APPENDIX E

STATISTICAL COMPARISON OF SITE AND BACKGROUND DATA

Table of Contents

Tables

Attachments

Statistical Comparison of Site and Background Data for Metals
Fill Area East of Reilly Airfield, Parcel 227(7) and Former Post Garbage Dump Parcel 126(7),McClellan, Anniston, Alabama

1.0 Introduction

This report presents a statistical evaluation of metals results for McClellan, Anniston, Alabama (McClellan) Fill Area East of Reilly and Former Post Garbage Dump, Parcels 227 (7) and 126(7) (collectively, "Site"). The statistical evaluation consists of a multi-tiered approach (Tier 1, Tier 2, and Tier 3) to identify metals that may be present at elevated concentrations as a result of Site-related activities. Statistical evaluations were performed for the surface water and sediment. Because only one groundwater sample was collected for this investigation, a limited statistical evaluation of groundwater data was performed. The Tier 1 statistical evaluation, involves comparing the maximum detected concentration (MDC) of each element to two times the arithmetic mean of the background data (background screening value) reported by Science Applications International Corporation (SAIC) (SAIC, 1998). Any metal that had a MDC greater than the background screening value was carried forward for Tier 2 statistical evaluation, which includes the Slippage Test, the Wilcoxon Rank Sum Test (WRS), and comparison to the corresponding background upper tolerance limit value (UTL). Analytical results for metals failing the Tier 2 evaluation were carried through the Tier 3 evaluation. The Tier 3 evaluation is a graphical assessment of relative concentrations of elements typically associated in media. The Tier 3 evaluation served as the final evaluation to identify metals having anomalously elevated concentrations. Additional description of the multi-tiered statistical processes is provided in the following sections.

2.0 Comparison Methodology

This section describes the statistical techniques that were employed in the Site-to-background comparisons.

2.1 Statistical Procedures

Contamination can be caused by a variety of processes that yield different spatial distributions of elevated contaminant concentrations. Slight but pervasive contamination can occur from non-point-source releases, and can result in slight increases in contaminant concentrations in a large percentage of samples. Localized, or "hot-spot," contamination can result in elevated concentrations in a small percentage of the total number of Site samples. No single two-sample statistical comparison test is sensitive to both of these modes of contamination. For this reason, the use of several statistical tests is recommended for a valid and complete comparison of Site versus background distributions (U.S. Environmental Protection Agency [EPA], 1989, 1992, and 1994; U.S. Navy, 2002).

Analytes that fail the Tier 1 and Tier 2 comparisons are subject to Tier 3 evaluation to identify if the elevated concentrations are due to natural processes or if they represent potential contamination.

2.1.1 Tier 1

In this step of the background screening process, the MDC of the Site data set is compared to the background screening value of two times the background mean (SAIC, 1998). Elements for which the Site MDC does not exceed the background screening value are considered to be present at background concentrations, and are not considered Site-related chemicals. Elements with Site MDCs exceeding the background screening value undergo further evaluation (Tier 2).

2.1.2 Tier 2

Tier 2 consists of the statistical tools summarized in the Sections below.

2.1.2.1 Slippage Test

The nonparametric Slippage test is designed to detect a difference between the upper tails of two distributions, and has been recommended for use in Site-to-background comparisons to identify potential localized, or hot-spot, contamination (U.S. Navy, 2002). The test is performed by counting the number (K) of detected concentrations in the Site data set that exceed the maximum background concentration, and then comparing this number to a critical value (K_c), which is a function of the number of background samples and the number of Site samples. If $K>K_c$, then potential contamination is indicated and the analyte will be subjected to geochemical evaluation. If $K = K_c$, then localized contamination is not suspected.

Critical values tables for Site and background data sets up to 50 in size are provided in the U.S. Navy's *Guidance for Environmental Background Analysis* (U.S. Navy, 2002). Critical values for larger data sets are calculated using the test statistic provided in Rosenbaum's *Tables for a Nonparametric Test of Location* (Rosenbaum, 1954). In this report, the Slippage test is performed at the 95 percent confidence level. The test should not be performed if the maximum background value is a non-detect, because the actual concentration in that sample is unknown.

2.1.2.2 Wilcoxon Rank Sum Test and Box Plots

The nonparametric WRS test is designed to detect a difference between the medians of two data sets, and has been recommended for use in Site-to-background comparisons to identify slight but pervasive contamination (EPA, 2000; U.S. Navy, 2002). In this report, the WRS test is performed when the Site and background data sets each contain less than 50 percent non-detects (i.e., measurements reported as not detected below the laboratory reporting limit). The WRS test is not performed on data sets containing 50 percent or more non-detects. The medians of such data sets are unknown, and hence the test results would lack sufficient power to yield reliable results.

The WRS test compares two data sets of size n and m ($n > m$), and tests the null hypothesis that the samples are drawn from populations with distributions having the same medians. To perform the test, the two sets of observations are pooled and arranged in order from smallest to largest. Each observation is assigned a rank; that is, the smallest is ranked 1, the next largest is ranked 2, and so on up to the largest observation, which is ranked ($n + m$). If ties occur between or within samples, each one is assigned the mid-rank. Next, the sum of the ranks of smaller data set m is calculated. Then the test statistic Z is determined,

$$Z = \frac{W - m(m+n+1)/2}{\sqrt{mn(m+n+1)/12}}$$

Where:

W = Sum of the ranks of the smaller data set
m = Number of data points in smaller group
n = Number of data points in larger group.

This test statistic Z is used to find the two-sided significance. For instance, if the test statistic yields a probability of a Type I error (p-level) less than 0.2, then there is a statistically significant difference between the medians at the 80 percent confidence level. A Type I error involves rejecting the null hypothesis when it is true. If the p-level is greater than 0.2, then there is no reasonable justification to reject the null hypothesis at the 80 percent confidence level. It can therefore be concluded that the medians of the two data sets are similar and are assumed to be drawn from the same population.

If the p-level is less than 0.2, then the medians of the two distributions are significantly different at the 80 percent confidence level. This can occur if the Site data are shifted higher or lower than the background data. If the Site data are shifted higher relative to background, then contamination may be indicated, and the analyte in question will be carried on for the Tier 3 evaluation; however, if the Site data are shifted lower relative to background, then contamination is not indicated. If the p-level is greater than 0.2, then pervasive Site contamination is not suspected.

The box plot comparison is a graphical method recommended by the EPA to visualize and compare two or more sets of data (EPA, 1989 and 1992). These plots provide a summary view of the entire data set, including the overall location and degree of symmetry. Box Plots was developed for metals in order to visually inspect any potential differences between site and background data. Box Plots provide a means to visually contrast and compare the characteristics of the distribution for the observed values and are particularly useful when comparing many groups of data. Box Plots display the median, 25th percentile, 75th percentile, and values far removed from the rest. The solid line drawn within the box indicates the median. The ends of the box indicate the 25th and 75th percentiles or interquartile range. The 'whiskers', extend from both ends of the box to the minimum and maximum values, except for any outside or far-outside points that are plotted separately. Outside points that are more than 1.5 times the interquartile range are shown as small squares. Far-outside points that are more than 3.0 times the interquartile range are shown as small squares with plus signs through them.

For each analyte, box plots of site and background data are placed side by side to visually compare the distributions and qualitatively determine whether the data sets are similar or distinct. Accordingly, the box plots are a necessary adjunct to the WRS test. As described previously, the WRS test may indicate that the medians of the site and background data sets are significantly different. Examination of the box plots identifies whether that difference is caused by site data that are shifted higher or lower relative to background.

2.1.2.3 Hot Measurement Test

The hot measurement test consists of comparing each Site measurement to a concentration value that is representative of the upper limit of the background distribution (EPA, 1994). This test is performed in instances where the maximum Site sample value is a non-detect or the percentage of non-detect sample values exceeds 50 percent. For this test, a Site sample with a concentration above the background screening value would, ideally have a low probability of being a member of the background population, and would be an indicator of contamination. It is important to select such a background screening value carefully so that the probability of falsely identifying Site samples as contaminated or uncontaminated is minimized.

The 95^{th} upper tolerance limit (95^{th} UTL) is recommended as a screening value for normally or lognormally distributed analytes and the 95^{th} percentile is recommended as a screening value for nonparametrically distributed analytes (EPA, 1989, 1992, and 1994). Site samples with concentrations above these values are not necessarily contaminated, but should be considered suspect. To perform the test, each analyte's Site MDC is compared to the background 95^{th} UTL or 95^{th} percentile, in accordance with the type of background distribution. If the Site MDC exceeds the 95^{th} UTL or 95^{th} percentile as appropriate, then that analyte will undergo a Tier 3 evaluation.

2.1.3 Tier 3

If an analyte fails either of the statistical tests described above, then the Tier 3 evaluation is performed to identify if elevated concentrations are caused by natural processes. Naturally occurring trace element concentrations in environmental media commonly exceed screening criteria. Trace element distributions in uncontaminated media tend to have very large ranges (two to three orders of magnitude are not uncommon), and are highly right-skewed, resembling lognormal distributions. These trace elements are naturally associated with specific media-forming minerals, and the preferential enrichment of a sample with these minerals will result in elevated trace element concentrations. It is thus important to be able to identify these naturally high concentrations and distinguish them from potential contamination.

The Tier 3 evaluation is performed by first constructing a scatter plot of two metals showing a statistical association or correlation. The evaluation includes the generation of plots in which detected metal concentrations in a set of samples are plotted on the y-axis, and the corresponding detected concentrations of the second metal are plotted on the x-axis. The method can be used with as few as four data points (i.e., four concentration values for each of two metals (U.S. Navy, 2002). Correlation exists between the two metals plotted if the data tend to occur along or near a straight line. Linear regression is used to evaluate the relationship. Prediction limits plotted alongside the linear regression are useful for identifying elevated metal concentrations that may be Site related. The slope of a best-fit line through the samples is equal to the average metal/metal ratio. If the metal concentrations plot on the same linear trend, then it is most probable that the observed concentrations are natural. If an individual Site sample concentration plots above the trend displayed by the uncontaminated samples, then there is evidence that that sample has an excess metal contribution.

3.0 Results of the Tier 1 and Tier 2 Evaluations

This section presents the results of the Site-to-background comparisons for 23 metals in the groundwater, surface water, and sediment at the Site. The WRS test results with corresponding box plots are provided in Attachment A. Tables E3-1 and E3-2 present the Tier 1 and Tier 2 test results for each medium as discussed in the following subsections.

3.1 Groundwater

One groundwater sample was collected from the Site and because of this only the Tier 1 evaluation could be performed.

3.1.1 Tier 1 Evaluation Results for Groundwater

Analytical results for the groundwater samples were compared to the background screening values. Nine metals (aluminum, barium, calcium, iron, lead, magnesium, manganese, sodium, and zinc) were detected in the groundwater sample. Of these metals, only aluminum exceeded the corresponding background screening value (two times the background mean). Accordingly, aluminum may be site related. The Tier 2 and Tier 3 statistical evaluations were not performed because of the small dataset.

3.2 Surface Water

Twenty-three metals were evaluated in the Site surface water data set. Table E3-1 presents a summary of the Tier 1 and Tier 2 evaluations results for surface water.

3.2.1 Tier 1 Evaluation Results for Surface Water

Aluminum, antimony, barium, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, potassium, selenium, silver, sodium, thallium, and vanadium have no detected concentrations above their respective background screening values (two times the background mean). Accordingly, these metals passed the Tier 1 evaluation and were not carried forward to the Tier 2 evaluation. The remaining six metals (arsenic, calcium, cobalt, magnesium, manganese, and zinc) were carried forward for the Tier 2 evaluation.

3.2.2 Tier 2 Evaluation Results for Surface Water

Table E3-1 summarizes the surface water statistical Site-to-background comparison results. Box plots are provided in Appendix E1. The following text summarizes the results of the Tier 2 evaluations.

Arsenic

Slippage Test

K_c for arsenic is 2, and no Site samples exceeded the maximum background measurement (K=0). Because $K < K_c$, arsenic passes the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background median at the 80 percent confidence level.

Box Plot

The Site MDC is smaller than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure A-1).

Conclusion

Because the median arsenic concentration in surface water is greater than the median background concentration, arsenic was carried forward to the Tier 3 evaluation.

Calcium

Slippage Test

K_c for calcium is 2, and no Site samples exceeded the maximum background measurement (K=0). Because $K < K_c$, calcium passes the Slippage test.

<u>WRS Test</u>
A statistically significant difference does not exist between the Site median and background median at the 80 percent confidence level.

<u>Box Plot</u>
The Site MDC is smaller than the corresponding background values. Additionally, the Site median is not significantly different than the corresponding background median, and the Site interquartile range is similar to the background interquartile range (Figure A-2).

<u>Conclusion</u>
Because the median calcium concentration in surface water is not greater than the median background concentration, calcium was not carried forward to the Tier 3 evaluation.

Cobalt

<u>Slippage Test</u>
K_c for cobalt is 2, and no Site samples exceeded the maximum background measurement (K=0). Because $K < K_c$, cobalt passes the Slippage test.

<u>WRS Test</u>
The WRS test was not performed because the site data set contained more than 50 percent non-detects.

