 0.190667 | -58.228 | 0.375667 |
| I4-1 | 12/8/14 | -8.211 | 0.202 | -58.16 | 0.381 |
| I4-2 | | -8.214 | 0.226 | -58.249 | 0.37 |
| I4-3 | | -8.248 | 0.196 | -58.378 | 0.351 |
| I4-Avg. | | -8.22433 | 0.208 | -58.2623 | 0.367333 |
| I5-1 | 12/9/14 | -8.389 | 0.193 | -59.626 | 0.359 |
| I5-2 | | -8.299 | 0.18 | -59.502 | 0.393 |
| I5-3 | | -8.39 | 0.195 | -59.708 | 0.416 |
| I5-Avg. | | -8.35933 | 0.189333 | -59.612 | 0.389333 |
| BF190 water-1 | Standard 1 | -16.591 | 0.201 | -122.236 | 0.4 |
| BF190 water-2 | | -16.649 | 0.185 | -122.621 | 0.444 |
| BF190 water-3 | | -16.629 | 0.19 | -122.661 | 0.519 |
| BF190 water-Avg. | | -16.623 | 0.192 | -122.506 | 0.454333 |
| BH423 water-1 | Standard 2 | -10.787 | 0.192 | -75.534 | 0.37 |
| BH423 water-2 | | -10.846 | 0.2 | -75.729 | 0.39 |
| BH423 water-3 | | -10.784 | 0.182 | -75.529 | 0.374 |
| BH423 water-Avg. | | -10.8057 | 0.191333 | -75.5973 | 0.378 |
| KONA water-1 | Standard 3 | 0.345 | 0.185 | 2.198 | 0.406 |
| KONA water-2 | | 0.469 | 0.195 | 3.12 | 0.376 |
| KONA water-3 | | 0.397 | 0.186 | 2.647 | 0.424 |
| KONA water-Avg. | | 0.403667 | 0.188667 | 2.655 | 0.402 |

| April 3, 2015 Isco Automatic Sampler | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date Sampled | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| BF190 water-1 | Standard 1 | -16.559 | 0.2 | -122.702 | 0.457 |
| BF190 water-2 | | -16.585 | 0.202 | -122.884 | 0.407 |
| BF190 water-3 | | -16.554 | 0.189 | -122.727 | 0.454 |
| BF190 water-Avg. | | -16.566 | 0.197 | -122.771 | 0.439333 |
| BH423 water-1 | Standard 2 | -10.846 | 0.202 | -76.37 | 0.426 |
| BH423 water-2 | | -10.809 | 0.192 | -76.061 | 0.497 |
| BH423 water-3 | | -10.84 | 0.188 | -76.174 | 0.472 |
| BH423 water-Avg. | | -10.8317 | 0.194 | -76.2017 | 0.465 |

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| KONA water-1 | | 0.336 | 0.19 | 1.636 | 0.457 |
| KONA water-2 | Standard 3 | 0.371 | 0.195 | 1.814 | 0.448 |
| KONA water-3 | | 0.374 | 0.179 | 2.078 | 0.466 |
| KONA water-Avg. | | 0.360333 | 0.188 | 1.842667 | 0.457 |
| I6-1 | | -8.35 | 0.187 | -59.008 | 0.403 |
| I6-2 | 12/10/14 | -8.326 | 0.186 | -59.038 | 0.429 |
| I6-3 | | -8.361 | 0.206 | -59.177 | 0.407 |
| I6-Avg. | | -8.34567 | 0.193 | -59.0743 | 0.413 |
| I8-1 | | -8.424 | 0.213 | -59.853 | 0.413 |
| I8-2 | 12/12/14 | -8.438 | 0.197 | -59.898 | 0.431 |
| I8-3 | | -8.421 | 0.193 | -59.891 | 0.439 |
| I8-Avg. | | -8.42767 | 0.201 | -59.8807 | 0.427667 |
| I9-1 | | -8.377 | 0.196 | -59.302 | 0.452 |
| I9-2 | 12/13/14 | -8.408 | 0.183 | -59.408 | 0.437 |
| I9-3 | | -8.39 | 0.186 | -59.28 | 0.41 |
| I9-Avg. | | -8.39167 | 0.188333 | -59.33 | 0.433 |
| I10-1 | | -8.371 | 0.2 | -58.955 | 0.419 |
| I10-2 | 12/14/14 | -8.354 | 0.183 | -58.986 | 0.459 |
| I10-3 | | -8.339 | 0.191 | -58.922 | 0.454 |
| I10-Avg. | | -8.35467 | 0.191333 | -58.9543 | 0.444 |
| I11-1 | | -8.341 | 0.188 | -58.671 | 0.418 |
| I11-2 | 12/15/14 | -8.307 | 0.178 | -58.606 | 0.463 |
| I11-3 | | -8.323 | 0.186 | -58.568 | 0.409 |
| I11-Avg. | | -8.32367 | 0.184 | -58.615 | 0.43 |
| I12-1 | | -8.078 | 0.18 | -57.645 | 0.414 |
| I12-2 | 12/16/14 | -8.06 | 0.172 | -57.69 | 0.429 |
| I12-3 | | -8.057 | 0.197 | -57.616 | 0.427 |
| I12-Avg. | | -8.065 | 0.183 | -57.6503 | 0.423333 |
| I13-1 | | -8.476 | 0.194 | -58.591 | 0.419 |
| I13-2 | 12/17/14 | -8.457 | 0.199 | -58.59 | 0.434 |
| I13-3 | | -8.466 | 0.215 | -58.616 | 0.489 |
| I13-Avg. | | -8.46633 | 0.202667 | -58.599 | 0.447333 |
| F0-1 | | -8.597 | 0.191 | -58.411 | 0.379 |
| F0-2 | 3/7/14 | -8.56 | 0.173 | -58.445 | 0.453 |
| F0-3 | | -8.596 | 0.206 | -58.367 | 0.412 |
| F0-Avg. | | -8.58433 | 0.19 | -58.4077 | 0.414667 |
| F1-1 | | -8.489 | 0.195 | -59.672 | 0.451 |
| F1-2 | 3/7/14 | -8.464 | 0.186 | -59.671 | 0.472 |
| F1-3 | | -8.449 | 0.183 | -59.679 | 0.44 |
| F1-Avg. | | -8.46733 | 0.188 | -59.674 | 0.454333 |
| F2-1 | | -8.552 | 0.198 | -60.396 | 0.409 |
| F2-2 | 3/7/14 | -8.512 | 0.185 | -60.224 | 0.41 |
| F2-3 | | -8.591 | 0.192 | -60.538 | 0.46 |
| F2-Avg. | | -8.55167 | 0.191667 | -60.386 | 0.426333 |
| FA-1 | | -8.627 | 0.192 | -60.773 | 0.445 |
| FA-2 | 3/7/14 | -8.56 | 0.185 | -60.622 | 0.444 |
| FA-3 | | -8.656 | 0.185 | -60.879 | 0.451 |

