PH REPORT
WHITE MESA URANIUM MILL

Blanding, Utah

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EXECUTIVE SUMMARY

This Report addresses the dual exceedances of pH in 11 of the groundwater monitoring wells at the White Mesa Mill (the "Mill"), and investigates the overall decreasing trend in pH that has been observed across the site. The purpose of this investigation is to determine whether the decline in pH in groundwater wells is the result of natural phenomenon unrelated to Mill operations, and to propose revised Groundwater Compliance Limits ("GWCLs") for pH in all compliance monitoring wells at the site where appropriate.

Given the recent analyses in the Background Reports, the Source Assessment Report (SAR) and other recent analyses and investigations at the site, Energy Fuels Resources (USA) Inc. ("EFRI") believes that the general decline in pH observed across the site are due to background influences, including increasing water levels and the possible oxidation of pyrite (or other sulfides). Pyrite has been noted and confirmed by laboratory observation and/or analysis in nearly all boring logs for wells at the site. This hypothesis is being tested by Hydro Geo Chem, Inc. (HGC) and a report will be submitted under separate cover. EFRI has concluded that all of the dual exceedances for pH at the Mill site are therefore due to natural background influences and/or the fact that the GWCLs for pH have incorrectly been set based on laboratory pH rather than field pH data.

All wells at the site were subjected to statistical analysis according to the Flowsheet, which was developed to handle statistics in accordance with the U.S. Environmental Protection Agency's Unified Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (2009). Nearly all groundwater monitoring wells and chloroform wells at the site show a decline in pH. The few wells that do not have decreasing trends are pumping wells, which are being manipulated and the impact on the quality of the water in those wells from the pumping is unclear, and nitrate wells, which are newer and have fewer data points. Groundwater monitoring wells with dual exceedances in any constituent were also analyzed for pH decreases and indicator parameter trends. The results of the statistical analysis for pH in groundwater monitoring wells are consistent with previously submitted reports. The decline in pH across the site cannot be attributed to Mill activity, as demonstrated by the indicator parameter analysis.

Revised GWCLs for field pH are proposed for all compliance monitoring wells at the site other than pumping wells and upgradient wells, for which EFRI proposes that all GWCLs be eliminated from the Mill's Groundwater Discharge GWDP.

EFRI maintains that GWCLs for pH in all monitoring wells that have decreasing trends, resulting from background influences, should be revised regularly, as is recommended by the United States Environmental Protection Agency's Unified Guidance (USEPA, 2009), to account for the trends and to minimize unwarranted out-of-compliance status in such wells.

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ABBREVIATIONS AND ACRONYMS

Denison	Denison Mines (USA) Corp.
Director	Director of the Utah Division of Radiation Control
DRC	Division of Radiation Control
EFRI	Energy Fuels Resources (USA) Inc.
EPA	United States Environmental Protection Agency
GWCL	Groundwater Compliance Limit
GWDP	State of Utah Ground Water Discharge Permit GWDP UGW370004
HGC	Hydro Geo Chem
INTERA	INTERA Incorporated
mean - 2σ	mean minus two sigma
mg/L	milligrams per liter
Mill	White Mesa Uranium Mill
Report	pH Report
SAR	Source Assessment Report
s.u.	standard units

1.0 INTRODUCTION

Energy Fuels Resources (USA) Inc. ("EFRI") (formerly named Denison Mines (USA) Corp. ["Denison"]) operates the White Mesa Uranium Mill (the "Mill"), located near Blanding, Utah (Figure 1), under State of Utah Groundwater Discharge Permit GWDP UGW370004 (the "GWDP"). This document is a pH Report ("Report") required under Part I.G.4 of the GWDP relating to violations of Part I.G.2 of the GWDP.

This Report addresses the dual exceedances of pH in 11 of the groundwater monitoring wells at the Mill, and investigates the overall decreasing trend in pH that has been observed across the site (Table 1) (Figure 2). The purpose of this investigation is to determine whether the decline in pH in groundwater wells is the result of natural phenomenon unrelated to Mill operations, and to propose revised Groundwater Compliance Limits ("GWCLs") for all compliance monitoring wells at the site. Figure 3 presents spatial distribution of pH in all wells at the site.

EFRI has recently completed a Source Assessment Report ("SAR") to address analytes other than pH that have been out of compliance. The SAR was submitted October 10, 2012, and is currently being reviewed by the Director (the "Director") of the Utah Division of Radiation Control ("DRC") (the Director was formerly the Executive Secretary of the Utah Radiation Control Board and the Co-Executive Secretary of the Utah Water Quality Board).

Part I.G.2 of the GWDP provides that out-of-compliance status exists when the concentration of a constituent in two consecutive samples from a compliance monitoring point exceeds a GWCL in Table 2 of the GWDP. The GWDP was originally issued in March 2005, at which time GWCLs were set on an interim basis, based on fractions of State of Utah Ground Water Quality Standards ("GWQSs") or the equivalent, without reference to natural background at the Mill site. The GWDP also required that EFRI prepare a background groundwater quality report to evaluate all historical data for the purposes of establishing background groundwater quality at the site and developing GWCLs under the GWDP. As required by then Part I.H.3 of the GWDP, EFRI submitted the following to the Director:

- A Revised Background Groundwater Quality Report: Existing Wells for Denison Mines (USA) Corp.'s Mill Site, San Juan County, Utah, October 2007, prepared by INTERA Incorporated (the "Existing Wells Background Report").
- A Revised Addendum: Evaluation of Available Pre-Operational and Regional Background Data, Background Groundwater Quality Report: Existing Wells for Denison Mines (USA) Corp.'s Mill Site, San Juan County, Utah, November 16, 2007, prepared by INTERA Incorporated (the "Regional Background Report").

- A Revised Addendum: Background Groundwater Quality Report: New Wells for Denison Mines (USA) Corp.'s Mill Site, San Juan County, Utah, April 30, 2008, prepared by INTERA Incorporated (the "New Wells Background Report," and together with the "Existing Wells Background Report" and the "Regional Background Report," the "Background Reports").

Based on a review of the Background Reports and other information and analyses, the Director re-opened the GWDP and modified the GWCLs to be equal to the mean concentration plus two standard deviations or the equivalent. The modified GWCLs became effective on January 20, 2010.

1.1 Summary of pH Activities

During the completion of the *4th Quarter 2010 Quarterly Groundwater Monitoring Report,* Denison noted 11 perched groundwater monitoring wells with pH measurements below the GWCLs. These wells are located upgradient, cross-gradient, and downgradient of the Mill and tailings cells. Investigation into the 11 pH GWCLs in question indicated that the GWCLs for groundwater pH in all wells established in the January 20, 2010 GWDP were erroneously based on historical laboratory results instead of field measurements as contemplated by Table 2 of the GWDP. EFRI notified DRC in a letter dated February 1, 2011, that the existing GWCLs for groundwater pH were incorrectly based on laboratory results rather than field measurements and proposed to submit revised descriptive statistics for field pH to be used as revised pH GWCLs by the end of the second quarter 2011. EFRI received approval from DRC by e-mail on February 14, 2011, to proceed with the revision of the pH GWCLs based on field measurements. EFRI's geochemical consultant, INTERA Incorporated ("INTERA"), completed the data processing and statistical assessments necessary to revise the GWCLs based on historical field pH data. The data processing and statistical assessments completed by INTERA were based on the DRC-approved methods in the logic flow diagram (the "Flowsheet") included as Figure 17 of the *New Wells Background Report* (INTERA, 2008), a copy of the Flowsheet is included as Figure 4 to this Report. Following the statistical evaluation of pH data by INTERA, EFRI compared the Mill's groundwater pH data from the second quarter of 2011, including accelerated sampling results through June 2011, and noted that all of the June 2011 groundwater results, and many of the other results from the second quarter, were already outside the revised GWCLs to be proposed in the June 30, 2011, letter, based on the Flowsheet. INTERA further noted that the historical trend of decreasing pH, which was addressed in the Background Study Reports, appeared to be present in nearly all wells throughout the Mill site area, including upgradient, downgradient, and cross-gradient wells in the groundwater monitoring program.

EFRI notified DRC on June 28, 2011, by telephone and by follow-up letter dated June 30, 2011, that the second quarter 2011 data exceeded the recalculated GWCLs. EFRI advised DRC that, as a result of these findings, EFRI did not believe it was appropriate to continue with its efforts to reset the GWCLs for pH based on field pH data, as originally planned, but instead it appeared that it would be more appropriate to undertake a study to determine whether the decreasing trends in PH are due to natural influences and, if so, to determine a more appropriate way to determine GWCLs. Additionally, EFRI requested the opportunity for a meeting with DRC to discuss EFRI's findings to date and to agree upon any further investigations to be completed, as well as to agree upon the steps and milestone dates to be incorporated in the pH plan. The meetings with DRC were conducted via teleconference on December 5, and December 19, 2011. These teleconferences resulted in the January 20, 2012, letter and a revised pH Plan. A subsequent teleconference on March 12, 2012, led to the development of this pH Report. For these reasons also, revised GWCLs for pH have been calculated for all compliance monitoring wells at the site, based on field pH data, regardless of whether or not they are out of compliance for pH or exhibit statistically significant decreasing trends in pH, because all current GWCLs were incorrectly set based on laboratory, not field, pH data.

1.2 Conclusions from the pH Data Analyses Conducted to Date

The primary conclusion from the activities conducted to date is that the historical trend of decreasing pH, which was addressed in the Background Study Reports, appears to be present in nearly all wells throughout the Mill site area, including upgradient, downgradient, and crossgradient wells in the groundwater monitoring program, and there seems to be no abatement of the trend. The wide-spread nature of the decrease in pH in upgradient, downgradient, and crossgradient wells suggests that the pH decreases result from a natural phenomenon unrelated to Mill operations, which is also confirmed by the indicator parameter analysis discussed in Section 2.5.1.1 below. As discussed in more detail in Section 3.2 below, the most likely cause of declining pH across the site appears at this time to be the oxidation of pyrite, possibly due to increasing water levels at the site attributed primarily to recharge of wildlife ponds and/or the introduction of oxygen into the perched water zone as a result of increased groundwater sampling frequency.

1.3 Source Assessment Report for Out-of-Compliance Constituents Other than pH

INTERA has prepared and submitted a SAR on behalf of EFRI (INTERA, 2012). The SAR addressed constituents, other than pH, that had more than one concurrent consecutive exceedance (dual exceedance). Several of the dual exceedances occurred in wells with parameters which are sensitive to a decline in pH. These constituents and wells are presented in Table 2.

The first step of analysis in the SAR for constituents which may be impacted by declining pH, was to perform a geochemical analysis evaluating the behavior of the constituents in the well in question to determine if there have been any changes in the behavior of indicator parameters, such as chloride, sulfate, fluoride, and uranium, since the date of the Background Reports that may suggest a change in the behavior of that well since the dates of those reports.

If it was determined through the geochemical analysis of the indicator parameters that the behavior of a particular well has changed since the Background Reports, a mass balance analysis was performed to evaluate the observed concentrations of the constituent in light of the concentrations in Mill tailings and the presence or absence of any mounding at the location of the well in question. In cases where the wells in question (wells that were determined to have changed behavior since the Background Reports) are distant from the Mill's tailings cells, a hydrogeologic analysis was performed to determine the plausibility of any potential impact from Mill tailings.

In addition to the aforementioned approach, a pH analysis was performed in the SAR for each well that contains constituents that may be influenced by a decreasing pH trend. That analysis reviewed the behavior of pH in the well in question to determine if there has been a significant decrease in pH in the well. If there was a significant decreasing trend in pH in that well, the impact from any such decrease on the constituent in question was also analyzed.

1.4 Report Organization

Section 2.0 of this Report outlines the approach to the statistical and geochemical analyses. Section 3.0 discusses the results of the analyses. The results are presented on a well-by-well basis and include discussions about the indicator parameter analysis for each well, and present the revised GWCLs for each well. Conclusions and recommendations are presented in Section 4.0, and references can be found in Section 5.0. Figures and tables referenced in this Report are included as attachments. The appendices to this Report contain the statistical and geochemical evaluation for wells that have either a significantly decreasing trend or are out of compliance for field pH. Appendix A contains the statistical analysis for pH in groundwater monitoring wells. That analysis includes a box plot used to identify and omit extreme outliers from further analysis, histograms used in the Shapiro-Wilk test for normality, the Mann-Kendall trend test outputs for constituents that are not normally or lognormally distributed, linear regressions of field pH in each well, regardless of distribution, and descriptive statistics. Exploratory linear regressions, where the wells with the most data were divided into two categories, pre- and post-2005, are presented in Appendix B. Groundwater elevation and field pH plotted over time for all wells at the Site are presented in Appendix C. Appendix D contains the indicator parameter analysis for groundwater monitoring wells that are currently out of compliance for any constituent, including

pH, or are showing a significantly decreasing trend in pH. Appendices E and F contain the statistical analysis of pH in chloroform wells and nitrate wells, respectively. Appendix G is an electronic folder containing input and output files used during the analysis.

2.0 APPROACH TO THE STATISTICAL AND GEOCHEMICAL EVALUATION

This Report consists of a statistical and geochemical evaluation which is discussed in the following sections. A field investigation to verify the presence of pyrite is being conducted by Hydro Geo Chem (HGC) and will be submitted under separate cover.

As discussed in Section 1.1, EFRI has been aware of the site-wide decline in pH trends for some time. The New Wells Background Report (INTERA, 2008) stated:

> *"[O]n a review of the pH time plots in all existing wells (see Appendix D of the Background Report), there appears to be a general decreasing trend in pH in all wells. Figure 18 shows results of linear regression analyses for all site monitoring wells over the same time period used for new wells. Regression lines trend downward in all site monitoring wells and among the existing wells the trends are statistically significant in MW-3, MW-12, MW-14 and MW-17. The fact that pH is trending downward in all site monitoring wells indicates that statistically significant decreasing trends in pH in MW-25, MW-27, MW-28, and MW-3A are not related to any potential tailings seepage impacts. Instead there is a systematic process occurring that affects the site as a whole. This process may be a natural phenomenon related to regional changes or it could be some systematic change in the way that samples are collected or analyzed."*

In INTERA's *Response to URS Memorandum: Completeness Review for the Revised Background Groundwater Quality Report: Existing Wells for Denison Mines (USA) Corp.'s White Mesa Mill Site, San Juan County, Utah,* dated July 2, 2008, INTERA predicted that pH in some wells could fall below GWCLs if methods of calculating GWCLs for pH were not modified. In this Report, EFRI performs a statistical analysis of pH in data collected from all compliance monitoring wells, chloroform monitoring wells and nitrate monitoring wells across the site and a geochemical analysis of indicator parameters in the 11 pH wells in question and all other compliance monitoring wells that have a statistically significant decreasing trend in pH or any other out-of-compliance parameters, to obtain a more complete and up-to-date understanding of pH trends across the site and any potential relationship to Mill operations.

2.1 Statistical Analysis of pH Data

A statistical analysis of pH data from all groundwater monitoring wells at the Mill has been performed in accordance with statistical methods described in the Existing Wells Background Report (INTERA, 2007a) and the State of Utah Department of Environmental Quality approved Flowsheet (Figure 4). Table 3 provides a summary of the Flowsheet-based analysis for

groundwater monitoring wells at the Mill. A test for trends is particularly important and has been conducted in accordance with Section 6 (Testing for Trends and Calculating the GWCL) of the Existing Wells Background Report (INTERA, 2007a).

2.2 Linear Regression to Test for Trends

As there are no non-detect values in pH data, linear regression is the best test for normally or lognormally distributed data. The correlation coefficient (R) represents the linear relationship between two variables. R Square (R2) shows how closely X and Y are related. By taking the square of the R value, all values of R2 are positive (values of R can range from -1 to +1), and fall between 0 (no correlation) and 1 (perfect correlation). The R2 value is a measure of the strength of the predictive capability of the regression line. An R2 value of 0 indicates that the regression line has no predictive ability at all. An R2 value of 1 indicates that the regression line fits the data perfectly and, therefore, has the highest possible predictive capability. Generally, an R2 value less than 0.5 is considered to be a poor correlation, and the linear regression line is not considered to be a reliable representation of the data (i.e., it explains less than half of the data). The significance of a correlation coefficient of a particular strength or fit will change depending on the size of the sample from which it was computed. In this Report, linear regression trends are considered to be statistically significant if there are enough data points to make a determination and enough of those points fall within the calculated variance of the data set. Least squares regression analysis of the data will be performed to determine whether the association between the variables is statistically significant at the 95 percent level.

The statistical significance (p-level) of a result is an estimated measure of the degree to which it is "true" (in the sense of "representative of the population"). More technically, the value of the p-level represents a decreasing index of the reliability of a result. The higher the p-level, the less we can believe that the observed relation between variables in the sample is a reliable indicator of the relation between the respective variables in the population. Specifically, the p-level represents the probability of error that is involved in accepting our observed result as valid, that is, as "representative of the population." For example, the p-level of .05 (i.e., 1/20) indicates that there is a 5 percent probability that the relation between the variables found in our sample is a "fluke." In other words, assuming that in the population there was no relation between those variables whatsoever, and we were repeating experiments like ours one after another, we could expect that in approximately every 20 replications of the experiment there would be one in which the relation between the variables in question would be equal or stronger than in ours. In many areas of research, the p-level of .05 is customarily treated as a "border-line acceptable" error level (StatSoft, Inc., 2005. STATISTICA [data analysis software system], version 7.1. www.statsoft.com).

In accordance with the Flowsheet, the distribution of a data set will determine whether linear regression or Mann-Kendall is appropriate to identify significant trends. For informational purposes, linear regressions were performed for all data sets, whether or not the data set was normally or lognormally distributed (Appendix A-4). Data that were not normally or lognormally distributed were also subjected to the Mann-Kendall test for trends (Appendix A-3). A summary of these test results are provided in Table 3.

2.3 Data Exploration

Some monitor wells at the site have data extending from 1979 to the present, while others have barely eight recent data rounds. To date, decreasing pH trends have been observed most strongly in data collected from 2005 to the present. Therefore, the timing of data sets has been explored to ascertain if there are any particular time periods during which pH data have shown a site-wide decline and if such declines have happened in the past. If such declines have happened in the past or if they can be tied to a particular period, it may provide evidence for a process or cause of the declines.

Field pH measurements in older wells at the Mill site have been divided into two categories for data exploration purposes. The categories are: measurements collected prior to 2005 and measurements collected from 2005 through the second half of 2012.

2.4 Updating Compliance Limits

As mentioned in EFRI's June 13, 2011, response to the Notice of Violation and Compliance Order, Docket No. UGW11-02, the United States Environmental Protection Agency ("EPA") has recognized the need to update compliance limits periodically to reflect changes to background conditions.

As stated in *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance* (EPA, 2009):

> *"We recommend that other reviews of background also take place periodically.*
>
> *These include the following situations:*
>
> - *When periodically updating background, say every 1-2 years*
> - *When performing a 5-10 year permit review*
>
> *During these reviews, all observations designated as background should be evaluated to ensure that they still adequately reflect current natural or baseline groundwater conditions. In particular, the background samples should be investigated for apparent trends or outliers. Statistical outliers may need to be*

removed, especially if an error or discrepancy can be identified, so that subsequent compliance tests can be improved. If trends are indicated, a change in the statistical method or approach may be warranted."

And

"Site-wide changes in the underlying aquifer should be identifiable as similar trends in both upgradient and compliance wells. In this case, it might be possible to remove a common trend from both the background and compliance point wells and to perform interwell testing on the trend residuals."

EPA further states:

"5.3.4 UPDATING WHEN TRENDS ARE APPARENT

An increasing or decreasing trend may be apparent between the existing background and the newer set of candidate background values, either using a time series plot or applying Chapter 17 trend analyses. Should such trend data be added to the existing background sample? Most detection monitoring tests assume that background is stationary over time, with no discernible trends or seasonal variation. A mild trend will probably make very little difference, especially if a Student-t or Wilcoxon rank-sum test between the existing and candidate background data sets is non-significant. More severe or continuing trends are likely to be flagged as SSIs by formal intrawell prediction limit or control chart tests.

With interwell tests, a stronger trend in the common upgradient background may signify a change in natural groundwater quality across the aquifer or an incomplete characterization of the full range of background variation. If a change is evident, it may be necessary to delete some of the earlier background values from the updated background sample, so as to ensure that compliance testing is based on current groundwater conditions and not on outdated measures of groundwater quality."

In accordance with the Unified Guidance referenced above, and with the Flowsheet, GWCLs have been updated for field pH in all compliance monitoring wells at the site. However, as discussed in Section 2.5.4 below, although revised GWCLs for pH have been calculated for all compliance monitoring wells, ERFI is proposing that GWCLs be eliminated for all pumping wells (MW-26) and upgradient wells (MW-1, MW-18 and MW-19), and is therefore not proposing that any revised GWCLs be adopted for those wells. The revised GWCLs are presented in Table 3.

It should be emphasized that, as discussed in the April 13, 2012 pH Plan, since there are and have historically been decreasing trends in site-wide pH, it is likely that the wells for which new pH GWCLs have been proposed will exceed these GWCLs or reach out-of-compliance status in the near future. Since it has been established in this Report that these pH trends are not due to potential tailings leakage or Mill activities, other methods for establishing pH GWCLs, beyond those identified in the Flowchart, may need to be considered in the near future.

2.5 Geochemical Analysis of Wells with Significantly Declining pH

If the pH trend data from a monitor well is determined to be statistically significant, a geochemical analysis has been performed to determine if the declining pH trends can be related to potential Mill processes. The geochemical analysis consisted of the following and is described in further detail in the sections below:

- Analysis of indicator parameters
- Mass balance analysis
- Analysis of potential for transport

2.5.1 Analysis of Indicator Parameters

2.5.1.1 Approach

Potential seepage from the tailings impoundments would be indicated by rising concentrations of chloride, sulfate, fluoride, and uranium because: (1) these constituents are abundant in tailings wastewater (see Table 15 of the Revised Background Report, INTERA, 2007a), and (2) these constituents are relatively mobile and conservative in the groundwater environment. In contrast, many other constituents are either not present in relatively high concentrations in tailings wastewater and/or are reactive in the subsurface environment. Time concentration plots of these four indicator parameters have been prepared using data from all monitor wells on-site that have significantly decreasing pH or that are out of compliance for pH or any other constituents, to determine if there is evidence that the decreasing trends or in or out-of-compliance status of field pH, can be related to potential Mill processes (Appendix D).

As discussed in detail in Section 9.0 of the Existing Wells Background Report and Section 2.5.1.2 below, chloride is the best indicator of potential tailings cell leakage, followed by fluoride, then sulfate (due to mobility and abundance in tailings). Uranium is probably the most mobile and is the best indicator parameter for metals and radionuclides. Any potential seepage from tailings impoundments would be expected to exhibit rising concentrations of chloride and possibly fluoride, sulfate and uranium. It is important to note, however, that while a lack of a rising trend in chloride would indicate that there has been no impact from tailings, a rising trend

in chloride could also be due to some natural influences (see Section 12.0 of the Existing Wells Background Report). Therefore, in situations where there is a significant rising trend in chloride, other evaluations would need to be performed, such as a determination if any other indicator parameters have demonstrated a significant rising trend, whether there are any other factors that may have caused the rising trend in chloride, and whether or not the concentrations and mass balance indicate a potential tailings cell leak.

2.5.1.2 Chloride as the Best Indicator Parameter

Chloride has chemical properties that lend themselves most readily to transport by water. Chloride is often chosen as a tracer of groundwater flow because common chloride minerals are highly soluble in water and have little tendency to crystallize from solution. Since chloride participates in relatively few environmental chemical reactions, concentrations move along a groundwater flow path with little attenuation (retardation) in concentrations. A retardation factor of one (no retardation) is commonly assumed for chloride in most groundwater systems.

As one of the few constituents found in groundwater systems with a retardation factor approaching one, chloride meets at least two specifications of an ideal indicator of potential tailings solution impact to groundwater. It is common in ambient groundwater (ranging in natural background from less than 1.0 milligrams per liter (mg/L) at MW-23 on the downgradient margin of Cell 3 to 94 mg/L in upgradient monitoring well MW-19, after extremes are removed), but the average chloride concentration calculated using 2012 sample results from Cell 1, Cell 2 Slimes Drain, Cell 3, and Cells 4A and 4B tailings impoundment solutions of 20,752 mg/L is sufficient to guarantee that any potential seepage from tailings impoundments would be measurable in groundwater before any substantial volume had entered the system. Thus, chloride is a primary indicator of potential tailings impact.

Any potential seepage from tailings impoundments would be expected to exhibit rising concentrations of chloride and possibly fluoride, sulfate, and uranium. However, none of these parameters provides the utility of chloride as a tracer in groundwater at the Mill site. The utility of nitrate as a tracer is reduced in systems where nitrate is present in large amounts. This is because nitrate is a redox-sensitive member of the natural nitrogen cycle and, as such, is subject to transformative redox reactions that mask the original abundance. Note also that near surface transformation products can easily be masked by the presence of the large nitrogen reservoir in the atmosphere (nitrogen gas accounts for approximately 78 percent of ambient air).

Sulfate is present in tailings solutions at high concentrations but is present in ambient groundwater at proportionally higher concentrations than chloride. Further, the solubility of common calcium sulfate minerals is much higher than the most common chloride minerals,

limiting the amount of sulfate that can remain dissolved and retarding sulfate concentrations along a flow path. However, given the high average concentrations of sulfate calculated from 2012 samples in the tailings Cell 1, Cell 2 Slimes Drain, Cell 3, and Cells 4A and 4B of approximately 96,040 mg/L, it should still be considered to be a good indicator parameter.

Other than chloride, the constituent with most promise for indicating potential impacts from tailings solutions is fluoride. Referring to the periodic table of the elements, fluoride is in the same elemental period occupied by chloride and, for this reason exhibits similar chemical properties. Fluoride is present in tailings impoundment solutions from Cell 1, Cell 2 Slimes Drain, Cell 3, and Cells 4A and 4B at an average concentration of nearly 486 mg/L in 2012. Fluoride is present in natural groundwater at concentrations ranging from less than detection to more than 100 mg/L, but concentrations are typically near one mg/L. However, unlike chloride, the common trace mineral apatite is known to act as a solubility control that can reduce fluoride concentrations along a flow path. Thus, while fluoride concentrations should be monitored, fluoride should be secondary to chloride as an indicator of impact.

While uranium may be the most mobile of trace (metal) elements, it is typically retarded behind chloride and would likely not be expressed in groundwater until sometime later than chloride concentrations had begun to rise. This is because uranium is a metal cation and behaves as other metals with respect to pH. Metals are soluble and transportable at low pH but exhibit progressively higher retardation coefficients as pH values rise above the 3 to 4.5 range. Experience at a large number of uranium mill tailings facilities in the western United States indicates that low pH in tailings solutions rarely persists more than a few hundreds of feet in any transport direction from a source due to the high neutralization potential generally observed in alkaline soils from arid regions of the western United States.

2.5.1.3 Behavior of Chloride and Nitrate in Groundwater

Nitrate and chloride behave in a similar way in many groundwater systems. With some exceptions described below, both are non-reactive and conservative constituents whose concentrations are diminished in groundwater only by diffusion and dispersion with travel distance.

Since it is very soluble and does not bind to soils, nitrate has a high potential to migrate to groundwater. Because it does not evaporate, nitrate/nitrite is likely to remain in water until consumed by plants or other organisms (http://www.epa.gov/safewater/contaminants/dw_contamfs/nitrates.htm). The retardation factor (R) is one of the coefficients that describe the migration abilities of particular components in groundwater. It shows how many times the migration of the substance subjected to adsorption is slower than the actual speed of water flow

in pores. The average intensity of nitrate adsorption is described as low, and the retardation factor ranges between 1 and 2 (Deutch, 1997). However, if nitrate is discharged into anoxic ground water, or if toxic groundwater containing nitrate either migrates into anoxic conditions or is made anoxic by anthropogenic discharges, de-nitrification can occur, converting nitrate to nitrogen gas (N_2) (McQuillan, 2004).

Chloride ions do not significantly enter into oxidation or reduction reactions and they form no important solute complexes with other ions unless the chloride concentration is extremely high. Chloride ions do not form salts of low solubility, are not significantly adsorbed on mineral surfaces, and play few vital biochemical roles. Thus, the attenuation of chloride ions in the hydrologic cycle is largely through the physical processes of hydrodynamic dispersion and diffusion (Hem, 1992).

As a result, nitrate can move as fast as chloride in some environments, but not in others. We can therefore conclude that chloride moves at least as fast as nitrate, and faster in some circumstances.

2.5.1.4 Limitations of pH as an Indicator Parameter

In the absence of increasing trends in any of the indicator parameters of chloride, sulfate, fluoride, and uranium, and most particularly chloride, it is possible to rule out any potential seepage from the tailings cells as being the cause of the decreasing trend in field pH. This is because chloride moves in groundwater at the speed of water, whereas pH moves by chemical reaction. Carbonate in the subsurface formations will neutralize the pH in any potential tailings seepage, thereby increasing the pH in the seepage as it is carried by the water through the formations. As a result, any low pH associated with potential tailings seepage cannot be detected any faster than the water in the formation, and will neutralize as it flows through carbonate bearing sediments, becoming less detectable (effectively diluted) as it travels. Since chloride moves with the speed of the water in the subsurface, any influence of low pH would not be detected before increases in chloride concentrations. Therefore, it is not possible to see a significant impact in the form of a declining trend in pH caused by any potential tailings seepage without also seeing a significant increase in chloride.

2.5.2 Mass Balance Analysis

If any indicator parameter showed a significant upward trend that could not be attributed to natural background conditions in that well, a mass balance calculation was also performed to determine if there is evidence that concentrations can be related to potential Mill processes. It is possible to estimate the mass of each indicator parameter in the groundwater beneath the Mill site by assuming a saturated thickness of groundwater in the aquifer matrix, a porosity of the

aquifer matrix, an average concentration of constituents in groundwater, and an area to which the average concentration applies. Any potential source of indicator parameters will be evaluated to determine if it has the potential to have caused the mass of the indicator observed in the groundwater beneath the Mill site. First, the potential source must have a means to reach groundwater such as sufficient water or other fluid to travel through the vadose zone. Second there must have been sufficient concentrations of the indicator parameter in the source to account for the mass of indicator parameter observed in the groundwater. Both conditions can be evaluated by mass balance calculations.

An example of a mass balance calculation was presented in INTERA's *Nitrate Contamination Investigation Report, White Mesa Uranium Mill Site, Blanding Utah* (2009), where one of the suggested possibilities was a groundwater mound from the tailings cells that might cause elevated nitrate and chloride concentrations upgradient in the area of the nitrate and chloride plume. A calculation for nitrate to evaluate this possibility (a calculation for chloride would be similar) suggests that on the order of 11 percent tailings solution (assuming the highest recently observed nitrate concentration in the tailings of 290 mg/L) would have to mix with unimpacted groundwater (assuming 1 mg/L) in order to account for the observed mass of nitrate in groundwater, assuming an average nitrate concentration in the plume above the 20 mg/L isopleth of 30 mg/L. The details of this example calculation based on nitrate are provided below. The size of the nitrate plume above 20 mg/L is approximately 40 acres, or approximately 1,740,000 square feet in map area. Assuming 45 feet of saturated thickness (based on HGC, 2007) and a porosity of 0.2, there are approximately 15,700,000 cubic feet or 117,000,000 gallons of groundwater in that area. Eleven (11) percent of that is approximately 12,900,000 gallons (approximately 40 acre feet), which is a conservative estimate of the volume of tailings solution that would have to be mixed with groundwater to account for the mass of nitrate in the portion of the plume above 20 mg/L nitrate. The following calculations support these estimates.

Assume:

- Nitrate concentration in tailings solution 290 mg/L
- Nitrate concentration in un-impacted groundwater 1 mg/L
- Average plume concentration 30 mg/L

Mixing Equation: $Ct*Vt + Cg*Vg = Cm*Vm$ (eq1)

Where:
Ct = Concentration of nitrate in tailings solutions
Vt = Volume of tailings solution
Cg = Concentration of nitrate in unimpacted groundwater
Vg = Volume of unimpacted groundwater
Cm = Concentration of nitrate in mixture of groundwater and tailings solutions

Vm = Volume of mixture of groundwater and tailings solutions

Another Equation: $Vt + Vg = Vm$ (eq2)

Substituting eq2 in eq1: $Ct*Vt + Cg*Vg = Cm* (Vt + Vg)$ (eq3)

Substitute Nitrate Concentrations in eq3

$$290*Vt + 1*Vg = 30*(Vt + Vg)$$

$$290*Vt + 1*Vg = 30*Vt + 30*Vg$$

$$260*Vt = 29*Vg$$

$$Vt = 29/260*Vg = 0.11*Vg$$

Based on the above, the volume of tailings solution would have to be approximately 11 percent of the volume of un-impacted groundwater in the mixture. The above mass balance is an example of calculations that would be prepared for, and the reasoning that would be applied to, indicator parameters in data from wells that are out of compliance for pH, if those wells have rising trends in the indicator parameters. In the case of the indicator parameters, their concentrations would be used instead of nitrate in the above equation(s). These calculations would provide one line of evidence to test the possibility that any potential rising trend in indicator parameters and the decreasing pH (in wells that are out of compliance for pH) could or could not be related to Mill operations.

2.5.3 Potential Transport Analysis

In cases where data from out-of-compliance wells that have statistically significant decreasing pH trends and increasing indicator trends, are distant from the Mill's tailings cells, a transport analysis will be performed to determine the plausibility of impact from Mill-related processes. The transport analysis will consider the geochemical transport properties of each indicator parameter with a significantly increasing trend and an analytical calculation of potential travel times to the well from potential Mill-related sources will be performed to determine if there is evidence that the indicator parameter could plausibly have arrived at the well during the life of the Mill.

2.5.4 Proposed Revised GWCLs

As mentioned above, the GWCLs for groundwater pH in all wells established in the January 20, 2010 GWDP were erroneously based on historical laboratory results instead of field measurements as contemplated by Table 2 of the GWDP. As a result, this Report calculates

revised GWCLs for pH in all of the compliance monitoring wells at the site, based on field pH data rather than laboratory pH data.

However, although revised GWCLs for pH have been calculated for all compliance monitoring wells, ERFI is proposing that GWCLs be eliminated for all pumping wells (MW-26) and upgradient wells (MW-1, MW-18 and MW-19), and is therefore not proposing that any revised GWCLs be adopted for those wells.

As a pumping well, MW-26 is being manipulated, and the impact on the quality of the water in that well from the pumping is unclear and cannot be predicted with enough certainty to establish compliance standards under the GWDP. MW-1, MW-18 and MW-19 are far upgradient from the Mill site and cannot be impacted by Mill activities. It is therefore not appropriate to establish compliance standards under the GWDP for those wells. It is proposed that future monitoring of all of those wells will be conducted at their normal, un-accelerated, frequency for informational purposes only, and to help define background conditions at the site.

Table 3 summarizes the GWCLs for pH in all compliance monitoring wells based on an application of the Flowsheet. Revised GWCLs for pH in MW-26, MW-1, MW-18 and MW-19 are included on that Table for completeness and to show recalculated GWCLs based on the Flowsheet. Those would be the appropriate revised GWCLs, were revised GWCLs adopted for those wells. However, EFRI is not proposing that GWCLs not be adopted for those wells.

It is assumed that once revised GWCLs for pH are set, accelerated monitoring for pH will cease.

2.6 Newly Installed Wells with Interim GWCLs

MW-35 was installed in August and September of 2010 as required by the GWDP. Sampling commenced in the fourth quarter of 2010. Eight consecutive quarters of groundwater sampling and analysis have been completed as of the third quarter 2012; however, because some data has been rejected as a result of the quality assurance (Q/A) analysis required by the Flowsheet, one or more additional quarters of sampling are required. Upon receipt of at least eight quarters of data for each constituent in MW-35, EFRI will submit a background report for Director approval. GWCLs for pH have not yet been set in MW-35

EFRI is preparing a Background Report for MW-35 where all available data will be used to calculate a proposed GWCL for pH using the Flowsheet. The MW-35 Background Report is currently expected to be submitted during the First Quarter 2013.

Similarly, MW-36 and MW-37 were installed in 2011, and eight quarters of pH data is not yet available for those wells. Upon receipt of eight quarters of data for those wells, a background report will be submitted with proposed GWCLs for pH in those wells.

As a result, GWCLs for pH are not calculated or proposed in this Report for MW-35, MW-36 and MW-37.

2.7 MW-20

As noted in Section 3.1.1 the linear regression plots show that pH is declining in every groundwater monitoring well at the Mill site with the exception of MW-20 and MW-26. As noted in Section 2.5.4 above, MW-26 is a continuously pumping well and is discussed separately.

The general upward trend in pH at MW-20 is anomalous and appears to be the direct result of damage to the well resulting from the redevelopment activities that were conducted in April 2011. The redevelopment report (HGC, 2011) noted that damage occurred, as evidenced by decreased water production after redevelopment. Purge volumes prior to redevelopment were approximately 5 to 8 gallons with a recovery time of approximately 1 week. After redevelopment, the purge volumes are less than 5 gallons and recovery times exceed 1 month. Redevelopment impacted the production rates significantly, and, as a result may have impacted the chemical behavior in the well. The Background Groundwater Quality Report for Wells MW-20 and MW-22 submitted June 1, 2010, showed a downward trend in the field pH in MW-20, although the trend was not statistically significant. Additional data collected after the background study and before the redevelopment showed a continuation of the downward trend in the field pH. Since the redevelopment, the field pH measurements have increased significantly (in excess of 10 standard units [s.u.] in some cases). The data suggests that the increase may be due to damage to the well sustained during the redevelopment, possibly the result of bentonite being drawn into the well and/or the surrounding packing, because the high pH measurements were all collected following the redevelopment. Significant changes in water production and pH were noted after redevelopment. As a result, pH data from MW-20 should be considered anomalous.

2.8 pH Trends in Chloroform and Nitrate Monitoring Wells

As previously stated, this Report contains an analysis of all wells at the Mill site to quantify the decreasing trends in pH at the site as a whole and indicate which monitoring wells have significantly decreasing trends in pH. To address the wide-spread nature of the decrease in pH in upgradient, downgradient, and cross-gradient wells, an evaluation of all on-site wells including the chloroform program (TW4 series wells) and nitrate program wells (TWN series wells) was also completed. Appendices E and F contain the linear regressions as well as other descriptive statistics relating to the chloroform and nitrate program wells.

3.0 RESULTS OF THE STATISTICAL AND GEOCHEMICAL EVALUATION

This section describes the results of the statistical and geochemical evaluation.

3.1 Statistical Analysis of pH Data

Field pH data have been analyzed following the statistical methods as described in the New Wells Background Report (INTERA, 2008) and the Flowsheet (Figure 4). Since pH data are a field measurement and not a laboratory measurement, certain data quality checks included in the Flowsheet were not applicable. For example, there were no zero or negative values, pH units are always reported in standard units, and pH cannot be "non-detect" and therefore cannot be subject to an insensitive detection limit. Internal consistency checks of pH data are also not applicable. A summary of the statistical analysis for field pH in groundwater monitoring wells required by the Flowsheet is provided in Table 3, along with the revised GWCLs for pH in groundwater monitoring wells which are out of compliance or have a statistically decreasing trend in pH. Appendices A and D contain box plots, histograms, linear regressions, Mann-Kendall tests, and descriptive statistics for groundwater wells. Appendices E and F contain the analysis of field pH in chloroform and nitrate wells, respectively.

3.1.1 Linear Regression Tests

Linear regression tests were performed on all pH data, whether or not the data were normally/lognormally distributed. In cases where the data were not normally/lognormally distributed, the Mann-Kendall trend test was also performed. Results of the trend tests are summarized in Table 3. Appendix A-3 contains the Mann-Kendall trend test output files. Appendix A-4 contains linear regression plots of pH in each groundwater monitoring well at the Mill with more than eight data points. The linear regression plots show that pH is declining in every groundwater compliance monitoring well at the Mill site with the exception of MW-20 (which is damaged – see Section 2.7 above) and MW-26 (which is a pumping well and is not considered to be representative – see Section 2.5.4 above). Compliance monitoring wells that have statistically significant decreasing trends in pH are far downgradient wells MW-3 and MW-3A, far upgradient well MW-18, and Mill area wells MW-11, 12, 14,15, 17, 22, 24, 25, 30, and 32.

Appendix E-5 contains linear regression plots for pH in chloroform wells. Chloroform wells are also showing a decrease. Exceptions to the declining pH are TW4-13, TW4-19 (a pumping well – see Section 2.5.4 above), and TW4-22 which are showing little to no trend, and TW4-14, TW4-20 (a pumping well), and TW4-25 which are showing increasing trends. See Appendix E-1 for a complete summary of analysis of pH in chloroform wells according to the Flowsheet.

Appendix F-5 contains linear regressions for Nitrate wells. Nitrate wells were installed in 2009 and have fewer pH measurements than any of the other monitoring programs at the Site. Field pH in nitrate wells is not showing many significant trends, however a general increase in pH is observed in most of the nitrate wells. Appendix F-1 contains a complete summary of statistical analysis of pH in nitrate wells according to the Flowsheet.

Figure 3 is a map of the site, showing plots of pH in all site wells. The plots display relative levels of pH at each well by setting the area of the symbol (circle) in direct proportion to the level of pH. The larger the circle, the lower the pH level in the well. The circles are also color coded, with the red circles indicating wells with significantly decreasing trends in pH etc. Figure 3 shows the spatial distribution of pH levels and decreasing trends at the site.

3.1.2 Data Exploration

Because of the varying ages of groundwater monitoring wells on-site, some wells have pH measurement data going back as far as 1979. For these older wells (MW-1, 2, 3, 5, 11, 12, 14, 15, 17, 18, and 19), data have been divided into two categories for exploratory purposes. The two categories are

- All data through 2004
- Data from 2005 through the first half of 2012

Exploratory linear regressions were run on these two data sets (Appendix B). In general, the regressions show slightly decreasing pH in the earlier data set. Exceptions to the early decreasing trend are MW-5, 12, and 17, which show slightly increasing trends in pH in the earlier data set.

The later data set shows decreasing trends for all wells analyzed, with MW-11, 18, and 19 showing significantly decreasing trends since 2005.

3.2 Groundwater Elevation as a Possible Explanation for Decreasing Trends in pH at the Site

Appendix C contains plots with groundwater elevation and field pH over time. While there are two cases of decreasing water levels paired with decreasing pH (TW4-12, and TWN-2) all other wells in the MW series and the TW4 series have rising water levels correlated with decreasing pH.

In two cases where water levels are going down (MW-36 and TW4-25), pH is going up. In seven cases in the TWN series (TWN-9, TWN-12, TWN-13, TWN-14, TWN-15, TWN-18, and TWN-19), water levels are either flat or going up while pH is also going up. The TWN series wells are among the only wells at the site that have not seen decreasing pH trends. It is worth noting that

many of these wells had a pH below 7 when they were first sampled and have seen very little real change in groundwater levels since they were installed.

Most of the data are consistent with rising water levels oxidizing pyrite and causing decreased pH, whether the rising water levels are from the influence of the wildlife ponds or other natural causes.

Although not necessarily the only or primary cause, the oxidation of pyrite (or other sulfides) is expected to occur site-wide because pyrite has been noted in borings across the entire site (including borings located upgradient, cross-gradient, and downgradient of the Mill and tailings cells) and there is a general increase in groundwater elevation site-wide.

The initial visual identification of site-wide presence of pyrite documented at the time of well construction, has since been confirmed by laboratory, visual, and/or quantitative analysis in nearly all boring logs for wells at the site. These hypotheses are being tested by HGC, and a report will be submitted under separate cover (HGC, 2012a). Groundwater elevation data is generally consistent with pH data in that most wells that show increases in groundwater elevation show decreasing pH trends and the few wells that show decreases in groundwater elevation show rising pH trends. The correlation between groundwater elevation and pH may be due to the infiltration of oxidized water from the wildlife ponds reacting with pyrite in the aquifer matrix or rising water levels invading previously air filled pore space causing dissolution of pyrite that is reacting with oxygen in the presence of water. Other causes of decreasing pH at the site could be the increased sampling frequency of a number of the wells after implementation of the GWDP in 2005, including accelerated monitoring of wells and more extensive well purging for all sampling events, which would be expected to introduce oxygen into the perched aquifer. The exploratory statistics discussed in Section 3.1.2 above suggest that decreasing trends in pH in certain wells may be more pronounced after 2005. These hypotheses are being tested by HGC, and a report will be submitted under separate cover (HGC, 2012a). Regardless of the outcome of the pyrite investigation specified in this pH plan, it appears that the pH decline is a site-wide phenomenon resulting from one or more non-Mill related factors.

A review of Figure 3 is also instructive and supports the relationship between rising water levels and decreasing pH. The most noticeable cluster of wells with decreasing pH is located to the east of the site, close to the wildlife ponds, which have caused rising water levels in those areas. The nitrate wells, which have the fewest number of decreasing trends in pH are also newer, with fewer data points, and typically further away or upgradient from the influence of the wildlife ponds. This would suggest that either (a) many of the nitrate wells are not in the vicinity of the wildlife ponds and have not been influenced by the ponds; or (b) the nitrate wells in the vicinity of the wildlife ponds were installed after the rising water levels from the ponds had already

oxidized the available pyrite in the vicinity of the wells. For either reason, there would be no influence from the wildlife ponds to generate a decreasing trend in pH after installation of the nitrate monitoring wells.

3.3 Updating Compliance Limits

As described in Section 2.4 above, there is a need to update compliance limits when a naturally occurring trend has been identified in background data. As the regressions in the Background Reports and Appendices A and B demonstrate, there has been a decline in pH in most wells at the Mill site since monitoring began. As described in Section 2.5.4, above, it is also necessary to revise the GWCLs for pH in all compliance monitoring wells based on field pH data, rather than laboratory pH data.

GWCLs for pH in all compliance monitoring wells have been recalculated using the Flowsheet. However, as discussed in Section 2.5.4. above, although revised GWCLs for pH have been recalculated for all compliance monitoring wells, EFRI is not proposing that GWCLs be set for any pumping wells (MW-26) or any upgradient wells (MW-1, MW-18 and MW-19).

Table 3 presents the updated GWCLs and a rationale for the calculation based on the Flowsheet. Section 3.4 below breaks down the geochemical analysis of field pH and indicator parameters in each well for which pH or any other parameter is in out of compliance status or that demonstrates a significant decreasing trend in pH, and presents the updated GWCLs.

3.4 Geochemical Analysis of Wells that Are Out of Compliance or Have Significantly Declining Field pH Measurements

Every groundwater monitoring well at the Mill site shows a declining trend in pH, with the exception of MW-20 and MW-26. The wells with statistically significant (p-value of <0.5) decreasing trends in pH and wells that are in out-of-compliance status for field pH or any other constituent were subjected to additional studies which are discussed in more detail below.

3.4.1 MW-3

Field pH in MW-3 is in out-of-compliance status and shows a statistically significant decreasing trend (Appendix A-4). Exploratory regressions show a decline in pH for both data from before 2005 and data collected after 2005 (Appendix B).

Indicator parameters fluoride, sulfate, and uranium in MW-3 are showing statistically significant increasing trends at the time of this Report (see Appendix D-5). Sulfate and uranium were also trending upward significantly at the time of the Existing Wells Background Report (see Appendix E-3 of the SAR, INTERA, 2012), while the statistically significant increasing trend in

fluoride in MW-3 is a newly identified trend. However, chloride in MW-3 is not trending upward significantly today nor was it trending upward significantly at the time of the Existing Wells Background Report (see Appendices E-2 and E-3 of the SAR, INTERA, 2012).

Although fluoride is an indicator parameter and has recently demonstrated an upward trend, MW-3 is approximately 2,000 feet downgradient from the Mill's tailings cells, and it is extremely unlikely that any potential tailings cell leakage could reach MW-3 during the 30 years that the Mill has been in operation. As indicated in Section 4.2 of HGC (2012b), the estimated average travel time for a conservative solute, assuming no hydrodynamic dispersion, from tailings cell 4B to Ruin Spring along a path that crosses near MW-3, is 0.90 feet/year. It would therefore be expected to take over 2,000 years for any potential tailings solutions from the tailings cells to reach MW-3. Further, and more importantly, it is inconceivable that, even if any potential tailings cell leakage could have reached MW-3 in the 30 years of Mill operations, a rising trend in fluoride would be observed without an equal or more pronounced rising trend in chloride.

Further, MW-3 was included in the University of Utah Study, where Hurst and Solomon concluded that "[s]table isotope fingerprints do not suggest contamination of groundwater by tailings cell leakage, evidence that is corroborated by trace metal concentrations similar to historically-observed observations." With regard to MW-3, specifically, Hurst and Solomon (2008) concluded that "[m]onitoring wells MW-3, MW-3A, . . . MW-18, . . . have more depleted $\delta^{18}O$. These wells have elevated uranium concentrations, but as they do not bear an evaporated stable isotope signal it does not appear that the elevated uranium values are the result of leakage from tailing cells (or wildlife ponds)."

For these reasons, we can conclude that the decreasing trend in pH in MW-3 has not been caused by Mill operations, and is the result of natural influences and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL for field pH in MW-3 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 6.04-8.5 s.u., which is the mean minus two sigma (mean - 2σ).

3.4.2 MW-3A

Field pH in MW-3A is in out-of-compliance status and is showing a statistically significant decreasing trend (Appendix A-4). Field pH measurements in MW-3A appear to show an upward trend starting in 2011. As MW-3A is a neighboring well to MW-3, all of the discussions above pertaining to travel time and distance from the tailings cells to MW-3 are relevant for MW-3A as well.

Analysis of indicator parameters shows that there are no significantly increasing trends in chloride, fluoride, sulfate, or uranium in MW-3A. In fact, all indicator parameters in MW-3A are trending downward with the exception of sulfate.

MW-3A was included in the University of Utah study, where Hurst and Solomon concluded that "[s]table isotope fingerprints do not suggest contamination of groundwater by tailings cell leakage, evidence that is corroborated by trace metal concentrations similar to historically-observed observations." With regard to MW-3-A, specifically, Hurst and Solomon (2008) concluded that "[m]onitoring wells MW-3, MW-3A, . . . MW-18, . . . have more depleted $\delta^{18}O$. These wells have elevated uranium concentrations, but as they do not bear an evaporated stable isotope signal it does not appear that the elevated uranium values are the result of leakage from tailing cells (or wildlife ponds)."

For these reasons, we can conclude that the decreasing trend in pH in MW-3A has not been caused by Mill operations, and is the result of natural influences and/or the improperly set GWCLs. The current GWCL for field pH in MW-3A is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.84-8.5s.u., which is the mean - 2σ.

3.4.3 MW-5

Field pH in MW-5 does not show a statistically significant decreasing trend (Appendix A-4). However, uranium in MW-5 is currently in out-of-compliance status and was addressed in the SAR (INTERA, 2012). As discussed in Section 4.3.5 of the SAR, MW-5 is one of the original monitoring wells at the Mill site. The time versus concentration plot for the second quarter of 2012, a copy of which is included in Appendix E-1 of the SAR, shows that since the end of 2010, concentrations of uranium in MW-5 have been erratic and have included some values that are an order of magnitude higher than the mean. Two of these values, the 11/11/2010 value of 11.6 µg/L, and the 02/14/2011 value of 29.5 µg/L, have caused the exceedances that have led to MW-5 being listed on Table 1 of the SAR. Since then, an additional elevated value of 18.6 µg/L was reported during the first quarter of 2012. These concentrations are unusually high for this well. Geochemical analysis of uranium in MW-5 requires identification and omission of extreme outliers (any value over three times the standard deviation on either side of the mean) (see the Flowsheet, Figure 4). After the extreme outliers were identified and omitted, there were no longer any values that were out of compliance.

After these values were omitted, the test for normality showed that the data set was neither normal nor lognormal, therefore subjecting these data to Mann-Kendall trend analysis. The trend analysis performed on the data with extreme outliers removed, as required by the Flowsheet, shows a significantly decreasing trend at this time (see Appendix E-1 of the SAR). This

decreasing trend, although not significant, was also identified at the time of the Existing Wells Background Report (see Appendix E-1 of the SAR). Chloride and sulfate concentrations are not significantly increasing at this time or at the time of the Existing Wells Background Report (see Appendices E-2 and E-3 of the SAR). In fact, chloride in MW-5 is significantly decreasing (see Appendix D-5). Concentrations of fluoride in MW-5 are significantly increasing, and this trend was also identified at the time of the Existing Wells Background Report (see Appendices E-2 and E-3 of the SAR). However, fluoride concentrations in MW-5 appear to be decreasing since 2008.

For these reasons, we can conclude that pH in MW-5 has not been impacted by Mill operations, and is the result of natural influences and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL for pH in MW-5 is 6.5-8.5 s.u., and was set based on laboratory pH data. In accordance with the Flowsheet, the proposed revised GWCL, based on field pH data, is 7.04-8.5s.u., which is the mean - 2σ.

3.4.4 MW-11

Field pH in MW-11 is showing a statistically significant decreasing trend (Appendix A-4); however it is not in out-of-compliance status. Exploratory regressions (Appendix B) show a slight downward trend in the field pH measured prior to 2005 and a statistically significant decreasing trend in field pH measured after 2005.

Regression plots for the indicator parameters chloride, sulfate, fluoride, and uranium at the time of this report are provided in Appendix D-5. Sulfate concentrations in MW-11 are significantly increasing; however, sulfate concentrations were also significantly increasing at the time of the Existing Wells Background Report. In Section 11.2 of the Existing Wells Background Report, we noted that a number of wells, including MW-11, had significantly increasing trends in sulfate, but that the most significant increasing trend, which represented the highest percentage increase in sulfate, was in upgradient well MW-18 (INTERA, 2007a). This fact, and the fact that none of the wells with increasing trends in sulfate had significant increasing trends in chloride, led to the conclusion in the Background Reports that the increasing trends in sulfate at the Mill site were due to natural causes.

Sulfate has risen from near 900 mg/L to near 1150 mg/L in MW-11; a difference of approximately 250 mg/L. Based on the average sulfate concentration in Cell 1 of 167,280 mg/L and the average chloride concentration of 25,230 mg/L, chloride would have had to increase by at least 38 mg/L to accommodate the sulfate increase. Chloride concentrations in MW-11 are now decreasing, whereas at the time of the Existing Wells Background Report they were not trending at all. Fluoride and uranium continue to not demonstrate a significantly increasing trend.

In fact, uranium is trending (albeit not significantly) downwards. As discussed in Section 2.5.1.4 above, it is not possible for pH related to tailings seepage to be detected faster than chloride.

Further, MW-11 was included in the University of Utah Study, where Hurst and Solomon concluded that "[s]table isotope fingerprints do not suggest contamination of groundwater by tailings cell leakage, evidence that is corroborated by trace metal concentrations similar to historically-observed observations." With regard to MW-11, specifically, Hurst and Solomon concluded that "[s]amples from MW-11 . . . contained the largest amounts of terrigenic helium and thus contain the largest components of old water," and "MW-11 does not show an evaporated signal suggesting that neither pond water or leakage from tailing cells is present at this well today."

For these reasons, we can conclude that the decreasing trend in pH in MW-11 is the result of natural influences and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL for field pH in MW-11 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 6.25-8.5 s.u., which is the lowest historical value.

3.4.5 MW-12

Field pH in MW-12 is in out-of-compliance status and is showing a significantly decreasing trend (Appendix A-4). Exploratory regressions (see Appendix B) for field pH in MW-12 show an upward trend in field pH when plotting data measured prior to 2005. Measurements collected beginning in 2005 through the first half of 2012 show a declining trend. Neither exploratory trend is significant.

Regression plots for the indicator parameters in MW-12 show that uranium is significantly increasing (see Appendix D-5). This significant trend was also identified at the time of the Existing Wells Background Report. Other indicator parameters in MW-12 are not showing significantly increasing trends. In fact, chloride in MW-12 is showing a significant decreasing trend. As discussed in Section 2.5.1.4 above, it is not possible for pH related to tailings seepage to be detected faster than chloride.

Groundwater in MW-12 has been analyzed in the SAR (INTERA, 2012), concluding that a significant change in behavior has not occurred since the time of the Existing Wells Background Report, and therefore we can conclude that the decline in pH in MW-12 is not due to any Mill-related activities, and is the result of natural influences and/or the improperly set current GWCLs that are based on laboratory pH.. The current GWCL for field pH in MW-12 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.86-8.5 s.u., which is the lowest historical value.

3.4.6 MW-14

Field pH in MW-14 is in out-of-compliance status and is showing a significantly decreasing trend (Appendix A-4). Exploratory regressions (Appendix B) show slightly decreasing trends in field pH in both the pre-2005 data set and in the data from 2005 through the first half of 2012.

At the time of this Report, indicator parameter uranium is showing a significantly increasing trend. The increasing trend in uranium was also identified at the time of the Existing Wells Background Report. Chloride and fluoride are both showing significantly decreasing trends. As discussed in Section 2.5.1.4 above, it is not possible for pH related to tailings seepage to be detected faster than chloride.

Groundwater in MW-14 has not changed significantly since the time of the Background Report. There are no other out-of-compliance constituents in MW-14. Indicator parameters do not show increasing trends (with the exception of uranium, which was identified at the time of the Background Report). For these reasons, we can conclude that the decreasing pH in MW-14 is the result of natural influences and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL for field pH in MW-14 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.42-8.5 s.u., which is the lowest historical value.

3.4.7 MW-15

Field pH in MW-15 is not in out-of-compliance status; however, it is showing a significantly decreasing trend (Appendix A-4). Exploratory regressions (Appendix B) show that pH measurements were trending upward slightly in measurements collected prior to 2005. Measurements collected in 2005 through the second half of 2012 show a slightly downward trend.

Analysis of indicator parameters (Appendix D-5) show that at the time of this Report, uranium is exhibiting a significantly increasing trend. This trend in uranium was also identified at the time of the Existing Wells Background Report (see Appendix E-3 of the SAR). Chloride and fluoride in MW-15 are downward trending (fluoride significantly), and sulfate is showing a slightly increasing trend. As discussed in Section 2.5.1.4 above, it is not possible for pH related to tailings seepage to be detected faster than chloride.

The results of the indicator parameter analysis suggest that the decline in pH at MW-15 can be attributed to natural background influences and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL for field pH in MW-15 is 6.62-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.88-8.5 s.u., which is the lowest historical value.

3.4.8 MW-17

Field pH in MW-17 is not in out-of-compliance status; however, it is exhibiting a significantly decreasing trend (Appendix A-4). Exploratory regressions show that field pH was trending upward in the pre-2005 data set (Appendix B). Measurements collected since 2005 show the field pH trending downward.

Analysis of indicator parameters shows no significantly increasing trends (Appendix D-5). As discussed in Section 2.5.1.4 above, it is not possible for pH related to tailings seepage to be detected faster than chloride. For this reason, the significantly decreasing trend in pH can be attributed to natural background influences and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL for field pH in MW-17 is 6.4-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 6.27-8.5 s.u., which is the mean - 2σ.

3.4.9 MW-18

Field pH in upgradient well MW-18 is showing a significantly decreasing trend (Appendix A-4); however, pH in this well is not in out-of-compliance status. Exploratory regressions show steep declines in field pH in both the pre-2005 data set and the 2005 through first half of 2012 data set. The later data set shows a significantly decreasing trend (Appendix B).

Indicator parameters chloride, sulfate, and uranium are showing significantly increasing trends. Sulfate and uranium were identified as having significantly increasing trends at the time of the Existing Wells Background Report (see Appendix E-3 of the SAR, INTERA, 2012). An increasing trend in chloride was observed in MW-18 at the time of the Existing Wells Background Report, although it was not statistically significant at that time (see Appendix E-3 and Section 12 of the Existing Wells Background Report, INTERA, 2007a). This increasing trend in chloride is now significant. However, MW-18 is located so far upgradient from the Mill site that these trends could not possibly be the result of Mill activities.

In addition, MW-18 was included in the University of Utah Study in which Hurst and Solomon concluded that "stable isotope fingerprints do not suggest contamination of groundwater by tailings cell leakage, evidence that is corroborated by trace metal concentrations similar to historically-observed concentrations." Hurst and Solomon made this conclusion in light of the documented trends in thallium, sulfate, and uranium in MW-18 at that time.

The decreasing trend in field pH in MW-18 can therefore be attributed to natural influences. As discussed in Section 3.2 of the SAR (INTERA, 2012), EFRI has proposed to continue sampling in MW-18 for informational purposes, and to eliminate GWCLs in that well.

The current GWCL for field pH in MW-18 is 6.25-8.5 s.u. The revised GWCL for field pH in MW-18 would be 5.87-8.5 s.u., which is the mean - 2σ, in accordance with the Flowsheet. That would be the appropriate GWCL, were a revised GWCL to be adopted. However, for the reasons discussed in Section 3.2 of the SAR, EFRI is not proposing that such a revised GWCL be adopted for MW-18. Rather, as discussed in Section 3.2 of the SAR and Section 2.5.4 above, EFRI proposes that the GWDP be amended to remove all GWCLs from MW-18 and upgradient wells MW-1 and MW-19.

3.4.10 MW-19

Field pH in upgradient well MW-19 is not showing a significantly decreasing trend (Appendix A-4); however it is in out-of-compliance status for nitrate. Nitrate in MW-19 was not addressed in the SAR because the exceedance of nitrate is due to the nitrate/chloride plume and is currently being investigated by EFRI pursuant to a September 30, 2011 Stipulated Consent Agreement. Field pH in MW-19 was included in this analysis, and because of the out-of compliance status for nitrate in this well, an indicator parameter analysis was also performed.

Although field pH in MW-19 is not significantly decreasing, it is trending downward (Appendix A-4). Results of Exploratory regressions show steep declines in field pH in both the pre-2005 data set and the 2005 through first half of 2012 data set. The later data set shows a significantly decreasing trend (Appendix B).

Indicator analysis shows that chloride, sulfate, and uranium are decreasing significantly, and fluoride is not showing a significant trend.

MW-19 is an upgradient well and is not being impacted by activities at the Mill. The current GWCL for pH in MW-19 is 6.78-8.5 s.u., and was set based on laboratory pH measurements. In accordance with the Flowsheet, the revised GWCL for pH in MW-19 is 6.27-8.5 s.u., which is the mean - 2σ. That would be the appropriate GWCL, were a revised GWCL to be adopted. However, for the reasons discussed in Section 3.2 of the SAR, EFRI is not proposing that such a revised GWCL be adopted for MW-19. Rather, as discussed in Section 3.2 of the SAR and Section 2.5.4 above, EFRI proposes that the GWDP be amended to remove all GWCLs from MW-19 and upgradient wells MW-1 and MW-18.

3.4.11 MW-22

MW-22 is classified in the GWDP as a general monitoring well, and no GWCLs have been established in that well. Therefore field pH in MW-22 is not in out-of-compliance status. However, pH is showing a significantly decreasing trend (Appendix A-4). Analysis of indicator parameters shows no significantly increasing trends. In fact, chloride, sulfate, and uranium are

trending downward (Appendix D-5). As discussed in Section 2.5.1 above, it is not possible for pH related to tailings seepage to be detected faster than chloride. The decreasing trend in field pH in MW-22 can be attributed to natural background influences.

3.4.12 MW-23

MW-23 is not exhibiting a statistically significant decreasing trend; however, the trend is declining (Appendix A-4). Field pH in MW-23 is in out-of-compliance status due in part to the fact that the GWCL was set based on laboratory pH, not field pH. Analysis of indicator parameters (Appendix D-5) shows that chloride is exhibiting a significantly increasing trend. This trend in chloride was identified at the time of the New Wells Background Report, but was not a concern at that time because the concentration of chloride (less than 10 mg/L) was among the lowest at the site and the trend appeared to have been influenced disproportionately by one very low sample result taken in the early 2000s prior to the implementation of the GWDP. The current regression analysis for chloride in MW-23 is consistent with that previous analysis and does not appear to show a rising trend since the time of the New Wells Background Report. Fluoride and uranium are showing significantly decreasing trends.

Groundwater in MW-23 has therefore not changed significantly since the time of the New Wells Background Report. The out-of-compliance status of field pH in MW-23 can be attributed to natural background influences. The current GWCL for field pH in MW-23 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.97-8.5 s.u., which is the mean - 2σ.

3.4.13 MW-24

Field pH in MW-24 is both out of compliance and exhibiting a significantly decreasing trend (Appendix A-4). Cadmium and thallium in MW-24 are also out of compliance and were addressed in the SAR (INTERA, 2012).

Analysis of indicator parameters (Appendix D-5) shows no significantly increasing trends in chloride, fluoride, sulfate, or uranium. As discussed in Section 2.5.1.4 above, it is not possible for pH related to tailings seepage to be detected faster than chloride.

The out-of-compliance status of field pH in MW-24 can therefore be attributed to natural background influences and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL for field pH in MW-24 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.55-8.5, which is the mean - 2σ.

3.4.14 MW-25

Field pH in MW-25 is both out of compliance and showing a significantly decreasing trend (although recent data for the third quarter of 2012 has indicated that pH in MW-25 may now be in compliance). Uranium in MW-25 is also out of compliance and was addressed in the SAR (INTERA, 2012). As discussed in the SAR, the geochemical analysis of uranium in MW-25 shows a significantly increasing trend at the time of the SAR, but not at the time of the New Wells Background Report (see Appendix E-1 of the SAR, INTERA, 2012). However, other indicator parameters (chloride, fluoride, and sulfate) do not exhibit statistically significant increasing trends at this time (Appendix D-5) or at the time of the New Wells Background Report (see Appendix E-3 of the SAR, INTERA, 2012). In fact, chloride, fluoride, and sulfate are trending downward. For the reasons discussed in Section 4.3.1 of the SAR and Section 2.5.1 above, decreasing pH without increasing chloride is not indicative of any potential tailings cell leakage.

We have therefore concluded that potential tailings cell seepage is not impacting MW-25. The current GWCL for field pH in MW-25 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.77-8.5 s.u., which is the lowest historical value.

3.4.15 MW-26

Field pH in MW-26 is in out-of-compliance status; however, it does not have a significantly decreasing trend. In fact, MW-26 is one of the two wells at the Mill site that does not exhibit a downward trend in field pH.

MW-26 is a pumping well. In the SAR (INTERA, 2012), EFRI proposed continued sampling in pumping well MW-26 and upgradient wells MW-1, MW-18, and MW-19 for informational purposes only, and to eliminate the GWCLs for those wells. As a pumping well, MW-26 is being manipulated, and the impact on the quality of the water in that well from the pumping is unclear and cannot be predicted with enough certainty to establish compliance standards under the GWDP. MW-1, MW-18, and MW-19 are far upgradient from the Mill site and cannot be impacted by Mill activities. It is therefore not appropriate to establish compliance standards under the GWDP for those wells. However, although EFRI proposes that the GWCLs in those wells be eliminated, EFRI proposes to continue monitoring those wells at their normal, un-accelerated frequency for informational purposes only, and to help define background conditions at the site.

The geochemical analysis of indicator parameters in MW-26 shows that the behavior in the well, while inconsistent and erratic, has not changed significantly since the time of the Existing Wells Background Report. Uranium concentrations in MW-26 continue to show a significantly increasing trend (this trend was identified at the time of the Existing Wells Background Report).

A newly identified significantly increasing trend in chloride was identified, which could represent water drawn into the well from the nitrate/chloride plume and/or the chloroform plume (which is also associated with relatively high concentrations of chloride). Other indicator parameters, namely fluoride and sulfate, were not found to have significantly increasing trends at the time of the Existing Wells Background Report or at the time of this Report (Appendix D-5). See Appendices E-2 and E-3 of the SAR (INTERA, 2012) for regression plots for these indicator parameters at the time of the SAR and the Existing Wells Background Report, respectively.

As mentioned above, MW-26 is being manipulated, and the impact on the quality of the water in that well from the pumping is unclear and cannot be predicted with enough certainty to establish compliance standards under the GWDP. For example, pumping wells are intended to pull water in from areas of the perched aquifer that would normally flow into other wells. In fact, the pumping wells are having the effect of drawing down water levels in other wells (e.g., see Appendix D, Figure 2, in the second quarter 2007 Chloroform Monitoring report (DUSA, 2007)). This water may be associated with its own background quality that will impact the water quality in the pumping well. Any increasing or decreasing trends in constituents in pumping wells, such as MW-26, are therefore not unexpected and should be given little, if any, weight in analyzing potential impacts to groundwater from Mill activities.

As stated in the September 2009 Statement of Basis (UDRC, 2009) (page 23) in support of the January 20, 2010, revisions to the GWDP, "[i]t should be noted that, because MW-26 is a pumping well for chloroform removal, concentrations of all constituents in that well are subject to potential variation over time as a result of the pumping activity. This will be taken into account by the Executive Secretary in determining compliance for this well."

The current GWCL for pH in MW-26 is 6.74-8.5 s.u. For informational purposes, an updated GWCL for field pH in MW-26 of 5.61-8.5 s.u., based on the lowest historical value using all of the available data to date, has been calculated in accordance with the Flowsheet. That would be the appropriate GWCL, were a revised GWCL to be adopted. However, as discussed in Section 2.5.4 above, since GWCLs for pumping wells have no meaning, EFRI does not propose that a revised GWCL for field pH or any other parameter in MW-26 be adopted. Further, EFRI proposes that the Mill continue to pump and monitor MW-26, but that the GWDP be amended to remove all GWCLs for all constituents in MW-26.

3.4.16 MW-27

TDS in MW-27 is currently in out-of-compliance status and is addressed in the SAR. Field pH in MW-27 is not out of compliance, nor is it exhibiting a significantly decreasing trend (Appendix A-4). As discussed in Section 4.5.1 of the SAR, the geochemical evaluation of TDS

in MW-27 shows that TDS concentrations in this well are exhibiting a statistically significant increasing trend at this time, although not at the time of the New Wells Background Report (see Appendix E-1 of the SAR). Indicator parameters chloride and sulfate are also showing significantly increasing trends in this well today, but not at the time of the New Wells Background Report, although fluoride and uranium are currently showing significant downward trends in MW-27 (see Appendix E-3 of the SAR). The location of this well is important when determining potential sources of contamination. MW-27 is located at the margin of the nitrate/chloride plume (Figure 3 of the SAR), which has been the subject of many studies that are described in detail in the following reports:

- Nitrate Contamination Investigation Report (INTERA, 2009)
- Quarterly Nitrate Reports (EFRI, 2009–2012)

A mass balance was performed and presented in the December 30, 2009, Nitrate Contamination Investigation Report, where one of the suggested possibilities was a groundwater mound from the tailings cells that might cause elevated nitrate and chloride concentrations upgradient in the area of the nitrate/chloride plume. The nitrate/chloride plume with associated sulfate in groundwater is the cause of the increase in TDS observed in monitor well MW-27 located at the margins of the plume in areas where increases would be expected. A calculation for nitrate to evaluate this possibility (a calculation for chloride would be similar) suggests that on the order of 11 percent tailings solution (assuming the highest recently observed nitrate concentration in the tailings of 290 mg/L) would have to mix with unimpacted groundwater (assuming 1 mg/L) to account for the observed mass of nitrate in groundwater, assuming an average nitrate concentration in the plume above the 20 mg/L isopleth of 30 mg/L.

The size of the nitrate plume above 20 mg/L is approximately 40 acres, or 1,800,000 square feet in map area. Assuming 45 feet of saturation (INTERA, 2009) and a porosity of 0.2, there are 16,200,000 cubic feet or 121,176,000 gallons of groundwater in that area. Eleven percent of that is 13,329,360 gallons (approximately 41 acre feet), which is a conservative estimate of the volume of tailings solution that would have to be mixed with groundwater to account for the mass of nitrate in the portion of the plume above 20 mg/L nitrate.

Assume:

- Nitrate concentration in tailings solution 290 mg/L
- Nitrate concentration in un-impacted groundwater 1 mg/L
- Average plume concentration 30 mg/L

Mixing equation: $C_t*V_t + C_g*V_g = C_m*V_m$ (eq 1)

Where: C_t = Concentration of nitrate in tailings solutions

V_t = Volume of tailings solutions

C_g = Concentration of nitrate in unimpacted groundwater

V_g = Volume of unimpacted groundwater

C_m = Concentration of nitrate in mixture of groundwater and tailings solutions

V_m = Volume of mixture of groundwater and tailings solutions

Another equation: $V_t + V_g = V_m$ (eq 2)

Substituting eq2 in eq1: $C_t*V_t + C_g*V_g = C_m* (V_t + V_g)$ (eq 3)

Substitute nitrate concentrations in eq 3:

$290*V_t + 1*V_g = 30*(V_t + V_g)$

$290*V_t + 1*V_g = 30*V_t + 30*V_g$

$260*V_t = 29*V_g$

$V_t = 29/260*V_g = 0.11*V_g$

The volume of tailings solution would have to be 11 percent of the volume of un-impacted groundwater in the mixture.

That theoretical volume of potential seepage from the tailings cells would certainly generate a detectable groundwater mound. Such a mound would have to be on the order of 5 feet on average over the entire 40 acres, but would likely be much higher than that at the centroid of the theoretical plume (beneath the tailings cells) and would taper off toward the edges of the plume. However, no such mounding exists under the tailings cells. While groundwater mounding can be observed towards the eastern portion of the site, away from the tailings cells, it is clearly related to the wildlife ponds and not the tailings cells. Equally as important, if the concentration of nitrate in tailings documented in the Statement of Basis for the 2005 GWDP (24 mg/L) or as documented in the annual tailings sampling and analysis, were used in the calculation, no amount of tailings solution would bring the plume concentration to 30 mg/L.

MW-27 is on the margin of the nitrate-chloride plume where concentrations of plume constituents would be most likely to change. Based on the current average chloride concentration in Cell 1 of 25,230 mg/L and the current average nitrate concentration of 192 mg/L any potential seepage from Cell 1 would have a chloride/nitrate ratio of over 130. Current chloride/nitrate ratios in the nitrate-chloride plume are in the range of 2 to 28, indicating that the chloride-nitrate

plume does not represent tailings seepage. With respect to MW-27, the current chloride and nitrate concentrations (see the 2nd Quarter 2012 Groundwater Monitoring Report for the Mill) are 46 mg/L and 6.2 mg/L, respectively, yielding a ratio of 7.4, which is well below the ratio expected from any potential tailings cell seepage.

It is also important to note that, as discussed in more detail in Section 3.3 above, MW-27 was included in the University of Utah Study, in which Hurst and Solomon concluded that "stable isotope fingerprints do not suggest contamination of groundwater by tailings cell leakage, evidence that is corroborated by trace metal concentrations similar to historically-observed concentrations." With respect to MW-27, specifically, Hurst and Solomon noted that "$D^{34}S$-SO_4 and $\delta^{18}O$-SO_4 fingerprints closely relate MW-27 to wildlife pond water, while the exceptionally low concentration of sulfate in MW-27, the only groundwater site to exhibit sulfate levels below 100 mg/L, suggest no leachate from the tailings cells has reached the well."

We therefore conclude that the increased nitrate and chloride concentrations around MW-27 are not caused by any potential tailings cell seepage. Since nitrate and chloride form a substantial part of TDS, it is expected that increases in nitrate and chloride in MW-27 would lead to corresponding increases in TDS in that well. As a result, the out-of-compliance status of TDS in MW-27 is likely due to the impacted groundwater of the nitrate/chloride plume.

We have therefore concluded that potential tailings cell seepage is not impacting MW-27. The current GWCL for field pH in MW-27 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 6.47-8.5 s.u., which is the mean - 2σ.

3.4.17 MW-28

Field pH in MW-28 is in out-of-compliance status, but does not exhibit a significantly decreasing trend (Appendix A-4). Analysis of indicator parameters (Appendix D-5) shows a significantly increasing trend in chloride; however, fluoride, sulfate, and uranium are trending downward, fluoride significantly. Chloride was trending upward, although not significantly at the time of the New Wells Background Report (see Appendix E-3 of the SAR).

MW-28 is on the margin of the chloride plume where concentrations of plume constituents would be most likely to change, but is outside of the nitrate plume (see Figures I-1 and I-2 of the 2nd Quarter 2012 Nitrate Monitoring Report for the Mill). Since all of the other indicator parameters are trending downward, with fluoride, the most mobile indicator other than chloride (see Section 2.5.1), significantly trending downward, the increasing trend in chloride is considered to be caused by the chloride plume and not by any potential tailings cell seepage.

For this reason, the out-of-compliance status for field pH in MW-28 can be attributed to natural influences, and/or the improperly set current GWCLs that are based on laboratory pH. The current GWCL is 6.1-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL, based on field pH is 5.58-8.5 s.u., which is the mean - 2σ.

3.4.18 MW-29

Field pH in MW-29 is in out-of-compliance status, but does not exhibit a significantly increasing trend (Appendix A-4). TDS was just identified as being out of compliance as of fourth quarter 2012.

Analysis of indicator parameters (Appendix D-5) shows a significantly increasing trend in uranium. Uranium in MW-29 was showing an increasing trend, although it was not significant, at the time of the New Wells Background Report. Chloride, fluoride, and sulfate in MW-29 are exhibiting downward trends. As discussed in Section 2.5.1.4 above, decreasing pH without increasing chloride is not indicative of potential tailings cell leakage.

The out-of-compliance status of field pH in MW-29 can be attributed to the fact that the existing GWCL was improperly calculated, based on laboratory pH data. The current GWCL for field pH is 6.46-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL, based on field pH data, is 5.94-8.5 s.u., which is the mean - 2σ.

3.4.19 MW-30

Field pH in MW-30 is exhibiting a significantly decreasing trend (Appendix A-4). Analysis of indicator parameters (Appendix D) shows that chloride is significantly increasing. As discussed in Section 4.3.3 and Section 5.0 of the SAR (INTERA, 2012), MW-30 is located at the margins of the nitrate/chloride plume, and it is likely that groundwater in this well is being impacted by that plume. The nitrate/chloride plume is already being addressed by corrective actions. Sulfate is showing a significant decreasing trend in MW-30, and fluoride is also showing a decreasing trend (although not statistically significant), while uranium is relatively low for the site but is showing an upward trend that is not statistically significant.

As described above, MW-30 is on the margin of the nitrate-chloride plume where concentrations of plume constituents would be most likely to change. Based on the current average chloride concentration in Cell 1 of 25,230 mg/L and the current average nitrate concentration of 192 mg/L any potential seepage from Cell 1 would have a chloride/nitrate ratio of over 130. Current chloride/nitrate ratios in the nitrate-chloride plume are in the range of 2 to 28, indicating that the chloride-nitrate plume does not represent tailings seepage. With respect to MW-30, the current chloride and nitrate concentrations (see the 2nd Quarter 2012 Groundwater Monitoring Report for

the Mill) are 124 mg/L and 16 mg/L, respectively, yielding a ratio of 7.75, which is well below the ratio expected from any potential tailings cell seepage.

Therefore, the increasing trend in chloride in MW-30 can be attributed to the nitrate/chloride plume and is not indicative of potential tailings cell impacts. The decline in pH at MW-30 can therefore be attributed to natural influences. The current GWCL for field pH in MW-30 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 6.47-8.5, which is the mean - 2σ.

3.4.20 MW-31

Sulfate and TDS in MW-31 are in out-of-compliance status and were addressed in the SAR (INTERA, 2012). Field pH in MW-31 is not significantly decreasing, nor is it out of compliance.

As discussed in Section 4.5.1 of the SAR, MW-31 is located on the downgradient margin of the nitrate/chloride plume (Figure 3 of the SAR). Sulfate and TDS in MW-31 have a significantly increasing trend (see Appendix E-2 of the SAR). These trends were not apparent at the time of the New Wells Background Report (see Appendix E-3 of the SAR). TDS and indicator parameter chloride are also showing significantly increasing trends (see Appendix D-5 of this Report and Appendices E-1 and E-2 of the SAR), although fluoride is showing a significantly decreasing trend and uranium is trending downward in MW-31.

MW-31 is on the margin of the nitrate-chloride plume where concentrations of plume constituents would be most likely to change. Based on the current average chloride concentration in Cell 1 of 25,230 mg/L and the current average nitrate concentration of 192 mg/L any potential seepage from Cell 1 would have a chloride/nitrate ratio of over 130. Current chloride/nitrate ratios in the nitrate-chloride plume are in the range of 2 to 28, indicating that the chloride-nitrate plume does not represent tailings seepage. With respect to MW-31, the current chloride and nitrate concentrations (see the 2nd Quarter 2012 Groundwater Monitoring Report for the Mill) are 151 mg/L and 20 mg/L, respectively, yielding a ratio of 7.55, which is well below the ratio expected from any potential tailings cell seepage.

As discussed in the SAR, MW-31 was included in the University of Utah Study, where Hurst and Solomon concluded that "[s]table isotope fingerprints do not suggest contamination of groundwater by tailings cell leakage, evidence that is corroborated by trace metal concentrations similar to historically-observed observations." However, groundwater in MW-31 is being impacted by the nitrate/ chloride plume.

Current sulfate concentrations in MW-31 are among the lowest at the Site. Other monitor wells show sulfate concentrations that are three to seven times higher than those in MW-31. A mass

balance for sulfate would therefore be unlikely to be useful in identifying a potential tailings seepage source given that nearby wells all show significantly higher sulfate concentrations, which have previously been determined to represent background.

The geochemical evaluation of TDS in MW-31 shows that TDS concentrations in this well is exhibiting a statistically significant increasing trend at this time, although not at the time of the New Wells Background Report (see Appendix E-1 of the SAR). Indicator parameters chloride and sulfate are also showing significantly increasing trends in this well today (Appendix D-5), but not at the time of the New Wells Background Report, although fluoride and uranium are currently showing significant downward trends in MW-31 (see Appendices E-2 and E-3 of the SAR). The location of this well is important when determining potential sources of contamination. MW-31 is located at the margin of the nitrate/chloride plume (Figure 3 of the SAR), which has been the subject of many studies that are described in detail in the following reports:

- Nitrate Contamination Investigation Report (INTERA, 2009)
- Quarterly Nitrate Reports (EFRI, 2009–2012)

A mass balance was performed and presented in the December 30, 2009, Nitrate Contamination Investigation Report, where one of the suggested possibilities was a groundwater mound from the tailings cells that might cause elevated nitrate and chloride concentrations upgradient in the area of the nitrate/chloride plume. The nitrate/chloride plume with associated sulfate in groundwater is the cause of the increase in TDS observed in monitor well MW-31 located at the margins of the plume in areas where increases would be expected. A calculation for nitrate to evaluate this possibility (a calculation for chloride would be similar) suggests that on the order of 11 percent tailings solution (assuming the highest recently observed nitrate concentration in the tailings of 290 mg/L) would have to mix with unimpacted groundwater (assuming 1 mg/L) to account for the observed mass of nitrate in groundwater, assuming an average nitrate concentration in the plume above the 20 mg/L isopleth of 30 mg/L.

We therefore conclude that the increased nitrate and chloride concentrations around MW-31 are not caused by any potential tailings cell seepage. Since nitrate and chloride form a substantial part of TDS, it is expected that increases in nitrate and chloride in MW-31 would lead to corresponding increases in TDS in that well. As a result, the out-of-compliance status of TDS in MW-31 is likely due to the impacted groundwater of the nitrate/chloride plume.

The out-of-compliance status of field pH in MW-31 can be attributed to the fact that the existing GWCL was improperly calculated, based on laboratory pH data. The current GWCL for field pH,

based on laboratory pH data, is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL, based on field pH data, is 6.57-8.5 s.u., which is the mean - 2σ.

3.4.21 MW-32

Field pH in MW-32 is in out-of-compliance status and is exhibiting a significantly decreasing trend (Appendix A-4). Analysis of indicator parameters (Appendix D-5) shows that chloride, fluoride, sulfate, and uranium are all trending downward; however, those trends are not statistically significant. As discussed in Section 2.5.1.4 above, declining pH without increasing chloride is not indicative of potential tailings cell seepage.

The declining trend and out-of-compliance status for field pH in MW-32 can be attributed to natural influences. The current GWCL for field pH in MW-32 is 6.4-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL is 5.31-8.5 s.u., which is the mean -2σ.

3.5 Remaining Compliance Monitoring Wells

As mentioned in Section 5.2.4 above, all current GWCLs for pH at the site were incorrectly set, based on laboratory pH. The GWCLs in all compliance monitoring wells must therefore be recalculated based on field pH data. Compliance monitoring wells MW-1 and MW-2 are not out of compliance for pH, do not have significant decreasing trends in pH, and do not have any other constituents in out-of-compliance status. Based on the Flowsheet, the following GWCLs would be set for these wells:

MW-1: The current GWCL for field pH in MW-1 is 6.77-8.5 s.u. The revised GWCL for field pH in MW-1 would be 6.68-8.5 s.u., which is the mean - 2σ, in accordance with the Flowsheet. That would be the appropriate GWCL, were a revised GWCL to be adopted. However, for the reasons discussed in Section 3.2 of the SAR, EFRI is not proposing that such a revised GWCL be adopted for MW-1. Rather, as discussed in Section 3.2 of the SAR and Section 2.5.4 above, EFRI proposes that the GWDP be amended to remove all GWCLs from MW-1 and upgradient wells MW-18 and MW-19.

MW-2: The current GWCL for field pH in MW-2 is 6.5-8.5 s.u. In accordance with the Flowsheet, the proposed revised GWCL, based on field pH data, is 6.72-8.5 s.u., which is the mean - 2σ.

3.6 Summary of Findings from the SAR

The following section presents constituents cadmium, manganese, selenium, thallium, and uranium which are in out-of-compliance status in certain wells at the Mill site (see Appendix

A-1 of the SAR) and may be the result of declining pH. For a full discussion of the geochemical analysis associated with these constituents, see Section 4.3 of the SAR (INTERA, 2012).

Cadmium is more mobile in groundwater with low pH. The dominant cadmium species in groundwater below a pH value of 8.2 is Cd^{2+} (Rai and Zachara, 1984). At low pH (greater abundance of H_30^+ ions), there is greater competition for negative adsorption sites that might remove Cd^{2+} ions from solution. Therefore, Cd^{2+} concentrations are expected to increase in groundwater as pH falls.

Manganese can exist in +2, +3, +4, and +7 oxidation states. Under the reducing conditions that exist in groundwater at the Mill site, the dominant form of manganese in solution is the cation Mn^{2+}. At low pH (greater abundance of H_30^+ ions), there is greater competition for negative adsorption sites that might remove Mn^{2+} ions from solution. Therefore, Mn^{2+} concentrations are expected to increase in groundwater as pH falls.

Selenium may be more mobile in groundwater with low pH. Native selenium is stable in mildly oxidizing to extremely reducing conditions (Brookins, 1988). Decreasing pH may increase the solubility of native selenium (Mayland et al., 1991).

Under the reducing conditions that exist in groundwater at the Mill site, the dominant form of thallium in solution is the cation Tl^+. At low pH (greater abundance of H_30^+ ions), there is greater competition for negative adsorption sites that might remove Tl^+ ions from solution. Therefore, Tl^+ concentrations are expected to increase in groundwater as pH falls.

Uranium oxides are stable mineral phases at mildly to strongly reducing conditions such as those found in groundwater at White Mesa (Brookins, 1988). A decrease in pH increases the solubility of uranium oxides, causing concentrations of uranium to increase in groundwater.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The site-wide decline of pH is occurring in perched wells cross-gradient, upgradient, and downgradient of the Mill, suggesting that the potential causes are not related to Mill operation. Potential causes of the site-wide decline of pH may be the result of physical interactions, geochemical phenomenon, natural processes, or some combination of all of these factors. Physical interactions such as over-pumping, over-developing, and increased sample frequency and the associated increased purging of the perched wells may be contributing factors. The decreasing trends in data from 2005 through the first half of 2012 supports this hypothesis, as the foregoing physical interactions increased with the implementation of the GWDP in 2005. A geochemical phenomenon (such as the oxidation of pyrite) is a potential mechanism for the decline in pH and could be enhanced by increased oxygen transport resulting from these physical interactions. Natural processes such as drought conditions which may increase the rate of oxygen transport in the vadose zone may also be contributing factors.

Although not necessarily the only or primary cause, the oxidation of pyrite (or other sulfides) is expected to occur site-wide because pyrite has been noted in borings across the entire site (including borings located upgradient, cross-gradient, and downgradient of the Mill and tailings cells) and there is a general increase in groundwater elevation site-wide. Groundwater elevation data is generally consistent with pH data in that most wells that show increases in groundwater elevation show decreasing pH trends and the few wells that show decreases in groundwater elevation show rising pH trends. The correlation between groundwater elevation and pH may be due to infiltration of oxidized water from the wildlife ponds reacting with pyrite in the aquifer matrix or rising water levels invading previously air filled pore space causing dissolution of pyrite that is reacting with oxygen in the presence of water. This hypothesis, together with the potential impact to groundwater from increased sampling activities discussed above, is being tested by HGC, and a report will be submitted under separate cover (HGC, 2012a). Regardless of the outcome of the pyrite investigation specified in this pH plan, it appears that the pH decline is a site-wide phenomenon resulting from one or more non-Mill related factors.

Background at the Mill site has been recently thoroughly studied in the Background Reports and in the University of Utah Study. Both the Background Reports (INTERA, 2007a, 2007b, 2008) and the University of Utah Study (Hurst and Solomon, 2008) concluded that groundwater at the site has not been impacted by Mill operations. Both of those studies also acknowledged that there are natural influences at play at the site that have given rise to increasing water trends and general variability of background groundwater at the site.

As identified at the time of the Background Reports, evidence of a site-wide decline in pH can be observed when plotting field measurements against time. The results of the analyses show that

there is not a single case where significantly decreasing pH can be linked with potential tailings seepage. Significant decline in pH can be observed in upgradient and far downgradient wells, which have been determined, through extensive studies including the University of Utah study (Hurst and Solomon, 2008), the Background Reports (INTERA, 2007a, 2007b, 2008), and the Site Hydrology Report (HGC, 2012b), to not be impacted by Mill activities.

Further, wells closer to the Mill site that are exhibiting significantly declining pH do not have support from the indicator parameters in those wells to show evidence of potential impact from tailings cells.

Revised GWCLs have been proposed. EFRI maintains that GWCLs for constituents in wells with significantly increasing trends (decreasing pH) should be revised regularly, as is recommended by the EPA's Unified Guidance (EPA, 2009), to account for the trends and to minimize unwarranted out-of-compliance status in such wells.

5.0 REFERENCES

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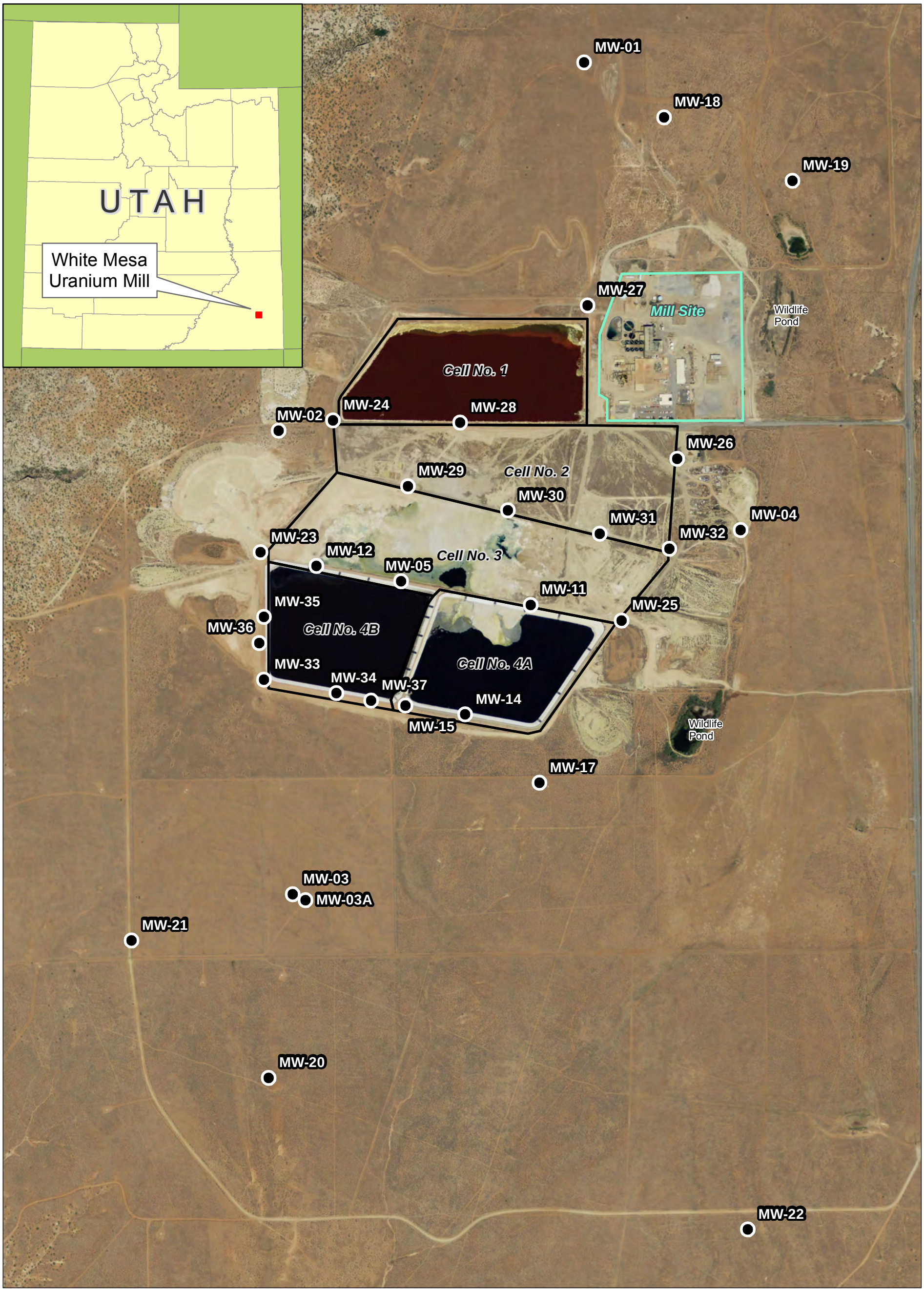
FIGURES



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Feet

Legend
Groundwater Monitoring Wells

Source(s): Aerial – NAIP Utah 2011;
Wells – HGC, Inc., May 2008 report.

Figure 1
Location of White Mesa Mill Site
pH Report

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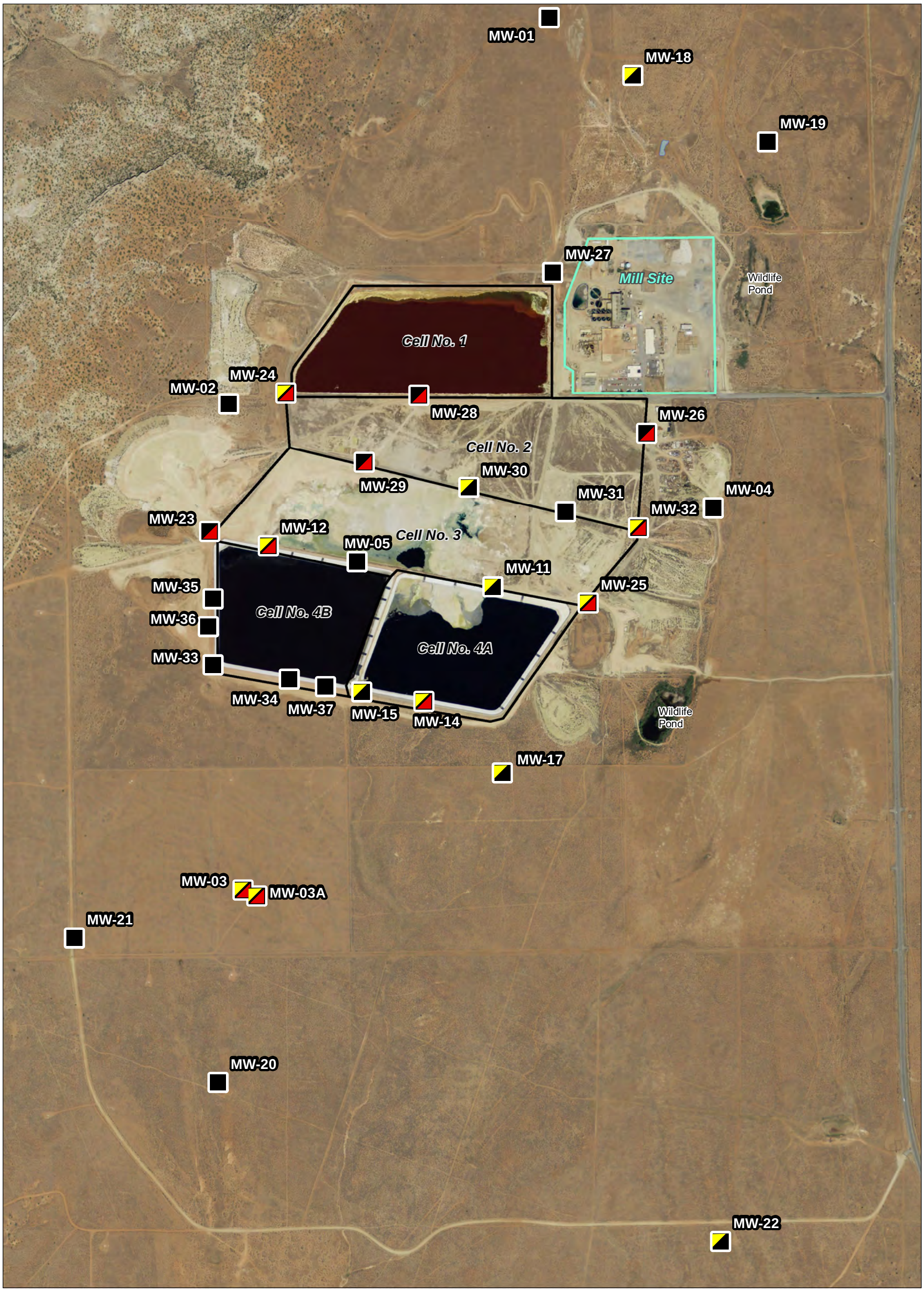

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Out of Compliance status for field pH

Significantly decreasing pH trend

Source(s): Aerial – NAIP Utah 2011;
Wells – HGC, Inc., May 2008 report;

Figure 2
Wells with pH exceedences
and significant decreasing pH trends
pH Report

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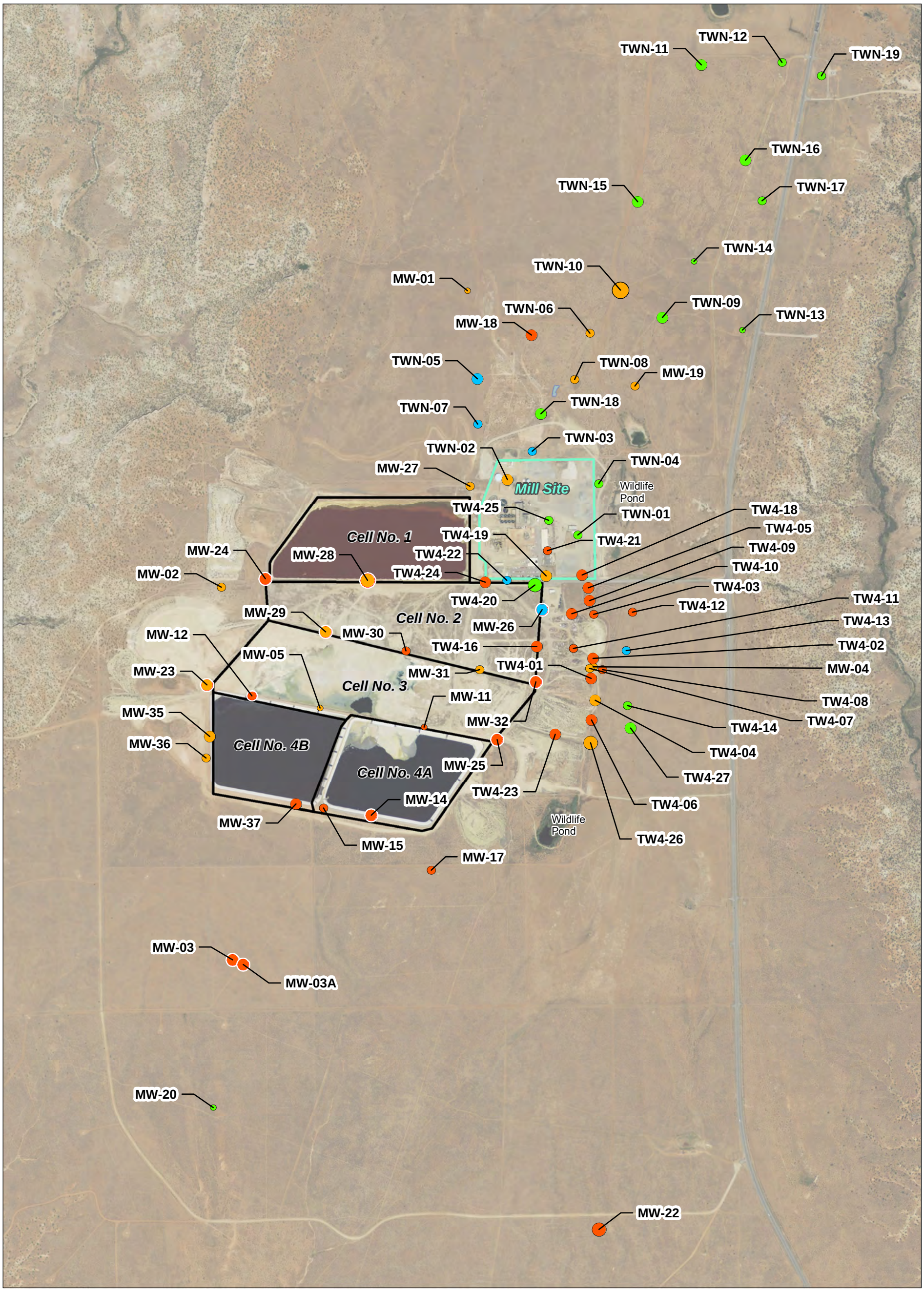

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Average pH	pH Compliance and Trends
3.97 - 4.23	Out of Compliance
4.24 - 6.39	Significantly Decreasing pH
6.40 - 6.87	Decreasing pH
6.88 - 7.30	Increasing pH
7.31 - 8.40	No Trend

INTERA

Source(s): Aerial – NAIP Utah 2011;
Wells – HGC, Inc., May 2008 report;

Figure 3
Circle plot of pH in all wells at the site
pH Report

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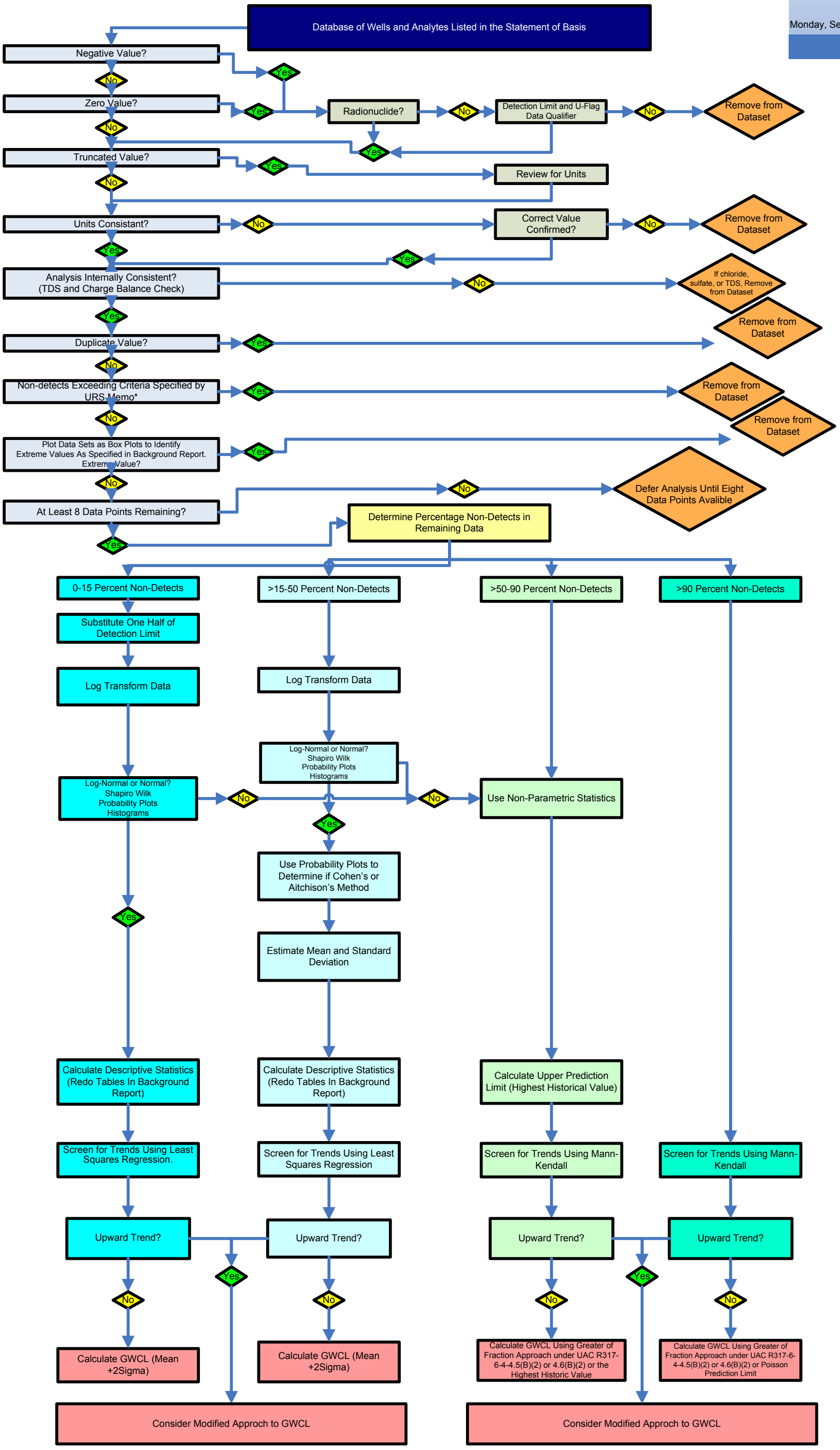
Groundwater Data Preparation and Statistical Process Flow for Calculating Groundwater Protection Standards, White Mesa Mill Site, San Juan County, Utah

Monday, September 24, 2012



*A non-detect considered "insensitive" will be the maximum reporting limit in a dataset and will exceed other non-detects by, for example, an order of magnitude (e.g., <10 versus <1.0 µg/L). In some cases, insensitive non-detects may also exceed detectable values in a dataset (e.g., <10 versus 3.5 µg/L).

Figure 4
Groundwater Data Preparation and Statistical Process Flow for Calculating Ground Water Compliance Limits, White Mesa Mill Site, San Juan County, Utah.

INTERA

TABLES

TABLE 1
Field PH Exhibiting Significantly Decreasing Trend or Out-of-Compliance Status

Well	Out of Compliance Status?	Significant Decreasing Trend?
MW-01	No	No
MW-02	No	No
MW-03	Yes	Yes
MW-03A	Yes	Yes
MW-05	No	No
MW-11	No	Yes
MW-12	Yes	Yes
MW-14	Yes	Yes
MW-15	No	Yes
MW-17	No	Yes
MW-18	No	Yes
MW-19	No	No
MW-20	No	No
MW-22	No	Yes
MW-23	Yes	No
MW-24	Yes	Yes
MW-25	Yes	Yes
MW-26	Yes	No
MW-27	No	No
MW-28	Yes	No
MW-29	Yes	No
MW-30	No	Yes
MW-31	No	No
MW-32	Yes	Yes
MW-35	No	No
MW-36	No	No
MW-37	No	Yes

TABLE 2
Out-of-Compliance Constituents Potentially Impacted by Decreasing pH Trends Across the Site

Constituent	Well
Cadmium	MW-24
Manganese	MW-11
Selenium	MW-12
	MW-3
	MW-30
	MW-3A
Thallium	MW-18
	MW-24
Uranium	MW-5
	MW-25
	MW-26

TABLE 3
Field pH Analysis Summary and Revised GWCLs

Well	N	Out-of-Compliance Status for Field pH?	Out-of-Compliance Status for Other Parameters?	Indicator Parameter with Significantly Increasing Trends	Shapiro-Wilks Test for Normality			Least Squares Regression Trend Analysis[a]		Mann-Kendall Trend Analysis[b]		Significant Trend	General Trend[c]	Trend Using Data through 2004	Trend Using Data 2005-present	Mean	Std.Dev.	Minimum	Maximum	Mean - 2σ	Current GWCL	Proposed GWCL	Rationale
					W	p	Normally or Lognormally distributed?	r^2	p	S	p												
MW-01	41	No			0.9690	0.3187	Yes	0.0560	0.1364			No	down	down (NS)	down (NS)	7.32	0.32	6.70	8.05	6.68	6.77-8.5	6.68-8.5	Mean - 2σ
MW-02	34	No			0.9738	0.5729	Yes	0.0523	0.1933			No	down	down (NS)	down (NS)	7.10	0.19	6.71	7.48	6.72	6.5-8.5	6.72-8.5	Mean - 2σ
MW-03	45	Yes	F, Se	F, SO4, U	0.9840	0.7802	Yes	0.2806	0.0002			Yes	down	down (NS)	down (NS)	6.58	0.27	5.95	7.11	6.04	6.5-8.5	6.04-8.5	Mean - 2σ
MW-03A	28	Yes	Se, SO4,	none	0.9382	0.0993	Yes	0.1827	0.0233			Yes	down	NA	NA	6.53	0.35	5.90	7.62	5.84	6.5-8.5	5.84-8.5	Mean - 2σ
MW-05	63	No	U	F	0.9875	0.7725	Yes	0.0440	0.0988			No	down	up (NS)	down (NS)	7.52	0.24	7.00	8.10	7.04	6.5-8.5	7.04-8.5	Mean - 2σ
MW-11	91	No	Mn	SO4	0.9711	0.0406	No	0.0561	0.0238	-924	7.76E-04	Yes	down	down (NS)	down (Sig)	7.68	0.39	6.25	9.00	6.90	6.5-8.5	6.25-8.5	LHV
MW-12	65	Yes	Se	U	0.9615	0.0411	No	0.1395	0.0022	-631	1.79E-04	Yes	down	up (NS)	down (NS)	6.87	0.33	5.86	7.90	6.21	6.5-8.5	5.86-8.5	LHV
MW-14	114	Yes		U	0.9416	0.0001	No	0.1308	0.0001	-1981	6.17E-07	Yes	down	down (NS)	down (NS)	6.62	0.35	5.42	7.75	5.93	6.5-8.5	5.42-8.5	LHV
MW-15	60	No		U	0.9525	0.0205	No	0.1219	0.0063	-578	1.15E-04	Yes	down	up (NS)	down (NS)	6.92	0.29	5.88	7.50	6.34	6.62-8.5	5.88-8.5	LHV
MW-17	59	No		none	0.9616	0.0602	Yes	0.1517	0.0023			Yes	down	up (NS)	down (NS)	6.93	0.33	6.03	8.10	6.27	6.4-8.5	6.27-8.5	Mean - 2σ
MW-18	38	No	TDS, Tl	Cl, SO4, U	0.9718	0.4420	Yes	0.3275	0.0002			Yes	down	down (NS)	down (Sig)	6.65	0.39	5.82	7.38	5.87	6.25-8.5	5.87-8.5	Mean - 2σ
MW-19	36	No	NO3	none	0.9769	0.6396	Yes	0.1063	0.0523			No	down	down (NS)	down (Sig)	6.99	0.36	6.09	7.72	6.27	6.78-8.5	6.27-8.5	Mean - 2σ
MW-20[d]	16	No			0.7520	0.0007	No	0.0185	0.6156	-29	0.103	No	up	NA	up (NS)	7.20	0.26	6.89	8.05	6.67		NA	NA
MW-22	17	No		none	0.9582	0.5980	Yes	0.2581	0.0374			Yes	down	NA	down (Sig)	5.72	0.31	5.05	6.38	5.11		NA	NA
MW-23	31	Yes		none	0.9714	0.5575	Yes	0.0645	0.1681			No	down	NA	down (NS)	6.60	0.32	5.74	7.19	5.97	6.5-8.5	5.97-8.5	Mean - 2σ
MW-24	25	Yes	Cd, Tl	none	0.9655	0.5348	Yes	0.4488	0.0002			Yes	down	NA	down (Sig)	6.50	0.48	5.73	7.54	5.55	6.5-8.5	5.55-8.5	Mean - 2σ
MW-25	41	Yes	U	U	0.9341	0.0198	No	0.1169	0.0287	-180	0.0221	Yes	down	NA	down (Sig)	6.64	0.26	5.77	7.25	6.13	6.5-8.5	5.77-8.5	LHV
MW-26	86	Yes	U, NO3, CHCl3 CL, CH3Cl2	Cl, U	0.9679	0.0309	No	0.0002	0.9077	160	0.277	No	flat	NA	none	6.64	0.36	5.61	7.88	5.92	6.74-8.5	5.61-8.5	LHV
MW-27	31	No	TDS, NO3, Cl	Cl, SO4	0.9554	0.2200	Yes	0.0592	0.1872			No	down	NA	down (NS)	7.06	0.30	6.39	7.68	6.47	6.5-8.5	6.47-8.5	Mean - 2σ
MW-28	32	Yes	Cl	Cl	0.9599	0.2727	Yes	0.1052	0.0701			No	down	NA	down (NS)	6.01	0.22	5.39	6.34	5.58	6.1-8.5	5.58-8.5	Mean - 2σ
MW-29	26	Yes	TDS*	U	0.9657	0.5152	Yes	0.0439	0.3041			No	down	NA	down (NS)	6.44	0.25	5.78	6.92	5.94	6.46-8.5	5.94-8.5	Mean - 2σ
MW-30	48	No	Se, NO3, CL,	Cl	0.9779	0.4947	Yes	0.1071	0.0232			Yes	down	NA	down (Sig)	6.88	0.20	6.52	7.47	6.47	6.5-8.5	6.47-8.5	Mean - 2σ
MW-31	48	No	SO4, TDS, NO3, Cl	Cl, SO4	0.9534	0.0548	Yes	0.0670	0.0757			No	down	NA	down (NS)	7.13	0.28	6.16	7.80	6.57	6.5-8.5	6.57-8.5	Mean - 2σ
MW-32	81	Yes		none	0.9610	0.0146	No	0.0354	0.0927	-670	0.00317	Yes	down	NA	down (Sig)	6.34	0.30	5.31	7.04	5.75	6.4-8.5	5.31-8.5	LHV
MW-35[e]	16	No	Mn, Se, Tl, U, GA	none	0.9403	0.3528	Yes	0.2293	0.0606			No	down	NA	down (NS)	6.70	0.33	6.25	7.46	6.05		NA	NA[e]
MW-36[e]	5	No			0.8695	0.2644	Yes	0.5726	0.1387			No	up	NA	up (NS)	6.91	0.21	6.57	7.10	6.50		NA	<8N[e]
MW-37[e]	5	No			0.8901	0.3574	Yes	0.8347	0.0301			Yes	down	NA	down (Sig)	6.76	0.11	6.65	6.89	6.55		NA	<8N[e]

Notes:

* = TDS in ME-29 is a newly identified dual exceedance as of 4Q2012
σ = sigma
N = number of valid data points

NA = not applicable
p = probability
r2 = The measure of how well the trendline fits the data where r2=1 represents a perfect fit.

S = MannKendall statistic
S.U. = standard units
W = Shapiro Wilk test value

(NS) = not signifcant
(Sig) = Significant

a = A regression test was performed on data from all wells, whether or not the data were normally/lognorally distributed
b = The Mann-Kendall test was performed on data that were not normally/lognormally distributed
c = The General Trend is the trend identified by looking at the regression plots
d = Well revelopment in MW-20 has resulted in very low water production in this well. Data from this well are unreliable.
e = GWCLs for all permit constituents in MW-35 , MW-36, and MW-37 will be proposed when the Background Report for those wells is submitted.
Regression Trend = The result of the linear regression test analysis using 1/2 of the detection limit for values reported as "not detected"
Mann-Kendall Trend = The result of the Mann-Kendall test for non-parametric distributions and for % Detect < 50%

Mean = The arithmatic, Cohen, or Aitchison mean as determined for normally or log-normally distributed constituents with % Detect > 50%
Standard Deviation = The standard deviation as determined for normally or log-normally distributed constituents with % Detect > 85%
Minimum = lowest value in the data set (extreme outliers excluded)

Maximum = highest value in the dataset (extreme outliers excluded)
Proposed GWCL = The Groundwater Compliance Limit as determined by the Flow Sheet

GWCLs for all permit constituents in MW-35 , MW-36, and MW-37 will be proposed when the Background Report for those wells is submitted.

Upgradient wells that EFRI proposes to continue sampling, but remove GWCLs for all GWDP constituents
Monitoring wells that are not compliance wells and therefore have no GWCLs
Pumping well that EFRI proposes to continue sampling, but remove GWCLs for all GWDP constituents

APPENDIX A

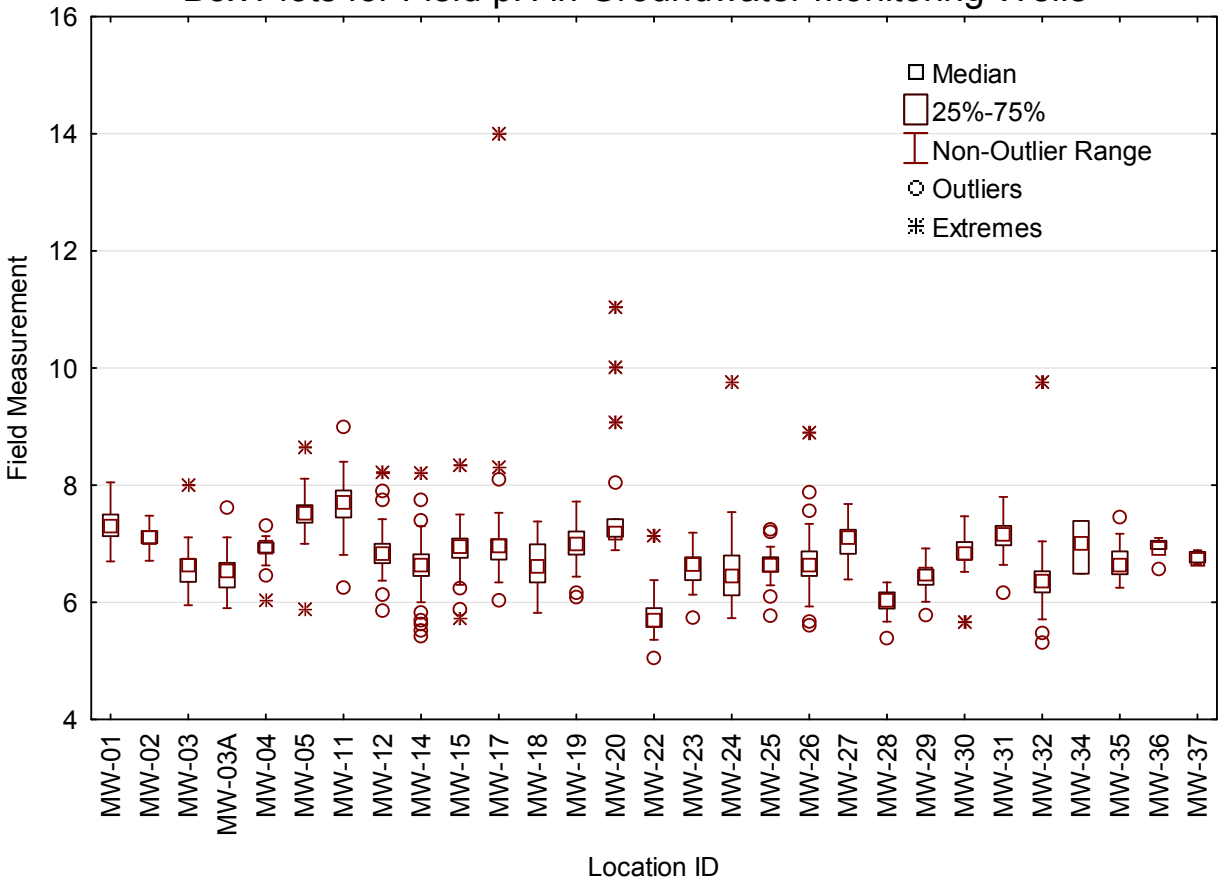
Statistical Analysis of Field PH in Groundwater Monitoring Wells

APPENDIX A-1

Box Plot for Field pH in Groundwater Monitoring Wells

Appendix A-1

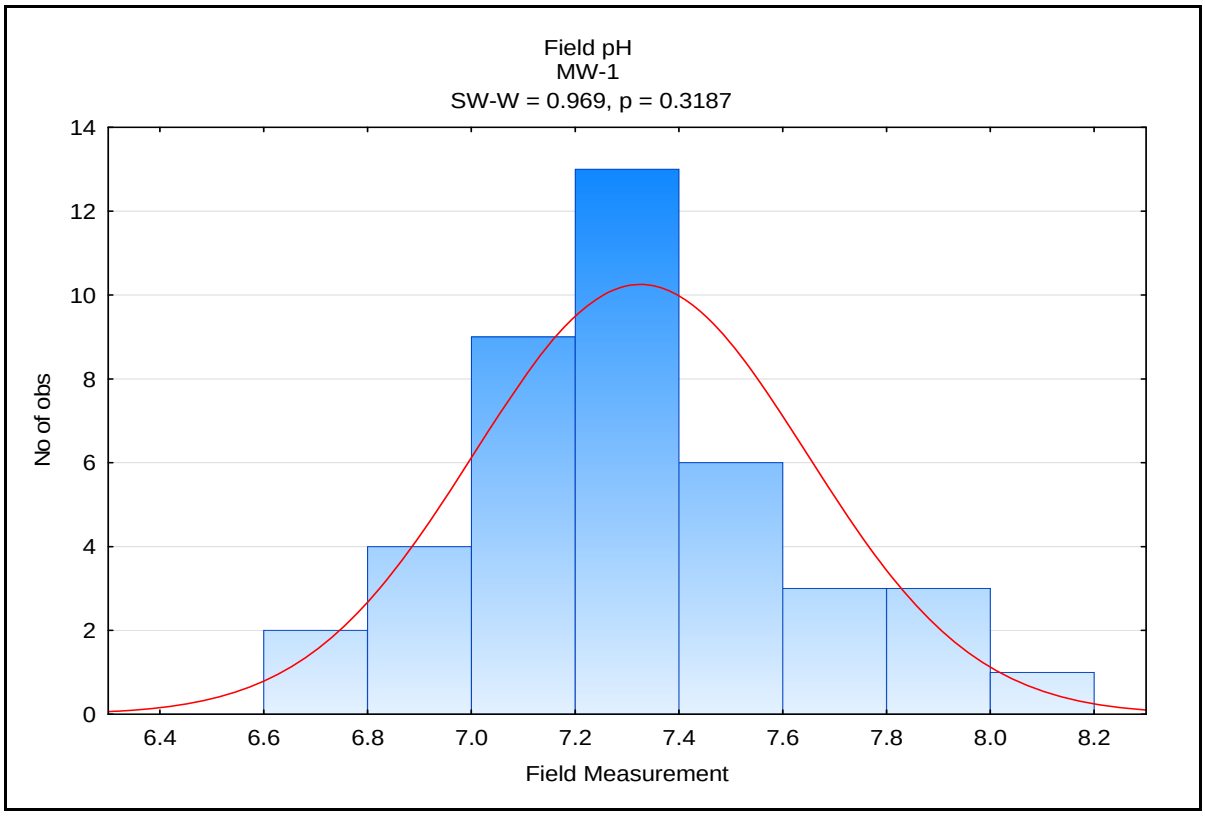
Box Plots for Field pH in Groundwater Monitoring Wells

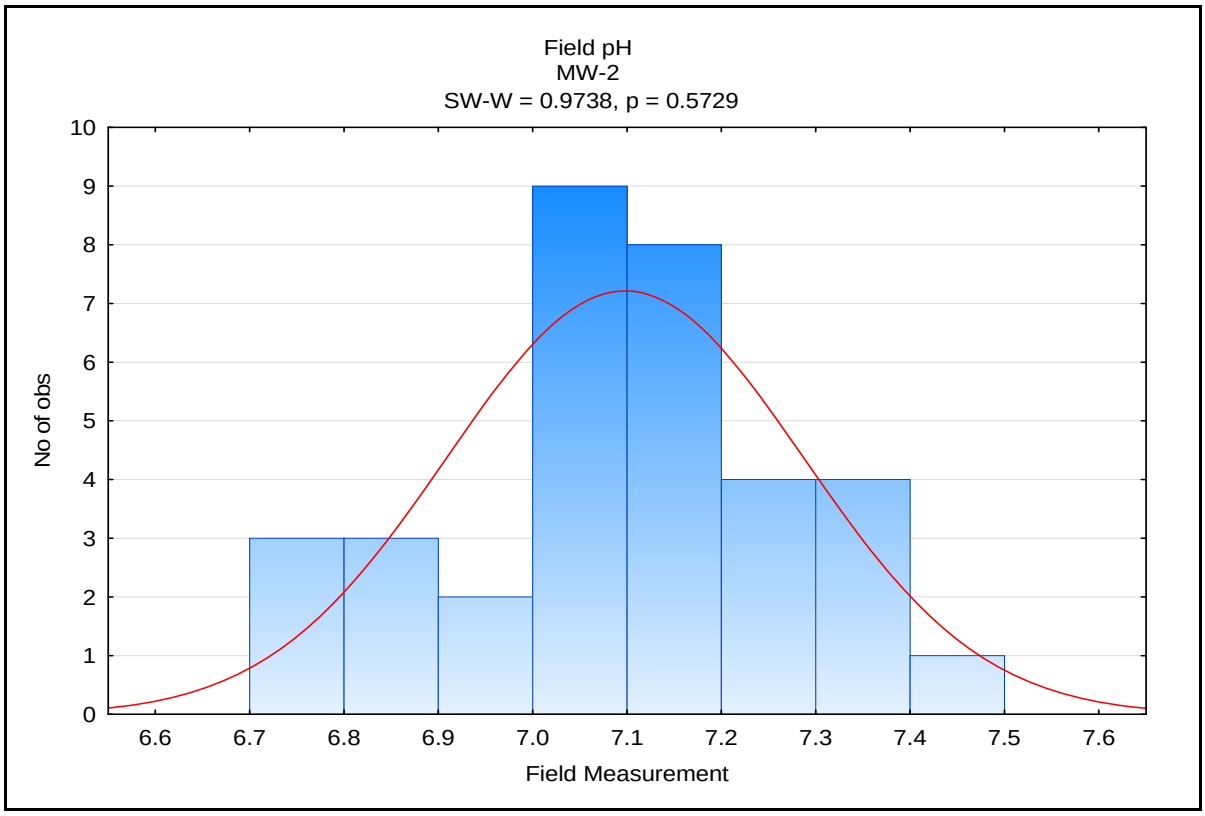


APPENDIX A-2

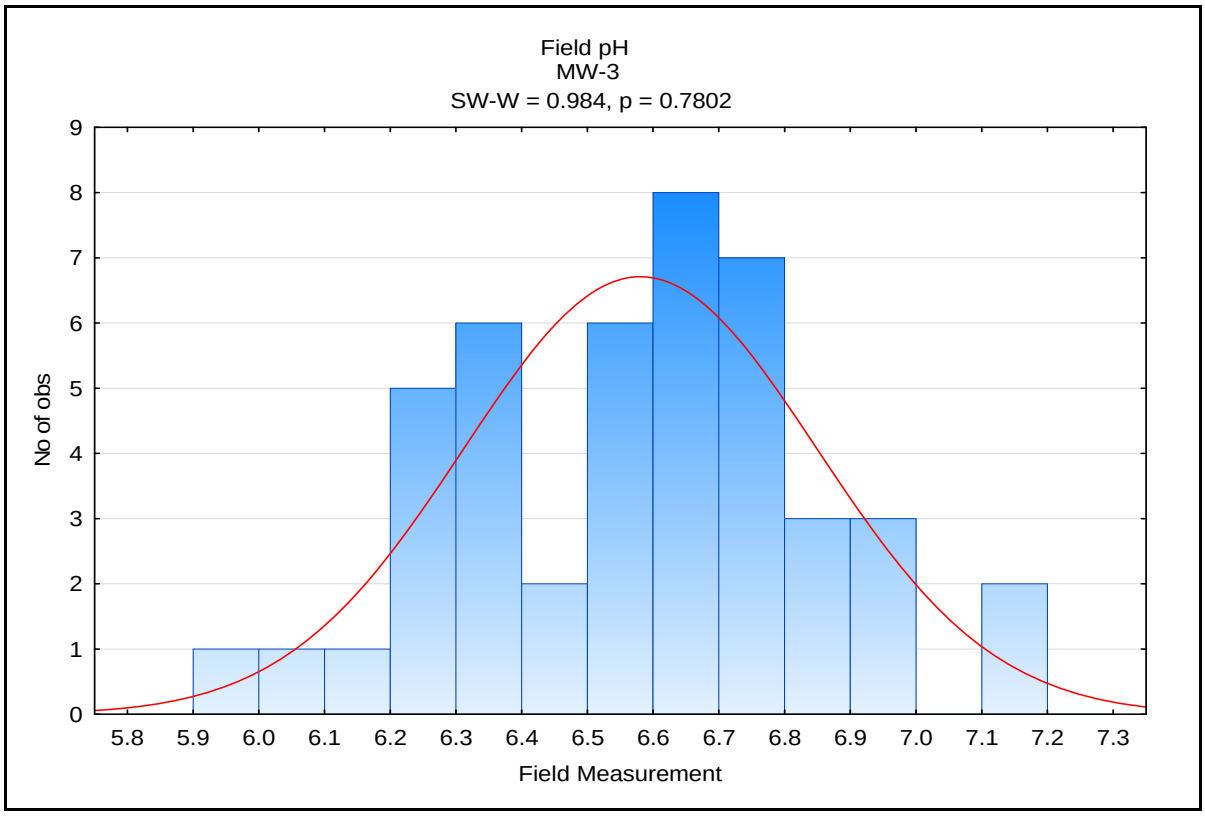
Histograms for Field PH in Groundwater Monitoring Wells

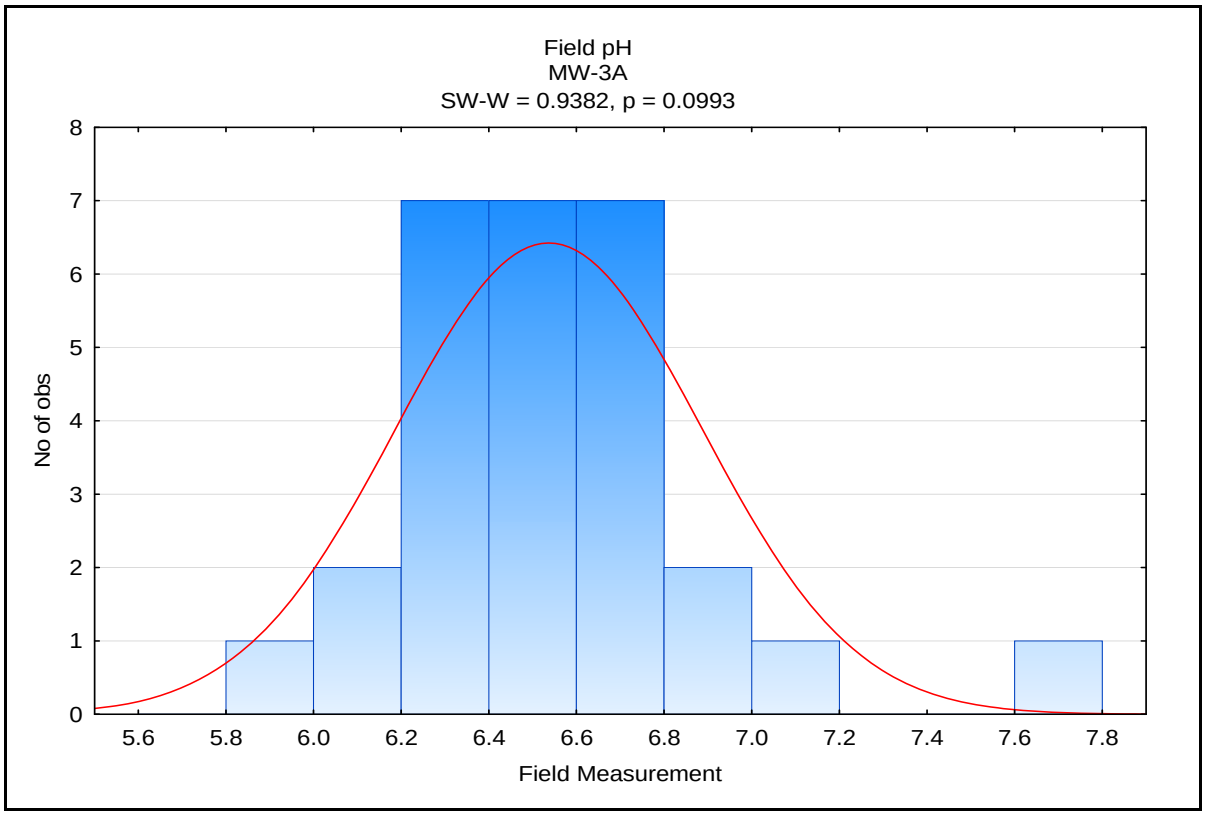
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



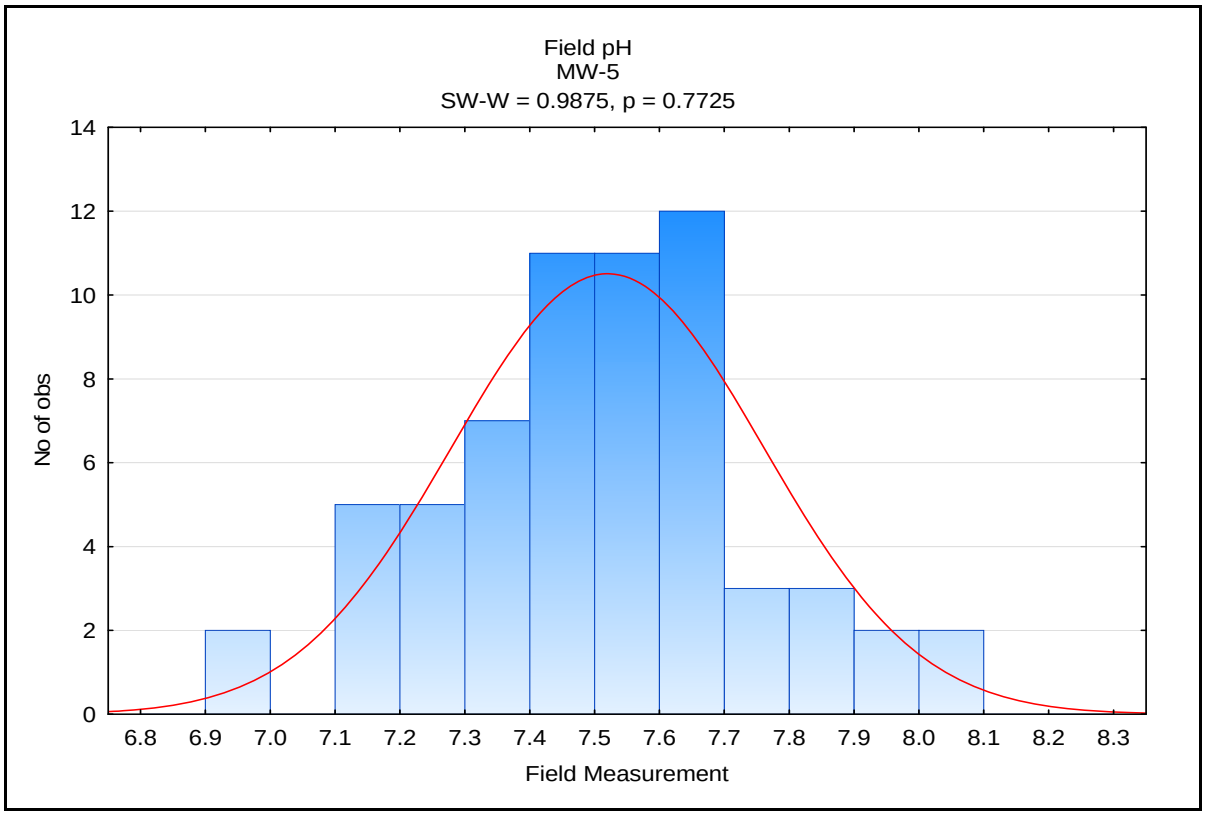


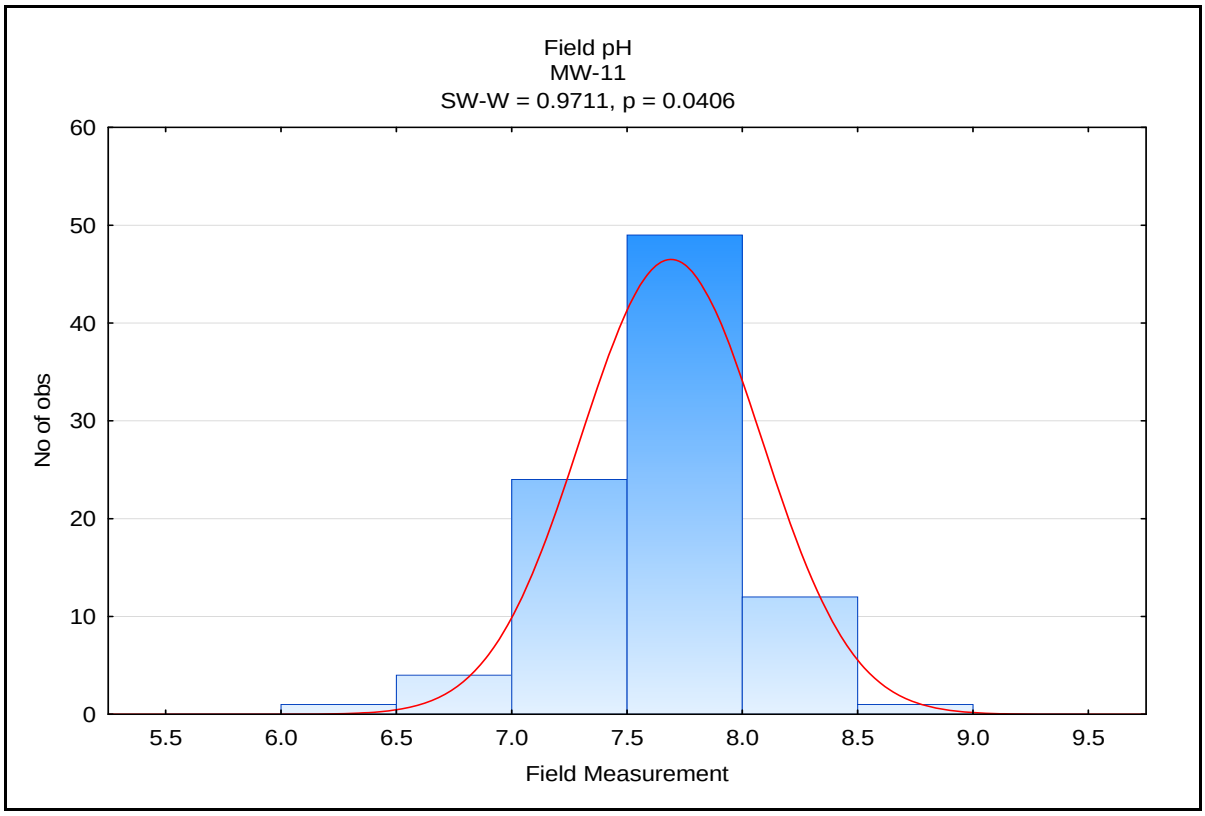
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



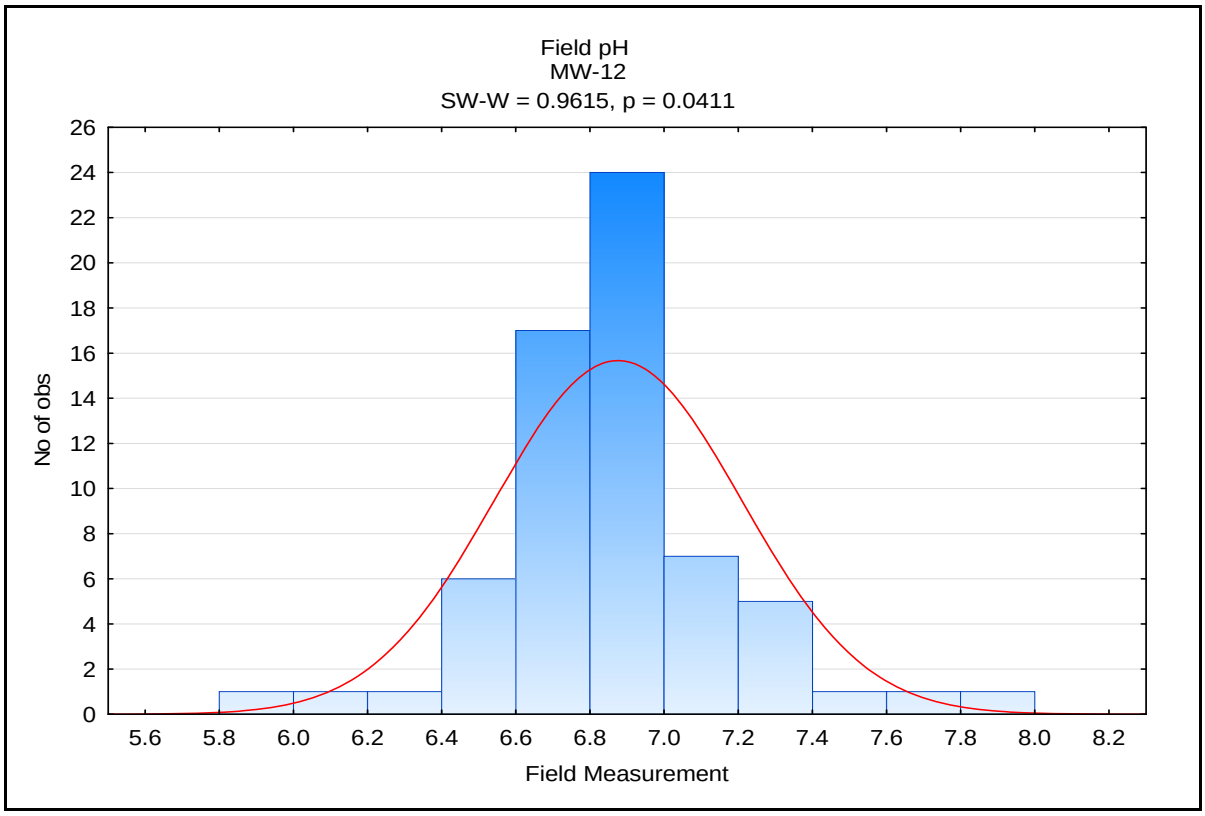


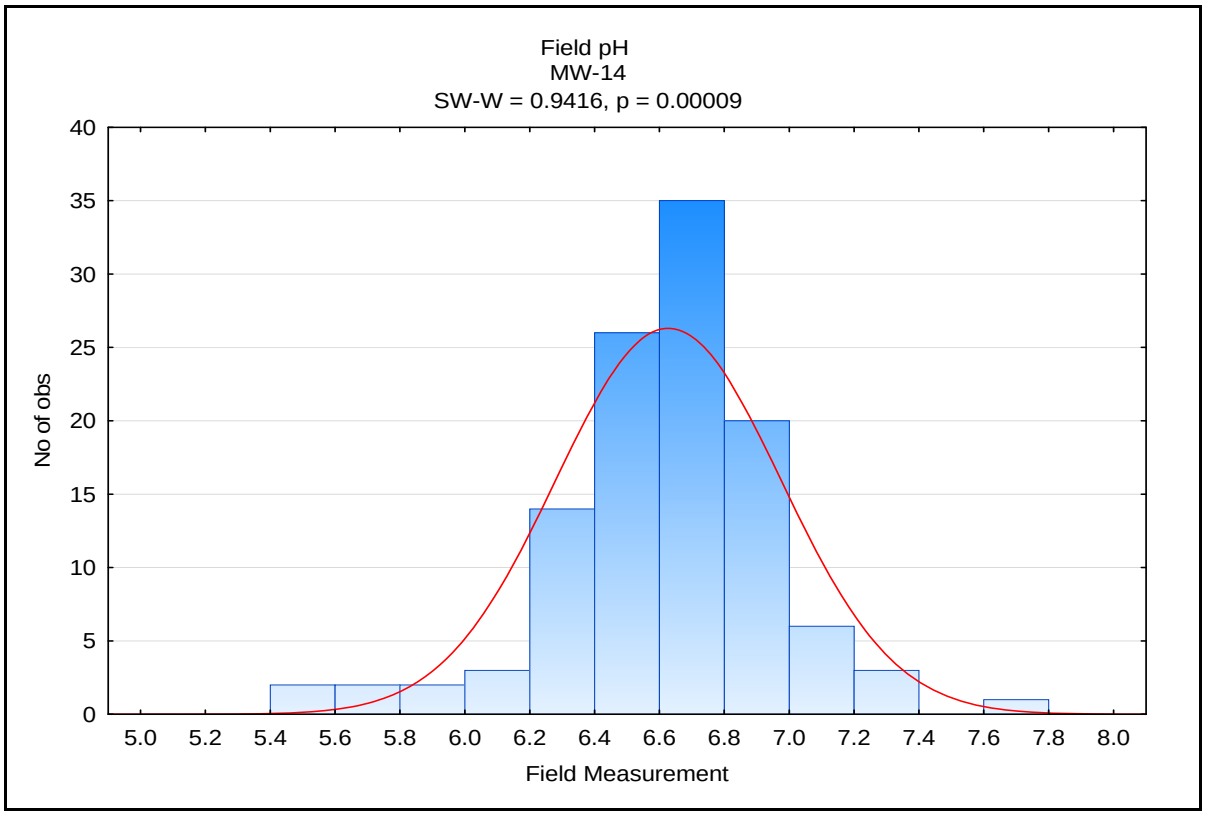
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



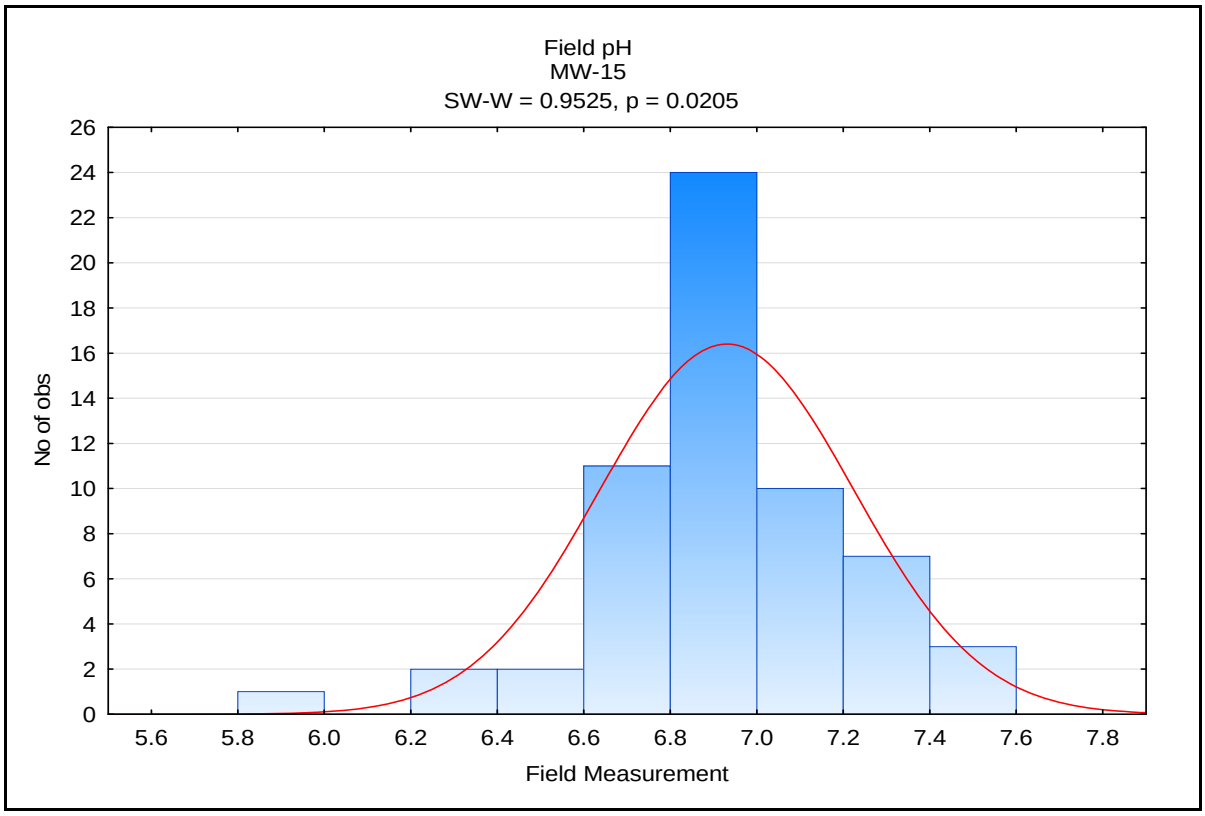


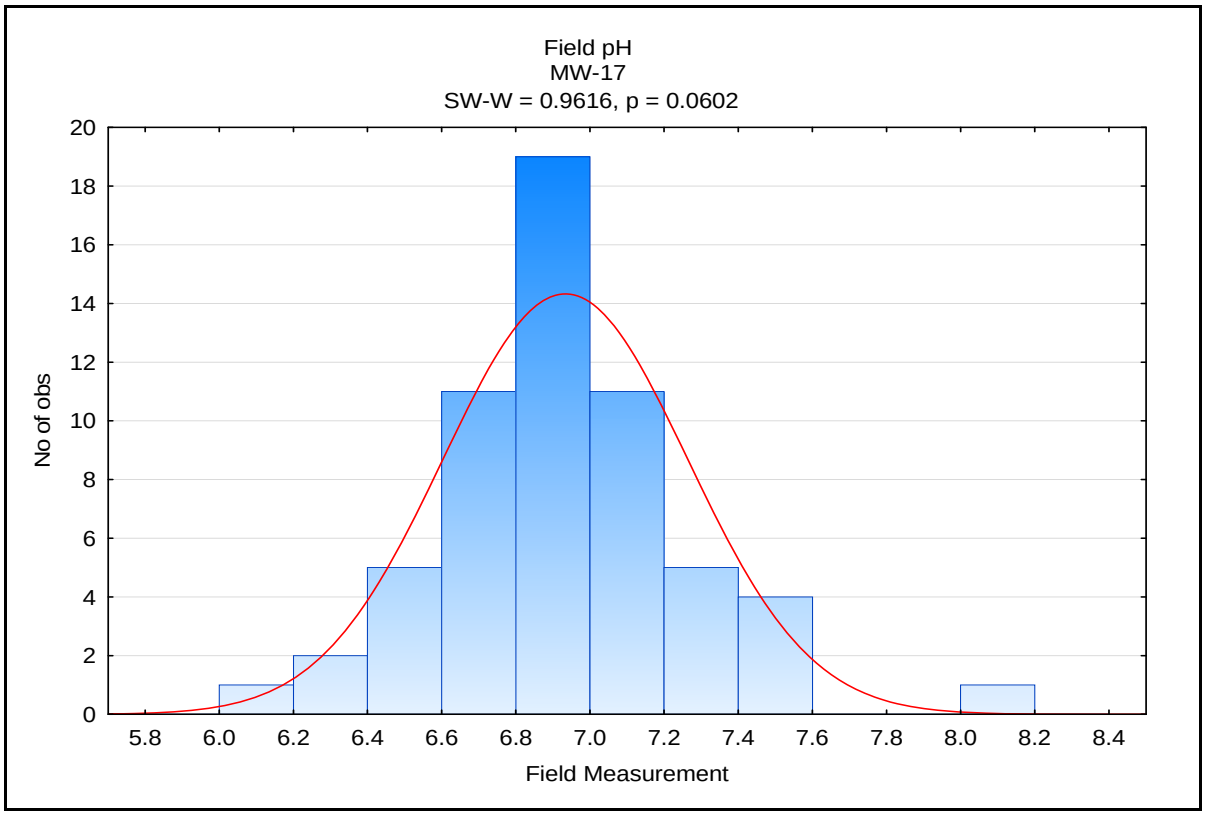
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



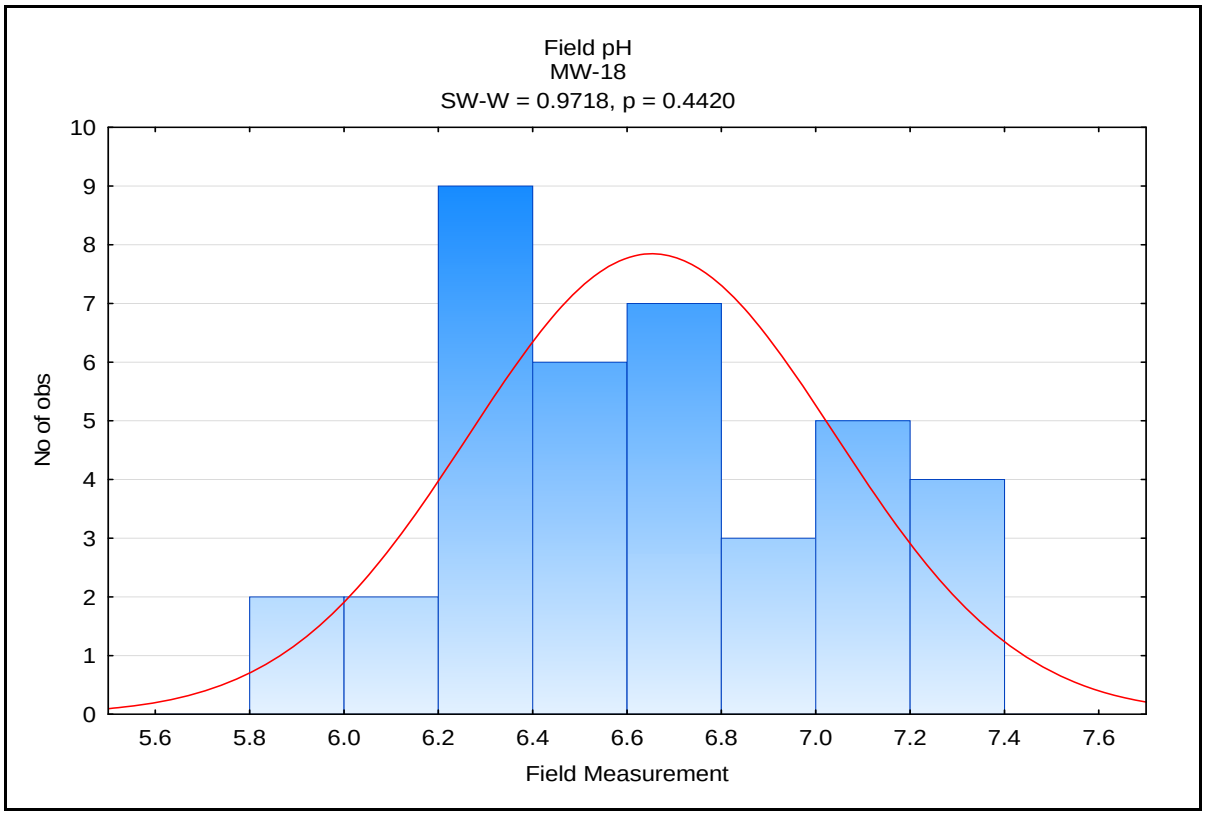


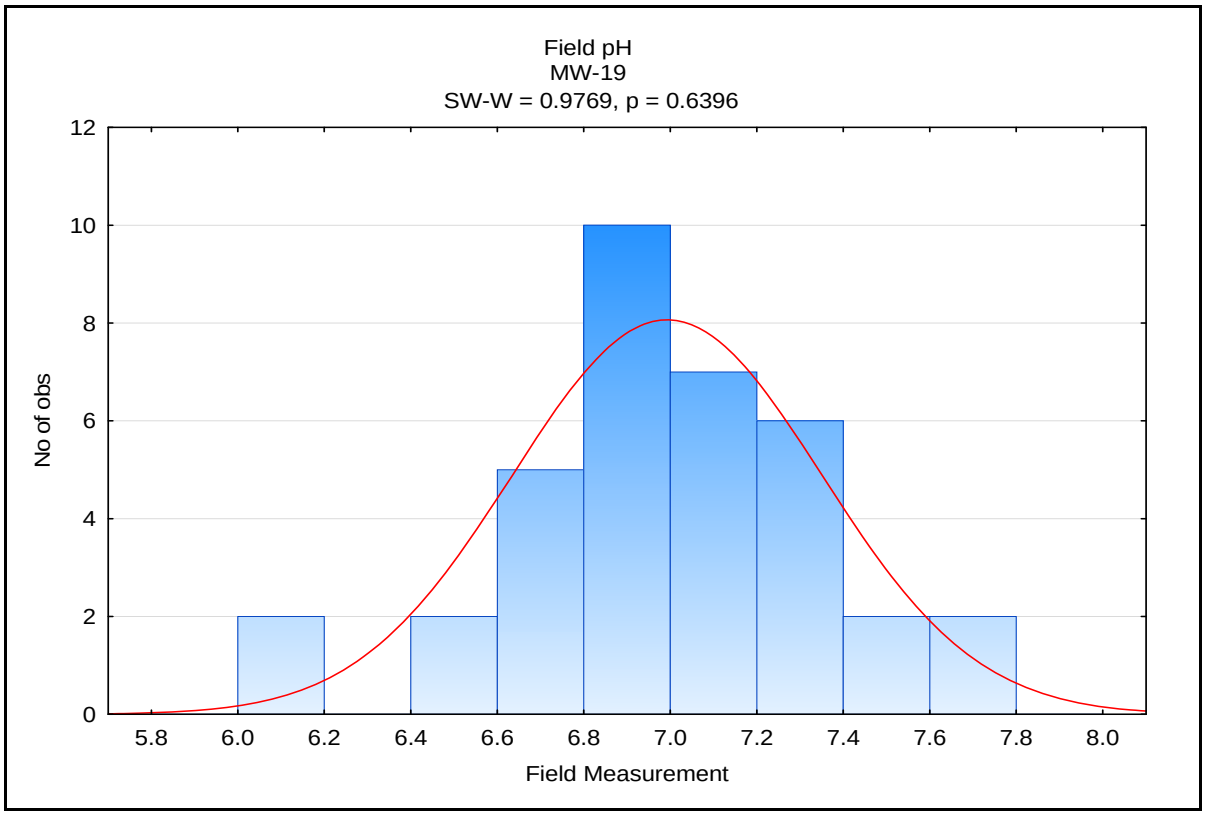
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



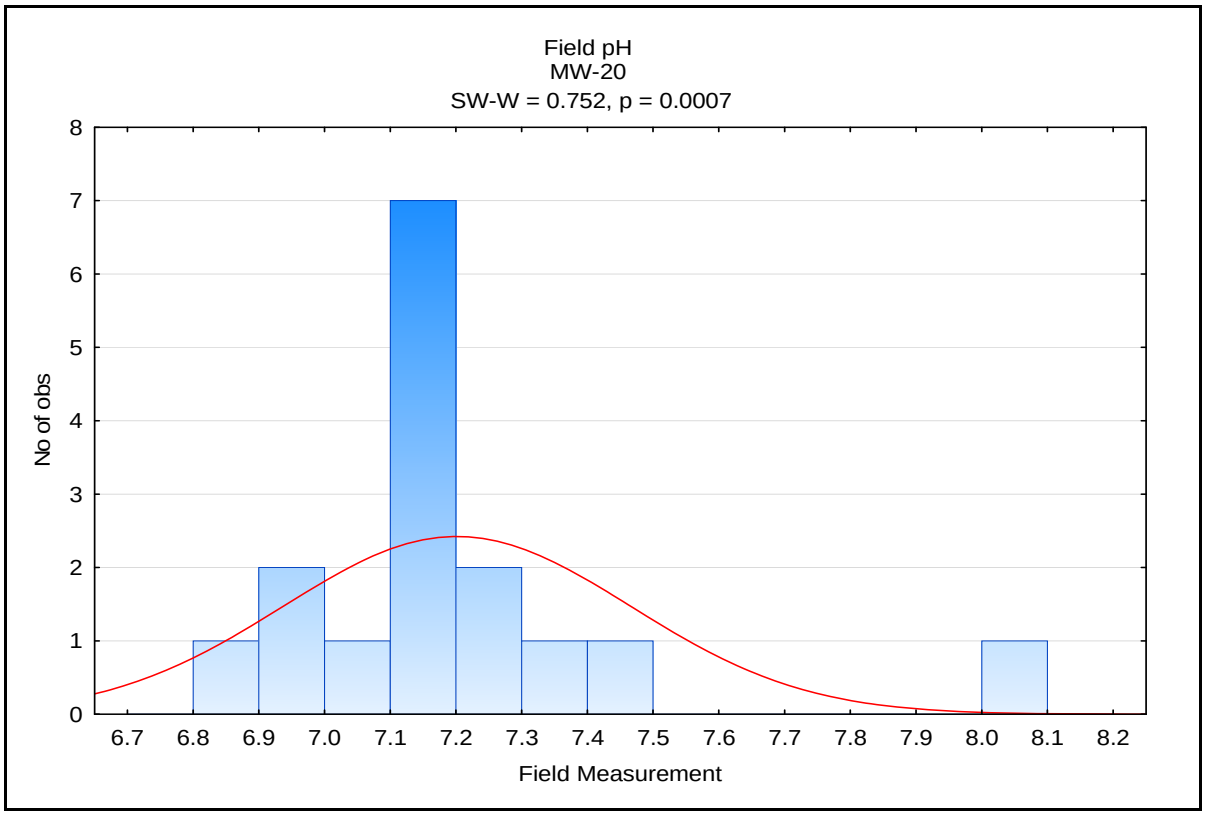


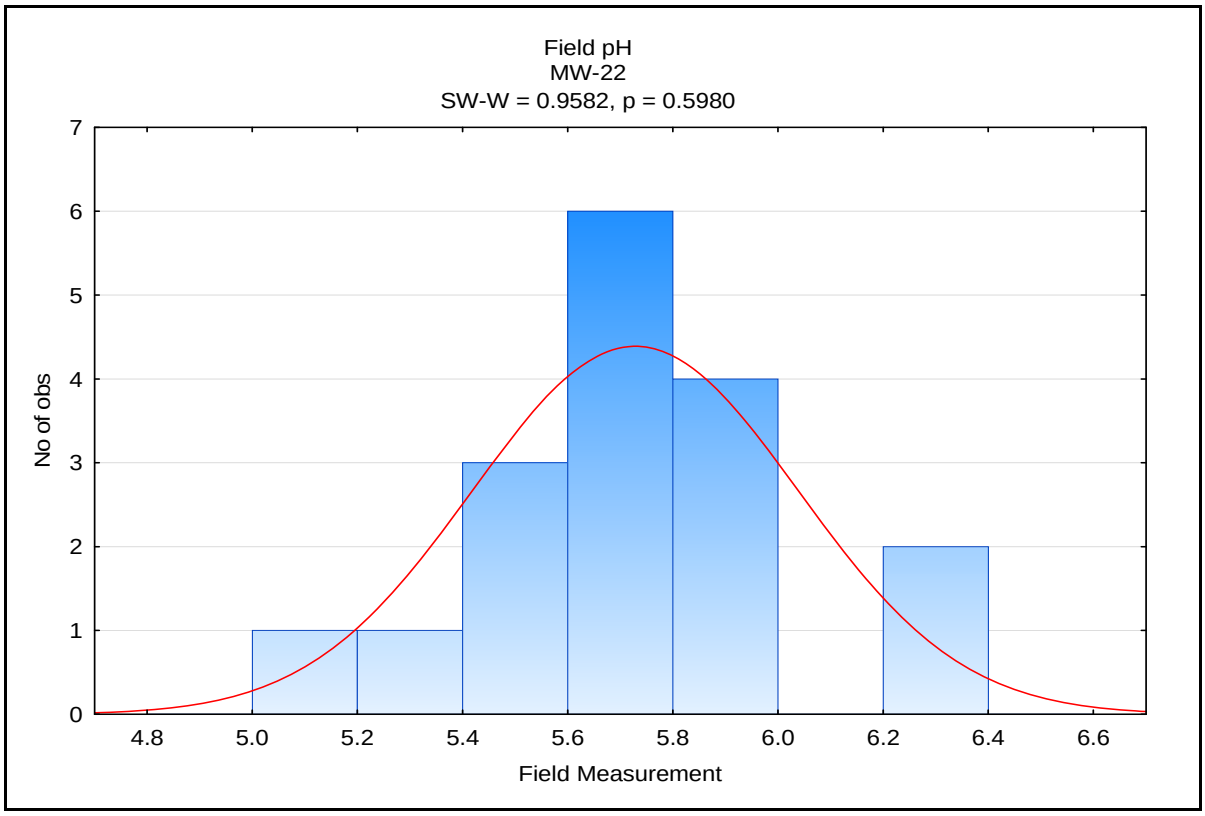
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



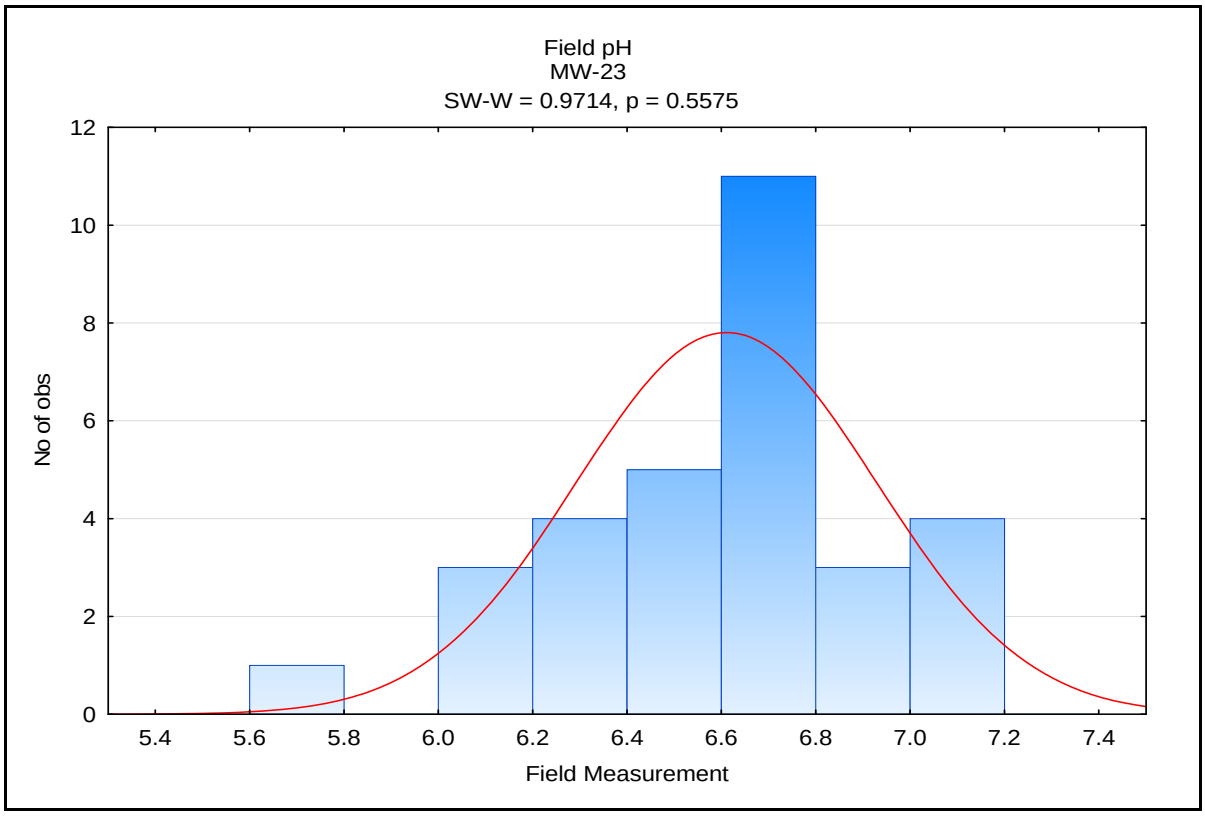


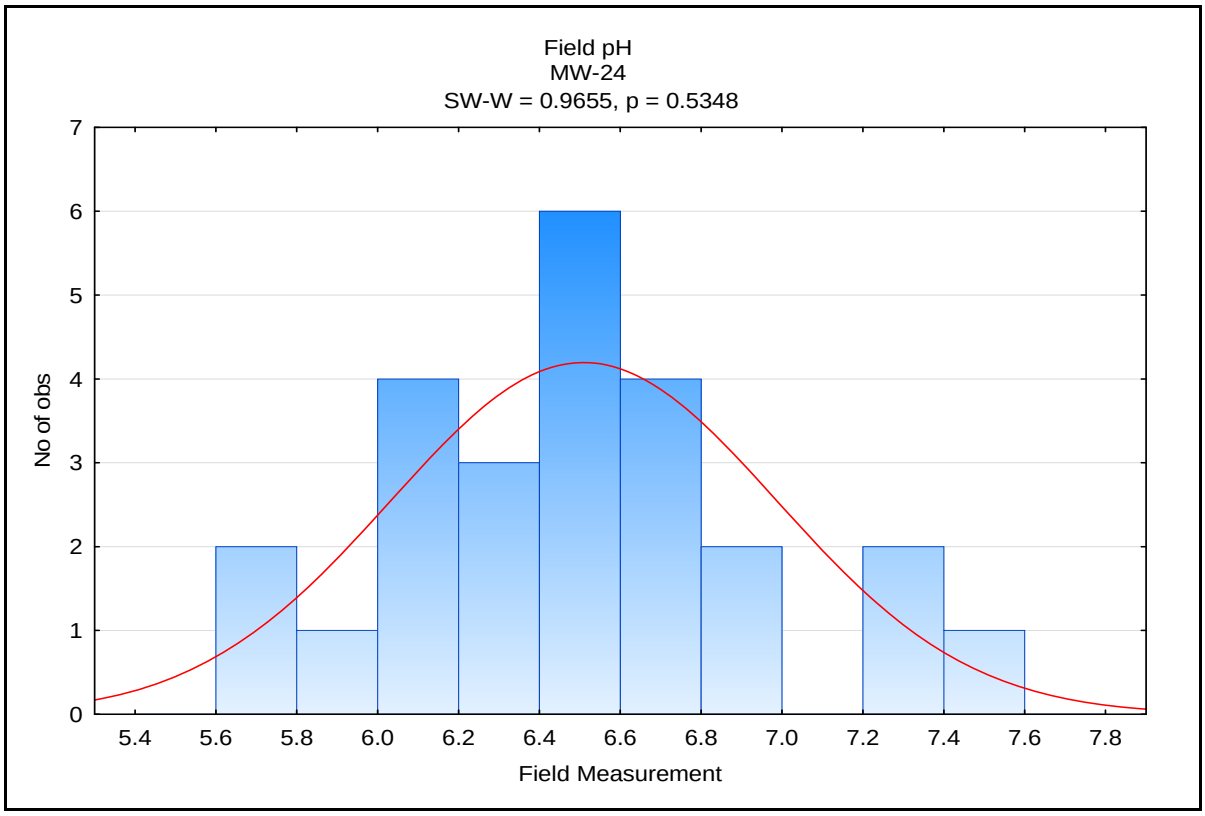
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



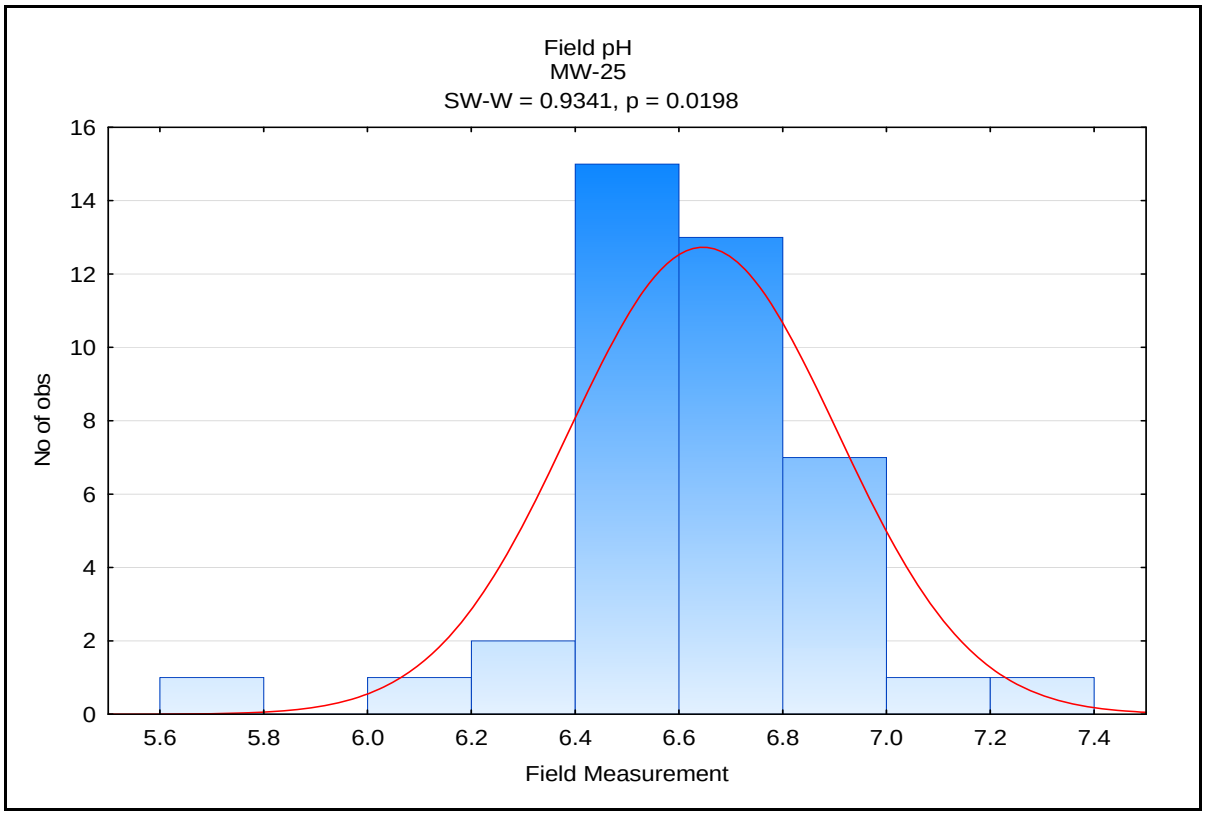


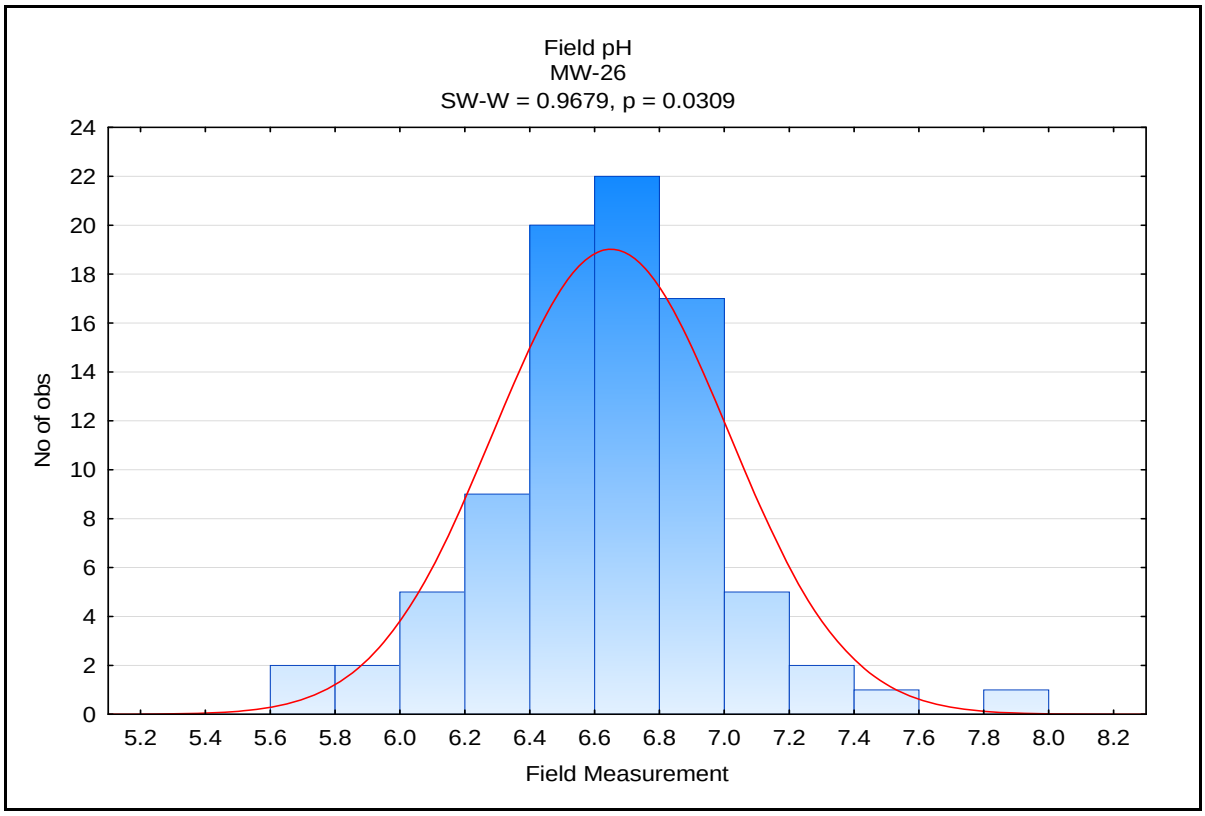
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