<u>Box Plot</u>
Box plots were not developed for cobalt because of the high percentage (67 percent) of non-detects in the site data set.

<u>Hot Measurement Test</u>
The hot measurement test could not be performed for cobalt in surface water. The hot measurement test compared the two detected concentrations of cobalt to the 95th percentile of cobalt in background surface water. Because 84 percent of the background samples were non-detects for cobalt and the highest reported value was a non detect a background value for the hot measurement test (95th percentile or a 95th percent UTL)

was not calculated for cobalt. Accordingly, cobalt is considered to have failed the hot measurement test.

Conclusion

Cobalt was detected in two site samples at concentrations of 0.00626 mg/L and 8.28 mg/L respectively. Because the Tier 2 statistical evaluation is inconclusive, the detected concentrations were carried forward to Tier 3.

Magnesium

Slippage Test

K_c for magnesium is 2, and no Site samples exceeded the maximum background measurement (K=0). Because $K < K_c$, magnesium passes the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background median at the 80 percent confidence level.

Box Plot

The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is similar to the background interquartile range (Figure A-3).

Conclusion

Because the median magnesium concentration in surface water is greater than the median background concentration, magnesium was carried forward to the Tier 3 evaluation.

Manganese

Slippage Test

K_c for manganese is 2, and no Site samples exceeded the maximum background measurement (K=0). Because $K < K_c$, manganese passes the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

<u>Box Plot</u>
The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure A-4).

<u>Conclusion</u>
Because the median manganese concentration in surface water is greater than the median background concentration, manganese was carried forward to the Tier 3 evaluation.

Zinc

<u>Slippage Test</u>
K_c for zinc is 2, and no Site samples exceeded the maximum background measurement (K=0). Because $K < K_c$, zinc passes the Slippage test.

<u>WRS Test</u>
A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

<u>Box Plot</u>
The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure A-5).

<u>Conclusion</u>
Because the median zinc concentration in surface water is greater than the median background concentration, zinc was carried forward to the Tier 3 evaluation.

3.3 Sediment

Twenty-three metals were evaluated in the Site sediment data set. Table E3-2 presents a summary of the Tier 1 and Tier 2 evaluations results for sediment.

3.3.1 Tier 1 Evaluation Results for Sediment

Cadmium, mercury, selenium, sodium, and thallium have no detected concentrations above their respective background screening values (two times the background mean). Accordingly these metals pass the Tier 1 evaluation and were not carried forward to the Tier 2 evaluation. The remaining 18 metals were carried forward for Tier 2 evaluation.

3.3.2 Tier 2 Evaluation Results for Sediment

Table E3-2 summarizes the statistical evaluation for Site to background comparison results for sediment. Box plots are presented in Attachment B. The following text summarizes the results of the Tier 2 evaluations.

Aluminum

<u>Slippage Test</u>

K_c for aluminum is 2, and one Site samples exceeded the maximum background measurement (K=1). Because $K < K_c$, aluminum passed the Slippage test.

<u>WRS Test</u>

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

<u>Box Plot</u>

The Site MDC is larger than the corresponding background values. Additionally, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-1).

<u>Conclusion</u>

Because the median aluminum concentration in sediment is greater than the median background concentration, aluminum was carried forward to the Tier 3 evaluation.

Antimony

<u>Slippage Test</u>

K_c for antimony is 2, and three Site samples exceeded the maximum background measurement (K=3). Because $K > K_c$, antimony failed the Slippage test.

WRS Test
The WRS test was not performed because the site data set contained more than 50 percent non-detects.

Box Plot
The Site MDC is greater than the corresponding background values. Additionally, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-2)

Conclusion
Because the median antimony concentration in sediment is greater than the median background concentration, antimony was carried forward to the Tier 3 evaluation.

Arsenic

Slippage Test
K_c for arsenic is 2, and one sample concentration exceeded the maximum background measurement (K=1). Because $K < K_c$, arsenic passed the Slippage test.

WRS Test
A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot
The Site MDC is larger than the corresponding background values. Moreover, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-3).

Conclusion
Because the median arsenic concentration in sediment is greater than the median background concentration, arsenic was carried forward to the Tier 3 evaluation.

Barium

Slippage Test

K_c for barium is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, barium passed the Slippage test.

WRS Test

A statistically significant difference does not exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, although the Site interquartile range is less than the background interquartile range (Figure B-4).

Conclusion

Because the median barium concentration in sediment was not statistically different from the median background concentration, barium was not carried forward to the Tier 3 evaluation.

Beryllium

Slippage Test

K_c for beryllium is 2, and two sample concentrations exceeded the maximum background measurement (K=2). Because $K = K_c$, beryllium passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is larger than the corresponding background values. In addition, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-5).

Conclusion

Because the median beryllium concentration in sediment is greater than the median background concentration, beryllium was carried forward to the Tier 3 evaluation.

Calcium

Slippage Test
K_c for calcium is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, calcium passed the Slippage test.

WRS Test
A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot
The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is less than the background interquartile range (Figure B-6).

Conclusion
Because the median calcium concentration in sediment is less than the median background concentration, calcium was not carried forward to the Tier 3 evaluation.

Chromium

Slippage Test
K_c for chromium is 2, and one sample concentration exceeded the maximum background measurement (K=1). Because $K < K_c$, chromium passed the Slippage test.

WRS Test
A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot
The Site MDC is larger than the corresponding background values. Additionally, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-7).

Conclusion
Because the median chromium concentration in sediment is greater than the median background concentration, chromium was carried forward to the Tier 3 evaluation.

Cobalt

Slippage Test
K_c for cobalt is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, cobalt passed the Slippage test.

WRS Test
A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot
The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background values, and the Site interquartile range is greater than the background interquartile range (Figure B-8).

Conclusion
Because the median cobalt concentration in sediment is greater than the median background concentration, cobalt was carried forward to the Tier 3 evaluation.

Copper

Slippage Test
K_c for copper is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, copper passed the Slippage test.

WRS Test
A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-9).

Conclusion

Because the median copper concentration in sediment is greater than the median background concentration, copper was carried forward to the Tier 3 evaluation.

Iron

Slippage Test

K_c for iron is 2, and one sample concentration exceeded the maximum background measurement (K=1). Because $K < K_c$, iron passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is greater than the corresponding background values. Additionally, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-10).

Conclusion

Because the median iron concentration in sediment is greater than the median background concentration, iron was carried forward to the Tier 3 evaluation.

Lead

Slippage Test

K_c for lead is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, lead passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-11).

Conclusion

Because the median lead concentration in sediment is greater than the median background concentration, lead was carried forward to the Tier 3 evaluation.

Magnesium

Slippage Test

K_c for magnesium is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, magnesium passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-12).

Conclusion

Because the median magnesium concentration in sediment is greater than the median background concentration, magnesium was carried forward to the Tier 3 evaluation.

Manganese

Slippage Test

K_c for manganese is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, manganese passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

<u>Box Plot</u>
The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, but the Site interquartile range is similar to the background interquartile range (Figure B-13).

<u>Conclusion</u>
Because the median manganese concentration in sediment is greater than the median background concentration, manganese was carried forward to the Tier 3 evaluation.

Nickel

<u>Slippage Test</u>
K_c for nickel is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, nickel passed the Slippage test.

<u>WRS Test</u>
A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

<u>Box Plot</u>
The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-14).

<u>Conclusion</u>
Because the median nickel concentration in sediment is greater than the median background concentration, nickel was carried forward to the Tier 3 evaluation.

Potassium

<u>Slippage Test</u>
K_c for potassium is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, potassium passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-15).

Conclusion

Because the median potassium concentration in sediment is greater than the median background concentration, potassium was carried forward to the Tier 3 evaluation.

Silver

Slippage Test

K_c for silver is 2, and two sample concentrations exceeded the maximum background measurement (K=2). Because $K = K_c$, silver passed the Slippage test.

WRS Test

The WRS test was not performed because the data set contained 50 percent non-detects.

Box Plot

Box plots were not developed for silver because of the high percentage (50 percent) of non-detects in the Site data set.

Hot Measurement Test

The hot measurement test was performed because the WRS test could not be performed. The hot measurement test involved the comparison of the three detected concentrations of silver to the 95th percentile (0.520 mg/kg) of silver in background sediment. The detected concentrations of silver exceed 0.520 mg/kg and failed the hot measurement test.

Conclusion

Silver was carried forward to the Tier 3 testing because the detected concentrations of silver were greater than the 95th percentile value.

Vanadium

Slippage Test

K_c for vanadium is 1, and one sample concentration exceeded the maximum background measurement (K=1). Because $K < K_c$, vanadium passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is greater than the corresponding background values. Additionally, the Site median is greater than the corresponding background median, and the Site interquartile range is greater than the background interquartile range (Figure B-16).

Conclusion

Because the median vanadium concentration in sediment is greater than the median background concentration, vanadium was carried forward to the Tier 3 evaluation.

Zinc

Slippage Test

K_c for zinc is 2, and no sample concentrations exceeded the maximum background measurement (K=0). Because $K < K_c$, zinc passed the Slippage test.

WRS Test

A statistically significant difference exists between the Site median and background at the 80 percent confidence level.

Box Plot

The Site MDC is less than the corresponding background values. However, the Site median is greater than the corresponding background values, and the Site interquartile range is greater than the background interquartile range (Figure B-17).

Conclusion

Because the median zinc concentration in sediment is greater than the median background concentration, zinc was carried forward to the Tier 3 evaluation.

4.0 Results of the Tier 3 Evaluation

This section provides the results of the Tier 3 evaluation of metals in surface water and sediment. The Tier 3 evaluation was performed for a total of five metals in surface water and 17 metals in sediment to identify whether the subject metals concentrations are naturally occurring or are Site related. Scatter plots were developed for each applicable metal-to-metal association. Up to two representative plots for each subject metal are presented in Attachments C and D for surface water and sediment respectively. The following subsections discuss results of the Tier 3 evaluation by medium.

4.1 Tier 3 Evaluation Results for Surface Water

Scatter plots developed for the Tier 3 evaluation of metals in surface water are presented in Attachment C. Table E4-1 presents a summary of the Site related metals for surface water as identified by the Tier 3 evaluation. Discussion of the Tier 3 evaluation of metals in surface water follows.

Arsenic

Arsenic was detected in three of the six Site surface water samples. Because of the small number of detected results the Tier 3 evaluation was not performed. Accordingly, the detected concentrations of arsenic in surface water that exceed the surface water background screening value may be site related.

Cobalt

Cobalt was detected in two of the six Site surface water samples. Because of the small number of detected results the Tier 3 evaluation was not performed. Accordingly, the detected concentrations of cobalt in surface water that exceed the surface water background screening value may be site related.

Magnesium

Analytical results for magnesium in surface water shows limited statistically significant relationships with other metals. The statistical relationships improve if the largest concentration of magnesium (17.9 mg/L) is not included in the scatter plots. With this point omitted, the remaining magnesium results show statistical relationships with barium and calcium. Scatter plots of magnesium versus barium and magnesium versus calcium are shown in Figures C-1 and C-2, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model with the exception of the elevated magnesium concentration (17.9 mg/kg). The elevated concentration of magnesium may be site related.

Manganese

Analytical results for manganese in surface water show a statistically significant relationship with metals including barium, calcium and iron. Scatter plots of manganese versus barium and manganese versus iron are shown in Figures C-3 and C-4, respectively. The analytical results plot near the best-fit linear model. Based on this analysis it is concluded that manganese is naturally occurring in surface water.

Zinc

Analytical results for zinc in surface water do not exhibit significant statistical relationship with other metals detected in surface water. Because of the lack of significant statistical relationships, the detected concentrations of zinc in surface water that exceed the surface water background screening value may be site related.

4.2 Tier 3 Evaluation Results for Sediment

Scatter plots developed for the Tier 3 evaluation of metals in sediment are presented in Attachment D. Table E4-1 presents a summary of the Site related metals for sediment as identified by the Tier 3 evaluation. Discussion of the Tier 3 evaluation of metals in sediment follows.

Aluminum

Analytical results for aluminum in sediment show statistically significant relationships with metals including barium, calcium, copper, lead, magnesium, nickel and potassium. Scatter plots of aluminum versus barium and aluminum versus magnesium are shown in Figures D-1 and D-2, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and it is concluded that aluminum is naturally occurring in sediment.

Antimony

Antimony was detected in three of the six Site sediment samples. Because of the small number of detected results the Tier 3 evaluation was not performed. Accordingly, the detected concentrations of antimony in sediment that exceed the sediment background screening value may be site related.

Arsenic

Analytical results for arsenic in sediment show statistically significant relationships with metals including beryllium, chromium, iron, and vanadium. Scatter plots of arsenic versus iron and arsenic versus vanadium are shown in Figures D-3 and D-4, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and it is concluded that arsenic is naturally occurring in sediment.

Barium

Analytical results for barium in sediment show statistically significant relationships with metals including aluminum, lead, magnesium, nickel and potassium. Scatter plots of barium versus aluminum and barium versus lead are shown in Figures D-5 and D-6, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and it is concluded that barium is naturally occurring in sediment.