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| FA-Avg. | | -8.61433 | 0.187333 | -60.758 | 0.446667 |
| F0-1 | 3/9/14 | -8.338 | 0.193 | -57.832 | 0.467 |
| F0-2 | | -8.323 | 0.204 | -57.998 | 0.422 |
| F0-3 | | -8.294 | 0.197 | -57.805 | 0.399 |
| F0-Avg. | | -8.31833 | 0.198 | -57.8783 | 0.429333 |
| F1-1 | 3/9/14 | -8.57 | 0.192 | -61.039 | 0.447 |
| F1-2 | | -8.546 | 0.194 | -60.98 | 0.414 |
| F1-3 | | -8.564 | 0.206 | -60.78 | 0.468 |
| F1-Avg. | | -8.56 | 0.183 | -60.933 | 0.437 |
| F2-1 | 3/9/14 | -8.744 | 0.19 | -61.665 | 0.447 |
| F2-2 | | -8.754 | 0.2 | -61.605 | 0.456 |
| F2-3 | | -8.764 | 0.191 | -61.572 | 0.446667 |
| F2-Avg. | | -8.754 | 0.183 | -61.614 | 0.437 |
| FA-1 | 3/9/14 | -8.56 | 0.197333 | -60.933 | 0.443 |
| FA-2 | | -8.677 | 0.19 | -61.677 | 0.461 |
| FA-3 | | -8.692 | 0.187 | -61.745 | 0.465 |
| FA-Avg. | | -8.666 | 0.188 | -61.624 | 0.421 |
| F0-1 | 3/12/14 | -11.064 | 0.212 | -79.044 | 0.473 |
| F0-2 | | -10.979 | 0.193 | -78.814 | 0.474 |
| F0-3 | | -11.015 | 0.179 | -78.793 | 0.414 |
| F0-Avg. | | -11.0193 | 0.194667 | -78.8837 | 0.453667 |
| F1-1 | 3/12/14 | -10.75 | 0.17 | -79.846 | 0.434 |
| F1-2 | | -10.762 | 0.188 | -79.699 | 0.44 |
| F1-3 | | -10.736 | 0.187 | -79.788 | 0.379 |
| F1-Avg. | | -10.7493 | 0.181667 | -79.7777 | 0.417667 |
| F2-1 | 3/12/14 | -10.436 | 0.182 | -77.274 | 0.452 |
| F2-2 | | -10.447 | 0.182 | -77.309 | 0.413 |
| F2-3 | | -10.479 | 0.192 | -77.395 | 0.437 |
| F2-Avg. | | -10.454 | 0.185333 | -77.326 | 0.434 |
| FA-1 | 3/12/14 | -10.578 | 0.201 | -78.895 | 0.438 |
| FA-2 | | -10.611 | 0.182 | -78.903 | 0.485 |
| FA-3 | | -10.595 | 0.19 | -78.94 | 0.431 |
| FA-Avg. | | -10.5947 | 0.191 | -78.9127 | 0.451333 |
| F0-1 | 3/15/14 | -12.133 | 0.187 | -89.596 | 0.405 |
| F0-2 | | -12.135 | 0.196 | -89.498 | 0.446 |
| F0-3 | | -12.141 | 0.187 | -89.54 | 0.411 |
| F0-Avg. | | -12.1363 | 0.19 | -89.5447 | 0.420667 |
| F1-1 | 3/15/14 | -10.5 | 0.176 | -77.558 | 0.458 |
| F1-2 | | -10.507 | 0.188 | -77.7 | 0.434 |
| F1-3 | | -10.456 | 0.182 | -77.553 | 0.44 |
| F1-Avg. | | -10.4877 | 0.182 | -77.6037 | 0.444 |
| F2-1 | 3/15/14 | -9.324 | 0.194 | -72.211 | 0.443 |
| F2-2 | | -9.296 | 0.2 | -72.123 | 0.432 |
| F2-3 | | -9.32 | 0.197 | -72.114 | 0.452 |
| F2-Avg. | | -9.31333 | 0.197 | -72.1493 | 0.442333 |
| FA-1 | 3/15/14 | -10.435 | 0.195 | -76.692 | 0.426 |
| FA-2 | | -10.455 | 0.2 | -76.663 | 0.421 |

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| FA-3 | | -10.472 | 0.208 | -76.712 | 0.427 |
| FA-Avg. | | -10.454 | 0.201 | -76.689 | 0.424667 |
| F3-1 | 3/15/14 | -10.756 | 0.188 | -78.046 | 0.484 |
| F3-2 | | -10.734 | 0.202 | -78.112 | 0.49 |
| F3-3 | | -10.768 | 0.183 | -78.286 | 0.484 |
| F3-Avg. | | -10.7527 | 0.191 | -78.148 | 0.486 |
| BF190 water-1 | Standard 1 | -16.538 | 0.186 | -122.186 | 0.46 |
| BF190 water-2 | | -16.588 | 0.166 | -122.354 | 0.439 |
| BF190 water-3 | | -16.553 | 0.184 | -122.353 | 0.428 |
| BF190 water-Avg. | | -16.5597 | 0.178667 | -122.298 | 0.442333 |
| BH423 water-1 | Standard 2 | -10.801 | 0.19 | -75.864 | 0.424 |
| BH423 water-2 | | -10.797 | 0.186 | -75.545 | 0.445 |
| BH423 water-3 | | -10.851 | 0.184 | -75.874 | 0.418 |
| BH423 water-Avg. | | -10.8163 | 0.186667 | -75.761 | 0.429 |
| KONA water-1 | Standard 3 | 0.354 | 0.183 | 1.928 | 0.513 |
| KONA water-2 | | 0.391 | 0.186 | 2.284 | 0.433 |
| KONA water-3 | | 0.452 | 0.196 | 2.6 | 0.494 |
| KONA water-Avg. | | 0.399 | 0.188333 | 2.270667 | 0.48 |

| April 4, 2015 Isco Automatic Sampler | | | | | |
|---|---|---|---|---|---|
| Sample ID | Date Sampled | d(18_16) | d(18_16)_Standard Deviation | d(D_H) | d(D_H)_Standard Deviation |
| BF190 water-1 | Standard 1 | -16.513 | 0.176 | -123.057 | 0.419 |
| BF190 water-2 | | -16.497 | 0.191 | -122.868 | 0.423 |
| BF190 water-3 | | -16.371 | 0.204 | -122.236 | 0.374 |
| BF190 water-Avg. | | -16.4603 | 0.190333 | -122.72 | 0.405333 |
| BH423 water-1 | Standard 2 | -10.706 | 0.18 | -76.193 | 0.388 |
| BH423 water-2 | | -10.706 | 0.21 | -76.009 | 0.411 |
| BH423 water-3 | | -10.755 | 0.193 | -75.905 | 0.411 |
| BH423 water-Avg. | | -10.7223 | 0.194333 | -76.0357 | 0.403333 |
| KONA water-1 | Standard 3 | 0.434 | 0.196 | 1.758 | 0.502 |
| KONA water-2 | | 0.401 | 0.199 | 1.847 | 0.442 |
| KONA water-3 | | 0.423 | 0.206 | 2.101 | 0.428 |
| KONA water-Avg. | | 0.419333 | 0.200333 | 1.902 | 0.457333 |
| SV631-1 | 4/7/15 | -8.889 | 0.199 | -59.986 | 0.391 |
| SV631-2 | | -8.966 | 0.186 | -60.125 | 0.364 |
| SV631-3 | | -8.984 | 0.19 | -60.597 | 0.401 |
| SV631-Avg. | | -8.94633 | 0.191667 | -60.236 | 0.385333 |
| B.B.Spring-1 | 4/7/15 | -7.375 | 0.18 | -51.86 | 0.399 |
| B.B.Spring-2 | | -7.366 | 0.177 | -51.791 | 0.415 |
| B.B.Spring-3 | | -7.297 | 0.184 | -51.428 | 0.354 |
| B.B.Spring-Avg. | | -7.346 | 0.180333 | -51.693 | 0.389333 |
| WK947-1 | 4/2/15 | -8.447 | 0.196 | -57.333 | 0.425 |

