# CALCULATION OF LEACHING-BASED SITE-SPECIFIC LEVELS BMI BETA DITCH/ NORTHWESTERN DITCHES LOCATED ON THE TITANIUM METALS CORPORATION PLANT SITE BMI COMMON AREAS CLARK COUNTY, NEVADA

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**JURAT**

*I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations and ordinances.*

For the services provided and attested to with this Jurat including compilation of information collected by other firms for incorporation into this Calculation of Leaching-Based Site-Specific Levels for the Beta Ditch Project and preparation of responses to NDEP comments on same:

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## CONTENTS

FIGURES ..... V
TABLES ..... V
ACRONYMS AND ABBREVIATIONS ..... VI
1.0 INTRODUCTION ..... 1
2.0 BASIS OF EVALUATION ..... 1
2.1 NDEP GUIDANCE ..... 2
2.2 SELECTION OF RISK BASED GROUNDWATER CONCENTRATIONS ..... 3
2.3 SOIL PHYSICAL PROPERTIES RESULTS ..... 3
2.3.1 Bulk Density ..... 3
2.3.2 Porosity, Moisture Content and Air Filled Porosity ..... 4
2.3.3 Fraction Organic Carbon ..... 4
2.4 CALCULATION OF DILUTION ATTENUATION FACTOR ..... 4
2.4.1 Hydraulic Conductivity ..... 5
2.4.2 Hydraulic Gradient ..... 5
2.4.3 Aquifer Thickness/Mixing Zone Depth ..... 5
2.4.4 Source Length ..... 5
2.4.5 Infiltration Rate ..... 5
2.5 ESTIMATION OF DISTRIBUTION COEFFICIENT ..... 8
3.0 SELECTION OF CHEMICALS OF POTENTIAL CONCERN ..... 8
3.1 INORGANICS ..... 8
3.2 ORGANICS ..... 9
4.0 CALCULATION OF LSSLS ..... 9
4.1 INORGANICS ..... 10
4.2 ORGANICS ..... 10
4.3 SITE-SPECIFIC LSSLS ..... 11
5.0 REFERENCES ..... 12

## CONTENTS (Continued)

### Appendices


A NDEP Comments and TIMET's Response to Comments

B Soil Physical Properties Report

C Precipitation, Runoff and Water Loss in Lower Colorado River – Salton Sea Area

D Statistical Evaluation of Inorganics and Radionuclides

E Soil Data Compared To LBCL DAF Values

F Laboratory Data Reports


## FIGURES


1 Site Location Map (Figure 1 from SAP)

2 Locations of Soil Borings Relative to Beta/Northwestern Ditches

3 Conceptual Stormwater Catchment Basin Design

4 Relationship Between Runoff and Cumulative Ponded Water

5 Dilution Attenuation Factor as a Function of Infiltration


## TABLES


1 Inorganic Screening Results

2 Organic Screening Results

3 Calculation of LSSLs at DAF-1 for Beta/Northwestern Ditch

4 Calculation of LSSLs at DAF-2.5 and DAF-66 for Beta/Northwestern Ditch

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BCL | Basic Comparison Level |
| BMI | Basic Metals Incorporated |
| $C_t$ | target concentration |
| DAF | dilution attenuation factor |
| $f_{oc}$ | fraction organic carbon |
| GiSdT | Guided Interactive Statistical Decision Tools |
| LBCL | Leaching-Based Basic Comparison Level |
| LSSL | Leaching-Based Site-Specific Level |
| LSSLs | Leaching-Based Site-Specific Levels |
| LVVSQMC | Las Vegas Valley Stormwater Quality Management Committee |
| MCL | Maximum Contaminant Level (USEPA) |
| NDEP | Nevada Division of Environmental Protection |
| RBGC | Risk-Based Groundwater Concentration |
| SPLP | Synthetic Precipitation Leaching Procedure |
| SWP | soil-water partition |
| TAC | Texas Administrative Code |
| TIMET | Titanium Metals Corporation |
| Tronox | Tronox LLC (formerly Kerr-McGee Chemical Corporation) |
| USEPA | U.S. Environmental Protection Agency |

## 1.0 INTRODUCTION

This technical memorandum has been prepared to present the results of further analysis of the soil leaching to groundwater pathway for the BMI Beta Ditch and Northwestern Ditches at the Titanium Metals Corporation (TIMET) Plant Site in Henderson, Nevada (Figure 1). The analysis was performed on samples collected from over thirty soil borings installed in three boring transects along the alignment of these two ditch features. TIMET performed data validation on data utilized in this evaluation. Data validation was presented to the NDEP in a document dated January 4, 2012 entitled *Data Validation Summary Report for 2011 Beta and Northwest Ditches Soil Data*. In 2013, NDEP requested a re-submittal of this document taking into account updated NDEP data validation guidance. TIMET submitted a revised data validation summary report (DVSR) to the NDEP on March 19, 2013; responded to NDEP comments on the DVSR report on April 10, 2013; provided clarification of the DVSR in electronic mail (e-mail) dated April 23, 2013; and received NDEP approval of the DVSR for 2011 data on April 29, 2013.

This analysis was performed in accordance with Attachment A — *Further Evaluation of Soil Leaching to Groundwater to the Nevada Division of Environmental Protection (NDEP) Basic Comparison Levels (BCLs) for use at the BMI Complex and Common Areas in Henderson Nevada* (NDEP 2009) and *Soil to Groundwater Leaching Guidance* (NDEP 2010).

The *User's Guide and Background Technical Document* (NDEP 2012) provides leaching-based BCLs (LBCLs) for organic and inorganic chemicals and eight radionuclides. Site-related contaminants were compared to LBCLs, and if exceedances were observed, or if LBCLs were not provided, Leaching-Based Site-Specific Levels (LSSLs) were computed using soil properties obtained during the investigation of the Beta/Northwestern Ditches.

The LSSLs were computed to evaluate soil that poses a current and/or future threat to ground water. Contaminant concentrations that exceed protective LSSLs will form the basis for removal of soil from select reaches of the Beta/Northwestern Ditches and the future stormwater catchment. Volumes of soil may exceed the LSSL for one or more contaminants; therefore, exceedance of one contaminant relative to the LSSL may define a volume of soil requiring removal even if other contaminants are below their respective LSSLs.

## 2.0 BASIS OF EVALUATION

The evaluation and calculation of LSSLs presented herein are based on NDEP guidance (2012 and 2010). During the course of the field investigation, numerous samples were collected and analyzed for soil physical properties, pH, cation exchange and fraction organic carbon. These "site specific data" provide the basis for adjusting LBCLs to site-specific soil conditions rendering LSSLs. In addition, infiltration is estimated, and dilution attenuation factors (DAFs) are calculated using site specific Darcy velocity, aquifer thickness and source length.

## 2.1 NDEP GUIDANCE

NDEP Guidance (2010) provides the progression of evaluating the soil-leaching-to-groundwater pathway, which includes, in order of application:

1. Comparison of soil chemical concentrations to LBCLs (NDEP, 2012) which employs a simple linear equilibrium equation with generic default values (U.S. EPA, 1996a and 1996b) for input parameters to the soil-water-partition (SWP) equation with site-specific data;

2. LSSLs which substitute site-specific data for the conservative, default input values;

3. Unsaturated zone fate-and-transport modeling, also employing site-specific data; and

4. SPLP testing as required to support either the SWP equation or unsaturated zone fate-and-transport modeling.

NDEP guidance notes that unsaturated zone modeling and use of SPLP assumes that unimpacted soil exists below the zone of contamination and the water table, such that migration via leaching of contaminants through this unimpacted zone would have to occur to impact underlying groundwater. If existing contamination is found to extend to the water table, then use of unsaturated zone modeling or SPLP is not recommended.

In the proposed stormwater catchment, contamination extends from the base of the ditch to the water table, thus neither modeling nor use of SPLP is applicable, and the LSSLs presented herein form the site-specific soil concentrations protective of groundwater. The Beta/Northwestern Ditches are generally impacted at shallower depths; therefore, application of modeling or SPLP may be warranted if the LSSLs computed herein do not prove protective.

The steps associated with computing LSSLs in accordance with NDEP guidance include:

1. Compare metals and radionuclide concentrations to background to determine if soil concentrations exceeded background. Those metals with concentrations exceeding background were retained for comparison with LBCL.

2. Comparison of soil contaminant concentrations to DAF-1 and DAF-20 LBCLs. For this analysis, if a contaminant concentration exceeded the DAF-1 LBCL, it was retained for computation of LSSLs at site-specific DAF.

3. Evaluation of soil physical properties. Porosity, water-filled porosity, air-filled porosity, dry bulk density, and fraction organic carbon were averaged to derive representative site specific values for use in the SWP.

4. Values for distribution coefficient ($K_d$) were obtained from the literature for metals, in some cases adjusted for pH dependence, and estimated by calculation for organics. For organics, $K_d$ was estimated as the octanol-water partition coefficient ($K_{oc}$) times the fraction organic carbon ($f_{oc}$).

5. Risk-based groundwater concentrations were obtained from NDEP guidance.

6. LSSL target concentrations ($C_t$) were then computed at DAF-1. $C_t$ is linear in DAF; therefore, $C_t$ at DAF-1 times a computed site-specific DAF equals the appropriate target concentration at the computed DAF.

## 2.2 SELECTION OF RISK BASED GROUNDWATER CONCENTRATIONS

RBGC were obtained from *Basic Comparison Levels (BCLs) for use at the BMI Complex and Common Areas in Henderson Nevada* (NDEP 2012), and consist of EPA Safe Drinking Water Act Maximum Contaminant Levels (MCLs), and cancer and non-cancer risk based screening levels computed in accordance with *The User's Guide and Background Technical Document* (NDEP 2012).

## 2.3 SOIL PHYSICAL PROPERTIES RESULTS

As part of the investigation of the Northwestern and Beta Ditches, thirteen soil samples were analyzed for bulk density, moisture content, and porosity. Particle size and Atterberg limits were analyzed to establish Unified Soil Classification System soil type. Cation exchange was analyzed to assist in estimating distribution coefficient for inorganics, and hydraulic conductivity to evaluate permeability of soil. Sixty samples at varying depths and locations (including the 13 just described) were analyzed for fraction organic carbon to evaluate sorption and distribution coefficients for organics on site soils. The laboratory report for the physical analysis is included in Appendix B.

In order to calculate LSSLs using site specific parameters, bulk density, porosity, initial moisture content and soil pH were used. The arithmetic mean of the soil results was computed and these values used (Appendix B). Soil pH is contained in the analytical laboratory report (Appendix F).

### 2.3.1 Bulk Density

The average bulk density for 13 samples collected from borings BD-1, BD-4, NW-2 and NW-8 is 1.44 grams per cubic centimeter ($g/cm^3$). The high value of the samples was 1.68 $g/cm^3$ and the low value 0.92 $g/cm^3$. The arithmetic mean of 1.44 $g/cm^3$ was used in calculating the LSSL (Table B-1, Appendix B).

### 2.3.2 Porosity, Moisture Content and Air Filled Porosity

The average total porosity and initial moisture content for the 13 samples are 46.8 and 16.9 percent, respectively (Table B-1, Appendix B). The relationship between total porosity, initial moisture content, and air filled porosity is:

$$Total\ Porosity = \theta = \theta_w + \theta_a = water\ filled\ porosity + air\ filled\ porosity$$

Air filled porosity was calculated from porosity and initial moisture content as 46.8 – 16.9 = 29.9 percent. Input parameters to LSSL calculations are thus:

- Porosity = 0.468 $cm^3/cm^3$
- Water filled porosity = 0.169 $cm^3/cm^3$
- Air filled porosity = 0.299 $cm^3/cm^3$

### 2.3.3 Fraction Organic Carbon

The arithmetic mean for the fraction of organic carbon for the 60 samples analyzed was 0.0019 g/g (Table B-2, Appendix B). Non-detected values at the detection limit of 0.001 g/g were assigned a value of 0.0005 g/g, or ½ the detection limit, for use in the average. Thirty four of the sixty samples contained fraction organic carbon below the detection limit, and were addressed in this manner. These $f_{oc}$ results indicate the low organic carbon content of site soils, and an attendant low sorptive capacity.

## 2.4 CALCULATION OF DILUTION ATTENUATION FACTOR

Dilution attenuation factor (DAF) is calculated according to the following equation:

$$DAF = 1 + \frac{K * i * d}{I * S}$$

Where:

K = hydraulic conductivity in ft per year
i = hydraulic gradient in ft/ft
d = mixing zone depth (ft) which equals Quaternary Alluvium aquifer thickness
I = infiltration rate (ft/year)
S = source width (ft) parallel to groundwater flow direction

The DAF is directly proportional to groundwater seepage velocity and dispersion to depth (i.e., the greater the velocity and dispersion, the more dilution), and inversely proportional to infiltration and source length (i.e., the greater the infiltration rate, the less dilution and the greater

the source length, the less dilution – e.g., more sourcing). Input parameters to the DAF equation were obtained from the following sources and/or analyses.

### 2.4.1 Hydraulic Conductivity

The hydraulic conductivity value used was presented in the water balance (Table 5) of the *Tasks I, II, and III Data Transmittal Report in Support of the Groundwater Remedial Alternatives Study* (TIMET 2008). The value presented in Table 5 for the flux at the northern end of the facility was 16.5 ft/day, or 6,023 ft/year.

### 2.4.2 Hydraulic Gradient

The hydraulic gradient used in the analysis is 0.02 ft/ft, the typical gradient reported in Plant Site monitoring reports, and equal to the gradient used at nearby TRONOX (Northgate 2011) in its analysis of LSSLs for the site.

### 2.4.3 Aquifer Thickness/Mixing Zone Depth

The aquifer mixing zone depth was constrained to the Quaternary alluvium thickness (i.e., no substantial mixing downward into transitional Muddy Creek Formation), and "d" was assigned a value of 7.5 feet since mixing depth is assumed to exceed aquifer thickness for the thin Quaternary alluvial aquifer.

The 7.5 feet aquifer thickness/mixing zone depth is based on the aquifer thickness used in the water balance, Table 5 of *Tasks I, II, and III Data Transmittal Report in Support of the Groundwater Remedial Alternatives Study* (TIMET 2008).

### 2.4.4 Source Length

The source length parallel to groundwater flow is 100 feet. This is based on the maximum width of highest impacted area of the Beta Ditch (BD-2, BD-3, BD-4, and BD-5 – Figure 2).

### 2.4.5 Infiltration Rate

NDEP's guidance states "For either industrial or municipal developed areas of the BMI Complex and Common Areas in Henderson Nevada, the Companies must develop a site-specific infiltration rate (I) factor. The infiltration rate (I) factors must be supported via specific references applicable to the site, analytical calculations, or numerical model simulations to show how the factors were developed. The NDEP must approve the factor(s) prior to use (NDEP, 2009)." Accordingly, TIMET proposed adopting the infiltration rate developed by Tronox (0.14 foot per year) to NDEP on November 2, 2011. Based upon NDEP's comments and the resulting discussion, the following approach was developed.

The infiltration rates for the proposed Stormwater Catchment and Beta/Northwestern Ditch are considered to be two different values conceptually. The basis for this follows:

- A segment of the Beta and Northwestern Ditches will become a stormwater detention/infiltration basin in the final grading plan of the remedial design (TIMET 2009). The detention basin will capture all stormwater runoff from the western 2/3 of the facility, a catchment of roughly 57 acres. The graded catchment is anticipated to have a floor area of 15,050 square feet (SF), and a rim or daylight area of 46,300 SF (Figure 3). For the purposes of infiltration footprint, an area of 20,000 SF is used, to account for ponded water on the slopes of the basin as well as the floor.

- The remaining segments of the Beta/Northwestern Ditch are anticipated to be filled and leveled, and the ditches existence as a site stormwater conveyance will vanish. Along these former reaches of the Beta/Northwestern Ditch, infiltration is expected to be substantially less than in the stormwater catchment, and will revert to a natural condition.

#### *2.4.5.1 Stormwater Catchment*

Infiltration through the stormwater catchment is estimated following guidance provided in *Precipitation, Runoff and Water Loss in the Lower Colorado River—Salton Sea Area* (Hely and Peck, 1964), which is included in this Technical Memorandum as Appendix C. Input parameters and assumptions to the infiltration analysis include:

- 0.1 inches of rain to produce significant runoff (LVVSQMC 2009, page 3-1)

- Average annual precipitation in Las Vegas, Nevada is 4.1 inches (National Climatic Data Center at http://www.ncdc.noaa.gov).

- For purpose of using the method described in Hely and Peck (1964), the TIMET Plant surface consists of alluvium, between steep and flat slopes. The threshold precipitation of 0.1 inches for developed ground versus 0.2 inches for undisturbed desert areas (LVVSQMC 2009) renders a higher runoff-curve number representative of the "disturbed nature" of the alluvium application. This value (0.1 inches) is considered the "initial infiltration" of Figure 10 (Hely and Peck 1964).

- Water shed area is 57 acres, or roughly 2,500,000 SF.

For these data and assumptions, the run-off curve number from Figure 10 (Hely and Peck 1964) is about 0.85, which results in about 0.15 percent of precipitation runoff from Figure 9 (Hely and Peck 1964).

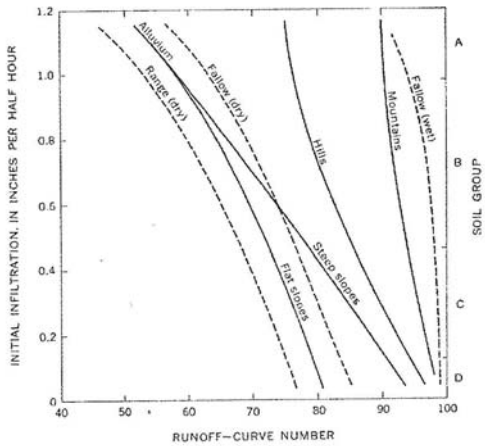


FIGURE 10.—Graph showing relations between initial infiltration and runoff-curve numbers.

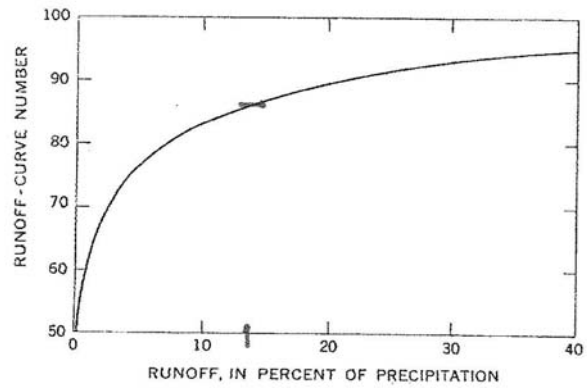


FIGURE 9.—Graph showing relation between runoff-curve number and mean annual runoff for the precipitation distribution indicated in table 1.

Figure 4 shows the relationship between percent of precipitation that runs off the Plant Site and into the stormwater catchment, and the attendant cumulative ponded water depth. It is important to note that this is cumulative height of ponded water for the year, and not a predicted pond depth relative to a specific storm event or hydrograph. Infiltration and evaporation reduces the standing water level in the stormwater catchment; however, the cumulative height of ponded water represents the "infiltration term" in the Dilution Attenuation Factor equation (Section 2.4). To be conservative, evaporation within the Stormwater Catchment is neglected.

The resultant cumulative ponded water for 0.15 percent of precipitation runoff in the stormwater catchment is between 6 and 6.5 feet annually, resulting in a DAF of about 2.5 (Figure 5).

#### *2.4.5.2 Beta and Northwestern Ditches*

Infiltration in the remaining segments of the Beta and Northwestern Ditches, which will be backfilled or graded post-remedial action, is qualitatively derived in the following manner. Surface water runoff will be diverted to the Stormwater Catchment; therefore, potential infiltration in the Beta/Northwestern Ditch is expected to revert to natural. The default infiltration rate (NDEP 2012) for undisturbed ground is 0.08 in/year. Plant Site surface water runoff will be controlled and significant portions of the Beta/Northwestern Ditch will be backfilled and graded. Because of existing site features in proximity to the site, NDEP has requested application of an adjusted infiltration rate developed for the former Tronox site (Northgate 2011). The adjusted infiltration rate of 0.14 feet per year is based upon an estimation of water distribution leaks due to age of the facility piping (installed in 1940s). The resultant DAF is calculated as follows:

$$DAF_{(infiltration=\ 0.14ft/yr)} = 1 + \frac{6{,}023\,\frac{ft}{yr} * 0.02\,\frac{ft}{ft} * 7.5\,ft}{100\,ft * \ 0.14\,\frac{ft}{yr}} = \ 66$$

The resultant DAF for an infiltration rate of 0.14 ft/year is 66.

### 2.5 ESTIMATION OF DISTRIBUTION COEFFICIENT

Values for distribution coefficient ($K_d$) were obtained from the literature for metals (Baes, et. al. 1984, EPA 1996 a and b) in cases adjusted for pH dependence (EPA 1996b), and estimated by calculation for organics. For organics, $K_d$ was estimated as the octonol-water partition coefficient ($K_{oc}$) times the fraction organic carbon ($f_{oc}$). $K_{oc}$ values were obtained from EPA (1996b) and for select organics for which EPA values were not listed, from the Texas Risk Reduction Program physical properties tables in Subpart D, Development of Protective Concentration Levels (30 TAC 350.D) and the Hazardous Substances Data Bank "Toxnet" (NLM 2012). Fraction organic carbon was obtained as described in Section 2.3.3.

## 3.0 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Chemicals of potential concern (COPC) for the purpose of calculating LSSLs were retained based on comparison to background and comparison to respective LBCL at DAF-1 and DAF-20.

### 3.1 INORGANICS

Inorganic chemicals of potential concern for the purpose of calculating LSSLs were selected in a two-step manner:

- Metals were compared to McCullough Range Background Values, the 0-10 foot interval and 10-foot to groundwater intervals (ERM 2010). Statistical evaluation (summary table and plots) and background comparison was conducted utilizing Neptune and Company Inc.'s GiSdT software. The statistical analysis is included in Appendix D. COPCs exceeding background concentrations were retained for evaluation. Radionuclides were not screened against background and all major isotopes were carried forward in the evaluation. Tables D-1 and D-2 of Appendix D summarize the statistics and screening results.

- COPCs exceeding background were then compared with LBCL (NDEP 2012) for DAF-1 and DAF-20. If any COPC lacked an established LBCL, they were retained for evaluation using available partitioning coefficients. Table E-1 of Appendix E provides the results of comparing the inorganic data to LBCL DAF.

The results of screening inorganic compounds against background and LBCLs are summarized in Table 1 with recommendation for further evaluation noted.