Beryllium

Analytical results for beryllium in sediment show a statistically significant relationship with metals including arsenic, iron, nickel and vanadium. Scatter plots of beryllium versus iron and beryllium versus nickel are shown in Figures D-7 and D-8, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and it is concluded that beryllium is naturally occurring in sediment.

Chromium

Analytical results for chromium in sediment show statistically significant relationships with metals in sediment including arsenic and iron. Scatter plots of chromium versus arsenic and chromium versus iron are shown in Figures D-9 and D-10, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and it is concluded that chromium is naturally occurring in sediment.

Cobalt

Analytical results for cobalt in sediment show a statistically significant relationship with nickel. The statistical relationships improve if the two largest concentrations of cobalt (14.9 and 19 mg/kg) are not included in the scatter plots. With these data omitted, the remaining cobalt results show statistical relationships with aluminum, barium, calcium, lead, magnesium and nickel. Scatter plots of cobalt versus barium and cobalt versus calcium are shown in Figures D-11 and D-12, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model with the exception of the two elevated cobalt concentrations (14.9 and 19 mg/kg). The two elevated concentrations of cobalt may be site related.

Copper

Analytical results for copper in sediment shows limited statistical relationships with other metals detected in the sediment samples. The statistical relationships improve if the two largest concentrations of copper (25.1 and 24.2 mg/kg) are not included in the scatter plots. With these data omitted, the remaining copper results show statistical relationships with arsenic, iron, nickel, selenium and vanadium. Scatter plots of copper versus iron and copper versus vanadium are shown in Figures D-13 and D-14, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model with the exception of the two elevated copper concentrations (25.1 and 24.2 mg/kg). The two elevated concentrations of copper may be site related.

Iron

Analytical results for iron in sediment show a statistically significant relationship with metals including arsenic, beryllium, chromium, and vanadium. Scatter plots of iron versus beryllium and iron versus vanadium are shown in Figures D-15 and D-16, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and based on this analysis it is concluded that iron in sediment is naturally occurring.

Lead

Analytical results for lead in sediment show a statistically significant relationship with metals including aluminum, barium, magnesium, nickel, and potassium. Scatter plots of lead versus aluminum and lead versus potassium are shown in Figures D-17 and D-18, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and based on this analysis it is concluded that lead in sediment is naturally occurring.

Magnesium

Analytical results for magnesium in sediment exhibit significant statistical relationships with other metals detected in the sediment including aluminum, barium, calcium, lead and potassium. Scatter plots of magnesium versus aluminum and magnesium versus potassium are shown in Figures D-19 and D-20, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and based on this analysis it is concluded that magnesium in sediment is naturally occurring.

Manganese

Analytical results for manganese in sediment shows limited statistical relationships with other metals detected in the sediment samples. The statistical relationships improve if the largest concentration of manganese (1360 mg/kg) and an anomalously low concentration of manganese are (93.3 mg/kg) not included in the scatter plots. With these data omitted, the remaining manganese results show statistical relationships with calcium, magnesium, and potassium. Scatter plots of manganese versus magnesium and manganese versus potassium are shown in Figures D-21 and D-22, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model with the exception of the elevated manganese concentration (1360 mg/kg). The elevated concentration of manganese may be site related.

Nickel

Analytical results for nickel in sediment show a statistically significant relationship with metals in sediment including aluminum, barium, beryllium, cobalt, lead, and vanadium. Scatter plots of nickel versus cobalt and nickel versus vanadium are shown in Figures D-23 and D-24, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and based on this analysis it is concluded that nickel in sediment is naturally occurring.

Potassium

Analytical results for potassium in sediment exhibit significant statistical relationships with other metals detected in the sediment including aluminum, barium, calcium, lead, and magnesium. Scatter plots of potassium versus aluminum and potassium versus barium are shown in Figures D-25 and D-26, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and based on this analysis it is concluded that potassium in sediment is naturally occurring.

Silver

Silver was detected in three of the six Site sediment samples. Because of the small number of detected results the Tier 3 evaluation was not performed. Accordingly, the detected concentrations of silver in sediment that exceed the sediment background screening value may be site related.

Vanadium

Analytical results for vanadium in sediment show a statistically significant relationship with arsenic, beryllium, iron, and nickel. Scatter plots of vanadium versus arsenic and vanadium versus iron are shown in Figures D-27 and D-28, respectively. The figures show analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and based on this analysis it is concluded that vanadium in sediment is naturally occurring.

Zinc

Analytical results for zinc in sediment show a statistically significant relationship with manganese. A scatter plot of zinc versus manganese is shown in Figure D-29. The figure shows analytical results, the best-fit linear model and associated 95 percent prediction limits. The analytical results plot closely to the best-fit linear model and based on this analysis it is concluded that zinc in sediment is naturally occurring.

5.0 References

Rosenbaum, S., 1954, *Tables for a Nonparametric Test of Location*, Annals of Mathematical Statistics, Vol. 24, pp. 146-150.

Science Application International Corporation (SAIC), 1998, *Final Background Metals Survey Report*, Fort McClellan, Anniston, Alabama, prepared for U.S. Army Corps of Engineers, Mobile, Alabama, July.

U.S. Environmental Protection Agency (EPA), 1989, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance*, Office of Solid Waste, Waste Management Division, EPA/530/SW-89/026, July.

EPA, 1992, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance*, Environmental Statistics and Information Division, Office of Policy, Planning and Evaluation, EPA/530/R-93/003, July.

EPA, 1994, *Statistical Methods for Evaluating the Attainment of Cleanup Standards*, Environmental Statistics and Information Division, Office of Policy, Planning, and Evaluation, EPA/230/R-94/004, June.

EPA, 2000, *Guidance of Data Quality Assessment: Practical Methods for Data Analysis, EPA QA/G-9*, QA00 Update, Office of Environmental Information, EPA/600/R-96/084, July.

U.S. Navy, 2002, *Guidance for Environmental Background Analysis, Volume 1: Soil, NFESC User's Guide UG-2049-ENV*, Naval Facilities Engineering Command, Washington, D.C., April.

Table E3-1: Site to Background Statistical Comparison for Surface Water
Fill Area East of Reilly Airfield, Parcel 227(7) and Former Post Garbage Dump, Parcel 126(7)
McClellan, Anniston, Alabama

	FOD	Tier 1 Evaluation	Hits Above Bkgr Max (K)	Slippage Test	Wilcoxon Rank Sum Test	Hot Measurement Test	Perform Tier 3 Test
Aluminum	2 / 6	Passed	0	NA	NA	Passed	No
Antimony	0 / 6	Passed	0	NA	NA	NA	No
Arsenic	3 / 6	Failed	0	Passed	Failed	NA	Yes
Barium	6 / 6	Passed	0	NA	NA	NA	No
Beryllium	0 / 6	Passed	0	NA	NA	Passed	No
Cadmium	0 / 6	Passed	0	NA	NA	NA	No
Calcium	6 / 6	Failed	0	Passed	Passed	NA	No
Chromium	0 / 6	Passed	0	NA	NA	NA	No
Cobalt	2 / 6	Failed	0	Passed	NA	Failed	Yes
Copper	0 / 6	Passed	0	NA	NA	Passed	No
Iron	6 / 6	Passed	0	NA	NA	NA	No
Lead	0 / 6	Passed	0	NA	NA	Passed	No
Magnesium	6 / 6	Failed	0	Passed	Failed	NA	Yes
Manganese	6 / 6	Failed	0	Passed	Failed	NA	Yes
Mercury	0 / 6	Passed	0	NA	NA	NA	No
Nickel	0 / 6	Passed	0	NA	NA	Passed	No
Potassium	0 / 6	Passed	0	NA	NA	Passed	No
Selenium	0 / 6	Passed	0	NA	NA	NA	No
Silver	0 / 6	Passed	0	NA	NA	NA	No
Sodium	6 / 6	Passed	0	NA	NA	NA	No
Thallium	0 / 6	Passed	0	NA	NA	NA	No
Vanadium	0 / 6	Passed	0	NA	NA	Passed	No
Zinc	5 / 6	Failed	0	Passed	Failed	NA	Yes

Notes:
FOD = frequency of detection
K = number of detected concentrations exceeding the maxiumum background value
NA = not applicable

Table E3-2: Site to Background Statistical Comparison for Sediment
Fill Area East of Reilly Airfield, Parcel 227(7) and Former Post Garbage Dump, Parcel 126(7)
McClellan, Anniston, Alabama

	FOD	Tier 1 Evaluation	Hits above bkgr max (K)	Slippage Test	Wilcoxon Rank Sum Test	Hot Measurement Test	Perform Tier 3 Test
Aluminum	6 / 6	Failed	1	Passed	Failed	NA	Yes
Antimony	3 / 6	Failed	3	Failed	NA	Failed	Yes
Arsenic	6 / 6	Failed	1	Passed	Failed	NA	Yes
Barium	6 / 6	Failed	0	Passed	Passed	NA	No
Beryllium	6 / 6	Failed	2	Passed	Failed	NA	Yes
Cadmium	0 / 6	Passed	0	NA	NA	Passed	No
Calcium	6 / 6	Failed	0	Passed	Passed	NA	No
Chromium	6 / 6	Failed	1	Passed	Failed	NA	Yes
Cobalt	6 / 6	Failed	0	Passed	Failed	NA	Yes
Copper	6 / 6	Failed	0	Passed	Failed	NA	Yes
Iron	6 / 6	Failed	1	Passed	Failed	NA	Yes
Lead	6 / 6	Failed	0	Passed	Failed	NA	Yes
Magnesium	6 / 6	Failed	0	Passed	Failed	NA	Yes
Manganese	6 / 6	Failed	0	Passed	Failed	NA	Yes
Mercury	2 / 6	Passed	0	NA	NA	Passed	No
Nickel	6 / 6	Failed	0	Passed	Failed	NA	Yes
Potassium	6 / 6	Failed	0	Passed	Failed	NA	Yes
Selenium	0 / 6	Passed	0	NA	NA	Passed	No
Silver	3 / 6	Failed	2	Passed	NA	Failed	Yes
Sodium	0 / 6	Passed	0	NA	NA	Passed	No
Thallium	0 / 6	Passed	0	NA	NA	Passed	No
Vanadium	6 / 6	Failed	1	Passed	Failed	NA	Yes
Zinc	6 / 6	Failed	0	Passed	Failed	NA	Yes

Notes:
FOD = frequency of detection
K = number of detected concentrations exceeding the maxiumum background value
NA = not applicable

Table E4-1: Summary of Possible Site-Related Metals
Fill Area East of Reilly Airfield, Parcel 227(7) and Former Post Garbage Dump, Parcel 126(7)
McClellan, Anniston, Alabama

Station Name	Site Related Metals				
Surface Water	**Arsenic (mg/L)**	**Cobalt (mg/L)**	**Magnesium (mg/L)**	**Zinc (mg/L)**	
FA-227-007-SW	0.00563 J	0.00626 J		0.0156 J	
FA-227-008-SW				0.0451 J	
FA-227-009-SW				0.0102 J	
FA-227-010-SW	0.00855 J	0.00828 J		0.00677 J	
FA-227-011-SW			17.9	0.0416 J	
FA-227-012-SW	0.00427 J				
Sediment	**Antimony (mg/kg)**	**Cobalt (mg/kg)**	**Copper (mg/kg)**	**Manganese (mg/kg)**	**Silver (mg/kg)**
FA-227-007-SD		14.9	25.1		1.14 J
FA-227-008-SD	6.63 J		24.2		
FA-227-009-SD				1360	1.15 J
FA-227-010-SD	6.84 J				1.01 J
FA-227-011-SD	3.22 J	19			
FA-227-012-SD					

Notes:
J = Estimated value. The analyte is positively identified and the concentration is less than the reporting limit but greater than the method detection limit.
mg/L = milligrams per liter
mg/kg = milligrams per liter