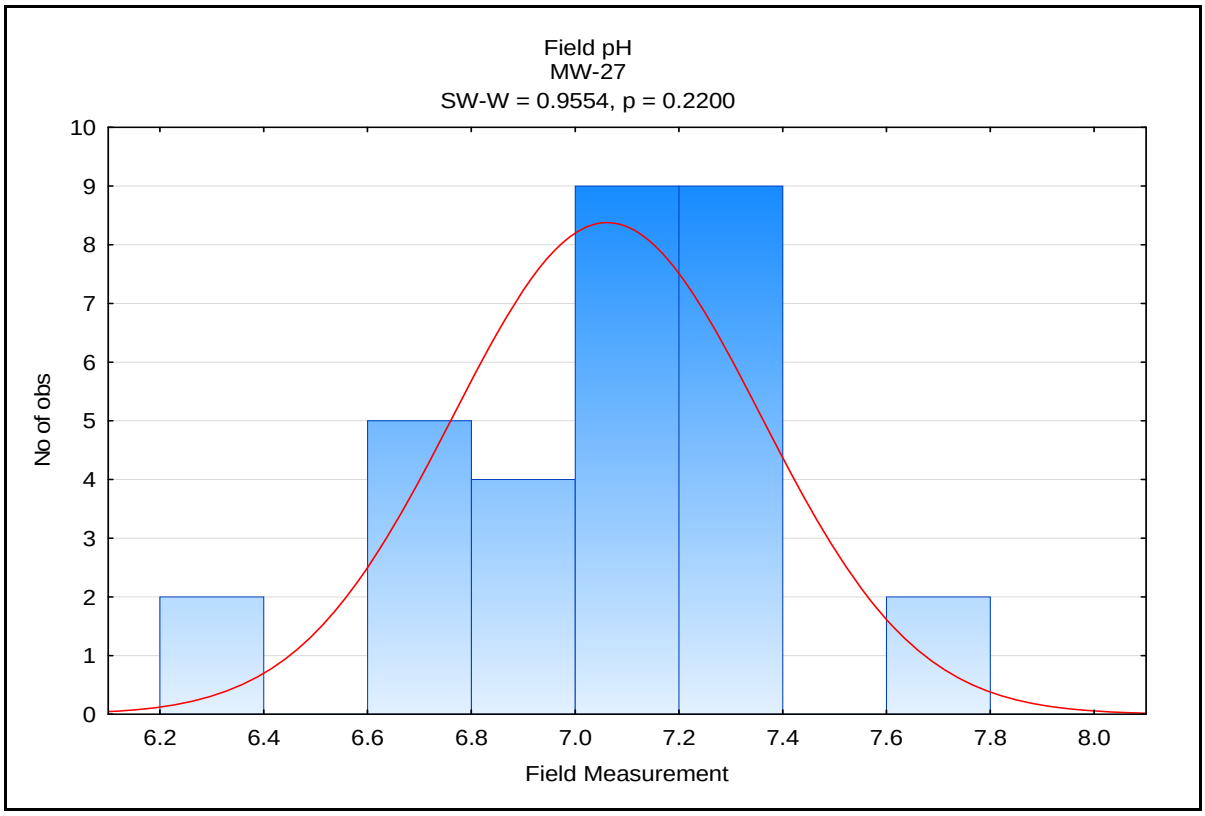


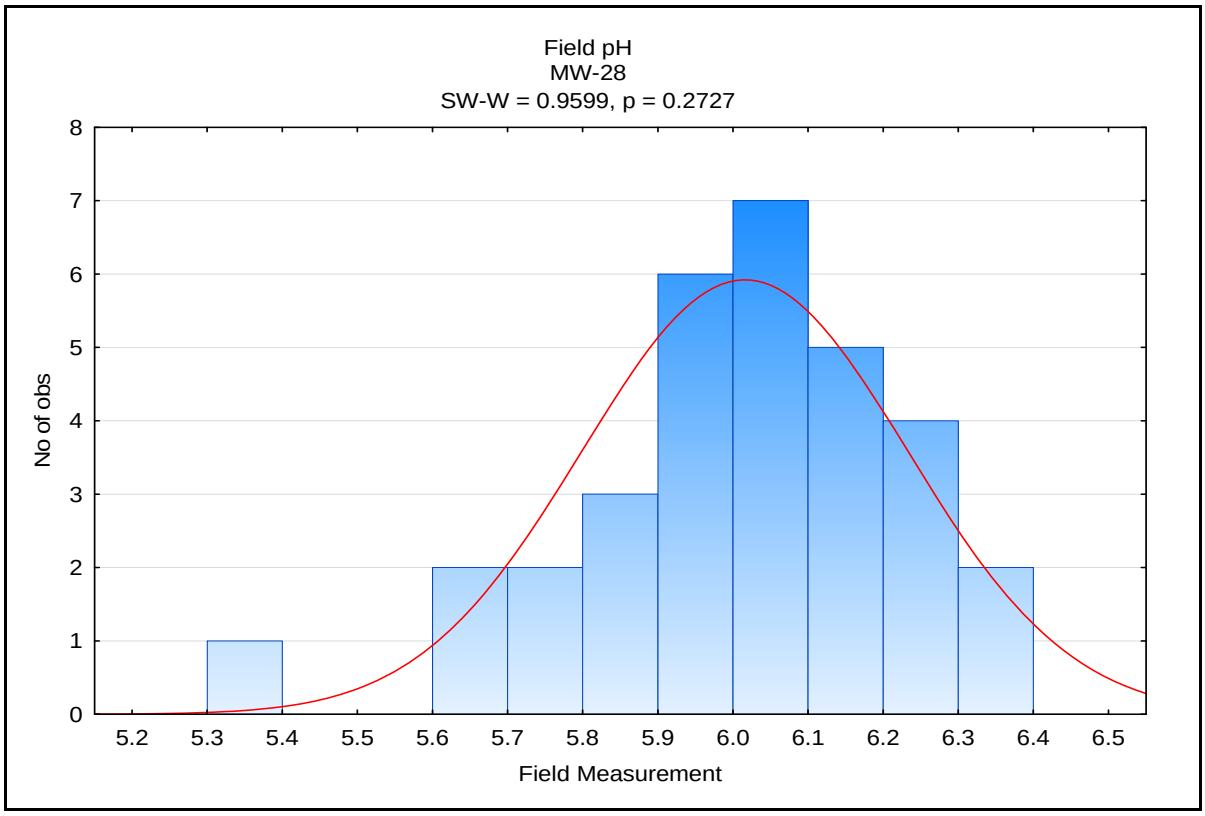
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



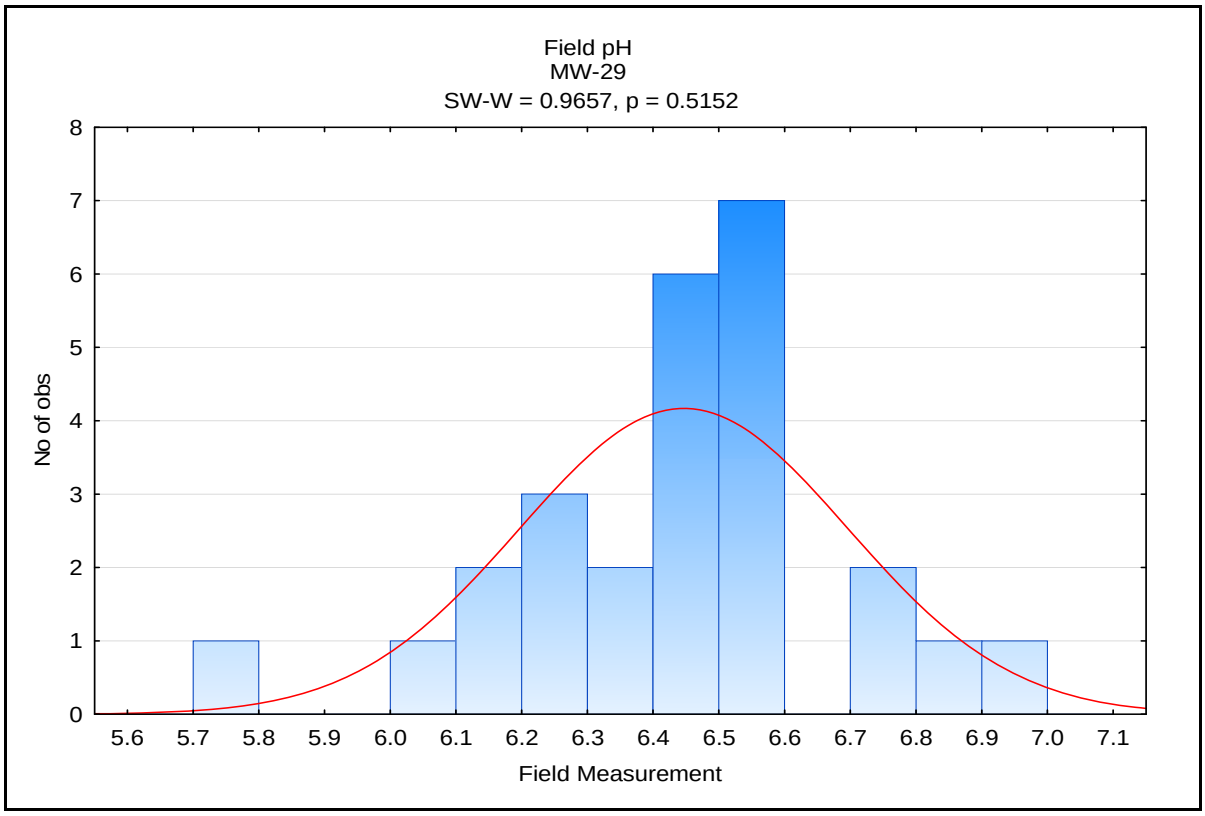


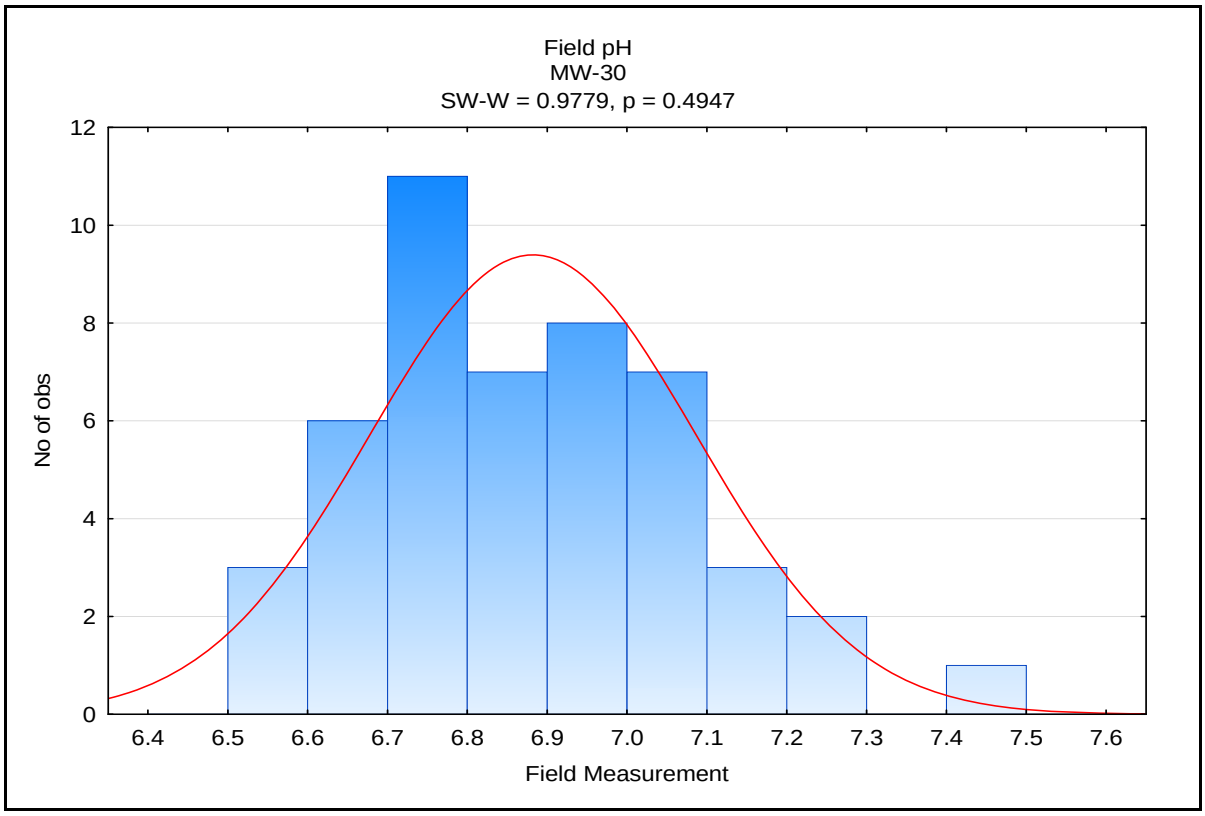
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



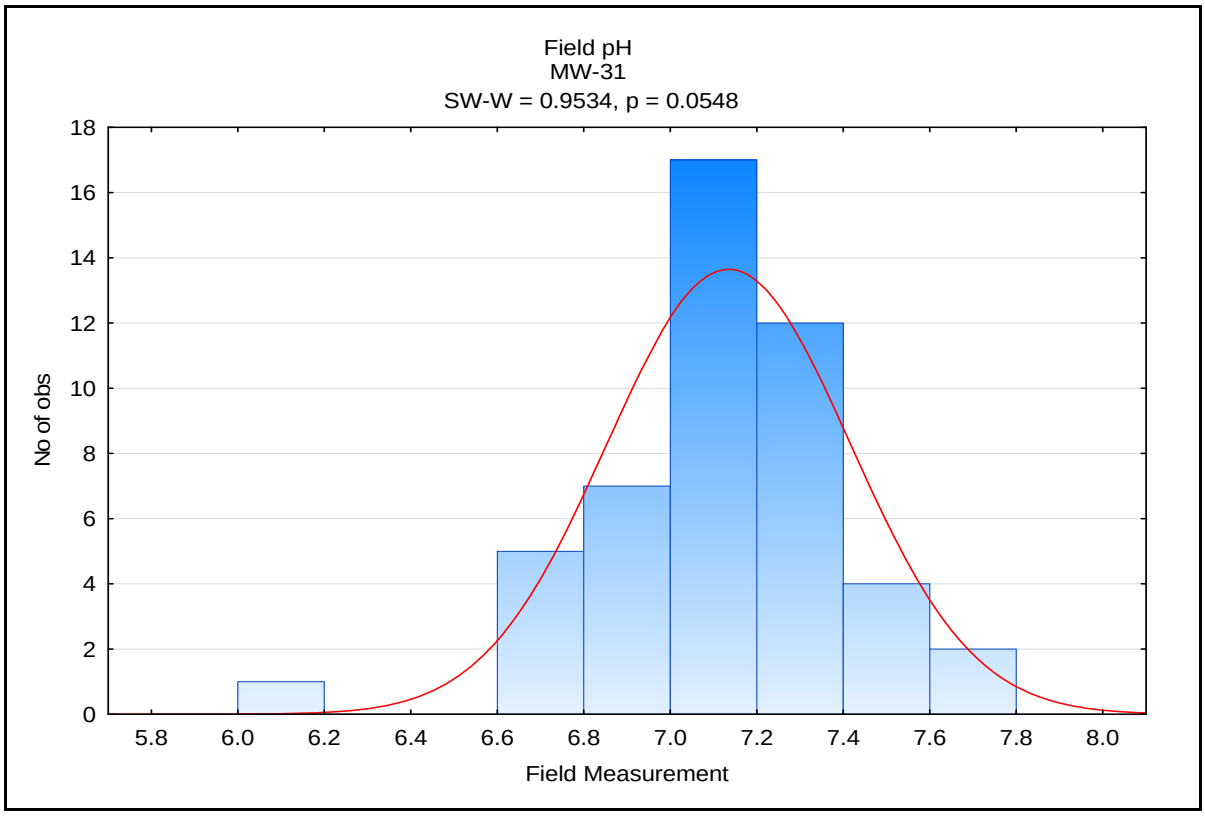


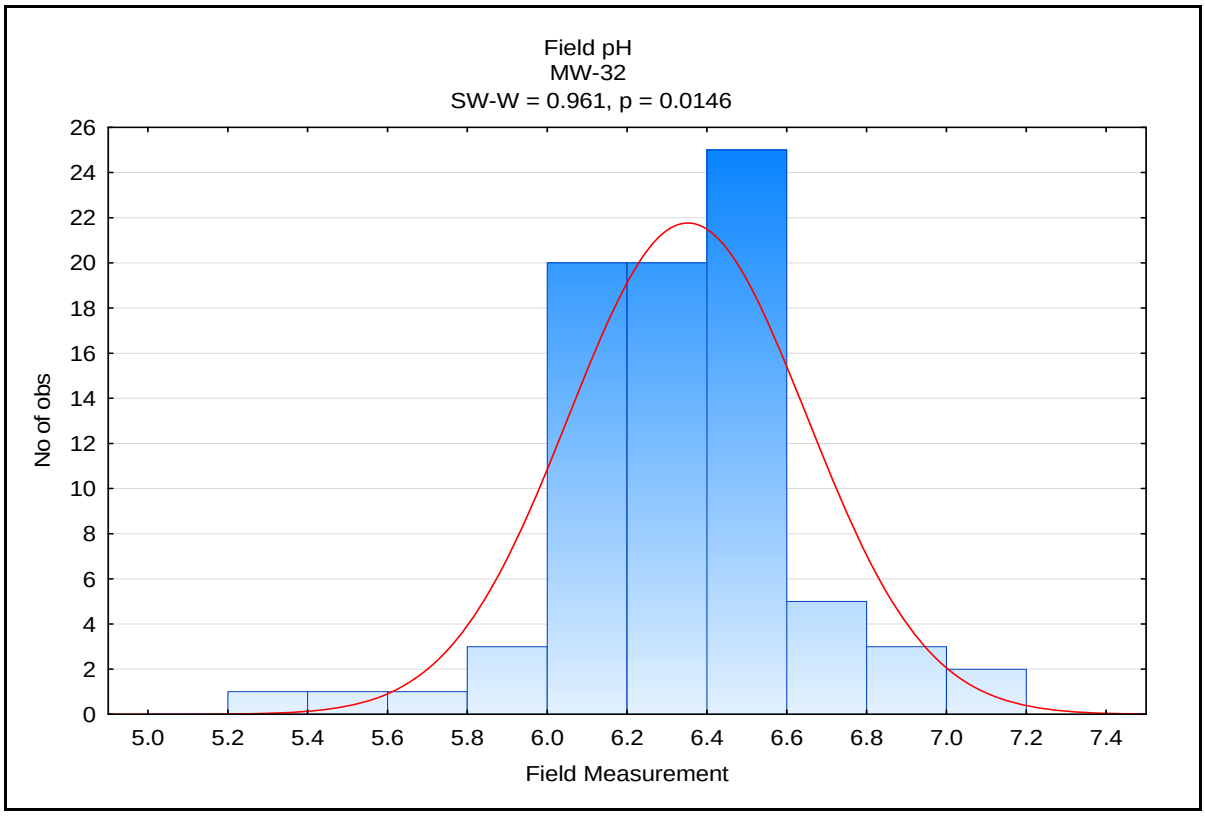
Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



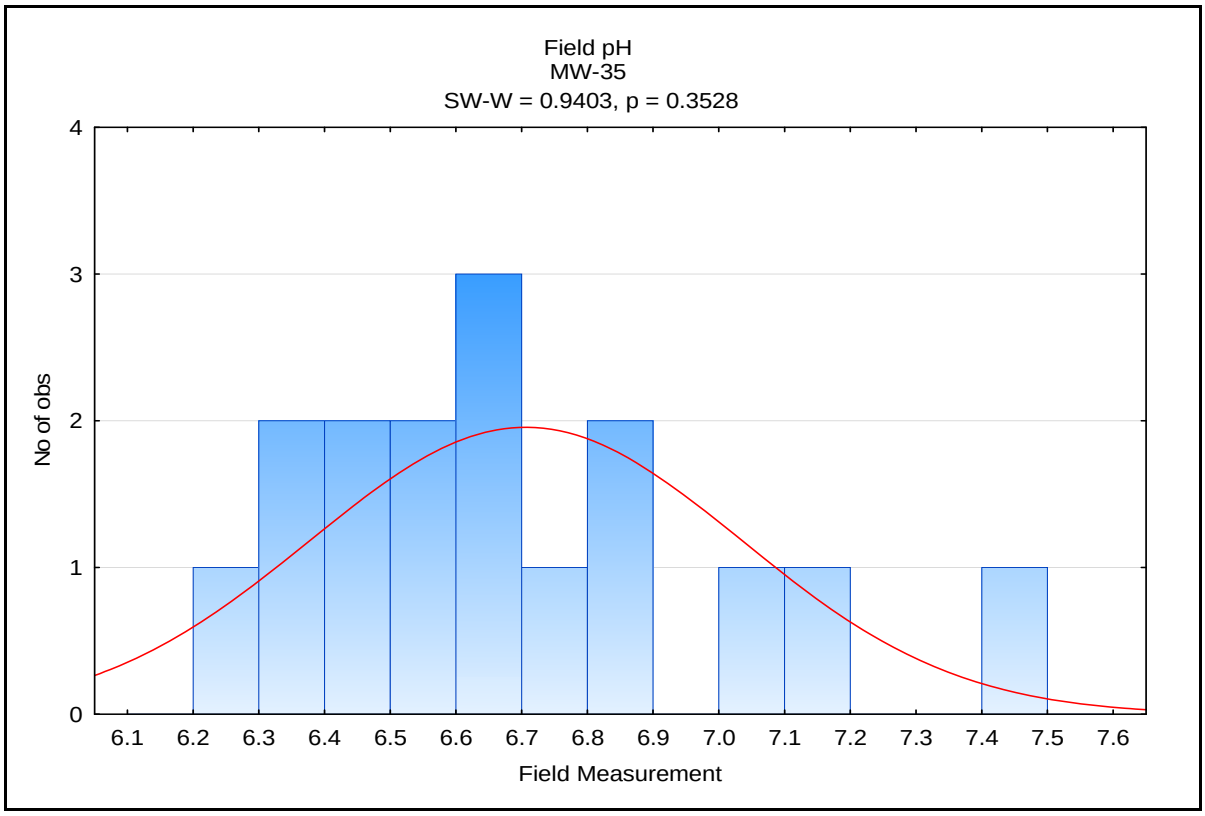


Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells





Appendix A-2
Histograms for Field pH in Groundwater Monitoring Wells



APPENDIX A-3

Mann-Kendall Output for Field PH in Groundwater Monitoring that is Not Normally or Lognormally Distributed

Appendix A-3
Mann Kendall Output for Field pH in Groundwater Monitoring that is Not Normally or Lognormally Distributed

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	9/9/2012 3:32:28 PM
From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

pH-mw-11

General Statistics

Number of Values	91
Minimum	6.25
Maximum	9
Mean	7.679
Geometric Mean	7.669
Median	7.71
Standard Deviation	0.39
SEM	0.0409

Mann-Kendall Test

Test Value (S)	-924
Critical Value (0.05)	-1.645
Standard Deviation of S	291.7
Standardized Value of S	-3.165
Approximate p-value	0.000776

Statistically significant evidence of a decreasing trend at the specified level of significance.

pH-mw-12

General Statistics

Number of Values	65
Minimum	5.86
Maximum	7.9
Mean	6.869
Geometric Mean	6.861
Median	6.82
Standard Deviation	0.331
SEM	0.0411

Mann-Kendall Test

Test Value (S)	-631
Critical Value (0.05)	-1.645
Standard Deviation of S	176.5
Standardized Value of S	-3.569
Approximate p-value	0.000179

Statistically significant evidence of a decreasing trend at the specified level of significance.

pH-mw-14

General Statistics

Number of Values	114
Minimum	5.42
Maximum	7.75
Mean	6.619
Geometric Mean	6.61
Median	6.63
Standard Deviation	0.346
SEM	0.0324

Mann-Kendall Test

Test Value (S)	-1981
Critical Value (0.05)	-1.645
Standard Deviation of S	408.2
Standardized Value of S	-4.85
Approximate p-value	6.17E-07

Statistically significant evidence of a decreasing trend at the specified level of significance.

pH-mw-15

General Statistics

Number of Values	60
Minimum	5.88
Maximum	7.5
Mean	6.924
Geometric Mean	6.917
Median	6.955
Standard Deviation	0.292
SEM	0.0377

Mann-Kendall Test

Test Value (S)	-578
Critical Value (0.05)	-1.645
Standard Deviation of S	156.7
Standardized Value of S	-3.683
Approximate p-value	0.000115

Statistically significant evidence of a decreasing trend at the specified level of significance.

pH-mw-20

General Statistics

Number of Values	16
Minimum	6.89
Maximum	8.05
Mean	7.199
Geometric Mean	7.194
Median	7.15
Standard Deviation	0.263
SEM	0.0659

Mann-Kendall Test

Test Value (S)	-29
Tabulated p-value	0.114
Standard Deviation of S	22.14
Standardized Value of S	-1.264
Approximate p-value	0.103

Insufficient evidence to identify a significant trend at the specified level of significance.

pH-mw-25

General Statistics

Number of Values	41
Minimum	5.77
Maximum	7.25
Mean	6.641
Geometric Mean	6.636
Median	6.63
Standard Deviation	0.257
SEM	0.0401

Mann-Kendall Test

Test Value (S)	-180

Critical Value (0.05)	-1.645
Standard Deviation of S	88.96
Standardized Value of S	-2.012
Approximate p-value	0.0221

Statistically significant evidence of a decreasing trend at the specified level of significance.

pH-mw-26

General Statistics

Number of Values	86
Minimum	5.61
Maximum	7.88
Mean	6.643
Geometric Mean	6.633
Median	6.64
Standard Deviation	0.361
SEM	0.0389

Mann-Kendall Test

Test Value (S)	160
Critical Value (0.05)	1.645
Standard Deviation of S	268
Standardized Value of S	0.593
Approximate p-value	0.277

Insufficient evidence to identify a significant trend at the specified level of significance.

pH-mw-32

General Statistics

Number of Values	81
Minimum	5.31
Maximum	7.04
Mean	6.345
Geometric Mean	6.338
Median	6.36
Standard Deviation	0.297
SEM	0.033

Mann-Kendall Test

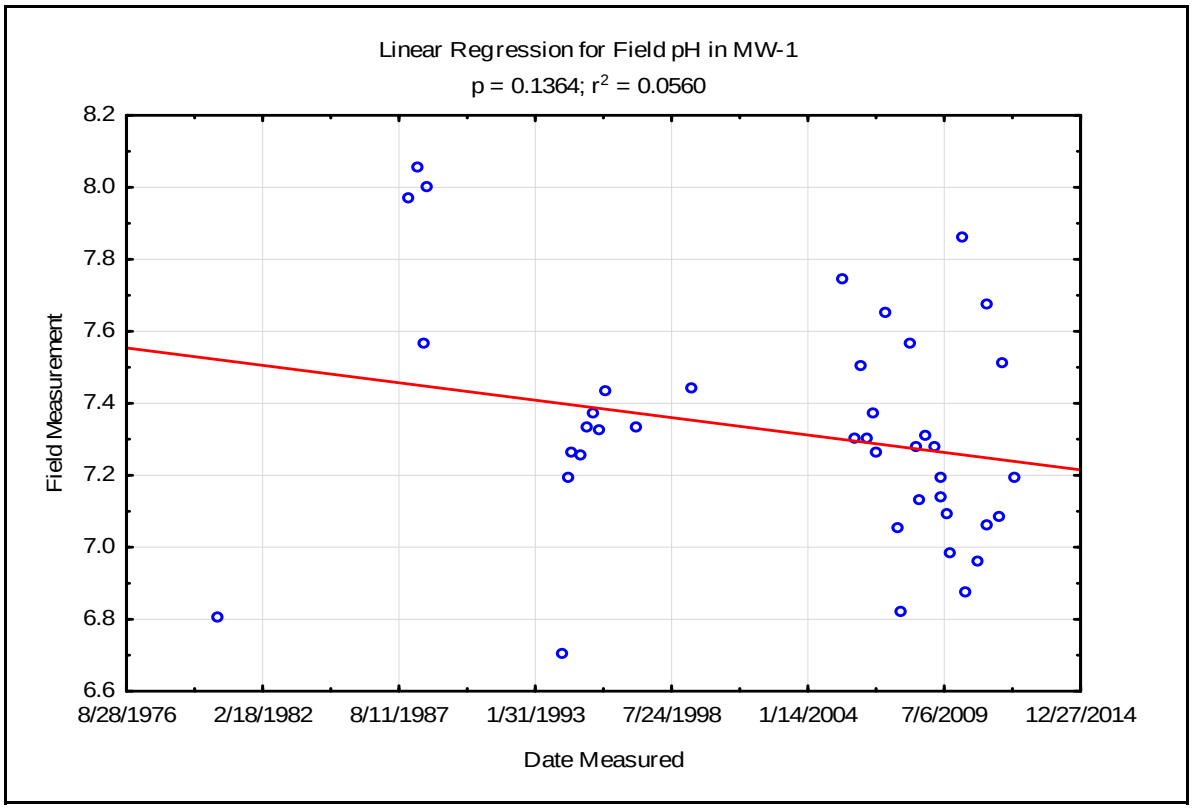
Test Value (S)	-670
Critical Value (0.05)	-1.645
Standard Deviation of S	245.1
Standardized Value of S	-2.729
Approximate p-value	0.00317

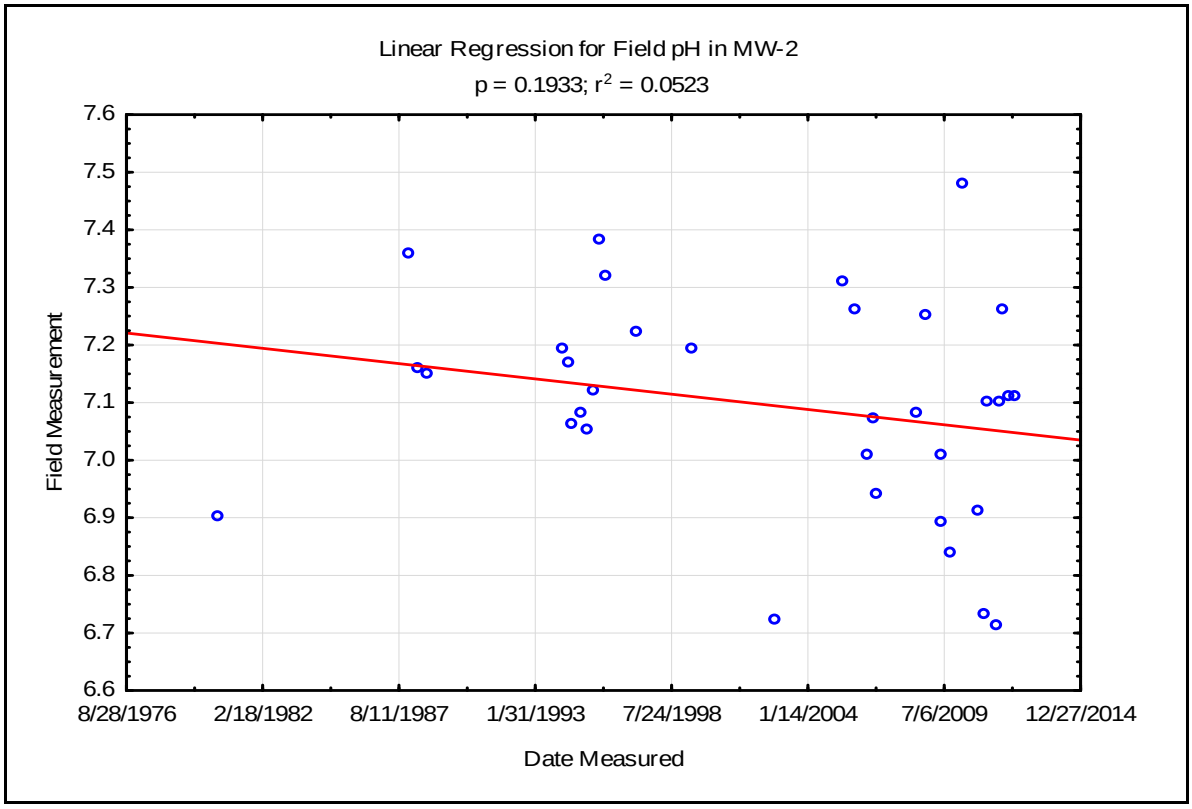
Statistically significant evidence of a decreasing trend at the specified level of significance.

APPENDIX A-4

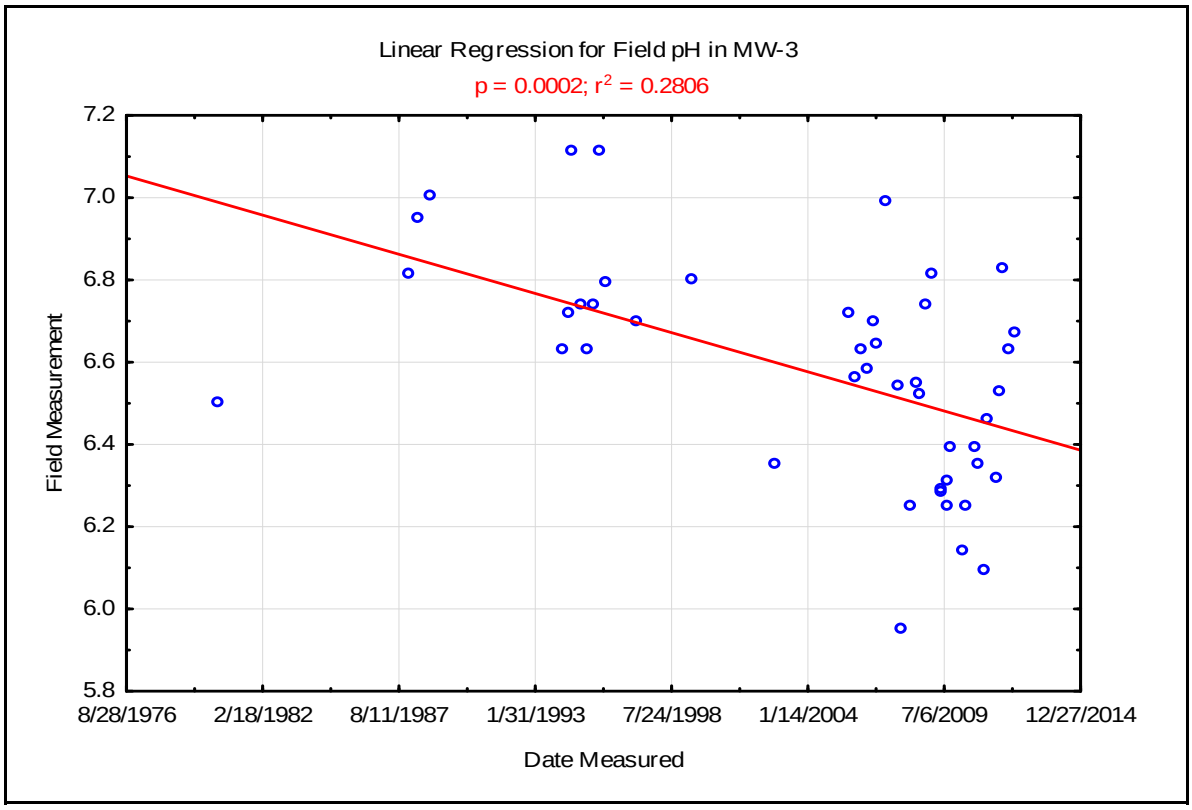
Linear Regressions for Field PH in Groundwater Monitoring Wells

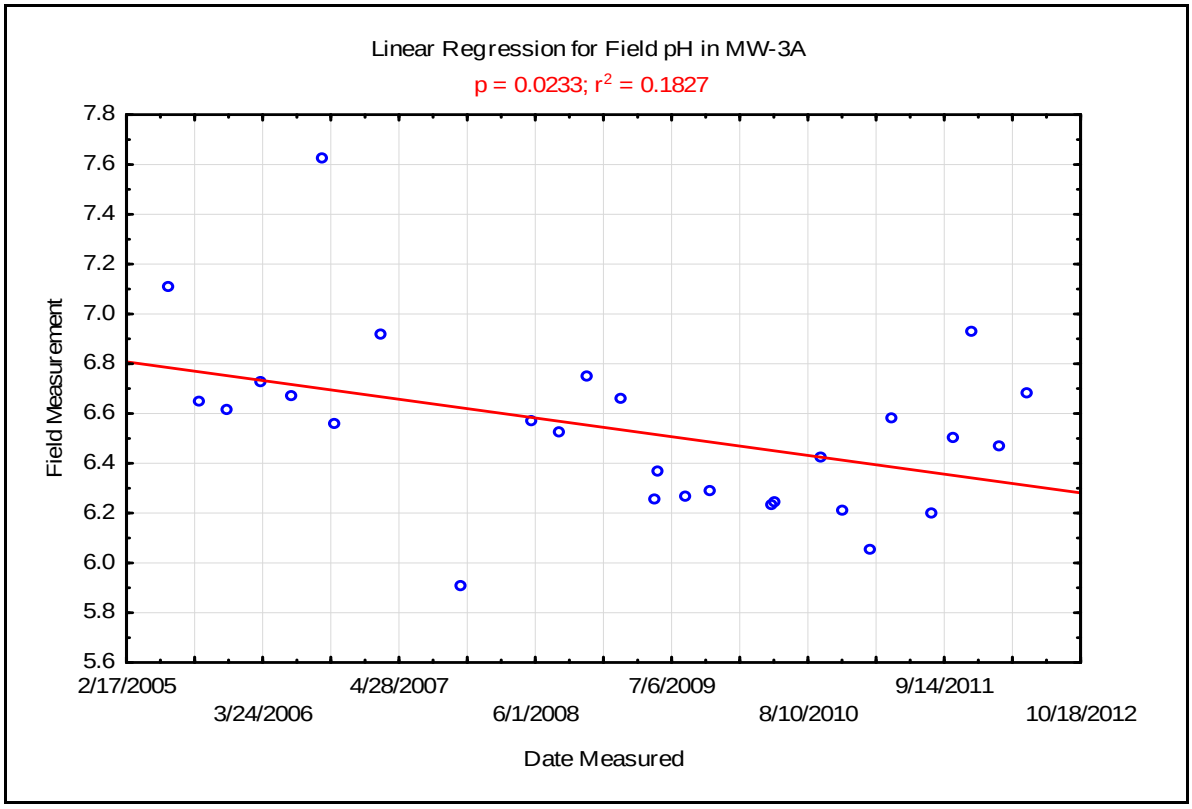
Appendix A-4 Linear Regressions for Field pH in Groundwater Monitoring Wells

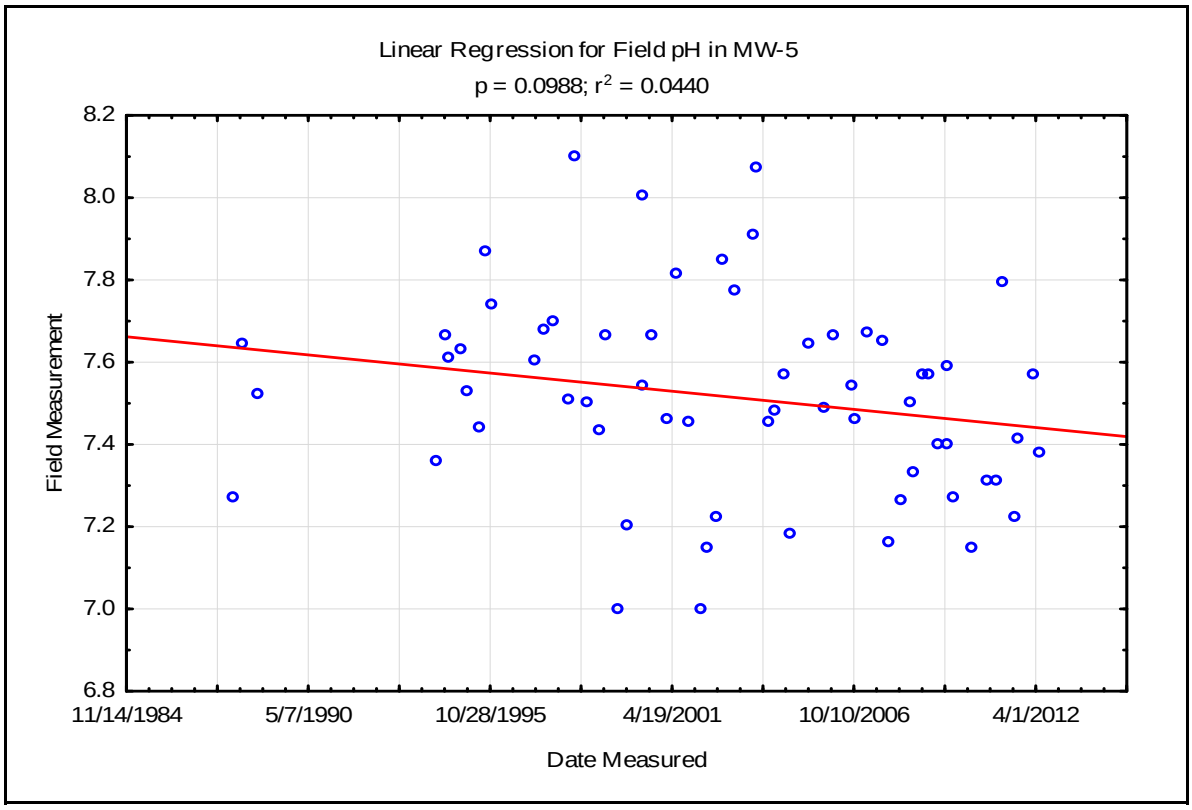


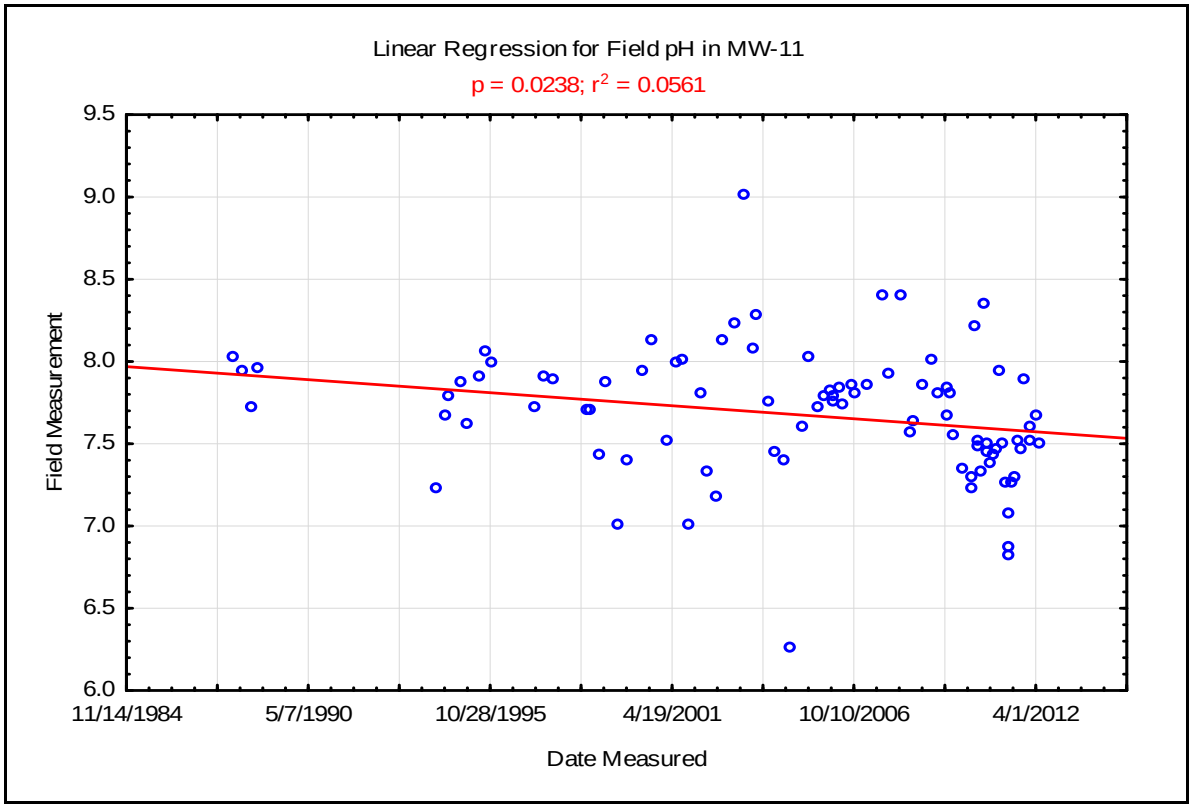


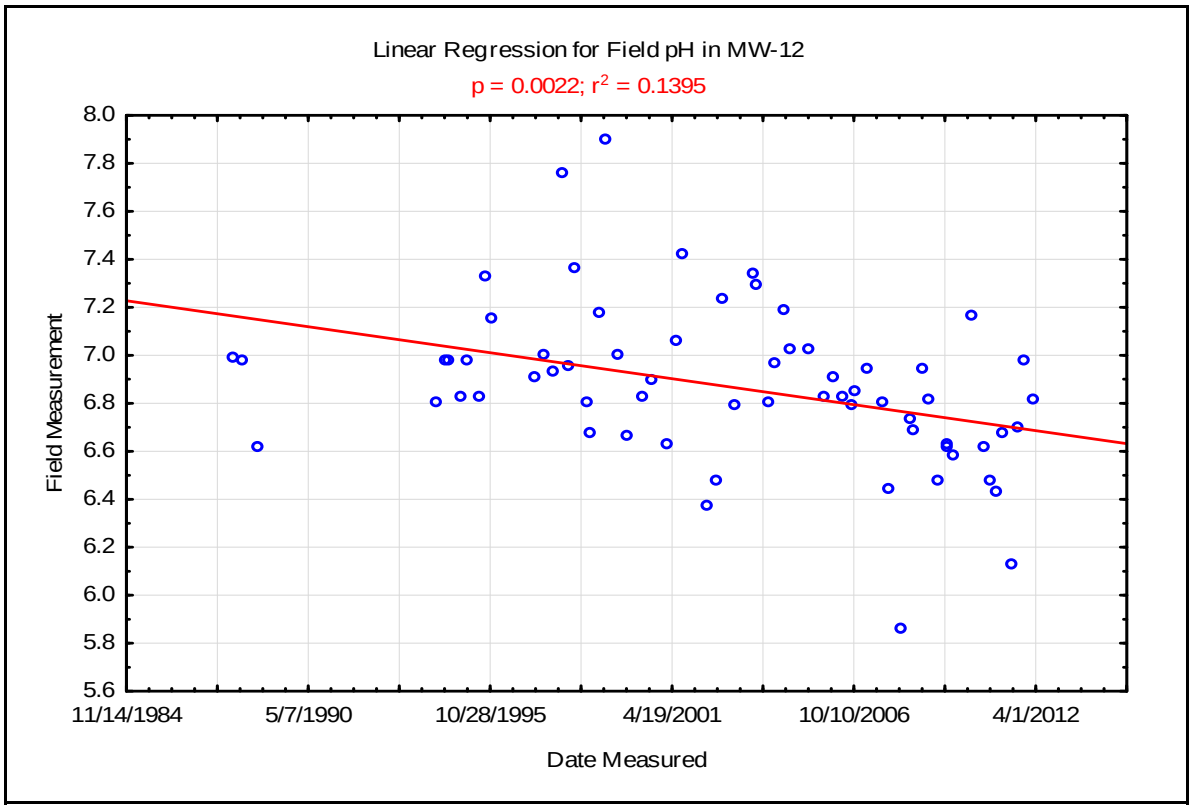
Appendix A-4 Linear Regressions for Field pH in Groundwater Monitoring Wells

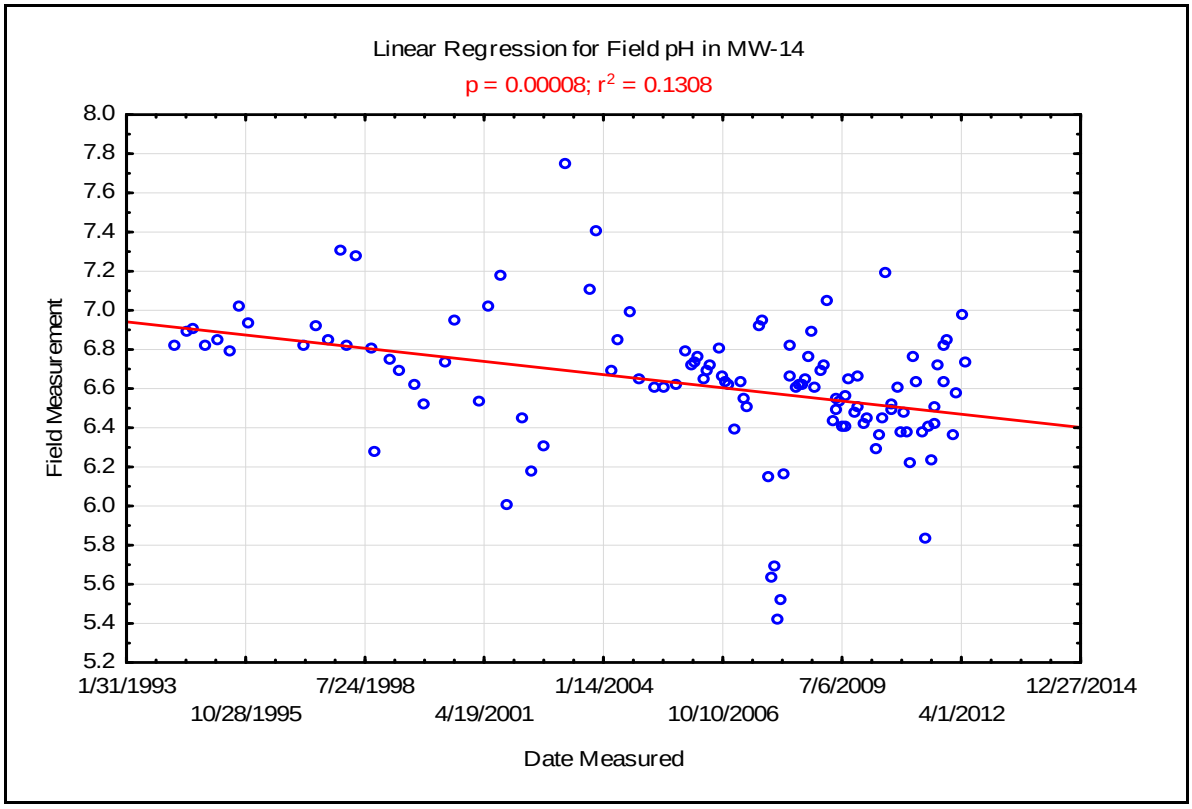


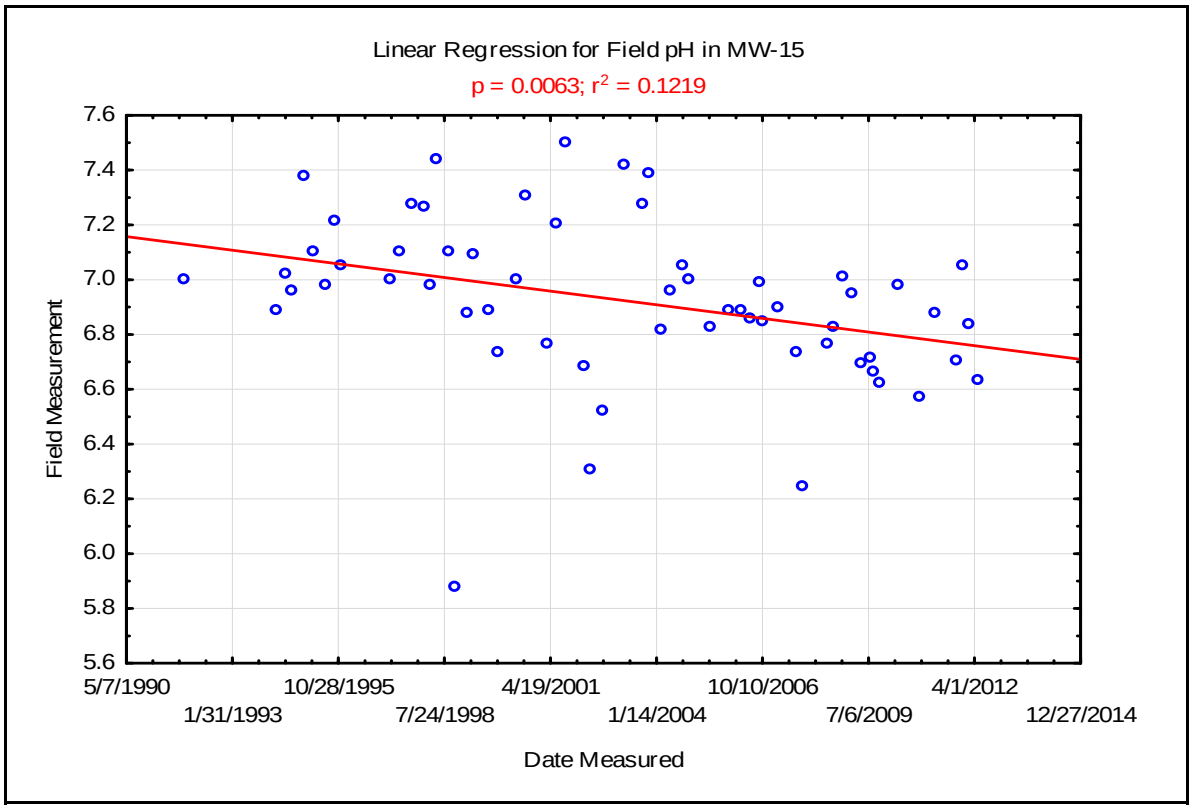


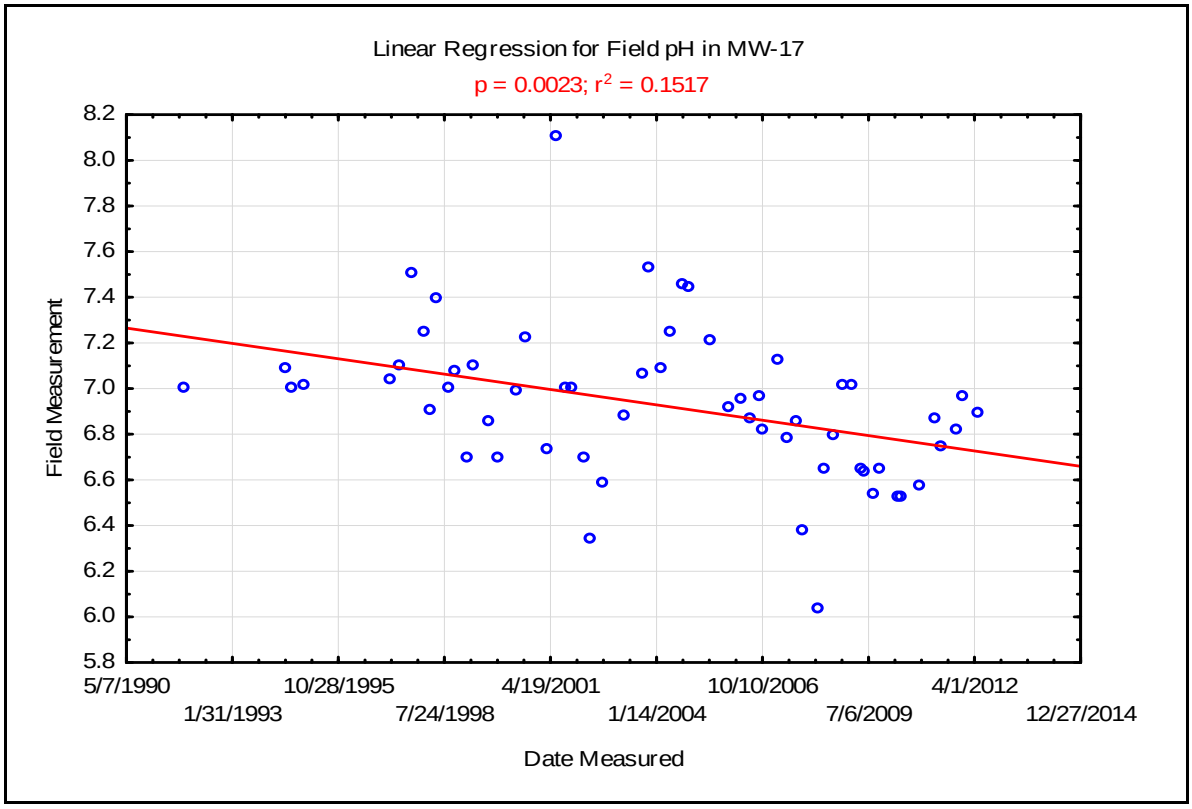

Linear Regression for Field pH in MW-5
p = 0.0988; r2 = 0.0440
Field Measurement
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
11/14/1984
5/7/1990
10/28/1995
4/19/2001
10/10/2006
4/1/2012
Date Measured


Linear Regression for Field pH in MW-11
p = 0.0238; r2 = 0.0561
Field Measurement
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
11/14/1984
5/7/1990
10/28/1995
4/19/2001
10/10/2006
4/1/2012
Date Measured

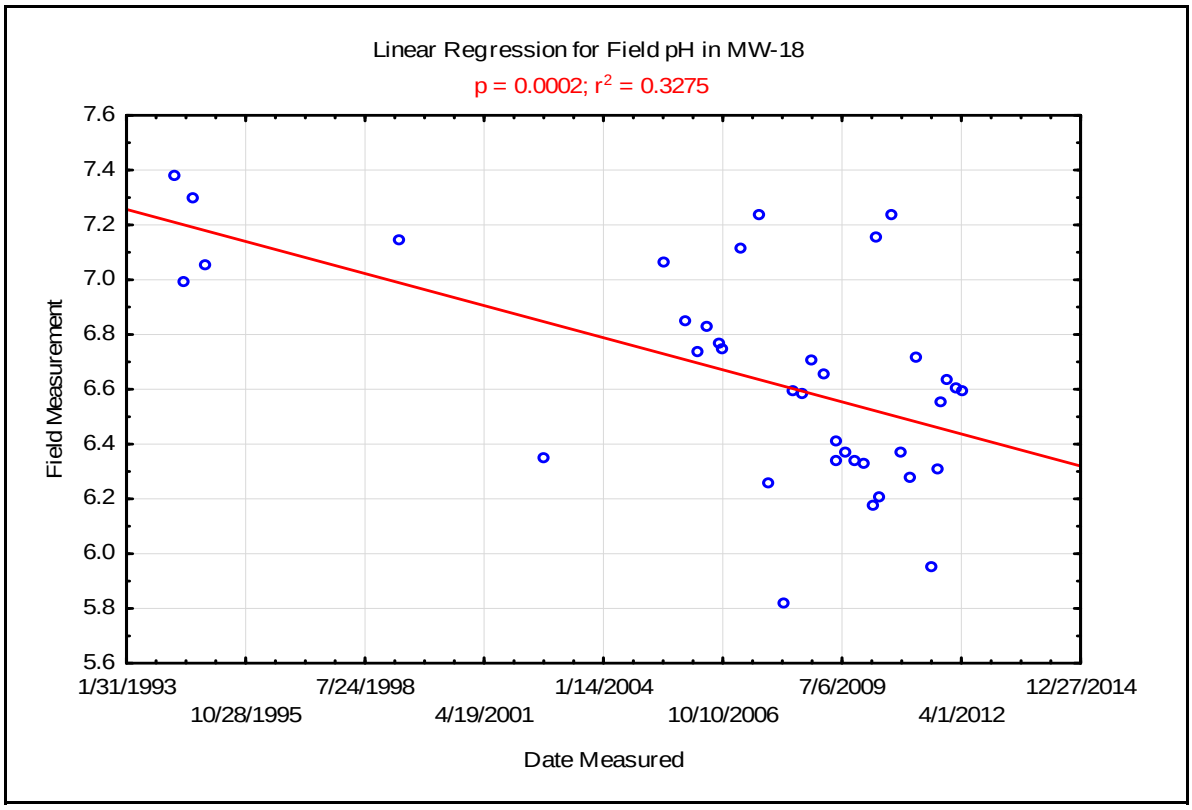

Linear Regression for Field pH in MW-12
p = 0.0022; r2 = 0.1395
Field Measurement
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
11/14/1984
5/7/1990
10/28/1995
4/19/2001
10/10/2006
4/1/2012
Date Measured

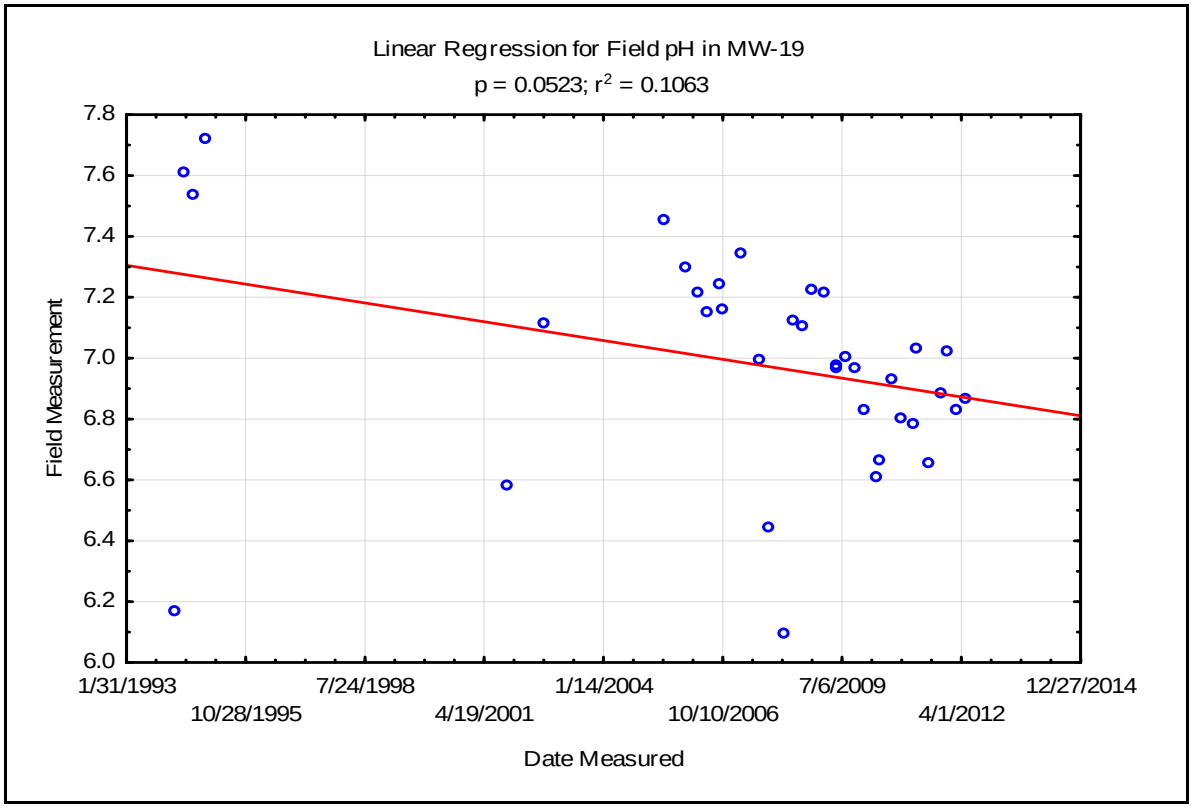

Linear Regression for Field pH in MW-14
p = 0.00008; r2 = 0.1308
Field Measurement
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
Date Measured

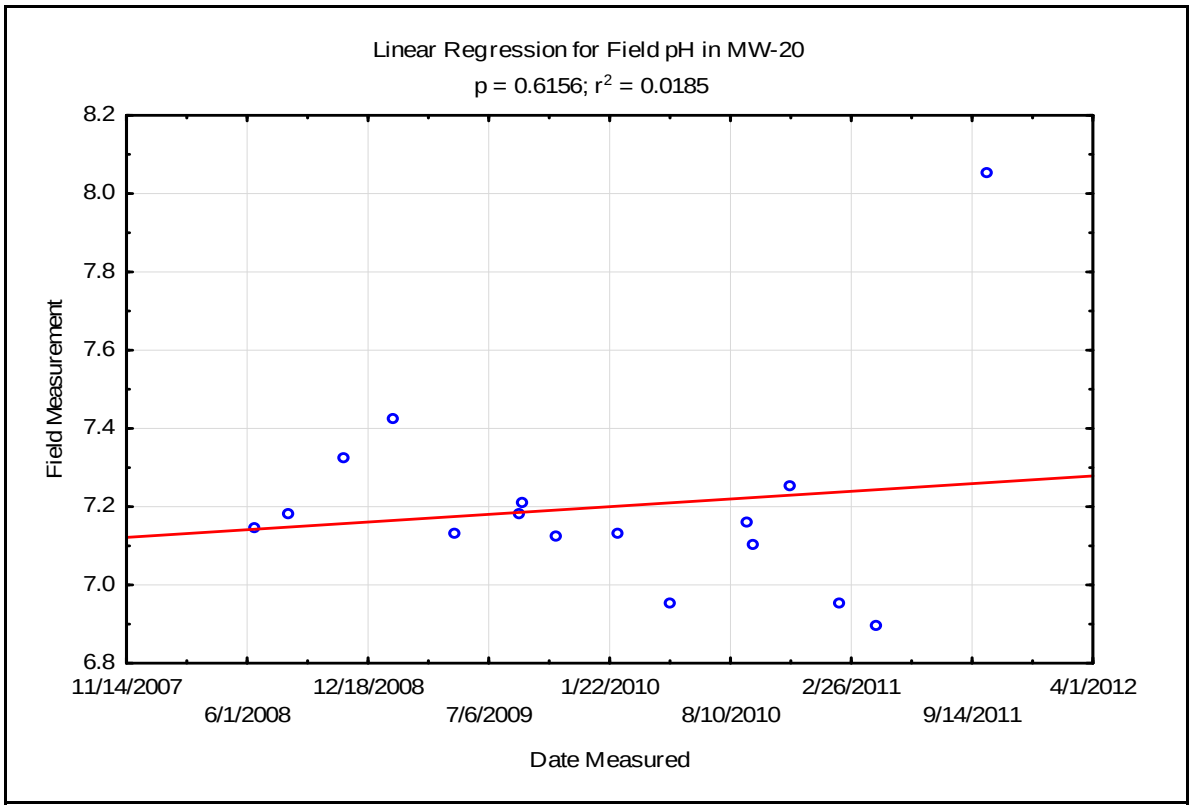

Linear Regression for Field pH in MW-15
p = 0.0063; r2 = 0.1219
Field Measurement
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5/7/1990
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
Date Measured

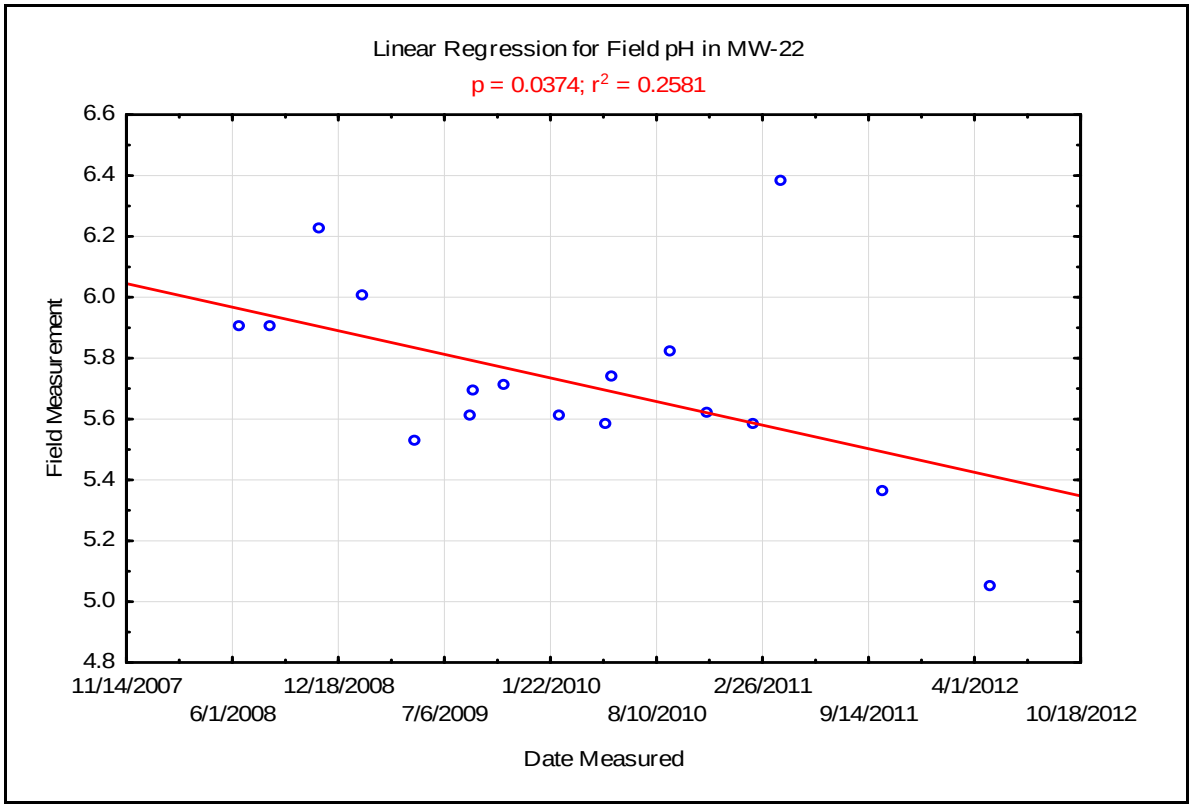

Linear Regression for Field pH in MW-17
p = 0.0023; r2 = 0.1517
Field Measurement
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5/7/1990
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
Date Measured

Appendix A-4 Linear Regressions for Field pH in Groundwater Monitoring Wells

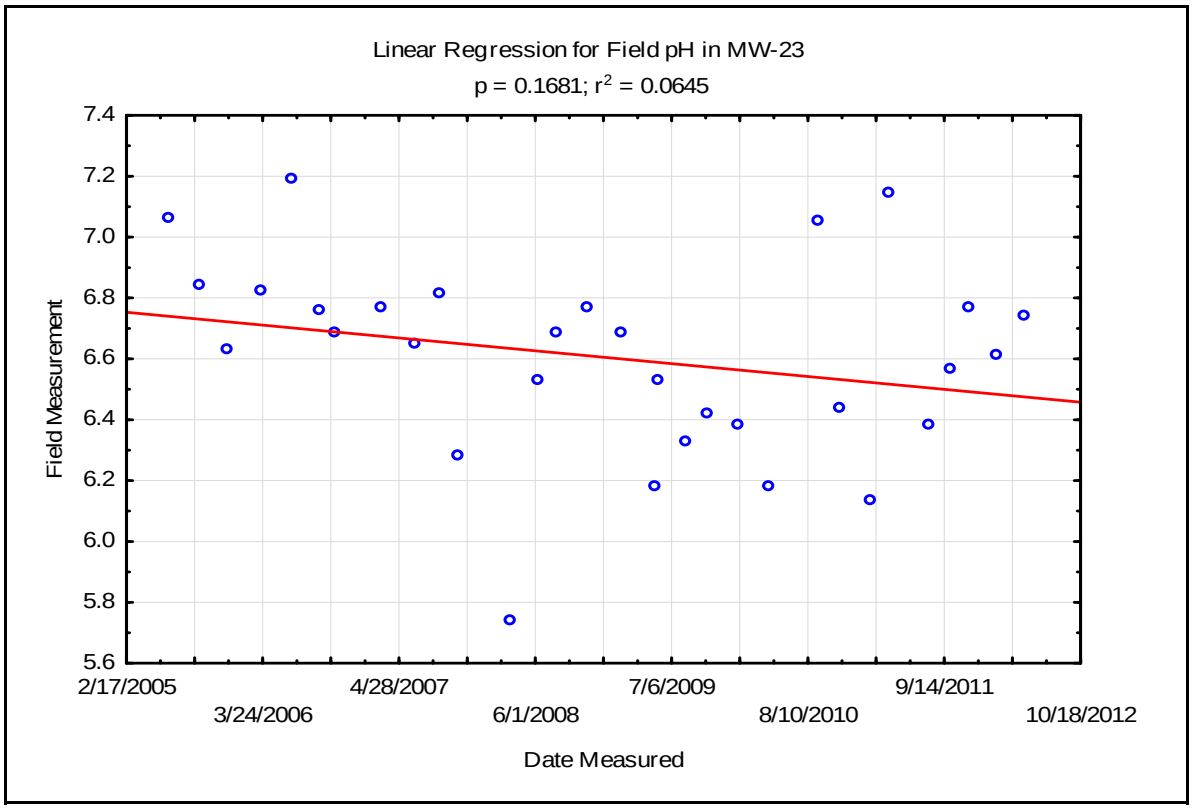


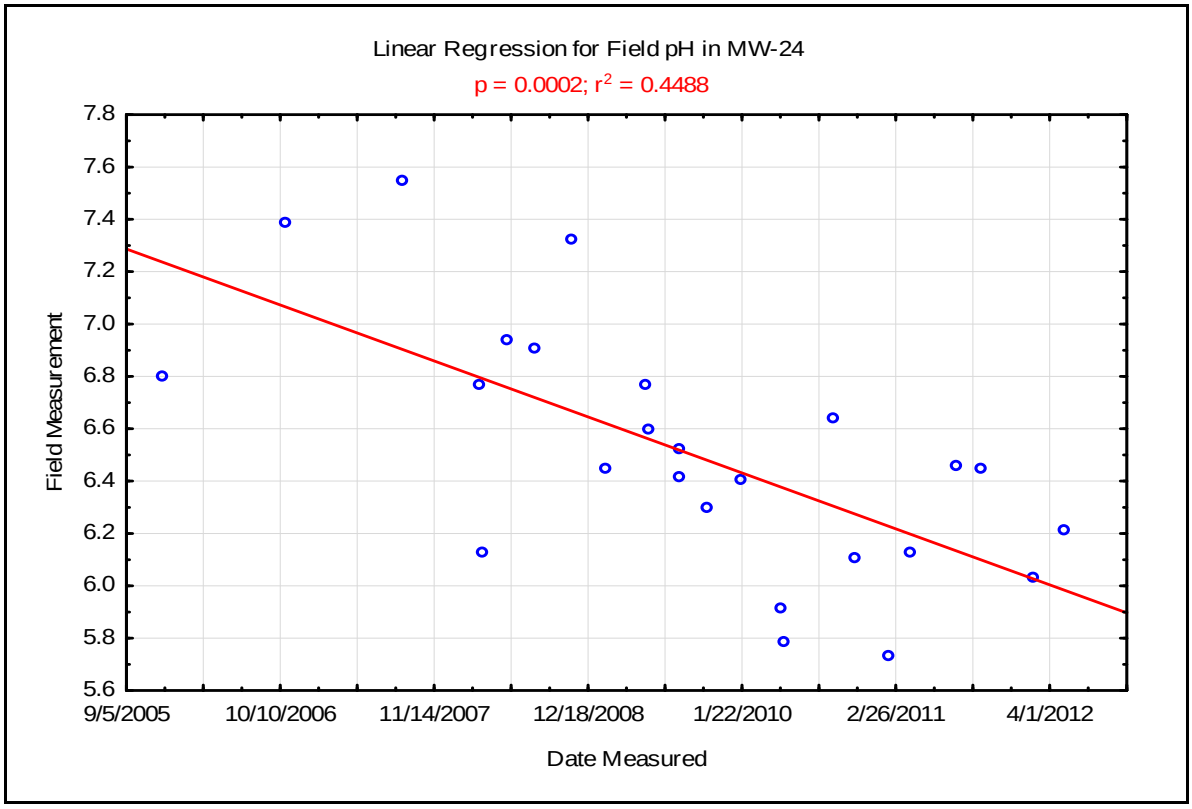


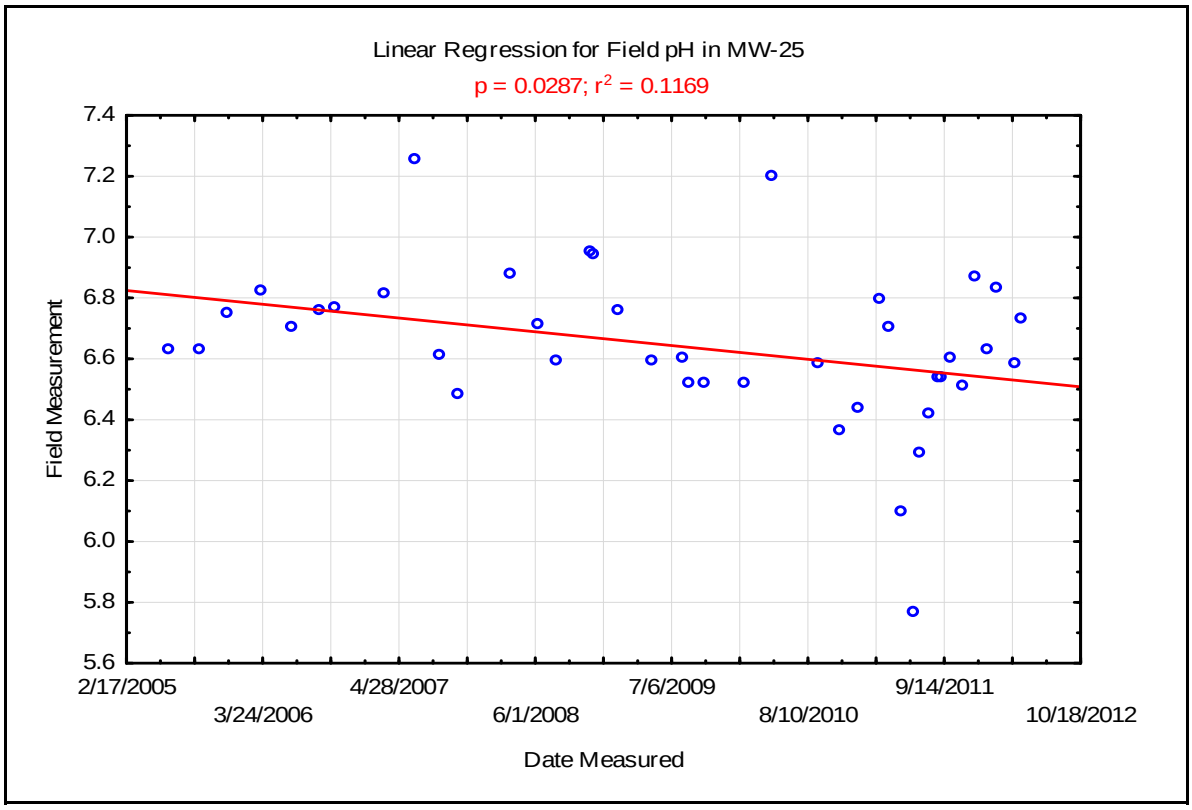

Linear Regression for Field pH in MW-20
p = 0.6156; r2 = 0.0185
Field Measurement
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
11/14/2007
6/1/2008
12/18/2008
7/6/2009
1/22/2010
8/10/2010
2/26/2011
9/14/2011
4/1/2012
Date Measured

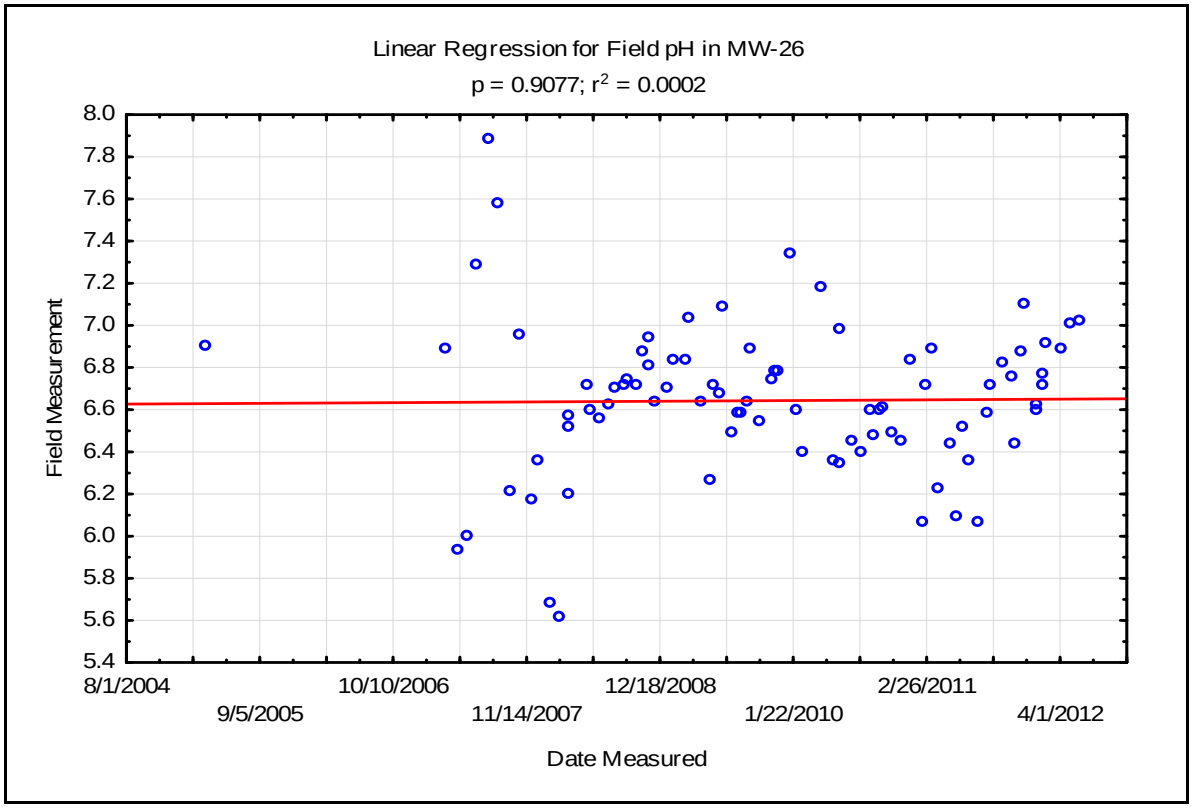

Linear Regression for Field pH in MW-22
p = 0.0374; r2 = 0.2581
Field Measurement
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
4.8
11/14/2007
6/1/2008
12/18/2008
7/6/2009
1/22/2010
8/10/2010
2/26/2011
9/14/2011
4/1/2012
10/18/2012
Date Measured

Appendix A-4 Linear Regressions for Field pH in Groundwater Monitoring Wells

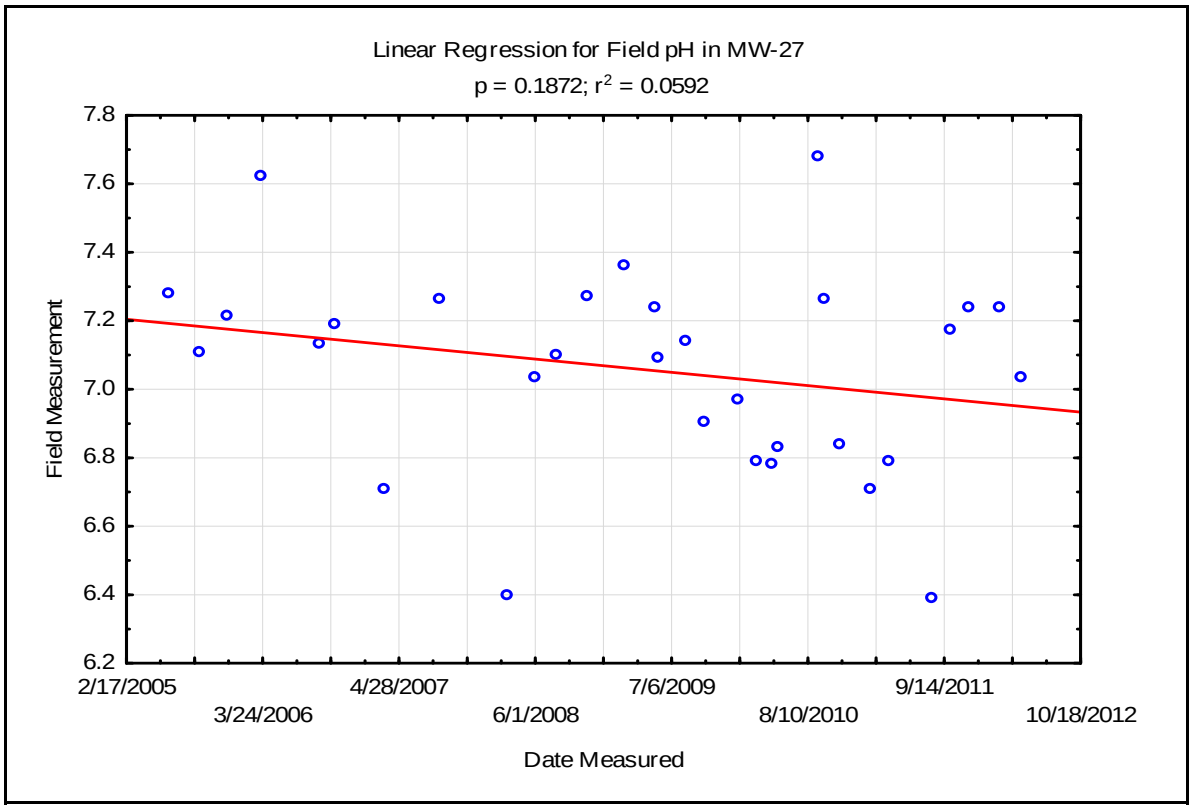


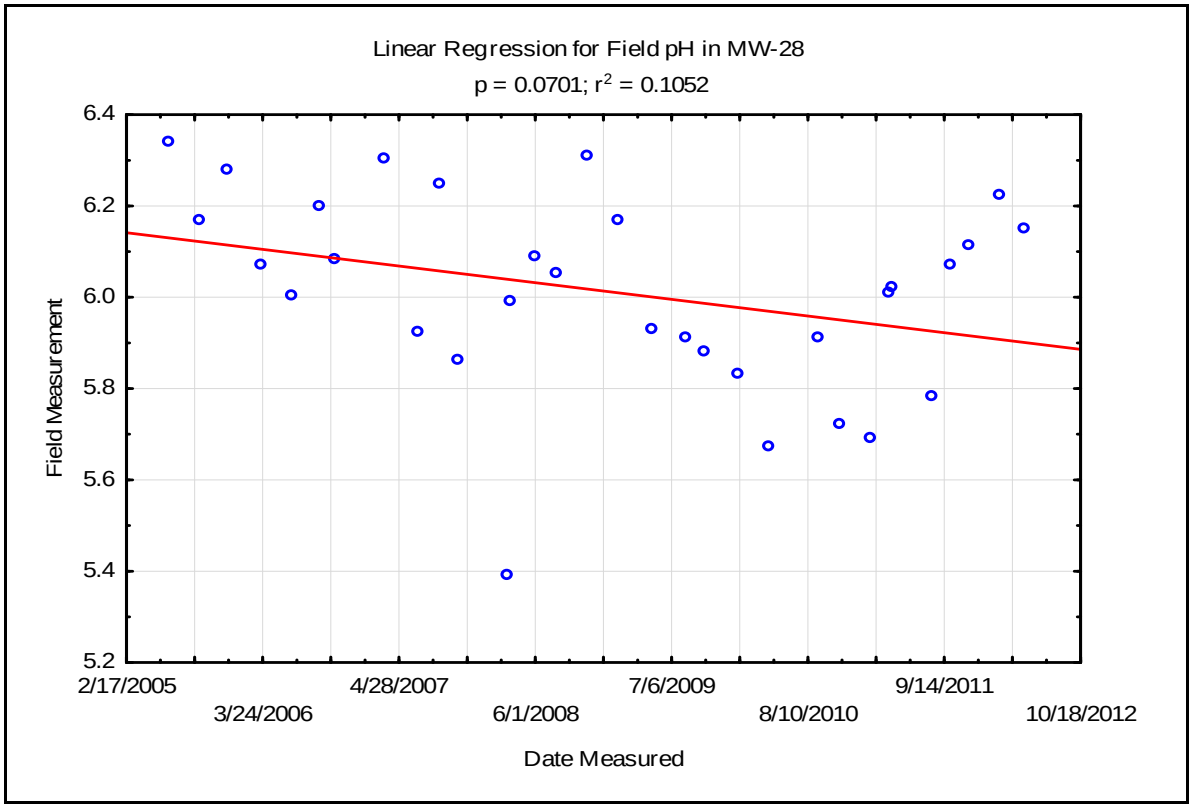



Linear Regression for Field pH in MW-25
p = 0.0287; r2 = 0.1169
Field Measurement
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
2/17/2005
3/24/2006
4/28/2007
6/1/2008
7/6/2009
8/10/2010
9/14/2011
10/18/2012
Date Measured

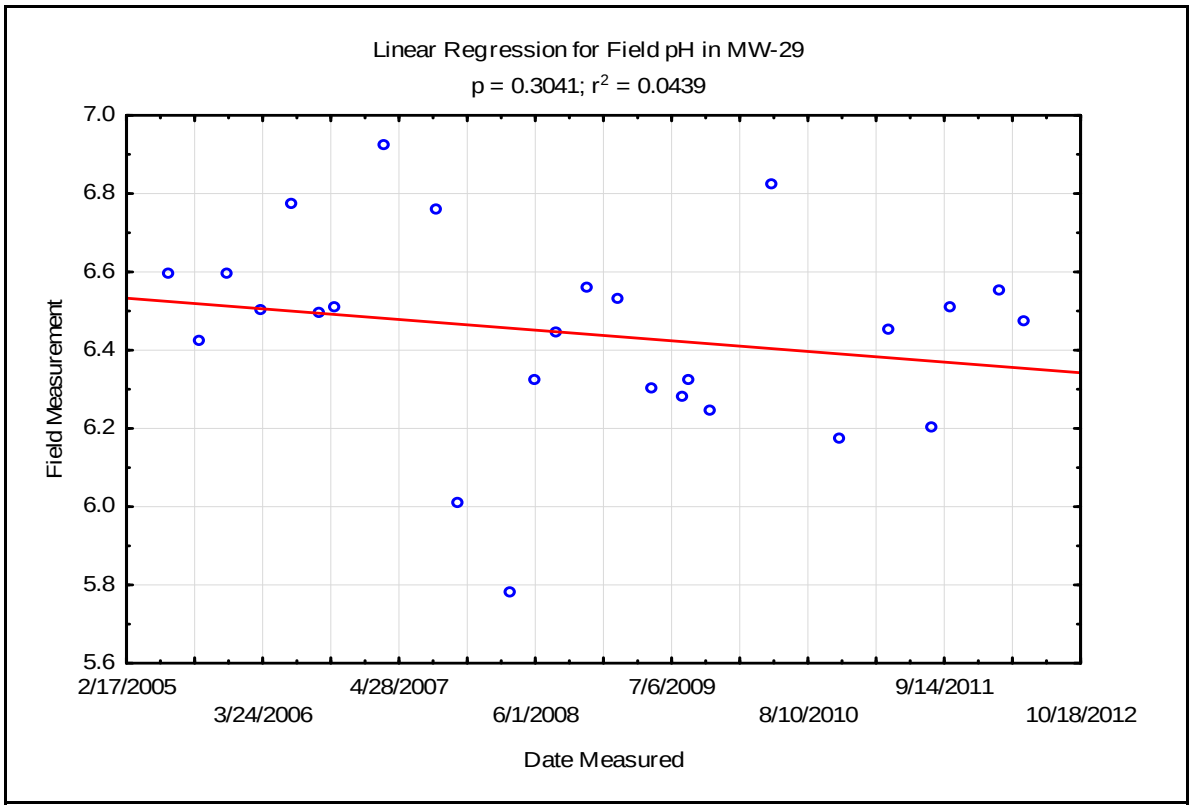

Linear Regression for Field pH in MW-26
p = 0.9077; r2 = 0.0002
Field Measurement
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
8/1/2004
9/5/2005
10/10/2006
11/14/2007
12/18/2008
1/22/2010
2/26/2011
4/1/2012
Date Measured

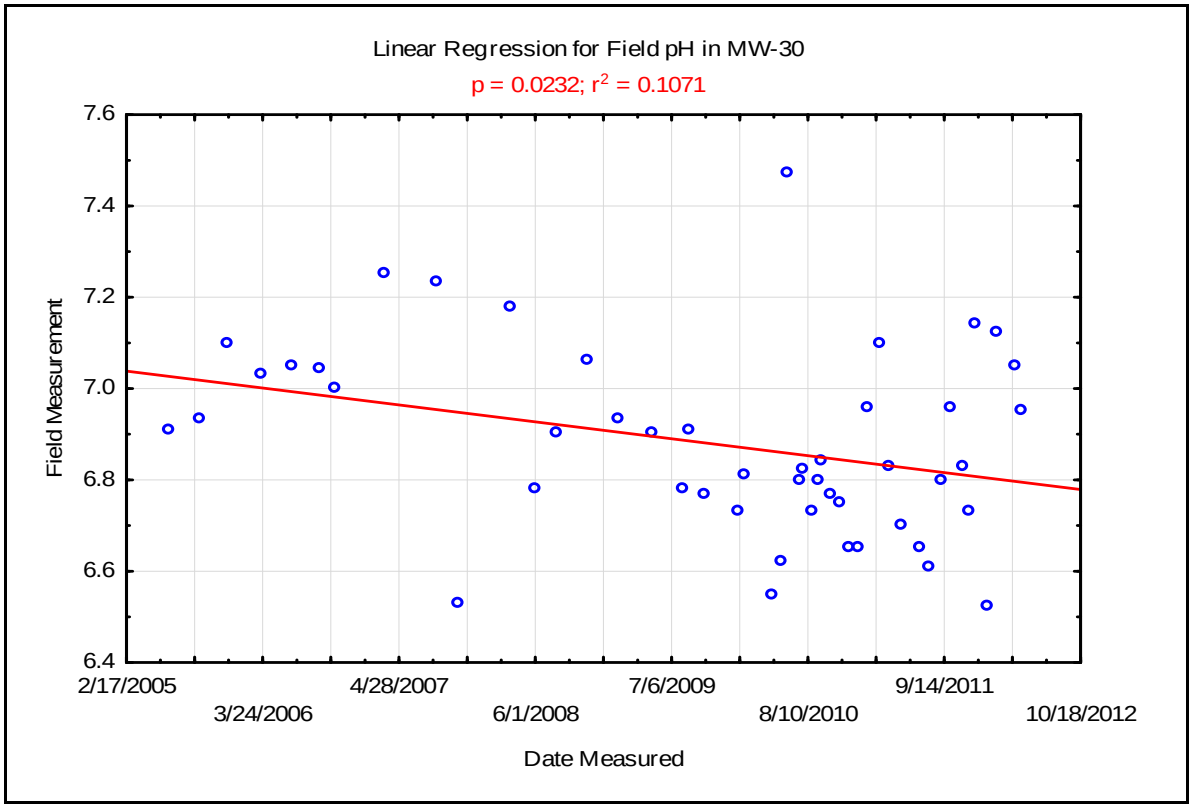
Appendix A-4 Linear Regressions for Field pH in Groundwater Monitoring Wells

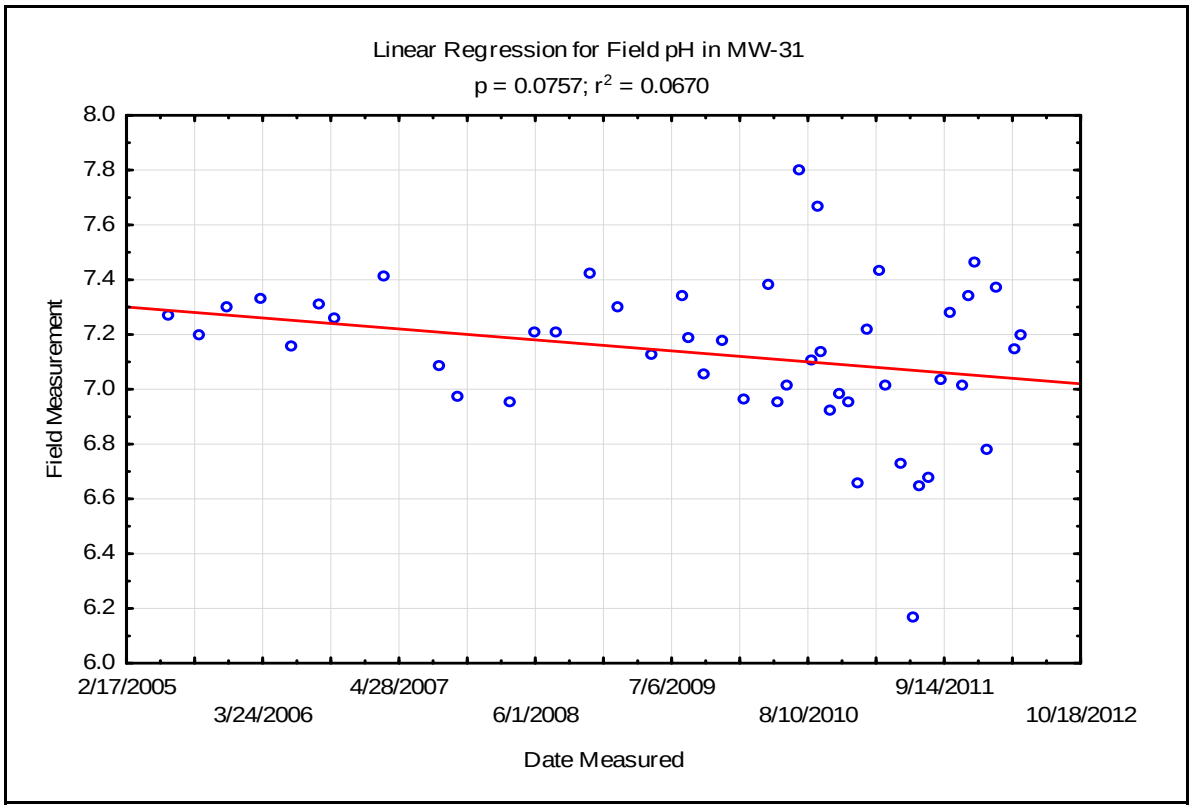


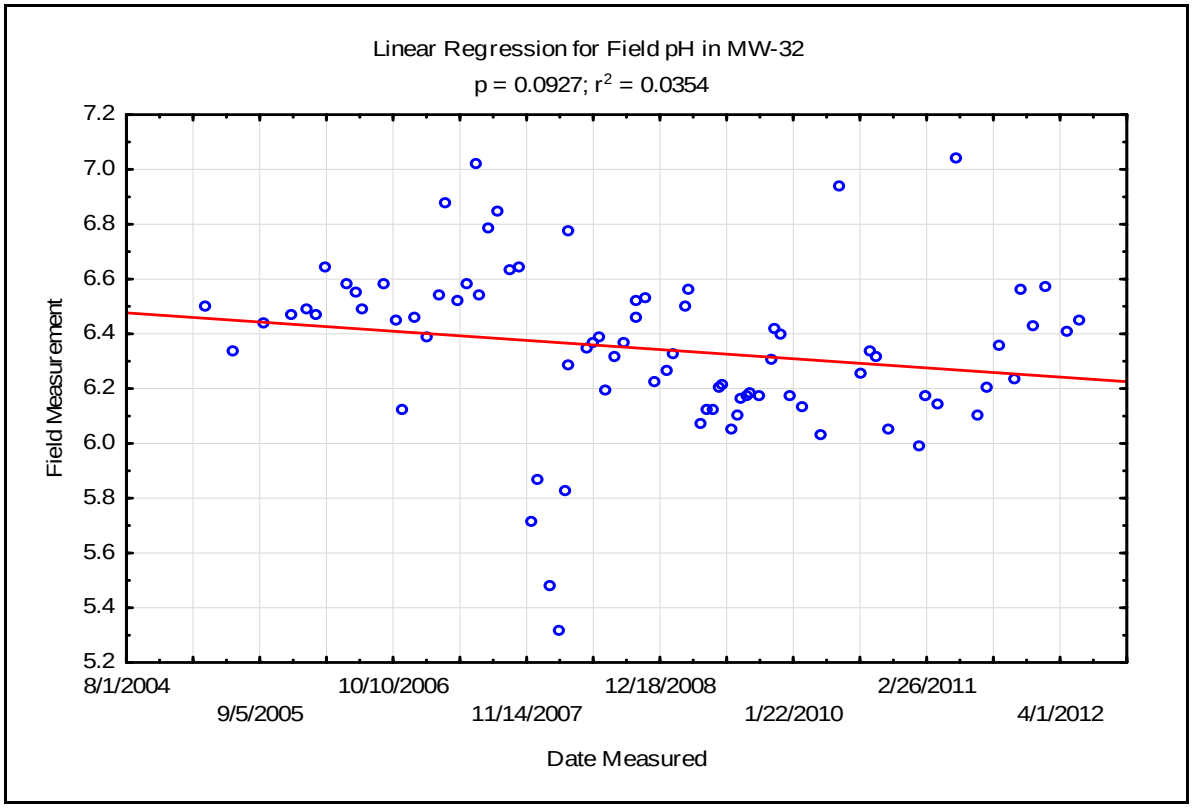


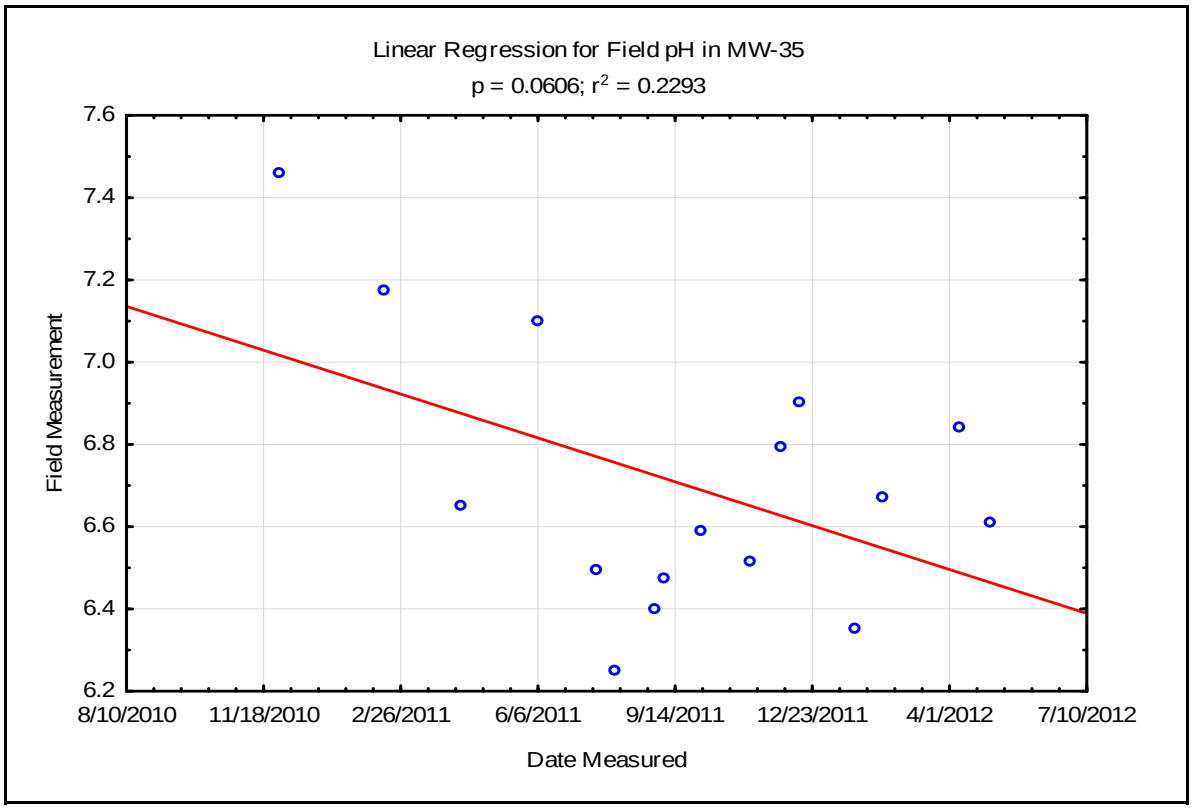
Appendix A-4 Linear Regressions for Field pH in Groundwater Monitoring Wells

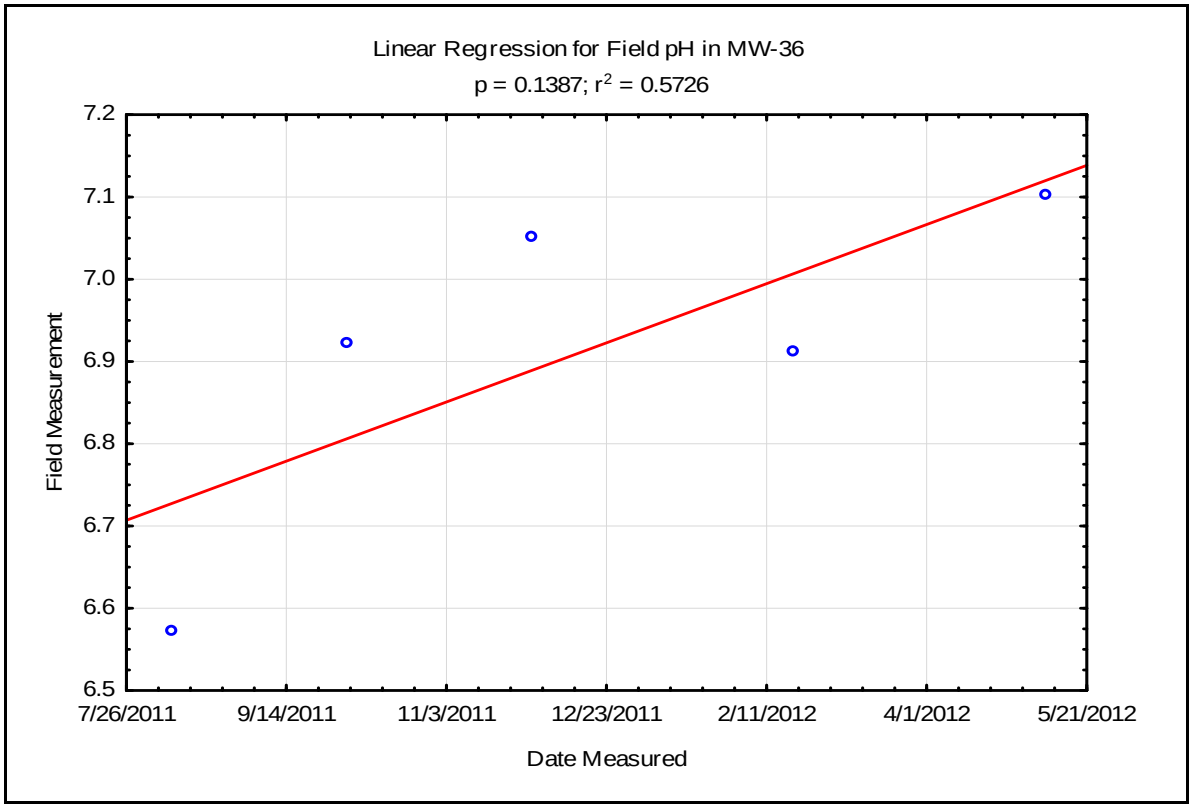


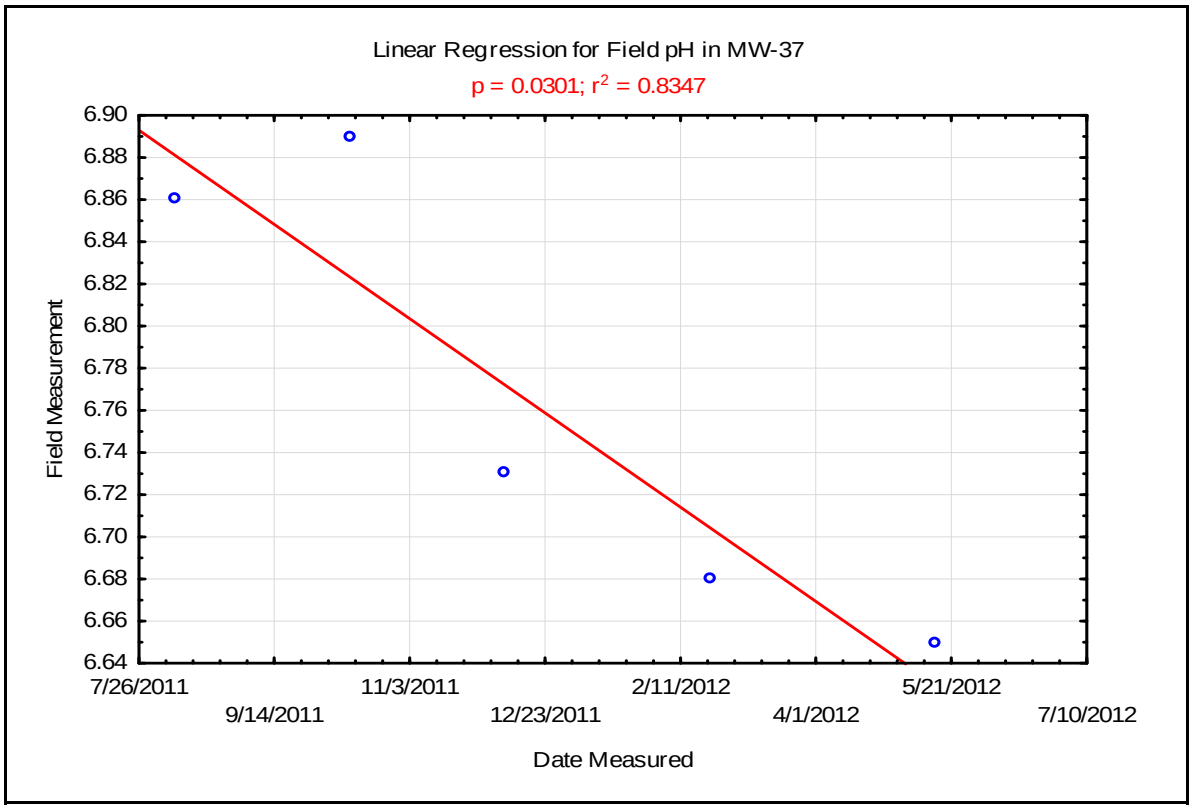



Linear Regression for Field pH in MW-31
p = 0.0757; r2 = 0.0670
Field Measurement
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
2/17/2005
3/24/2006
4/28/2007
6/1/2008
7/6/2009
8/10/2010
9/14/2011
10/18/2012
Date Measured


Linear Regression for Field pH in MW-32
p = 0.0927; r2 = 0.0354
Field Measurement
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
8/1/2004
9/5/2005
10/10/2006
11/14/2007
12/18/2008
1/22/2010
2/26/2011
4/1/2012
Date Measured


Linear Regression for Field pH in MW-35
p = 0.0606; r2 = 0.2293
Field Measurement
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
8/10/2010
11/18/2010
2/26/2011
6/6/2011
9/14/2011
12/23/2011
4/1/2012
7/10/2012
Date Measured


Linear Regression for Field pH in MW-36
p = 0.1387; r2 = 0.5726
Field Measurement
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
7/26/2011
9/14/2011
11/3/2011
12/23/2011
2/11/2012
4/1/2012
5/21/2012
Date Measured


Linear Regression for Field pH in MW-37
p = 0.0301; r2 = 0.8347
Field Measurement
6.90
6.88
6.86
6.84
6.82
6.80
6.78
6.76
6.74
6.72
6.70
6.68
6.66
6.64
7/26/2011
9/14/2011
11/3/2011
12/23/2011
2/11/2012
4/1/2012
5/21/2012
7/10/2012
Date Measured

APPENDIX A-5

Descriptive Statistics for Field PH in Groundwater Monitoring Wells

Appendix A-5 Field pH Descriptive Statistics for Groundwater Monitoring Wells

Well	N	Mean	Minimum	Maximum	Std.Dev.	Range	Geometric Mean	Skewness	Q25	Median	Q75
MW-01	41	7.32	6.70	8.05	0.32	1.35	7.31	0.452	7.13	7.30	7.50
MW-02	34	7.10	6.71	7.48	0.19	0.77	7.09	-0.320	7.01	7.11	7.22
MW-03	45	6.58	5.95	7.11	0.27	1.16	6.57	-0.102	6.35	6.63	6.74
MW-03A	28	6.53	5.90	7.62	0.35	1.72	6.52	1.014	6.26	6.54	6.68
MW-05	63	7.52	7.00	8.10	0.24	1.10	7.51	0.135	7.36	7.52	7.66
MW-11	91	7.68	6.25	9.00	0.39	2.75	7.67	-0.256	7.45	7.71	7.91
MW-12	65	6.87	5.86	7.90	0.33	2.04	6.86	0.213	6.67	6.82	7.00
MW-14	114	6.62	5.42	7.75	0.35	2.33	6.61	-0.573	6.45	6.63	6.82
MW-15	60	6.92	5.88	7.50	0.29	1.62	6.92	-0.746	6.76	6.96	7.07
MW-17	59	6.93	6.03	8.10	0.33	2.07	6.92	0.511	6.70	6.95	7.08
MW-18	38	6.65	5.82	7.38	0.39	1.56	6.64	0.077	6.34	6.62	6.99
MW-19	36	6.99	6.09	7.72	0.36	1.63	6.98	-0.407	6.82	7.00	7.21
MW-20	16	7.20	6.89	8.05	0.26	1.16	7.19	2.362	7.11	7.15	7.23
MW-22	17	5.72	5.05	6.38	0.31	1.33	5.72	0.162	5.58	5.69	5.90
MW-23	31	6.60	5.74	7.19	0.32	1.45	6.60	-0.450	6.38	6.65	6.77
MW-24	25	6.50	5.73	7.54	0.48	1.81	6.49	0.492	6.12	6.44	6.77
MW-25	41	6.64	5.77	7.25	0.26	1.48	6.64	-0.627	6.52	6.63	6.77
MW-26	86	6.64	5.61	7.88	0.36	2.27	6.63	0.067	6.45	6.64	6.83
MW-27	31	7.06	6.39	7.68	0.30	1.29	7.05	-0.326	6.83	7.11	7.24
MW-28	32	6.01	5.39	6.34	0.22	0.95	6.01	-0.749	5.90	6.04	6.17
MW-29	26	6.44	5.78	6.92	0.25	1.14	6.44	-0.517	6.30	6.48	6.56
MW-30	48	6.88	6.52	7.47	0.20	0.95	6.88	0.480	6.74	6.84	7.04
MW-31	48	7.13	6.16	7.80	0.28	1.64	7.12	-0.730	6.98	7.16	7.31
MW-32	81	6.34	5.31	7.04	0.30	1.73	6.34	-0.520	6.17	6.36	6.52
MW-34	3	6.96	6.49	7.39	0.45	0.90	6.95	-0.460	6.49	7.01	7.39
MW-35	16	6.70	6.25	7.46	0.33	1.21	6.70	0.903	6.48	6.63	6.87
MW-36	5	6.91	6.57	7.10	0.21	0.53	6.91	-1.395	6.91	6.92	7.05
MW-37	5	6.76	6.65	6.89	0.11	0.24	6.76	0.351	6.68	6.73	6.86

APPENDIX A-6

Data Omitted Prior to Statistical Analysis

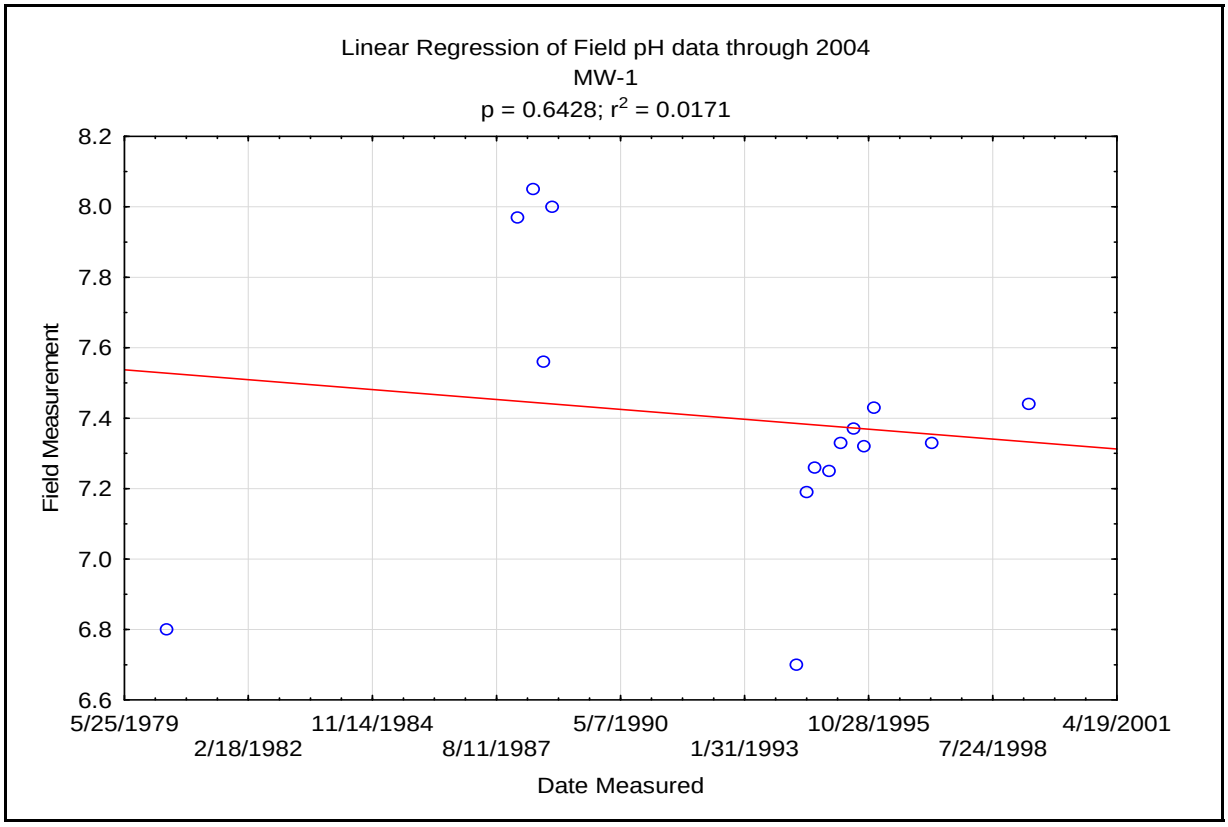
Appendix A-6 Data Omitted Prior to Statistical Analysis

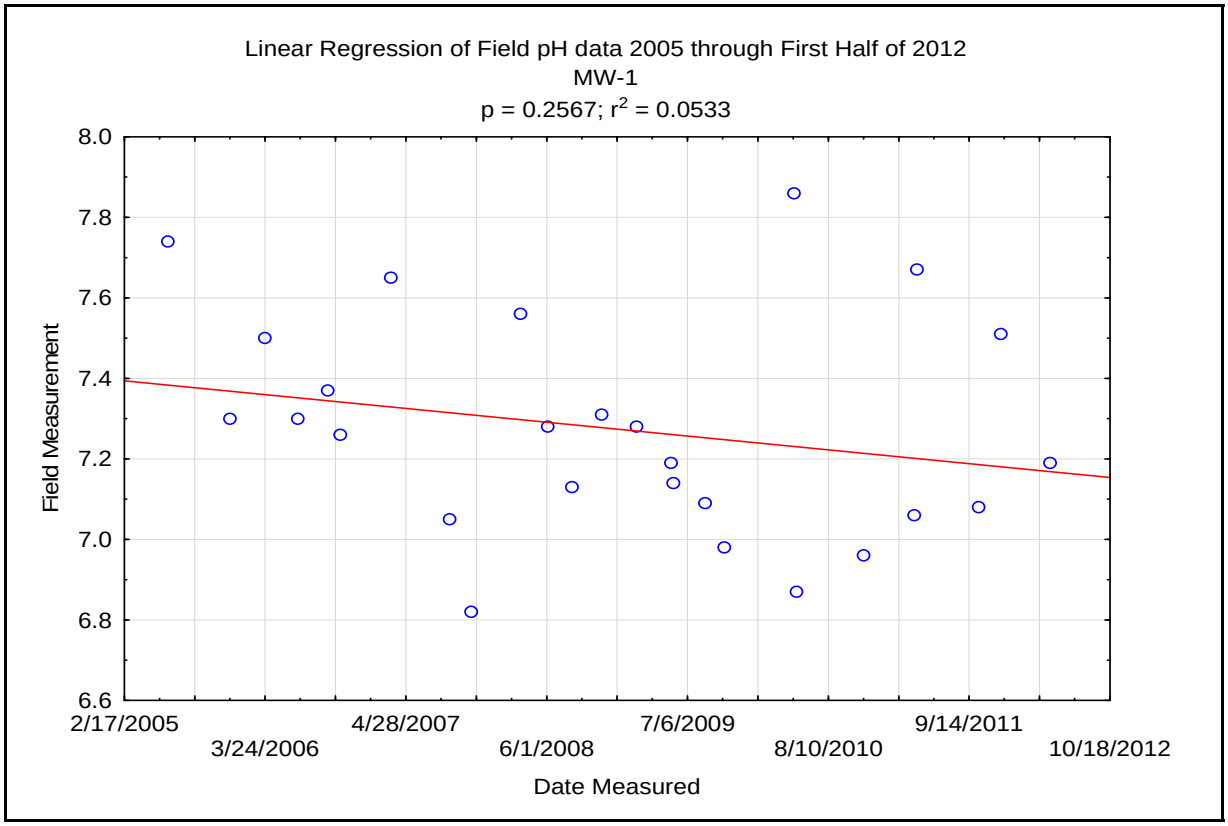
Reason	Location ID	Date Measured	Field Measurement
Extreme Oulier	MW-03	11/2/1988	8
Extreme Oulier	MW-04	6/1/2011	6.03
Extreme Oulier	MW-05	11/3/1998	5.88
Extreme Oulier	MW-05	9/7/2001	8.11
Extreme Oulier	MW-05	6/27/2003	8.65
Extreme Oulier	MW-12	6/27/2003	8.22
Extreme Oulier	MW-14	6/27/2003	8.21
Extreme Oulier	MW-15	6/27/2003	8.34
Extreme Oulier	MW-15	3/11/2008	5.73
Extreme Oulier	MW-17	3/24/1994	14
Extreme Oulier	MW-17	6/27/2003	8.31
Extreme Oulier	MW-20	12/13/1994	10.01
Extreme Oulier	MW-20	5/24/2011	11.04
Extreme Oulier	MW-20	5/8/2012	9.07
Extreme Oulier	MW-22	12/13/1994	7.14
Extreme Oulier	MW-24	6/20/2007	9.76
Extreme Oulier	MW-26	4/29/2008	8.9
Extreme Oulier	MW-30	6/20/2011	5.66
Extreme Oulier	MW-32	4/29/2008	9.76

APPENDIX B

Exploratory Linear Regressions for Field pH in Groundwater Monitoring Wells

Appendix B
Exploratory Linear Regressions for Field pH in Groundwater Monitoring Wells





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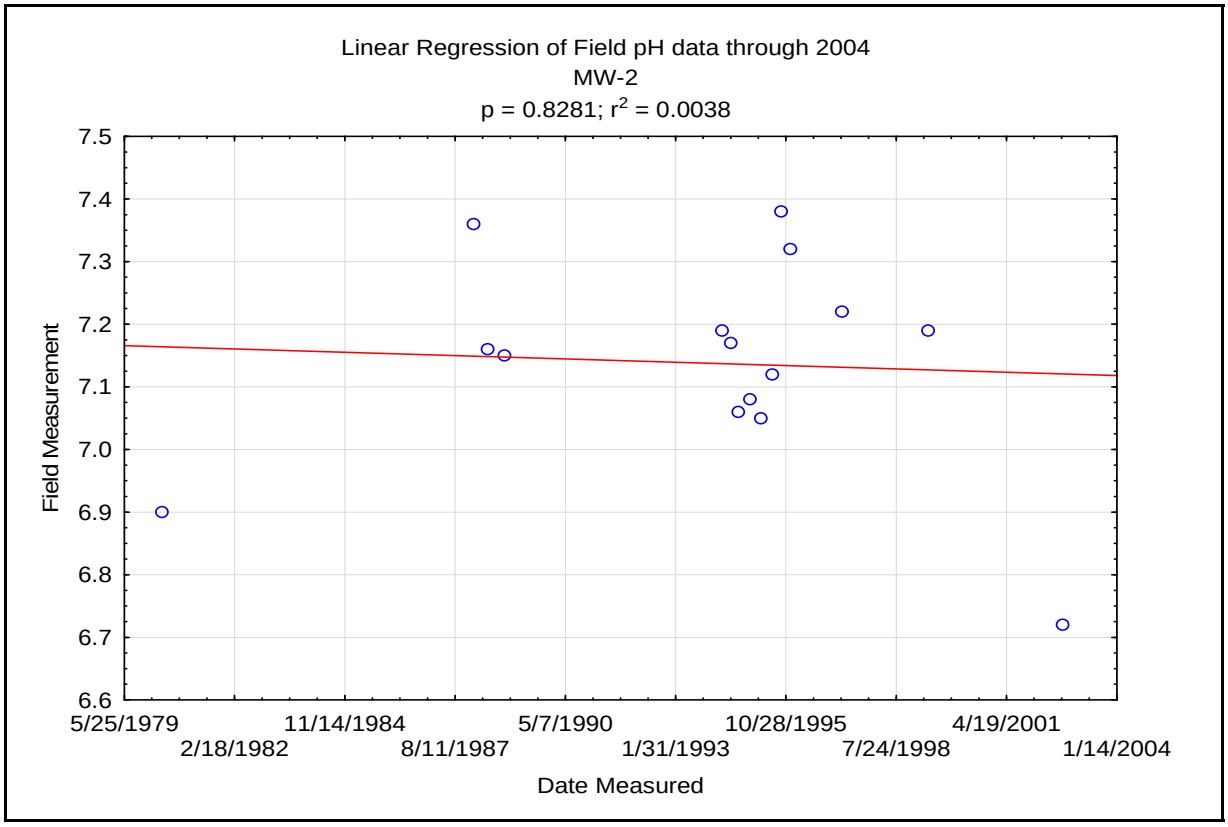
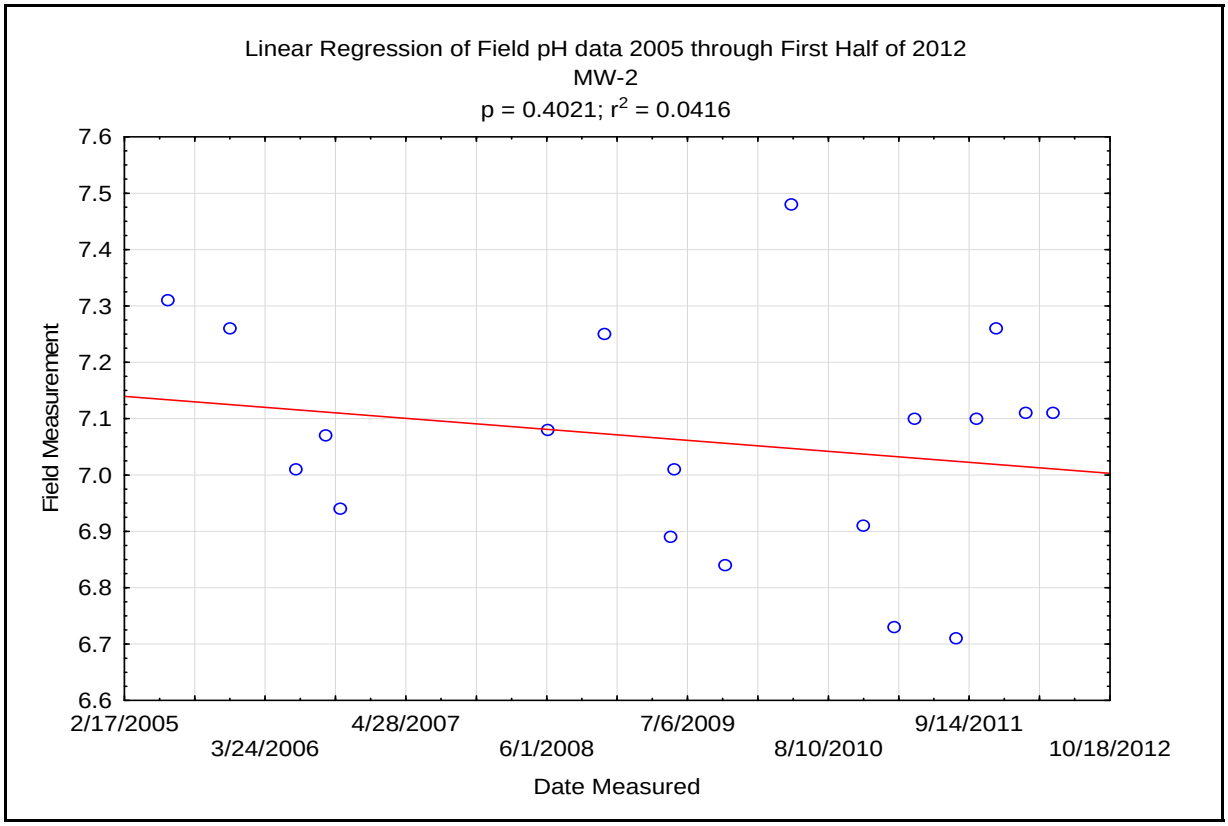
Exploratory Linear Regressions for Field pH in Groundwater Monitoring Wells





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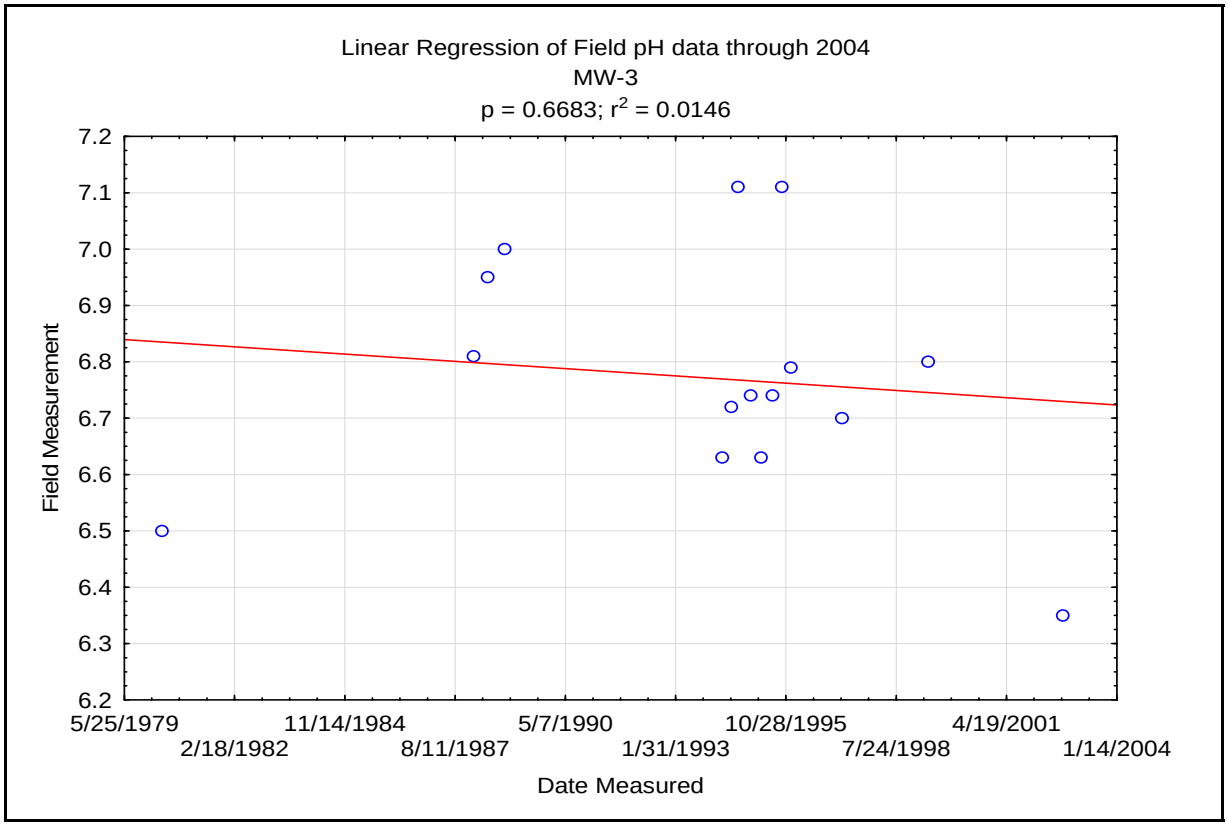

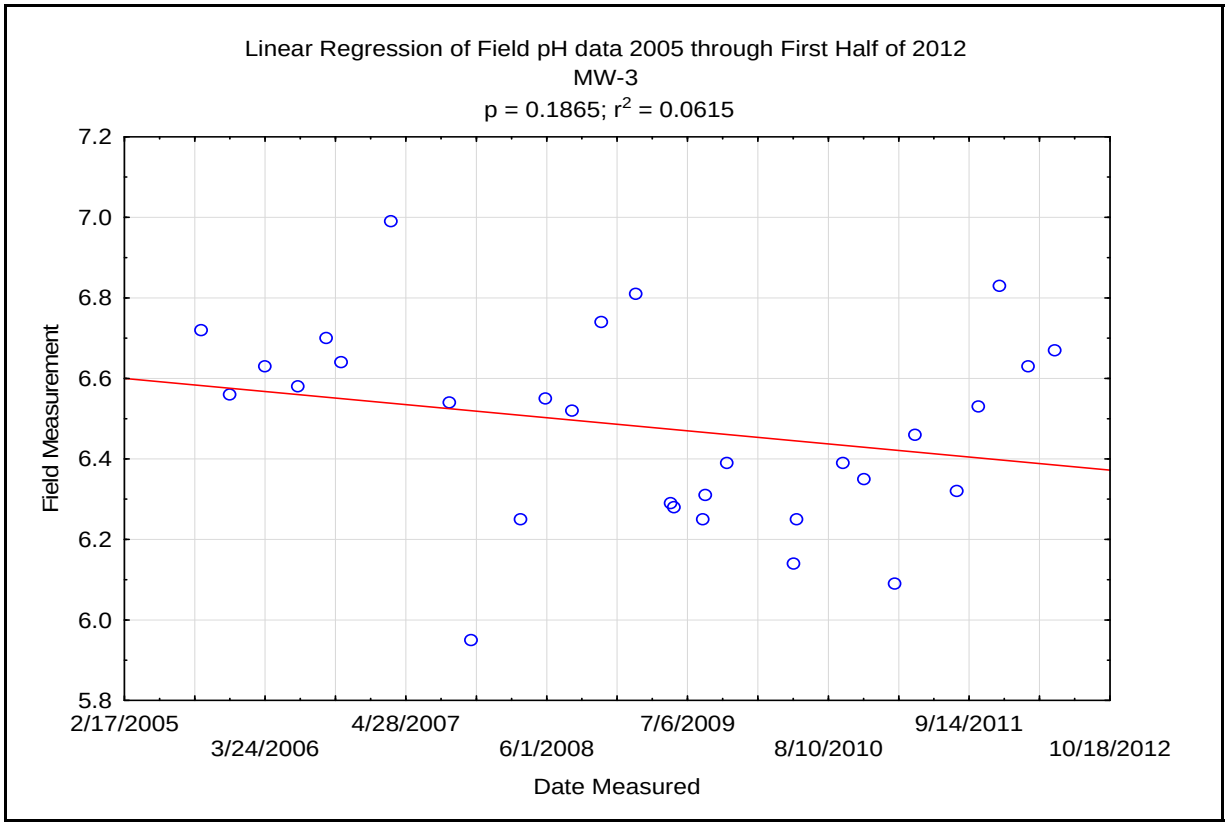

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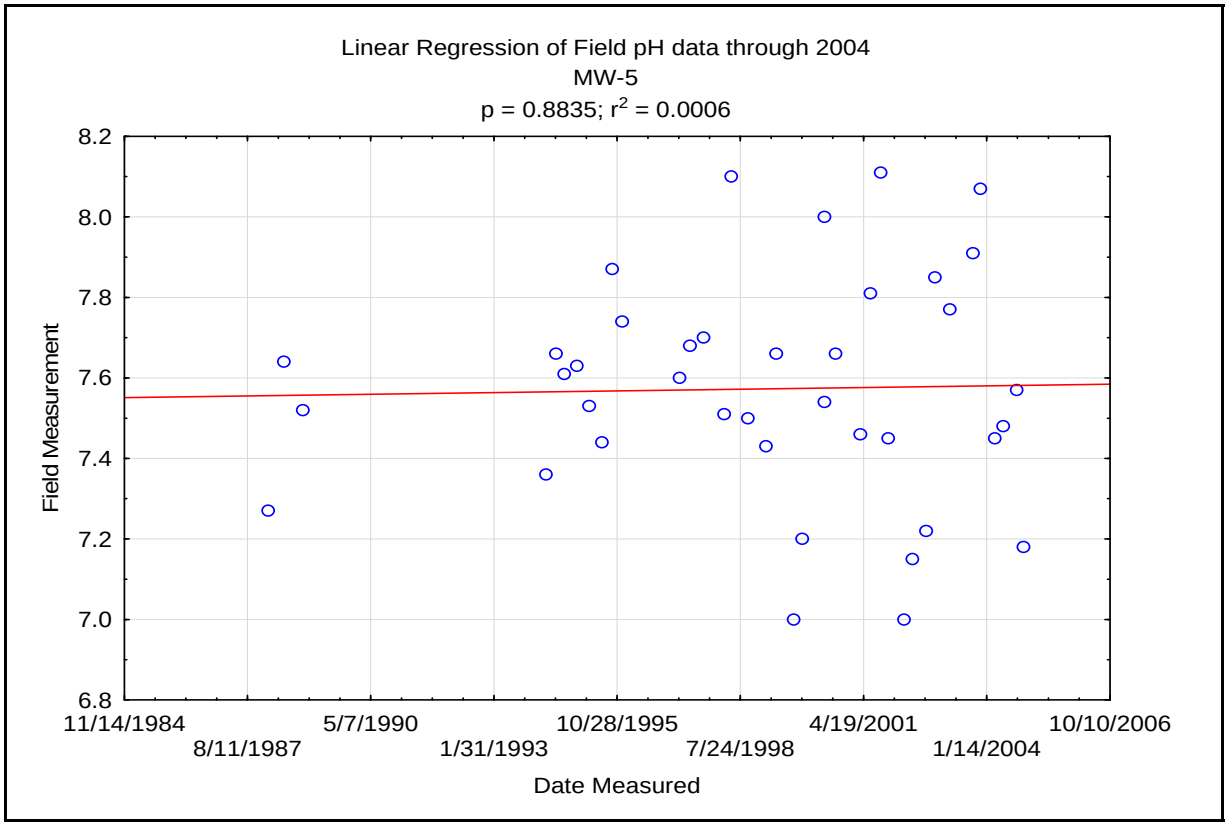

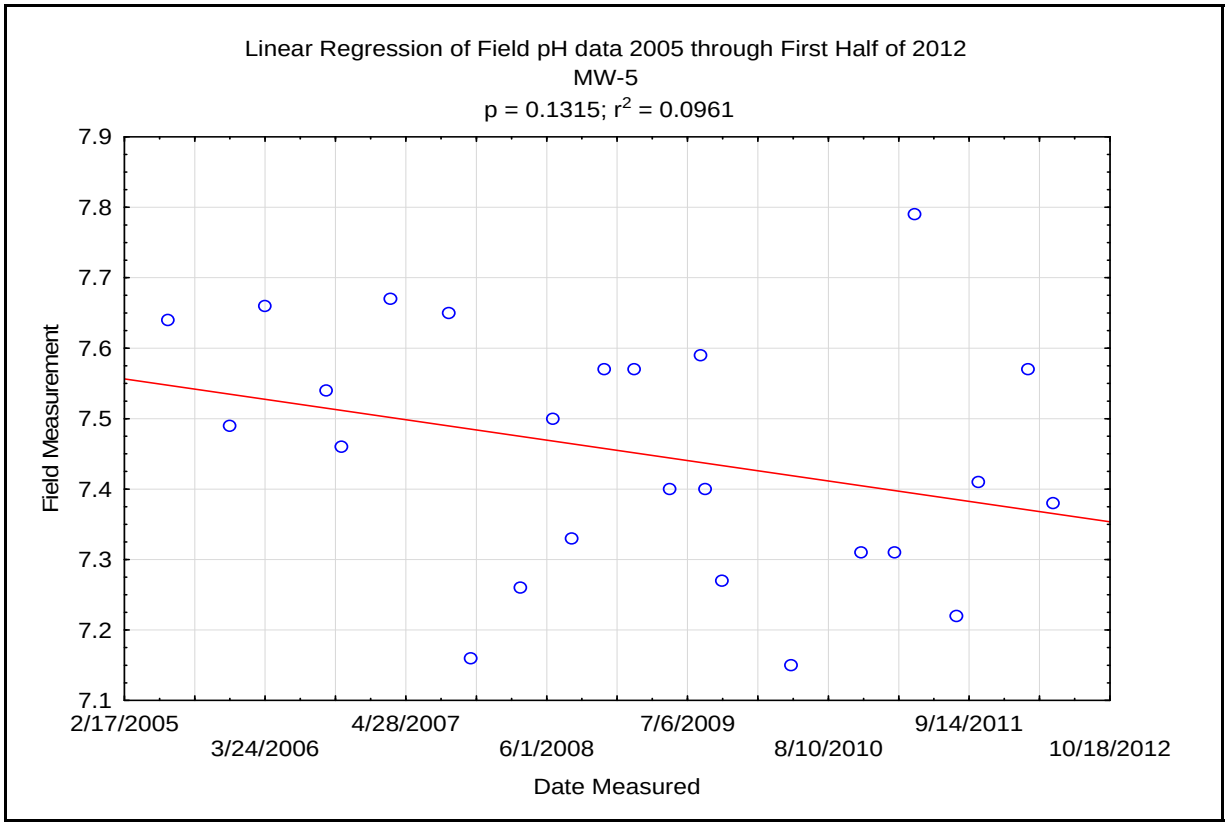

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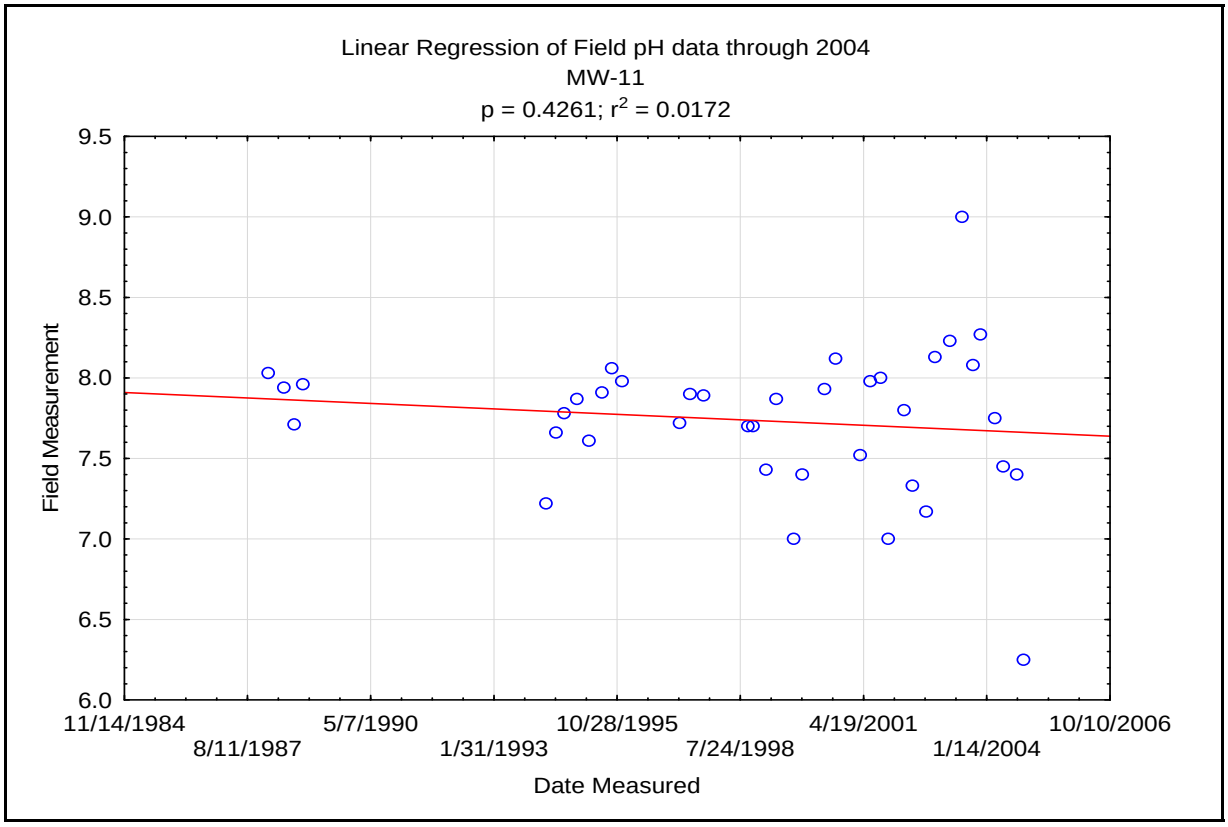

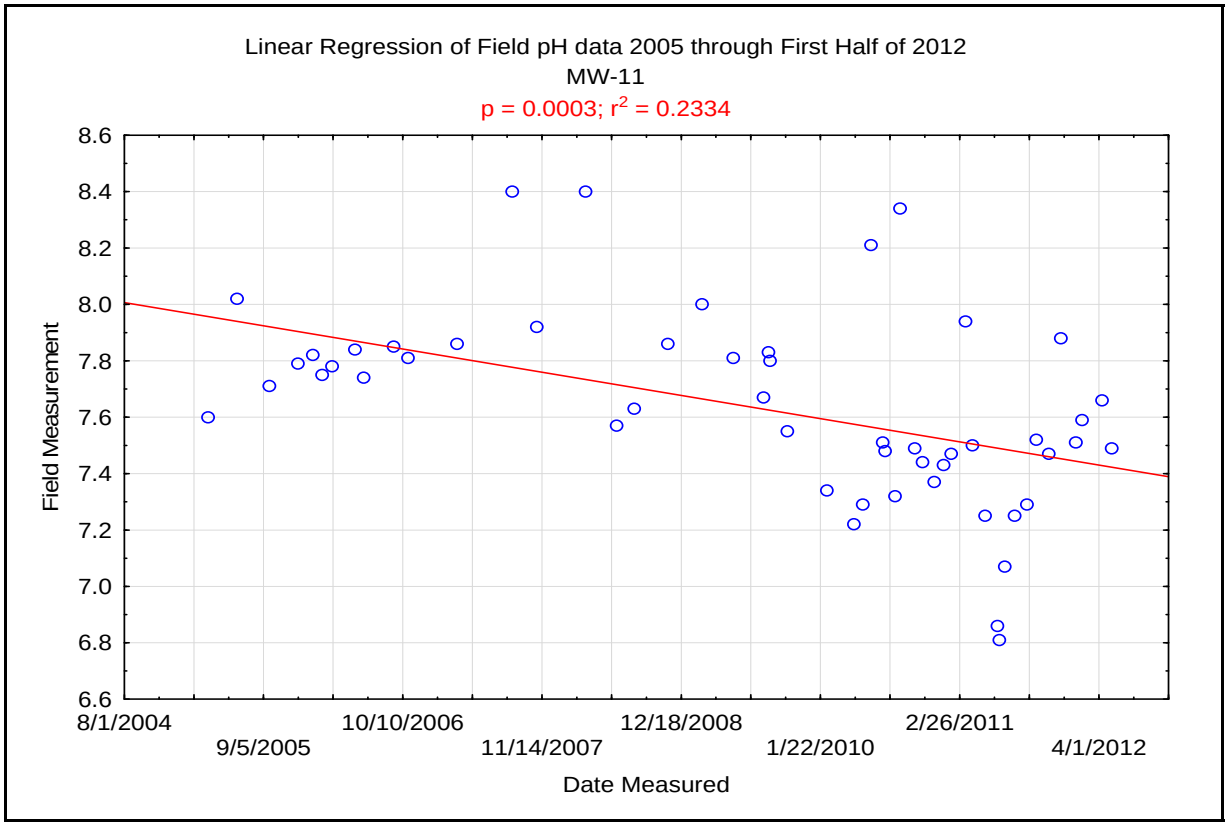

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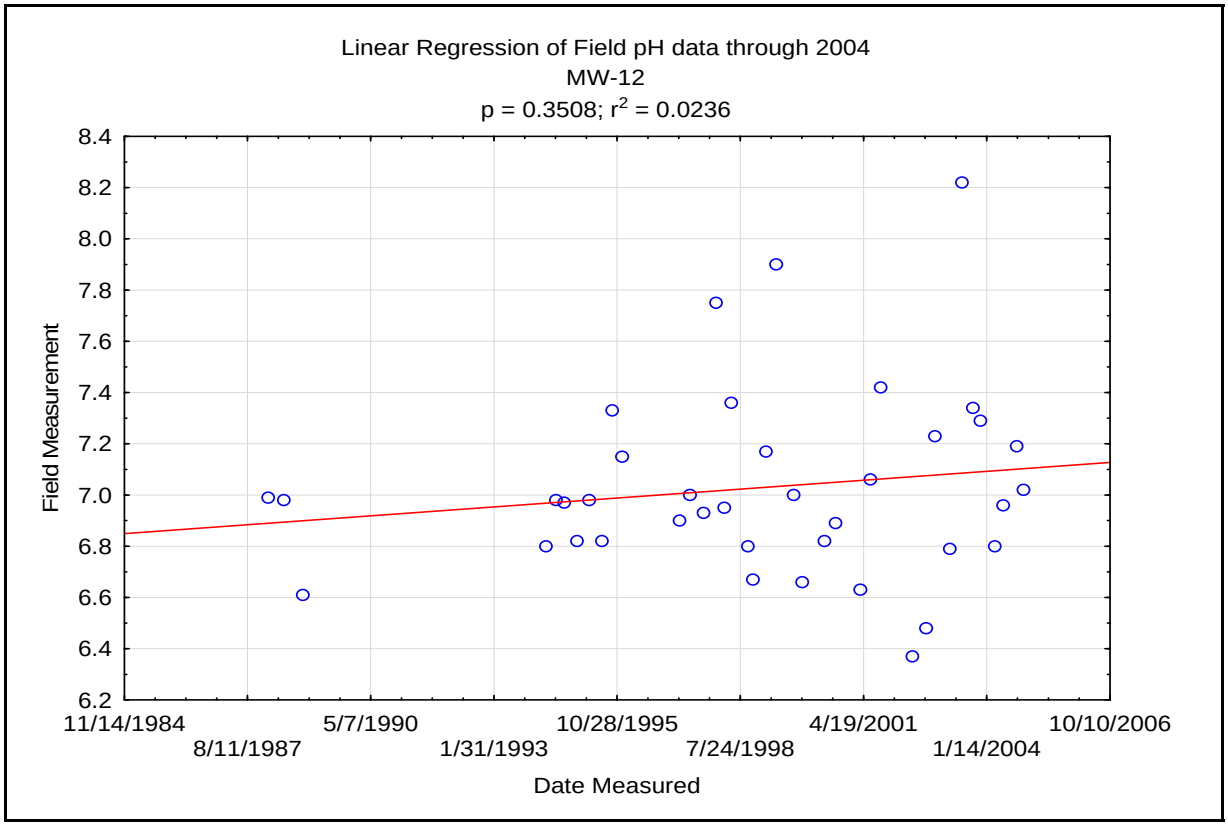
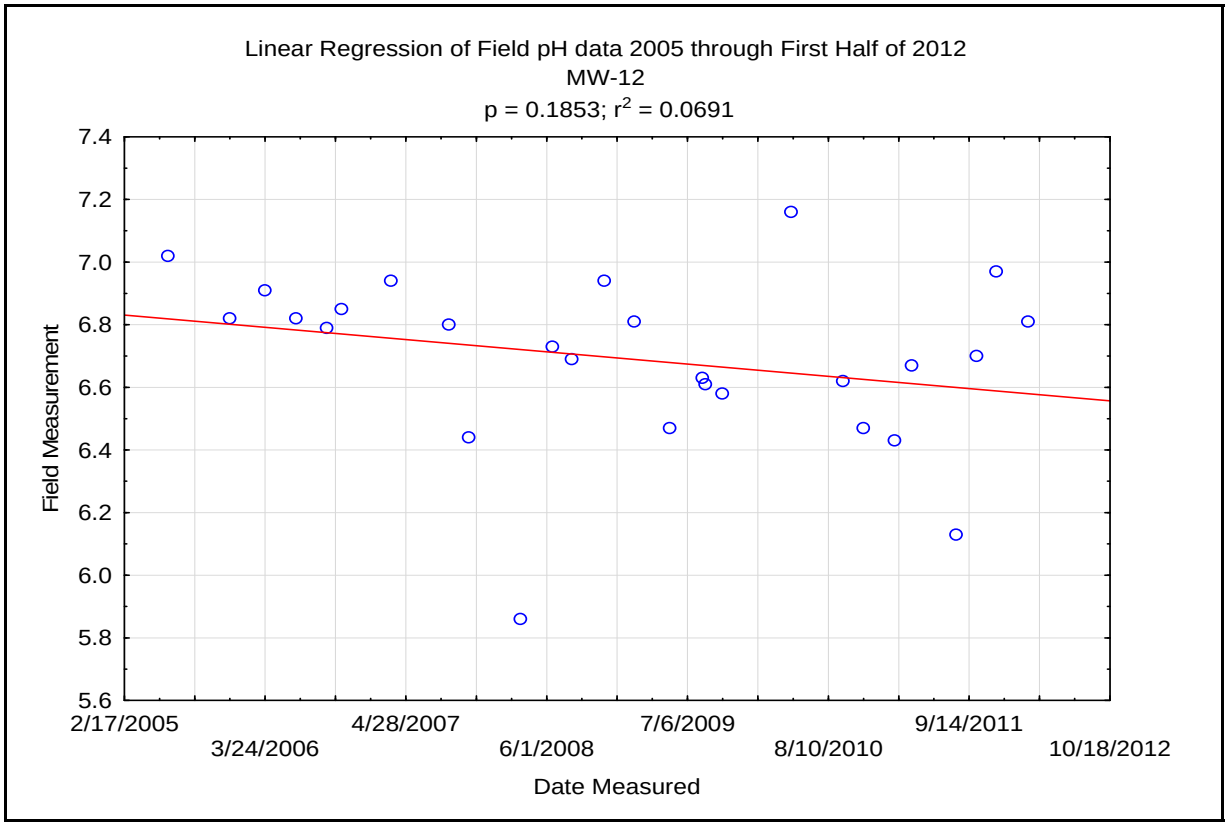
Exploratory Linear Regressions for Field pH in Groundwater Monitoring Wells





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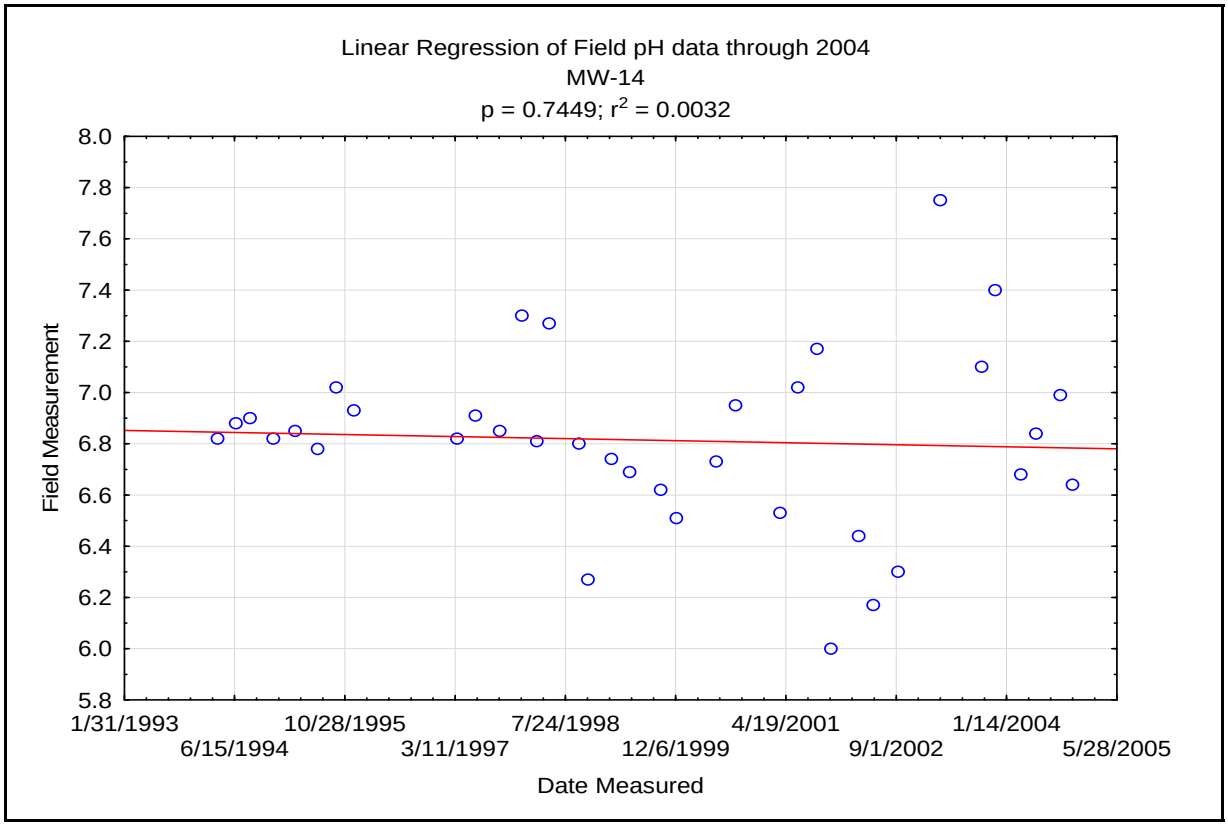

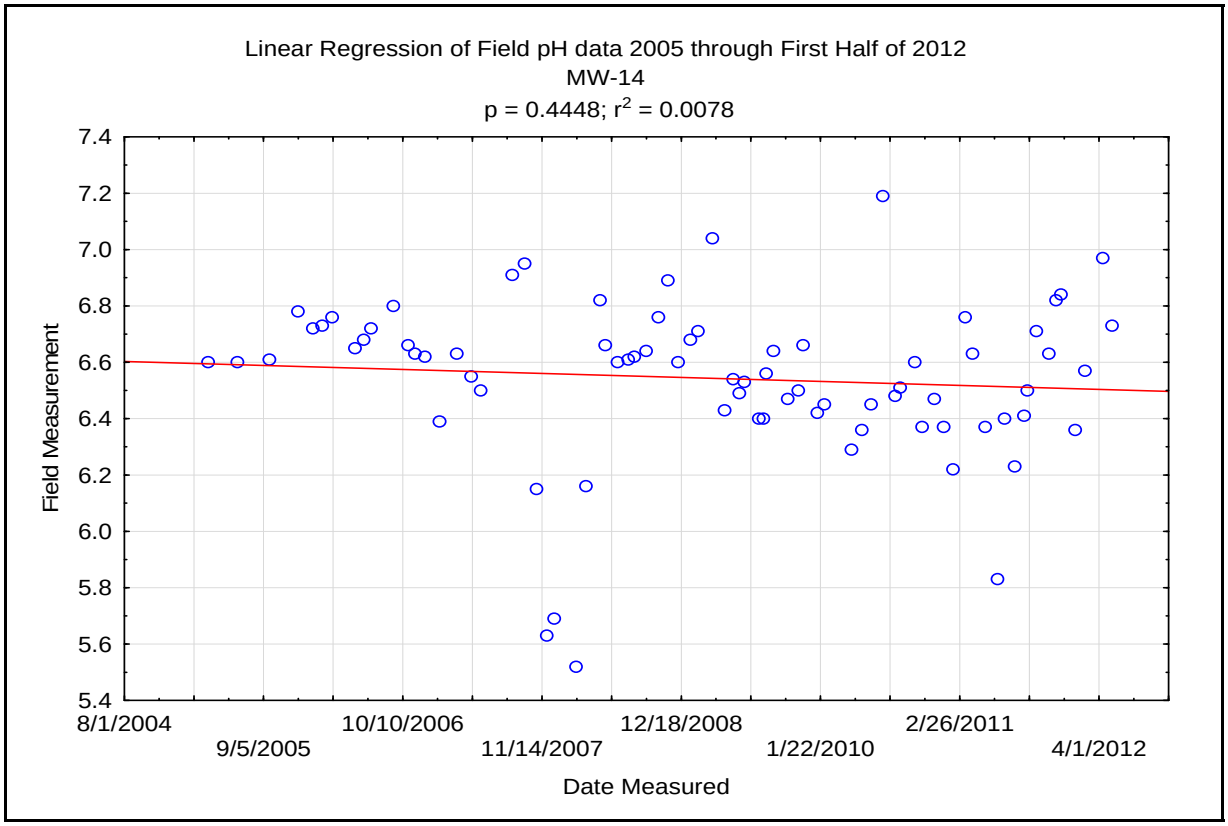

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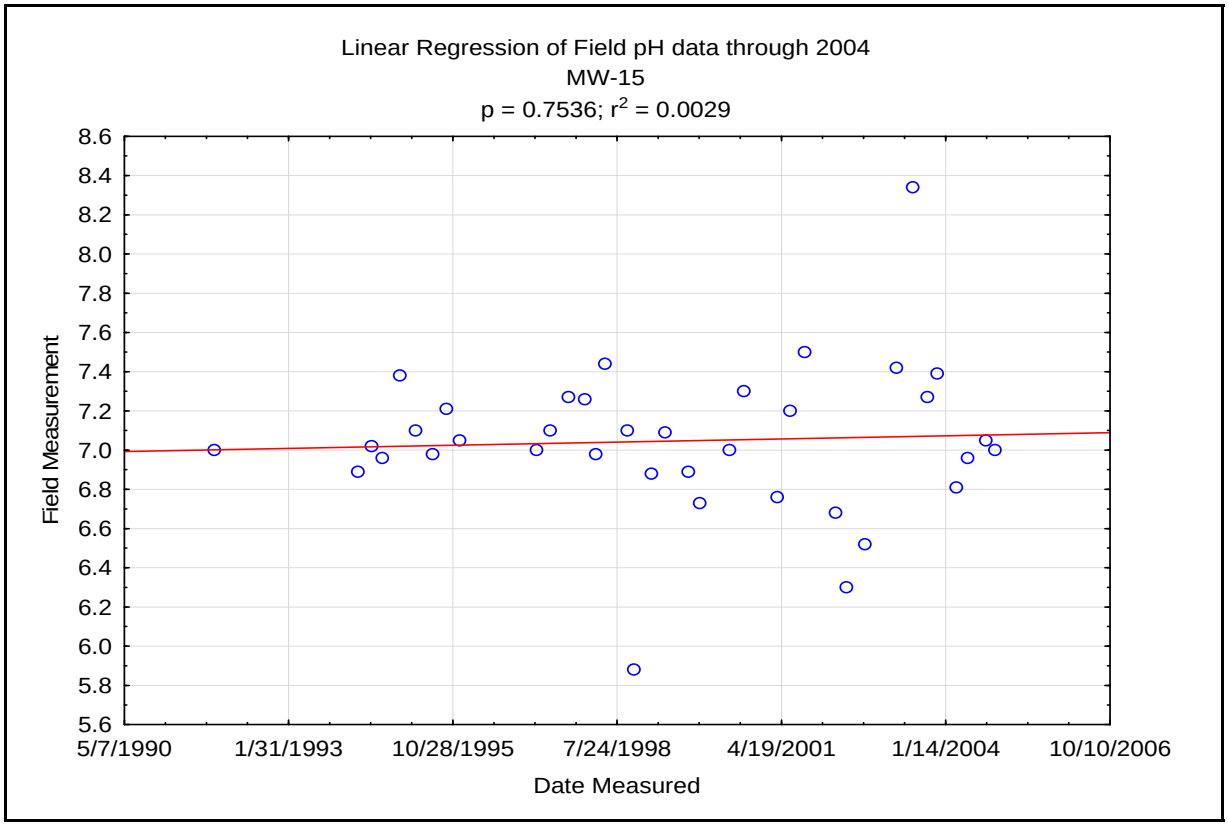

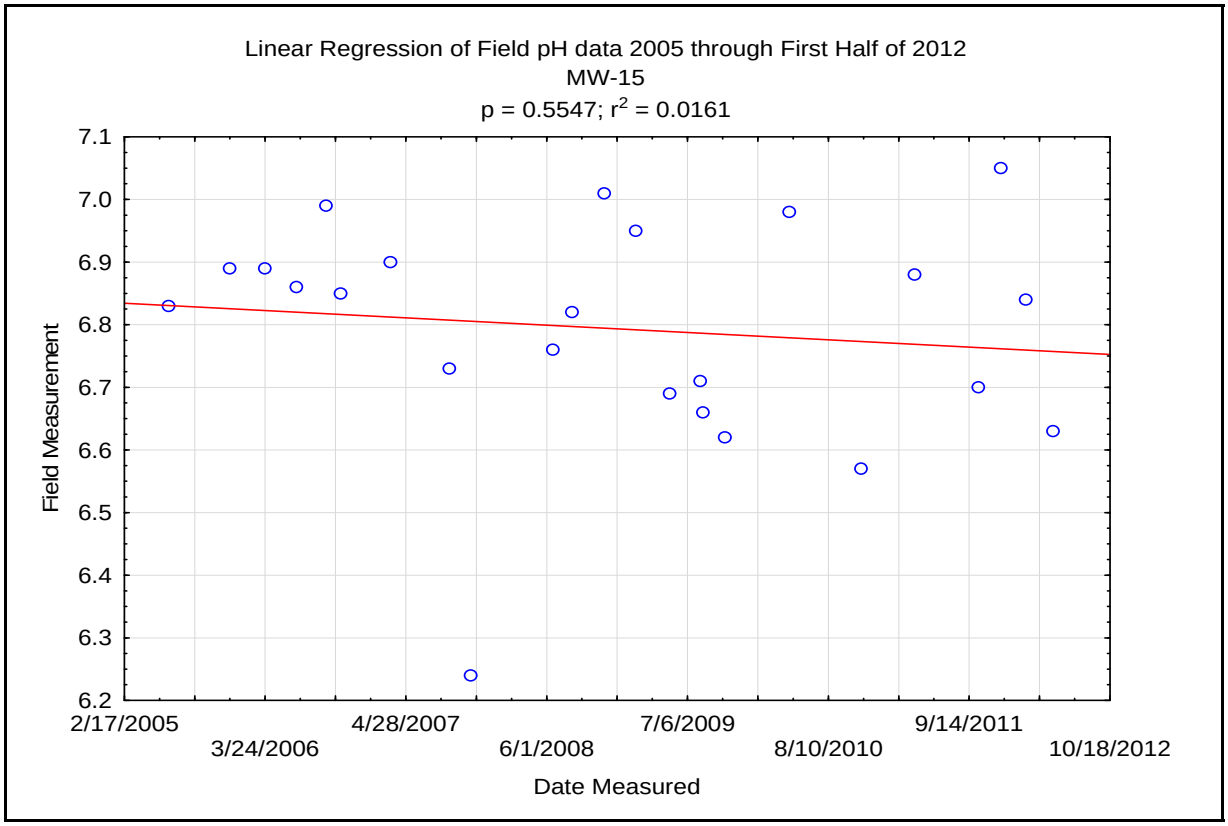

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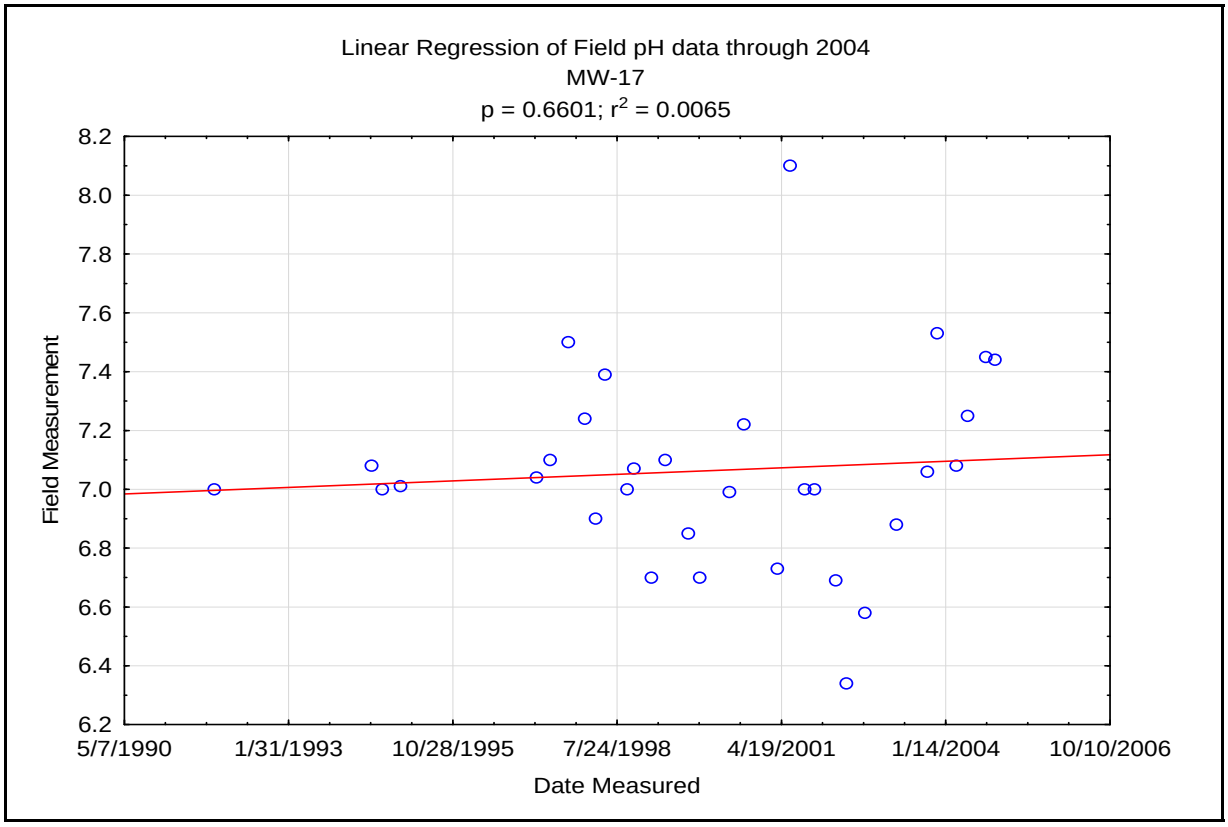

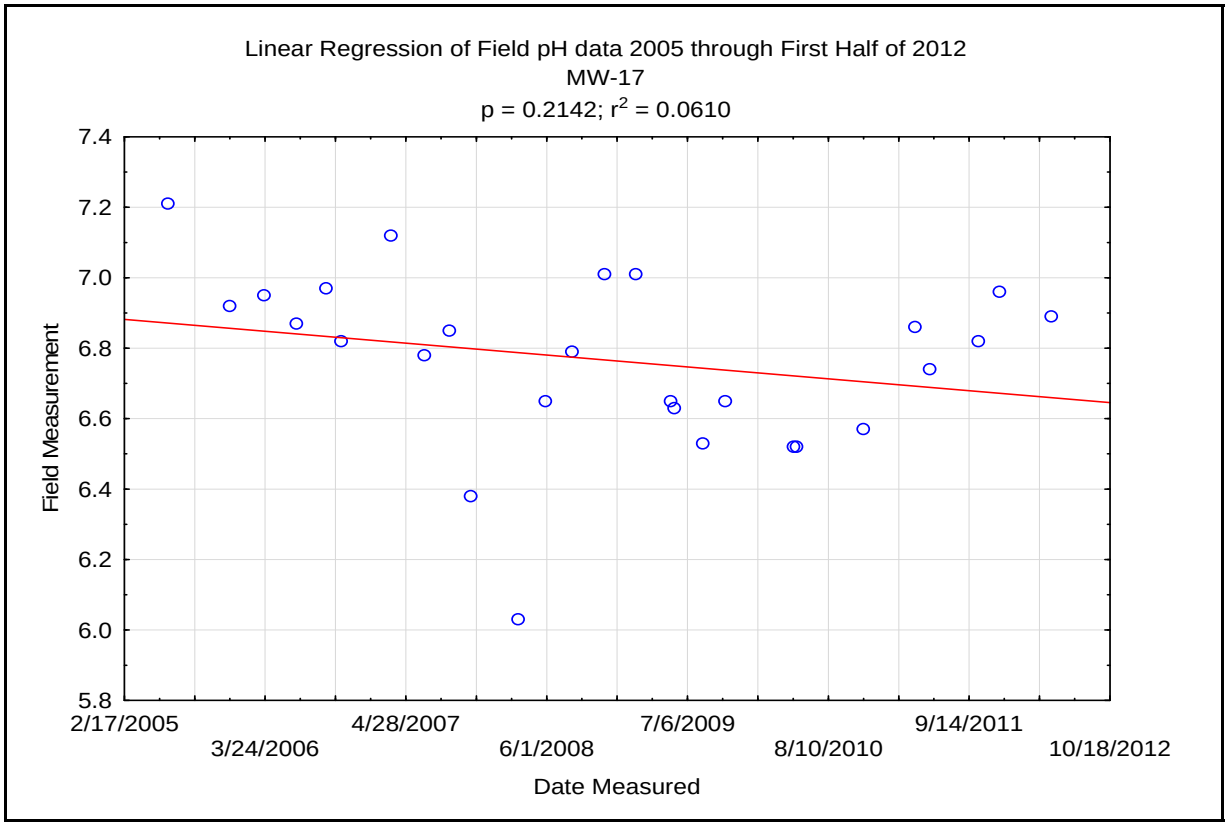

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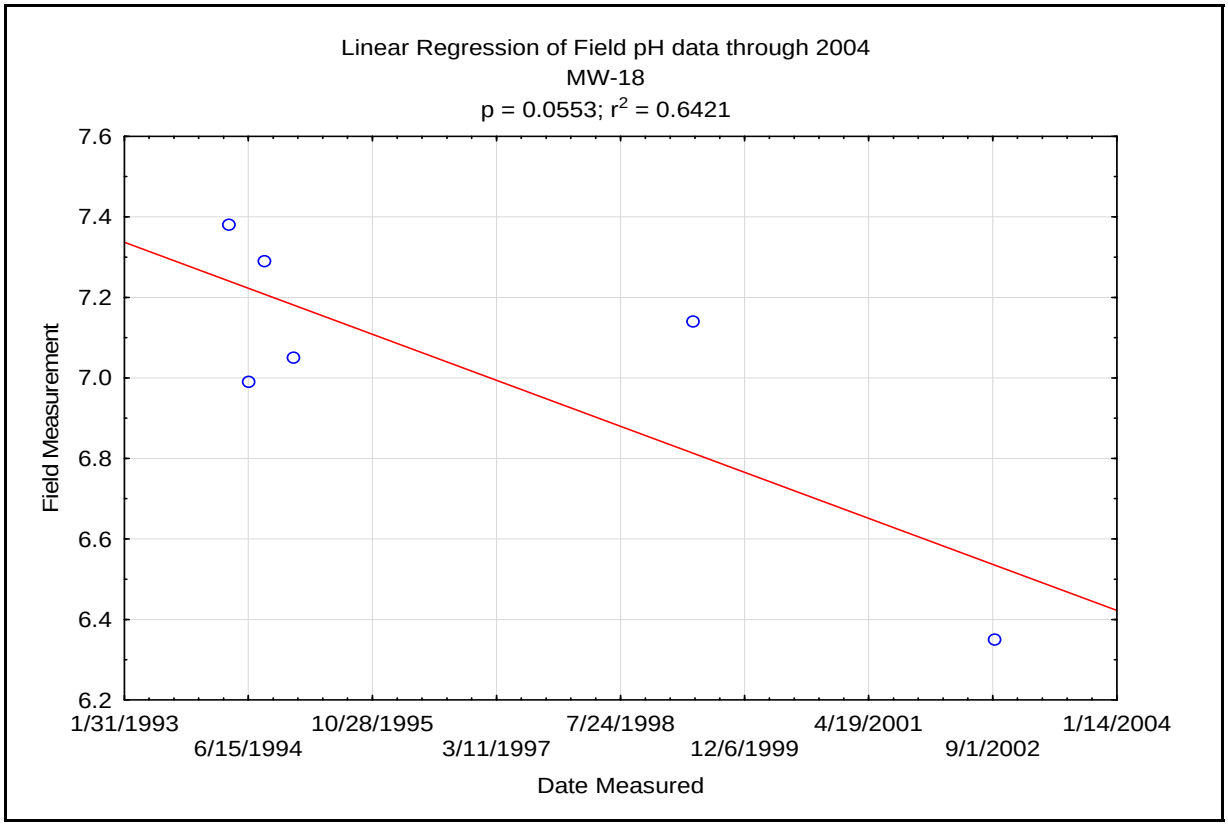
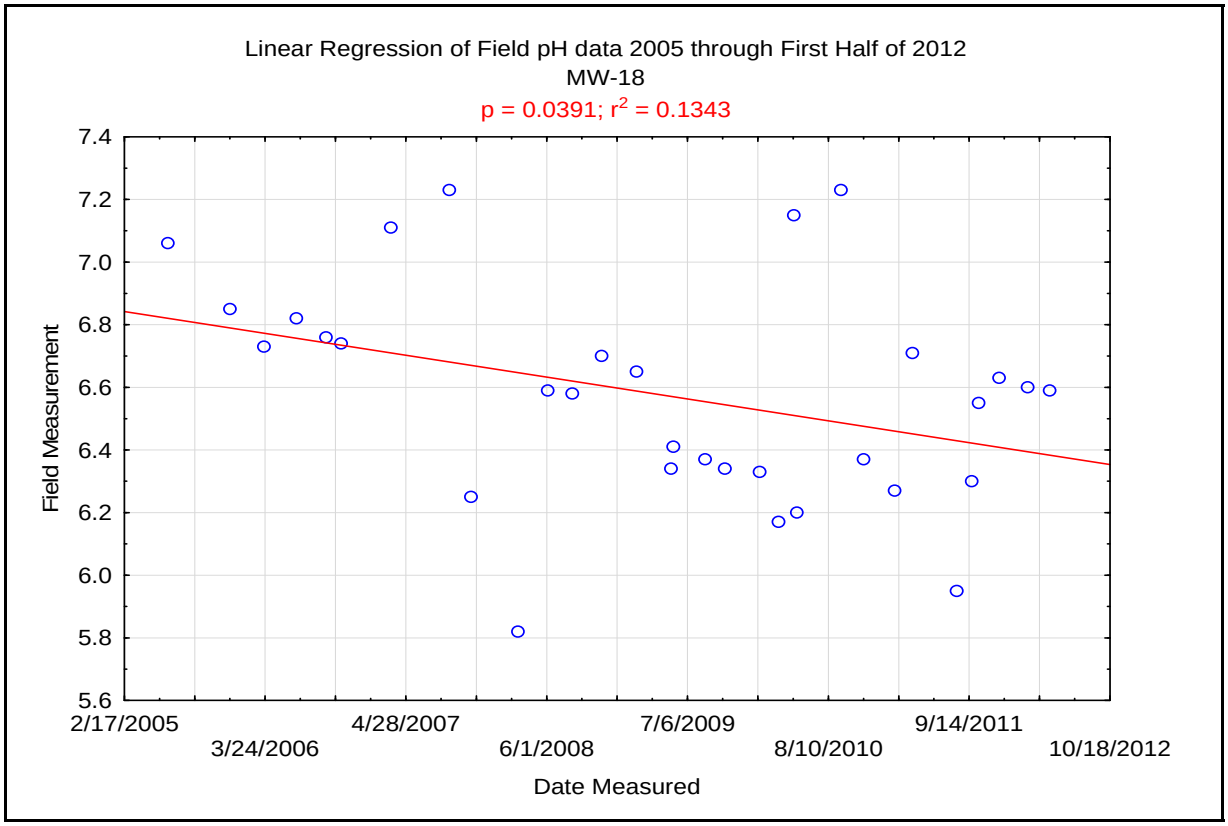
Exploratory Linear Regressions for Field pH in Groundwater Monitoring Wells