### 3.2 ORGANICS

Organic COPCs were assumed to be anthropogenic in nature, so all detections (including J-flagged values) were screened against LBCL at DAF-1 and DAF-20. Table E-2 of Appendix E provides the results of comparing the organic data to LBCL DAF. For organic COPCs that did not have LBCL developed, and where the frequency of detection was greater than 5% (see USEPA, 1989-Section 5.9), the following decision logic was followed:

- These sample locations were evaluated based upon location and excavation status. If they were all located in an existing excavation area, then no LSSL was developed.
- If they were not included in the current excavation boundaries, a risk based groundwater concentration was identified and a LSSL was developed.
- If no risk based groundwater concentrations were found, then TIMET would contact NDEP to provide surrogates.

This analysis is summarized in Table 2 and Table E-2 with recommendations for further evaluation noted.

## 4.0 CALCULATION OF LSSLS

Leaching-Based Site-Specific Levels were calculated in accordance with *Attachment A—Further Evaluation of Soil Leaching to Groundwater to the Nevada Division of Environmental Protection (NDEP) Basic Comparison Levels (BCLs) for use at the BMI Complex and Common Areas in Henderson Nevada* (NDEP, 2012) ) and *Soil to Groundwater Leaching Guidance* (NDEP 2010). Site specific soil properties discussed in Section 2.3 were used in the analysis. Calculation of DAFs for the Stormwater Catchment and Beta/Northwestern Ditches, with an evaluation of infiltration terms for these features were developed in Section 2.4.5. Sources and calculation of partition coefficients are discussed in Section 2.5.

Calculation of LSSLs in terms of target concentration is calculated by the following equation:

$$C_t = RBGC * DAF[K_d + \frac{(\theta_w + \theta_a * H')}{\rho_b}]$$

This equation is directly proportional to and linear in DAF, and DAF is calculated as:

$$DAF = 1 + \frac{K * i * d}{I * S}$$

The terms of these equations are defined previously and in NDEP guidance. Calculation of DAF is a function of Darcy velocity, infiltration rate, aquifer and mixing zone thickness, and source width. It is invariant of soil physical properties explicitly, and chemical properties of the subject contaminant of concern. Calculation of LSSLs ($C_t$) are therefore linear in DAF, regardless of chemical or soil properties. Calculating LSSLs at DAF-1 renders a resulting $C_t$ that is scalable for any DAF. Since it is known that DAF would be different for ponded water in the future catchment basin than in the abandoned and graded ditches, the LSSLs for these features is simply the DAF-1 LSSLs times the calculated DAF for these features.

## 4.1 INORGANICS

Inorganic LSSLs were calculated according to the following equation:

$$C_t = RBGC * DAF[K_d + \frac{(\theta_w + \theta_a * H')}{\rho_b}]$$

Where:
$C_t$ = Target concentration protective of soil-to-groundwater pathway (e.g., LSSL at appropriate DAF)
RBGC = Risk-Based Groundwater Concentration
$K_d$ = Distribution coefficient = ratio of contaminant concentration in soil and that in water
$\theta$, $\theta_w$ and $\theta_a$ = Total, water filled, and air filled porosity, respectively.
H´ = Henry's Law Constant
$\rho_b$ = Dry bulk density

## 4.2 ORGANICS

Organic LSSLs were calculated according to:

$$C_t = RBGC * DAF[(K_{oc} * f_{oc}) + \frac{\theta_w + \theta_a * H'}{\rho_b}]$$

Where:
$C_t$ = Target concentration protective of soil-to-groundwater pathway (e.g., LSSL at appropriate DAF)
RBGC = Risk-Based Groundwater Concentration
$K_{oc}$ = Octanol water partition coefficient
$f_{oc}$ = fraction organic carbon
$\theta$, $\theta_w$ and $\theta_a$ = Total, water filled, and air filled porosity, respectively.
H´ = Henry's Law Constant
$\rho_b$ = Dry bulk density

## 4.3 SITE-SPECIFIC LSSLS

Tables 1 and 2 provide a summary of the Beta / Northwestern Ditch data as compared to background and or LBCL DAF-1 and DAF-20. LSSLs were then computed for those site-related contaminants where further evaluation was recommended as described in Section 3.0. Comparisons were conservatively conducted on a per location basis (i.e. any analyte at a specific location exceeding the DAF-1 LBCL were retained).

Table 3 provides a summary of all input parameters, site specific soil properties, and calculation of LSSLs at DAF-1. Table 3 renders LSSLs that are scalable at any DAF which is calculated based on source width, infiltration rate, seepage velocity, etc.

Table 4 provides protective concentrations for the Stormwater Catchment and Beta/Northwestern Ditch areas at DAF-2.5 and DAF-66. Because of the linear relationship of LSSLs and DAF, LSSLs at DAF 66, for example, are simply 66 times the LSSLs at DAF-1.

## 5.0 REFERENCES

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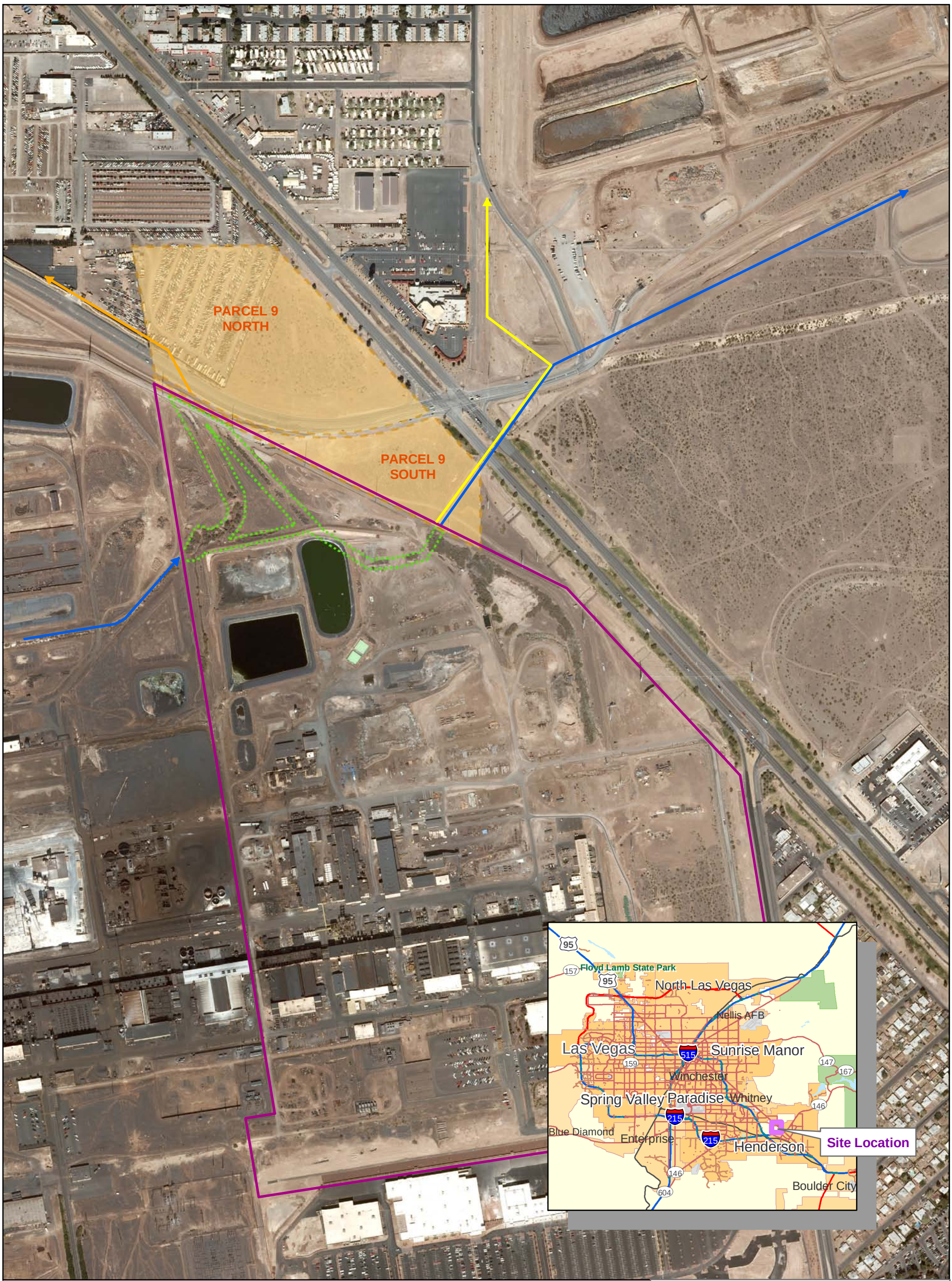
# FIGURES




TIMET Property

BETA DITCH /
NORTHWEST DITCH SITE DEFINITION

HISTORICAL NORTHWESTERN DITCH FLOW PATH

HISTORICAL BETA DITCH FLOW PATH

HISTORICAL ALPHA DITCH FLOW PATH

N
W E
S

500 250 0 500
Feet

Aerial Photo - Spring 2009

**Titanium Metals Corporation**
**Henderson, Nevada**

**FIGURE 1**
**SITE LOCATION MAP**

TIMET

08/26/2010 C:\TIMET\BMI_Siphon_NW_Ditch\mxd\Site_Location.mxd Michelle.Handley

## LEGEND:

- FENCE
- TREES AND SHRUBS
- MAJOR TOPOGRAPHIC CONTOUR
- MINOR TOPOGRAPHIC CONTOUR
- UTILITY POLE
- UNPAVED ROAD
- VALVE
- SIGN POST
- UTILITY POLE
- OVERHEAD ELECTRICAL LINE
- UNDERGROUND PIPE LINE
- BUREAU OF RECLAMATION (BOR) RIGHT OF WAY (ROW)
- SITE DEFINITION
- SLOPE STABILITY EVALUATION BORING
- SAMPLING LOCATION
- SLURRY WALL ALIGNMENT (APPROXIMATE)

150 75 0 150

SCALE IN FEET

SOURCES:
1. GOOGLE EARTH, MAY 29, 2009 IMAGE
2. KENNEY AERIAL MAPPING INC., NOV. 1, 2007 AERIAL SURVEY

Calculation of Leaching-Based SSLs
BMI Beta and Northwest Ditches
Titanium Metals Corporation
Henderson, Nevada

**FIGURE 2**
**Sampling Locations**

TIMET

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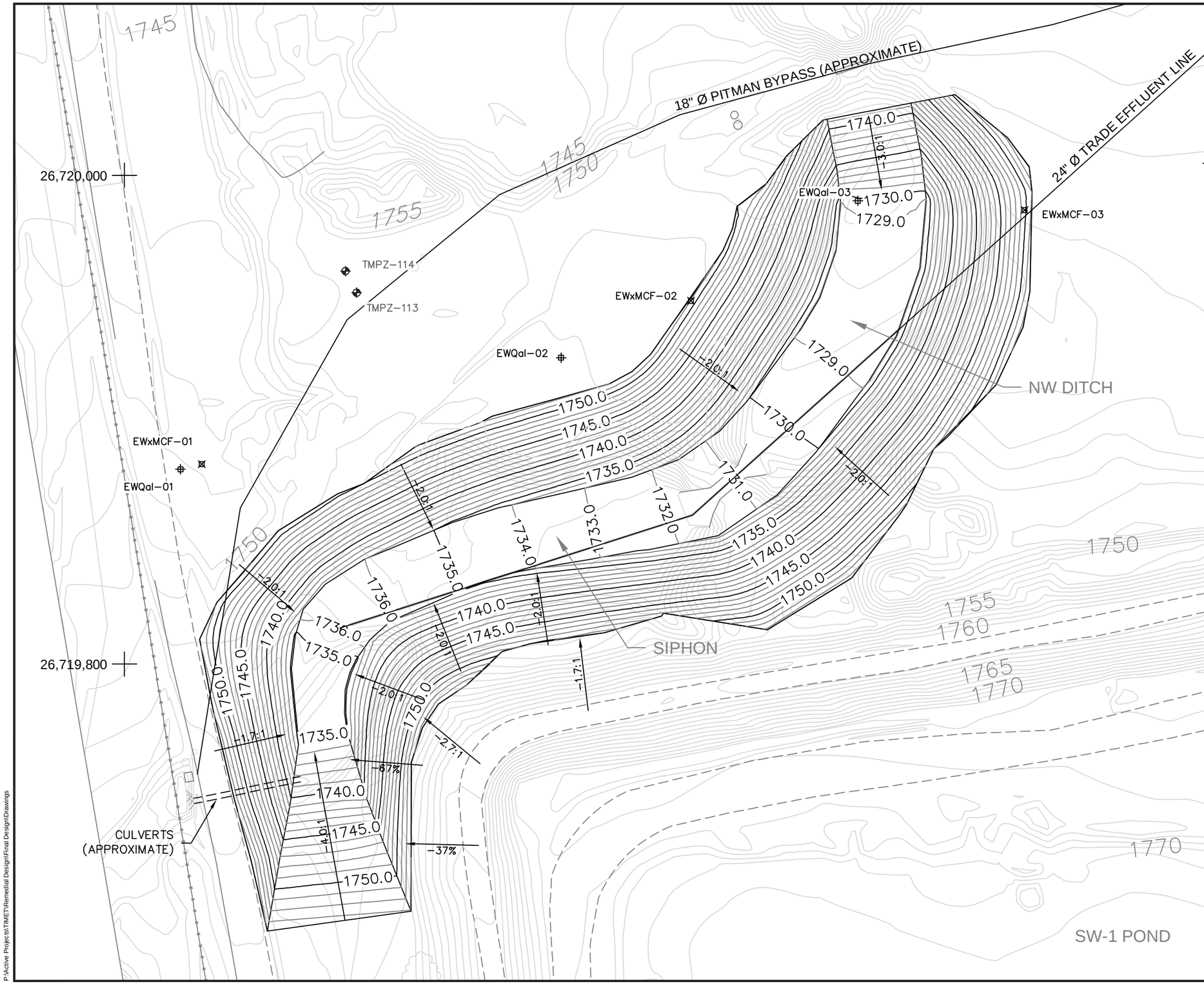


**LEGEND:**

- WELL
- NEVADA STATE PLANE NAD 1983 GRID MARK
- FENCE
- TREES AND SHRUBS
- 1770 MAJOR TOPOGRAPHIC CONTOUR
- 1771 MINOR TOPOGRAPHIC CONTOUR
- UTILITY POLE
- UNPAVED ROAD
- UNDEGROUND UTILITY LINE (APPROXIMATE)
- VALVE
- SIGN POST
- UTILITY POLE
- OVERHEAD ELECTRICAL LINE

40 20 0 40

SCALE IN FEET

Calculation of Leaching-Based SSLs
BMI Beta and Northwest Ditches
Titanium Metals Corporation
Henderson, Nevada

**FIGURE 3**
**Conceptual Stormwater Catchment Basin**

TIMET

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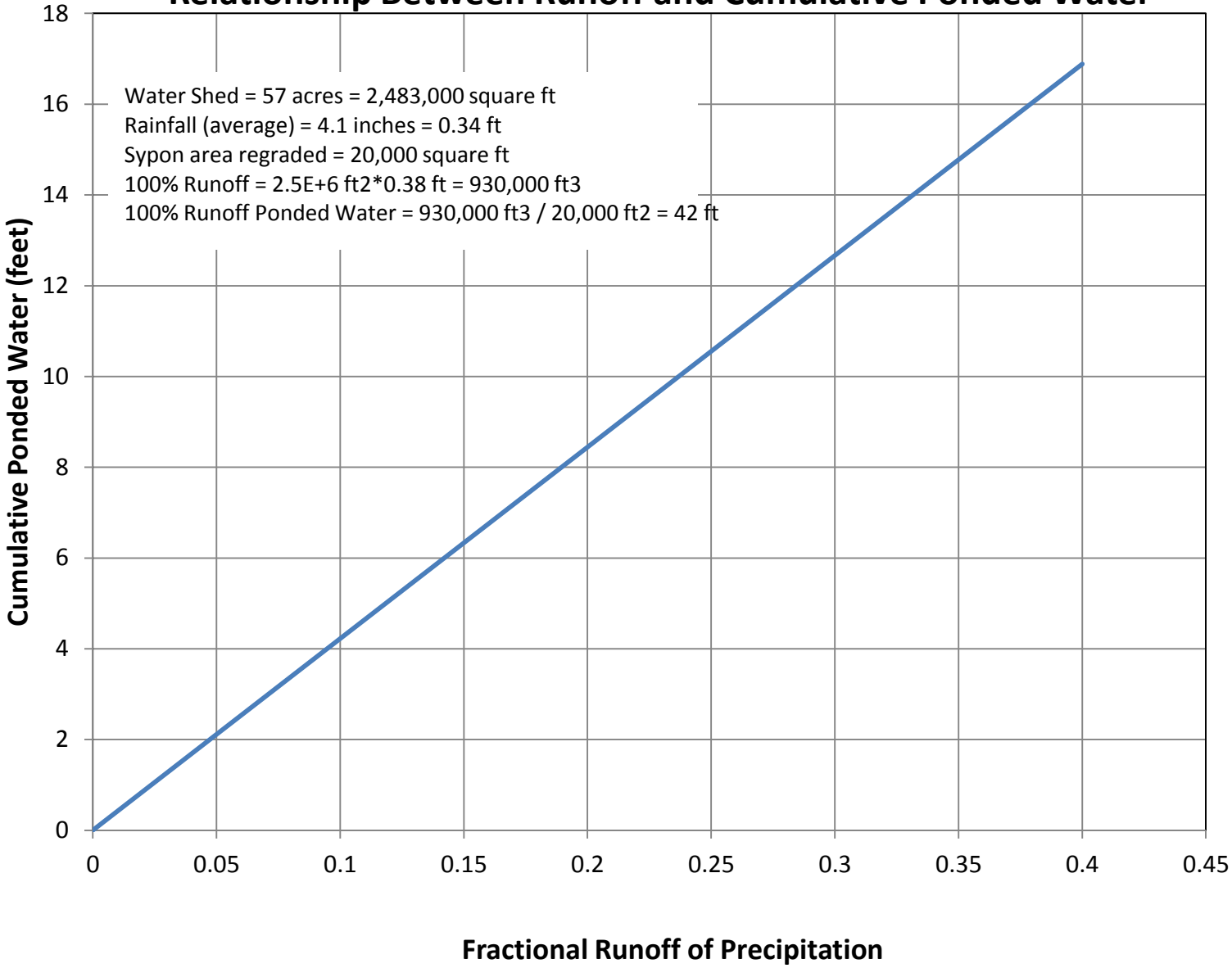
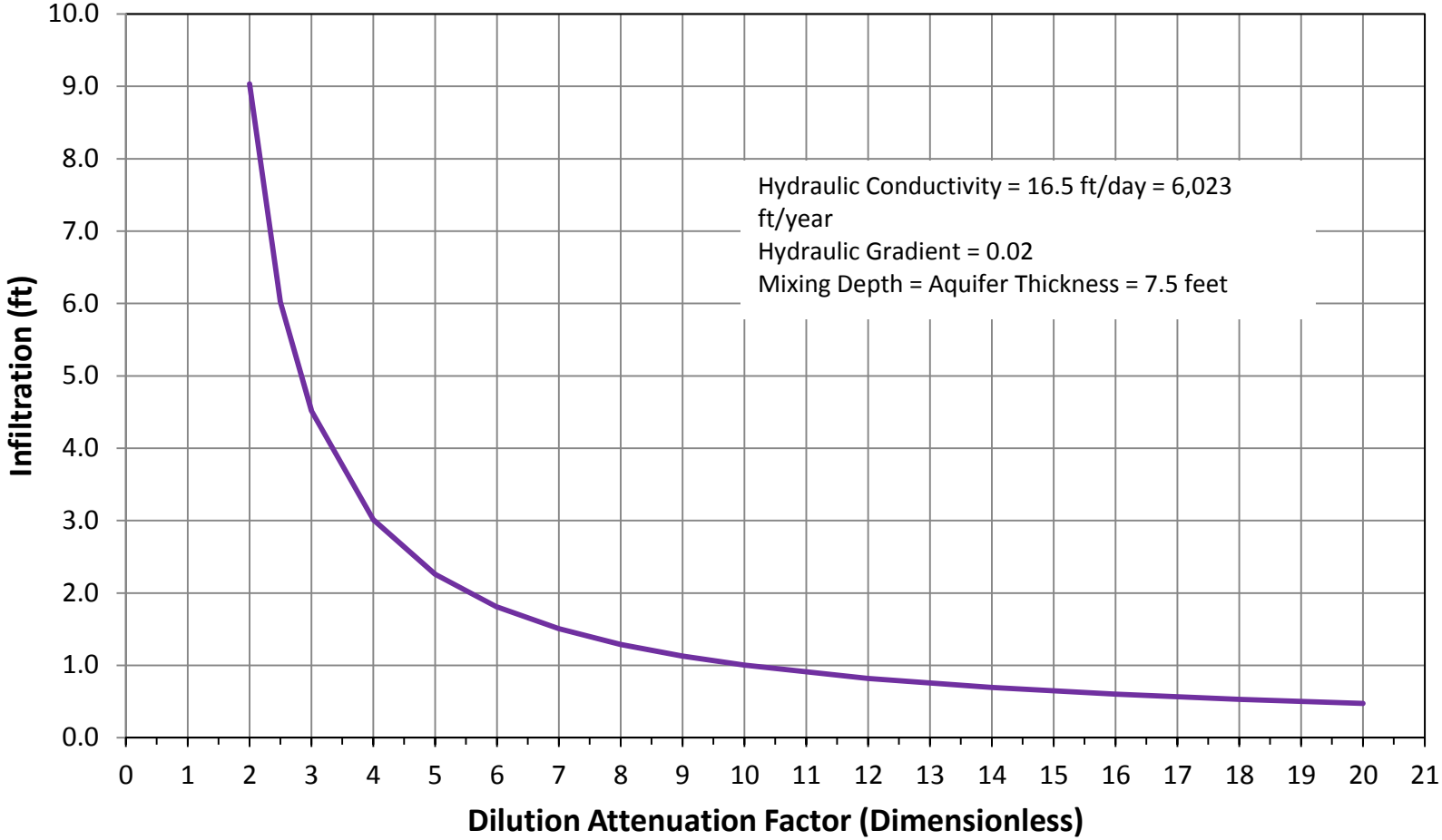
# Figure 4
## Relationship Between Runoff and Cumulative Ponded Water