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|---|---|---|---|---|---|
| WK947-2 | | -8.425 | 0.191 | -57.389 | 0.415 |
| WK947-3 | | -8.392 | 0.205 | -57.245 | 0.41 |
| WK947-Avg. | | -8.42133 | 0.197333 | -57.3223 | 0.416667 |
| RL255-1 | 4/2/15 | -8.801 | 0.188 | -59.109 | 0.439 |
| RL255-2 | | -8.734 | 0.174 | -58.819 | 0.365 |
| RL255-3 | | -8.792 | 0.178 | -58.984 | 0.403 |
| RL255-Avg. | | -8.77567 | 0.18 | -58.9707 | 0.402333 |
| RL256-1 | 4/2/15 | -8.676 | 0.197 | -58.025 | 0.431 |
| RL256-2 | | -8.64 | 0.184 | -58.109 | 0.406 |
| RL256-3 | | -8.645 | 0.18 | -58.021 | 0.397 |
| RL256-Avg. | | -8.65367 | 0.187 | -58.0517 | 0.411333 |
| Fox0-1 | 4/8/15 | -8.327 | 0.197 | -57.766 | 0.398 |
| Fox0-2 | | -8.351 | 0.189 | -57.757 | 0.445 |
| Fox0-3 | | -8.325 | 0.191 | -57.869 | 0.407 |
| Fox0-Avg. | | -8.33433 | 0.192333 | -57.7973 | 0.416667 |
| Fox1-1 | 4/8/15 | -8.153 | 0.179 | -56.529 | 0.385 |
| Fox1-2 | | -8.112 | 0.18 | -56.251 | 0.401 |
| Fox1-3 | | -8.134 | 0.175 | -56.278 | 0.414 |
| Fox1-Avg. | | -8.133 | 0.178 | -56.3527 | 0.4 |
| Fox2-1 | 4/8/15 | -8.435 | 0.199 | -58.143 | 0.401 |
| Fox2-2 | | -8.381 | 0.219 | -58.03 | 0.383 |
| Fox2-3 | | -8.465 | 0.193 | -58.43 | 0.41 |
| Fox2-Avg. | | -8.427 | 0.203667 | -58.201 | 0.398 |
| FoxA-1 | 4/9/15 | -5.965 | 0.184 | -35.608 | 0.424 |
| FoxA-2 | | -5.942 | 0.188 | -35.374 | 0.449 |
| FoxA-3 | | -5.967 | 0.174 | -35.649 | 0.425 |
| FoxA-Avg. | | -5.958 | 0.182 | -35.5437 | 0.432667 |
| Fox3-1 | 4/7/15 | -8.243 | 0.184 | -58.442 | 0.398 |
| Fox3-2 | | -8.213 | 0.168 | -58.228 | 0.414 |
| Fox3-3 | | -8.244 | 0.207 | -58.367 | 0.445 |
| Fox3-Avg. | | -8.23333 | 0.186333 | -58.3457 | 0.419 |
| RootR-1 | 4/7/15 | -8.646 | 0.186 | -61.052 | 0.396 |
| RootR-2 | | -8.573 | 0.182 | -60.969 | 0.381 |
| RootR-3 | | -8.633 | 0.215 | -60.978 | 0.393 |
| RootR-Avg. | | -8.61733 | 0.194333 | -60.9997 | 0.39 |
| UnderwoodCreek-1 | 4/8/15 | -7.017 | 0.164 | -43.693 | 0.398 |
| UnderwoodCreek-2 | | -6.959 | 0.206 | -43.399 | 0.384 |
| UnderwoodCreek-3 | | -6.91 | 0.209 | -43.316 | 0.418 |
| UnderwoodCreek-Avg. | | -6.962 | 0.193 | -43.4693 | 0.4 |
| SussexCreek-1 | 4/8/15 | -8.236 | 0.206 | -54.599 | 0.404 |
| SussexCreek-2 | | -8.23 | 0.206 | -54.666 | 0.38 |
| SussexCreek-3 | | -8.247 | 0.206 | -54.719 | 0.379 |
| SussexCreek-Avg. | | -8.23767 | 0.206 | -54.6613 | 0.387667 |
| Wauk.WWTP-1 | 4/2/15 | -10.258 | 0.182 | -72.917 | 0.402 |

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| Wauk.WWTP-2 | | -10.36 | 0.198 | -73.368 | 0.396 |
| Wauk.WWTP-3 | | -10.301 | 0.177 | -73.034 | 0.341 |
| Wauk.WWTP-Avg. | | -10.3063 | 0.185667 | -73.1063 | 0.379667 |
| SussexWWTP-1 | 4/8/15 | -9.569 | 0.199 | -67.734 | 0.382 |
| SussexWWTP-2 | | -9.606 | 0.192 | -67.826 | 0.397 |
| SussexWWTP-3 | | -9.637 | 0.2 | -67.876 | 0.4 |
| SussexWWTP-Avg. | | -9.604 | 0.197 | -67.812 | 0.393 |
| BF190 water-1 | Standard 1 | -16.396 | 0.203 | -121.457 | 0.427 |
| BF190 water-2 | | -16.402 | 0.204 | -121.609 | 0.473 |
| BF190 water-3 | | -16.45 | 0.191 | -122.017 | 0.371 |
| BF190 water-Avg. | | -16.416 | 0.199333 | -121.694 | 0.423667 |
| BH423 water-1 | Standard 2 | -10.647 | 0.199 | -75.33 | 0.386 |
| BH423 water-2 | | -10.68 | 0.167 | -75.239 | 0.446 |
| BH423 water-3 | | -10.672 | 0.196 | -75.085 | 0.409 |
| BH423 water-Avg. | | -10.6663 | 0.187333 | -75.218 | 0.413667 |
| KONA water-1 | Standard 3 | 0.455 | 0.191 | 2.286 | 0.431 |
| KONA water-2 | | 0.435 | 0.209 | 2.454 | 0.391 |
| KONA water-3 | | 0.464 | 0.182 | 2.471 | 0.451 |
| KONA water-Avg. | | 0.451333 | 0.194 | 2.403667 | 0.424333 |