ATTACHMENT A

BOX PLOT COMPARISON FOR SURFACE WATER SAMPLES

Figure A-1: Box Plot Comparison For Arsenic in Surface Water

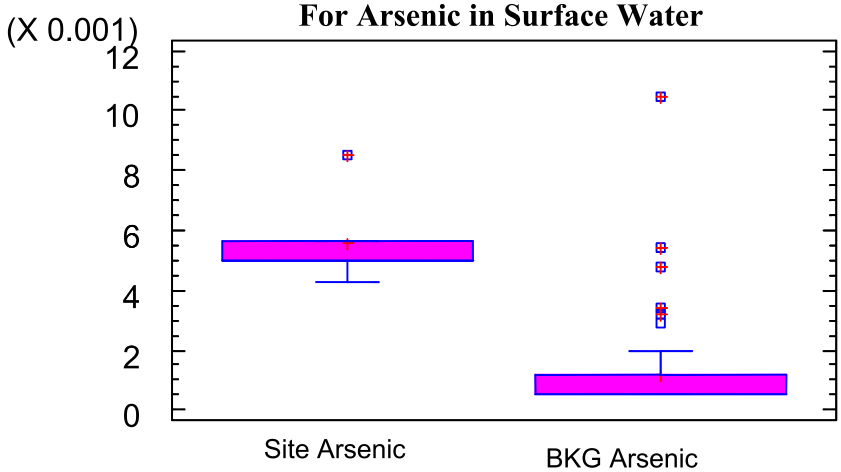


Figure A-2: Box Plot Comparison for Calcium in Surface Water

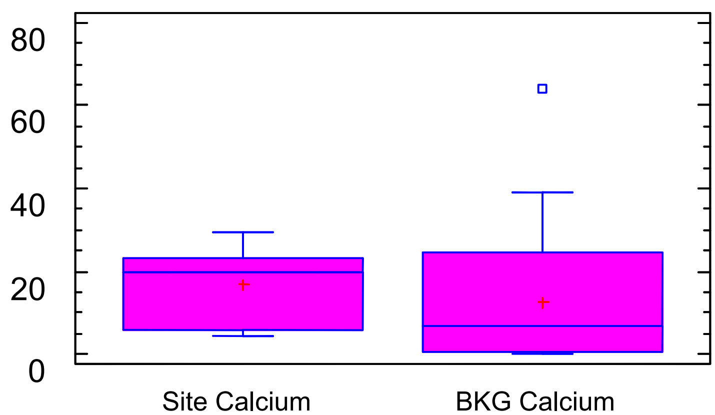


Figure A-3: Box Plot Comparison For Magnesium in Surface Water

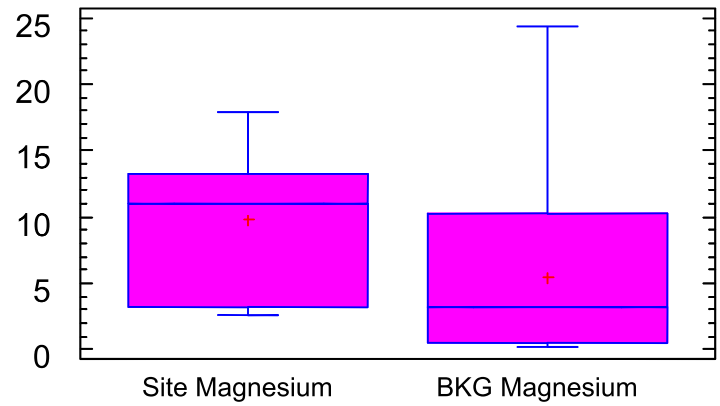


Figure A-4: Box Plot Comparison for Manganese in Surface Water

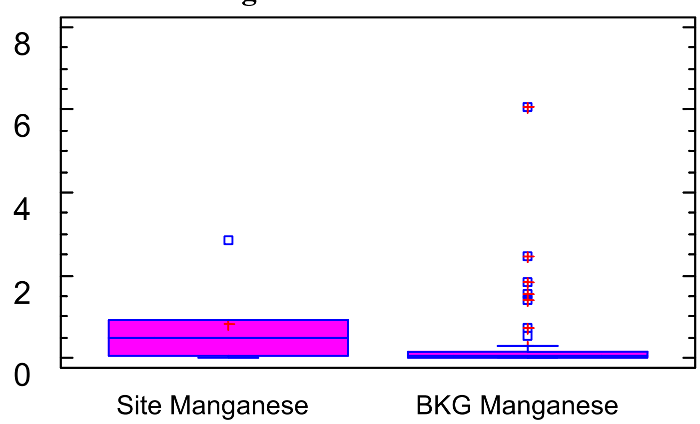
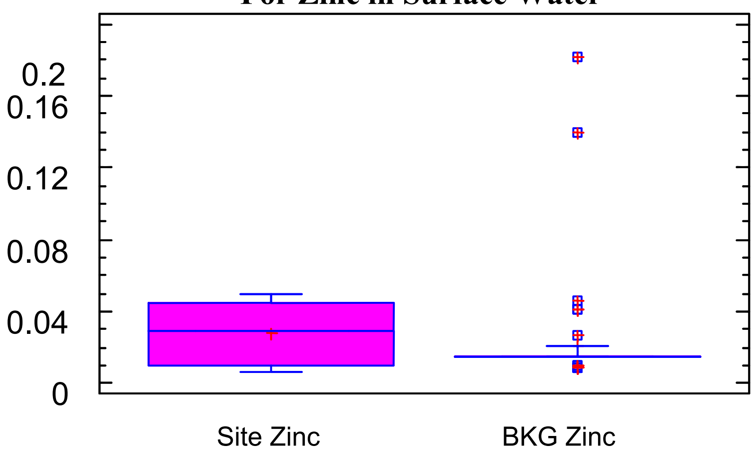