# FIGURE 5
## Dilution Attenuation Factor as Function of Infiltration



# TABLES

**TABLE 1**
**INORGANIC SCREENING RESULTS BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON NEVADA**


| | Exceeds Shallow Background | Exceeds Deep Background | Screen Against LBCL | | Exceeds LBCL DAF 1 | Develop LSSL |
|---|---|---|---|---|---|---|
| **Nitrate** | --- | --- | Yes | | Yes | Yes |
| **Perchlorate** | --- | --- | Yes | | Yes | Yes |
| Aluminum | No | No | No | | | |
| **Antimony** | Yes | Yes | Yes | | Yes | Yes |
| **Arsenic** | Yes | Yes | Yes | | Yes | Yes |
| **Barium** | Yes | No | Yes | | Yes | Yes |
| **Beryllium** | Yes | No | Yes | | Yes | Yes |
| **Boron** | Yes | Yes | Yes | | Yes | Yes |
| **Cadmium** | Yes | No | Yes | | Yes | Yes |
| **Calcium** | No | Yes | Yes | | NA | Yes |
| **Chromium VI** | Yes | Yes | Yes | | Yes | Yes |
| **Chromium** | Yes | Yes | Yes | | NA | Yes |
| **Cobalt** | Yes | No | Yes | | Yes | Yes |
| **Copper** | Yes | No | Yes | | Yes | Yes |
| **Iron** | Yes | No | Yes | | Yes | Yes |
| **Lead** | Yes | No | Yes | | NA | Yes |
| **Lithium** | Yes | Yes | Yes | | Yes | Yes |
| **Magnesium** | Yes | Yes | Yes | | Yes | Yes |
| **Manganese** | Yes | No | Yes | | Yes | Yes |
| **Mercury** | Yes | Yes | Yes | | Yes | Yes |
| **Molybdenum** | Yes | No | Yes | | Yes | Yes |
| Nickel | No | No | No | | | |
| **Niobium** | Yes | (1) | Yes | | NA | Yes |
| Palladium | No | (1) | No | | | |
| **Potassium** | Yes | Yes | Yes | | NA | Yes |
| **Selenium** | Yes | No | Yes | | Yes | Yes |
| Silicon | No | (1) | No | | | |
| **Silver** | Yes | No | Yes | | Yes | Yes |
| **Sodium** | Yes | Yes | Yes | | NA | Yes |
| Strontium | No | No | No | | | |
| **Thallium** | Yes | No | Yes | | Yes | Yes |
| **Tin** | Yes | No | Yes | | NA | Yes |
| Titanium | Yes | No | Yes | | No | No |
| **Uranium** | Yes | No | Yes | | Yes | Yes |
| **Vanadium** | Yes | No | Yes | | Yes | Yes |
| Zinc | Yes | No | Yes | | No | No |
| Zirconium | No | (1) | No | | | |
| **Radium-226** | --- | --- | Yes | | Yes | Yes |

**TABLE 1**
**INORGANIC SCREENING RESULTS BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON NEVADA**


| | Exceeds Shallow Background | Exceeds Deep Background | Screen Against LBCL | | Exceeds LBCL DAF 1 | Develop LSSL |
|---|---|---|---|---|---|---|
| **Radium-228** | --- | --- | Yes | | Yes | Yes |
| **Thorium-228** | --- | --- | Yes | | Yes | Yes |
| **Thorium-230** | --- | --- | Yes | | Yes | Yes |
| **Thorium-232** | --- | --- | Yes | | Yes | Yes |
| **Uranium-234** | --- | --- | Yes | | (2) | Yes |
| **Uranium-235** | --- | --- | Yes | | (2) | Yes |
| **Uranium-238** | --- | --- | Yes | | (2) | Yes |

Notes:

| | |
|---|---|
| NA | Not available |
| Bold font | Further evaluation recommended |
| --- | Radionuclides were not screened against background as agreed with NDEP. All isotopes carried forward in evaluation. |
| (1) | Only 10% of shallow soil samples were analyzed for niobium, palladium, silicon, and zirconium as approved by NDEP in the Sampling and Analysis Plan for the BMI Beta / Northwestern Ditch Located on Titanium Metals Corporation Plant Site, Revision 1, dated February 18, 2011 |
| (2) | LBCL DAF not available. Utilized uranium as surrogate. |
| | Inorganic compounds for which concentrations do not exceed either shallow or deep background data sets. |

**TABLE 2**
**ORGANIC SCREENING RESULTS BETA / NORTHWESTERN DITCHES**
**TITANIUM METAL CORPORATION PLANT SITE**
**HENDERSON NEVADA**


| Analytical Group | Analyte | Exceed LBCL DAF1 | Exceed LBCL DAF20 | Develop LSSL | Rationale |
|---|---|---|---|---|---|
| PEST | 2,4'-DDD | No | No | No | No detections |
| PEST | 2,4'-DDE | No | No | No | No exceedence of LBCLs |
| PEST | 4,4'-DDD | No | No | No | No detections |
| PEST | 4,4'-DDE | No | No | No | No exceedence of LBCLs |
| PEST | 4,4'-DDT | No | No | No | No exceedence of LBCLs |
| PEST | ALDRIN | No | No | No | No detections |
| PEST | **ALPHA-BHC** | Yes | No | **Yes** | |
| PEST | ALPHA-CHLORDANE | NA | NA | No | No detections |
| PEST | **BETA-BHC** | Yes | Yes | **Yes** | |
| PEST | BETA-CHLORDANE | NA | NA | No | No detections |
| PEST | CHLORDANE | No | No | No | No detections |
| PEST | DELTA-BHC | NA | NA | No | No detections |
| PEST | DIELDRIN | No | No | No | No detections |
| PEST | ENDOSULFAN I | NA | NA | No | No detections |
| PEST | ENDOSULFAN II | NA | NA | No | No detections |
| PEST | ENDOSULFAN SULFATE | No | No | No | No exceedence of LBCLs |
| PEST | **ENDRIN** | Yes | No | **Yes** | |
| PEST | ENDRIN ALDEHYDE | NA | NA | No | No detections |
| PEST | ENDRIN KETONE | NA | NA | No | No detections |
| PEST | GAMMA-BHC (LINDANE) | No | No | No | No detections |
| PEST | GAMMA-CHLORDANE | NA | NA | No | No detections |
| PEST | HEPTACHLOR | No | No | No | No detections |
| PEST | HEPTACHLOR EPOXIDE | No | No | No | No exceedence of LBCLs |
| PEST | METHOXYCHLOR | No | No | No | No detections |
| PEST | TOXAPHENE | No | No | No | No detections |
| SVOA | **1,2,4,5-TETRACHLOROBENZENE** | NA | NA | **Yes** | |
| SVOA | 1,2-DIPHENYLHYDROZINE/AZOBENZE | NA | NA | No | No detections |
| SVOA | 1,4 DIOXANE | NA | NA | No | No detections |
| SVOA | 2,4,5-TRICHLOROPHENOL | No | No | No | No exceedence of LBCLs |
| SVOA | **2,4,6-TRICHLOROPHENOL** | Yes | Yes | **Yes** | |
| SVOA | 2,4'-DDE | No | No | No | No exceedence of LBCLs |
| SVOA | 2,4'-DDT | No | No | No | No exceedence of LBCLs |
| SVOA | **2,4-DICHLOROPHENOL** | Yes | No | **Yes** | |
| SVOA | 2,4-DIMETHYLPHENOL | No | No | No | No detections |
| SVOA | 2,4-DINITROPHENOL | No | No | No | No detections |
| SVOA | 2,4-DINITROTOLUENE | No | No | No | No detections |
| SVOA | 2,6-DINITROTOLUENE | No | No | No | No detections |
| SVOA | 2-CHLORONAPHTHALENE | NA | NA | No | FOD < 5% |
| SVOA | 2-CHLOROPHENOL | No | No | No | No detections |
| SVOA | 2-METHYLNAPHTHALENE | NA | NA | No | No detections |

**TABLE 2**
**ORGANIC SCREENING RESULTS BETA / NORTHWESTERN DITCHES**
**TITANIUM METAL CORPORATION PLANT SITE**
**HENDERSON NEVADA**


| Analytical Group | Analyte | Exceed LBCL DAF1 | Exceed LBCL DAF20 | Develop LSSL | Rationale |
|---|---|---|---|---|---|
| SVOA | 2-METHYLPHENOL | No | No | No | No detections |
| SVOA | 2-NITROANILINE | NA | NA | No | No detections |
| SVOA | 2-NITROPHENOL | NA | NA | No | No detections |
| SVOA | 3,3'-DICHLOROBENZENE | No | No | No | No detections |
| SVOA | 3,4-METHYLPHENOL | NA | NA | No | No detections |
| SVOA | 3-NITROANILINE | NA | NA | No | No detections |
| SVOA | 4,4'-DDE | Yes | No | No | Considered with the results of pesticide methodology |
| SVOA | 4-BROMOPHENYL ETHER | NA | NA | No | No detections |
| SVOA | 4-CHLORO-3-METHYLPHENOL | NA | NA | No | No detections |
| SVOA | 4-CHLOROANILINE | No | No | No | No detections |
| SVOA | 4-CHLOROPHENYL PHENYL ETHER | NA | NA | No | No detections |
| SVOA | 4-NITROANILINE | NA | NA | No | No detections |
| SVOA | 4-NITROPHENOL | NA | NA | No | No detections |
| SVOA | ACENAPHTHENE | No | No | No | No detections |
| SVOA | ACENAPHTHYLENE | NA | NA | No | No detections |
| SVOA | ACETOPHENONE | NA | NA | No | No detections |
| SVOA | ANILINE | NA | NA | No | No detections |
| SVOA | ANTHRACENE | No | No | No | No exceedence of LBCLs |
| SVOA | **BENZO(A)ANTHRACENE** | Yes | No | **Yes** | |
| SVOA | BENZO(A)PYRENE | No | No | No | No exceedence of LBCLs |
| SVOA | **BENZO(B)FLUORANTHENE** | Yes | No | **Yes** | |
| SVOA | BENZO(G,H,I)PERYLENE | NA | NA | No | FOD < 5% |
| SVOA | BENZO(K)FLUORANTHENE | No | No | No | No exceedence of LBCLs |
| SVOA | BENZOIC ACID | No | No | No | No detections |
| SVOA | BENZYL ALCOHOL | NA | NA | No | No detections |
| SVOA | BIS(1-CHLOROISOPROPYL)ETHER | NA | NA | No | No detections |
| SVOA | BIS(2-CHLOROETHOXY)METHANE | NA | NA | No | No detections |
| SVOA | BIS(2-CHLOROETHYL)ETHER | No | No | No | No detections |
| SVOA | BIS(2-ETHYLHEXYL) PHTHALATE | No | No | No | No exceedence of LBCLs |
| SVOA | BUTYL BENZYL PHTHALATE | No | No | No | No detections |
| SVOA | CARBAZOLE | No | No | No | No detections |
| SVOA | CHRYSENE | No | No | No | No exceedence of LBCLs |
| SVOA | DIBENZO(A,H)ANTHRACENE | No | No | No | No exceedence of LBCLs |
| SVOA | DIBENZOFURAN | NA | NA | No | FOD < 5% |
| SVOA | DIETHYL PHTHALATE | NA | NA | No | No detections |
| SVOA | DIMETHYL PHTHALATE | NA | NA | No | FOD < 5% |
| SVOA | DI-N-BUTYL PHTHALATE | No | No | No | No detections |
| SVOA | DI-N-OCTYL PHTHALATE | NA | NA | No | No detections |
| SVOA | FLUORANTHENE | No | No | No | No exceedence of LBCLs |
| SVOA | FLUORENE | No | No | No | No detections |

**TABLE 2**
**ORGANIC SCREENING RESULTS BETA / NORTHWESTERN DITCHES**
**TITANIUM METAL CORPORATION PLANT SITE**
**HENDERSON NEVADA**


| Analytical Group | Analyte | Exceed LBCL DAF1 | Exceed LBCL DAF20 | Develop LSSL | Rationale |
|---|---|---|---|---|---|
| SVOA | **HEXACHLOROBENZENE** | Yes | Yes | **Yes** | |
| SVOA | **HEXACHLOROBUTADIENE** | Yes | No | **Yes** | |
| SVOA | HEXACHLOROCYCLOPENTADIENE | No | No | No | No detections |
| SVOA | HEXACHLOROETHANE | No | No | No | No detections |
| SVOA | INDENO(1,2,3-CD)PYRENE | No | No | No | No exceedence of LBCLs |
| SVOA | ISOPHORONE | No | No | No | No detections |
| SVOA | NAPHTHALENE | No | No | No | No detections |
| SVOA | NITROBENZENE | No | No | No | No detections |
| SVOA | N-NITROSO-DI-N-PROPYLAMINE | No | No | No | No detections |
| SVOA | N-NITROSODIPHENYLAMINE | No | No | No | No detections |
| SVOA | **OCTACHLOROSTYRENE** | NA | NA | **Yes** | |
| SVOA | **PENTACHLOROBENZENE** | NA | NA | **Yes** | |
| SVOA | **PENTACHLOROPHENOL** | Yes | Yes | **Yes** | |
| SVOA | PHENANTHRENE | NA | NA | No | FOD < 5% |
| SVOA | PHENOL | No | No | No | No detections |
| SVOA | PYRENE | No | No | No | No exceedence of LBCLs |
| SVOA | PYRIDINE | NA | NA | No | No detections |
| SVOA | TENTATIVELY IDENTIFIED COMPOUND | NA | NA | NA | |
| VOA | 1,1,1,2-TETRACHLOROETHANE | NA | NA | No | No detections |
| VOA | 1,1,1-TRICHLOROETHANE | No | No | No | No detections |
| VOA | 1,1,2,2-TETRACHLOROETHANE | No | No | No | No detections |
| VOA | 1,1,2-TRICHLOROETHANE | No | No | No | No detections |
| VOA | 1,1-DICHLOROETHANE | No | No | No | No detections |
| VOA | 1,1-DICHLOROETHENE | No | No | No | No detections |
| VOA | 1,1-DICHLOROPROPENE | NA | NA | No | No detections |
| VOA | 1,2,3-TRICHLOROBENZENE | No | No | No | No exceedence of LBCLs |
| VOA | 1,2,3-TRICHLOROPROPANE | NA | NA | No | No detections |
| VOA | 1,2,4-TRICHLOROBENZENE | No | No | No | No detections |
| VOA | 1,2,4-TRIMETHYLBENZENE | NA | NA | No | No detections |
| VOA | 1,2-DICHLOROBENZENE | No | No | No | No detections |
| VOA | 1,2-DICHLOROETHANE | No | No | No | No detections |
| VOA | 1,2-DICHLOROPROPANE | No | No | No | No detections |
| VOA | 1,3,5-TRIMETHYLBENZENE | NA | NA | No | No detections |
| VOA | 1,3-DICHLOROBENZENE | NA | NA | No | No detections |
| VOA | 1,3-DICHLOROPROPANE | No | No | No | No detections |
| VOA | 1,4-DICHLOROBENZENE | No | No | No | No detections |
| VOA | 2,2-DICHLOROPROPANE | NA | NA | No | No detections |
| VOA | 2-BUTANONE | NA | NA | No | No detections |
| VOA | 2-CHLOROTOLUENE | NA | NA | No | No detections |
| VOA | 2-HEXANONE | NA | NA | No | No detections |

**TABLE 2**
**ORGANIC SCREENING RESULTS BETA / NORTHWESTERN DITCHES**
**TITANIUM METAL CORPORATION PLANT SITE**
**HENDERSON NEVADA**


| Analytical Group | Analyte | Exceed LBCL DAF1 | Exceed LBCL DAF20 | Develop LSSL | Rationale |
|---|---|---|---|---|---|
| VOA | 4-CHLOROTOLUENE | NA | NA | No | No detections |
| VOA | 4-METHYL-2-PENTANONE | NA | NA | No | No detections |
| VOA | ACETONE | No | No | No | No exceedence of LBCLs |
| VOA | ACETONITRILE | NA | NA | No | No detections |
| VOA | BENZENE | No | No | No | No detections |
| VOA | BROMOBENZENE | NA | NA | No | No detections |
| VOA | BROMOCHLOROMETHANE | NA | NA | No | No detections |
| VOA | BROMODICHLOROMETHANE | No | No | No | No detections |
| VOA | BROMOFORM | No | No | No | No detections |
| VOA | BROMOMETHANE | No | No | No | No detections |
| VOA | CARBON DISULFIDE | No | No | No | No exceedence of LBCLs |
| VOA | CARBON TETRACHLORIDE | No | No | No | No detections |
| VOA | CHLOROBENZENE | No | No | No | No detections |
| VOA | CHLOROETHANE | NA | NA | No | No detections |
| VOA | **CHLOROFORM** | YES | No | **Yes** | |
| VOA | CHLOROMETHANE | NA | NA | No | No detections |
| VOA | CIS-1,2-DICHLOROETHENE | No | No | No | No detections |
| VOA | CIS-1,3-DICHLOROPROPENE | NA | NA | No | No detections |
| VOA | DIBROMOCHLOROMETHANE | No | No | No | No detections |
| VOA | DICHLORODIFLUOROMETHANE | NA | NA | No | No detections |
| VOA | ETHANOL | NA | NA | No | No detections |
| VOA | ETHYLBENZENE | No | No | No | No detections |
| VOA | HEXACHLOROBUTADIENE | No | No | No | No exceedence of LBCLs |
| VOA | ISOPROPYLBENZENE | NA | NA | No | No detections |
| VOA | METHYL IODIDE | NA | NA | No | No detections |
| VOA | METHYLENE BROMIDE | NA | NA | No | No detections |
| VOA | **METHYLENE CHLORIDE** | Yes | No | **Yes** | |
| VOA | METHYL-T-BUTYL ETHER | NA | NA | No | No detections |
| VOA | NAPHTHALENE | No | No | No | No detections |
| VOA | N-BUTYLBENZENE | NA | NA | No | No detections |
| VOA | N-PROPYLBENZENE | NA | NA | No | No detections |
| VOA | P-ISOPROPYLTOLUENE | NA | NA | No | No detections |
| VOA | SEC-BUTYLBENZENE | NA | NA | No | No detections |
| VOA | STYRENE | No | No | No | No detections |
| VOA | TERT-BUTYLBENZENE | NA | NA | No | No detections |
| VOA | **TETRACHLOROETHENE** | Yes | No | **Yes** | |
| VOA | TOLUENE | No | No | No | No exceedence of LBCLs |
| VOA | TRANS-1,2-DICHLOROETHENE | No | No | No | No detections |
| VOA | TRANS-1,3-DICHLOROPROPENE | NA | NA | No | No detections |
| VOA | TRICHLOROETHENE | No | No | No | No detections |

**TABLE 2**
**ORGANIC SCREENING RESULTS BETA / NORTHWESTERN DITCHES**
**TITANIUM METAL CORPORATION PLANT SITE**
**HENDERSON NEVADA**


| Analytical Group | Analyte | Exceed LBCL DAF1 | Exceed LBCL DAF20 | Develop LSSL | Rationale |
|---|---|---|---|---|---|
| VOA | TRICHLOROFLUOROMETHANE | NA | NA | No | No detections |
| VOA | VINYL ACETATE | No | No | No | No detections |
| VOA | VINYL CHLORIDE | No | No | No | No detections |
| VOA | XYLENE (TOTAL) | No | No | No | No detections |

Notes:
NA Not available
Bold font Further Evaluation Recommended

**TABLE 3**
**CALCULATION OF LSSL AT DAF-1 FOR BETA/NORTHWESTERN DITCH**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| Group | Analyte | LBCL DAF1 (mg/kg) | Kd [1] (L/kg) | ref. | RBGC (mg/L) | ref. | $C_{t(DAF1)}$ [2] (mg/kg) | $K_{oc}$ (L/kg) | ref. | Water Content[3] | Dry Bulk Density[3] ($g/cm^3$) | Foc[4] (g/g) | Total Porosity[3] ($cm^3/cm^3$) | Air Filled Porosity[5] ($cm^3/cm^3$) | H'[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| General | Nitrate | **7** | **0.5** | ndep | **10** | ndep | 6.17 | | | 0.169 | 1.44 | | | | |
| | Perchlorate | **0.185** | **0.83** | ndep | **0.026** | ndep | 0.02 | | | 0.169 | 1.44 | | | | |
| Metals | Antimony | 0.3 | 45 | a | 0.006 | m | 0.27 | | | 0.169 | 1.44 | | | | |
| | Arsenic | 1 | 31 | b | 0.010 | m | 0.31 | | | 0.169 | 1.44 | | | | |
| | Barium | 82 | 52 | b | 2.0 | m | 104 | | | 0.169 | 1.44 | | | | |
| | Beryllium | 3 | 1.0E+05 | b | 0.004 | m | 400 | | | 0.169 | 1.44 | | | | |
| | Boron | 23.36 | 3.0 | a | 7.3 | ndep | 22.8 | | | 0.169 | 1.44 | | | | |
| | Cadmium | 0.4 | 4,300 | b | 0.005 | m | 22 | | | 0.169 | 1.44 | | | | |
| | Calcium | --- | **Nutrient: No LSSL Required** | | | | | | | | | | | | |
| | Chromium VI | 2 | 14 | b | 0.100 | m | 1.41 | | | 0.169 | 1.44 | | | | |
| | Chromium | --- | 850 | a | 0.100 | m | 85.0 | | | 0.169 | 1.44 | | | | |
| | Cobalt | 0.49494 | 45 | a | 0.011 | ndep | 0.50 | | | 0.169 | 1.44 | | | | |
| | Copper | 45.76 | 35 | a | 1.360 | ndep | 47.8 | | | 0.169 | 1.44 | | | | |
| | Iron | 7.56 | 25 | a | **0.3** | ndep | 8 | | | 0.169 | 1.44 | | | | |
| | Lead | --- | 900 | a | 0.015 | -- | 13.5 | | | 0.169 | 1.44 | | | | |
| | Lithium | 21.9146 | 300 | a | 0.073 | ndep | 21.9 | | | 0.169 | 1.44 | | | | |
| | Magnesium | 972.689 | 4.5 | a | 207 | ndep | 956 | | | 0.169 | 1.44 | | | | |
| | Manganese | 1.304 | 65 | a | **0.020** | ndep | 1.3 | | | 0.169 | 1.44 | | | | |
| | Mercury | 0.10448 | 10 | a | 0.002 | m | 0.020 | | | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 0.467 |
| | Molybdenum | 3.6865 | 20 | a | 0.183 | ndep | 3.7 | | | 0.169 | 1.44 | | | | |
| | Niobium (columbium) | --- | **LSSL Provided by NDEP** | | | | | | | | | | | | |
| | Potassium | --- | **Nutrient: No LSSL Required** | | | | | | | | | | | | |
| | Selenium | 0.3 | 2.2 | b | 0.050 | m | 0.12 | | | 0.169 | 1.44 | | | | |
| | Silver | 0.85 | 110 | b | **0.100** | ndep | 11.0 | | | 0.169 | 1.44 | | | | |
| | Sodium | --- | **Nutrient: No LSSL Required** | | | | | | | | | | | | |
| | Thallium | 0.4 | 96 | b | 0.002 | m | 0.19 | | | 0.169 | 1.44 | | | | |
| | Tin | --- | 250 | a | 21.900 | ndep | 5478 | | | 0.169 | 1.44 | | | | |
| | Uranium | 13.506 | 450 | a | 0.03 | m | 14 | | | 0.169 | 1.44 | | | | |
| | Vanadium | 300 | 1,000 | a,b | **0.183** | ndep | 1.8E+02 | | | 0.169 | 1.44 | | | | |