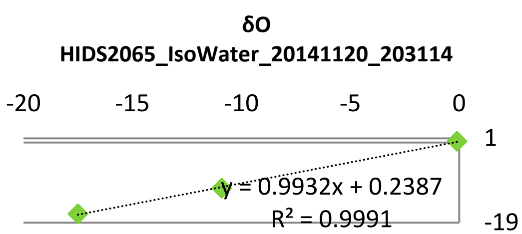
# 6. Stable Isotope Calibration

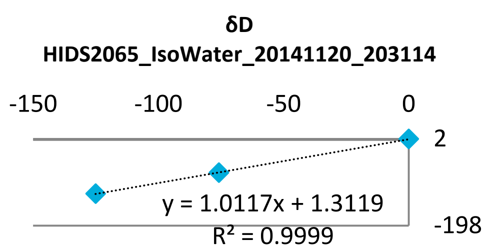
| Known Standards Values | O | D |
|---|---|---|
| Green Bay | -17.5 | -125 |
| Pewaukee | -10.9 | -75.8 |
| Kona | -0.1 | 0 |

| Correction | | |
|---|---|---|
| | 0.2387 | 1.3119 |

HIDS2065_IscoWater_20141120_203114

| Time | GB | d(18_16)Mean | d(D_H)Mean |
|---|---|---|---|
| 2014/11/20 15:28:08 | bf190 | -16.9557 | -124.663 |
| 2014/11/20 16:31:15 | DNR BH423 | -10.8877 | -76.1823 |
| 2014/11/20 17:34:25 | Kona Water | 0.253333 | 1.629333 |

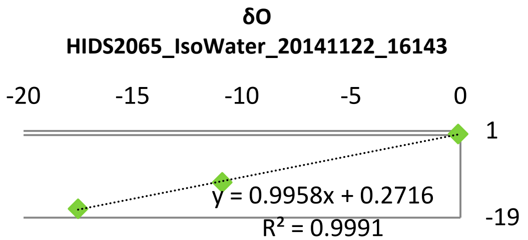


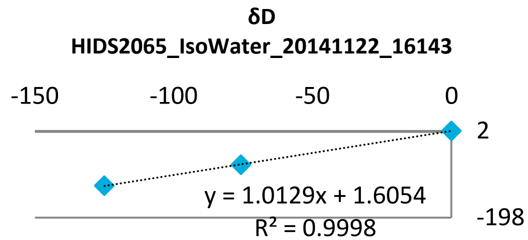




| Correction | | |
|---|---|---|
| | 0.2716 | 1.6054 |

HIDS2065_IsoWater_20141122_163143

| Time | GB | d(18_16)Mean | d(D_H)Mean |
|---|---|---|---|
| 2014/11/22 11:28:41 | bf190 | -16.971 | -124.426 |
| 2014/11/22 12:31:53 | DNR BH423 | -10.8773 | -76.1193 |
| 2014/11/22 13:35:06 | Kona Water | 0.284 | 1.979333 |

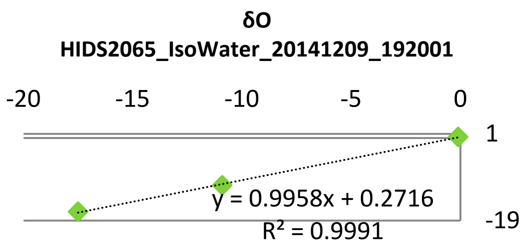


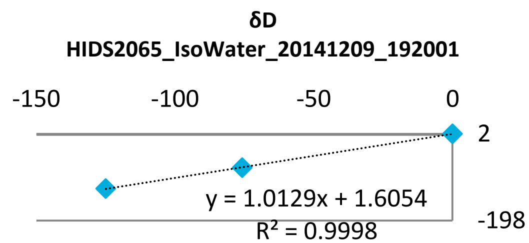




HIDS2065_IsoWater_20141209_192001

| Correction | |
|---|---|
| 0.3455 | 1.6483 |

| Time | GB | d(18_16)Mean | d(D_H)Mean |
|---|---|---|---|
| 2014/12/09 14:20:15 | bf190 | -16.7847 | -123.492 |
| 2014/12/09 15:29:02 | DNR BH423 | -10.7413 | -75.5863 |
| 2014/12/09 16:37:47 | Kona Water | 0.360667 | 2.036667 |

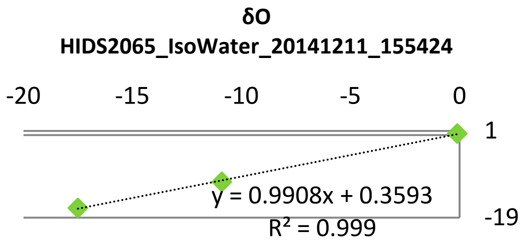


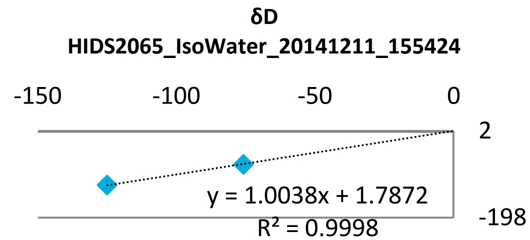




HIDS2065_IsoWater_20141211_155424

| Correction | |
|---|---|
| 0.3593 | 1.7872 |

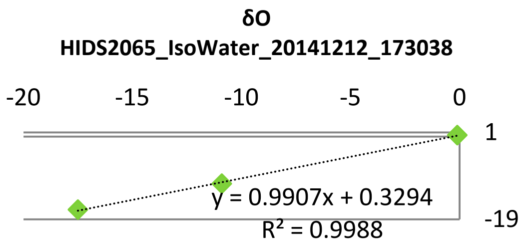
| Time | GB | d(18_16)Mean | d(D_H)Mean |
|---|---|---|---|
| 2014/12/11 10:56:21 | bf190 | -16.786 | -123.006 |
| 2014/12/11 12:05:06 | DNR BH423 | -10.754 | -75.4133 |
| 2014/12/11 13:13:49 | Kona Water | 0.379 | 2.226333 |

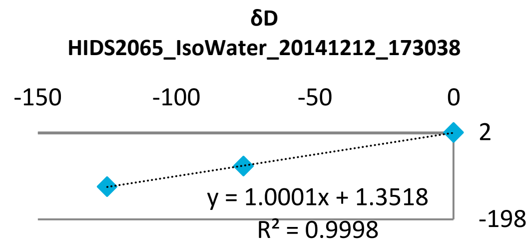


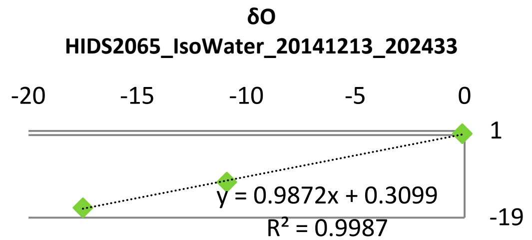

| HIDS2065_IsoWater_20141212_173038 | | Correction | |
|---|---|---|---|
| | | 0.3294 | 1.3518 |
| Time | | d(18_16)Mean | d(D_H)Mean |
| | GB | | |
| 2014/12/12 12:39:51 | bf190 | -16.796 | -122.979 |
| 2014/12/12 13:48:39 | DNR BH423 | -10.81 | -75.574 |
| 2014/12/12 14:57:27 | Kona Water | 0.359667 | 1.792667 |