Figure A-5: Box Plot Comparison For Zinc in Surface Water



ATTACHMENT B

BOX PLOT COMPARISON FOR SEDIMENT SAMPLES

Figure B-1: Box Plot Comparison for Aluminum in Sediment

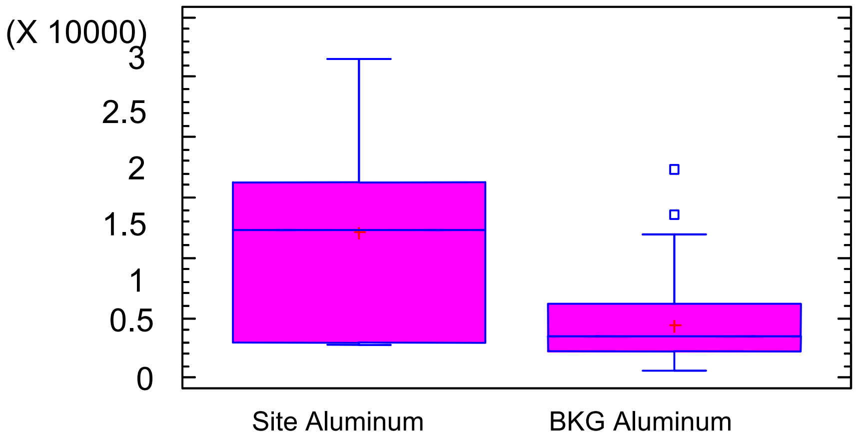


Figure B-2: Box Plot Comparison for Antimony in Sediment

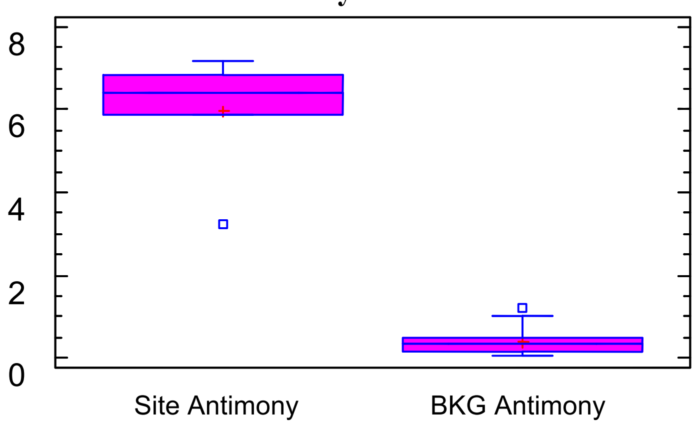


Figure B-3: Box Plot Comparison for Arsenic in Sediment

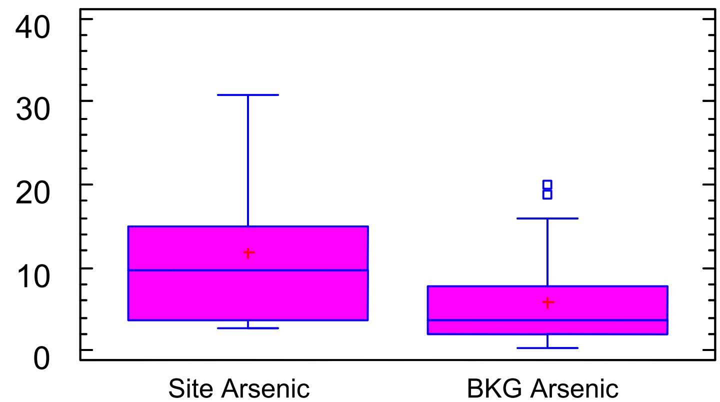


Figure B-4: Box Plot Comparison for Barium in Sediment

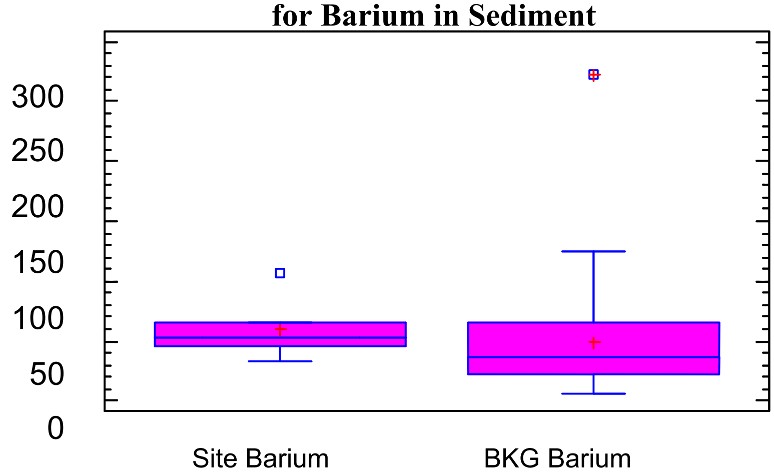


Figure B-5: Box Plot Comparison for Beryllium in Sediment

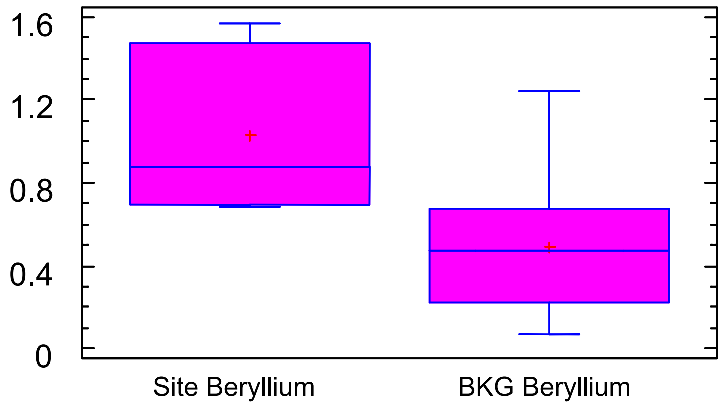


Figure B-6: Box Plot Comparison for Calcium in Sediment

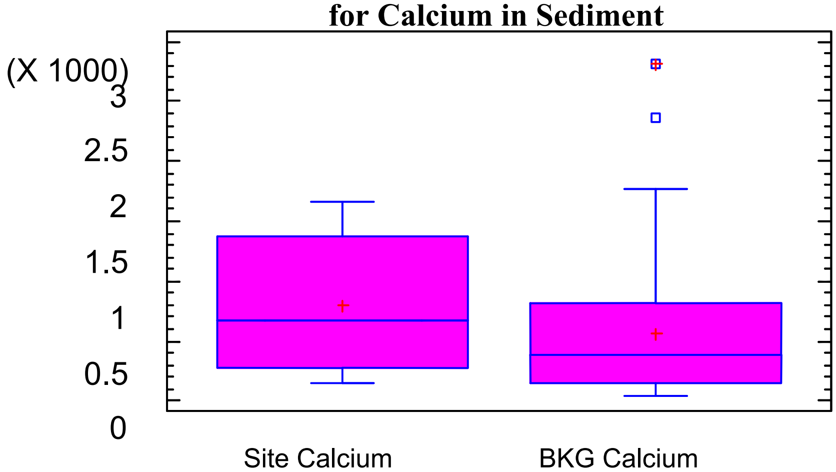


Figure B-7: Box Plot Comparison for Chromium in Sediment

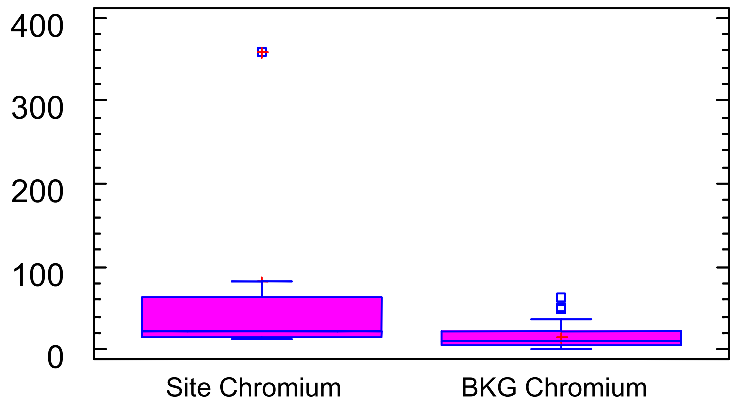


Figure B-8: Box Plot Comparison for Cobalt in Sediment

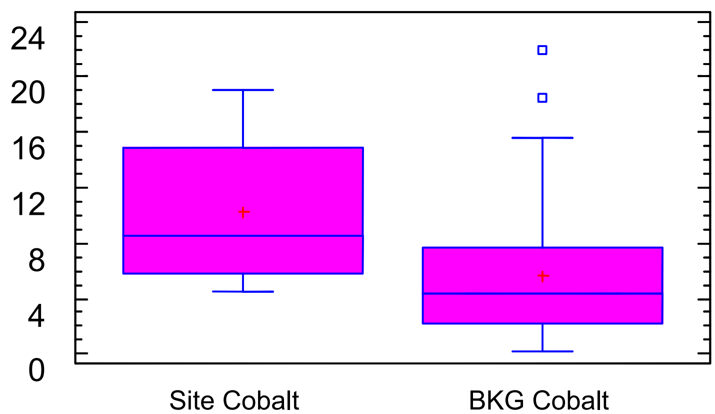


Figure B-9: Box Plot Comparison for Copper in Sediment

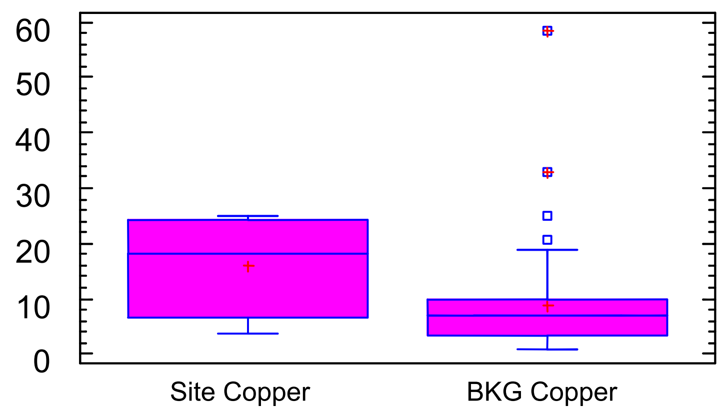


Figure B-10: Box Plot Comparison for Iron in Sediment

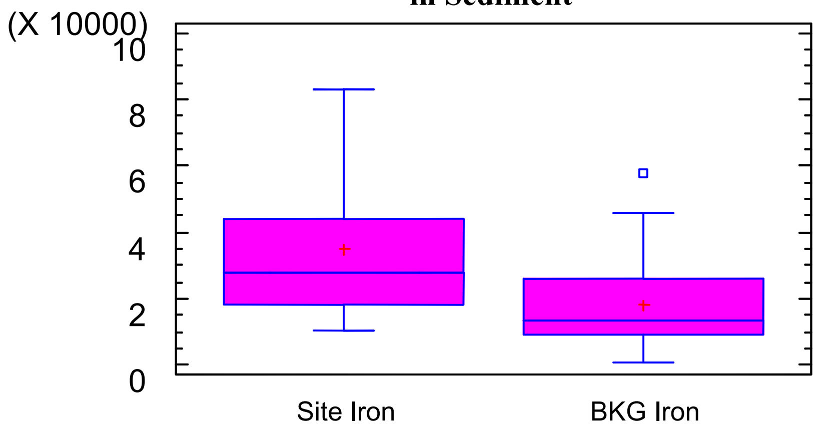


Figure B-11: Box Plot Comparison for Lead in Sediment

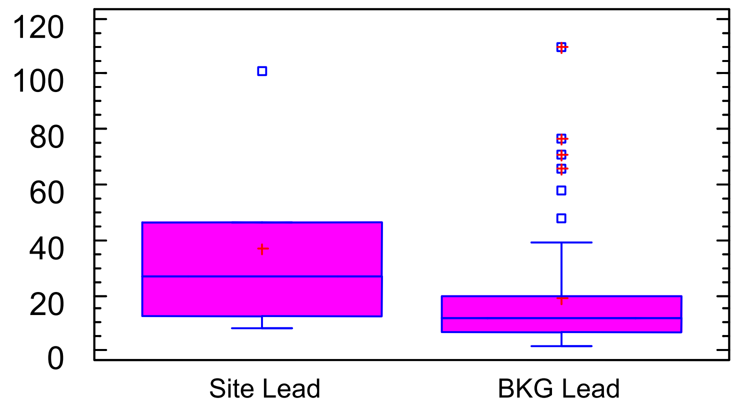


Figure B-12: Box Plot Comparison for Magnesium in Sediment

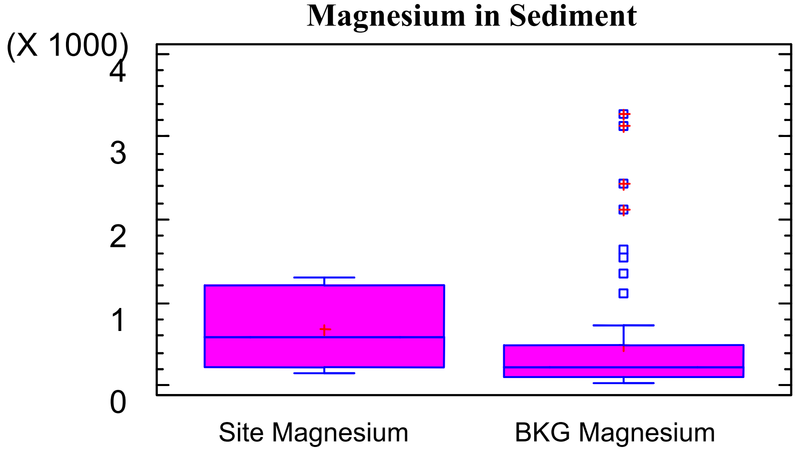


Figure B-13: Box Plot Comparison for Manganese in Sediment

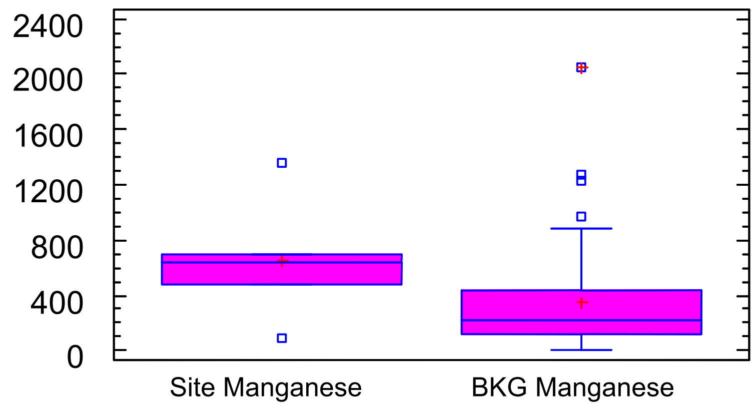


Figure B-14: Box Plot Comparison for Nickel in Sediment

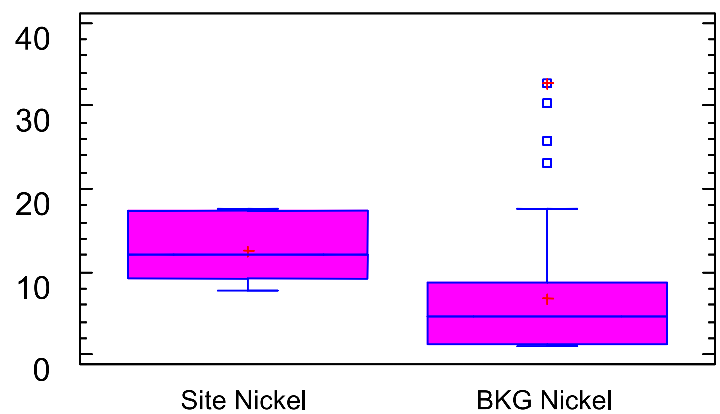


Figure B-15: Box Plot Comparison for Potassium in Sediment

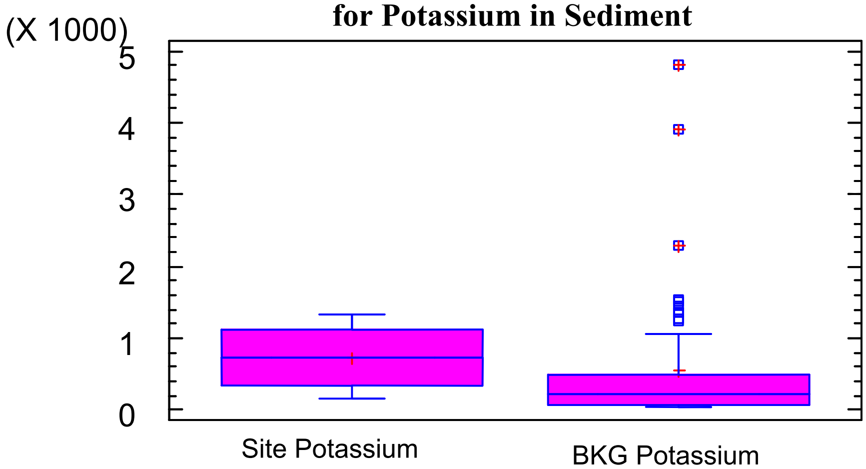


Figure B-16: Box Plot Comparison for Vanadium in Sediment

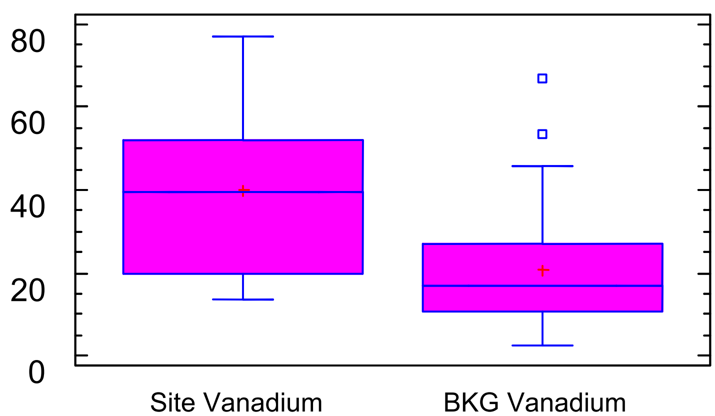
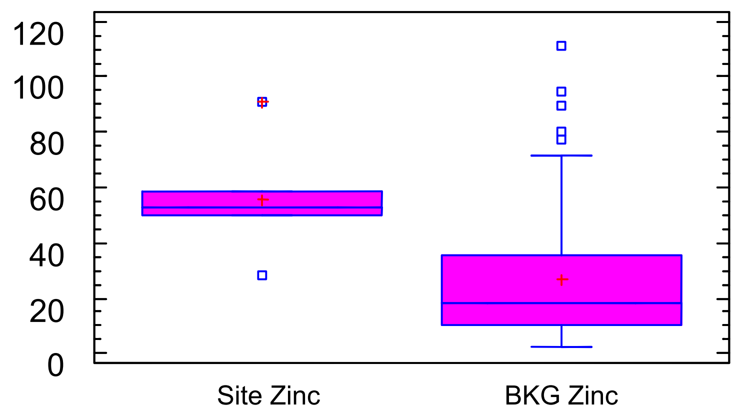