**TABLE 3**
**CALCULATION OF LSSL AT DAF-1 FOR BETA/NORTHWESTERN DITCH**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| Group | Analyte | LBCL DAF1 (mg/kg) | Kd [1] (L/kg) | ref. | RBGC (mg/L) | ref. | $C_{t(DAF1)}$ [2] (mg/kg) | $K_{oc}$ (L/kg) | ref. | Water Content[3] | Dry Bulk Density[3] ($g/cm^3$) | Foc[4] (g/g) | Total Porosity[3] ($cm^3/cm^3$) | Air Filled Porosity[5] ($cm^3/cm^3$) | H'[6] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Radionuclides | Radium 226 | 0.016 | 3 | f | 5 | ndep | 1.6E-02 | | | 0.169 | 1.44 | | | | |
| | Radium 228 | 0.016 | 3 | f | 5 | ndep | 1.6E-02 | | | 0.169 | 1.44 | | | | |
| | Thorium 228 | 0.0023 | 20 | f | 0.11 | ndep | 2.3E-03 | | | 0.169 | 1.44 | | | | |
| | Thorium 230 | 0.00084 | 2.0E+01 | f | 0.042 | ndep | 8.4E-04 | | | 0.169 | 1.44 | | | | |
| | Thorium 232 | 0.0029 | 2.0E+01 | f | 0.14 | ndep | 2.8E-03 | | | 0.169 | 1.44 | | | | |
| | Uranium 234 | --- | 450 | a | 0.03 | m | 14 | | | 0.169 | 1.44 | | | | |
| | Uranium 235 | --- | 450 | a | 0.03 | m | 14 | | | 0.169 | 1.44 | | | | |
| | Uranium 238 | --- | 450 | a | 0.03 | m | 14 | | | 0.169 | 1.44 | | | | |
| VOCs | Chloroform | 0.03 | Default to LBCL DAF1 | | | | | | | | | | | | |
| | Methylene Chloride | 0.001 | 0.022 | c | 0.005 | ndep | 7.91E-04 | 11.7 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 0.0898 |
| | Tetrachloroethene | 0.003 | 0.295 | c | 0.005 | ndep | 2.84E-03 | 155 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 0.754 |
| SVOCs | 1,2,4,5-Tetrachlorobenzene | --- | 3.0 | c | 0.011 | ndep | 0.03 | 1585 | e | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 0.0499 |
| | 2,4,6-Trichlorophenol | 0.008 | 0.72 | c | 0.00611 | ndep | 0.005 | 381 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 3.19E-04 |
| | 2,4-Dichlorophenol | 0.05 | 0.28 | c | 0.11 | ndep | 0.044 | 147 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 1.30E-04 |
| | Benzo(a)anthracene | 0.08 | 756.2 | c | 9.21E-05 | ndep | 0.07 | 3.98E+05 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 1.37E-04 |
| | Benzo(b)fluoranthene | 0.2 | 2337.0 | c | 9.21E-05 | ndep | 0.22 | 1.23E+06 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 4.55E-03 |
| | Hexachlorobenzene | 0.1 | Default to LBCL DAF1 | | | | | | | | | | | | |
| | Hexachlorobutadiene | --- | 102 | c | 8.62E-04 | ndep | 0.09 | 53700 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 0.334 |
| | Octachlorostyrene | 0.36 | 380 | h | 1.10E-03 | ndep | 0.42 | 200000 | g | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 0.334 |
| | Pentachlorobenzene | --- | 60 | c | 0.0292 | ndep | 1.8 | 31600 | e | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 0.0316 |
| | Pentachlorophenol | 0.001 | 1.12 | c | 0.001 | ndep | 0.0012 | 592 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 1.00E-06 |
| | Alpha BHC | 0.02913 | Default to LBCL DAF1 | | | | | | | | | | | | |
| | Beta BHC | 0.00596 | Default to LBCL DAF1 | | | | | | | | | | | | |
| | Endrin | 0.05 | 23 | c | 0.002 | ndep | 0.047 | 12300 | d | 0.169 | 1.44 | 0.0019 | 0.468 | 0.299 | 3.08E-04 |

References:

a = From figure 3.31 Baes, et.al., 1984.

b = From Table C-4, Attachment C, USEPA 1996a.

c = For organic COPC, $K_d = K_{oc} * f_{oc}$

d = From Table C-1, Attachment C, USEPA 1996a.

e = From 30 Texas Administrative Code 350, Subpart D, *Development of Protective Concentration Levels*

f = ORNL RAIS (http//rais.ornl.gov/cgi-bin/tox/TOX_select?select=rad)

g = http://toxnet.nlm.nih.gov

h = Value from Council of Great Lakes Industries (1999)

m = Federal MCL

ndep = User's Guide and Background Technical Document for NDEProtection Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas, May 2012

na = RBGC not available in mass/volume dimension

1 Based upon a pH of 8

2 $C_t$ calculated using Eq. 1, Attachment A, NDEP 2010. These values are reported in mg/kg except for radium and thorium which are reported in piC/g

3 Soil Physical Properties arithmetic mean of values reported by DBS&A 2011

4 Foc arithmetic mean of analyses performed by Walkley-Black (DBS&A 2011)

5 Air filled porosity calculated as total porosity minus water content

6 Henry's Law Constant (dimensionless)

**TABLE 4**
**CALCULATION OF LSSL DAF-2.5 AND DAF-66**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| | Leaching-Based Site-Specific Levels[4] | | |
|---|---|---|---|
| **Analyte** | $C_{t(DAF-1.0)}$[1] | $C_{t(DAF-2.5)}$[2] | $C_{t(DAF-66)}$[3] |
| Nitrate | 6.17E+00 | 1.54E+01 | 4.07E+02 |
| Perchlorate | 2.46E-02 | 6.16E-02 | 1.63E+00 |
| Antimony | 2.71E-01 | 6.77E-01 | 1.79E+01 |
| Arsenic | 3.11E-01 | 7.78E-01 | 2.05E+01 |
| Barium | 1.04E+02 | 2.61E+02 | 6.88E+03 |
| Beryllium | 4.00E+02 | 1.00E+03 | 2.64E+04 |
| Boron | 2.28E+01 | 5.69E+01 | 1.50E+03 |
| Cadmium | 2.15E+01 | 5.38E+01 | 1.42E+03 |
| Chrome VI | 1.41E+00 | 3.53E+00 | 9.32E+01 |
| Chrome | 8.50E+01 | 2.13E+02 | 5.61E+03 |
| Cobalt | 4.96E-01 | 1.24E+00 | 3.28E+01 |
| Copper | 4.78E+01 | 1.19E+02 | 3.15E+03 |
| Iron | 7.54E+00 | 1.88E+01 | 4.97E+02 |
| Lead | 1.35E+01 | 3.38E+01 | 8.91E+02 |
| Lithium | 2.19E+01 | 5.48E+01 | 1.45E+03 |
| Magnesium | 9.56E+02 | 2.39E+03 | 6.31E+04 |
| Manganese | 1.30E+00 | 3.26E+00 | 8.60E+01 |
| Mercury | 2.04E-02 | 5.11E-02 | 1.35E+00 |
| Molybdenum | 3.68E+00 | 9.20E+00 | 2.43E+02 |
| Selenium | 1.16E-01 | 2.90E-01 | 7.65E+00 |
| Silver | 1.10E+01 | 2.75E+01 | 7.27E+02 |
| Thallium | 1.92E-01 | 4.81E-01 | 1.27E+01 |
| Tin | 5.48E+03 | 1.37E+04 | 3.62E+05 |
| Uranium | 1.40E+01 | 3.50E+01 | 9.24E+02 |
| Vanadium | 1.83E+02 | 4.58E+02 | 1.21E+04 |
| Radium 226 | 1.56E-02 | 3.90E-02 | 1.03E+00 |
| Radium 228 | 1.56E-02 | 3.90E-02 | 1.03E+00 |
| Thorium 228 | 2.30E-03 | 5.75E-03 | 1.52E-01 |
| Thorium 230 | 8.45E-04 | 2.11E-03 | 5.58E-02 |
| Thorium 232 | 2.82E-03 | 7.04E-03 | 1.86E-01 |
| Uranium 234 | 1.35E+01 | 3.38E+01 | 8.91E+02 |
| Uranium 235 | 1.35E+01 | 3.38E+01 | 8.91E+02 |
| Uranium 238 | 1.35E+01 | 3.38E+01 | 8.91E+02 |
| Chloroform | 3.00E-02 | 7.50E-02 | 1.98E+00 |
| Methylene Chloride | 7.91E-04 | 1.98E-03 | 5.22E-02 |
| Tetrachloroethene | 2.84E-03 | 7.11E-03 | 1.88E-01 |
| 1,2,4,5-Tetrachlorobenzene | 3.45E-02 | 8.63E-02 | 2.28E+00 |
| 2,4,6-Trichlorophenol | 5.14E-03 | 1.29E-02 | 3.39E-01 |
| 2,4-Dichlorophenol | 4.36E-02 | 1.09E-01 | 2.88E+00 |

**TABLE 4**
**CALCULATION OF LSSL DAF-2.5 AND DAF-66**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| | Leaching-Based Site-Specific Levels[4] | | |
|---|---|---|---|
| **Analyte** | $C_{t(DAF-1.0)}$ [1] | $C_{t(DAF-2.5)}$ [2] | $C_{t(DAF-66)}$ [3] |
| Benzo(a)anthracene | 6.97E-02 | 1.74E-01 | 4.60E+00 |
| Benzo(b)fluoranthene | 2.15E-01 | 5.38E-01 | 1.42E+01 |
| Hexachlorobenzene | 1.00E-01 | 2.50E-01 | 6.60E+00 |
| Hexachlorobutadiene | 8.81E-02 | 2.20E-01 | 5.82E+00 |
| Octochlorostyrene | 4.18E-01 | 1.05E+00 | 2.76E+01 |
| Pentachlorobenzene | 1.76E+00 | 4.39E+00 | 1.16E+02 |
| Pentachlorophenol | 1.24E-03 | 3.11E-03 | 8.20E-02 |
| Alpha BHC | 2.91E-02 | 7.28E-02 | 1.92E+00 |
| Beta BHC | 5.96E-03 | 1.49E-02 | 3.93E-01 |
| Endrin | 4.70E-02 | 1.17E-01 | 3.10E+00 |

References:

1 $C_t$ calculated at DAF-1.0 for protection of groundwater - Using site-specific soil properties

2 $C_t$ calculated at DAF-2.5 for protection of groundwater - Stormwater Catchment

3 $C_t$ calculated at DAF-66 for protection of groundwater - Backfilled and graded Beta/Northwestern Ditch

4 All concentrations are reported in mg/kg except for radium and thorium which are reported in piC/g

# APPENDIX A
# NDEP'S MARCH 21, 2013 COMMENTS AND TIMET'S RESPONSES

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

Brian Sandoval, Governor
Leo M. Drozdoff, P.E., Director
Colleen Cripps, Ph.D., Administrator

March 21, 2013

Mr. David Hadzinsky
c/o TIMET – HSEA Dept.
PO Box 2128
Henderson, Nevada 89009

Re.: **NDEP Facility ID# H-000537 (TIMET)**
Nevada Division of Environmental Protection Response To:
*Calculation of Leaching-Based Site-Specific Levels BMI Beta Ditch / Northwestern Ditches Located on the Titanium Metals Corporation Plant Site BMI Commons Area*
Dated and Received: February 26, 2013

Dear Mr. Hadzinsky:

The Nevada Division of Environmental Protection (NDEP) has completed a review of the aforementioned Deliverable. We find that TIMET's responses to comments were inadequate as shown in NDEP's comments in Attachment A of this letter. Please submit responses to these comments **no later than May 17, 2013**. Additionally, in order to move forward under the NDEP-approved schedules, NDEP is specifically approving the calculated values of the Leaching-Based Site-Specific Levels (LSSLs) that were presented in this Deliverable for use in future deliverables including the Excavation Plan for the Beta and Northwest Ditches area. Please note that NDEP is not approving the referenced Deliverable; only the calculated LSSL values.

Please note that NDEP will develop the LSSL for niobium as was requested by TIMET and that the *Revised Data Validation Summary Report for 2011 Beta and Northwest Ditches Soil Data* (March 2013) is currently being reviewed and will confirm whether any additional LSSLs need to be developed.

Should you have any questions or concerns, please do not hesitate to contact me at (702) 486-2850 x247 or mpfriend@ndep.nv.gov.

Sincerely,

Michael Friend

Michael P Friend, P.E.
Staff Engineer III, Special Projects Branch
Bureau of Corrective Actions
NDEP-Las Vegas Office
Fax: (702) 486-2863

Attachments as stated

MF/sh

ec: Shannon Harbour, NDEP, BCA, Carson City
Greg Lovato, NDEP, BCA, Carson City
Adam Baas, Edgcomb Law Group
Allan DeLorme, ENVIRON International Corporation
Andrew Barnes, Geosyntec
Ashley Katri, McGinley and Associates
Brenda Pohlmann, City of Henderson
Brian Giroux, McGinley & Associates
Brian Rakvica, McGinley & Associates
Brian Waggle, Hargis +Associates
Chuck Elmendorf, Stauffer Management Company, LLC
Curt Richards, Olin Corporation
Ebrahim Juma, Clark County Clean Water Team
Ed Modiano, de maximis, inc.
Emi Donis, Precision Castparts Corp
George Crouse, Syngenta Crop Protection, Inc.
Jasmine Mehta, AG's Office
Jay Gear, Olin Co
Jay Steinberg, NERT
Jeff Gibson, AMPAC
Joanne Otani
Joe Kelly, Montrose Chemical Corporation
Joe Leedy, Clark County, Clean Water Team
Joe McGinley, McGinley & Associates
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Kirk Stowers, Broadbent & Associates
Kurt Fehling, McGinley & Associates
Kyle Gadley, Geosyntec
Lee Farris, BRC
Mark Jones, ERM
Michael Long, Hargis +Associates
Mike Balshi,, Neptune & Co.
Nicholas Pogoncheff, PES Environmental, Inc.
Paul Black, Neptune and Company, Inc.
Paul Hackenberry, Hackenberry Associates, LLC
Paul Sundberg, Montrose Chemical Corporation
Ranajit Sahu, BRC
Rebecca Shircliff, Neptune & Co.
Rex Heppe, Ninyo and Moore
Stephen Tyahla, EPA Region IX
Victoria Tyson, TIMET

**Attachment A**

1. Section 3.2 Organics, page 9, please reference the "U.S. EPA HRA Manual, 1989, Section 5.9 Further Reduction in the Number of Chemicals" for the five percent frequency of detection.
2. Appendix A, NDEP provides the following comments:
   a. Attachment A – NDEP Comments and TIMET's Response to Comments (RTCs), TIMET RTC #1, NDEP October 12, 2012 Correspondence, NDEP will review the maps included in the March 13, 2013 Deliverable.
   b. Attachment A – NDEP Comments and TIMET's RTCs, TIMET RTC #8, NDEP October 12, 2012 Correspondence, NDEP specifically requested that screening decisions in Tables E-1 and E-2 to be included on those Tables. TIMET did not provide the requested changes to these tables. Due to the numerous errors found between Table 2 and Table E-2, NDEP is again requesting that decisions indicated in Tables E-1 and E-2, then TIMET should provide a column in these Tables that indicate the decision. TIMET included the decisions in Table 2. A cross check of Tables 2, 3, and E-2 shows the following:
      i. Table 2 - Organic Screening Results, SVOA – 4,4-DDE indicates No exceedance of LBCLs; however, Table E-2 shows that one of six samples exceeded DAF1 (frequency of detection was 100 percent for six samples collected).
      ii. Table 2 - Organic Screening Results, SVOA – Dibenzofuran indicates No detections; however, Table E-2 shows that there were two detections.
      iii. Table 2 - Organic Screening Results, Pesticide – Chlordane shows No exceedance of LBCLs; however, Table E-2 shows that there were no detections for the analyte. This is comment applies for various analytes compared between Table 2 and Table E-2 and has not been repeated in each instance.
      iv. Table E-2 Inorganic Concentrations Compared to LBCL DAF, NDEP provided an LBCL DAF1 for octachlorostyrene (listed in Table 3), which does not appear to be included in Table E-2.

      Please include the screening decisions in Tables E-1 and E-2 as was originally requested and correct the above inconsistencies.
   c. Attachment A – NDEP Comments and TIMET's RTCs, RTC #5.c., NDEP discussed this matter with TIMET in February 2013 and proposed either using the LBCL of 0.03 mg/kg instead of the LSSL or calculate the LSSL using the MCL for THM. Please revise to include the proposed solutions.
   d. Issues Raised During Meetings with NDEP/TIMET Technical Teams (As Reflected in Meeting Minutes for February 5, 2013 and February 8, 2013), NDEP provides the following comments:
      i. RTC 1, the February 5, 2013 meeting minutes should be quoted verbatim and not paraphrased. Please revise to include the finalized version of the meeting minutes issued by NDEP.
3. Appendix D – Statistical Evaluation of Inorganics and Radionuclides, Exploratory Data Analysis Section. Boxplots and quantile plots were not provided as part of this Deliverable. Please include these plots as supporting information in the form of an

Appendix in all future Deliverables to support the conclusions being drawn in Appendix D (e.g., "Analytes with an asterisk failed only one of four Gilbert's Toolbox tests, and did not exceed background upon exploratory data analysis."). The NDEP was able to create these plots as part of this review in order to verify claims made in the text and expedite the review. These plots can be found in Attachments B and C.

4. Appendix D – Statistical Evaluation of Inorganics and Radionuclides, Summary of Inorganic COPC Selection for Leaching Evaluation Section. NDEP does not agree with the conclusions in the text, "Upon evaluation of Table D-1, analytes eliminated as COPCs in the 0-10 ft bgs interval because Gilbert's toolbox confirms they are within the range of shallow McCullough soils background are aluminum, calcium, lithium*, magnesium*, nickel, palladium, silicon, strontium, titanium*, thallium*, uranium*, vanadium* and zirconium. (Analytes with an asterisk failed only one of four Gilbert's Toolbox tests, and did not exceed background upon exploratory data analysis.)". Upon further exploration of the boxplots and probability plots that were created by the NDEP, it appears that lithium, magnesium, thallium, titanium, uranium, and vanadium failed the background comparisons and should be carried through as COPCs (see Attachment B for the plots). Please revise as necessary.
5. Appendix D – Statistical Evaluation of Inorganics and Radionuclides, background comparisons, NDEP would like to note the following for future Deliverables. Most of the metals failed background comparisons, but the effect for nearly all of these metals is that failure of background comparisons occurs because of "tail effects". That is, most of the data are similar to background, but there is a sizeable minority for which this is not the case. This implies the potential for spatial differences at the site, which should be explored. If spatial differences provide the explanation for the background comparison failures, then it might be the case that only a portion of the site is contaminated. Spatial plots are also needed to determine if this is the case.
6. Appendix F – Laboratory Data Reports, it appears that there is no discussion in the main body of the report or in this Appendix regarding the approval status of the data that was used to develop the Deliverable. Please reference the specific data validation summary reports (DVSRs) and the related NDEP approval letters.
7. Figure 2 – Locations of Soil Borings Relative to Beta/Northwestern Ditches, please provide the location of the proposed excavation for the slurry wall on this Figure or an alternate Figure to verify the statements within the body of the text regarding sample locations to be excavated.
8. Tables, all tables have undefined formatting such as yellow highlighting, red font, strike through, etc. Please include definitions for these formats in the notes for each table.
9. Table 3 – Calculation of LSSLs at DAF-1 for Beta/Northwestern Ditch, NDEP provides the following comments:
   a. The Kd reference for Ra-226 and Ra-228 is listed as "b" (SSL guidance) but should be "f" (RAIS database) based on the Kd value and lack of Kd value for Ra in the SSL guidance. Please revise as necessary.
   b. TIMET states that there are no risk-based groundwater concentrations available for four compounds. Please include a foot note and update the text to state that calcium, sodium, and potassium are nutrients and no LSSLs need to be developed

and include the niobium LSSL provided by NDEP. For future reference, TIMET should derive risk-based concentrations in accordance with the Nevada Administrative Code or request that NDEP complete this task on TIMET's behalf or provide justification that the sample locations for these compounds are in areas to be excavated and an LSSL would not be needed to be developed.

c. The perchlorate LBCL is 0.185 mg/kg not 0.0263 mg/kg as listed in Table 3. Please revise as necessary.

## *References*

Nevada Division of Environmental Protection, 2010. Soil to Groundwater Leaching Guidance. BMI Plant Sites and Common Areas Projects, Henderson, Nevada.

U.S. Environmental Protection Agency, 1996. Soil Screening Guidance: User's Guide. Office of Solid Waste and Emergency Response, OSWER 9355.4-23. July.

# TIMET
# Response to NDEP's March 21, 2013 Correspondence

1. Section 3.2 Organics, page 9, please reference the "U.S. EPA HRA Manual, 1989, Section 5.9 Further Reduction in the Number of Chemicals" for the five percent frequency of detection.

   **TIMET Response:** The text has been revised to reflect this reference.

2. Appendix A, NDEP provides the following comments:
   a. Attachment A – NDEP Comments and TIMET's Response to Comments (RTCs), TIMET RTC #1, NDEP October 12, 2012 Correspondence, NDEP will review the maps included in the March 13, 2013 Deliverable.

      **TIMET Response:** TIMET submitted updated versions of these maps to the NDEP in the Excavation Plan Technical Memorandum deliverable dated March 22, 2013.

   b. Attachment A – NDEP Comments and TIMET's RTCs, TIMET RTC #8, NDEP October 12, 2012 Correspondence, NDEP specifically requested that screening decisions in Tables E-1 and E-2 to be included on those Tables. TIMET did not provide the requested changes to these tables. Due to the numerous errors found between Table 2 and Table E-2, NDEP is again requesting that decisions indicated in Tables E-1 and E-2, then TIMET should provide a column in these Tables that indicate the decision. TIMET included the decisions in Table 2. A cross check of Tables 2, 3, and E-2 shows the following:
      i. Table 2 - Organic Screening Results, SVOA – 4,4-DDE indicates No exceedance of LBCLs; however, Table E-2 shows that one of six samples exceeded DAF1 (frequency of detection was 100 percent for six samples collected).