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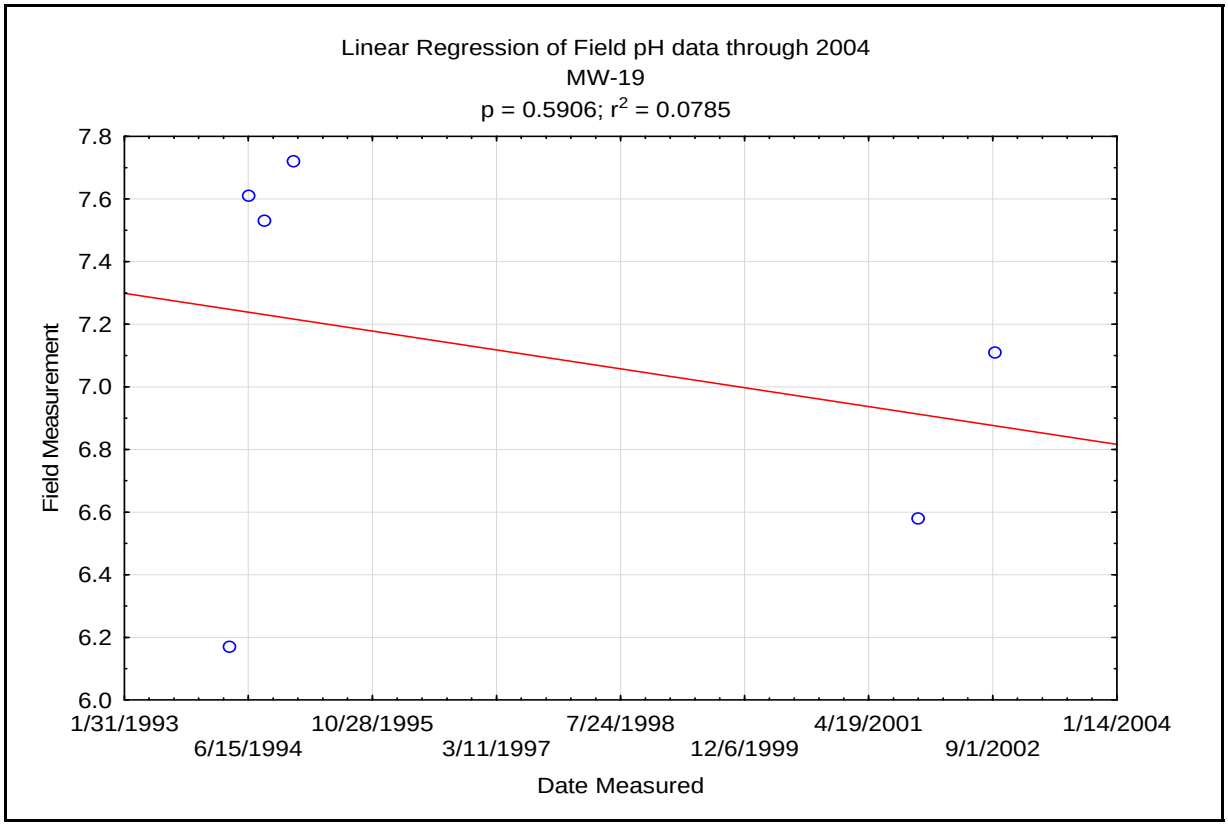
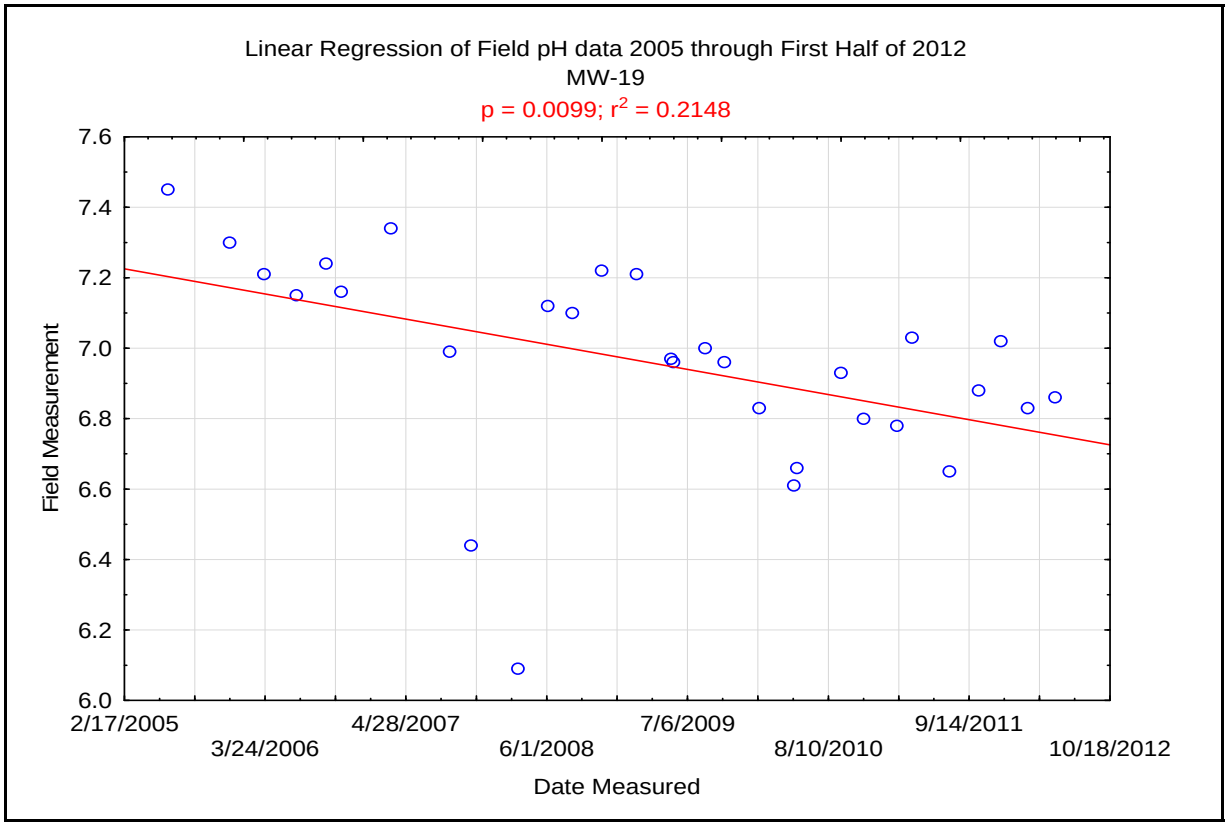
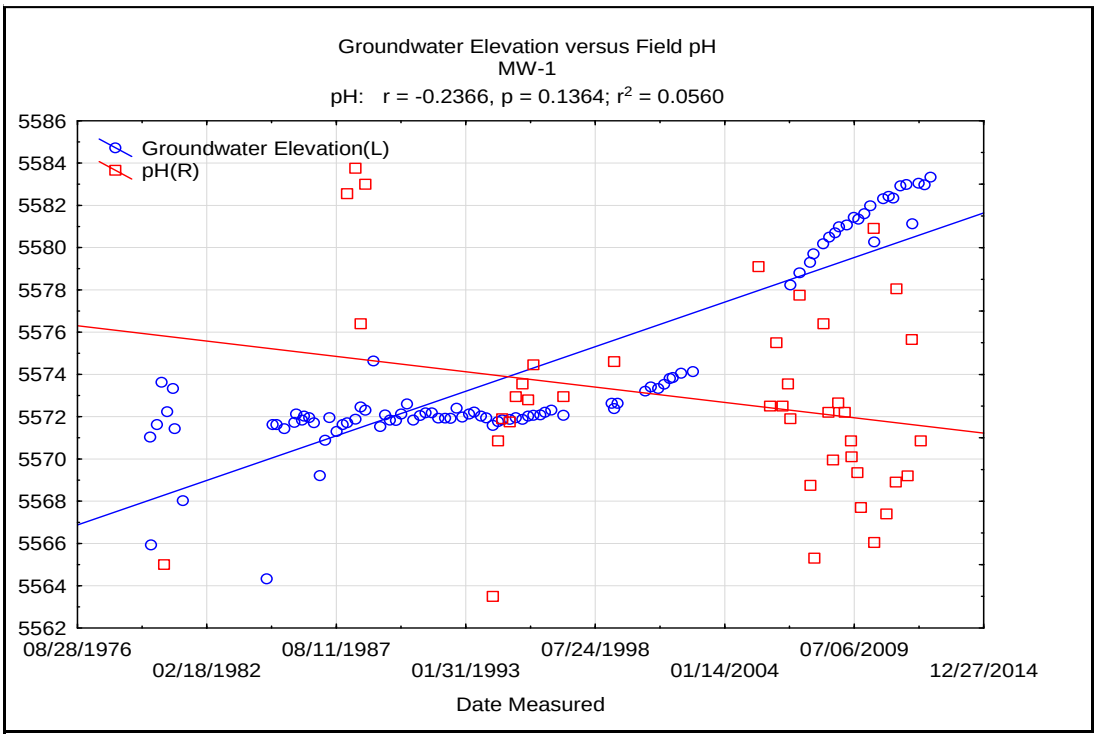


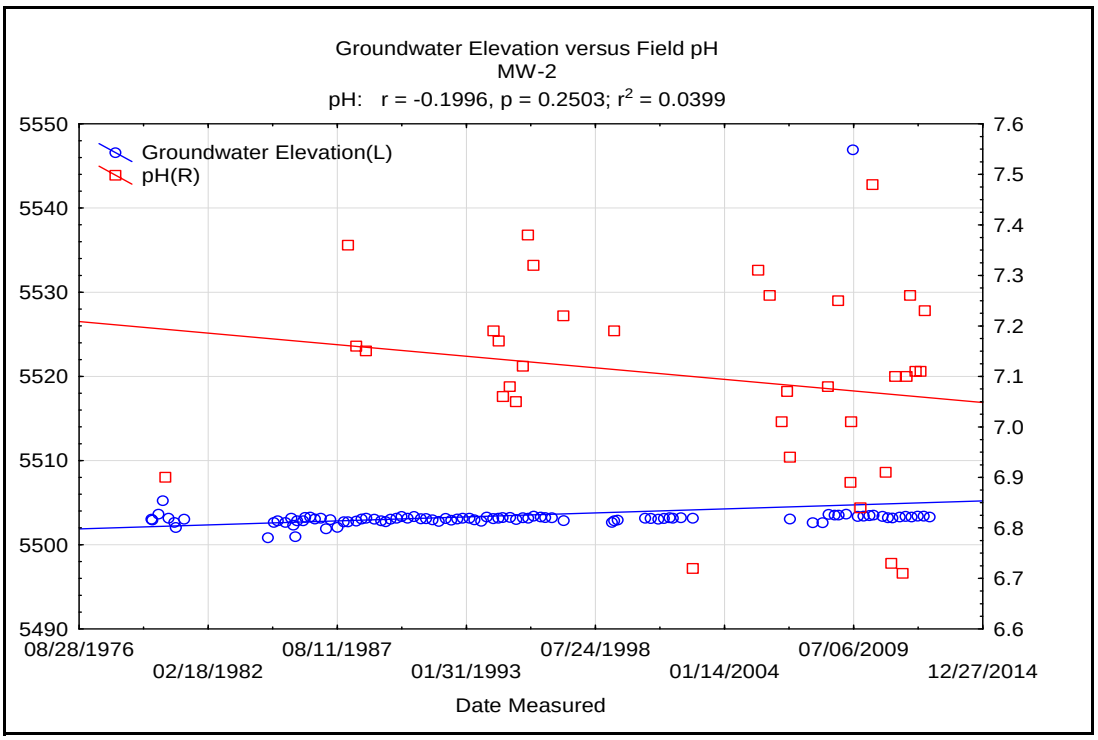


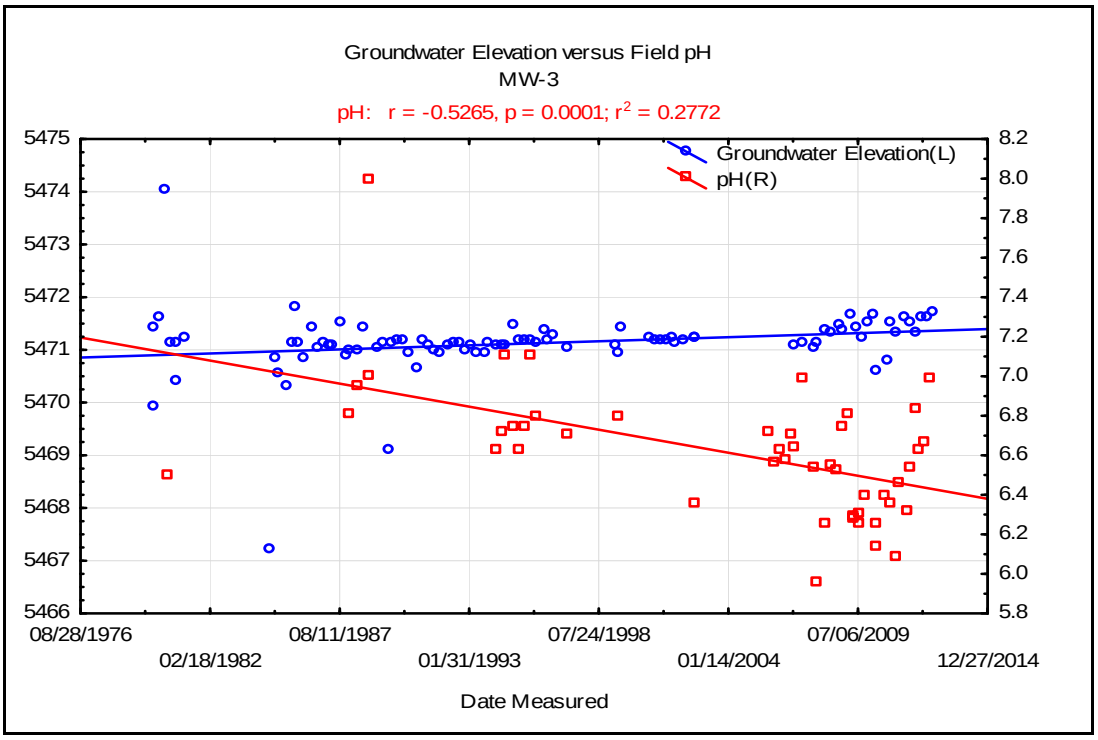
APPENDIX C

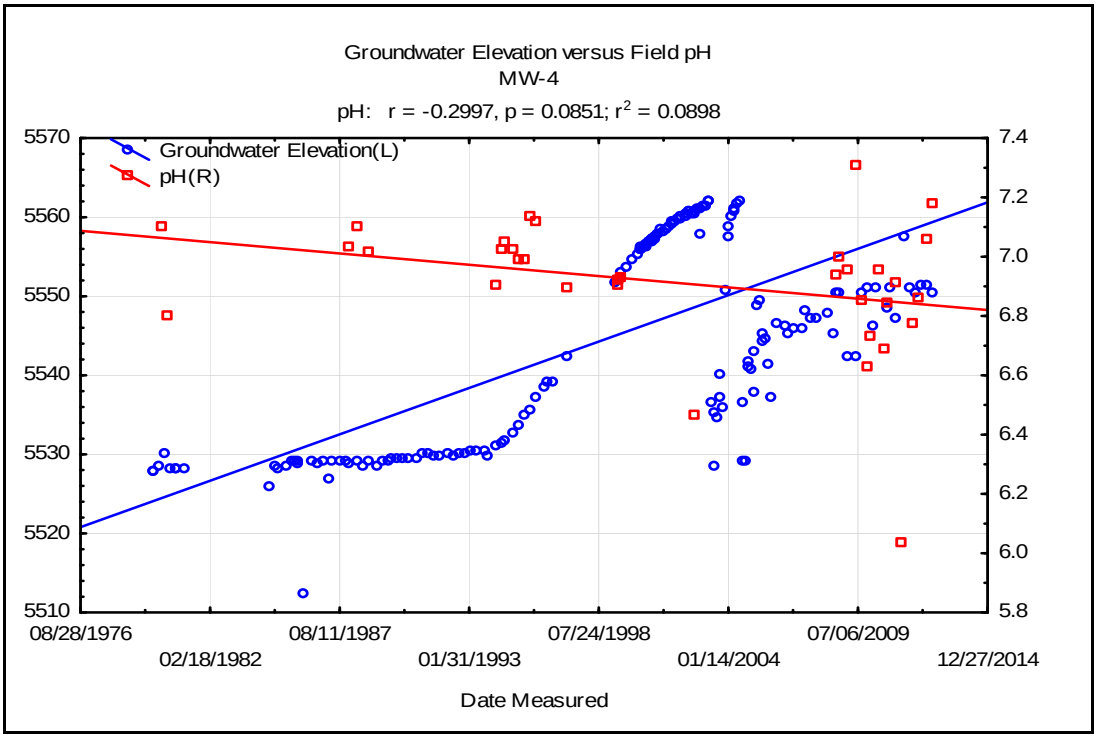
Groundwater Elevation and Field pH in All Wells

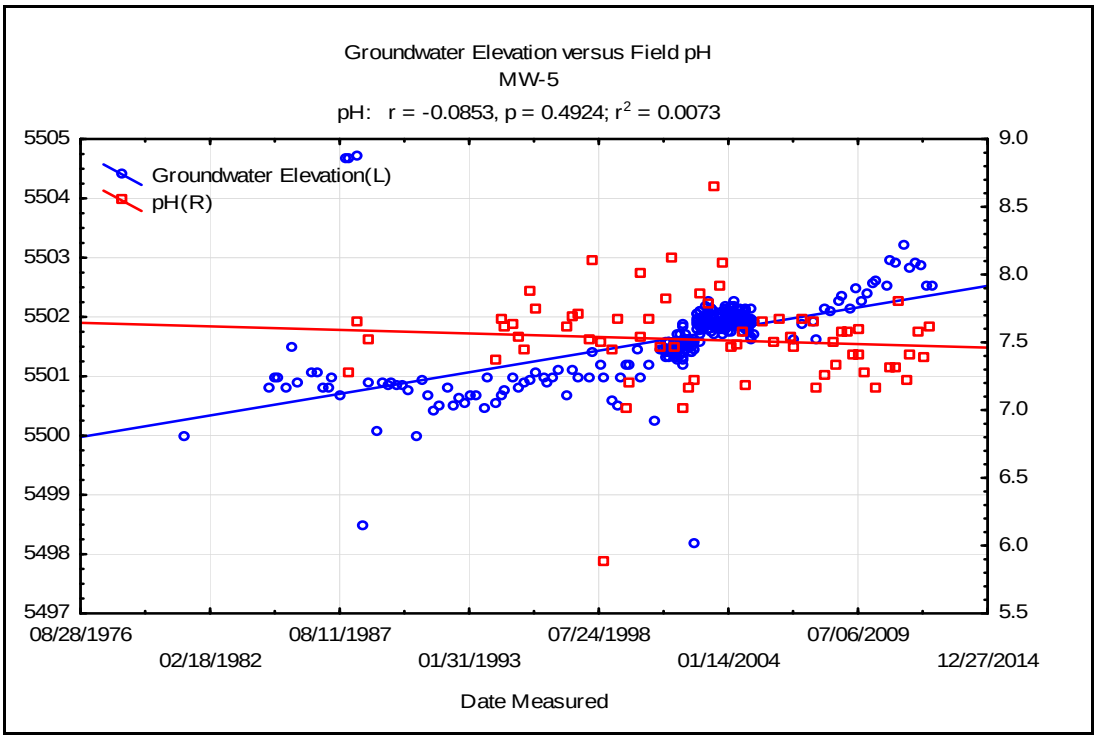
Appendix C Groundwater Elevation and Field pH in All Wells

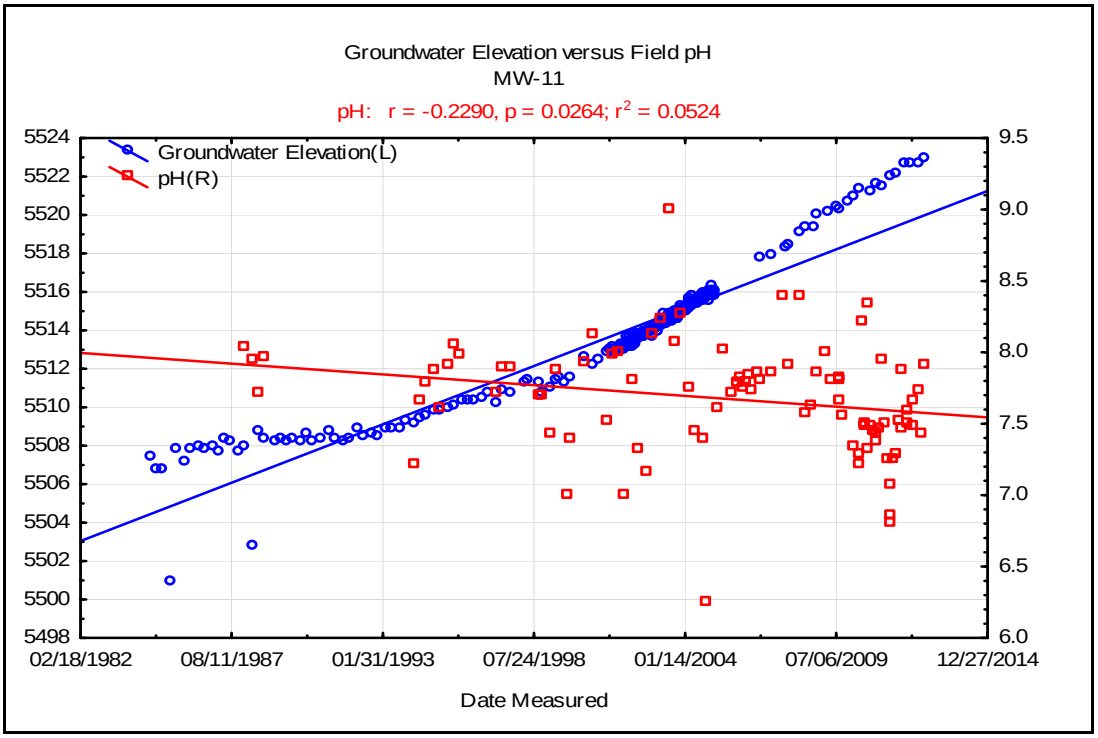


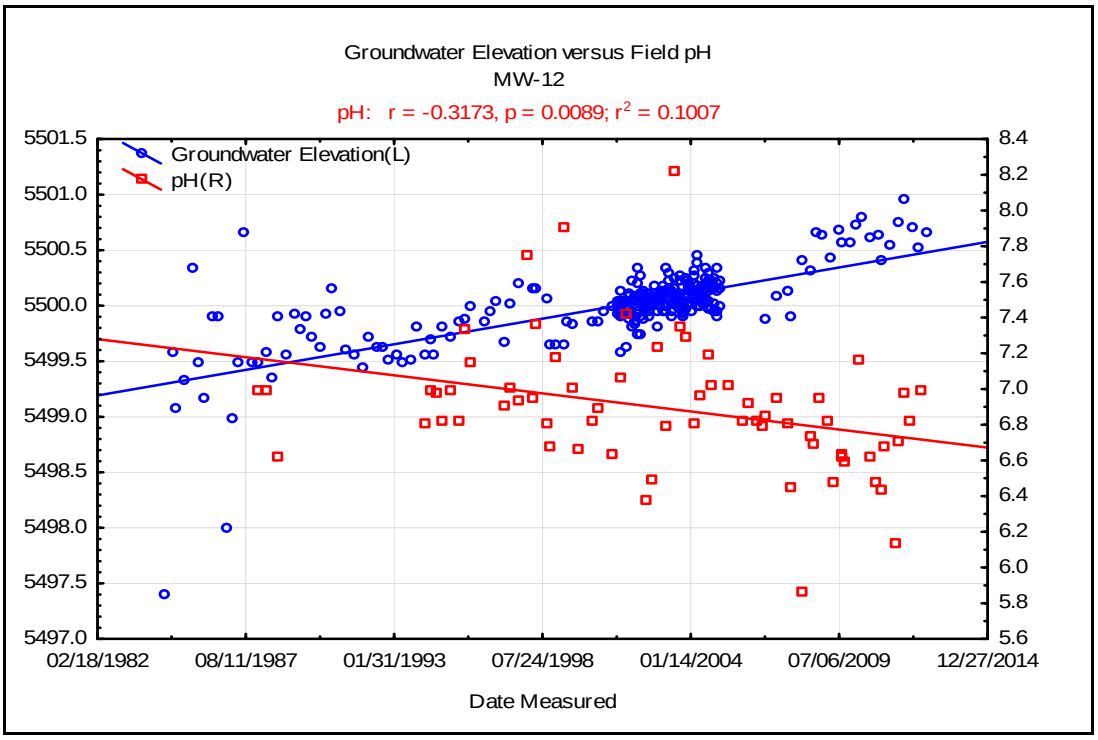


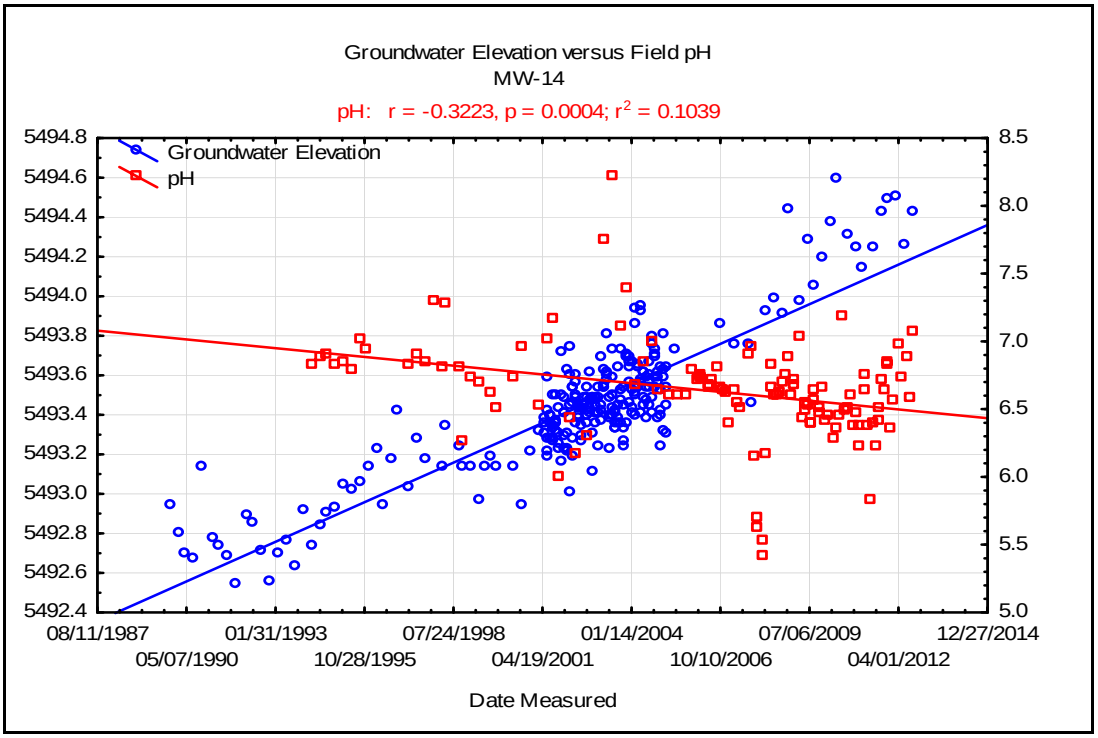

Groundwater Elevation versus Field pH
MW-3
pH: r = -0.5265, p = 0.0001; r2 = 0.2772
Groundwater Elevation(L)
pH(R)
5475
5474
5473
5472
5471
5470
5469
5468
5467
5466
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
08/28/1976
02/18/1982
08/11/1987
01/31/1993
07/24/1998
01/14/2004
07/06/2009
12/27/2014
Date Measured

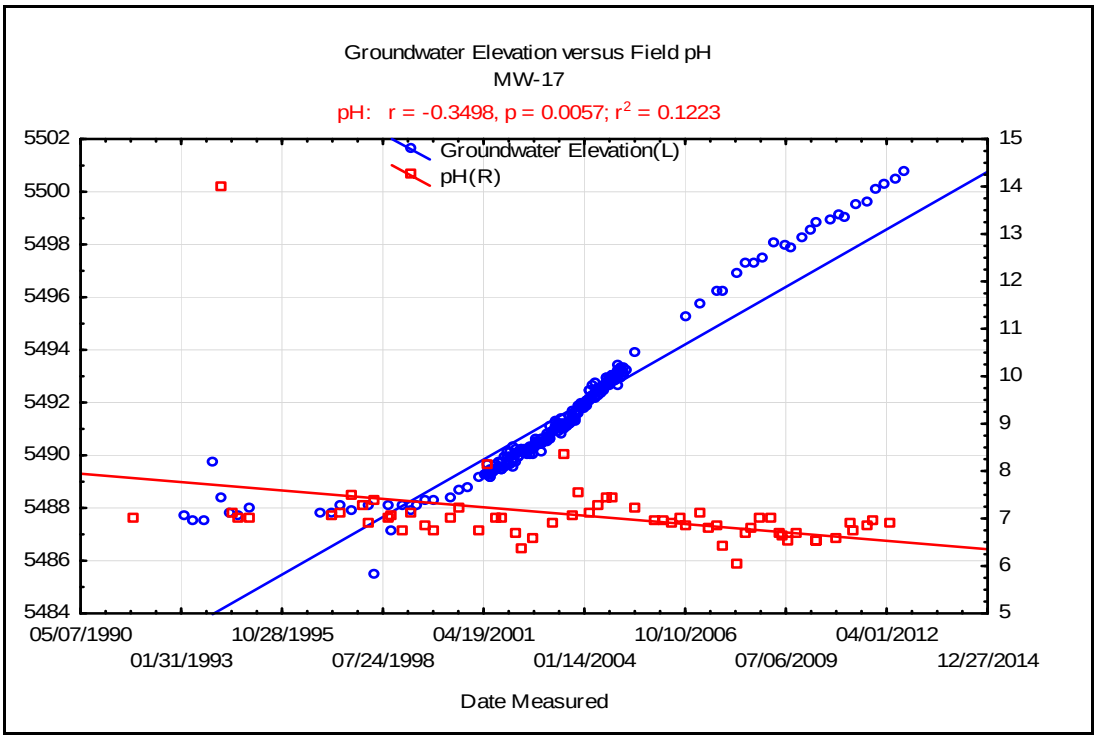

Groundwater Elevation versus Field pH
MW-4
pH: r = -0.2997, p = 0.0851; r2 = 0.0898
Groundwater Elevation(L)
pH(R)
5570
5560
5550
5540
5530
5520
5510
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
08/28/1976
02/18/1982
08/11/1987
01/31/1993
07/24/1998
01/14/2004
07/06/2009
12/27/2014
Date Measured

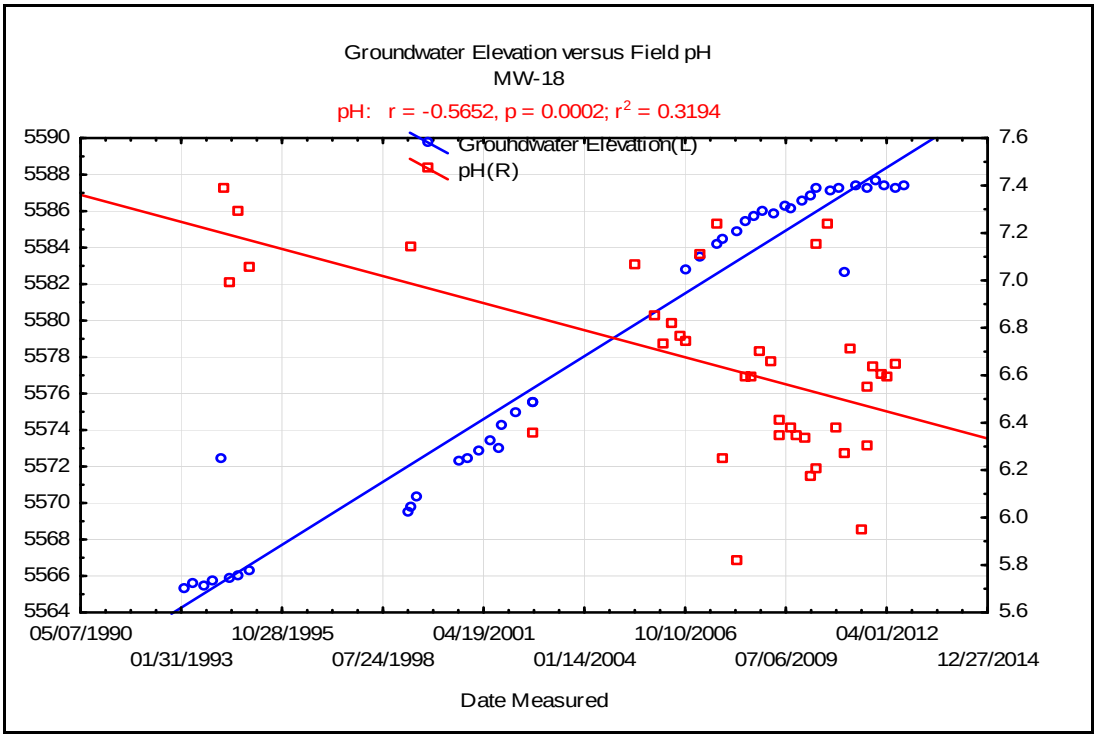

Groundwater Elevation versus Field pH
MW-5
pH: r = -0.0853, p = 0.4924; r2 = 0.0073
Groundwater Elevation(L)
pH(R)
5505
5504
5503
5502
5501
5500
5499
5498
5497
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
08/28/1976
02/18/1982
08/11/1987
01/31/1993
07/24/1998
01/14/2004
07/06/2009
12/27/2014
Date Measured

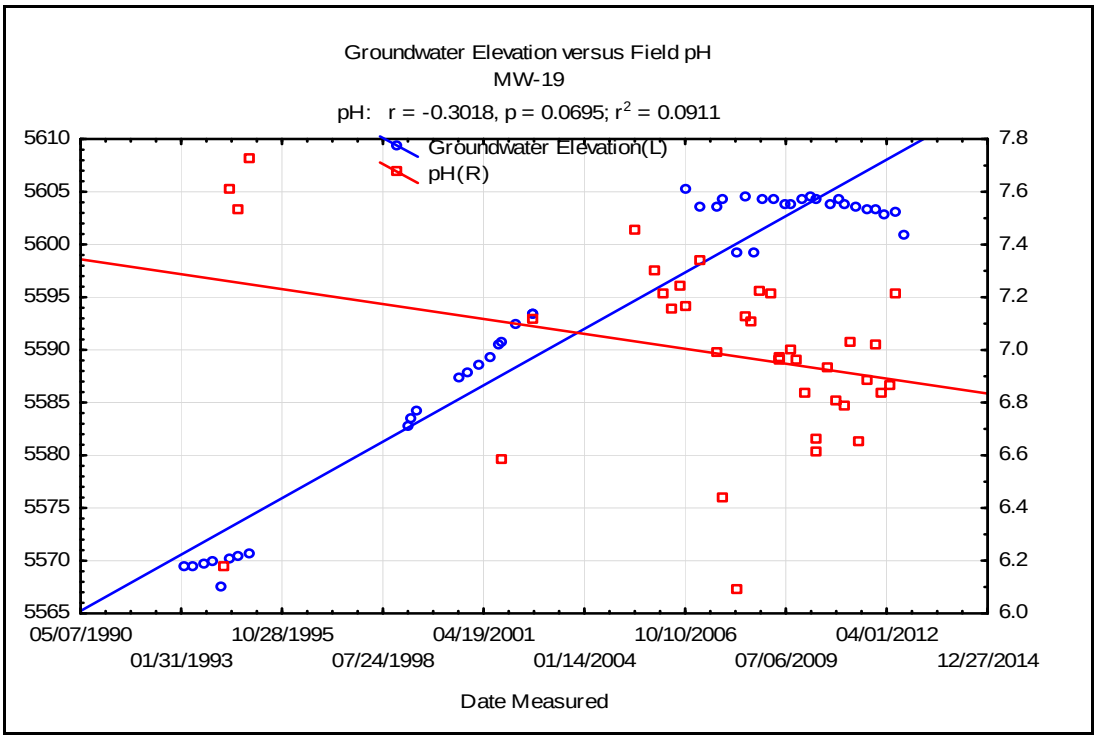

Groundwater Elevation versus Field pH
MW-11
pH: r = -0.2290, p = 0.0264; r2 = 0.0524
Groundwater Elevation(L)
pH(R)
5524
5522
5520
5518
5516
5514
5512
5510
5508
5506
5504
5502
5500
5498
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
02/18/1982
08/11/1987
01/31/1993
07/24/1998
01/14/2004
07/06/2009
12/27/2014
Date Measured

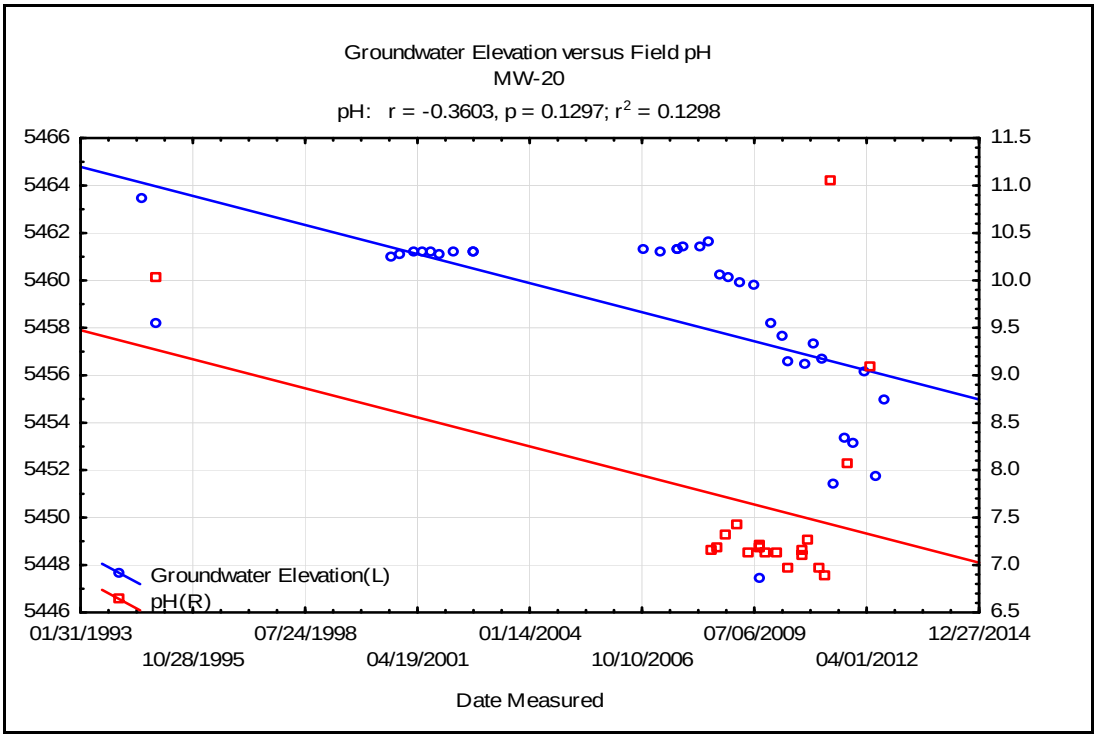

Groundwater Elevation versus Field pH
MW-12
pH: r = -0.3173, p = 0.0089; r2 = 0.1007
Groundwater Elevation(L)
pH(R)
5501.5
5501.0
5500.5
5500.0
5499.5
5499.0
5498.5
5498.0
5497.5
5497.0
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
02/18/1982
08/11/1987
01/31/1993
07/24/1998
01/14/2004
07/06/2009
12/27/2014
Date Measured

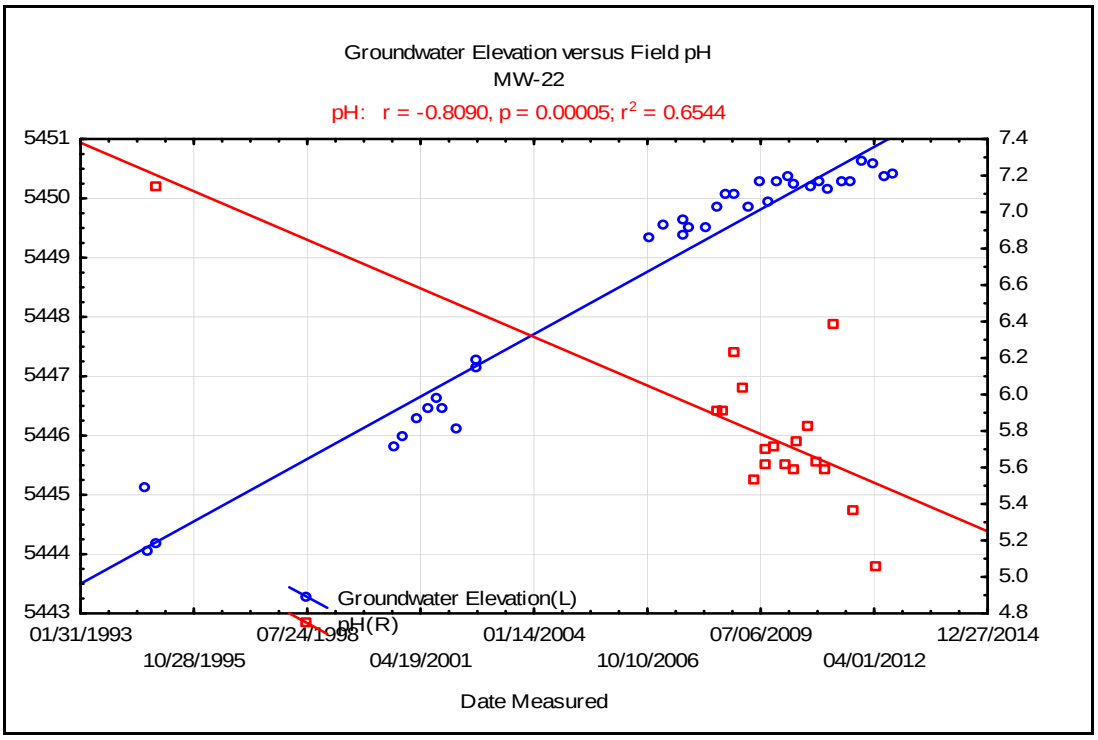

Groundwater Elevation versus Field pH
MW-14
pH: r = -0.3223, p = 0.0004; r2 = 0.1039
Groundwater Elevation
pH
5494.8
5494.6
5494.4
5494.2
5494.0
5493.8
5493.6
5493.4
5493.2
5493.0
5492.8
5492.6
5492.4
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
08/11/1987
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

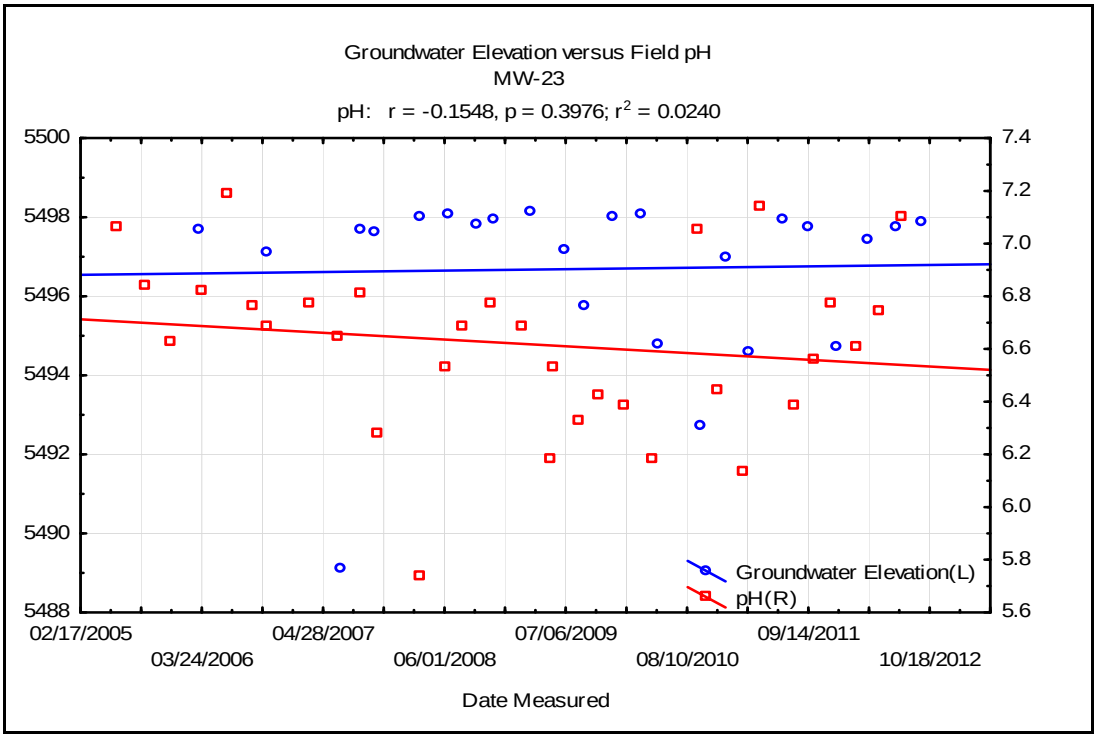

Groundwater Elevation versus Field pH
MW-17
pH: r = -0.3498, p = 0.0057; r2 = 0.1223
Groundwater Elevation(L)
pH(R)
5502
5500
5498
5496
5494
5492
5490
5488
5486
5484
15
14
13
12
11
10
9
8
7
6
5
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured


Groundwater Elevation versus Field pH
MW-18
pH: r = -0.5652, p = 0.0002; r2 = 0.3194
Groundwater Elevation(L)
pH(R)
5590
5588
5586
5584
5582
5580
5578
5576
5574
5572
5570
5568
5566
5564
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

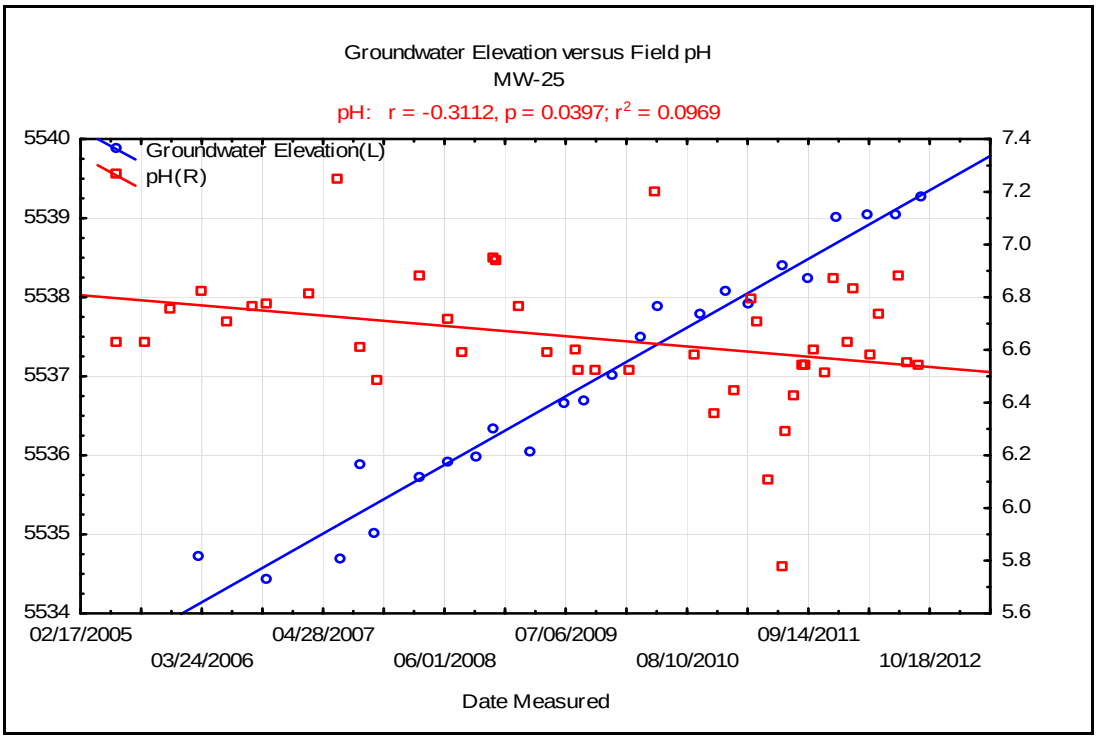

Groundwater Elevation versus Field pH
MW-19
pH: r = -0.3018, p = 0.0695; r2 = 0.0911
Groundwater Elevation(L)
pH(R)
5610
5605
5600
5595
5590
5585
5580
5575
5570
5565
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
05/07/1990
01/31/1993
10/28/1995
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

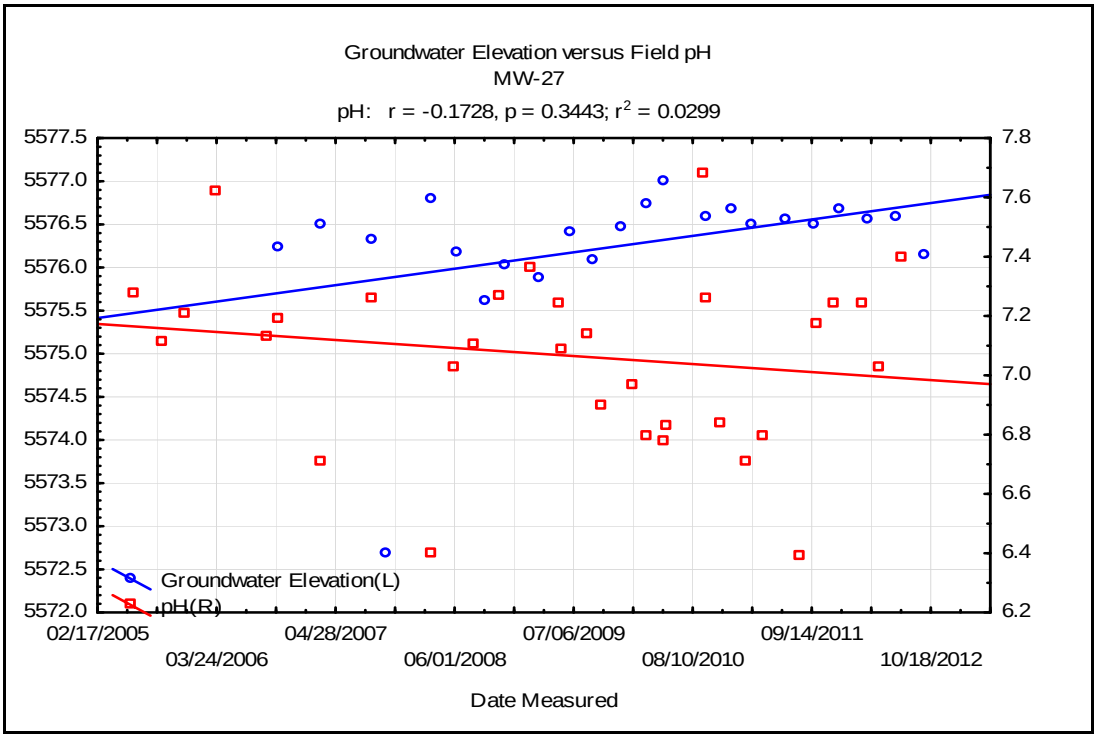

Groundwater Elevation versus Field pH
MW-20
pH: r = -0.3603, p = 0.1297; r2 = 0.1298
5466
5464
5462
5460
5458
5456
5454
5452
5450
5448
5446
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
Groundwater Elevation(L)
pH(R)
01/31/1993
10/28/1995
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured


Groundwater Elevation versus Field pH
MW-22
pH: r = -0.8090, p = 0.00005; r2 = 0.6544
5451
5450
5449
5448
5447
5446
5445
5444
5443
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
4.8
Groundwater Elevation(L)
pH(R)
01/31/1993
10/28/1995
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

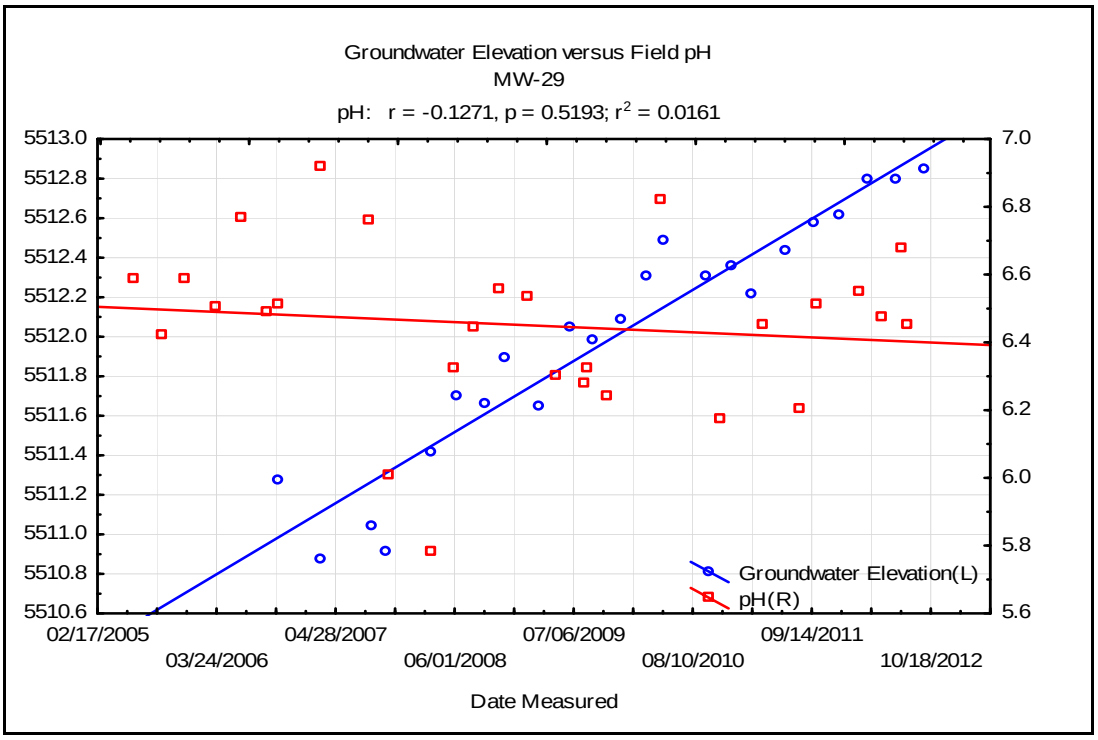

Groundwater Elevation versus Field pH
MW-23
pH: r = -0.1548, p = 0.3976; r2 = 0.0240
5500
5498
5496
5494
5492
5490
5488
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
Groundwater Elevation(L)
pH(R)
02/17/2005
03/24/2006
04/28/2007
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

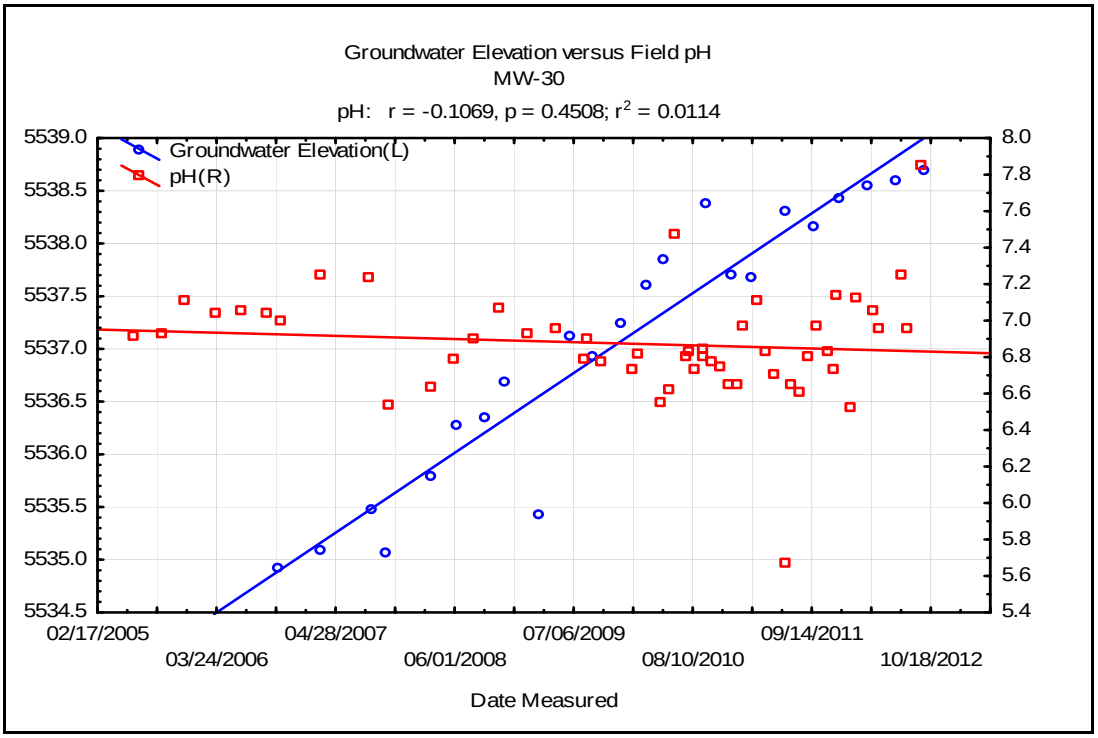
Appendix C Groundwater Elevation and Field pH in All Wells

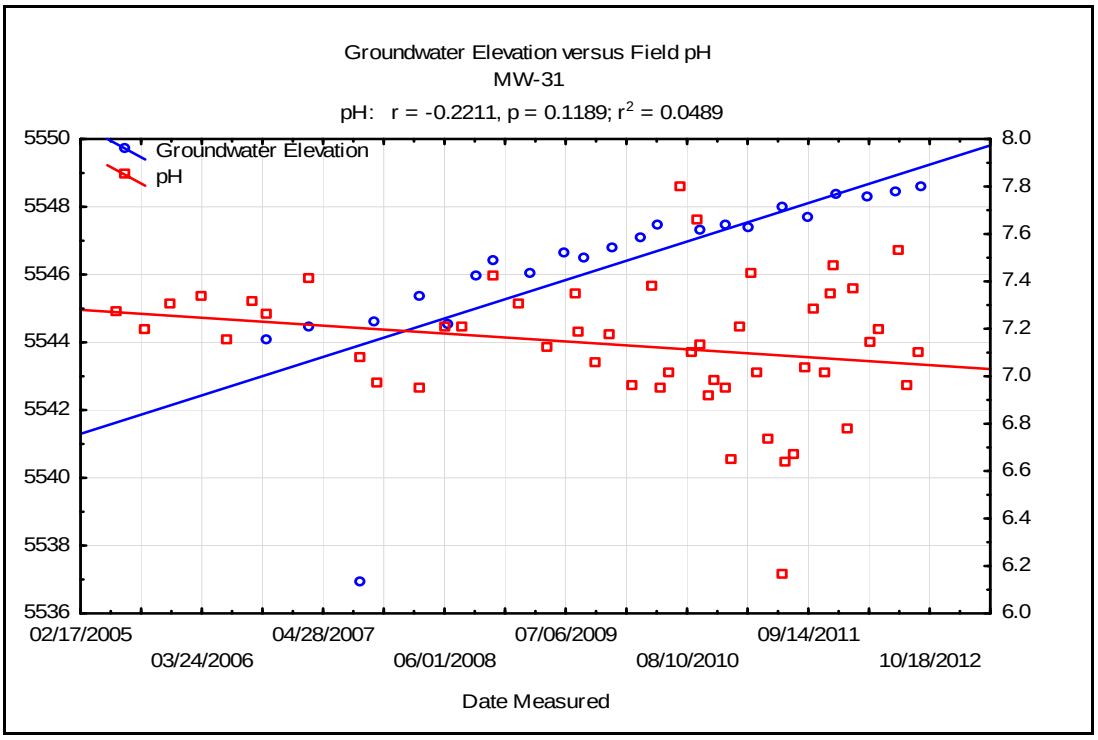


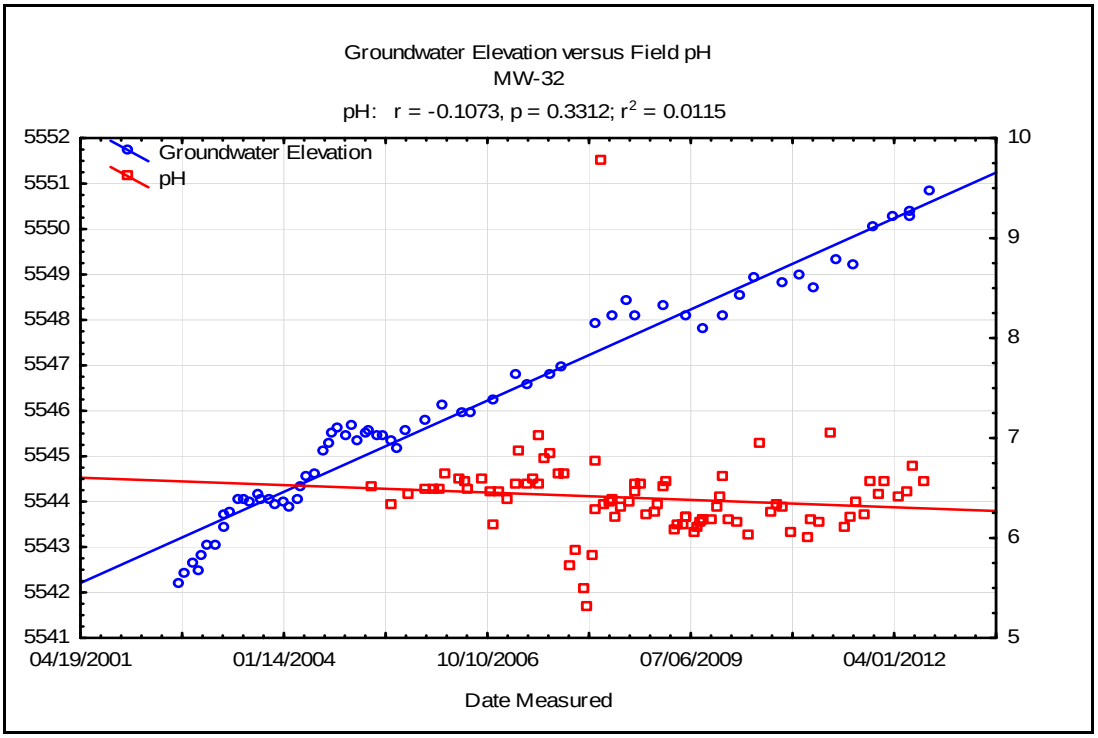


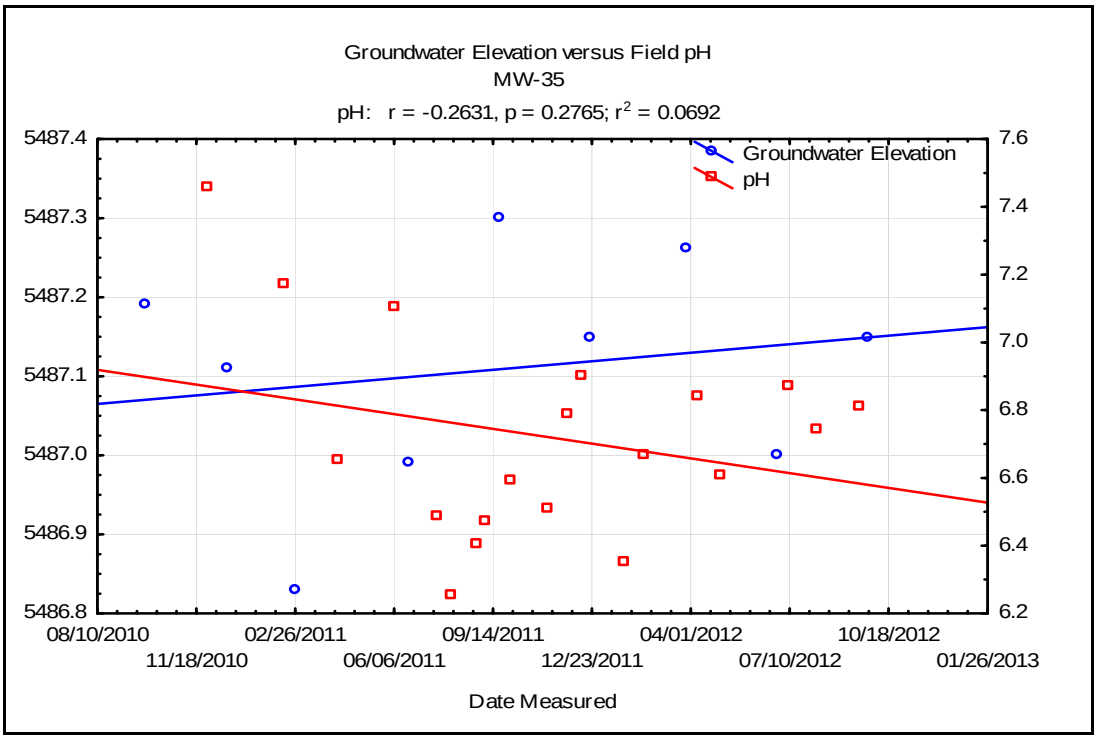
Appendix C Groundwater Elevation and Field pH in All Wells

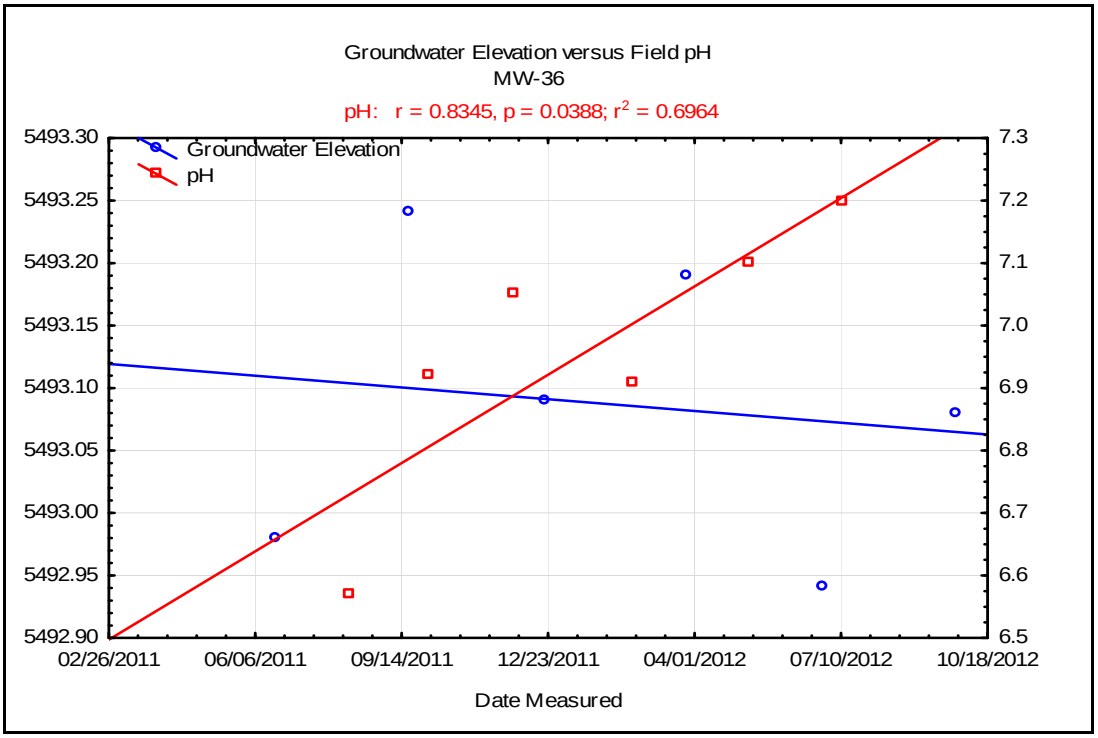


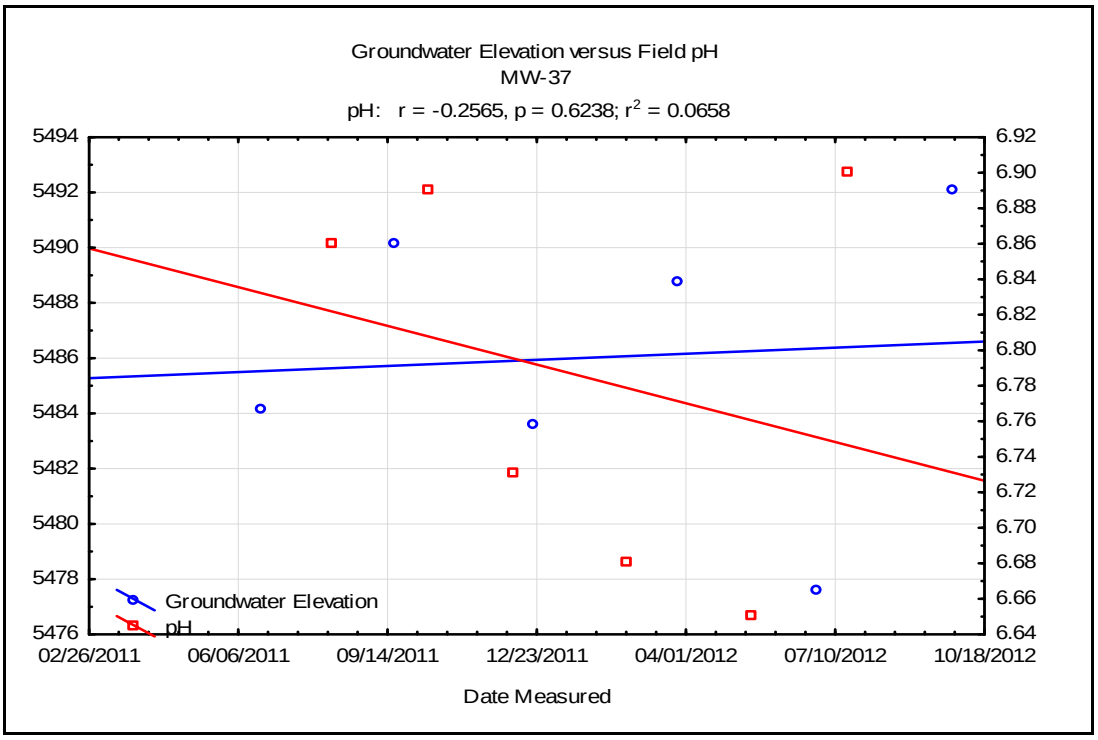


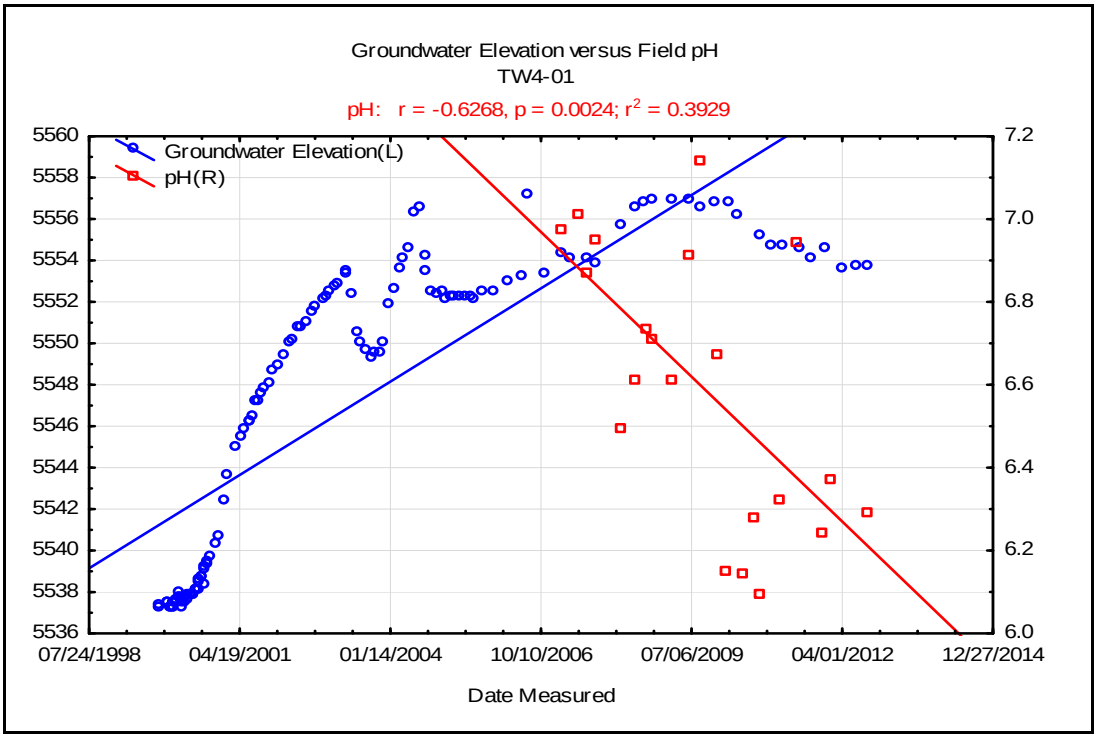

Groundwater Elevation versus Field pH
MW-31
pH: r = -0.2211, p = 0.1189; r2 = 0.0489
Groundwater Elevation
pH
5550
5548
5546
5544
5542
5540
5538
5536
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
02/17/2005
03/24/2006
04/28/2007
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

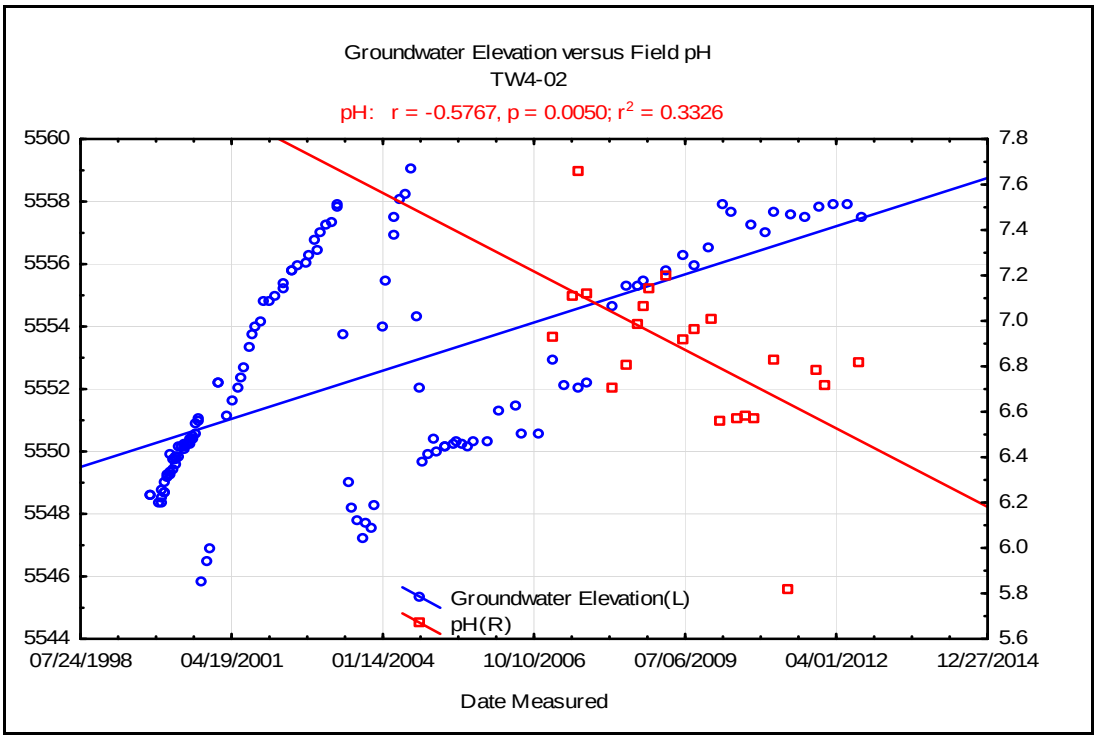

Groundwater Elevation versus Field pH
MW-32
pH: r = -0.1073, p = 0.3312; r2 = 0.0115
Groundwater Elevation
pH
5552
5551
5550
5549
5548
5547
5546
5545
5544
5543
5542
5541
10
9
8
7
6
5
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
Date Measured

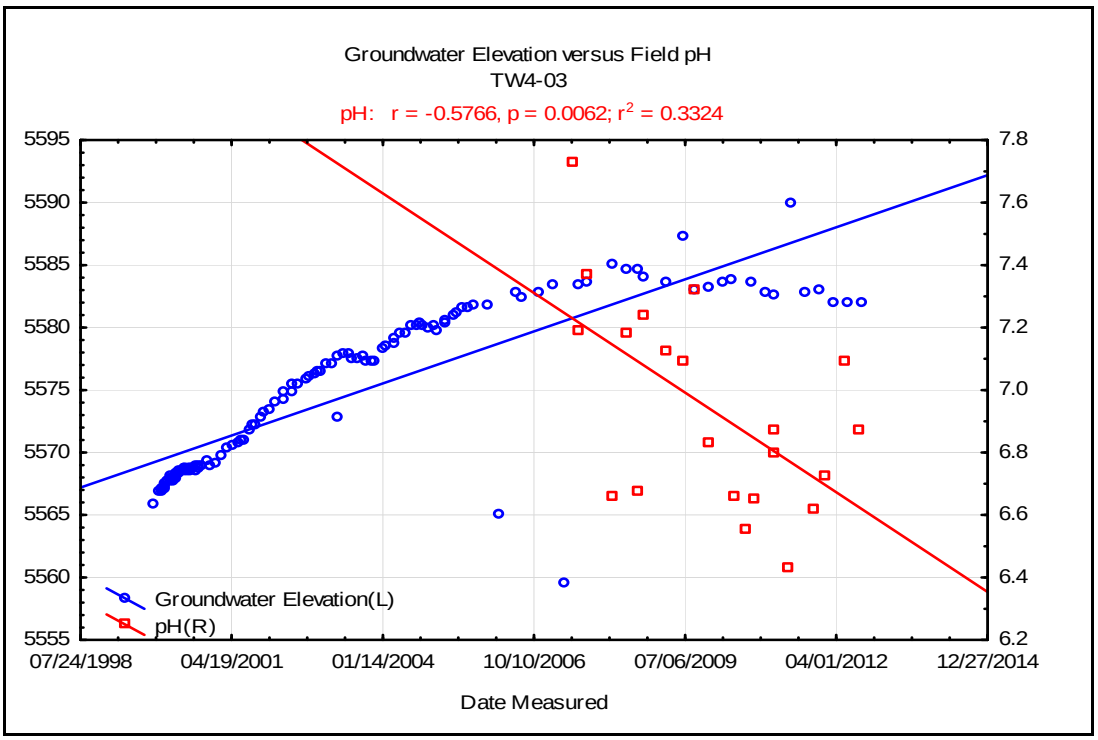

Groundwater Elevation versus Field pH
MW-35
pH: r = -0.2631, p = 0.2765; r2 = 0.0692
Groundwater Elevation
pH
5487.4
5487.3
5487.2
5487.1
5487.0
5486.9
5486.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
08/10/2010
11/18/2010
02/26/2011
06/06/2011
09/14/2011
12/23/2011
04/01/2012
07/10/2012
10/18/2012
01/26/2013
Date Measured

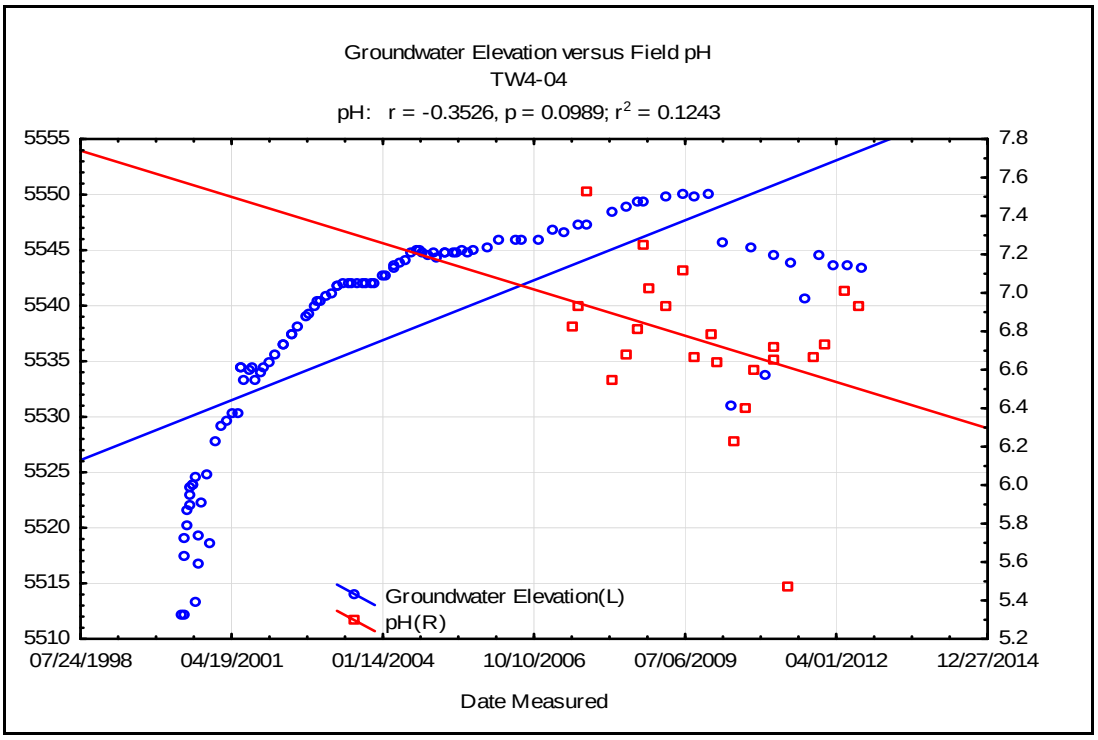

Groundwater Elevation versus Field pH
MW-36
pH: r = 0.8345, p = 0.0388; r2 = 0.6964
Groundwater Elevation
pH
5493.30
5493.25
5493.20
5493.15
5493.10
5493.05
5493.00
5492.95
5492.90
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
02/26/2011
06/06/2011
09/14/2011
12/23/2011
04/01/2012
07/10/2012
10/18/2012
Date Measured

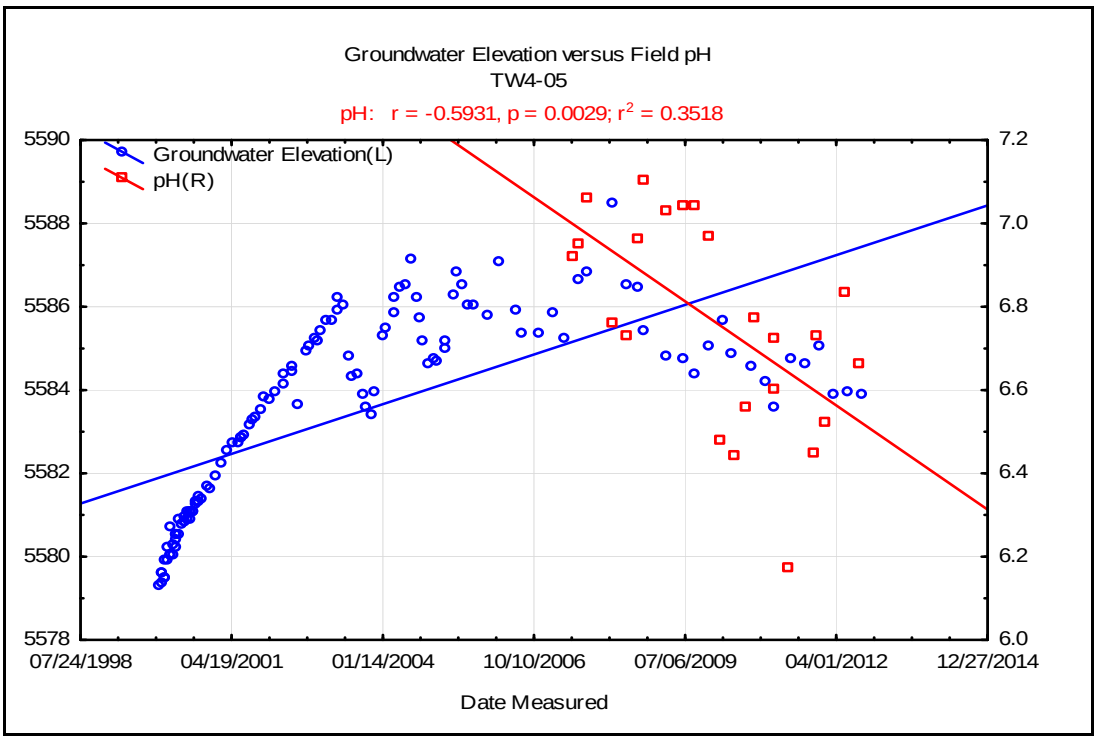

Groundwater Elevation versus Field pH
MW-37
pH: r = -0.2565, p = 0.6238; r2 = 0.0658
5494
5492
5490
5488
5486
5484
5482
5480
5478
5476
6.92
6.90
6.88
6.86
6.84
6.82
6.80
6.78
6.76
6.74
6.72
6.70
6.68
6.66
6.64
Groundwater Elevation
pH
02/26/2011
06/06/2011
09/14/2011
12/23/2011
04/01/2012
07/10/2012
10/18/2012
Date Measured

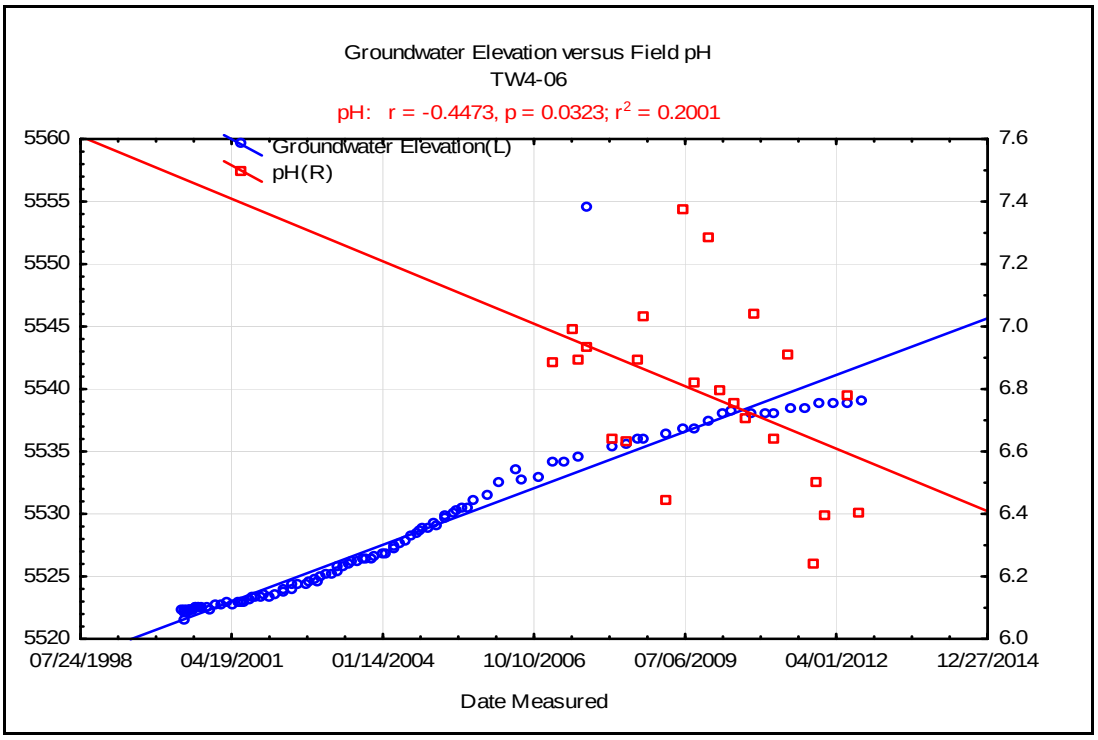

Groundwater Elevation versus Field pH
TW4-01
pH: r = -0.6268, p = 0.0024; r2 = 0.3929
5560
5558
5556
5554
5552
5550
5548
5546
5544
5542
5540
5538
5536
7.2
7.0
6.8
6.6
6.4
6.2
6.0
Groundwater Elevation(L)
pH(R)
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

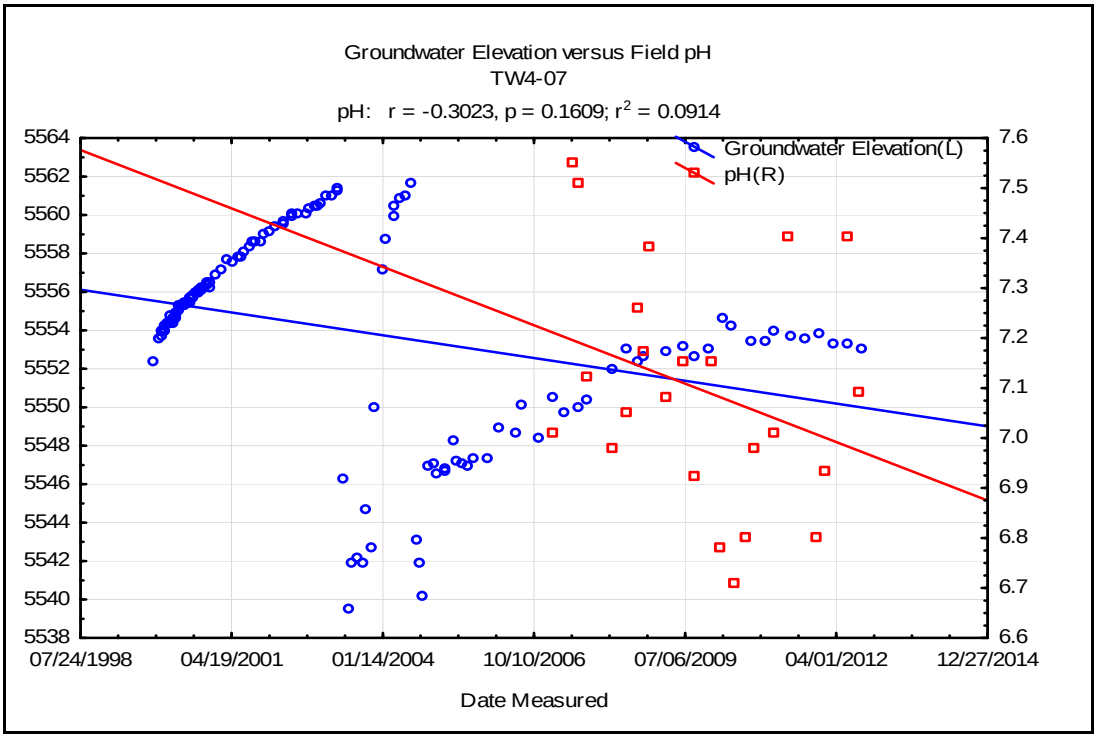

Groundwater Elevation versus Field pH
TW4-02
pH: r = -0.5767, p = 0.0050; r2 = 0.3326
5560
5558
5556
5554
5552
5550
5548
5546
5544
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
Groundwater Elevation(L)
pH(R)
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

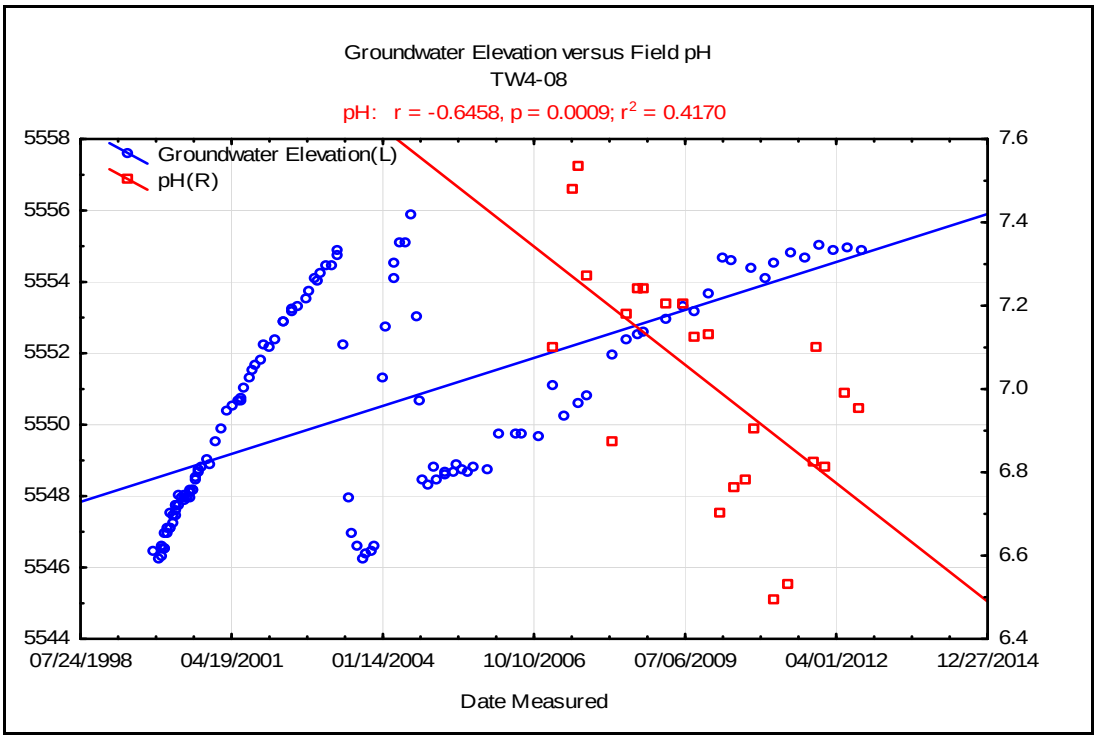

Groundwater Elevation versus Field pH
TW4-03
pH: r = -0.5766, p = 0.0062; r2 = 0.3324
5595
5590
5585
5580
5575
5570
5565
5560
5555
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
Groundwater Elevation(L)
pH(R)
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

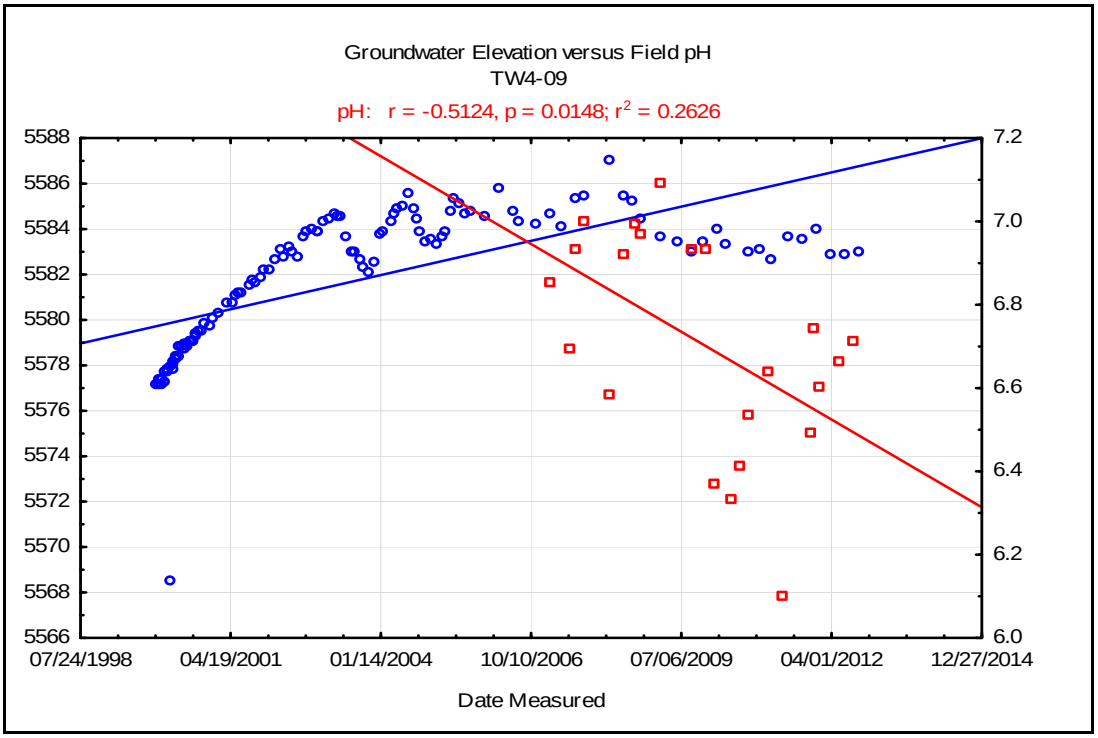

Groundwater Elevation versus Field pH
TW4-04
pH: r = -0.3526, p = 0.0989; r2 = 0.1243
5555
5550
5545
5540
5535
5530
5525
5520
5515
5510
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
Groundwater Elevation(L)
pH(R)
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

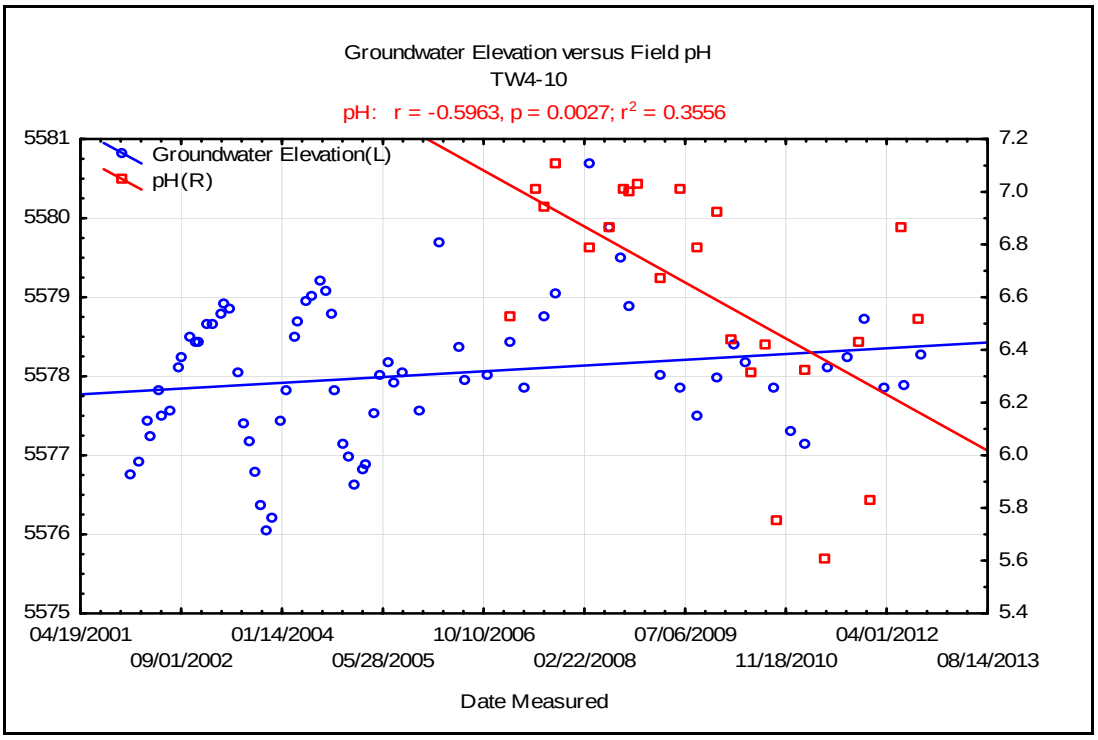

Groundwater Elevation versus Field pH
TW4-05
pH: r = -0.5931, p = 0.0029; r2 = 0.3518
5590
5588
5586
5584
5582
5580
5578
7.2
7.0
6.8
6.6
6.4
6.2
6.0
Groundwater Elevation(L)
pH(R)
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

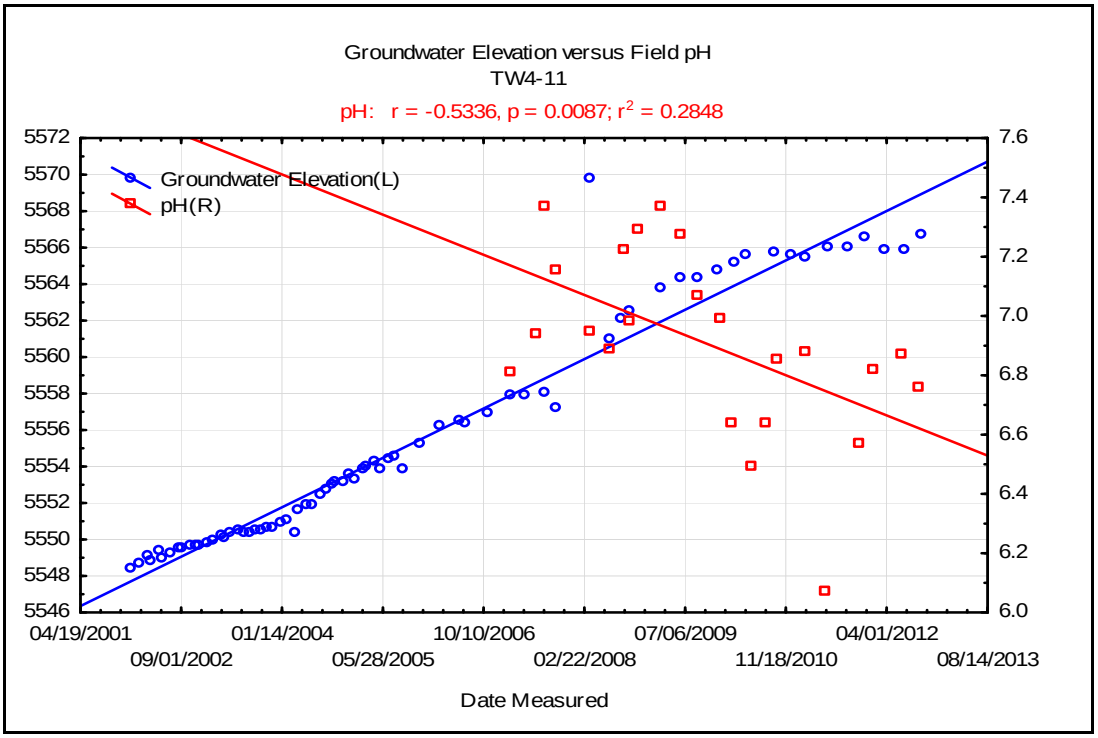

Groundwater Elevation versus Field pH
TW4-06
pH: r = -0.4473, p = 0.0323; r2 = 0.2001
Groundwater Elevation(L)
pH(R)
5560
5555
5550
5545
5540
5535
5530
5525
5520
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

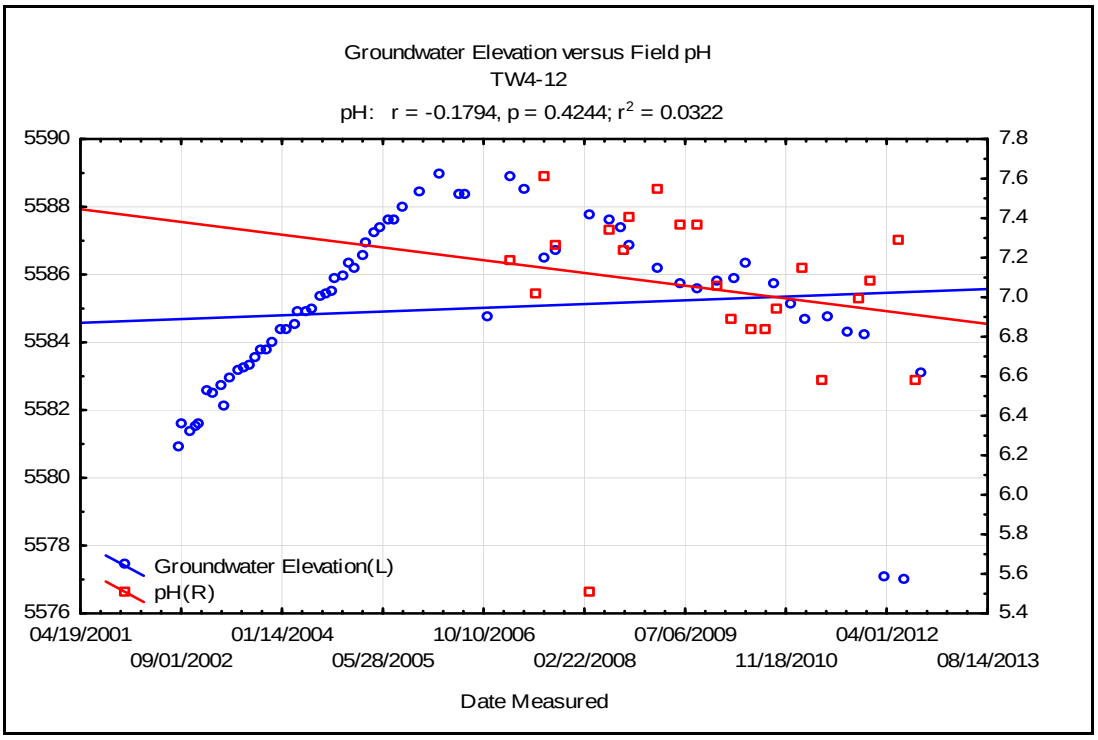

Groundwater Elevation versus Field pH
TW4-07
pH: r = -0.3023, p = 0.1609; r2 = 0.0914
Groundwater Elevation(L)
pH(R)
5564
5562
5560
5558
5556
5554
5552
5550
5548
5546
5544
5542
5540
5538
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

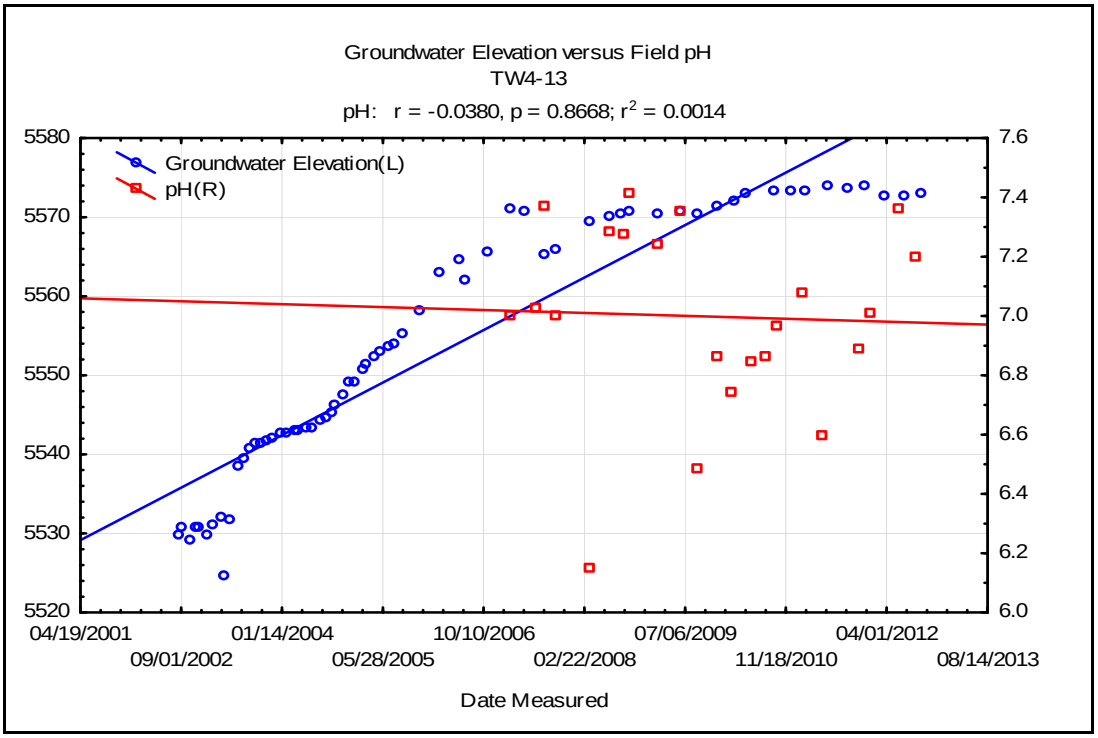

Groundwater Elevation versus Field pH
TW4-08
pH: r = -0.6458, p = 0.0009; r2 = 0.4170
Groundwater Elevation(L)
pH(R)
5558
5556
5554
5552
5550
5548
5546
5544
7.6
7.4
7.2
7.0
6.8
6.6
6.4
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

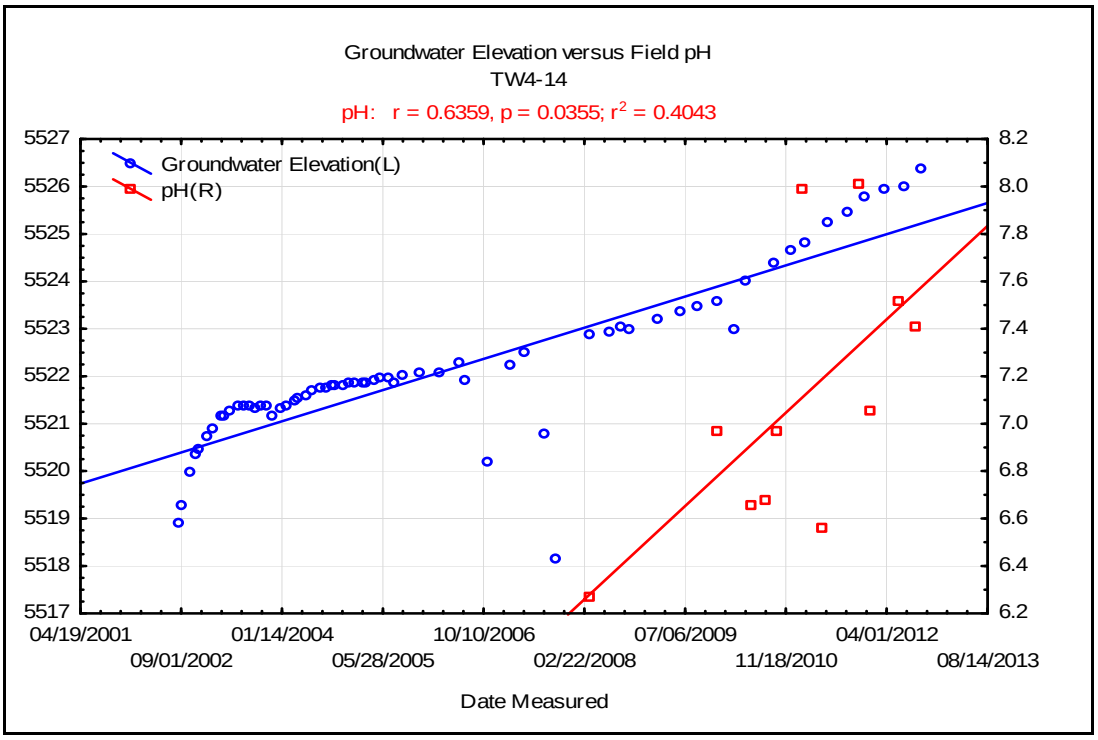

Groundwater Elevation versus Field pH
TW4-09
pH: r = -0.5124, p = 0.0148; r2 = 0.2626
5588
5586
5584
5582
5580
5578
5576
5574
5572
5570
5568
5566
7.2
7.0
6.8
6.6
6.4
6.2
6.0
07/24/1998
04/19/2001
01/14/2004
10/10/2006
07/06/2009
04/01/2012
12/27/2014
Date Measured

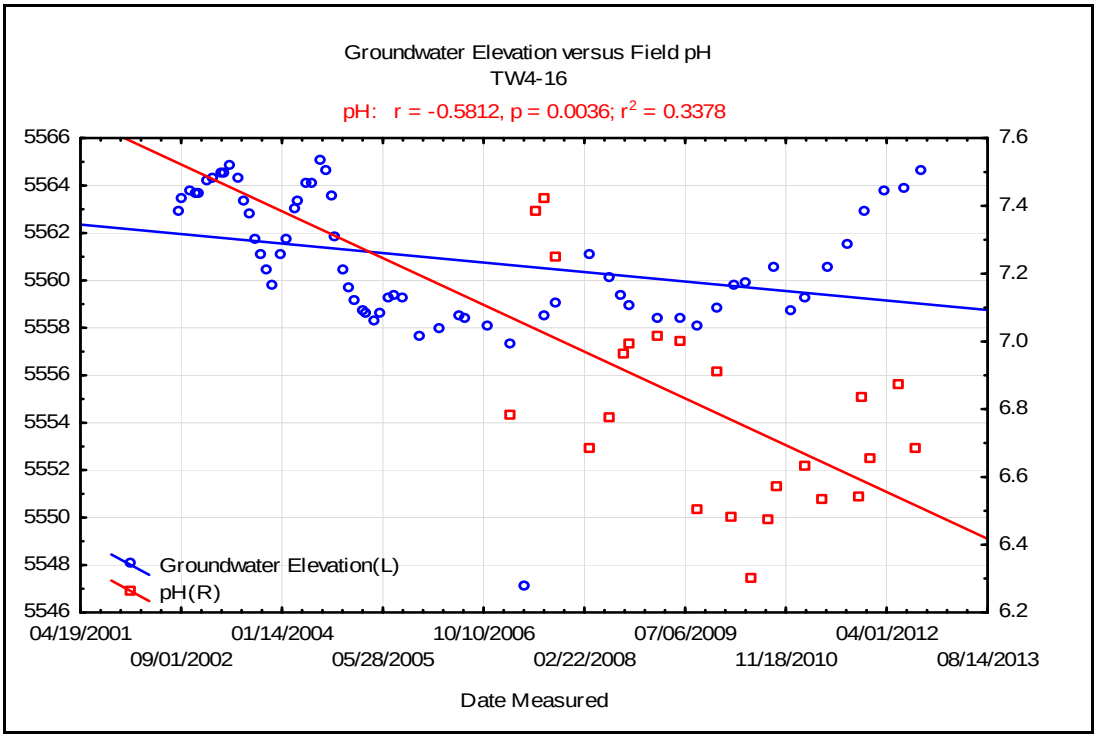

Groundwater Elevation versus Field pH
TW4-10
pH: r = -0.5963, p = 0.0027; r2 = 0.3556
Groundwater Elevation(L)
pH(R)
5581
5580
5579
5578
5577
5576
5575
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

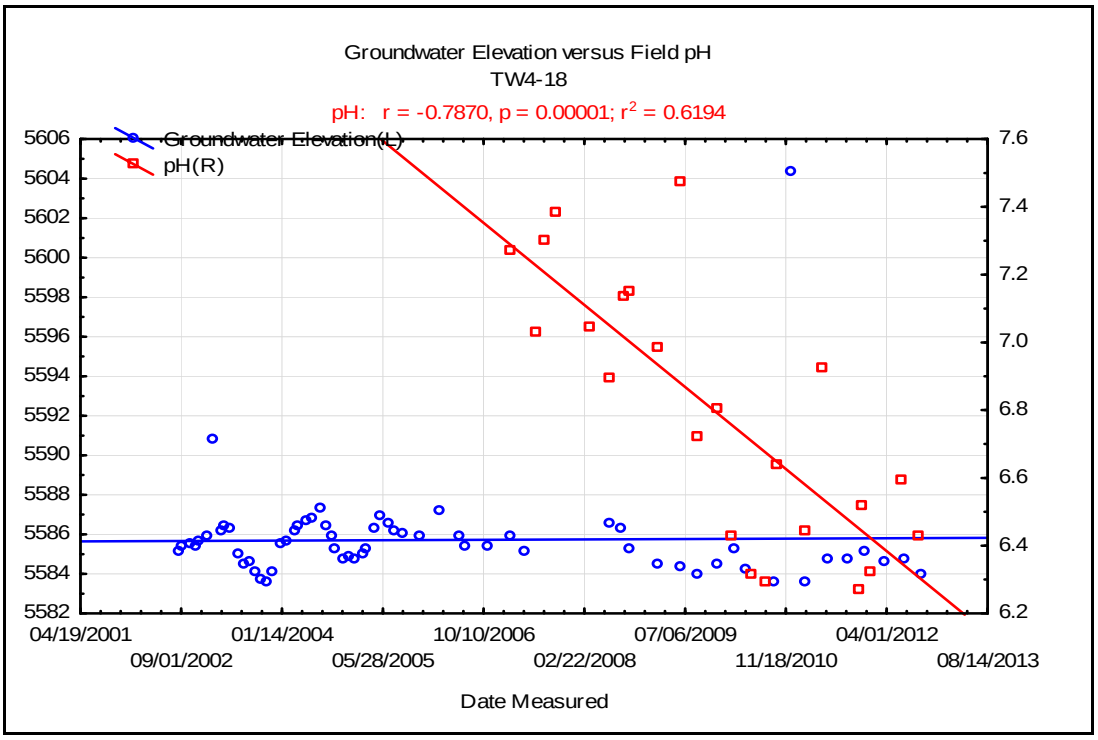

Groundwater Elevation versus Field pH
TW4-11
pH: r = -0.5336, p = 0.0087; r2 = 0.2848
Groundwater Elevation(L)
pH(R)
5572
5570
5568
5566
5564
5562
5560
5558
5556
5554
5552
5550
5548
5546
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

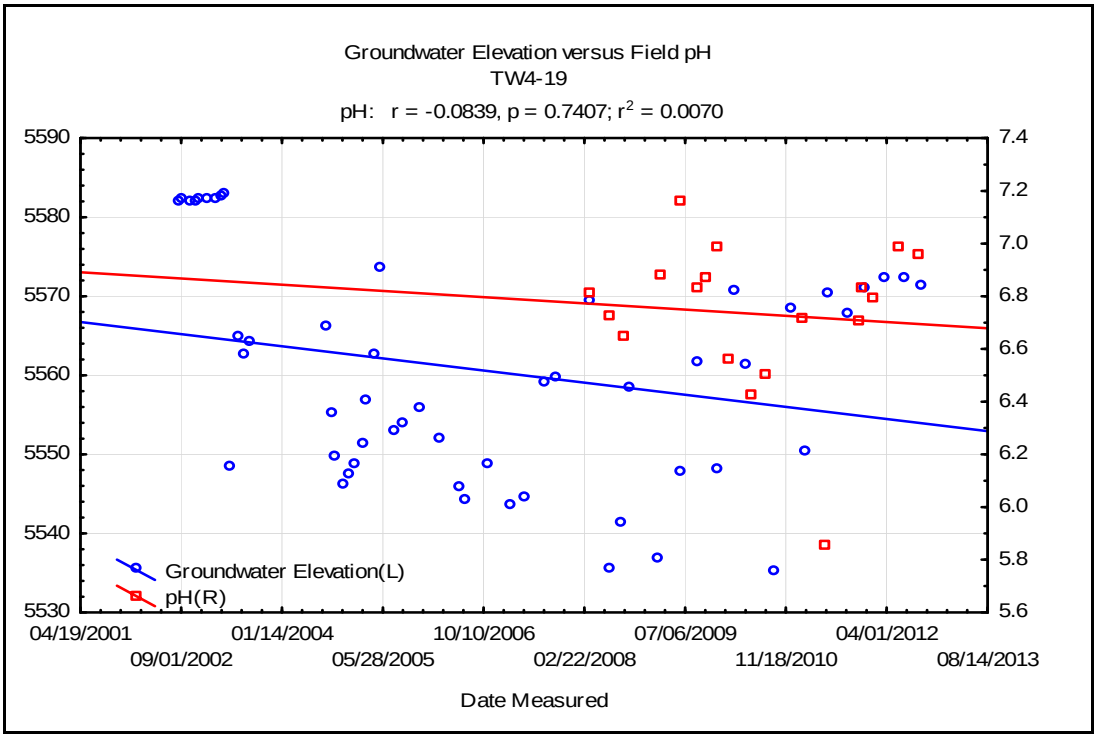

Groundwater Elevation versus Field pH
TW4-12
pH: r = -0.1794, p = 0.4244; r2 = 0.0322
5590
5588
5586
5584
5582
5580
5578
5576
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
Groundwater Elevation(L)
pH(R)
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

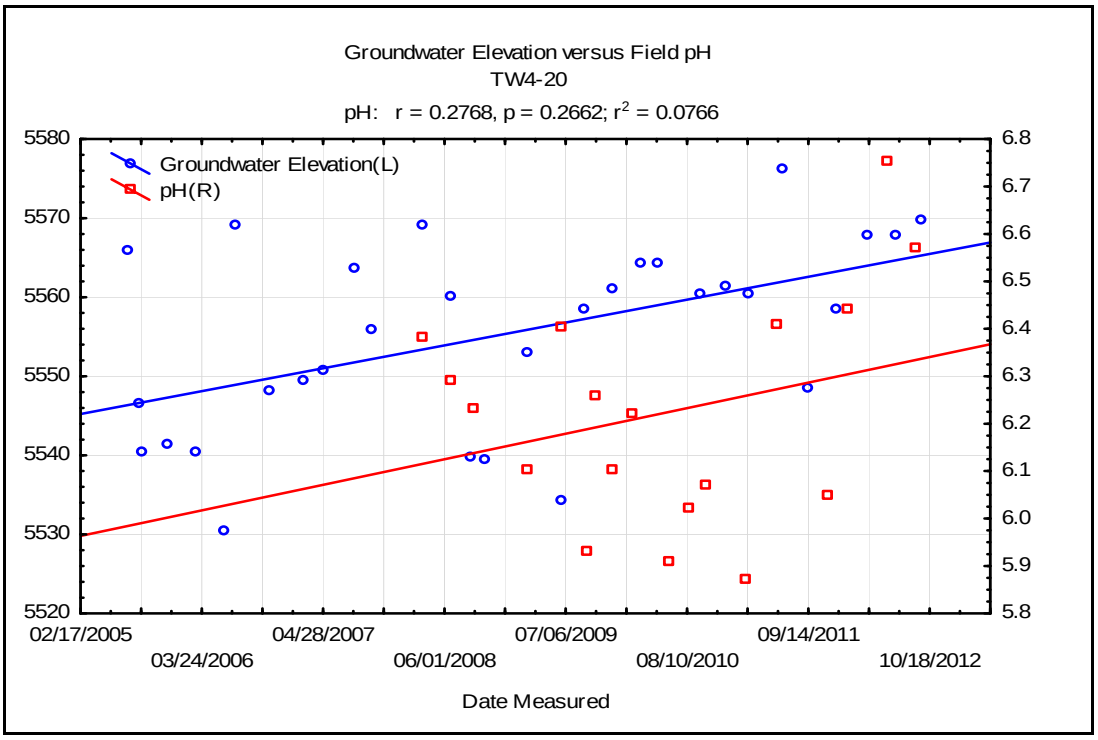

Groundwater Elevation versus Field pH
TW4-13
pH: r = -0.0380, p = 0.8668; r2 = 0.0014
5580
5570
5560
5550
5540
5530
5520
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
Groundwater Elevation(L)
pH(R)
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

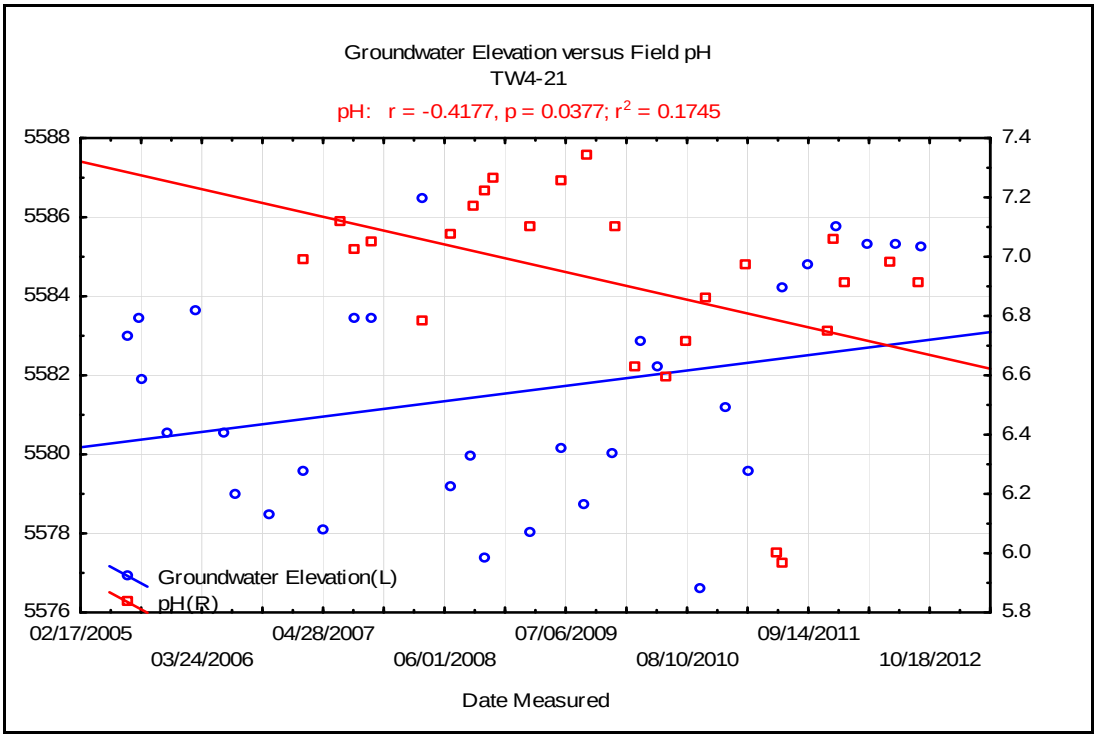

Groundwater Elevation versus Field pH
TW4-14
pH: r = 0.6359, p = 0.0355; r2 = 0.4043
Groundwater Elevation(L)
pH(R)
5527
5526
5525
5524
5523
5522
5521
5520
5519
5518
5517
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

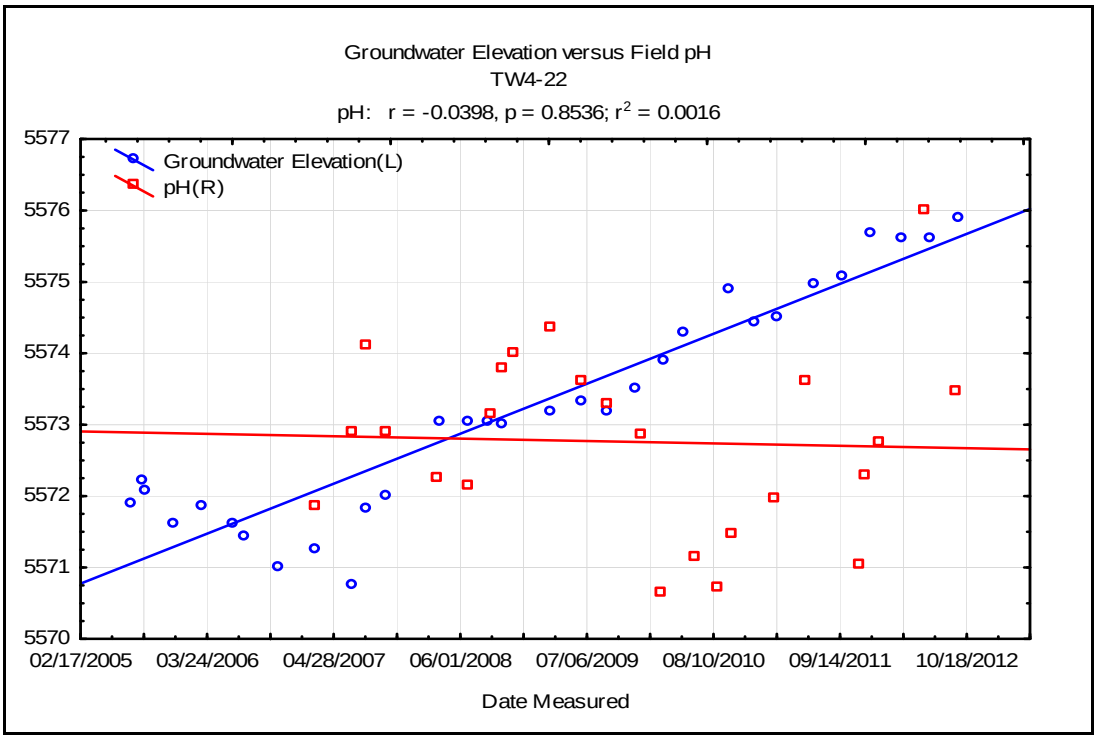

Groundwater Elevation versus Field pH
TW4-16
pH: r = -0.5812, p = 0.0036; r2 = 0.3378
Groundwater Elevation(L)
pH(R)
5566
5564
5562
5560
5558
5556
5554
5552
5550
5548
5546
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

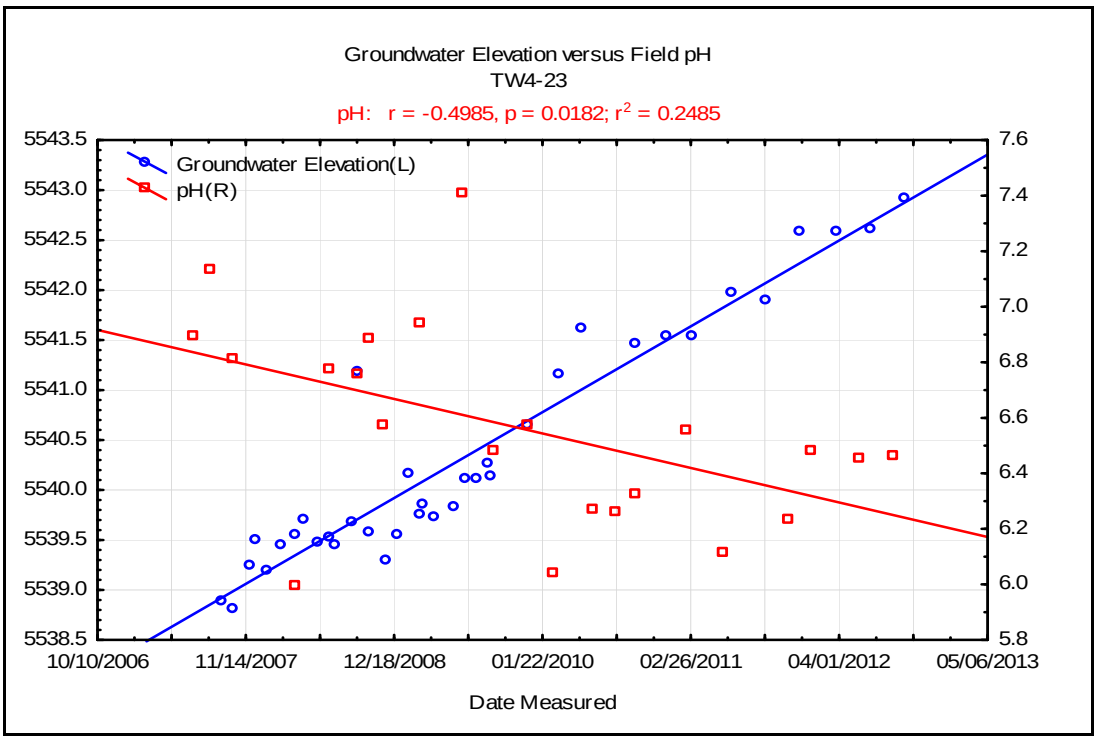

Groundwater Elevation versus Field pH
TW4-18
pH: r = -0.7870, p = 0.00001; r2 = 0.6194
Groundwater Elevation(L)
pH(R)
5606
5604
5602
5600
5598
5596
5594
5592
5590
5588
5586
5584
5582
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

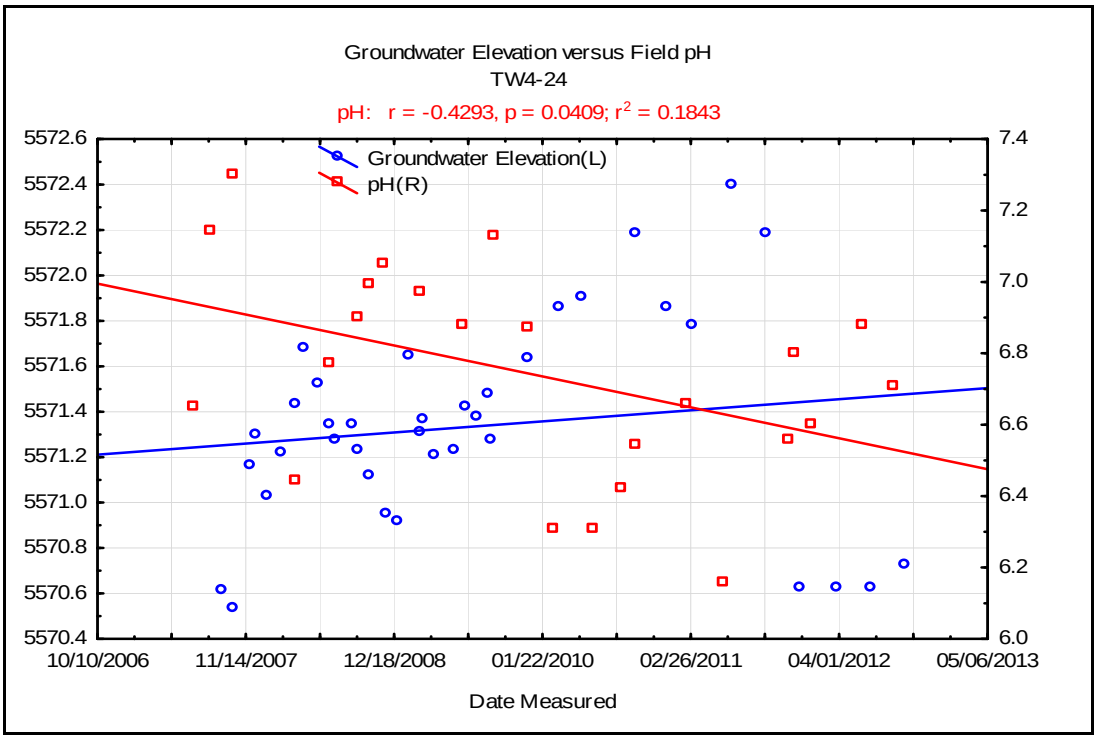

Groundwater Elevation versus Field pH
TW4-19
pH: r = -0.0839, p = 0.7407; r2 = 0.0070
5590
5580
5570
5560
5550
5540
5530
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
Groundwater Elevation(L)
pH(R)
04/19/2001
09/01/2002
01/14/2004
05/28/2005
10/10/2006
02/22/2008
07/06/2009
11/18/2010
04/01/2012
08/14/2013
Date Measured

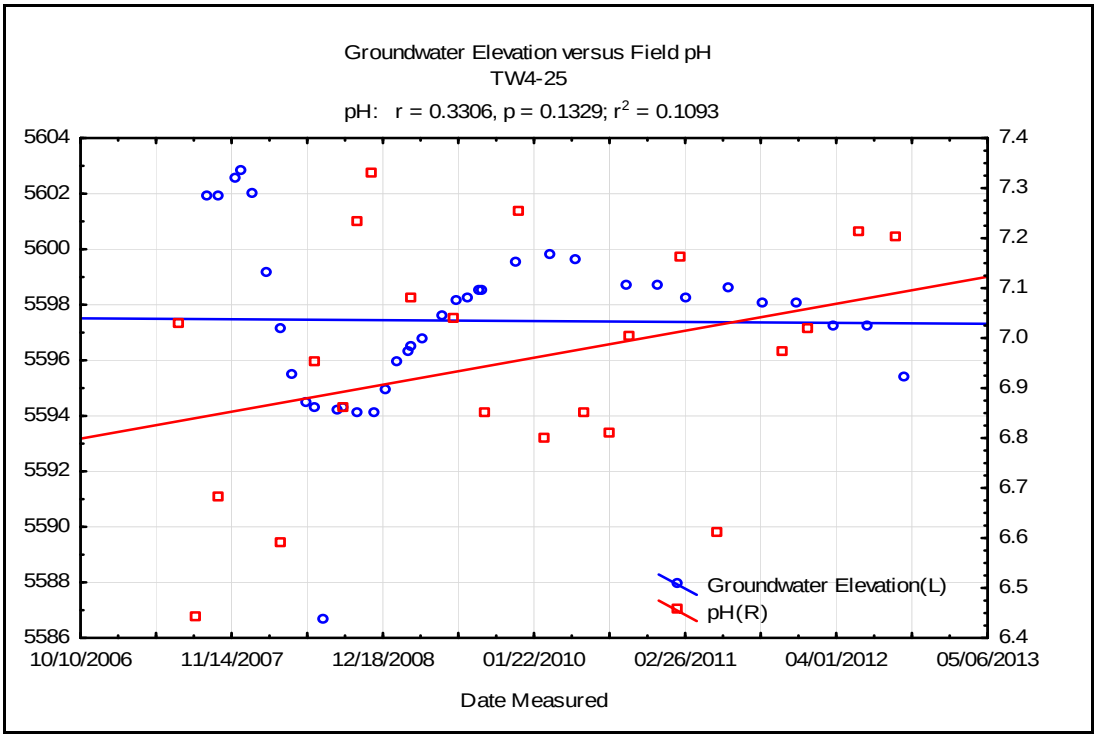

Groundwater Elevation versus Field pH
TW4-20
pH: r = 0.2768, p = 0.2662; r2 = 0.0766
Groundwater Elevation(L)
pH(R)
5580
5570
5560
5550
5540
5530
5520
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6.0
5.9
5.8
02/17/2005
03/24/2006
04/28/2007
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

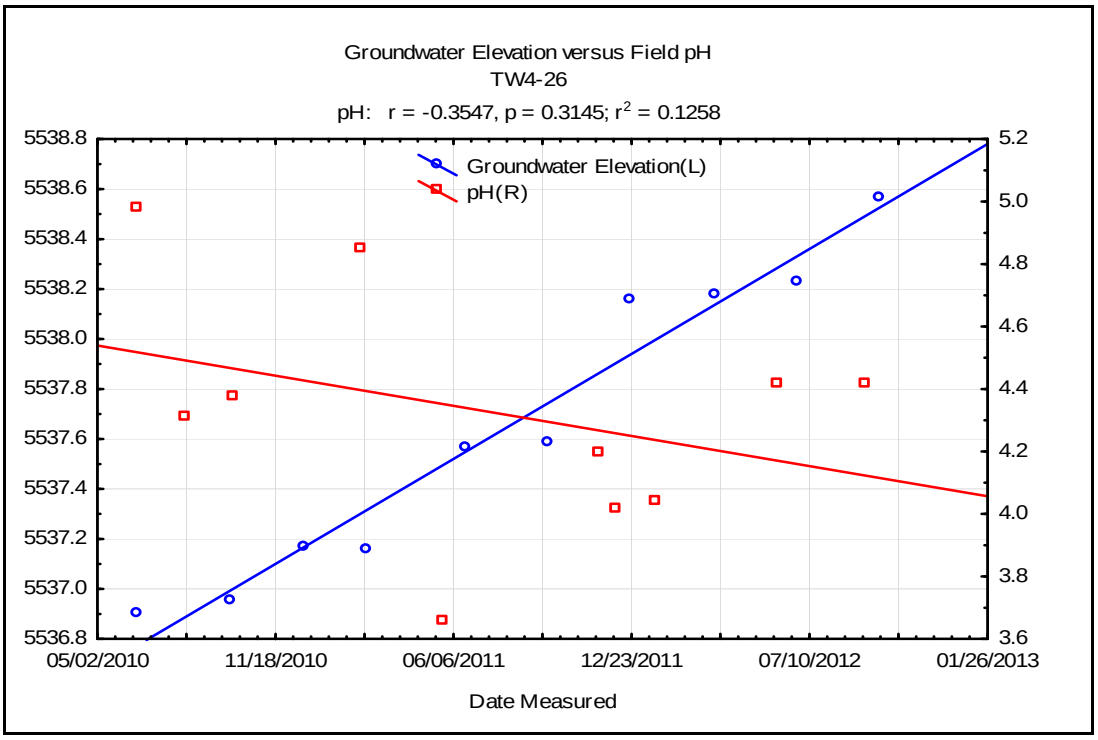

Groundwater Elevation versus Field pH
TW4-21
pH: r = -0.4177, p = 0.0377; r2 = 0.1745
Groundwater Elevation(L)
pH(R)
5588
5586
5584
5582
5580
5578
5576
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
02/17/2005
03/24/2006
04/28/2007
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

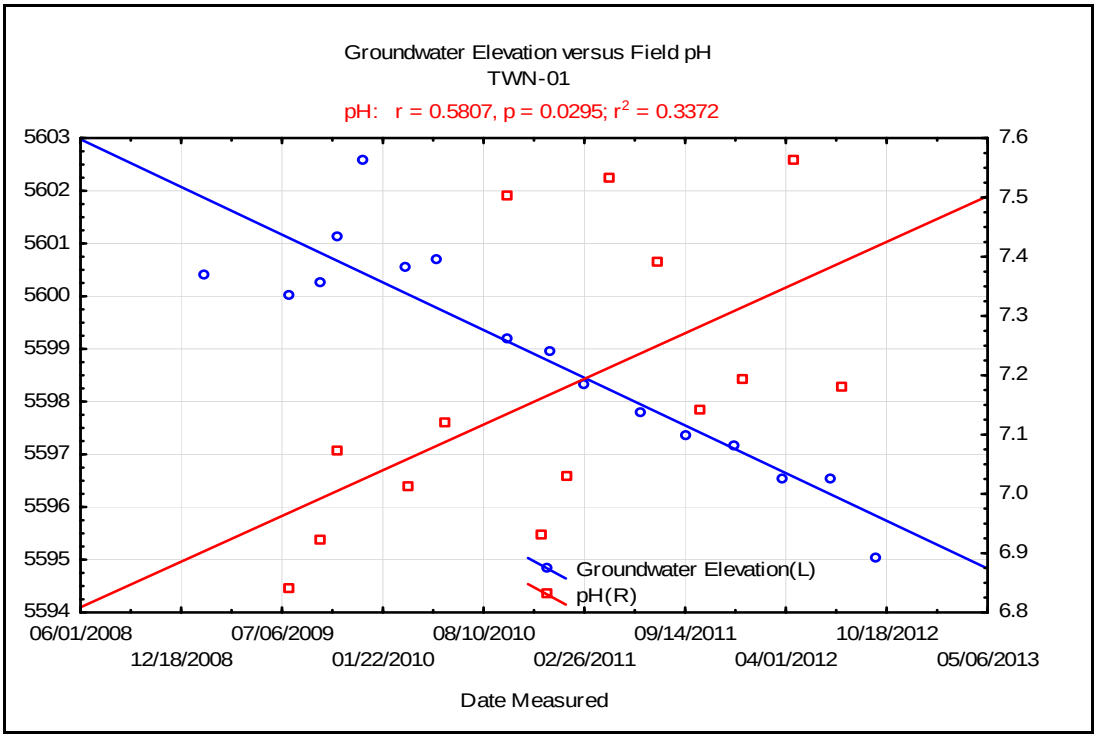

Groundwater Elevation versus Field pH
TW4-22
pH: r = -0.0398, p = 0.8536; r2 = 0.0016
Groundwater Elevation(L)
pH(R)
5577
5576
5575
5574
5573
5572
5571
5570
02/17/2005
03/24/2006
04/28/2007
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

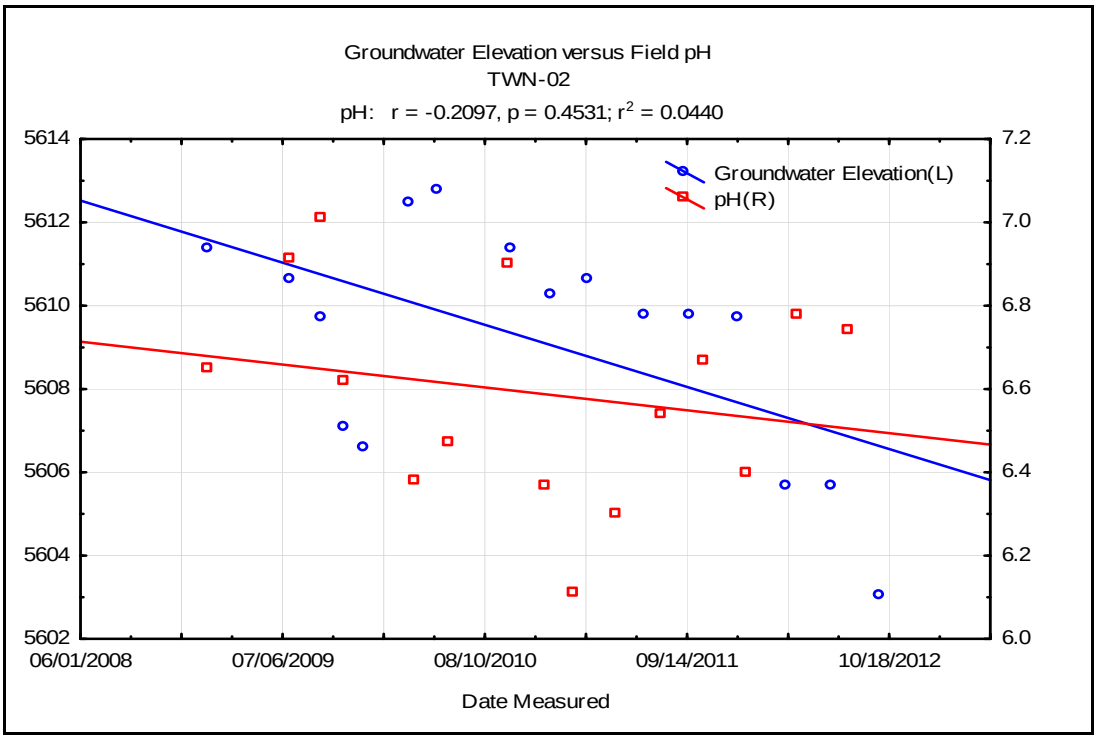

Groundwater Elevation versus Field pH
TW4-23
pH: r = -0.4985, p = 0.0182; r2 = 0.2485
Groundwater Elevation(L)
pH(R)
5543.5
5543.0
5542.5
5542.0
5541.5
5541.0
5540.5
5540.0
5539.5
5539.0
5538.5
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
5.8
10/10/2006
11/14/2007
12/18/2008
01/22/2010
02/26/2011
04/01/2012
05/06/2013
Date Measured

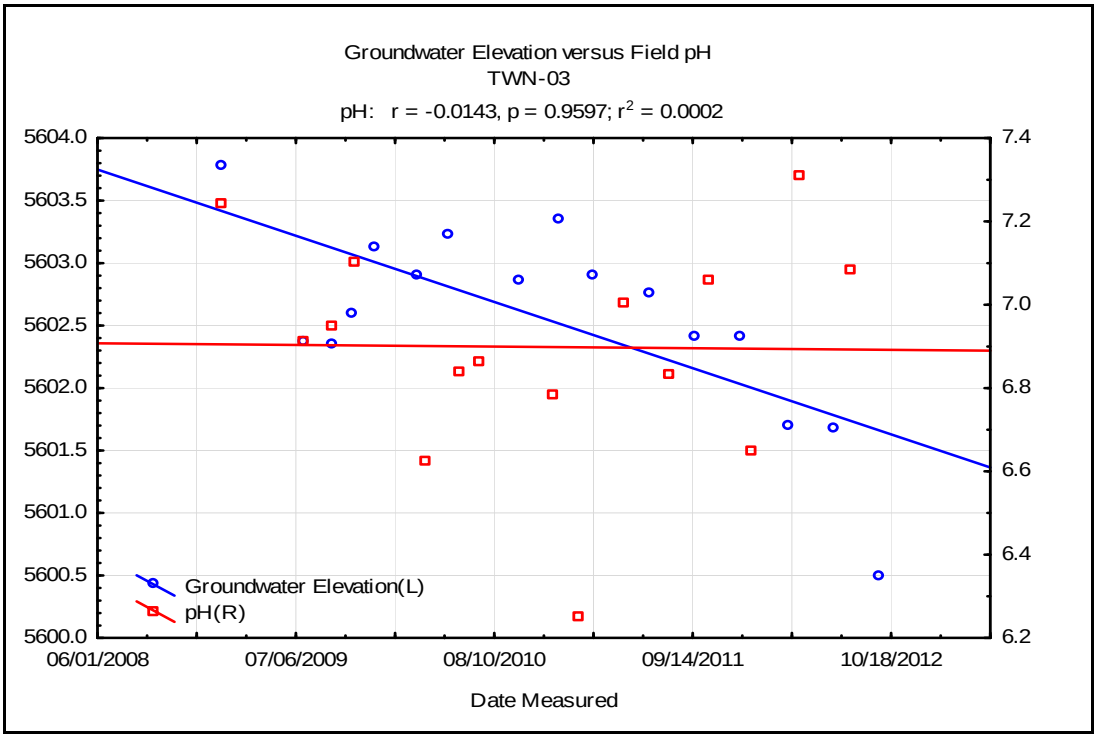

Groundwater Elevation versus Field pH
TW4-24
pH: r = -0.4293, p = 0.0409; r2 = 0.1843
Groundwater Elevation(L)
pH(R)
5572.6
5572.4
5572.2
5572.0
5571.8
5571.6
5571.4
5571.2
5571.0
5570.8
5570.6
5570.4
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
10/10/2006
11/14/2007
12/18/2008
01/22/2010
02/26/2011
04/01/2012
05/06/2013
Date Measured

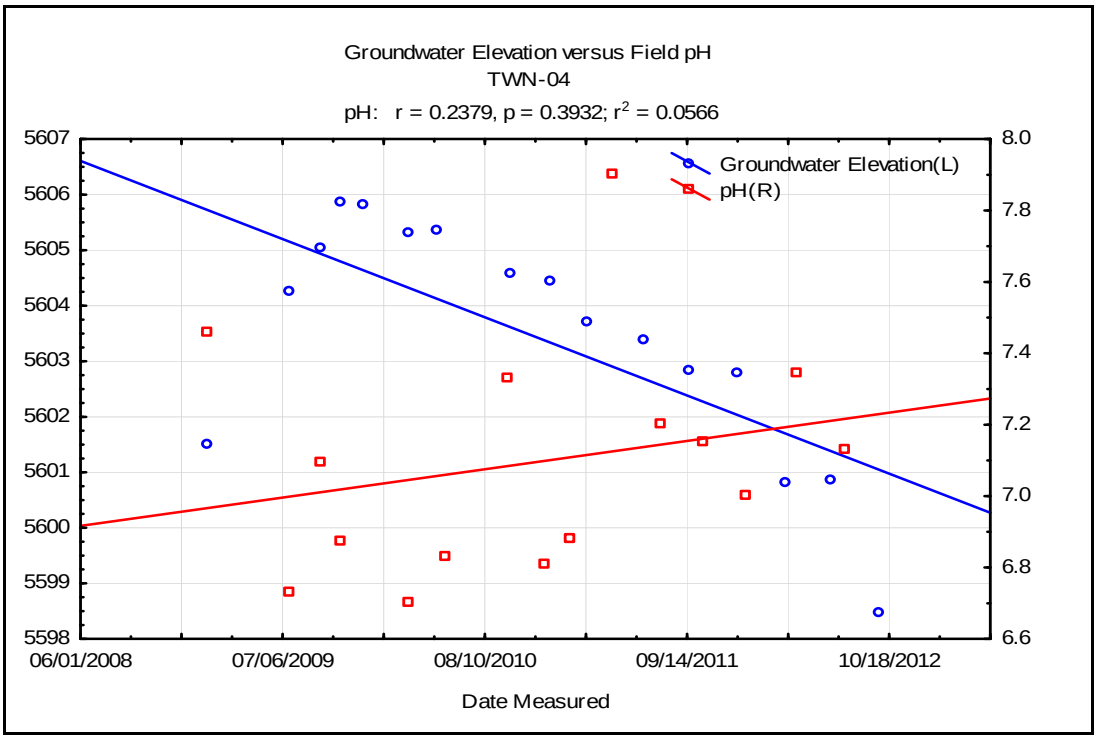

Groundwater Elevation versus Field pH
TW4-25
pH: r = 0.3306, p = 0.1329; r2 = 0.1093
5604
5602
5600
5598
5596
5594
5592
5590
5588
5586
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
6.4
Groundwater Elevation(L)
pH(R)
10/10/2006
11/14/2007
12/18/2008
01/22/2010
02/26/2011
04/01/2012
05/06/2013
Date Measured

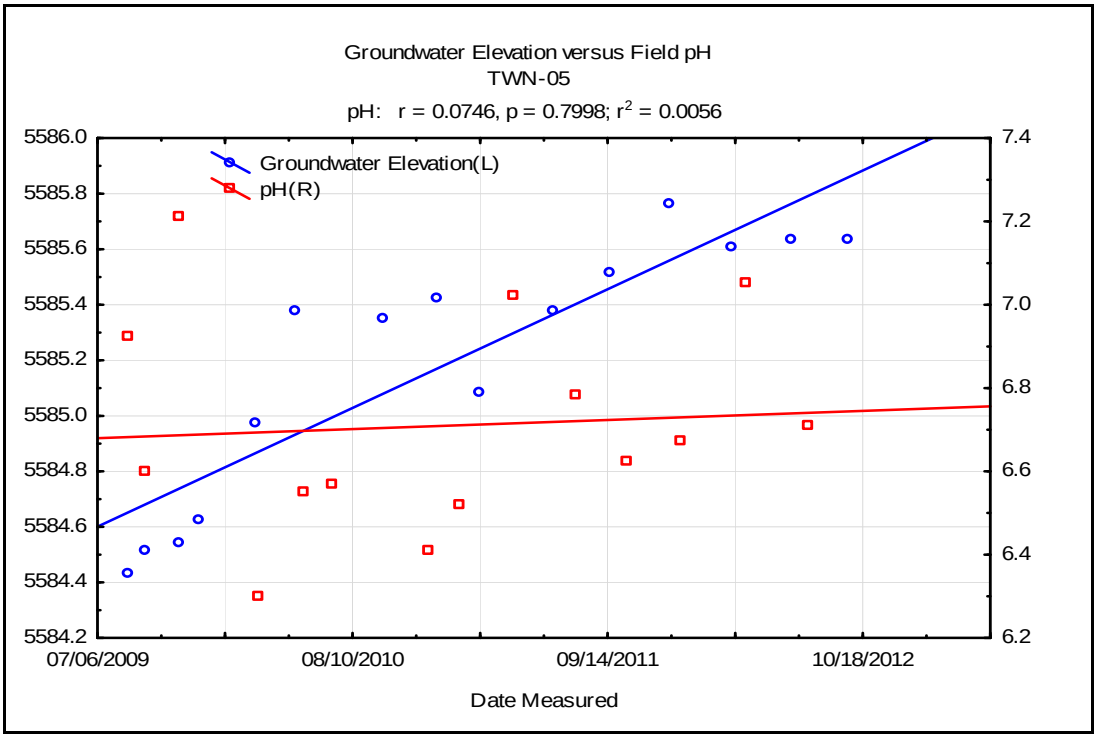

Groundwater Elevation versus Field pH
TW4-26
pH: r = -0.3547, p = 0.3145; r2 = 0.1258
Groundwater Elevation(L)
pH(R)
5538.8
5538.6
5538.4
5538.2
5538.0
5537.8
5537.6
5537.4
5537.2
5537.0
5536.8
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
05/02/2010
11/18/2010
06/06/2011
12/23/2011
07/10/2012
01/26/2013
Date Measured

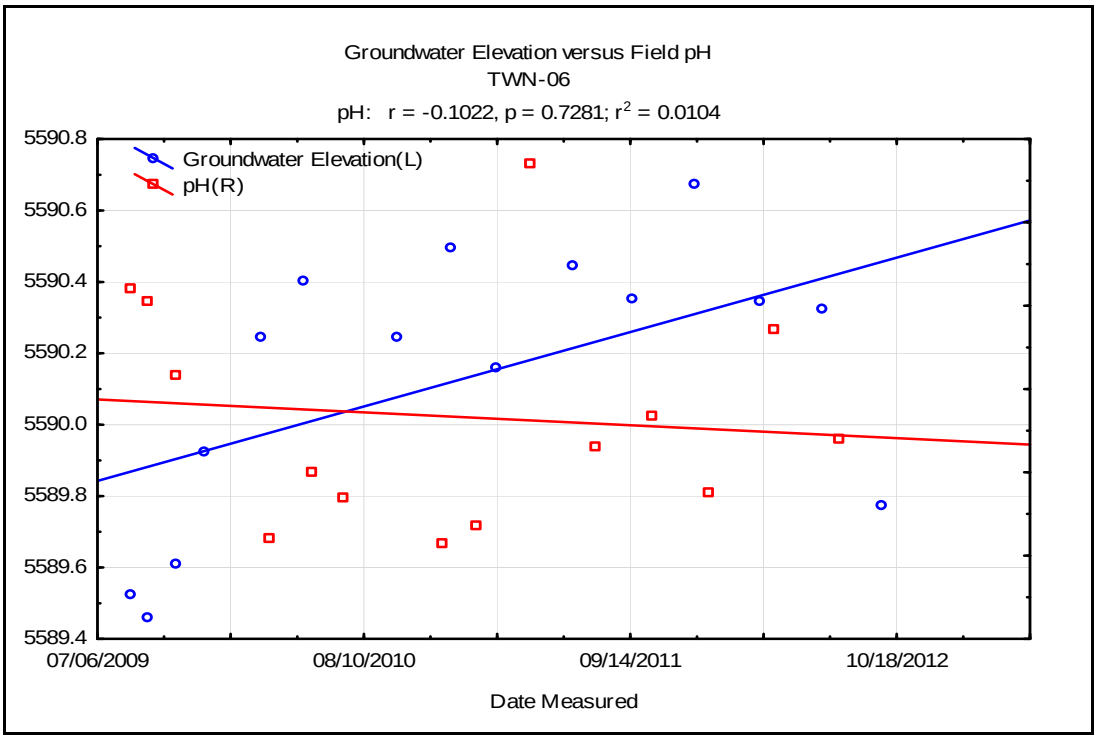

Groundwater Elevation versus Field pH
TWN-01
pH: r = 0.5807, p = 0.0295; r2 = 0.3372
5603
5602
5601
5600
5599
5598
5597
5596
5595
5594
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
6.8
Groundwater Elevation(L)
pH(R)
06/01/2008
12/18/2008
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured

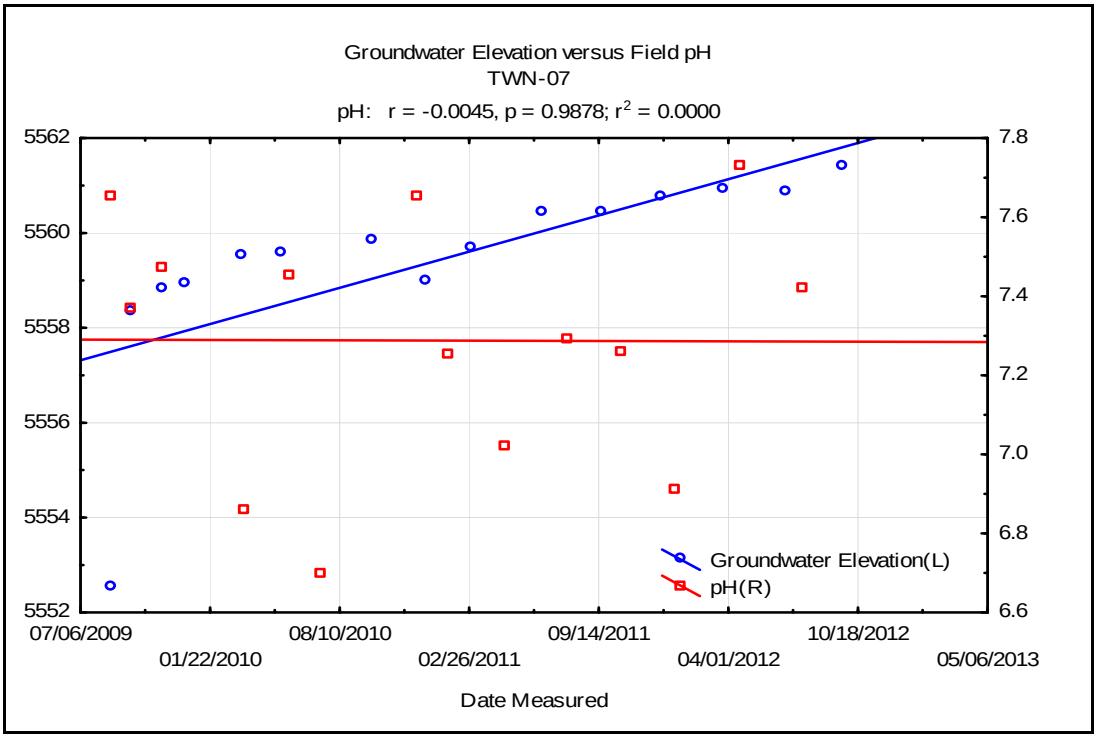

Groundwater Elevation versus Field pH
TWN-02
pH: r = -0.2097, p = 0.4531; r2 = 0.0440
5614
5612
5610
5608
5606
5604
5602
7.2
7.0
6.8
6.6
6.4
6.2
6.0
Groundwater Elevation(L)
pH(R)
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

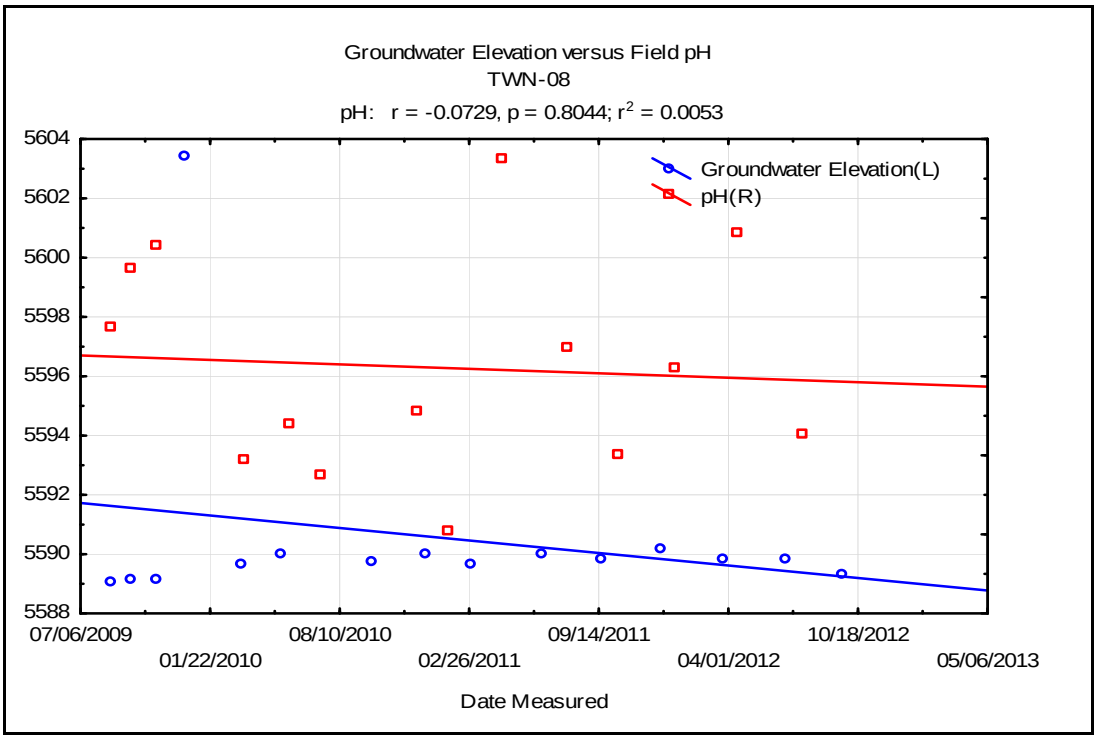

Groundwater Elevation versus Field pH
TWN-03
pH: r = -0.0143, p = 0.9597; r2 = 0.0002
5604.0
5603.5
5603.0
5602.5
5602.0
5601.5
5601.0
5600.5
5600.0
7.4
7.2
7.0
6.8
6.6
6.4
6.2
Groundwater Elevation(L)
pH(R)
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

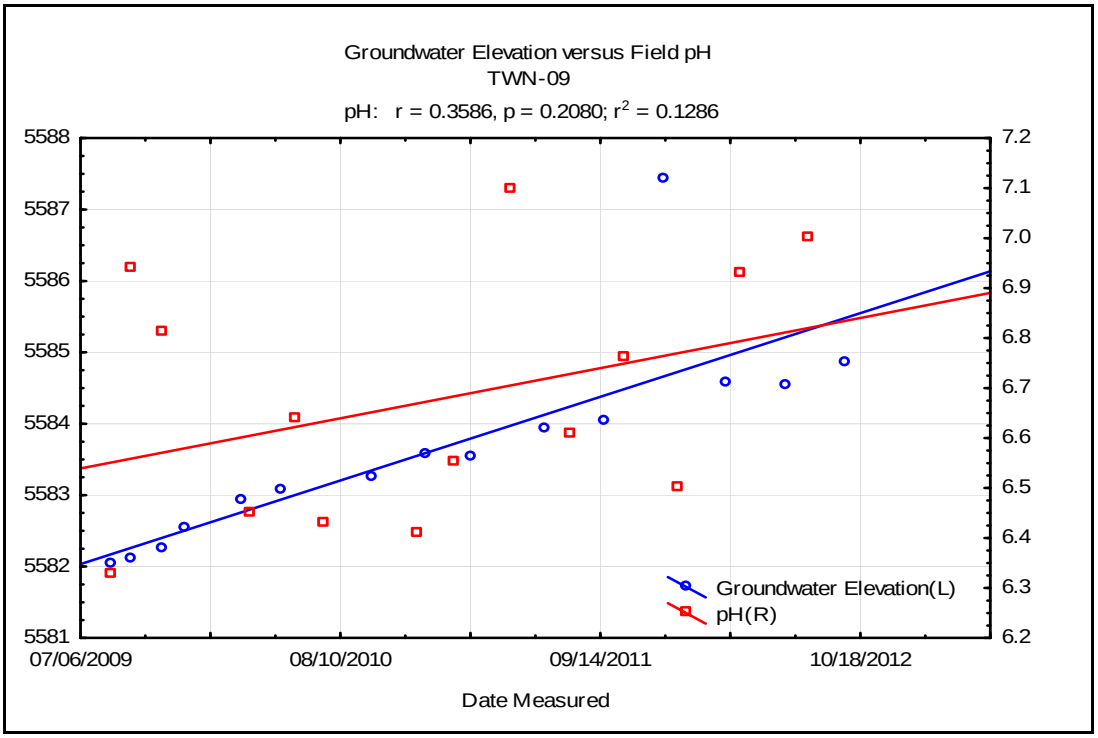

Groundwater Elevation versus Field pH
TWN-04
pH: r = 0.2379, p = 0.3932; r2 = 0.0566
Groundwater Elevation(L)
pH(R)
5607
5606
5605
5604
5603
5602
5601
5600
5599
5598
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
06/01/2008
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

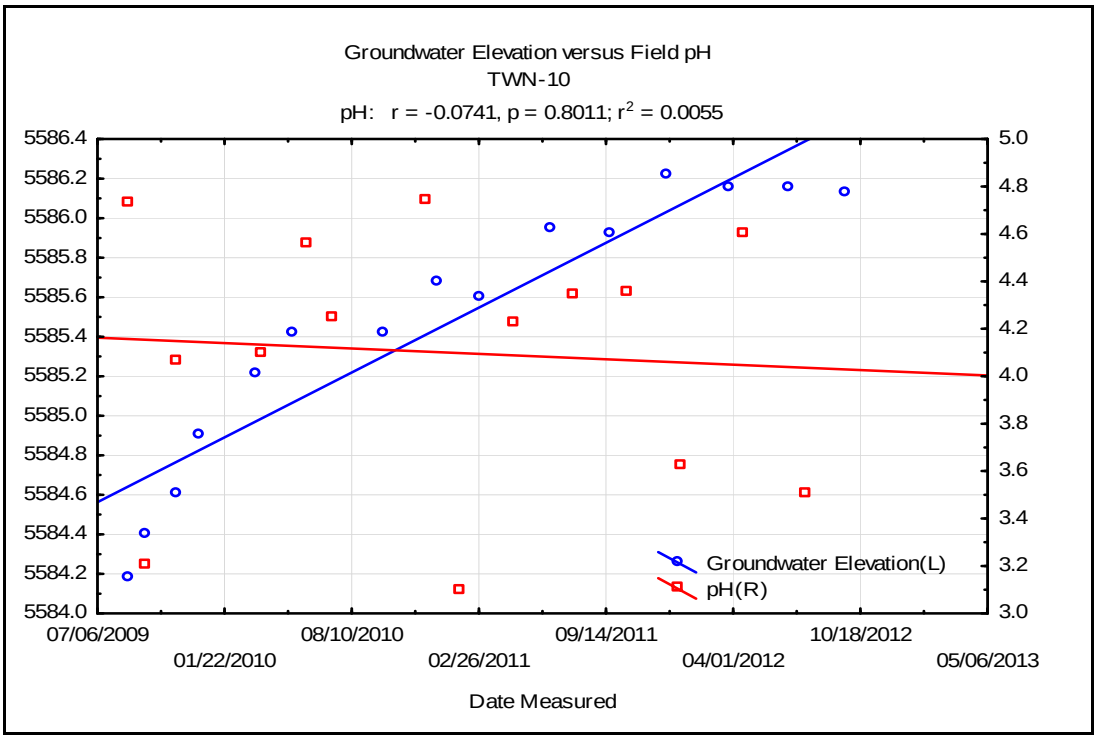

Groundwater Elevation versus Field pH
TWN-05
pH: r = 0.0746, p = 0.7998; r2 = 0.0056
Groundwater Elevation(L)
pH(R)
5586.0
5585.8
5585.6
5585.4
5585.2
5585.0
5584.8
5584.6
5584.4
5584.2
7.4
7.2
7.0
6.8
6.6
6.4
6.2
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

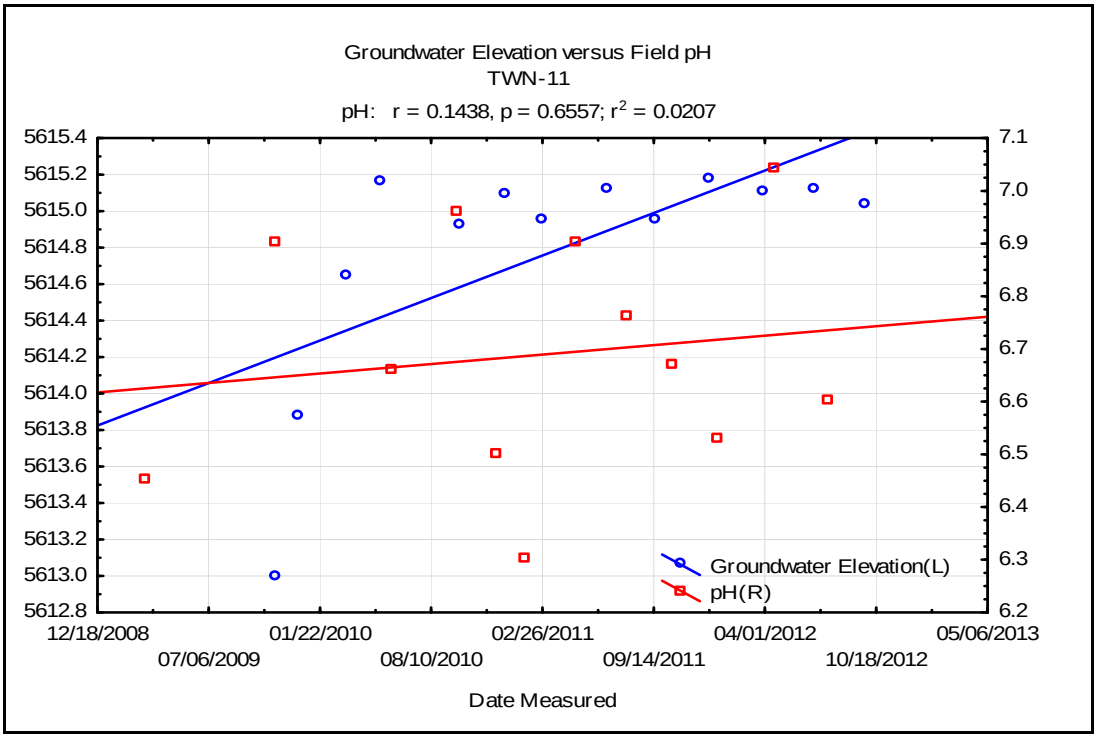

Groundwater Elevation versus Field pH
TWN-06
pH: r = -0.1022, p = 0.7281; r2 = 0.0104
Groundwater Elevation(L)
pH(R)
5590.8
5590.6
5590.4
5590.2
5590.0
5589.8
5589.6
5589.4
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

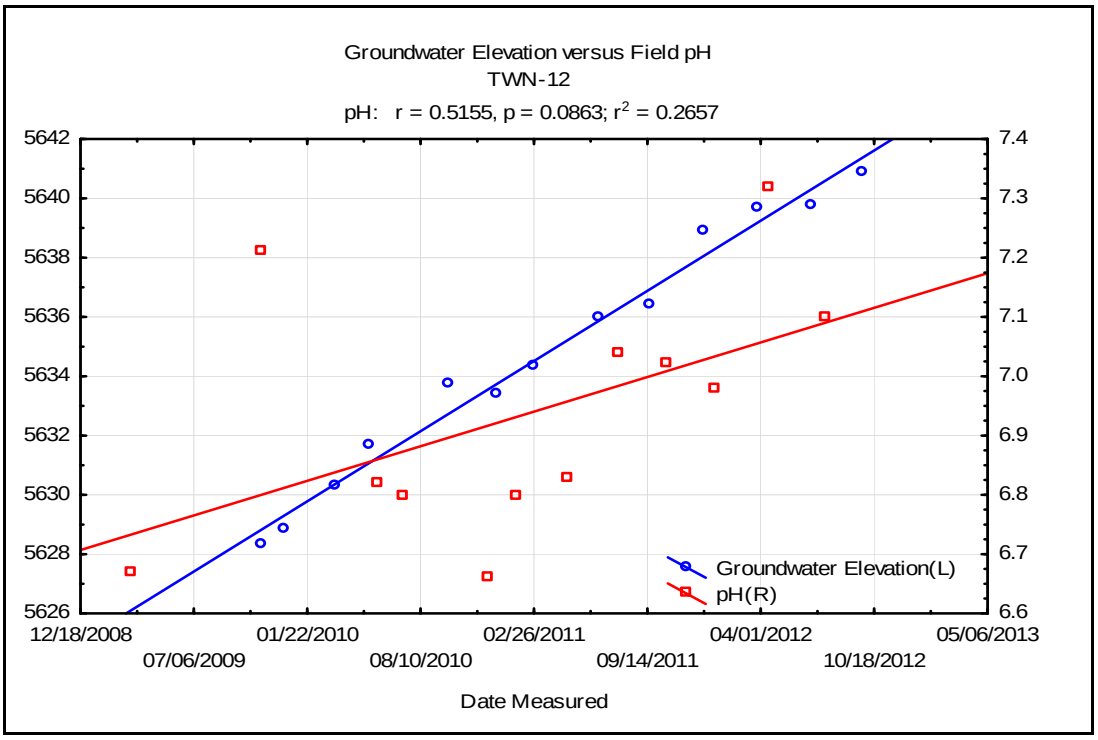

Groundwater Elevation versus Field pH
TWN-07
pH: r = -0.0045, p = 0.9878; r2 = 0.0000
5562
5560
5558
5556
5554
5552
7.8
7.6
7.4
7.2
7.0
6.8
6.6
Groundwater Elevation(L)
pH(R)
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured

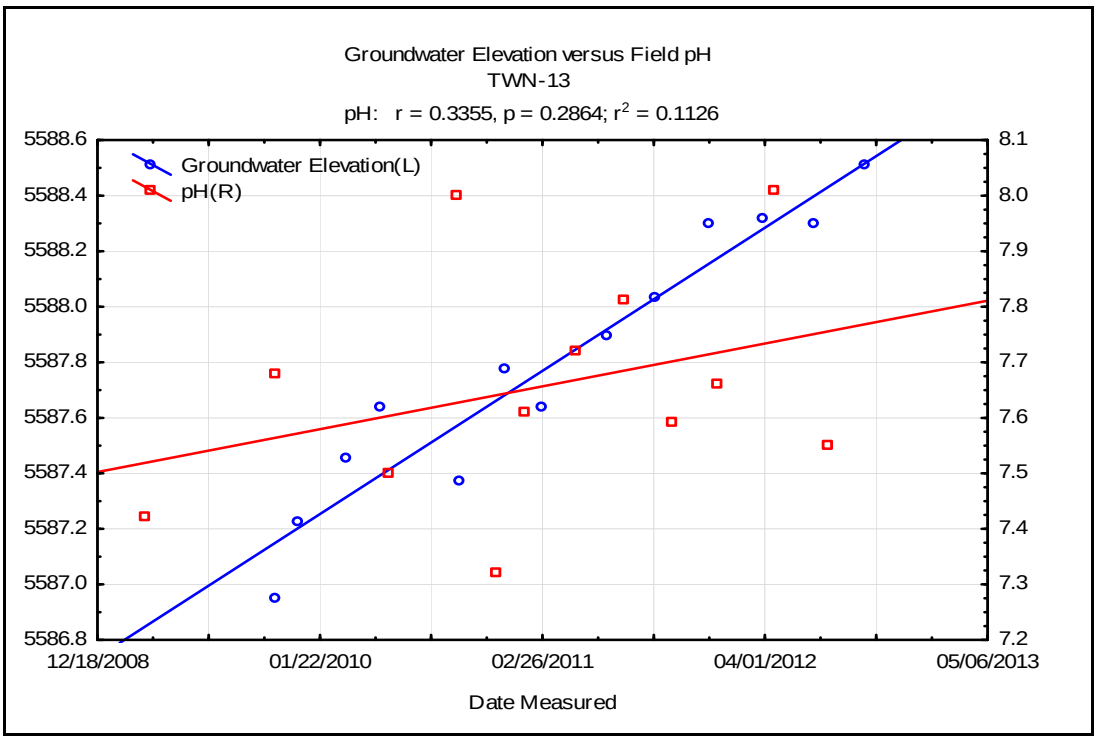

Groundwater Elevation versus Field pH
TWN-08
pH: r = -0.0729, p = 0.8044; r2 = 0.0053
5604
5602
5600
5598
5596
5594
5592
5590
5588
Groundwater Elevation(L)
pH(R)
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured

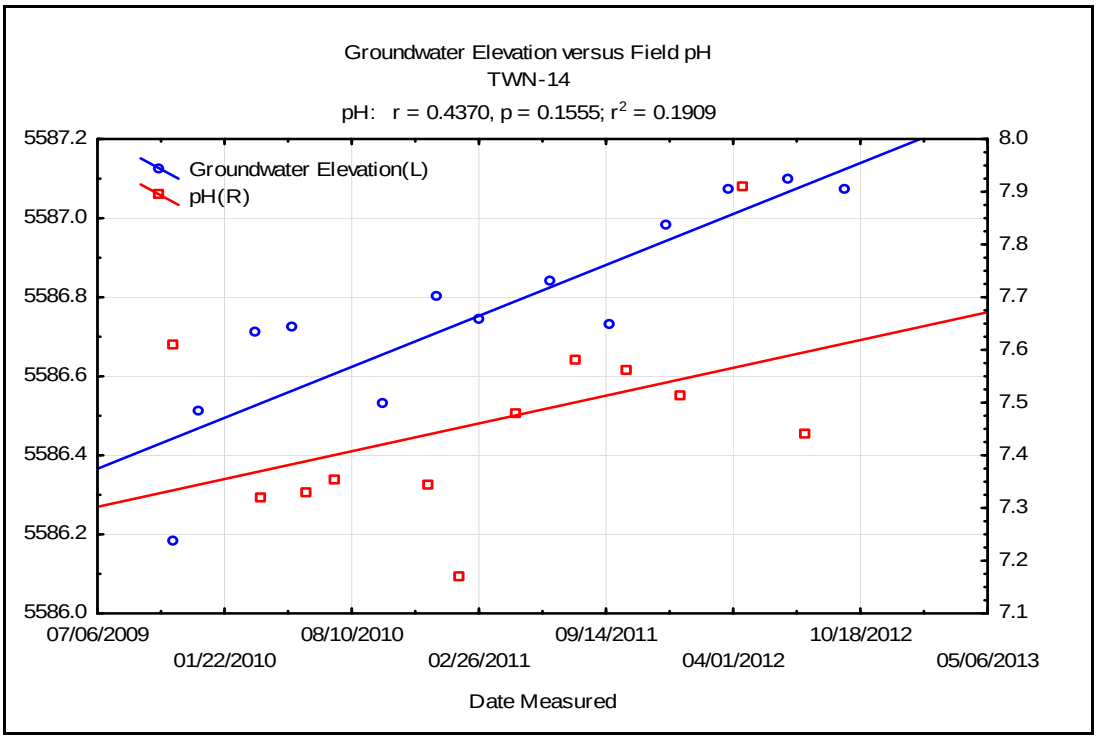

Groundwater Elevation versus Field pH
TWN-09
pH: r = 0.3586, p = 0.2080; r2 = 0.1286
5588
5587
5586
5585
5584
5583
5582
5581
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
Groundwater Elevation(L)
pH(R)
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured

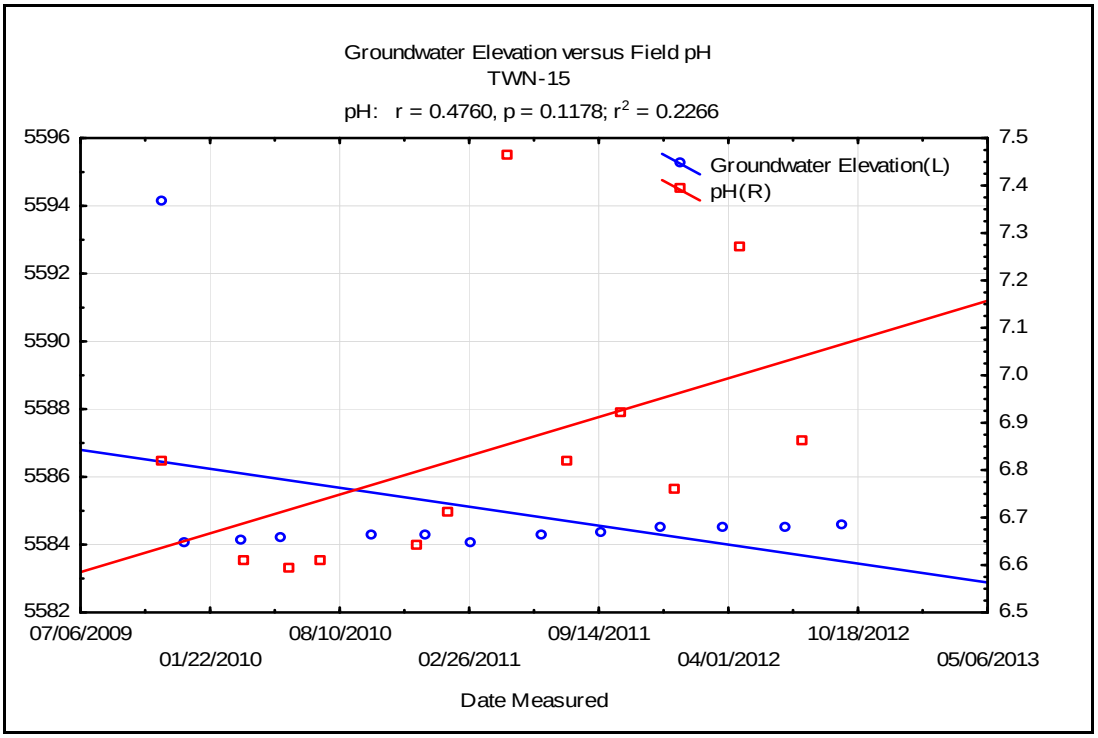

Groundwater Elevation versus Field pH
TWN-10
pH: r = -0.0741, p = 0.8011; r2 = 0.0055
5586.4
5586.2
5586.0
5585.8
5585.6
5585.4
5585.2
5585.0
5584.8
5584.6
5584.4
5584.2
5584.0
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured
Groundwater Elevation(L)
pH(R)

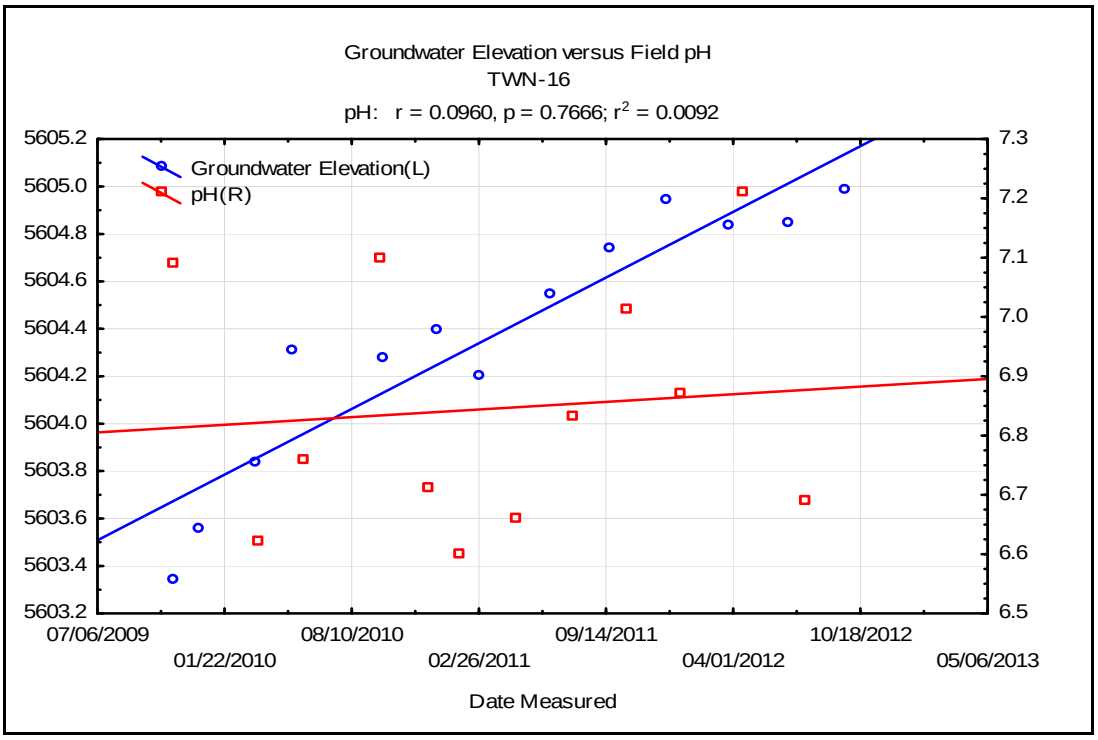

Groundwater Elevation versus Field pH
TWN-11
pH: r = 0.1438, p = 0.6557; r2 = 0.0207
5615.4
5615.2
5615.0
5614.8
5614.6
5614.4
5614.2
5614.0
5613.8
5613.6
5613.4
5613.2
5613.0
5612.8
7.1
7.0
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
12/18/2008
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured
Groundwater Elevation(L)
pH(R)

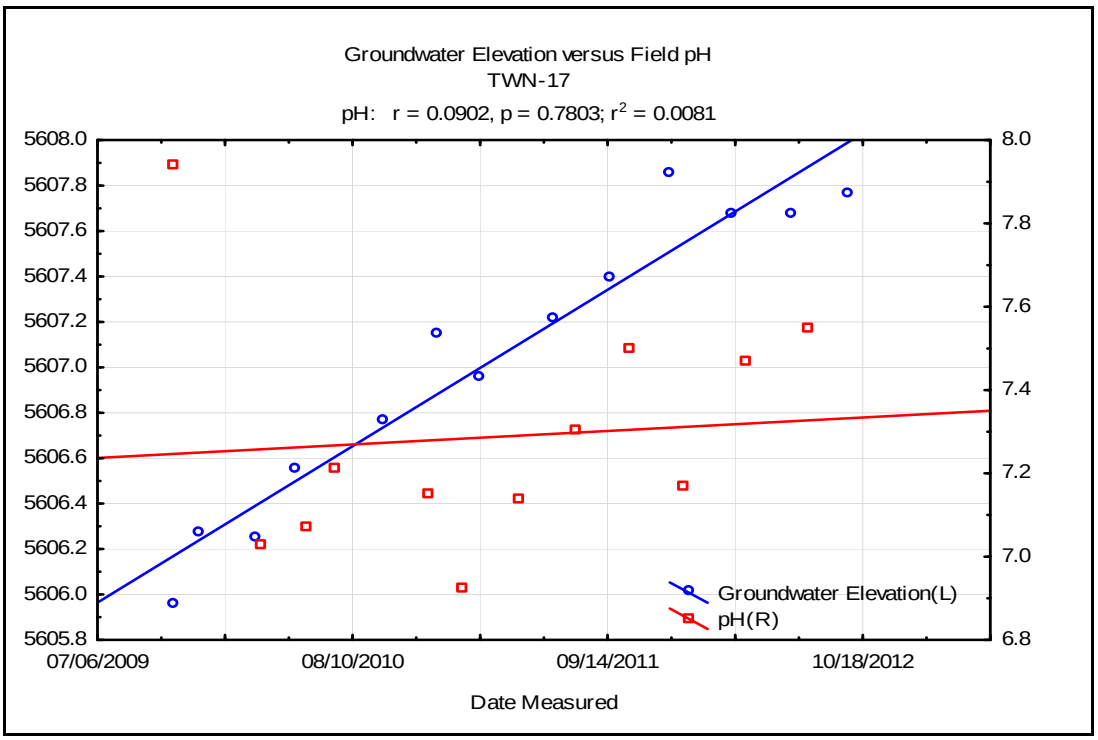

Groundwater Elevation versus Field pH
TWN-12
pH: r = 0.5155, p = 0.0863; r2 = 0.2657
5642
5640
5638
5636
5634
5632
5630
5628
5626
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
Groundwater Elevation(L)
pH(R)
12/18/2008
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured

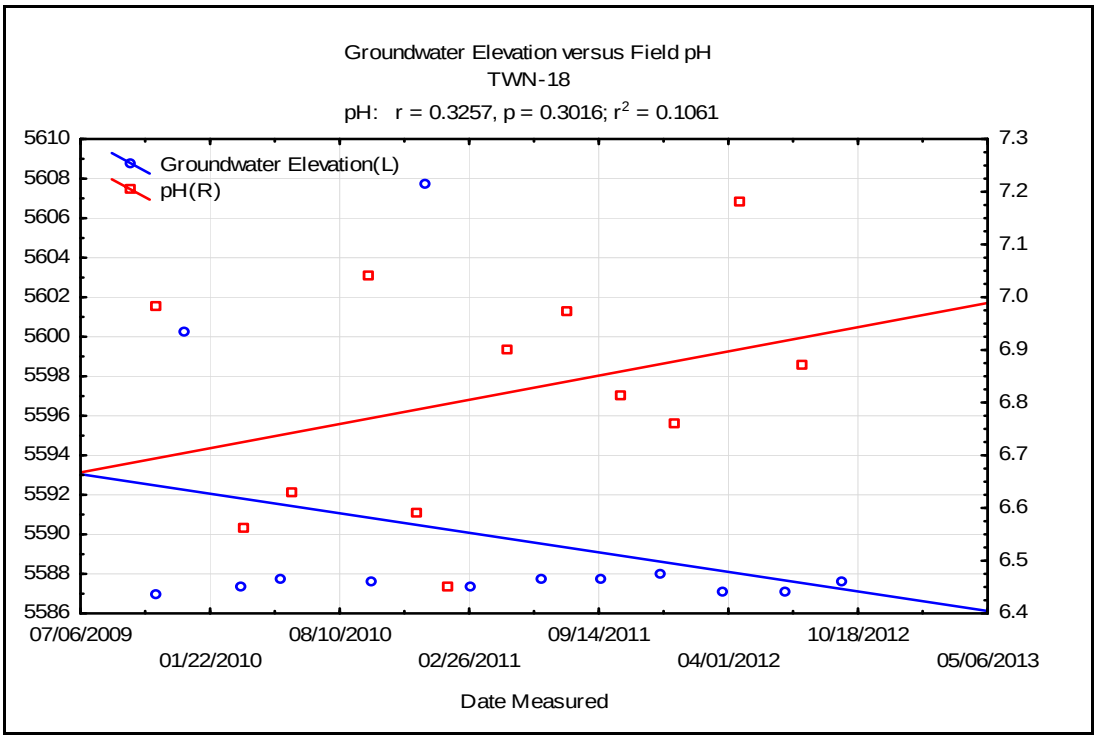

Groundwater Elevation versus Field pH
TWN-13
pH: r = 0.3355, p = 0.2864; r2 = 0.1126
5588.6
5588.4
5588.2
5588.0
5587.8
5587.6
5587.4
5587.2
5587.0
5586.8
8.1
8.0
7.9
7.8
7.7
7.6
7.5
7.4
7.3
7.2
Groundwater Elevation(L)
pH(R)
12/18/2008
01/22/2010
02/26/2011
04/01/2012
05/06/2013
Date Measured

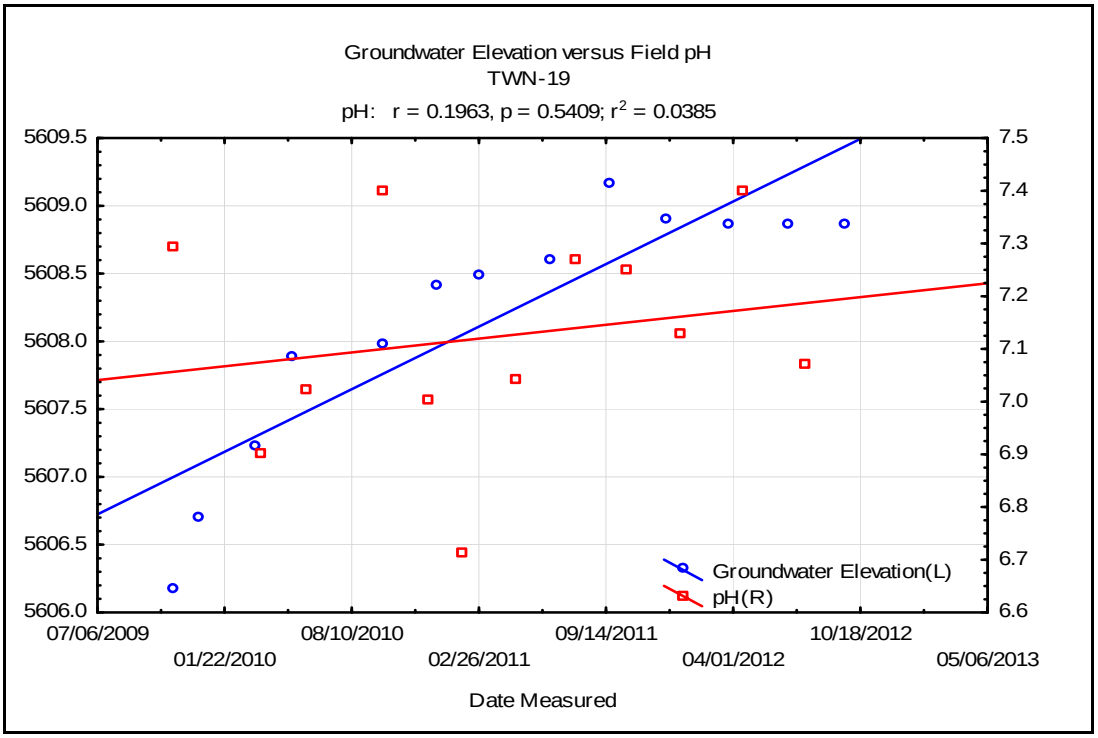

Groundwater Elevation versus Field pH
TWN-14
pH: r = 0.4370, p = 0.1555; r2 = 0.1909
Groundwater Elevation(L)
pH(R)
5587.2
5587.0
5586.8
5586.6
5586.4
5586.2
5586.0
8.0
7.9
7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured


Groundwater Elevation versus Field pH
TWN-15
pH: r = 0.4760, p = 0.1178; r2 = 0.2266
Groundwater Elevation(L)
pH(R)
5596
5594
5592
5590
5588
5586
5584
5582
7.5
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured


Groundwater Elevation versus Field pH
TWN-16
pH: r = 0.0960, p = 0.7666; r2 = 0.0092
Groundwater Elevation(L)
pH(R)
5605.2
5605.0
5604.8
5604.6
5604.4
5604.2
5604.0
5603.8
5603.6
5603.4
5603.2
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured


Groundwater Elevation versus Field pH
TWN-17
pH: r = 0.0902, p = 0.7803; r2 = 0.0081
5608.0
5607.8
5607.6
5607.4
5607.2
5607.0
5606.8
5606.6
5606.4
5606.2
5606.0
5605.8
8.0
7.8
7.6
7.4
7.2
7.0
6.8
Groundwater Elevation(L)
pH(R)
07/06/2009
08/10/2010
09/14/2011
10/18/2012
Date Measured


Groundwater Elevation versus Field pH
TWN-18
pH: r = 0.3257, p = 0.3016; r2 = 0.1061
Groundwater Elevation(L)
pH(R)
5610
5608
5606
5604
5602
5600
5598
5596
5594
5592
5590
5588
5586
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
6.5
6.4
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured


Groundwater Elevation versus Field pH
TWN-19
pH: r = 0.1963, p = 0.5409; r2 = 0.0385
5609.5
5609.0
5608.5
5608.0
5607.5
5607.0
5606.5
5606.0
7.5
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
Groundwater Elevation(L)
pH(R)
07/06/2009
01/22/2010
08/10/2010
02/26/2011
09/14/2011
04/01/2012
10/18/2012
05/06/2013
Date Measured

APPENDIX D

Indicator Parameter Analysis for Wells with Out-of-Compliance Status or Statistically Significant Decreasing Trends in Field pH

APPENDIX D-1

Indicator Parameter Summary Table

Appendix D-1 Indicator Parameter Analysis Summary Table for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Parameter	N	Mean	Shapiro Wilks Test for Normality[a]			Least Squares Regression Trend Analysis[b]		Mann-Kendall Trend Analysis[c]		Significant Trend
				W	P	Normally or Lognormally Distributed?	R^2	p	S	p	
MW-03	Chloride	84	64.78	0.951985	0.003627	No			-642	0.00565	Decreasing
MW-03	Fluoride	44	0.54	0.878543	0.000254	No			497	2.57E-07	Increasing
MW-03	Sulfate	90	3091.67	0.8724	0	No			1055	0.0001194	Increasing
MW-03	Uranium	85	22.93	0.914540	0.000032	No			708	7.54E-04	Increasing
MW-03A	Chloride	19	59.16	0.831107	0.003356	No			-28	0.171	None
MW-03A	Fluoride	19	1.24	0.9505	0.4022	Yes	0.095334	0.198376			None
MW-03A	Sulfate	23	3583.48	0.956940	0.404451	Yes	0.075173	0.205511			None
MW-03A	Uranium	19	20.53	0.9358	0.2449	Yes	0.235296	0.035283			Decreasing
MW-05	Chloride	123	52.49	0.973761	0.016807	No			-1344	0.00164	Decreasing
MW-05	Fluoride	44	0.88	0.8447	0.00003	No			280	0.00235	Increasing
MW-05	Sulfate	90	1133.28	0.9761	0.0956	Yes	0.008872	0.377201			Decreasing
MW-05	Uranium	87	0.95	0.931516	0.000186	No			-865	3.75E-04	Decreasing
MW-11	Chloride	121	32.37	0.157212	0.000000	No			-801	0.0362	Decreasing
MW-11	Fluoride	35	0.54	0.911485	0.008169	No			-98	0.0833	None
MW-11	Sulfate	87	1038.97	0.9666	0.0238	No			2015	7.516E-14	Increasing
MW-11	Uranium	104	0.74	0.586407	0.000000	No			-174	0.303	None
MW-12	Chloride	100	59.49	0.904525	0.000003	No			-1321	3.25E-05	Decreasing
MW-12	Fluoride	20	0.28	0.924357	0.120215	Yes	0.179192	0.062920			Decreasing
MW-12	Sulfate	71	2320.23	0.9551	0.0126	No			-539	0.00378	Decreasing
MW-12	Uranium	97	15.49	0.7322	0	No			2066	5.952E-11	Increasing

Appendix D-1 Indicator Parameter Analysis Summary Table for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Parameter	N	Mean	Shapiro Wilks Test for Normality[a]			Least Squares Regression Trend Analysis[b]		Mann-Kendall Trend Analysis[c]		Significant Trend
				W	P	Normally or Lognormally Distributed?	R^2	p	S	p	
MW-14	Chloride	95	19.81	0.9616	0.007	No			-1248	2.85E-05	Decreasing
MW-14	Fluoride	35	0.17	0.8695	0.0007	No			-254	1.24E-04	Decreasing
MW-14	Sulfate	64	2139.00	0.9247	0.0008	No			222	0.1	None
MW-14	Uranium	122	61.07	0.8426	0	No			1099	0.00755	Increasing
MW-15	Chloride	84	40.71	0.9245	0.0001	No			-259	0.158	None
MW-15	Fluoride	18	0.25	0.8707	0.0183	No			-81	9.45E-04	Decreasing
MW-15	Sulfate	50	2305.00	0.9403	0.0139	No			-3	0.493	None
MW-15	Uranium	86	43.91	0.9592	0.0083	No			821	0.00111	Increasing
MW-17	Chloride	64	31.03	0.9116	0.0002	No			40	0.411	None
MW-17	Fluoride	20	0.29	0.8232	0.002	No			-81	0.00404	Decreasing
MW-17	Sulfate	30	2489.00	0.9322	0.0562	Yes					None
MW-17	Uranium	65	28.87	0.818	0	No			-68	0.352	None
MW-18	Chloride	27	46.87	0.937094	0.103303	Yes	0.191858	0.022304			Increasing
MW-18	Fluoride	20	0.25	0.504478	0.000000	No			-122	3.606E-05	Decreasing
MW-18	Sulfate	30	1668.47	0.8998	0.0083	No			255	2.887E-06	Increasing
MW-18	Uranium	33	33.23	0.704	0	No			292	3.259E-06	Increasing
MW-19	Chloride	30	48.54	0.8835	0.0034	No			-230	2.18E-05	Decreasing
MW-19	Fluoride	29	1.04	0.9448	0.1337	Yes	0.042841	0.281337			None
MW-19	Sulfate	29	1142.83	0.9534	0.224	Yes	0.486535	0.000026			Decreasing
MW-19	Uranium	33	9.66	0.9175	0.0156	No			-350	3.172E-08	Decreasing

Appendix D-1 Indicator Parameter Analysis Summary Table for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Parameter	N	Mean	Shapiro Wilks Test for Normality[a]			Least Squares Regression Trend Analysis[b]		Mann-Kendall Trend Analysis[c]		Significant Trend
				W	P	Normally or Lognormally Distributed?	R^2	p	S	p	
MW-22	Chloride	16	58.77	0.9288	0.2335	Yes					None
MW-22	Fluoride	14	2.99	0.918	0.2059	Yes					None
MW-22	Sulfate	16	5103.00	0.8367	0.0087	No			-11	0.326	None
MW-22	Uranium	16	52.40	0.8202	0.0051	No			-53	0.00955	Decreasing
MW-23	Chloride	24	6.78	0.5673	0	No			38	0.174	None
MW-23	Fluoride	22	0.25	0.8637	0.006	No			-90	0.00535	Decreasing
MW-23	Sulfate	24	2224.00	0.8708	0.0054	No			32	0.221	None
MW-23	Uranium	23	18.61	0.9386	0.1676	Yes					Decreasing
MW-24	Chloride	22	44.82	0.891355	0.020038	No			-39	0.137	None
MW-24	Fluoride	26	0.18	0.9512	0.2477	Yes	0.100989	0.113641			Decreasing
MW-24	Sulfate	26	2651.92	0.9787	0.845	Yes	0.020837	0.481722			None
MW-24	Uranium	24	2.97	0.9153	0.046	No			-77	0.0297	Decreasing
MW-25	Chloride	28	31.21	0.861340	0.001597	No			-117	0.0094	Decreasing
MW-25	Fluoride	29	0.33	0.9462	0.1459	Yes	0.076238	0.147097			None
MW-25	Sulfate	29	1692.76	0.9471	0.1535	Yes	0.093612	0.106494			None
MW-25	Uranium	41	6.11	0.982722	0.777429	Yes	0.167711	0.007840			Increasing
MW-26	Chloride	49	57.77	0.969850	0.238862	Yes	0.124006	0.013086			Increasing
MW-26	Fluoride	29	0.28	0.9391	0.0952	Yes	0.202891	0.014205			Decreasing
MW-26	Sulfate	31	1903.87	0.9056	0.01	No			41	0.248	None
MW-26	Uranium	83	38.52	0.961779	0.014478	No			1436	8.33E-09	Increasing

Appendix D-1 Indicator Parameter Analysis Summary Table for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Parameter	N	Mean	Shapiro Wilks Test for Normality[a]			Least Squares Regression Trend Analysis[b]		Mann-Kendall Trend Analysis[c]		Significant Trend
				W	P	Normally or Lognormally Distributed?	R^2	p	S	p	
MW-27	Chloride	27	39.37	0.936008	0.097123	Yes	0.856640	0.000000			Increasing
MW-27	Fluoride	25	0.72	0.9785	0.8543	Yes	0.350983	0.001806			Decreasing
MW-27	Sulfate	27	432.78	0.8964	0.0111	No			154	0.0007028	Increasing
MW-27	Uranium	23	30.59	0.9757	0.8214	Yes	0.412236	0.000957			Decreasing
MW-28	Chloride	29	99.07	0.9595	0.3193	Yes	0.583600	0.000001			Increasing
MW-28	Fluoride	26	0.61	0.964	0.4772	Yes	0.265954	0.007006			Decreasing
MW-28	Sulfate	23	2348.70	0.9156	0.0536	Yes	0.024868	0.472377			None
MW-28	Uranium	23	2.69	0.9048	0.0318	No			-39	1.57E-01	None
MW-30	Chloride	37	124.56	0.907222	0.004708	No			137	0.0368	Increasing
MW-30	Fluoride	29	0.36	0.9431	0.1206	Yes	0.026177	0.401753			None
MW-30	Sulfate	29	812.62	0.9846	0.937	Yes	0.799048	0.000000			Decreasing
MW-30	Uranium	31	6.99	0.935229	0.060949	Yes	0.094116	0.093219			None
MW-31	Chloride	37	137.50	0.970404	0.419417	Yes	0.367596	0.000070			None
MW-31	Fluoride	27	0.88	0.9816	0.8971	Yes	0.228389	0.011696			Decreasing
MW-31	Sulfate	39	517.33	0.883904	0.000787	No			274	4.73E-04	Increasing
MW-31	Uranium	28	7.26	0.9494	0.1919	Yes	0.021673	0.454716			None
MW-32	Chloride	25	31.80	0.8585	0.0026	No			-35	0.21	None
MW-32	Fluoride	24	0.20	0.9362	0.1338	Yes					None
MW-32	Sulfate	26	2336.00	0.8094	0.0003	No			1	0.5	None
MW-32	Uranium	26	2.58	0.7845	0.0001	No			-68	0.698	None

Appendix D-1 Indicator Parameter Analysis Summary Table for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Parameter	N	Mean	Shapiro Wilks Test for Normality[a]			Least Squares Regression Trend Analysis[b]		Mann-Kendall Trend Analysis[c]		Significant Trend
				W	P	Normally or Lognormally Distributed?	R^2	p	S	p	
MW-35	Chloride	7	61.571	0.779212	0.025361	No	0.040405	0.633134			None
MW-35	Fluoride	8	0.370	0.959394	0.804309	Yes	0.249516	0.253704			None
MW-35	Sulfate	7	2307.143	0.918085	0.454660	Yes					None
MW-35	Uranium	17	22.829	0.897873	0.062587	Yes	0.000012	0.989343			None

Notes:

S.U. = standard units
N/A = not applicable
W = Shapiro Wilk test value
N = number of valid data points
p = probability
R2 = The measure of how well the trendline fits the data where r2=1 represents a perfect fit.
S = MannKendall statistic

a = The Shapiro-Wilk Distribution test was performed on all data

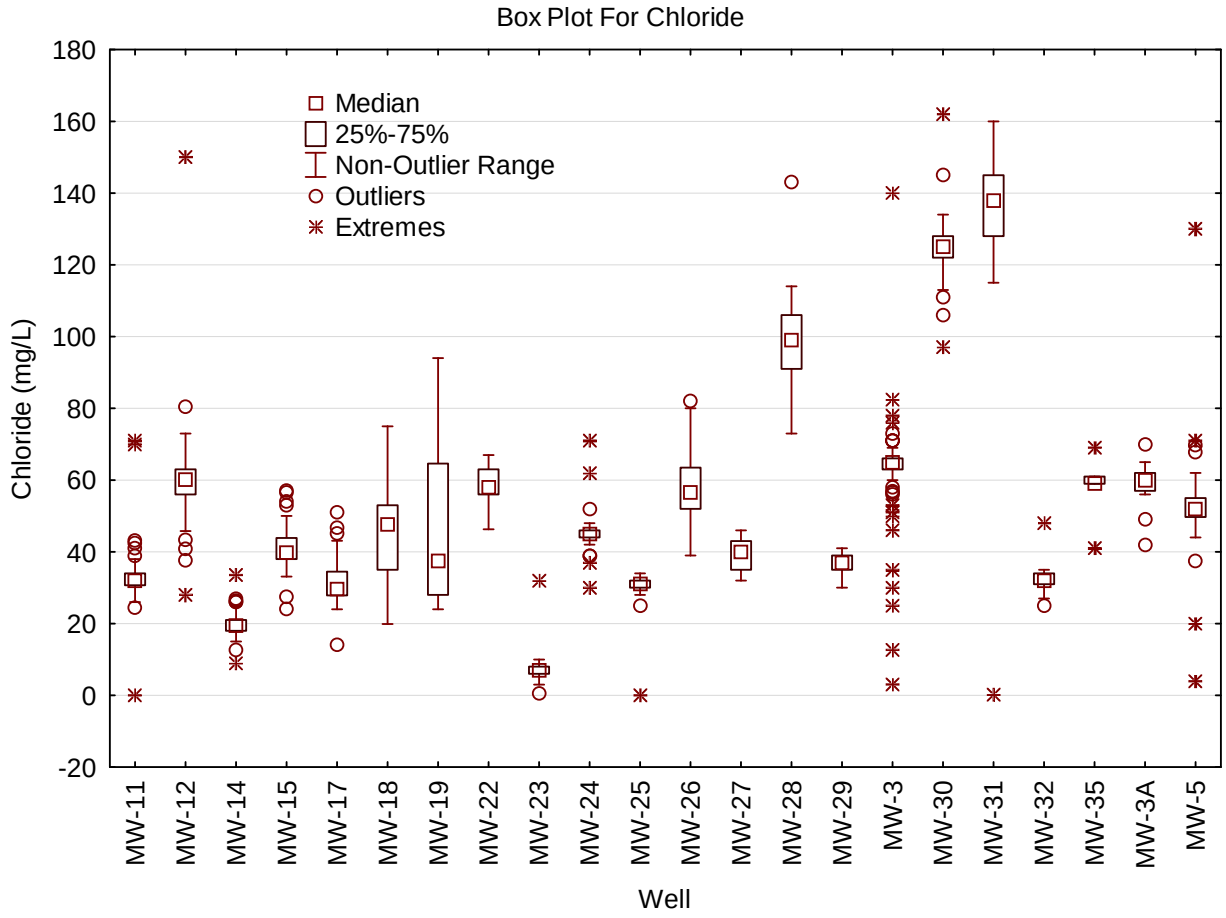
b = A regression test was performed on data that was determined to have either a normal or log-normal distributionfor non-detected values

c = The Mann-Kendall test was performed on data that was not normally or lognormally distributed

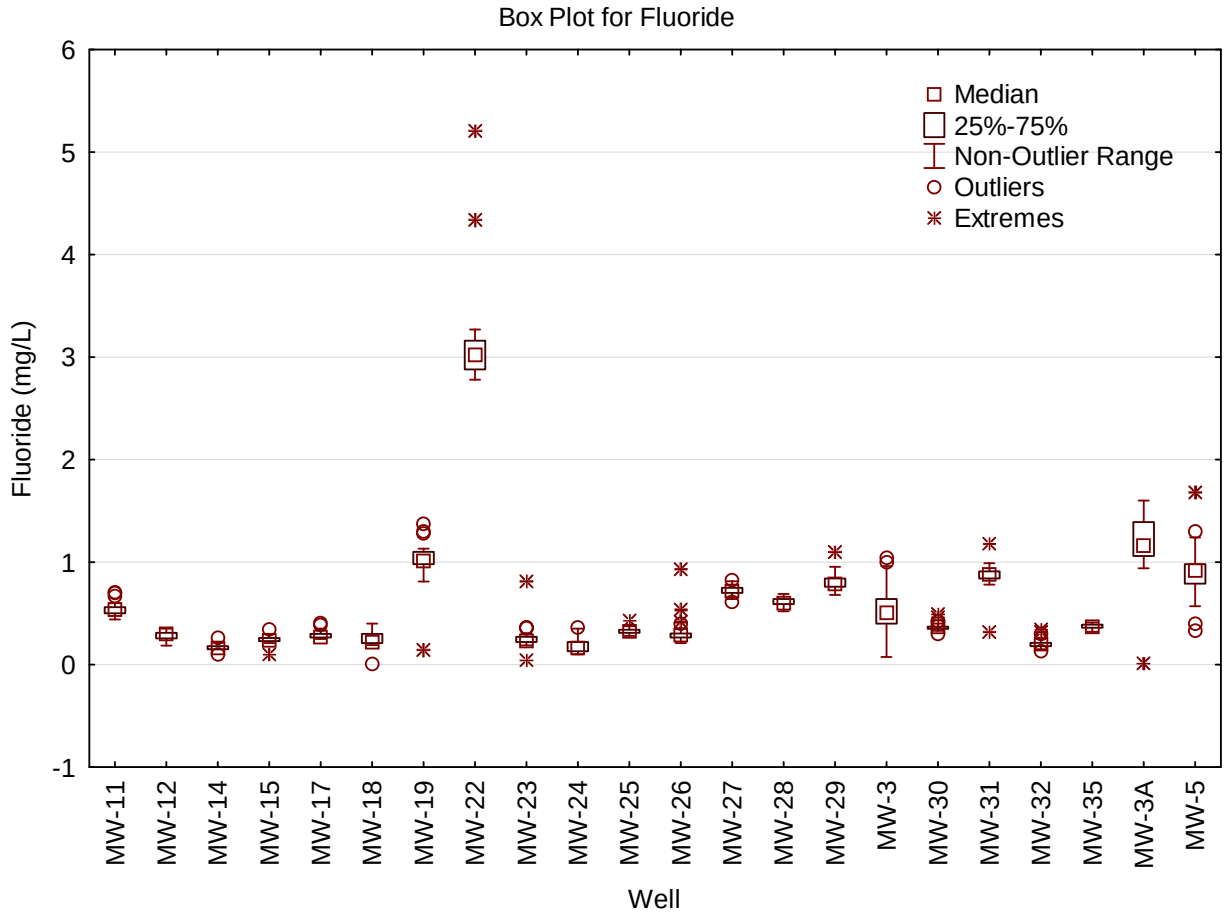
APPENDIX D-2

Box Plots for Indicator Parameters

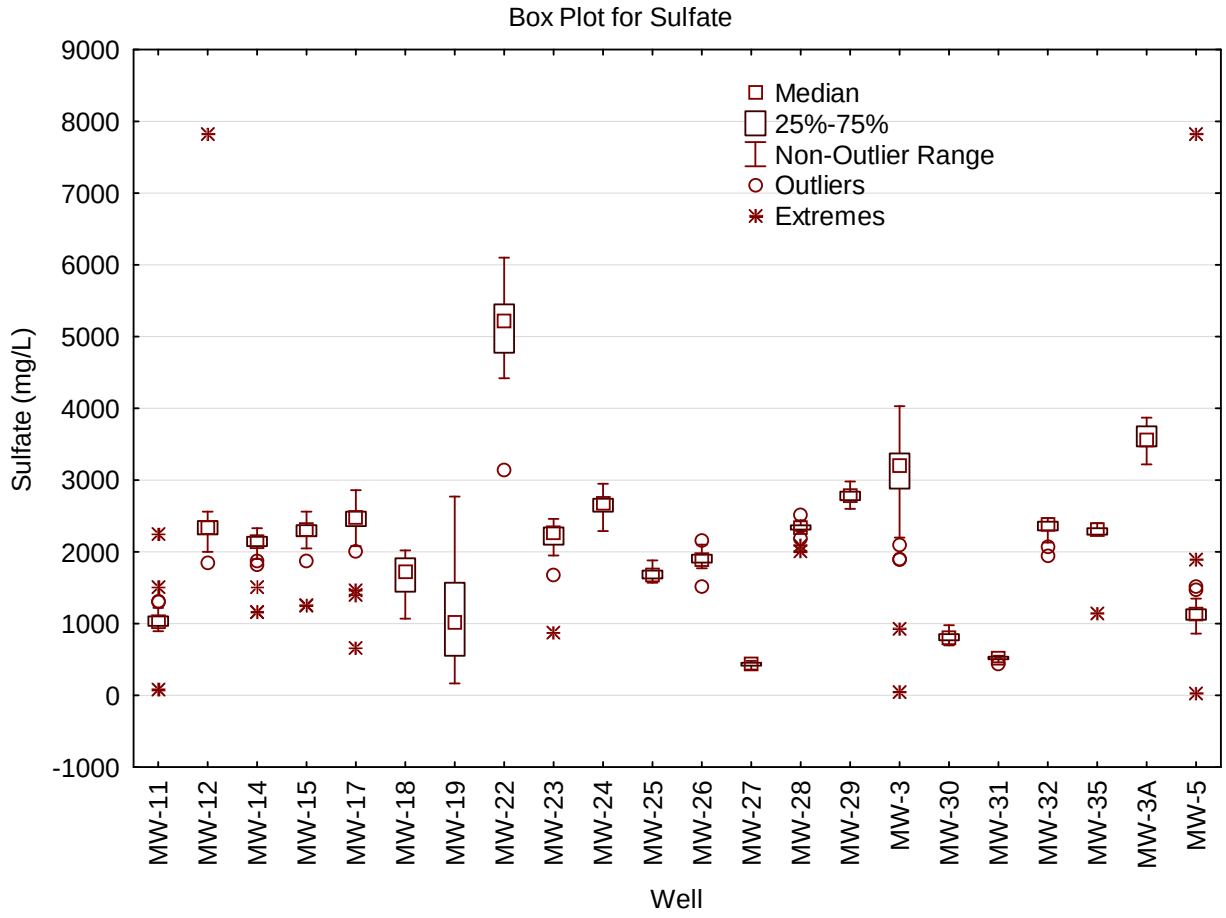
Appendix D-2
Box Plots for Indicator Parameters



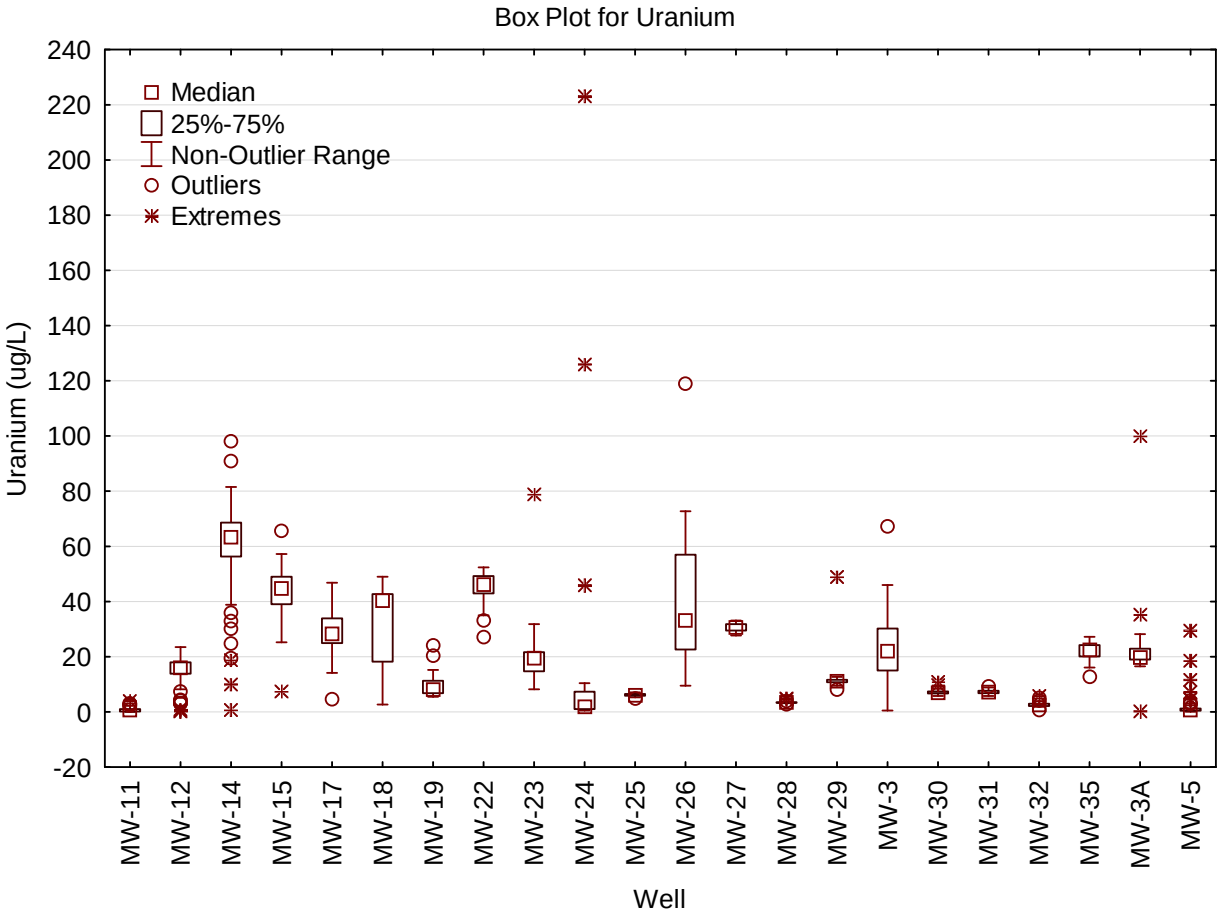
Appendix D-2
Box Plots for Indicator Parameters



Appendix D-2
Box Plots for Indicator Parameters



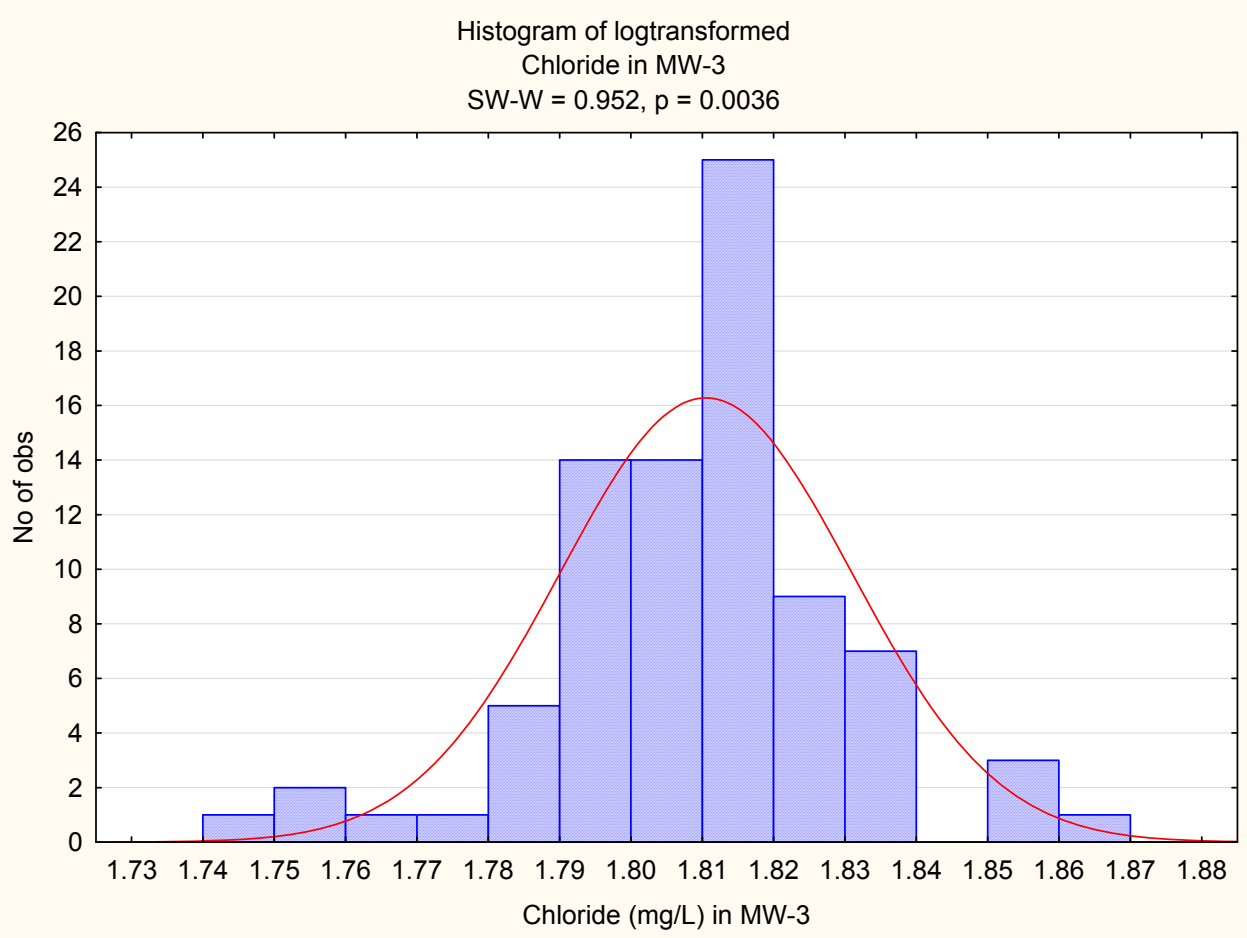
Appendix D-2
Box Plots for Indicator Parameters



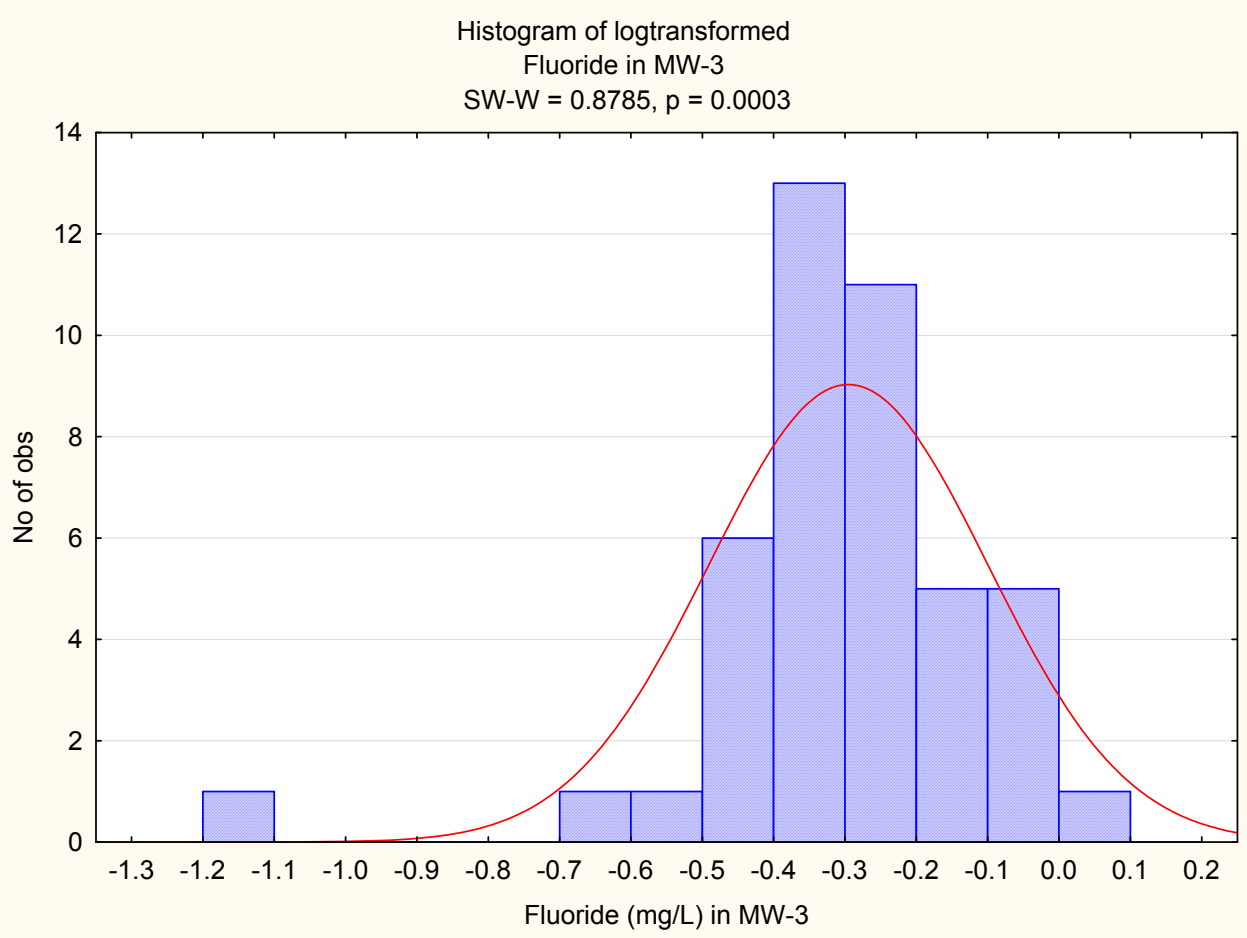
APPENDIX D-3

Histograms for Indicator Parameters

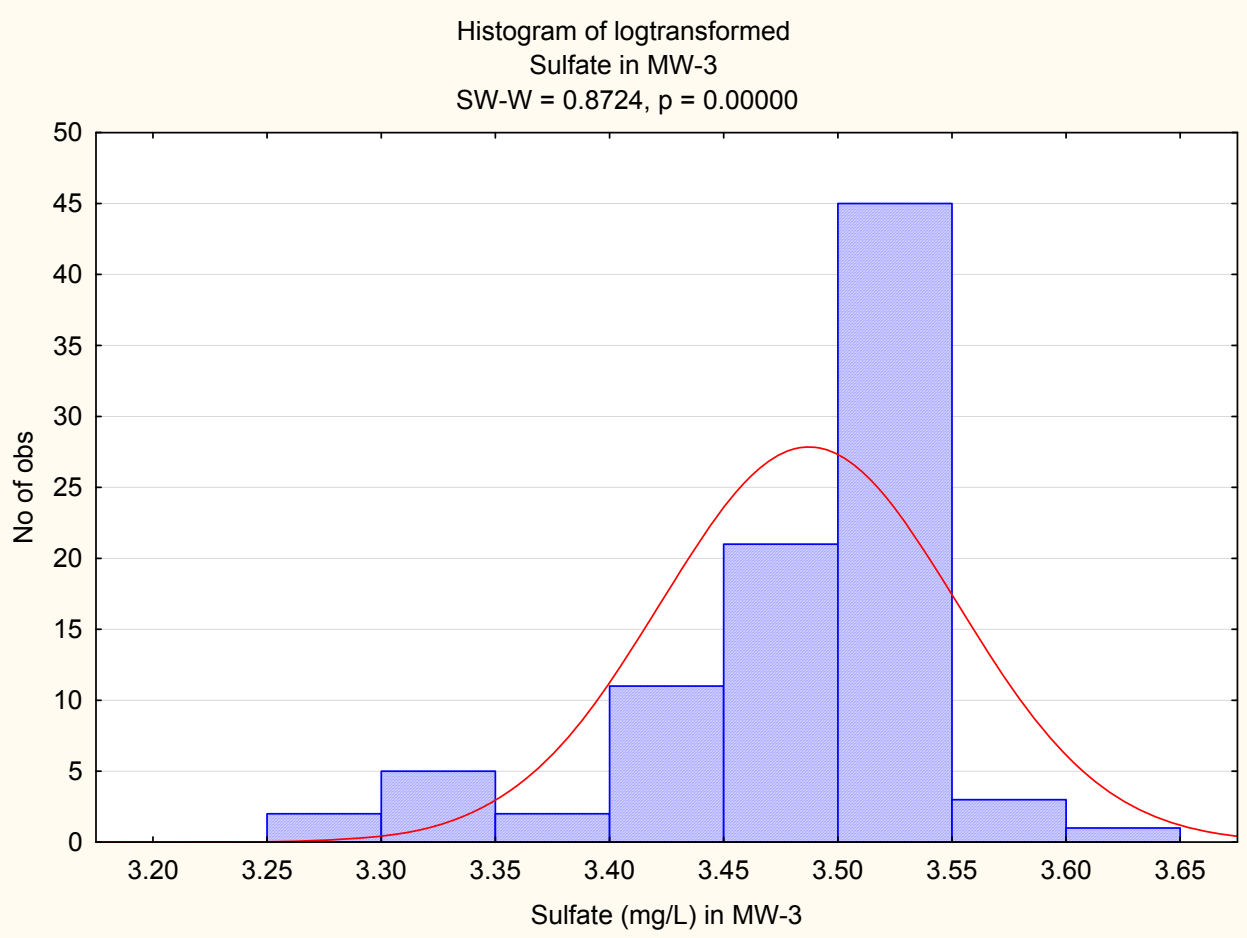
Appendix D-3
Histograms for Indicator Parameters



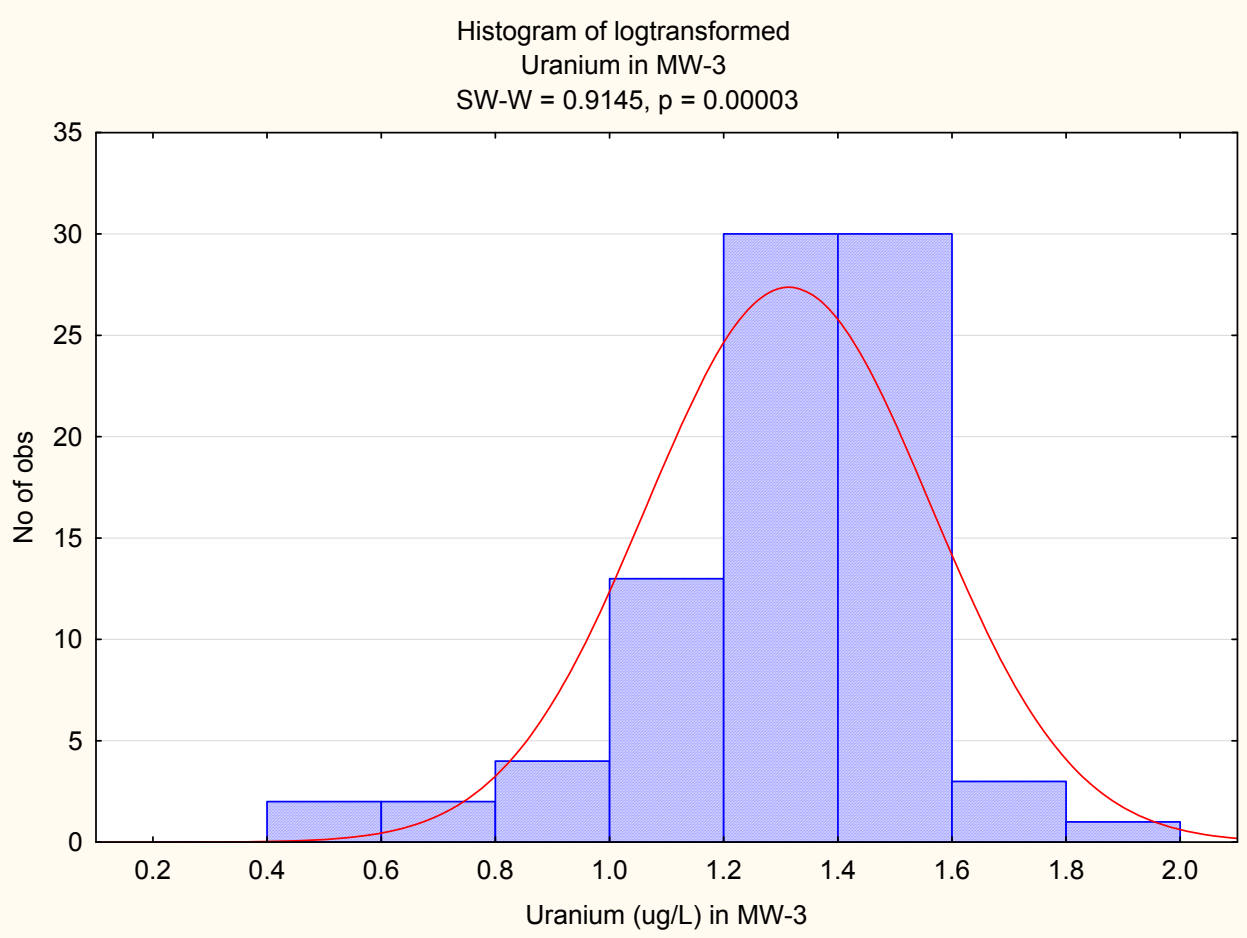
Appendix D-3
Histograms for Indicator Parameters



Appendix D-3
Histograms for Indicator Parameters



Appendix D-3
Histograms for Indicator Parameters



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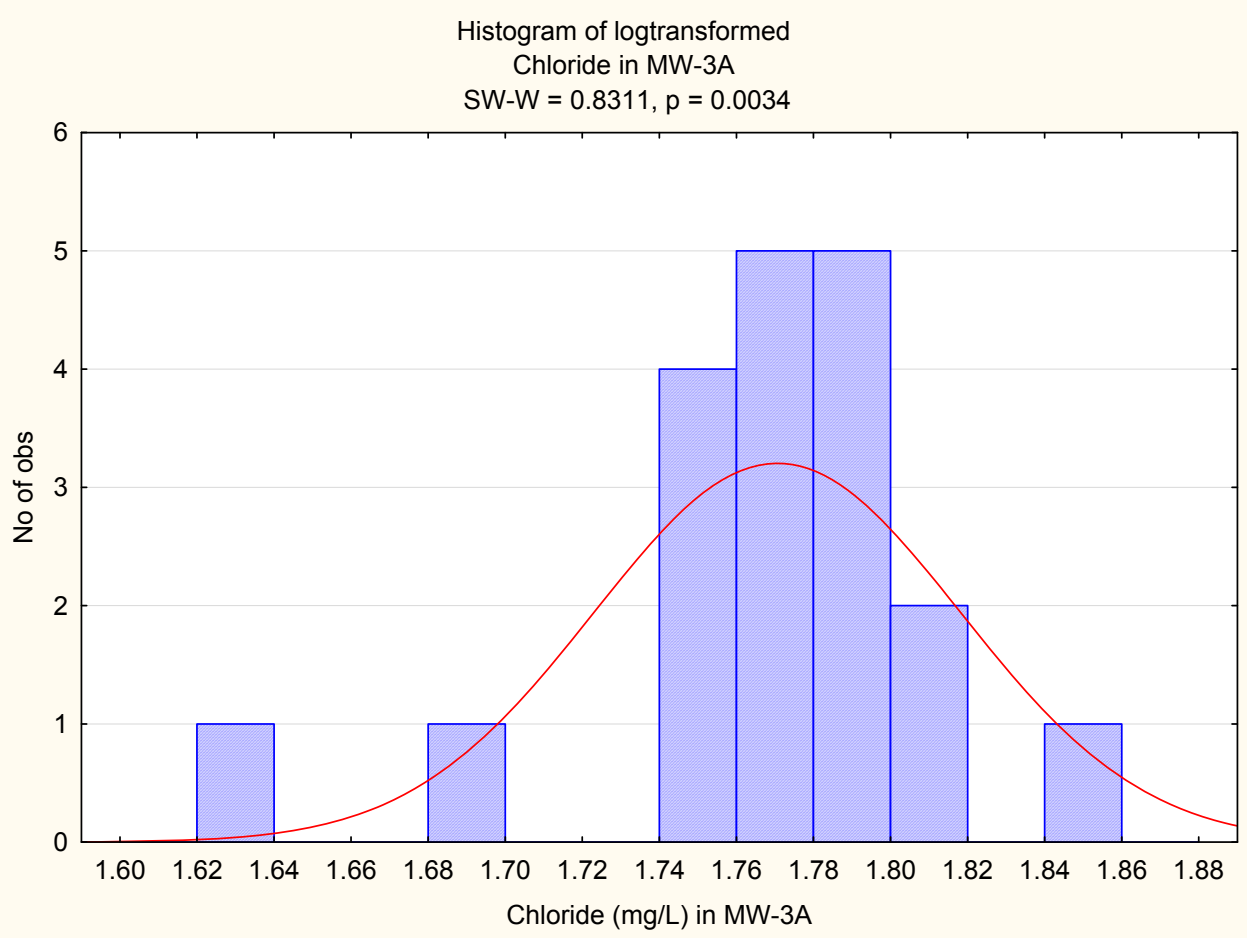
Histograms for Indicator Parameters



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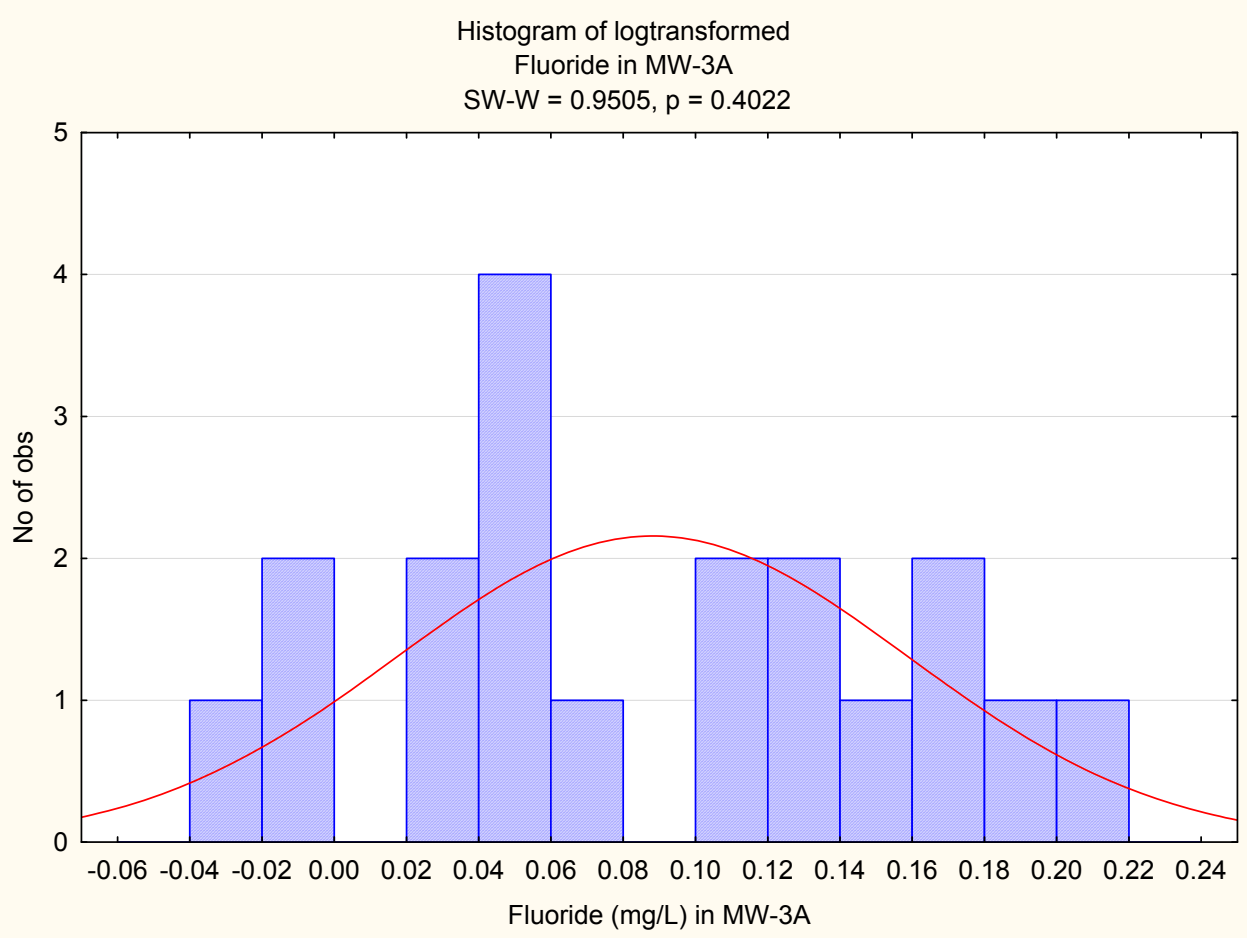
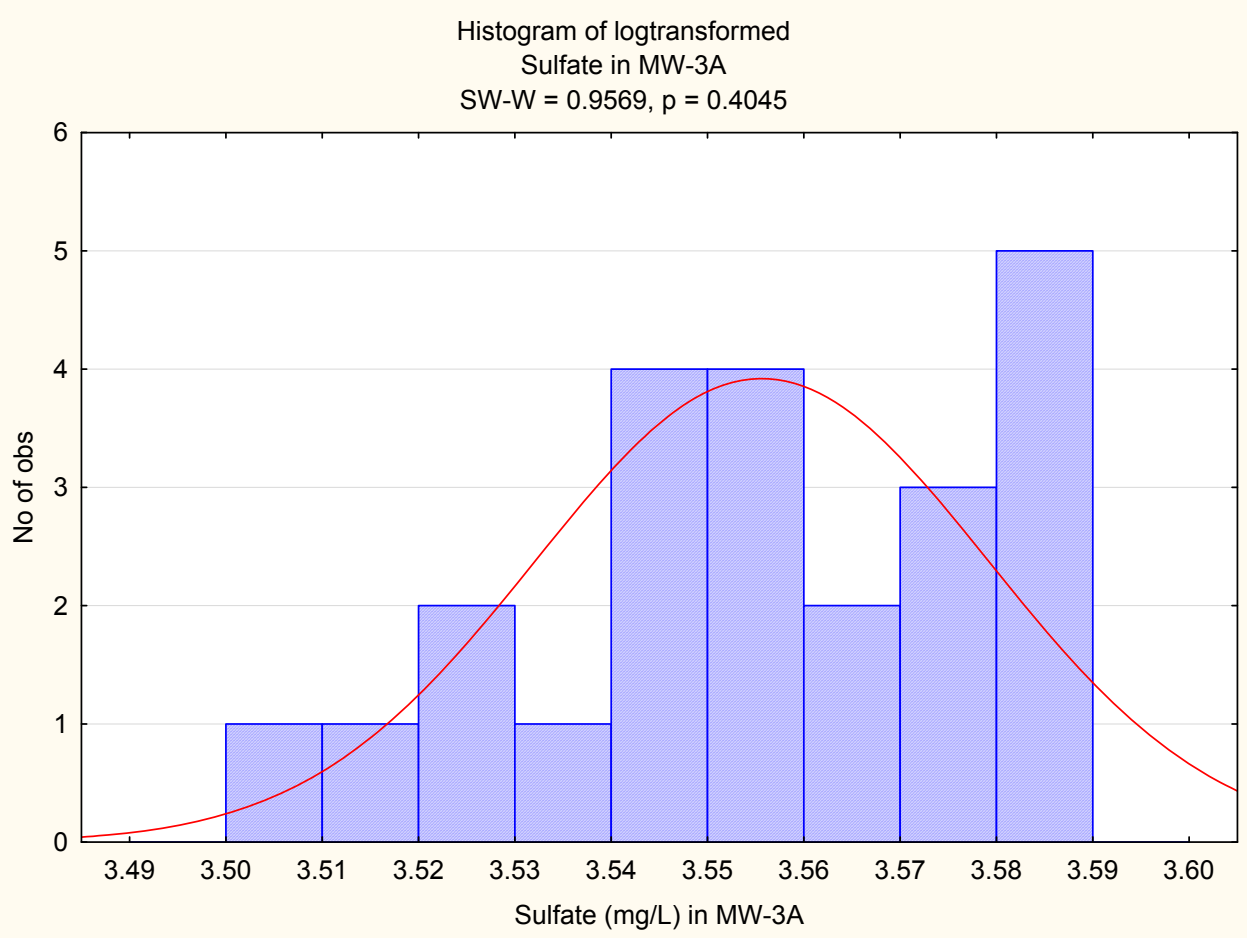
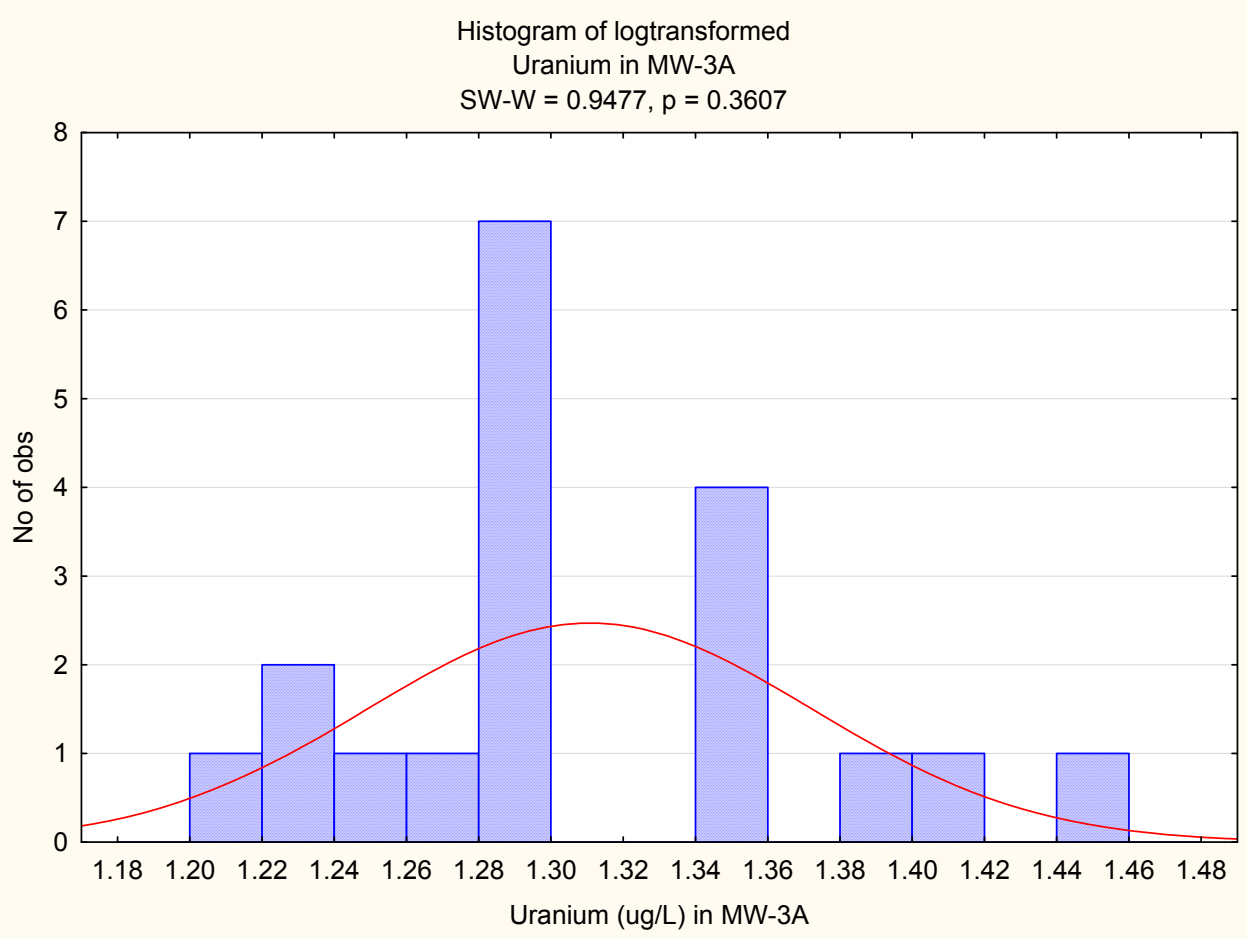
Histograms for Indicator Parameters



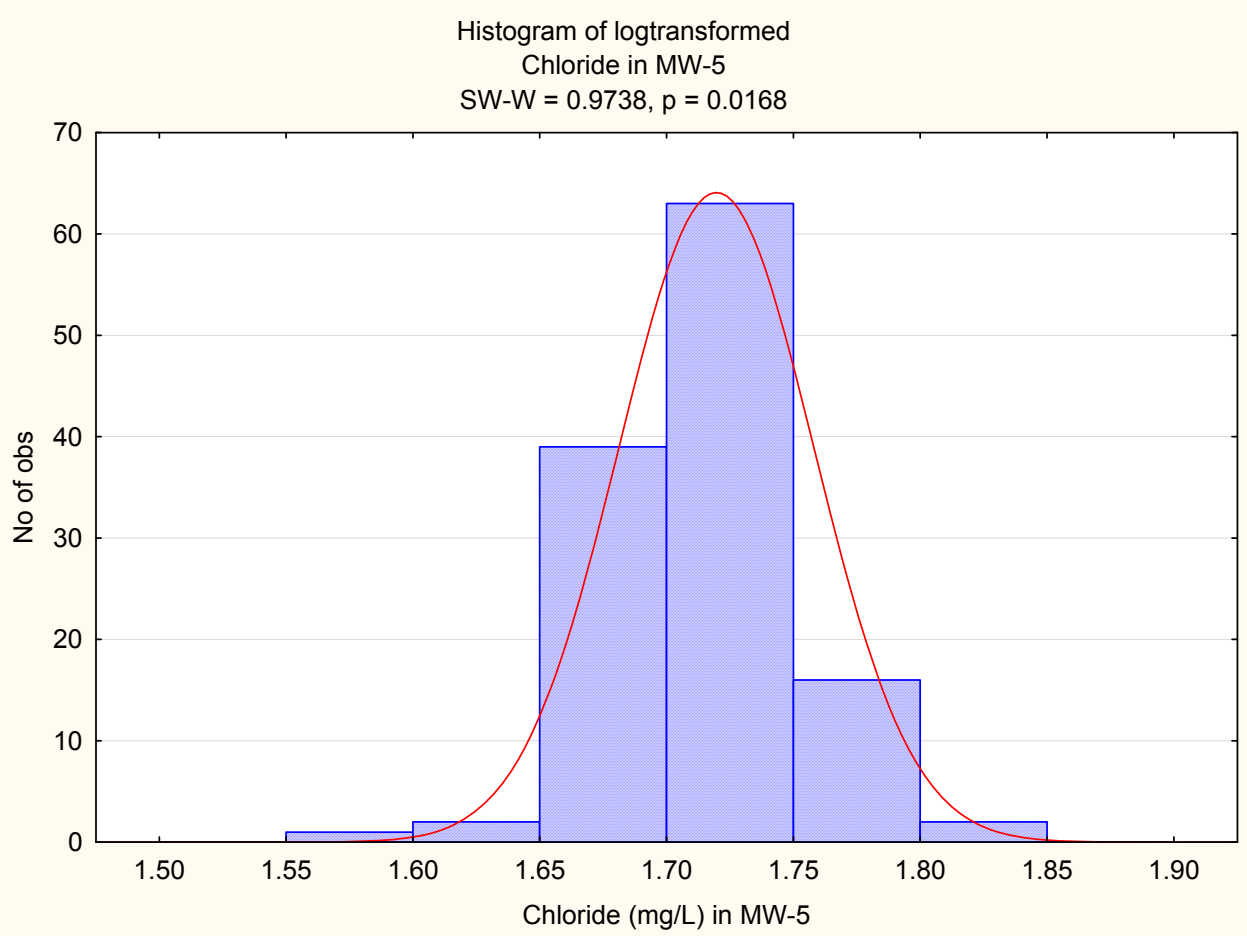
Appendix D-3
Histograms for Indicator Parameters



Appendix D-3
Histograms for Indicator Parameters



Appendix D-3
Histograms for Indicator Parameters



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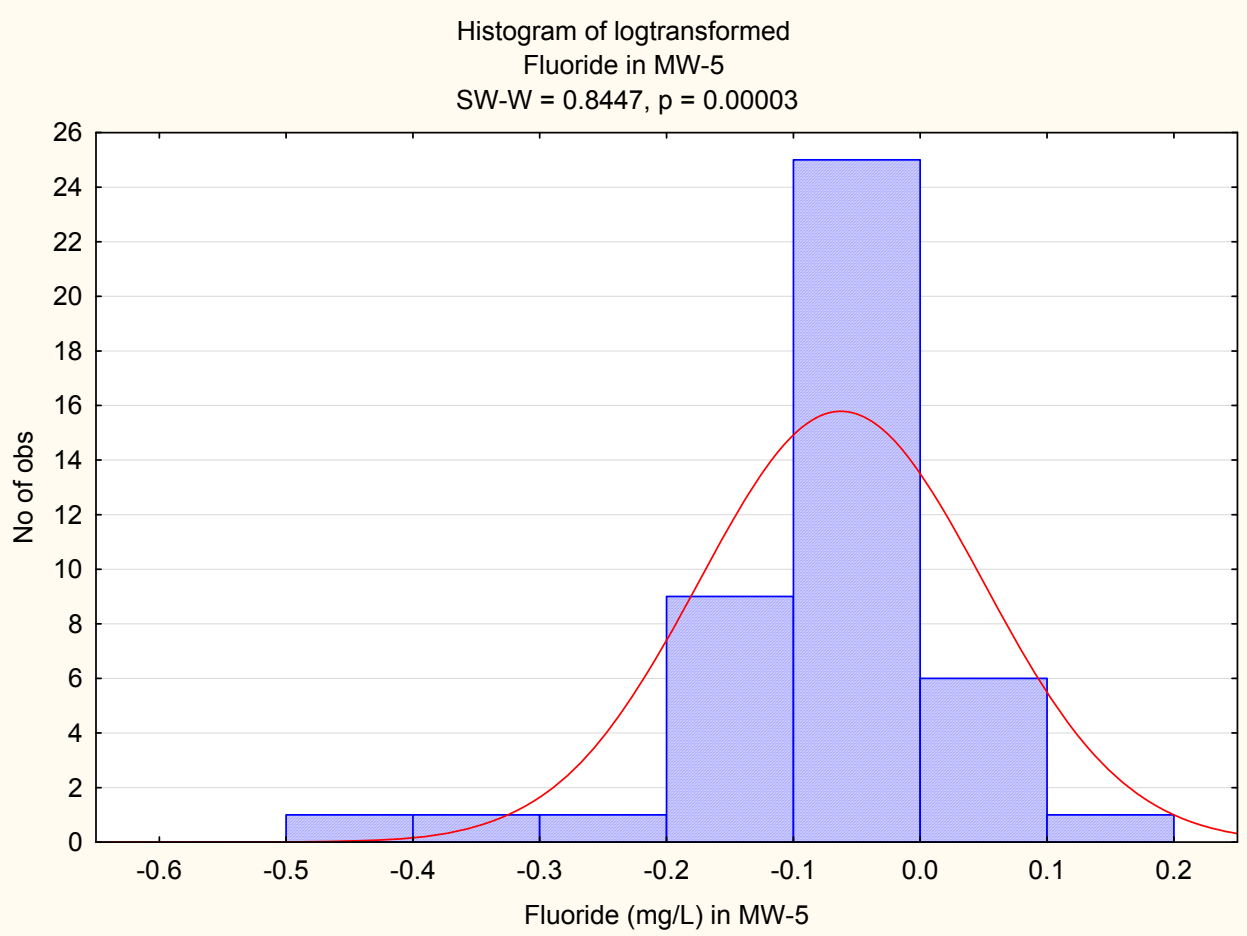
Histograms for Indicator Parameters



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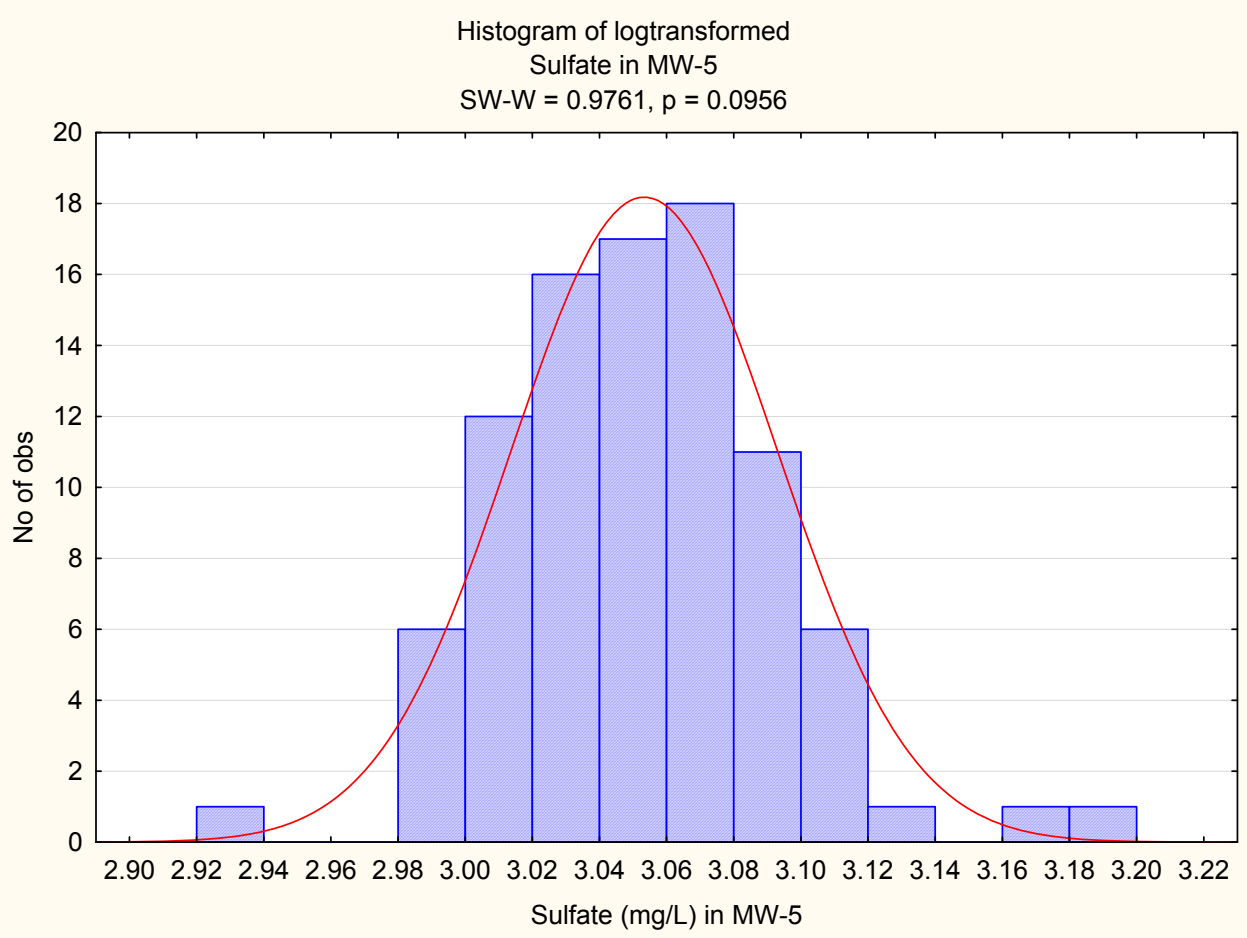
Histograms for Indicator Parameters



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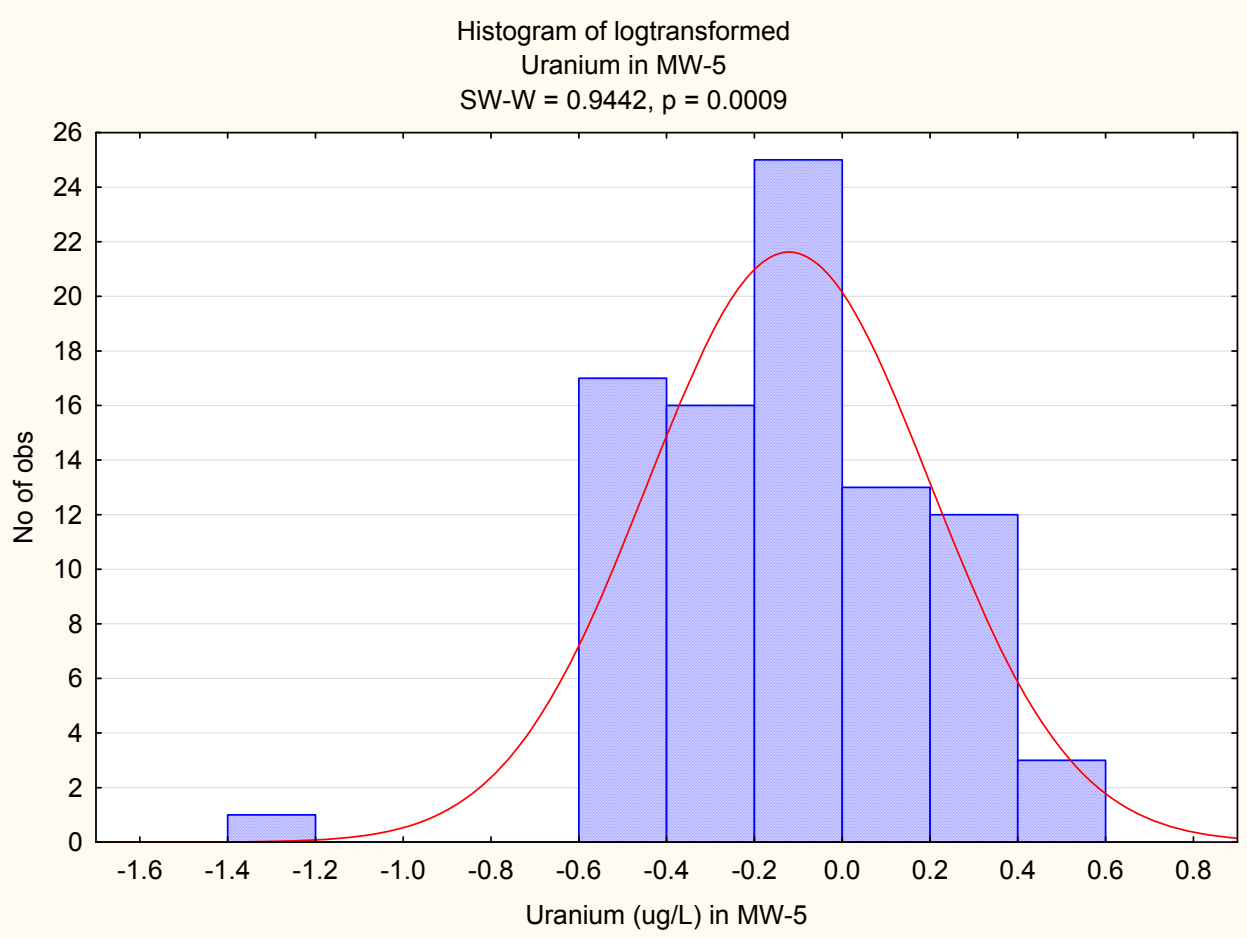
Histograms for Indicator Parameters



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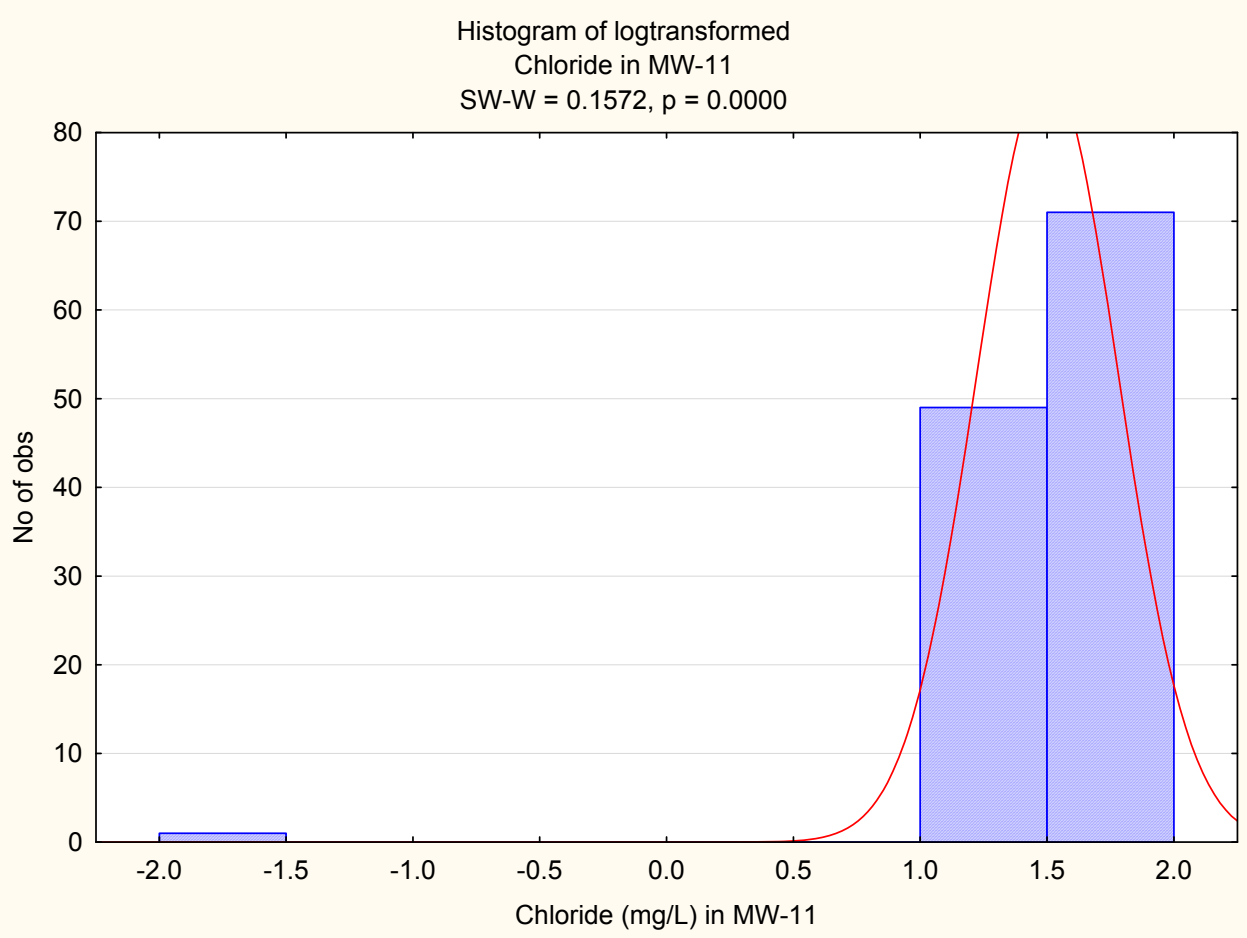
Histograms for Indicator Parameters



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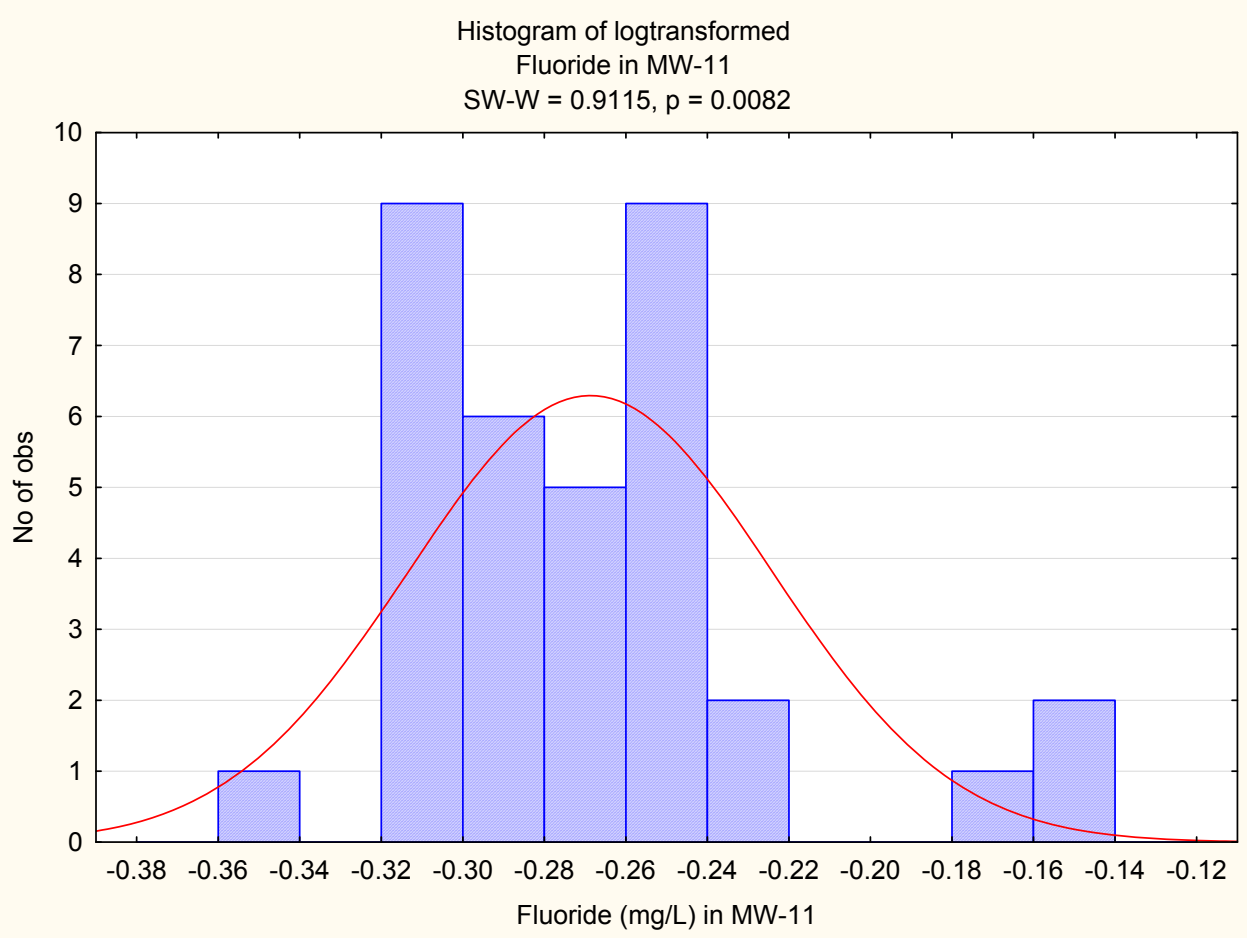
Histograms for Indicator Parameters



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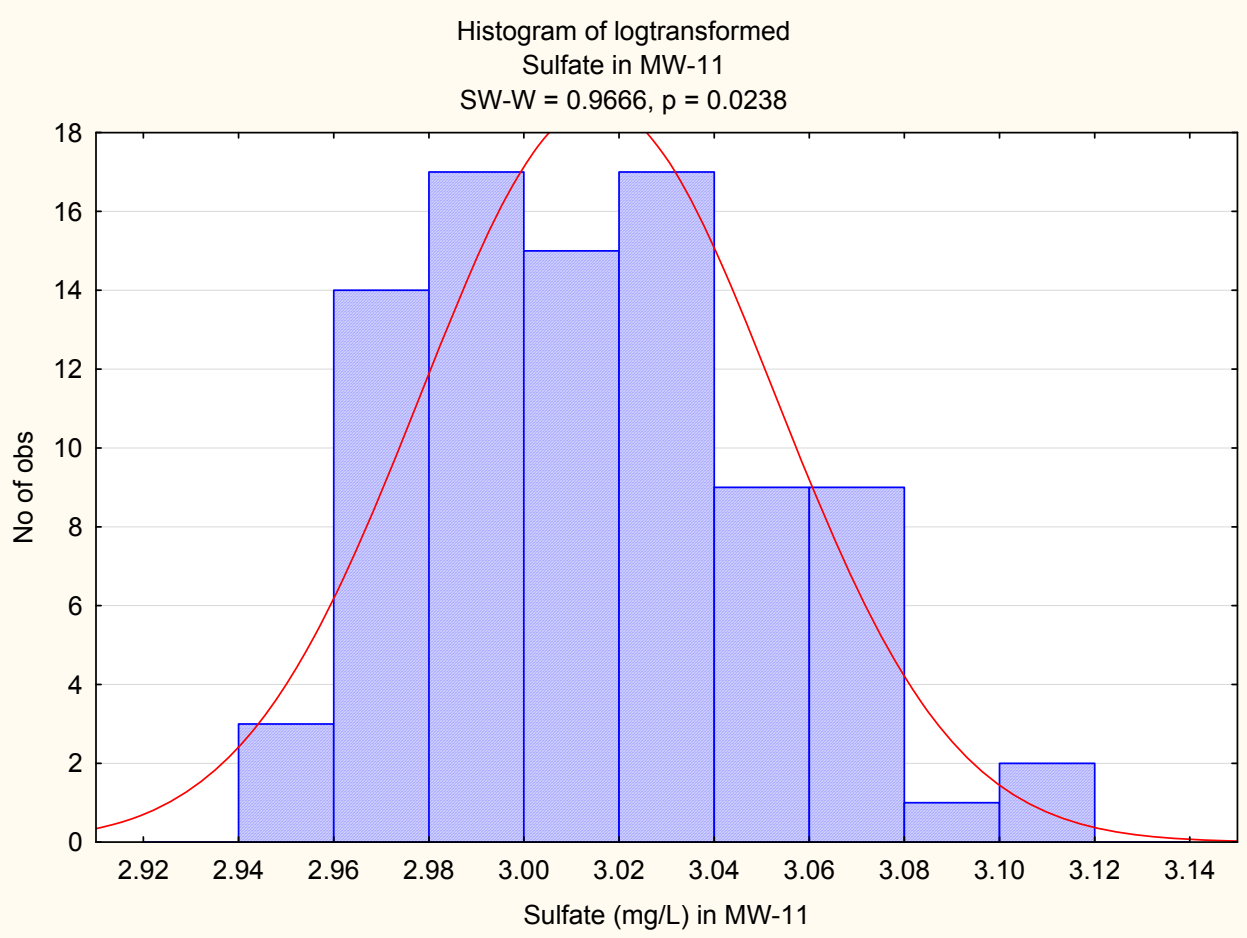
Histograms for Indicator Parameters



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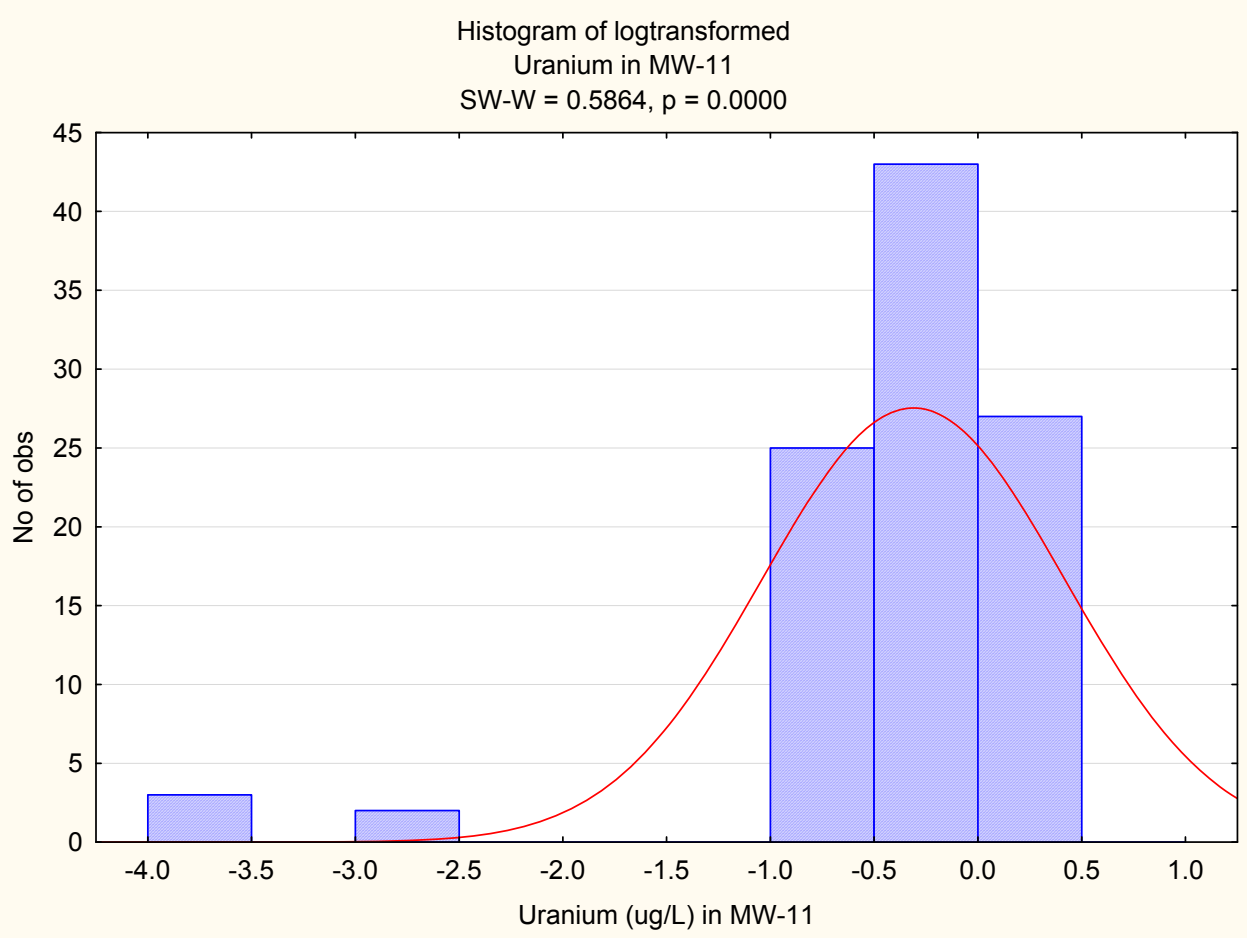
Histograms for Indicator Parameters



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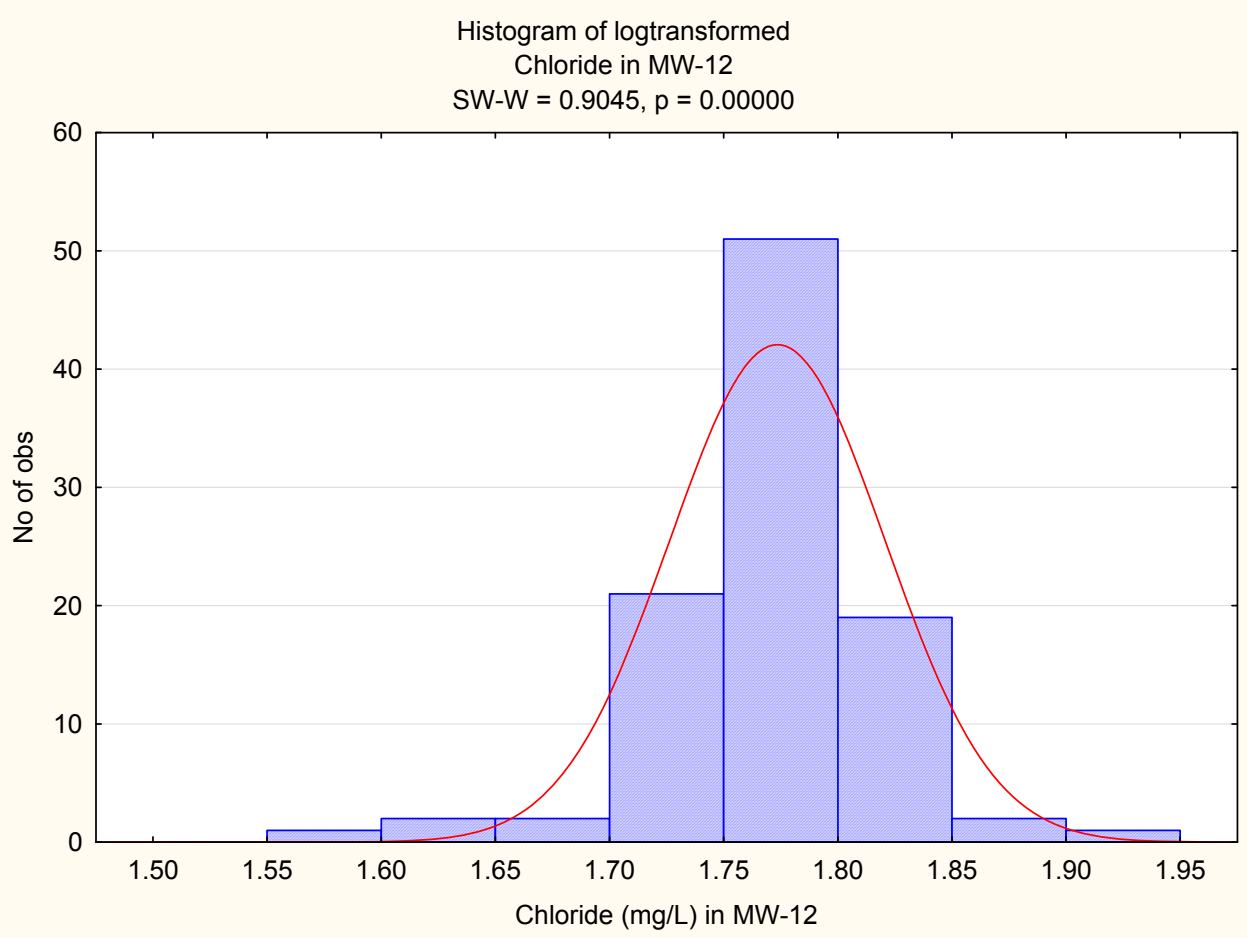

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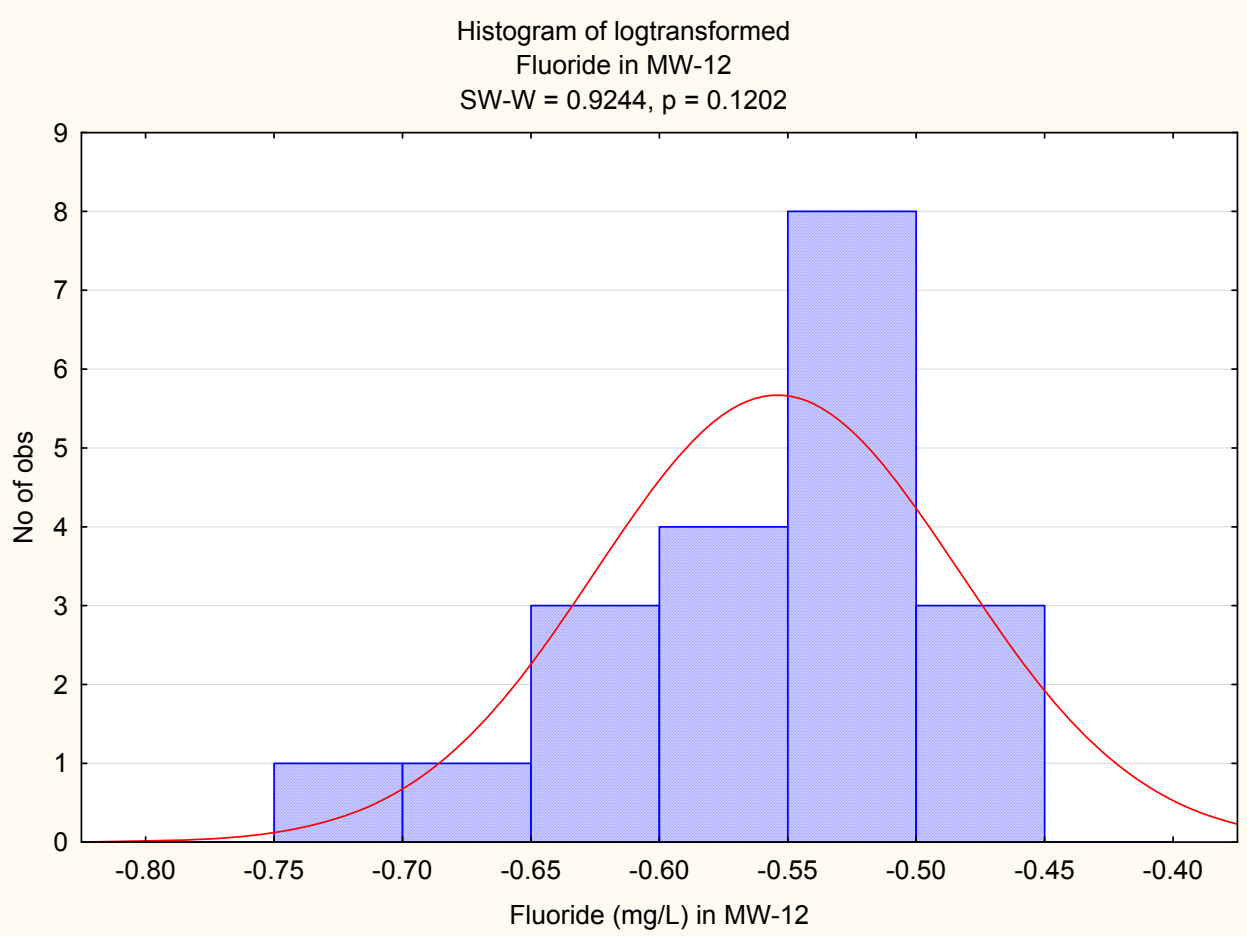
Histograms for Indicator Parameters



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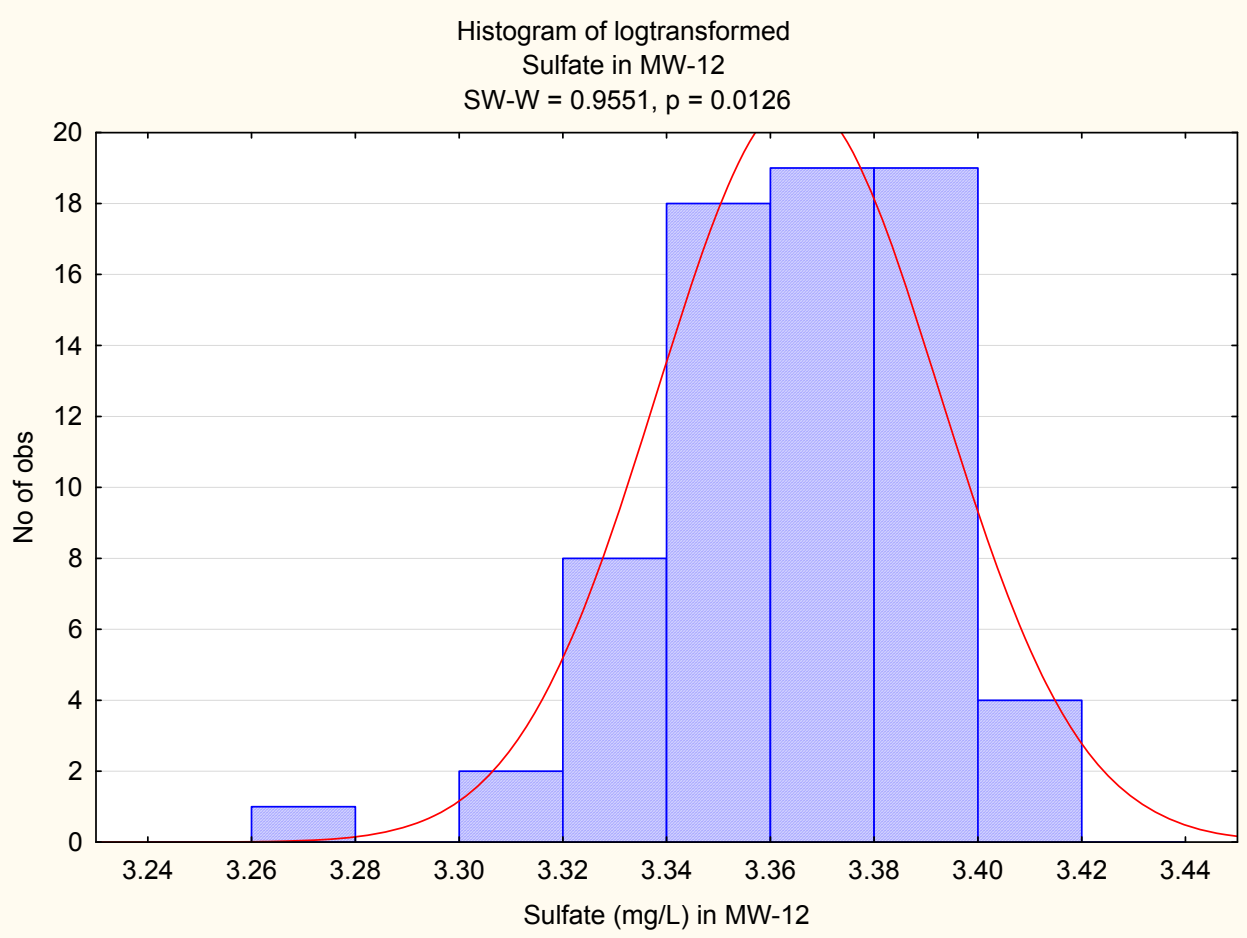
Histograms for Indicator Parameters



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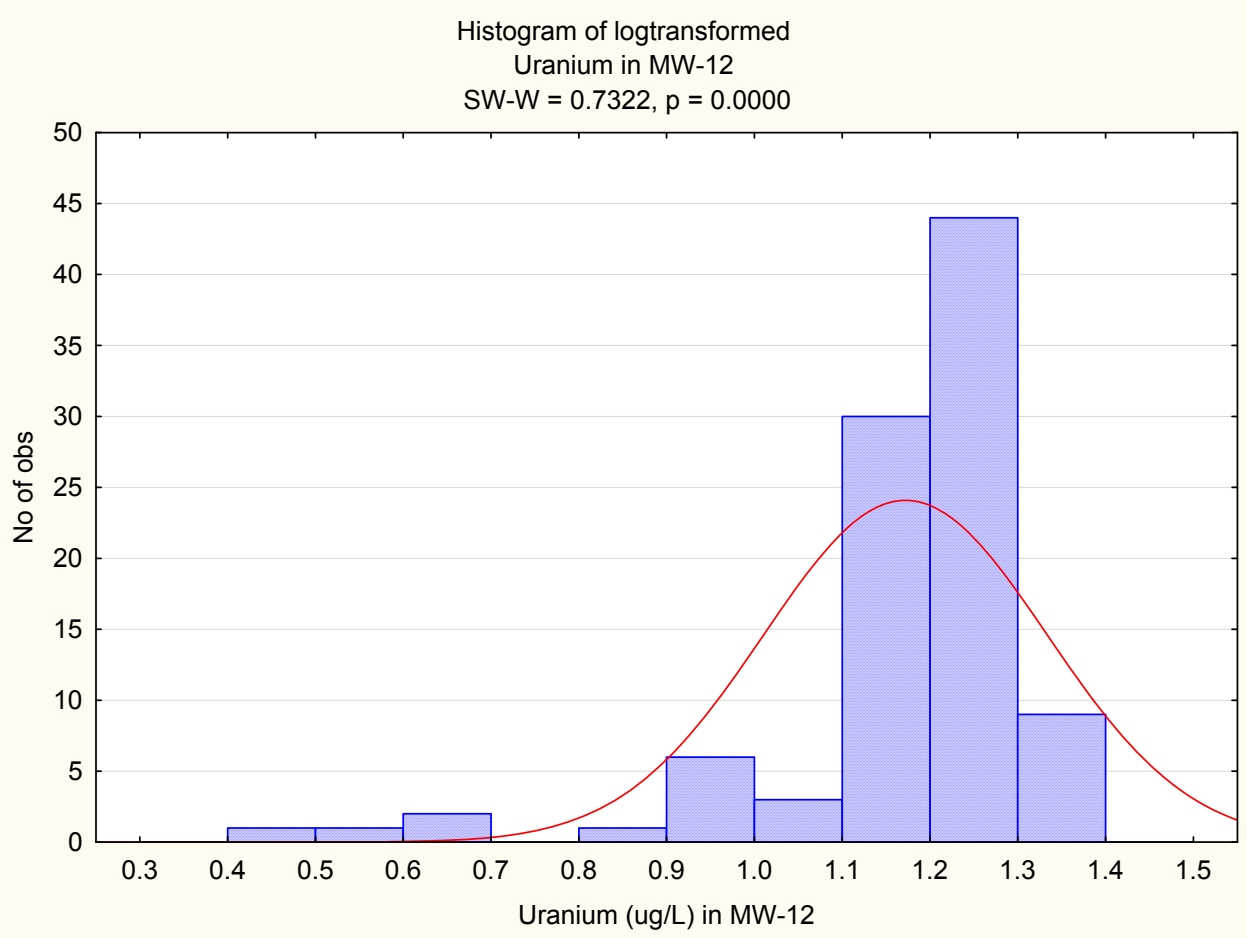
Histograms for Indicator Parameters



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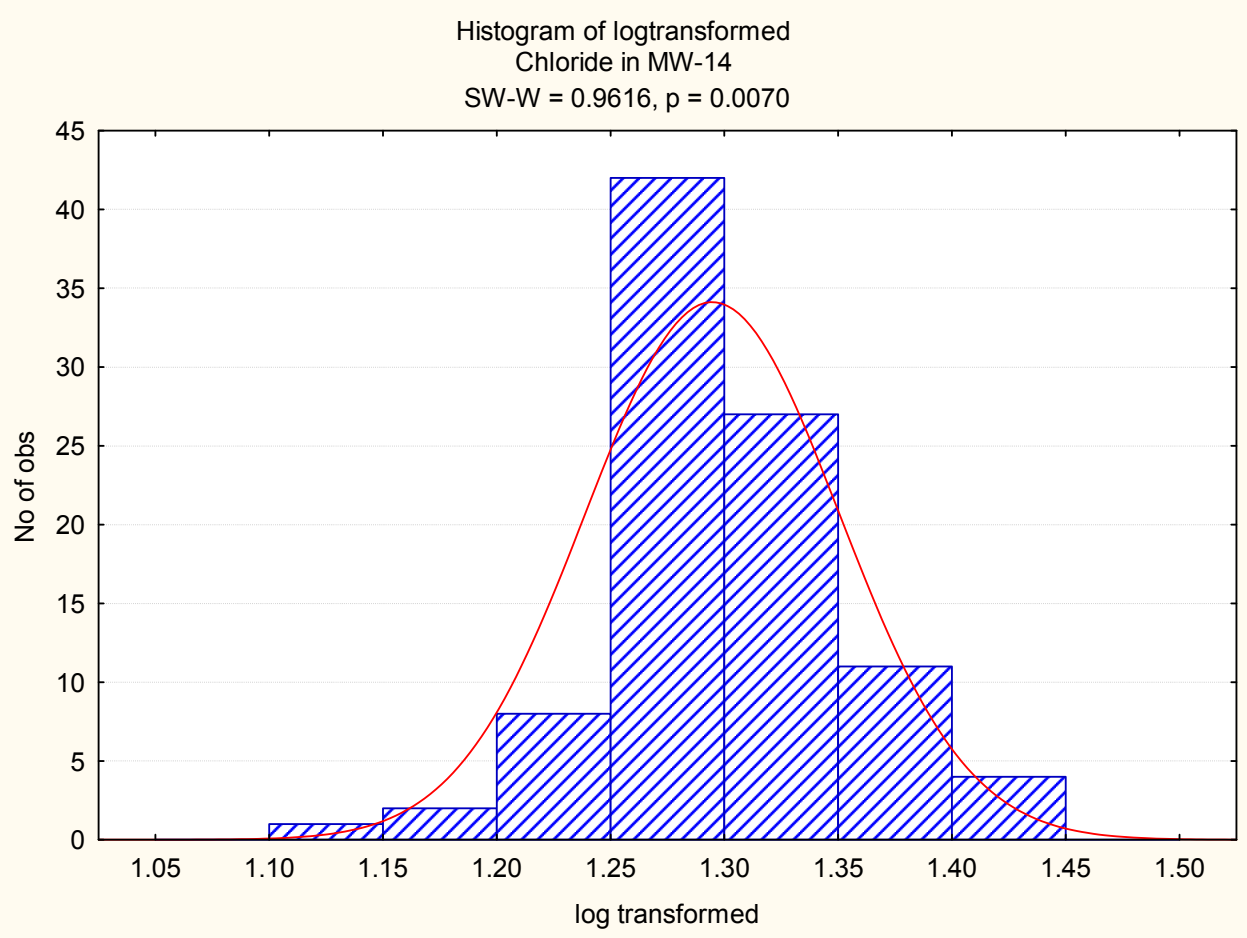
Histograms for Indicator Parameters



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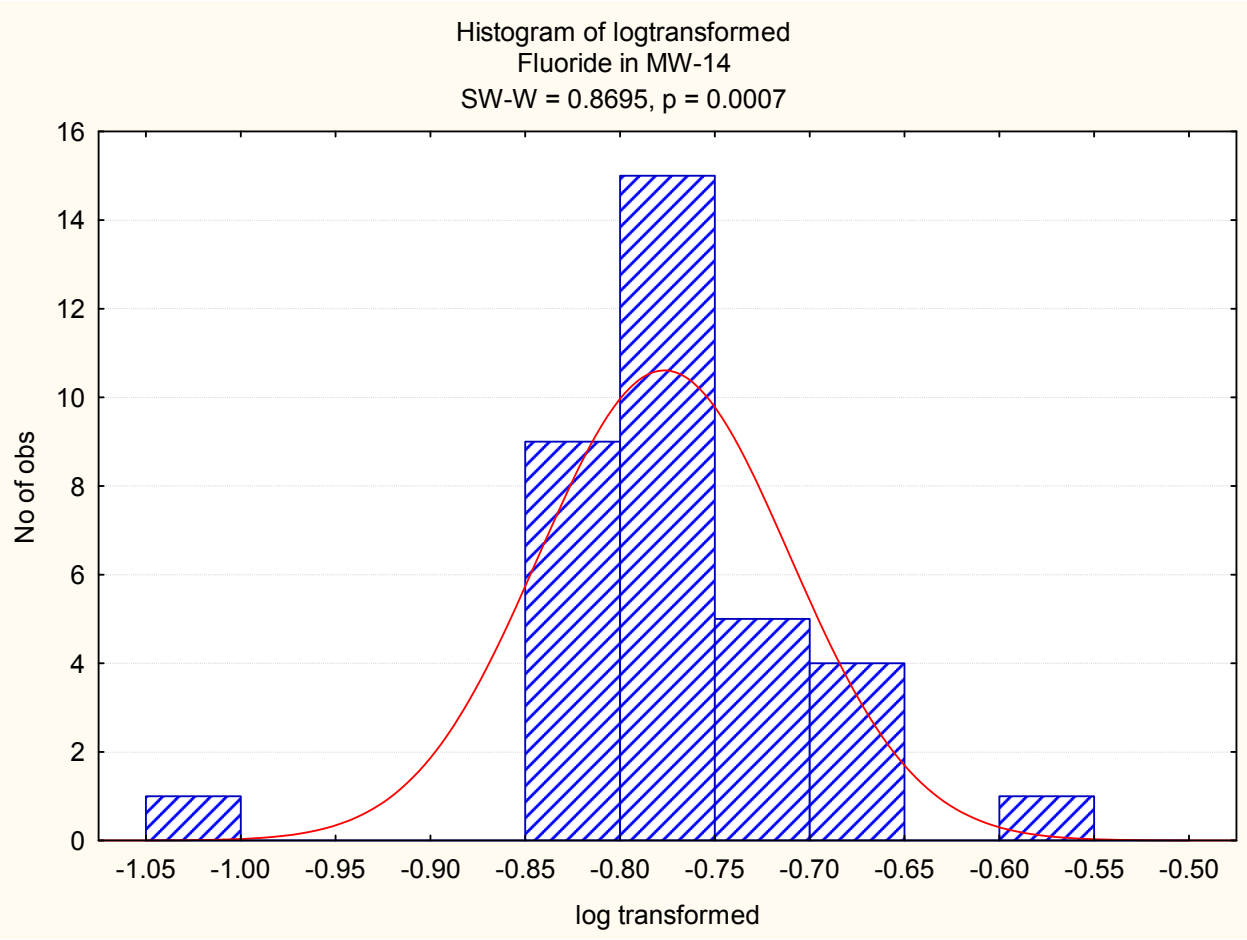
Histograms for Indicator Parameters



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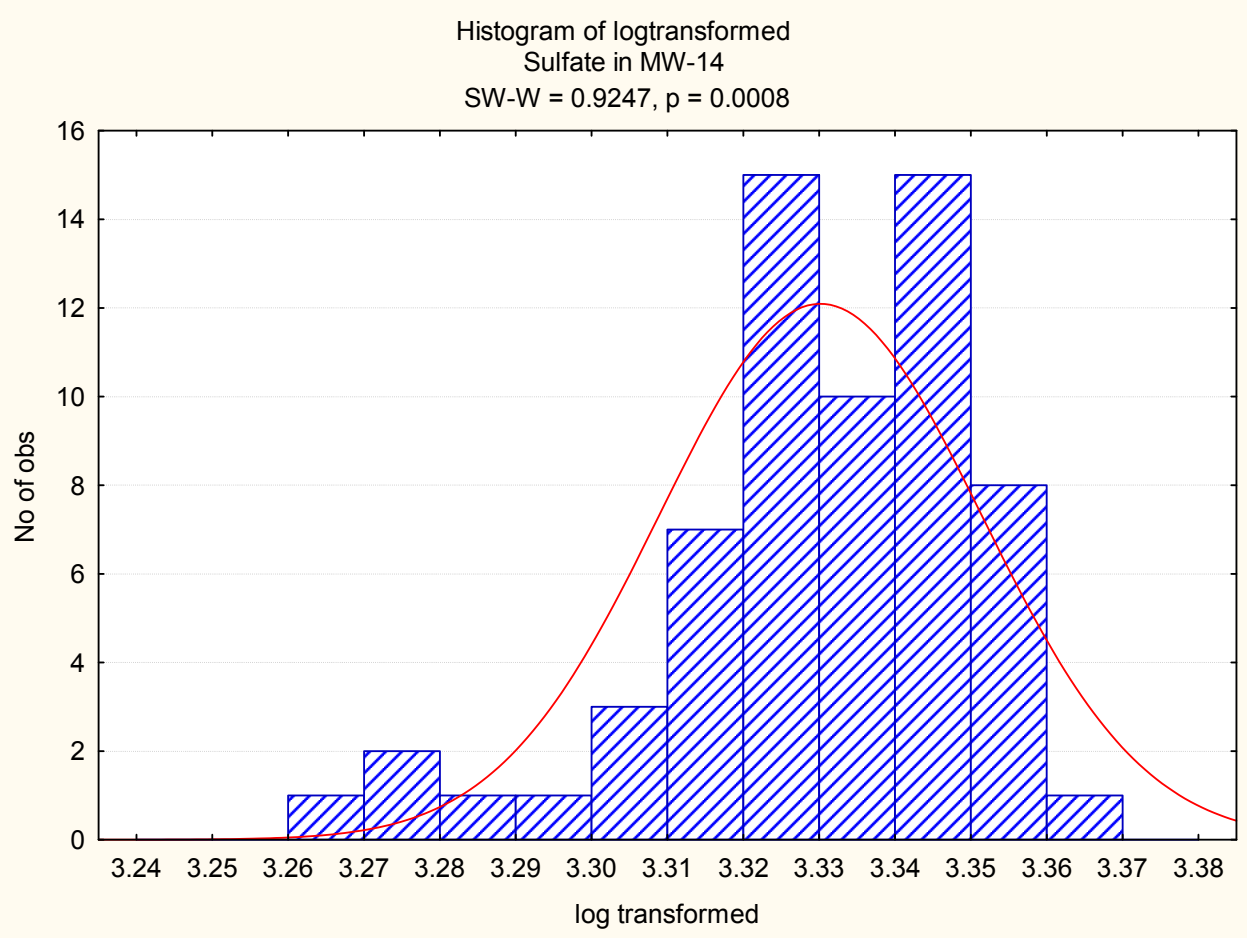
Histograms for Indicator Parameters



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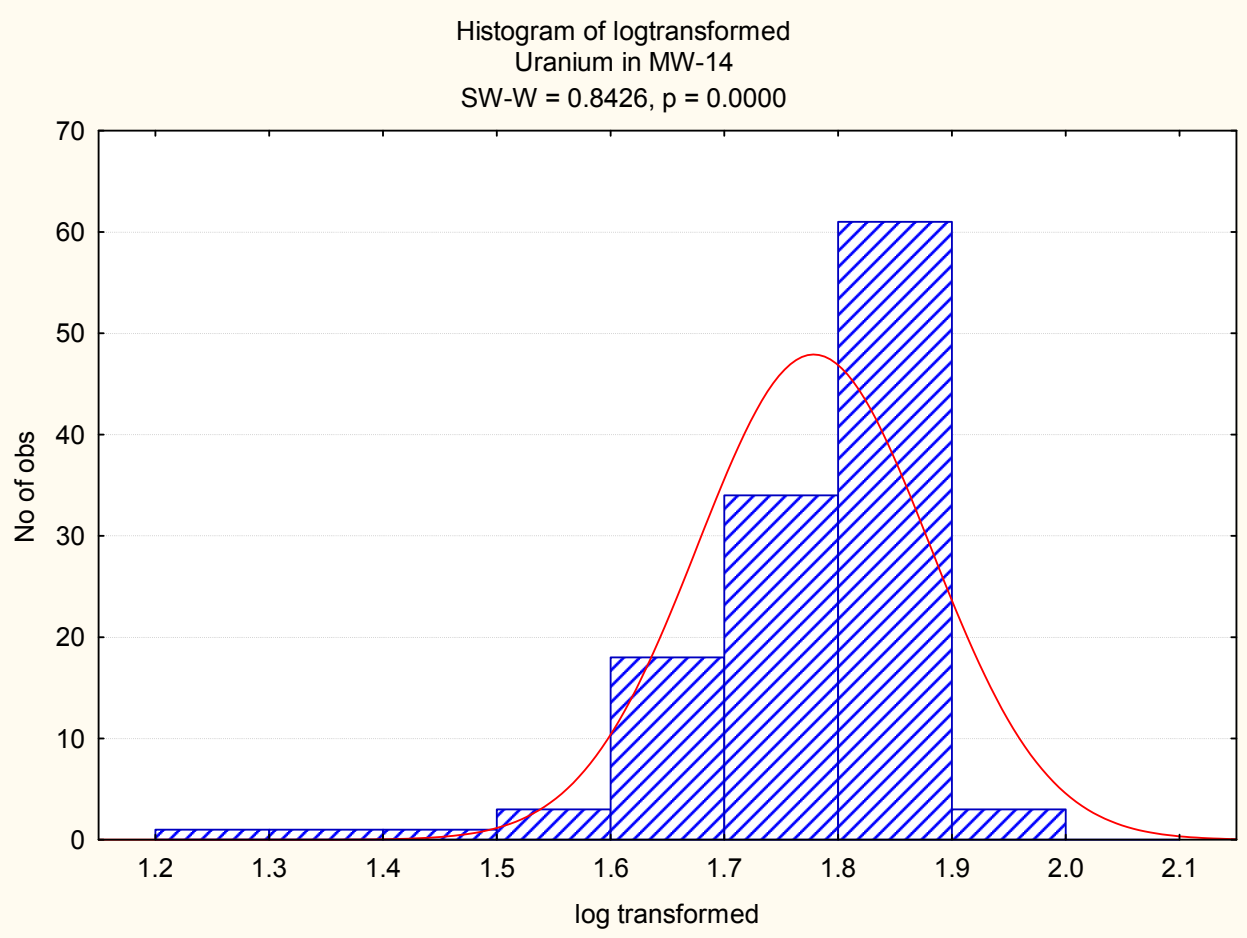
Histograms for Indicator Parameters



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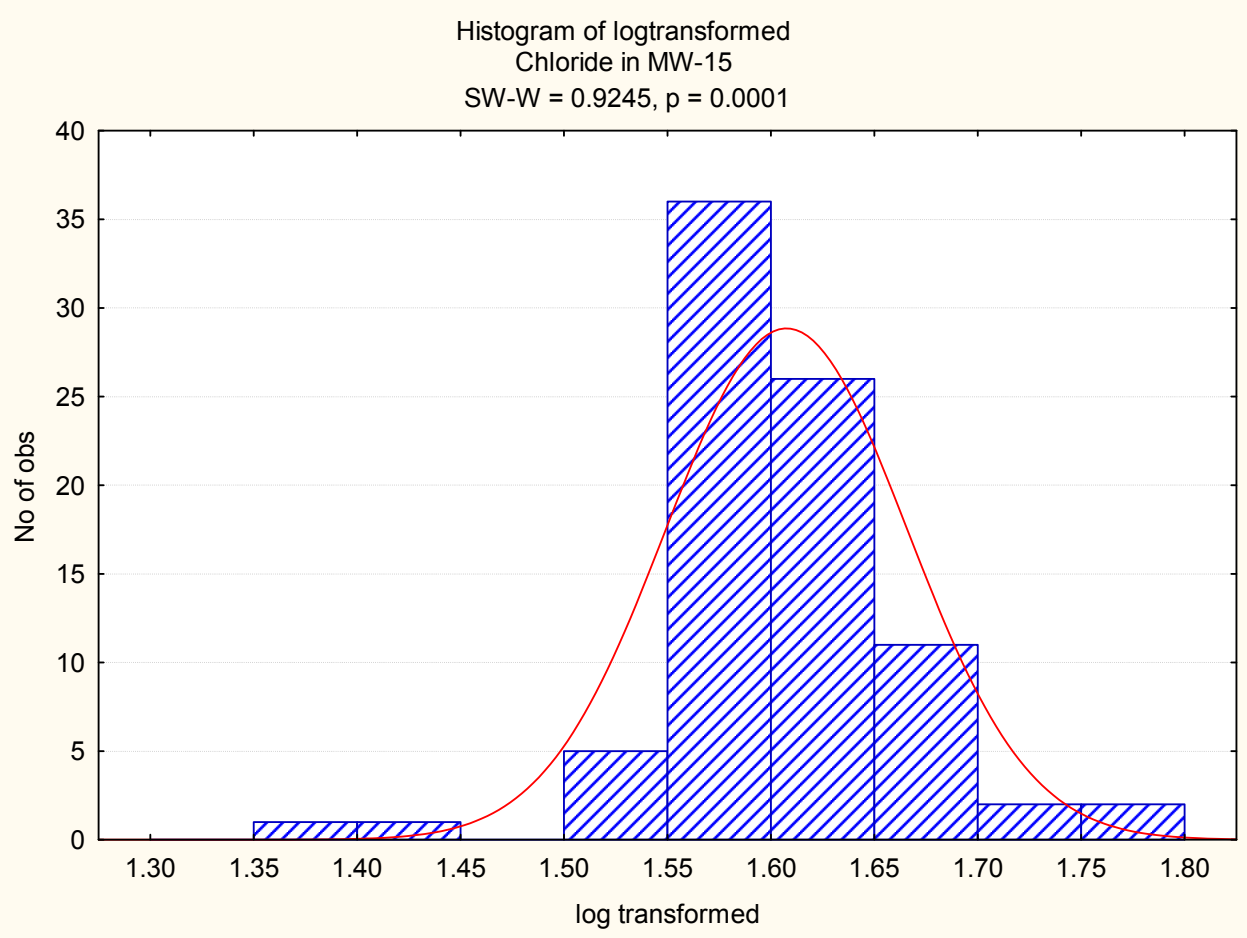

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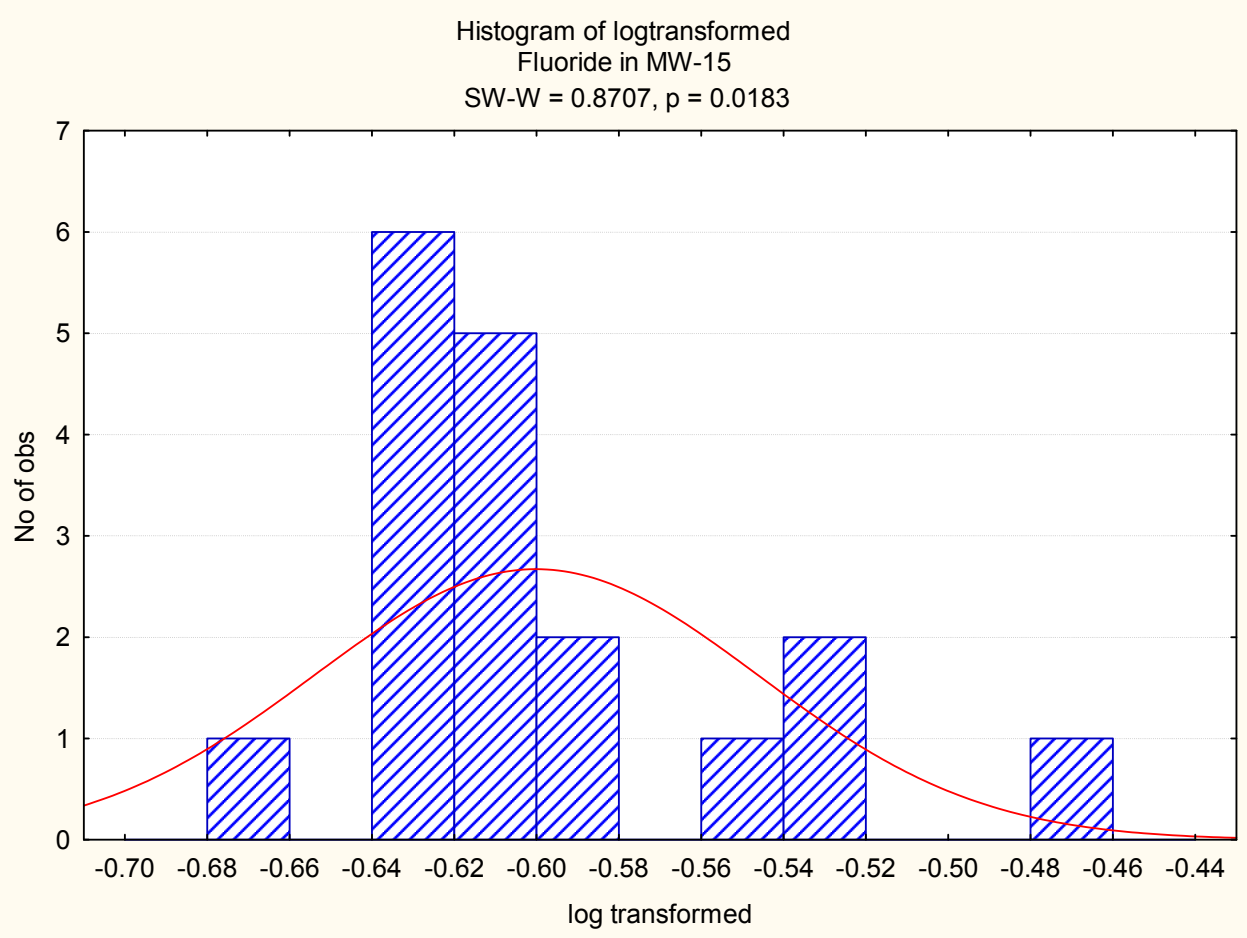
Histograms for Indicator Parameters



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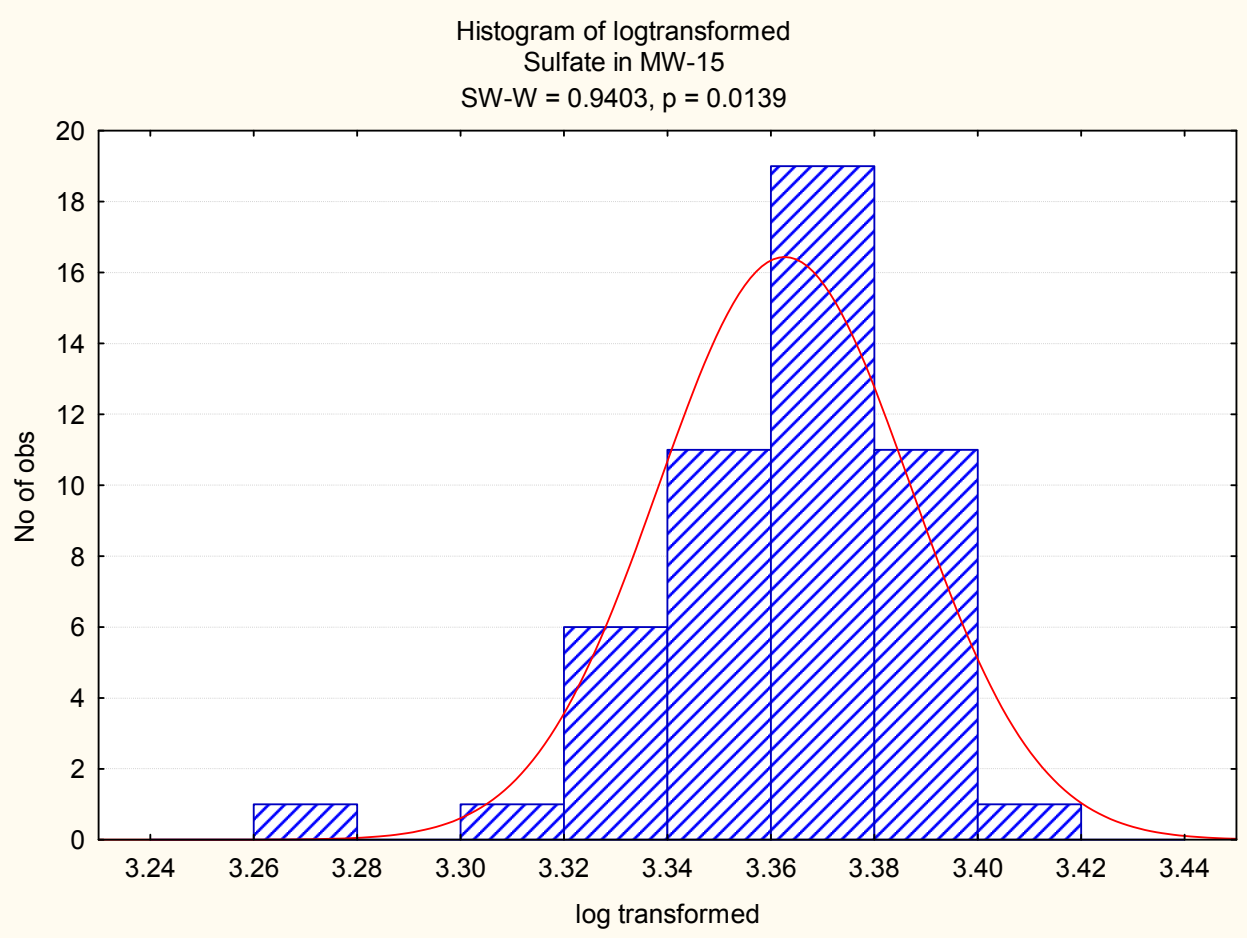
Histograms for Indicator Parameters



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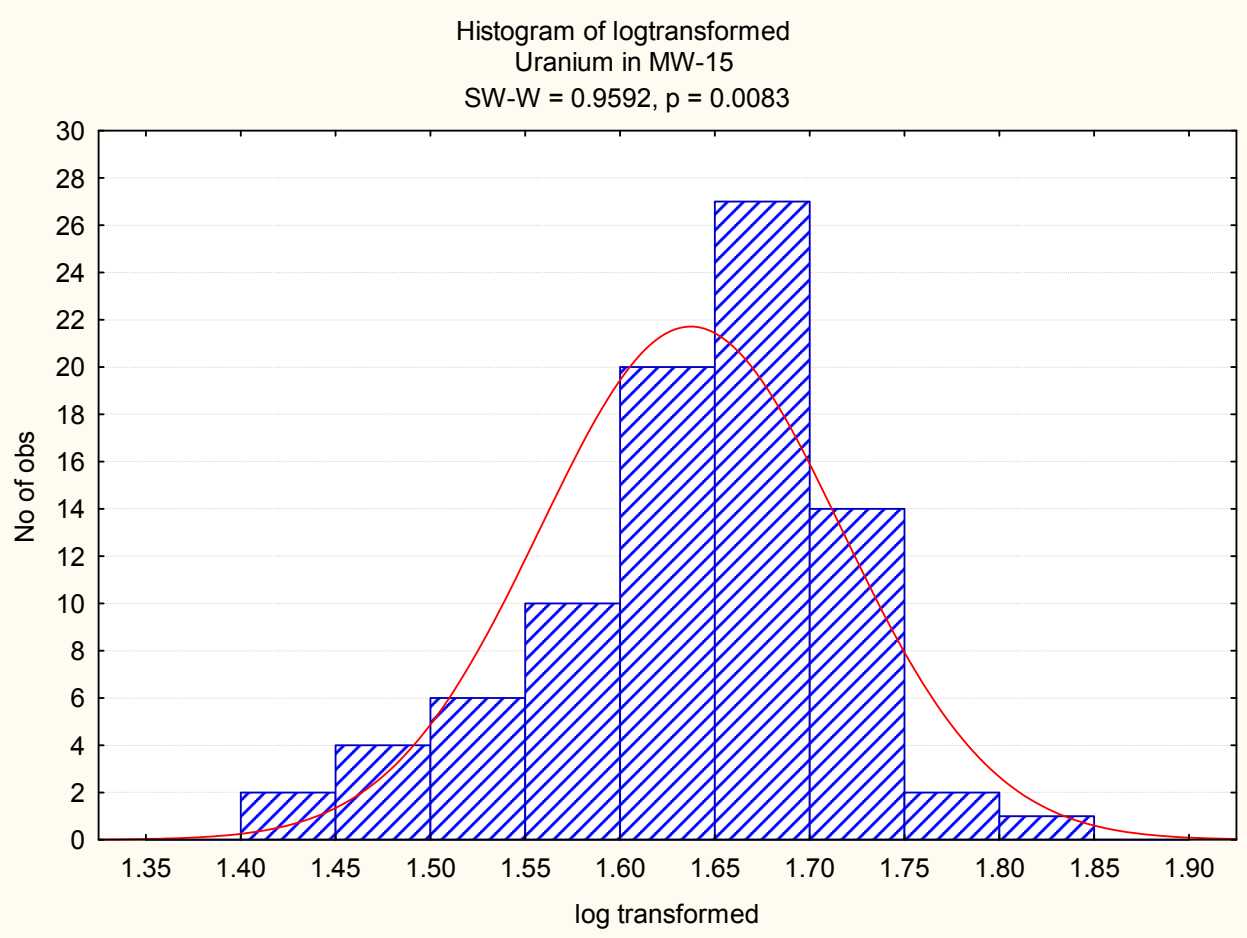
Histograms for Indicator Parameters



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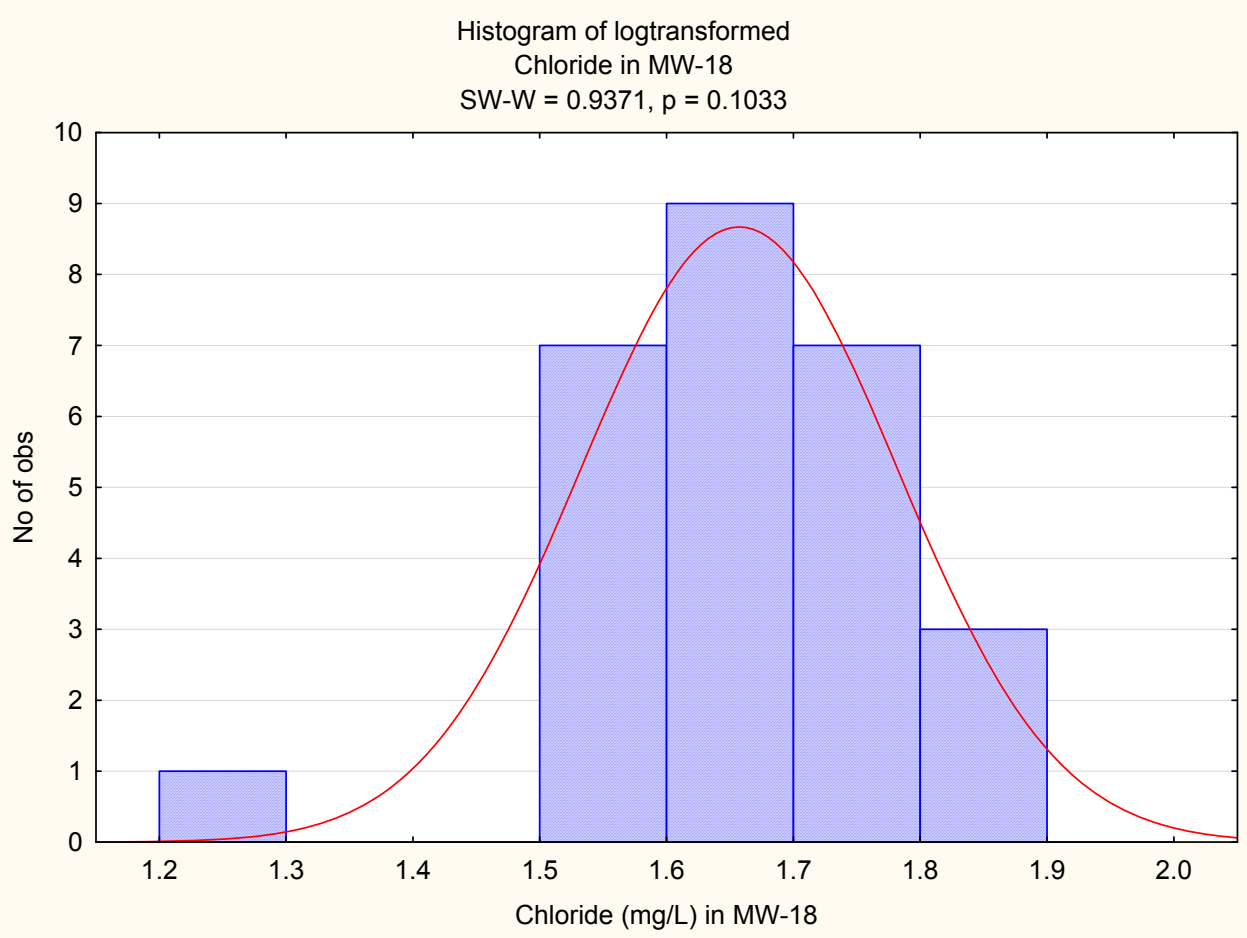
Histograms for Indicator Parameters



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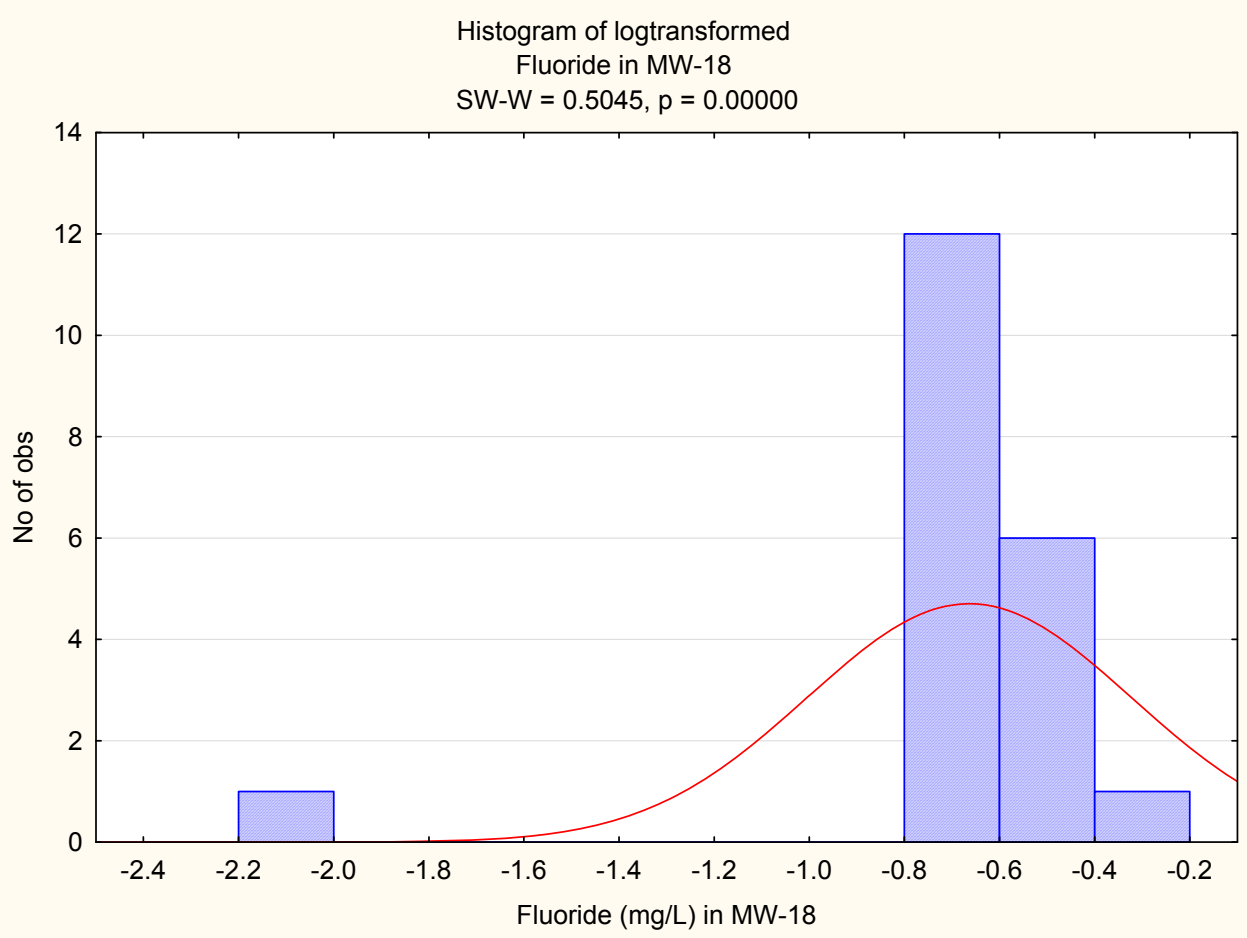

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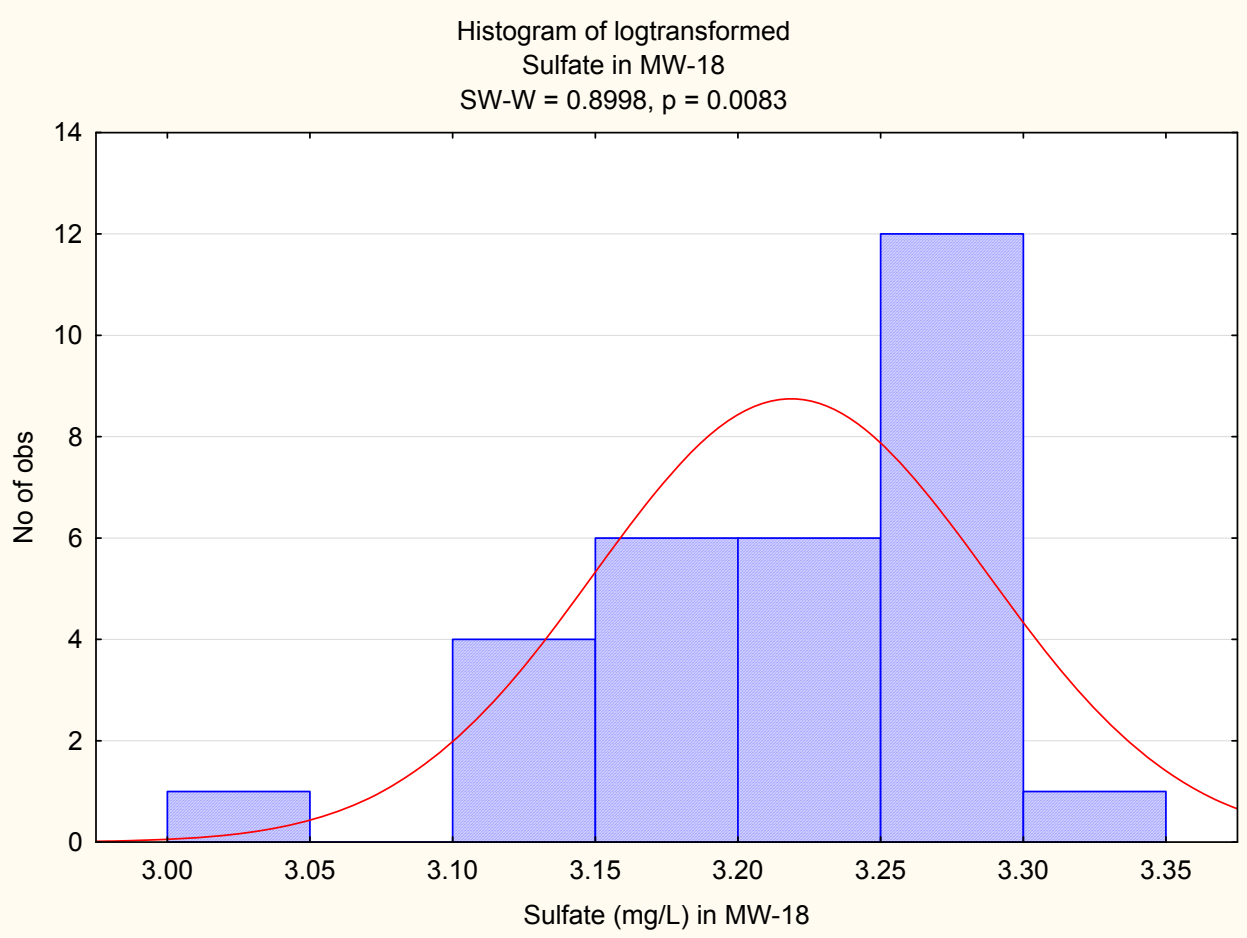
Histograms for Indicator Parameters



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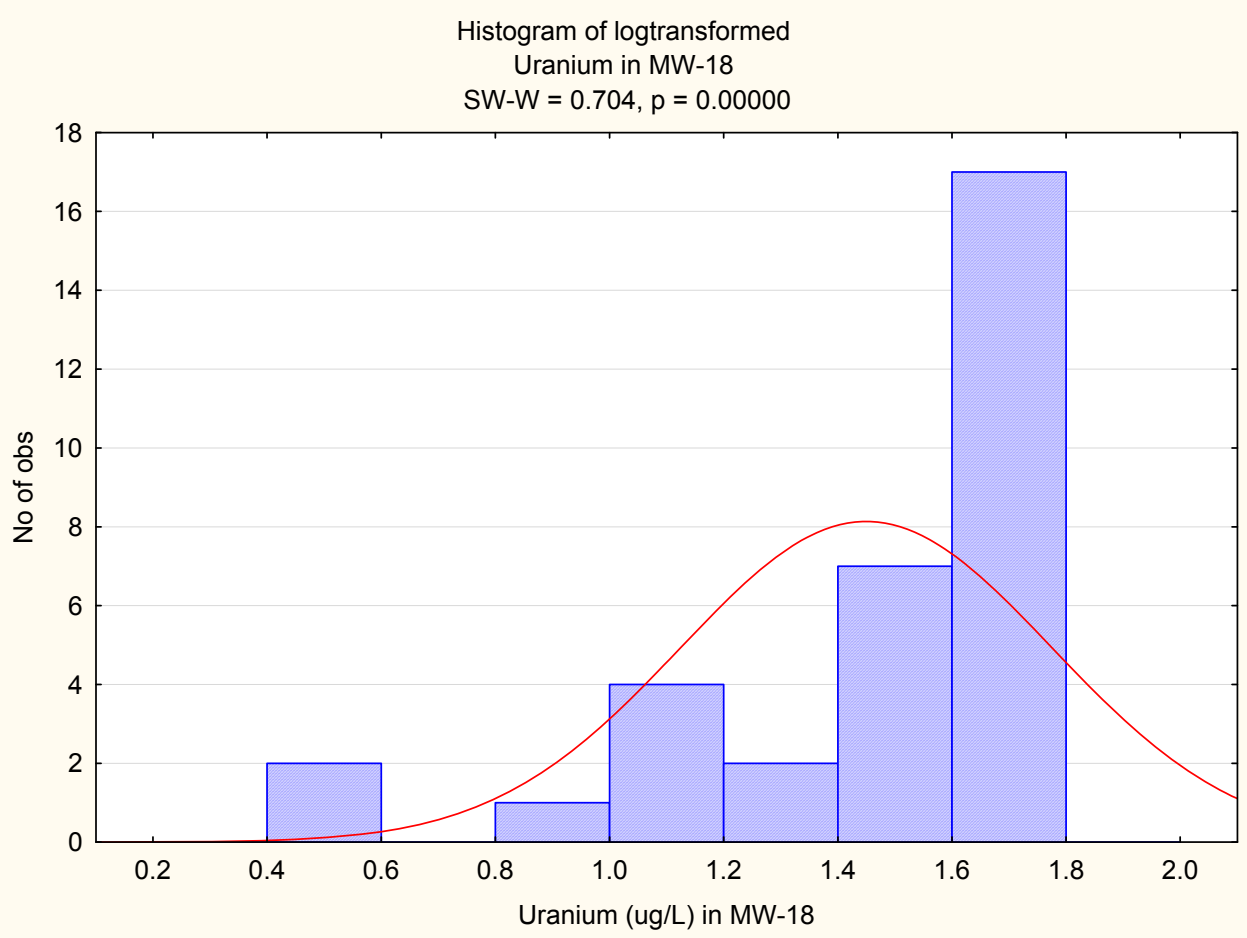
Histograms for Indicator Parameters



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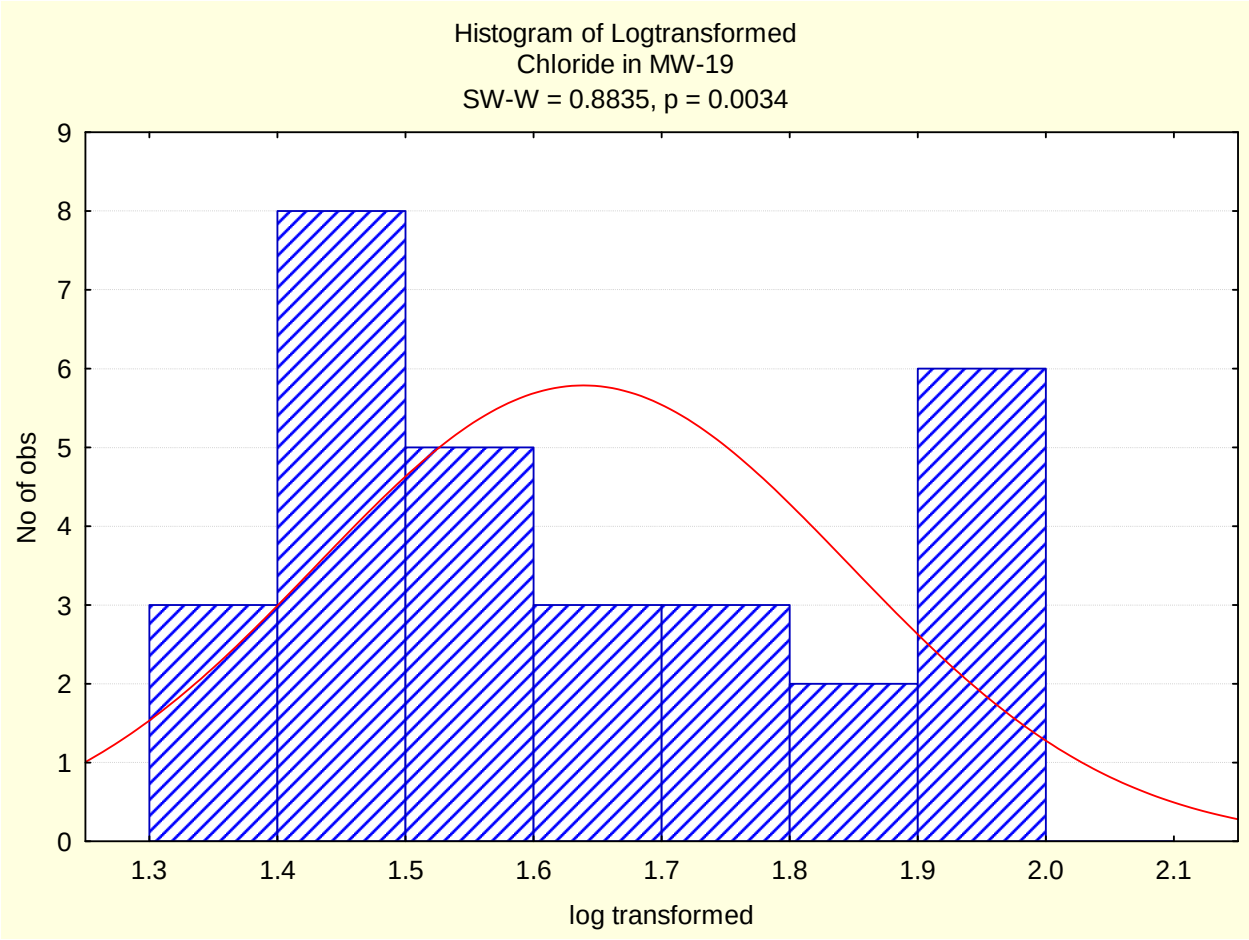
Histograms for Indicator Parameters



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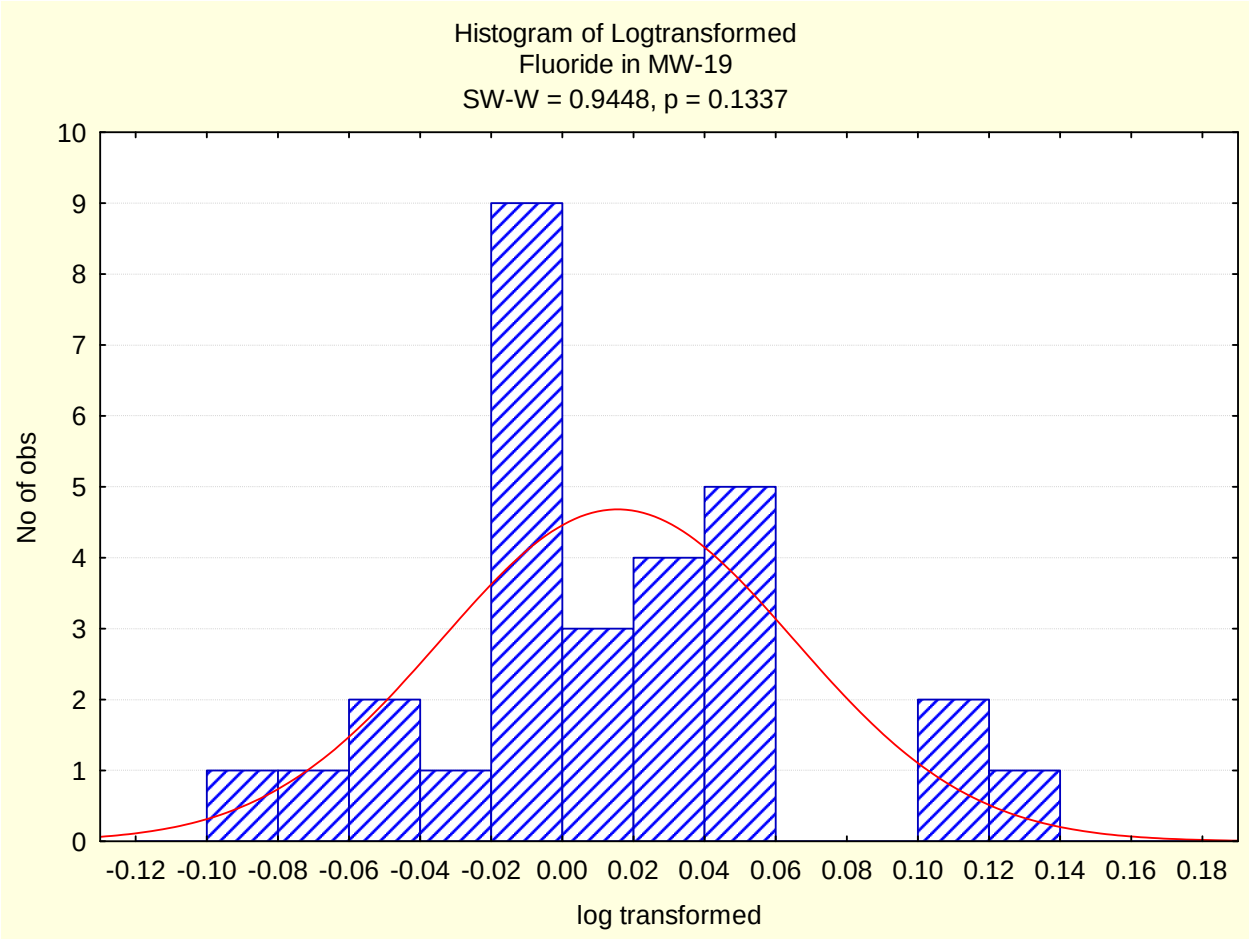
Histograms for Indicator Parameters



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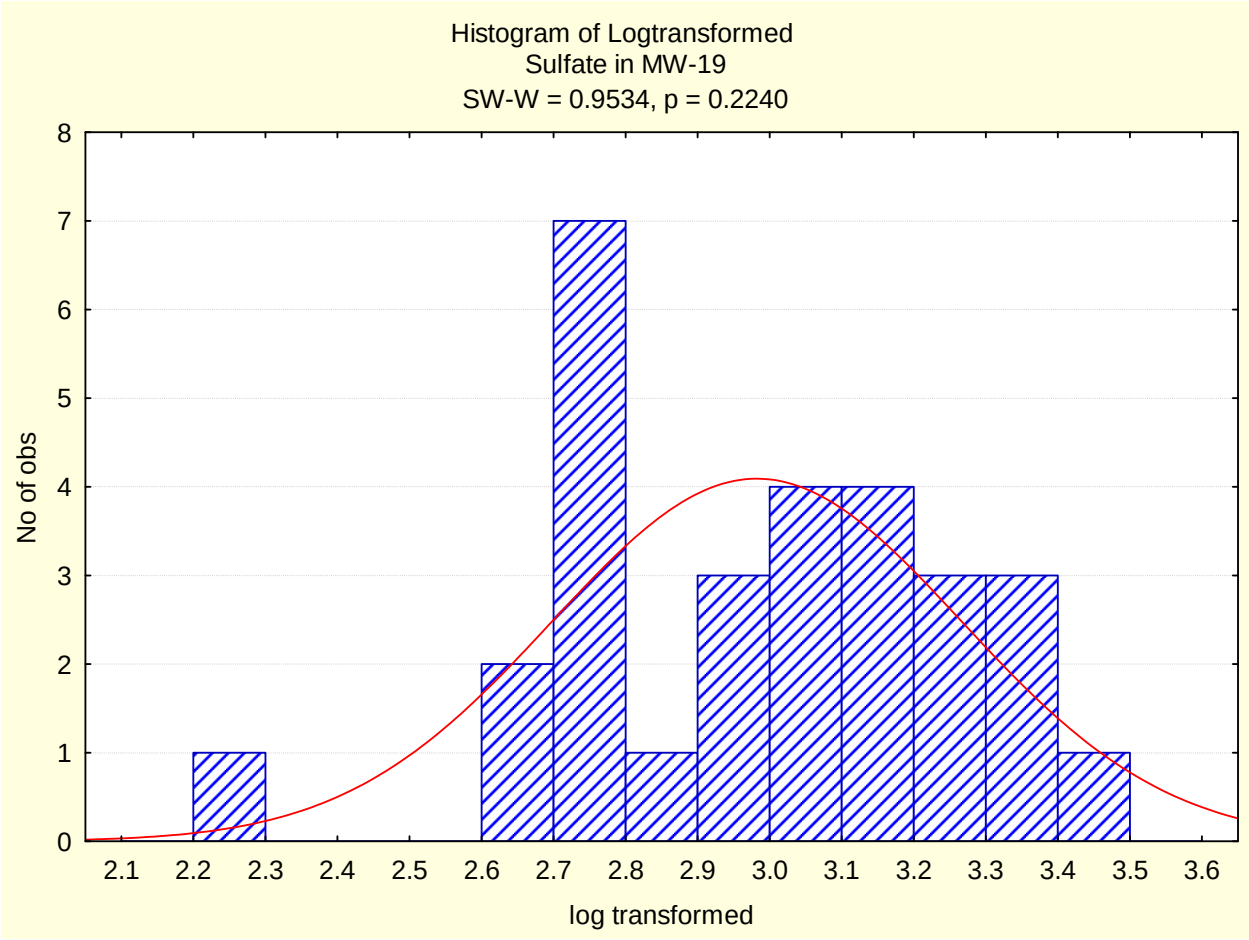

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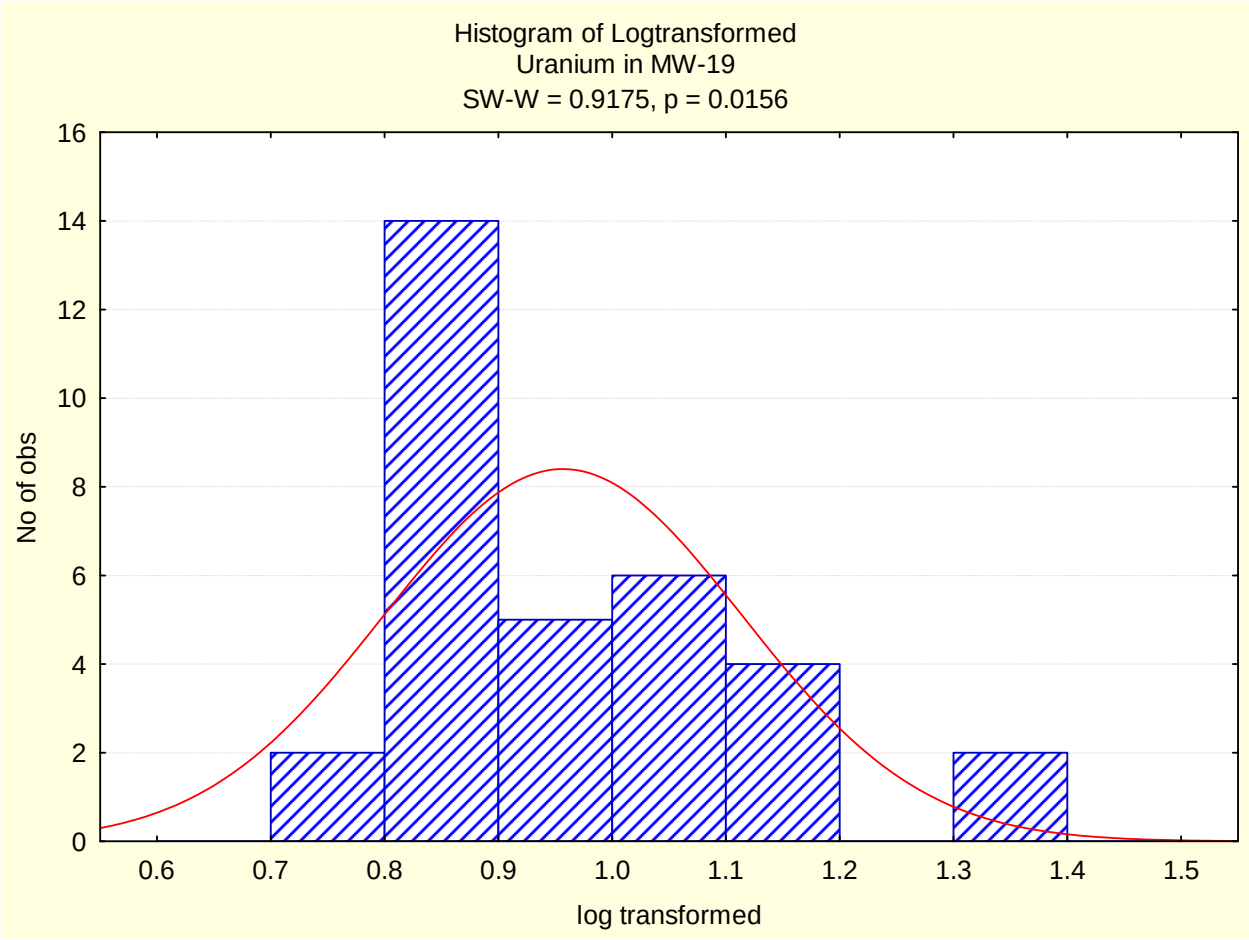

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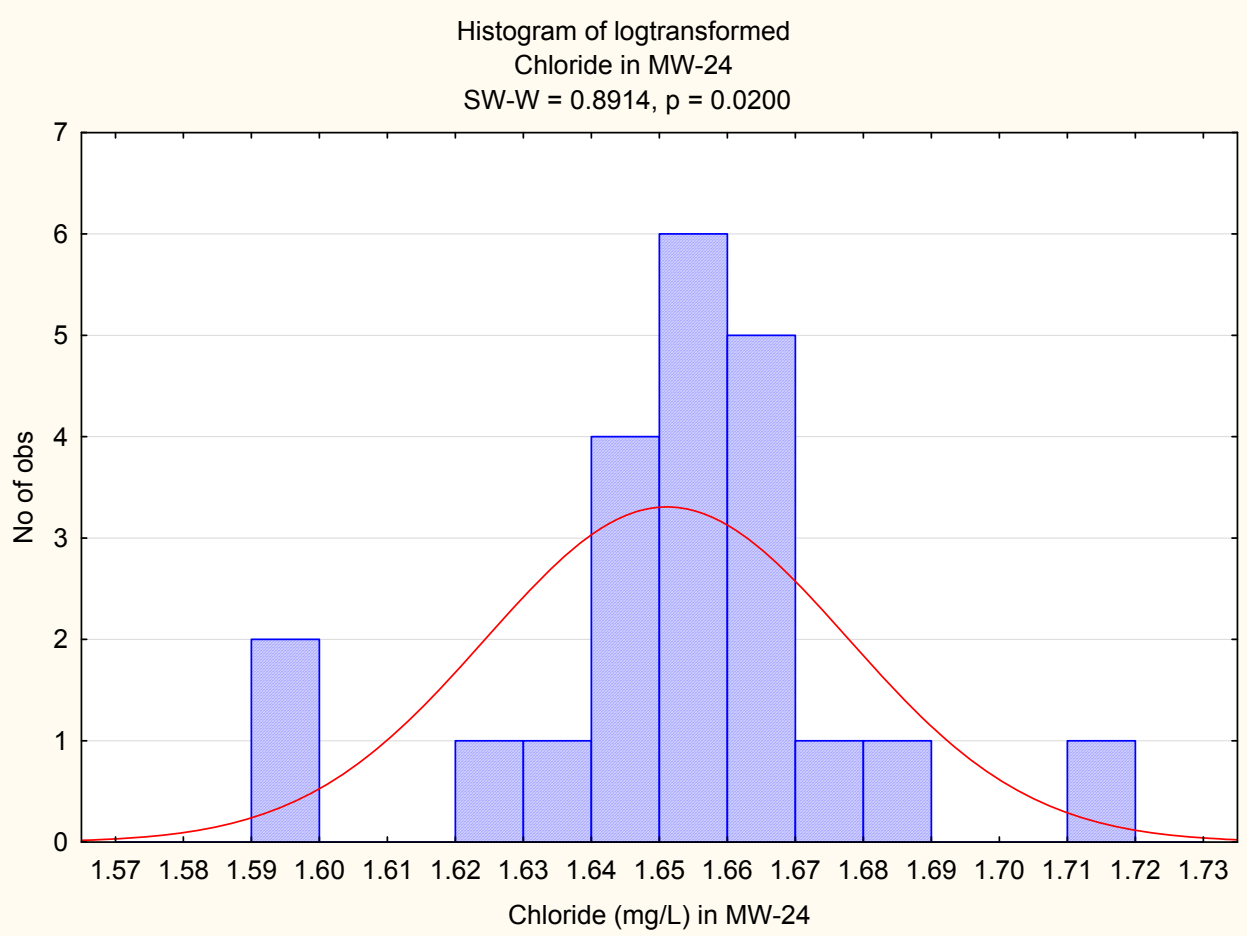
Histograms for Indicator Parameters



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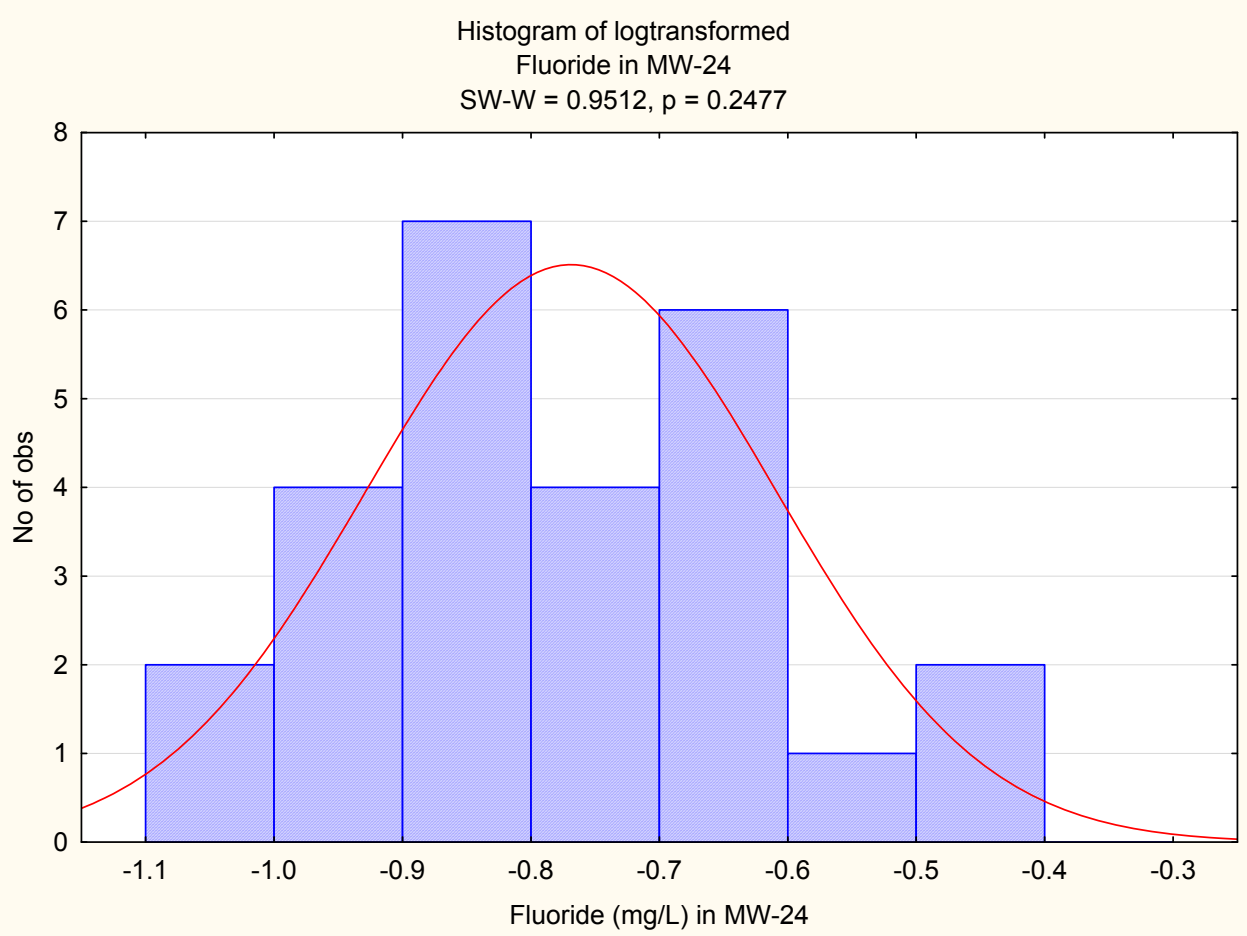
Histograms for Indicator Parameters