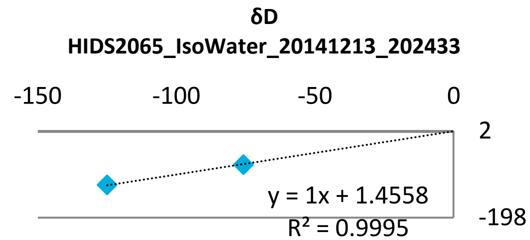





| HIDS2065_IsoWater_20141213_202433 | | Correction | |
|---|---|---|---|
| | | 0.3099 | 1.4558 |
| Time | | d(18_16)Mean | d(D_H)Mean |
| | GB | | |
| 2014/12/13 15:26:01 | bf190 | -16.7417 | -122.613 |
| 2014/12/13 16:34:46 | DNR BH423 | -10.8133 | -75.8767 |
| 2014/12/13 17:43:34 | Kona Water | 0.348667 | 2.059333 |

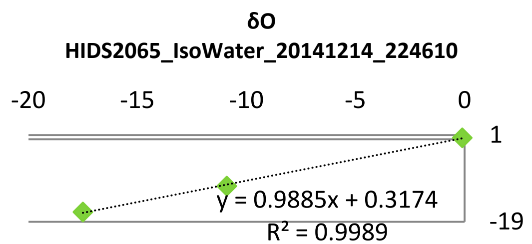


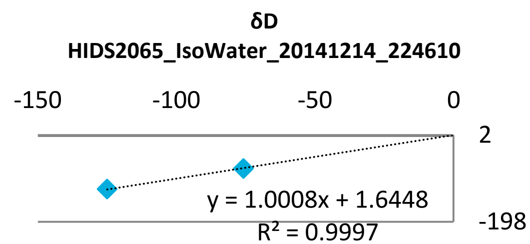




| Correction | |
|---|---|
| 0.3174 | 1.6448 |

HIDS2065_IsoWater_20141214_224610

| Time | GB | d(18_16)Mean | d(D_H)Mean |
|---|---|---|---|
| 2014/12/14 17:58:35 | bf190 | -16.7733 | -122.743 |
| 2014/12/14 19:07:20 | DNR BH423 | -10.791 | -75.3853 |
| 2014/12/14 20:16:07 | Kona Water | 0.345333 | 2.105667 |

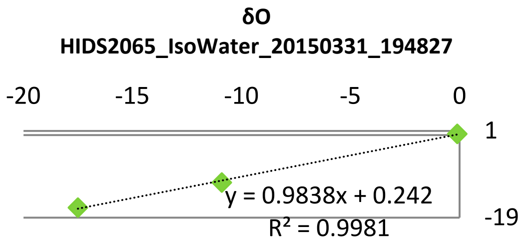


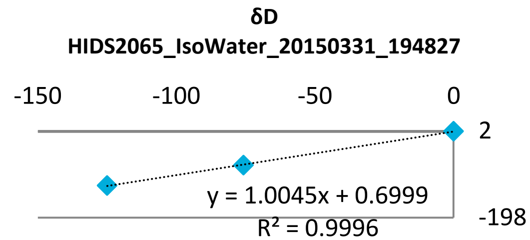




| Correction | |
|---|---|
| 0.242 | 0.6999 |

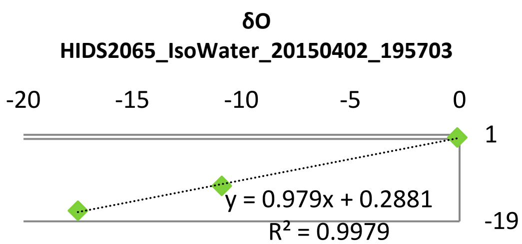
HIDS2065_IsoWater_20150331_194827

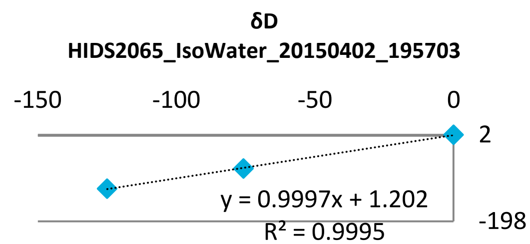
| Time | GB | d(18_16)Mean | d(D_H)Mean |
|---|---|---|---|
| 2015/03/31 14:54:26 | bf190 | -16.7053 | -123.977 |
| 2015/03/31 15:58:51 | DNR BH423 | -10.916 | -76.9117 |
| 2015/03/31 17:03:19 | Kona Water | 0.308333 | 1.277667 |




| HIDS2065_IsoWater_20150402_195703 | | Correction | |
|---|---|---|---|
| | | 0.2881 | 1.202 |
| Time | GB | d(18_16)Mean | d(D_H)Mean |
| 2015/04/02 15:03:03 | bf190 | -16.566 | -122.771 |
| 2015/04/02 16:07:27 | DNR BH423 | -10.8317 | -76.2017 |
| 2015/04/02 17:11:52 | Kona Water | 0.360333 | 1.842667 |



# Appendix C:
# PHREEQC Modeling data

1. Inverse Modeling Input Files

**RL255**

```
SOLUTION 1 Pristine Groundwater(April 16, 2010- July 23,2015)
    temp      10
    pH        7.09
    pe        8.4
    redox     pe
    units     mmol/kgw
    density   1
    Alkalinity 6.42
    Ca        2.41
    Cl        2.34
    K         0.07
    Mg        2.27
    Na        1.61
    S         1.10
    -water    1 # kg
SOLUTION 2 infilling Isco& Fox2(2014 April-Dec., pH from Fox 2 4/07-10/14)
    temp      10
    pH        7.86
    pe        8.4
    redox     pe
    units     mmol/kgw
    density   1
    Alkalinity 4.59
    Ca        2.03
    Cl        7.43
    K         0.12
    Mg        1.58
    Na        6.22
    S         0.63
    -water    1 # kg
SOLUTION 3 Final RL255 May2014-July2015
    temp      10
    pH        6.96
    pe        8.4
    redox     pe
    units     mmol/kgw
    density   1
    Alkalinity 7.05
    Ca        2.77
    Cl        5.34
    K         0.09
    Mg        2.28
    Na        4.35
    S         0.73
    -water    1 # kg
EXCHANGE 1
    X       42
    -equilibrate with solution 3
    -pitzer_exchange_gammas true
INVERSE_MODELING 1 Finding Mixing Ratio of Fox River & Aquifer Water
    -solutions      1        2        3
    -uncertainty    0.1      0.1      0.1
    -phases
        Calcite
```

```
        Dolomite
        CO2(g)
    -balances
        Cl          0.03     0.03     0.03
        K           0.2      0.2      0.2
        S           0.1      0.1      0.1
        Na          0.1      0.1      0.1
    -range              1000
    -tolerance          1e-10
    -mineral_water      true
SELECTED_OUTPUT 1
    -file                  C:\Users\LFS\Desktop\Working RBI
Project\PHREEQC\Working Files
(615)\Inverse\(11.13.15)RL255RealInverseModel.xslx.sel
    -totals                Alkalinity  Ca  Cl  K  Mg  Na
    -molalities            CaCO3  CO2  MgCO3
    -activities            NaX
    -saturation_indices    Calcite  Dolomite  CO2(g)
    -gases                 CO2(g)
    -inverse_modeling      true

END
```