      **TIMET Response:** Screening decisions have been added to Tables E-1 and E-2. Table 2 has been corrected to show the DAF-1 exceedance for 4-4-DDE. The decision to exclude 4,4-DDE from LSSL development was developed in consideration of the pesticide methodology results which suggest this parameter will not drive the removal action.

      ii. Table 2 - Organic Screening Results, SVOA – Dibenzofuran indicates No detections; however, Table E-2 shows that there were two detections.

**TIMET Response:** The notation in the Rationale column for dibenzofuran should read "FOD < 5%" since there were 2 detections out of 248 samples. Table 2 has been revised accordingly.

iii. Table 2 - Organic Screening Results, Pesticide – Chlordane shows No exceedance of LBCLs; however, Table E-2 shows that there were no detections for the analyte. This is comment applies for various analytes compared between Table 2 and Table E-2 and has not been repeated in each instance.

**TIMET Response:** Table 2 has been revised accordingly.

iv. Table E-2 Inorganic Concentrations Compared to LBCL DAF, NDEP provided an LBCL DAF1 for octachlorostyrene (listed in Table 3), which does not appear to be included in Table E-2.

**TIMET Response:** The entry for octachlorostyrene has been included in Table E-2.

Please include the screening decisions in Tables E-1 and E-2 as was originally requested and correct the above inconsistencies.

**TIMET Response:** Screening decisions have been added to Tables E-1 and E-2. The tables have been cross-checked with Table 2 and corrections were made as appropriate.

c. Attachment A – NDEP Comments and TIMET's RTCs, RTC #5.c., NDEP discussed this matter with TIMET in February 2013 and proposed either using the LBCL of 0.03 mg/kg instead of the LSSL or calculate the LSSL using the MCL for THM. Please revise to include the proposed solutions.

**TIMET Response:** The LBCL of 0.03 mg/kg has been used.

d. Issues Raised During Meetings with NDEP/TIMET Technical Teams (As Reflected in Meeting Minutes for February 5, 2013 and February 8, 2013), NDEP provides the following comments:

i. RTC 1, the February 5, 2013 meeting minutes should be quoted verbatim and not paraphrased. Please revise to include the finalized version of the meeting minutes issued by NDEP.

**TIMET Response:** TIMET is unclear what is meant by this comment, as copies of both referenced meeting minutes were included in Appendix A of TIMET's previous submittal (Revision #4).

3. Appendix D – Statistical Evaluation of Inorganics and Radionuclides, Exploratory Data Analysis Section. Boxplots and quantile plots were not provided as part of this Deliverable. Please include these plots as supporting information in the form of an Appendix in all future Deliverables to support the conclusions being drawn in Appendix D (e.g., "Analytes with an asterisk failed only one of four Gilbert's Toolbox tests, and did not exceed background upon exploratory data analysis."). The NDEP was able to create these plots as part of this review in order to verify claims made in the text and expedite the review. These plots can be found in Attachments B and C.

   **TIMET Response:** These plots have been included in Appendix D.

4. Appendix D – Statistical Evaluation of Inorganics and Radionuclides, Summary of Inorganic COPC Selection for Leaching Evaluation Section. NDEP does not agree with the conclusions in the text, "Upon evaluation of Table D-1, analytes eliminated as COPCs in the 0-10 ft bgs interval because Gilbert's toolbox confirms they are within the range of shallow McCullough soils background are aluminum, calcium, lithium*, magnesium*, nickel, palladium, silicon, strontium, titanium*, thallium*, uranium*, vanadium* and zirconium. (Analytes with an asterisk failed only one of four Gilbert's Toolbox tests, and did not exceed background upon exploratory data analysis.)". Upon further exploration of the boxplots and probability plots that were created by the NDEP, it appears that lithium, magnesium, thallium, titanium, uranium, and vanadium failed the background comparisons and should be carried through as COPCs (see Attachment B for the plots). Please revise as necessary.

   **TIMET Response:** Appendix D has been modified such that lithium, magnesium, thallium, titanium, uranium and vanadium are carried through as COPCs.

5. Appendix D – Statistical Evaluation of Inorganics and Radionuclides, background comparisons, NDEP would like to note the following for future Deliverables. Most of the metals failed background comparisons, but the effect for nearly all of these metals is that failure of background comparisons occurs because of "tail effects". That is, most of the data are similar to background, but there is a sizeable minority for which this is not the case. This implies the potential for spatial differences at the site, which should be explored. If spatial differences provide the explanation for the background comparison failures, then it might be the case that only a portion of the site is contaminated. Spatial plots are also needed to determine if this is the case.

   **TIMET Response:** Comment noted.

6. Appendix F – Laboratory Data Reports, it appears that there is no discussion in the main body of the report or in this Appendix regarding the approval status of the data

that was used to develop the Deliverable. Please reference the specific data validation summary reports (DVSRs) and the related NDEP approval letters.

**TIMET Response:** TIMET performed data validation on data collected from the BMI Beta / Northwestern Ditches in two phases.

Data validation of data collected in 2011 was presented to the NDEP in a document dated January 4, 2012 entitled *Data Validation Summary Report for 2011 Beta and Northwest Ditches Soil Data*. Due to a change in NDEP case officers, the NDEP did not respond to this submittal and, in 2013, requested a re-submittal of this document taking into account updated NDEP data validation guidance. TIMET submitted a revised data validation summary report (DVSR) to the NDEP on March 19, 2013; responded to NDEP comments on the DVSR report on April 10, 2013; provided clarification of the DVSR in electronic mail (e-mail) dated April 23, 2013; and received NDEP approval of the DVSR for 2011 data on April 29, 2013.

Data validation of data collected in 2012 (as a result of a data gap work plan) was presented to the NDEP in a document dated October 29, 2012 entitled *Data Validation Summary Report, 2012 Beta and Northwest Ditches Soil Data*. TIMET provided a response to NDEP comments on the DVSR on January 7, 2013; submitted a revised EDD by e-mail on January 31, 2013; and received NDEP approval of the DVSR for 2012 data on February 12, 2013.

The main body of the report has been revised to include this information.

7. Figure 2 – Locations of Soil Borings Relative to Beta/Northwestern Ditches, please provide the location of the proposed excavation for the slurry wall on this Figure or an alternate Figure to verify the statements within the body of the text regarding sample locations to be excavated.

**TIMET Response:** The approximate alignment of the proposed slurry wall has been added to Figure 2.

8. Tables, all tables have undefined formatting such as yellow highlighting, red font, strike through, etc. Please include definitions for these formats in the notes for each table.

**TIMET Response:** The undefined formatting was intended to denote changes from prior revisions and is not relevant to the current submittal. The undefined formatting has been removed and those chemicals shown with strike-out lines on Tables 3 and 4 (previously denoting the chemicals have been dropped from LSSL development) have been removed from the Tables in accordance with the screening decisions identified in Tables 1 and 2 (and E-1 and E-2).

9. Table 3 – Calculation of LSSLs at DAF-1 for Beta/Northwestern Ditch, NDEP provides the following comments:
   a. The Kd reference for Ra-226 and Ra-228 is listed as “b” (SSL guidance) but should be “f” (RAIS database) based on the Kd value and lack of Kd value for Ra in the SSL guidance. Please revise as necessary.

      **TIMET Response:** Table 3 has been revised accordingly.

   b. TIMET states that there are no risk-based groundwater concentrations available for four compounds. Please include a foot note and update the text to state that calcium, sodium, and potassium are nutrients and no LSSLs need to be developed and include the niobium LSSL provided by NDEP. For future reference, TIMET should derive risk-based concentrations in accordance with the Nevada Administrative Code or request that NDEP complete this task on TIMET’s behalf or provide justification that the sample locations for these compounds are in areas to be excavated and an LSSL would not be needed to be developed.

      **TIMET Response:** Table E-1 has been revised accordingly.

   c. The perchlorate LBCL is 0.185 mg/kg not 0.0263 mg/kg as listed in Table 3. Please revise as necessary.

      **TIMET Response:** Table 3 has been revised accordingly.

# APPENDIX B
# SOIL PHYSICAL PROPERTIES REPORT

# Table B-1
## Summary of Bulk Density, Moisture Content and Porosity

*Daniel B. Stephens & Associates, Inc.*

### Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

| | Moisture Content | | | | | | |
|---|---|---|---|---|---|---|---|
| | As Received | | Remolded | | | | |
| Sample Number | Gravimetric (%, g/g) | Volumetric (%, $cm^3/cm^3$) | Gravimetric (%, g/g) | Volumetric (%, $cm^3/cm^3$) | Dry Bulk Density ($g/cm^3$) | Wet Bulk Density ($g/cm^3$) | Calculated Porosity (%) |
| BD-1-5 | 9.6 | 13.7 | --- | --- | 1.44 | 1.58 | 47.5 |
| BD-1-10 | 10.6 | 14.3 | --- | --- | 1.35 | 1.50 | 50.0 |
| BD-1-20 | 18.7 | 27.1 | --- | --- | 1.45 | 1.72 | 46.7 |
| BD-4-1.5 | 14.4 | 13.2 | --- | --- | 0.92 | 1.05 | 65.9 |
| BD-4-5 | 4.9 | 8.2 | --- | --- | 1.68 | 1.76 | 38.1 |
| BD-4-15 | 10.3 | 15.6 | --- | --- | 1.52 | 1.68 | 43.9 |
| BD-4-22 | 10.3 | 16.9 | --- | --- | 1.64 | 1.81 | 38.9 |
| NW-2-5 | 9.3 | 13.4 | --- | --- | 1.44 | 1.57 | 47.6 |
| NW-2-10 | 9.8 | 13.8 | --- | --- | 1.41 | 1.55 | 48.1 |
| NW-2-20 | 32.5 | 39.5 | --- | --- | 1.21 | 1.61 | 55.2 |
| NW-8-5 | 10.3 | 15.6 | --- | --- | 1.51 | 1.67 | 44.6 |
| NW-8-10 | 9.8 | 15.3 | --- | --- | 1.56 | 1.71 | 41.7 |
| NW-8-20 | 8.2 | 13.5 | --- | --- | 1.64 | 1.77 | 39.7 |
| ***Averages*** | | ***16.9*** | | | ***1.44*** | | ***46.8*** |

NA = Not analyzed

--- = This sample was not remolded

# Table B-2
# Fraction Organic Carbon Results


*Daniel B. Stephens & Associates, Inc.*

## Summary of Fractional Organic Carbon Tests

| Sample Number | Fractional Organic Carbon (%) | Fractional Organic Carbon (g/g) |
|---|---|---|
| BD-1-5 | 0.40 | 0.004 |
| BD-1-10 | 0.22 | 0.0022 |
| BD-1-20 | *ND | 0.0005 |
| BD-2-0.5 | 0.10 | 0.001 |
| BD-3-0.5 | 1.1 | 0.011 |
| BD-3-1.5 | 0.45 | 0.0045 |
| BD-4-0.5 | 0.21 | 0.0021 |
| BD-4-1.5 | 0.12 | 0.0012 |
| BD-4-5 | 0.20 | 0.002 |
| BD-4-15 | *ND | 0.0005 |
| BD-4-22 | *ND | 0.0005 |
| BD-5-0.5 | 0.25 | 0.0025 |
| BD-6-0.5 | 0.20 | 0.002 |
| BD-7-0.5 | *ND | 0.0005 |
| BD-7-1.5 | *ND | 0.0005 |
| BD-8-0.5 | *ND | 0.0005 |
| BD-9-0.5 | *ND | 0.0005 |
| BD-10-0.5 | 0.29 | 0.0029 |
| BD-11-0.5 | *ND | 0.0005 |
| BD-11-1.5 | *ND | 0.0005 |
| BD-12-0.5 | *ND | 0.0005 |
| BD-12-1.5 | *ND | 0.0005 |
| BD-13-0.5 | 0.64 | 0.0064 |
| BD-14-0.5 | 1.2 | 0.012 |
| BD-14-1.5 | *ND | 0.0005 |
| BD-15-0.5 | 0.88 | 0.0088 |

## Summary of Fractional Organic Carbon Tests

| Sample Number | Fractional Organic Carbon (%) | Fractional Organic Carbon (g/g) |
|---|---|---|
| BD-15-1.5 | *ND | 0.0005 |
| NW-1-0.5 | 0.17 | 0.0017 |
| NW-2-5 | 0.11 | 0.0011 |
| NW-2-10 | 0.33 | 0.0033 |
| NW-2-20 | *ND | 0.0005 |
| NW-3-0.5 | 0.44 | 0.0044 |
| NW-3-1.5 | *ND | 0.0005 |
| NW-4-0.5 | *ND | 0.0005 |
| NW-4-1.5 | *ND | 0.0005 |
| NW-5-0.5 | *ND | 0.0005 |
| NW-6-0.5 | *ND | 0.0005 |
| NW-7-0.5 | *ND | 0.0005 |
| NW-7-1.5 | *ND | 0.0005 |
| NW-8-5 | 0.11 | 0.0011 |
| NW-8-10 | *ND | 0.0005 |
| NW-8-20 | 0.11 | 0.0011 |
| NW-9-0.5 | 0.12 | 0.0012 |
| NW-9-1.5 | 0.10 | 0.001 |
| NW-10-0.5 | *ND | 0.0005 |
| NW-10-1.5 | 0.16 | 0.0016 |
| NW-11-0.5 | 0.45 | 0.0045 |
| NW-12-0.5 | 0.17 | 0.0017 |
| NW-12-1.5 | *ND | 0.0005 |
| NW-13-0.5 | *ND | 0.0005 |
| NW-13-1.5 | *ND | 0.0005 |
| NW-14-0.5 | 1.1 | 0.011 |

## Summary of Fractional Organic Carbon Tests

| Sample Number | Fractional Organic Carbon (%) | Fractional Organic Carbon (g/g) |
|---|---|---|
| NW-15-0.5 | *ND | 0.0005 |
| NW-15-1.5 | *ND | 0.0005 |
| NW-16-0.5 | 0.23 | 0.0023 |
| NW-16-1.5 | *ND | 0.0005 |
| NW-17-0.5 | 0.13 | 0.0013 |
| NW-18-0.5 | *ND | 0.0005 |
| NW-18-1.5 | *ND | 0.0005 |
| NW-19-0.5 | *ND | 0.0005 |
| NW-19-1.5 | *ND | 0.0005 |
| | ***Arithmetic Mean*** | ***0.0019*** |

*Analysis provided by Hall Environmental, Albuquerque, NM.*

**ND = not detected at the reporting limit of 0.1% C; 1/2 detection limit used for averaging*

Daniel B. Stephens & Associates, Inc.

# Summary of Tests Performed

| Laboratory Sample Number | Initial Soil Properties[1] | | | Saturated Hydraulic Conductivity[2] | | | Moisture Characteristics[3] | | | | | | | | Particle Size[4] | | | Specific Gravity[5] | | CEC | FOC | Atterberg Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | VM | VD | CH | FH | FW | HC | PP | FP | DPP | RH | EP | WHC | $K_{unsat}$ | DS | WS | H | F | C | | | |
| BD-1-5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-1-10 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-2-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-3-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-3-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-4-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-4-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-4-5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-5-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-6-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-10-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-13-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-14-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-15-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-1-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-2-5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-2-10 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-3-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-8-5 | | | | | | | | | | | | | | | | | | | | | X | |

# Summary of Tests Performed

| Laboratory Sample Number | Initial Soil Properties[1] | | | Saturated Hydraulic Conductivity[2] | | | Moisture Characteristics[3] | | | | | | | | Particle Size[4] | | | Specific Gravity[5] | | CEC | FOC | Atterberg Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | VM | VD | CH | FH | FW | HC | PP | FP | DPP | RH | EP | WHC | $K_{unsat}$ | DS | WS | H | F | C | | | |
| NW-8-20 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-9-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-9-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-10-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-11-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-12-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-14-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-16-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-17-0.5 | | | | | | | | | | | | | | | | | | | | | X | |

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

# Summary of Tests Performed

| Laboratory Sample Number | Initial Soil Properties[1] | | | Saturated Hydraulic Conductivity[2] | | | Moisture Characteristics[3] | | | | | | | | Particle Size[4] | | | Specific Gravity[5] | | CEC | FOC | Atterberg Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | VM | VD | CH | FH | FW | HC | PP | FP | DPP | RH | EP | WHC | $K_{unsat}$ | DS | WS | H | F | C | | | |
| BD-1-5 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| BD-1-10 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| BD-1-20 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| BD-2-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-3-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-3-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-4-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-4-1.5 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| BD-4-5 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| BD-4-15 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| BD-4-22 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| BD-5-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-6-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-7-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-7-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-8-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-9-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-10-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-11-0.5 | | | | | | | | | | | | | | | | | | | | | X | |

# Summary of Tests Performed

| Laboratory Sample Number | Initial Soil Properties[1] | | | Saturated Hydraulic Conductivity[2] | | | Moisture Characteristics[3] | | | | | | | | Particle Size[4] | | | Specific Gravity[5] | | CEC | FOC | Atterberg Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | VM | VD | CH | FH | FW | HC | PP | FP | DPP | RH | EP | WHC | $K_{unsat}$ | DS | WS | H | F | C | | | |
| BD-11-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-12-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-12-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-13-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-14-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-14-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-15-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| BD-15-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-1-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-2-5 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| NW-2-10 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| NW-2-20 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| NW-3-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-3-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-4-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-4-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-5-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-6-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-7-0.5 | | | | | | | | | | | | | | | | | | | | | X | |

# Summary of Tests Performed

| Laboratory Sample Number | Initial Soil Properties[1] | | | Saturated Hydraulic Conductivity[2] | | | Moisture Characteristics[3] | | | | | | | | Particle Size[4] | | | Specific Gravity[5] | | CEC | FOC | Atterberg Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | VM | VD | CH | FH | FW | HC | PP | FP | DPP | RH | EP | WHC | $K_{unsat}$ | DS | WS | H | F | C | | | |
| NW-7-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-8-5 | X | X | | X | | | | | | | | X | | | | X | X | X | | X | X | X |
| NW-8-10 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| NW-8-20 | X | X | | X | | | | | | | | X | | | | X | X | X | X | X | X | X |
| NW-9-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-9-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-10-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-10-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-11-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-12-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-12-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-13-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-13-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-14-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-15-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-15-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-16-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-16-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-17-0.5 | | | | | | | | | | | | | | | | | | | | | X | |

# Summary of Tests Performed

| Laboratory Sample Number | Initial Soil Properties[1] | | | Saturated Hydraulic Conductivity[2] | | | Moisture Characteristics[3] | | | | | | | | Particle Size[4] | | | Specific Gravity[5] | | CEC | FOC | Atterberg Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | G | VM | VD | CH | FH | FW | HC | PP | FP | DPP | RH | EP | WHC | $K_{unsat}$ | DS | WS | H | F | C | | | |
| NW-18-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-18-1.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-19-0.5 | | | | | | | | | | | | | | | | | | | | | X | |
| NW-19-1.5 | | | | | | | | | | | | | | | | | | | | | X | |

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

# APPENDIX C
# PRECIPITATION, RUNOFF AND WATER LOSS IN LOWER COLORADO RIVER – SALTON SEA AREA

# Precipitation, Runoff and Water Loss in the Lower Colorado River–Salton Sea Area

*By* ALLEN G. HELY *and* EUGENE L. PECK

WATER RESOURCES OF LOWER COLORADO RIVER–SALTON SEA AREA

GEOLOGICAL SURVEY PROFESSIONAL PAPER 486-B

*Prepared in collaboration with the U.S. Weather Bureau*

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UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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# CONTENTS


| | Page |
|---|---|
| Abstract | B1 |
| Introduction | 1 |
| General description of the area | 1 |
| Precipitation | 2 |
| Isohyetal maps | 3 |
| Variations in time | 4 |
| Temperature | 6 |
| Runoff | B6 |
| Methods used in estimating runoff | 11 |
| Reliability | 14 |
| Water loss | 15 |
| Evaporation | 15 |
| Evapotranspiration | 16 |
| References | 16 |


# ILLUSTRATIONS

[Plates are in pocket]


PLATES 1–3. Maps showing mean precipitation, 1931–60, lower Colorado River–Salton Sea area:
1. Winter (October–April).
2. Summer (May–September).
3. Annual.

4. Map showing mean annual temperature, 1931–60, lower Colorado River–Salton Sea area.
5. Map showing estimated mean annual runoff from small tracts, lower Colorado River–Salton Sea area.
6. Map showing mean annual lake evaporation, 1946–55, lower Colorado River–Salton Sea area.
7. Map showing estimated mean annual evapotranspiration, 1931–60, lower Colorado River–Salton Sea area.

| | | Page |
|---|---|---|
| FIGURE | 1. Map showing location of area discussed in this report | B2 |
| | 2. Map showing zones used in analysis of precipitation data | 4 |
| | 3. Seasonal and water-year totals of precipitation | 5 |
| | 4. Cumulative departures from 30-year mean precipitation | 7 |
| | 5. Normals and extremes of monthly precipitation | 8 |
| | 6. Map showing total precipitation during September 1939 | 9 |
| | 7. Monthly normals, normal ranges, and extremes of temperature | 10 |
| | 8. Graph showing relations between direct runoff and storm rainfall | 12 |
| | 9. Graph showing relation between runoff-curve number and mean annual runoff for the precipitation distribution indicated in table 1 | 13 |
| | 10. Graph showing relations between initial infiltration and runoff-curve numbers | 14 |


# TABLE


| | | Page |
|---|---|---|
| TABLE | 1. Summary of daily precipitation data for seven desert stations | B12 |

# PRECIPITATION, RUNOFF, AND WATER LOSS IN THE LOWER COLORADO RIVER–SALTON SEA AREA

By Allen G. Hely and Eugene L. Peck


## ABSTRACT

The economy of the 25,000-square-mile area discussed in this report, which includes the western part of the region tributary to Colorado River below Davis Dam, Ariz.–Nev., and the adjoining Salton Sea basin, depends primarily on irrigation with water from the Colorado River. Nevertheless, an adequate appraisal of the water resources of the area must include information on the precipitation, runoff, and natural water loss within the area because these quantities affect water supplies of local origin and also the use of Colorado River water.

Mean annual precipitation ranges from less than 3 inches near the Salton Sea to more than 40 inches on Mount San Gorgonio, the highest peak on the western divide. In most of the area, including virtually all of the irrigable lands, the mean precipitation is less than 8 inches. Precipitation is strongly influenced by season and topography. Summer precipitation is almost insignificant in comparison with winter precipitation in the western part of the area, but in the southeastern part, summer and winter precipitation means are almost the same. Isohyetal maps of both seasonal and annual means are adjusted for the effects of topography.