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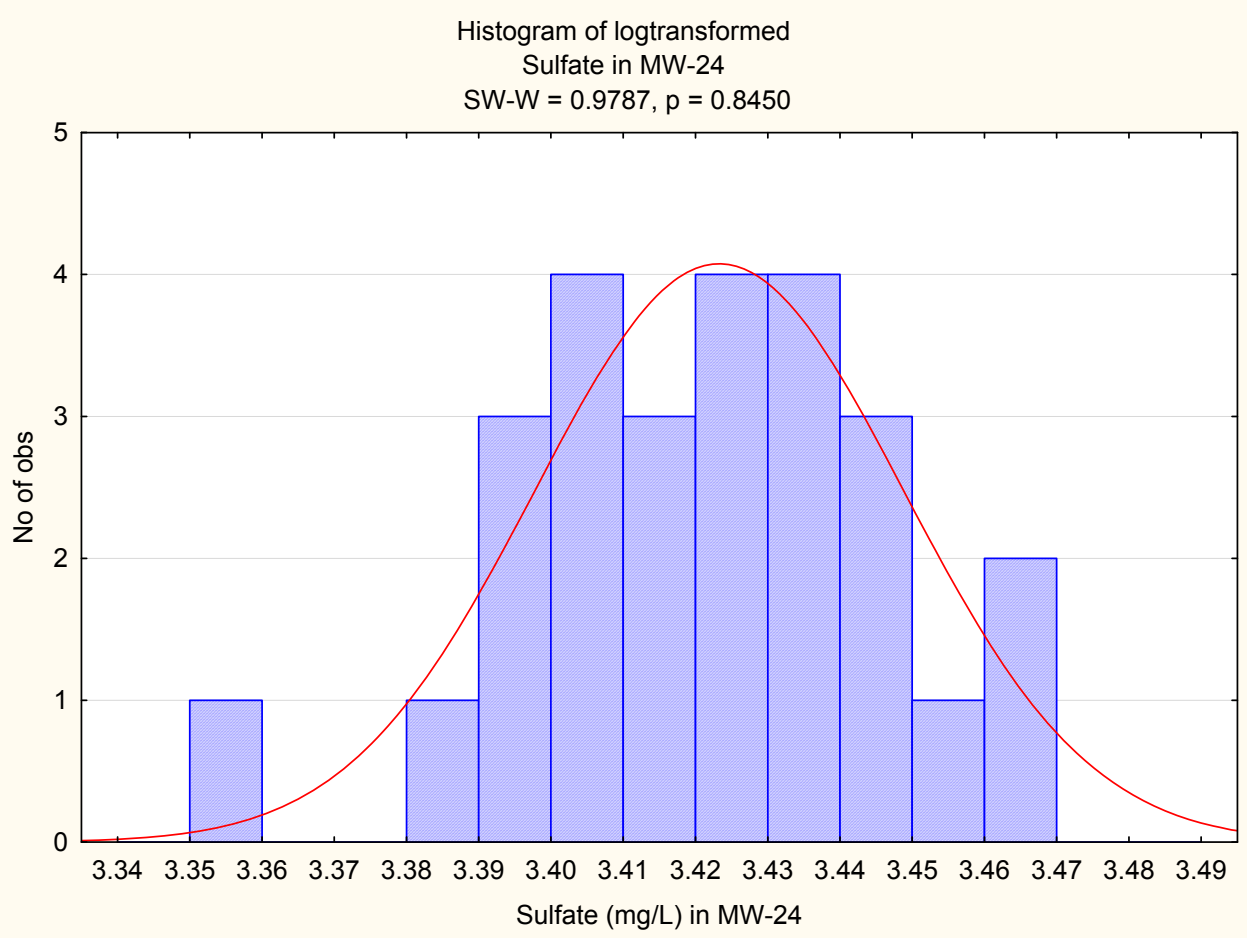

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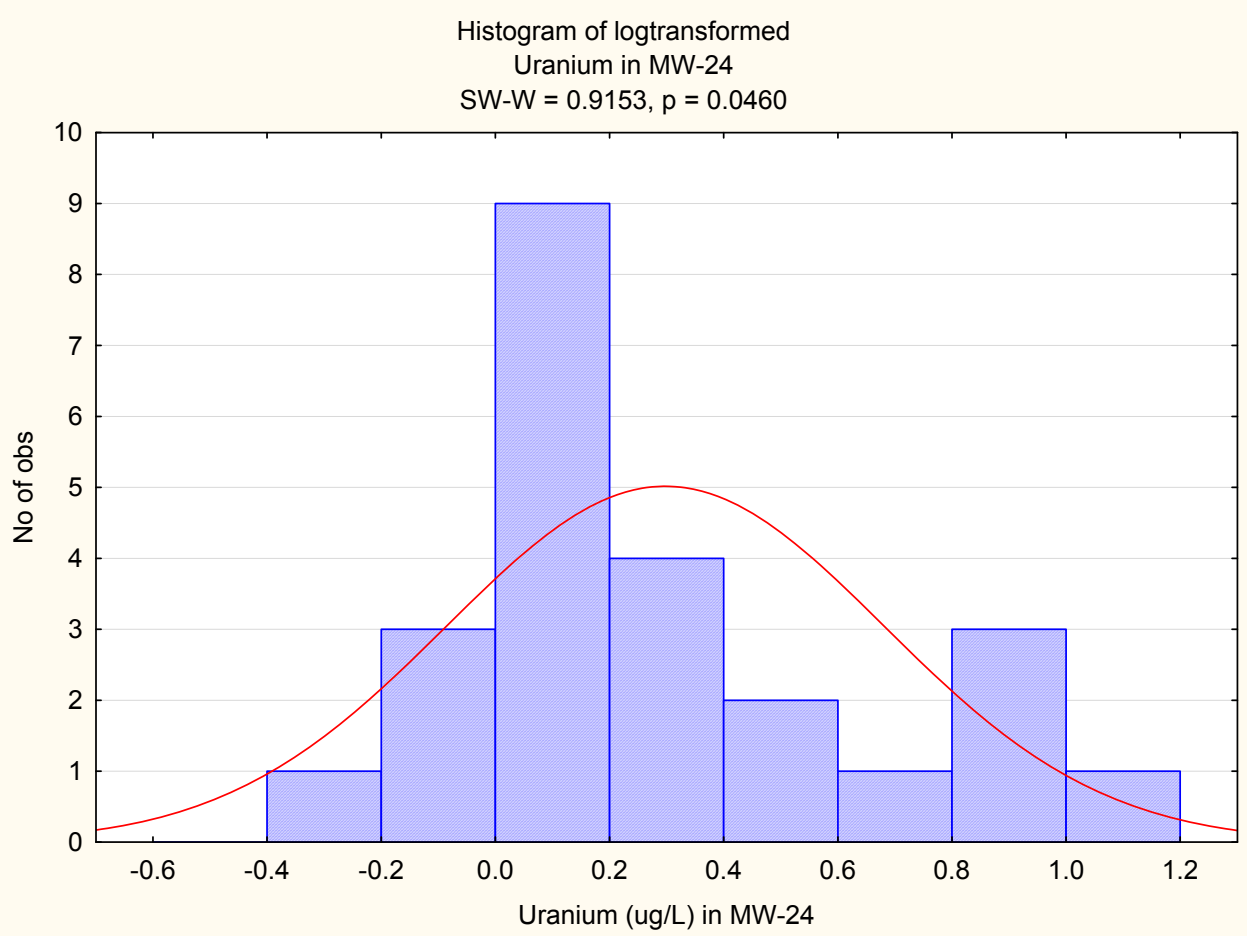

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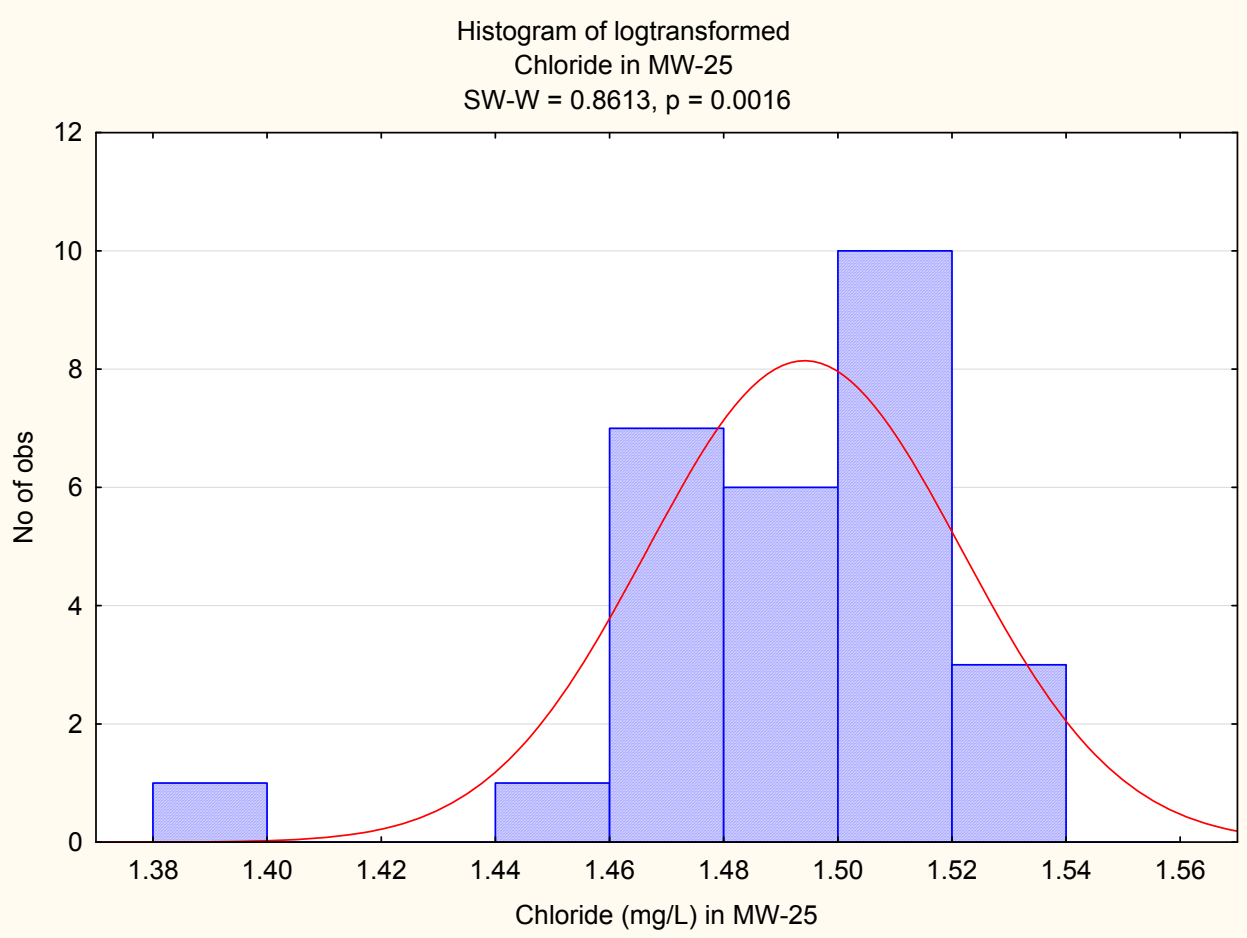

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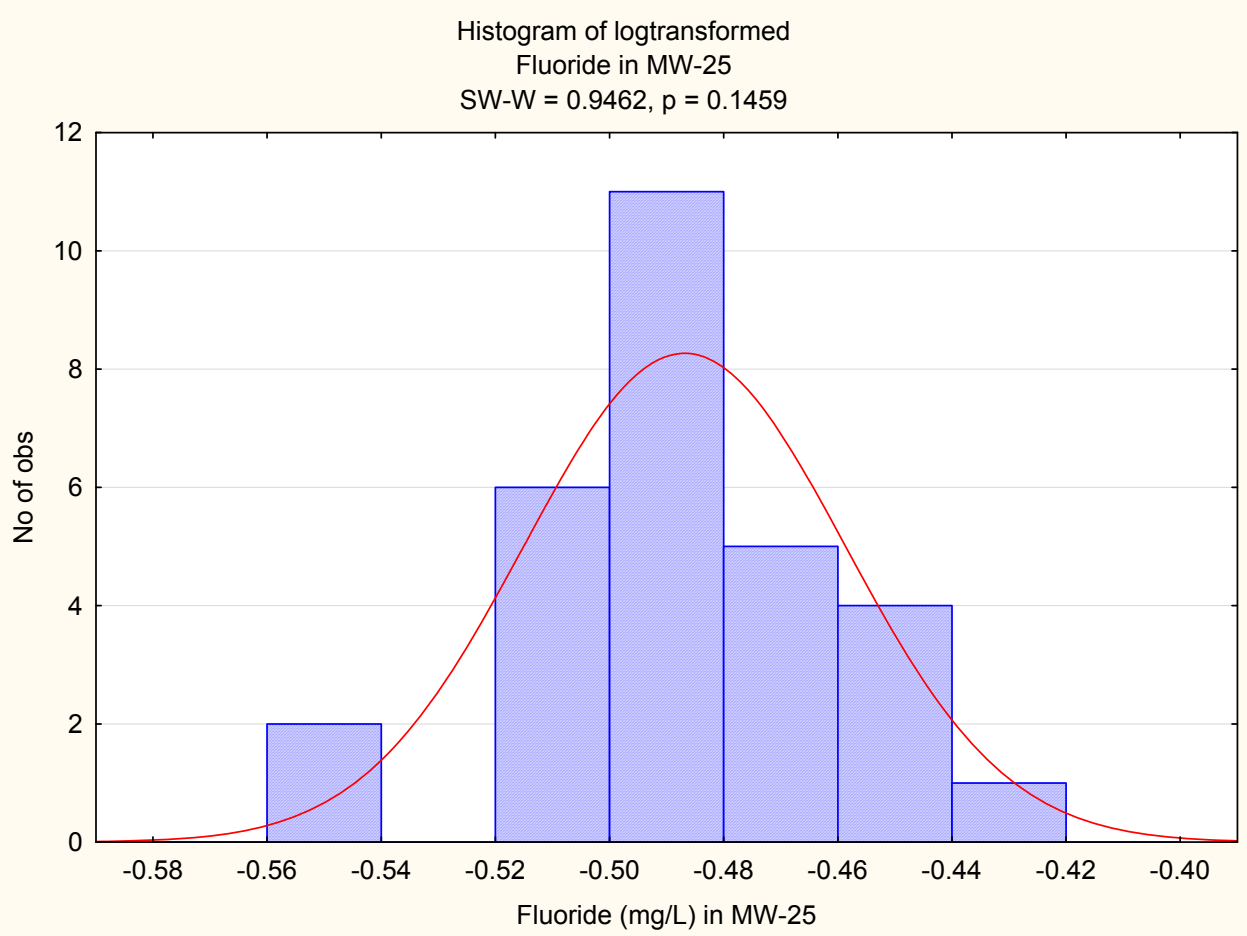

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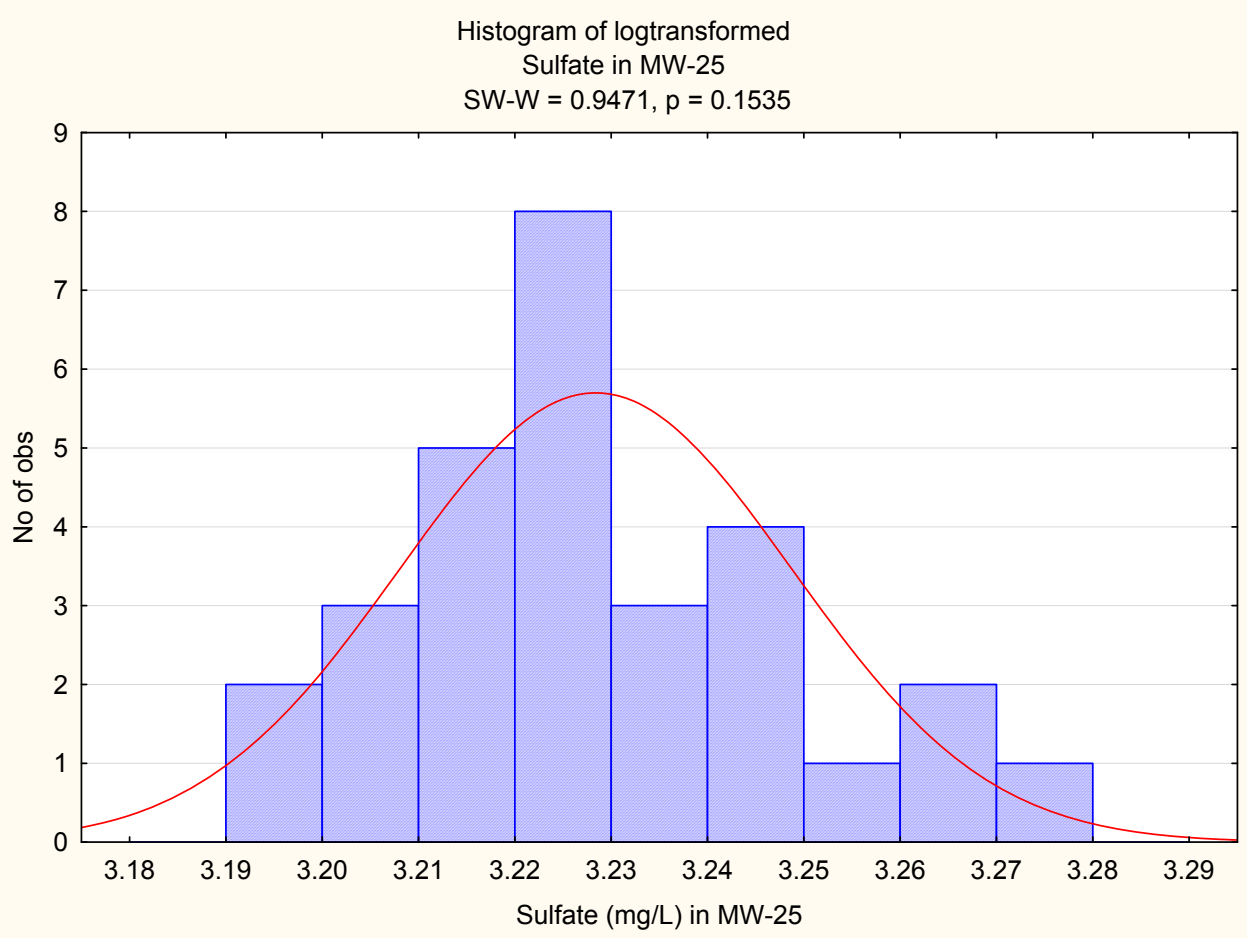

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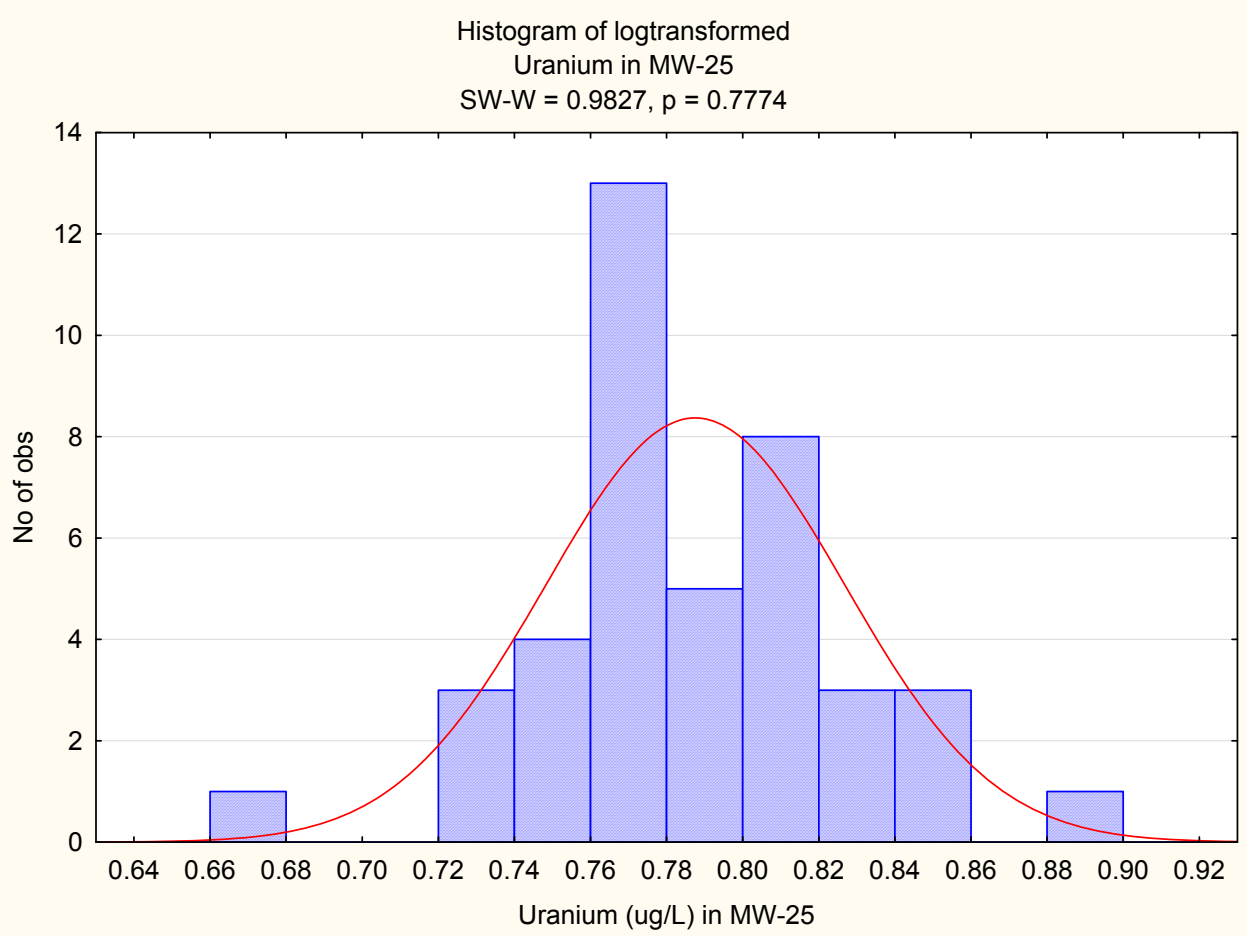

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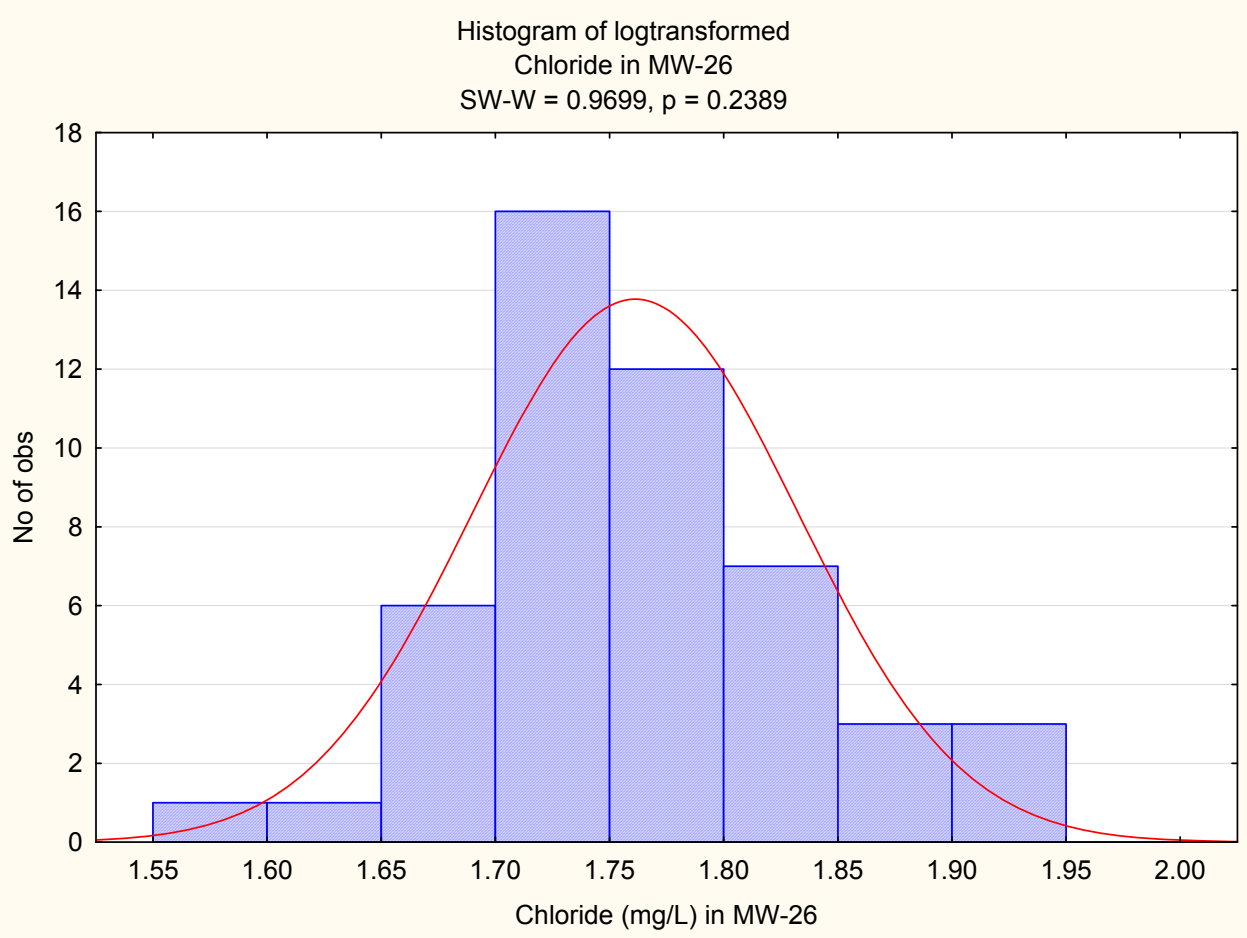

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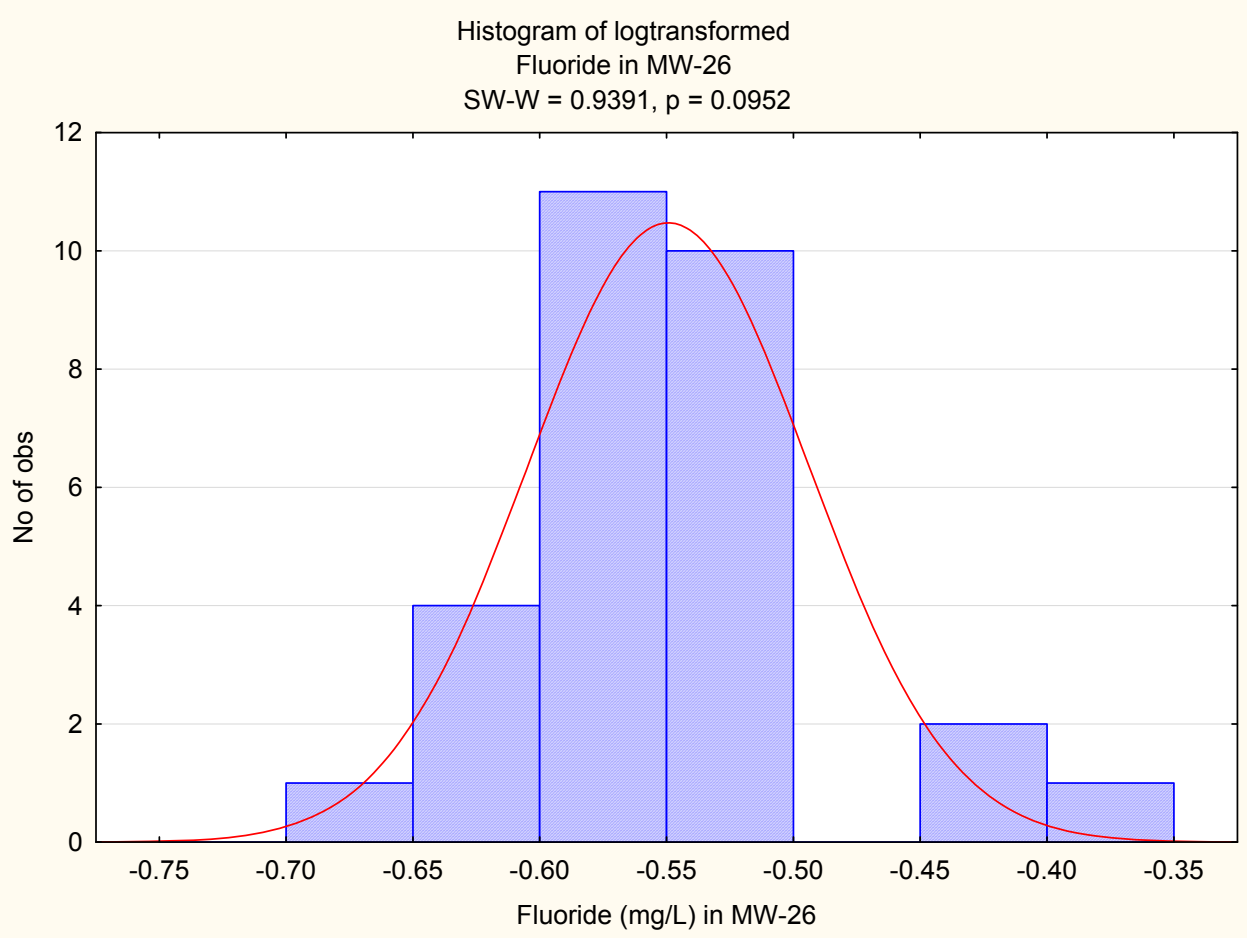

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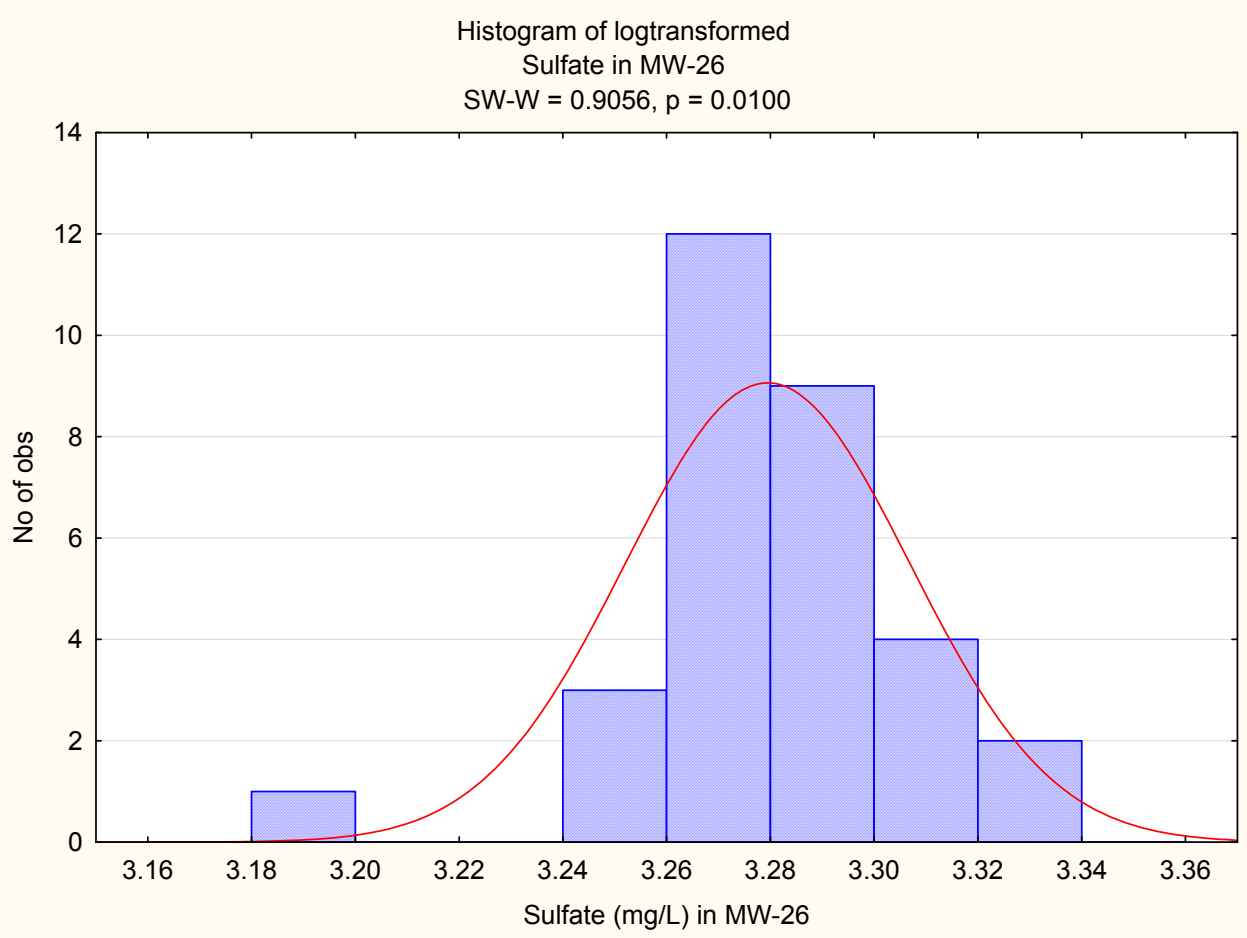

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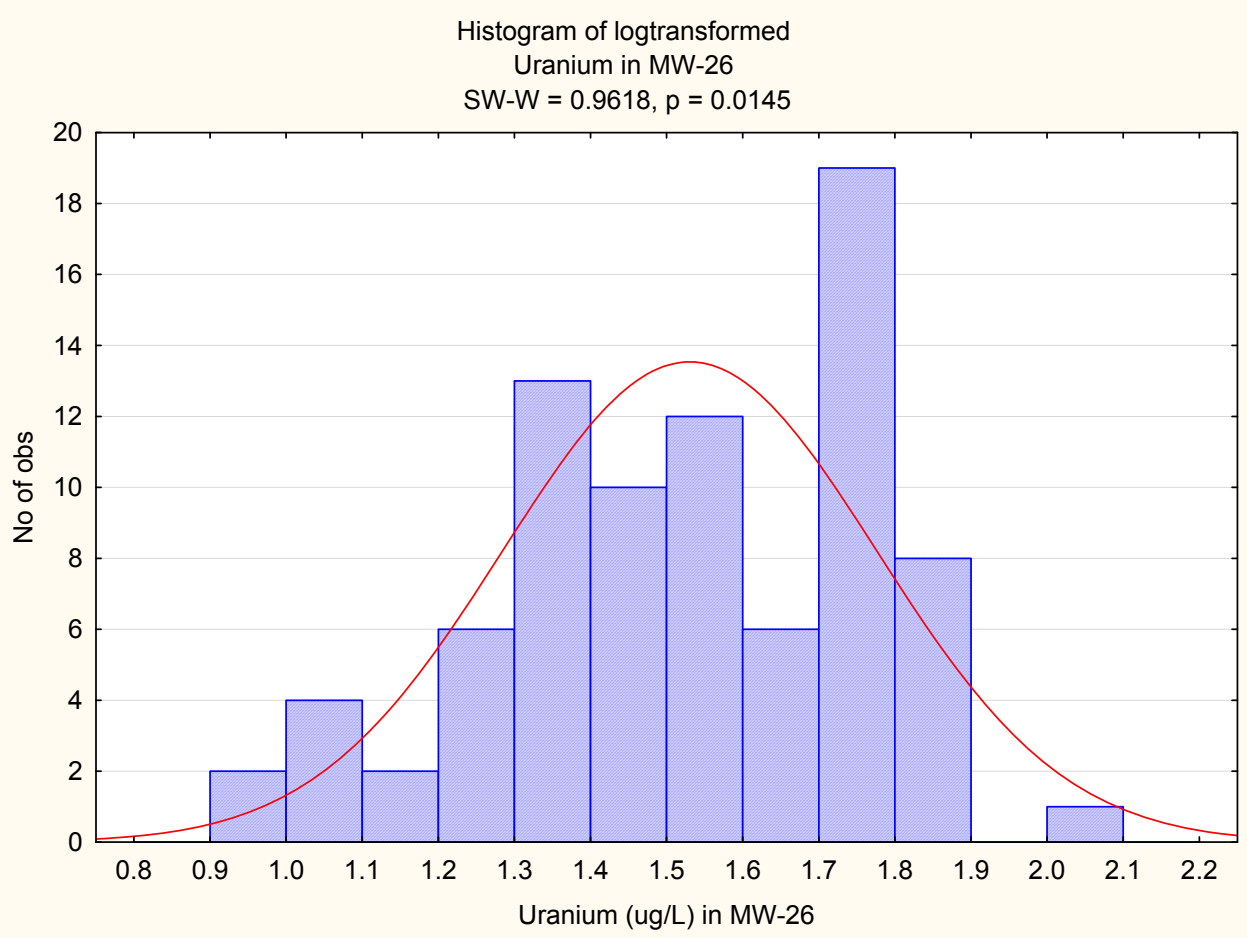

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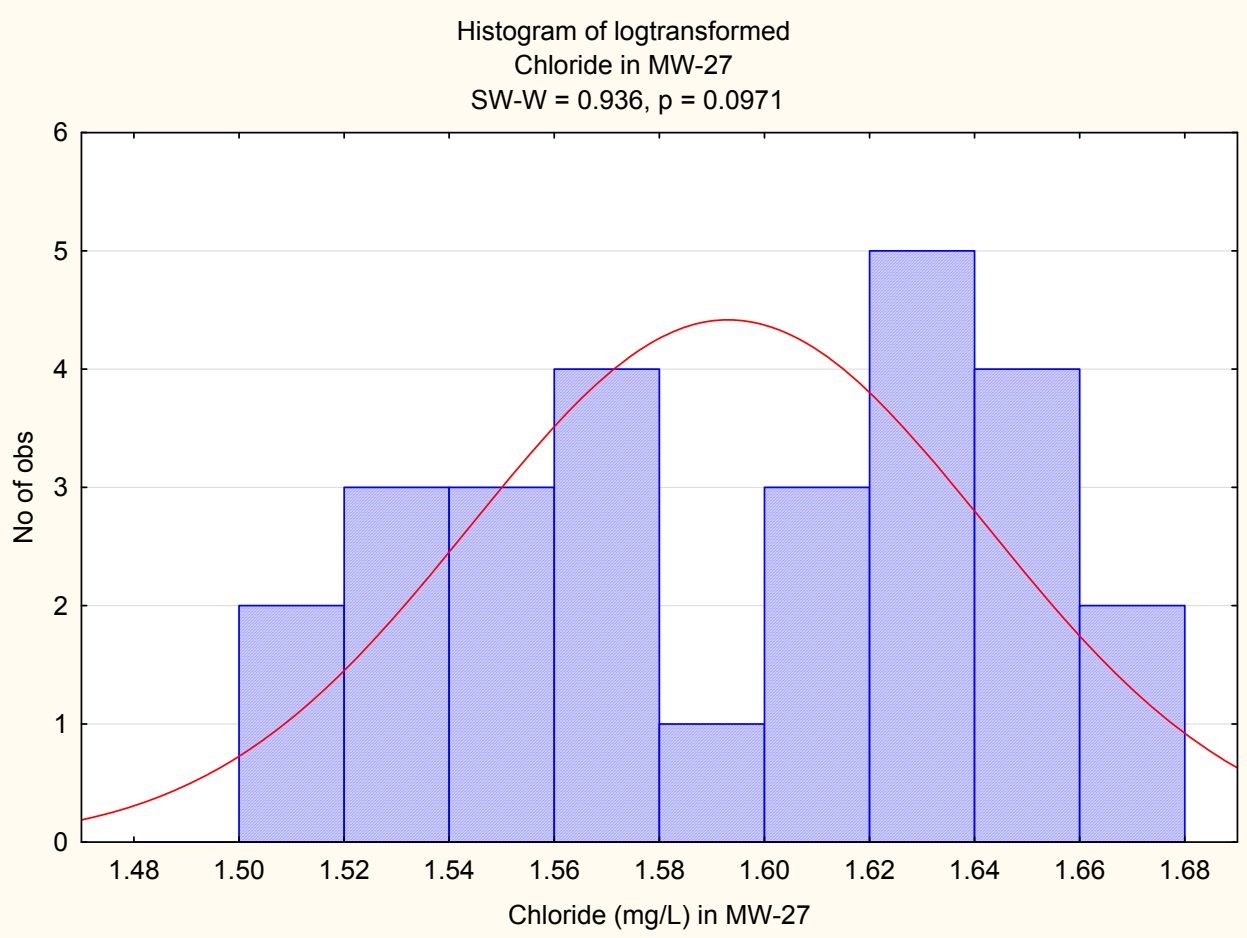

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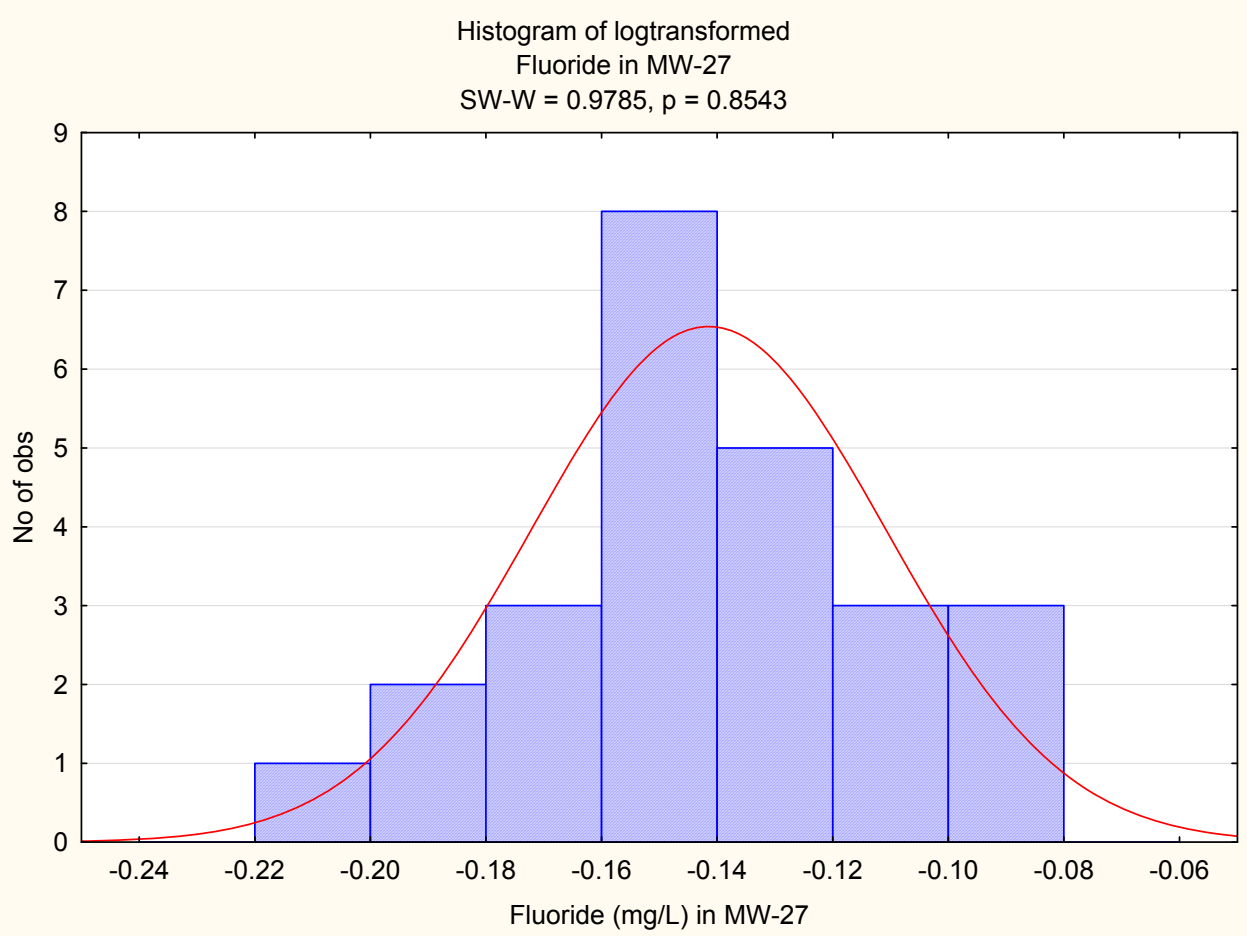

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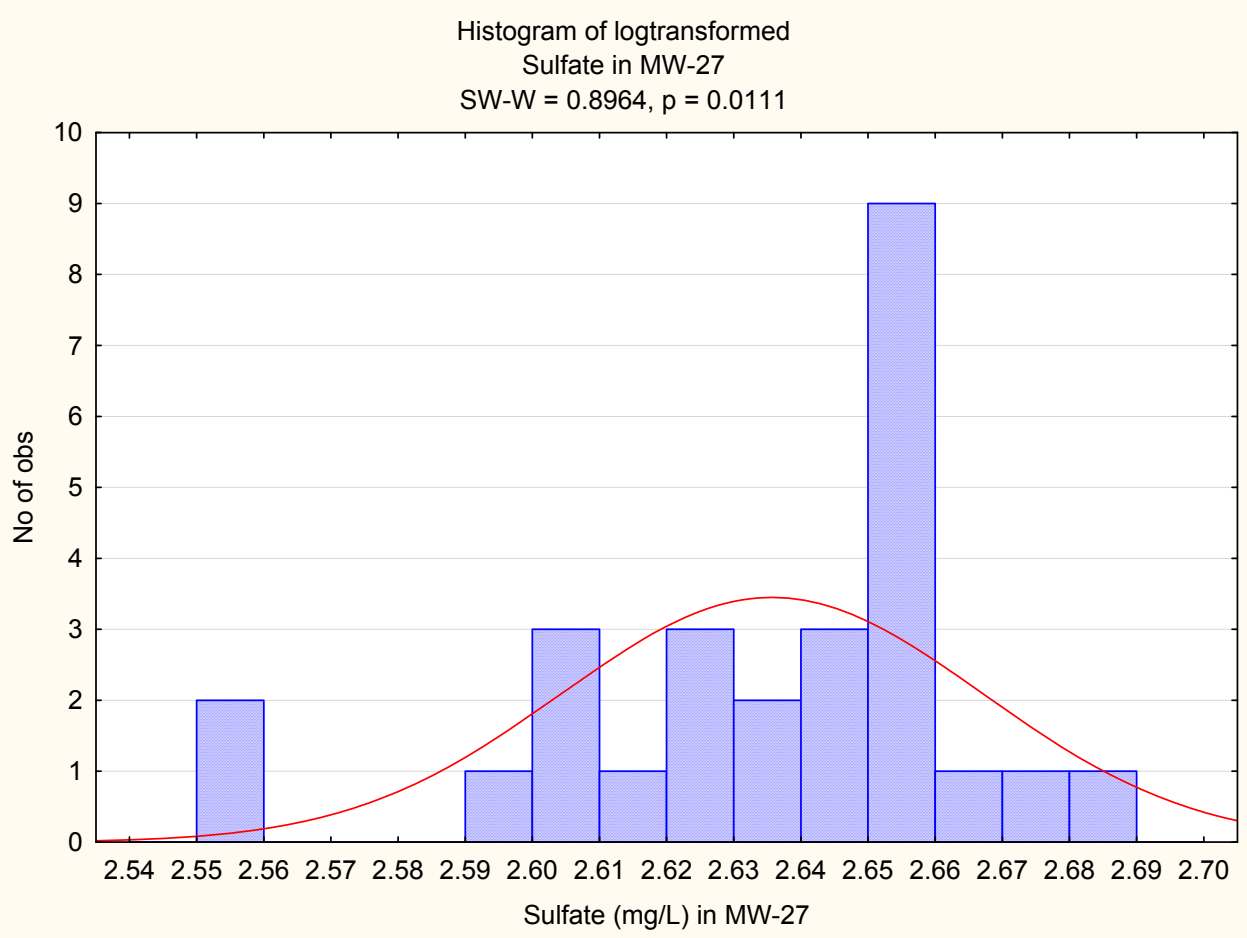

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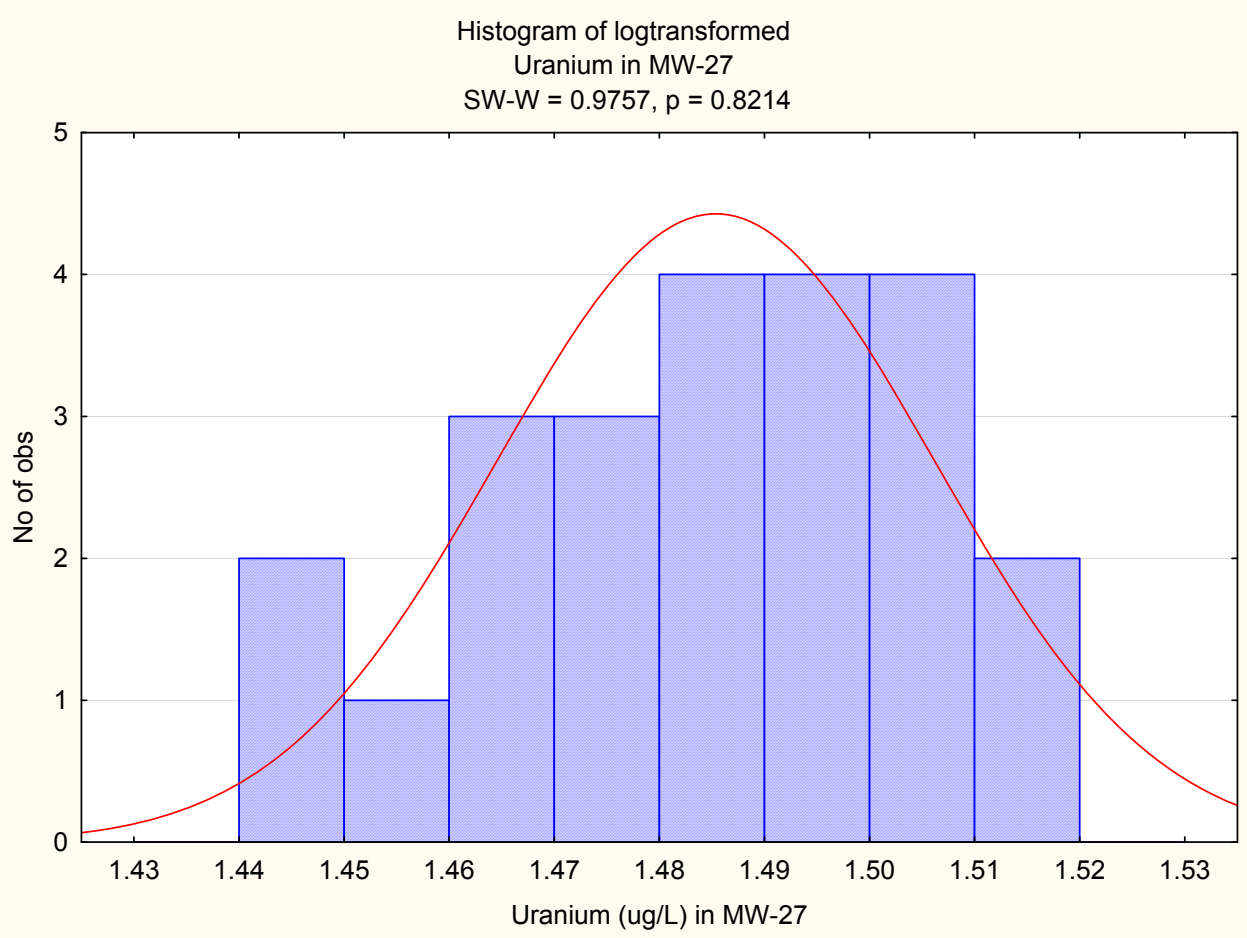
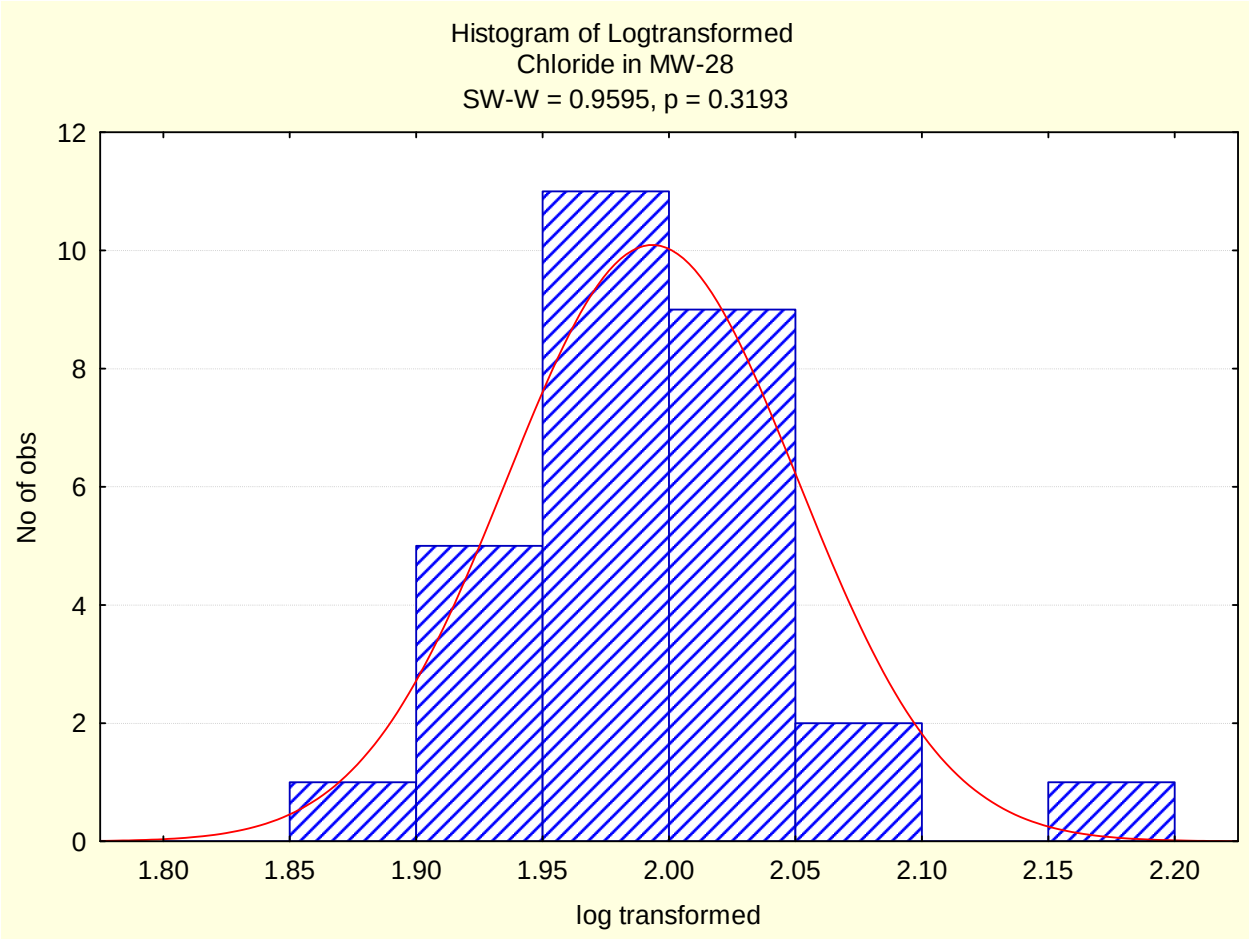
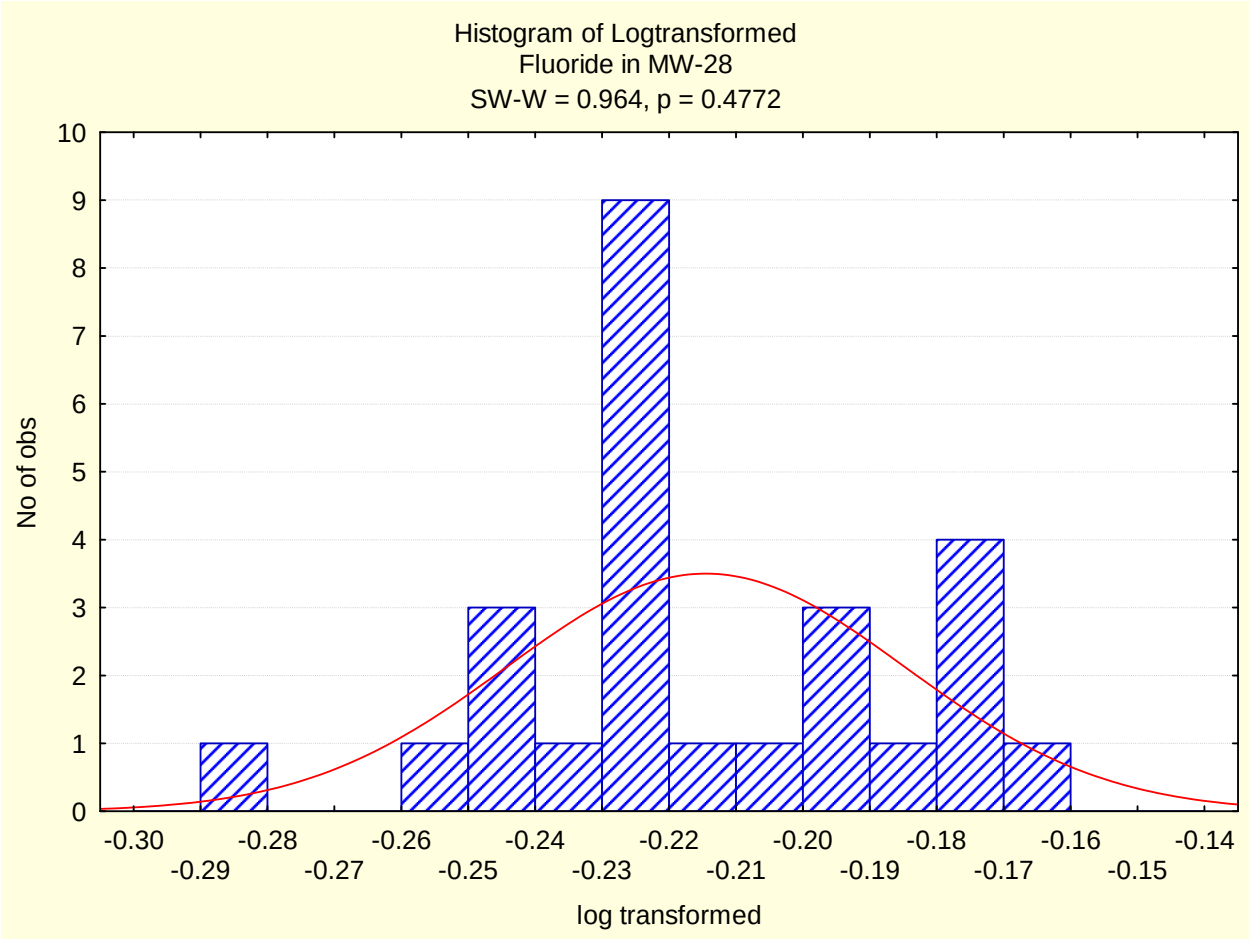


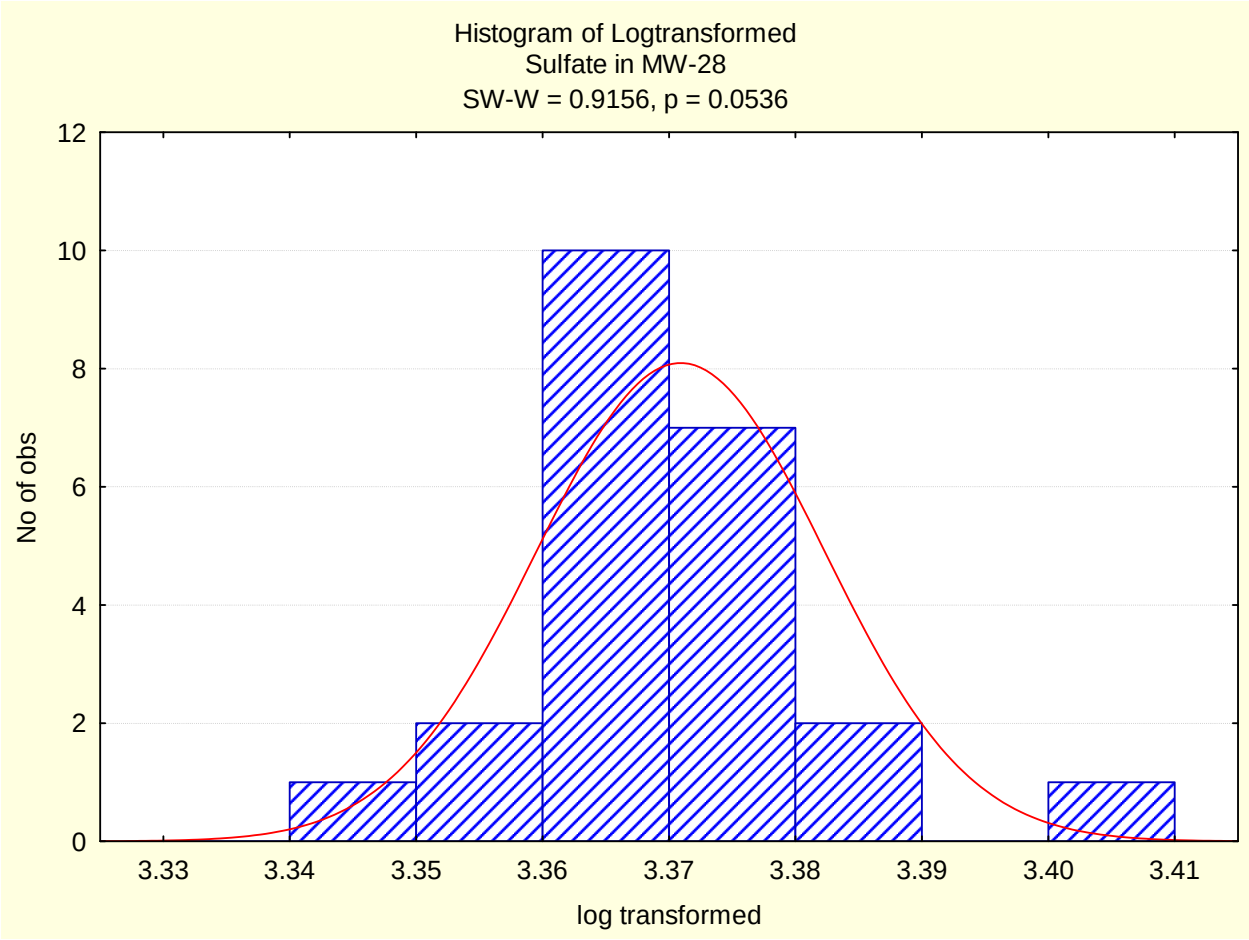
Appendix D-3
Histograms for Indicator Parameters



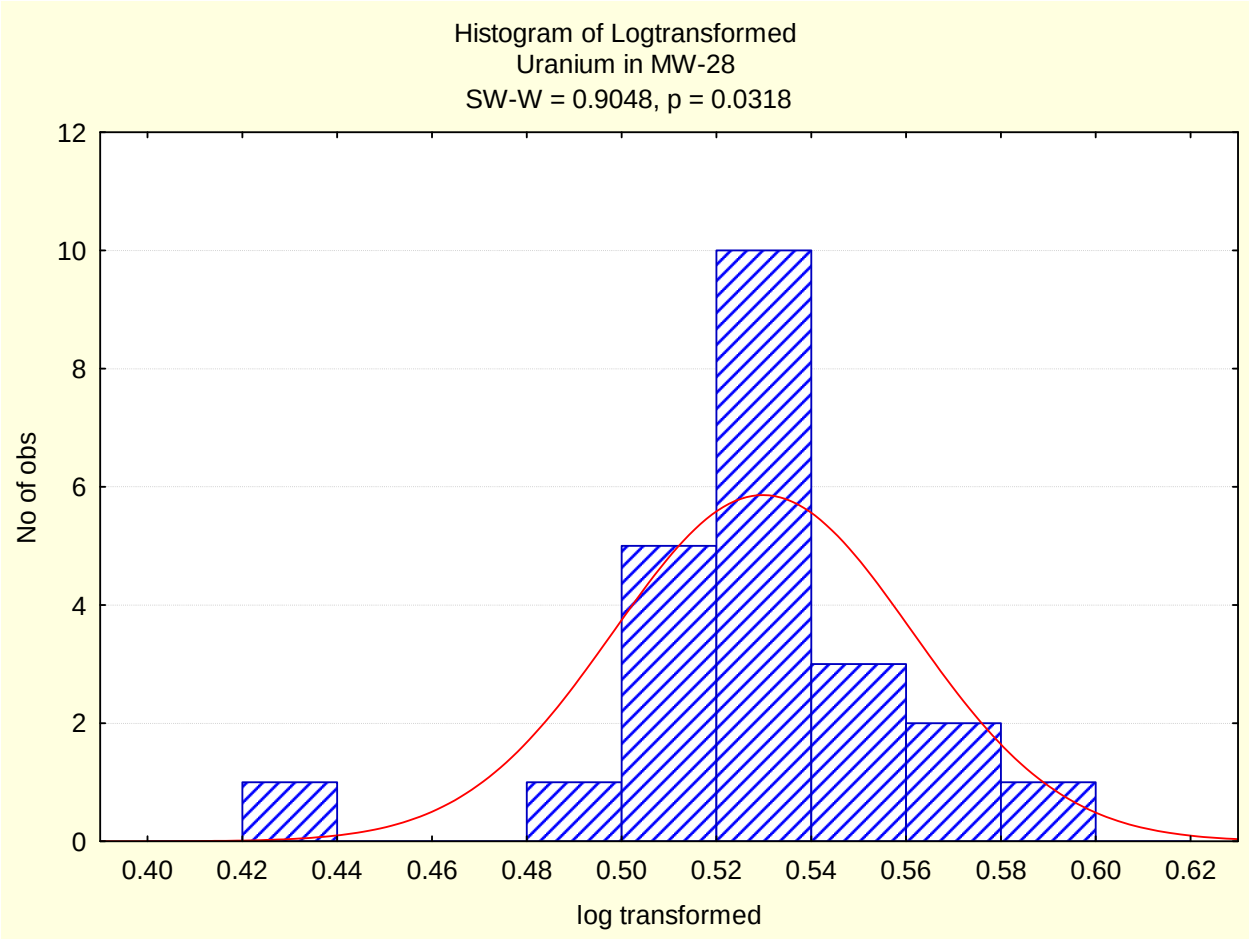
Appendix D-3
Histograms for Indicator Parameters



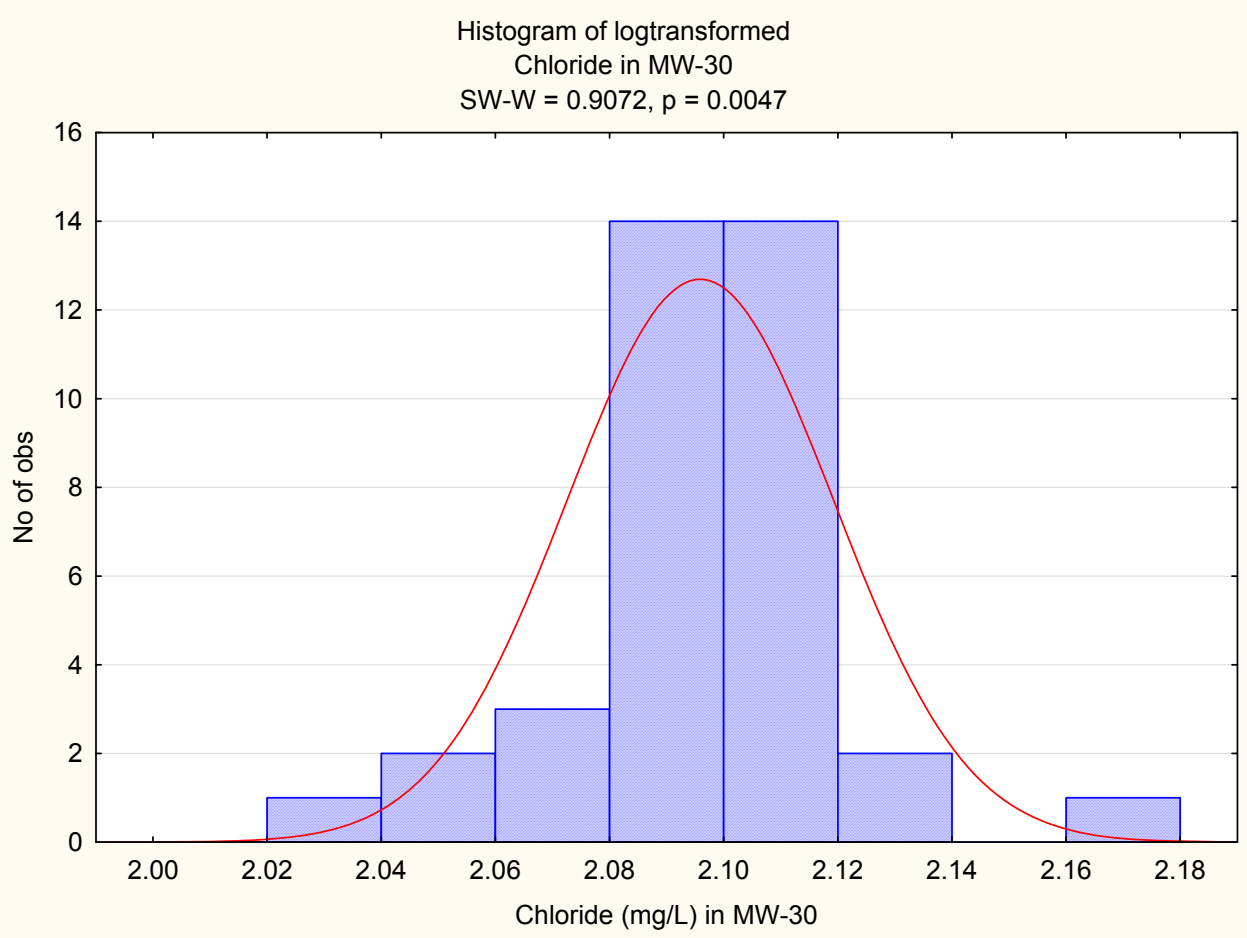
Appendix D-3
Histograms for Indicator Parameters



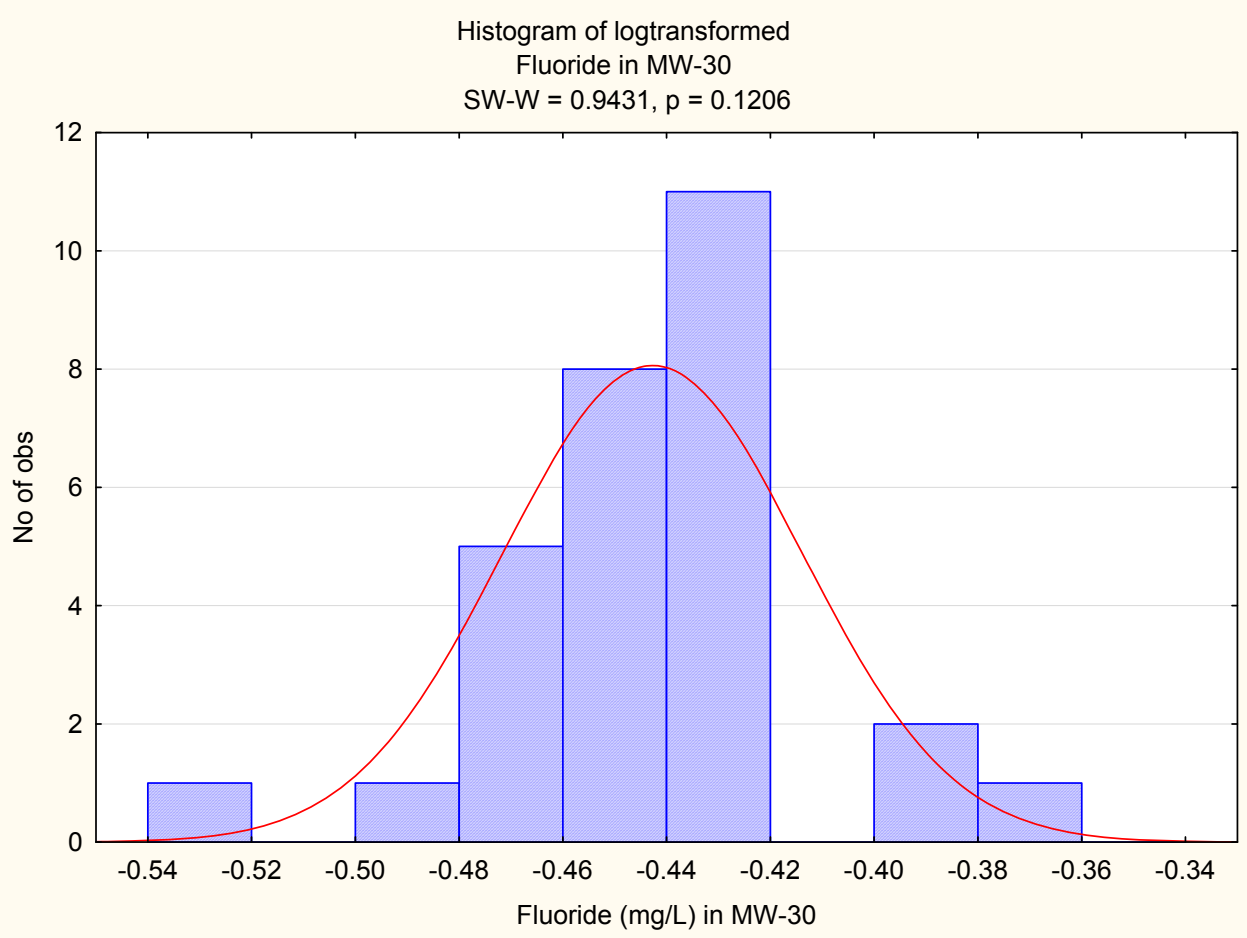
Appendix D-3
Histograms for Indicator Parameters



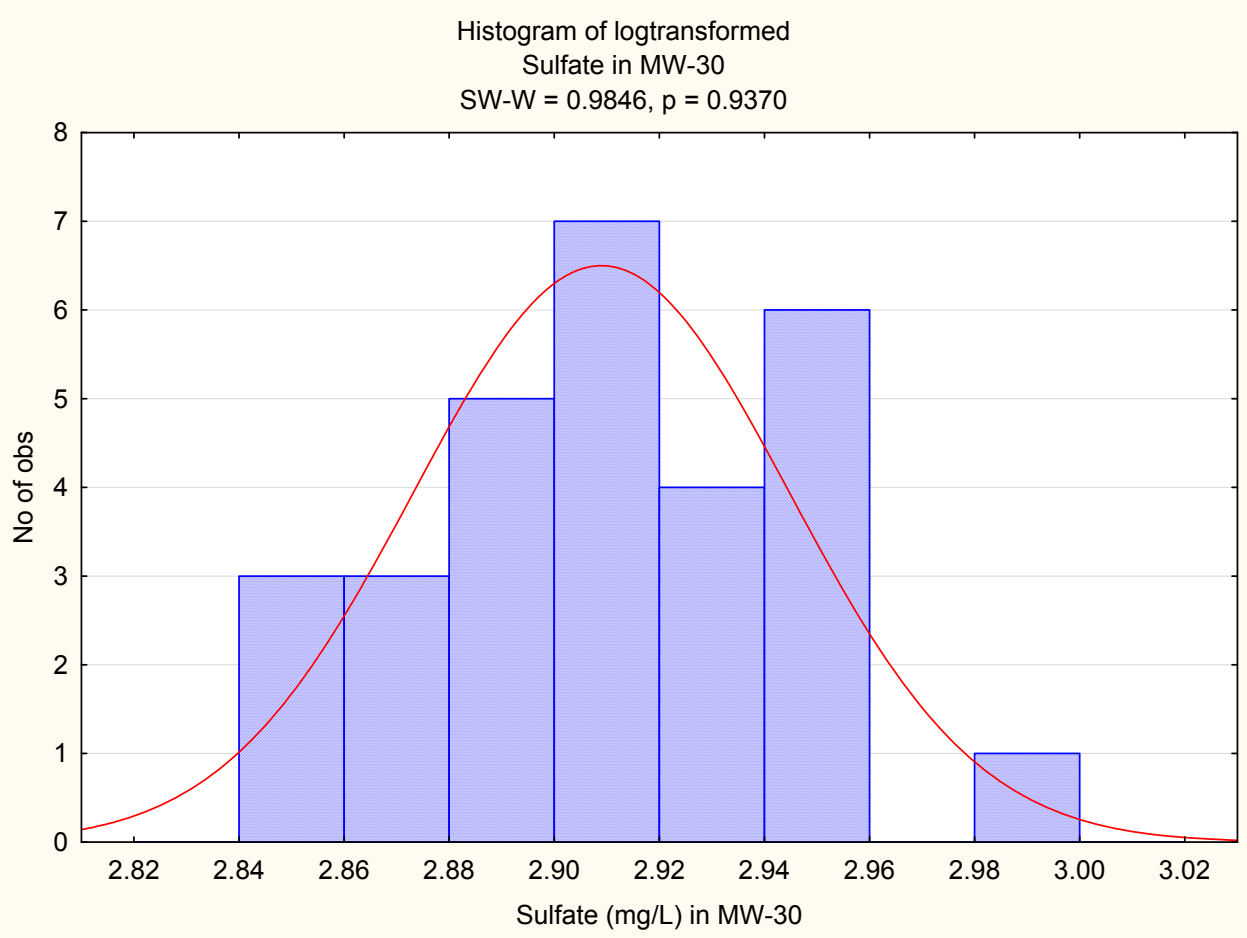
Appendix D-3
Histograms for Indicator Parameters



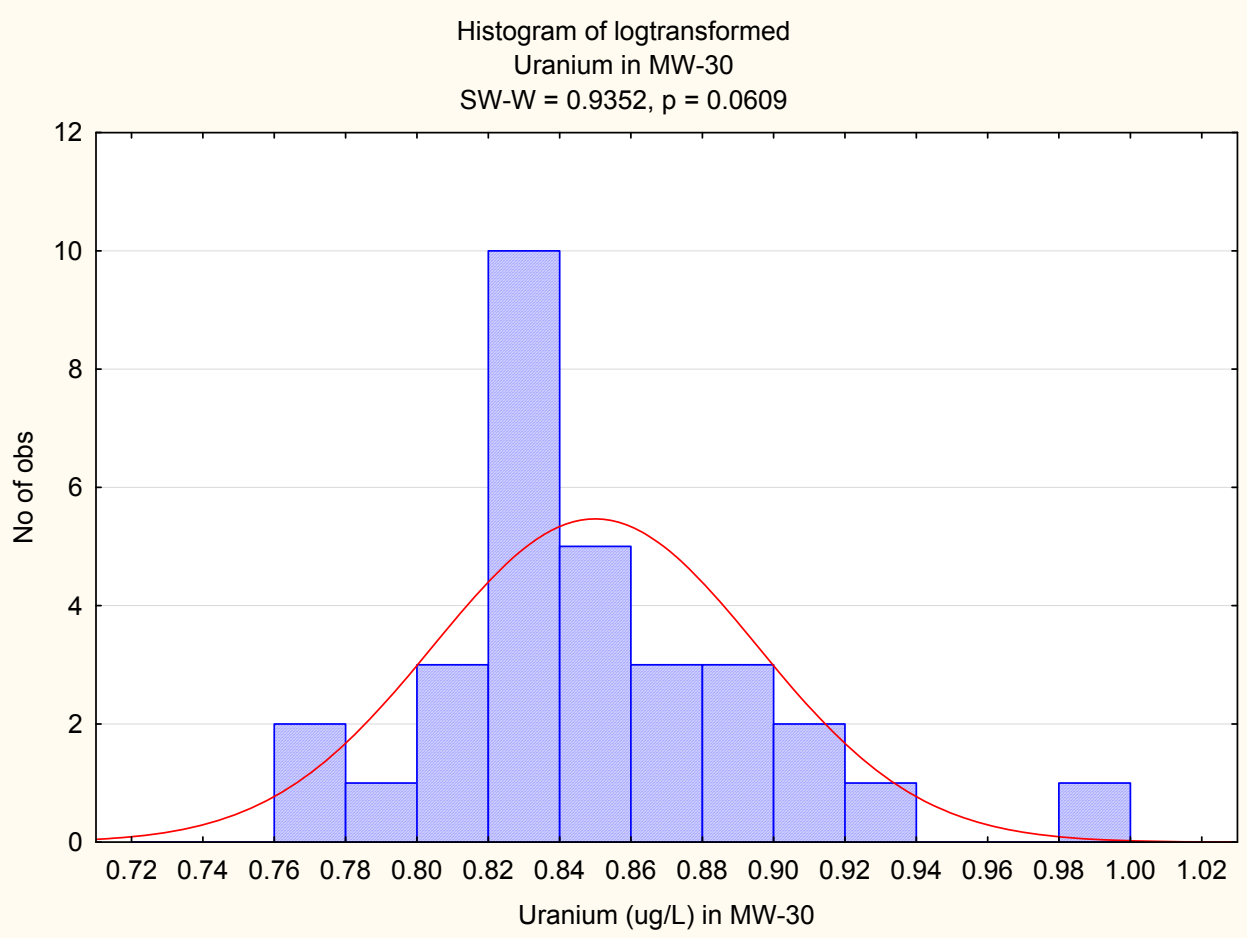
Appendix D-3
Histograms for Indicator Parameters



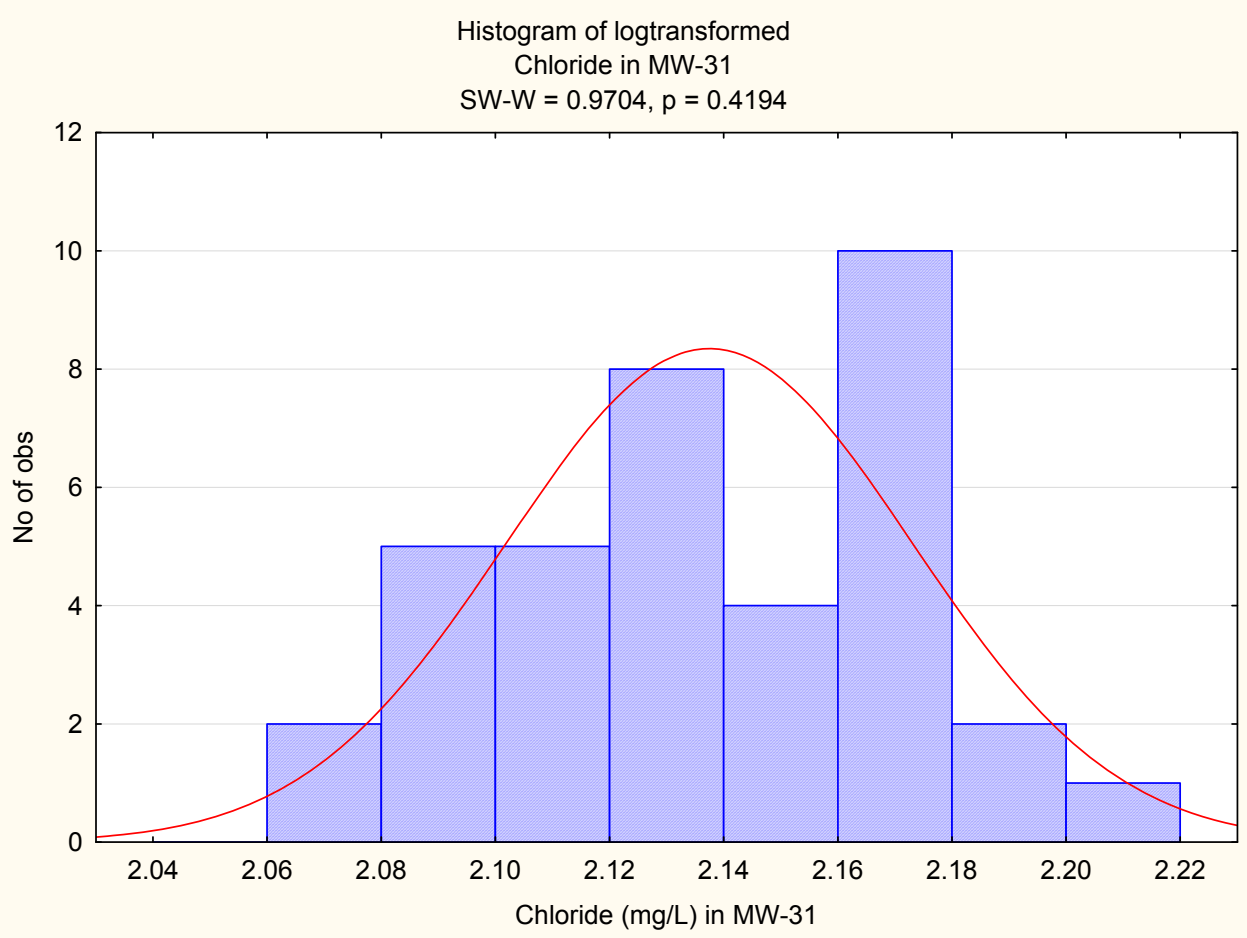
Appendix D-3
Histograms for Indicator Parameters



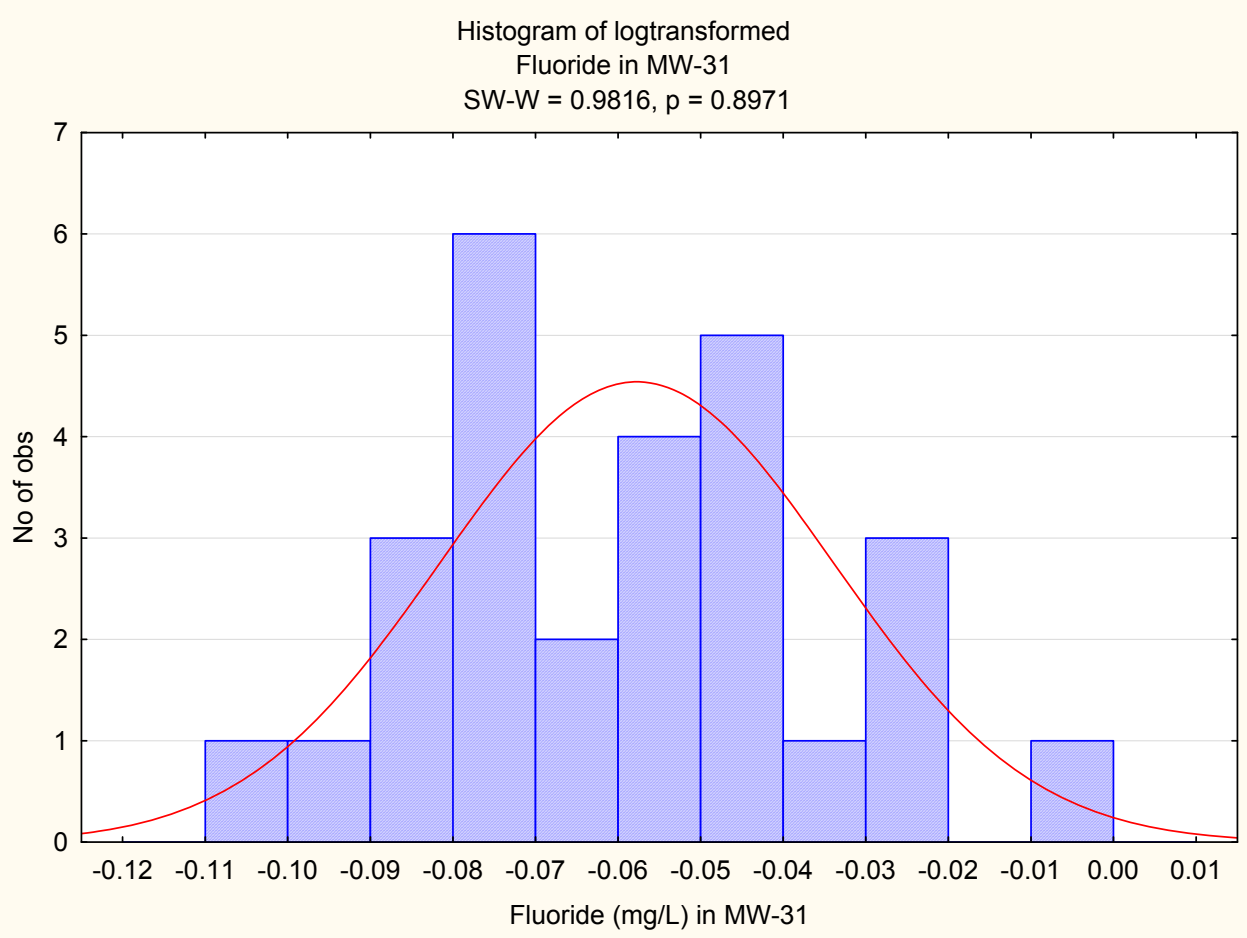
Appendix D-3
Histograms for Indicator Parameters



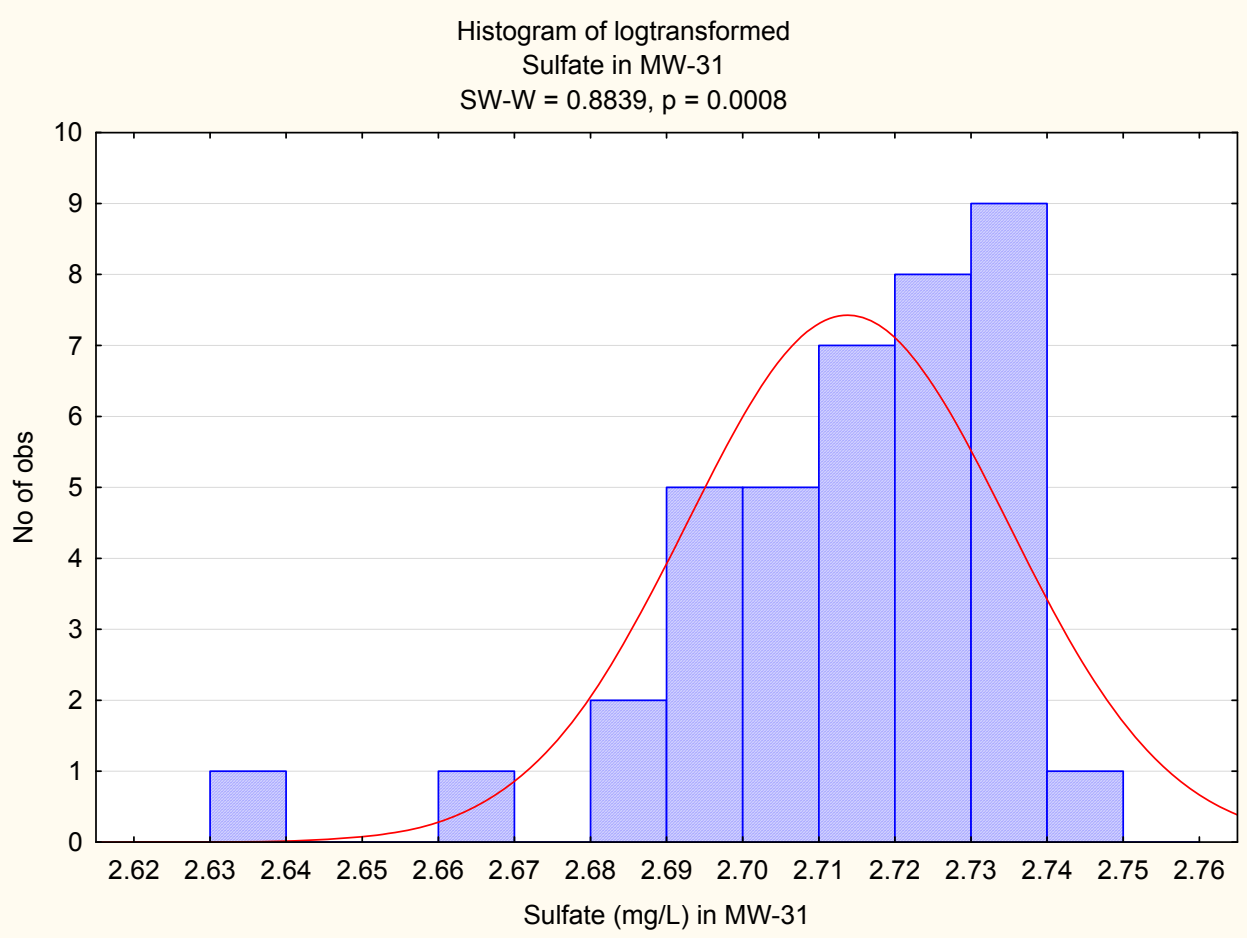
Appendix D-3
Histograms for Indicator Parameters



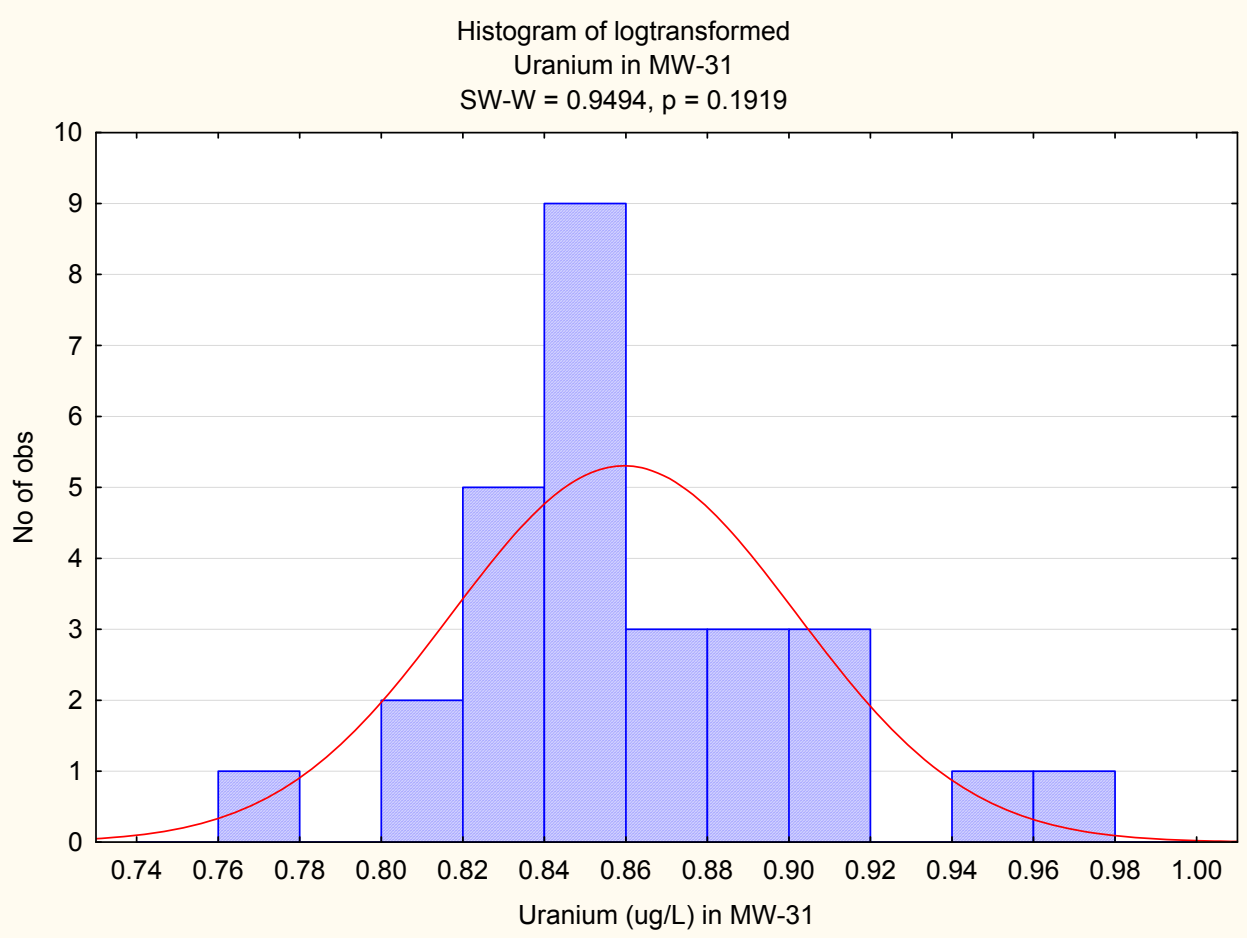
Appendix D-3
Histograms for Indicator Parameters



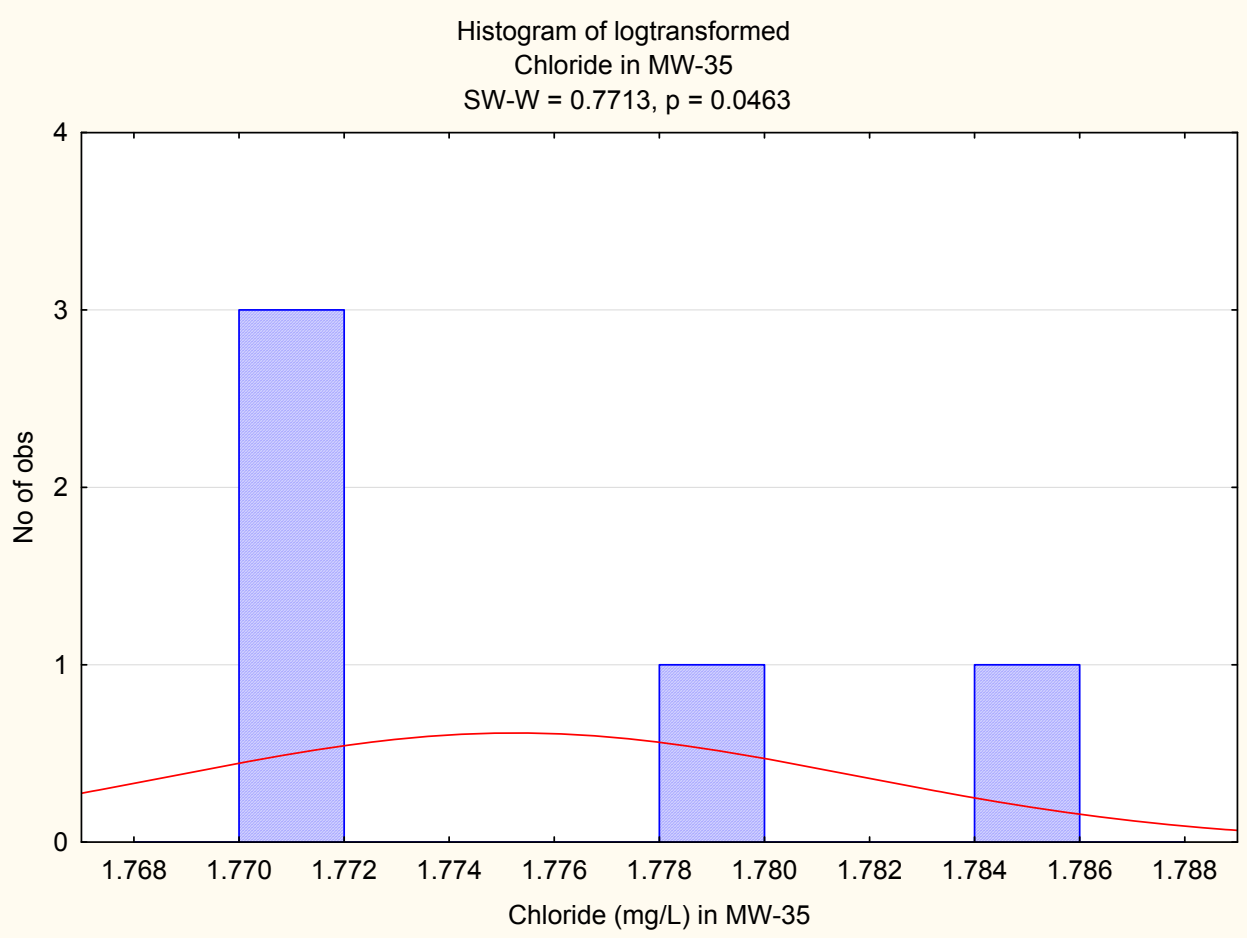
Appendix D-3
Histograms for Indicator Parameters



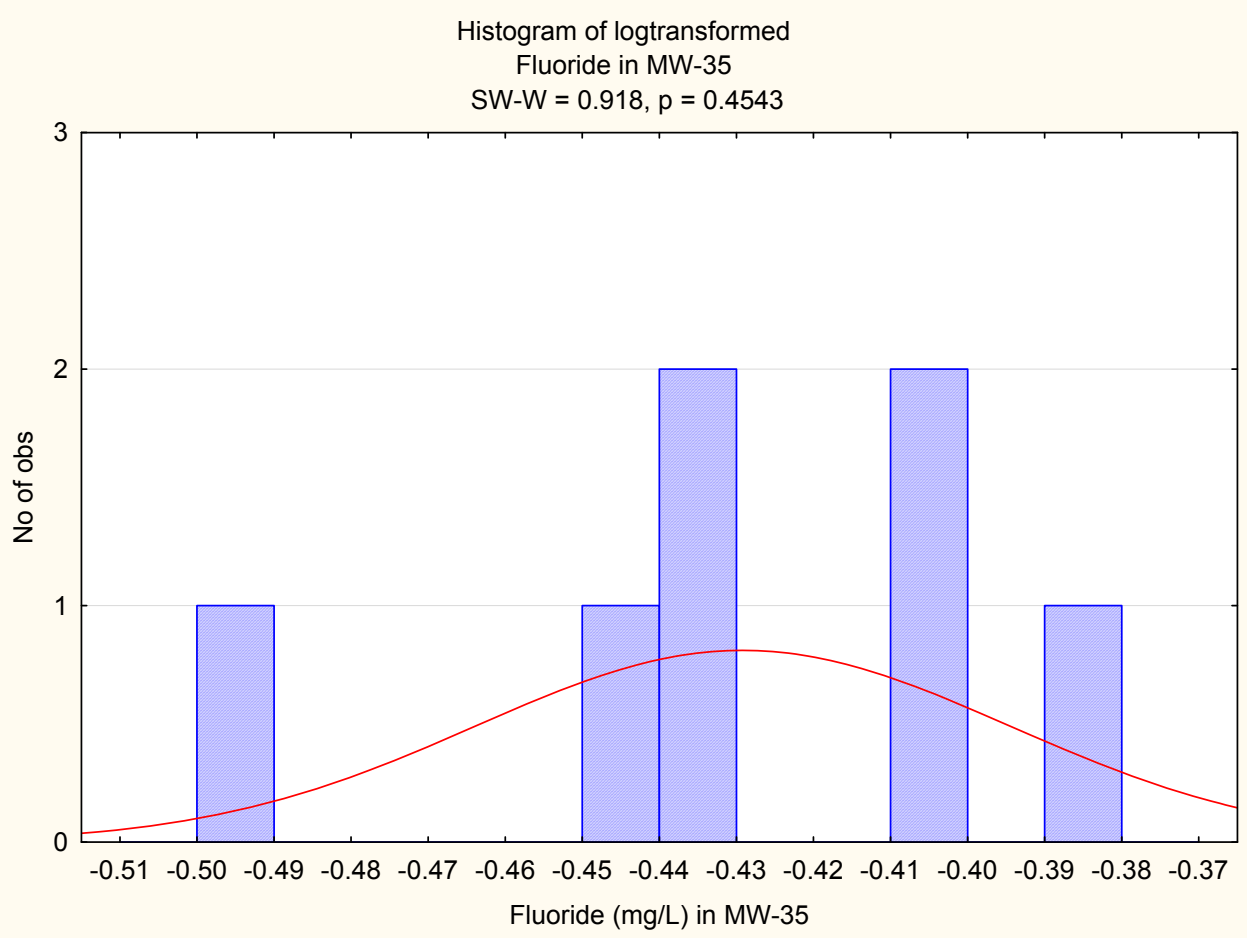
Appendix D-3
Histograms for Indicator Parameters



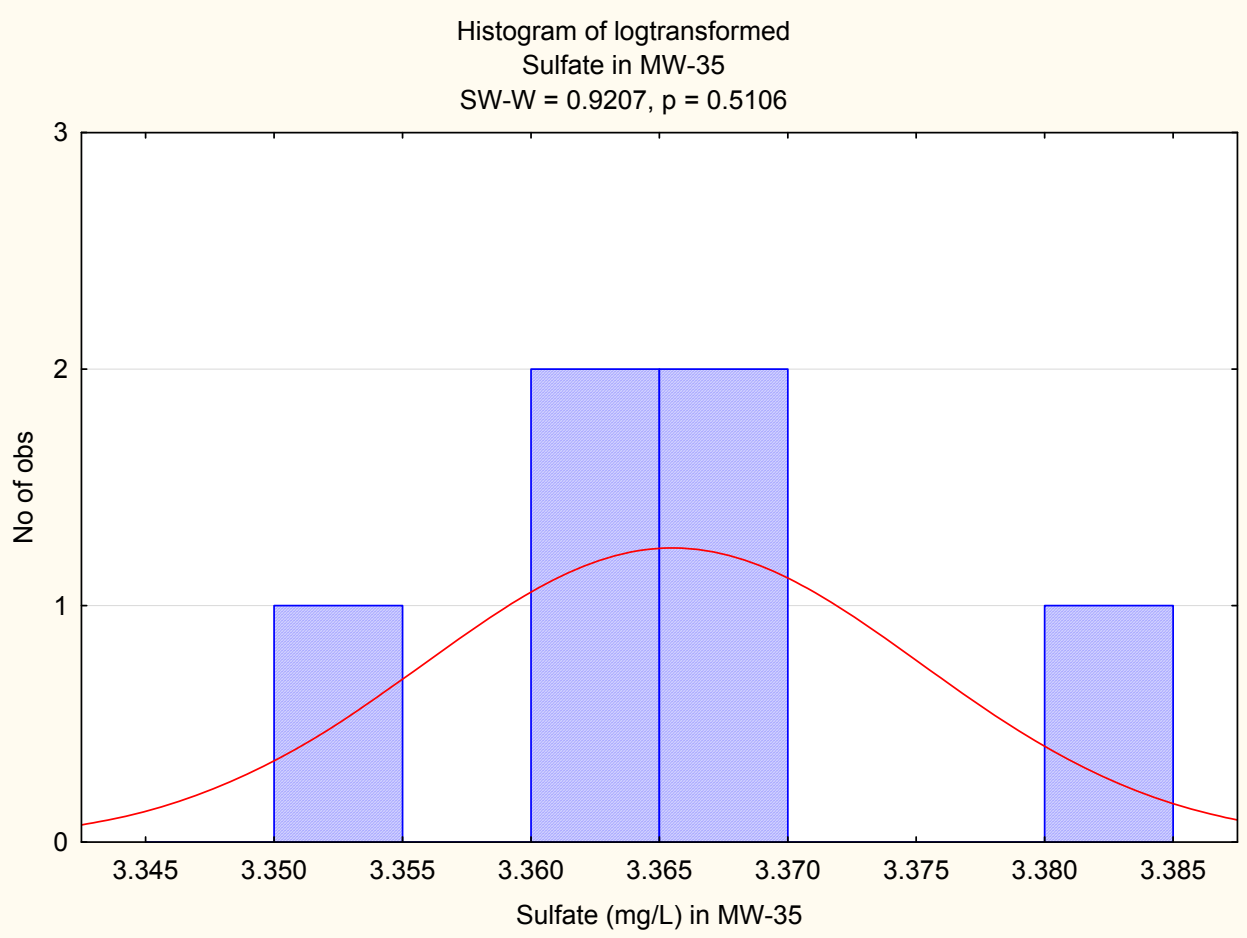
Appendix D-3
Histograms for Indicator Parameters



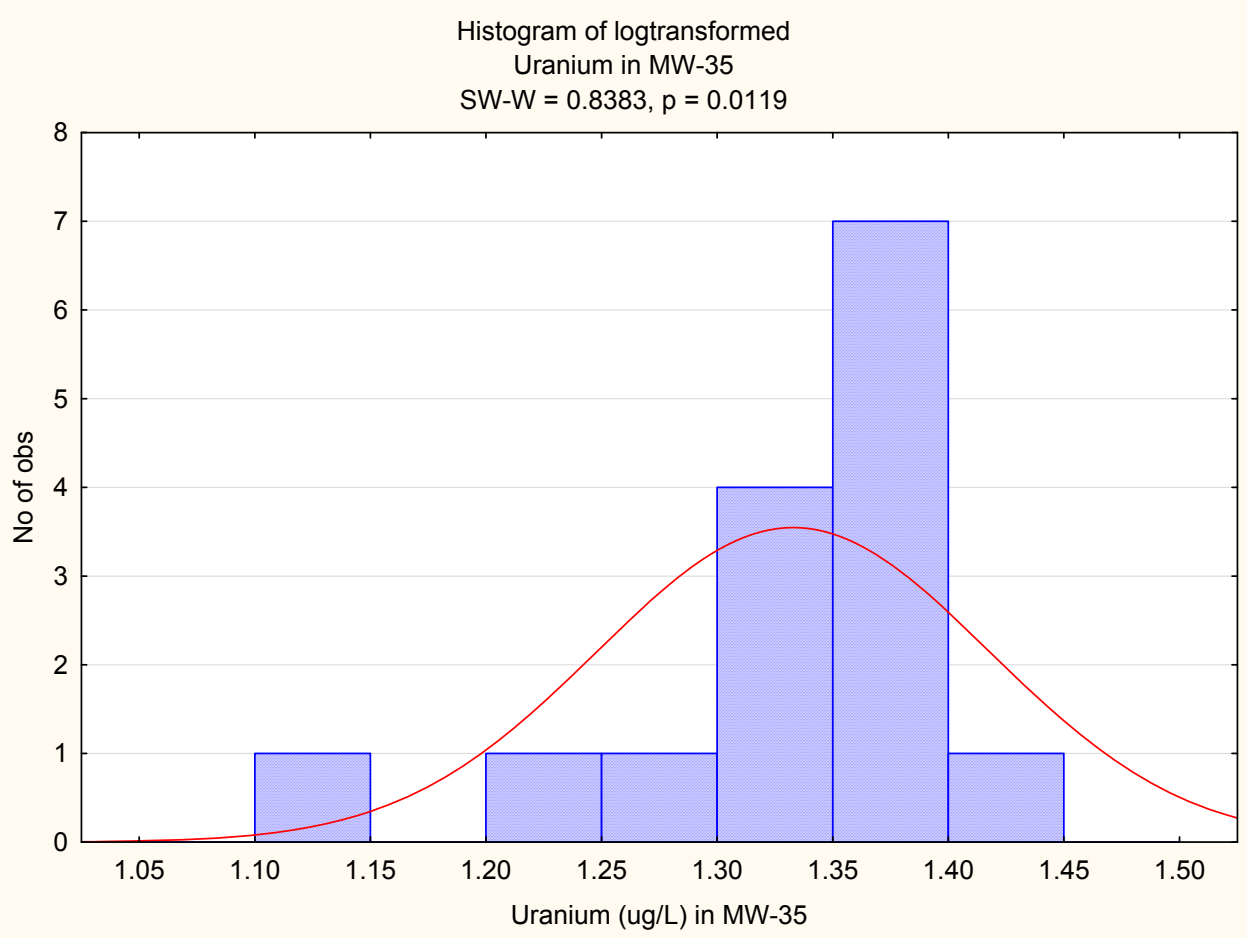
Appendix D-3
Histograms for Indicator Parameters



Appendix D-3
Histograms for Indicator Parameters



Appendix D-3
Histograms for Indicator Parameters



APPENDIX D-4

Mann-Kendall Output for Indicator Parameters

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	10/29/2012 11:58:09 AM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Chloride (mg/L)-mw-14

General Statistics

Number of Values	95
Minimum	12.7
Maximum	27
Mean	19.81
Geometric Mean	19.65
Median	19.4
Standard Deviation	2.573
SEM	0.264

Mann-Kendall Test

Test Value (S)	-1248
Critical Value (0.05)	-1.645
Standard Deviation of S	309.8
Standardized Value of S	-4.025
Approximate p-value	2.854E-05

Statistically significant evidence of a decreasing trend at the specified level of significance.

Chloride (mg/L)-mw-15

General Statistics

Number of Values	84
Minimum	24.1
Maximum	57.1
Mean	40.71
Geometric Mean	40.36
Median	39.75
Standard Deviation	5.446
SEM	0.594

Mann-Kendall Test

Test Value (S)	-259
Critical Value (0.05)	-1.645
Standard Deviation of S	257.6

Standardized Value of S	-1.002
Approximate p-value	0.158

Insufficient evidence to identify a significant trend at the specified level of significance.

Chloride (mg/L)-mw-17

General Statistics

Number of Values	64
Minimum	14.1
Maximum	51
Mean	31.25
Geometric Mean	30.72
Median	29.7
Standard Deviation	5.856
SEM	0.732

Mann-Kendall Test

Test Value (S)	40
Critical Value (0.05)	1.645
Standard Deviation of S	172.4
Standardized Value of S	0.226
Approximate p-value	0.411

Insufficient evidence to identify a significant trend at the specified level of significance.

Chloride (mg/L)-mw-22

General Statistics

Number of Values	16
Minimum	46.3
Maximum	67
Mean	58.77
Geometric Mean	58.55
Median	58
Standard Deviation	5.095
SEM	1.274

Mann-Kendall Test

Test Value (S)	-11
Tabulated p-value	0.345
Standard Deviation of S	22.08
Standardized Value of S	-0.453
Approximate p-value	0.325

Insufficient evidence to identify a significant trend at the specified level of significance.

Chloride (mg/L)-mw-23

General Statistics

Number of Values	24
Minimum	1
Maximum	10
Mean	6.775
Geometric Mean	6.308
Median	7
Standard Deviation	1.964
SEM	0.401

Mann-Kendall Test

Test Value (S)	38
Critical Value (0.05)	1.645
Standard Deviation of S	39.5
Standardized Value of S	0.937
Approximate p-value	0.174

Insufficient evidence to identify a significant trend at the specified level of significance.

Chloride (mg/L)-mw-32

General Statistics

Number of Values	25
Minimum	25
Maximum	35
Mean	31.8
Geometric Mean	31.72
Median	32
Standard Deviation	2.331
SEM	0.466

Mann-Kendall Test

Test Value (S)	-35
Critical Value (0.05)	-1.645
Standard Deviation of S	42.13
Standardized Value of S	-0.807
Approximate p-value	0.21

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	9/14/2012 5:10:08 PM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Chloride (mg/L)-mw-11

General Statistics

Number of Values	121
Minimum	0.031
Maximum	43.2
Mean	32.1
Geometric Mean	30.42
Median	32
Standard Deviation	4.318
SEM	0.393

Mann-Kendall Test

Test Value (S)	-801
Critical Value (0.05)	-1.645
Standard Deviation of S	445.4
Standardized Value of S	-1.796
Approximate p-value	0.0362

Statistically significant evidence of a decreasing trend at the specified level of significance.

Chloride (mg/L)-mw-12

General Statistics

Number of Values	99
Minimum	37.6
Maximum	80.5
Mean	59.49
Geometric Mean	59.16
Median	60.3
Standard Deviation	6.093
SEM	0.612

Mann-Kendall Test

Test Value (S)	-1321
Critical Value (0.05)	-1.645
Standard Deviation of S	330.5

Standardized Value of S	-3.994
Approximate p-value	3.251E-05

Statistically significant evidence of a decreasing trend at the specified level of significance.

Chloride (mg/L)-mw-18

General Statistics

Number of Values	27
Minimum	19.9
Maximum	75
Mean	46.87
Geometric Mean	45.15
Median	47.6
Standard Deviation	12.64
SEM	2.433

Mann-Kendall Test

Test Value (S)	166
Critical Value (0.05)	1.645
Standard Deviation of S	47.85
Standardized Value of S	3.448
Approximate p-value	0.0002819

Statistically significant evidence of an increasing trend at the specified level of significance.

Chloride (mg/L)-mw-24

General Statistics

Number of Values	22
Minimum	39
Maximum	52
Mean	44.82
Geometric Mean	44.74
Median	45
Standard Deviation	2.719
SEM	0.58

Mann-Kendall Test

Test Value (S)	-39
Tabulated p-value	0.144
Standard Deviation of S	34.68
Standardized Value of S	-1.096
Approximate p-value	0.137

Insufficient evidence to identify a significant trend at the specified level of significance.

Chloride (mg/L)-mw-25

General Statistics

Number of Values	28
Minimum	25
Maximum	34
Mean	31.21
Geometric Mean	31.16
Median	31
Standard Deviation	1.893
SEM	0.358

Mann-Kendall Test

Test Value (S)	-117
Critical Value (0.05)	-1.645
Standard Deviation of S	49.37
Standardized Value of S	-2.349
Approximate p-value	0.0094

Statistically significant evidence of a decreasing trend at the specified level of significance.

Chloride (mg/L)-mw-26

General Statistics

Number of Values	49
Minimum	39
Maximum	85
Mean	58.33
Geometric Mean	57.56
Median	57
Standard Deviation	9.807
SEM	1.401

Mann-Kendall Test

Test Value (S)	352
Critical Value (0.05)	1.645
Standard Deviation of S	115.7
Standardized Value of S	3.033
Approximate p-value	0.00121

Statistically significant evidence of an increasing trend at the specified level of significance.

Chloride (mg/L)-mw-27

General Statistics

Number of Values	27
Minimum	32
Maximum	46
Mean	39.37
Geometric Mean	39.13
Median	40
Standard Deviation	4.378
SEM	0.843

Mann-Kendall Test

Test Value (S)	273
Critical Value (0.05)	1.645
Standard Deviation of S	47.74
Standardized Value of S	5.698
Approximate p-value	6.073E-09

Statistically significant evidence of an increasing trend at the specified level of significance.

Chloride (mg/L)-mw-3

General Statistics

Number of Values	83
Minimum	56
Maximum	73
Mean	64.65
Geometric Mean	64.58
Median	65
Standard Deviation	2.996
SEM	0.329

Mann-Kendall Test

Test Value (S)	-642
Critical Value (0.05)	-1.645
Standard Deviation of S	253
Standardized Value of S	-2.533
Approximate p-value	0.00565

Statistically significant evidence of a decreasing trend at the specified level of significance.

Chloride (mg/L)-mw-30

General Statistics

Number of Values	37

Minimum	106
Maximum	145
Mean	124.7
Geometric Mean	124.6
Median	125
Standard Deviation	6.615
SEM	1.087

Mann-Kendall Test

Test Value (S)	137
Critical Value (0.05)	1.645
Standard Deviation of S	76.04
Standardized Value of S	1.788
Approximate p-value	0.0368

Statistically significant evidence of an increasing trend at the specified level of significance.

Chloride (mg/L)-mw-31

General Statistics

Number of Values	37
Minimum	115
Maximum	160
Mean	137.5
Geometric Mean	137.1
Median	138
Standard Deviation	11.08
SEM	1.822

Mann-Kendall Test

Test Value (S)	344
Critical Value (0.05)	1.645
Standard Deviation of S	76.21
Standardized Value of S	4.5
Approximate p-value	3.391E-06

Statistically significant evidence of an increasing trend at the specified level of significance.

Chloride (mg/L)-mw-35

General Statistics

Number of Values	5
Minimum	59
Maximum	61
Mean	59.6

Geometric Mean	59.59
Median	59
Standard Deviation	0.894
SEM	0.4

Mann-Kendall Test

Test Value (S)	-3
Tabulated p-value	0.408
Standard Deviation of S	3.606
Standardized Value of S	-0.555
Approximate p-value	0.29

Insufficient evidence to identify a significant trend at the specified level of significance.

Chloride (mg/L)-mw-3a

General Statistics

Number of Values	19
Minimum	42
Maximum	70
Mean	59.16
Geometric Mean	58.84
Median	60
Standard Deviation	5.947
SEM	1.364

Mann-Kendall Test

Test Value (S)	-28
Tabulated p-value	0.166
Standard Deviation of S	28.4
Standardized Value of S	-0.951
Approximate p-value	0.171

Insufficient evidence to identify a significant trend at the specified level of significance.

Chloride (mg/L)-mw-5

General Statistics

Number of Values	123
Minimum	37.5
Maximum	69.7
Mean	52.49
Geometric Mean	52.29
Median	52
Standard Deviation	4.672

SEM	0.421

Mann-Kendall Test

Test Value (S)	-1344
Critical Value (0.05)	-1.645
Standard Deviation of S	456.7
Standardized Value of S	-2.941
Approximate p-value	0.00164

Statistically significant evidence of a decreasing trend at the specified level of significance.

Chloride (mg/L)-mw-19

General Statistics

Number of Values	30
Minimum	24
Maximum	94
Mean	48.54
Geometric Mean	43.33
Median	37.5
Standard Deviation	24.29
SEM	4.435

Mann-Kendall Test

Test Value (S)	-230
Critical Value (0.05)	-1.645
Standard Deviation of S	56.02
Standardized Value of S	-4.088
Approximate p-value	2.18E-05

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	10/29/2012 11:57:30 AM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Fluoride (mg/L)-mw-14

General Statistics

Number of Values	35
Minimum	0.1
Maximum	0.261
Mean	0.169
Geometric Mean	0.167
Median	0.16
Standard Deviation	0.026
SEM	0.00439

Mann-Kendall Test

Test Value (S)	-254
Critical Value (0.05)	-1.645
Standard Deviation of S	69.03
Standardized Value of S	-3.665
Approximate p-value	0.0001237

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-15

General Statistics

Number of Values	18
Minimum	0.21
Maximum	0.344
Mean	0.253
Geometric Mean	0.251
Median	0.24
Standard Deviation	0.0335
SEM	0.0079

Mann-Kendall Test

Test Value (S)	-81
Tabulated p-value	0.001
Standard Deviation of S	25.75

Standardized Value of S	-3.107
Approximate p-value	0.0009452

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-17

General Statistics

Number of Values	20
Minimum	0.25
Maximum	0.404
Mean	0.291
Geometric Mean	0.288
Median	0.27
Standard Deviation	0.0425
SEM	0.0095

Mann-Kendall Test

Test Value (S)	-81
Tabulated p-value	0.005
Standard Deviation of S	30.2
Standardized Value of S	-2.649
Approximate p-value	0.00404

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-22

General Statistics

Number of Values	14
Minimum	2.78
Maximum	3.27
Mean	2.991
Geometric Mean	2.988
Median	2.94
Standard Deviation	0.151
SEM	0.0404

Mann-Kendall Test

Test Value (S)	27
Tabulated p-value	0.079
Standard Deviation of S	17.97
Standardized Value of S	1.447
Approximate p-value	0.074

Insufficient evidence to identify a significant trend at the specified level of significance.

Fluoride (mg/L)-mw-23

General Statistics

Number of Values	22
Minimum	0.188
Maximum	0.36
Mean	0.25
Geometric Mean	0.246
Median	0.23
Standard Deviation	0.052
SEM	0.0111

Mann-Kendall Test

Test Value (S)	-90
Tabulated p-value	0.005
Standard Deviation of S	34.87
Standardized Value of S	-2.552
Approximate p-value	0.00535

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-32

General Statistics

Number of Values	24
Minimum	0.13
Maximum	0.3
Mean	0.198
Geometric Mean	0.196
Median	0.2
Standard Deviation	0.0328
SEM	0.00669

Mann-Kendall Test

Test Value (S)	20
Critical Value (0.05)	1.645
Standard Deviation of S	39.92
Standardized Value of S	0.476
Approximate p-value	0.317

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	9/14/2012 5:12:31 PM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Fluoride (mg/L)-mw-11

General Statistics

Number of Values	35
Minimum	0.44
Maximum	0.705
Mean	0.541
Geometric Mean	0.538
Median	0.54
Standard Deviation	0.0582
SEM	0.00984

Mann-Kendall Test

Test Value (S)	-98
Critical Value (0.05)	-1.645
Standard Deviation of S	70.11
Standardized Value of S	-1.383
Approximate p-value	0.0833

Insufficient evidence to identify a significant trend at the specified level of significance.

Fluoride (mg/L)-mw-12

General Statistics

Number of Values	20
Minimum	0.186
Maximum	0.35
Mean	0.282
Geometric Mean	0.278
Median	0.3
Standard Deviation	0.0428
SEM	0.00957

Mann-Kendall Test

Test Value (S)	-85
Tabulated p-value	0.003
Standard Deviation of S	30.46

Standardized Value of S	-2.758
Approximate p-value	0.00291

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-18

General Statistics

Number of Values	20
Minimum	0.0089
Maximum	0.4
Mean	0.246
Geometric Mean	0.212
Median	0.22
Standard Deviation	0.0847
SEM	0.0189

Mann-Kendall Test

Test Value (S)	-122
Tabulated p-value	0
Standard Deviation of S	30.48
Standardized Value of S	-3.969
Approximate p-value	3.606E-05

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-24

General Statistics

Number of Values	26
Minimum	0.1
Maximum	0.36
Mean	0.181
Geometric Mean	0.17
Median	0.163
Standard Deviation	0.0722
SEM	0.0141

Mann-Kendall Test

Test Value (S)	-98
Critical Value (0.05)	-1.645
Standard Deviation of S	45.26
Standardized Value of S	-2.143
Approximate p-value	0.0161

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-25

General Statistics

Number of Values	29
Minimum	0.28
Maximum	0.375
Mean	0.326
Geometric Mean	0.326
Median	0.321
Standard Deviation	0.0208
SEM	0.00387

Mann-Kendall Test

Test Value (S)	-87
Critical Value (0.05)	-1.645
Standard Deviation of S	52.6
Standardized Value of S	-1.635
Approximate p-value	0.051

Insufficient evidence to identify a significant trend at the specified level of significance.

Fluoride (mg/L)-mw-26

General Statistics

Number of Values	29
Minimum	0.21
Maximum	0.4
Mean	0.284
Geometric Mean	0.282
Median	0.28
Standard Deviation	0.0378
SEM	0.00702

Mann-Kendall Test

Test Value (S)	-93
Critical Value (0.05)	-1.645
Standard Deviation of S	52.82
Standardized Value of S	-1.742
Approximate p-value	0.0408

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-27

General Statistics

Number of Values	25
Minimum	0.61
Maximum	0.824
Mean	0.723
Geometric Mean	0.721
Median	0.72
Standard Deviation	0.0505
SEM	0.0101

Mann-Kendall Test

Test Value (S)	-134
Critical Value (0.05)	-1.645
Standard Deviation of S	42.68
Standardized Value of S	-3.116
Approximate p-value	0.0009171

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-3

General Statistics

Number of Values	44
Minimum	0.074
Maximum	1.04
Mean	0.543
Geometric Mean	0.501
Median	0.505
Standard Deviation	0.206
SEM	0.0311

Mann-Kendall Test

Test Value (S)	497
Critical Value (0.05)	1.645
Standard Deviation of S	98.79
Standardized Value of S	5.021
Approximate p-value	2.572E-07

Statistically significant evidence of an increasing trend at the specified level of significance.

Fluoride (mg/L)-mw-30

General Statistics

Number of Values	29

Minimum	0.3
Maximum	0.423
Mean	0.361
Geometric Mean	0.36
Median	0.36
Standard Deviation	0.0238
SEM	0.00442

Mann-Kendall Test

Test Value (S)	-66
Critical Value (0.05)	-1.645
Standard Deviation of S	52.15
Standardized Value of S	-1.246
Approximate p-value	0.106

Insufficient evidence to identify a significant trend at the specified level of significance.

Fluoride (mg/L)-mw-31

General Statistics

Number of Values	27
Minimum	0.78
Maximum	0.989
Mean	0.876
Geometric Mean	0.875
Median	0.88
Standard Deviation	0.048
SEM	0.00924

Mann-Kendall Test

Test Value (S)	-147
Critical Value (0.05)	-1.645
Standard Deviation of S	47.77
Standardized Value of S	-3.056
Approximate p-value	0.00112

Statistically significant evidence of a decreasing trend at the specified level of significance.

Fluoride (mg/L)-mw-35

General Statistics

Number of Values	7
Minimum	0.32
Maximum	0.41
Mean	0.373

Geometric Mean	0.372
Median	0.37
Standard Deviation	0.0287
SEM	0.0108

Mann-Kendall Test

Test Value (S)	-5
Tabulated p-value	0.281
Standard Deviation of S	6.506
Standardized Value of S	-0.615
Approximate p-value	0.269

Insufficient evidence to identify a significant trend at the specified level of significance.

Fluoride (mg/L)-mw-3a

General Statistics

Number of Values	19
Minimum	0.94
Maximum	1.6
Mean	1.238
Geometric Mean	1.223
Median	1.177
Standard Deviation	0.201
SEM	0.0462

Mann-Kendall Test

Test Value (S)	-38
Tabulated p-value	0.093
Standard Deviation of S	28.53
Standardized Value of S	-1.297
Approximate p-value	0.0973

Insufficient evidence to identify a significant trend at the specified level of significance.

Fluoride (mg/L)-mw-5

General Statistics

Number of Values	44
Minimum	0.33
Maximum	1.3
Mean	0.885
Geometric Mean	0.86
Median	0.92
Standard Deviation	0.19

SEM	0.0286

Mann-Kendall Test

Test Value (S)	280
Critical Value (0.05)	1.645
Standard Deviation of S	98.69
Standardized Value of S	2.827
Approximate p-value	0.00235

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	10/29/2012 11:56:54 AM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Sulfate (mg/L)-mw-14

General Statistics

Number of Values	64
Minimum	1820
Maximum	2330
Mean	2139
Geometric Mean	2136
Median	2145
Standard Deviation	101.3
SEM	12.67

Mann-Kendall Test

Test Value (S)	222
Critical Value (0.05)	1.645
Standard Deviation of S	172.4
Standardized Value of S	1.282
Approximate p-value	0.1

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-15

General Statistics

Number of Values	50
Minimum	1876
Maximum	2560
Mean	2305
Geometric Mean	2301
Median	2315
Standard Deviation	125.3
SEM	17.72

Mann-Kendall Test

Test Value (S)	-3
Critical Value (0.05)	-1.645
Standard Deviation of S	119.5

Standardized Value of S	-0.0167
Approximate p-value	0.493

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-17

General Statistics

Number of Values	30
Minimum	2004
Maximum	2860
Mean	2489
Geometric Mean	2481
Median	2510
Standard Deviation	195
SEM	35.6

Mann-Kendall Test

Test Value (S)	-85
Critical Value (0.05)	-1.645
Standard Deviation of S	56.03
Standardized Value of S	-1.499
Approximate p-value	0.0669

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-22

General Statistics

Number of Values	16
Minimum	3142
Maximum	6100
Mean	5103
Geometric Mean	5049
Median	5215
Standard Deviation	711.7
SEM	177.9

Mann-Kendall Test

Test Value (S)	-11
Tabulated p-value	0.345
Standard Deviation of S	22.19
Standardized Value of S	-0.451
Approximate p-value	0.326

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-23

General Statistics

Number of Values	24
Minimum	1680
Maximum	2460
Mean	2224
Geometric Mean	2217
Median	2275
Standard Deviation	179.1
SEM	36.55

Mann-Kendall Test

Test Value (S)	32
Critical Value (0.05)	1.645
Standard Deviation of S	40.27
Standardized Value of S	0.77
Approximate p-value	0.221

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-32

General Statistics

Number of Values	26
Minimum	1950
Maximum	2470
Mean	2336
Geometric Mean	2333
Median	2380
Standard Deviation	127.6
SEM	25.02

Mann-Kendall Test

Test Value (S)	1
Critical Value (0.05)	1.645
Standard Deviation of S	45.32
Standardized Value of S	0
Approximate p-value	0.5

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	9/14/2012 5:14:25 PM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Sulfate (mg/L)-mw-11

General Statistics

Number of Values	87
Minimum	895
Maximum	1309
Mean	1039
Geometric Mean	1035
Median	1023
Standard Deviation	90.78
SEM	9.733

Mann-Kendall Test

Test Value (S)	2015
Critical Value (0.05)	1.645
Standard Deviation of S	272.6
Standardized Value of S	7.387
Approximate p-value	7.516E-14

Statistically significant evidence of an increasing trend at the specified level of significance.

Sulfate (mg/L)-mw-12

General Statistics

Number of Values	71
Minimum	1850
Maximum	2560
Mean	2320
Geometric Mean	2316
Median	2338
Standard Deviation	140.9
SEM	16.72

Mann-Kendall Test

Test Value (S)	-539
Critical Value (0.05)	-1.645
Standard Deviation of S	201.4

Standardized Value of S	-2.671
Approximate p-value	0.00378

Statistically significant evidence of a decreasing trend at the specified level of significance.

Sulfate (mg/L)-mw-18

General Statistics

Number of Values	30
Minimum	1069
Maximum	2020
Mean	1668
Geometric Mean	1649
Median	1720
Standard Deviation	249.2
SEM	45.49

Mann-Kendall Test

Test Value (S)	255
Critical Value (0.05)	1.645
Standard Deviation of S	56.01
Standardized Value of S	4.535
Approximate p-value	2.887E-06

Statistically significant evidence of an increasing trend at the specified level of significance.

Sulfate (mg/L)-mw-24

General Statistics

Number of Values	26
Minimum	2290
Maximum	2950
Mean	2652
Geometric Mean	2648
Median	2675
Standard Deviation	154.5
SEM	30.31

Mann-Kendall Test

Test Value (S)	41
Critical Value (0.05)	1.645
Standard Deviation of S	45.27
Standardized Value of S	0.884
Approximate p-value	0.188

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-25

General Statistics

Number of Values	29
Minimum	1570
Maximum	1880
Mean	1693
Geometric Mean	1691
Median	1680
Standard Deviation	80.4
SEM	14.93

Mann-Kendall Test

Test Value (S)	-72
Critical Value (0.05)	-1.645
Standard Deviation of S	53.19
Standardized Value of S	-1.335
Approximate p-value	0.0909

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-26

General Statistics

Number of Values	31
Minimum	1520
Maximum	2160
Mean	1904
Geometric Mean	1900
Median	1890
Standard Deviation	116.2
SEM	20.87

Mann-Kendall Test

Test Value (S)	41
Critical Value (0.05)	1.645
Standard Deviation of S	58.7
Standardized Value of S	0.681
Approximate p-value	0.248

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-27

General Statistics

Number of Values	27
Minimum	360
Maximum	480
Mean	432.8
Geometric Mean	431.7
Median	442
Standard Deviation	30.02
SEM	5.778

Mann-Kendall Test

Test Value (S)	154
Critical Value (0.05)	1.645
Standard Deviation of S	47.91
Standardized Value of S	3.194
Approximate p-value	0.0007028

Statistically significant evidence of an increasing trend at the specified level of significance.

Sulfate (mg/L)-mw-3

General Statistics

Number of Values	90
Minimum	1890
Maximum	4030
Mean	3092
Geometric Mean	3060
Median	3202
Standard Deviation	418.1
SEM	44.07

Mann-Kendall Test

Test Value (S)	1055
Critical Value (0.05)	1.645
Standard Deviation of S	286.9
Standardized Value of S	3.674
Approximate p-value	0.0001194

Statistically significant evidence of an increasing trend at the specified level of significance.

Sulfate (mg/L)-mw-30

General Statistics

Number of Values	29

Minimum	696
Maximum	977
Mean	812.6
Geometric Mean	810
Median	799
Standard Deviation	67.22
SEM	12.48

Mann-Kendall Test

Test Value (S)	-307
Critical Value (0.05)	-1.645
Standard Deviation of S	53.3
Standardized Value of S	-5.741
Approximate p-value	4.707E-09

Statistically significant evidence of a decreasing trend at the specified level of significance.

Sulfate (mg/L)-mw-31

General Statistics

Number of Values	39
Minimum	436
Maximum	552
Mean	517.3
Geometric Mean	516.8
Median	522
Standard Deviation	24.15
SEM	3.867

Mann-Kendall Test

Test Value (S)	274
Critical Value (0.05)	1.645
Standard Deviation of S	82.58
Standardized Value of S	3.306
Approximate p-value	0.0004731

Statistically significant evidence of an increasing trend at the specified level of significance.

Sulfate (mg/L)-mw-35

General Statistics

Number of Values	6
Minimum	2240
Maximum	2400
Mean	2320

Geometric Mean	2320
Median	2320
Standard Deviation	51.38
SEM	20.98

Mann-Kendall Test

Test Value (S)	1
Tabulated p-value	0.5
Standard Deviation of S	5.132
Standardized Value of S	0
Approximate p-value	0.5

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-3a

General Statistics

Number of Values	23
Minimum	3220
Maximum	3870
Mean	3597
Geometric Mean	3592
Median	3560
Standard Deviation	192.3
SEM	40.11

Mann-Kendall Test

Test Value (S)	52
Critical Value (0.05)	1.645
Standard Deviation of S	37.82
Standardized Value of S	1.348
Approximate p-value	0.0888

Insufficient evidence to identify a significant trend at the specified level of significance.

Sulfate (mg/L)-mw-5

General Statistics

Number of Values	90
Minimum	860
Maximum	1518
Mean	1133
Geometric Mean	1129
Median	1130
Standard Deviation	105.1

SEM	11.08

Mann-Kendall Test

Test Value (S)	-619
Critical Value (0.05)	-1.645
Standard Deviation of S	286.8
Standardized Value of S	-2.155
Approximate p-value	0.0156

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	10/29/2012 11:56:08 AM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Uranium (ug/L)-mw-14

General Statistics

Number of Values	122
Minimum	19.4
Maximum	98
Mean	61.07
Geometric Mean	59.63
Median	63.4
Standard Deviation	12.08
SEM	1.093

Mann-Kendall Test

Test Value (S)	1099
Critical Value (0.05)	1.645
Standard Deviation of S	451.9
Standardized Value of S	2.43
Approximate p-value	0.00755

Statistically significant evidence of an increasing trend at the specified level of significance.

Uranium (ug/L)-mw-15

General Statistics

Number of Values	86
Minimum	25.22
Maximum	65.67
Mean	43.91
Geometric Mean	43.22
Median	44.78
Standard Deviation	7.54
SEM	0.813

Mann-Kendall Test

Test Value (S)	821
Critical Value (0.05)	1.645
Standard Deviation of S	268.1

Standardized Value of S	3.059
Approximate p-value	0.00111

Statistically significant evidence of an increasing trend at the specified level of significance.

Uranium (ug/L)-mw-17

General Statistics

Number of Values	65
Minimum	4.627
Maximum	46.8
Mean	28.87
Geometric Mean	27.6
Median	28.2
Standard Deviation	7.629
SEM	0.946

Mann-Kendall Test

Test Value (S)	-68
Critical Value (0.05)	-1.645
Standard Deviation of S	176.6
Standardized Value of S	-0.379
Approximate p-value	0.352

Insufficient evidence to identify a significant trend at the specified level of significance.

Uranium (ug/L)-mw-22

General Statistics

Number of Values	16
Minimum	27.2
Maximum	52.4
Mean	44.54
Geometric Mean	43.91
Median	46.1
Standard Deviation	7.145
SEM	1.786

Mann-Kendall Test

Test Value (S)	-53
Tabulated p-value	0.01
Standard Deviation of S	22.19
Standardized Value of S	-2.344
Approximate p-value	0.00955

Statistically significant evidence of a decreasing trend at the specified level of significance.

Uranium (ug/L)-mw-23

General Statistics

Number of Values	23
Minimum	8.21
Maximum	31.8
Mean	18.61
Geometric Mean	17.68
Median	19.4
Standard Deviation	5.788
SEM	1.207

Mann-Kendall Test

Test Value (S)	-185
Critical Value (0.05)	-1.645
Standard Deviation of S	37.84
Standardized Value of S	-4.863
Approximate p-value	5.783E-07

Statistically significant evidence of a decreasing trend at the specified level of significance.

Uranium (ug/L)-mw-32

General Statistics

Number of Values	26
Minimum	0.58
Maximum	5.15
Mean	2.582
Geometric Mean	2.436
Median	2.49
Standard Deviation	0.849
SEM	0.166

Mann-Kendall Test

Test Value (S)	-68
Critical Value (0.05)	-1.645
Standard Deviation of S	45.36
Standardized Value of S	-1.477
Approximate p-value	0.0698

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	9/14/2012 5:17:42 PM
From File	Cl.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Uranium (ug/L)-mw-11

General Statistics

Number of Values	100
Minimum	0.00015
Maximum	3.03
Mean	0.747
Geometric Mean	0.396
Median	0.723
Standard Deviation	0.625
SEM	0.0625

Mann-Kendall Test

Test Value (S)	-174
Critical Value (0.05)	-1.645
Standard Deviation of S	335.2
Standardized Value of S	-0.516
Approximate p-value	0.303

Insufficient evidence to identify a significant trend at the specified level of significance.

Uranium (ug/L)-mw-12

General Statistics

Number of Values	97
Minimum	3
Maximum	23.5
Mean	15.49
Geometric Mean	14.7
Median	16
Standard Deviation	4.031
SEM	0.409

Mann-Kendall Test

Test Value (S)	2066
Critical Value (0.05)	1.645
Standard Deviation of S	320.6

Standardized Value of S	6.441
Approximate p-value	5.952E-11

Statistically significant evidence of an increasing trend at the specified level of significance.

Uranium (ug/L)-mw-18

General Statistics

Number of Values	33
Minimum	2.687
Maximum	49
Mean	33.23
Geometric Mean	27.74
Median	40.3
Standard Deviation	14.37
SEM	2.501

Mann-Kendall Test

Test Value (S)	292
Critical Value (0.05)	1.645
Standard Deviation of S	64.54
Standardized Value of S	4.509
Approximate p-value	3.259E-06

Statistically significant evidence of an increasing trend at the specified level of significance.

Uranium (ug/L)-mw-24

General Statistics

Number of Values	24
Minimum	0.5
Maximum	10.4
Mean	2.969
Geometric Mean	1.962
Median	1.56
Standard Deviation	3.129
SEM	0.639

Mann-Kendall Test

Test Value (S)	-77
Critical Value (0.05)	-1.645
Standard Deviation of S	40.3
Standardized Value of S	-1.886
Approximate p-value	0.0297

Statistically significant evidence of a decreasing trend at the specified level of significance.

Uranium (ug/L)-mw-25

General Statistics

Number of Values	41
Minimum	4.77
Maximum	7.6
Mean	6.144
Geometric Mean	6.12
Median	6.02
Standard Deviation	0.551
SEM	0.0861

Mann-Kendall Test

Test Value (S)	250
Critical Value (0.05)	1.645
Standard Deviation of S	89.01
Standardized Value of S	2.797
Approximate p-value	0.00258

Statistically significant evidence of an increasing trend at the specified level of significance.

Uranium (ug/L)-mw-26

General Statistics

Number of Values	83
Minimum	9.48
Maximum	119
Mean	38.86
Geometric Mean	33.61
Median	33.6
Standard Deviation	20.36
SEM	2.235

Mann-Kendall Test

Test Value (S)	1436
Critical Value (0.05)	1.645
Standard Deviation of S	254.3
Standardized Value of S	5.644
Approximate p-value	8.328E-09

Statistically significant evidence of an increasing trend at the specified level of significance.

Uranium (ug/L)-mw-27

General Statistics

Number of Values	23
Minimum	27.7
Maximum	33.1
Mean	30.59
Geometric Mean	30.55
Median	30.7
Standard Deviation	1.448
SEM	0.302

Mann-Kendall Test

Test Value (S)	-105
Critical Value (0.05)	-1.645
Standard Deviation of S	37.84
Standardized Value of S	-2.749
Approximate p-value	0.00299

Statistically significant evidence of a decreasing trend at the specified level of significance.

Uranium (ug/L)-mw-3

General Statistics

Number of Values	85
Minimum	3
Maximum	67.16
Mean	23.2
Geometric Mean	20.32
Median	21.94
Standard Deviation	10.87
SEM	1.179

Mann-Kendall Test

Test Value (S)	708
Critical Value (0.05)	1.645
Standard Deviation of S	263.4
Standardized Value of S	2.684
Approximate p-value	0.00364

Statistically significant evidence of an increasing trend at the specified level of significance.

Uranium (ug/L)-mw-30

General Statistics

Number of Values	31

Minimum	5.79
Maximum	9.83
Mean	7.106
Geometric Mean	7.068
Median	6.9
Standard Deviation	0.78
SEM	0.14

Mann-Kendall Test

Test Value (S)	48
Critical Value (0.05)	1.645
Standard Deviation of S	58.81
Standardized Value of S	0.799
Approximate p-value	0.212

Insufficient evidence to identify a significant trend at the specified level of significance.

Uranium (ug/L)-mw-31

General Statistics

Number of Values	28
Minimum	5.77
Maximum	9.32
Mean	7.26
Geometric Mean	7.226
Median	7.15
Standard Deviation	0.725
SEM	0.137

Mann-Kendall Test

Test Value (S)	-57
Critical Value (0.05)	-1.645
Standard Deviation of S	50.61
Standardized Value of S	-1.107
Approximate p-value	0.134

Insufficient evidence to identify a significant trend at the specified level of significance.

Uranium (ug/L)-mw-35

General Statistics

Number of Values	15
Minimum	12.7
Maximum	27.2
Mean	21.79

Geometric Mean	21.45
Median	22.4
Standard Deviation	3.71
SEM	0.958

Mann-Kendall Test

Test Value (S)	11
Tabulated p-value	0.313
Standard Deviation of S	20.21
Standardized Value of S	0.495
Approximate p-value	0.31

Insufficient evidence to identify a significant trend at the specified level of significance.

Uranium (ug/L)-mw-3a

General Statistics

Number of Values	19
Minimum	16.5
Maximum	28.2
Mean	20.62
Geometric Mean	20.42
Median	19.7
Standard Deviation	3.032
SEM	0.696

Mann-Kendall Test

Test Value (S)	-52
Tabulated p-value	0.034
Standard Deviation of S	28.48
Standardized Value of S	-1.79
Approximate p-value	0.0367

Statistically significant evidence of a decreasing trend at the specified level of significance.

Uranium (ug/L)-mw-5

General Statistics

Number of Values	87
Minimum	0.04
Maximum	3.4
Mean	0.924
Geometric Mean	0.659
Median	0.791
Standard Deviation	0.713

SEM	0.0764

Mann-Kendall Test

Test Value (S)	-865
Critical Value (0.05)	-1.645
Standard Deviation of S	272.3
Standardized Value of S	-3.173
Approximate p-value	0.0007538

Statistically significant evidence of a decreasing trend at the specified level of significance.

Uranium (ug/L)-mw-19

General Statistics

Number of Values	33
Minimum	5.48
Maximum	24
Mean	9.664
Geometric Mean	9.01
Median	8.06
Standard Deviation	4.16
SEM	0.724

Mann-Kendall Test

Test Value (S)	-350
Critical Value (0.05)	-1.645
Standard Deviation of S	64.52
Standardized Value of S	-5.409
Approximate p-value	3.172E-08

Statistically significant evidence of a decreasing trend at the specified level of significance.

Uranium (ug/L)-mw-28

General Statistics

Number of Values	23
Minimum	2.69
Maximum	3.89
Mean	3.39
Geometric Mean	3.381
Median	3.42
Standard Deviation	0.237
SEM	0.0493

Appendix D-4
Mann-Kendall Output for Indicator Parameters

Mann-Kendall Test

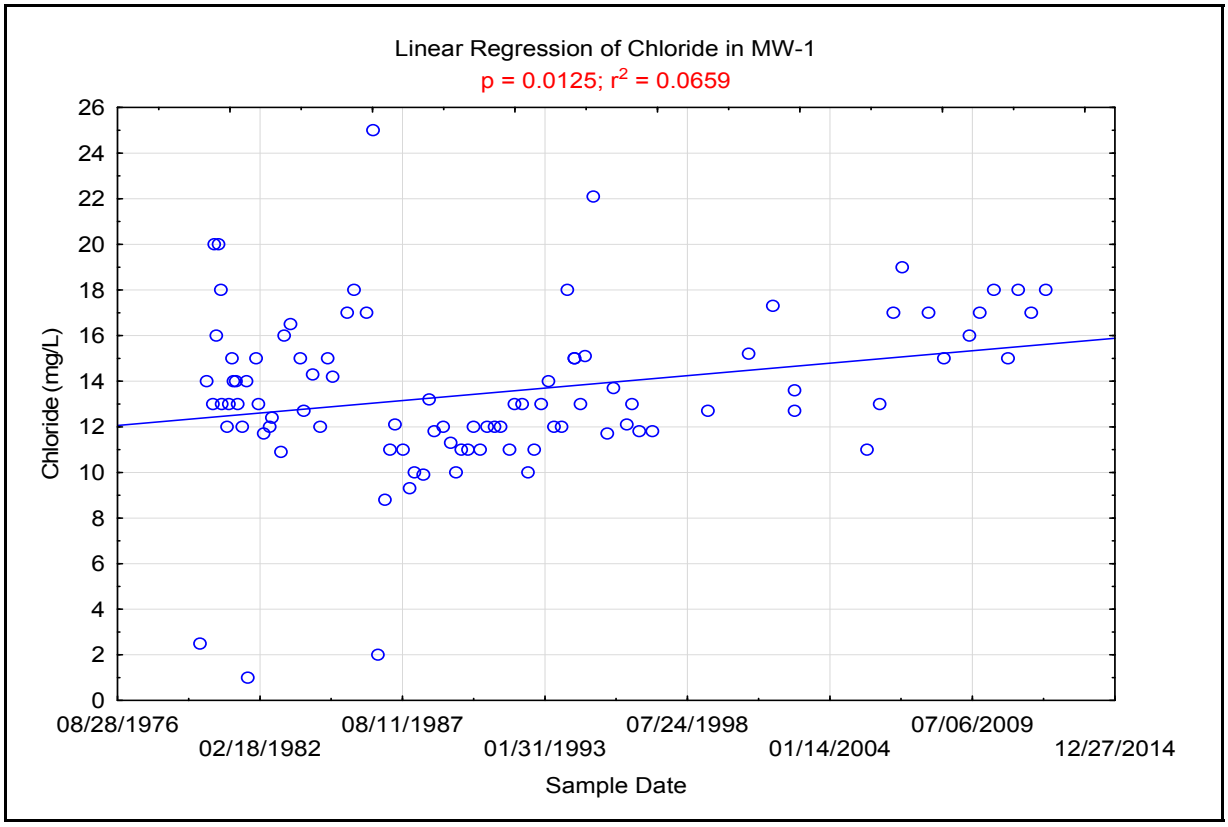
Test Value (S)	-39
Critical Value (0.05)	-1.645
Standard Deviation of S	37.8
Standardized Value of S	-1.005
Approximate p-value	0.157

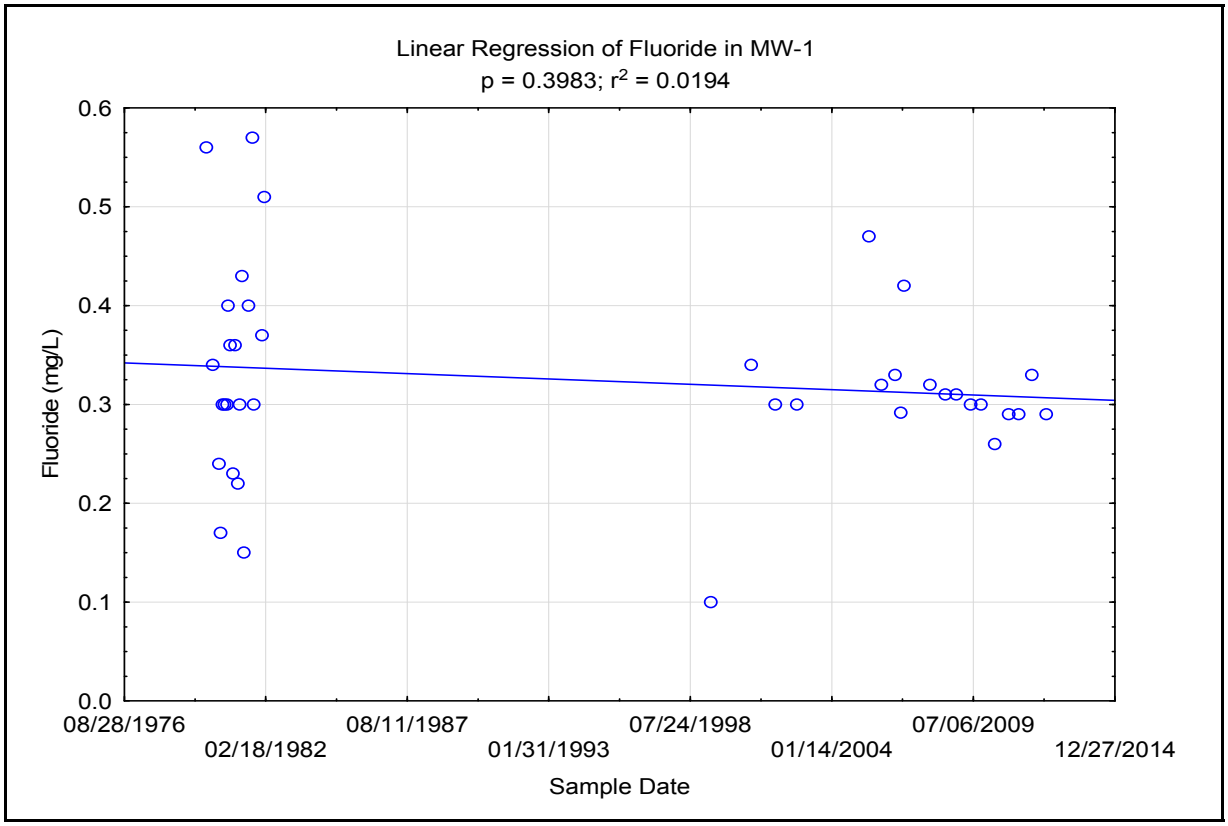
Insufficient evidence to identify a significant trend at the specified level of significance.