Figure B-17: Box Plot Comparison for Zinc in Sediment



ATTACHMENT C

METAL-TO-METAL ASSOCIATIONS FOR SURFACE WATER RESULTS

Figure C-1: Magnesium vs Barium in Surface Water

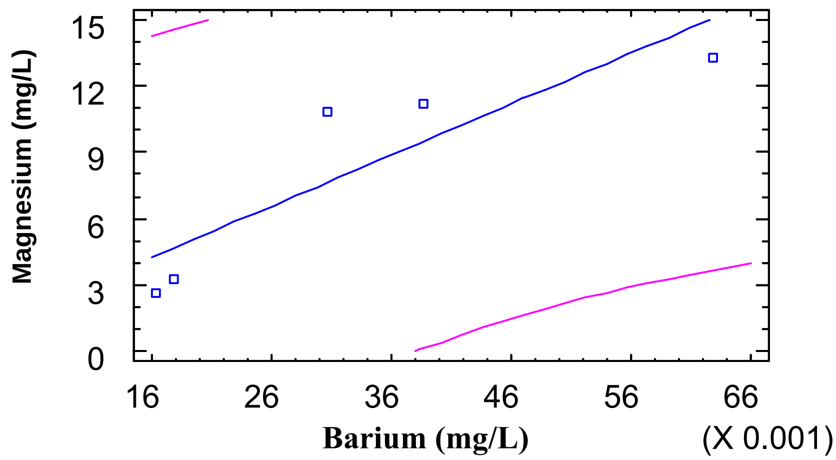


Figure C-2: Magnesium vs Calcium in Surface Water

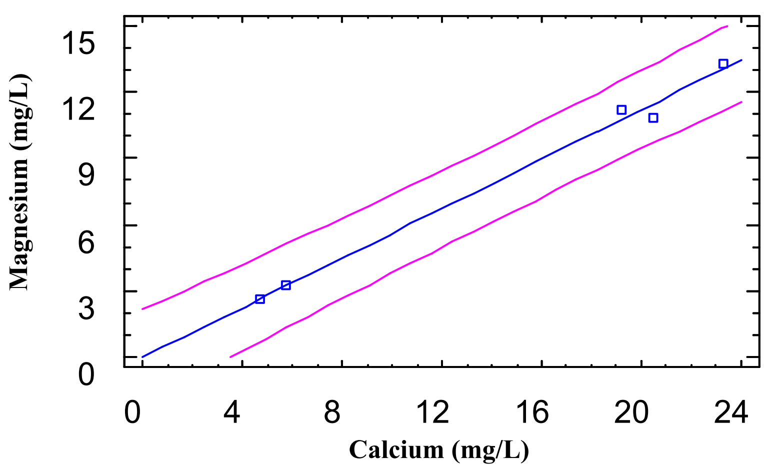


Figure C-3: Manganese vs Barium in Surface Water

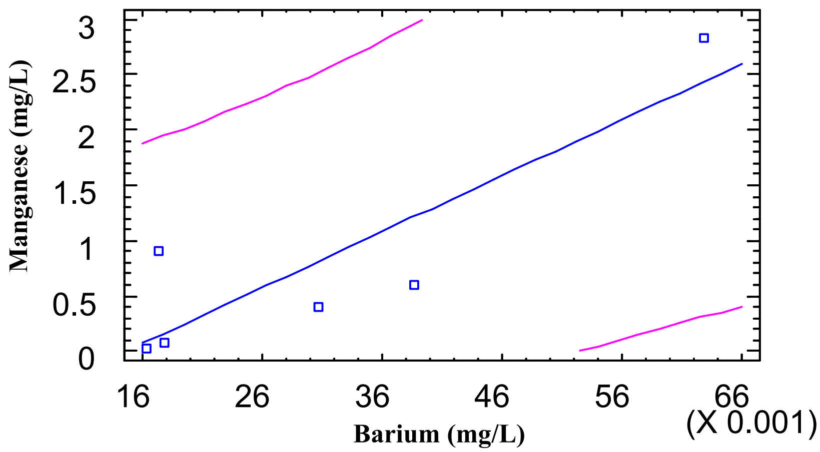
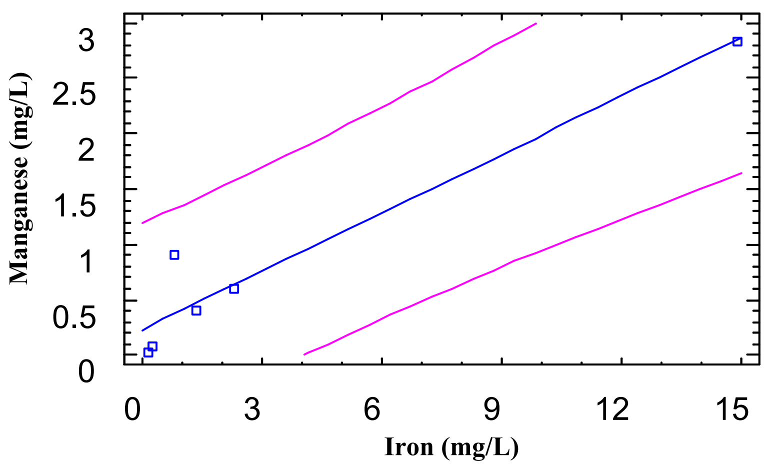