**RL256**

```
SOLUTION 1 Pristine Groundwater(April 16, 2010- July 23,2015)
    temp      10
    pH        7.09
    pe        8.4
    redox     pe
    units     mmol/kgw
    density   1
    Alkalinity 6.42
    Ca        2.41
    Cl        2.34
    K         0.07
    Mg        2.27
    Na        1.61
    S         1.10
    -water    1 # kg
SOLUTION 2 infilling Isco& Fox2(2014 April-Dec., pH from Fox 2 4/07-10/14)
    temp      10
    pH        7.86
    pe        8.4
    redox     pe
    units     mmol/kgw
    density   1
    Alkalinity 4.59
    Ca        2.03
    Cl        7.43
    K         0.12
    Mg        1.58
    Na        6.22
    S         0.63
    -water    1 # kg
SOLUTION 3 Final RL256 April2010-June2012
    temp      10
```

```
    pH        6.88
    pe        8.4
    redox     pe
    units     mmol/kgw
    density   1
    Alkalinity 6.66
    Ca        2.63
    Cl        4.09
    K         0.06
    Mg        2.20
    Na        2.89
    S         0.93
    -water    1 # kg
EXCHANGE 1
    X       30
    -equilibrate with solution 3
    -pitzer_exchange_gammas false
INVERSE_MODELING 1 Finding Mixing Ratio of Fox River & Aquifer Water
    -solutions      1        2        3
    -uncertainty    0.1      0.1      0.1
    -phases
        Calcite
        Dolomite
        CO2(g)
    -balances
        Cl          0.03     0.03     0.03
        K           0.2      0.2      0.2
        S           0.2      0.1      0.2
        Na          0.1      0.1      0.1
    -range             1000
    -tolerance         1e-10
    -mineral_water     true
SELECTED_OUTPUT 1
    -file                 C:\Users\LFS\Desktop\Working RBI
Project\PHREEQC\Working Files (615)\RL256InverseModel(Nov.13.15).sel
    -totals               Alkalinity  Ca  Cl  K  Mg  Na
    -molalities           CaCO3  CO2  MgCO3
    -saturation_indices   Calcite  Dolomite  CO2(g)
    -gases                CO2(g)
    -inverse_modeling     true
END
```

# Appendix D:

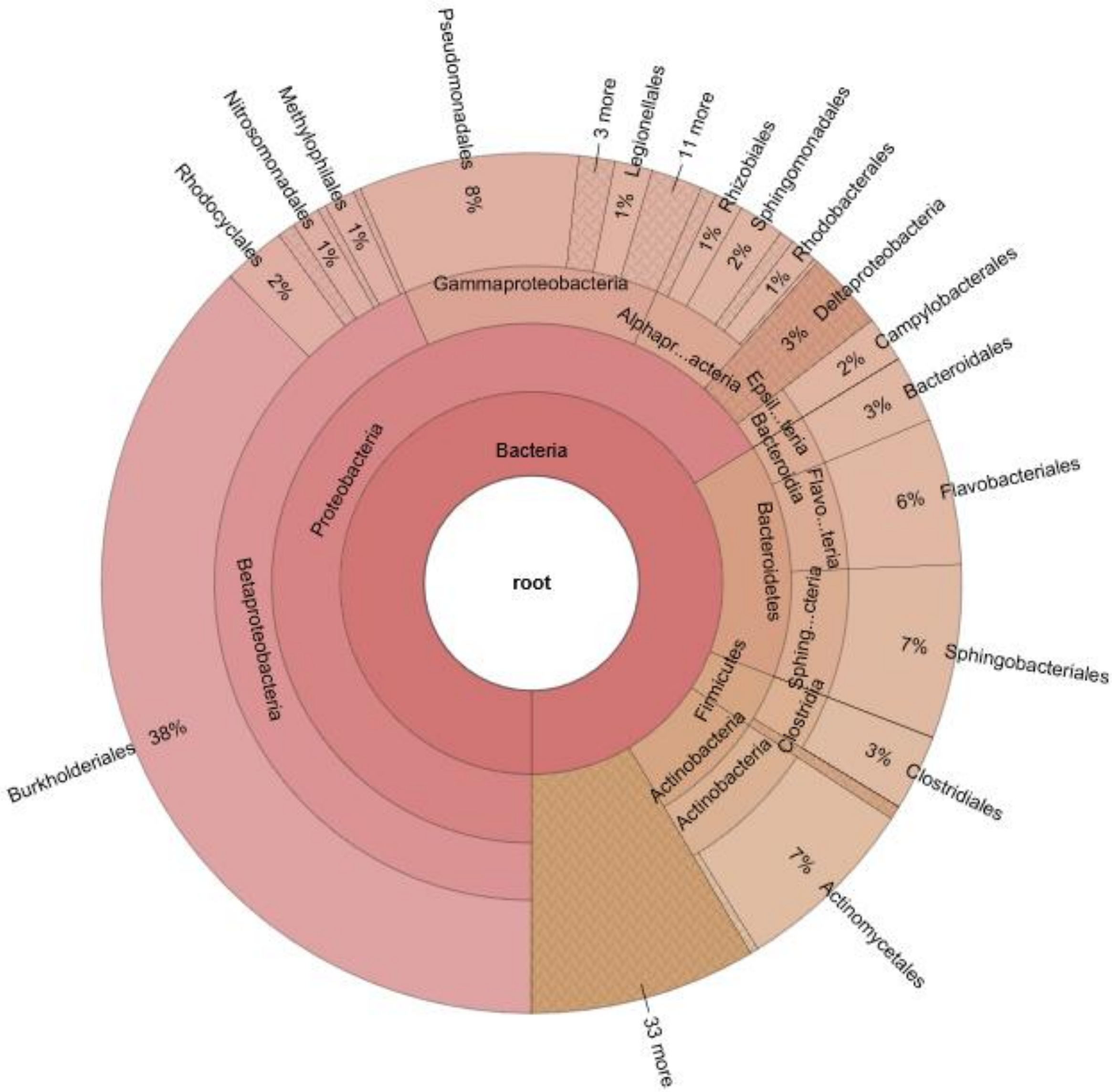
# 16s rRNA Squencing

Not enough RNA was present in the RL255 and WK947 samples for amplification. Future sampling for this method at these sites should be run with 5L per filter. The sequence counts for Brookfield WWTP were an order of magnitude lower than all of the other samples, though the community patterns were on par with the other WWTP samples. Fox 2 was had the most different microbial community of the samples taken, with the least amount of community diversity, which may be a fluke in sampling or filtering technique. All three of the WWTPs were not treating with chlorine or UV light at the time of sampling, so it was not due to die off from WWTP treatment, but may be due to the interaction between the river and WWTP microbial communities. There were no patterns indicating flow from the WWTPs into the river and then into the wells.