APPENDIX D-5

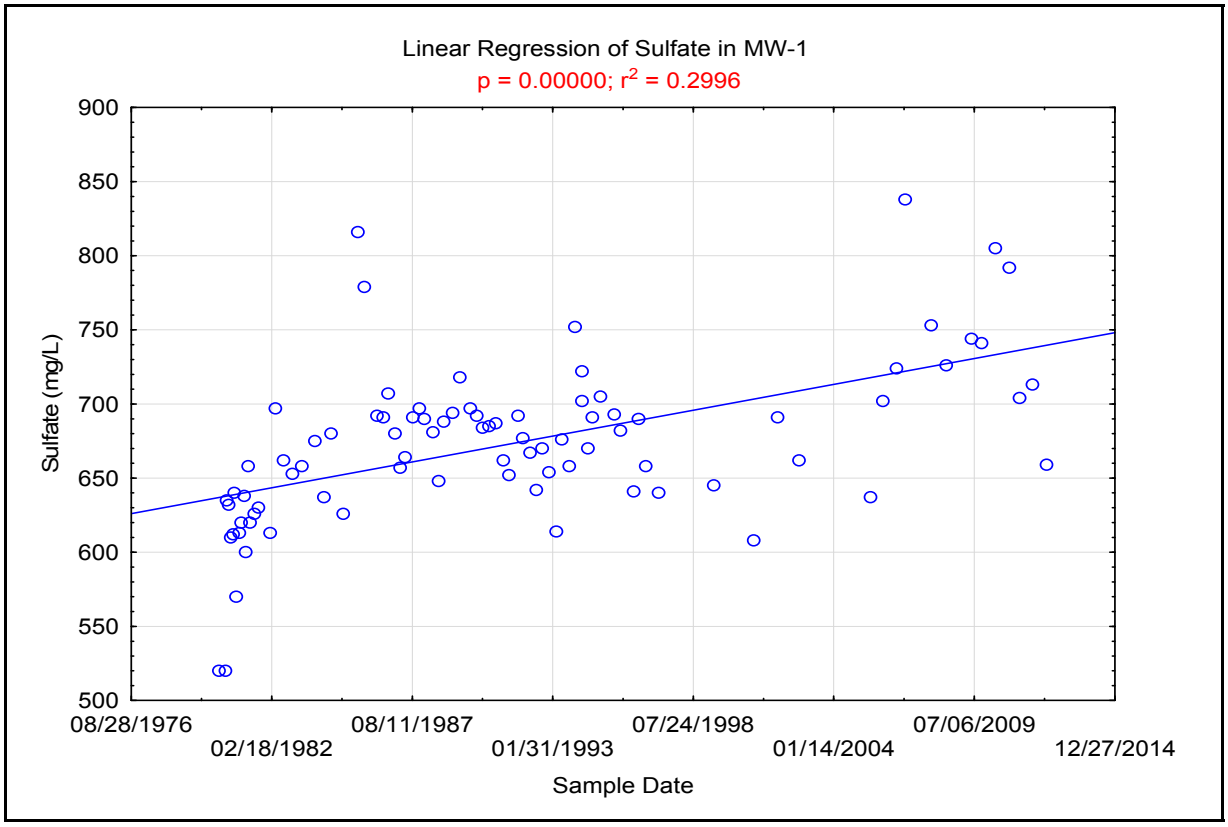
Linear Regression Plots for Indicator Parameters

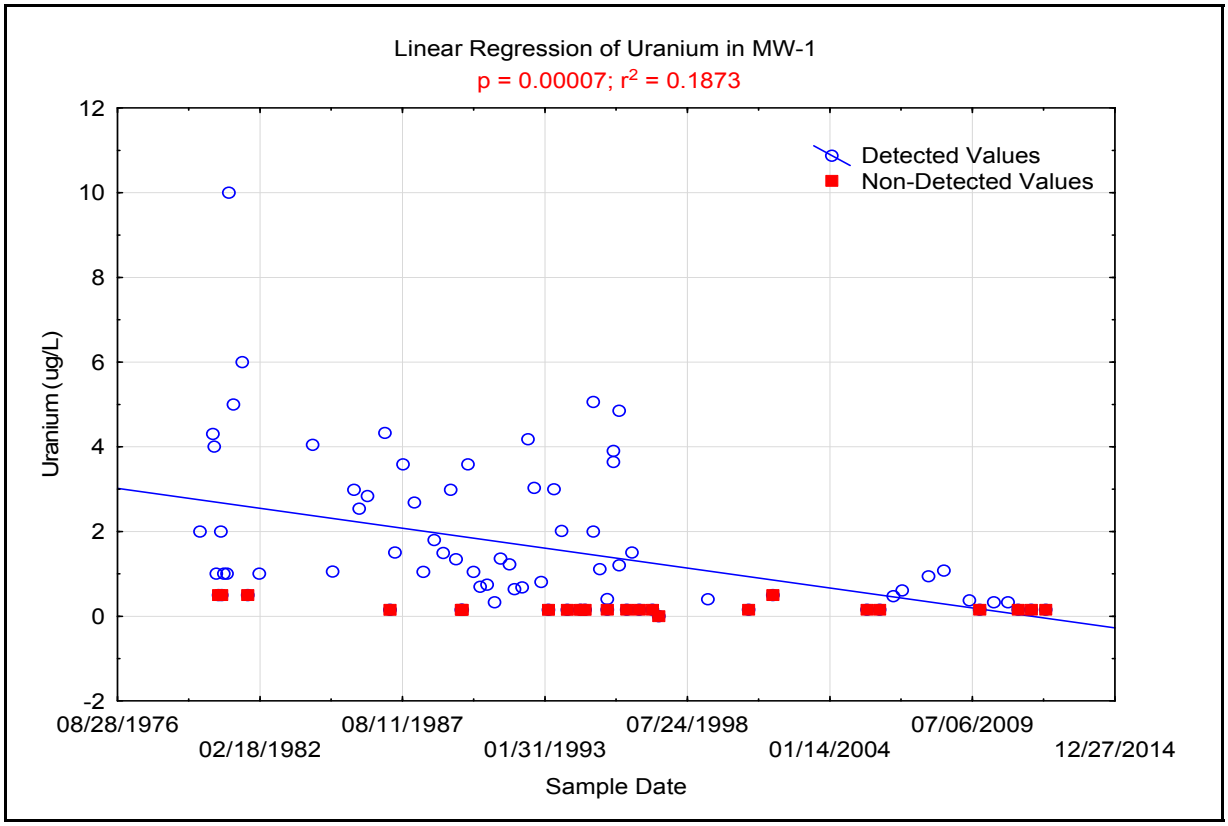
Appendix D-5
Linear Regression Plots for Indicator Parameters



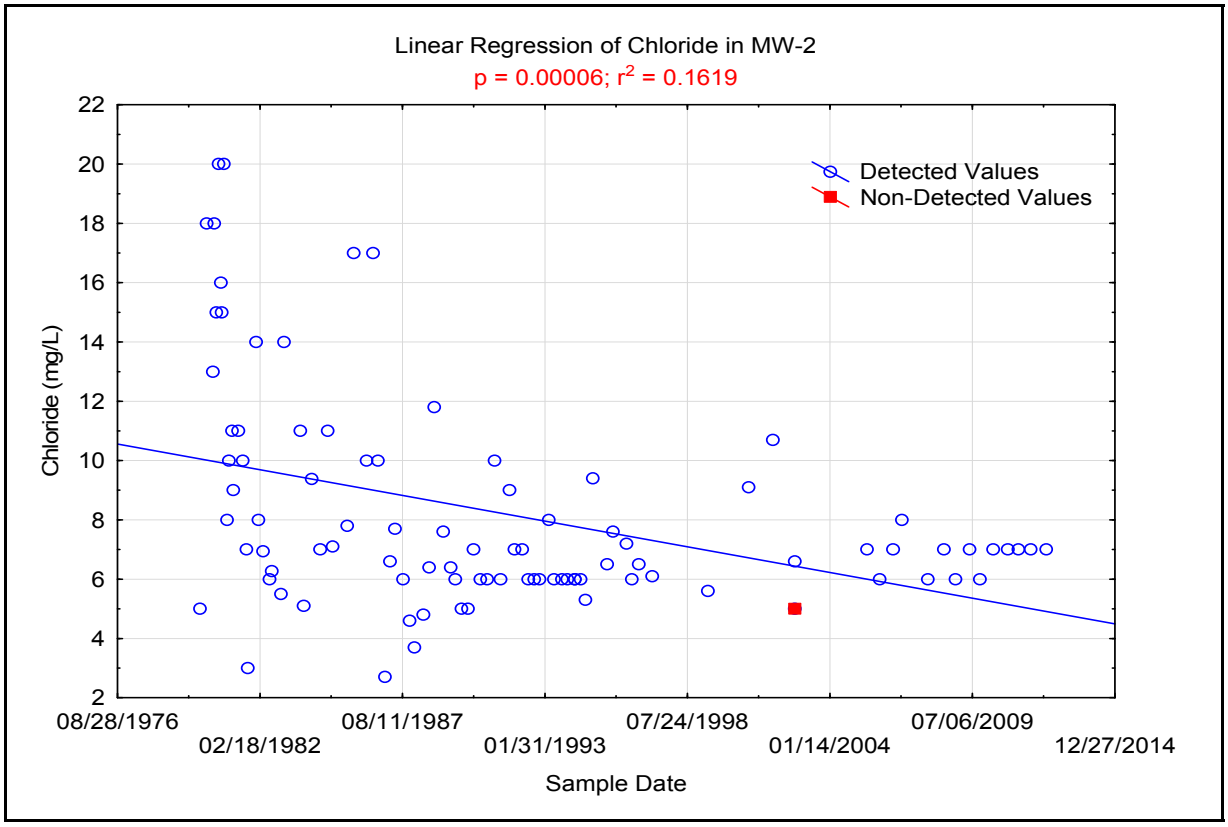


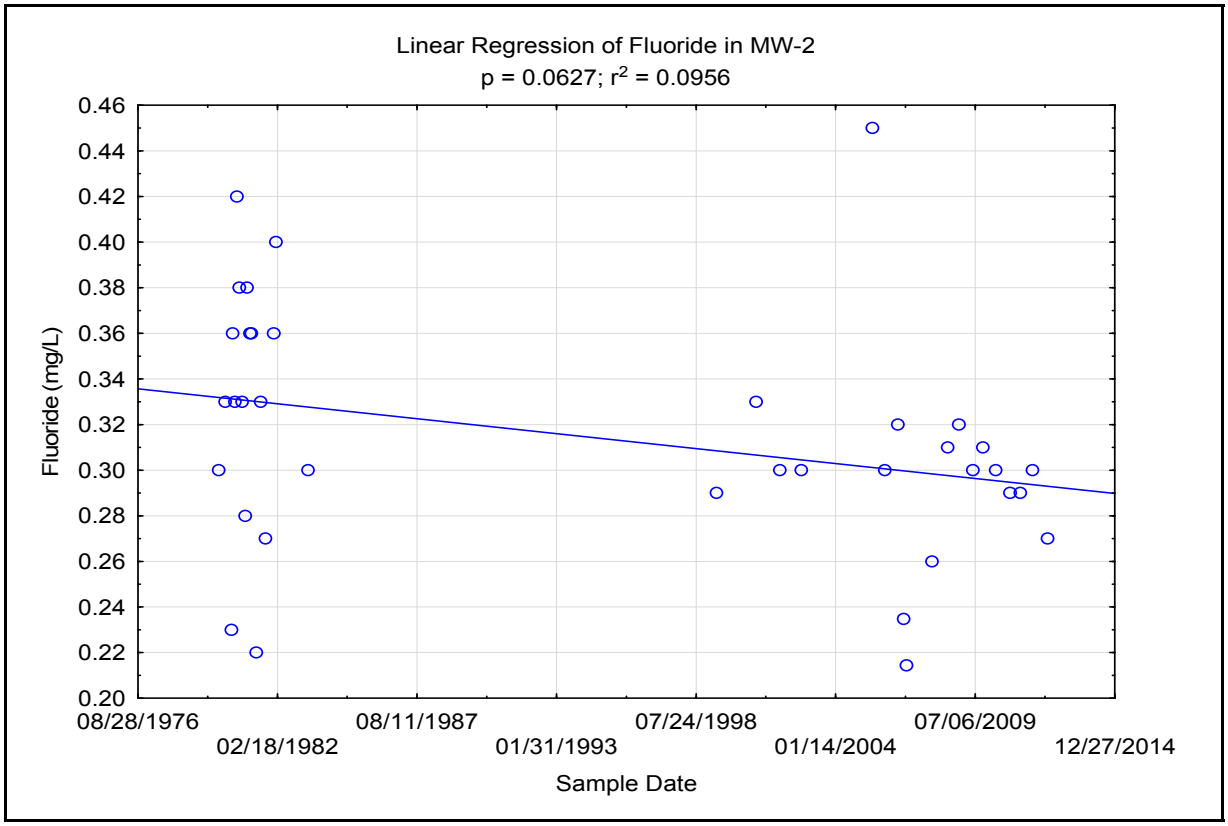
Appendix D-5
Linear Regression Plots for Indicator Parameters



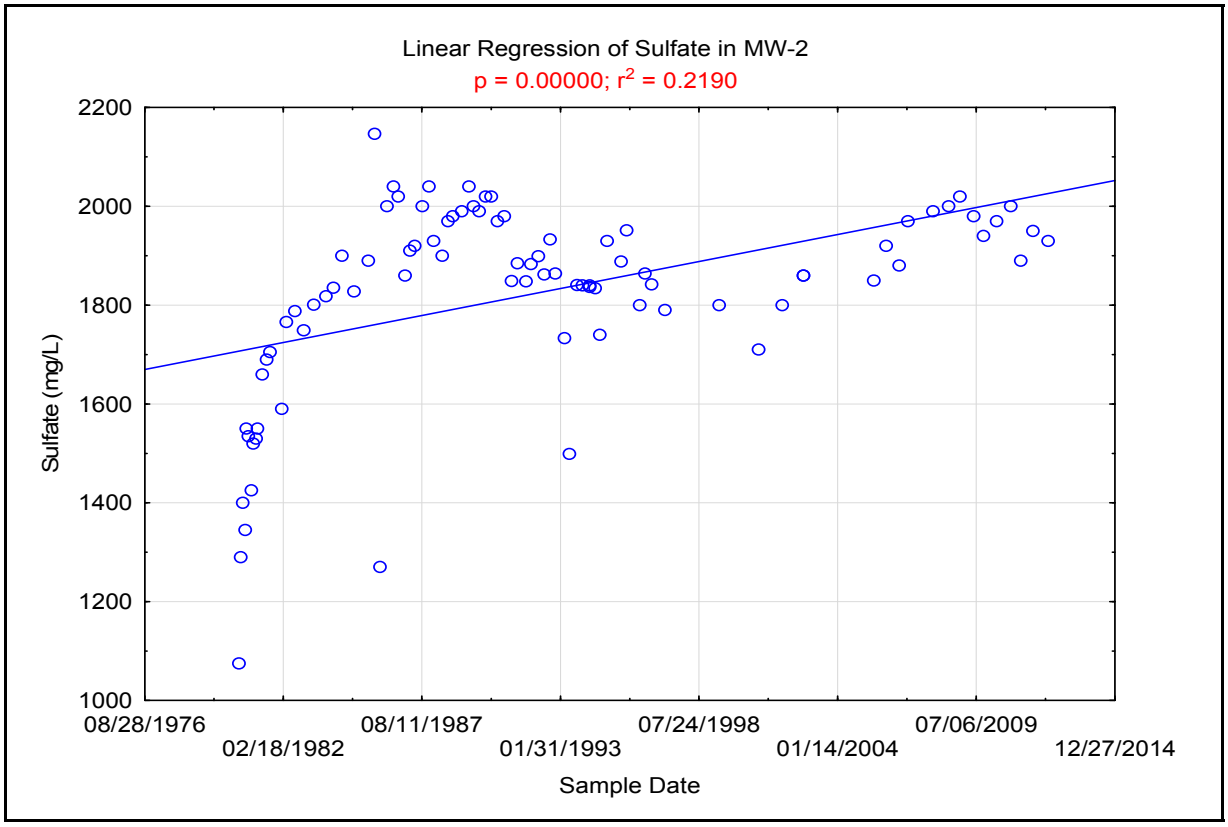


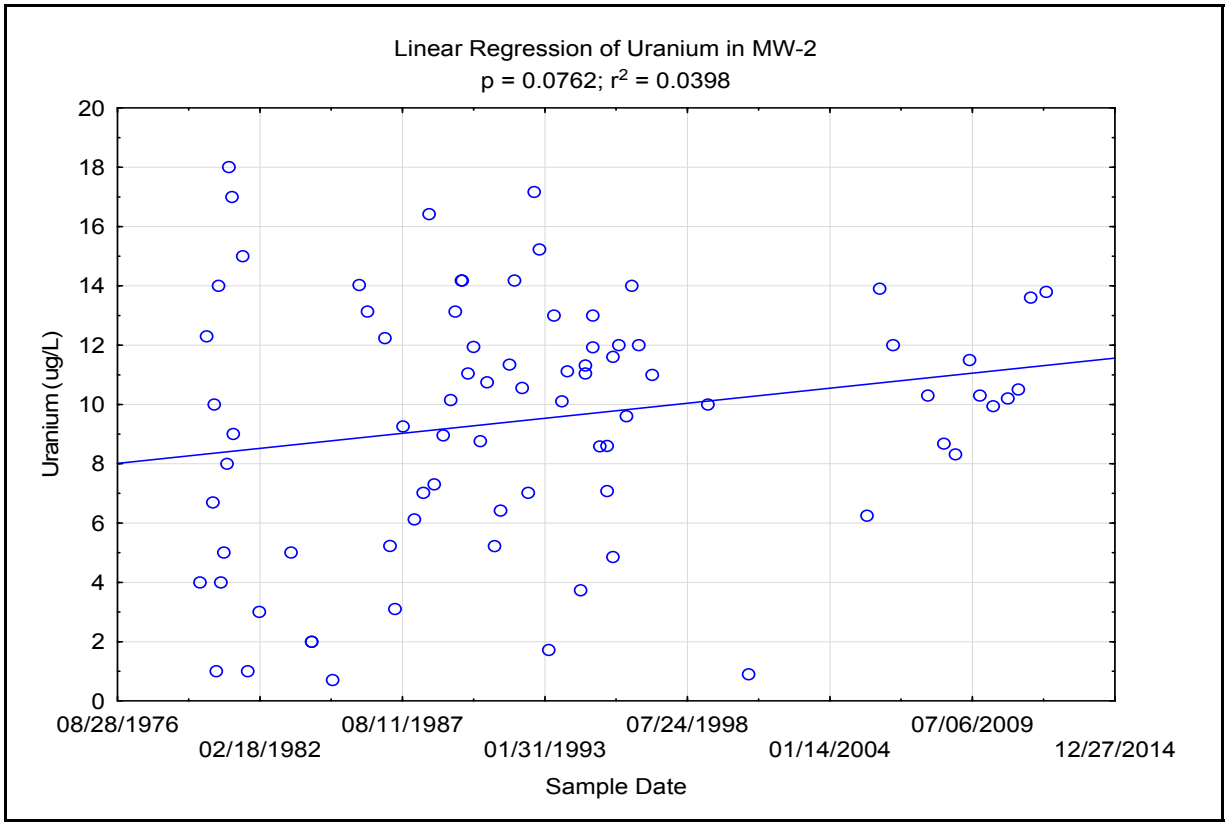
Appendix D-5
Linear Regression Plots for Indicator Parameters





Appendix D-5
Linear Regression Plots for Indicator Parameters





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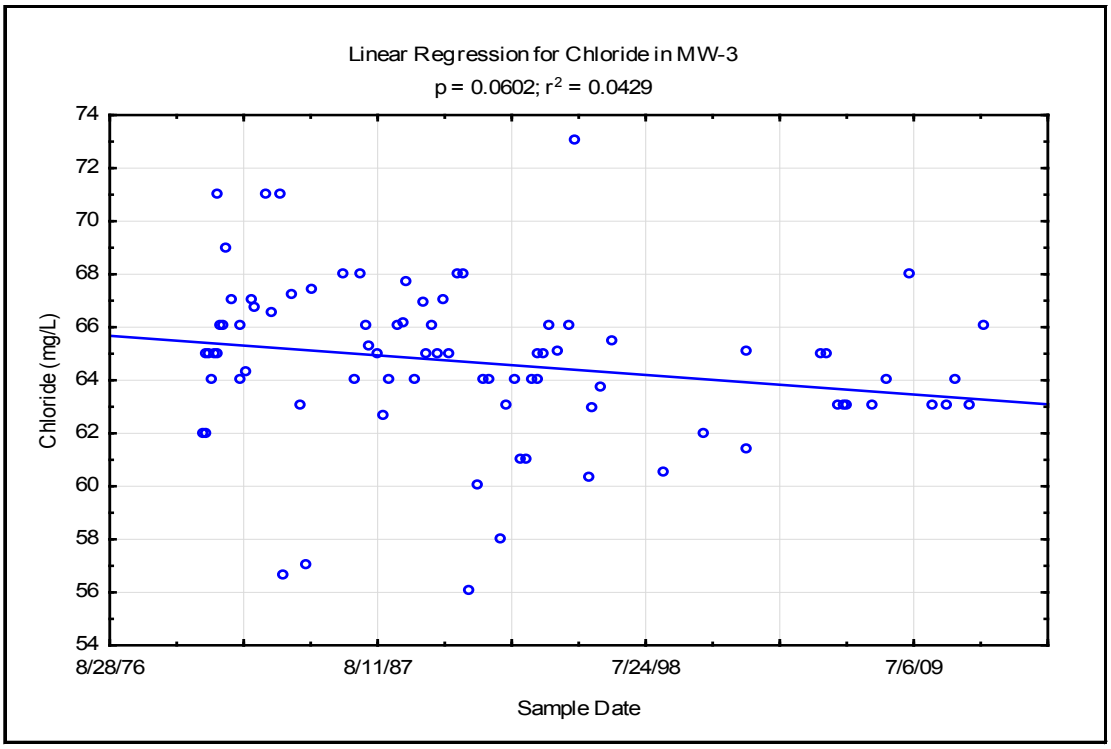

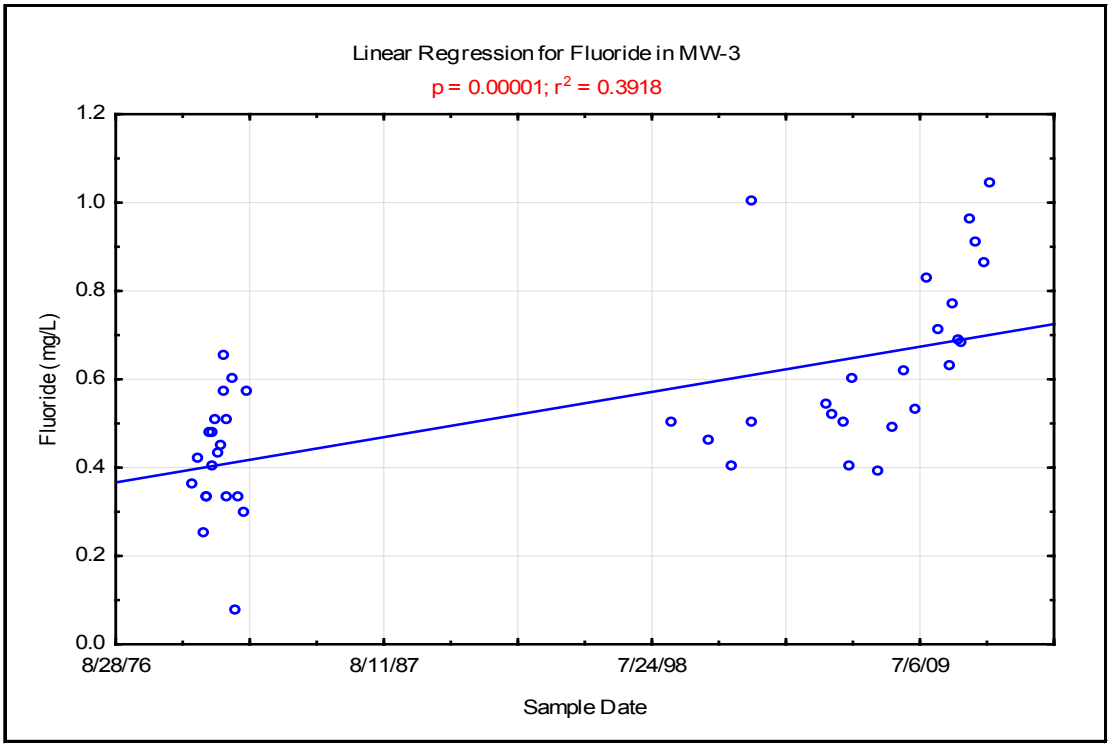

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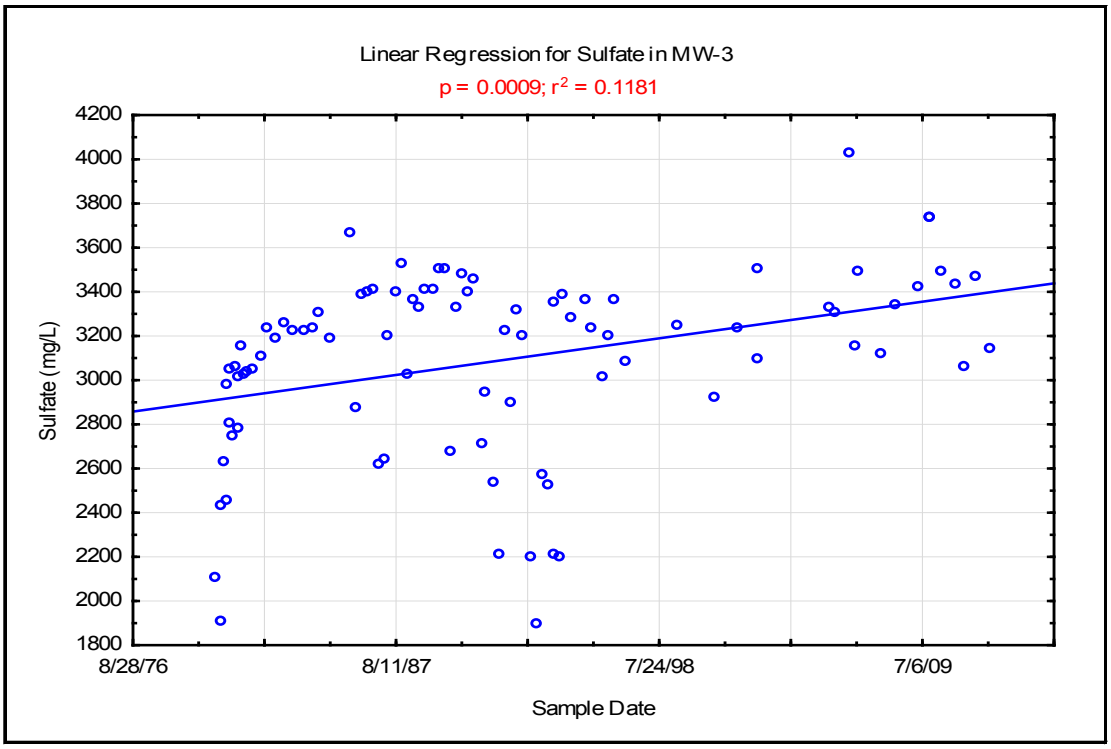

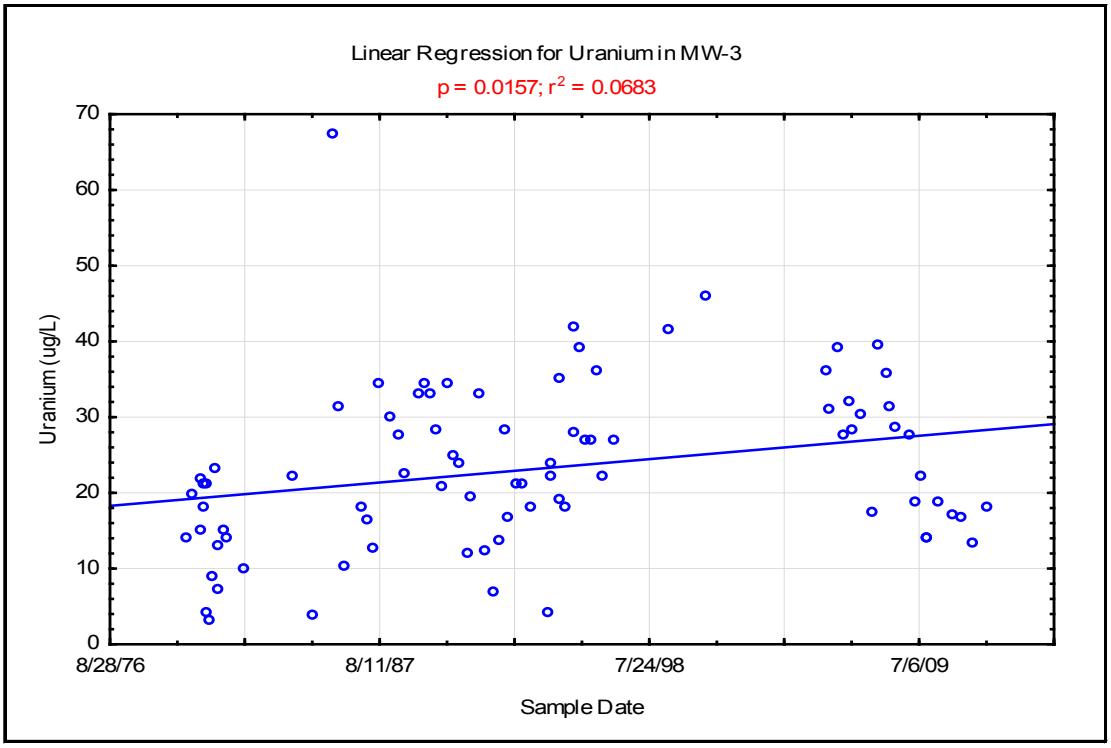

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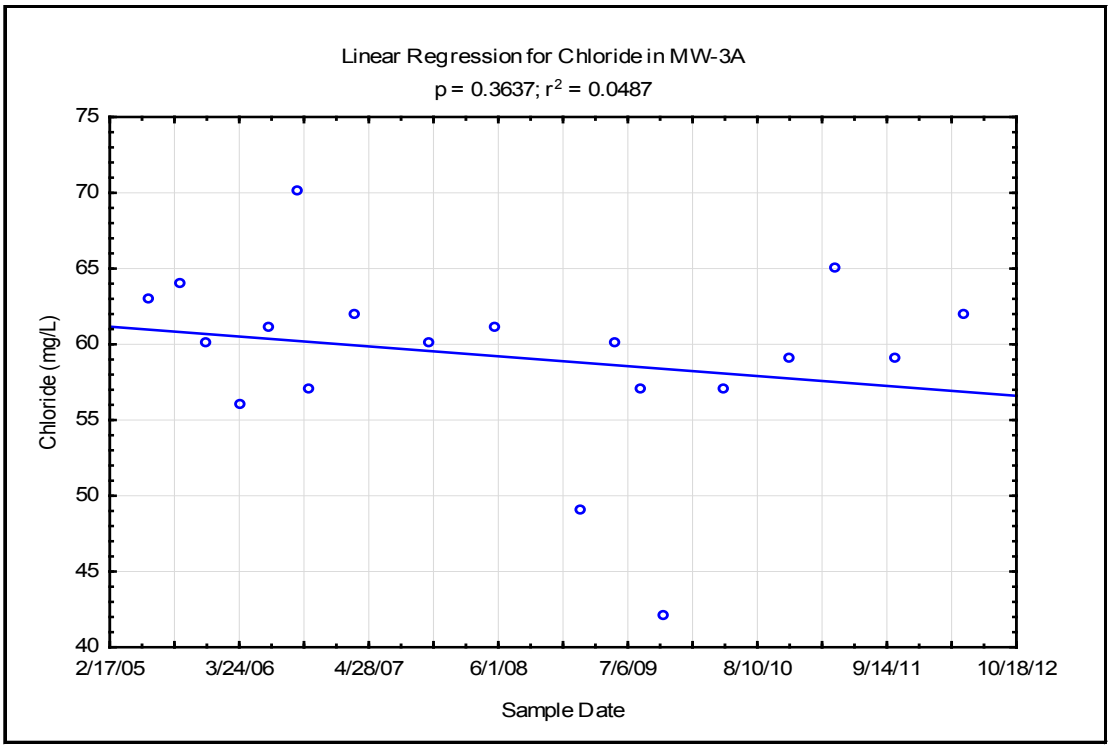

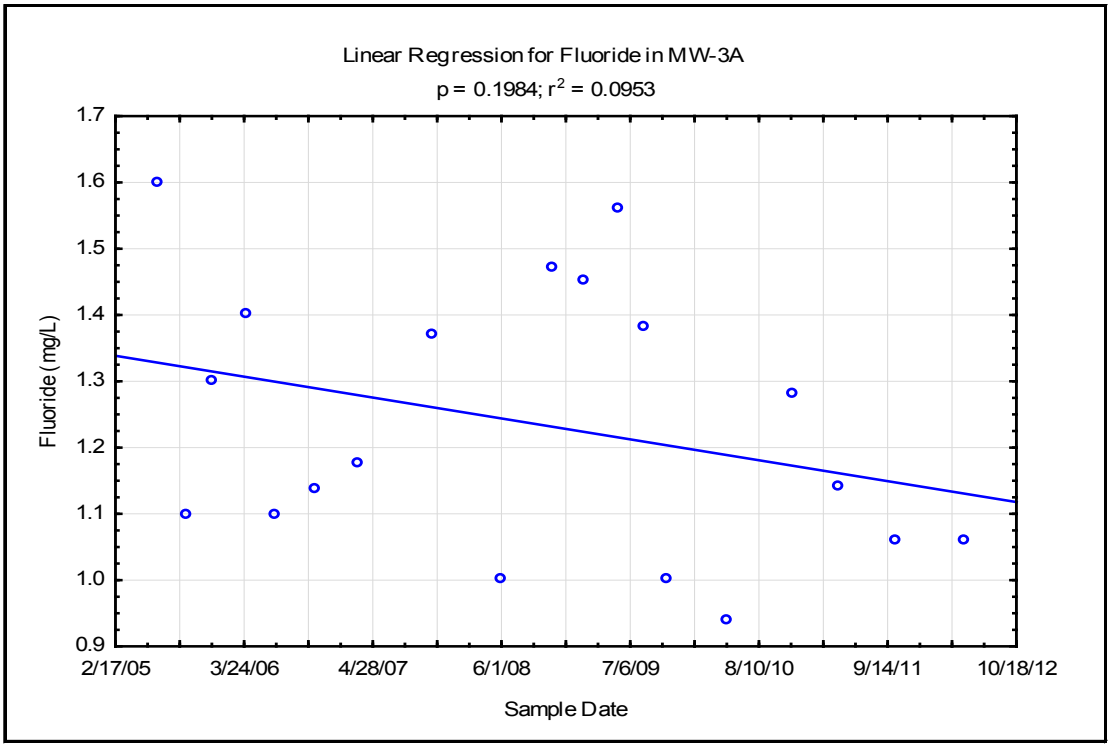

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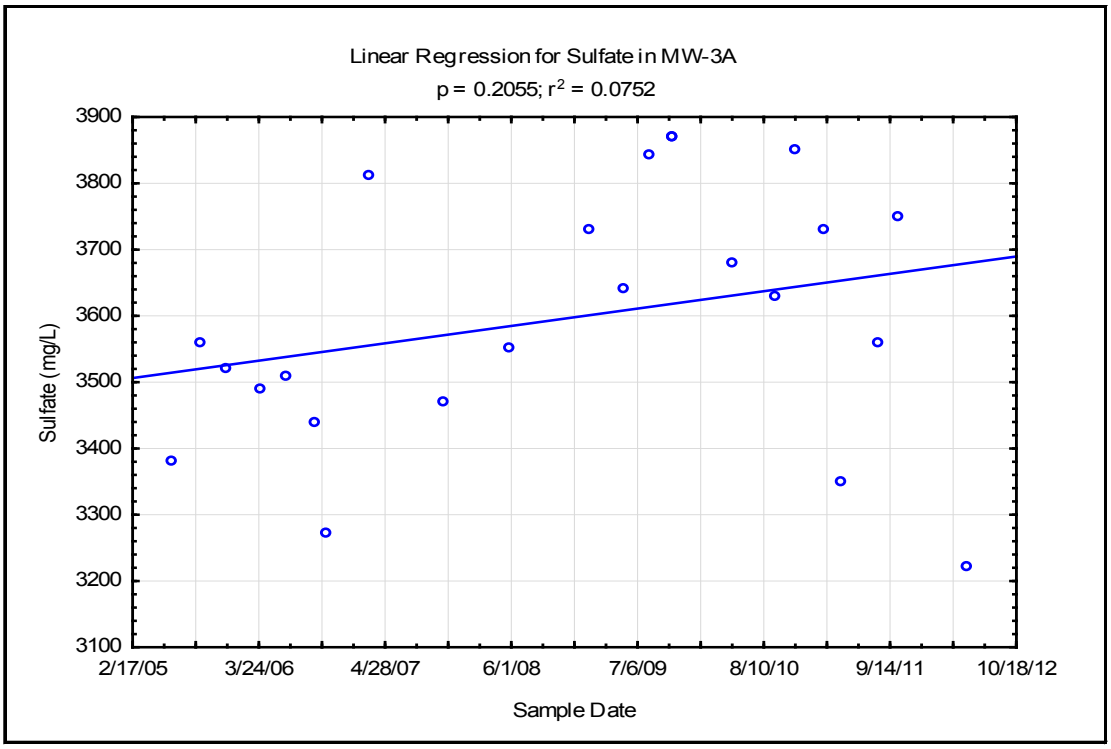

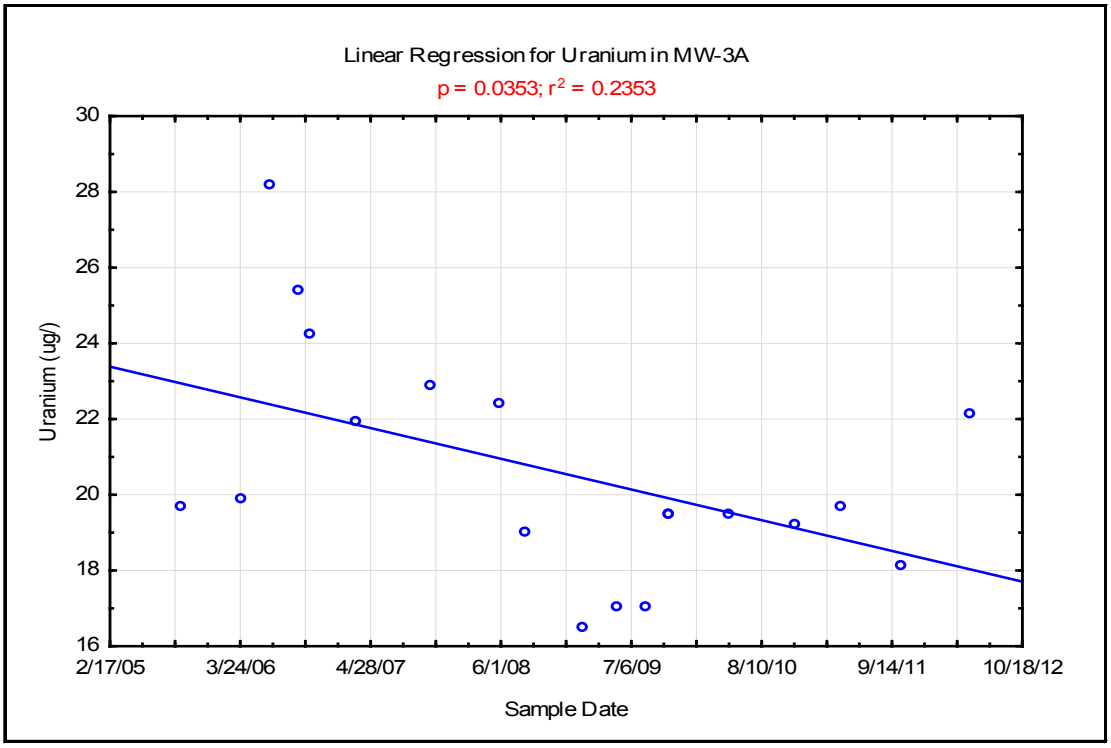

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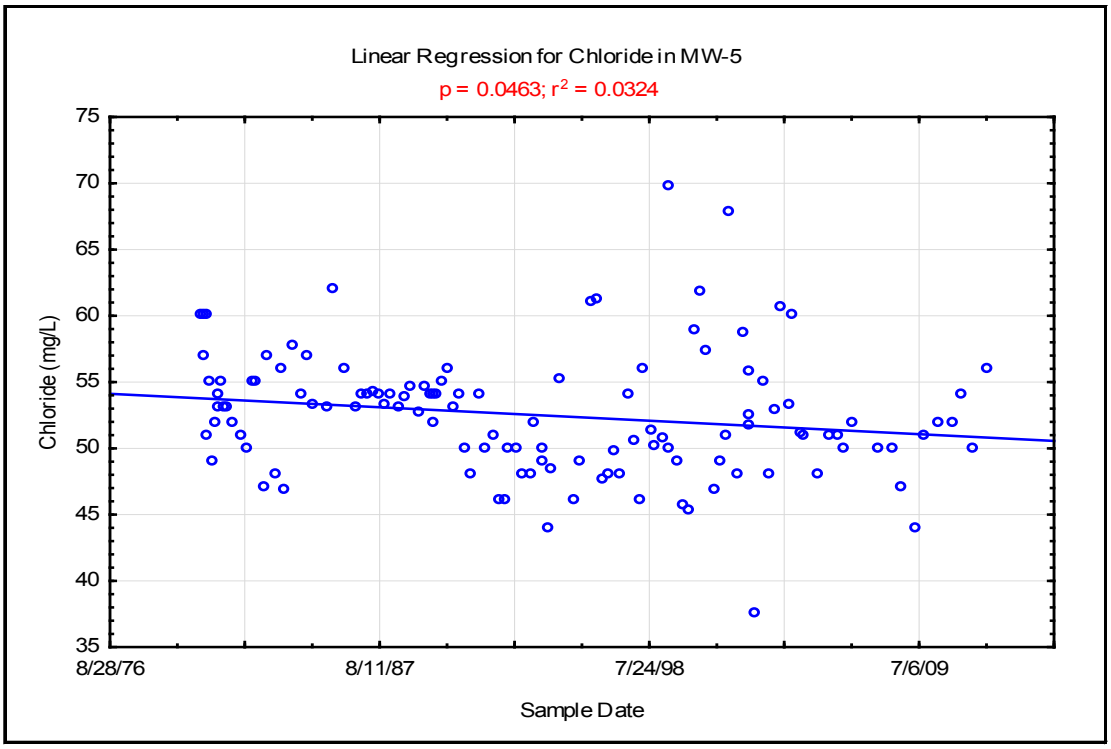

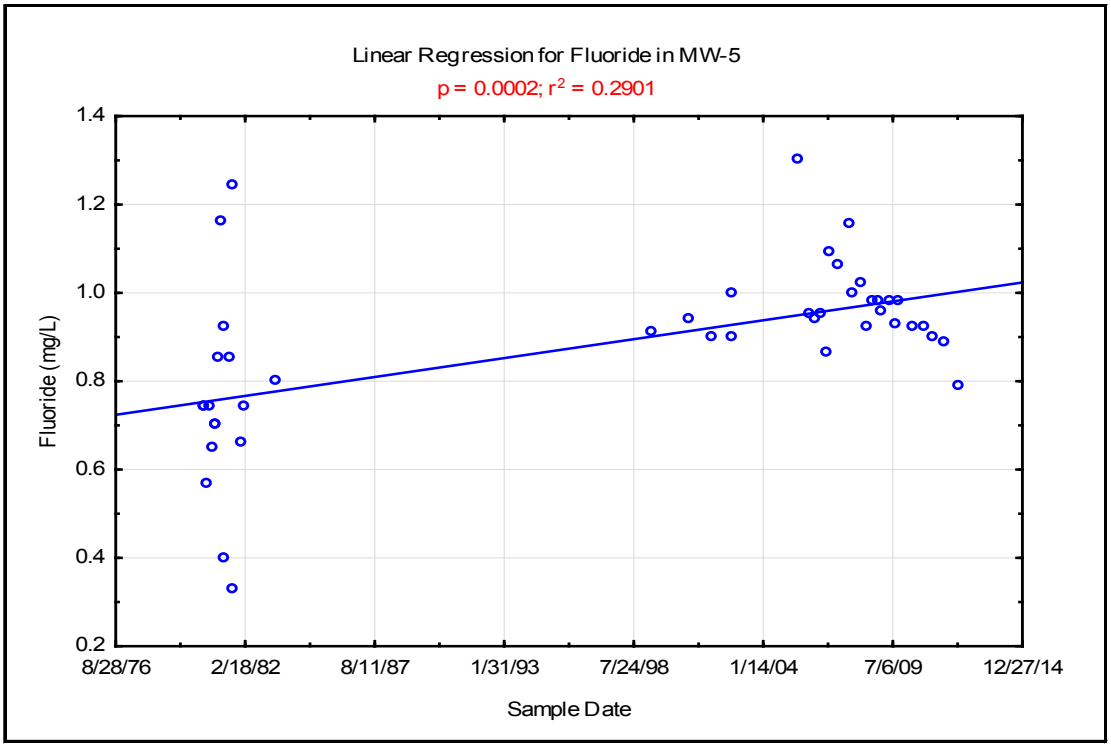

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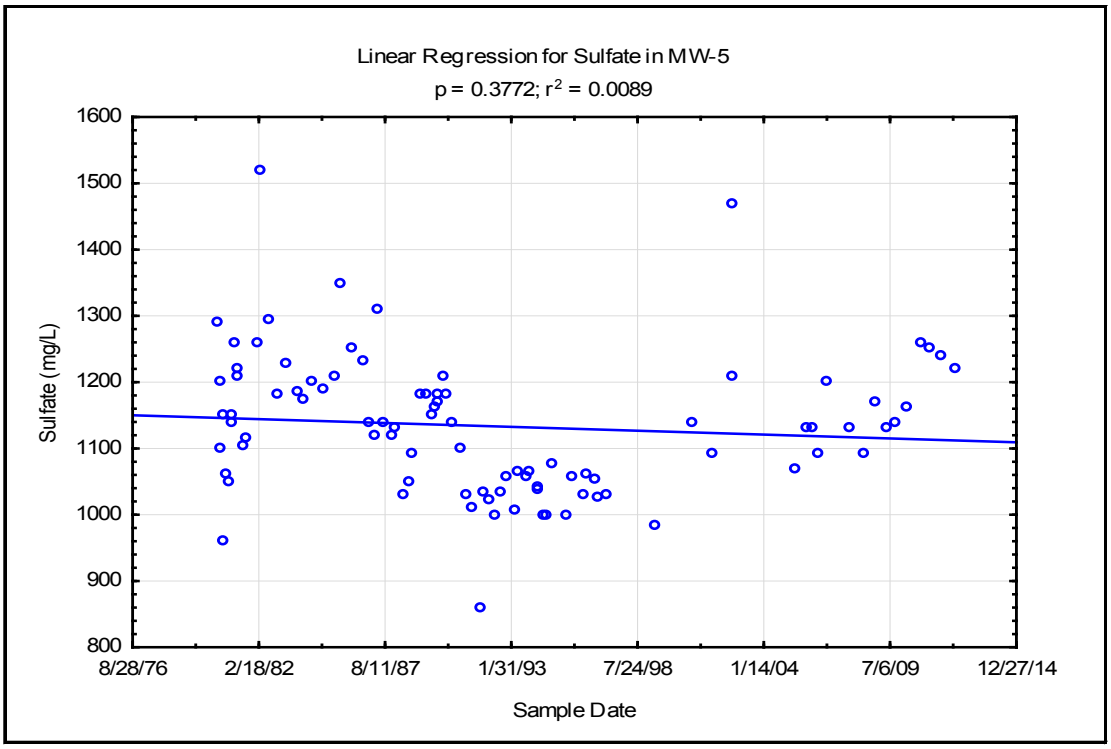

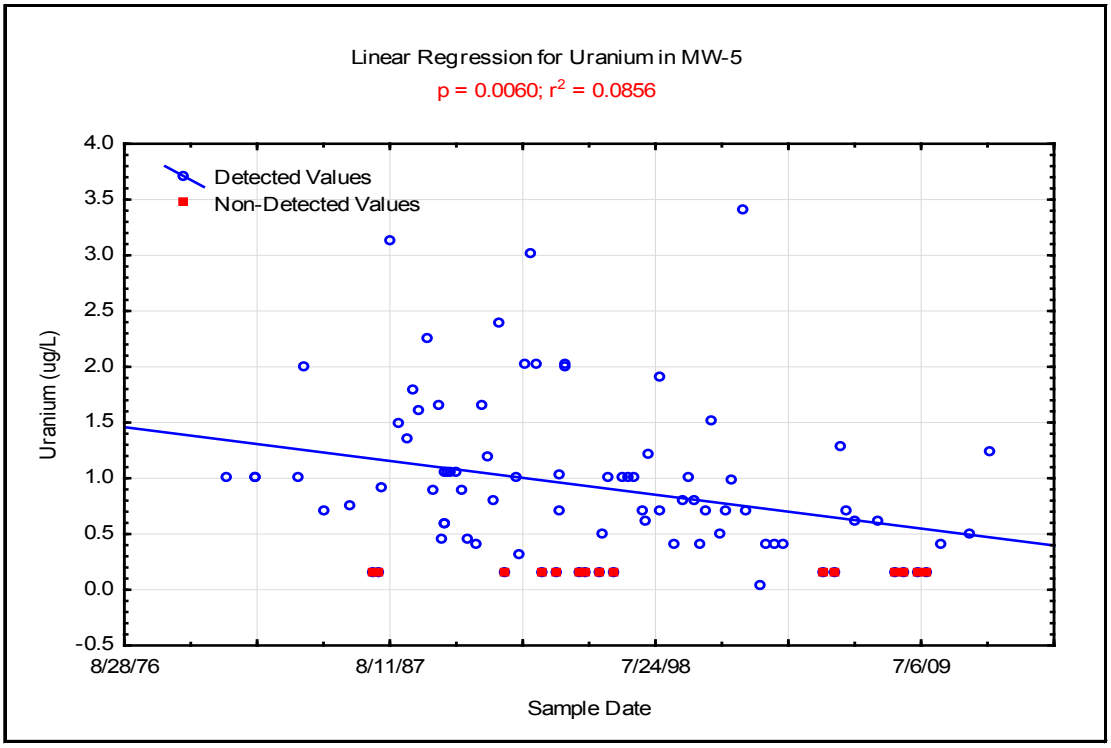

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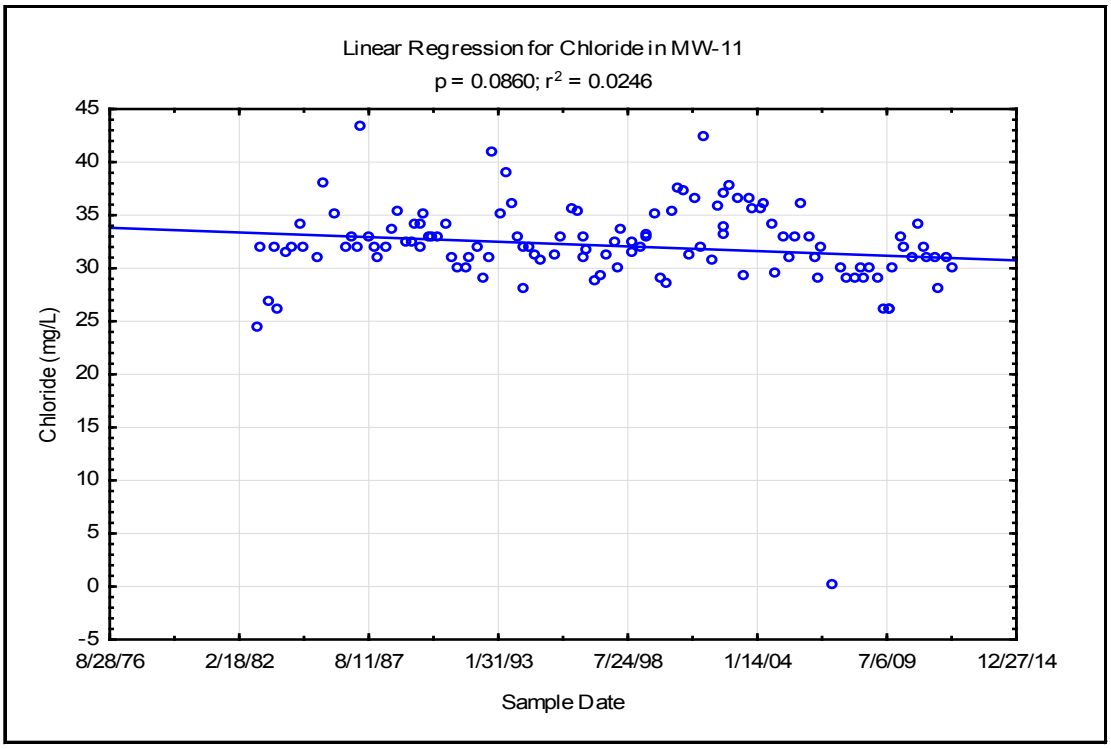

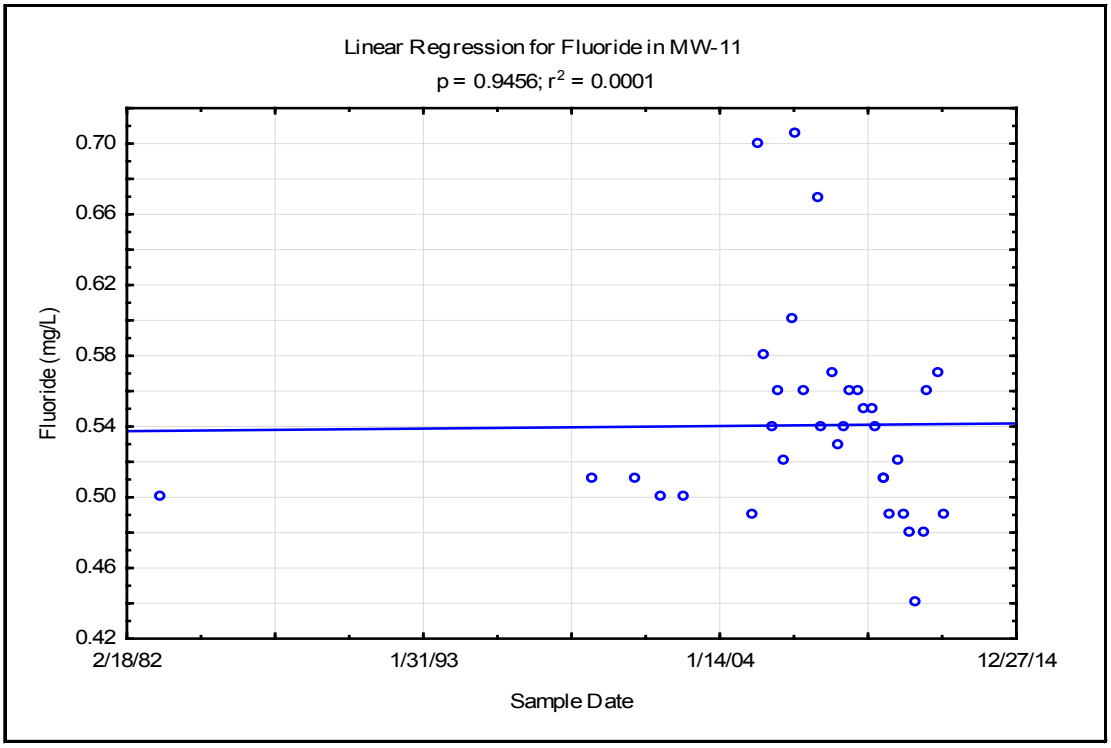

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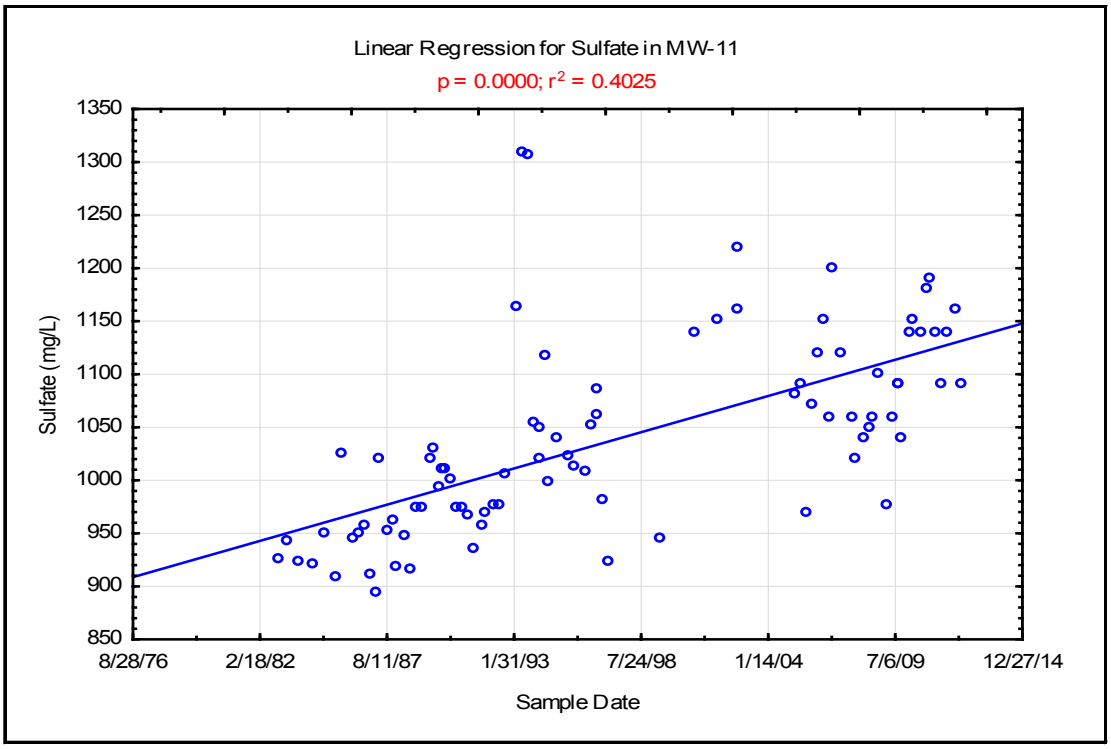

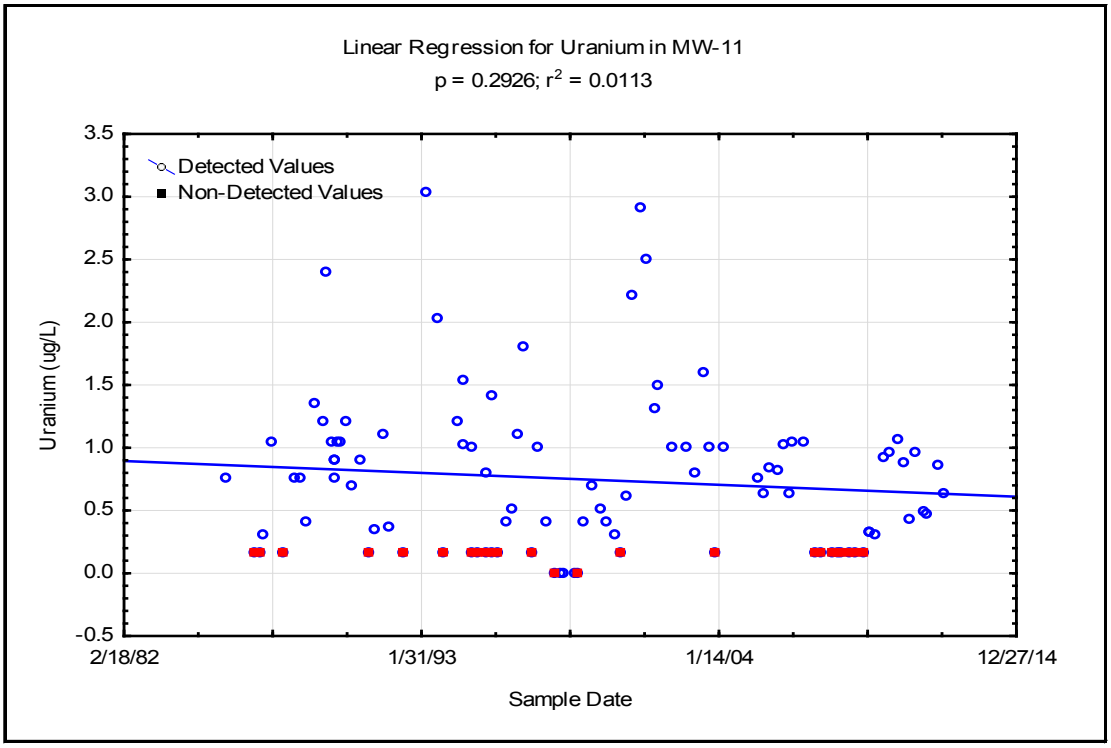

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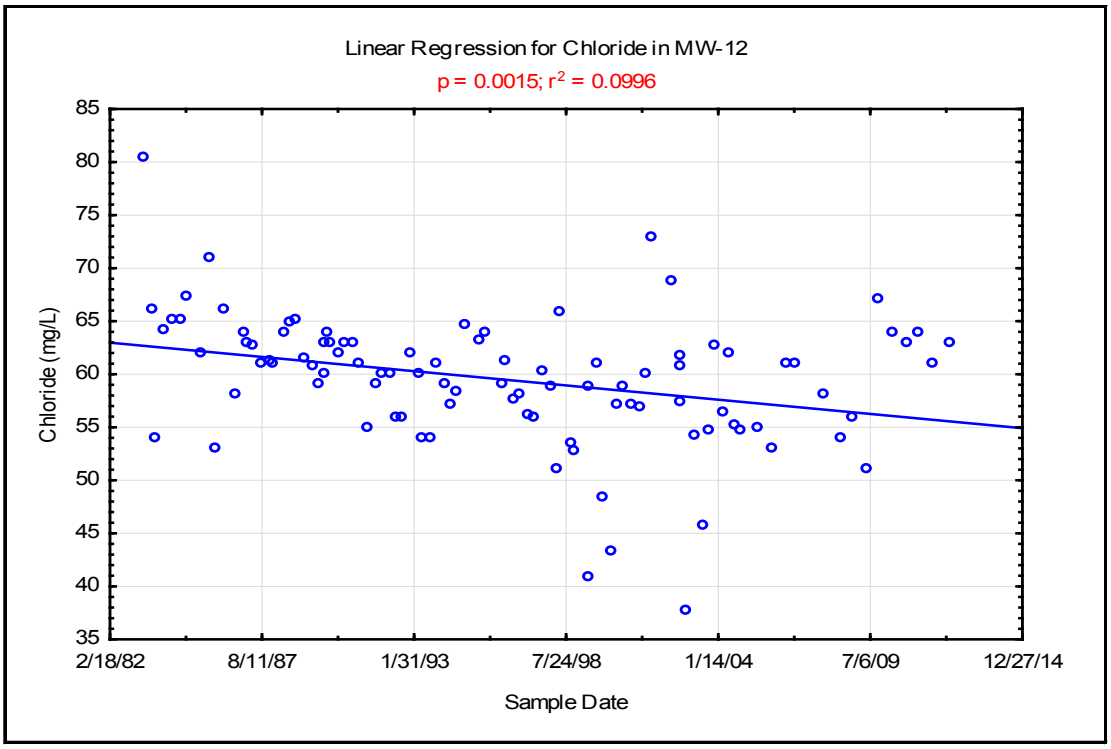

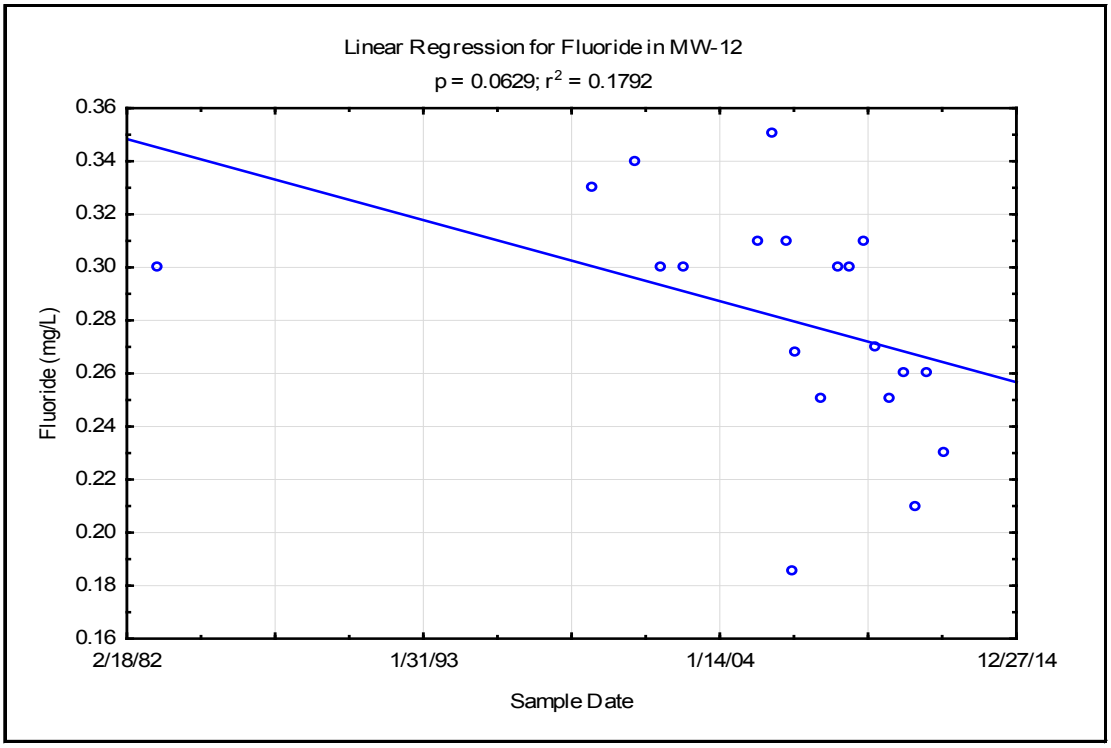

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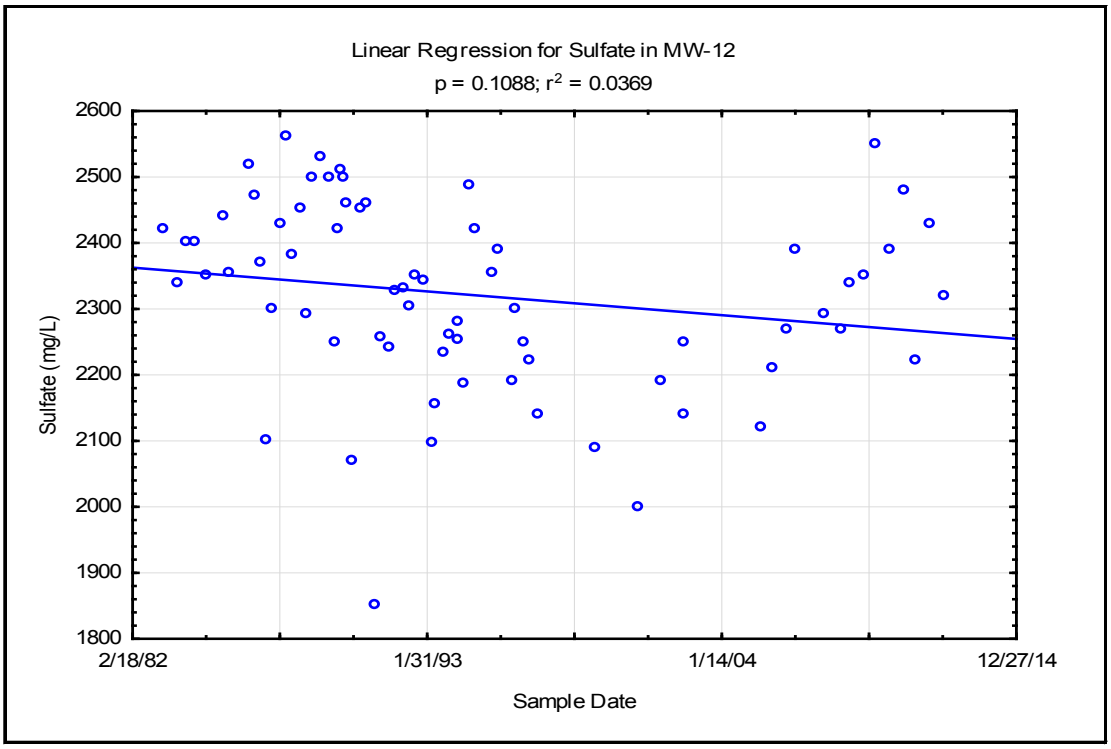

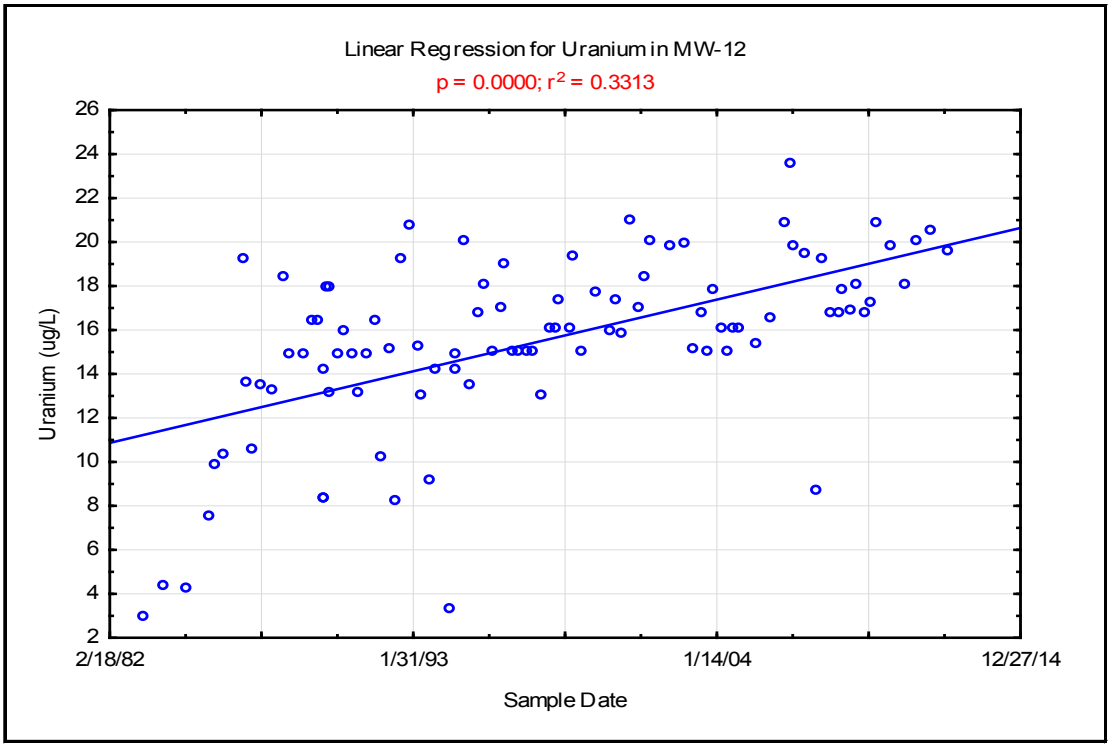

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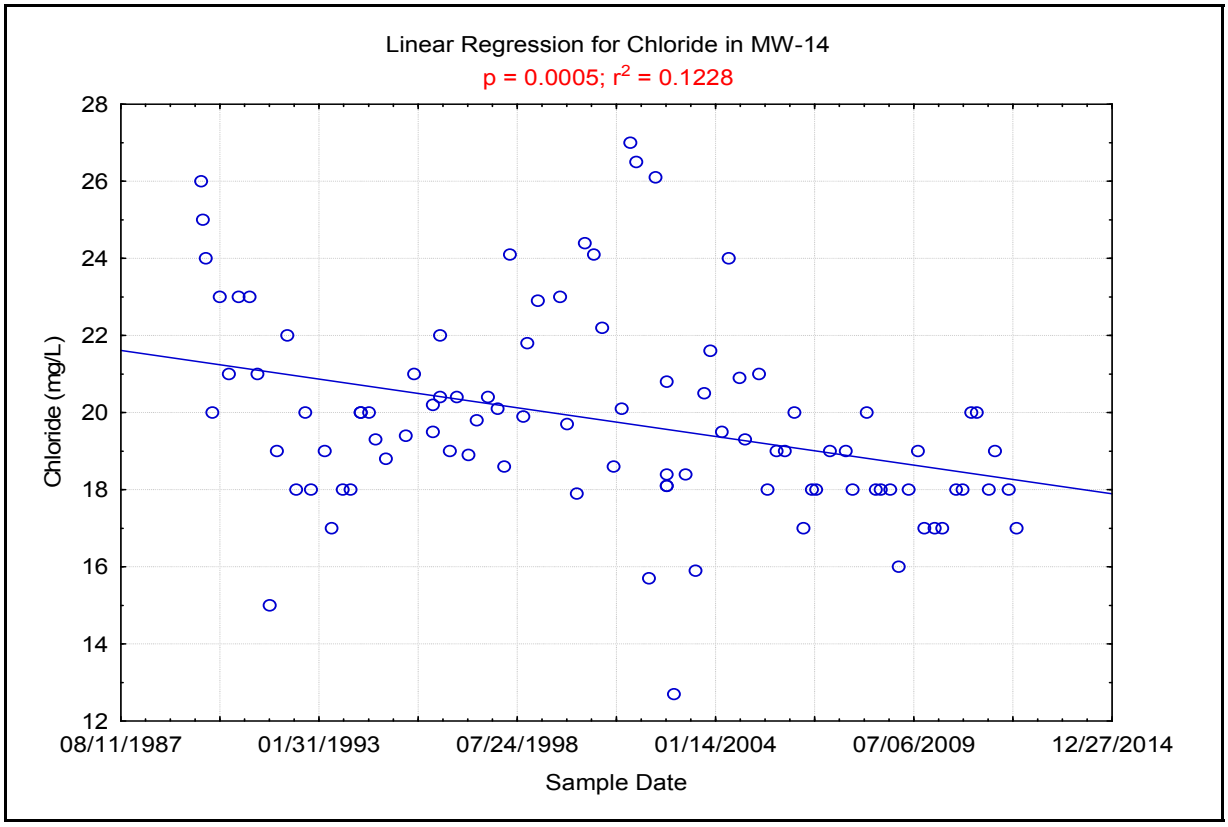

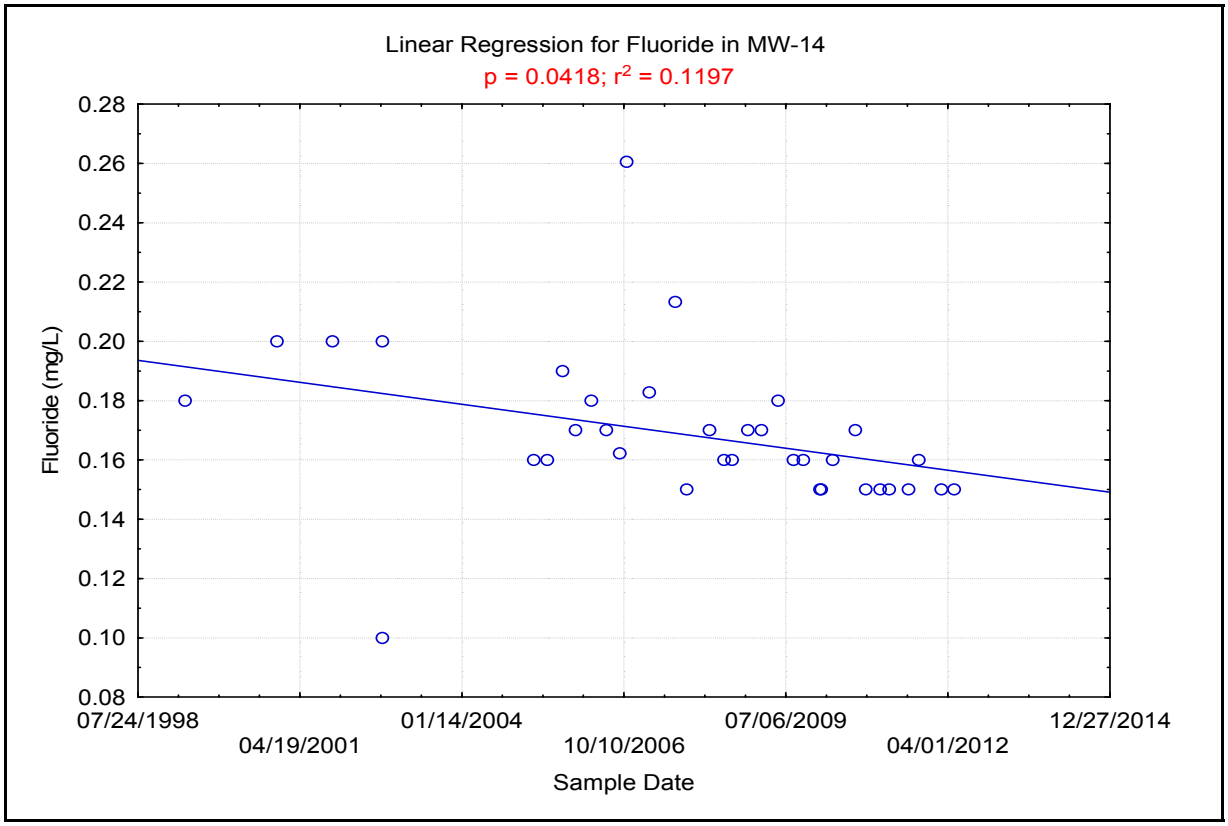

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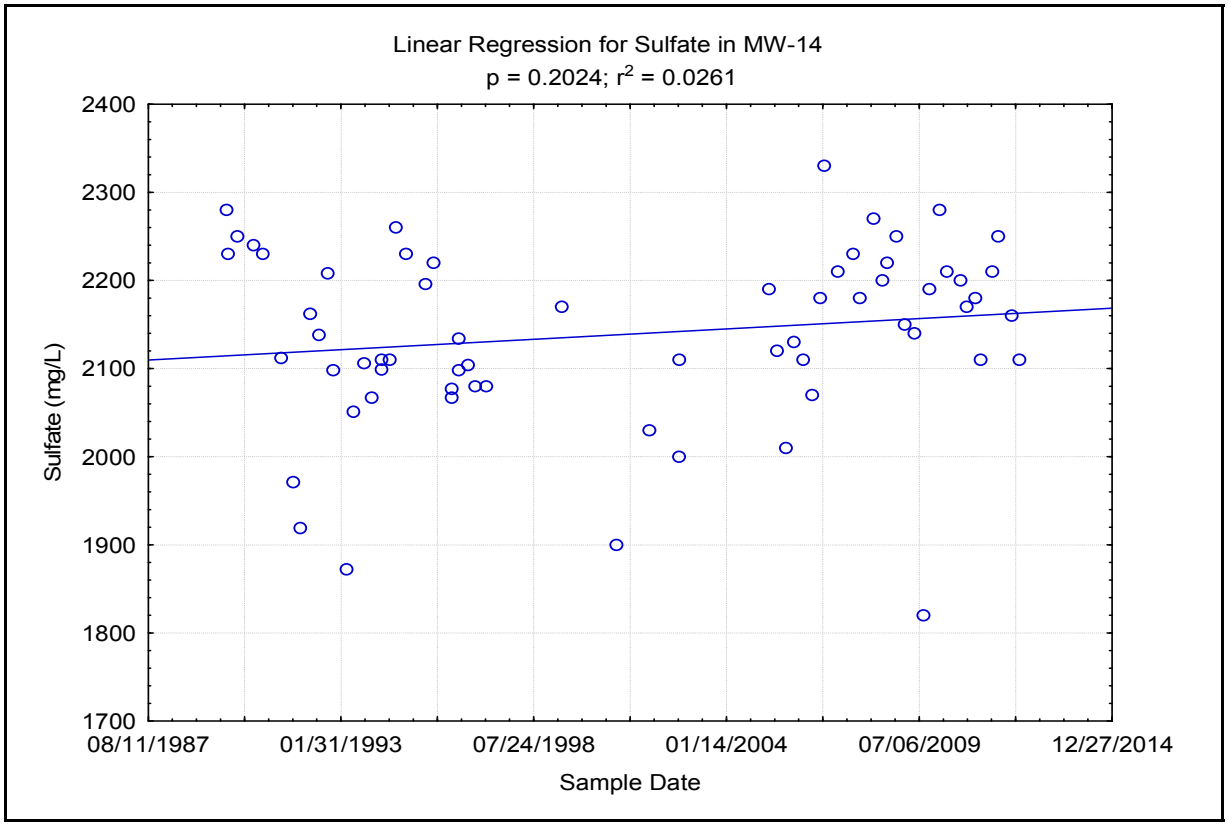

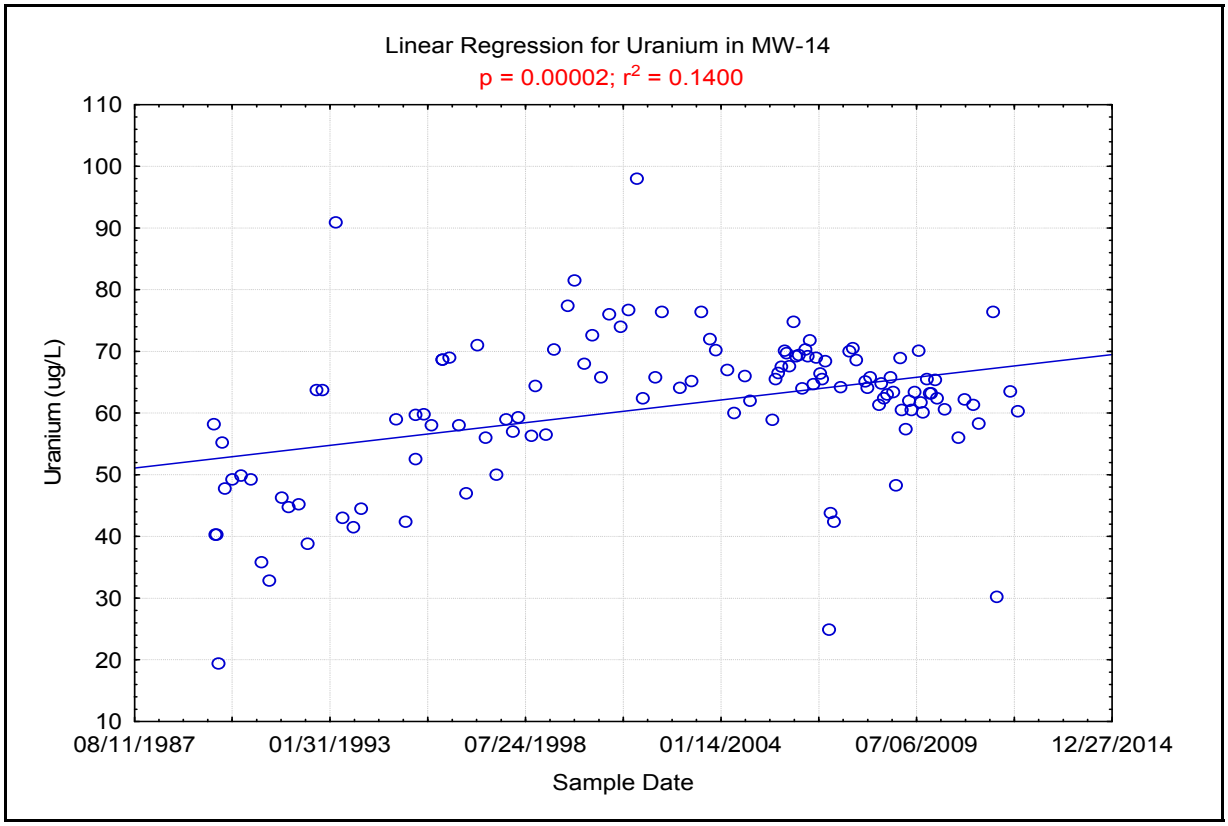

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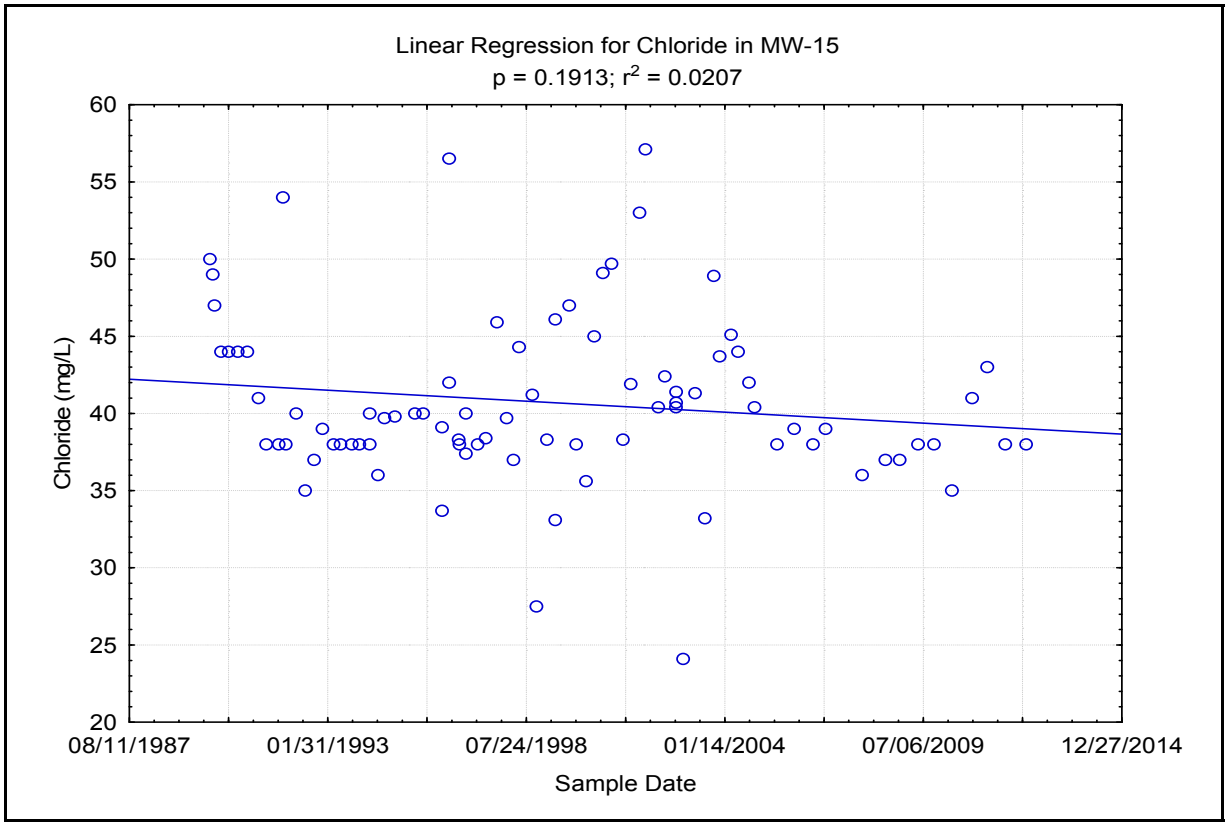

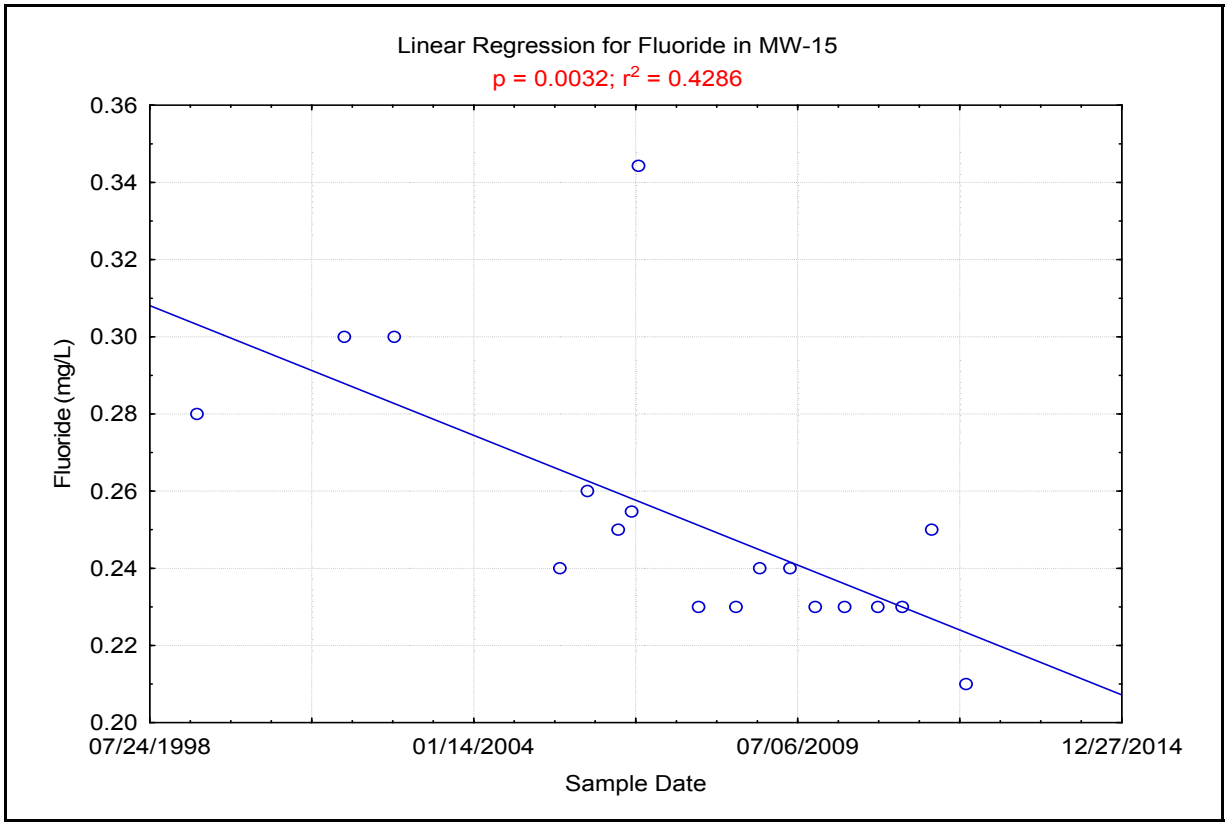

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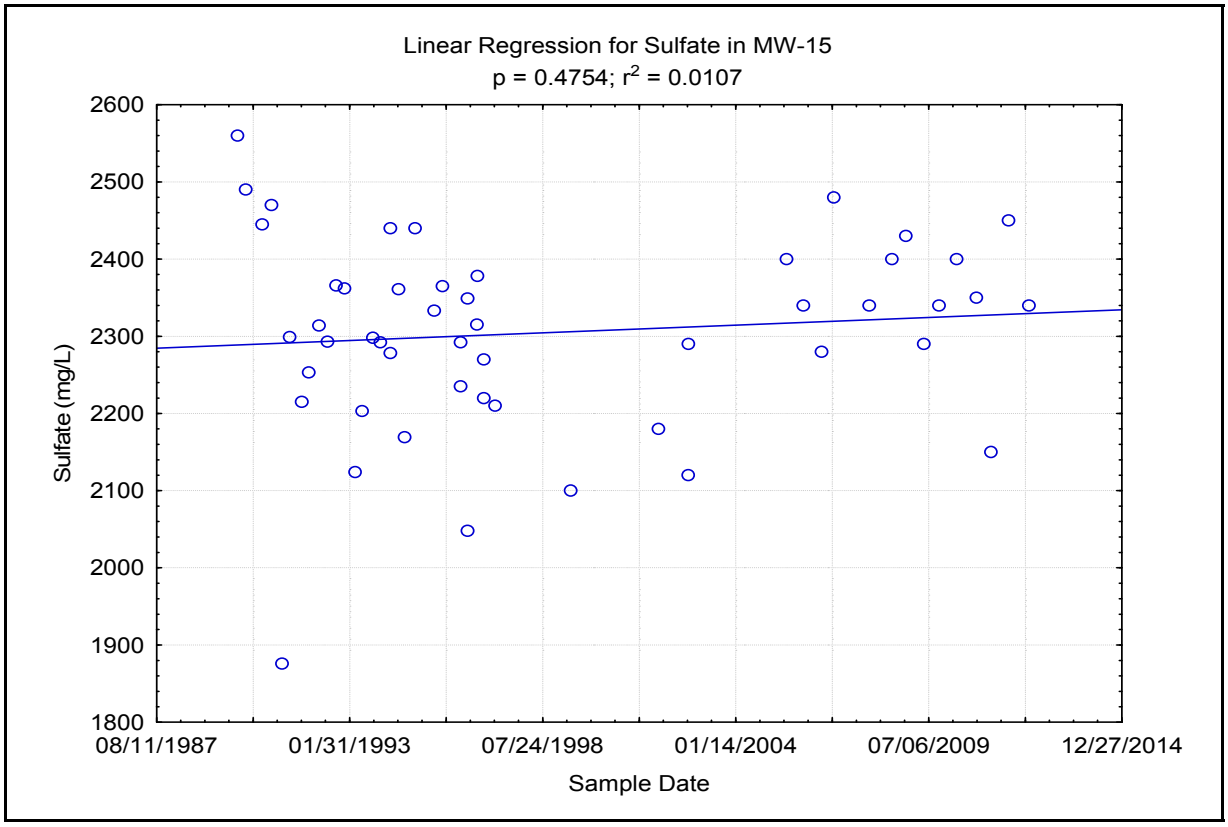

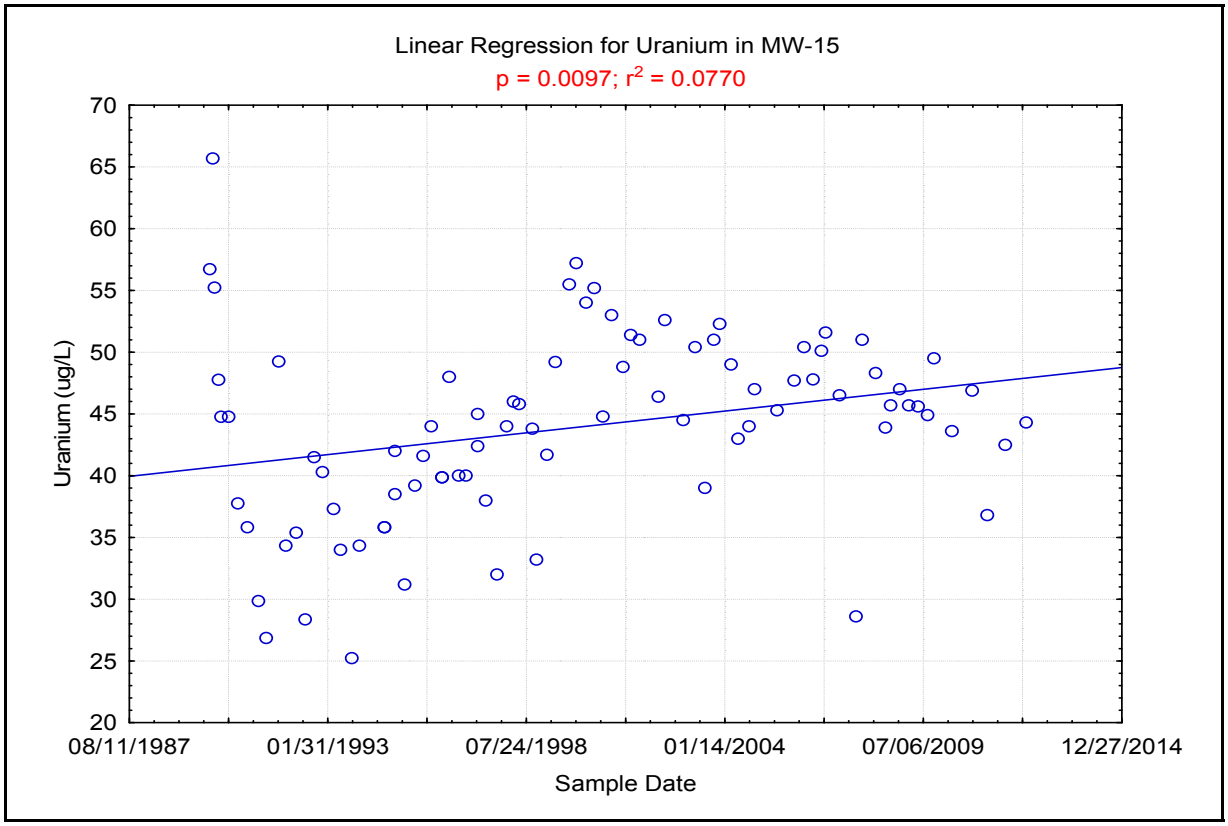

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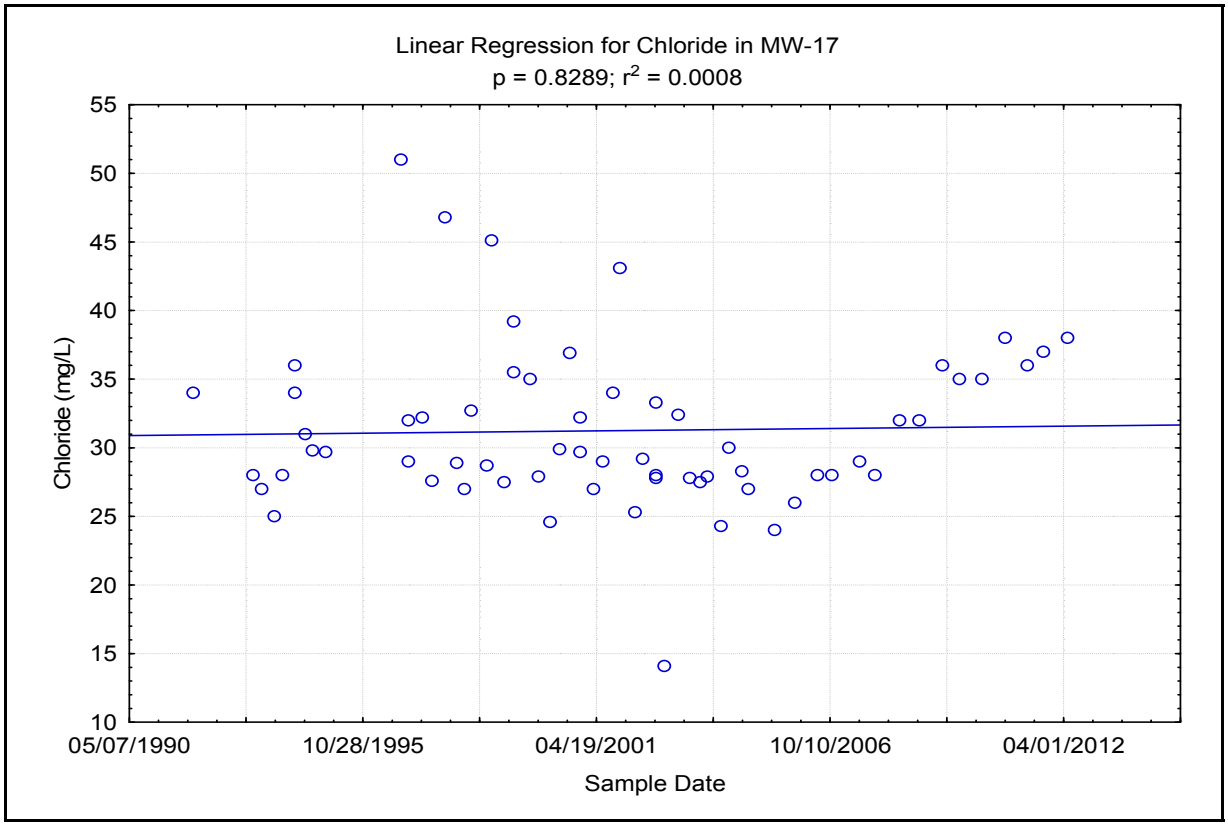

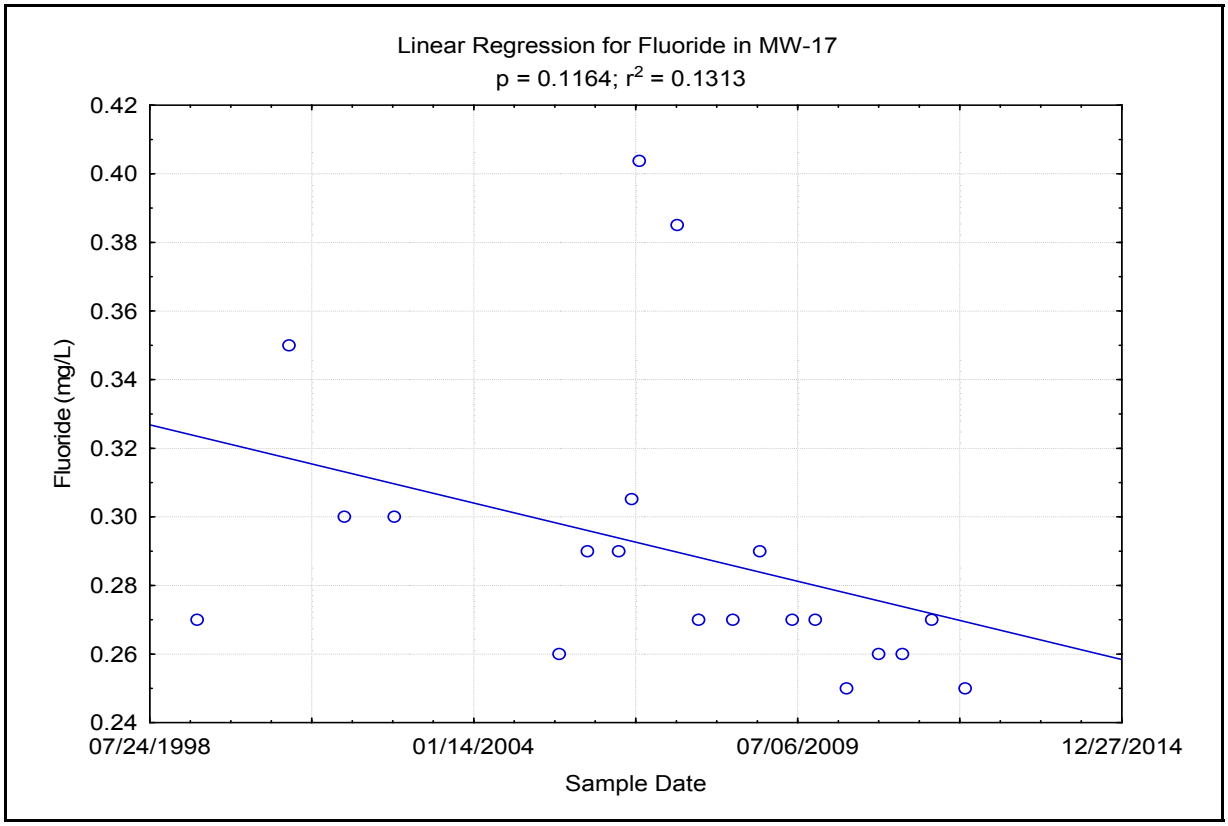

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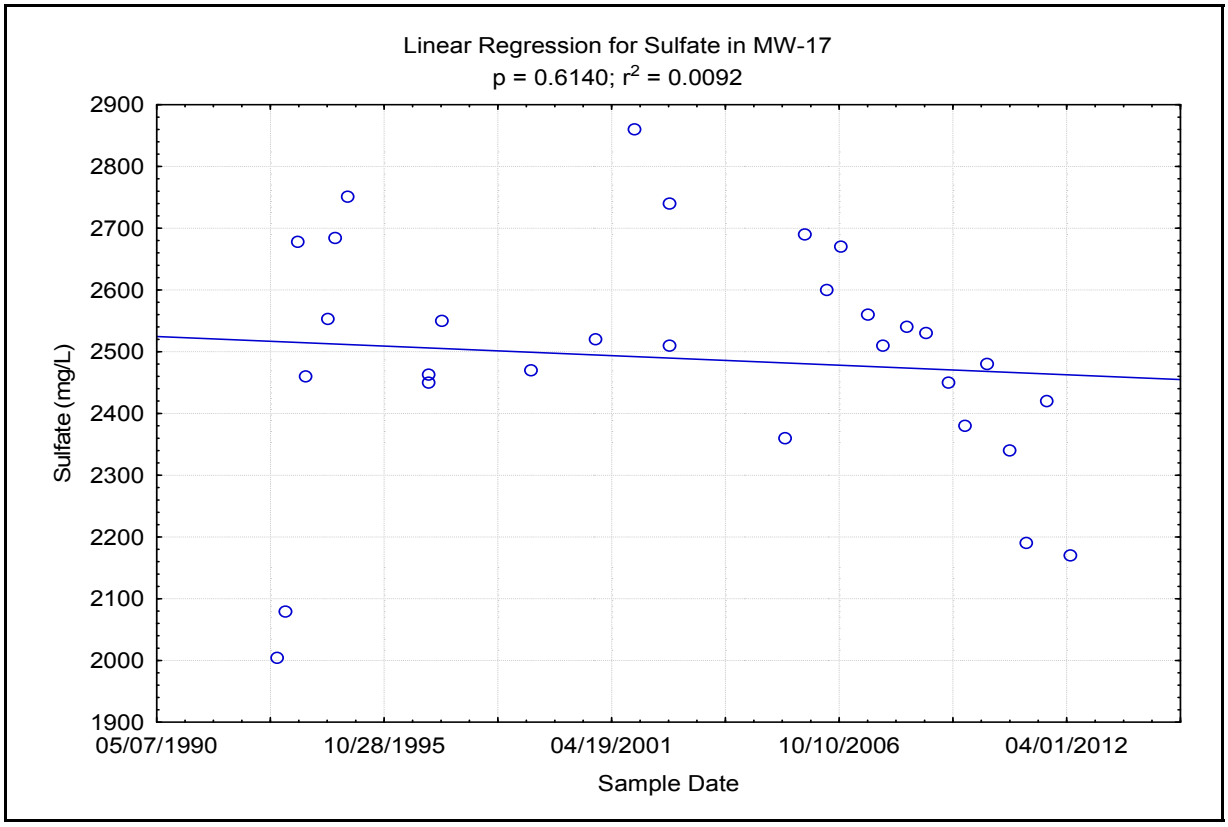

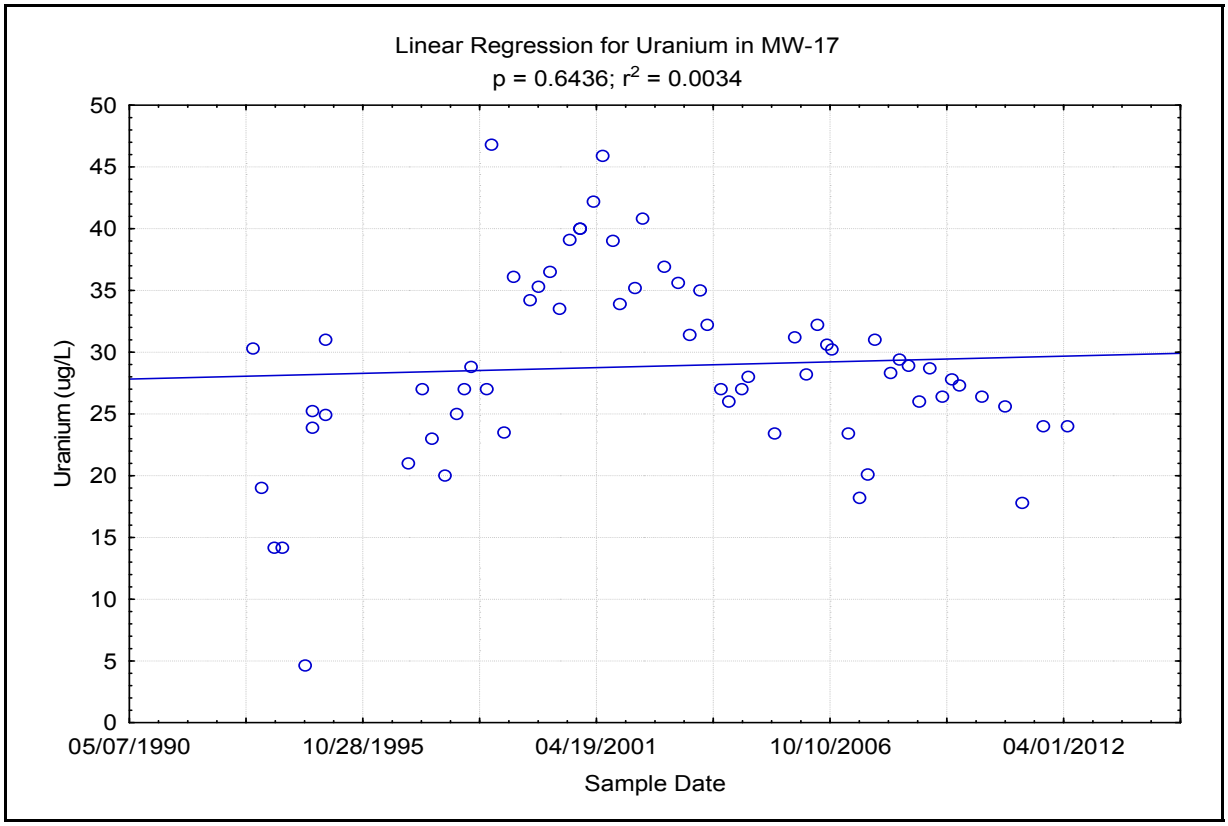

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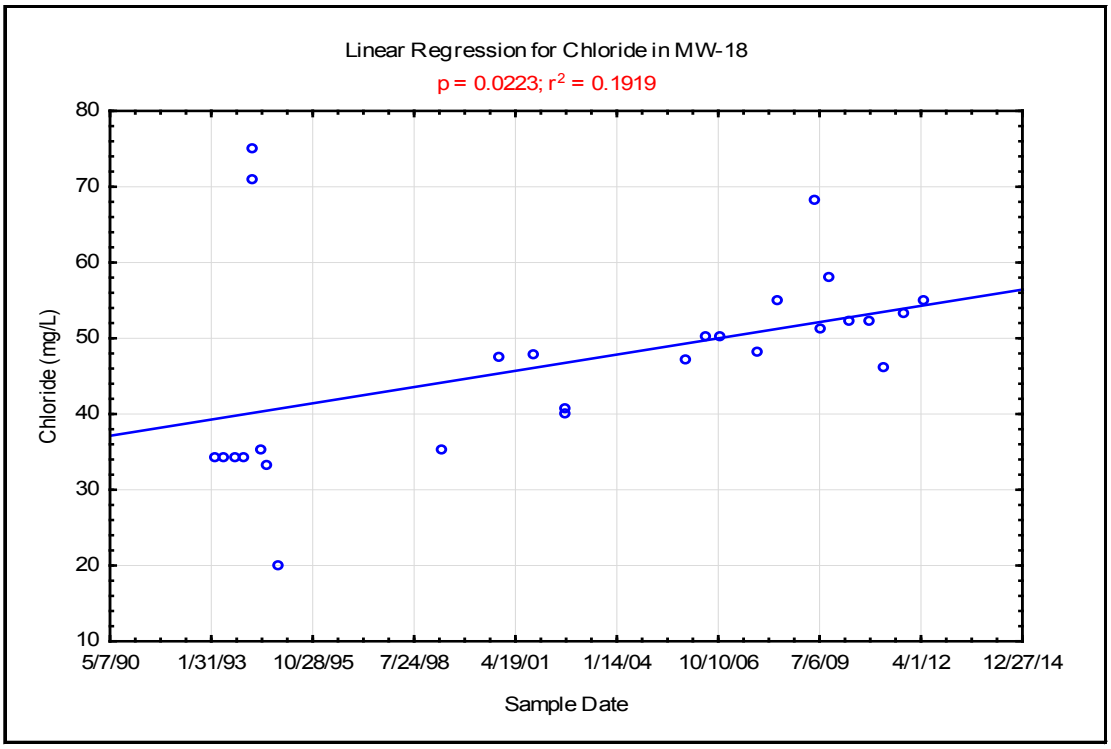

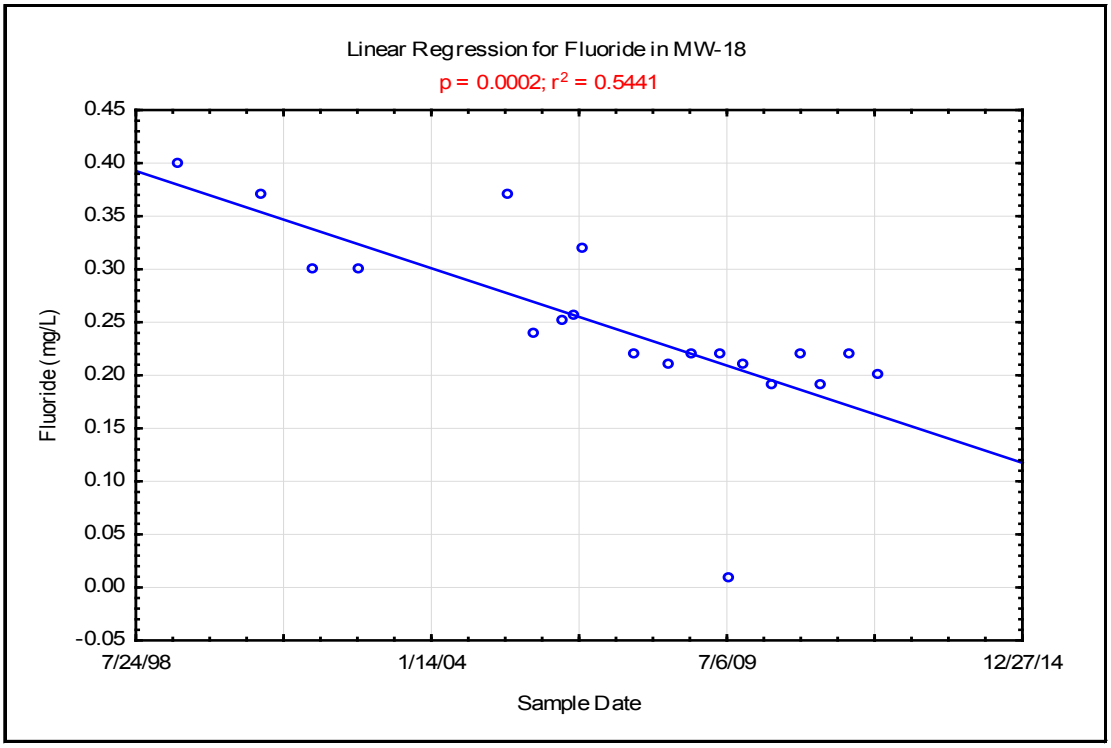

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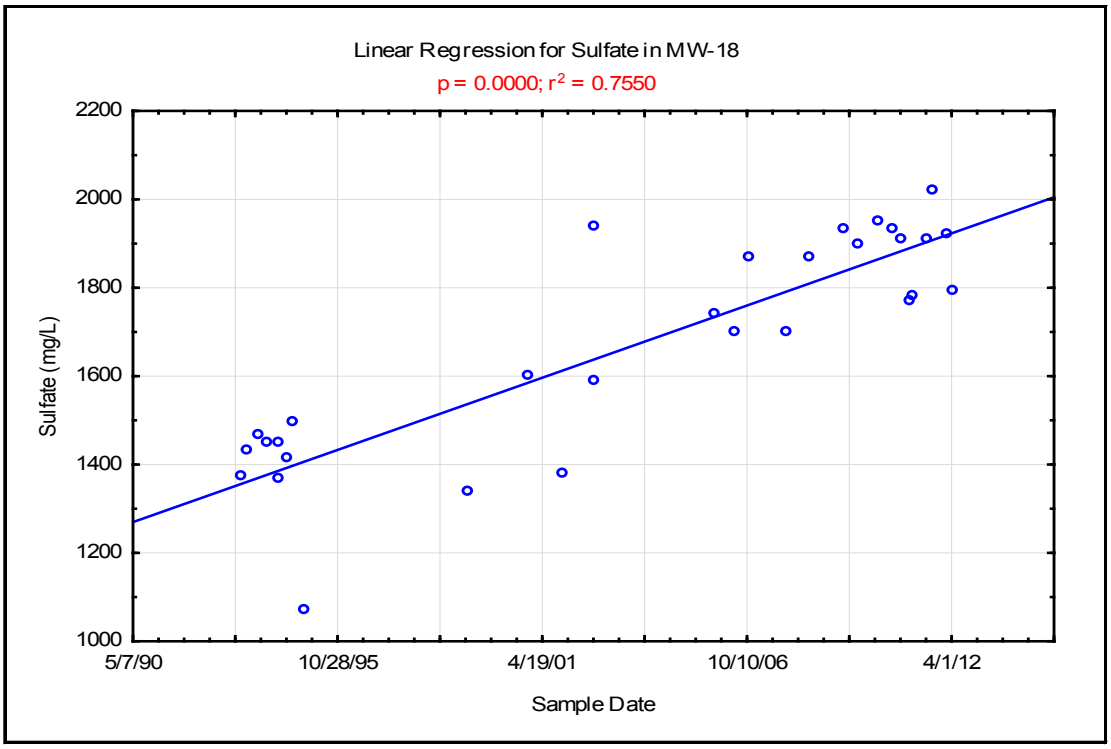

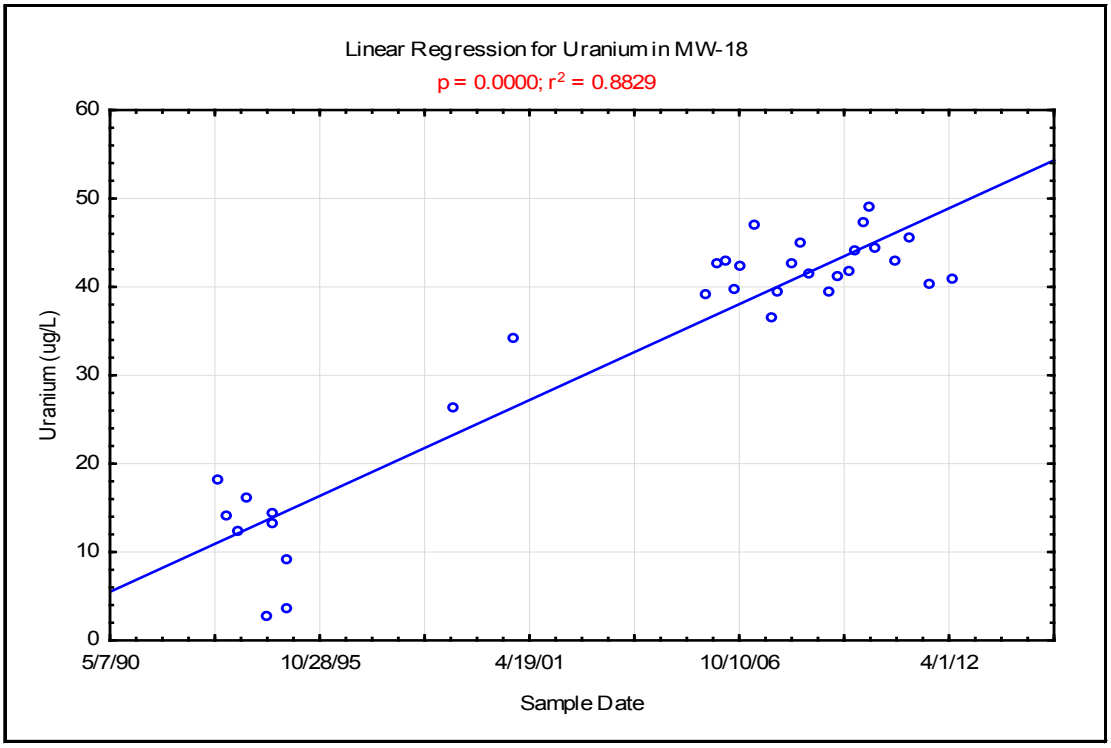

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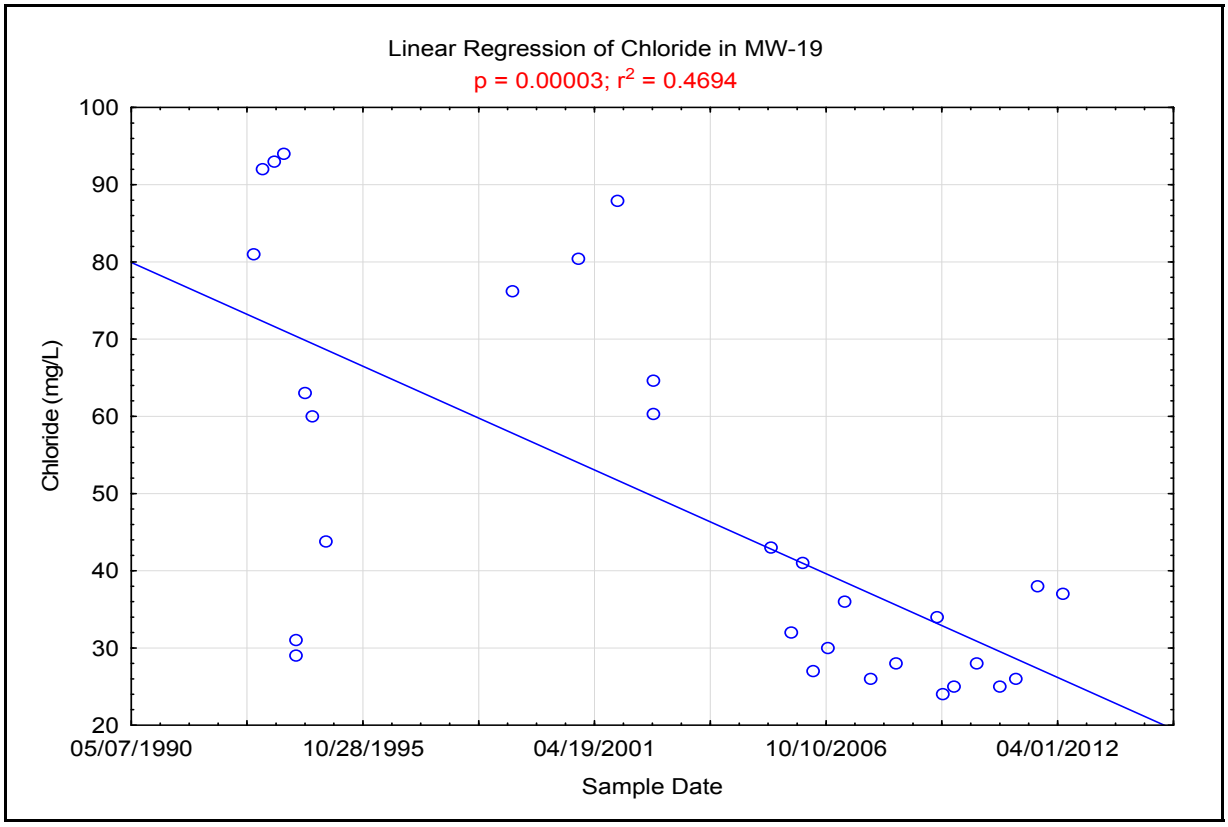

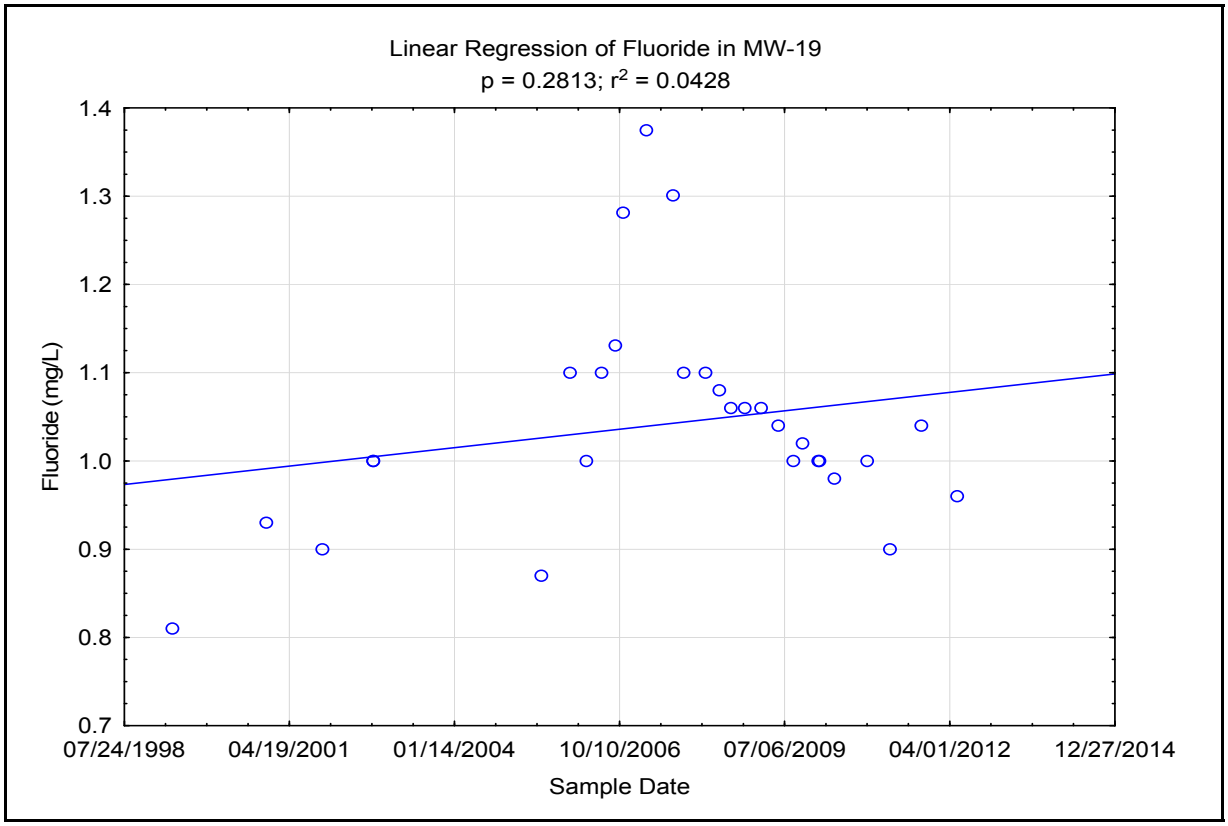

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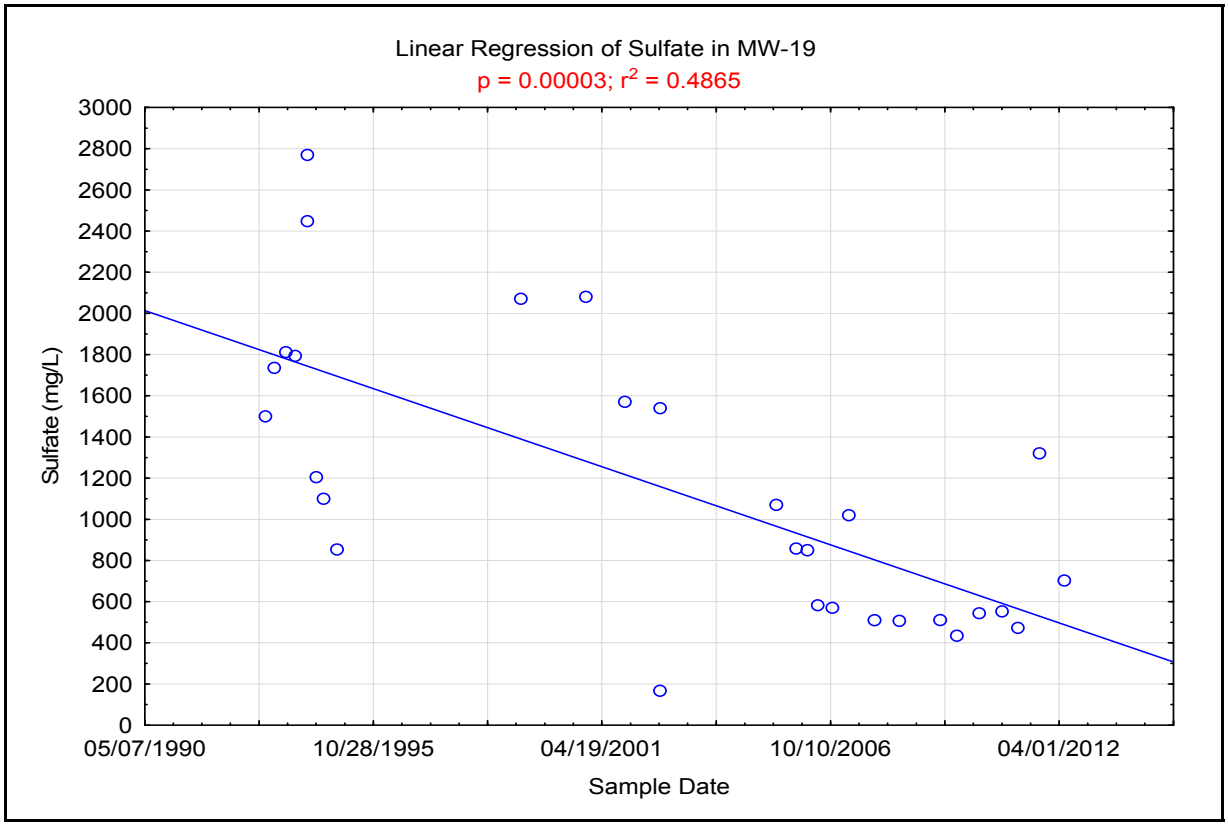

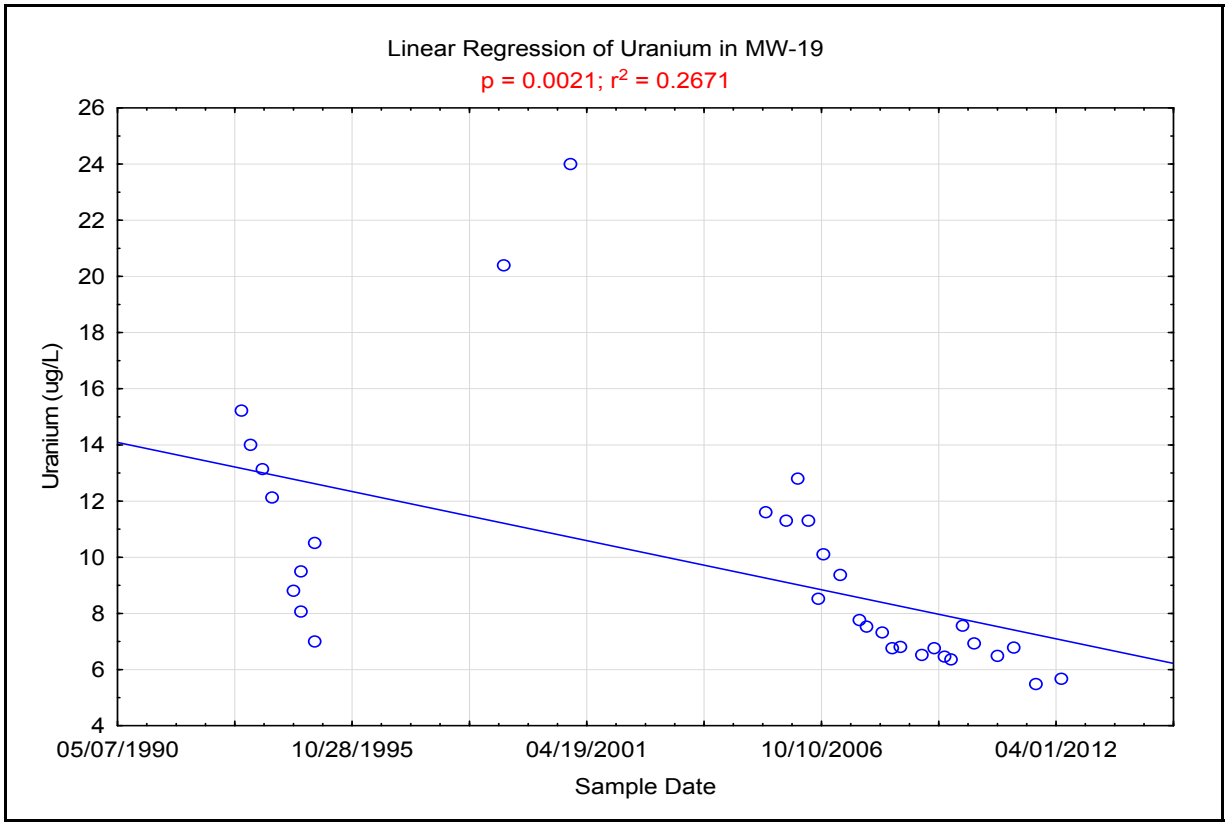

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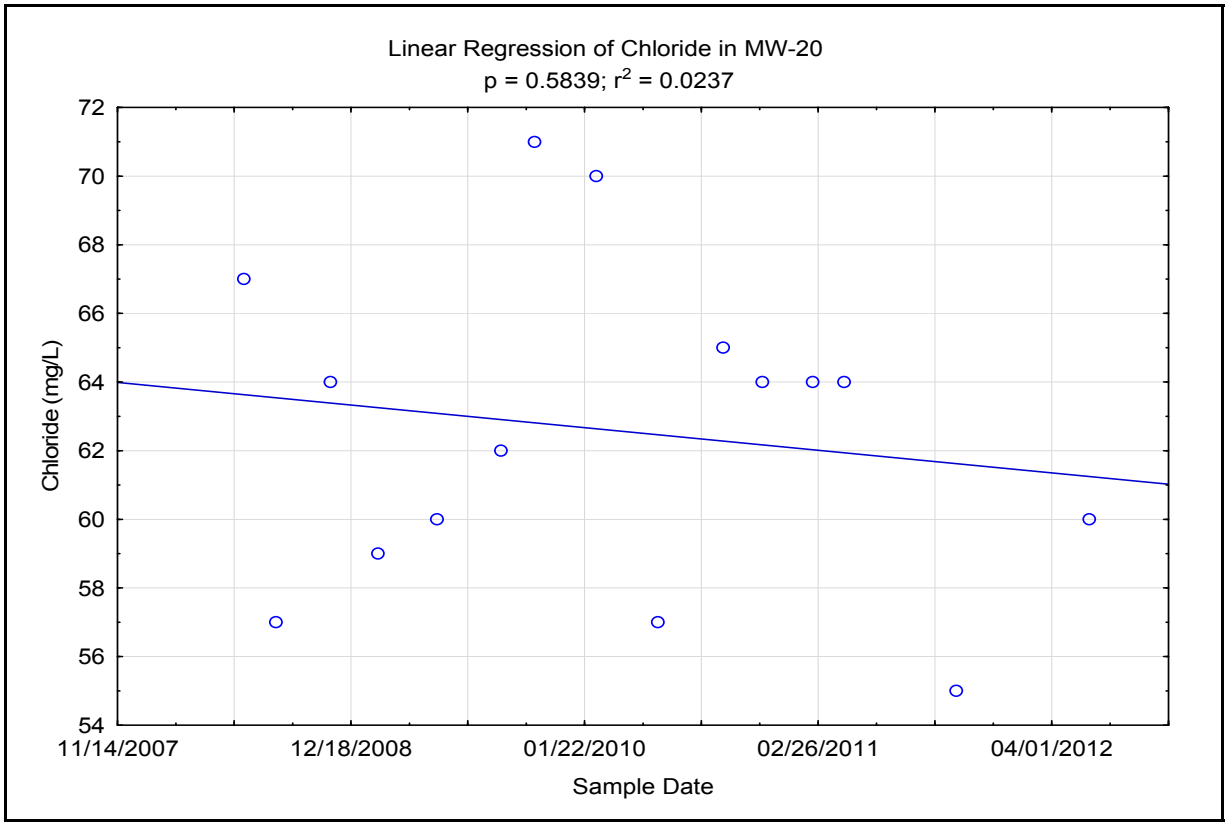

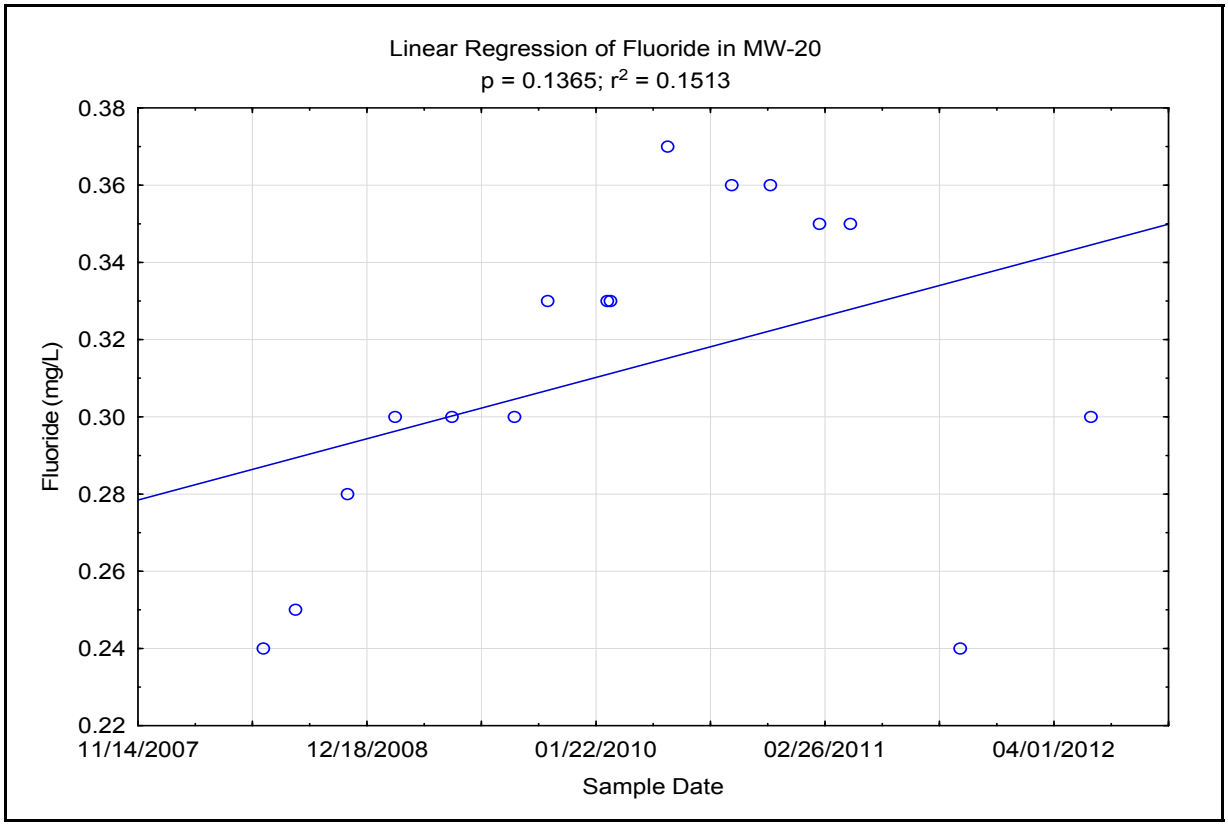

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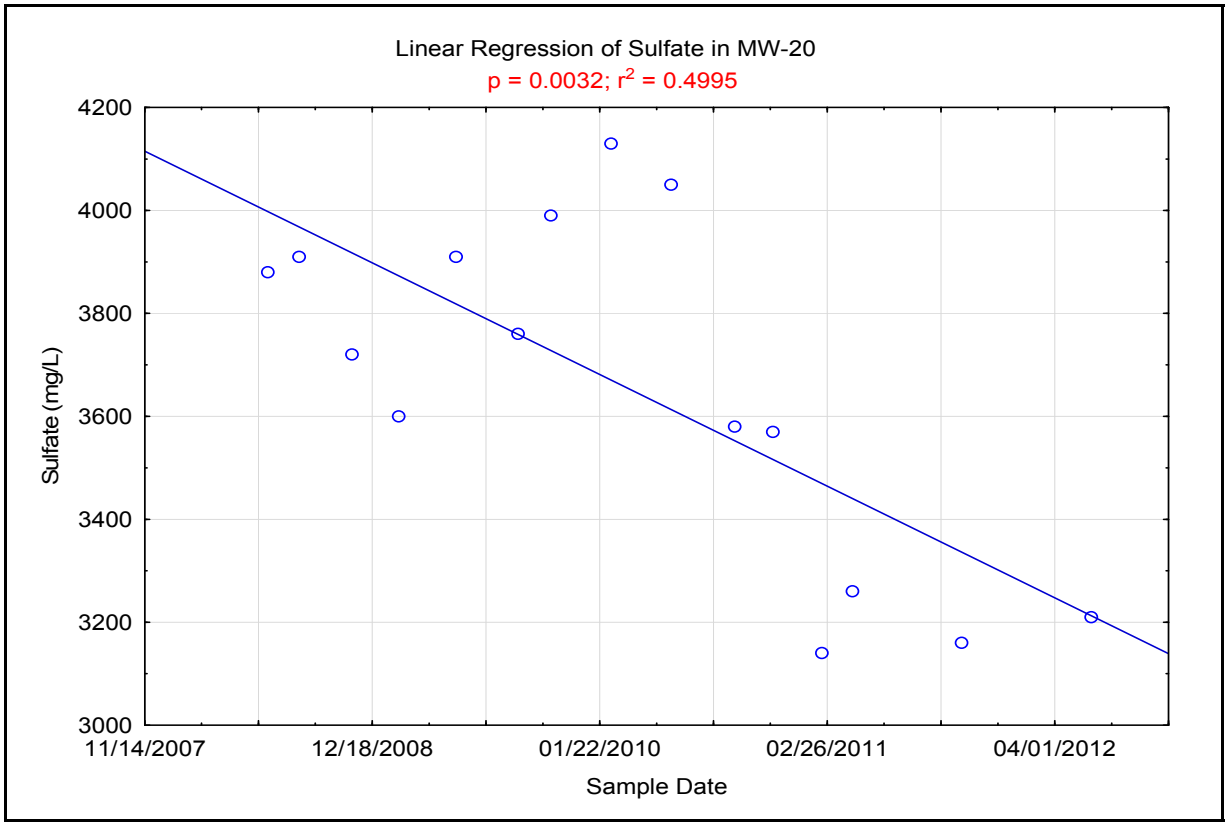

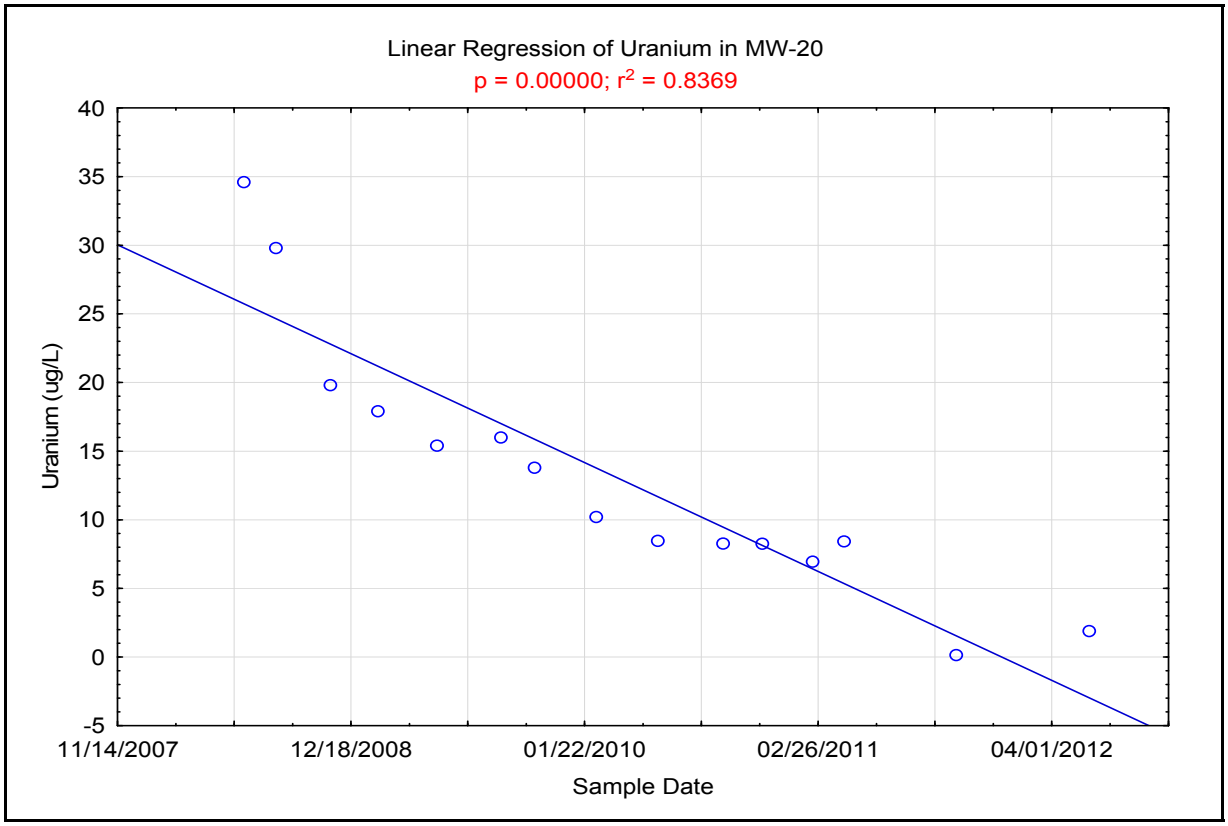

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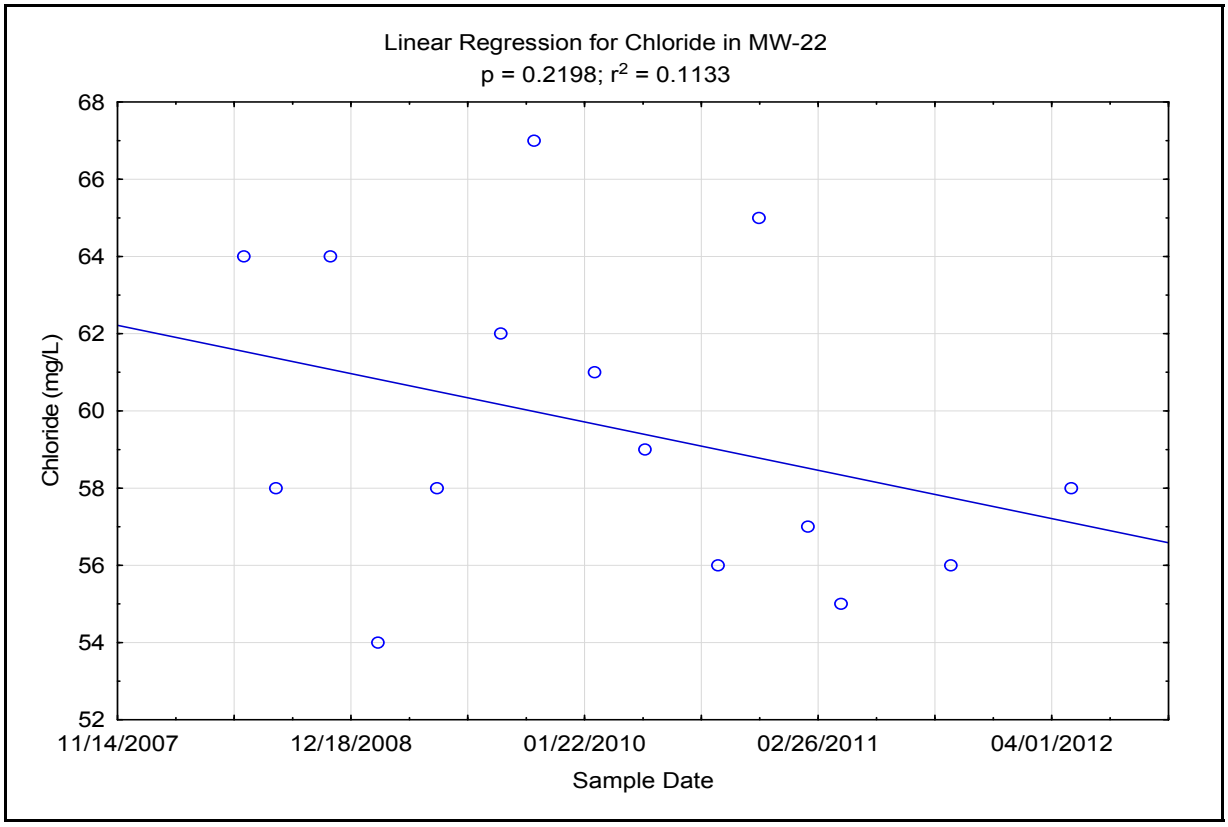

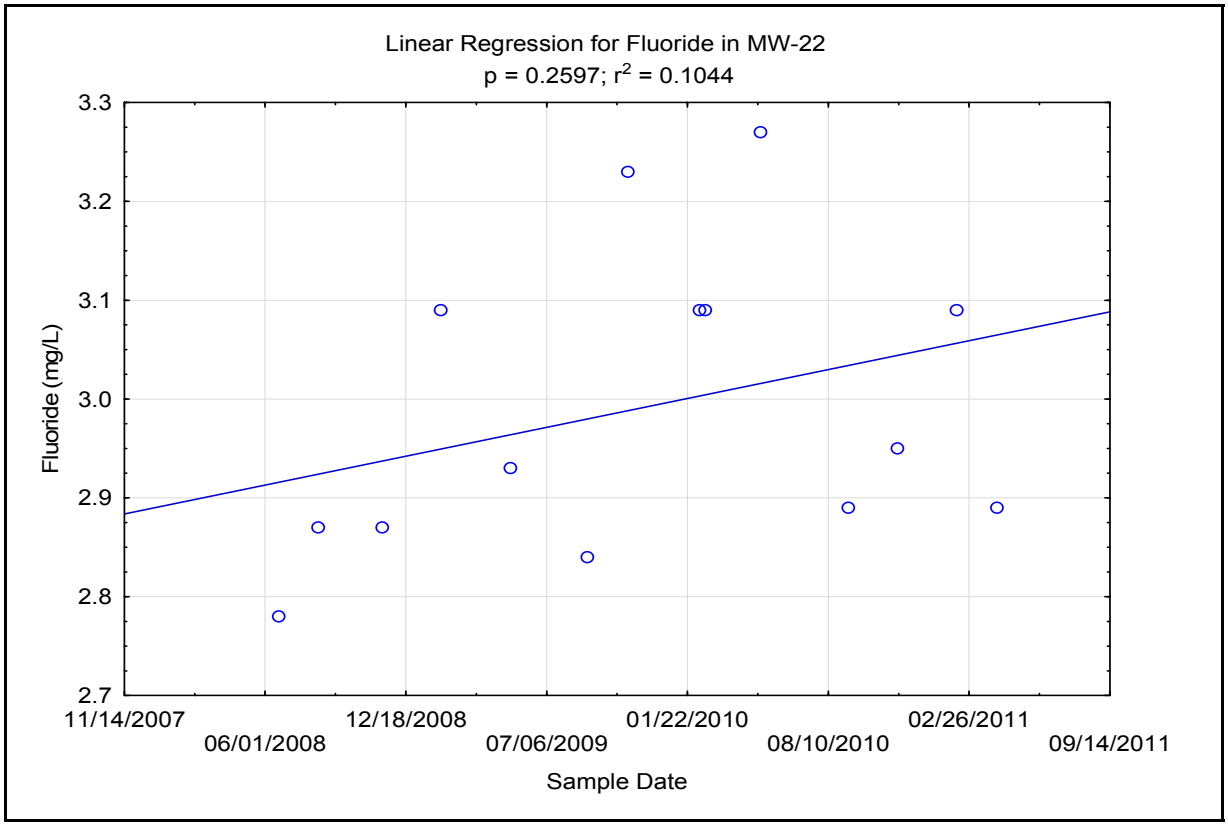

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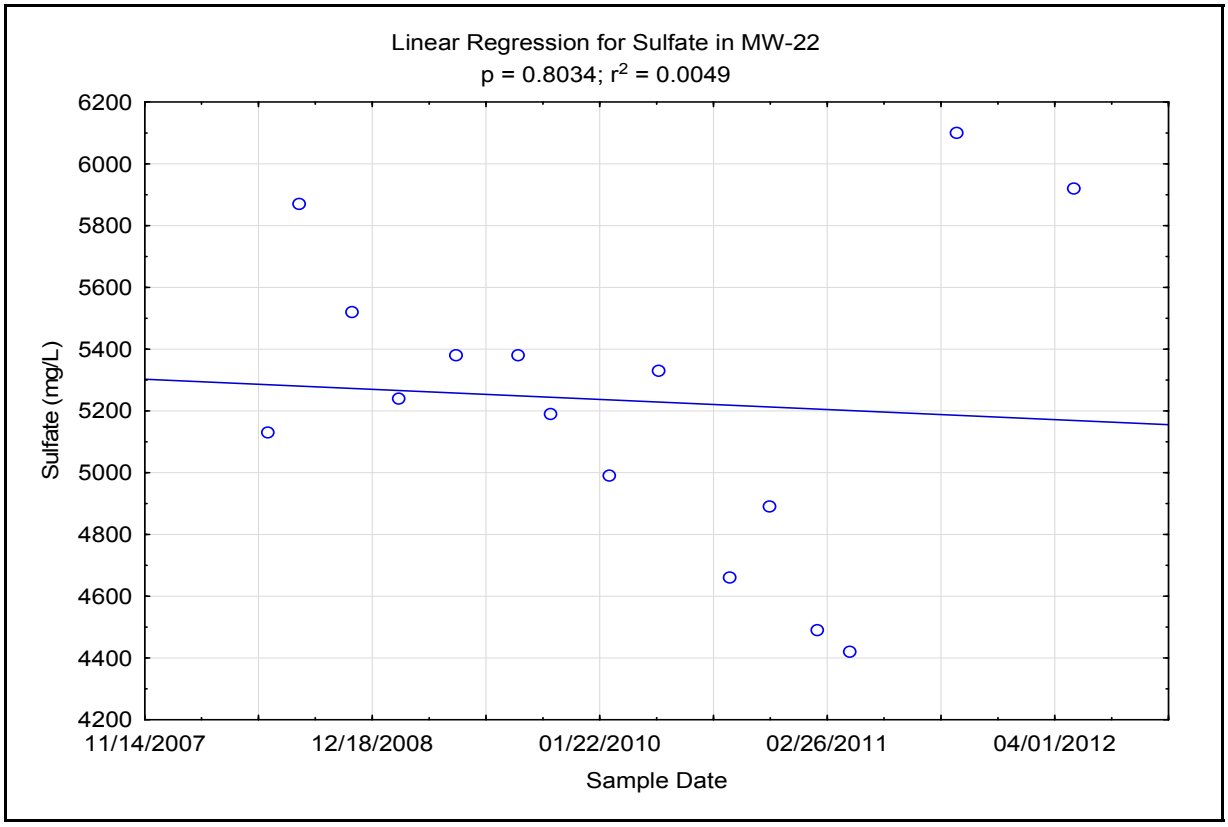

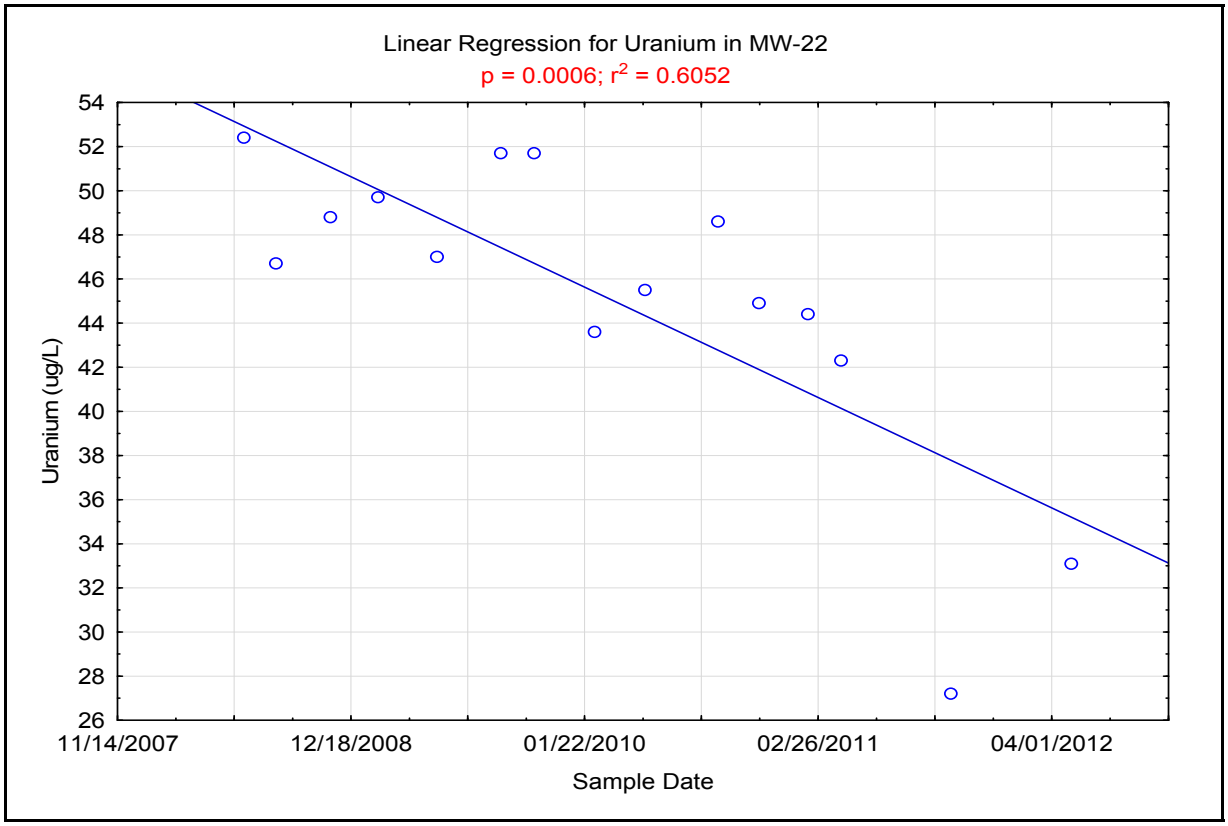

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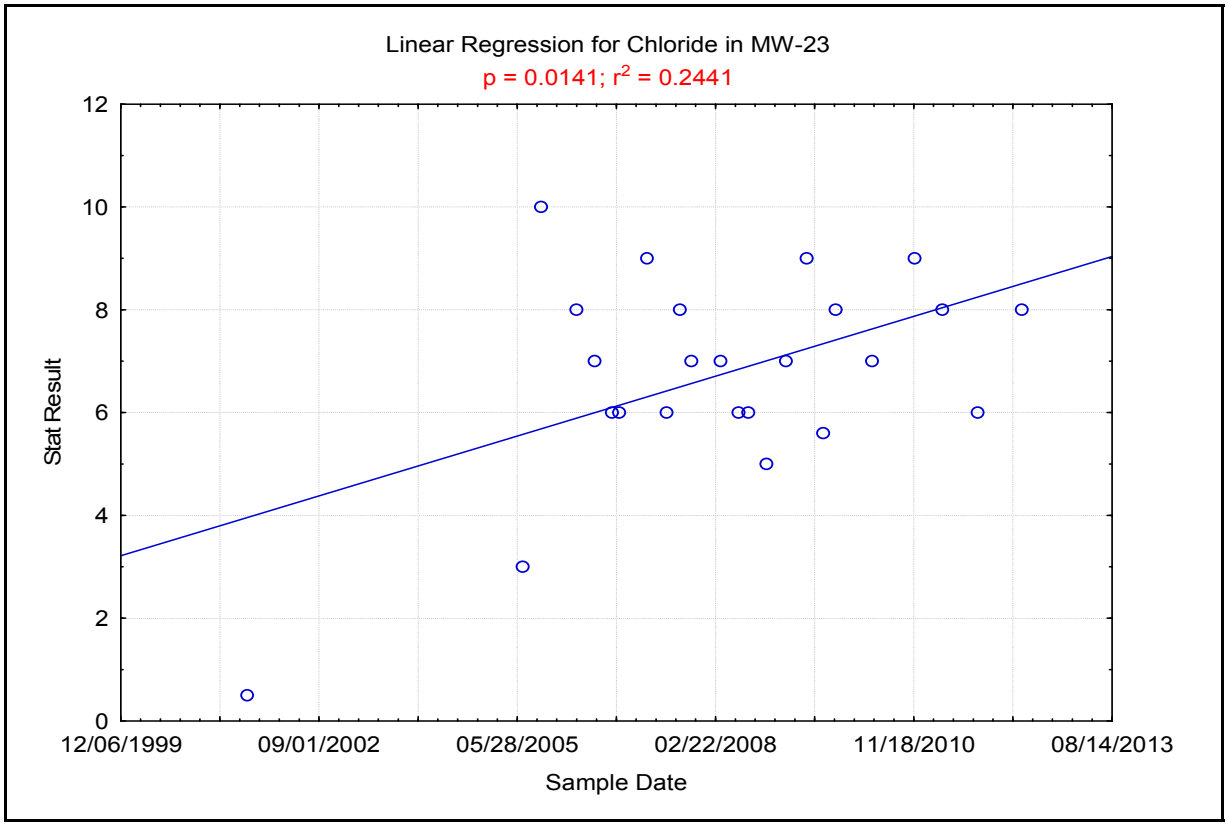

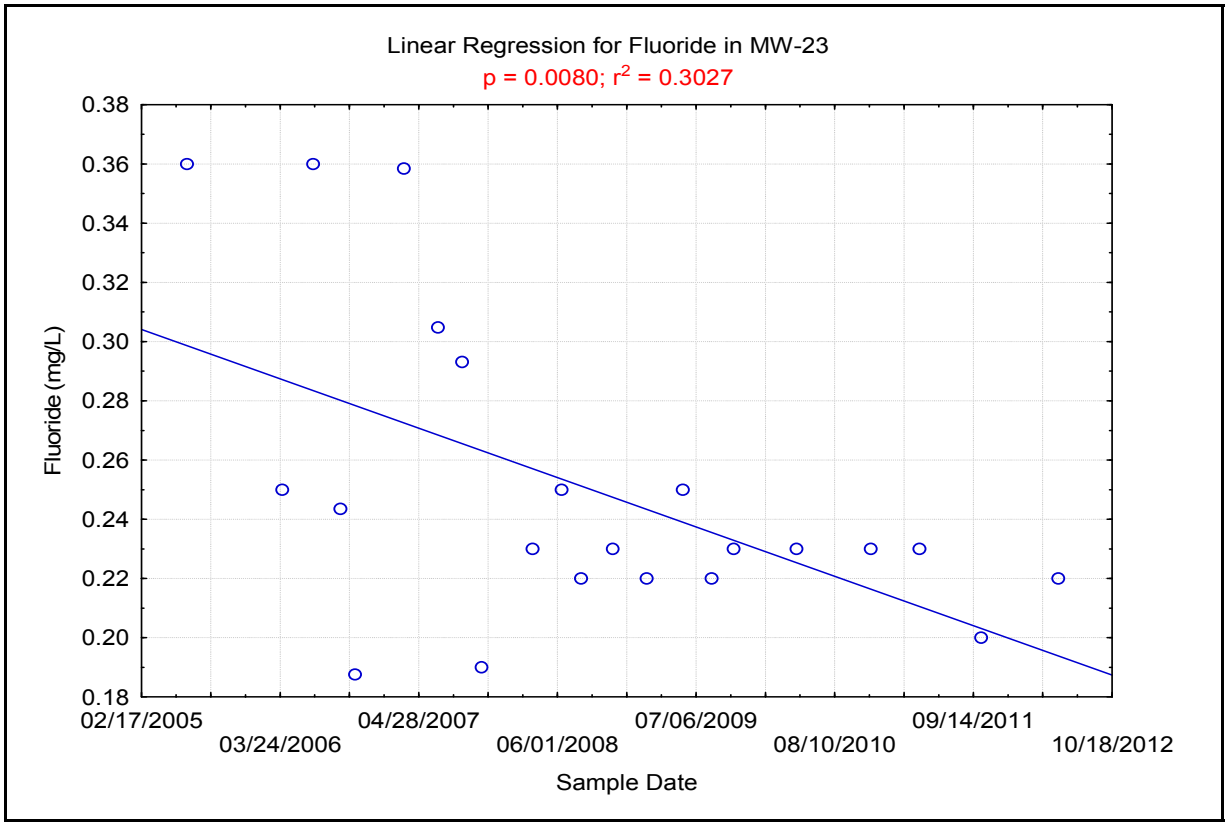

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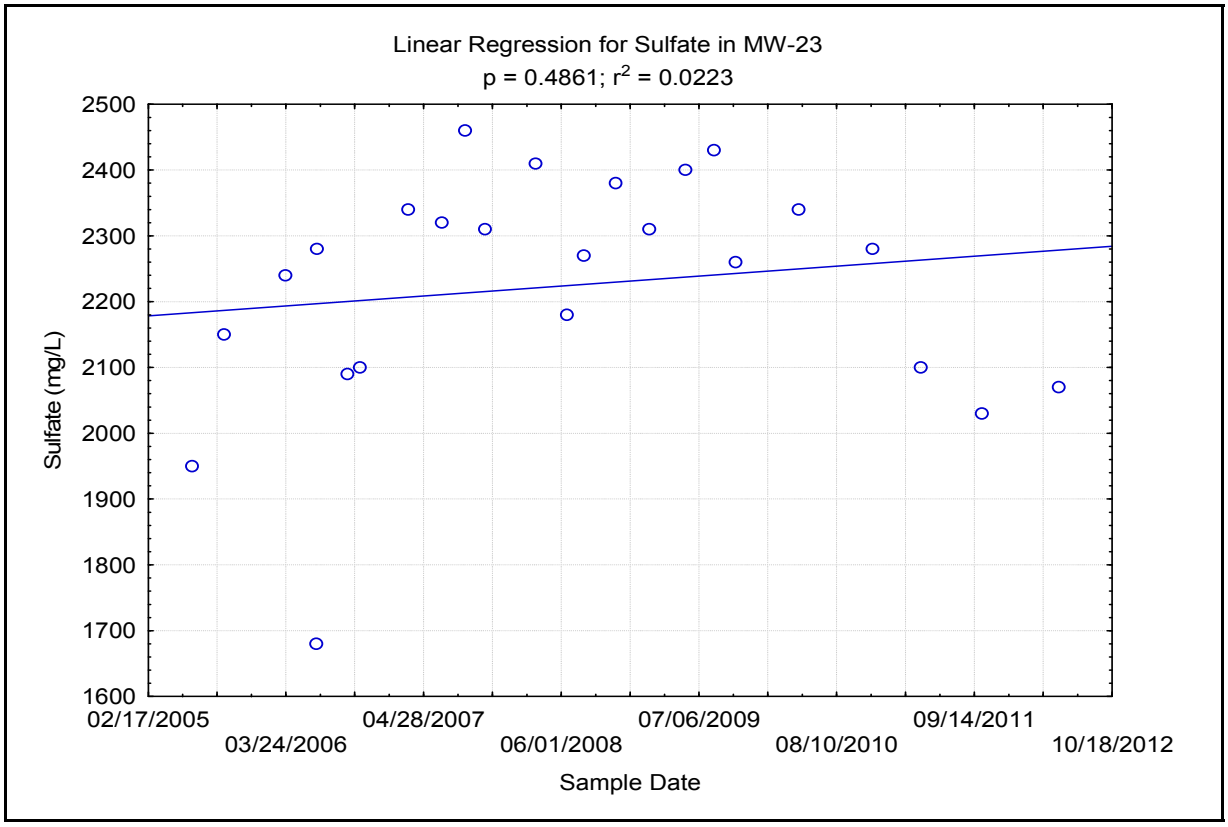

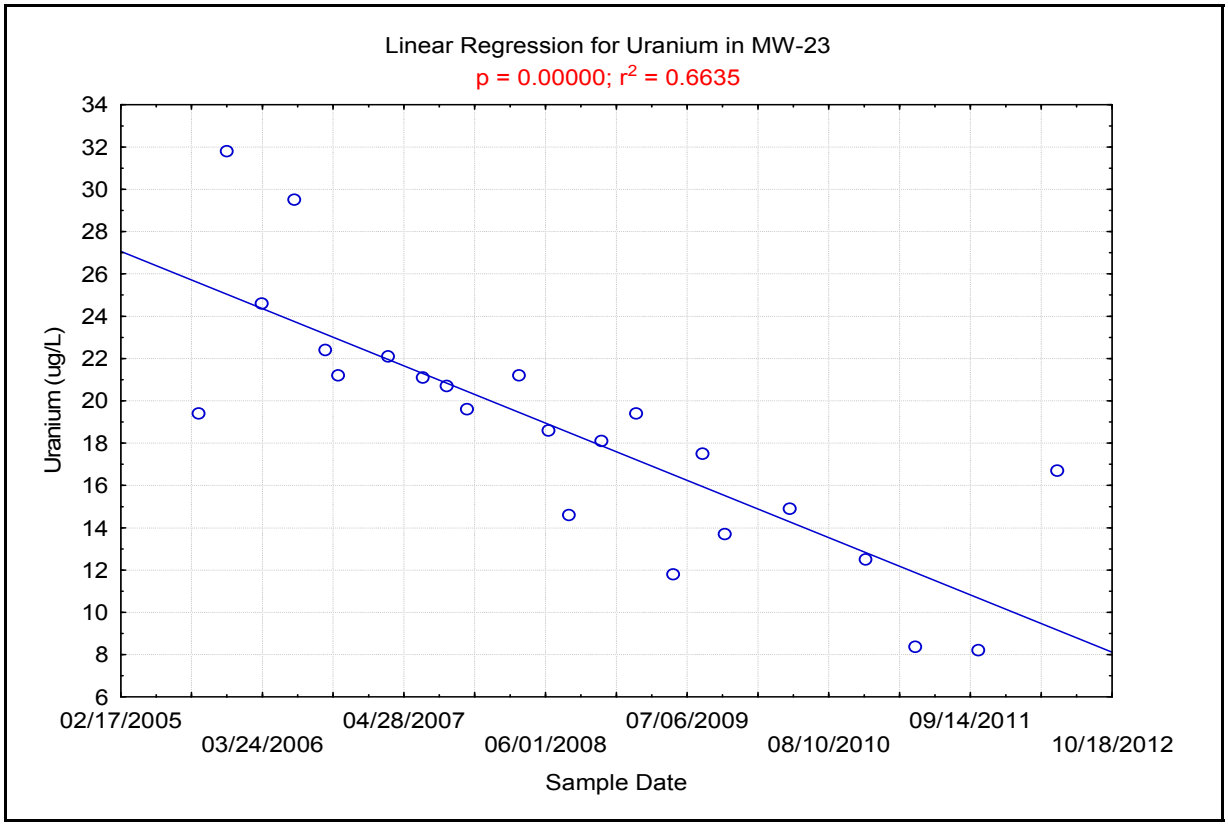

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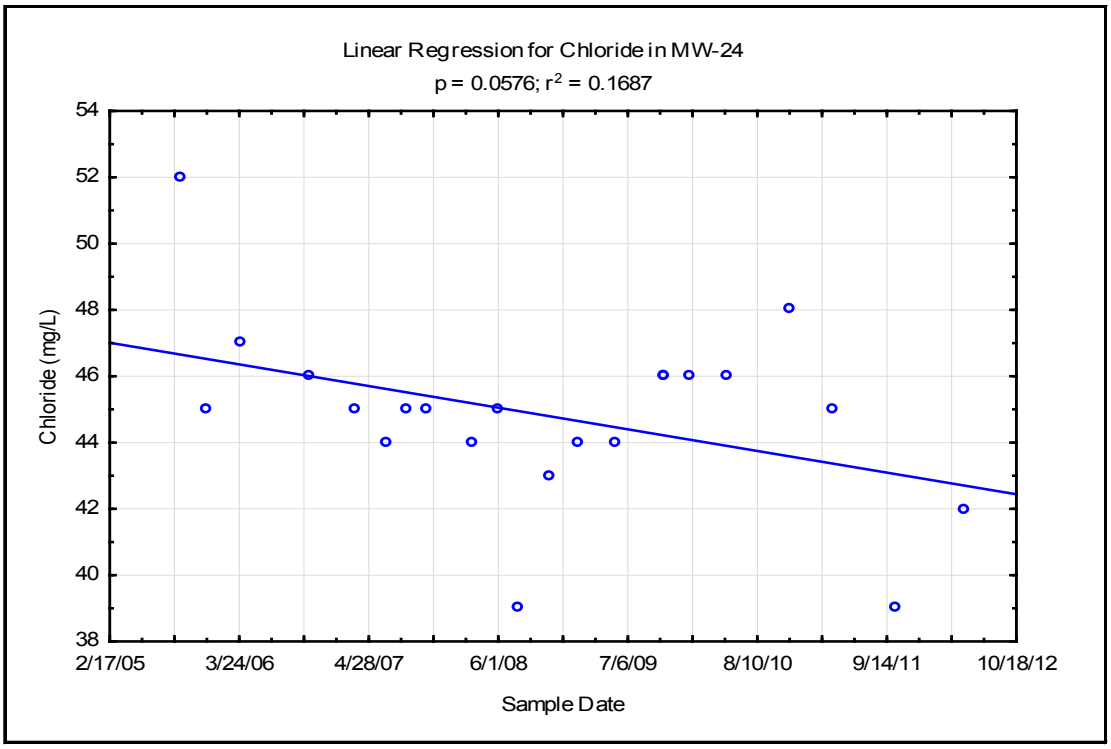

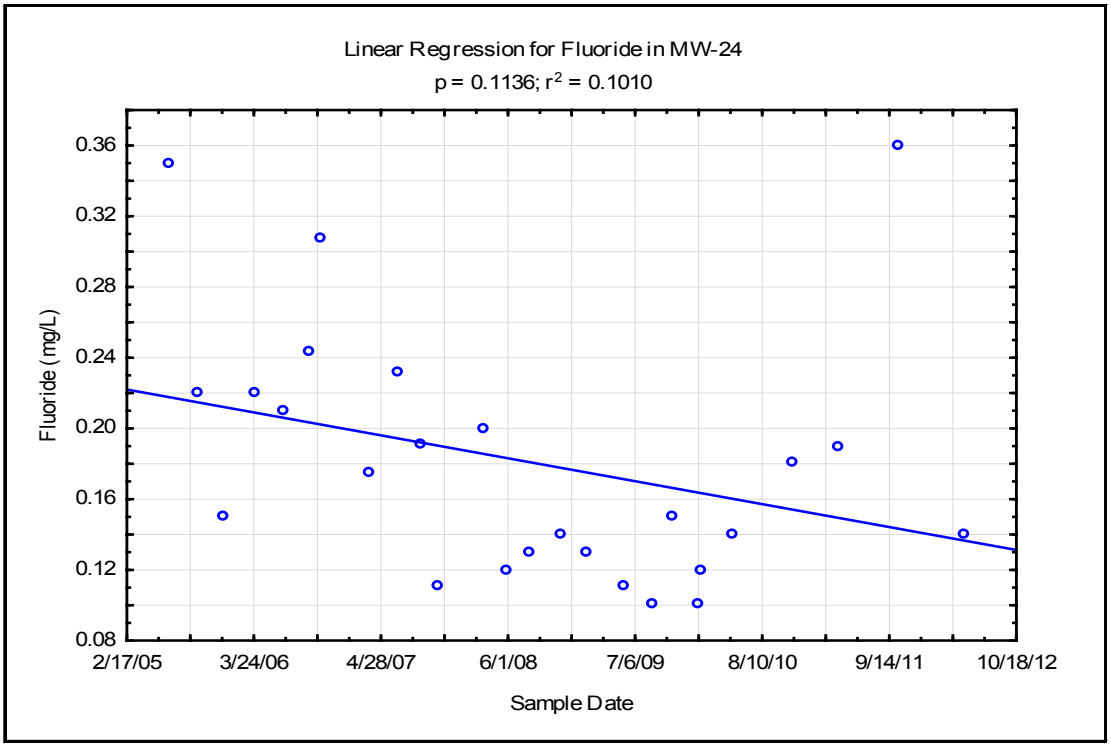

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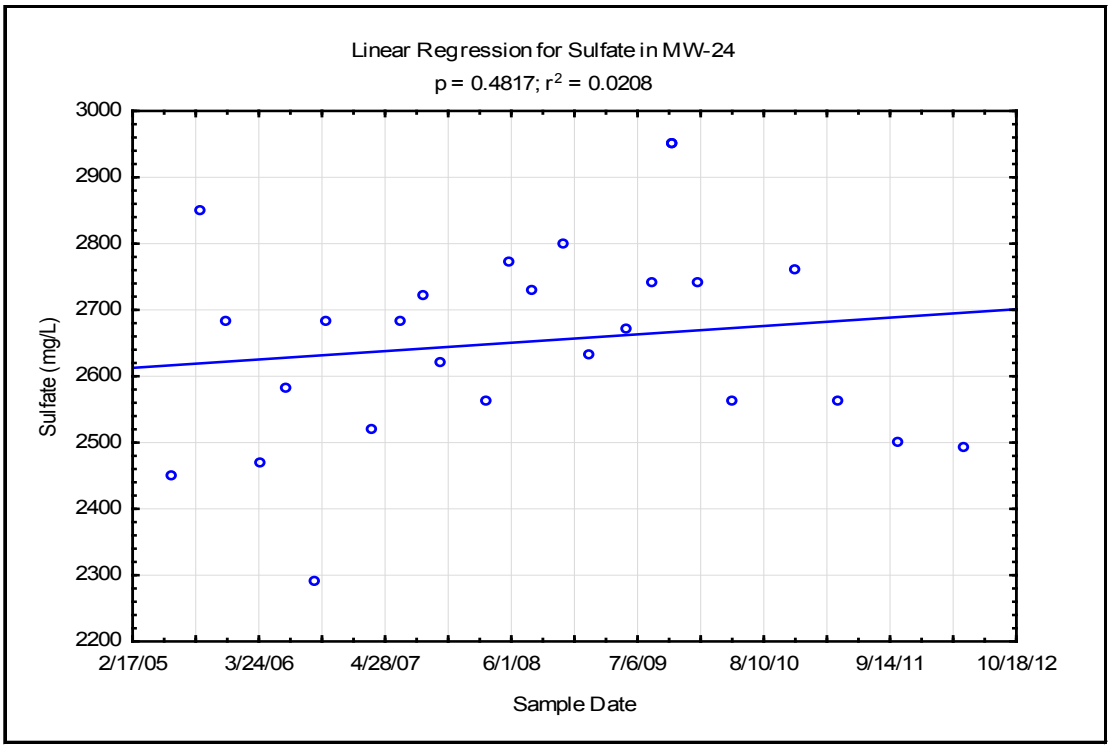

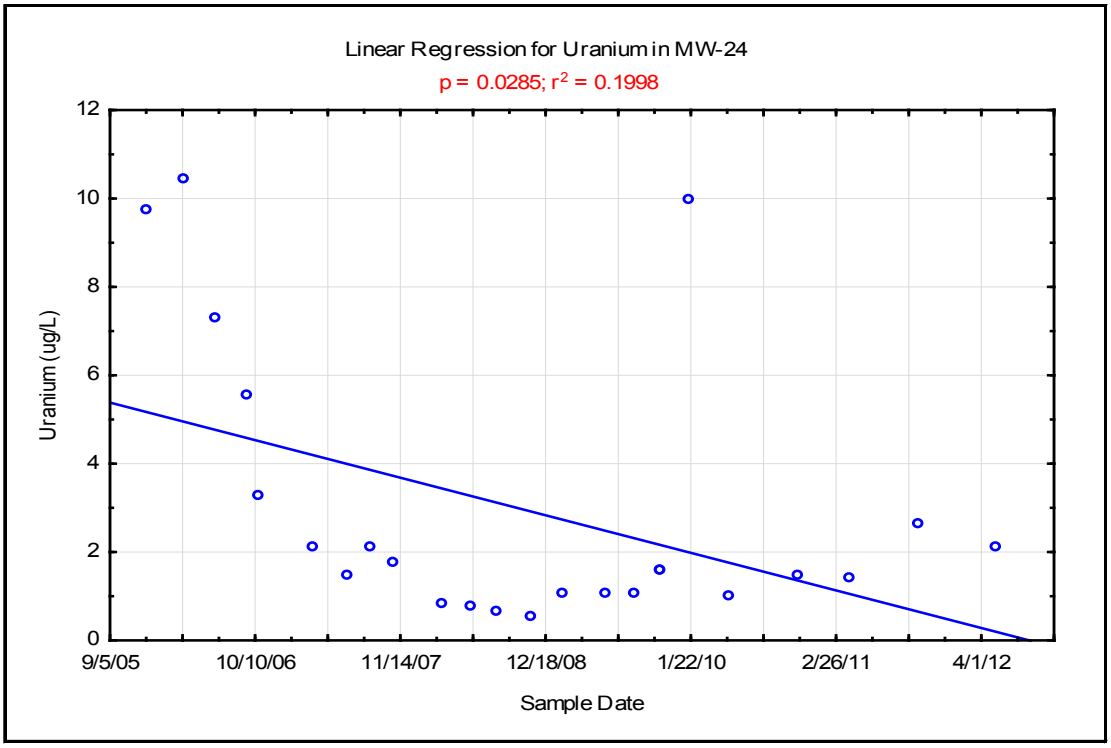

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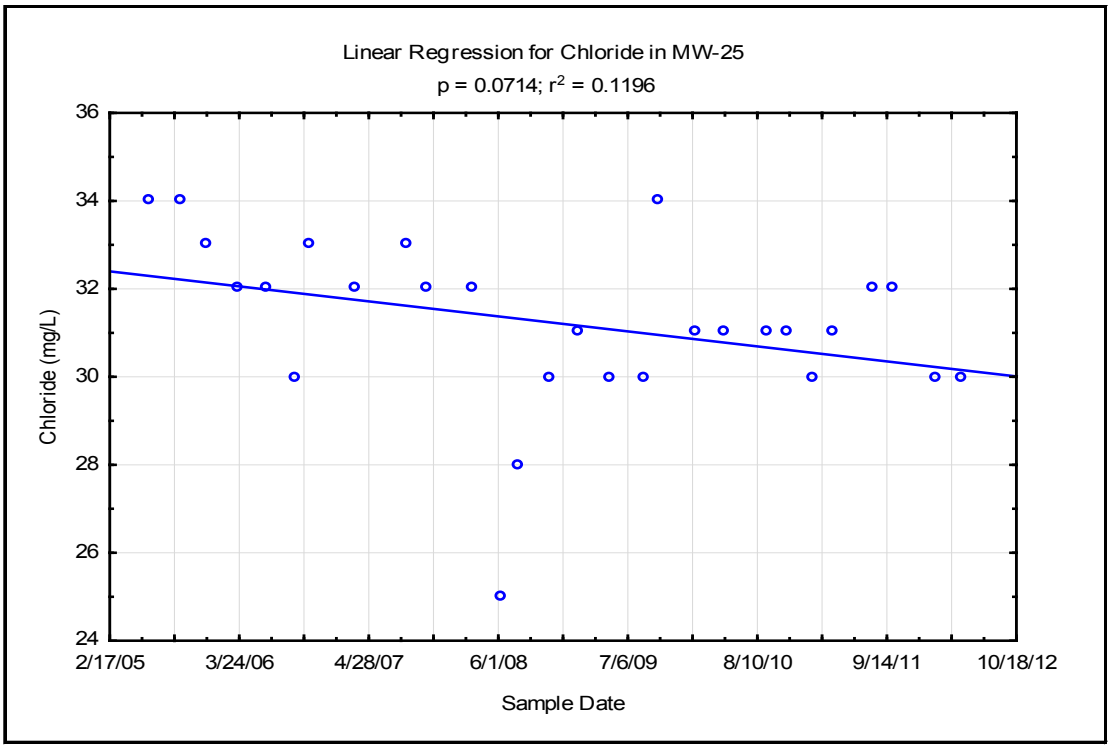
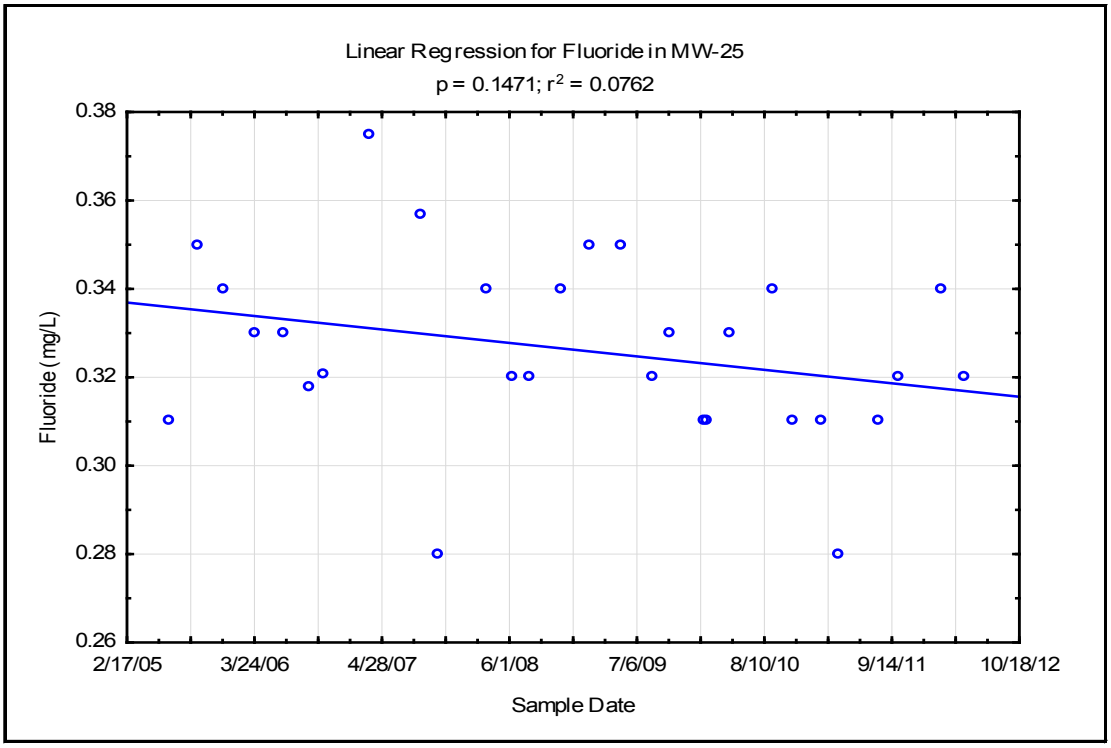
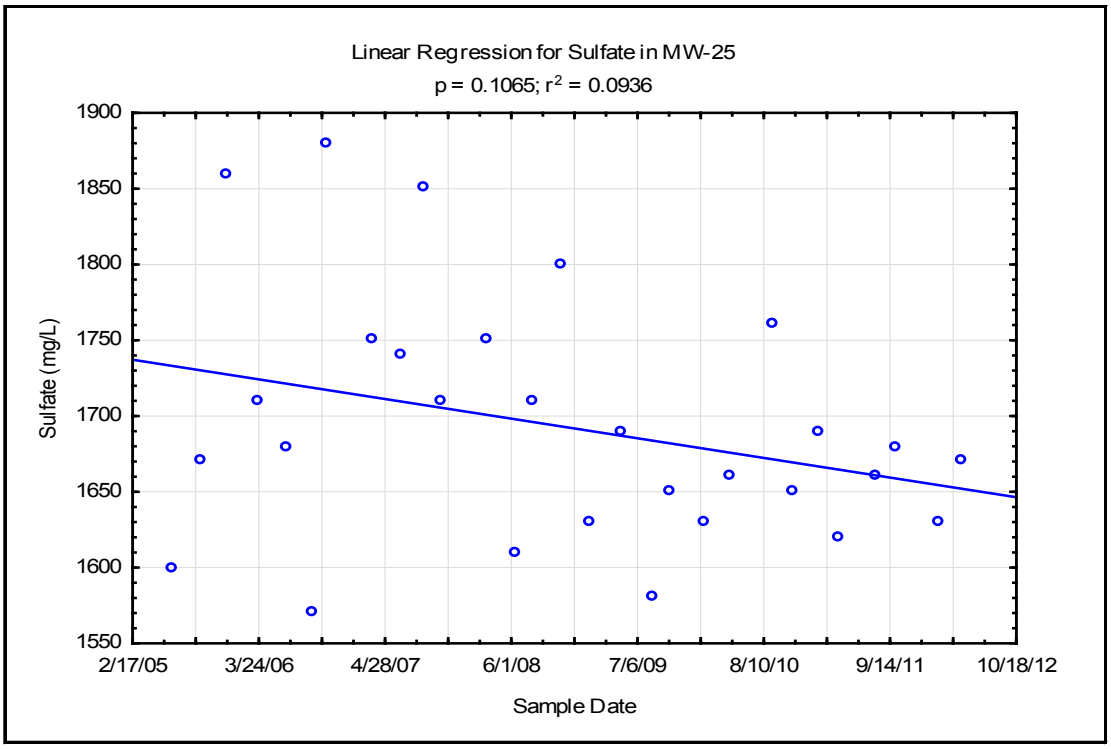
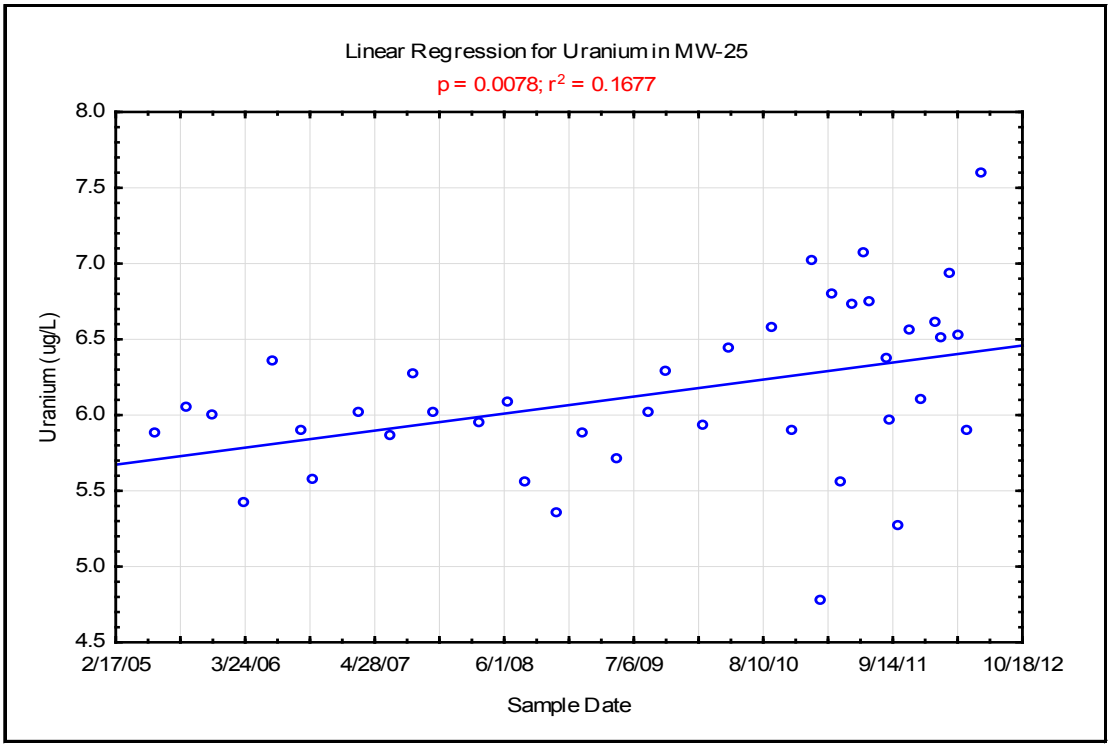
Linear Regression Plots for Indicator Parameters



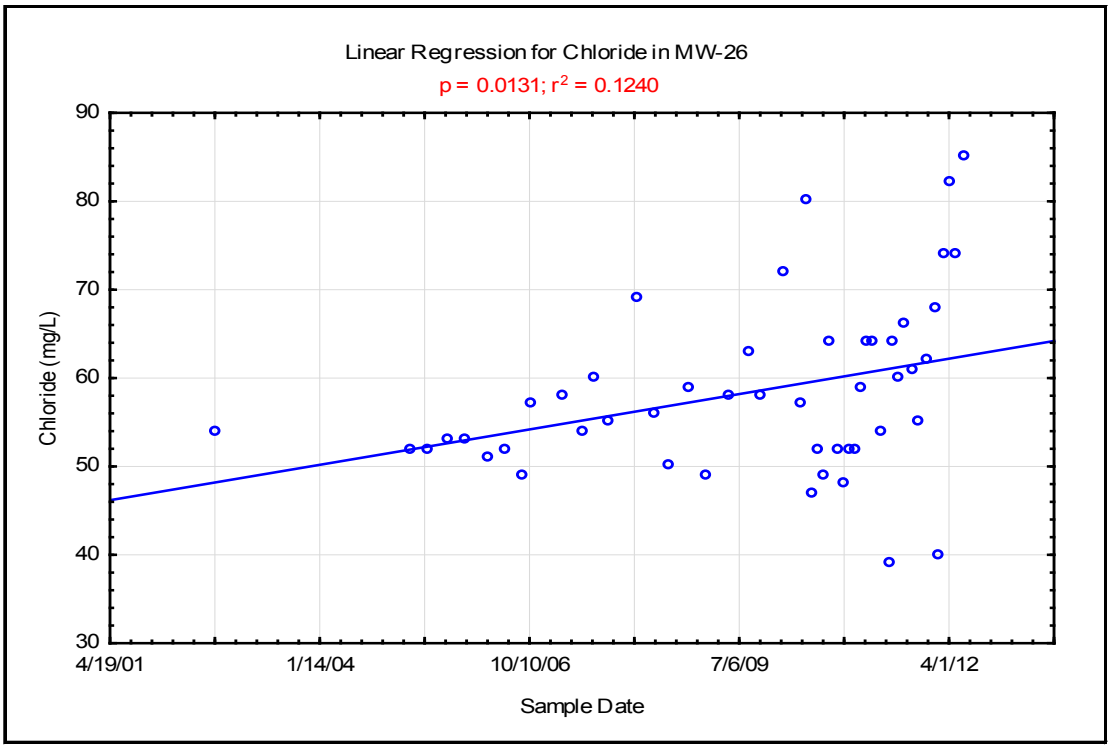


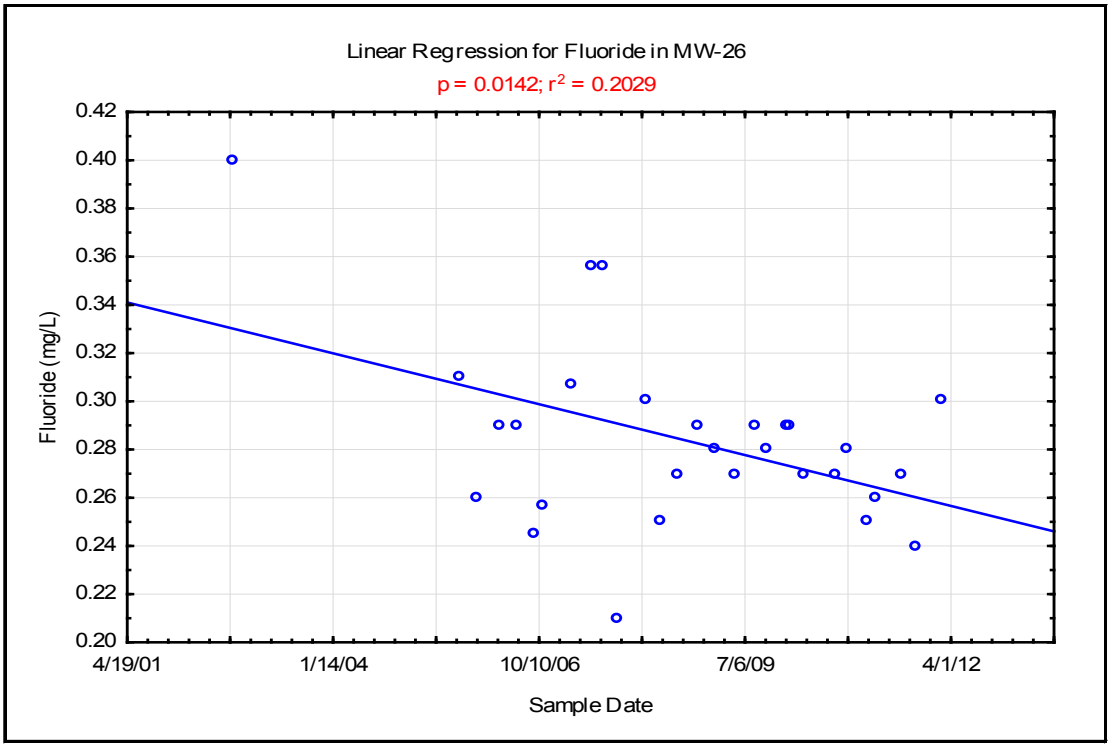
Appendix D-5
Linear Regression Plots for Indicator Parameters





Appendix D-5
Linear Regression Plots for Indicator Parameters





Appendix D-5
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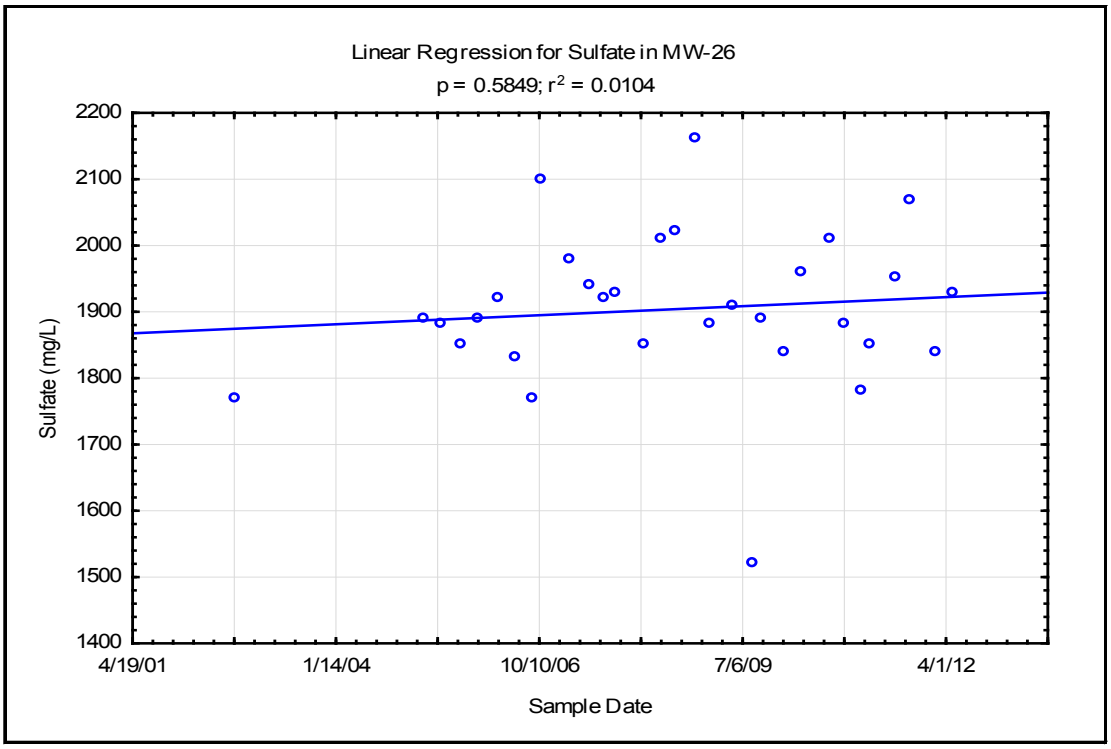