A map showing mean annual temperature is included because of the dominant effect of temperature on natural water loss and on use of water by man. The mean generally decreases about 3.2°F for each 1,000 feet of increase in altitude, but it does not change significantly with change in latitude.

A large part of the runoff generated by precipitation within the area is absorbed in the alluvium of the valleys and plains. Available streamflow records provide very little information regarding the local runoff, which, consequently, was estimated on the basis of precipitation data, rainfall-runoff relations, and observed characteristics of the terrain. The runoff map indicates mean annual amounts generated by rainfall on tracts of 10–20 square miles. As no adjustment for the effects of absorption in the alluvium is included, the runoff from larger tracts cannot be determined from the map, except for tracts that contain no large deposits of alluvium.

Natural water loss includes evaporation from water surfaces and evapotranspiration from land areas and is relatively high in this area. Evaporation from reservoirs on the lower Colorado River, including Lake Mead, is estimated as about 1.2 million acre-feet—nearly 10 percent of the mean annual streamflow in the lower Colorado River for 1931–60. Evapotranspiration from many unirrigated tracts exceeds the precipitation because of the absorption of runoff from nearby mountains. Evapotranspiration from irrigated tracts greatly exceeds the precipitation and varies with the type of crop and irrigation practices. It has no relation to local precipitation or runoff because the water is supplied chiefly by the Colorado River.


## INTRODUCTION

The data and maps in this report are part of an appraisal of the total water resources of the area in which the lower Colorado River is the principal source of water supply. In such an appraisal the precipitation, runoff, and water loss within the area are important not only because they affect the Colorado River but also because they determine the magnitude of local water supplies that are relatively independent of the river.

Adequate descriptions of precipitation and runoff generally include the areal distribution of normal annual values and also the variability of annual values at specific localities. However, because of a lack of information on runoff in the study area, the description of runoff is limited to normal annual values.

The 30-year period 1931–60, which the U.S. Weather Bureau and the World Meterological Organization use as the current basis for normals (means) of meteorological data, is the standard period used for computation of means in this report when such a period is applicable.

The text and illustrations relating to precipitation and temperatures were prepared by E. L. Peck, hydrologist-in-charge, assisted by E. G. Christensen and E. S. McDonough, Water Supply Forecast Unit, U.S. Weather Bureau, Salt Lake City, Utah. The text and illustrations relating to runoff and water loss were prepared by A. G. Hely under the general supervison of C. C. McDonald, project hydrologist, U.S. Geological Survey. The assistance of many colleagues who reviewed the manuscript and offered helpful suggestions is gratefully acknowledged.

## GENERAL DESCRIPTION OF THE AREA

The area discussed in this report, as defined by natural drainage boundaries, comprises the Salton Sea basin and the drainage area of Colorado River below Davis Dam, Ariz.–Nev., excluding the Bill Williams River basin above the gaging station near Alamo, Ariz., the Gila River basin above the Wellton-Mohawk Irrigation and Drainage District, and the drainage area of

San Cristobal Wash. Although this wash enters the Gila River from the south within the irrigation district, its drainage area is omitted to keep the map of the study area within convenient limits. The southern part of the Colorado River delta in Mexico also is excluded from the study. The location of the area and its relation to the Upper and Lower Basins of the Colorado River as defined in the Colorado River Compact of 1922, are indicated in figure 1.

Mountain ranges that are roughly parallel to the Pacific coast form the drainage divide between the southern coastal basins in California and the southern part of the Great Basin, of which the Salton Sea basin is a part. The mountain ranges are also the chief cause of the difference between the mild, Mediterranean-type climate of southwestern California and the hot dry climate of the deserts in the Great Basin and the lower Colorado River basin. These ranges are highest and steepest at the northwestern end of the Salton Sea basin, where they reach altitudes of more than 10,000 feet. Farther south, in the vicinity of the international boundary, their altitude is about 4,000 feet.

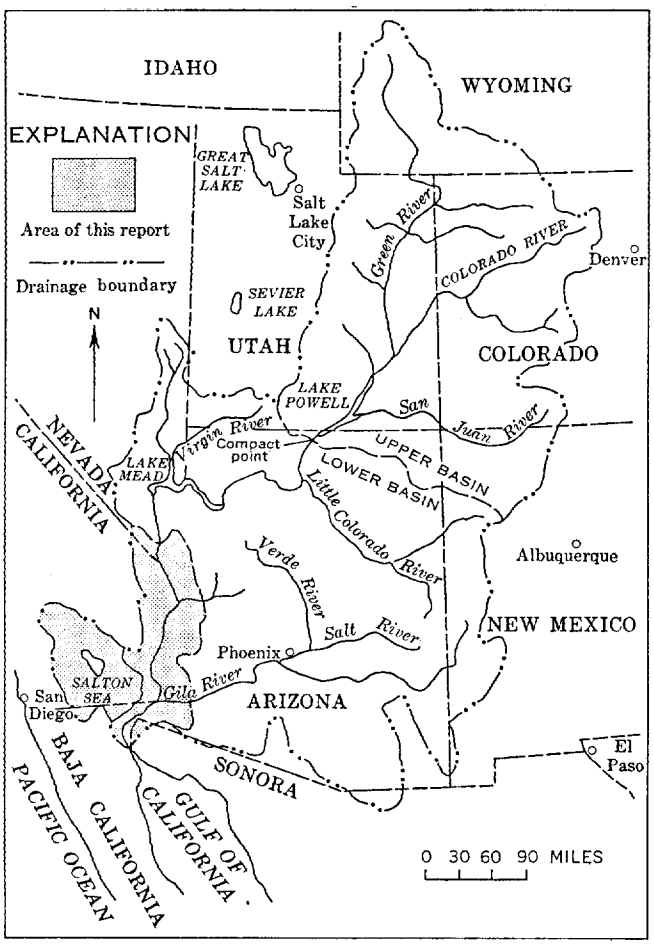



FIGURE 1.—Map showing location of area discussed in this report.

The elongate depression that contains the Gulf of California and the Salton Sea lies east of these mountains. The Colorado River enters the depression near the international boundary, and its delta forms a barrier more than 100 miles wide between the gulf and the Salton Sea. The lowest point on the divide is about 35 feet above sea level, and the lowest part of the Salton Sea basin is about 278 feet below mean sea level (revised on the basis of soundings made by Shawn Biehler of California Institute of Technology in August 1962).

The desert area north and east of the depression contains numerous ranges of hills and mountains, which are somewhat lower than those on the western edge of the Salton Sea basin. The Hualpai Mountains in Arizona in the northeastern part of the area reach an altitude of more than 8,000 feet, but few peaks in the vicinity of the international boundary are more than 3,000 feet above sea level. Many of the ranges are extremely rugged and barren, although of only moderate height. The mountain masses generally consist of dense rocks having very thin mantles of weathered rock or soil. The intermontane valleys and plains are underlain by thick deposits of alluvium eroded from the mountains or transported into the region by the Colorado and Gila Rivers.

The Colorado River has cut canyons through some low mountains that lie across its path and has built wide flood plains in the intervening valleys. Just above its delta, the Colorado River is joined by the Gila River, which also is bordered by wide flood plains except where it passes between the Gila and Laguna Mountains about 10 miles above the junction of the two rivers.

The delta and the flood plains, together with some smaller tracts, support an extensive agriculture that depends entirely on irrigation and is the mainstay of the economy of the area. Some low-lying tracts that are not cultivated support a dense growth of native bottom-land vegetation which draws its water supply from the shallow ground water.

The study area includes about 25,000 square miles in the States of Arizona, California, and Nevada, and in Baja California and Sonora, Mexico. About two dozen cities and towns had populations of more than 1,000 in 1960. Mexicali, Baja Calif., the largest city in the area, and Yuma, Ariz., the largest city north of the international boundary, had populations of about 65,000 and 24,000, respectively. Some of the larger cities and some new communities in recreational areas are growing very rapidly.

## PRECIPITATION

Mean annual precipitation is less than 8 inches in most of the study area and ranges from less than 3 inches

in the Colorado River delta and lower Coachella Valley areas to more than 40 inches on Mount San Gorgonio, the highest peak. These areal variations are closely related to topography and to exposure to moist air from the Pacific Ocean in winter and from the Gulf of Mexico in summer.

In places, many consecutive months may pass with no precipitation, but rainfall greater than the normal annual amount may occur during a single brief storm. These variations at specific localities are due to erratic changes in weather (common to all localities) superimposed on periodic variations associated with the seasons.

The maps and charts on plates 1–3 and in figures 3–6 provide a general description of the precipitation and its variations by years, seasons, and months.

### ISOHYETAL MAPS

During the 7-month period October–April, the prevailing weather patterns and associated precipitation differ markedly from those for the 5-month period May–September. Because of these differences, the separate analysis of precipitation data for each season is preferable to analysis of annual data. Furthermore, maps of seasonal precipitation are useful in many hydrologic studies. Hence, isohyetal maps have been compiled for the winter season—October–April (pl. 1)—and for the summer season—May–September (pl. 2). The annual map (pl. 3) was drawn by combining the two seasonal maps.

The network of precipitation stations in areas of low relief is fairly adequate, but in areas of high relief, where effects of topography are greatest, there are very few stations. Methods of mapping precipitation in areas of high relief have been greatly improved during the past 15 years. The method used in this report was described by Peck and Brown (1962).

The study area and its immediate surroundings were divided into eight zones (fig. 2) to facilitate computation of 30-year means for short-term records (as explained below) and the development of altitude-precipitation relations.

Nearly 300 records from files and publications of the Weather Bureau and other Federal and State agencies were used to help define the seasonal maps. Several other records were examined but were found to be inconsistent, too fragmentary, or too short to be useful. The minimum lengths of record used are 5 years for winter and 10 years for summer. All winter records were checked for consistency by the double-mass analysis technique described by Linsley, Kohler, and Paulhus (1949). Summer records were assumed to have the same discontinuities as those determined for the winter period.

Normals (30-year means) for each season were determined separately. For each incomplete record, the normal winter precipitation was determined by extrapolation of the relation line defined by double-mass plotting of the incomplete record against a base. The base for a specific zone is the average of all complete records of acceptable quality from that zone. Normal summer precipitation for stations that have incomplete records was extrapolated by the ratio method. The record for a full-term station that has as nearly as possible the same altitude and exposure as those of the station having an incomplete record was used for comparison. The ratio of cumulative precipitation at the short-term station to that at the full-term station, as defined for the concurrent period, was assumed to apply to the 30-year period also.

Relations between altitude and seasonal normals of precipitation for each of the eight zones are fairly well defined. These relations and the normals for each station could be used to draw isohyets for each zone, but discontinuities would exist at the borders, where differences between the relations for adjacent zones may be large. This difficulty was avoided by preparation of anomaly maps, as described below.

The altitude-precipitation relations for zones A, B, C, E, G, and H (fig. 2) are practically parallel. Consequently, these individual relations were combined in a mean curve for the six zones, and anomalies (departures) from the mean curve were computed for each precipitation station within or adjacent to these zones. The relations for zones D and F, also, are practically parallel but have a slope that differs from the slope for other zones. Anomalies from a mean curve for zones D and F were computed for each station within or adjacent to these zones. Analysis of the anomalies showed that they were closely related to physiographic features and that lines of equal anomaly could be drawn with considerable confidence except in areas where precipitation data are most deficient. The overlap of anomaly patterns facilitated the smooth transition between groups of zones when the isohyetal maps were drawn.

In preparing the seasonal isohyetal maps, the normals for each station were plotted, and normals for additional points were computed from the anomaly maps. Values were determined for each intersection of a grid that has lines spaced 20 minutes apart and for other points in certain critical areas. The isohyets are based on the plotted values and on the topography.

Although the accuracy of the final maps cannot be determined, the reliability of the maps is greatly improved by the systematic adjustments for the effects of topography. Any map of a large area must be gen-

eralized somewhat. Consequently, the maps indicate the normal precipitation for an appreciable area more accurately than the normal for a point.

### VARIATIONS IN TIME

The isohyetal maps described above show how the normal precipitation varies areally, and they also illustrate one aspect of how the precipitation varies in time. Other aspects of this variation are illustrated in figures 3–6.

The charts in figure 3 illustrate the variations from season to season and from year to year at four locations (which are indicated in fig. 6). Means for different short periods vary quite erratically, but the means for long periods of record are almost the same as those for the 30-year period 1931–60.

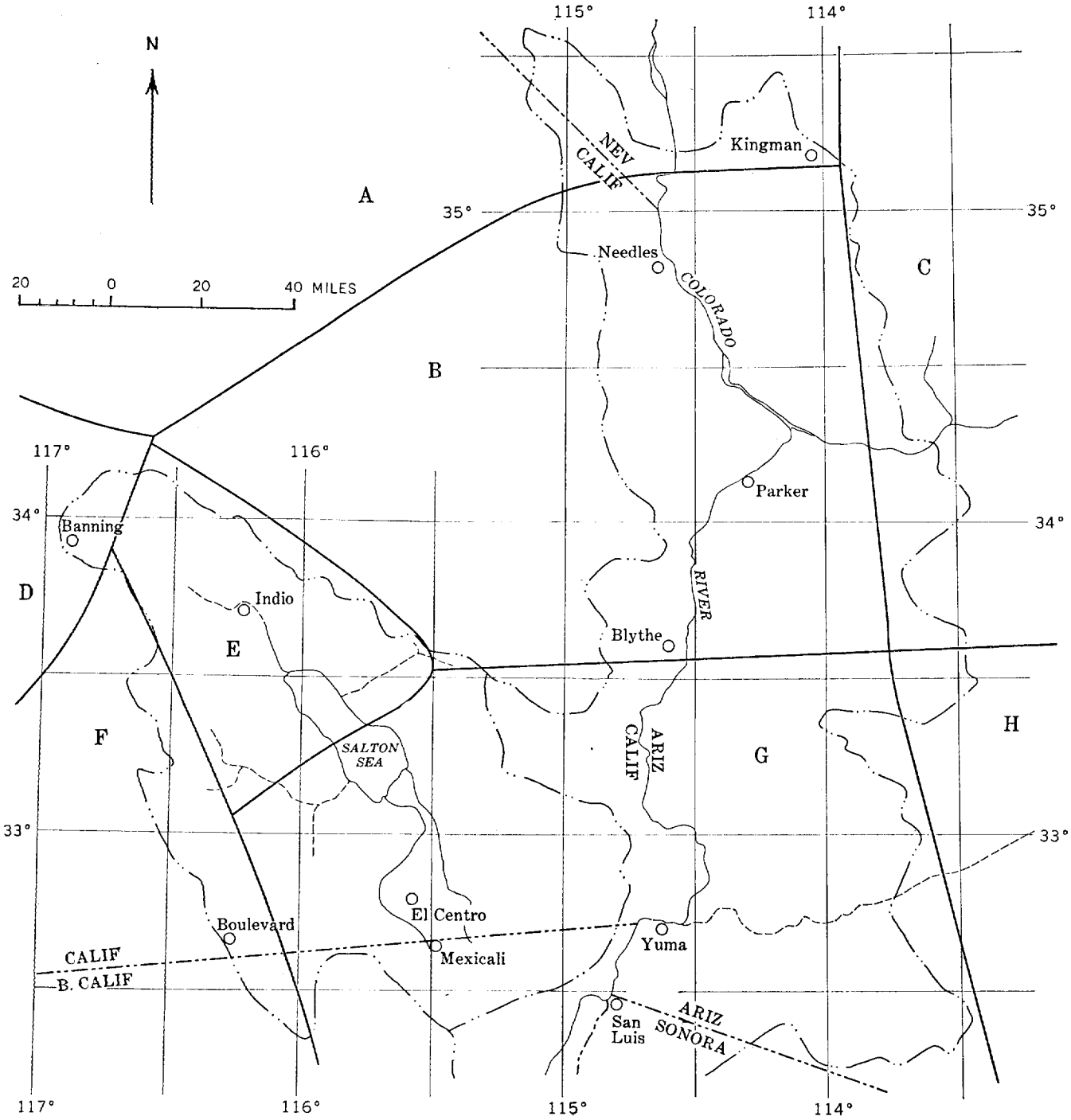



FIGURE 2.—Map showing zones used in analysis of precipitation data.

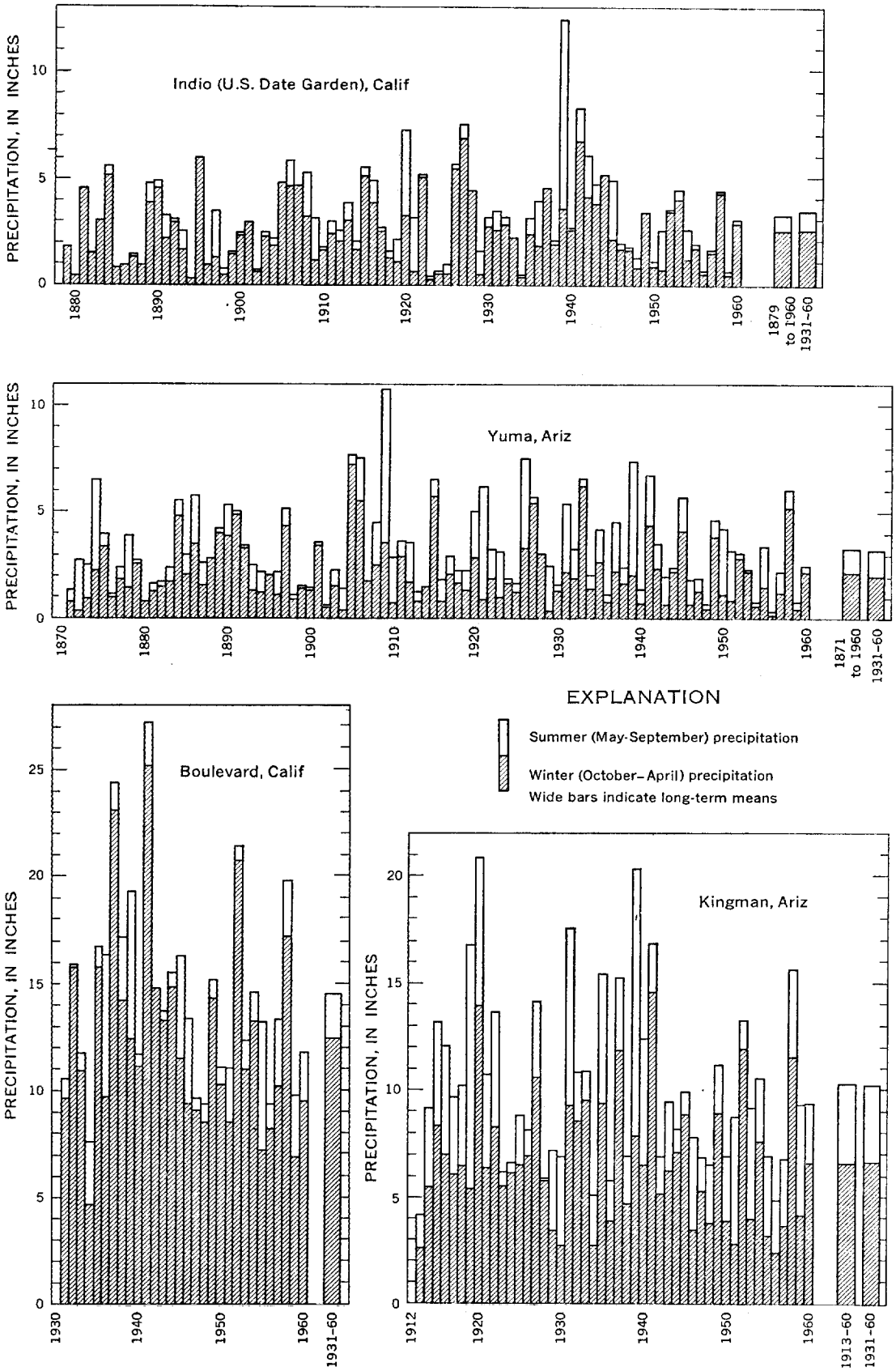



FIGURE 3.—Seasonal and water-year totals of precipitation.

No long-term record is available for the most humid part of the area, but the record for Boulevard, Calif., is sufficient to indicate the variations.

The absolute variation—indicated by the range—tends to be greatest where the mean precipitation is greatest, but the relative variation—indicated by the range expressed as a percentage of the mean—tends to be greatest where the mean precipitation is least. For example, the range in annual precipitation for 1931–60 at Boulevard is 19.6 inches, or 135 percent of the mean. For the same period the range at Indio is 12.1 inches, or 360 percent of the mean.

Both figure 3 and the seasonal isohyetal maps (pls. 1, 2) demonstrate that summer precipitation accounts for a very small proportion of the annual precipitation at the western edge of the study area and a much larger proportion toward the east.

Graphs showing accumulated departures from the mean (fig. 4) help to identify wet and dry periods and indicate the severity of drought or the excess of rainfall. All departures were computed from the mean for 1931–60, the longest period common to all four records. The lines start at zero at the beginning of the 1931 water year (Oct. 1, 1930) and extend in both directions if records prior to 1931 are available. The trend of the line, rather than its position above or below the base line, is the significant aspect because the position depends on the starting point. Downward trends indicate below-normal precipitation, and upward trends indicate above-normal precipitation.

The charts of monthly precipitation in figure 5 indicate the nature of the seasonal cycle in more detail and also emphasize the extreme variability. Median values (the amounts equalled or exceeded 50 percent of the time) as well as normals (means for 1931–60) are indicated because they are particularly significant in arid climates. In the study area the median generally is only a small fraction of the mean and may be zero if the mean is small. On the other hand, in humid regions the mean and median are nearly the same.

The maximum monthly precipitation indicated in figure 5 often is the result of an intense storm that covers only a small area, particularly in the summer. On rare occasions, however, a general summer storm produces heavy rain over a large area. The isohyetal map in figure 6 (not adjusted for effects of topography) shows the total monthly precipitation for September 1939, when the precipitation exceeded the normal annual total in most of the desert area. Most of the rainfall occurred in two general storms following tropical disturbances that moved into the Baja California region.

## TEMPERATURE

Although air temperature is not a primary topic of hydrology, it is significant because of its dominant influence on natural water loss and on the use of water by man. A description of the variations is provided by the map on plate 4 and by the charts in figure 7.

For the most part, temperatures correlate well with altitude, changing approximately 3.2° F. for each 1,000 feet of altitude. Drainage of cool air from uplands to adjacent valleys causes many anomalies from this general pattern. An outstanding example of this occurs in the valleys of the lower Colorado and Gila Rivers near Yuma, Ariz., where the mean annual temperature is slightly lower than that of the surrounding area, and daily minimum temperatures often are markedly lower. Latitude has no significant effect upon temperature within the study area.