Figure C-4: Manganese vs Iron in Surface Water



ATTACHMENT D

METAL-TO-METAL ASSOCIATIONS FOR SEDIMENT RESULTS

Figure D-1: Aluminum vs Barium in Sediment

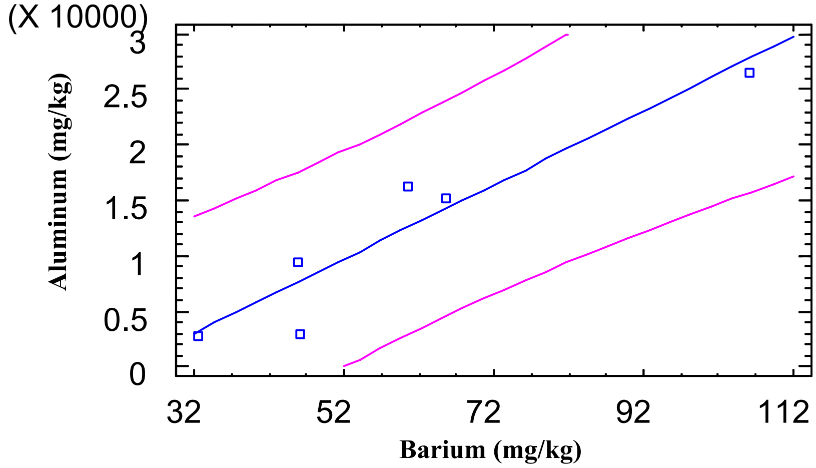


Figure D-2: Aluminum vs Magnesium in Sediment

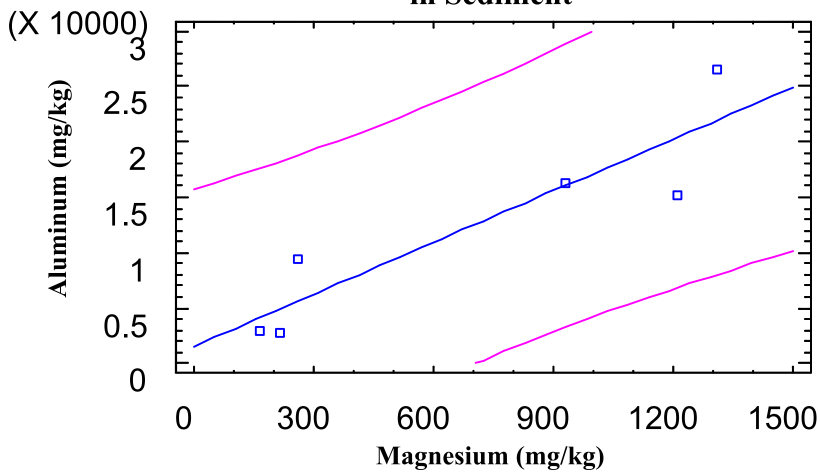


Figure D-3: Arsenic vs Iron in Sediment

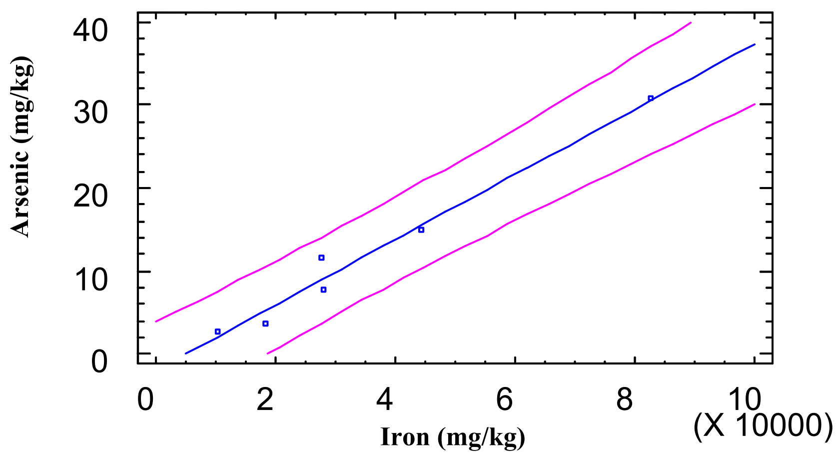


Figure D-4: Arsenic vs Vanadium in Sediment

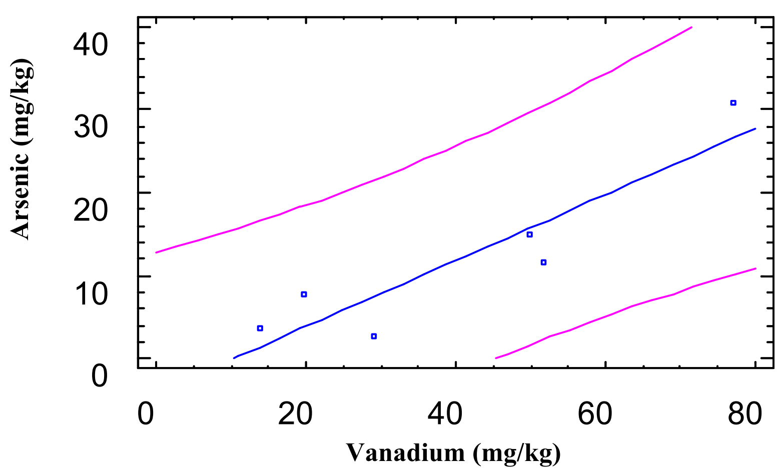


Figure D-5: Barium vs Aluminum in Sediment

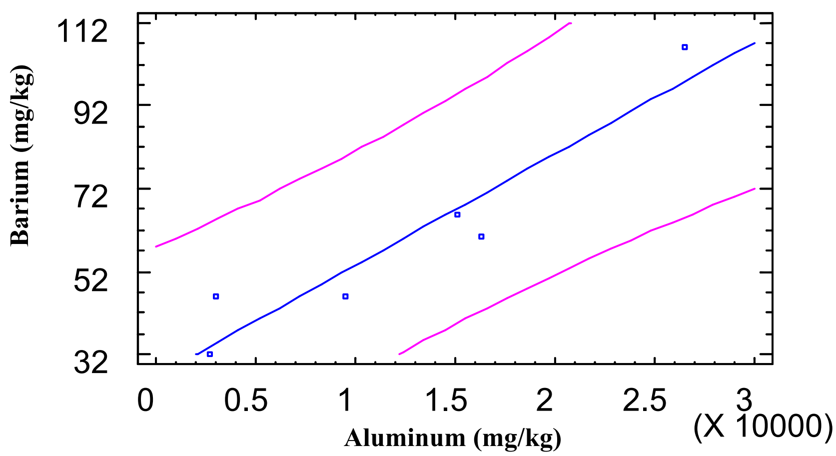


Figure D-6: Barium vs Lead in Sediment

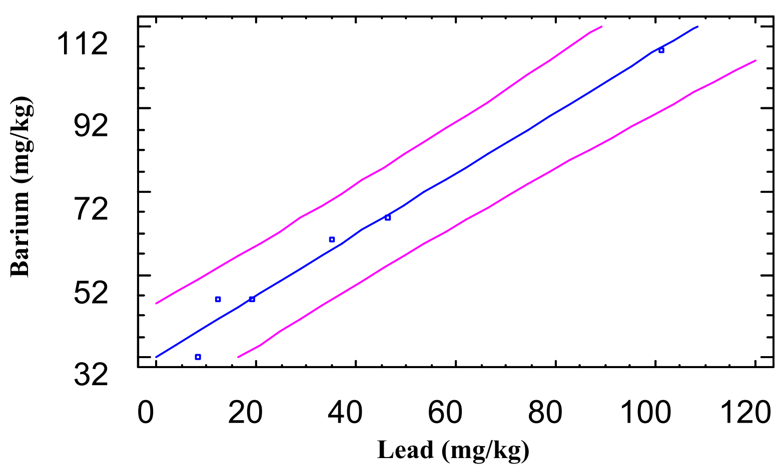


Figure D-7: Beryllium vs Iron in Sediment

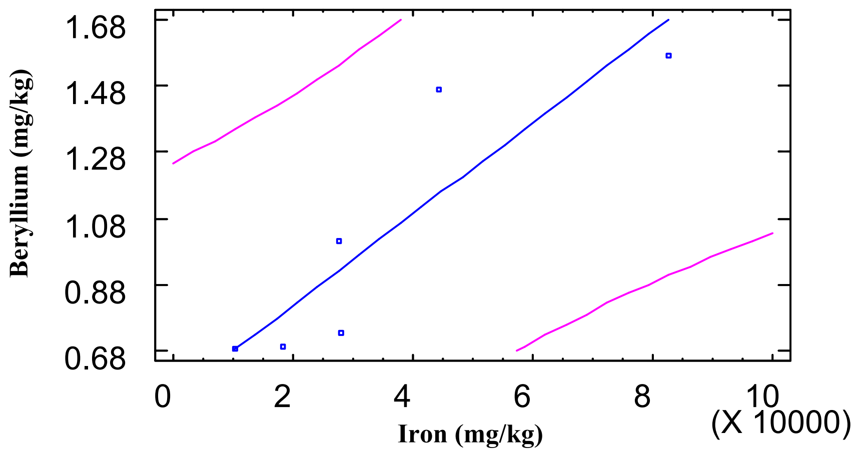


Figure D-8: Beryllium vs Nickel in Sediment

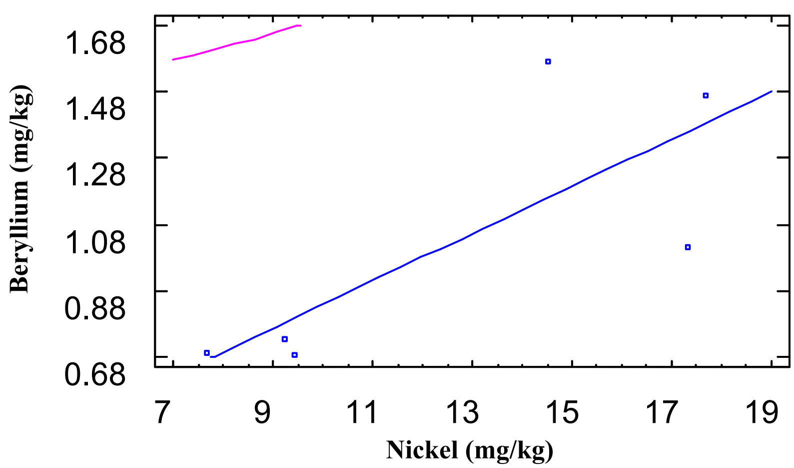


Figure D-9: Chromium vs Arsenic in Sediment

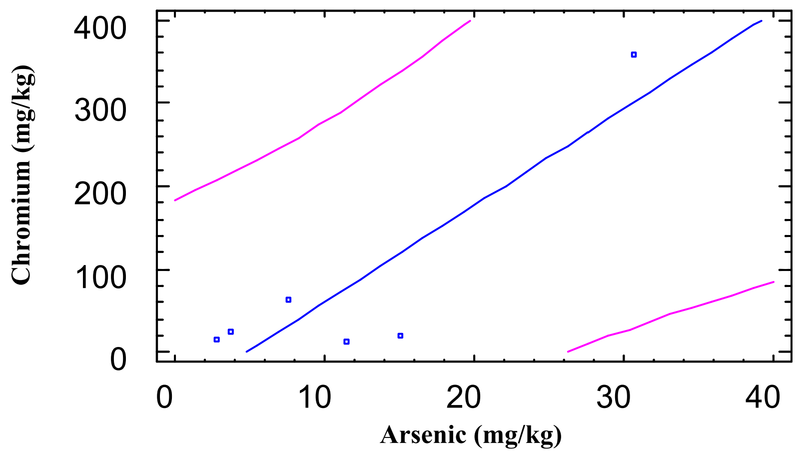


Figure D-10: Chromium vs Iron in Sediment

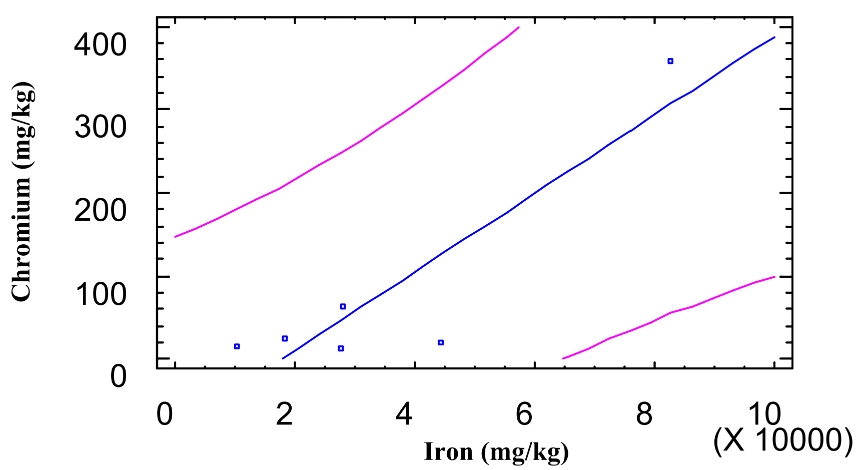


Figure D-11: Cobalt vs Barium in Sediment

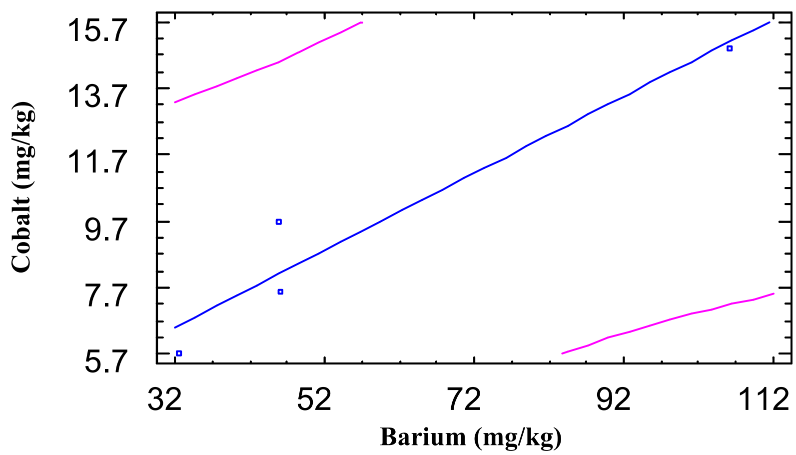


Figure D-12: Cobalt vs Calcium in Sediment

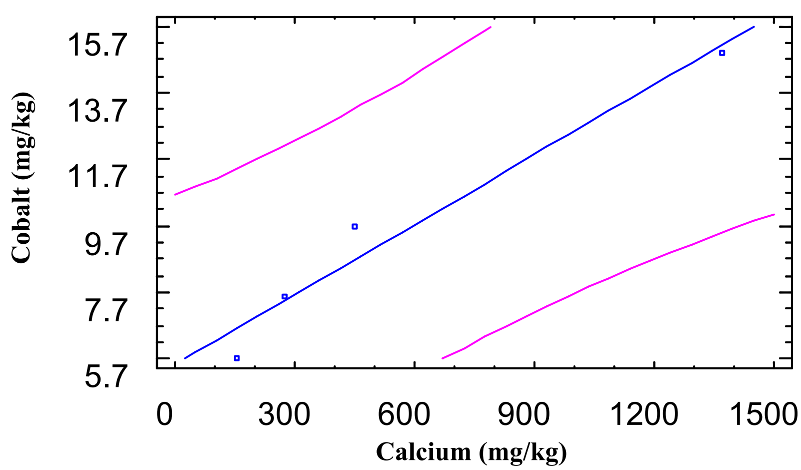


Figure D-13: Copper vs Iron in Sediment

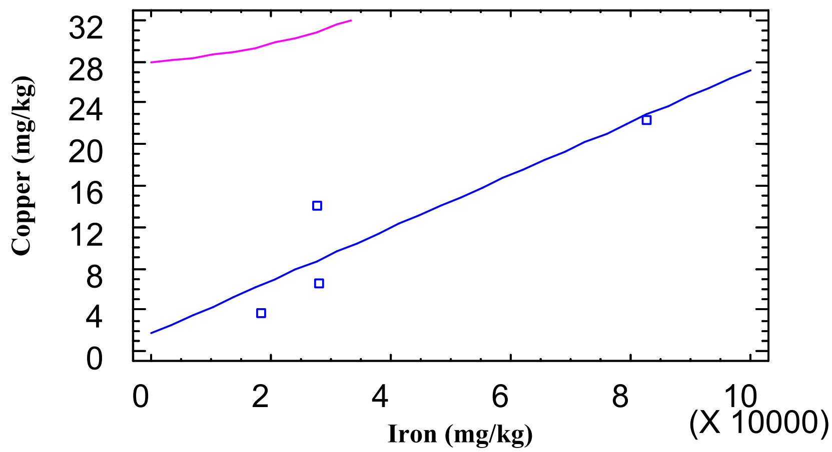


Figure D-14: Copper vs Vanadium in Sediment

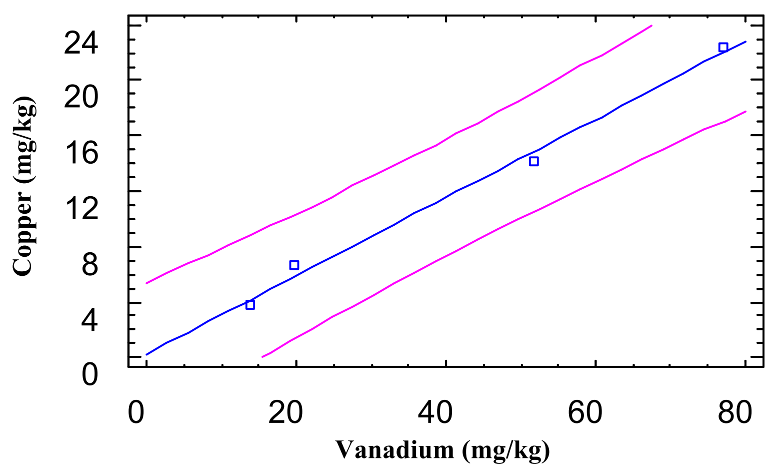