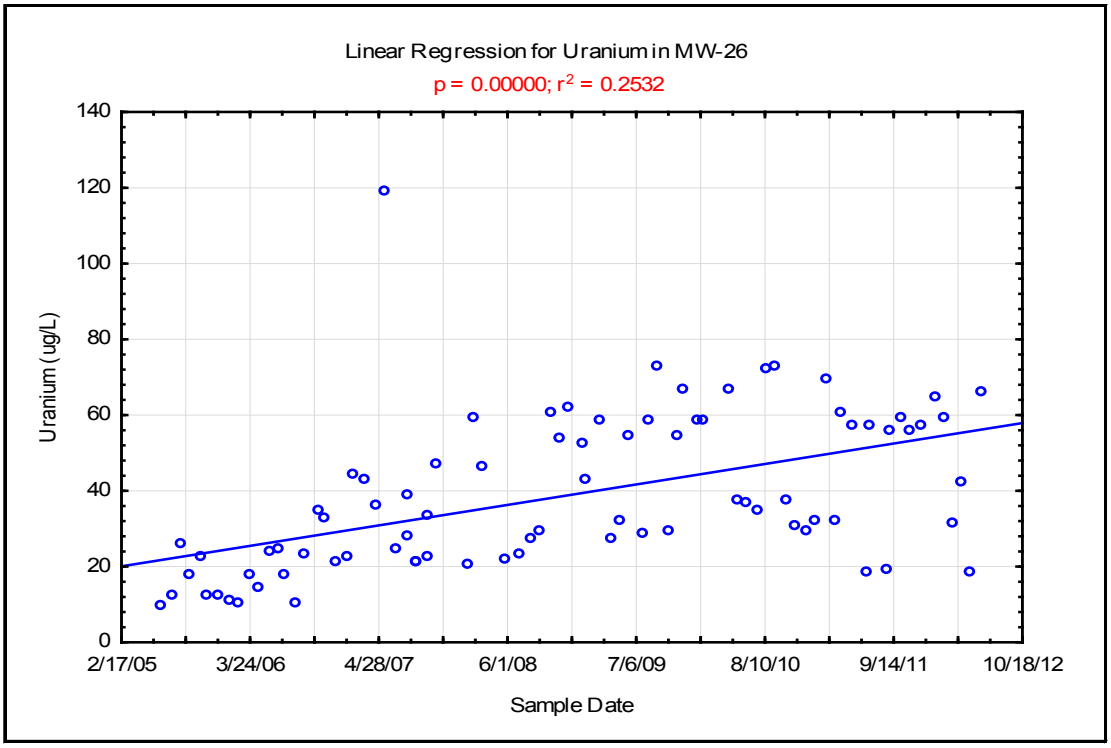

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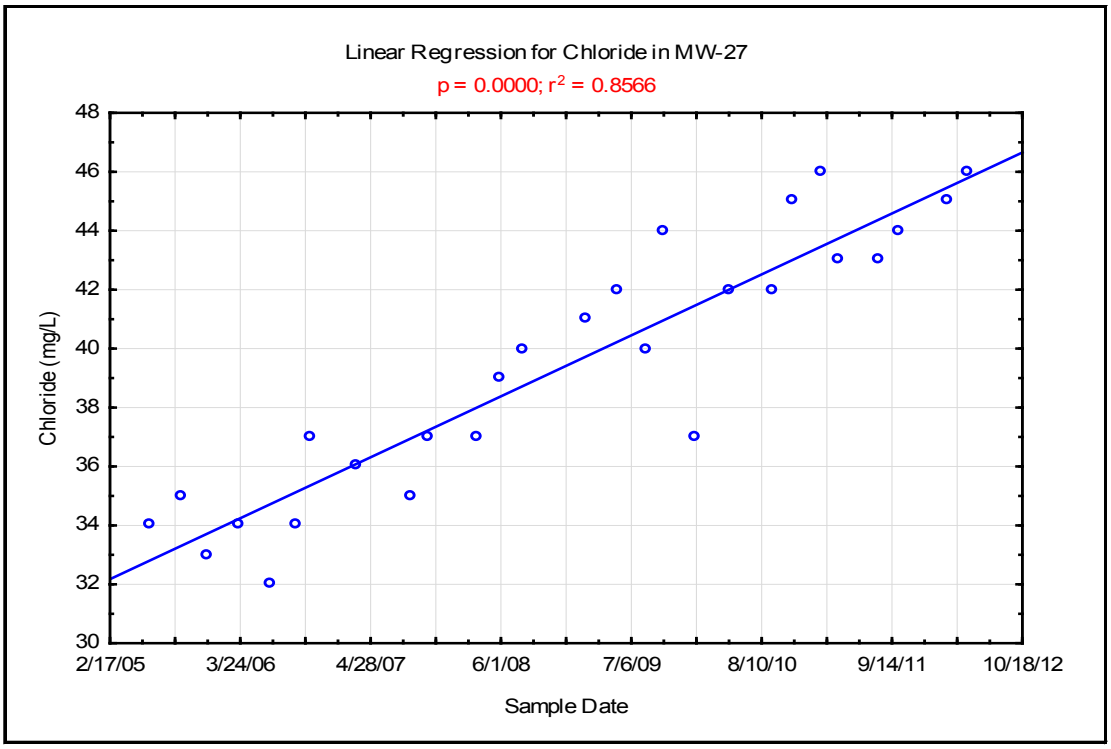
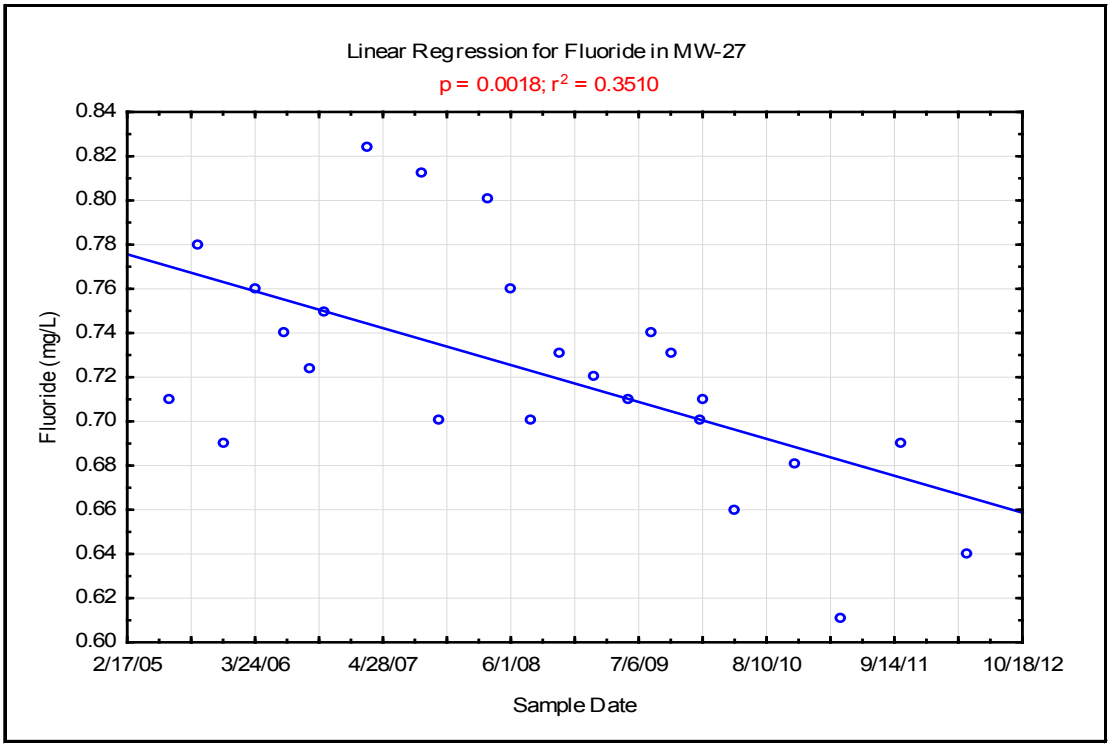
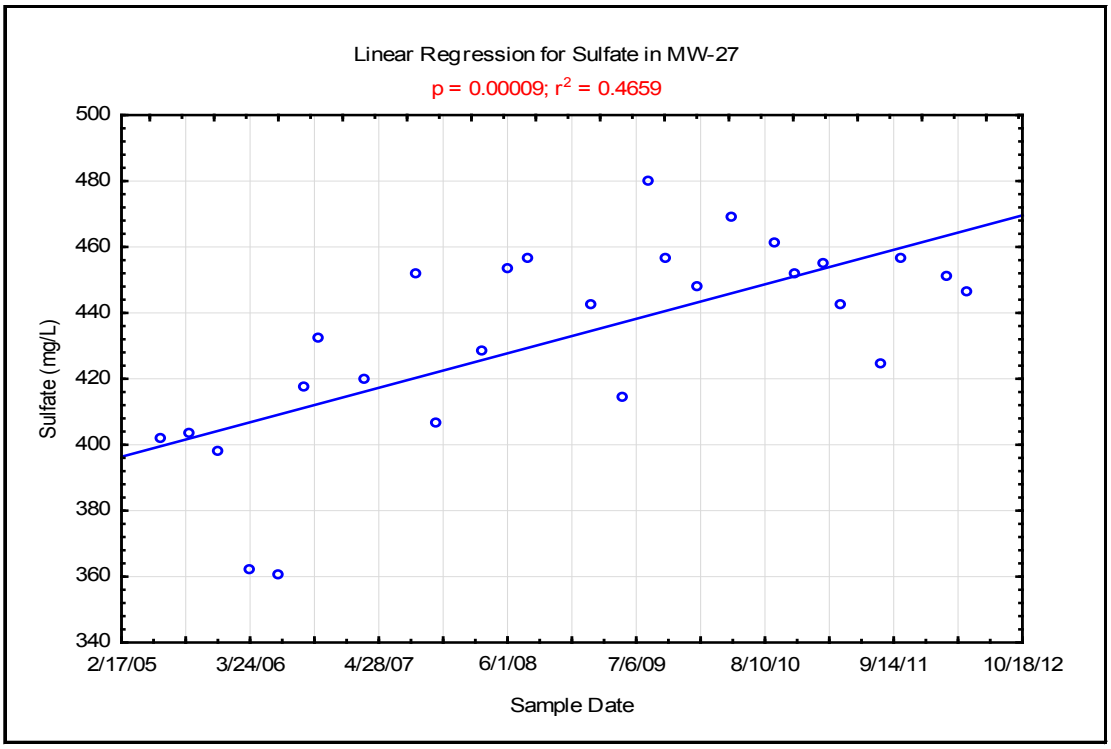
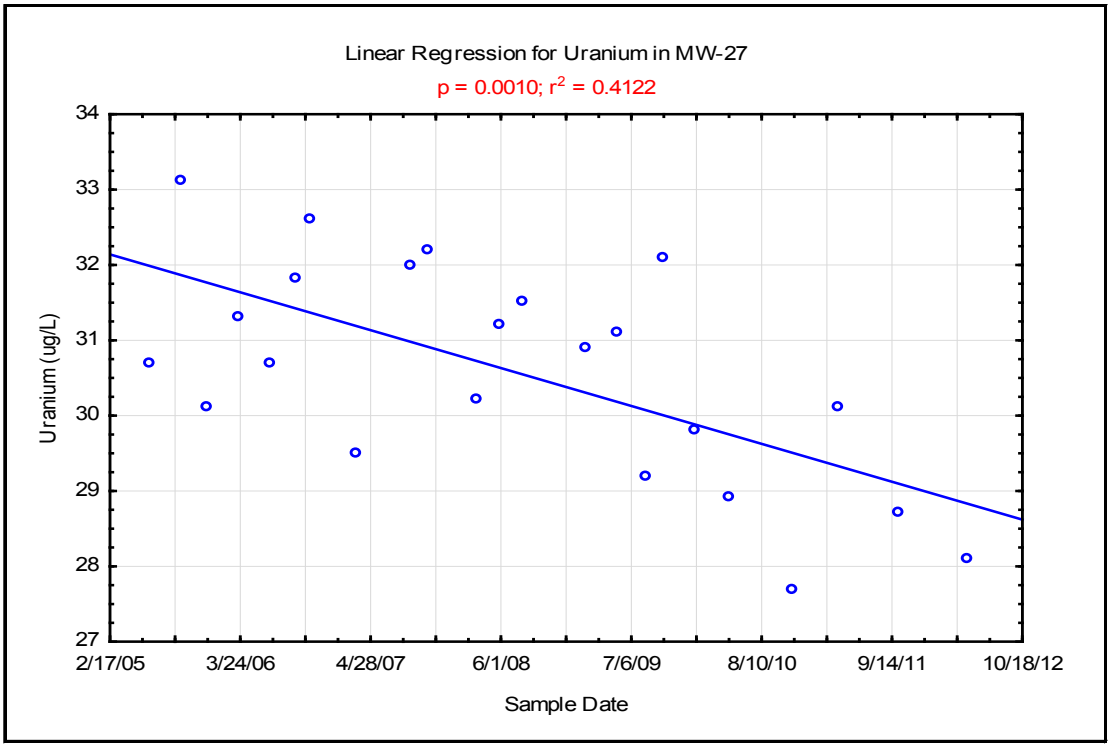


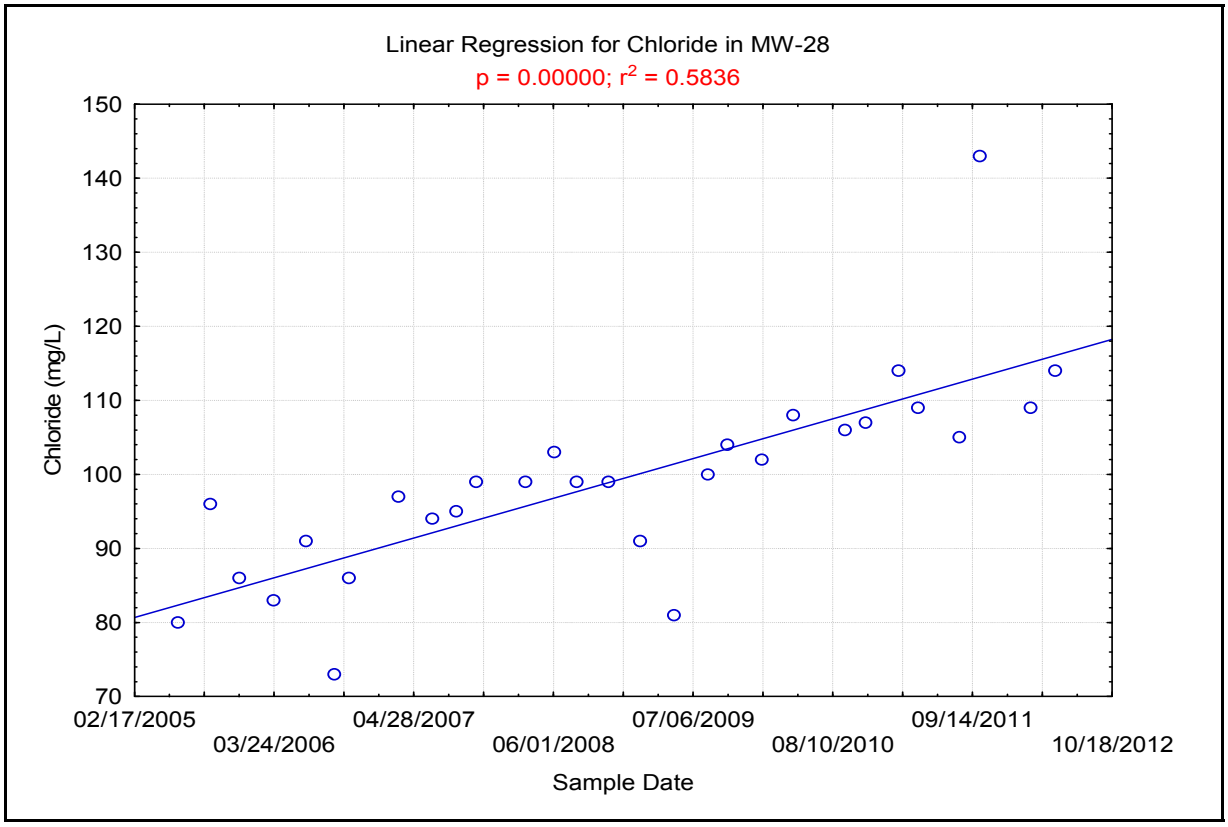


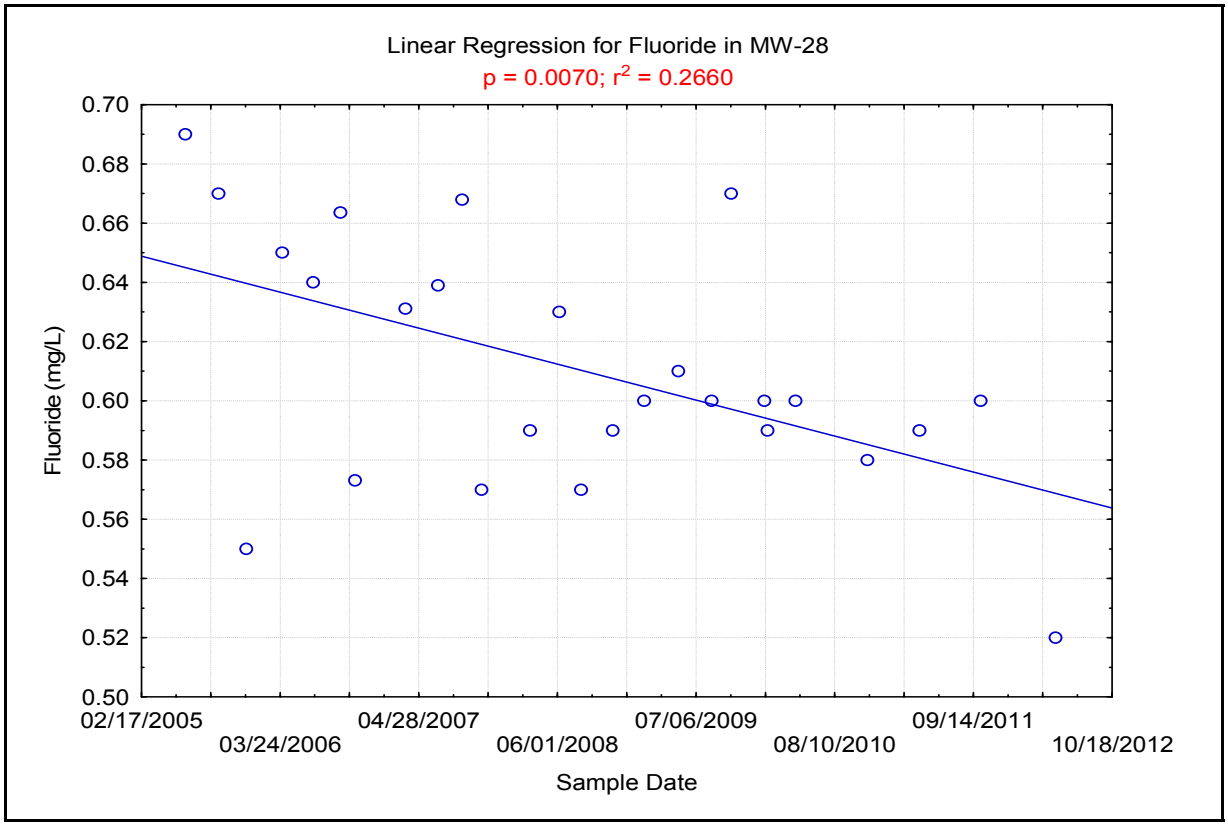
Appendix D-5
Linear Regression Plots for Indicator Parameters



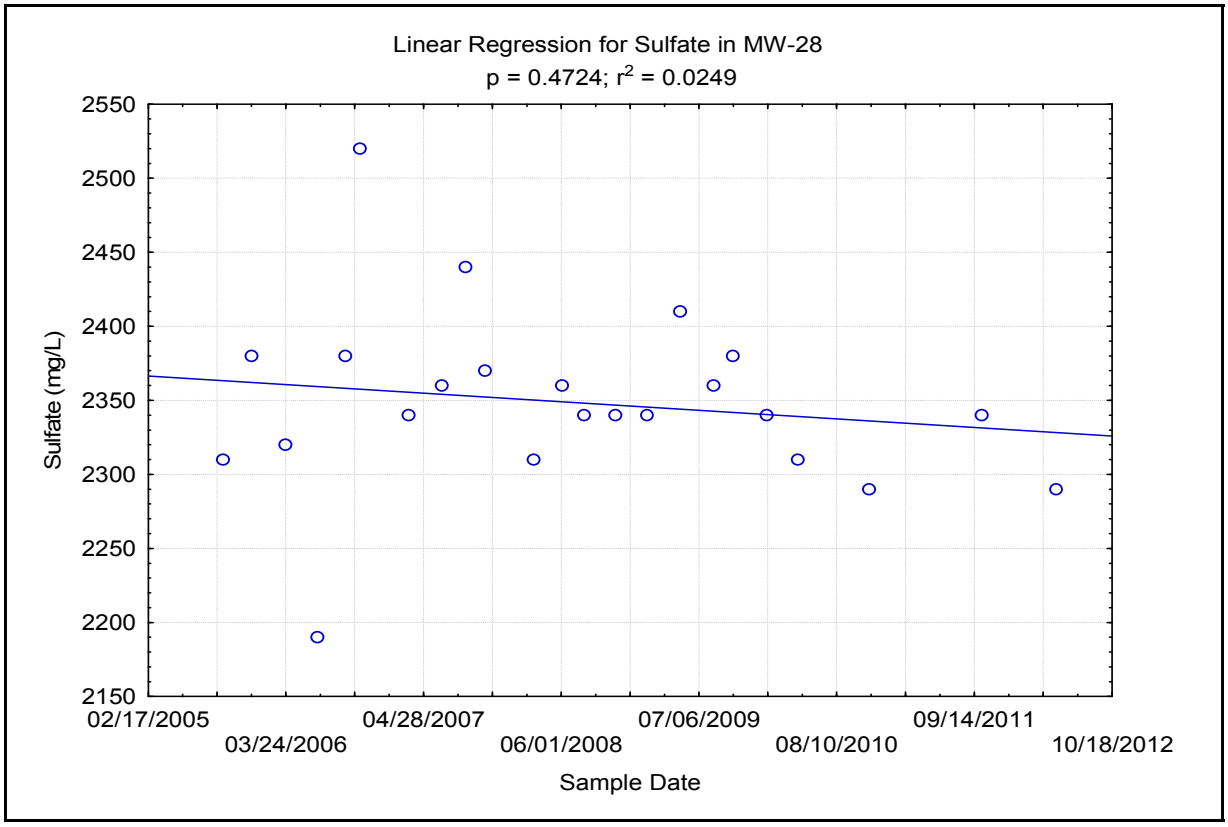


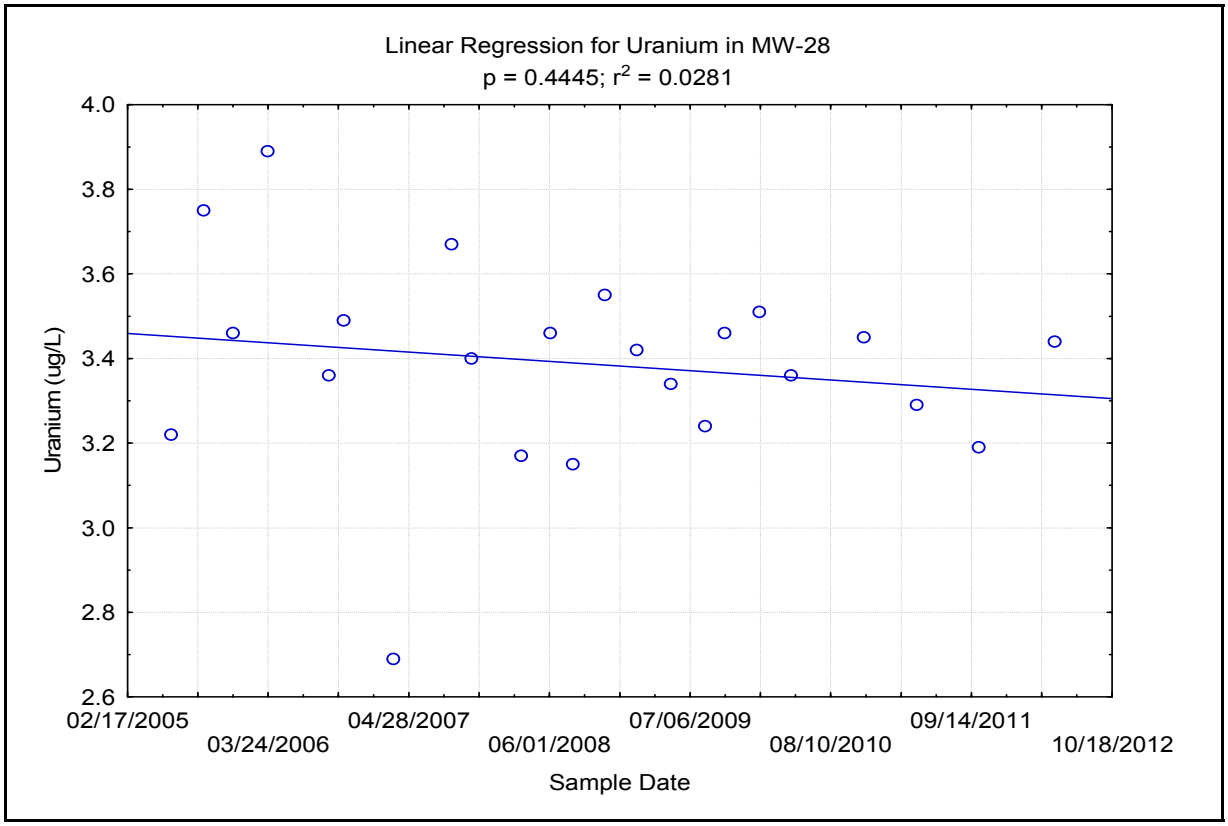
Appendix D-5
Linear Regression Plots for Indicator Parameters



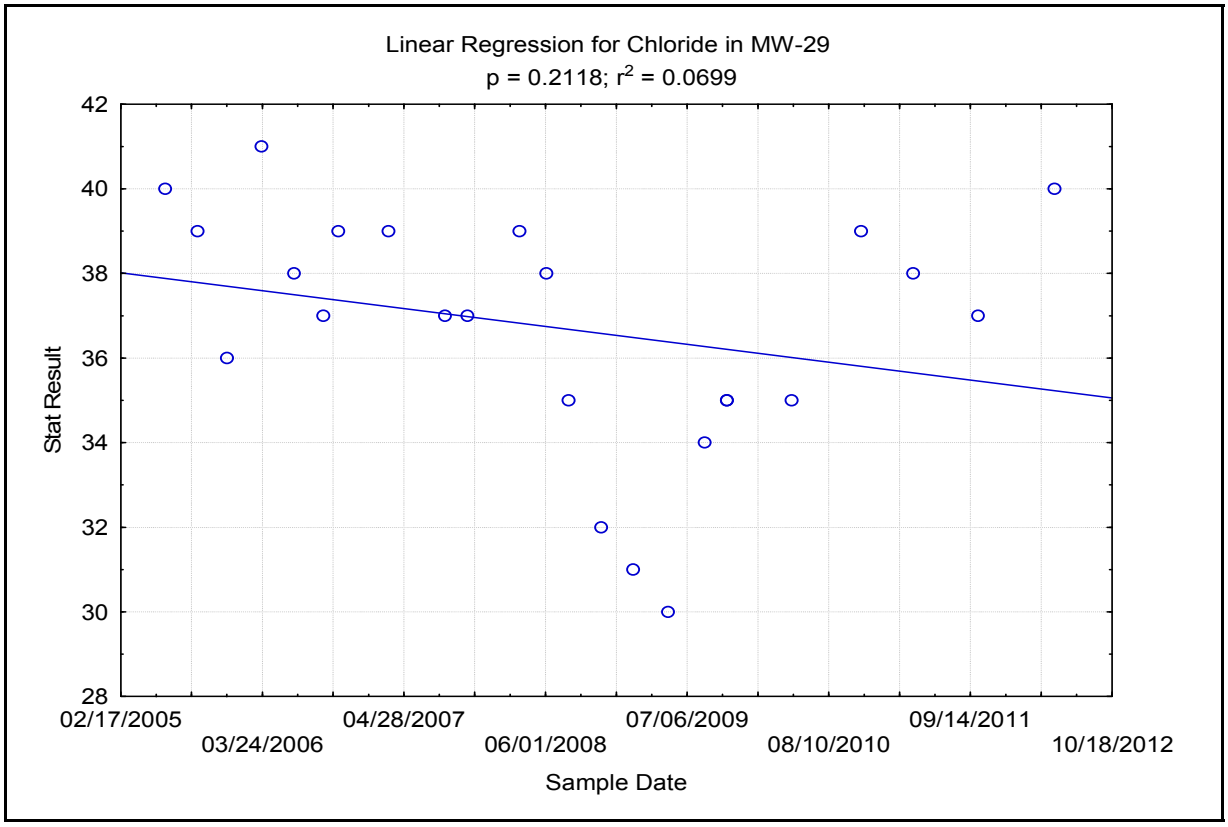


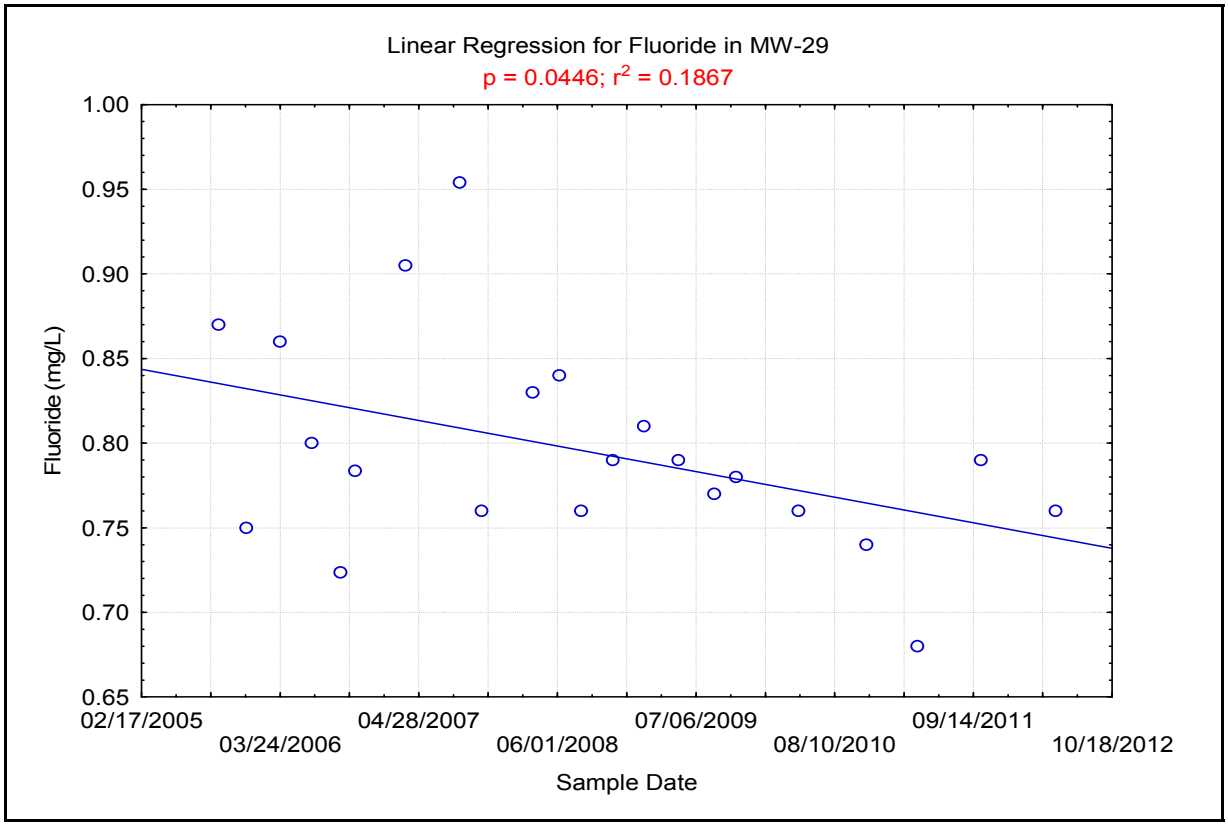
Appendix D-5
Linear Regression Plots for Indicator Parameters





Appendix D-5
Linear Regression Plots for Indicator Parameters





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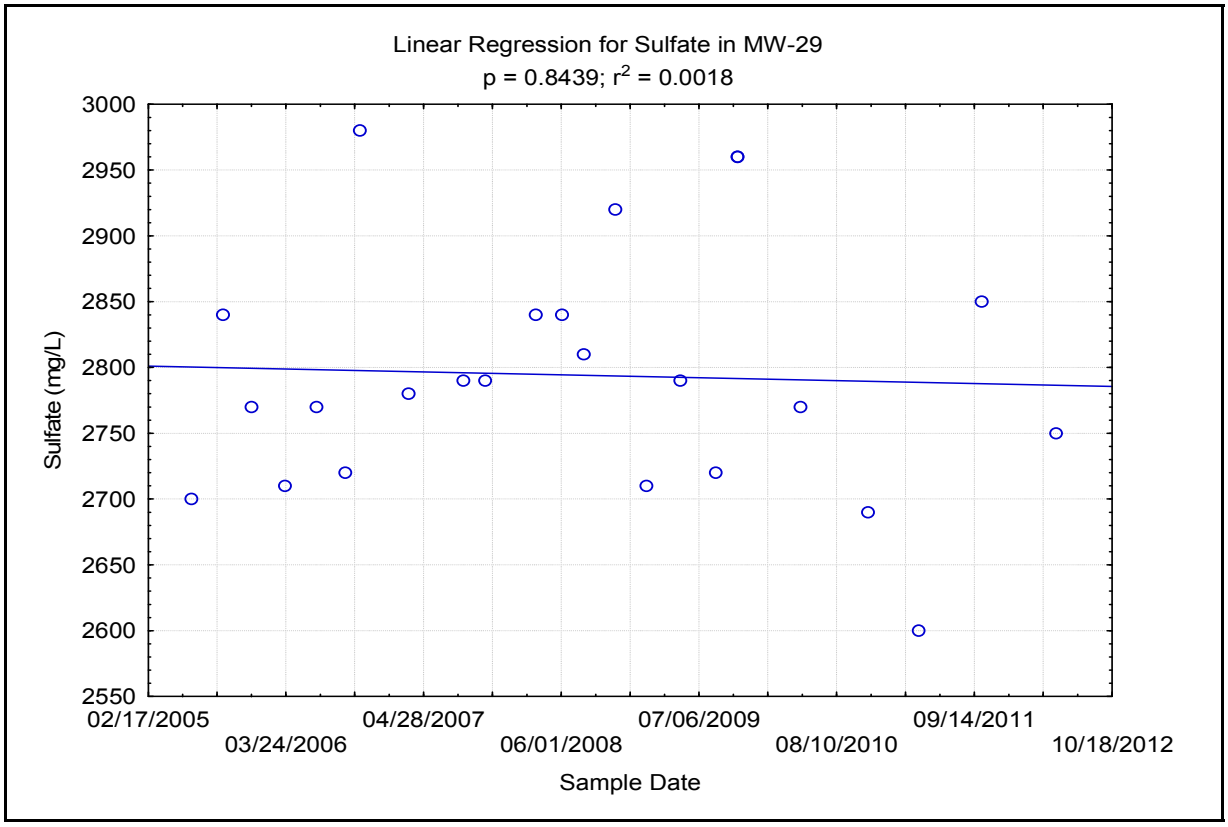
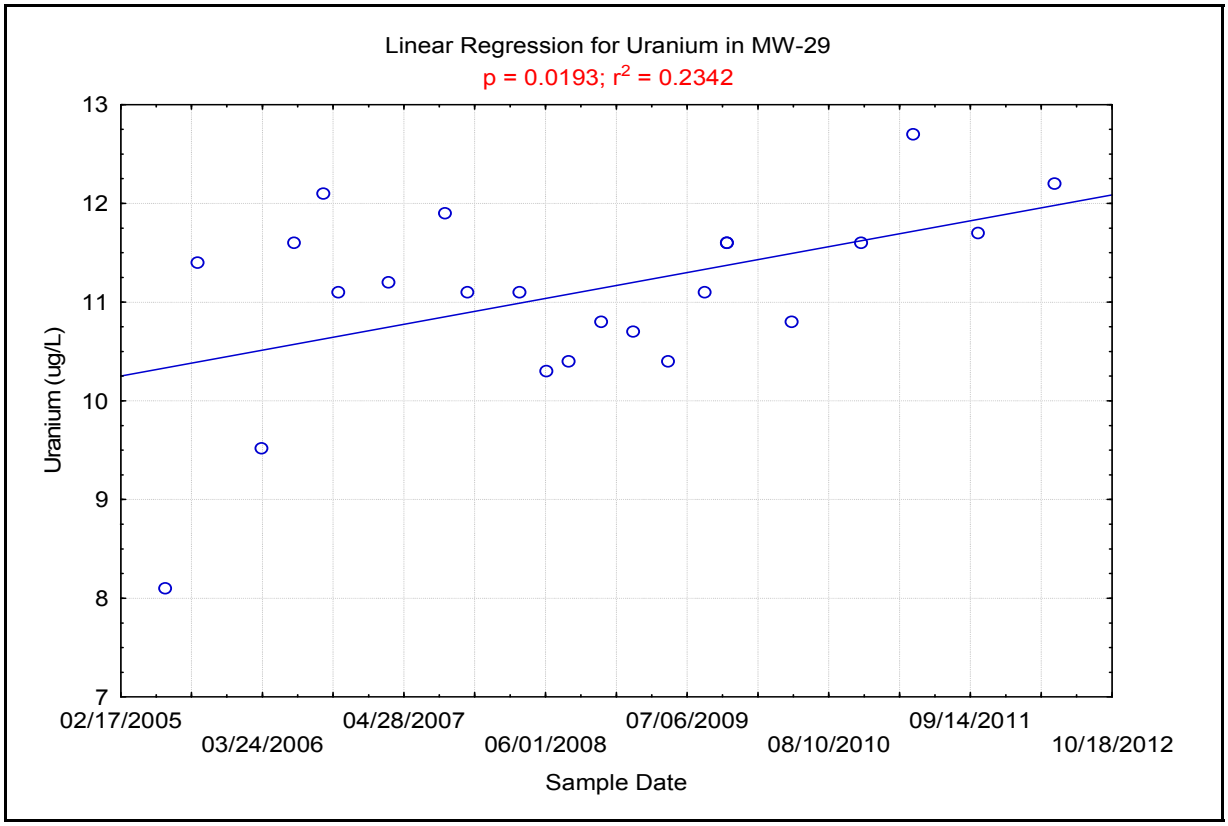
Linear Regression Plots for Indicator Parameters





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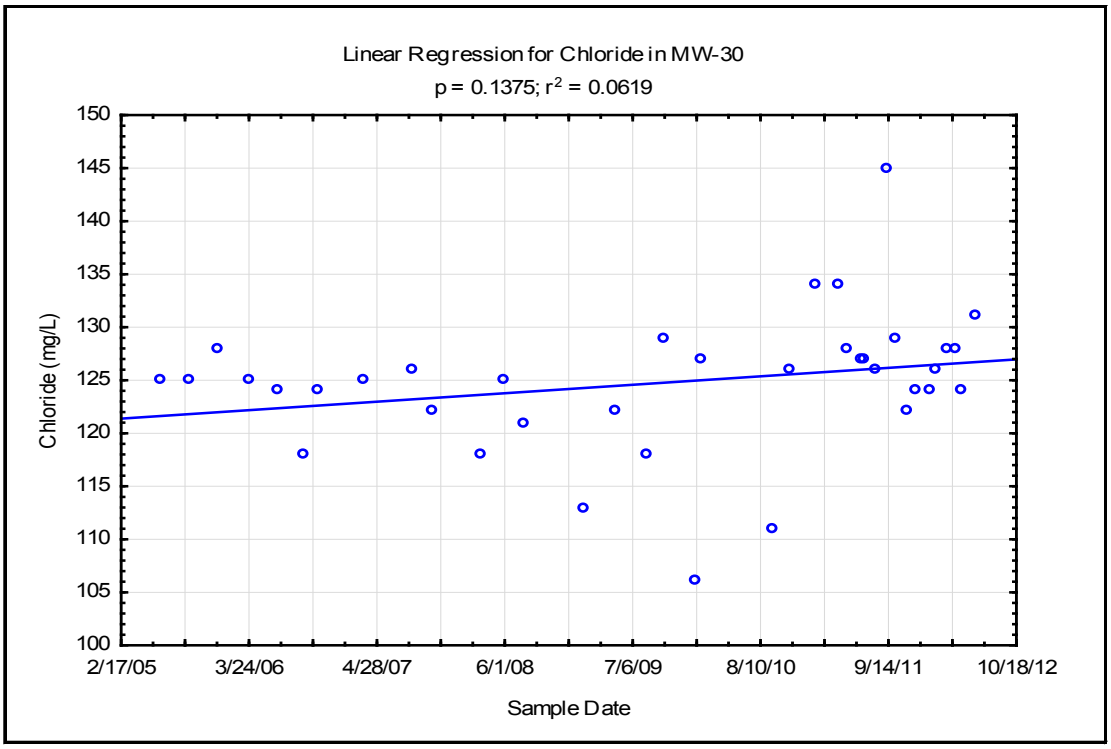
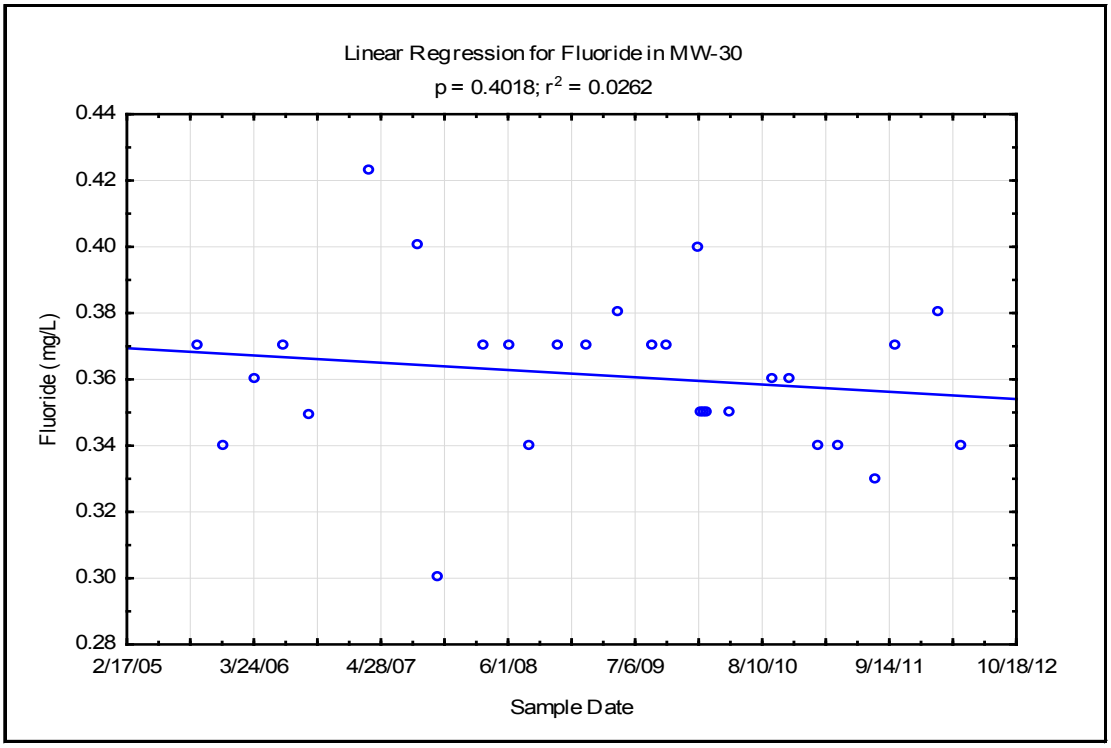
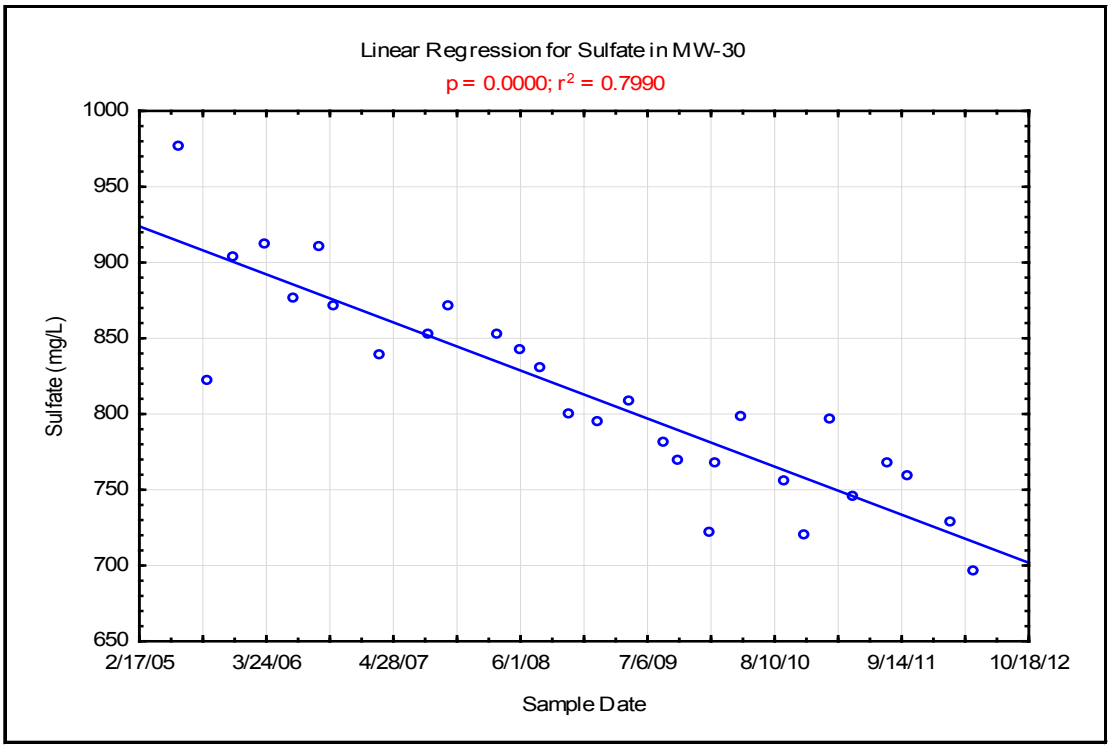
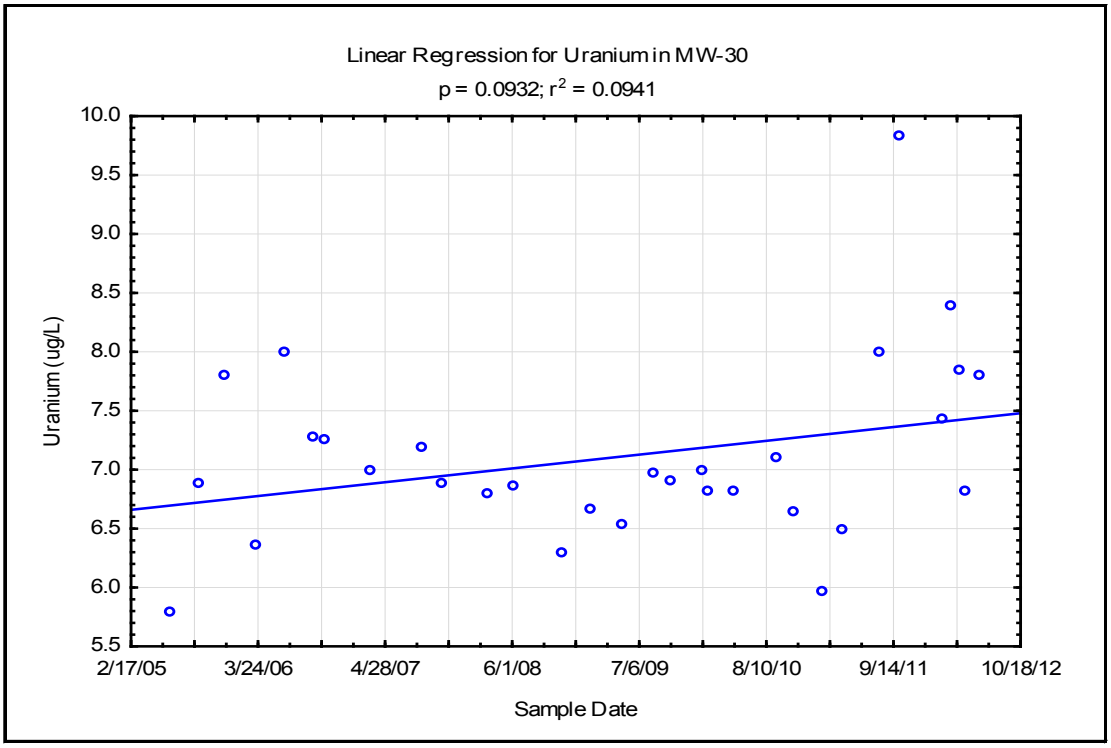
Linear Regression Plots for Indicator Parameters





Appendix D-5
Linear Regression Plots for Indicator Parameters





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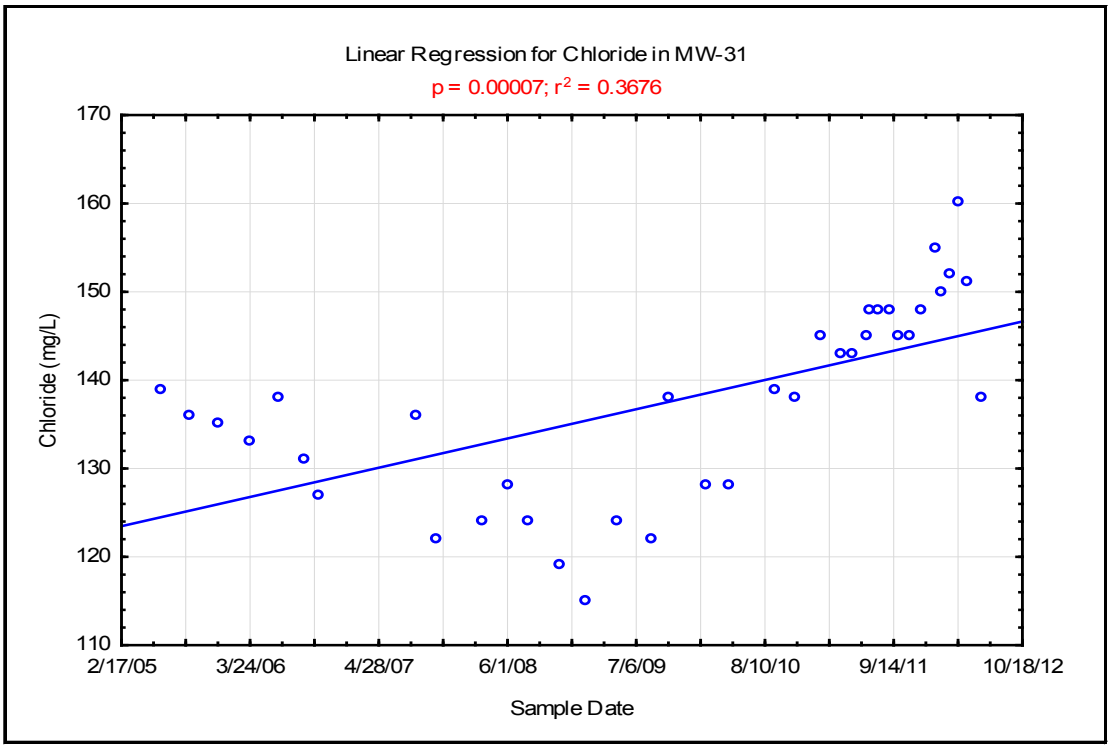
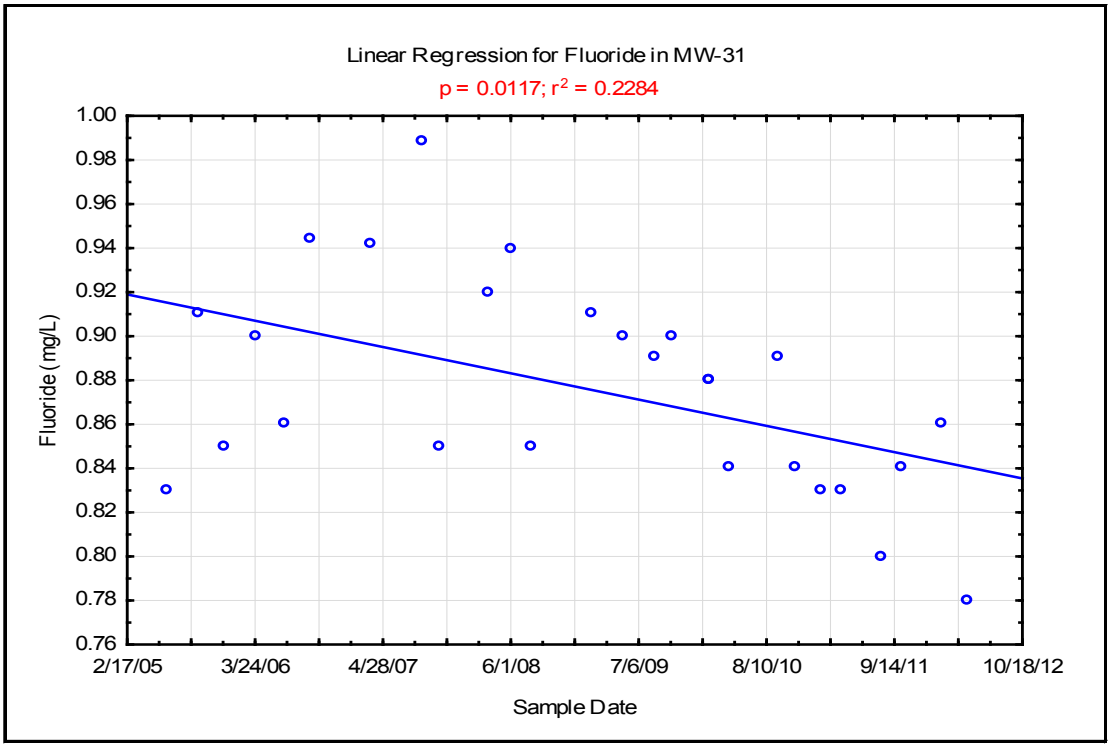
Linear Regression Plots for Indicator Parameters





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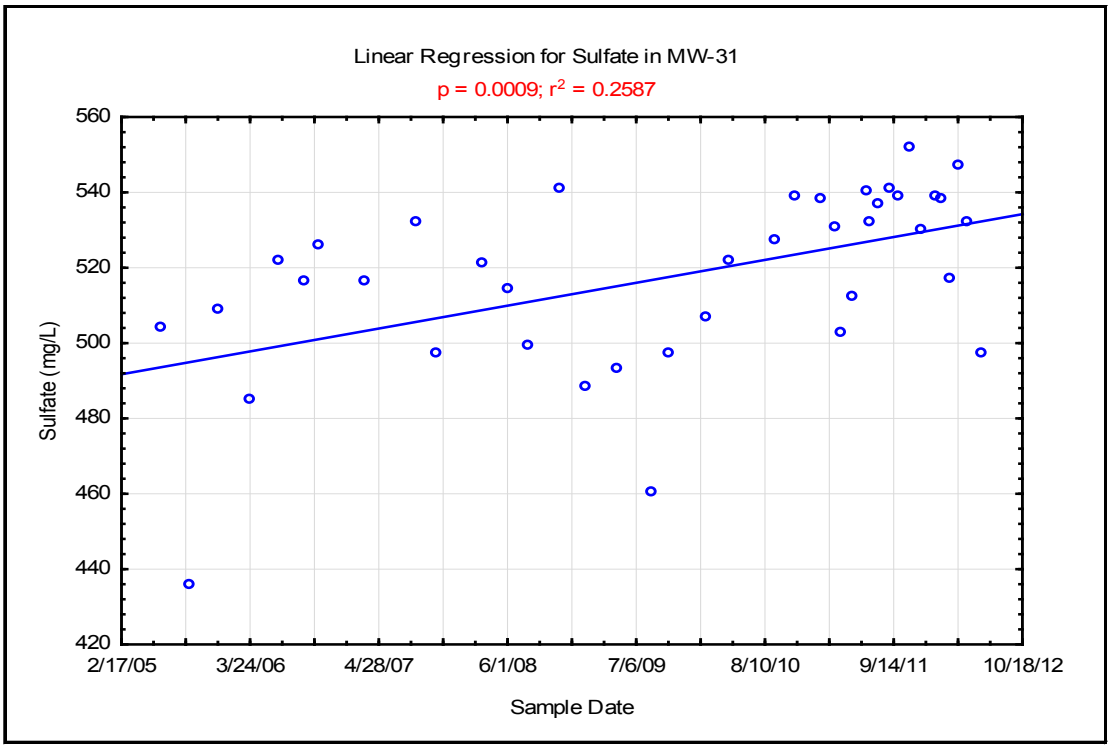
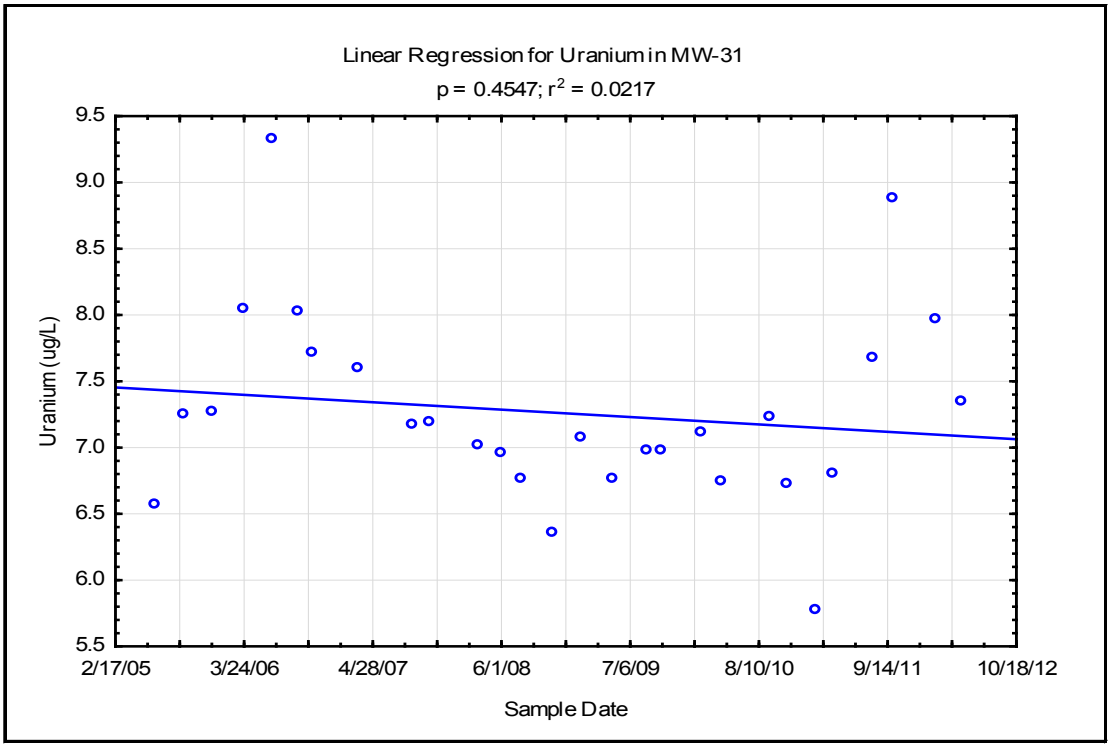
Linear Regression Plots for Indicator Parameters





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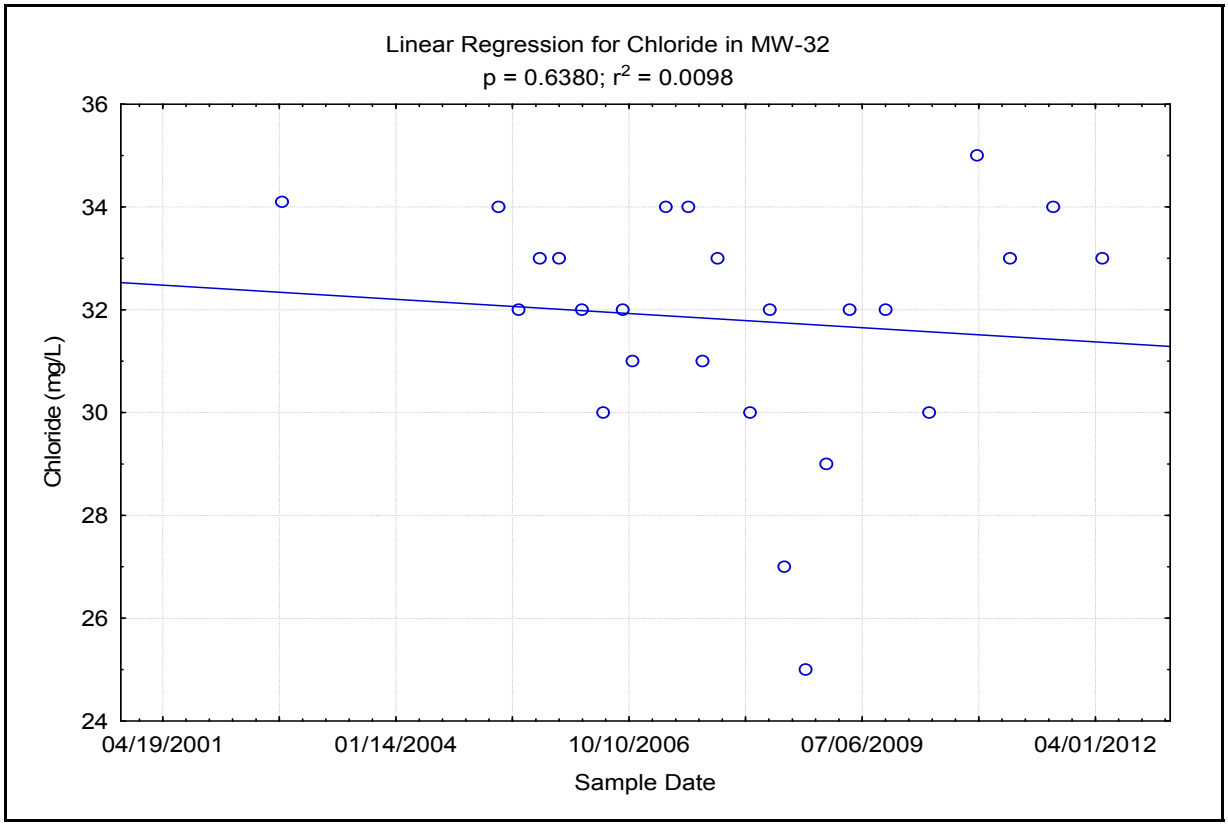

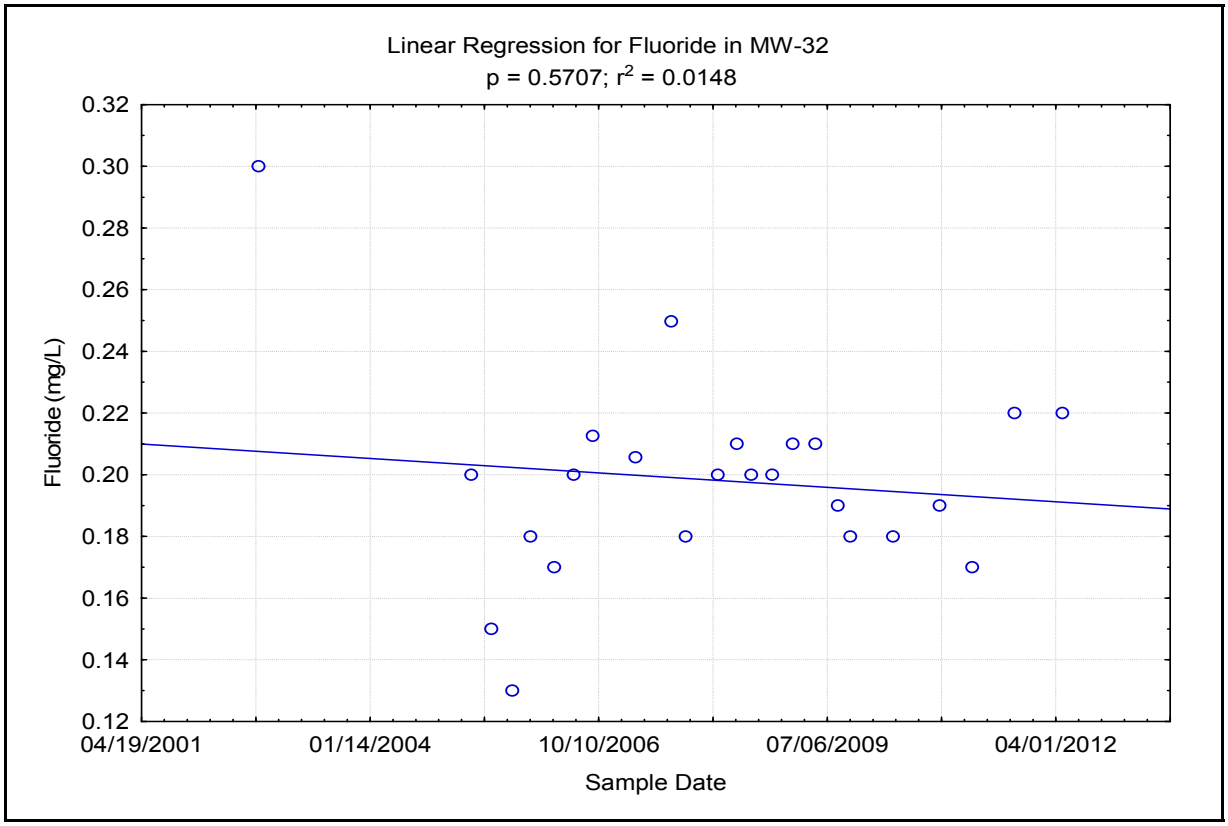

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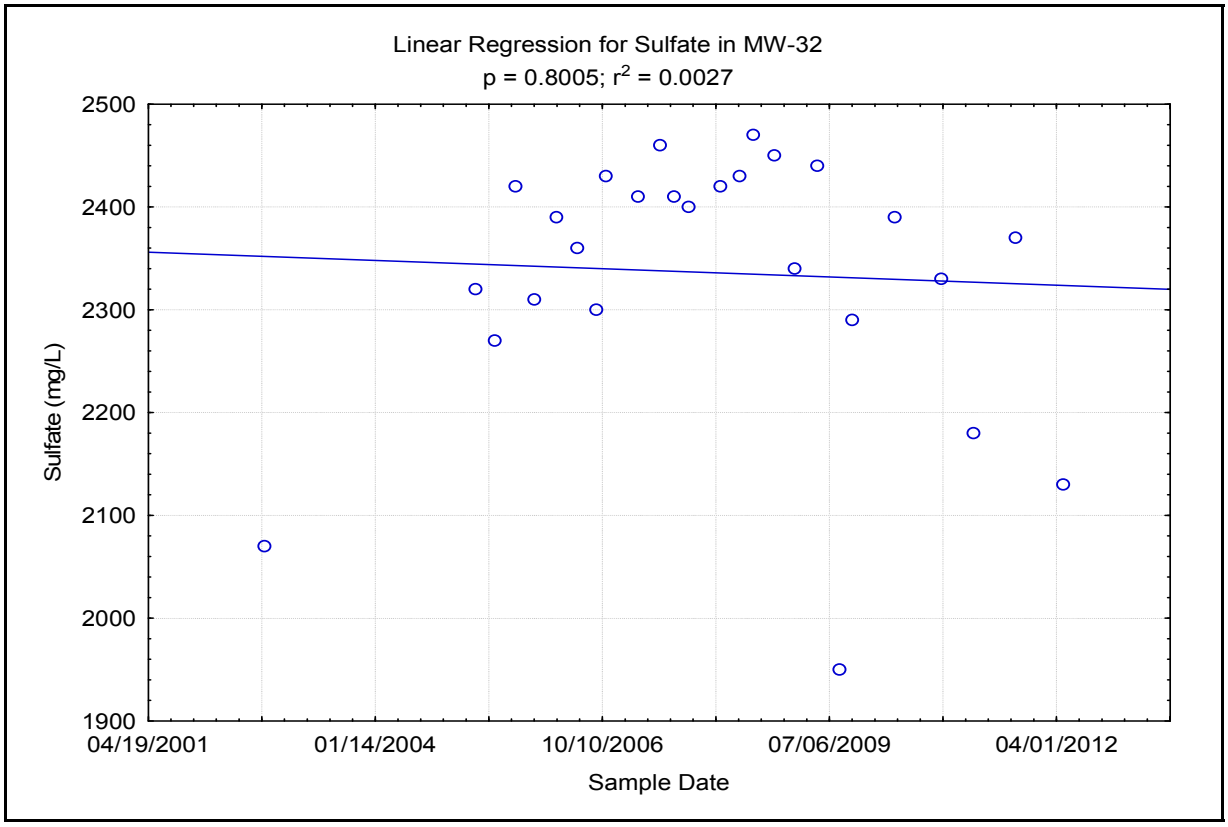

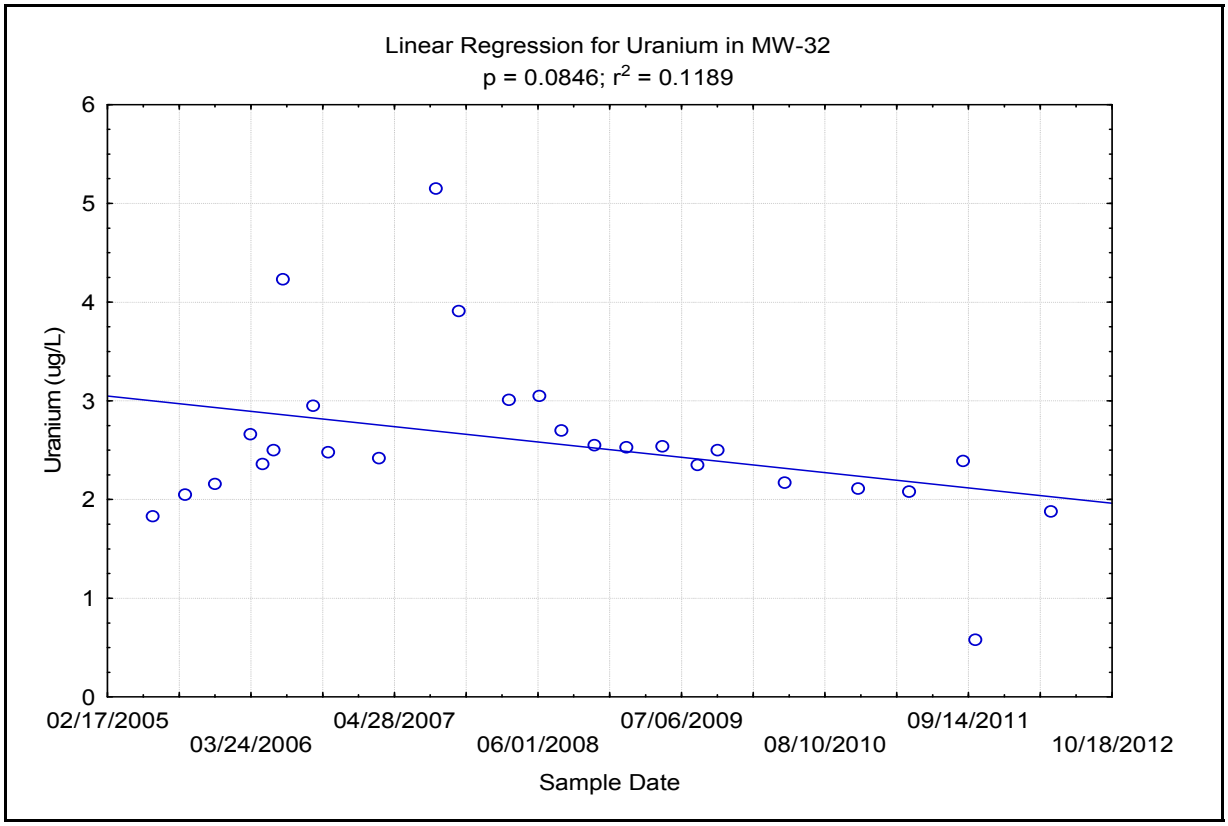

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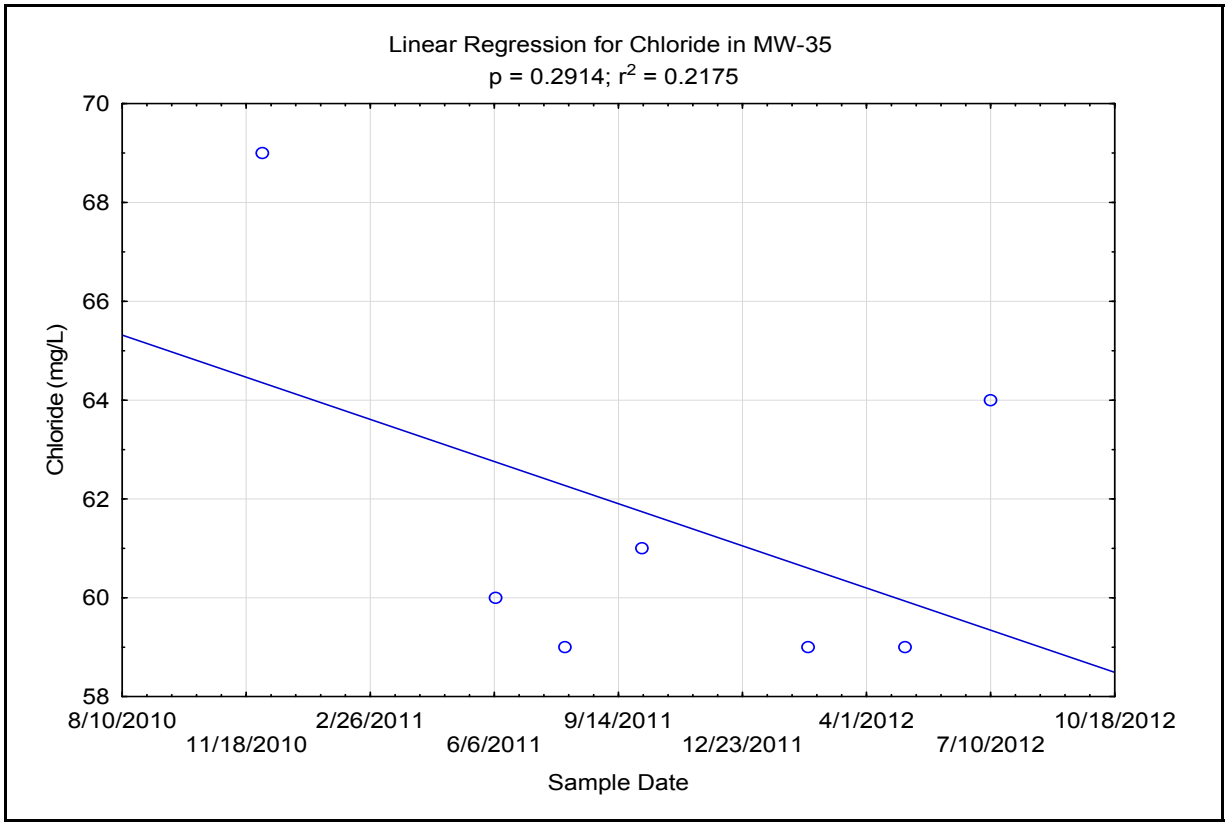
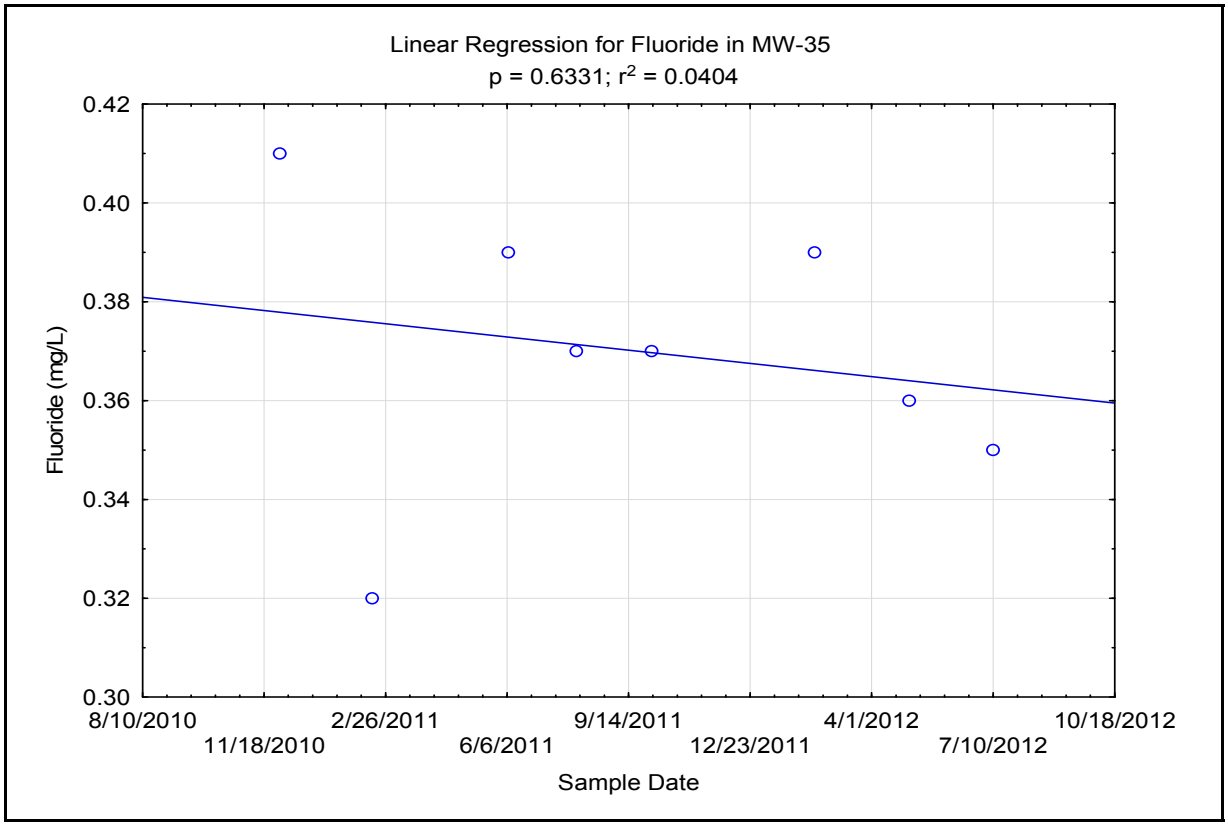
Linear Regression Plots for Indicator Parameters





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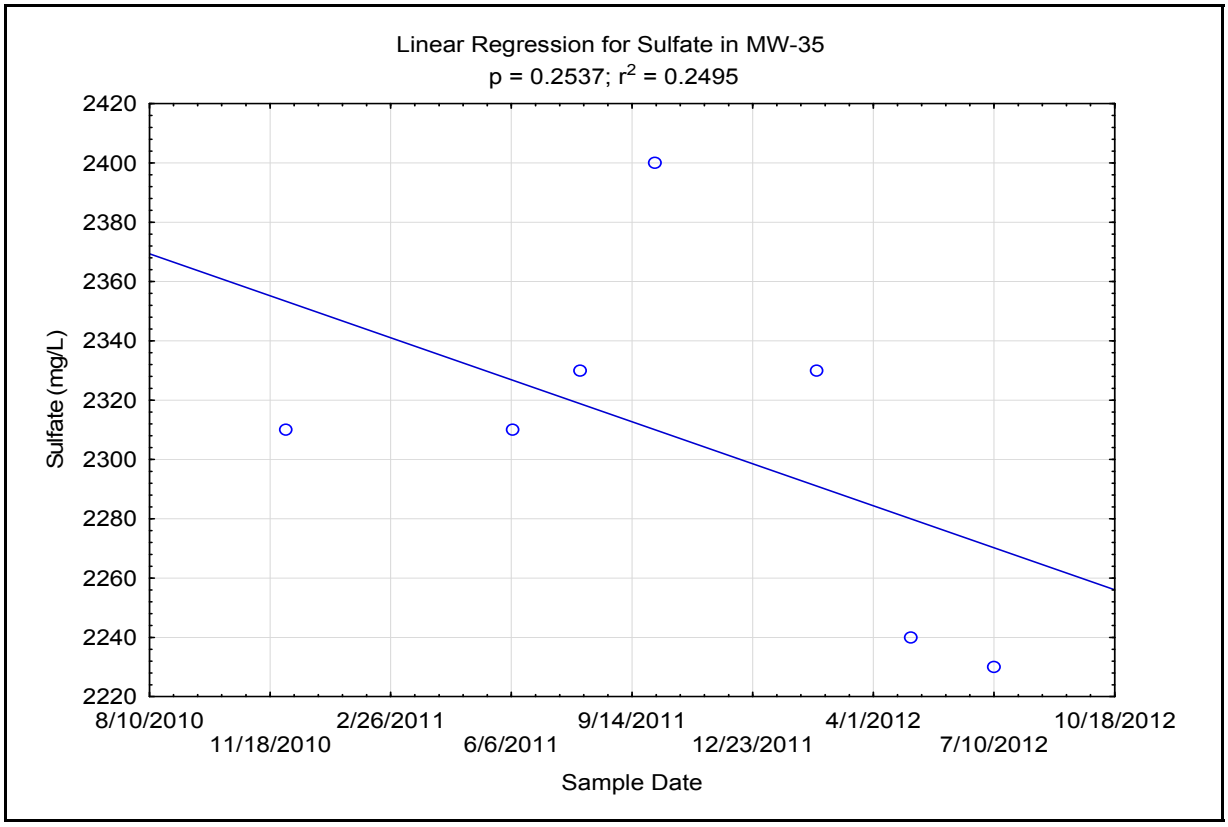
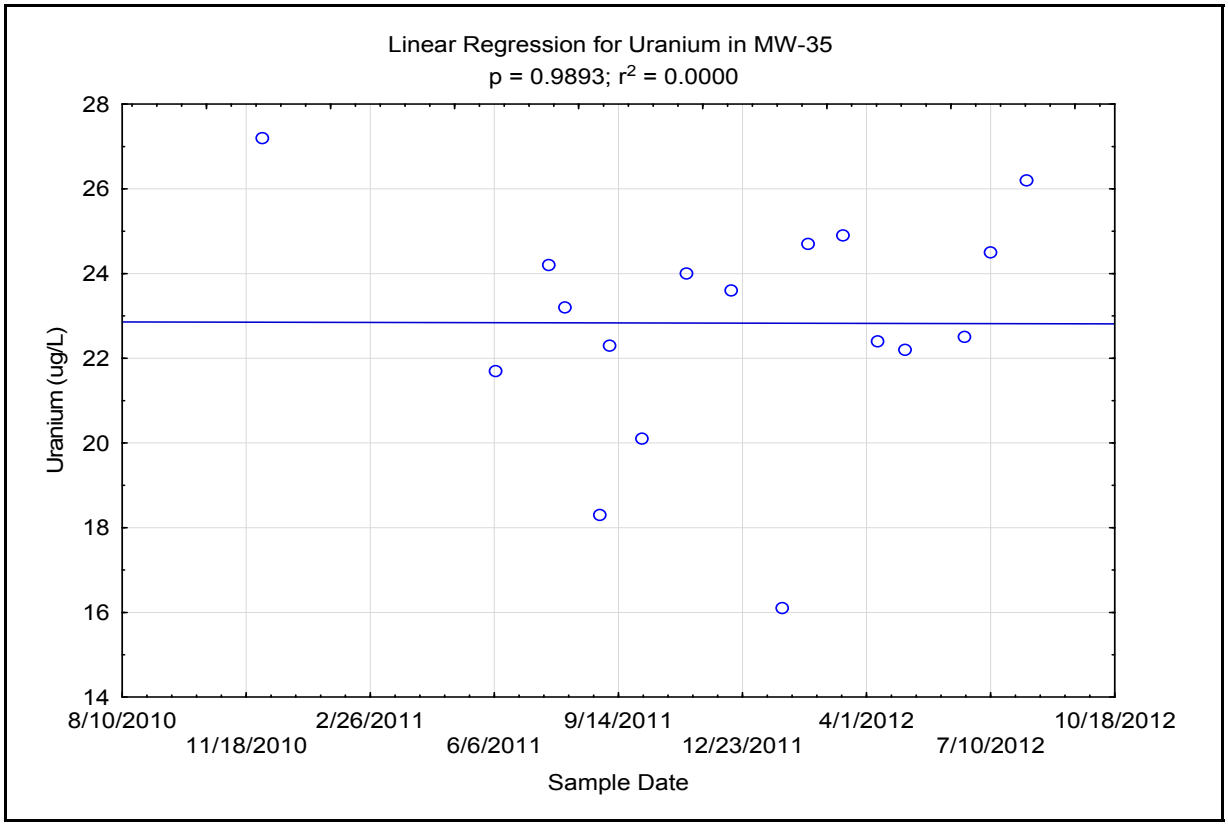
Linear Regression Plots for Indicator Parameters





APPENDIX D-6

Descriptive Statistics for Indicator Parameters

Appendix D-6 Indicator Parameter descriptive Statistics for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Chemical	N	Mean	Minimum	Maximum	Std.Dev.	Range	Geometric Mean	Skewness	Q25	Median	Q75
MW-03	Chloride	84	64.78	56.000	76.000	3.2254	20.000	64.704	0.17801	63.000	65.000	66.050
MW-03	Fluoride	44	0.54	0.074	1.040	0.2061	0.966	0.501	0.59349	0.400	0.505	0.640
MW-03	Sulfate	90	3091.67	1890.000	4030.000	418.0796	2140.000	3060.274	-0.97033	2920.000	3201.500	3381.000
MW-03	Uranium	87	22.93	1.000	67.164	11.0063	66.164	19.651	0.69939	15.000	21.940	30.200
MW-03A	Chloride	19	59.16	42.000	70.000	5.9466	28.000	58.844	-1.31589	57.000	60.000	62.000
MW-03A	Fluoride	19	1.24	0.940	1.600	0.2014	0.660	1.223	0.30560	1.060	1.177	1.400
MW-03A	Sulfate	23	3596.52	3220.000	3870.000	192.3446	650.000	3591.556	-0.21868	3470.000	3560.000	3750.000
MW-03A	Uranium	18	20.53	16.500	28.200	3.0978	11.700	20.327	1.02078	19.000	19.600	22.400
MW-05	Chloride	123	52.49	37.500	69.700	4.6723	32.200	52.288	0.57027	49.900	52.000	55.000
MW-05	Fluoride	44	0.88	0.330	1.300	0.1899	0.970	0.860	-0.65166	0.765	0.920	0.980
MW-05	Sulfate	90	1133.28	860.000	1518.000	105.1179	658.000	1128.602	0.76178	1055.000	1130.000	1200.000
MW-05	Uranium	101	0.96	0.040	3.400	0.6483	3.360	0.770	1.50046	0.448	0.980	1.045
MW-11	Chloride	120	32.37	24.400	43.200	3.1762	18.800	32.219	0.55959	30.850	32.000	34.000
MW-11	Fluoride	35	0.54	0.440	0.705	0.0582	0.265	0.538	1.36437	0.500	0.540	0.560
MW-11	Sulfate	87	1038.97	895.000	1309.000	90.7839	414.000	1035.166	0.69692	968.000	1023.000	1090.000
MW-11	Uranium	104	0.79	0.000	3.030	0.5850	3.030	0.481	1.56474	0.300	0.746	1.017
MW-12	Chloride	100	59.49	37.600	80.500	6.0627	42.900	59.159	-0.51853	56.050	60.150	63.000
MW-12	Fluoride	20	0.28	0.186	0.350	0.0428	0.164	0.278	-0.56084	0.255	0.300	0.310
MW-12	Sulfate	71	2320.23	1850.000	2560.000	140.8901	710.000	2315.873	-0.65857	2240.000	2338.000	2430.000
MW-12	Uranium	97	15.49	3.000	23.500	4.0309	20.500	14.703	-1.14186	14.179	16.000	18.000
MW-14	Chloride	95	19.81	12.700	27.000	2.5728	14.300	19.650	0.63757	18.000	19.400	21.000
MW-14	Fluoride	35	0.17	0.100	0.261	0.0260	0.161	0.167	1.05912	0.150	0.160	0.180
MW-14	Sulfate	64	2138.89	1820.000	2330.000	101.3500	510.000	2136.447	-0.95870	2098.000	2145.000	2210.000
MW-14	Uranium	122	61.07	19.403	98.000	12.0763	78.597	59.632	-0.70649	57.000	63.400	68.657
MW-15	Chloride	84	40.71	24.100	57.100	5.4463	33.000	40.355	0.57604	38.000	39.750	43.850
MW-15	Fluoride	18	0.25	0.210	0.344	0.0335	0.134	0.251	1.48709	0.230	0.240	0.260
MW-15	Sulfate	50	2304.86	1876.000	2560.000	125.2700	684.000	2301.403	-0.85371	2235.000	2314.500	2378.000
MW-15	Uranium	86	43.91	25.224	65.672	7.5402	40.448	43.224	-0.20025	39.200	44.776	49.000

Appendix D-6 Indicator Parameter descriptive Statistics for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Chemical	N	Mean	Minimum	Maximum	Std.Dev.	Range	Geometric Mean	Skewness	Q25	Median	Q75
MW-17	Chloride	64	31.25	14.100	51.000	5.8557	36.900	30.720	0.84264	27.850	29.700	34.500
MW-17	Fluoride	20	0.29	0.250	0.404	0.0425	0.154	0.288	1.69507	0.265	0.270	0.300
MW-17	Sulfate	30	2488.73	2004.000	2860.000	194.9773	856.000	2481.043	-0.66302	2420.000	2510.000	2600.000
MW-17	Uranium	65	28.87	4.627	46.800	7.6290	42.173	27.602	-0.17378	24.925	28.200	33.900
MW-18	Chloride	27	46.87	19.900	75.000	12.6399	55.100	45.153	0.29082	35.000	47.600	53.000
MW-18	Fluoride	20	0.25	0.009	0.400	0.0847	0.391	0.212	-0.54295	0.210	0.220	0.300
MW-18	Sulfate	30	1668.47	1069.000	2020.000	249.1623	951.000	1649.304	-0.46360	1446.000	1720.000	1910.000
MW-18	Uranium	33	33.23	2.687	49.000	14.3669	46.313	27.742	-0.97195	18.209	40.300	42.700
MW-19	Chloride	30	48.54	24.000	94.000	24.2940	70.000	43.332	0.77195	28.000	37.500	64.600
MW-19	Fluoride	29	1.04	0.810	1.375	0.1222	0.565	1.035	0.92995	1.000	1.020	1.100
MW-19	Sulfate	29	1142.83	167.000	2770.000	674.5585	2603.000	949.617	0.72841	552.000	1020.000	1570.000
MW-19	Uranium	33	9.66	5.480	24.000	4.1603	18.520	9.010	1.89025	6.780	8.060	11.300
MW-22	Chloride	16	58.77	46.300	67.000	5.0953	20.700	58.553	-0.58690	56.000	58.000	63.000
MW-22	Fluoride	14	2.99	2.780	3.270	0.1510	0.490	2.988	0.52436	2.870	2.940	3.090
MW-22	Sulfate	16	5103.25	3142.000	6100.000	711.7066	2958.000	5049.378	-1.28420	4775.000	5215.000	5450.000
MW-22	Uranium	16	44.54	27.200	52.400	7.1452	25.200	43.910	-1.26531	42.950	46.100	49.250
MW-23	Chloride	24	6.78	1.000	10.000	1.9643	9.000	6.308	-1.13000	6.000	7.000	8.000
MW-23	Fluoride	22	0.25	0.188	0.360	0.0520	0.172	0.246	1.25804	0.220	0.230	0.250
MW-23	Sulfate	24	2224.17	1680.000	2460.000	179.0535	780.000	2216.714	-1.29098	2100.000	2275.000	2340.000
MW-23	Uranium	23	18.61	8.210	31.800	5.7880	23.590	17.679	0.25142	14.600	19.400	21.200
MW-24	Chloride	22	44.82	39.000	52.000	2.7192	13.000	44.739	-0.00827	44.000	45.000	46.000
MW-24	Fluoride	26	0.18	0.100	0.360	0.0722	0.260	0.170	1.16884	0.130	0.163	0.220
MW-24	Sulfate	26	2651.92	2290.000	2950.000	154.5320	660.000	2647.567	-0.06258	2560.000	2675.000	2740.000
MW-24	Uranium	24	2.97	0.500	10.400	3.1294	9.900	1.962	1.63900	1.035	1.560	2.930
MW-25	Chloride	28	31.21	25.000	34.000	1.8926	9.000	31.156	-1.17933	30.000	31.000	32.000
MW-25	Fluoride	29	0.33	0.280	0.375	0.0208	0.095	0.326	-0.11361	0.310	0.321	0.340
MW-25	Sulfate	29	1692.76	1570.000	1880.000	80.3962	310.000	1690.955	0.82188	1630.000	1680.000	1740.000
MW-25	Uranium	40	6.11	4.770	7.060	0.5057	2.290	6.087	-0.18200	5.870	6.020	6.510

Appendix D-6 Indicator Parameter descriptive Statistics for Monitoring Wells with Out-of-Compliance Status or Significantly Decreasing Field pH Measurements

Well	Chemical	N	Mean	Minimum	Maximum	Std.Dev.	Range	Geometric Mean	Skewness	Q25	Median	Q75
MW-26	Chloride	48	57.77	39.000	82.000	9.0981	43.000	57.092	0.64686	52.000	56.500	63.500
MW-26	Fluoride	29	0.28	0.210	0.400	0.0378	0.190	0.282	1.19637	0.260	0.280	0.290
MW-26	Sulfate	31	1903.87	1520.000	2160.000	116.2089	640.000	1900.311	-0.70410	1850.000	1890.000	1960.000
MW-26	Uranium	82	38.52	9.480	119.000	20.2576	109.520	33.332	0.89575	22.600	33.100	57.000
MW-27	Chloride	27	39.37	32.000	46.000	4.3778	14.000	39.134	-0.04408	35.000	40.000	43.000
MW-27	Fluoride	25	0.72	0.610	0.824	0.0505	0.214	0.721	0.03361	0.700	0.720	0.749
MW-27	Sulfate	27	432.78	360.000	480.000	30.0248	120.000	431.727	-0.93690	414.000	442.000	455.000
MW-27	Uranium	23	30.59	27.700	33.100	1.4477	5.400	30.554	-0.29327	29.500	30.700	31.800
MW-28	Chloride	29	99.07	73.000	143.000	13.3682	70.000	98.231	0.88168	91.000	99.000	106.000
MW-28	Fluoride	26	0.61	0.520	0.690	0.0416	0.170	0.610	0.06887	0.590	0.600	0.640
MW-28	Sulfate	23	2348.70	2190.000	2520.000	61.4450	330.000	2347.930	0.32663	2310.000	2340.000	2380.000
MW-28	Uranium	23	3.39	2.690	3.890	0.2366	1.200	3.381	-0.68227	3.240	3.420	3.490
MW-29	Chloride	24	36.71	30.000	41.000	2.8814	11.000	36.595	-0.82342	35.000	37.000	39.000
MW-29	Fluoride	22	0.80	0.680	0.954	0.0617	0.274	0.794	0.81775	0.760	0.787	0.830
MW-29	Sulfate	24	2794.17	2600.000	2980.000	93.6189	380.000	2792.673	0.37993	2720.000	2785.000	2840.000
MW-29	Uranium	23	11.09	8.100	12.700	0.9611	4.600	11.044	-1.33645	10.700	11.100	11.600
MW-30	Chloride	36	124.56	106.000	145.000	6.6222	39.000	124.383	-0.07691	122.000	125.000	127.500
MW-30	Fluoride	29	0.36	0.300	0.423	0.0238	0.123	0.360	0.17838	0.349	0.360	0.370
MW-30	Sulfate	29	812.62	696.000	977.000	67.2237	281.000	809.974	0.40812	767.000	799.000	853.000
MW-30	Uranium	29	6.99	5.790	8.380	0.5963	2.590	6.964	0.42210	6.670	6.880	7.250
MW-31	Chloride	36	137.50	115.000	160.000	11.2415	45.000	137.048	-0.12349	128.000	138.000	146.500
MW-31	Fluoride	27	0.88	0.780	0.989	0.0480	0.209	0.875	0.25119	0.840	0.880	0.910
MW-31	Sulfate	38	517.87	436.000	552.000	24.2389	116.000	517.291	-1.37715	504.000	522.000	538.000
MW-31	Uranium	28	7.26	5.770	9.320	0.7254	3.550	7.226	0.96898	6.790	7.150	7.640
MW-32	Chloride	25	31.80	25.000	35.000	2.3314	10.000	31.716	-1.32540	31.000	32.000	33.000
MW-32	Fluoride	24	0.20	0.130	0.300	0.0328	0.170	0.196	0.96783	0.180	0.200	0.210
MW-32	Sulfate	26	2336.15	1950.000	2470.000	127.5642	520.000	2332.597	-1.63468	2300.000	2380.000	2420.000
MW-32	Uranium	26	2.58	0.580	5.150	0.8485	4.570	2.436	1.03629	2.160	2.490	2.700

APPENDIX D-7

Data Omitted Prior to Statistical Analysis

Appendix D-7: Data Omitted Prior to Statistical Analysis

Reason	Well	Sample Date	Reviewed /Report	Chemical	Result	Units	Qualifier
Extreme Outiler	MW-11	2/15/1984	9/23/2007	Sulfate	2250	mg/L	
Extreme Outiler	MW-11	12/15/1985	8/30/2007	Chloride	71	mg/L	
Extreme Outiler	MW-11	12/15/1985	8/30/2007	Sulfate	79	mg/L	
Extreme Outiler	MW-11	6/26/1986		Chloride	70	mg/L	
Extreme Outiler	MW-11	11/12/1992	9/5/2007	Sulfate	1507	mg/L	
Extreme Outiler	MW-11	6/10/1993	9/6/2007	Uranium	4	ug/L	
Extreme Outiler	MW-11	3/15/2007	9/20/2007	Chloride	0.031	mg/L	
Extreme Outiler	MW-19	7/17/2009	C09070691	Fluoride	0.1458	mg/L	
Extreme Outiler	MW-24	6/23/2005	9/24/2007	Chloride	71	mg/L	D
Extreme Outiler	MW-24	6/23/2005	9/24/2007	Uranium	46	ug/L	D
Extreme Outiler	MW-24	7/26/2005	9/13/2007	Uranium	126	ug/L	
Extreme Outiler	MW-24	9/25/2005	9/14/2007	Uranium	223	ug/L	
Extreme Outiler	MW-24	6/22/2006	9/18/2007	Chloride	30	mg/L	
Extreme Outiler	MW-24	9/15/2006	9/17/2007	Chloride	62	mg/L	
Extreme Outiler	MW-24	8/24/2009	C09081027-005	Chloride	37	mg/L	
Extreme Outiler	MW-25	6/20/2007	9/18/2007	Chloride	0.031	mg/L	
Extreme Outiler	MW-25	6/22/2007	C07061184	Fluoride	0.432766	mg/L	
Extreme Outiler	MW-26	4/1/2005	C05040027	Fluoride	0.93	mg/L	
Extreme Outiler	MW-26	6/23/2005	C05060997	Fluoride	0.42	mg/L	
Extreme Outiler	MW-26	5/7/2012	C12050272-003	Fluoride	0.54	mg/L	
Extreme Outiler	MW-28	6/21/2005	9/24/2007	Sulfate	2010	mg/L	
Extreme Outiler	MW-28	6/23/2006	9/18/2007	Uranium	4.89	ug/L	
Extreme Outiler	MW-28	6/20/2007	9/18/2007	Uranium	4.56	ug/L	
Extreme Outiler	MW-28	4/11/2011	C11040506-010	Sulfate	2090	mg/L	D
Extreme Outiler	MW-3	10/31/1979	8/30/2007	Chloride	12.6	mg/L	
Extreme Outiler	MW-3	10/31/1979	8/30/2007	Sulfate	930	mg/L	
Extreme Outiler	MW-3	1/31/1980	8/31/2007	Chloride	25	mg/L	
Extreme Outiler	MW-3	4/30/1980	8/31/2007	Chloride	30	mg/L	
Extreme Outiler	MW-3	5/19/1980	9/4/2007	Chloride	50	mg/L	
Extreme Outiler	MW-3	6/16/1980	9/4/2007	Chloride	51	mg/L	
Extreme Outiler	MW-3	9/1/1981	9/13/2007	Chloride	3	mg/L	
Extreme Outiler	MW-3	9/1/1981	9/13/2007	Sulfate	42	mg/L	
Extreme Outiler	MW-3	12/13/1982		Chloride	53	mg/L	
Extreme Outiler	MW-3	9/30/1985	8/30/2007	Chloride	78	mg/L	
Extreme Outiler	MW-3	12/15/1985	8/30/2007	Chloride	35	mg/L	
Extreme Outiler	MW-3	6/26/1986		Chloride	140	mg/L	
Extreme Outiler	MW-3	11/6/2001	9/10/2007	Chloride	82.5	mg/L	
Extreme Outiler	MW-3	10/26/2009	C09101105-001	Chloride	46	mg/L	
Extreme Outiler	MW-30	6/24/2005	C05061037	Fluoride	0.46	mg/L	
Extreme Outiler	MW-30	10/27/2006	C06101300	Fluoride	0.492675	mg/L	
Extreme Outiler	MW-30	8/4/2008	C08080344	Uranium	11	ug/L	
Extreme Outiler	MW-30	11/5/2008	C08110279-003	Chloride	162	mg/L	
Extreme Outiler	MW-30	4/27/2010	C10041010	Chloride	97	mg/L	
Extreme Outiler	MW-30	10/4/2011	C11100300-010	Uranium	9.83	ug/L	
Extreme Outiler	MW-31	10/27/2006	C06101300	Fluoride	1.183244	mg/L	
Extreme Outiler	MW-31	3/15/2007	9/20/2007	Chloride	0.132	mg/L	
Extreme Outiler	MW-31	11/14/2008	C08110568	Fluoride	0.32	mg/L	
Extreme Outiler	MW-3A	6/23/2005	9/24/2007	Uranium	35.2	ug/L	
Extreme Outiler	MW-3A	12/14/2005	9/14/2007	Uranium	0.3	ug/L	U
Extreme Outiler	MW-3A	9/14/2006	C06090583	Fluoride	0.020307	mg/L	U

Appendix D-7: Data Omitted Prior to Statistical Analysis

Reason	Well	Sample Date	Reviewed /Report	Chemical	Result	Units	Qualifier
Extreme Outiler	MW-3A	5/15/2012	C12050723-002	Uranium	100	ug/L	
Extreme Outiler	MW-5	9/1/1980	9/6/2007	Fluoride	1.68	mg/L	
Extreme Outiler	MW-5	9/1/1981	9/13/2007	Chloride	4	mg/L	
Extreme Outiler	MW-5	9/1/1981	9/13/2007	Sulfate	28	mg/L	
Extreme Outiler	MW-5	12/28/1981		Chloride	20	mg/L	
Extreme Outiler	MW-5	12/15/1985	8/30/2007	Chloride	71	mg/L	
Extreme Outiler	MW-5	12/15/1985	8/30/2007	Sulfate	7820	mg/L	
Extreme Outiler	MW-5	6/26/1986		Chloride	130	mg/L	
Extreme Outiler	MW-5	6/26/1986		Sulfate	1890	mg/L	
Extreme Outiler	MW-5	9/19/1995	8/31/2007	Uranium	4.7	ug/L	
Extreme Outiler	MW-5	11/11/2010	C10110584	Uranium	11.6	ug/L	
Extreme Outiler	MW-5	2/14/2011	C11020544	Uranium	29.5	ug/L	
Extreme Outiler	MW-5	4/12/2011	C11040506-005	Uranium	7.16	ug/L	
Extreme Outiler	MW-5	10/10/2011	C11100567-004	Uranium	4.52	ug/L	
Extreme Outiler	MW-5	2/28/2012	C12030065-003A	Uranium	18.6	ug/L	

APPENDIX E

Statistical Analysis of Field pH in Chloroform Wells

APPENDIX E-1

Field pH Analysis for Chloroform Wells Summary Table

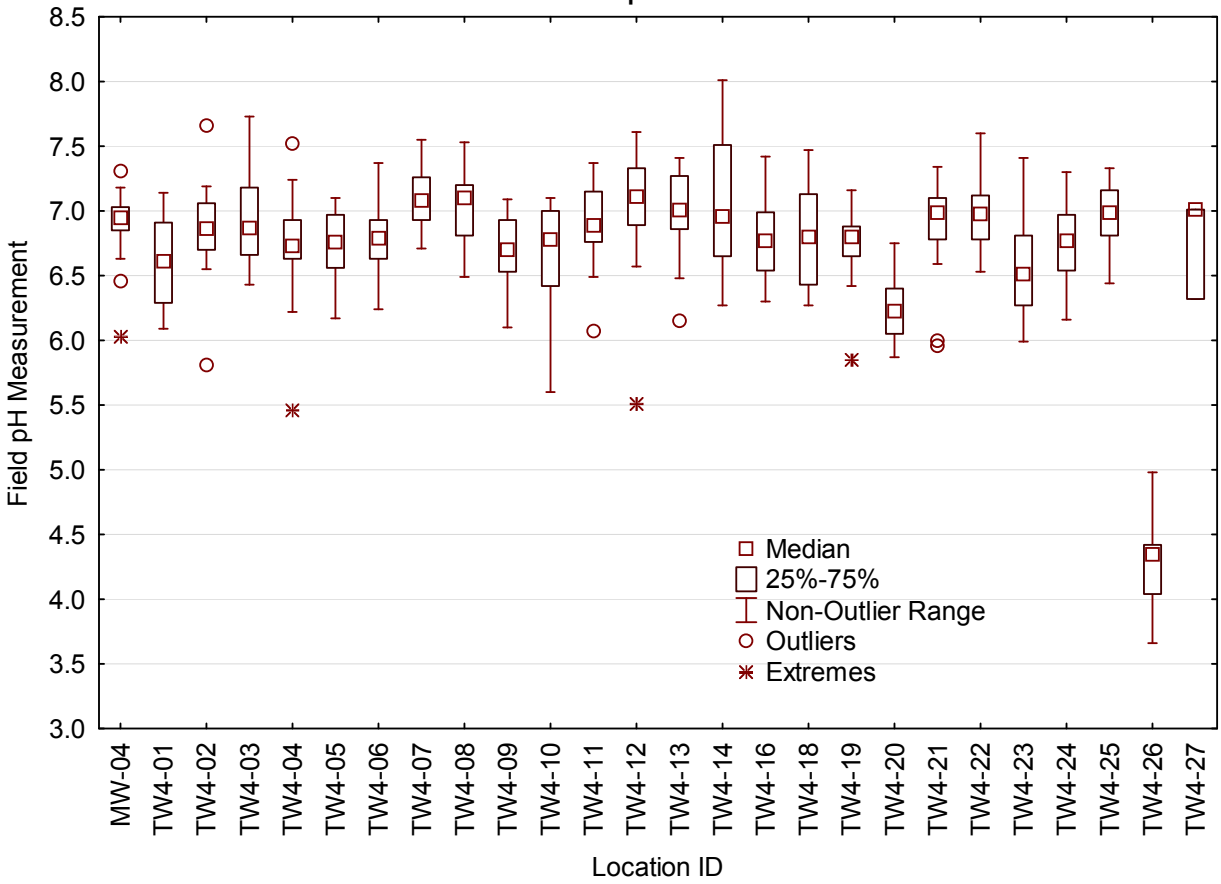
Appendix E-1 Field pH Analysis Summary Table for Chloroform Wells

Well	N	Shapiro- Wilk Test for Normality			Linear Regression Trend Test		Mann-Kendall Trend Test		Significant Trend?	General Trend?
		W	p	Normally or Lognormally Distributed?	R	p	S	p		
TW4-01	21	0.9347	0.1709	Yes	0.3929	0.0024			Down	
TW4-02	22	0.9122	0.0526	Yes	0.3326	0.0050			Down	
TW4-03	21	0.9471	0.2994	Yes	0.3324	0.0062			Down	
TW4-04	23	0.8892	0.0153	No			-51	0.0932		Down
TW4-05	23	0.9451	0.2311	Yes	0.3518	0.0029			Down	
TW4-06	23	0.9795	0.8974	Yes	0.2001	0.0323			Down	
TW4-07	23	0.9606	0.4764	Yes	0.0914	0.1609				Down
TW4-08	23	0.9725	0.7491	Yes	0.4170	0.0009			Down	
TW4-09	22	0.9523	0.3499	Yes	0.2626	0.0148			Down	
TW4-10	23	0.8734	0.0074	No			-114	0.00139	Down	
TW4-11	23	0.9520	0.3219	Yes	0.2848	0.0087			Down	
TW4-12	21	0.9742	0.8235	Yes	0.3144	0.0082			Down	
TW4-13	22	0.9286	0.1149	Yes	0.0014	0.8668				Flat
TW4-14	11	0.9356	0.4697	Yes	0.4043	0.0355			Up	
TW4-16	23	0.9505	0.3001	Yes	0.3378	0.0036			Down	
TW4-18	23	0.9382	0.1643	Yes	0.3378	0.0036			Down	
TW4-19	18	0.8650	0.0147	No			-1	0.5		Down
TW4-20	18	0.9658	0.7163	Yes	0.0766	0.2662				Up
TW4-21	25	0.8377	0.0010	No			-72	0.0485	Down	
TW4-22	24	0.9711	0.6939	Yes	0.0016	0.8536				Flat
TW4-23	22	0.9721	0.7596	Yes	0.2485	0.0182			Down	
TW4-24	23	0.9852	0.9734	Yes	0.1843	0.0409			Down	
TW4-25	22	0.9684	0.6748	Yes	0.1093	0.1329				Up
TW4-26	10	0.9597	0.7830	Yes	0.1258	0.3145				Down
TW4-27	3	0.7500	0.0000	No			2	0.27		Up

APPENDIX E-2

Box Plot for Field pH in Chloroform Wells

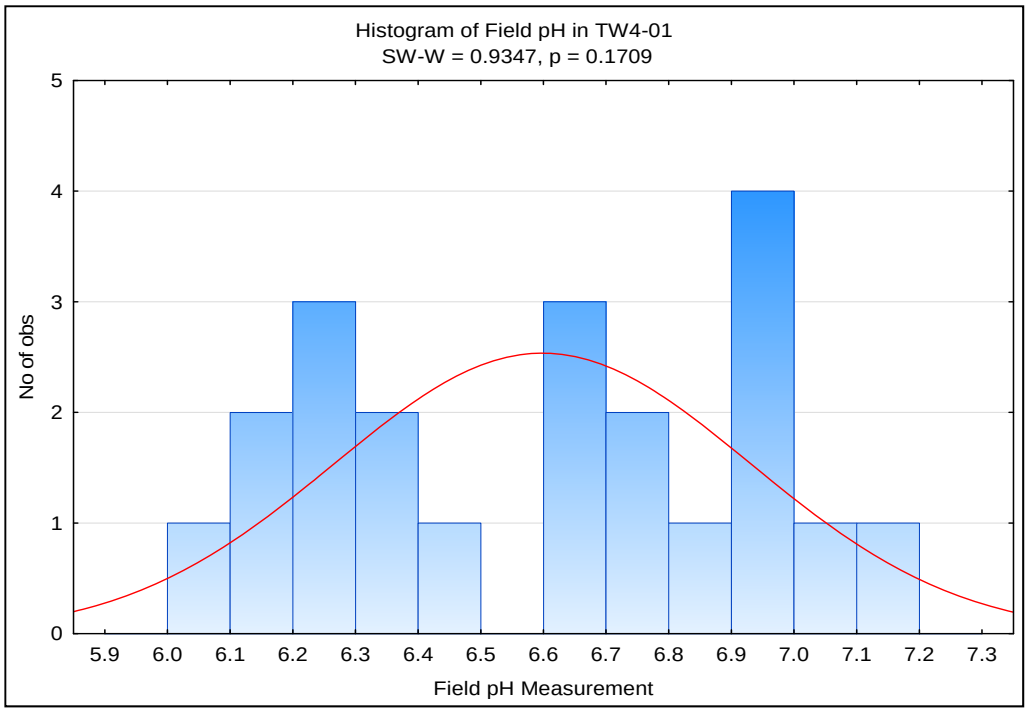
Appendix E-2
Box Plot for Field pH in Chloroform Wells

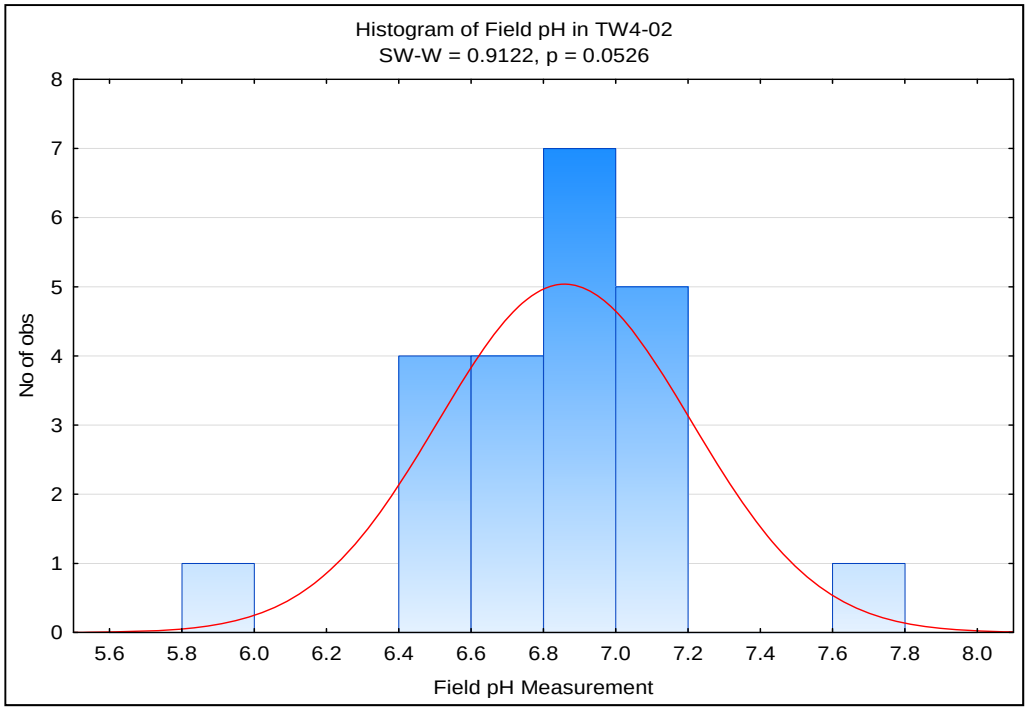


APPENDIX E-3

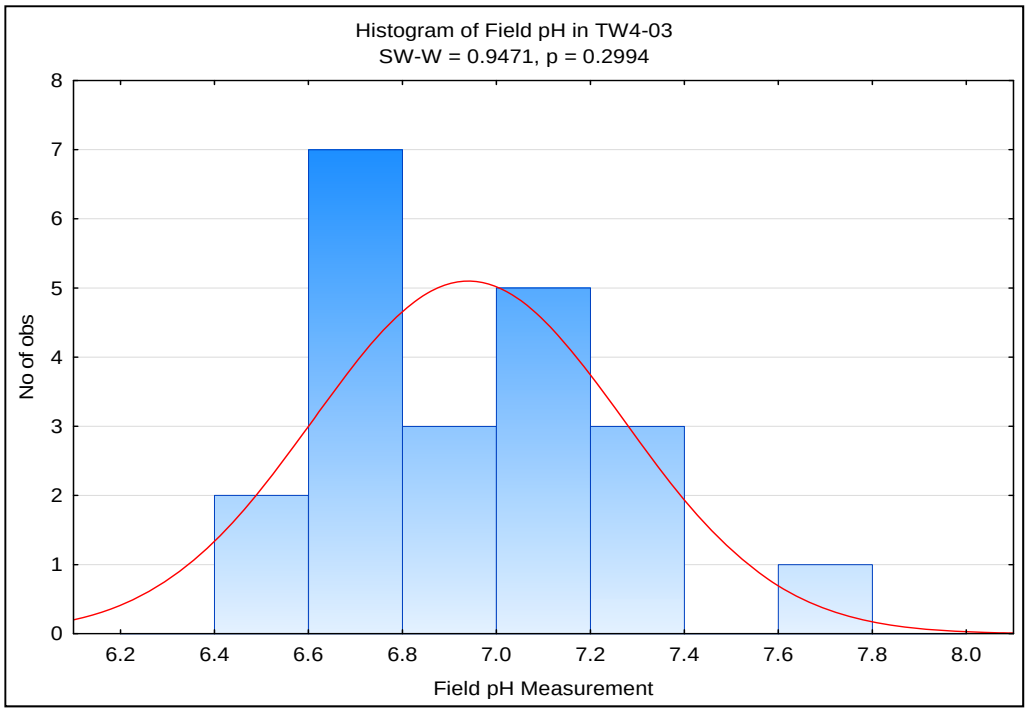
Histograms for Field pH in Chloroform Wells

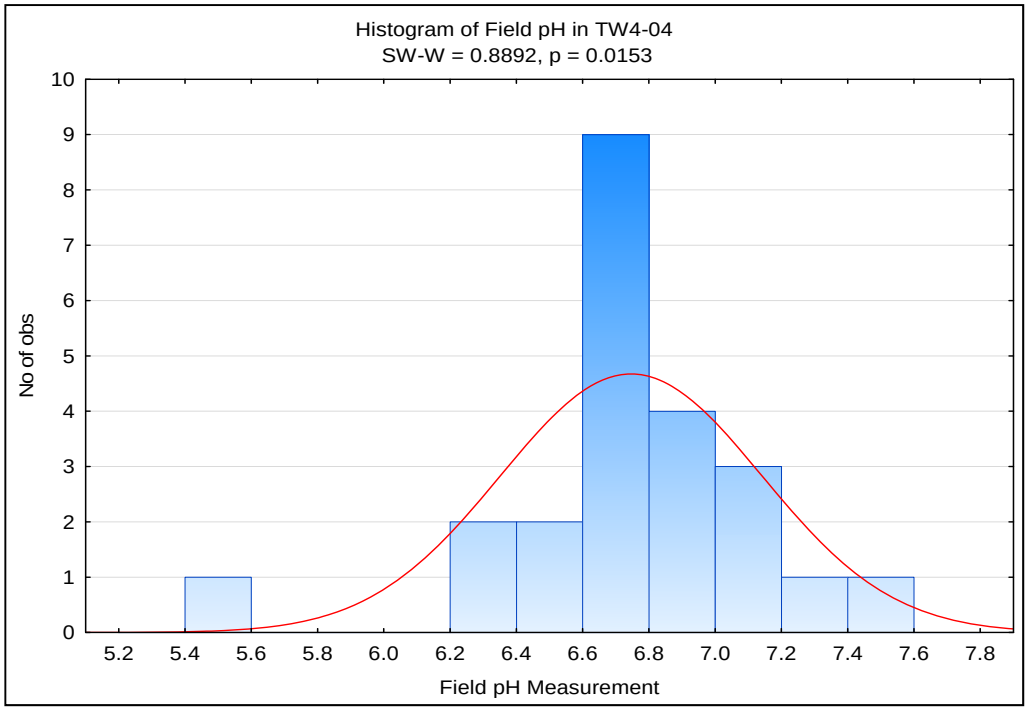
Appendix E-3
Histograms for Field pH in Chloroform Wells



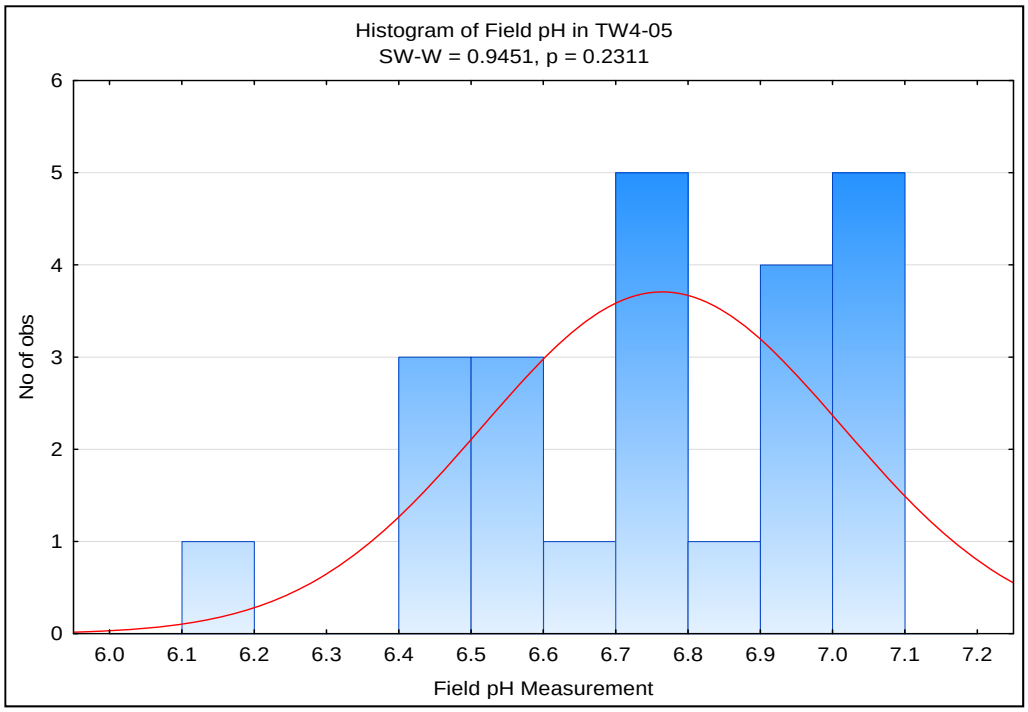


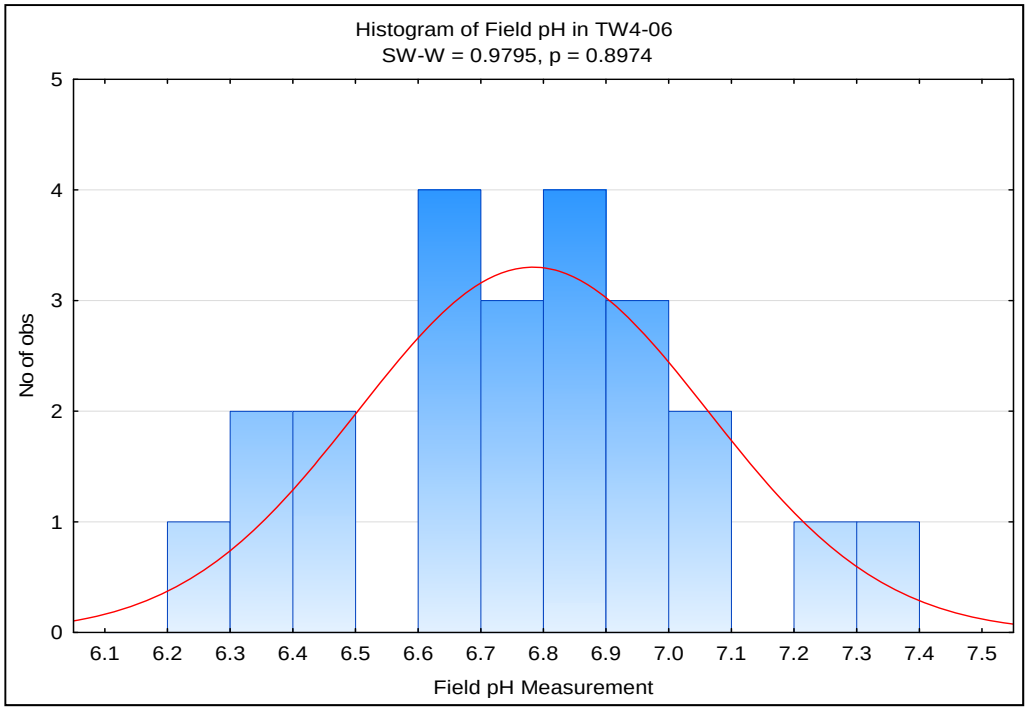
Appendix E-3
Histograms for Field pH in Chloroform Wells



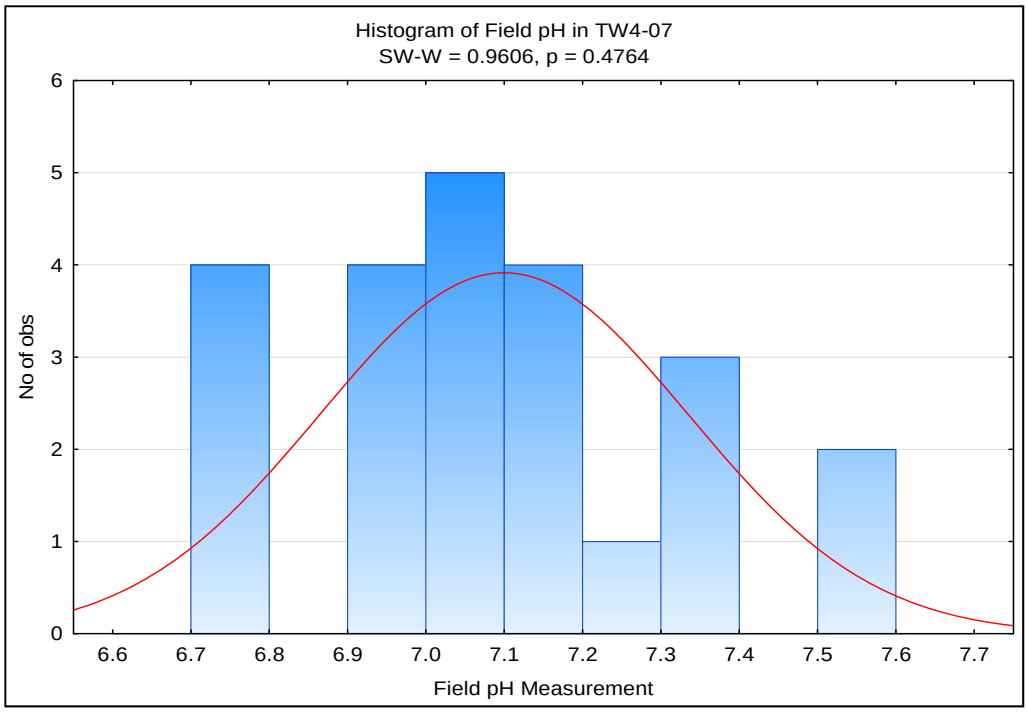


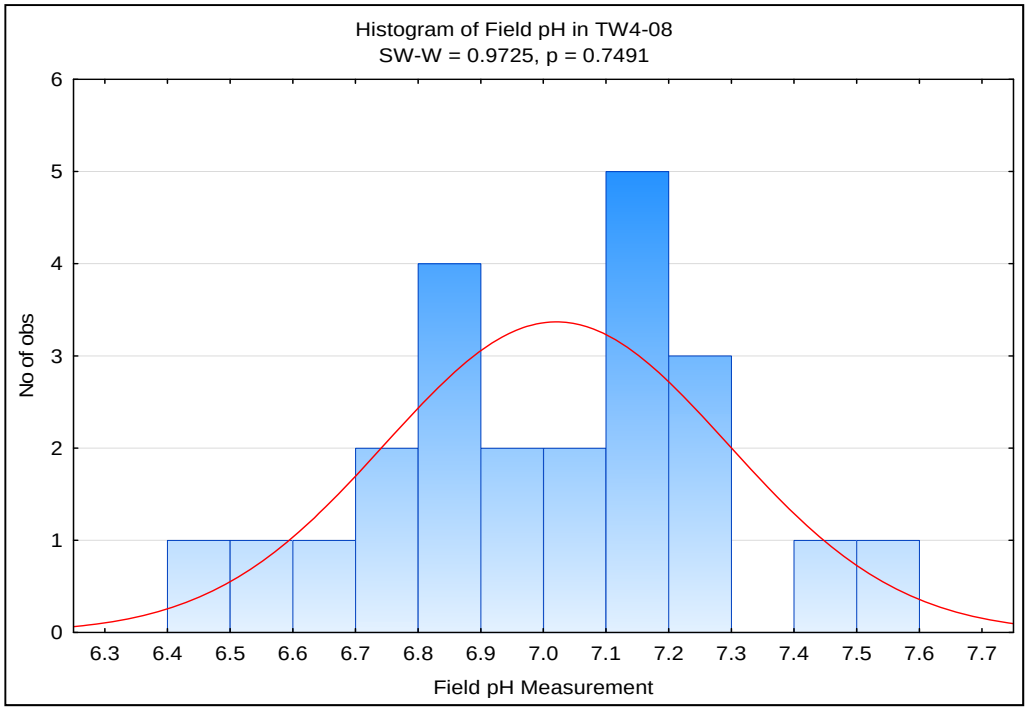
Appendix E-3
Histograms for Field pH in Chloroform Wells





Appendix E-3
Histograms for Field pH in Chloroform Wells





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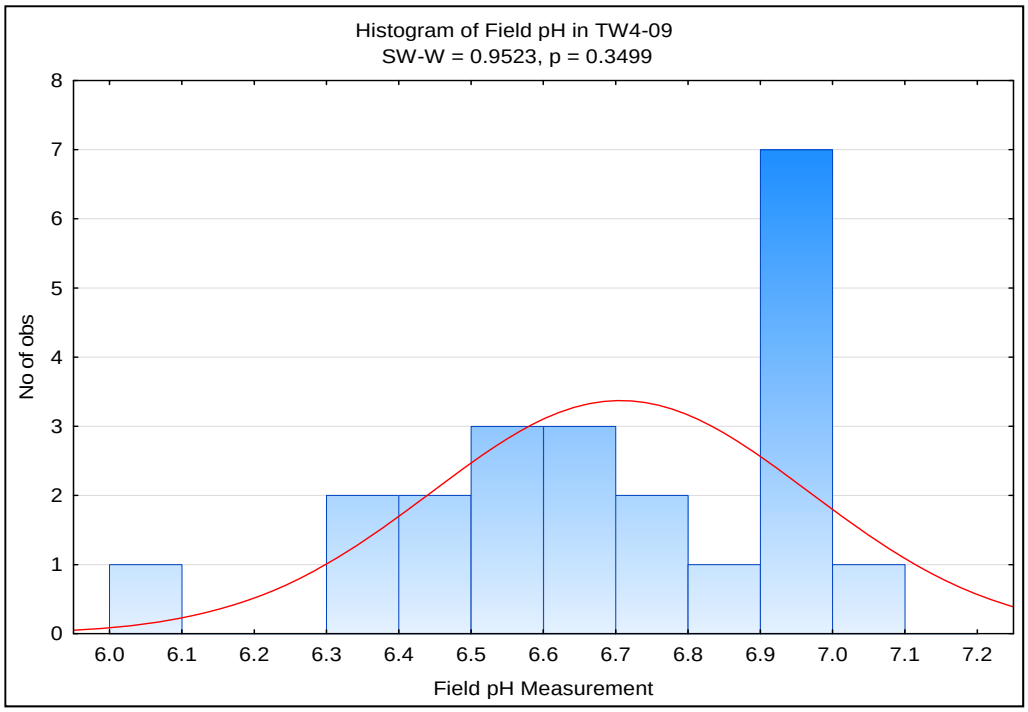
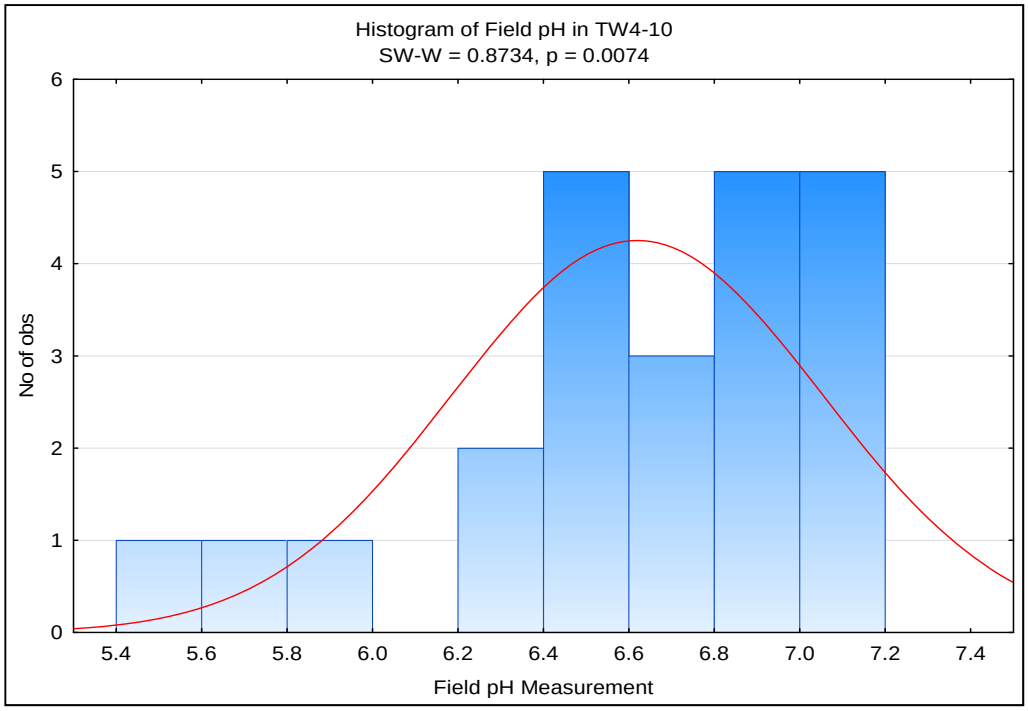
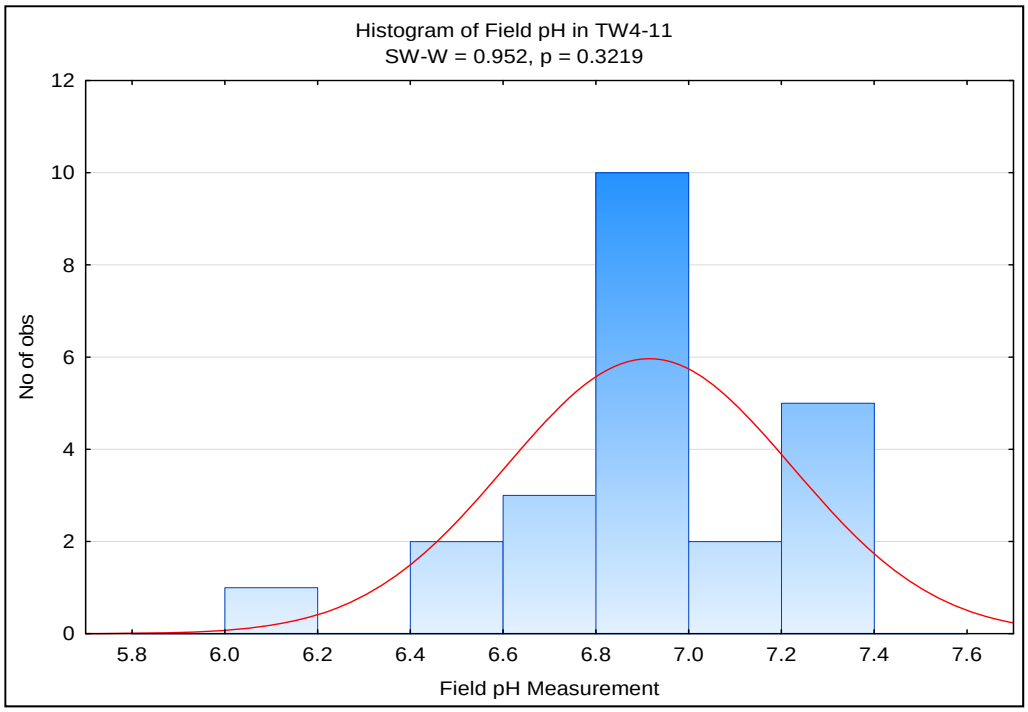
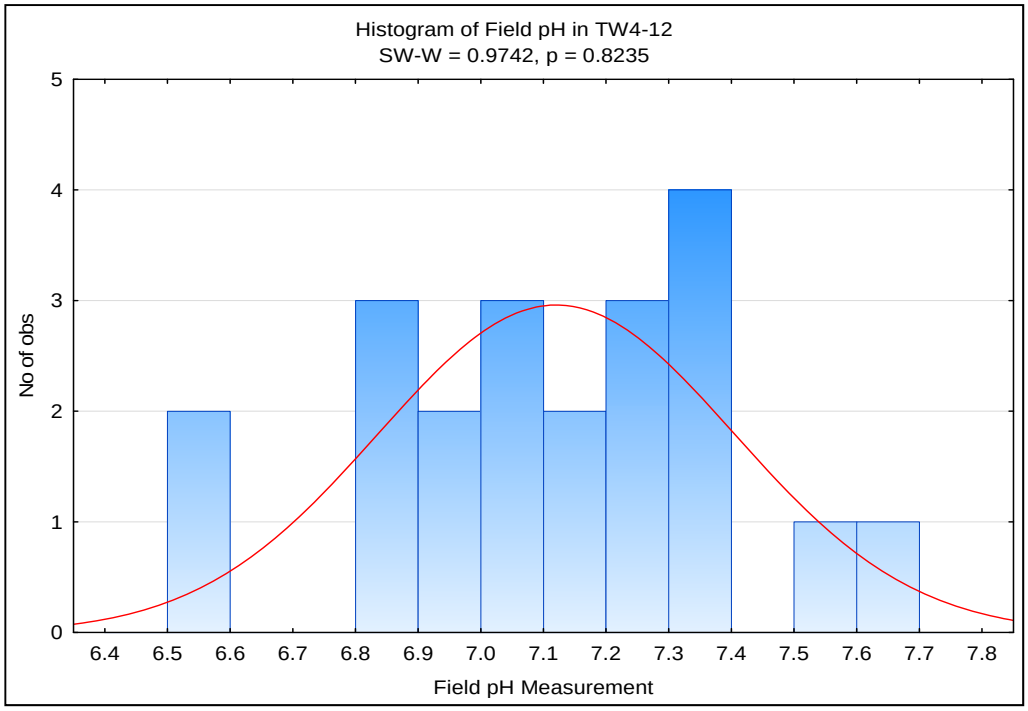
Histograms for Field pH in Chloroform Wells





Appendix E-3
Histograms for Field pH in Chloroform Wells





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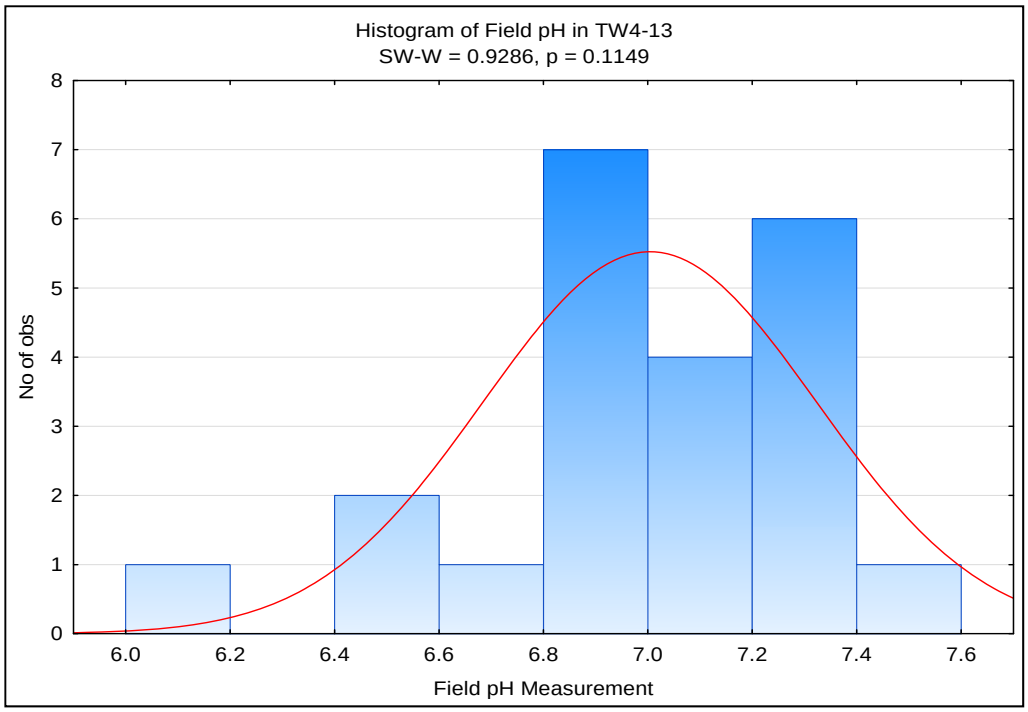
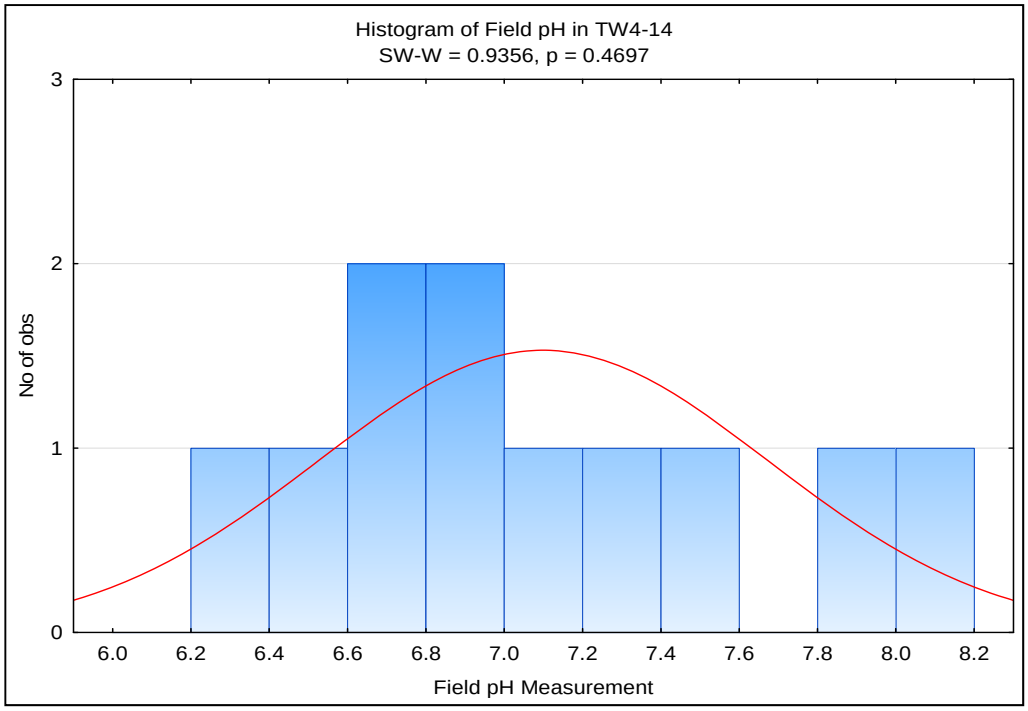
Histograms for Field pH in Chloroform Wells





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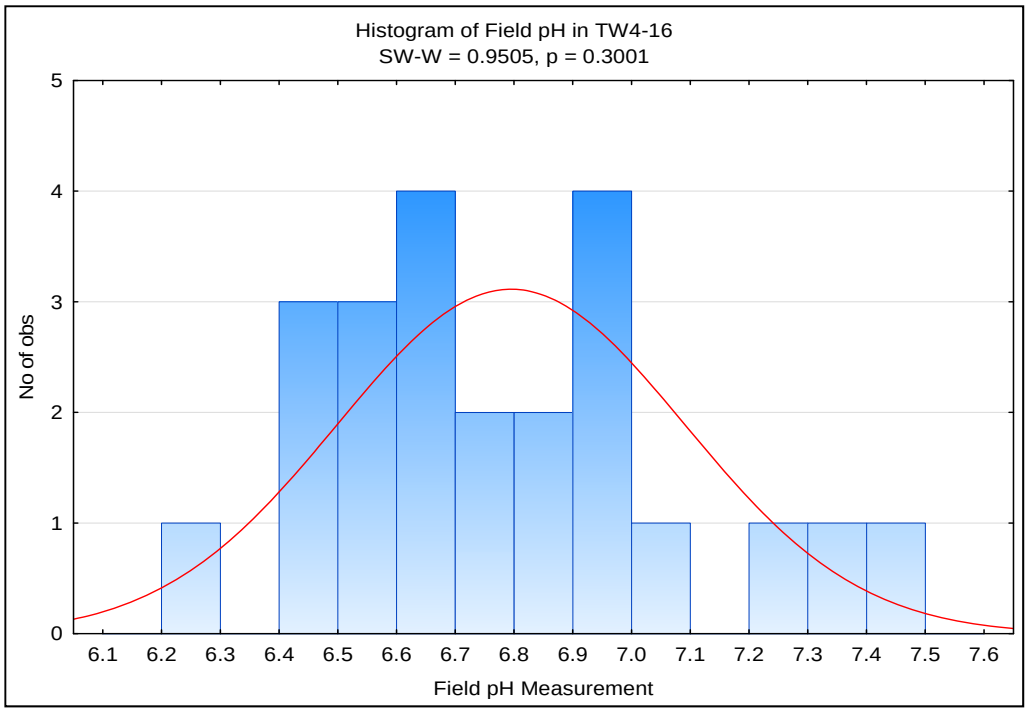
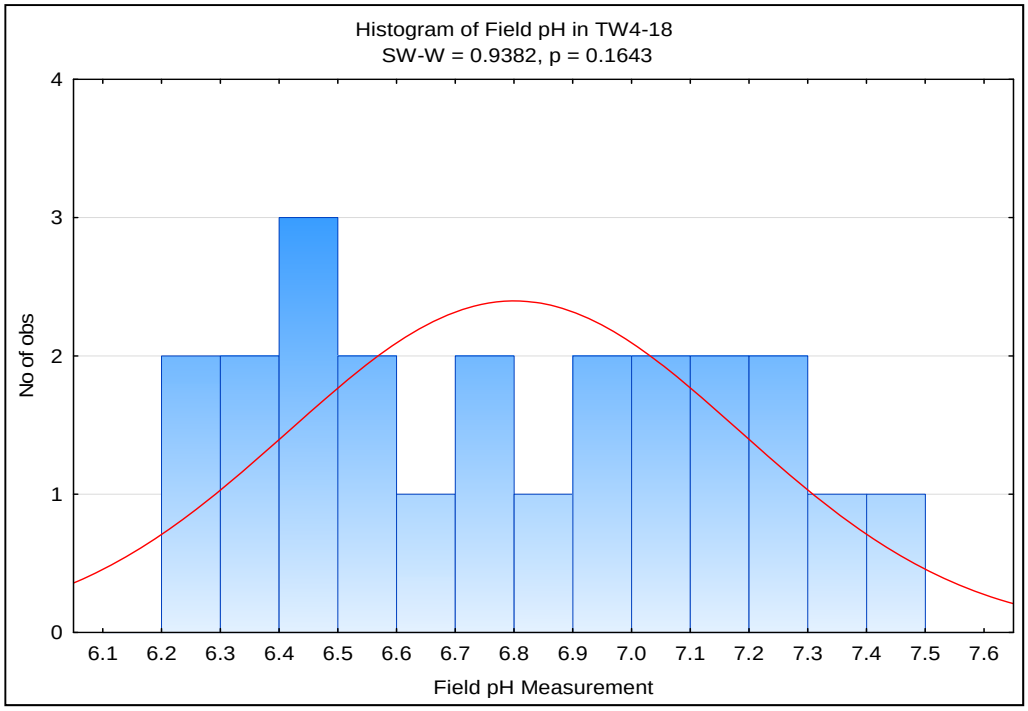
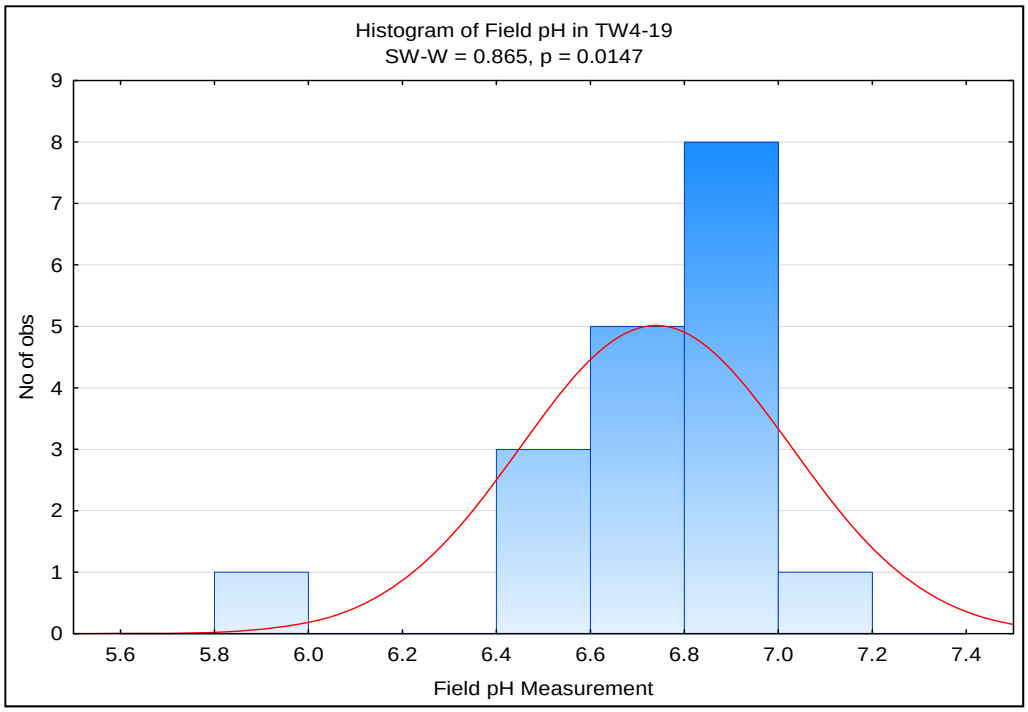
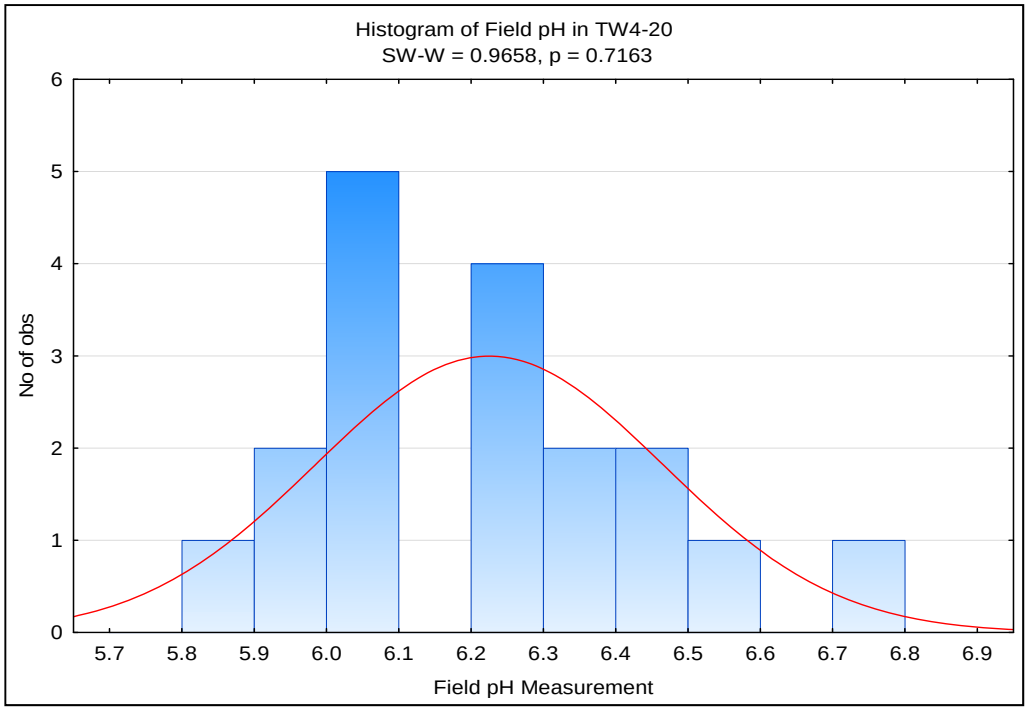
Histograms for Field pH in Chloroform Wells



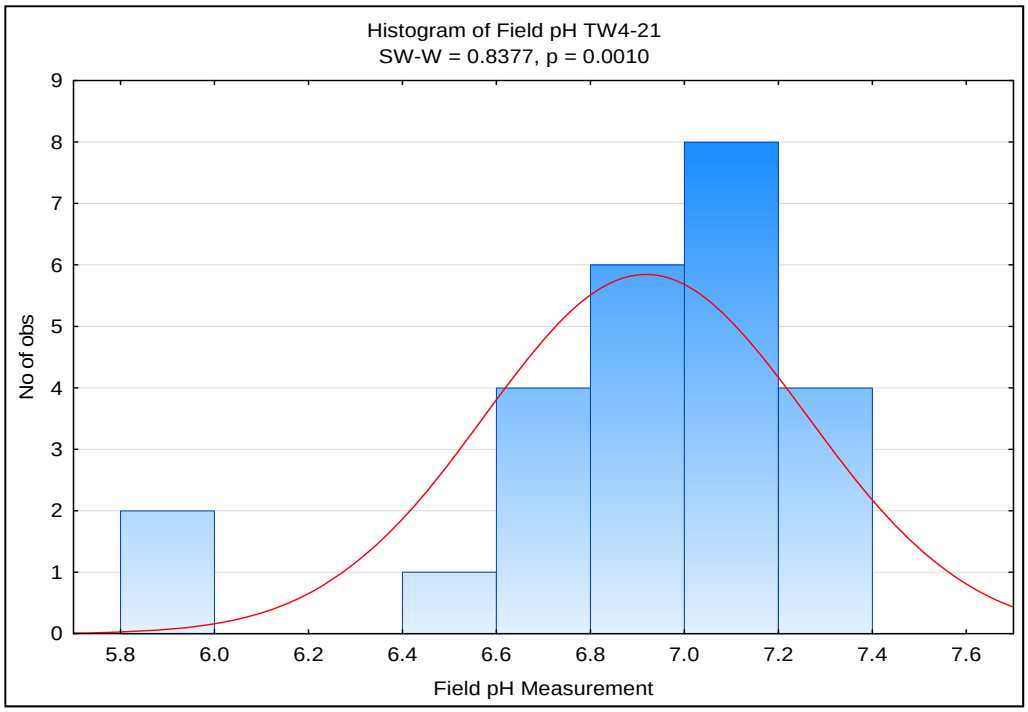


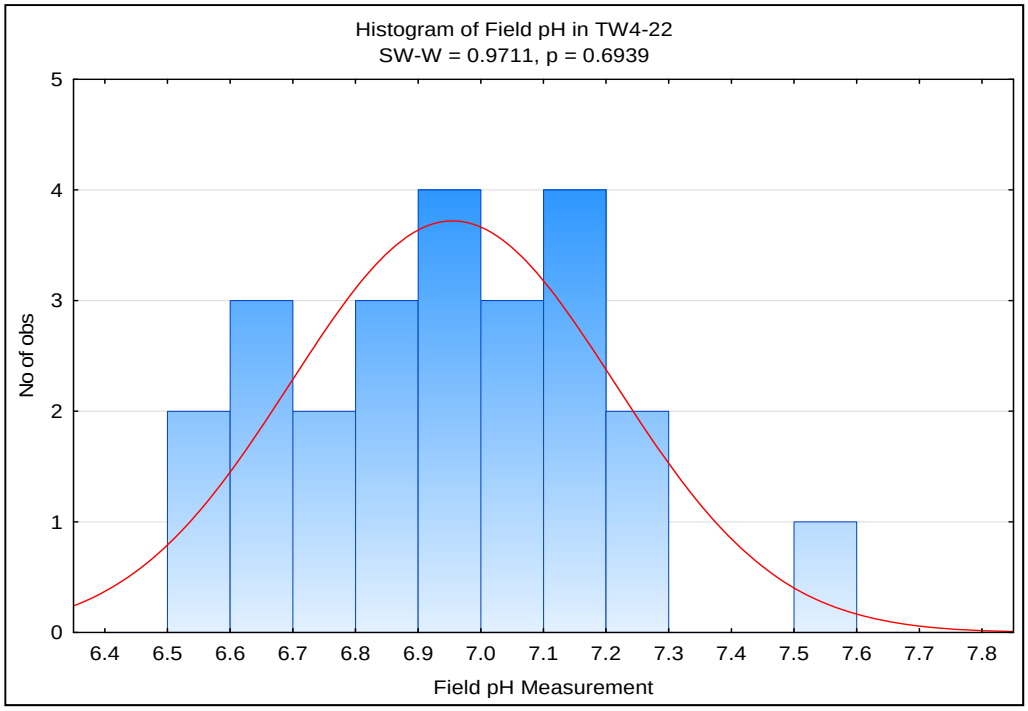
Appendix E-3
Histograms for Field pH in Chloroform Wells



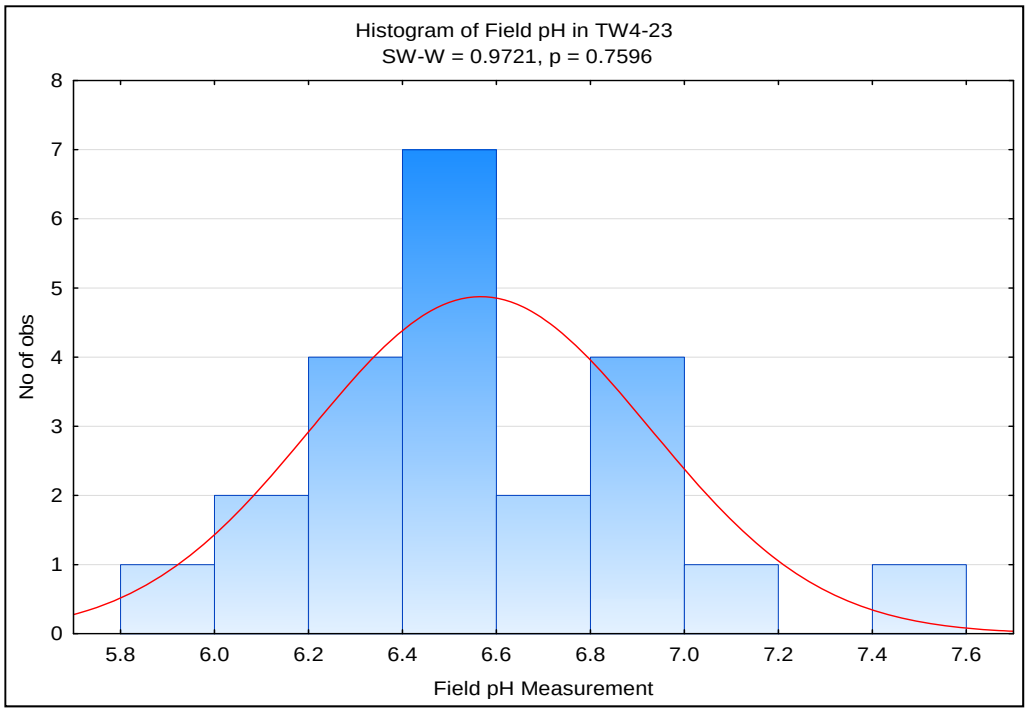


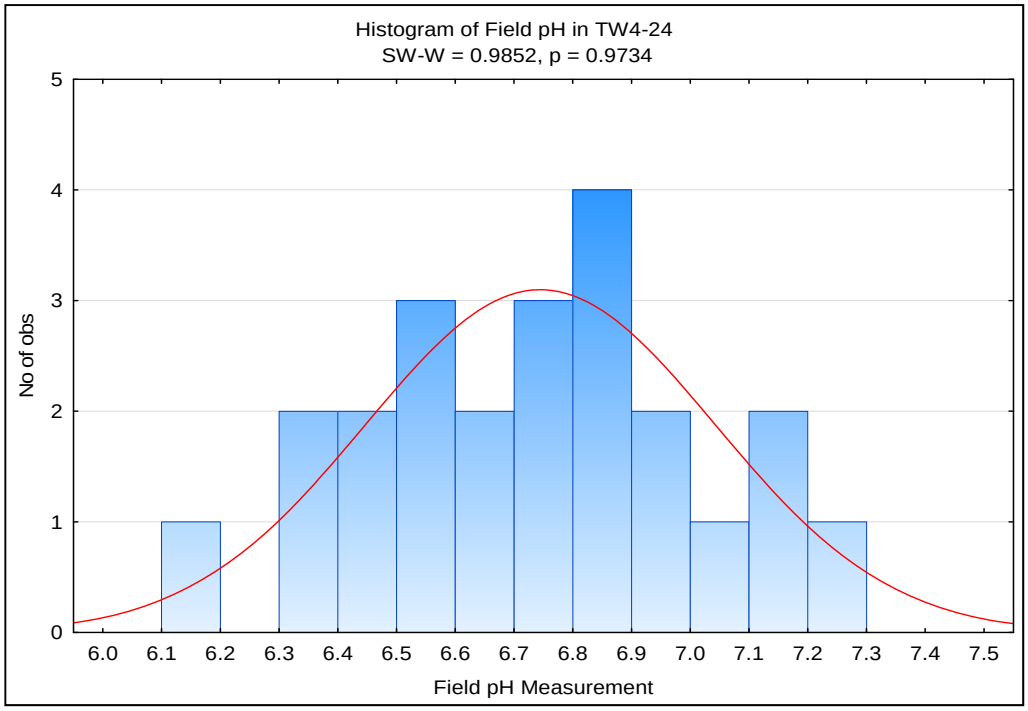
Appendix E-3
Histograms for Field pH in Chloroform Wells



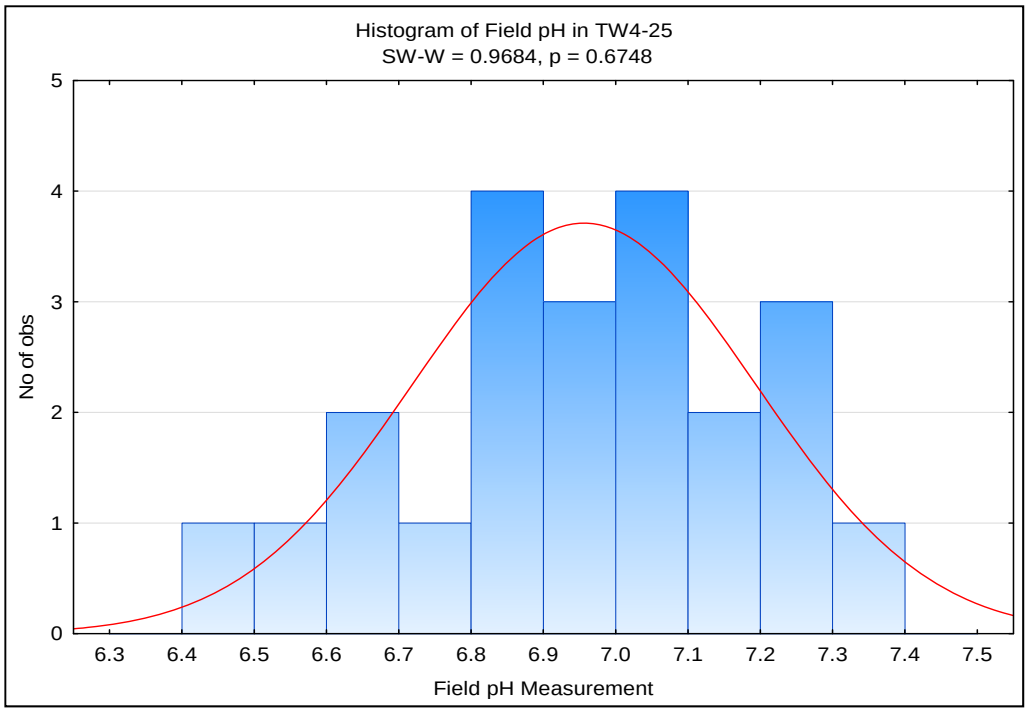


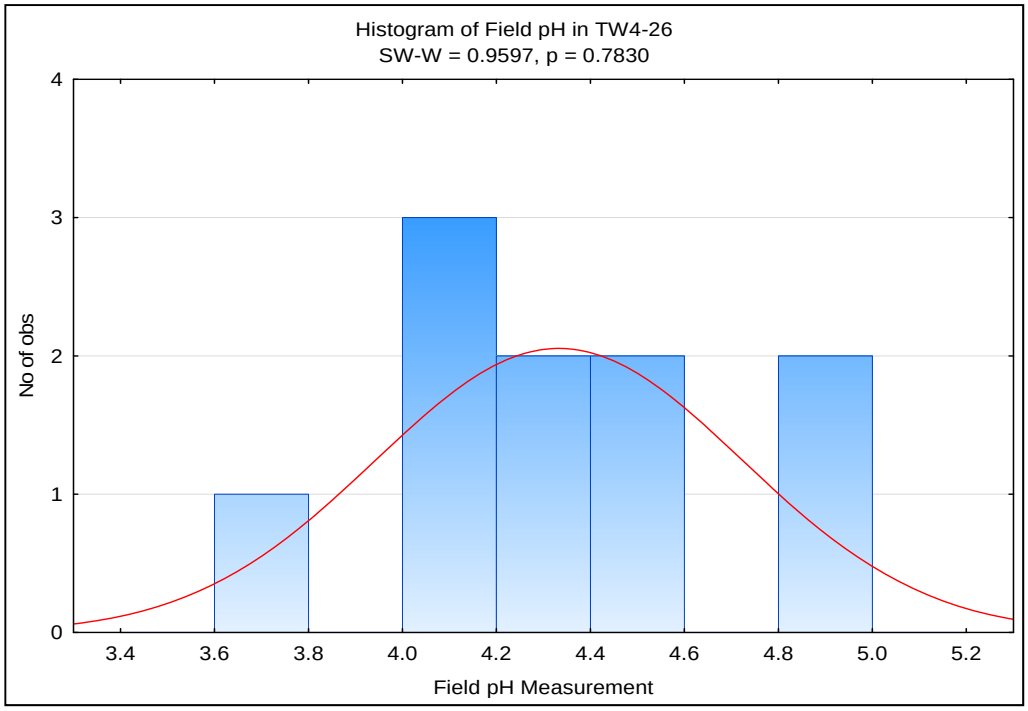
Appendix E-3
Histograms for Field pH in Chloroform Wells



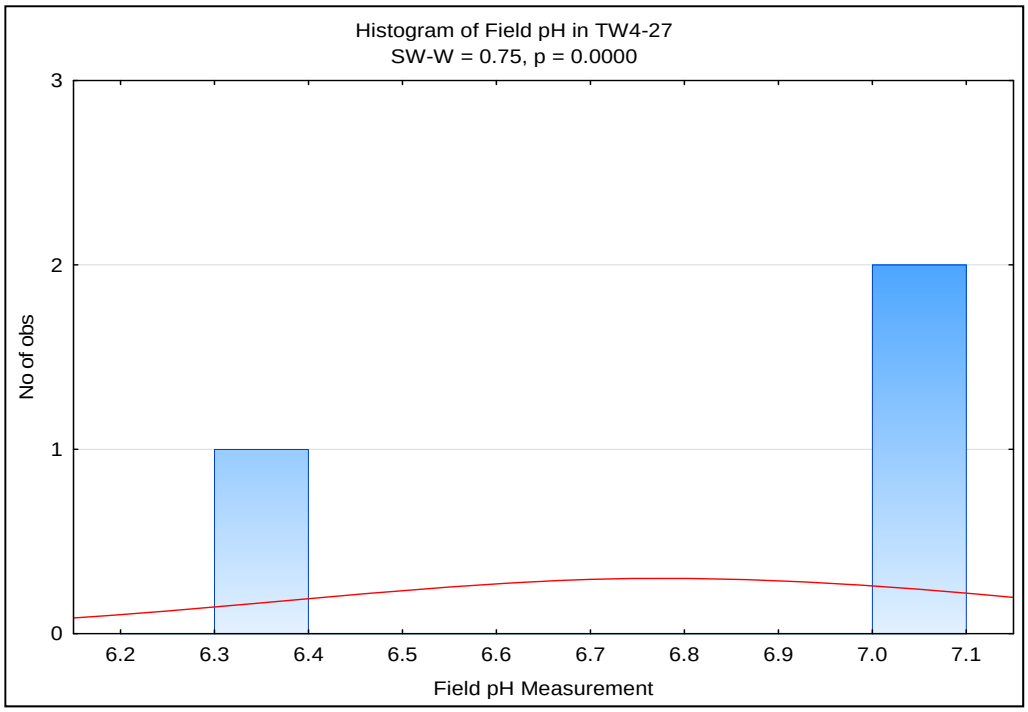


Appendix E-3
Histograms for Field pH in Chloroform Wells





Appendix E-3
Histograms for Field pH in Chloroform Wells



APPENDIX E-4

Mann Kendall Output for Field pH in Chloroform Wells that Are Not Normally or Lognormally Distributed

Appendix E-4
Mann-Kendall Output for Field pH in Chloroform Wells That are Not Normally or Lognormally Distributed

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	11/1/2012 4:24:33 PM
From File	Sheet2.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Field pH Measurement-tw4-04

General Statistics

Number of Values	23
Minimum	5.46
Maximum	7.52
Mean	6.738
Geometric Mean	6.727
Median	6.73
Standard Deviation	0.393
SEM	0.0819

Mann-Kendall Test

Test Value (S)	-51
Critical Value (0.05)	-1.645
Standard Deviation of S	37.84
Standardized Value of S	-1.321
Approximate p-value	0.0932

Insufficient evidence to identify a significant trend at the specified level of significance.

Field pH Measurement-tw4-10

General Statistics

Number of Values	23
Minimum	5.6
Maximum	7.1
Mean	6.613
Geometric Mean	6.599
Median	6.78
Standard Deviation	0.432
SEM	0.09

Mann-Kendall Test

Test Value (S)	-114
Critical Value (0.05)	-1.645

Standard Deviation of S	37.79
Standardized Value of S	-2.99
Approximate p-value	0.00139

Statistically significant evidence of a decreasing trend at the specified level of significance.

Field pH Measurement-tw4-19

General Statistics

Number of Values	18
Minimum	5.85
Maximum	7.16
Mean	6.733
Geometric Mean	6.727
Median	6.8
Standard Deviation	0.286
SEM	0.0675

Mann-Kendall Test

Test Value (S)	-1
Tabulated p-value	0.5
Standard Deviation of S	26.36
Standardized Value of S	0
Approximate p-value	0.5

Insufficient evidence to identify a significant trend at the specified level of significance.

Field pH Measurement-tw4-21

General Statistics

Number of Values	25
Minimum	5.96
Maximum	7.34
Mean	6.912
Geometric Mean	6.903
Median	6.99
Standard Deviation	0.341
SEM	0.0682

Mann-Kendall Test

Test Value (S)	-72
Critical Value (0.05)	-1.645

Appendix E-4
Mann-Kendall Output for Field pH in Chloroform Wells That are Not Normally or Lognormally Distributed

Standard Deviation of S	42.79
Standardized Value of S	-1.659
Approximate p-value	0.0485

Statistically significant evidence of a decreasing trend at the specified level of significance.

Field pH Measurement-tw4-27

General Statistics

Number of Values	3
Minimum	6.32
Maximum	7.01
Mean	6.78
Geometric Mean	6.772
Median	7.01
Standard Deviation	0.398
SEM	0.23

Mann-Kendall Test

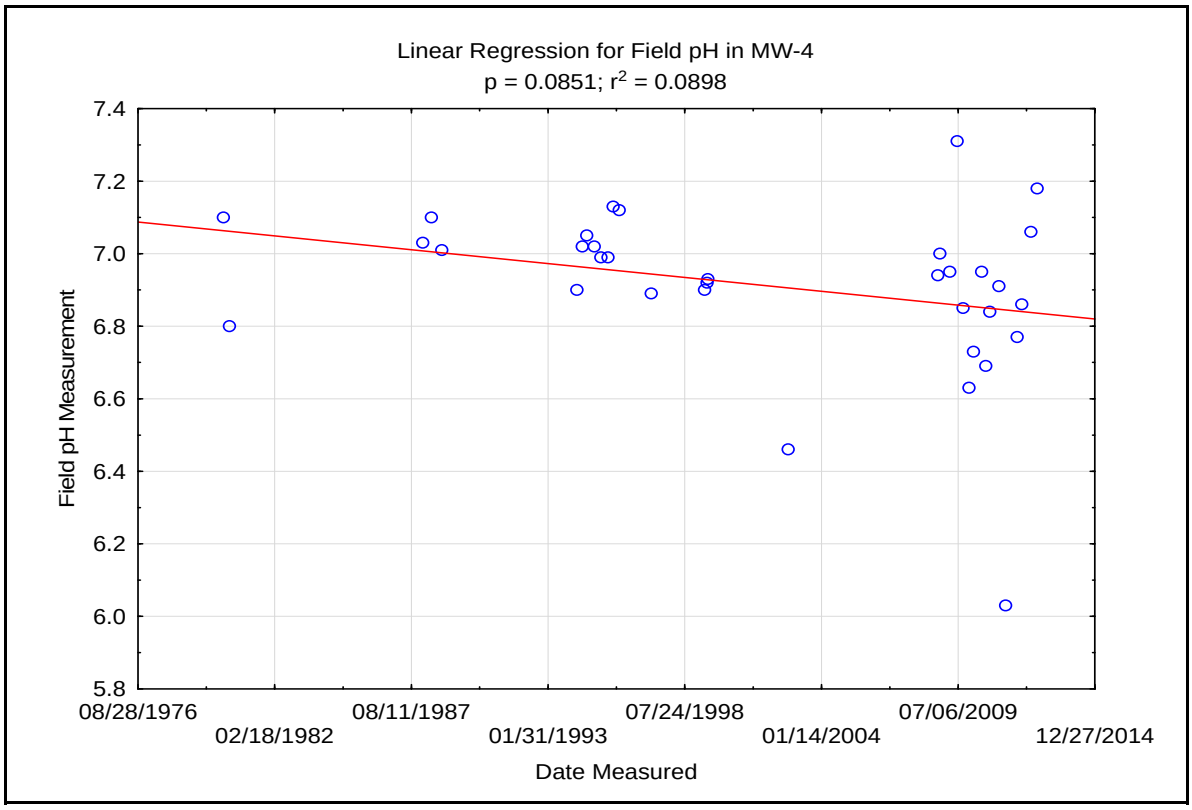
Test Value (S)	2
Tabulated p-value	N/A
Standard Deviation of S	1.633
Standardized Value of S	0.612
Approximate p-value	0.27

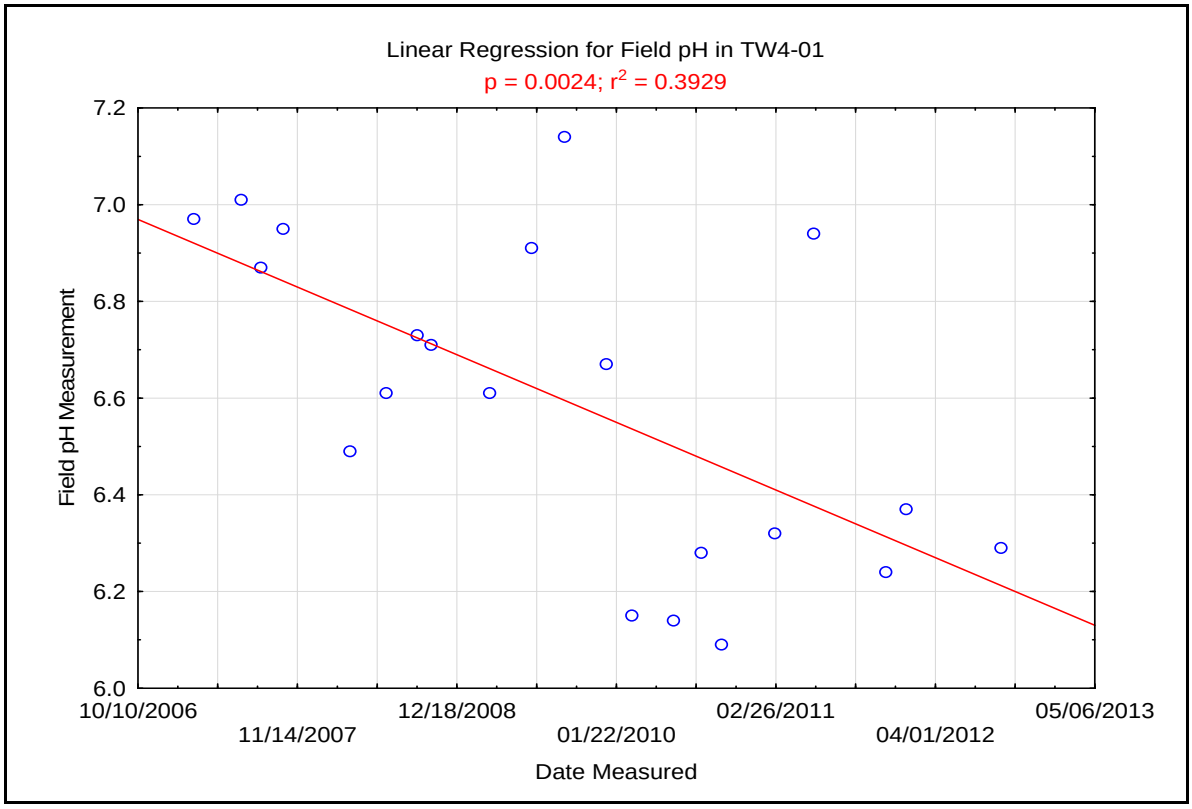
Insufficient evidence to identify a significant trend at the specified level of significance.