The map of mean annual temperature (pl. 4) is based on all available temperature records of more than 5 years. Means for incomplete records were adjusted to the 30-year period by the departure method. The departure from the established normal for a nearby station was determined for the short period and applied to the incomplete record.

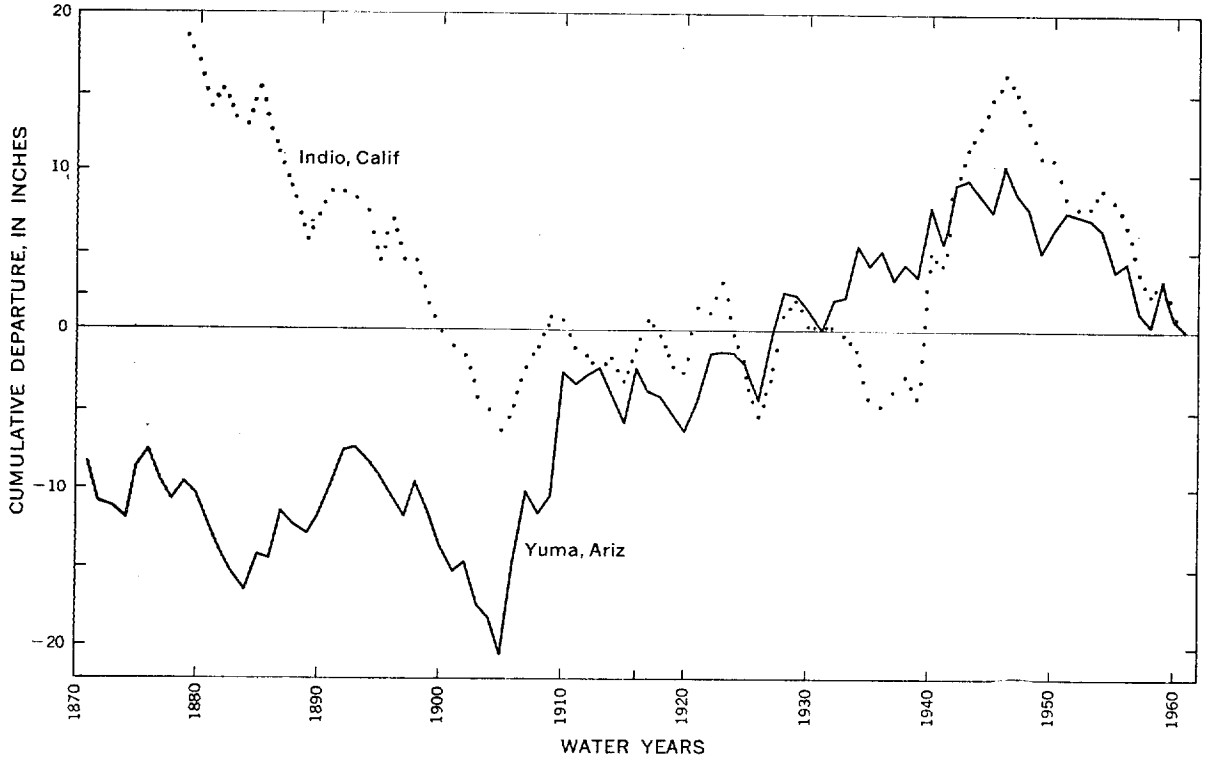
Mean daily maximum and minimum temperatures for January and July were analyzed and mapped in the course of the study. The general pattern of the isotherms on these maps is very similar to that on the annual map and tends to confirm it.

The extreme variability and the seasonal pattern of variations at specific localities is demonstrated by the charts in figure 7. The seasonal patterns are rather uniform, but the range in temperature for each month is large. Such ranges are characteristic of the desert, where low humidity and general absence of cloud cover favor rapid radiation of heat.

## RUNOFF

Streamflow in arid regions differs markedly from that in humid regions, for which most runoff maps have been prepared. Consequently, the proper interpretation of a runoff map of an arid region depends on an understanding of the basis for the map.

In humid regions drained by perennial streams, conventional streamflow records often are an adequate basis for a runoff map. The flow is composed partly of direct (storm) runoff and partly of ground-water runoff, both of which tend to increase as the drainage area increases. Although local differences in terrain or geology may cause large differences in the proportions of direct runoff and ground-water runoff, they usually have relatively little effect on the total long-term runoff.



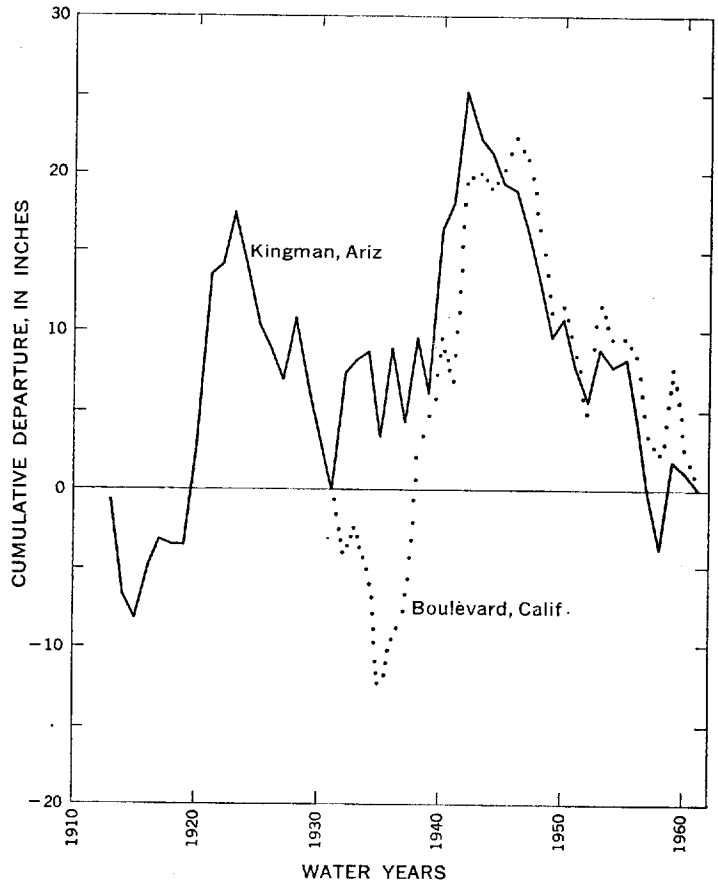




FIGURE 4.—Cumulative departures from 30-year mean precipitation, 1931–60. Plot starts at beginning of 1931 water year. Upward trends indicate wet periods; downward trends, dry periods.

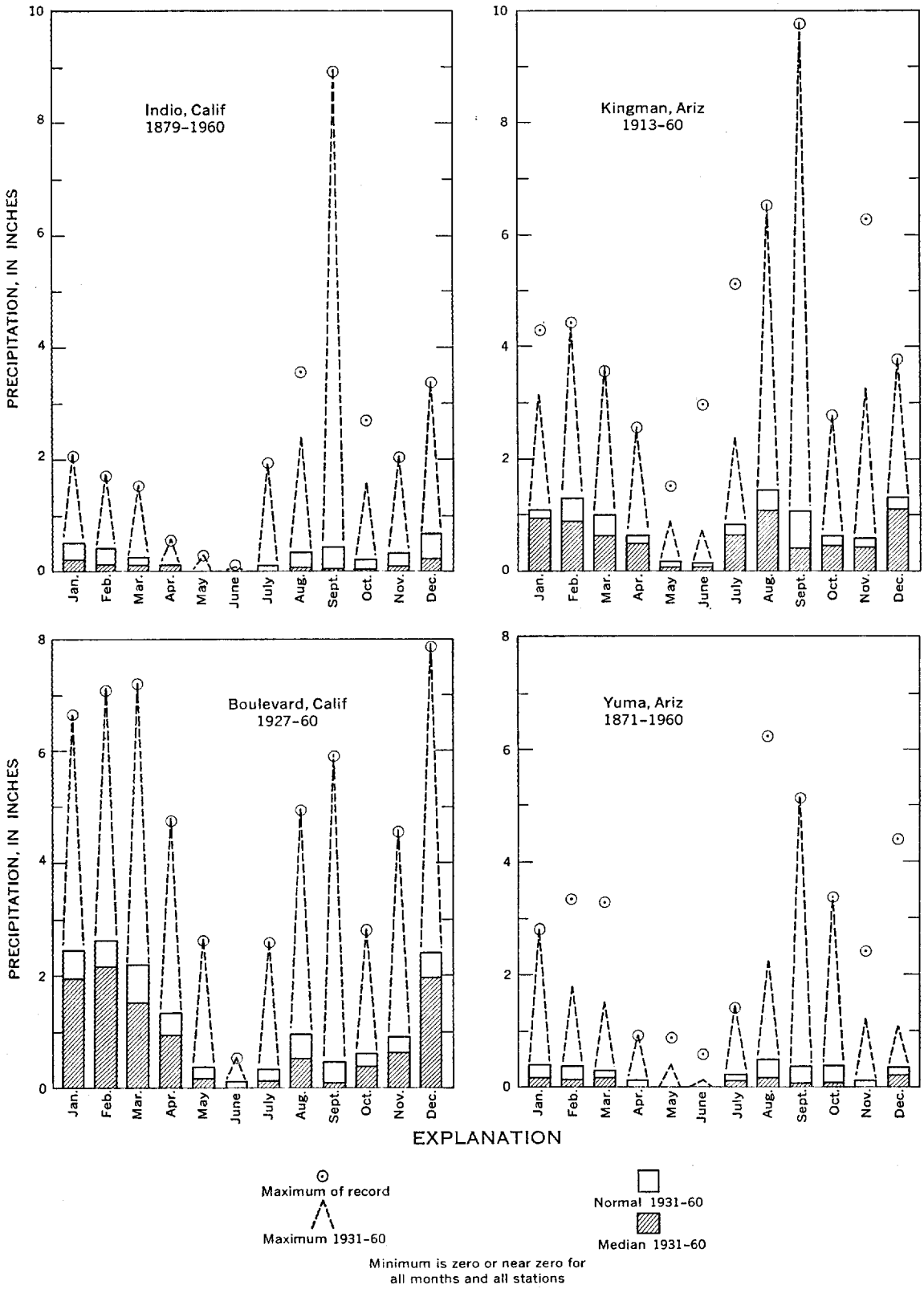



FIGURE 5.—Normals and extremes of monthly precipitation.

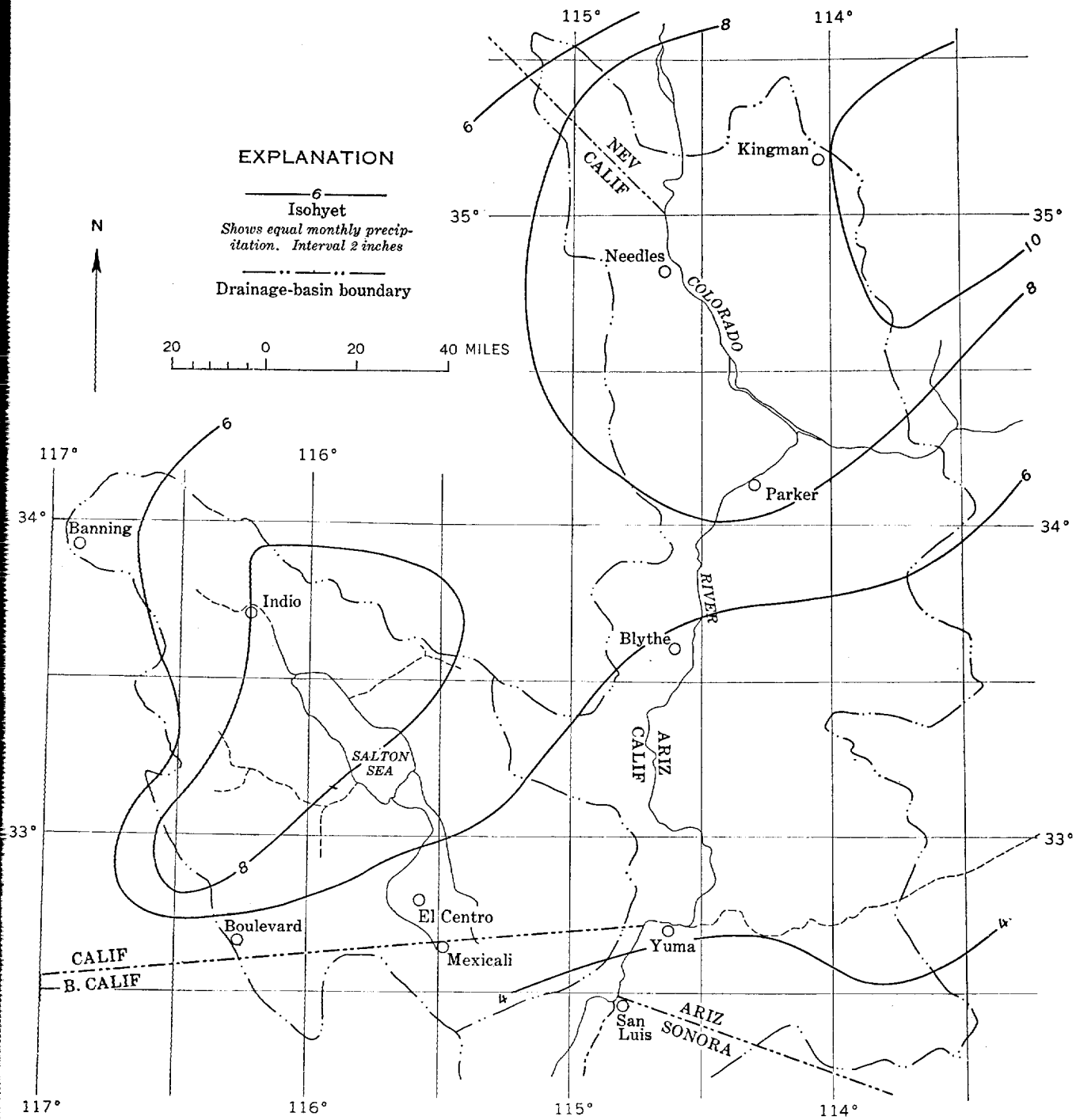



FIGURE 6.—Map showing total precipitation during September 1939.

Arid regions, on the other hand, generally are drained by ephemeral streams, which flow only briefly during and after some storms. The water table is far below most of the local stream channels and contributes no flow to them but it may contribute small amounts to a perennial stream, such as the Colorado River, that flows through the region. Many of the ephemeral stream channels traverse deposits of alluvium that absorb part or all the flow that originates in relatively impermeable areas or areas of intense local precipitation.

Thus, in the study area, most local streams head in mountain ranges where there are no extensive alluvial deposits, and the average flow in a channel of this type tends to increase as the drainage area increases. Where a flow reaches permeable alluvium in the valleys,

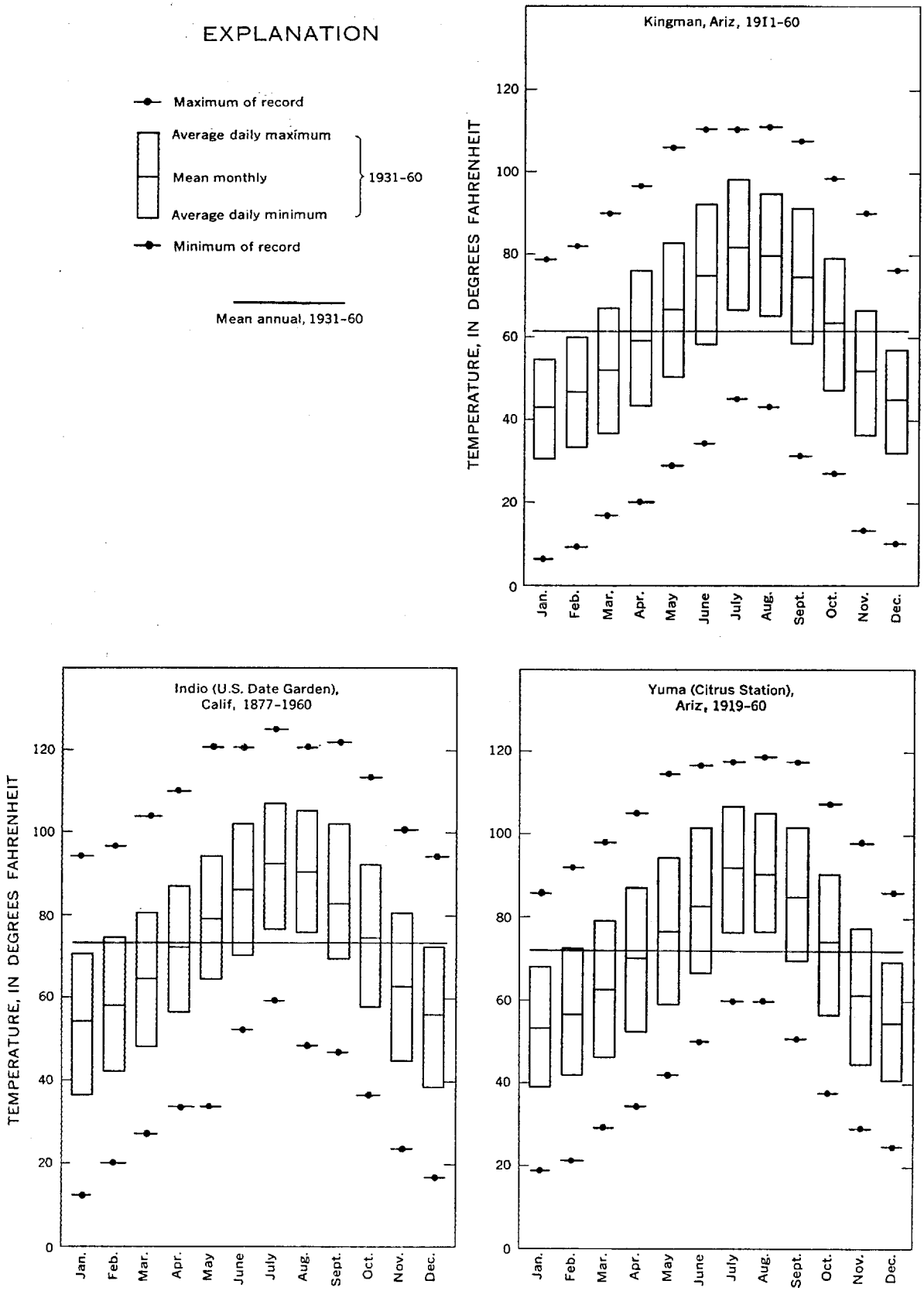



FIGURE 7.—Monthly normals, normal ranges, and extremes of temperature.

absorption of streamflow generally causes a change in the rate of increase of flow or a decrease in average flow as the drainage area or stream length increases. Consequently, the residual flow in the channel below the point where absorption of flow begins does not represent the total runoff.

Conventional records of desert streamflow are extremely expensive relative to the small quantities of water involved, are difficult to obtain, and are often difficult to evaluate because of the absorption of streamflow. As a result, few records have been obtained, and it is not likely that an adequate network of conventional gaging stations will be operated in the foreseeable future. A network of partial-record stations (chiefly for determination of peak discharge) in conjunction with a few conventional stations eventually may make it possible to determine desert runoff from streamflow data; but because of the extreme variability of desert runoff, this will require many years of record.

Water resources originating within the study area cannot be ignored in an evaluation of total water resources; consequently, runoff from the desert has been estimated as described below.

Most runoff maps that have been drawn for large regions, such as the Western United States, are based on streamflow records for major streams and are useful in the studies of the major streams rather than of the hydrology of small arid areas. The runoff map of the study area (pl. 5) shows the areal variations in mean annual runoff from small tracts (10–20 sq mi). In desert areas, as defined below, the isograms indicate the amount of direct runoff that is generated locally. As no allowance is made for depletion of streamflow by absorption in the alluvium, the isograms do not necessarily represent the runoff that reaches a major stream.

The map as a whole may be more representative of long-term runoff than of the mean for any specific period because the method used to estimate runoff from most of the area involves several generalizations and approximations.

The estimated runoff varies from nearly zero in much of the Colorado River delta and many smaller areas to more than 20 inches on Mount San Gorgonio.

In some parts of the area the pattern of equal-runoff lines is very similar to the pattern of isohyets (pl. 3). but in other parts the patterns have no relation because geology and soils are dominant influences on the runoff.

It may seem anomalous that the estimated runoff from parts of the Castle Dome and Kofa Mountains, northeast of Yuma, Ariz., exceeds 2.5 inches but that runoff from mountains farther north, where precipitation is much greater, does not reach 2.5 inches. This difference is readily accounted for by differences in soil depth and permeability and in vegetative cover. The top of the Hualpai Mountain range, south of Kingman, Ariz., is forested; the Castle Dome and Kofa Mountains are extremely barren, rocky, and steep.

## METHODS USED IN ESTIMATING RUNOFF

The only streamflow records that are usable for estimating runoff from the study area are those obtained from eight stations on small streams in the San Bernardino and San Jacinto Mountains, near Palm Springs, Calif. None of the records covers the full period 1931–60; one covers 24 of the 30 years, five cover 10 to 13 years, one covers only 4 years within the period but extends back an additional 9 years, and one covers 7 years prior to 1931. The records are adjusted approximately to the period 1931–60 by the double-mass analysis technique, but the adjustments may not always be reliable because records for adjacent streams in this region do not correlate well.

For the area covered by streamflow records, the isograms of runoff on plate 5 are drawn on the basis of the shapes of the isohyetal lines (pl. 3) and the adjusted average runoff from the gaged areas. In drawing the isograms, due consideration was given to the resulting differences between precipitation and runoff and to a runoff map for the Pacific slopes of the San Bernardino and San Jacinto Mountains, which was prepared by Stafford and Troxell (1953). However, Stafford and Troxell's map is based on a different period and a different isohyetal map. Consequently, the two runoff maps should not be expected to match closely at the divide.

For other mountain areas where there are perennial streams but no usable streamflow records, the runoff is estimated primarily on the basis of runoff from similar gaged areas elsewhere in the Southwest.

About 95 percent of the study area is desert on which the mean annual precipitation is less than 12 inches. As runoff from the desert normally includes no groundwater discharge, its magnitude is determined by rainfall intensity and duration and by the capacity of the soil to absorb water. Detailed information on these factors also is lacking. However, the U.S. Soil Conservation Service has developed an empirical method for estimating direct runoff from total storm rainfall and from information on soils. The method, described in publications of the Soil Conservation Service [no dates] and the U.S. Bureau of Reclamation (1960), has been adapted to the problem of estimating mean annual runoff from the available precipitation data and from the infiltration characteristics of soils in the study area.