Figure D-15: Iron vs Bervllium in Sediment

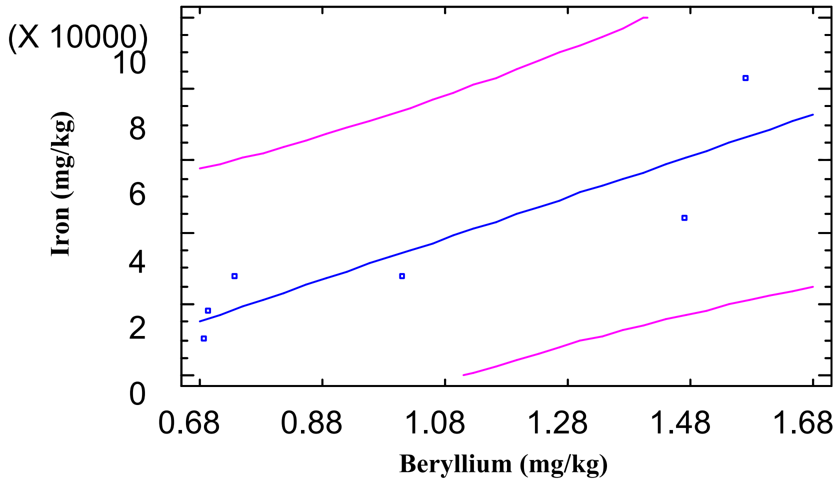


Figure D-16: Iron vs Vanadium in Sediment

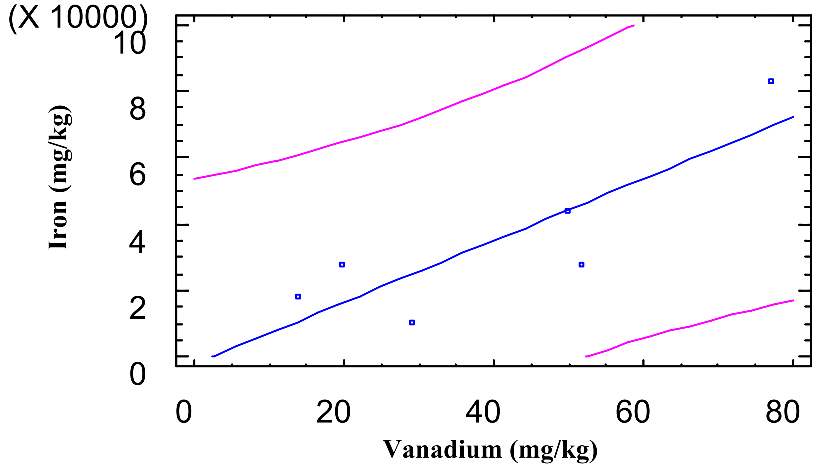


Figure D-17: Lead vs Aluminum in Sediment

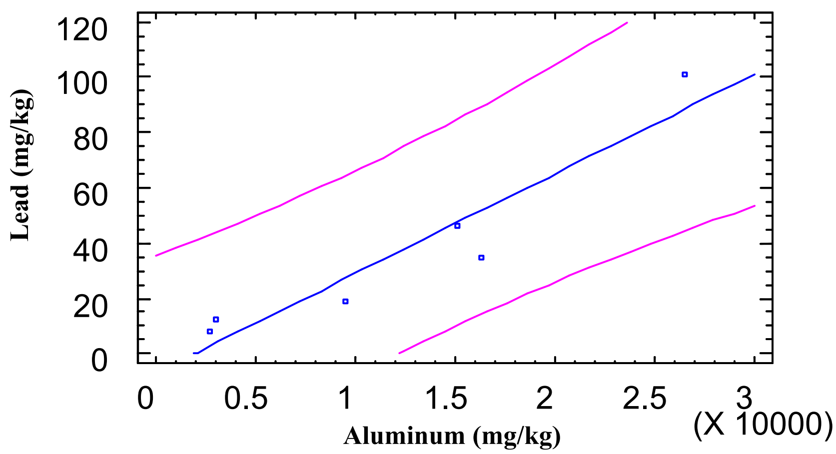


Figure D-18: Lead vs Potassium in Sediment

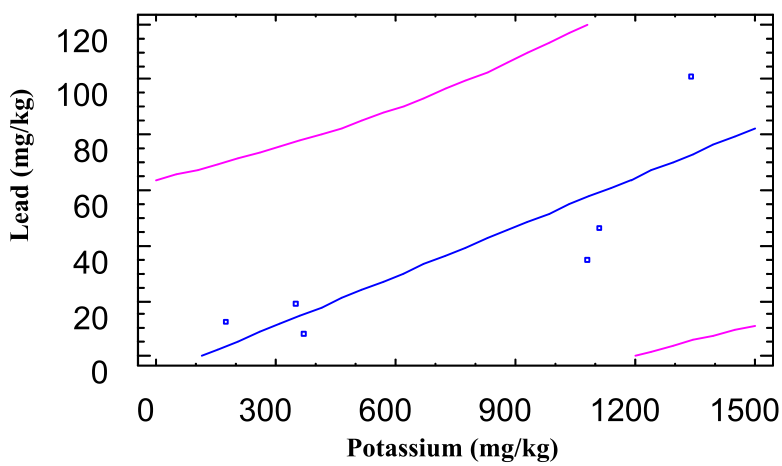


Figure D-19: Magnesium vs Aluminum in Sediment

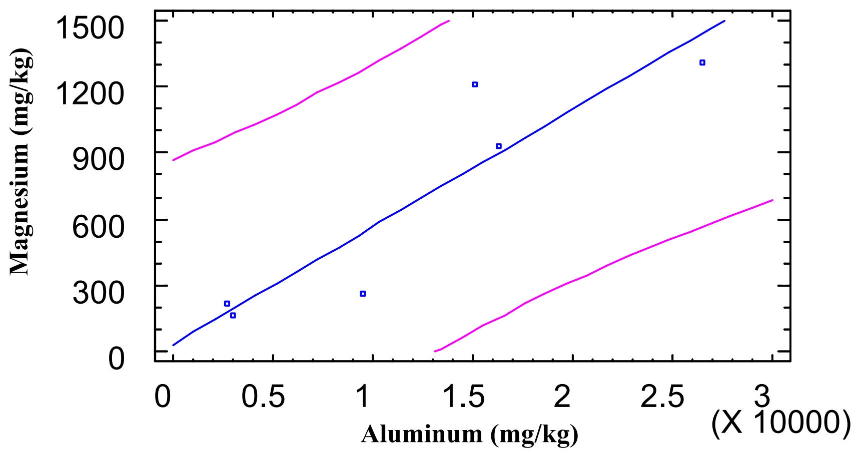


Figure D-20: Magnesium vs Potassium in Sediment

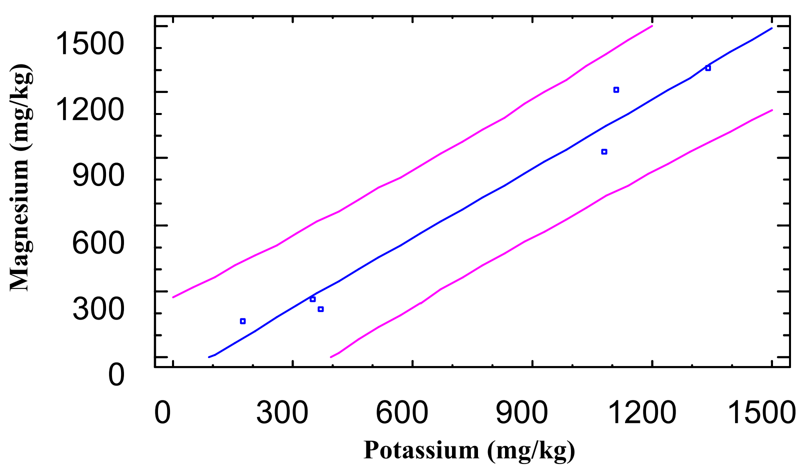


Figure D-21: Manganese vs Magnesium in Sediment

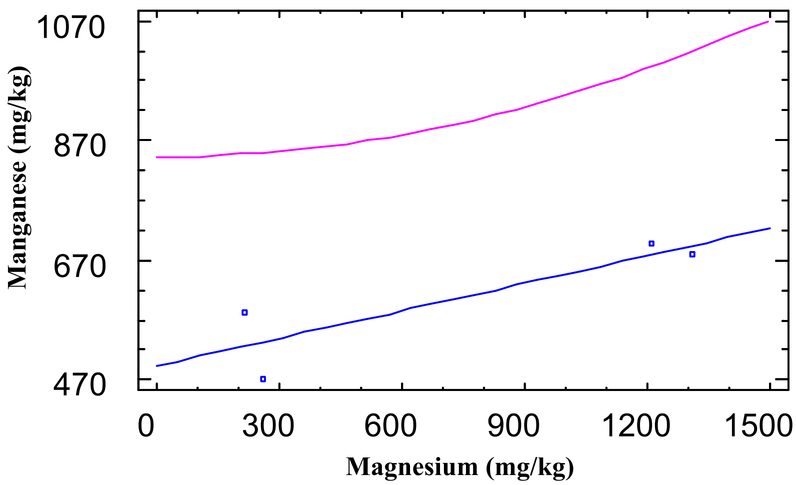


Figure D-22: Manganese vs Potassium in Sediment

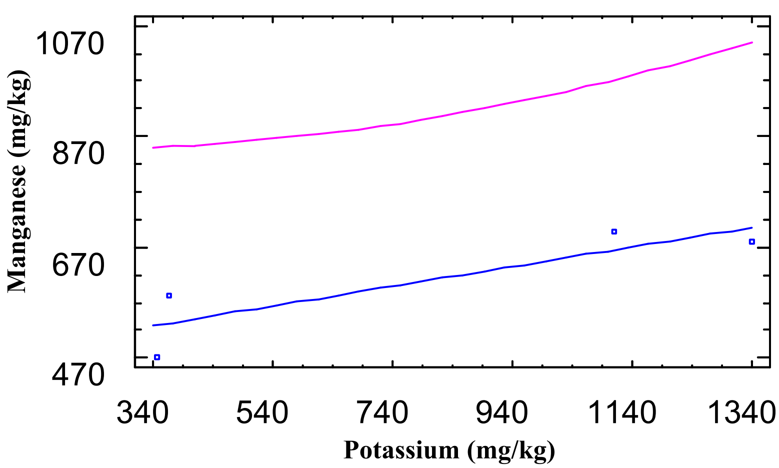


Figure D-23: Nickel vs Cobalt in Sediment

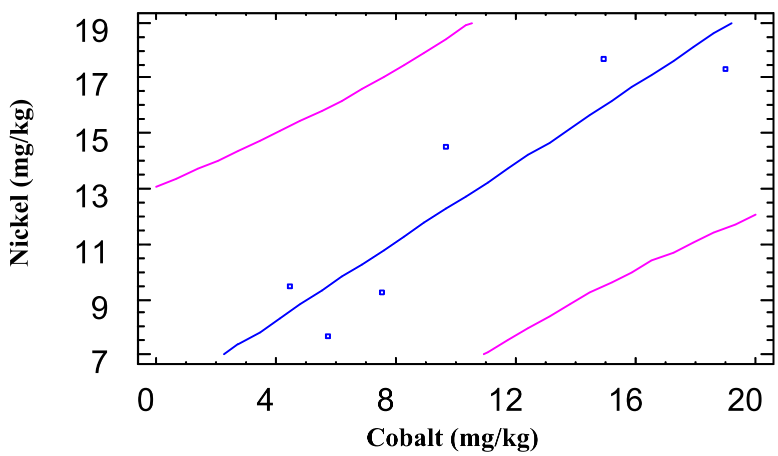


Figure D-24: Nickel vs Vanadium in Sediment

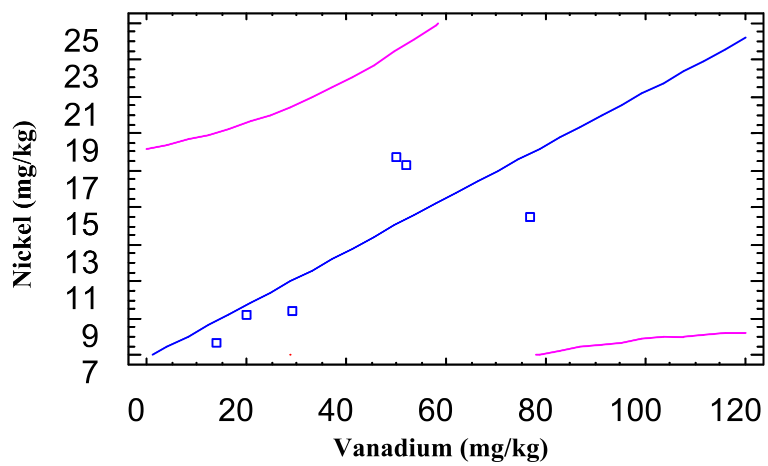


Figure D-25: Potassium vs Aluminum in Sediment

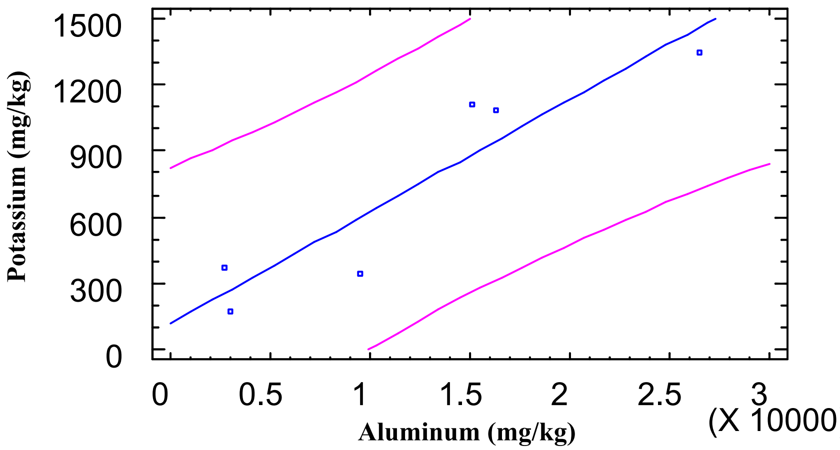


Figure D-26: Potassium vs Barium in Sediment

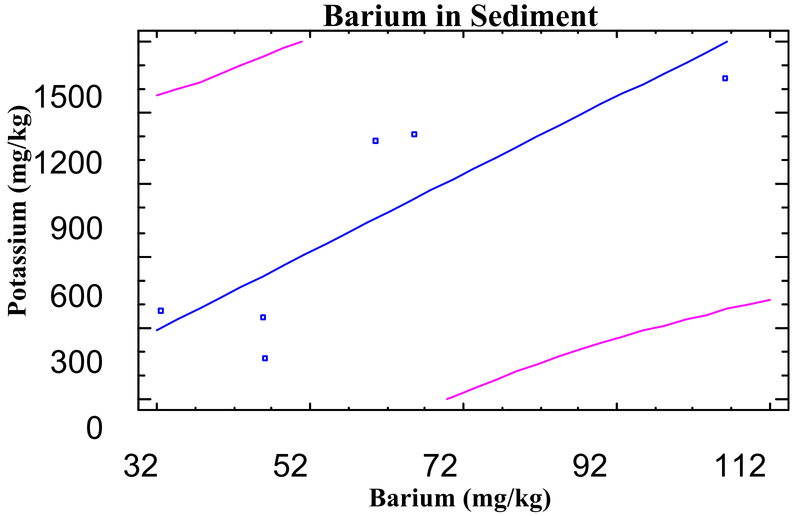


Figure D-27: Vanadium vs Arsenic in Sediment

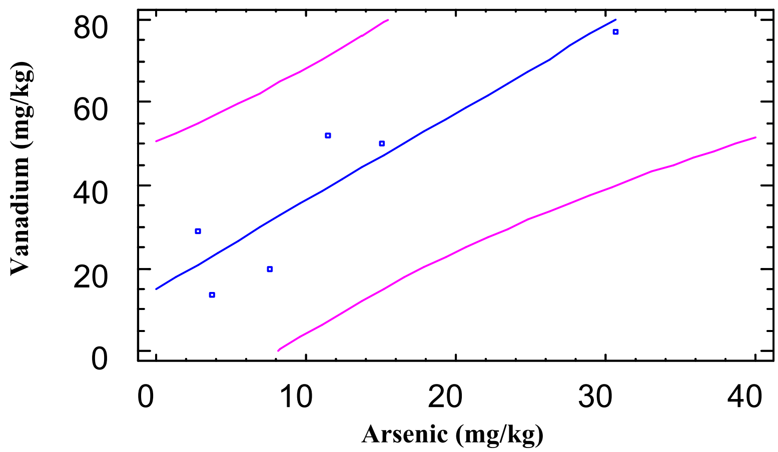


Figure D-28: Vanadium vs Iron in Sediment

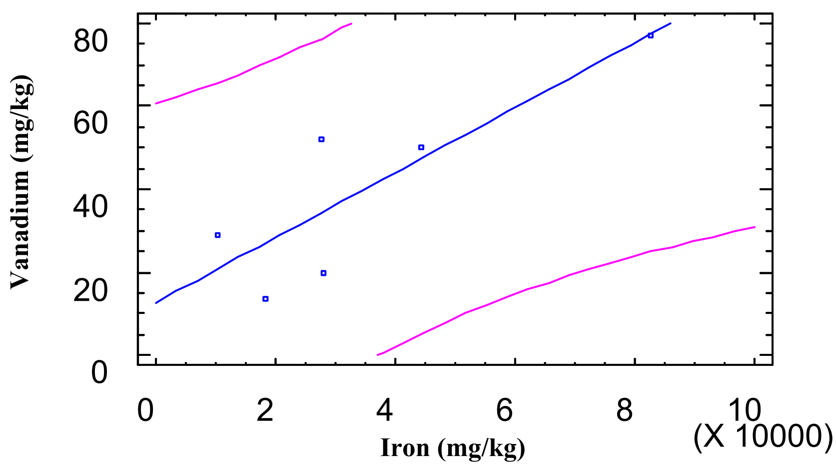


Figure D-29: Zinc vs Manganese in Sediment