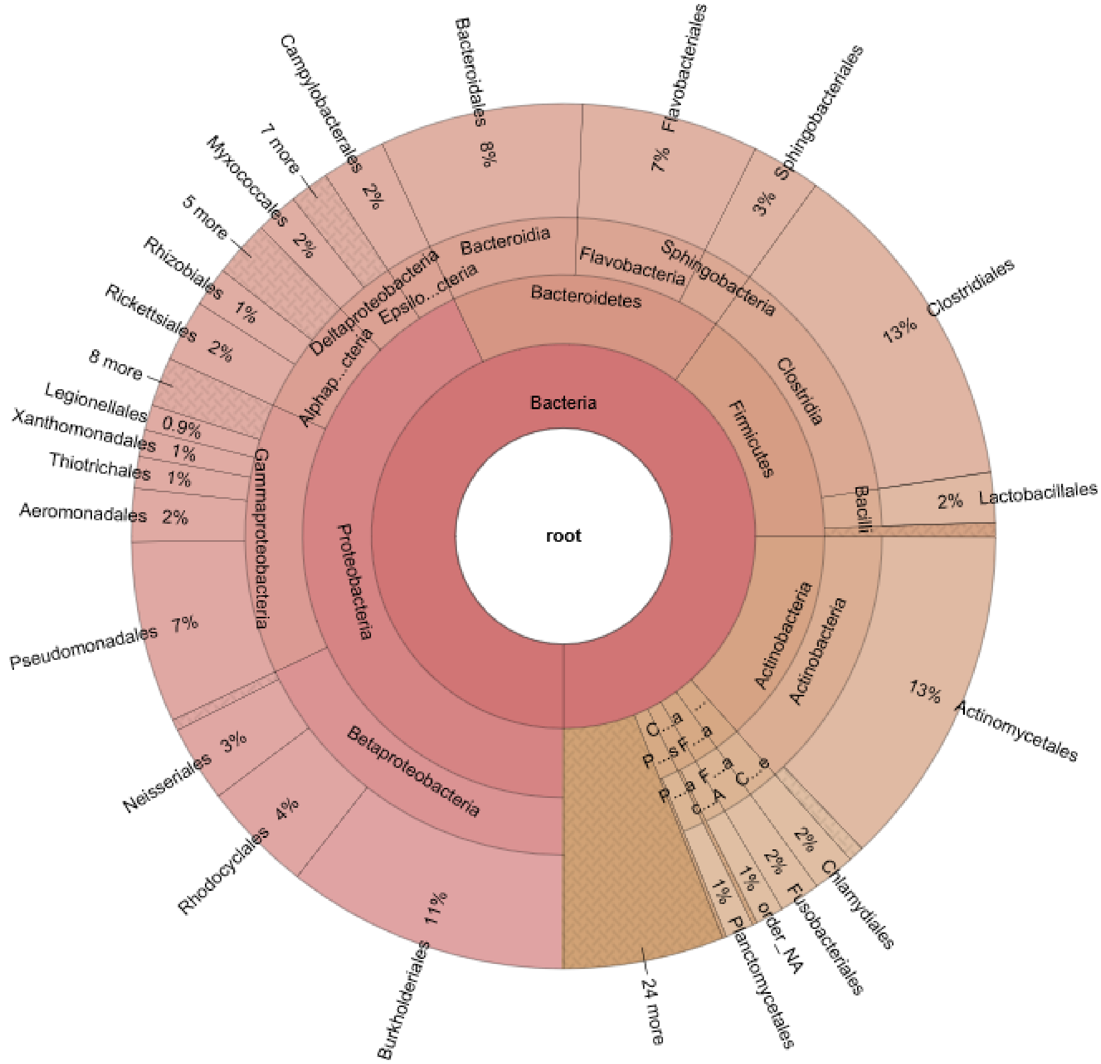
Potential tracers and counts from 16s RNA sequencing

| Taxa | RL256 | | Fox0 | | Fox2 | | B-WWTP | | S-WWTP | | W-WWTP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Count | % | Count | % | Count | % | Count | % | Count | % | Count | % |
| Rhodobacter | 10 | 0.01 | 768 | 0.76 | 556 | 0.68 | 19 | 0.3 | 215 | 0.23 | 362 | 0.44 |
| Rickettsiales | 101 | 0.3 | 604 | 0.6 | 395 | 0.48 | 145 | 2.31 | 2,880 | 3.07 | 4,661 | 5.65 |
| Sphingomonadaceae | 109 | 0.14 | 1,549 | 1.53 | 553 | 0.68 | 34 | 0.54 | 2,253 | 2.4 | 1,890 | 2.29 |
| Rhodoferax | 334 | 261 | 7,553 | 0.748 | 4,125 | 5.04 | 106 | 1.69 | 1,051 | 1.12 | 780 | 0.95 |
| Hydrogenophilaceae | 19,535 | 25.02 | 313 | 0.31 | 43 | 0.05 | 7 | 0.11 | 55 | 0.06 | 42 | 0.05 |
| Neisseriaceae | 33 | 0.04 | 674 | 0.67 | 344 | 0.42 | 179 | 2.85 | 3762 | 4.01 | 4,280 | 5.19 |
| Rhodocyclales | 8,398 | 10.75 | 2,394 | 2.37 | 443 | 0.54 | 261 | 4.16 | 4,868 | 5.18 | 1,021 | 1.24 |
| Zooglea | 12 | 0.02 | 3 | 0.002 | 28 | 0.03 | 164 | 2.62 | 47 | 0.05 | 142 | 0.17 |
| Bacteriovoraceae | 105 | 0.13 | 3,370 | 0.33 | 68 | 0.08 | 12 | 0.19 | 755 | 0.8 | 1,127 | 1.37 |
| Legionella | 280 | 0.36 | 665 | 0.65 | 229 | 0.28 | 51 | 0.8 | 15,370 | 16.34 | 5,037 | 6.09 |
| Acinetobacter | 9 | 0.01 | 7,843 | 7.77 | 52 | 0.06 | 269 | 4.29 | 917 | 0.98 | 816 | 0.99 |
| Planctomyces | 171 | 0.22 | 158 | 0.16 | 56 | 0.07 | 22 | 0.35 | 682 | 0.73 | 1,067 | 1.29 |