APPENDIX E-5

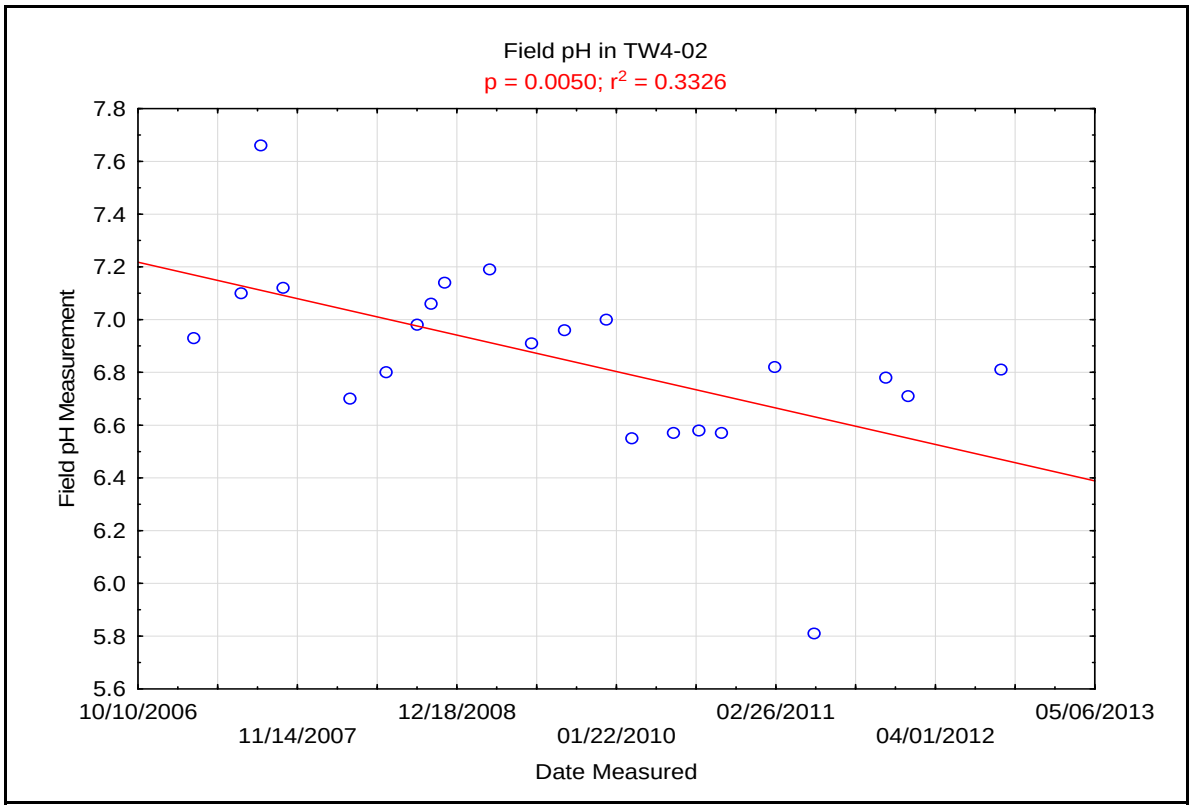
Linear Regression for Field pH in All Chloroform Wells

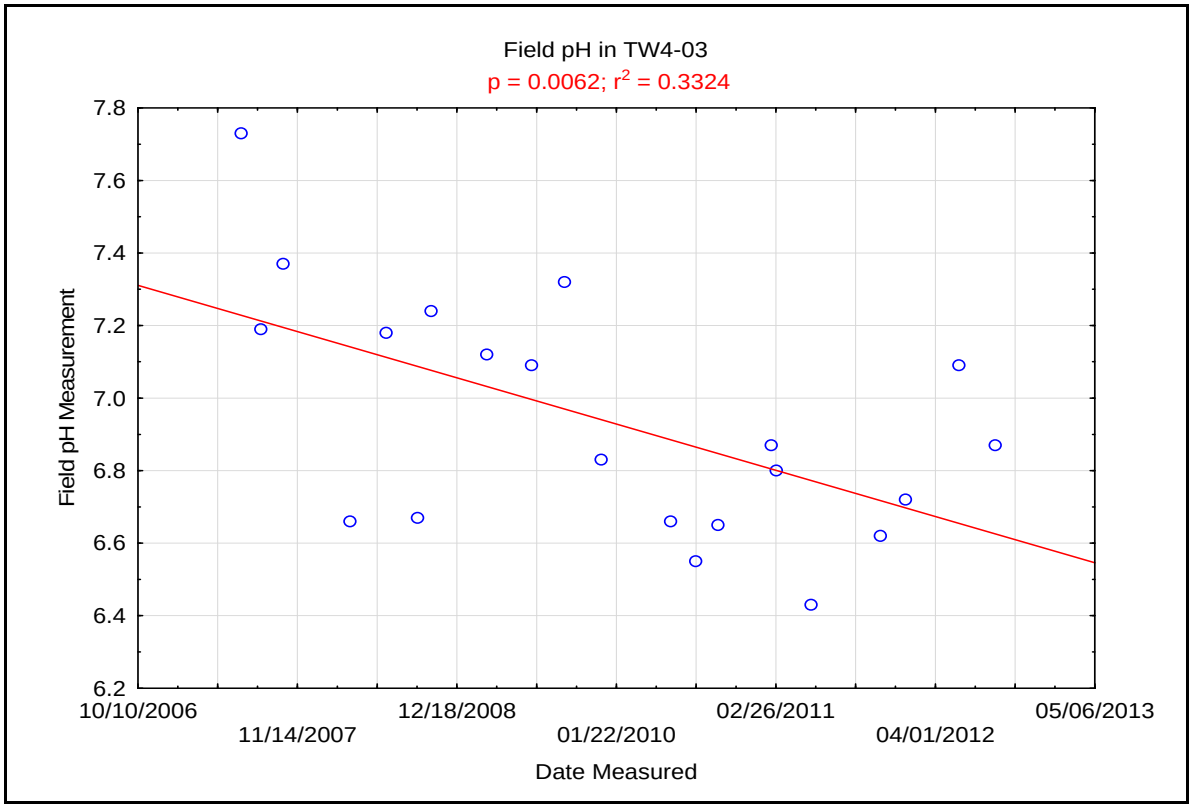
Appendix E-5
Linear Regression for Field pH in All Chloroform Wells



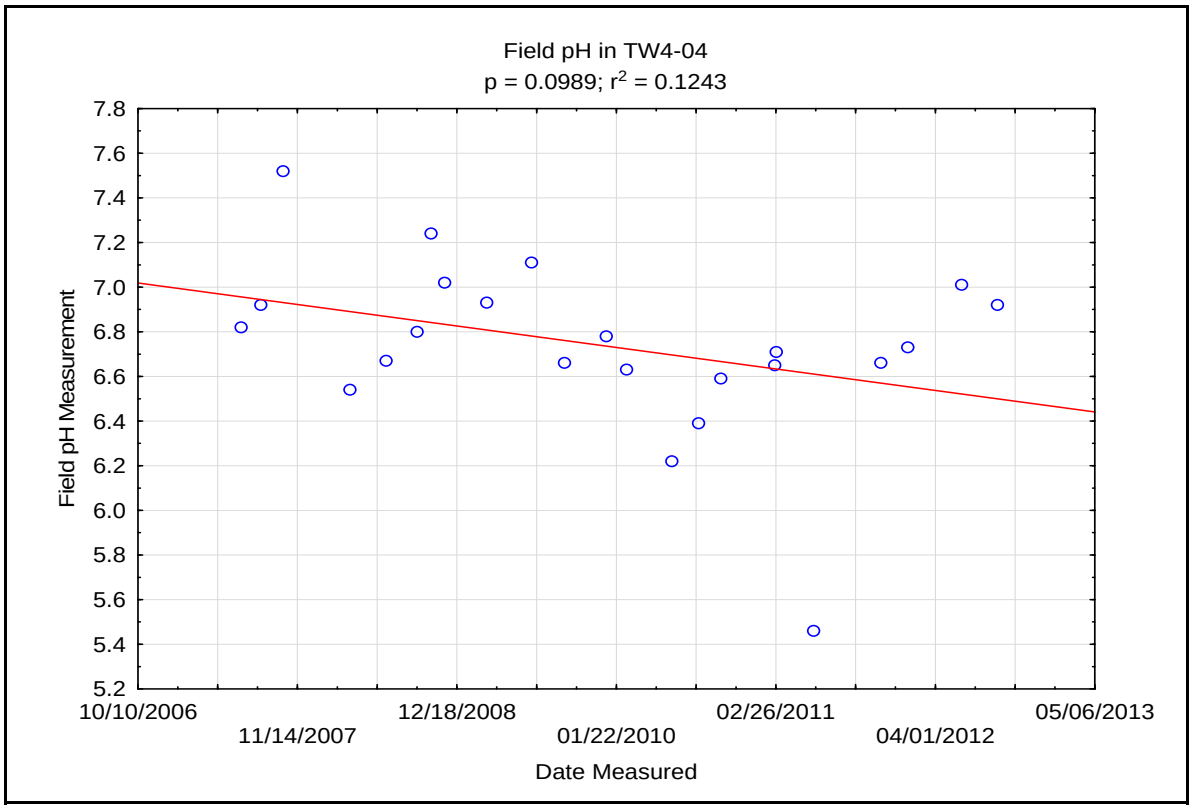


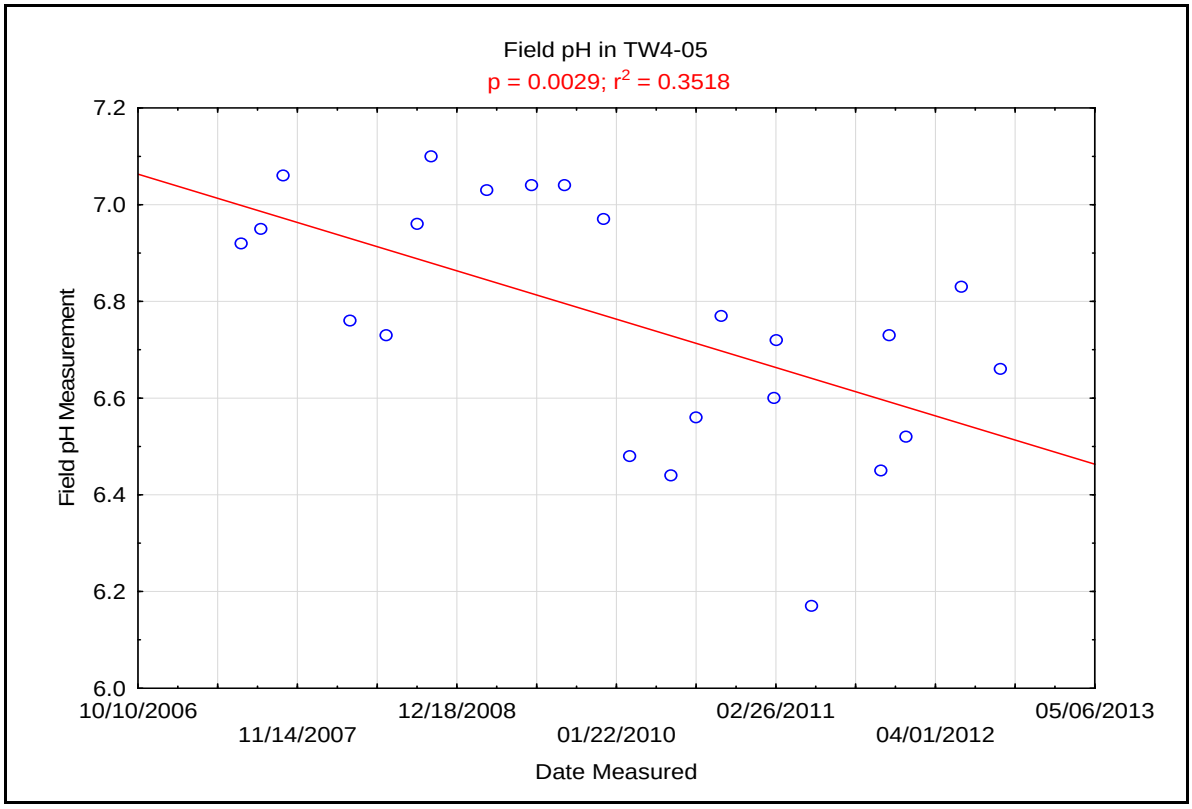
Appendix E-5
Linear Regression for Field pH in All Chloroform Wells



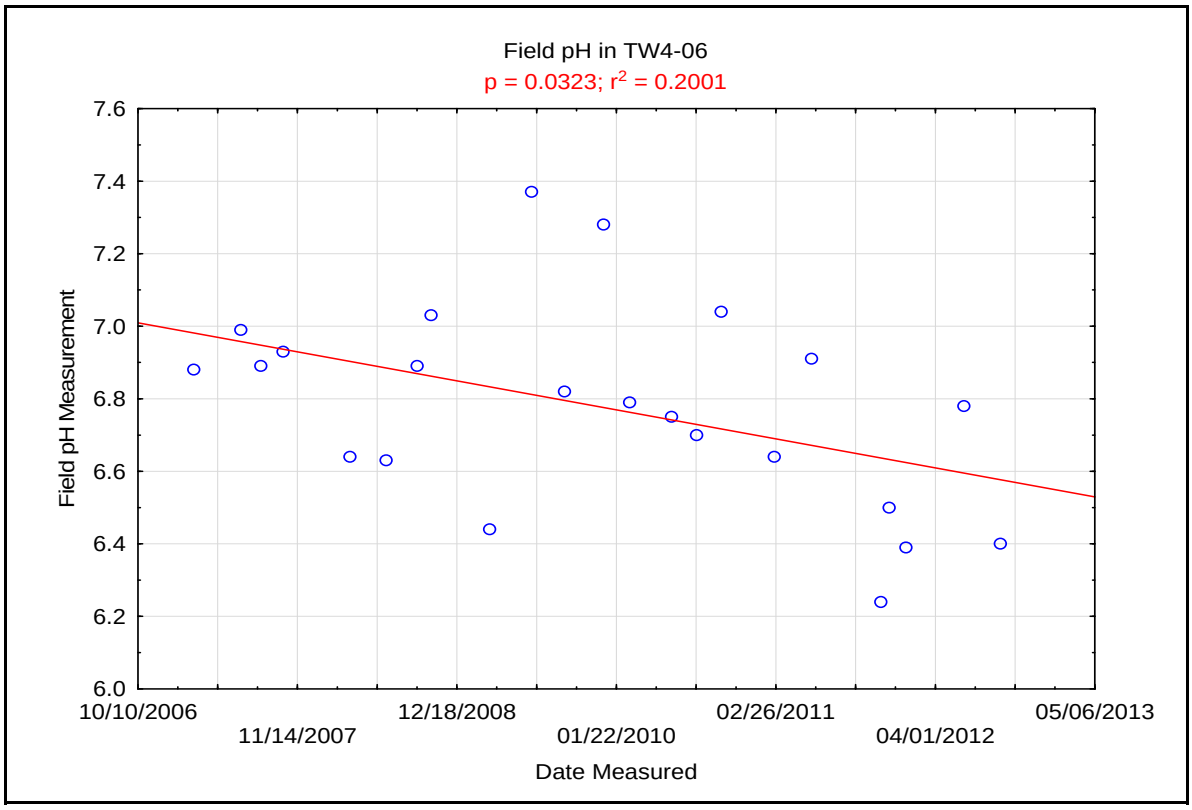


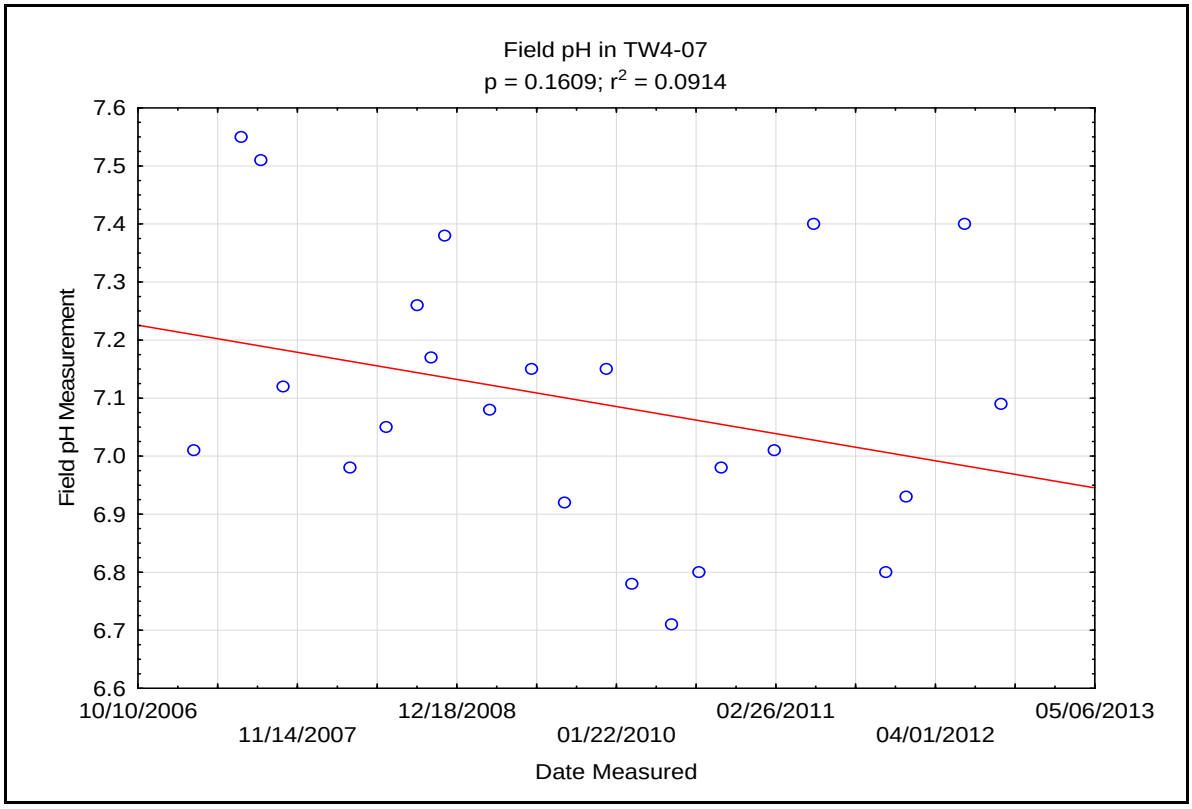
Appendix E-5
Linear Regression for Field pH in All Chloroform Wells



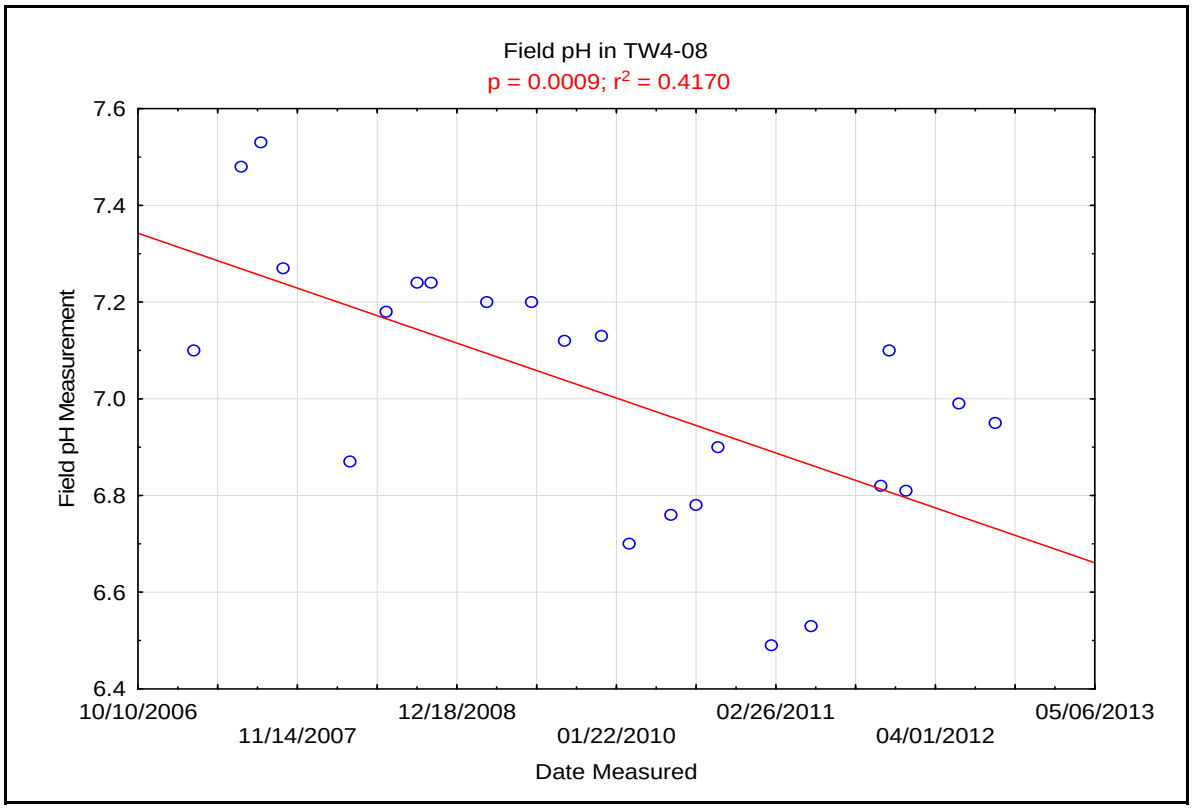


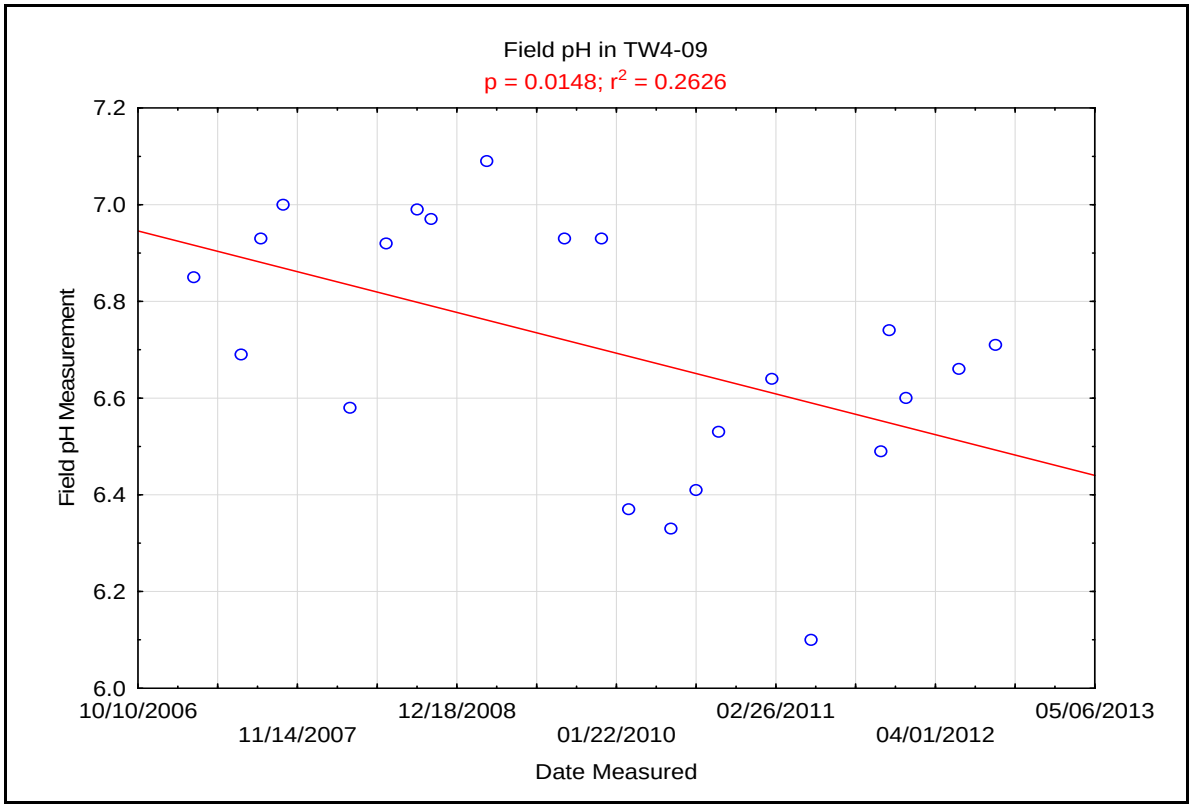
Appendix E-5
Linear Regression for Field pH in All Chloroform Wells



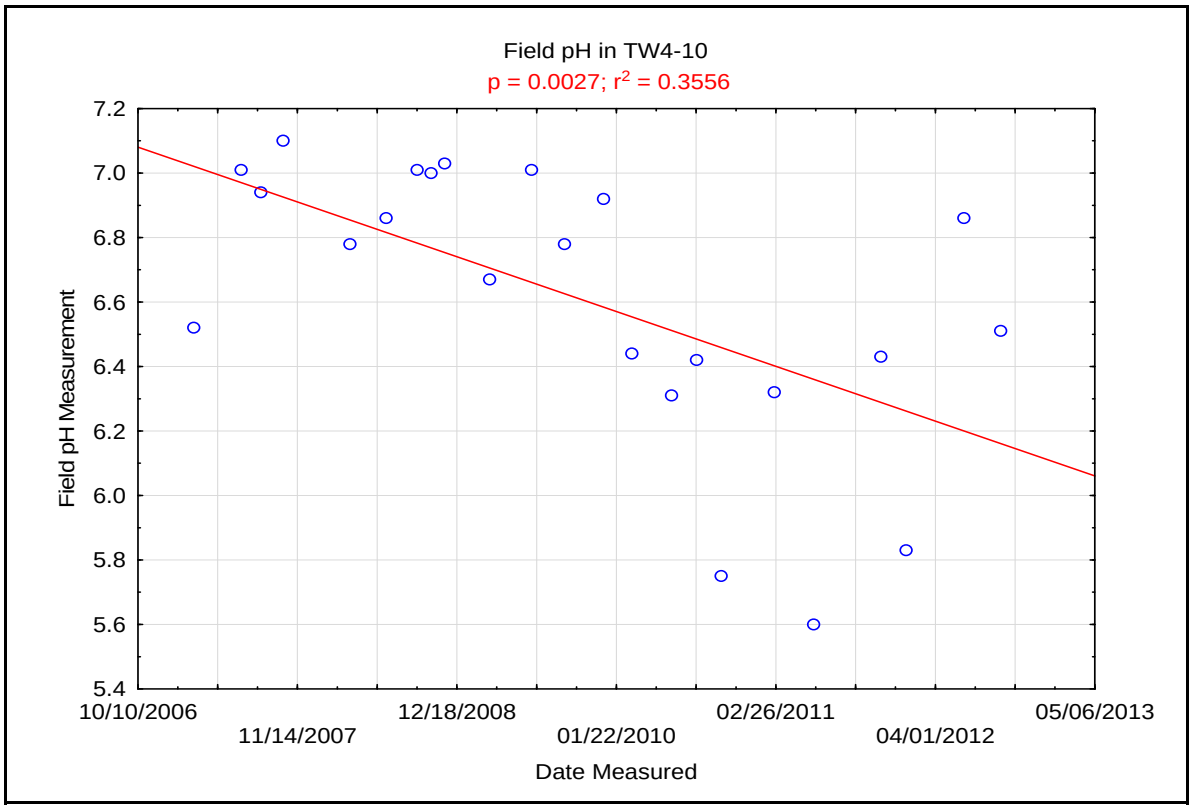


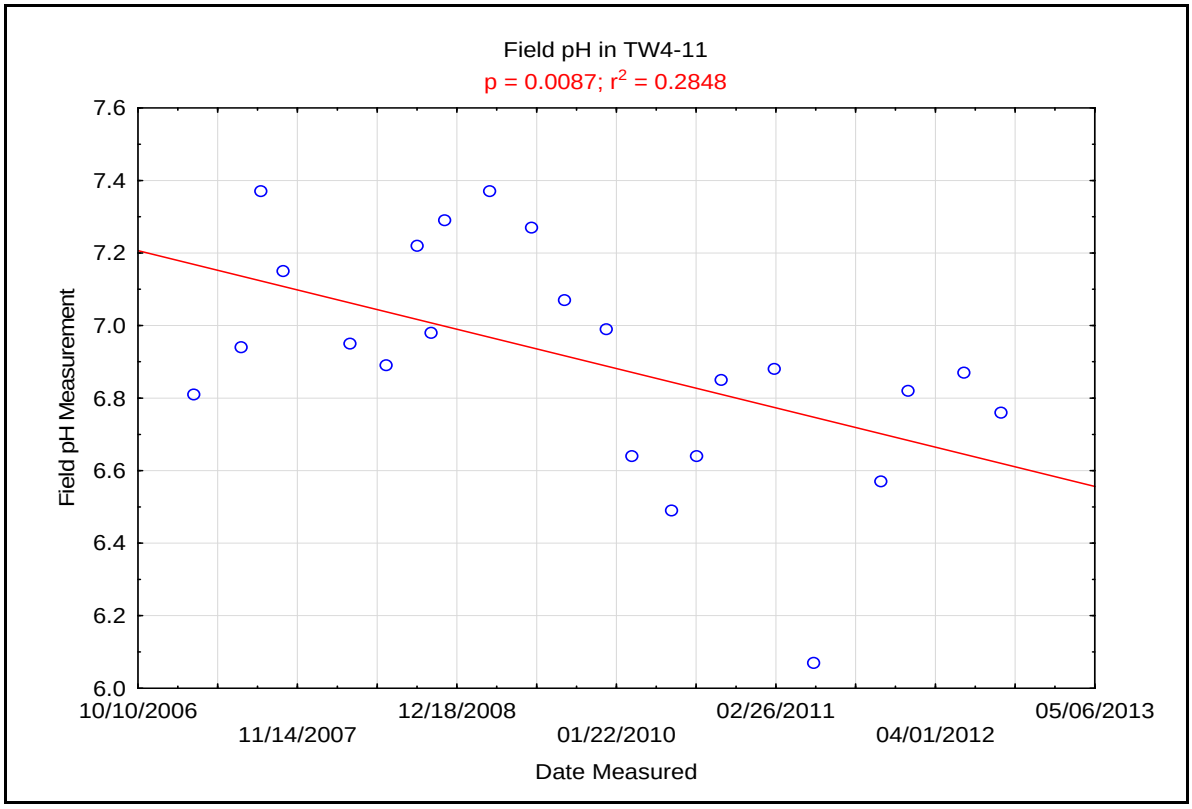
Appendix E-5
Linear Regression for Field pH in All Chloroform Wells



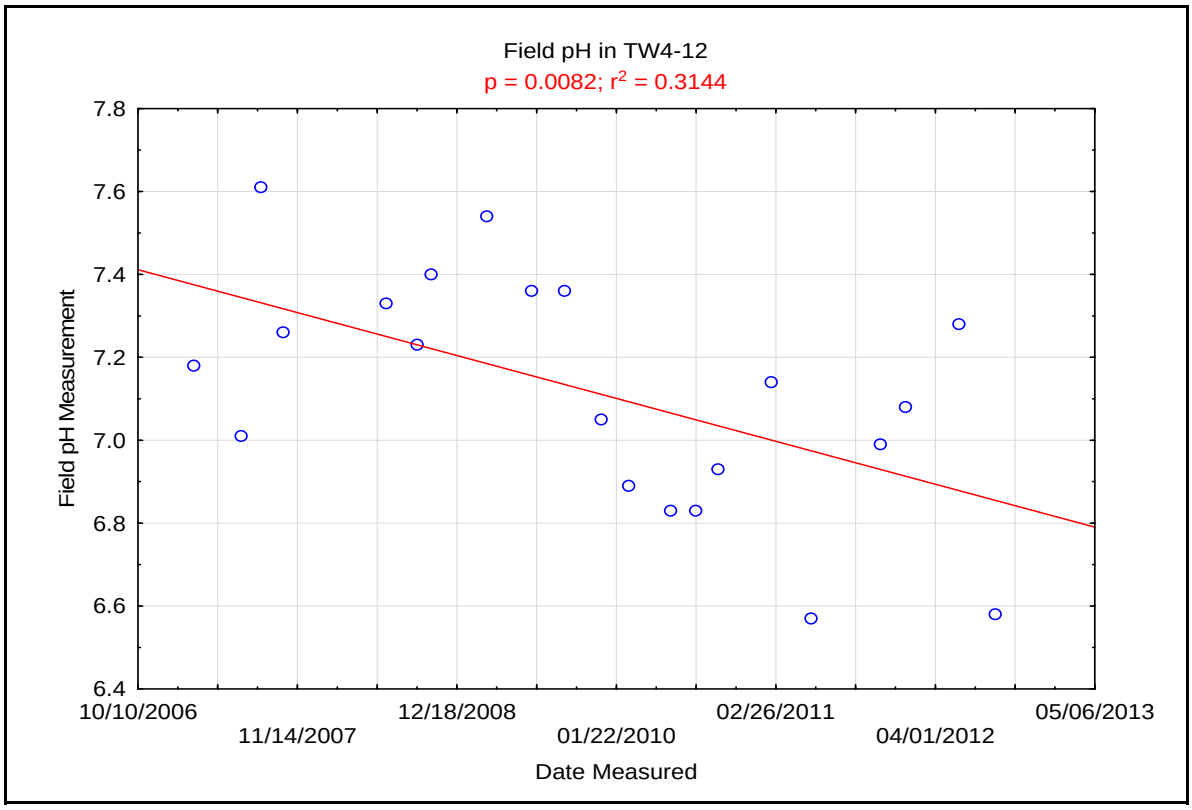


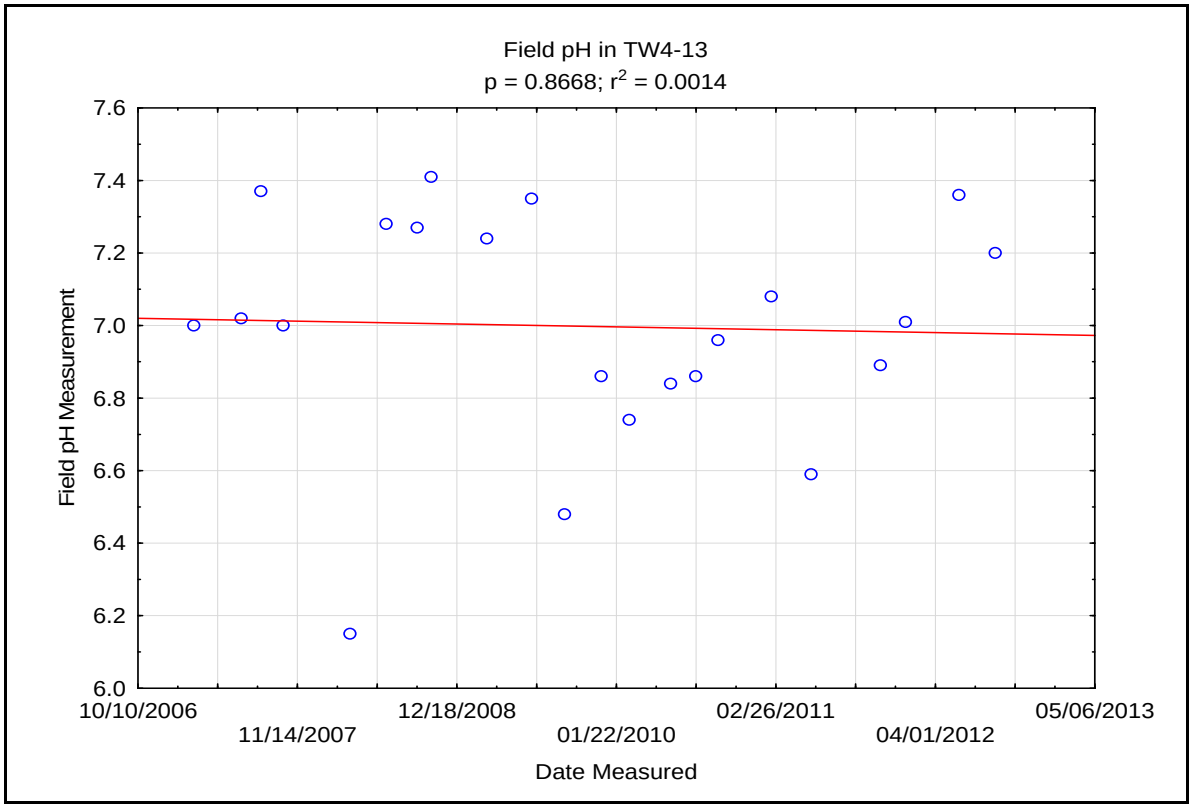
Appendix E-5
Linear Regression for Field pH in All Chloroform Wells





Appendix E-5
Linear Regression for Field pH in All Chloroform Wells





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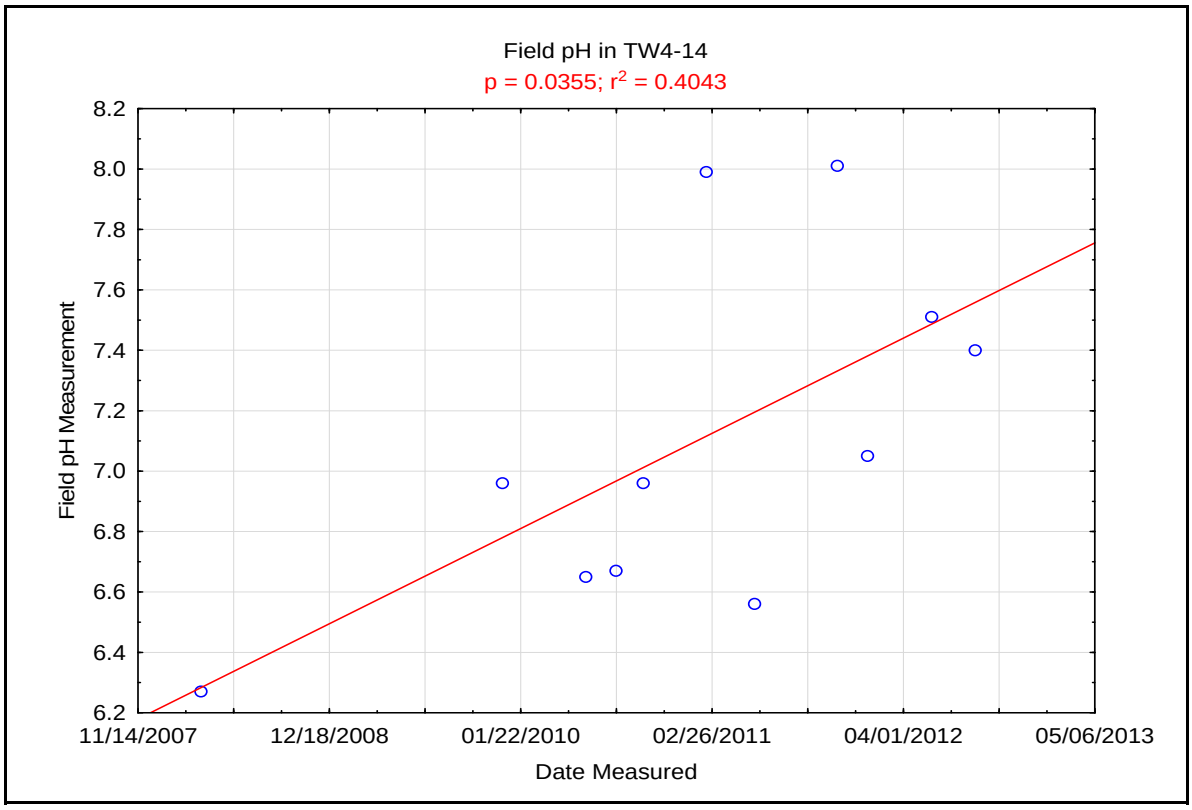
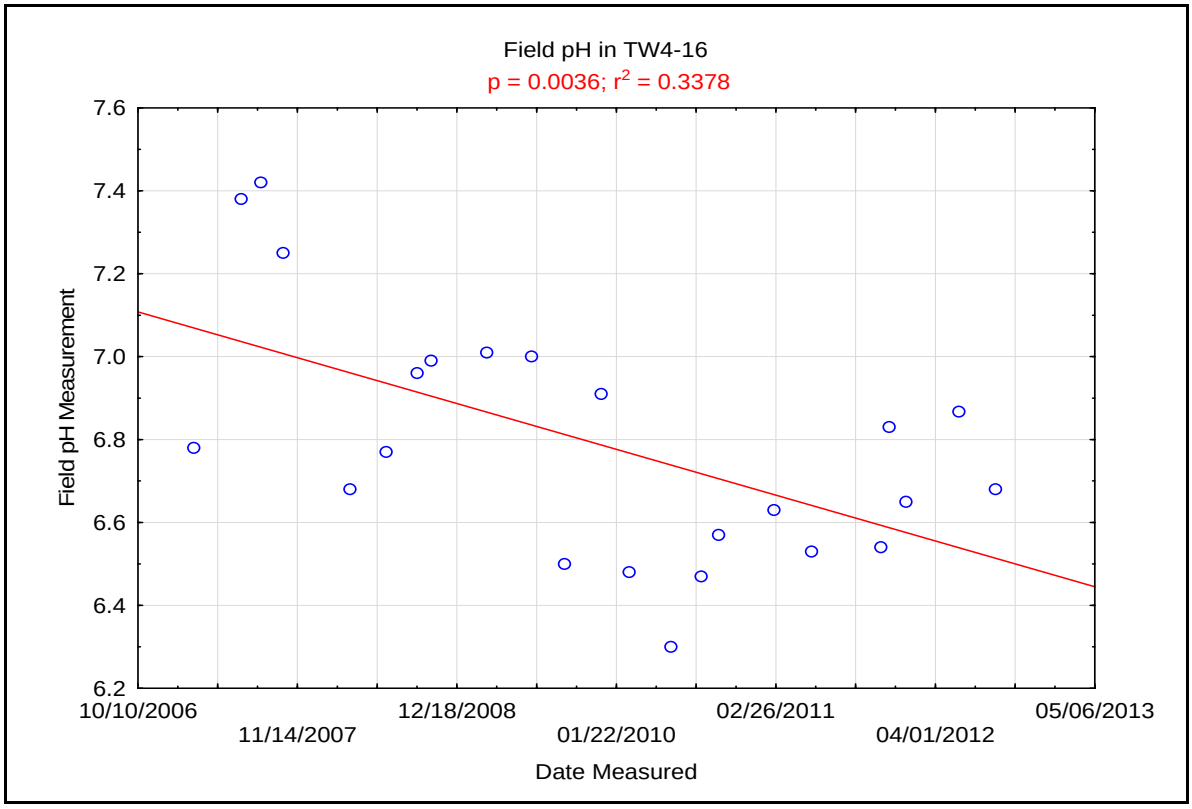
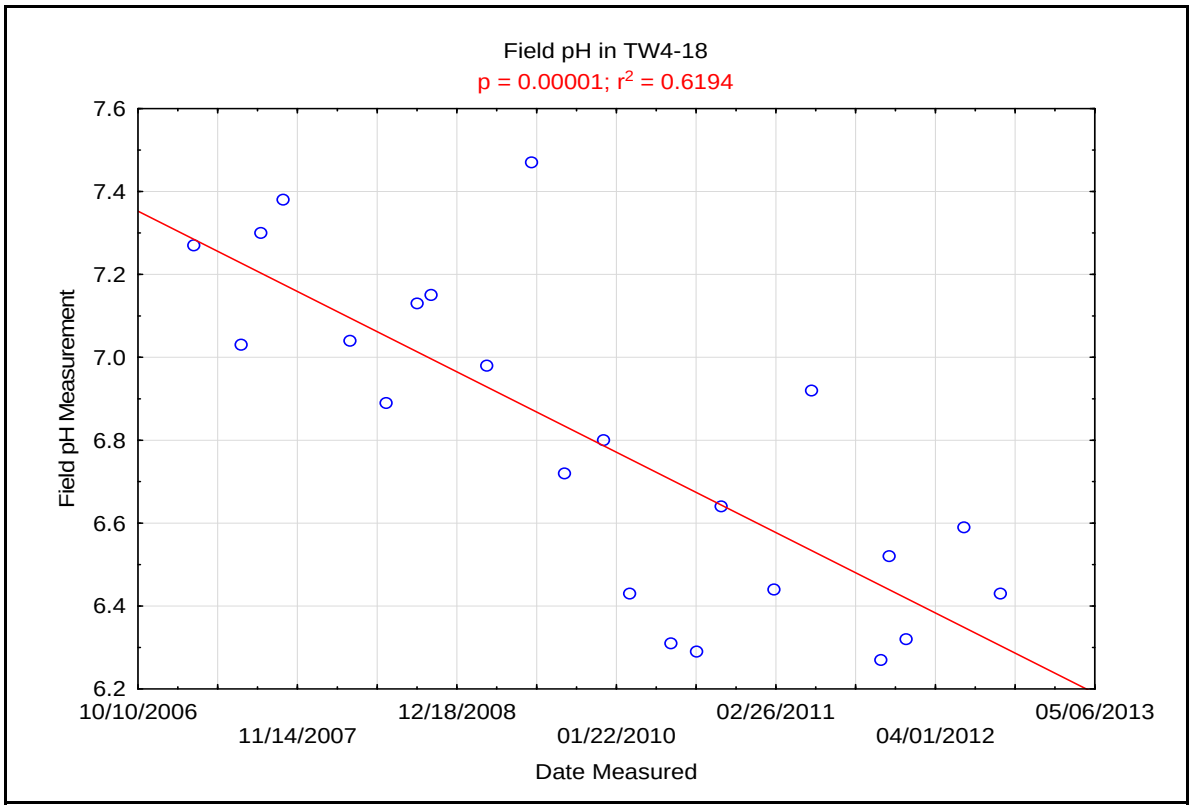
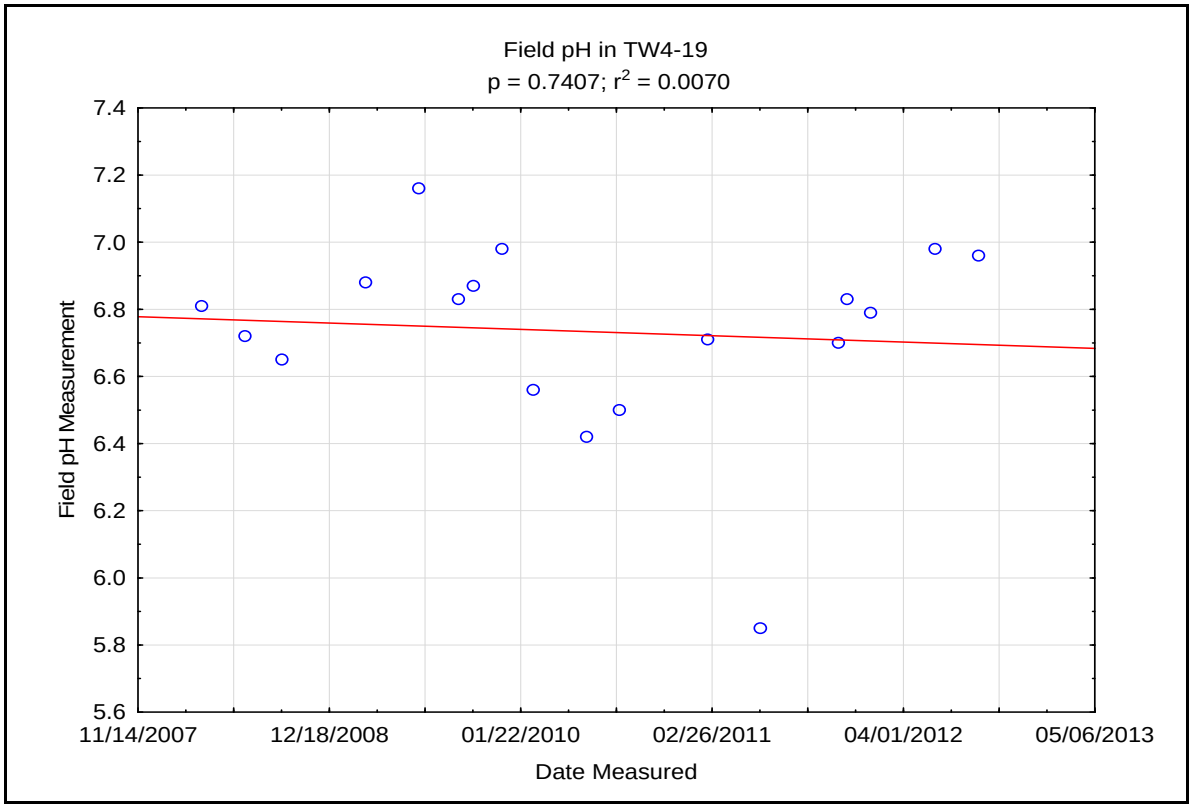
Linear Regression for Field pH in All Chloroform Wells





Appendix E-5
Linear Regression for Field pH in All Chloroform Wells





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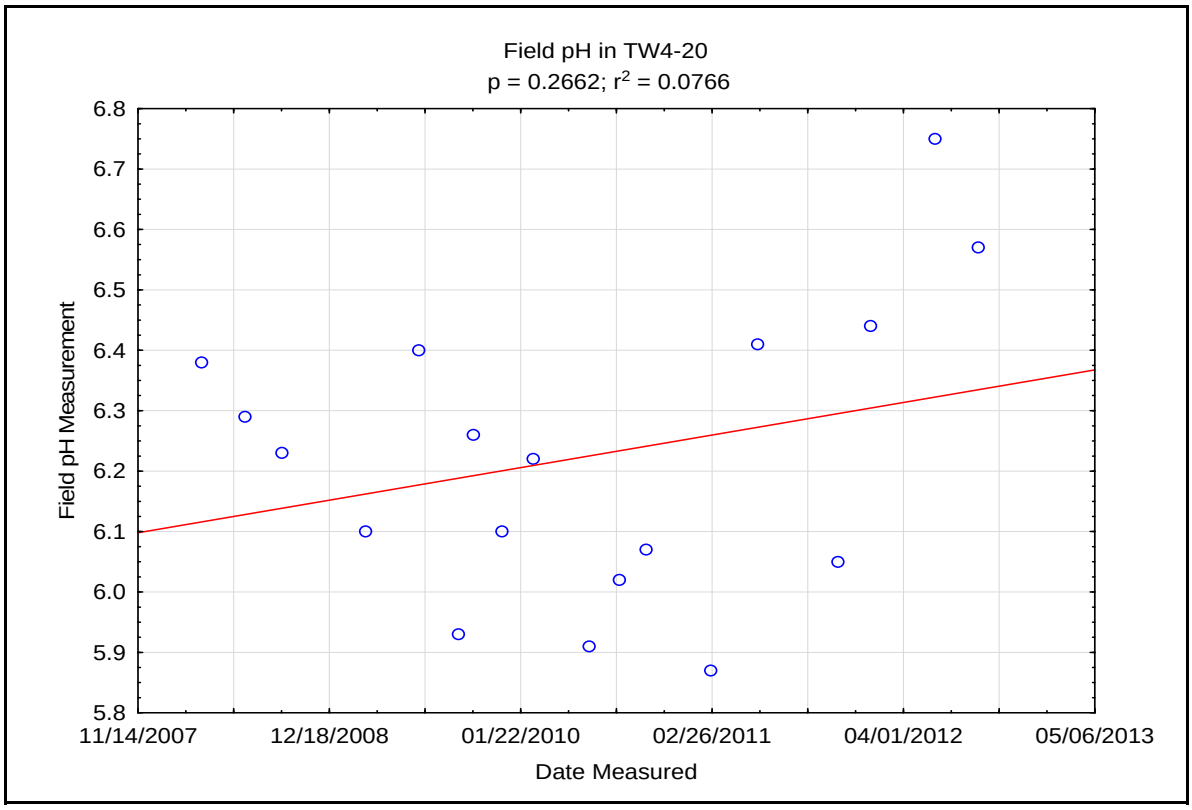
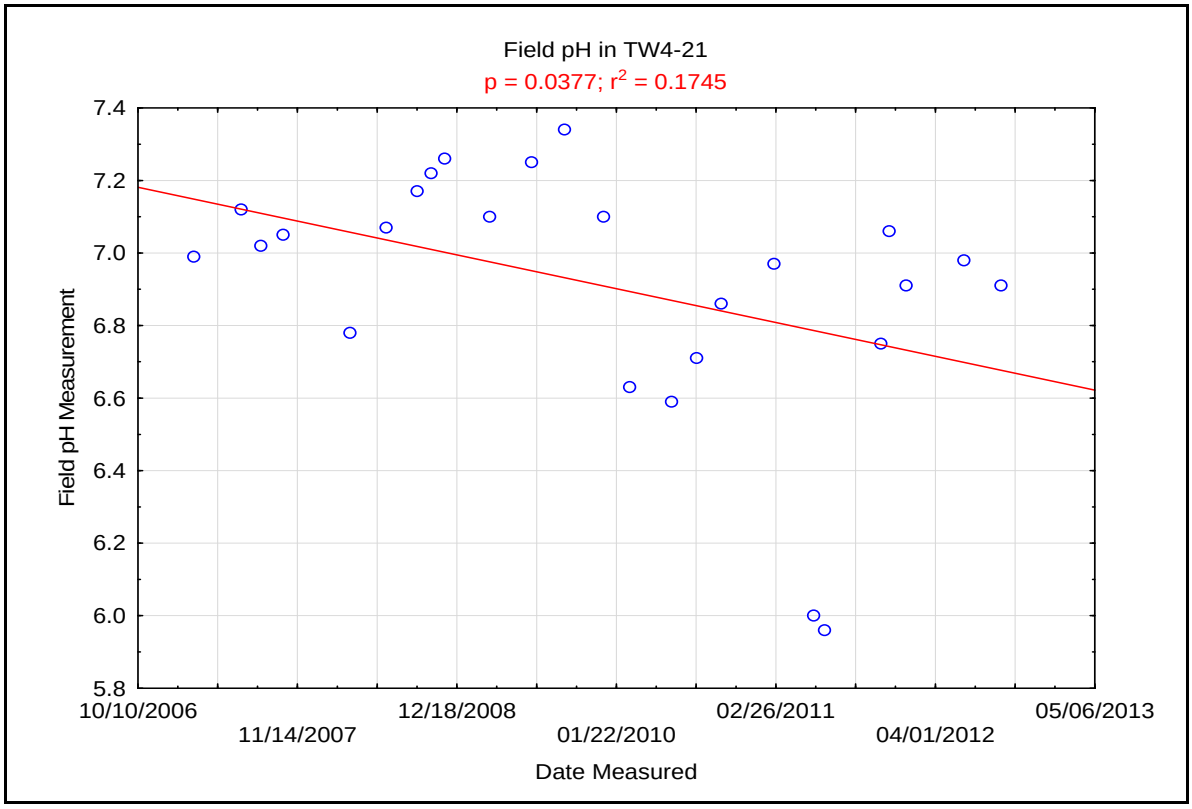
Linear Regression for Field pH in All Chloroform Wells





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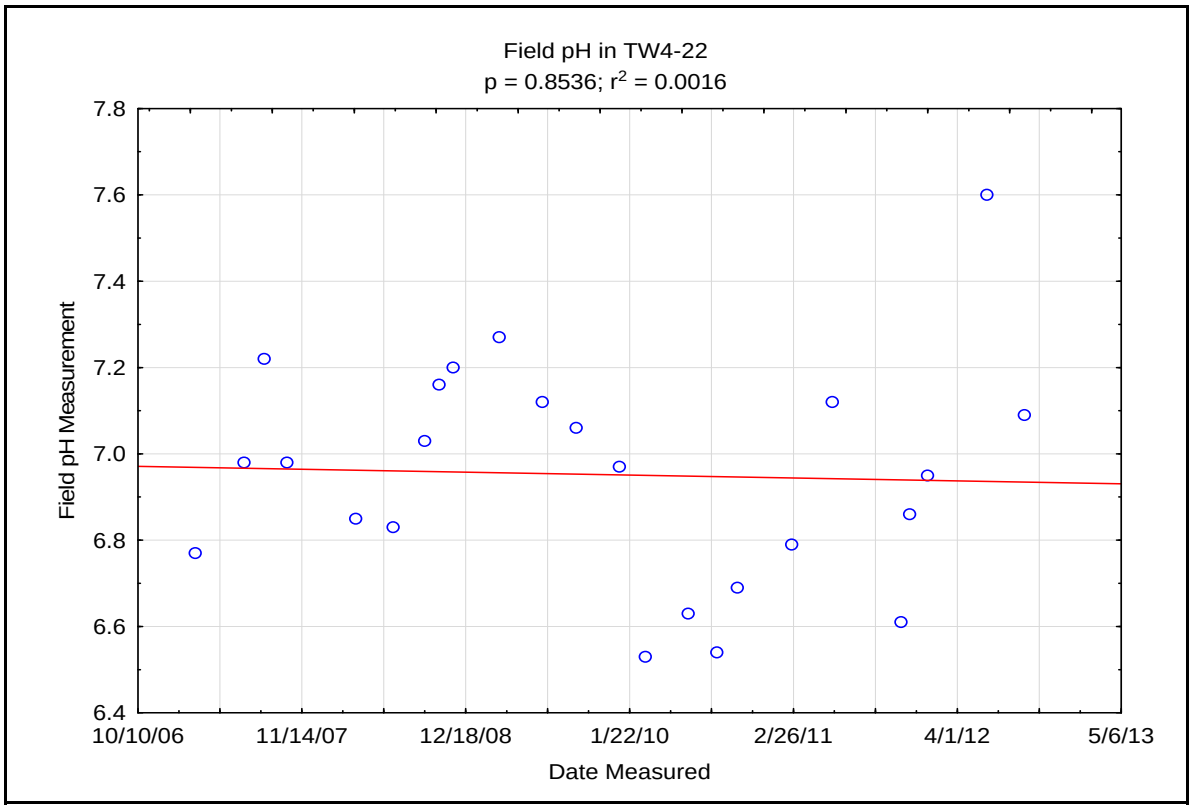
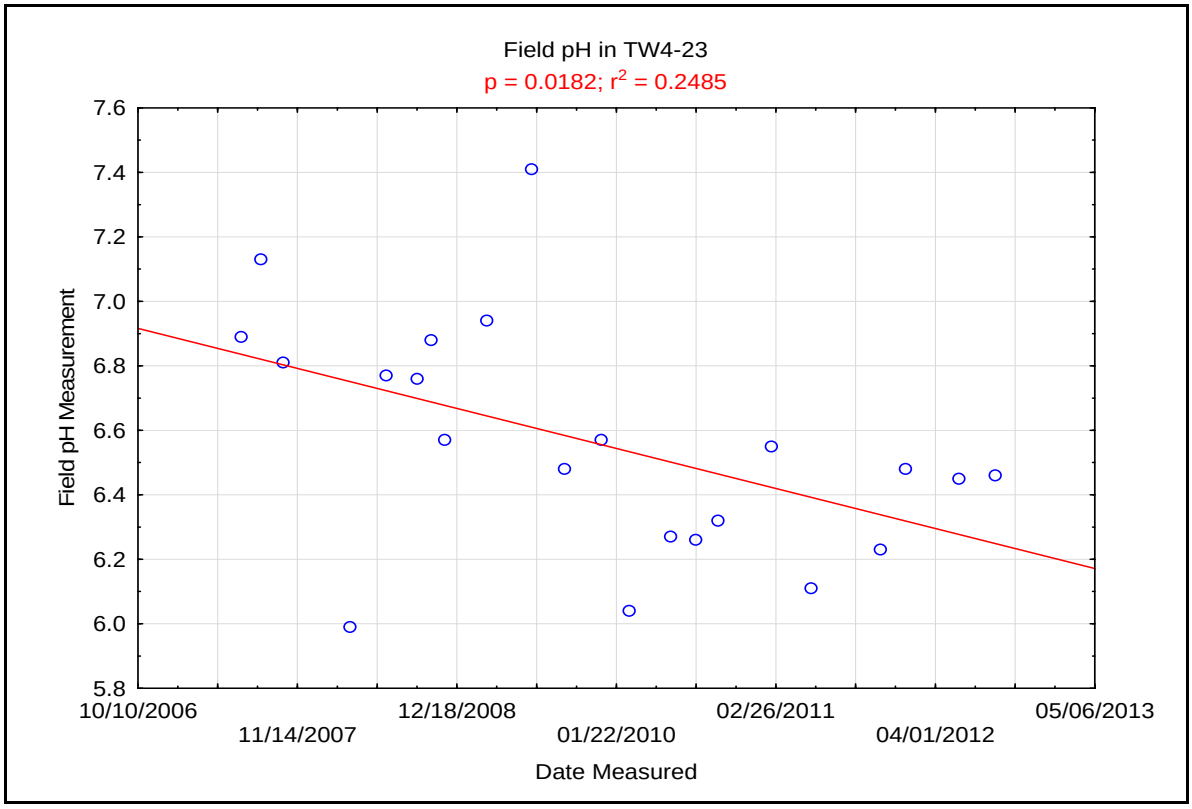
Linear Regression for Field pH in All Chloroform Wells





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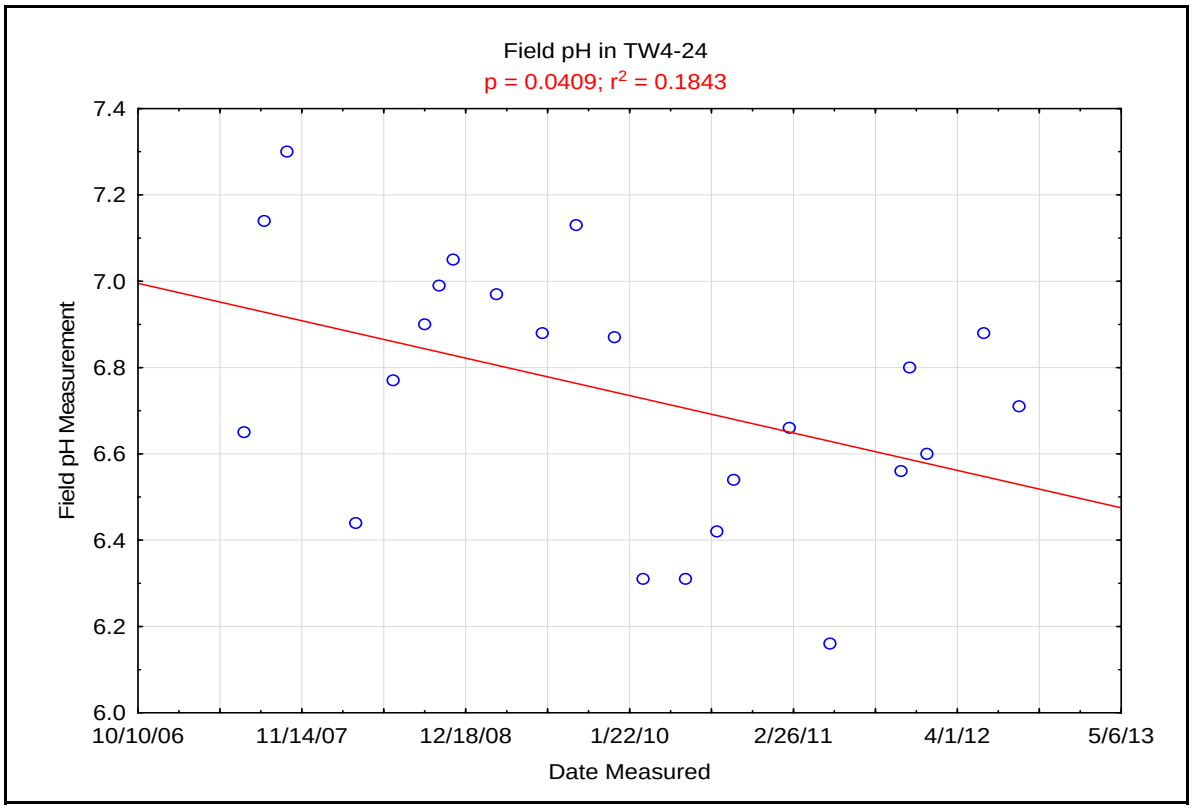
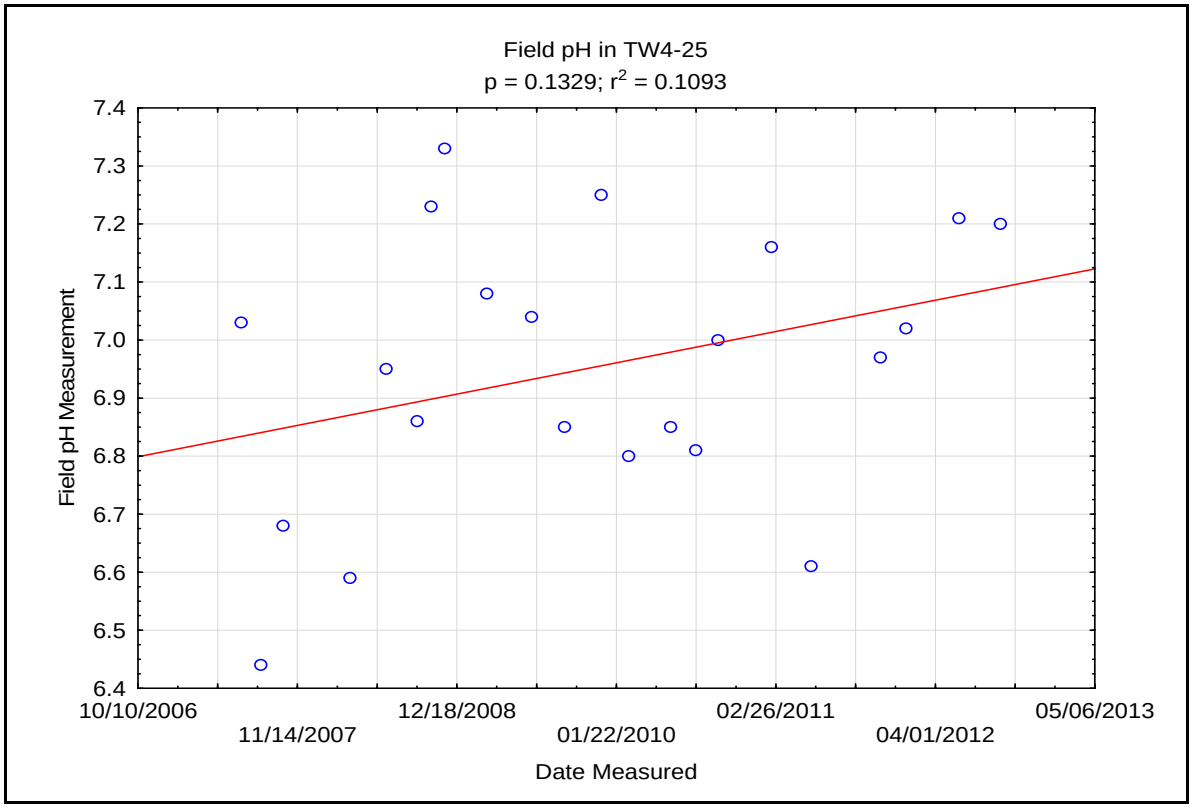
Linear Regression for Field pH in All Chloroform Wells





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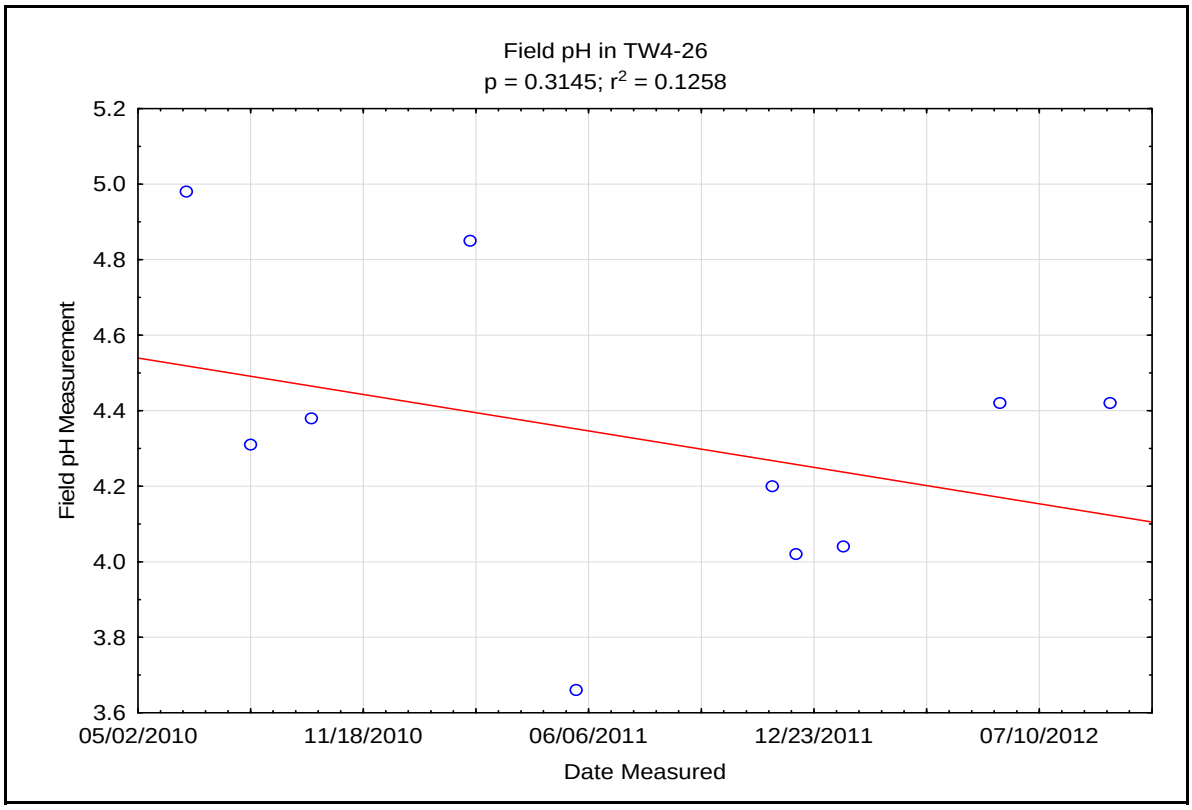
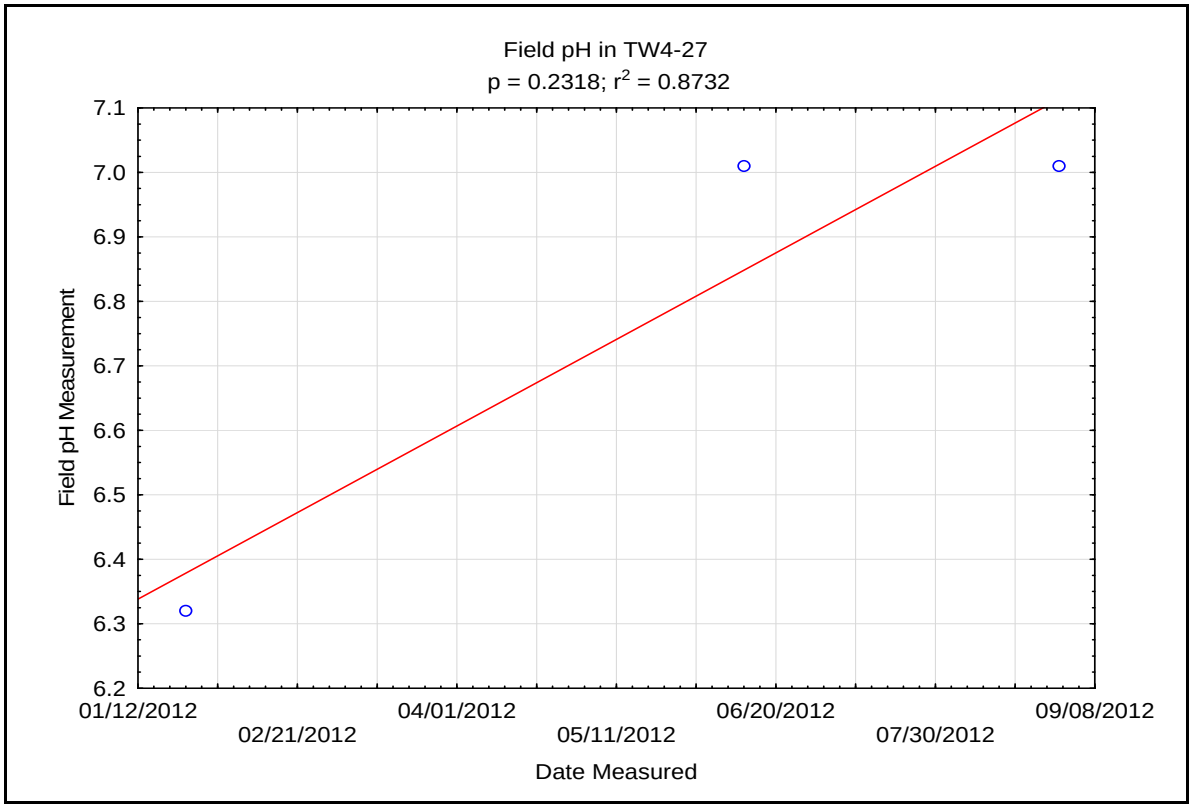
Linear Regression for Field pH in All Chloroform Wells





APPENDIX E-6

Descriptive Statistics for Field pH in Chloroform Wells

Appendix E-6 Field pH Descriptive Statistics for Chloroform Wells

Well	N	Mean	Minimum	Maximum	Std.Dev.	Range	Geometric Mean	Skewness	Q25	Median	Q75
MW-04	7	32.00	6.46	7.31	0.16	0.85	6.93	-0.632	6.86	6.95	7.03
TW4-01	21	6.59	6.09	7.14	0.33	1.05	6.59	-0.029	6.29	6.61	6.91
TW4-02	22	6.85	5.81	7.66	0.35	1.85	6.84	-0.733	6.70	6.87	7.06
TW4-03	21	6.94	6.43	7.73	0.33	1.30	6.93	0.612	6.66	6.87	7.18
TW4-04	23	6.74	5.46	7.52	0.39	2.06	6.73	-1.288	6.63	6.73	6.93
TW4-05	23	6.76	6.17	7.10	0.25	0.93	6.76	-0.526	6.56	6.76	6.97
TW4-06	23	6.78	6.24	7.37	0.28	1.13	6.77	0.098	6.63	6.79	6.93
TW4-07	23	7.10	6.71	7.55	0.23	0.84	7.09	0.347	6.93	7.08	7.26
TW4-08	23	7.02	6.49	7.53	0.27	1.04	7.01	-0.129	6.81	7.10	7.20
TW4-09	22	6.70	6.10	7.09	0.26	0.99	6.70	-0.519	6.53	6.70	6.93
TW4-10	23	6.61	5.60	7.10	0.43	1.50	6.60	-1.052	6.42	6.78	7.00
TW4-11	23	6.91	6.07	7.37	0.31	1.30	6.90	-0.676	6.76	6.89	7.15
TW4-12	21	7.12	6.57	7.61	0.28	1.04	7.11	-0.294	6.93	7.14	7.33
TW4-13	22	7.00	6.15	7.41	0.32	1.26	6.99	-0.927	6.86	7.01	7.27
TW4-14	11	7.09	6.27	8.01	0.57	1.74	7.07	0.462	6.65	6.96	7.51
TW4-16	23	6.79	6.30	7.42	0.29	1.12	6.79	0.628	6.54	6.77	6.99
TW4-18	23	6.80	6.27	7.47	0.38	1.20	6.79	0.158	6.43	6.80	7.13
TW4-19	18	6.73	5.85	7.16	0.29	1.31	6.73	-1.721	6.65	6.80	6.88
TW4-20	18	6.22	5.87	6.75	0.24	0.88	6.22	0.464	6.05	6.23	6.40
TW4-21	25	6.91	5.96	7.34	0.34	1.38	6.90	-1.656	6.78	6.99	7.10
TW4-22	24	6.95	6.53	7.60	0.26	1.07	6.95	0.309	6.78	6.98	7.12
TW4-23	22	6.56	5.99	7.41	0.36	1.42	6.55	0.466	6.27	6.52	6.81
TW4-24	23	6.74	6.16	7.30	0.30	1.14	6.73	-0.131	6.54	6.77	6.97
TW4-25	22	6.95	6.44	7.33	0.24	0.89	6.95	-0.422	6.81	6.99	7.16
TW4-26	10	4.33	3.66	4.98	0.39	1.32	4.31	0.161	4.04	4.35	4.42
TW4-27	3	6.78	6.32	7.01	0.40	0.69	6.77	-1.732	6.32	7.01	7.01

APPENDIX E-7

Data Omitted Prior to Statistical Analysis

Appendix E-7 Data Omitted Prior to Statistical Analysis

Reason	Location ID	Date Measured	Field Measurement
Extreme Outlier	TW4-12	3/25/2008	5.51

APPENDIX F

Statistical Analysis of Field pH in Nitrate Wells

APPENDIX F-1

Field pH Analysis for Nitrate Wells Summary Table

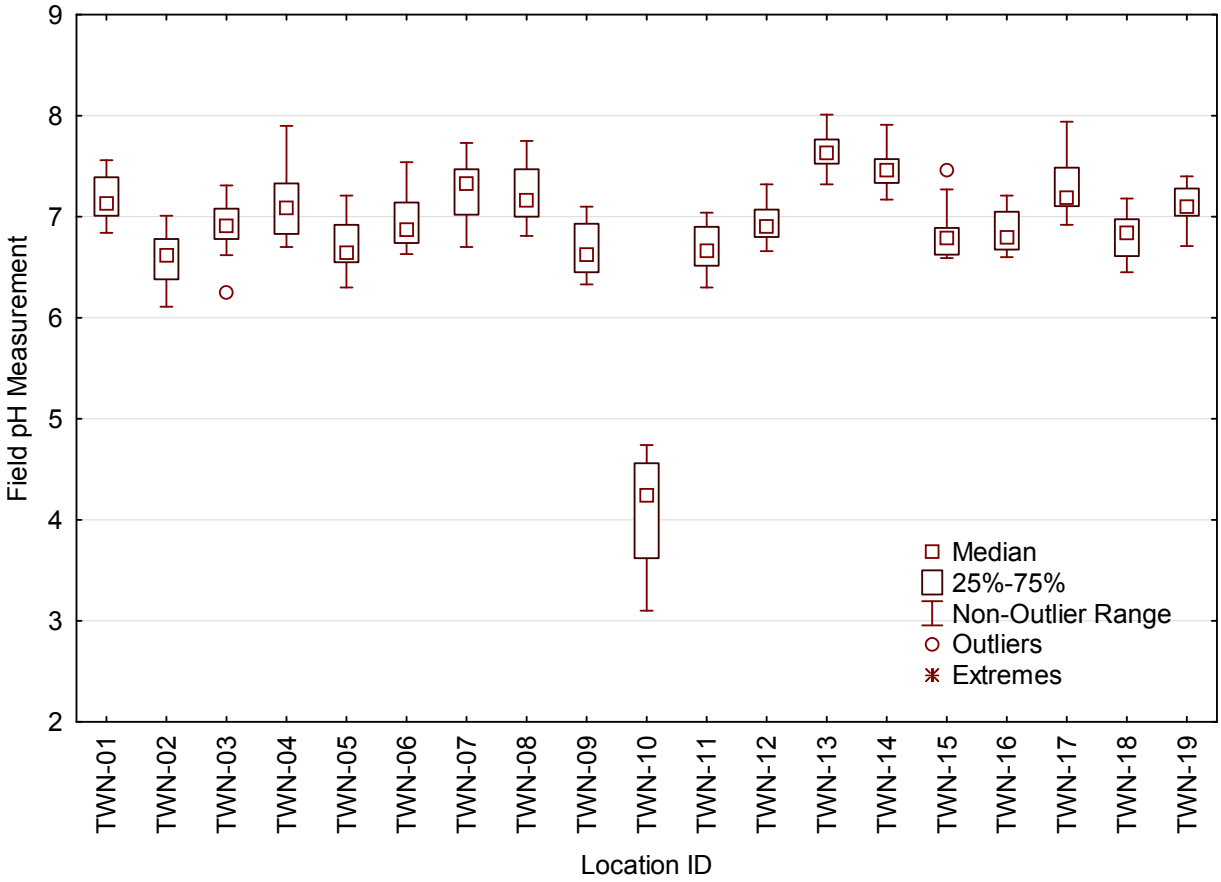
Appendix F-1 Field pH Analysis Summary Table for Nitrate Wells

Well	N	Shapiro- Wilk Test for Normality			Linear Regression		Mann-Kendall Trend Test		Significant Trend?	General Trend?
		W	p	Normally or Lognormally Distributed?	R	p	S	p		
TWN-01	14	0.9190	0.2126	Yes	0.3372	0.0295			Up	Up
TWN-02	15	0.9789	0.9615	Yes	0.0440	0.4531				Down
TWN-03	15	0.9552	0.6104	Yes	0.0002	0.9597				Flat
TWN-04	15	0.9220	0.2068	Yes	0.0566	0.3932				Up
TWN-05	14	0.9603	0.7287	Yes	0.0056	0.7998				Flat
TWN-06	14	0.9178	0.2047	Yes	0.0104	0.7281				Down
TWN-07	14	0.9477	0.5257	Yes	0.0000	0.9878				Flat
TWN-08	14	0.9564	0.6644	Yes	0.0053	0.8044				Down
TWN-09	14	0.9402	0.4204	Yes	0.1286	0.2080				Up
TWN-10	14	0.9053	0.1347	Yes	0.0055	0.8011				Down
TWN-11	12	0.9681	0.8904	Yes	0.0207	0.6557				Up
TWN-12	12	0.9463	0.5833	Yes	0.2657	0.0863				Up
TWN-13	12	0.9585	0.7615	Yes	0.1126	0.2864				Up
TWN-14	12	0.9354	0.4412	Yes	0.1909	0.1555				Up
TWN-15	12	0.8224	0.0170	No			32	0.0163	UP	Up
TWN-16	12	0.9122	0.2274	Yes	0.0092	0.7666				Up
TWN-17	12	0.9173	0.2641	Yes	0.0081	0.7803				Up
TWN-18	12	0.9743	0.9499	Yes	0.1061	0.3016				Up
TWN-19	12	0.9537	0.6922	Yes	0.0385	0.5409				Up

APPENDIX F-2

Box Plot for Field pH in Nitrate Wells

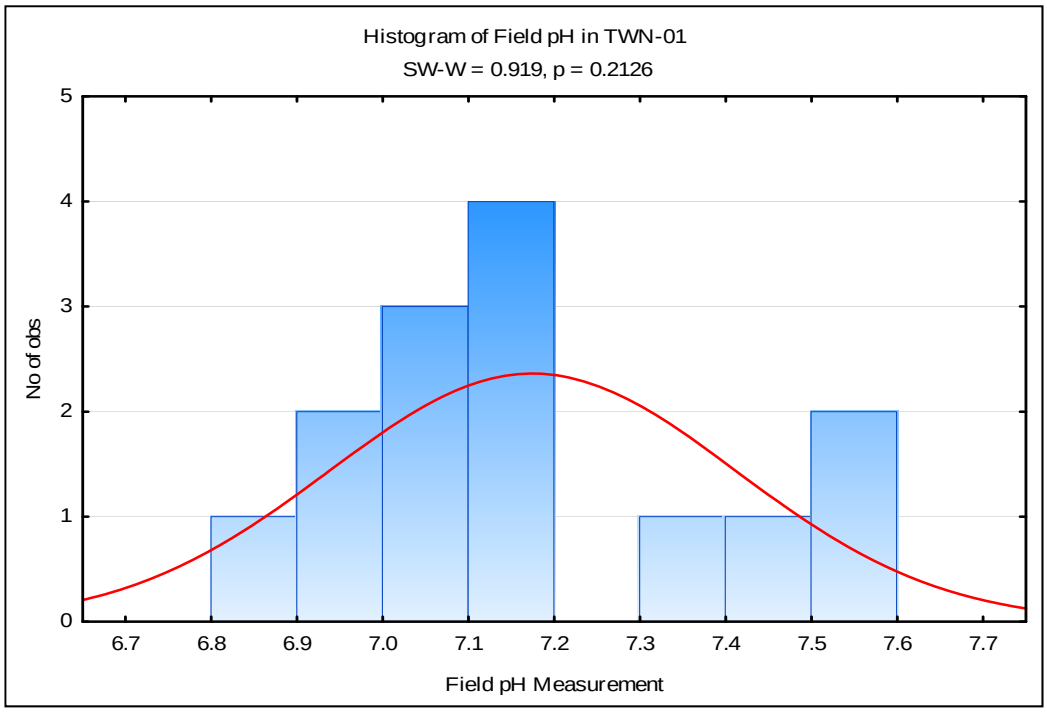
Appendix F-2
Box Plot for Field pH in Nitrate Wells

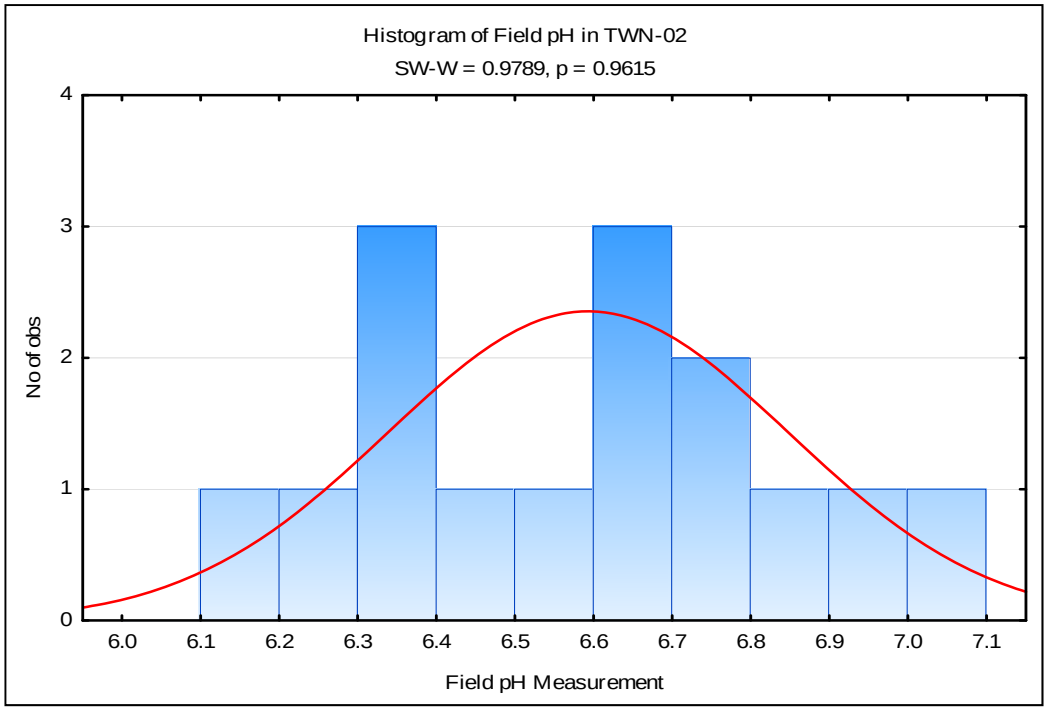


APPENDIX F-3

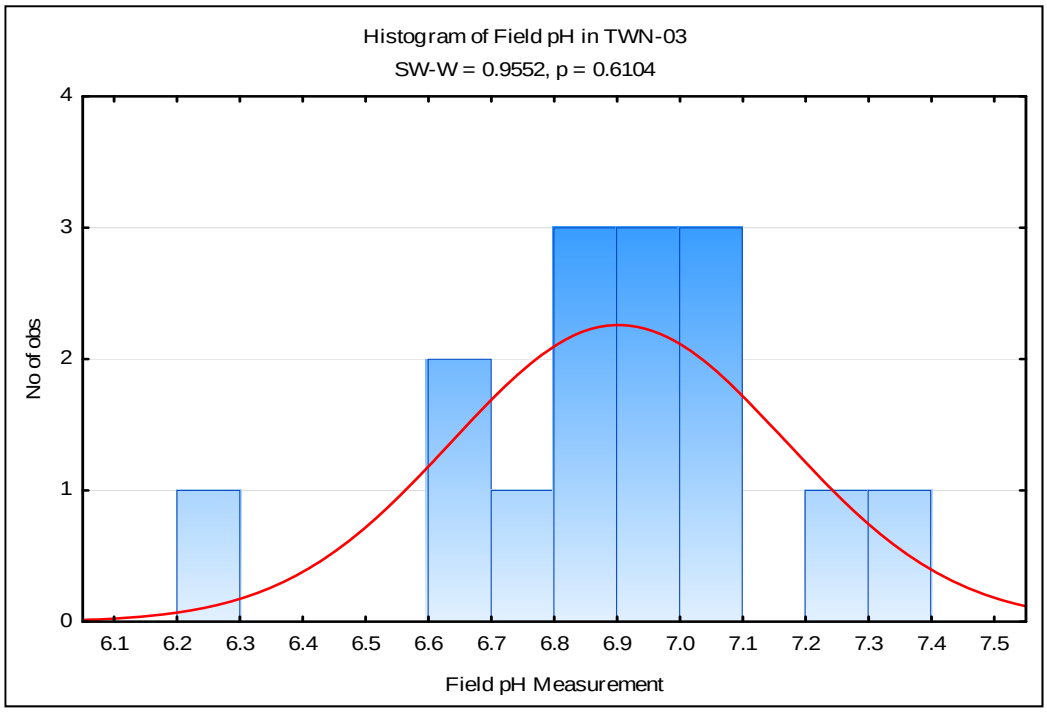
Histograms for Field pH in Nitrate Wells

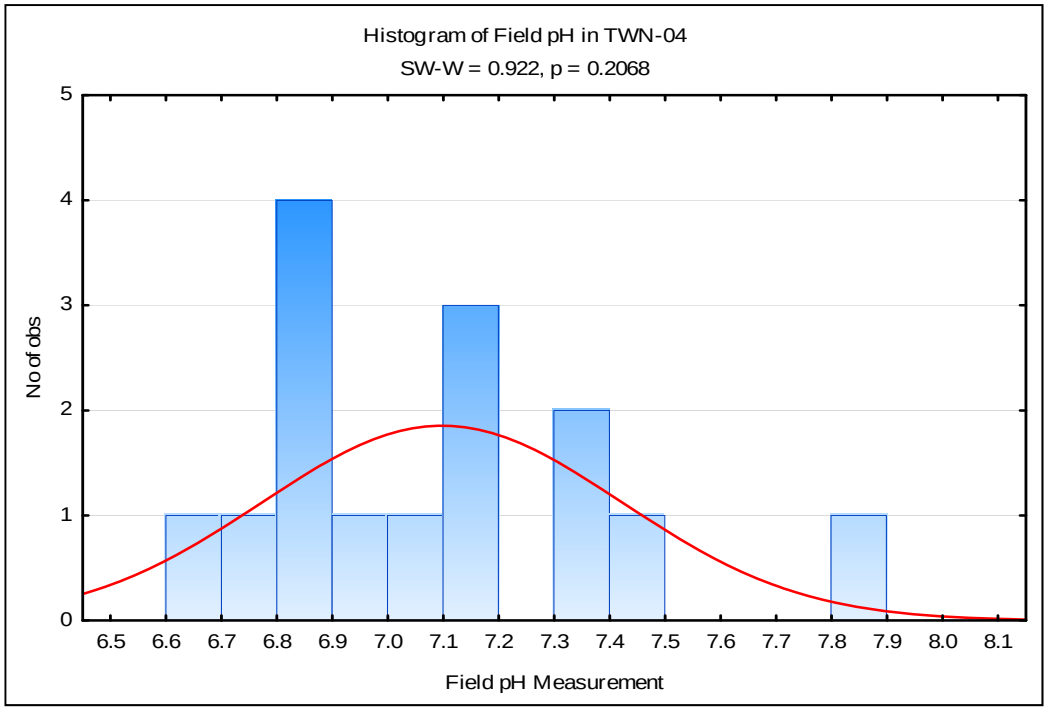
Appendix F-3
Histograms for Field pH in Nitrate Wells



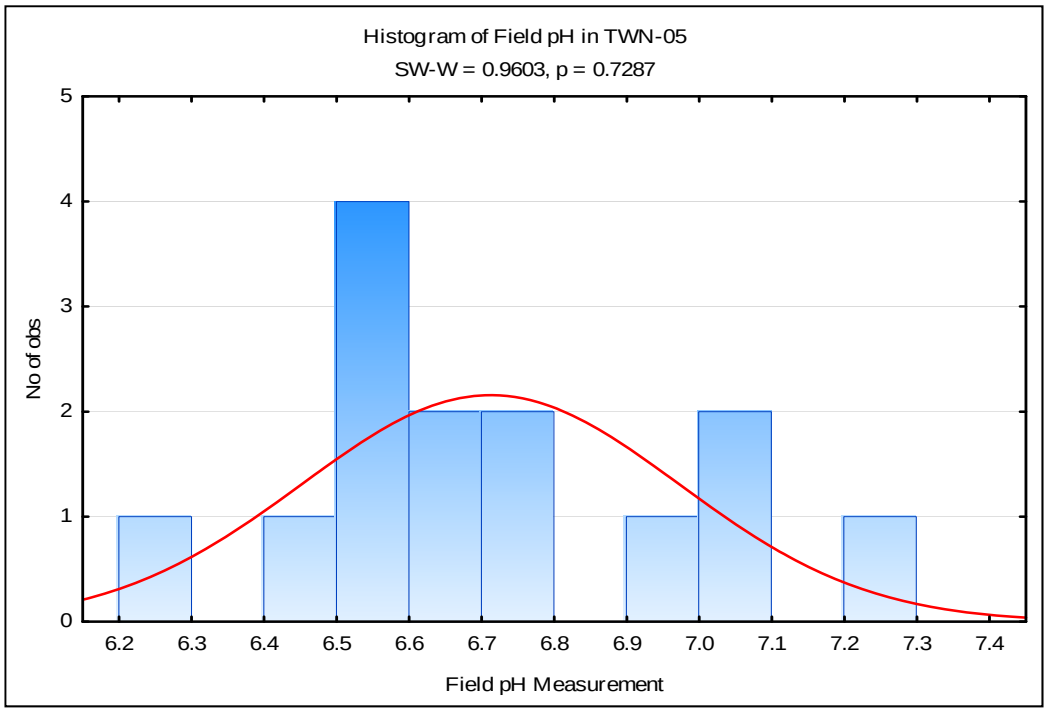


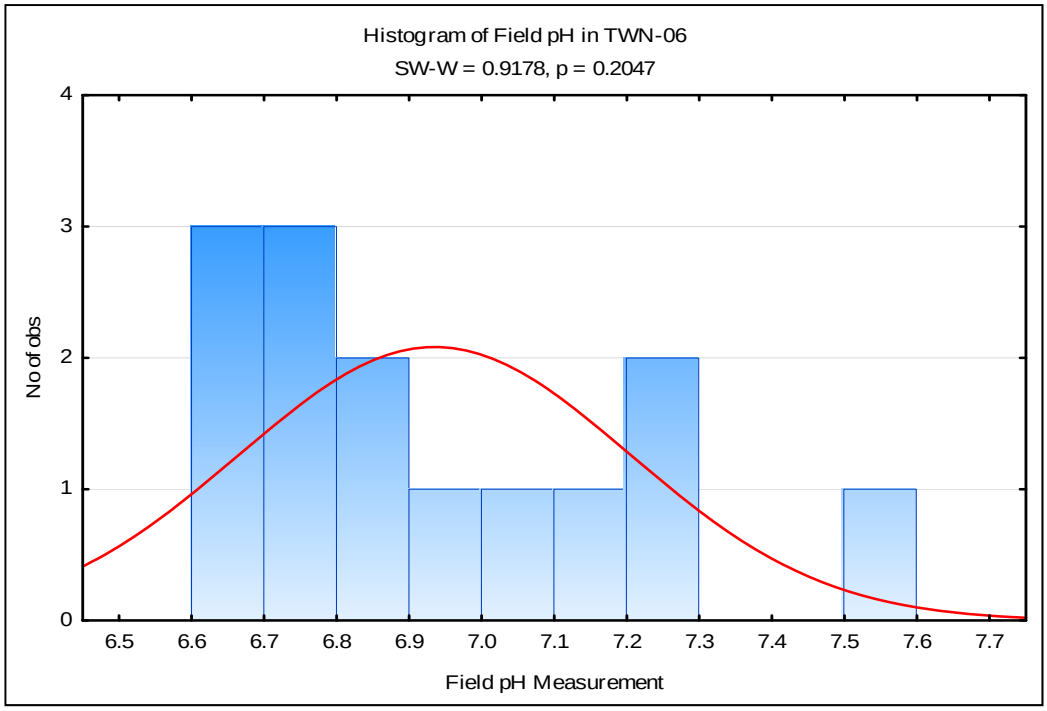
Appendix F-3
Histograms for Field pH in Nitrate Wells





Appendix F-3
Histograms for Field pH in Nitrate Wells





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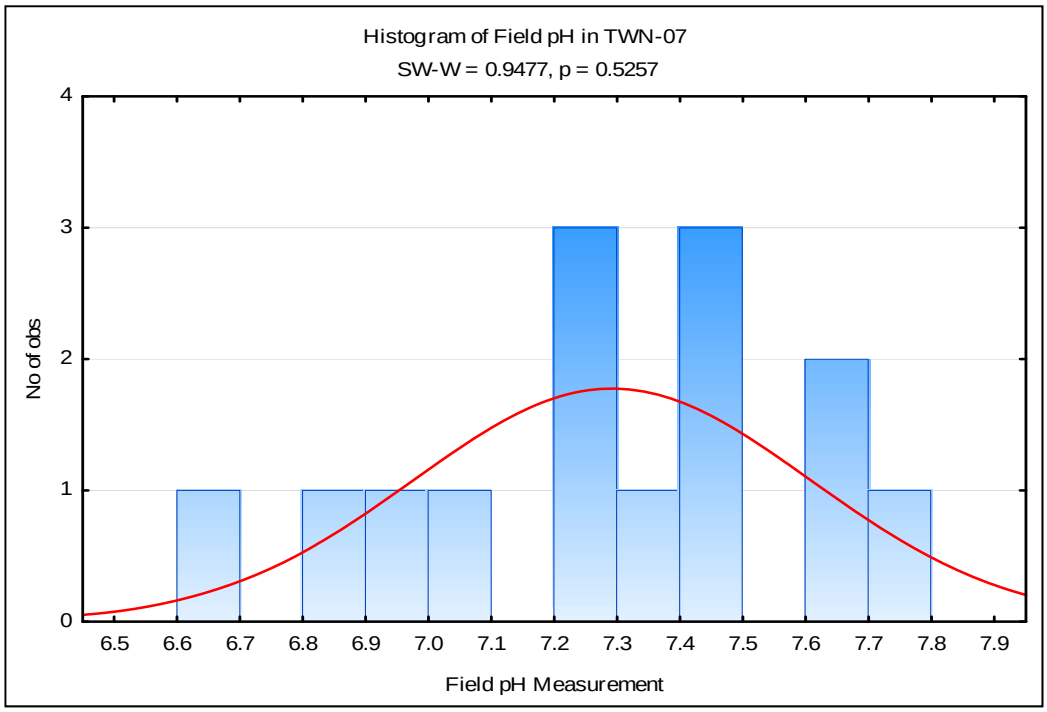

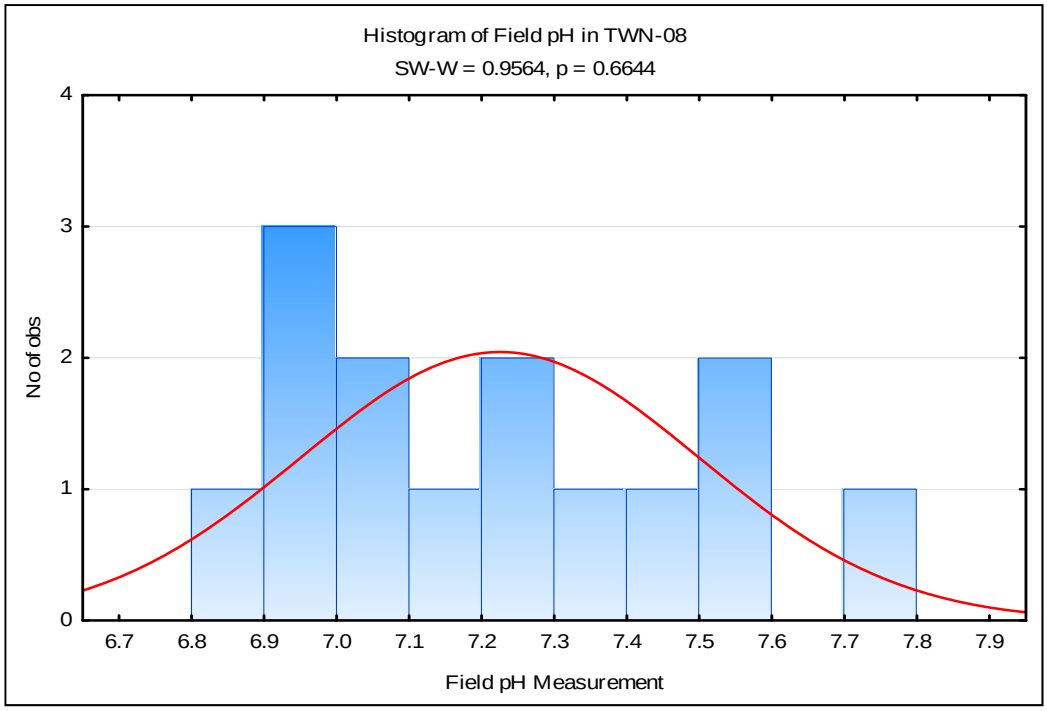

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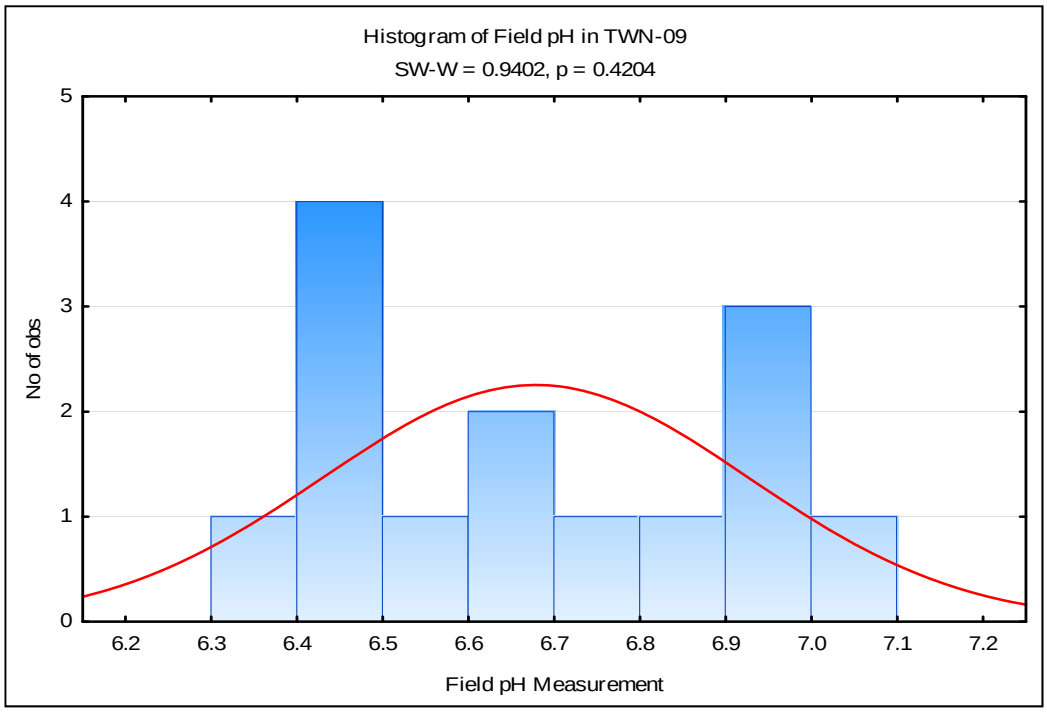

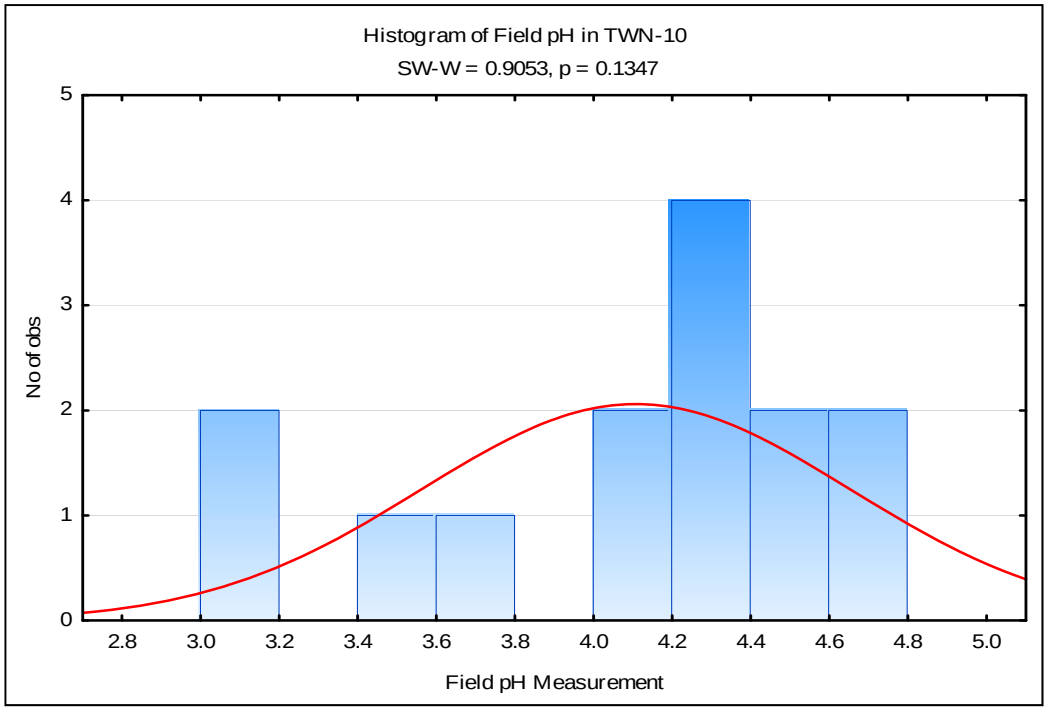

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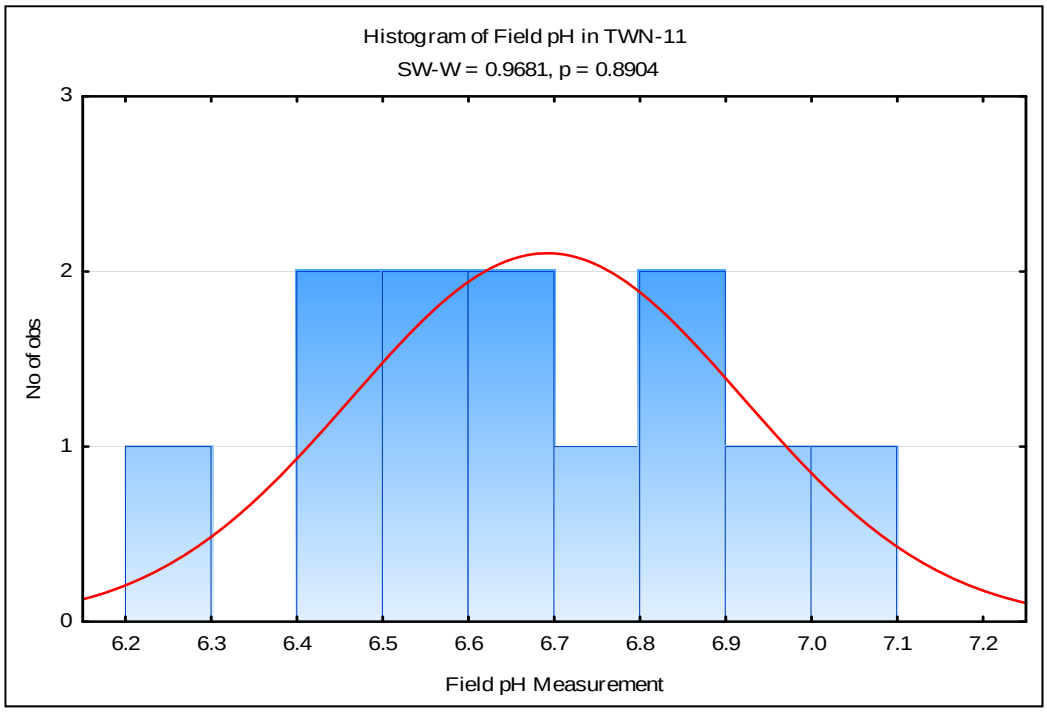

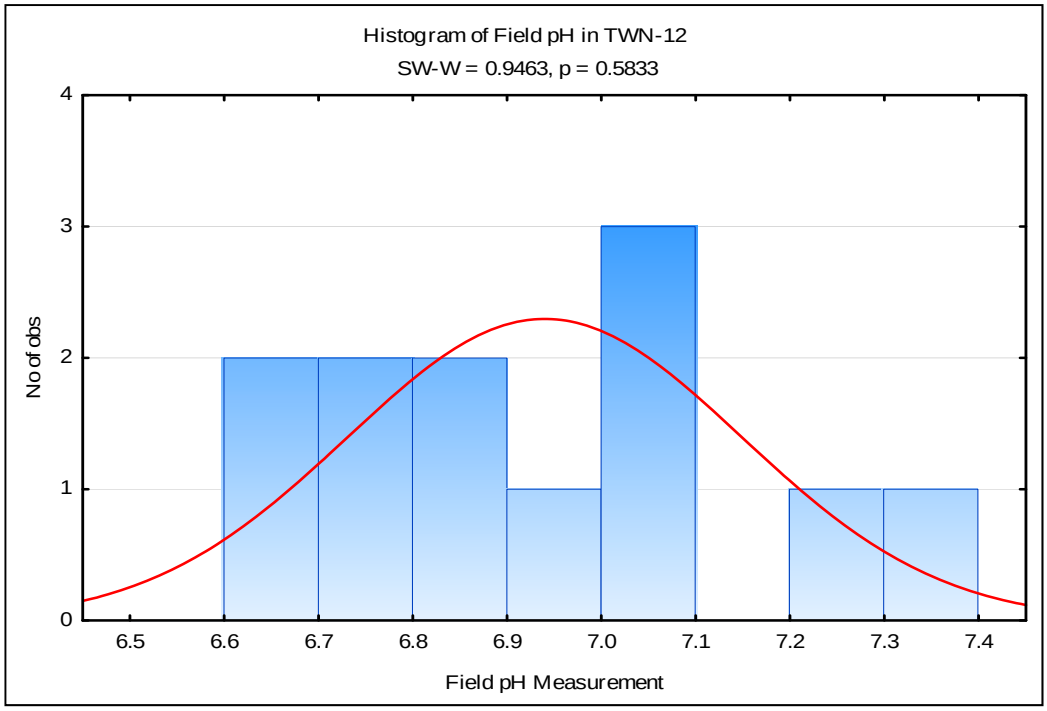

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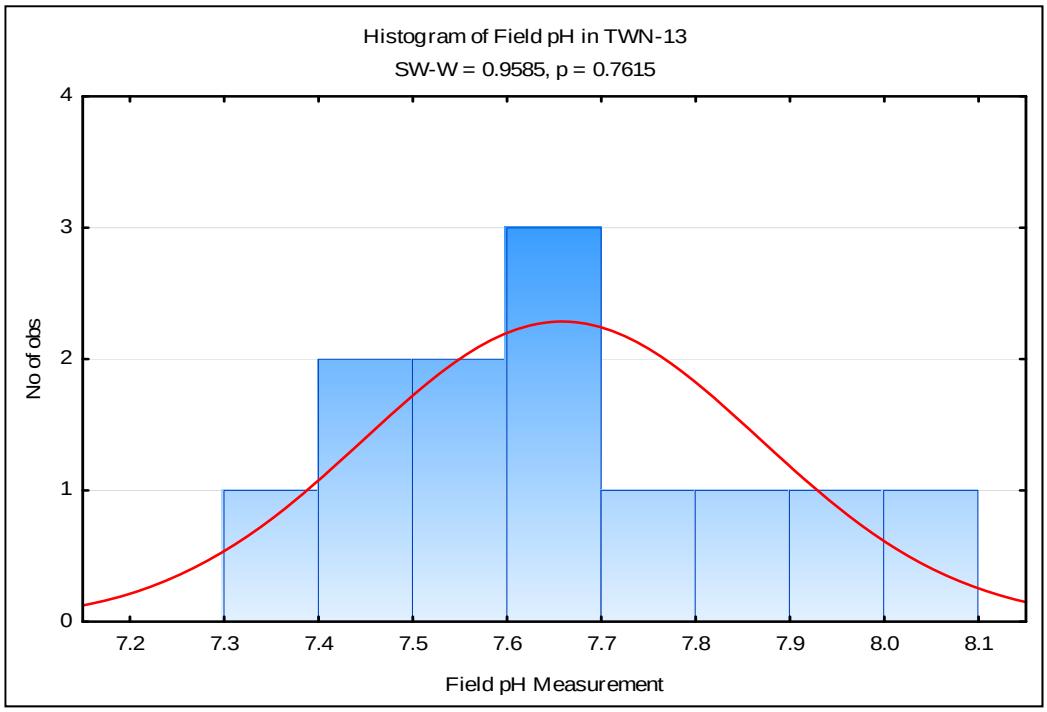

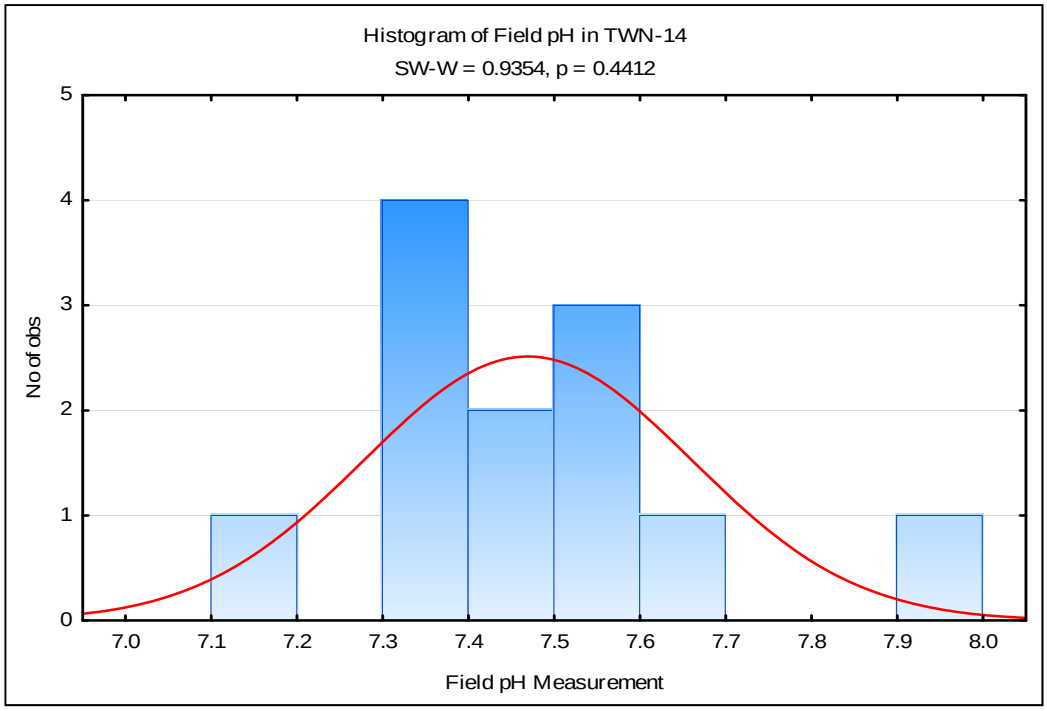

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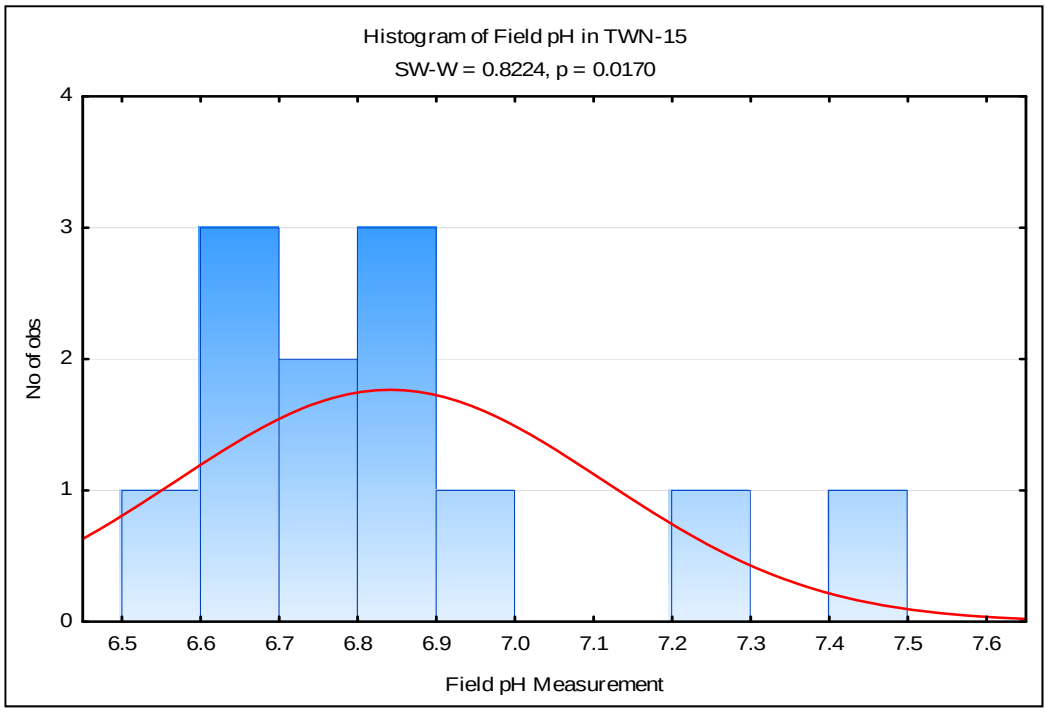

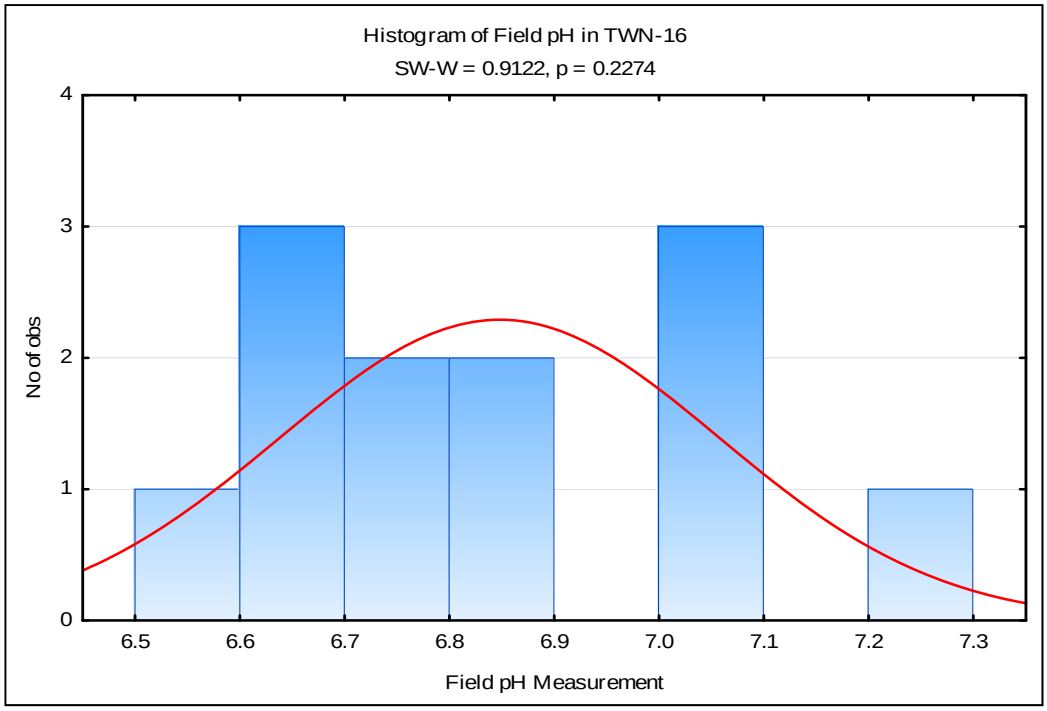

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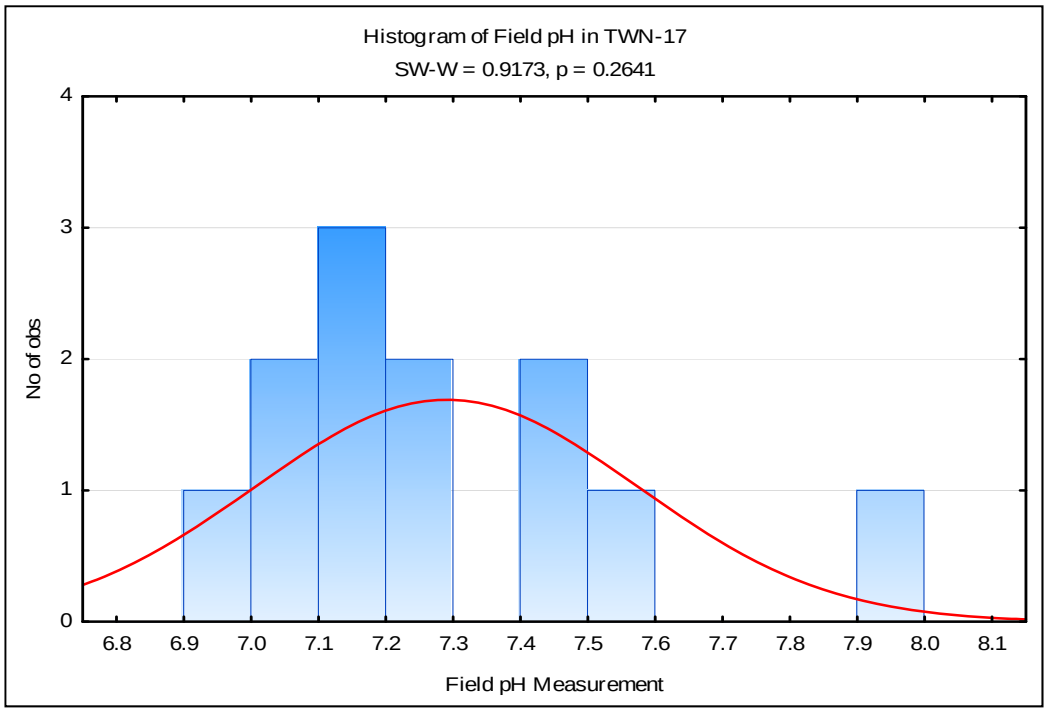

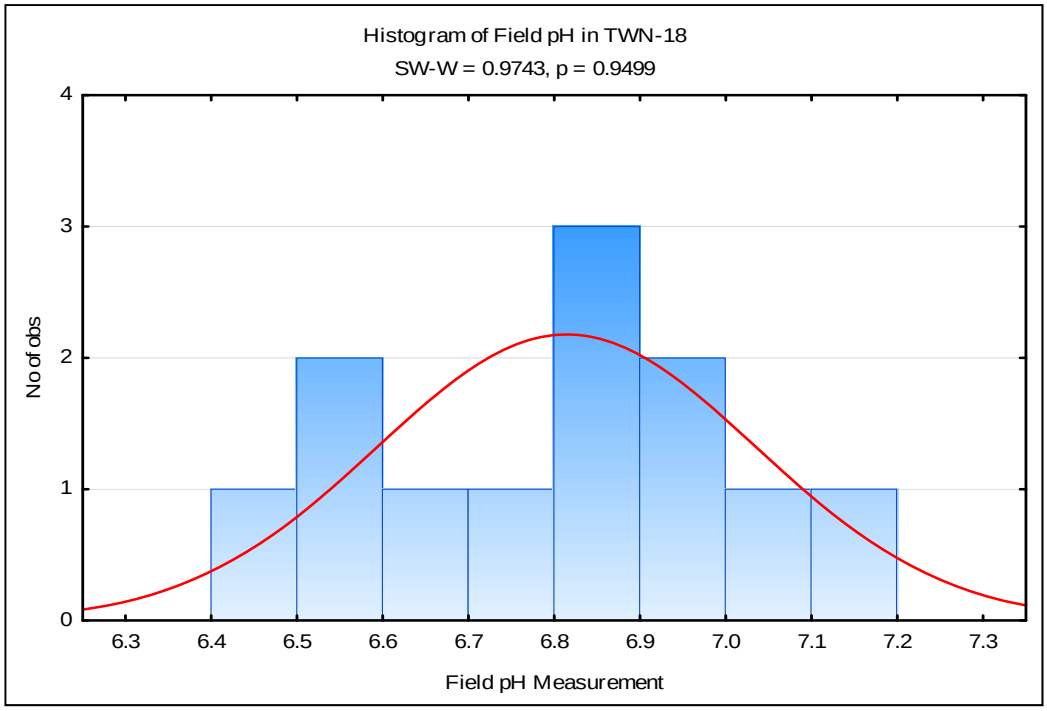

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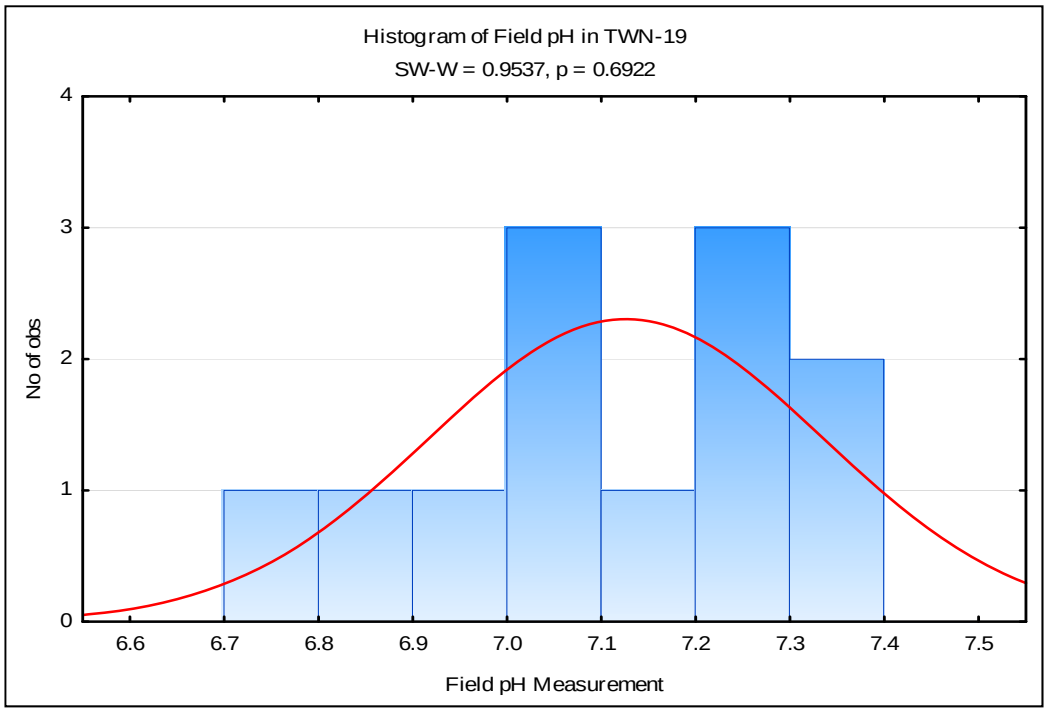

APPENDIX F-4

Mann-Kendall Output for Field pH in Nitrate Wells that Are Not Normally or Lognormally Distributed

Appendix F-4
Mann-Kendall Output for Field pH in Nitrate Wells That are Not Normally or Lognormally Distributed

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	11/1/2012 4:24:33 PM
From File	Sheet2.wst
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Field pH Measurement-twn-15

General Statistics

Number of Values	12
Minimum	6.59
Maximum	7.46
Mean	6.839
Geometric Mean	6.834
Median	6.79
Standard Deviation	0.271
SEM	0.0783

Mann-Kendall Test

Test Value (S)	32
Tabulated p-value	0.016
Standard Deviation of S	14.51
Standardized Value of S	2.136
Approximate p-value	0.0163

Statistically significant evidence of an increasing trend at the specified level of significance.

APPENDIX F-5

Linear Regression for Field pH in All Nitrate Wells

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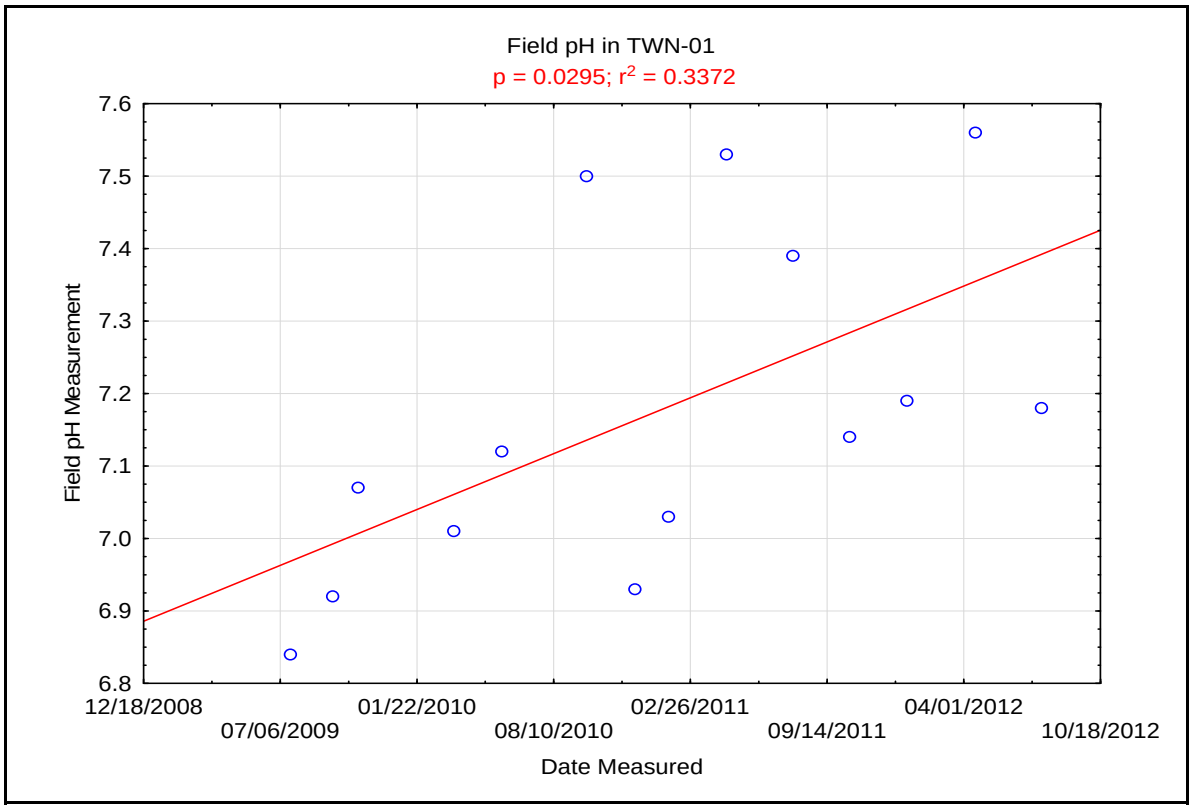
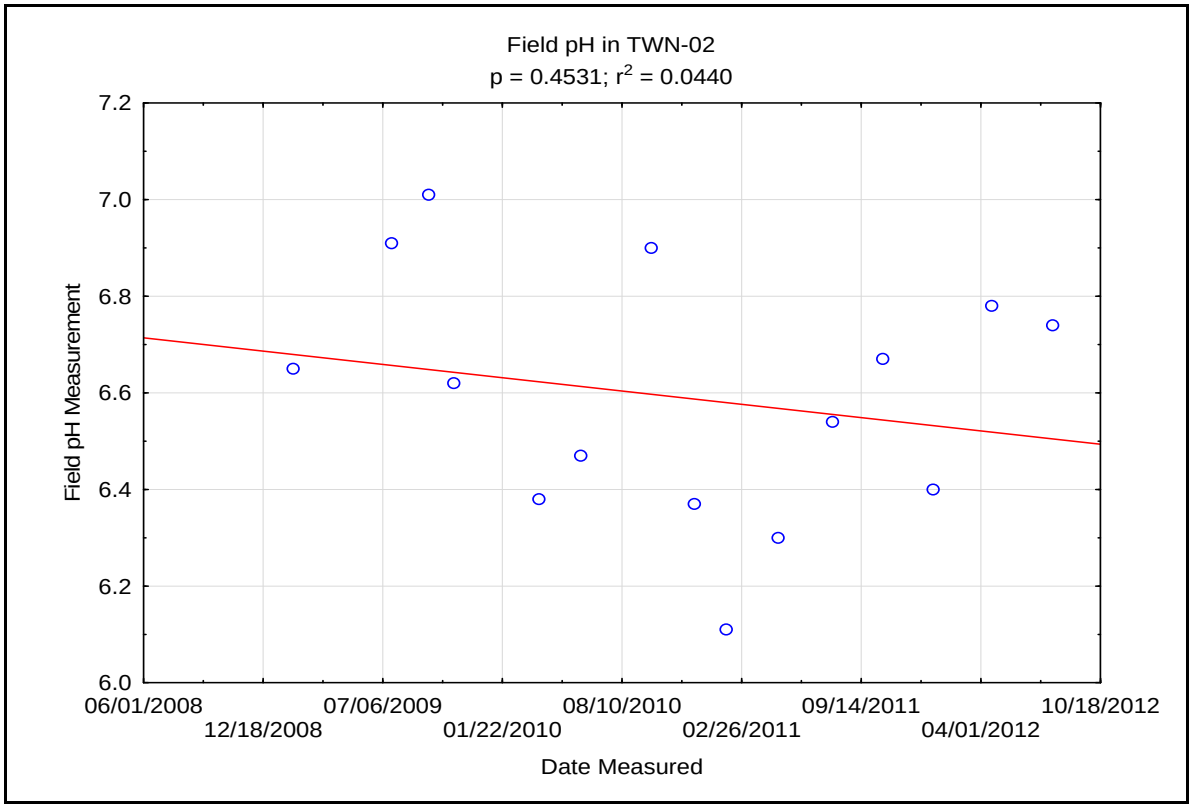
Linear Regression for Field pH in All Nitrate Wells





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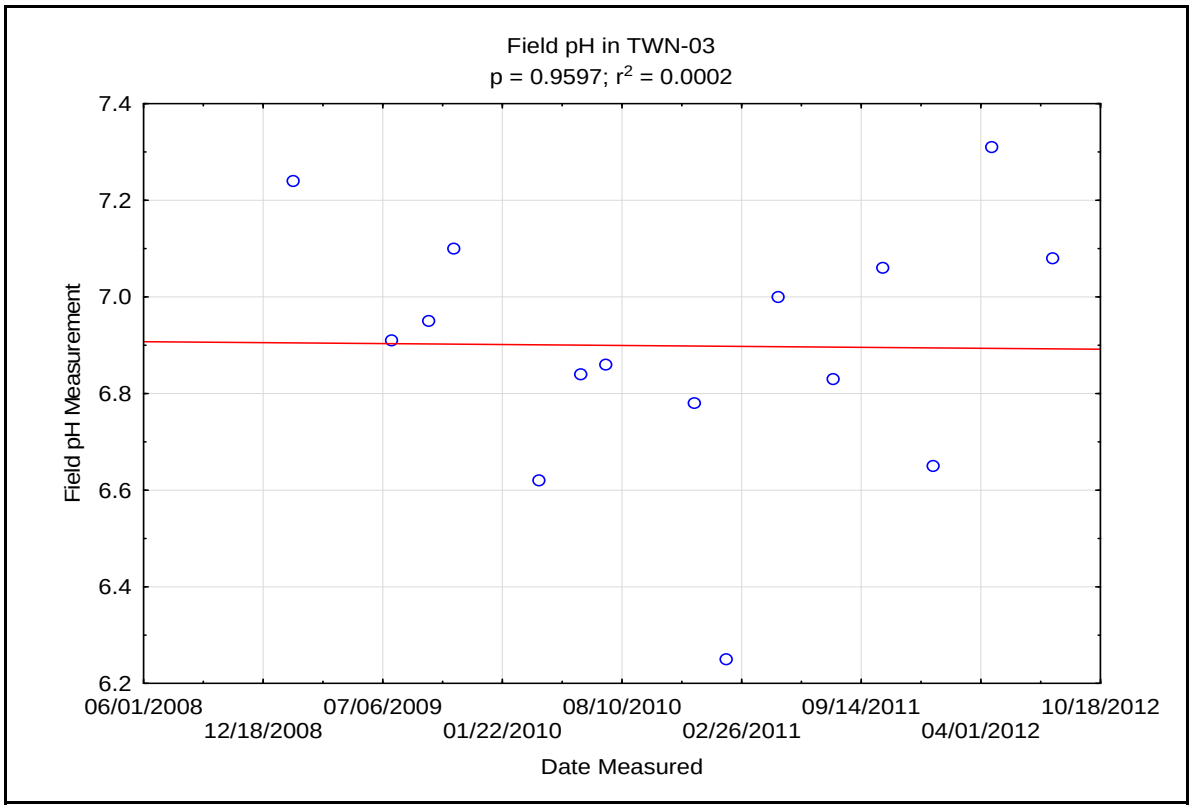

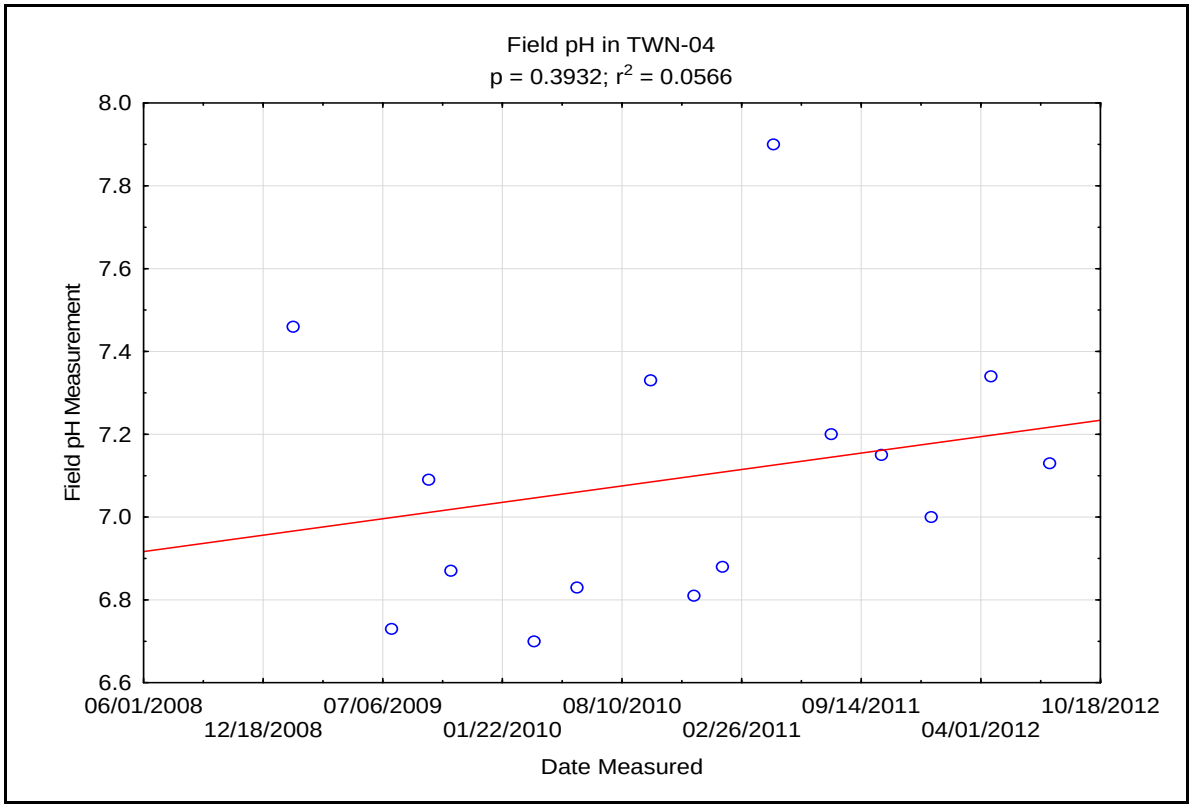

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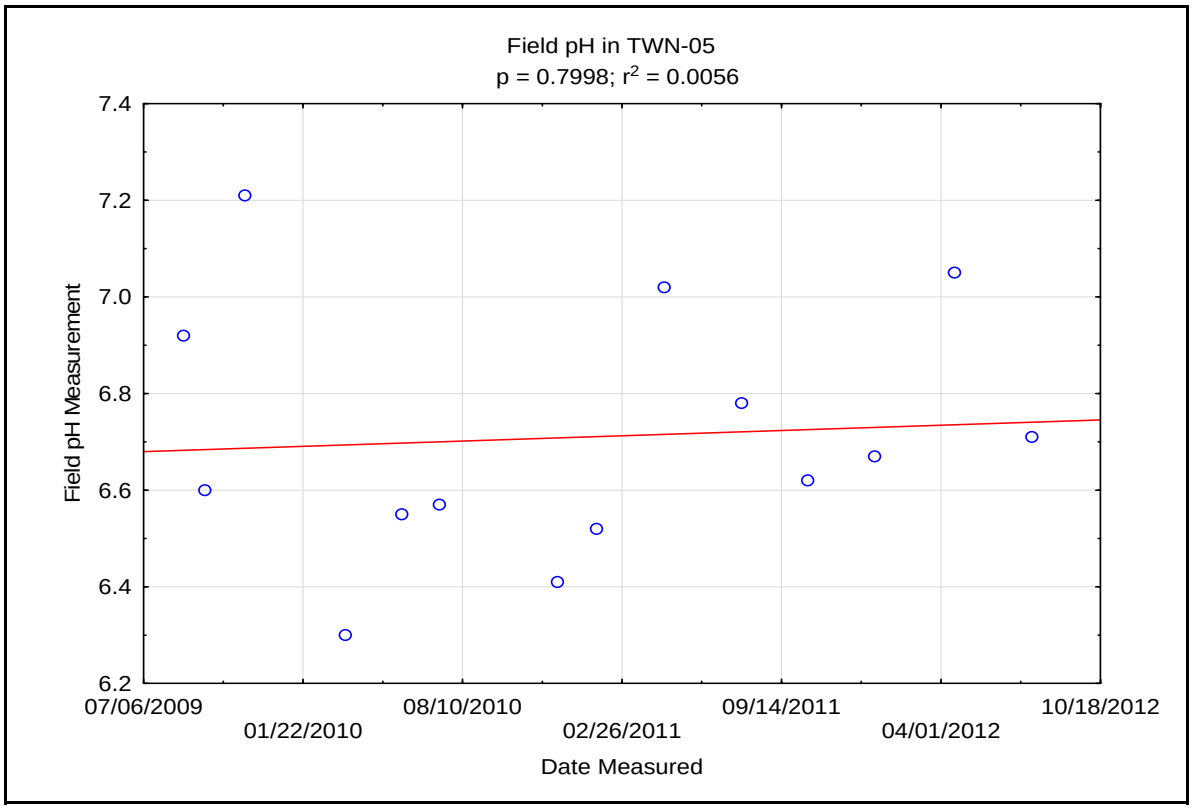

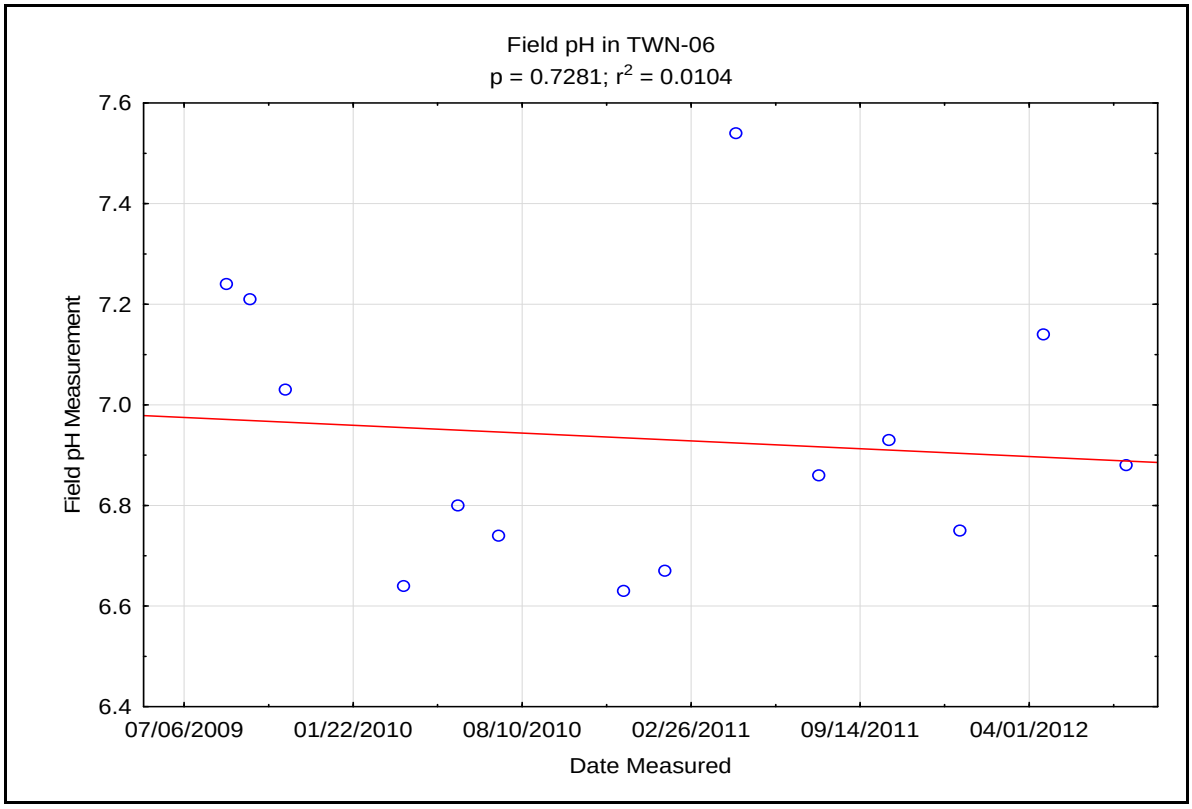

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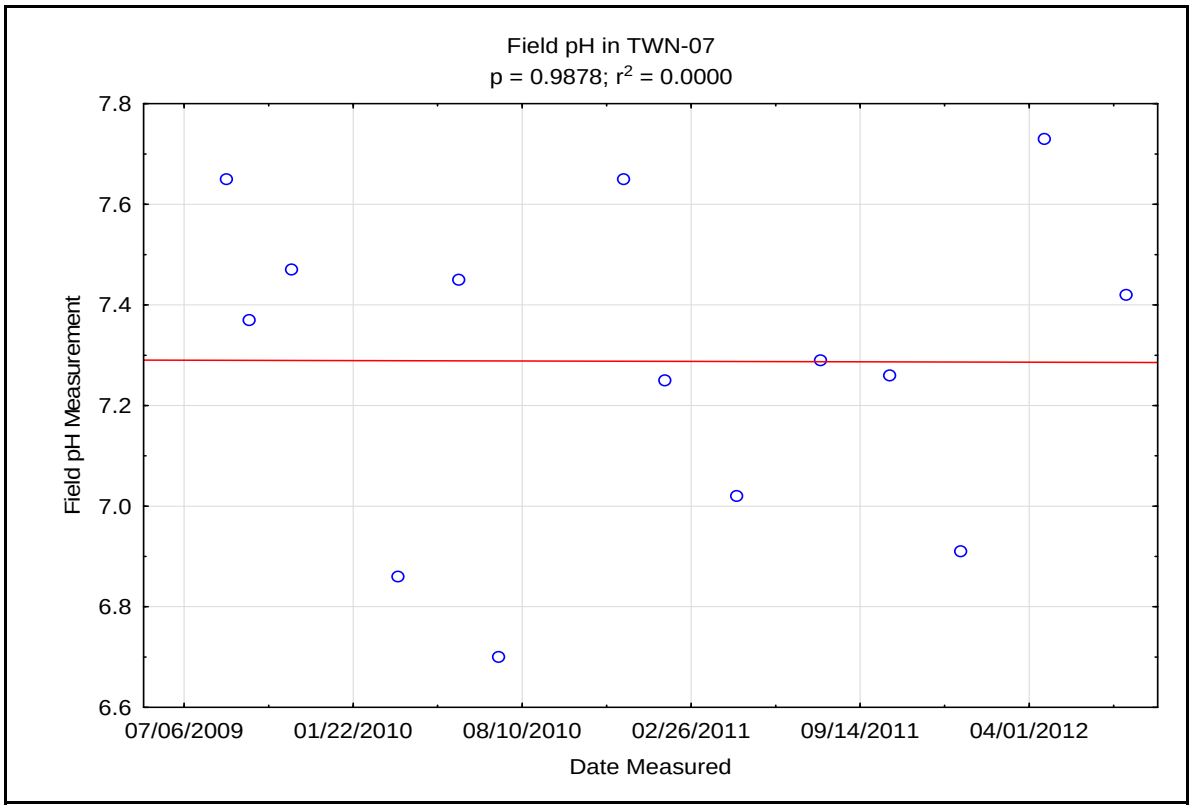

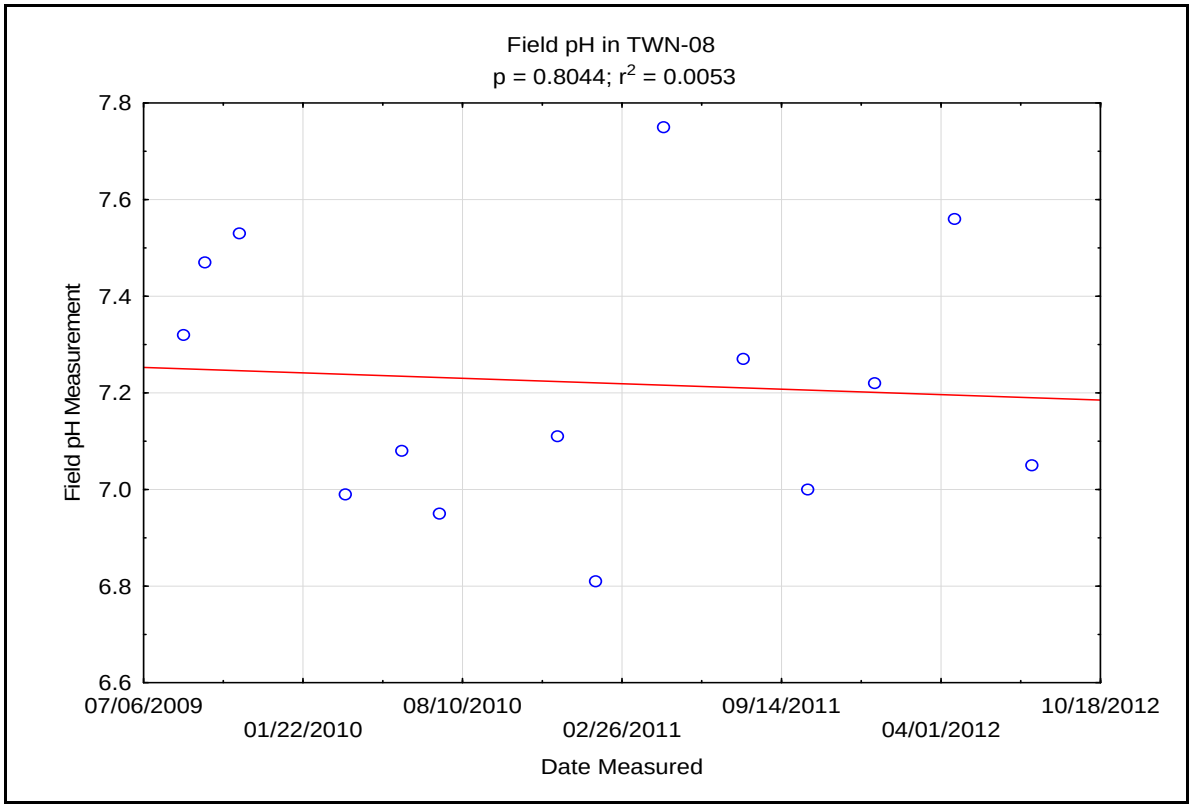

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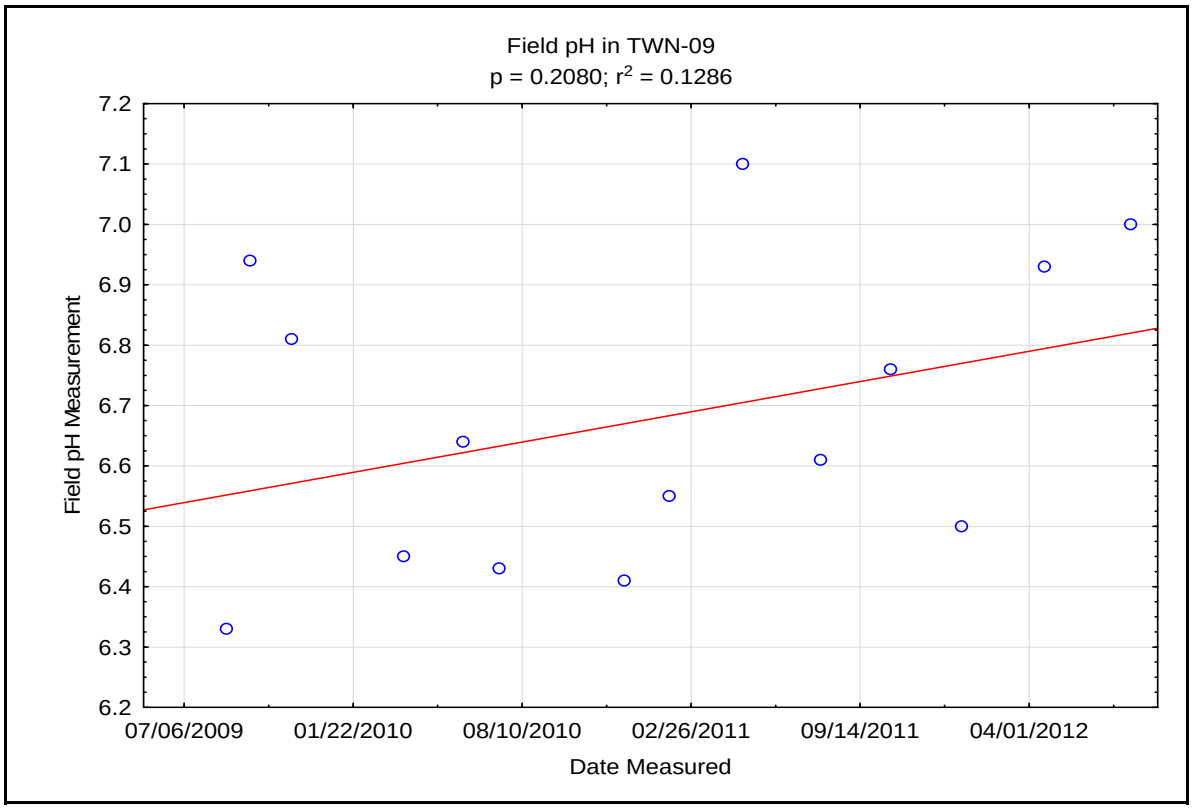

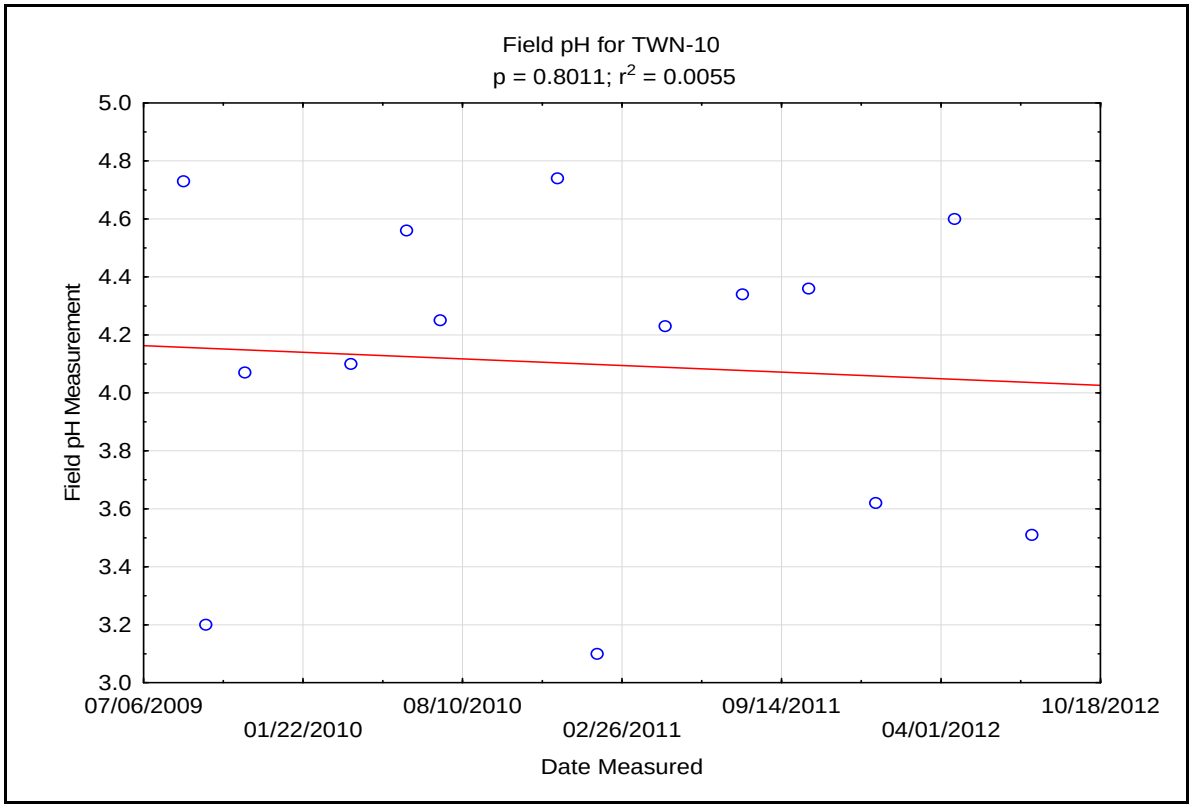

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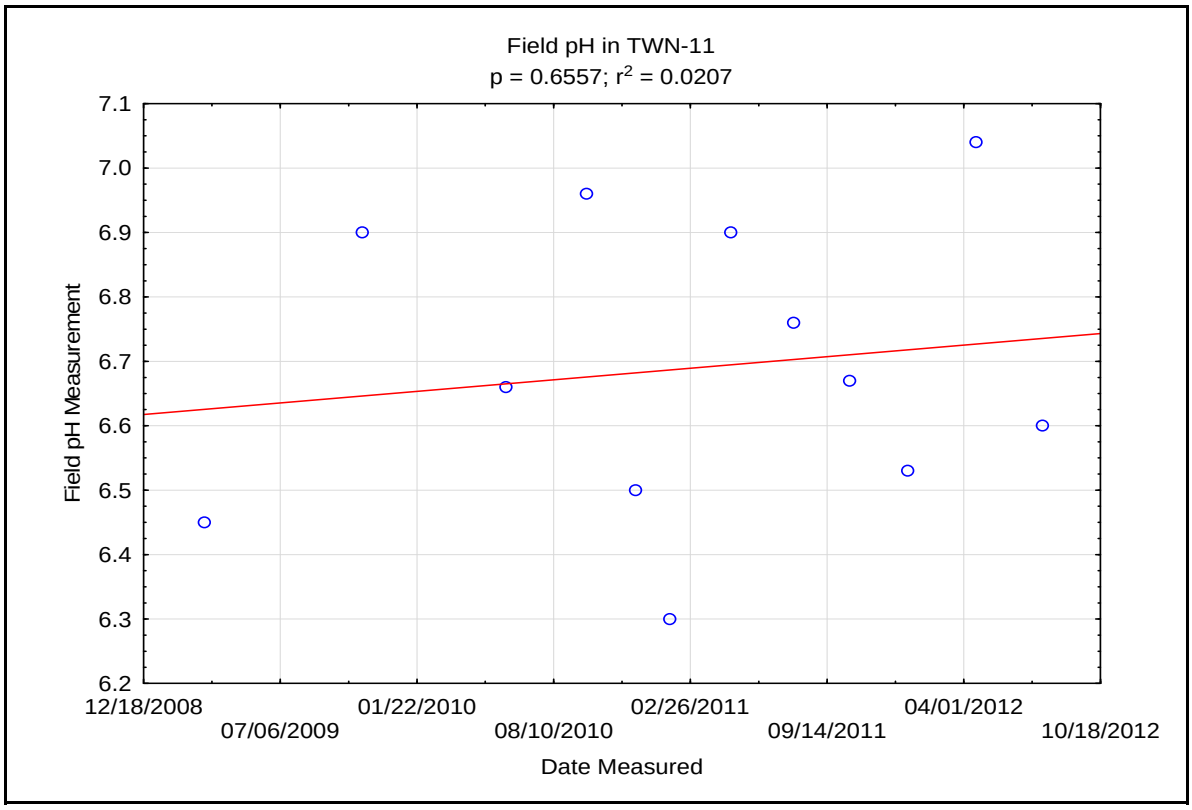
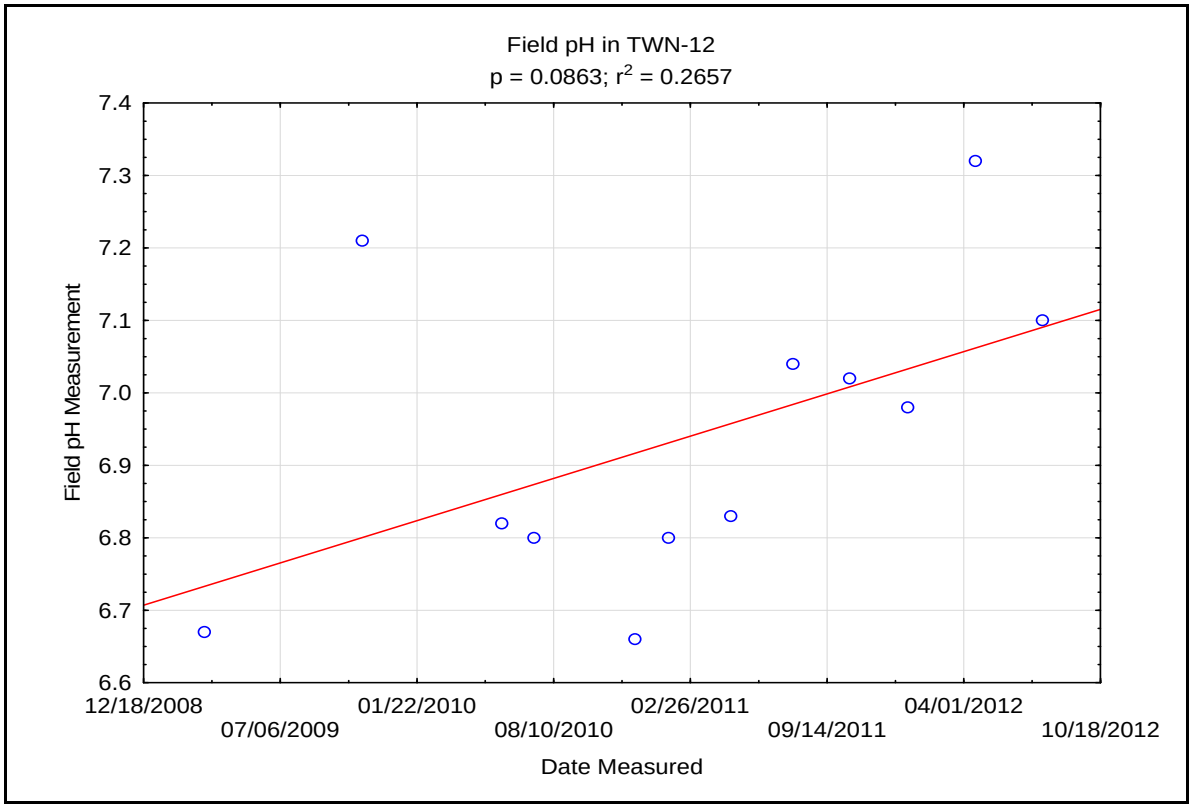
Linear Regression for Field pH in All Nitrate Wells





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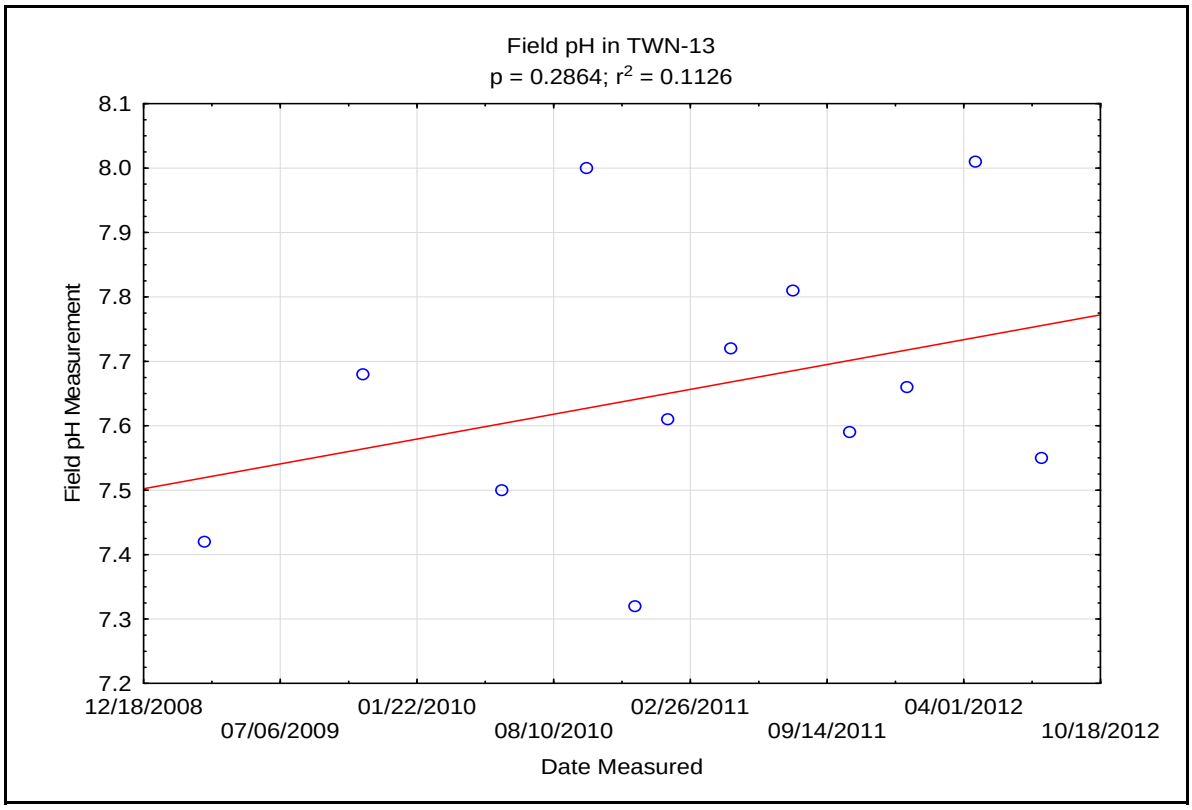

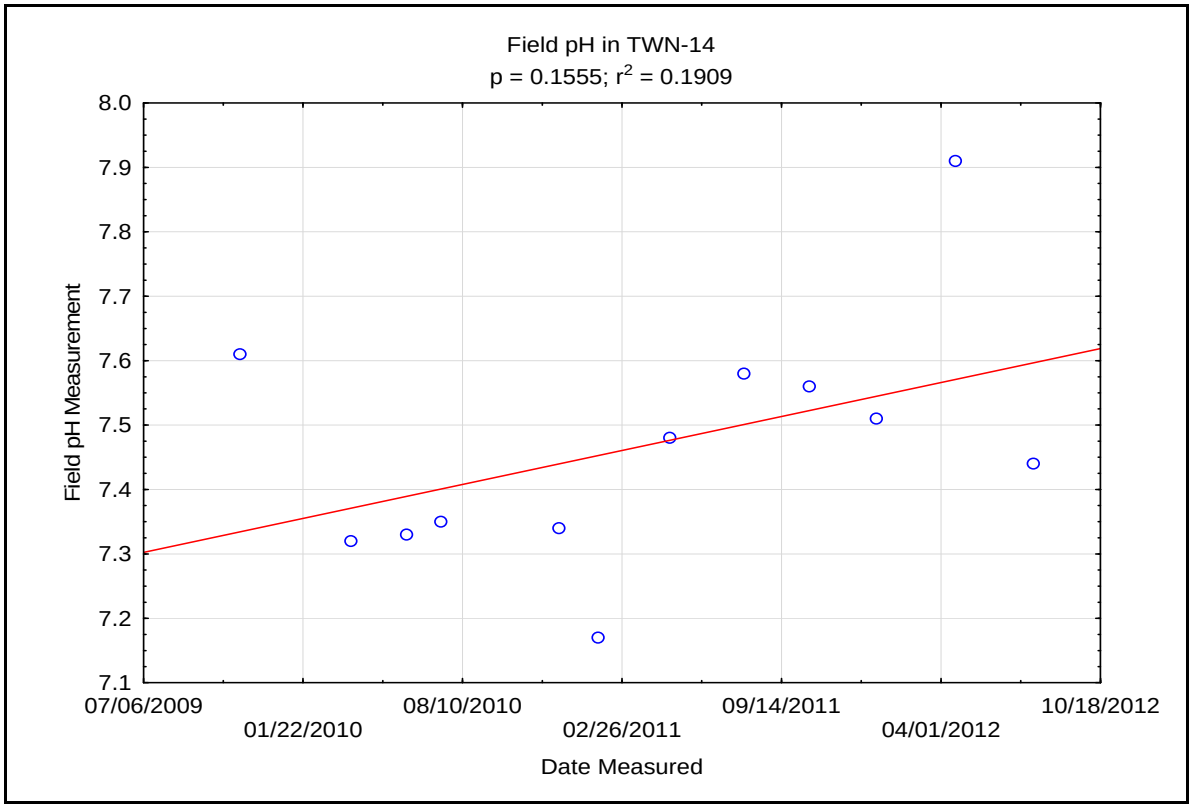

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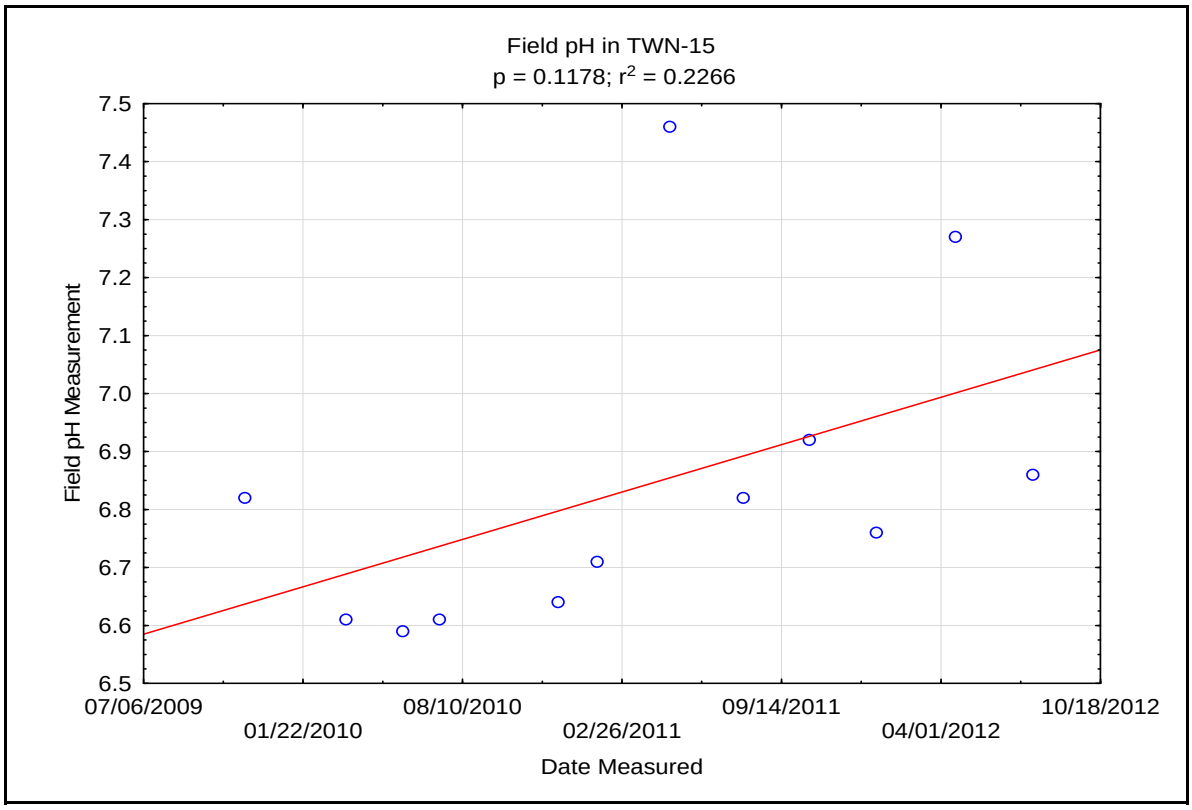
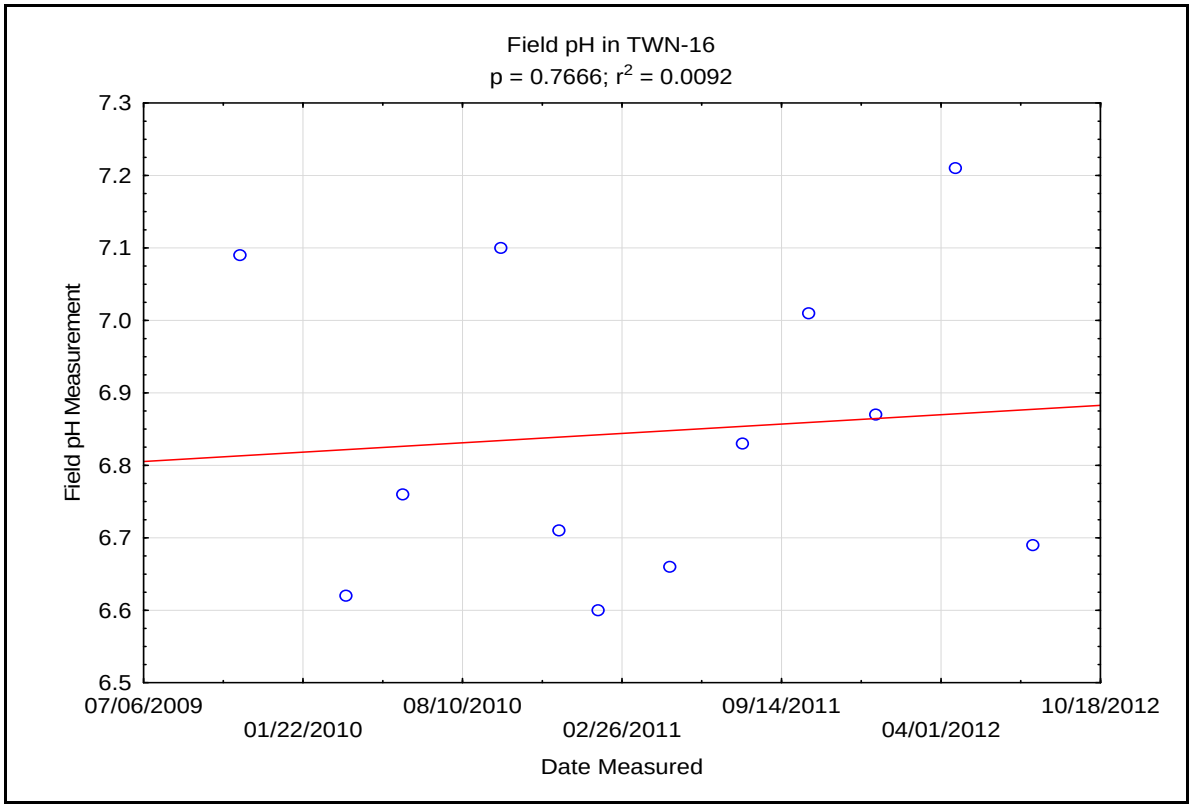
Linear Regression for Field pH in All Nitrate Wells





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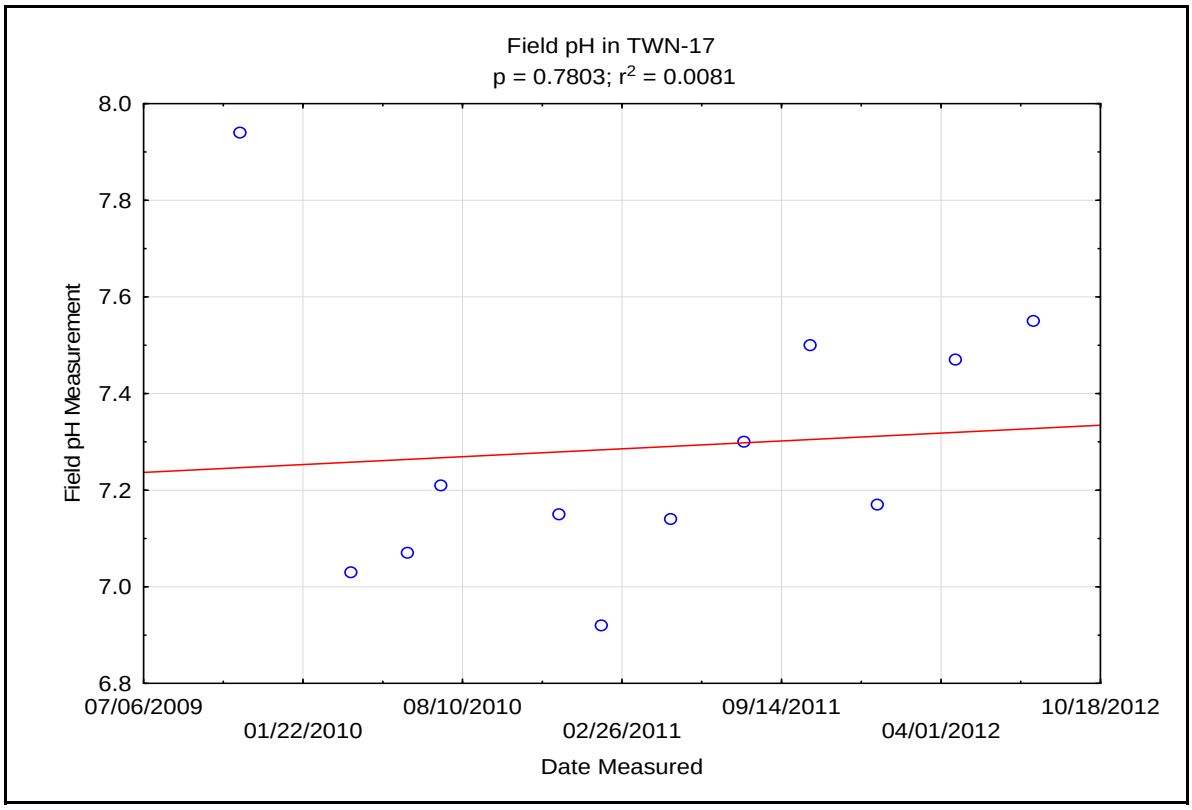

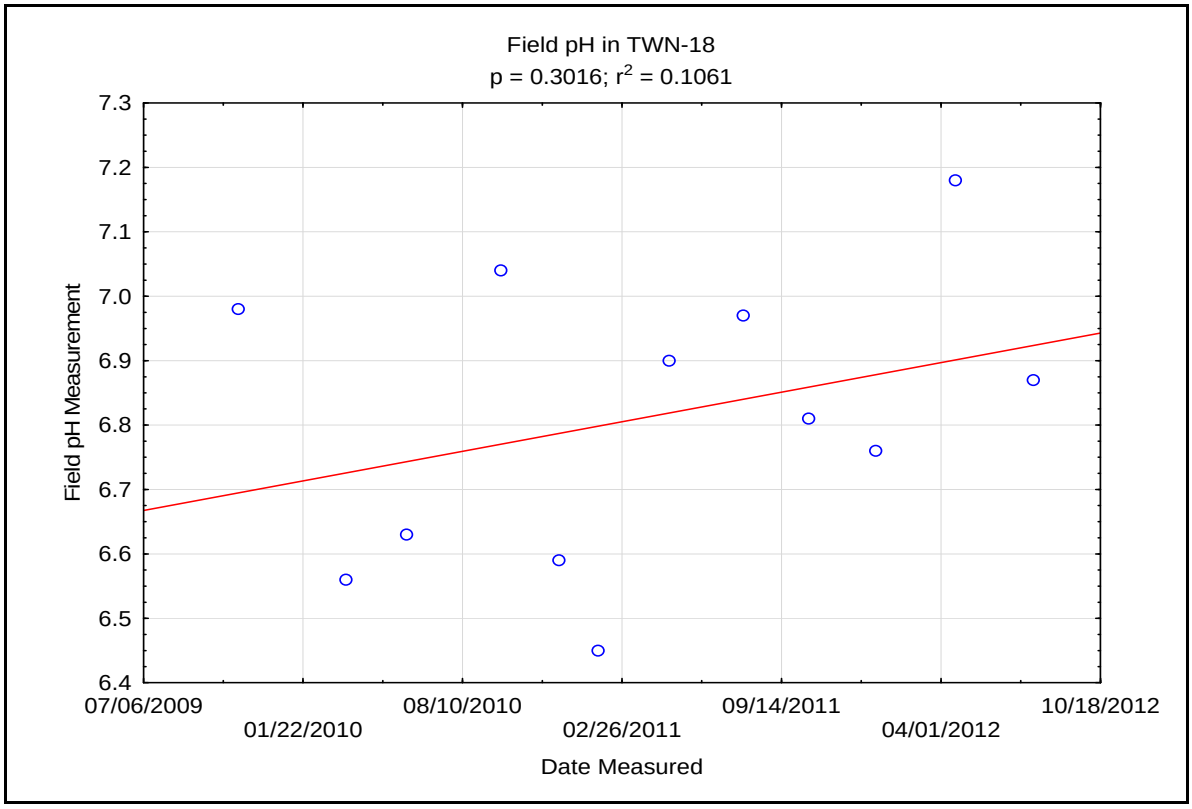

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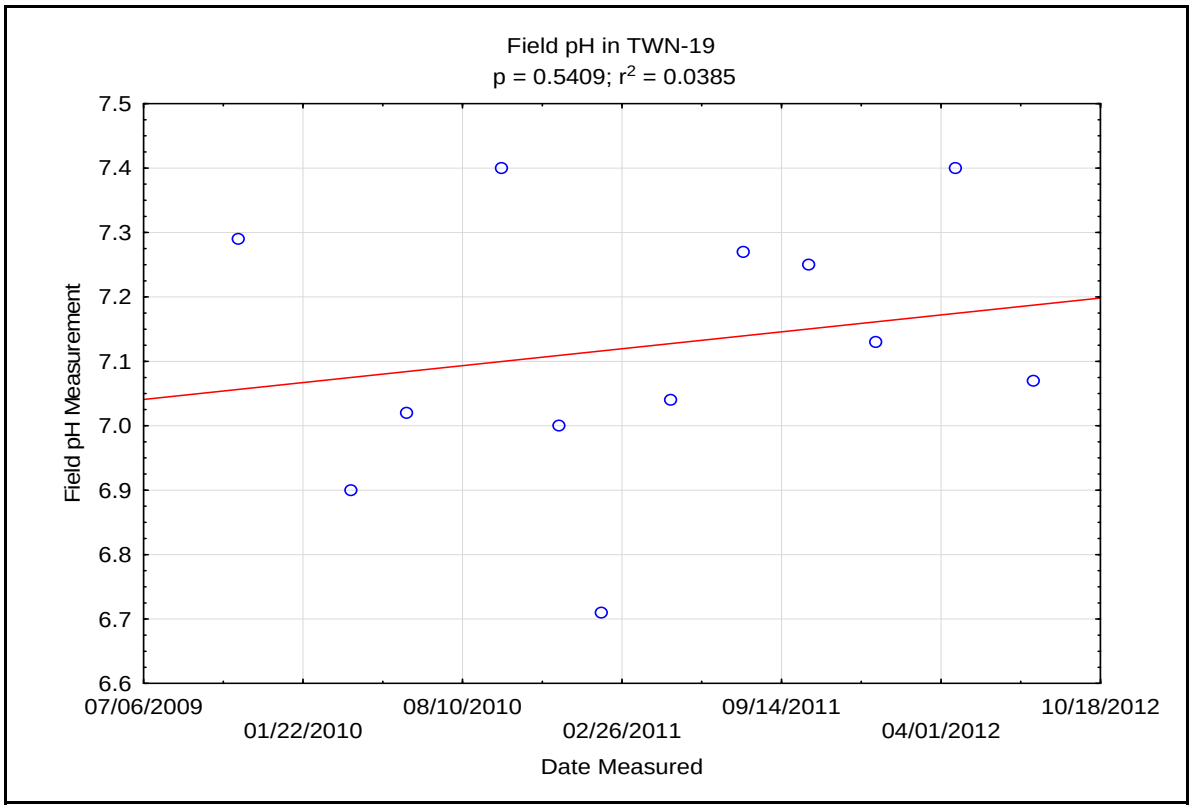

APPENDIX F-6

Descriptive Statistics for Field pH in Nitrate Wells

Appendix F-6 Field pH Descriptive Statistics for Nitrate Wells

Well	Mean	N	Minimum	Maximum	Std.Dev.	Range	Geometric Mean	Skewness	Q25	Median	Q75
TWN-01	14	7.17	6.84	7.56	0.24	0.72	7.17	0.506	7.01	7.13	7.39
TWN-02	15	6.59	6.11	7.01	0.25	0.90	6.59	-0.080	6.38	6.62	6.78
TWN-03	15	6.90	6.25	7.31	0.26	1.06	6.89	-0.813	6.78	6.91	7.08
TWN-04	15	7.09	6.70	7.90	0.32	1.20	7.09	1.046	6.83	7.09	7.33
TWN-05	14	6.71	6.30	7.21	0.26	0.91	6.70	0.485	6.55	6.65	6.92
TWN-06	14	6.93	6.63	7.54	0.27	0.91	6.93	0.915	6.74	6.87	7.14
TWN-07	14	7.29	6.70	7.73	0.31	1.03	7.28	-0.461	7.02	7.33	7.47
TWN-08	14	7.22	6.81	7.75	0.27	0.94	7.22	0.476	7.00	7.17	7.47
TWN-09	14	6.68	6.33	7.10	0.25	0.77	6.67	0.320	6.45	6.63	6.93
TWN-10	14	4.10	3.10	4.74	0.54	1.64	4.07	-0.722	3.62	4.24	4.56
TWN-11	12	6.69	6.30	7.04	0.23	0.74	6.69	-0.019	6.52	6.67	6.90
TWN-12	12	6.94	6.66	7.32	0.21	0.66	6.93	0.405	6.80	6.91	7.07
TWN-13	12	7.66	7.32	8.01	0.21	0.69	7.65	0.389	7.53	7.64	7.77
TWN-14	12	7.47	7.17	7.91	0.19	0.74	7.46	0.899	7.34	7.46	7.57
TWN-15	12	6.84	6.59	7.46	0.27	0.87	6.83	1.476	6.63	6.79	6.89
TWN-16	12	6.85	6.60	7.21	0.21	0.61	6.84	0.525	6.68	6.80	7.05
TWN-17	12	7.29	6.92	7.94	0.28	1.02	7.28	1.088	7.11	7.19	7.49
TWN-18	12	6.81	6.45	7.18	0.22	0.73	6.81	-0.090	6.61	6.84	6.98
TWN-19	12	7.12	6.71	7.40	0.21	0.69	7.12	-0.405	7.01	7.10	7.28

APPENDIX G

Input and Output Files (Electronic Only)