**Fox 0**
Percent of Orders Present in Samples from 16s rRNA Sequencing

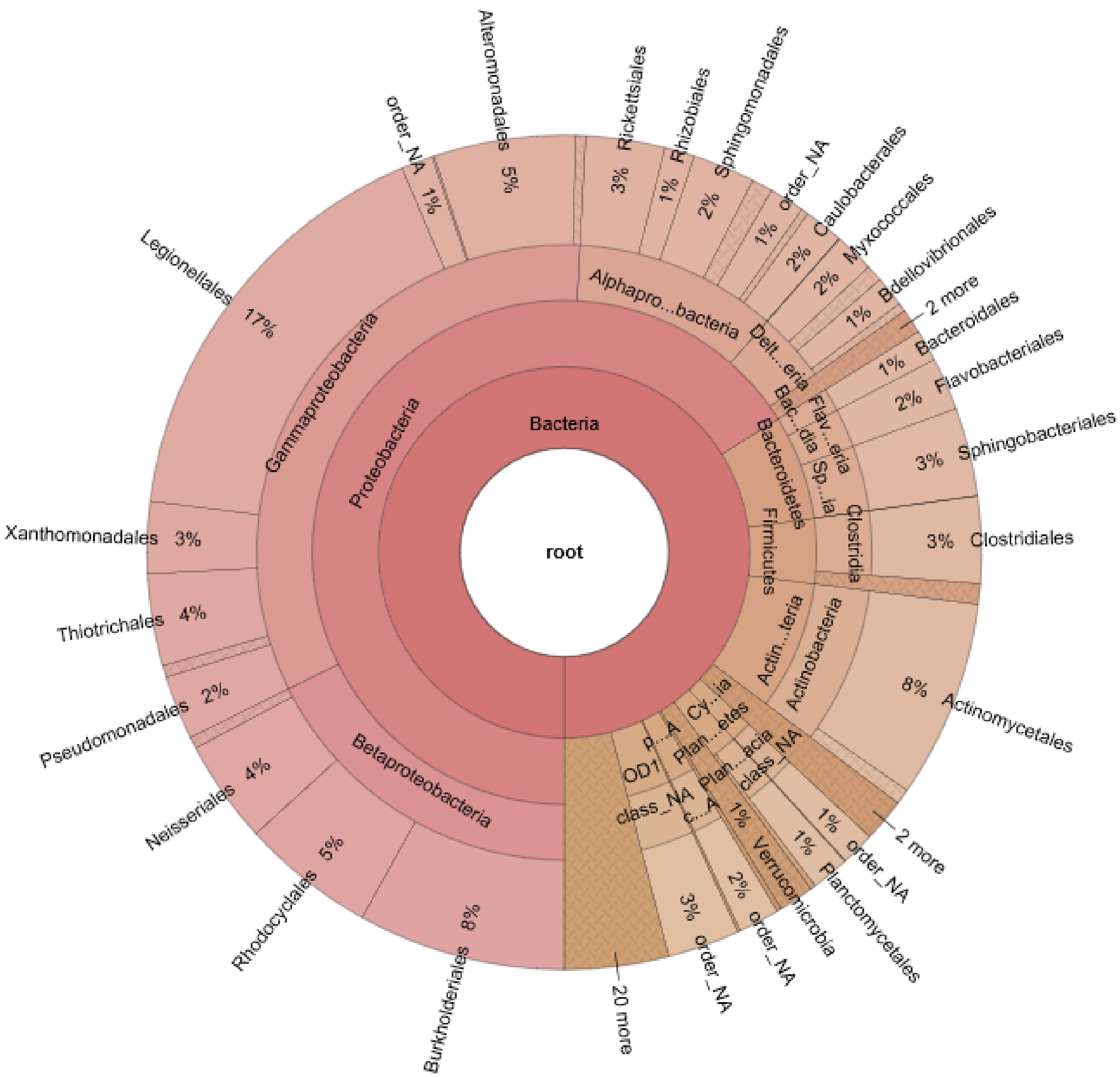


**Brookfield WWTP**
Percent of Orders Present in Samples from 16s rRNA Sequencing



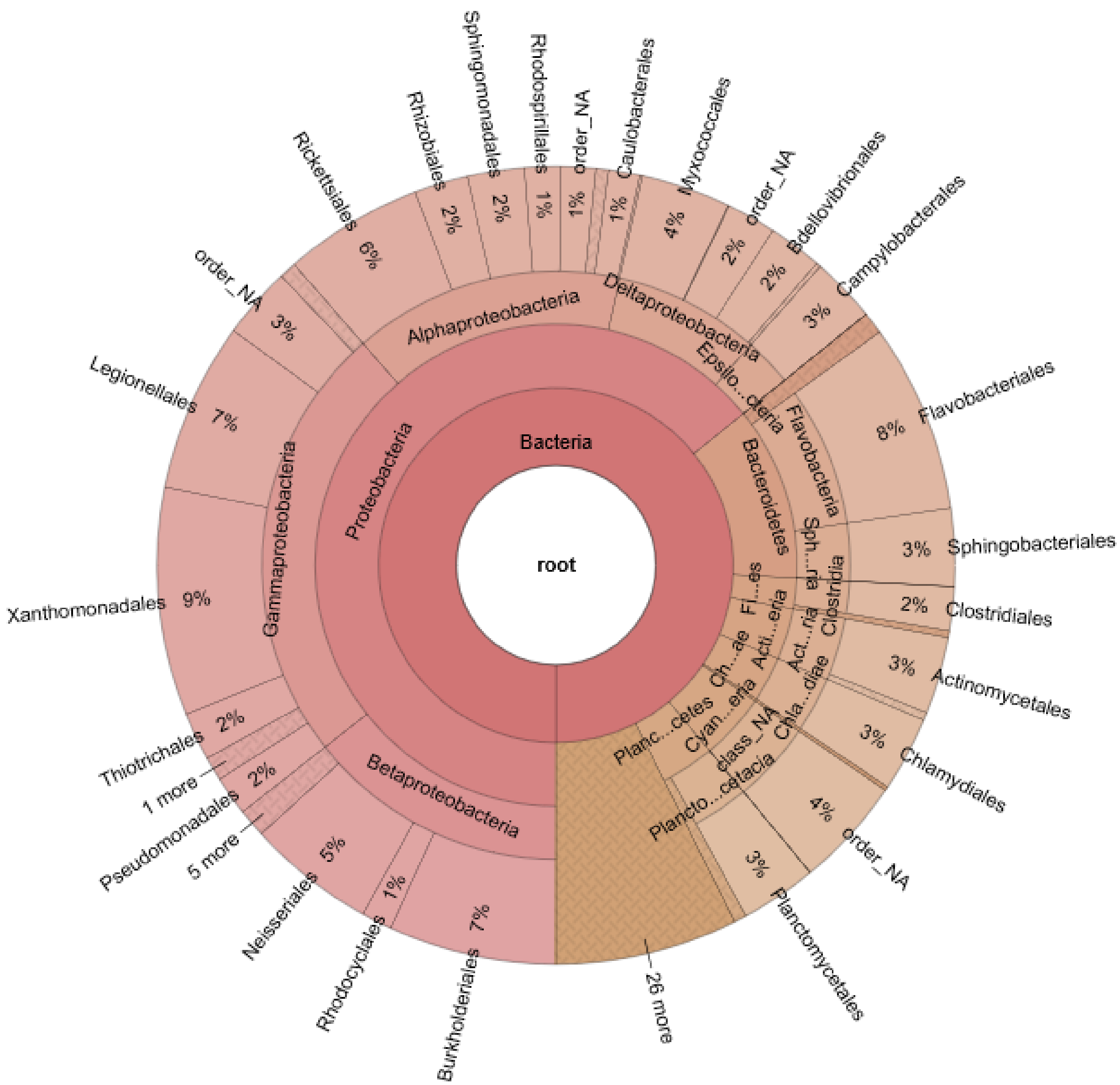
**Sussex WWTP**

Percent of Orders Present in Samples from 16s rRNA Sequencing



## Waukesha WWTP

Percent of Orders Present in Samples from 16s rRNA Sequencing



**Fox 2**

Percent of Orders Present in Samples from 16s rRNA Sequencing

## RL256

Percent of Orders Present in Samples from 16s rRNA Sequencing