A principal element of the method is a family of curves, defined by data from many gaged watersheds in

many parts of the country, showing average relations between direct runoff and total storm rainfall. Although the relations indicated by these curves are greatly simplified, attempts to refine them by inclusion of additional variables have generally been unsuccessful. Figure 8 illustrates selected curves of the family for the range of storm rainfall required in this study.

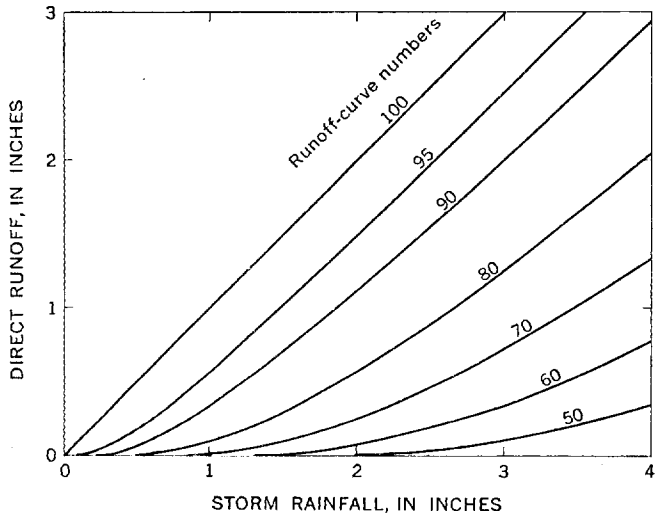



FIGURE 8.—Graph showing relations between direct runoff and storm rainfall. After U.S. Soil Conservation Service.

The curves are numbered from 0 to 100, in order of increasing runoff. Curve 0 would apply to a sand or gravel so permeable that no runoff would occur for any rainfall. Curve 100 represents the the unattainable condition of 100 percent runoff. The curve numbers between 0 and 100 are determined by a formula and are not percentages.

Much of the information needed for application of the method as described in the literature is lacking. Consequently, modifications of the method, as described below, are necessary for application of the method to the present problem.

Weather Bureau records of daily precipitation (which is practically all rainfall) for 1931–60 for seven desert stations (Kingman, Parker, Salome, and Yuma, Ariz., and Brawley, Indio, and Needles, Calif.) were analyzed to provide an index to the magnitude of storm rainfall. Daily values were separated into seven classes according to magnitude, and the percentage of the total that fell within the range of each class was computed. The variation in these percentages is not excessive and does not follow any areal pattern. Consequently, the means for the seven stations are considered more nearly representative of the typical distribution of storm rainfall than the percentages for any one station would be. Results of this analysis are summarized in table 1. Column 1 indicates the range of daily precipitation in each class except the last one; column 2 indicates a representative value (selected as explained below) of storm rainfall for each class; columns 3 and 4 indicate the range in percentages of the total precipitation for each class; and column 5 indicates the rounded mean percentage for the seven stations.

TABLE 1.—*Summary of daily precipitation data for seven desert stations*

| Class limits of daily precipitation (inches) | Representative storm rainfall (inches) | Percentages of total precipitation | | |
|---|---|---|---|---|
| | | Maximum | Minimum | Rounded mean |
| 0.01–0.10 | 0.08 | 13.1 | 7.5 | 10 |
| .11–.30 | .25 | 25.8 | 21.3 | 24 |
| .31–.60 | .53 | 26.8 | 24.3 | 26 |
| .61–1.00 | .9 | 25.4 | 12.4 | 18 |
| 1.01–1.50 | 1.4 | 14.2 | 7.2 | 11 |
| 1.51–2.00 | 1.9 | 6.7 | 2.5 | 5 |
| >2.00 | 2.9 | 13.0 | 1.0 | 6 |

In tables of this type, each class normally is represented by its midvalue. However, storm rainfall generally tends to be greater than daily precipitation because many storms occur in more than one observational day. Consequently, the average of the mean and maximum daily values for each class (rather than the mean) was selected to represent the storm rainfall for the class. Thus, the third line of the table indicates that 26 percent of the total precipitation occurred in daily amounts of 0.31–0.60 inch, which is considered equivalent to 26 percent of the total occurring in storms of about 0.53 inch.

The last class in table 1 is an open-end class containing all daily values over 2.0 inches. The maximum daily precipitation observed at any of the seven stations is 6.4 inches. However, at some other desert stations the maximum is as low as 2.0 inches. Use of 6.4 inches as a class limit in computing the representative storm rainfall would give excessive weight to an unusual occurrence at a single station. Therefore, the maximum selected for this purpose is the average maximum for 25 desert stations in or near the study area (U.S. Weather Bureau, 1952). This average maximum is 3.2 inches, and the corresponding representative storm rainfall, computed as above, is 2.9 inches.

The mean annual runoff corresponding to any of the runoff curves (fig. 8) can be computed by using the values in columns 2 and 5 of table 1. For example, for curve 90, the runoff corresponding to a storm of 2.9 inches is 1.9 inches, and table 1 indicates that about 6 percent of the total precipitation occurs in storms of this magnitude. Therefore, 6(1.9/2.9) or 3.9 percent of the total precipitation is accounted for as runoff caused by storms in this class. The runoff for all classes of storms

(computed in this manner) is 21 percent of the total precipitation. Similar percentages computed for 10 curves (numbers 50, 55, 60 . . . . 95) define the relation between runoff-curve number and the runoff, in percent of precipitation (fig. 9), if the distribution of precipitation is as indicated in table 1.

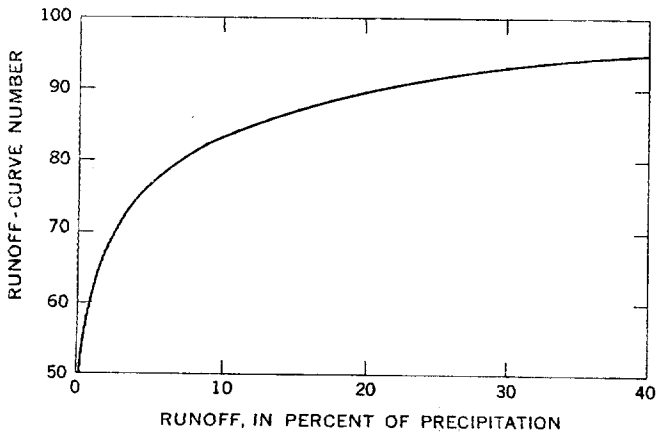



FIGURE 9.—Graph showing relation between runoff-curve number and mean annual runoff for the precipitation distribution indicated in table 1.

The remaining problem in estimating mean annual runoff is selection of proper runoff curves for particular localities. For this purpose information in the reference literature was combined with information on the study area as described below.

The reference literature describes a classification of soils in four groups—A, B, C, and D, according to their capacity to absorb rainfall. Thus, group A includes very permeable soils, typically sandy; and group D includes the least permeable soils, typically clay. Most agricultural soils of the United States have been classified, but little of the desert wasteland in the study area has been so classified.

A reconnaissance of the accessible parts of the study area was made to obtain information on infiltration characteristics. This reconnaissance included nearly 100 tests with an infiltrometer of the rainfall-simulator type. One standard test was adopted because infiltration data are useful chiefly for comparing soil characteristics. The total infiltration for a 30-minute period was determined for each site by applying water to initially dry or slightly moist soils at a rate that would produce runoff within 10 minutes. A correction for the effects caused by the spreading of the water beyond the infiltrometer ring was estimated by observing the volume of wetted soil and was applied to the total infiltration to obtain the adjusted infiltration (hereafter designated initial infiltration). The standard tests were supplemented by several hundred observations on the behavior of water poured into shallow depressions. These observations helped to determine if the test sites were representative of appreciable areas and also helped to define the limits of certain types of areas.

Generalized results of the reconnaissance are summarized in the following paragraphs. The initial infiltration varies from 0.15 inch to more than 2 inches. Initial infiltration greater than 1.1 or 1.2 inches generally occurs only on very sandy soils where there is no evidence of local runoff. Near the Colorado River these soils commonly occur in the central parts of valleys or on benches adjacent to the river flood plain. In the western part of the Salton Sea basin, they commonly extend to the bedrock outcrops at the base of the mountains. Although most of these sandy areas are nearly flat or gently sloping, some, notably the sand hills at the eastern edge of Imperial Valley, are characterized by considerable relief.

Under natural conditions some runoff would occur from many of the soils in irrigated areas. However, the preparation of fields for irrigation by flooding prevents any local runoff. The occasional flood damage in these areas is a result of runoff from adjacent higher land or from local urban areas. Hence, most irrigated areas are included with the sandy soils described above as areas of negligible runoff (less than 0.02 inch). Areas of native bottomland vegetation also are included in areas of negligible runoff, as the local topography and dense vegetation generally favor surface detention of rainfall and increase the opportunity for infiltration.

The initial infiltration for soils on mountains and foothills in the desert commonly is similar to that for the adjacent alluvium, provided that the soils on the mountains are deep enough to prevent saturation to bedrock within 30 miuntes. In the southern half of the Colorado River area, the mountains have very thin soils and many outcrops of slightly weathered bedrock. The soils on and near these mountains are the least permeable in the study area. The depth and permeability of soils on the mountains tend to increase toward the north, particularly north of Bill Williams River, and toward the west. They are greatest in the western part of the Salton Sea basin.

The curves in figure 10, described below, are guides for selecting an appropriate runoff curve for a specific locality from the available information on initial infiltration, topography, and soil depth. After the curve number is selected, it is used to obtain the runoff, in percent of precipitation, from figure 9; the mean annual runoff, in inches, is computed from this percentage and the mean annual precipitation (pl. 3).

Probably very few agricultural soils are as permeable as those in which the initial infiltration was more than 1.2 inches; hence, the four soil groups—A, B, C, and

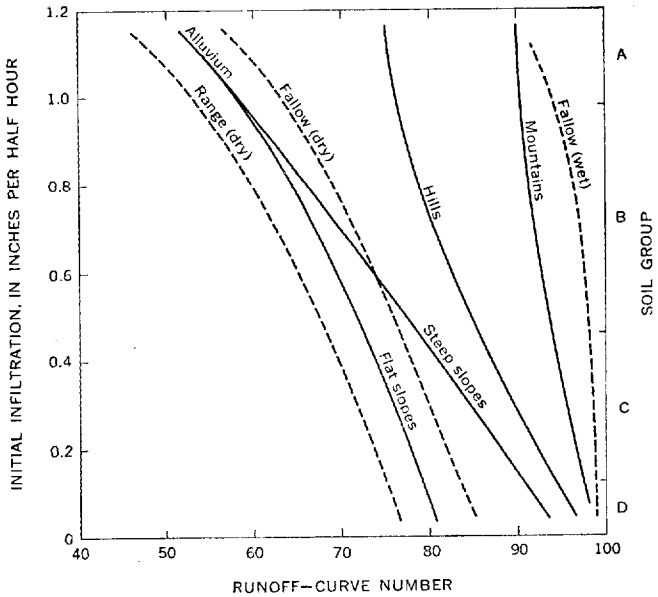



FIGURE 10.—Graph showing relations between initial infiltration and runoff-curve numbers.

D—probably correspond to the range in initial infiltration of 0 to 1.2 inches. Soil group A covers about 18.2 percent of this range; group B, 43.6 percent; group C, 27.8 percent; and group D, 10.4 percent (U.S. Bureau of Reclamation, 1960, fig. A–1). The relation of the soil groups to the initial infiltration is indicated by the vertical scales in figure 10.

Published data on curve numbers for each of these groups are assumed to correspond to the middle values of initial infiltration for that group. On this basis, the published data define the three dashed curves. That labelled "Fallow (dry)" represents soils that are devoid of vegetation and that have soil moisture near the wilting point. That labelled "Range (dry)" represents poor range that has about 50 percent vegetative cover. The curve labelled "Fallow (wet)" represents fallow soils that are saturated at the beginning of a storm and is included to illustrate the variation in infiltration that can occur in the same soil.

The solid curve labelled "Alluvium—flat slopes" is an average of the first two curves and is considered representative of some of the alluvium in the study area, which usually is very dry at the beginning of a storm and generally has considerably less than 50 percent vegetative cover. At zero infiltration this curve indicates a relatively low runoff-curve number, or a large abstraction from precipitation, which in turn indicates a large volume of retention in surface depressions. The indicated retention is reasonable for flat slopes but not for steep ones; consequently, the modified curve marked "Steep slopes" is considered applicable to the steeply sloping alluvium.

Although soil group D contains some soils that are described as thin, these soils are not as thin as the soil cover on most of the mountains and hills in the desert area. These soils can absorb only a small amount of water before becoming saturated, so that nearly all additional rain, regardless of intensity, runs off. Accordingly, the curve labelled "Mountains" is drawn so that the runoff-curve number at zero infiltration is about 99 and at high values of infiltration does not become less than 90, which corresponds to a maximum abstraction from precipitation of about 1 inch. This "Mountain" curve is considered appropriate for some of the most rugged areas, where vegetation is extremely sparse and much bedrock is exposed.

The curve labeled "Hills" is an intermediate curve representing gentler slopes, deeper soils, or denser cover than does the "Mountain" curve, and it includes some foothill areas and plateaus.

The selection of a runoff curve for a point is based on the topography, as indicated by the series of 7½- and 15-minute quadrangles and by aerial photographs as well as by the reconnaissance described above. The "Mountain" curve is regarded as an upper limit and the "Alluvium" curve as near a lower limit for the runoff-curve numbers that are applicable to the study area.

## RELIABILITY

The empirical relations described above are not intended to have any significance beyond that of providing a systematic method of estimating mean annual runoff from the desert part of the study area. Use of the method does not remove the element of personal judgment from the resulting estimates, but it does help in the utilization of available information and in the maintenance of areal consistency.

Although there are virtually no checks on the accuracy of the map, except in the San Gorgonio and San Jacinto Mountain areas, it is appropriate to compare the indicated runoff with some fragments of information on runoff within the area and with runoff from other arid regions.

Floods from the 41.5-square-mile drainage area of Picacho Wash sometimes cause damage to structures and irrigated lands in the valley north of Yuma, Ariz. Consequently, the Bureau of Reclamation has estimated the magnitude of several outstanding floods. The estimated peak discharges of five outstanding floods during 1920–39 range from 4,400 to 37,000 cfs (cubic feet per second), and the volume of water in the largest flood was estimated to be 6,950 acre-feet (Bureau of Reclamation, oral commun.). If the relation of volume to peak discharge for other floods is the same as for the largest flood, the five floods represent a total runoff of

8.7 inches or an average annual runoff of 0.44 inch for 20 years. Only three of these floods, including the largest, occurred during 1931–60, but many smaller floods occurred before and after 1931. The runoff map (pl. 5) shows that most of the area is between the 0.02-inch and 0.5-inch lines, but maximum values of about 1.0 inch are indicated at headwater areas in the Cargo Muchacho and Chocolate Mountains.

The average annual measured flow of Bill Williams River near Alamo, Ariz., represents 0.3 inch of runoff. However, this figure is affected by diversion for irrigation and by depletion of streamflow in the alluvium. If allowance is made for these depletions, the runoff is fairly consistent with the values for local runoff from small areas below Alamo as indicated by the map. Other gaging stations in desert areas of Arizona indicate average annual runoff ranging from less than 0.1 inch to 0.6 inch. Many of these records are affected by diversion, and all are affected by depletion of flow in alluvial channels.

A program of determining runoff from small areas in California provides data that vividly illustrate the extreme variability of runoff from the desert, but the program has not been in operation long enough to be very helpful in making estimates of mean annual runoff. At some stations, even in mountainous areas, there is no flow for two or more consecutive years (Young and Click, 1962). On the other hand, peak discharges greater than 100 cfs per sq mi are not uncommon. A peak of 2,280 cfs per sq mi has been computed for an area of 0.043 square mile near Needles, Calif. A peak of greater significance, however, is one of 918 cfs per sq mi from an area of 20.9 square miles near Borrego, Calif.; it is comparable to the largest peak (890 cfs per sq mi) from the 41.5-square-mile area of Picacho Wash.

Data published by the Agricultural Research Service [no date] of the U.S. Department of Agriculture for seven small agricultural watersheds near Albuquerque and Mexican Springs, N. Mex., show that runoff ranged from 0.8 to 9.3 percent of precipitation for periods of 5 to 15 years. The average percentage was 4.3 and corresponds approximately to that for runoff-curve 75 (fig. 9). Figure 10 indicates that this runoff curve is applicable for alluvium that has an initial infiltration of about 0.5 inch. Thus, the data are in reasonable agreement with the estimates in this report.

## WATER LOSS

In this report the term "water loss" refers to water returned to the atmosphere by evaporation from free water surfaces and by evapotranspiration from land areas. This definition is in general agreement with common usage, but a slightly different meaning is attached to the term in some circumstances. For example, in humid regions the difference between mean annual precipitation and mean annual runoff for a period of several years often is designated "water loss." This difference is usually a good estimate of the loss to the atmosphere, but it may include other losses, such as groundwater that discharges directly to the ocean (rather than to streams), or it may be affected by appreciable changes in storage within the area considered.

## EVAPORATION

Evaporation from free water surfaces tends to be greatest where precipitation and runoff are least and, consequently, is a major item in the hydrologic cycle for arid regions. Meyers (1962) estimated that the mean annual evaporation from reservoirs on the lower Colorado River (including Lake Mead) is about 1.2 million acre-feet—nearly 10 percent of the average annual flow of Colorado River below Hoover Dam during 1931–60.

The map of average annual evaporation (pl. 6) is adapted from a small-scale map of the United States (U.S. Weather Bureau, 1959) and is more generalized than other maps in this report. The available data on evaporation do not warrant mapping it in the same detail as precipitation. The rate of evaporation for the 30-year period 1931–60 probably is not significantly different from the rates shown for the 10-year period 1946–55.

Rates of evaporation are affected by storage of heat in a water body and advection of heat by inflowing or outflowing water as well as by climatic and other environmental factors. The effects of storage and advection on monthly rates of evaporation may be large; however, these often—but not always—tend to cancel each other in the course of 1 or more years.

During recent years the evaporation from several lakes has been determined by means of energy-budget studies (U.S. Geological Survey, 1954: Harbeck and others, 1958). Preliminary results of both energy-budget and water-budget studies of Salton Sea, conducted during 1961–62, indicate that average annual evaporation from the sea is about 69 inches.

The Weather Bureau report also includes maps which show the variation in the coefficient required to convert Class A pan data to lake evaporation and which show the variation in the percentage of annual evaporation that occurs during the summer.

The coefficient, which for many years was generally considered to be about 0.7 for all parts of the United States, varies from 0.60, or slightly less, in the south-

western desert, to 0.81 in eastern Maine and to 0.79 on the Pacific coast. In the study area, values of 0.60, or less, to 0.65 apply to all the desert; values higher than 0.65 apply to the mountains at the western edge of the area.

Evaporation from May through October accounts for about 68 percent of the annual evaporation. There is little variation in this percentage within the study area, except in the higher mountains, where evaporation from May through October is probably near 75 or 80 percent of the annual evaporation.

## EVAPOTRANSPIRATION

The conventional method of estimating evapotranspiration in humid regions (subtracting mean annual runoff from mean annual precipitation) generally is applicable to the mountains in the study area. However, where alluvial deposits absorb appreciable quantities of runoff from adjacent areas, the method does not apply without modification, because part of the absorbed runoff in addition to the absorbed precipitation may be available for evapotranspiration. In some places evapotranspiration exceeds precipitation.

The areal variation in mean annual evapotranspiration is indicated on plate 7. For mountainous areas the estimated evapotranspiration is the difference between precipitation and runoff, but for alluvial areas this difference is adjusted for the effects of absorbed runoff. As a result of this adjustment, the isograms for alluvial areas are displaced in the direction of lower precipitation from the position they would have assumed if the conventional method had been applicable.

In areas that are irrigated or are occupied by native bottom-land vegetation, evapotranspiration has no relation to either precipitation or local runoff. Most of the water evaporated and transpired from these areas is from the Colorado River. Rates of evapotranspiration vary considerably, depending on type of vegetation and irrigation practices. Results of experiments on consumptive use of water and records of diversion to, and return flows from, irrigation units indicate that annual evapotranspiration from such areas generally exceeds 36 inches and, in some areas, may exceed 60 inches.

The accuracy of the map is affected by the accuracy of both the precipitation and runoff maps and also by the estimated adjustments for absorbed runoff. However, the accuracy of the estimated evapotranspiration is most comparable to that of the isohyetal map, because precipitation is the dominant influence. For this reason, the evapotranspiration map is considered applicable to the standard period 1931–60.

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# APPENDIX D
# STATISTICAL EVALUATION OF INORGANICS AND RADIONUCLIDES

# APPENDIX D
# Part I: BACKGROUND COMPARISON AND Part II: SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR THE SOIL-TO-GROUNDWATER LEACHING EVALUATION

This attachment presents the background comparison evaluation for metals in soil (Part I) and the selection of chemicals of potential concern for the soil-to-groundwater leaching evaluation (Part II).

## PART I: Background Evaluation

Consistent with United States Environmental Protection Agency (USEPA) guidance (1989, 2002), TIMET ditch data for inorganics were evaluated relative to background concentrations to identify those metals that are not elevated above naturally occurring levels and can, therefore, be eliminated from further quantitative evaluation in the leaching evaluation. Given that some removal of soil will occur prior to selection of chemicals of potential concern (COPC) for risk assessment, this pre-removal background evaluation was completed primarily to identify COPCs for the leaching pathway. A post-removal assessment for COPC selection for risk assessment will be conducted after the removal action.

This evaluation was based on a combination of exploratory data analysis (EDA) and appropriate statistical methods (USEPA 2002), each of which is discussed further below. When the weight-of-evidence of the EDA and results of the statistical analyses indicate that a particular analyte is within background levels, then these analytes will not be evaluated further in the COPC selection process. Statistical methods were compliant with NDEP (2009) guidance.

The shallow (BRC/TIMET 2007) and deep (ERM 2010) McCullough Range soils datasets are appropriate for background comparisons at the TIMET Plant Site, including the TIMET ditch network investigation.

### Shallow McCullough Background Dataset

NDEP has approved the shallow background dataset (BRC/TIMET 2007) for use at the BMI Complex. The shallow McCullough Range soil samples were collected as part of the BRC/TIMET background investigation as well as during an Environ background investigation and analyzed for inorganics in accordance with the NDEP-approved work plans. Samples collected to represent 0 to 10 ft bgs appear in the shallow dataset for comparison to appropriate subsets of the TIMET ditch data.

As shown in Table D-1, statistical comparisons for the shallow interval span from 0 to 10 ft bgs.

### Deep McCullough Background Dataset

NDEP has approved the deep (over 10 ft bgs) McCullough background dataset for use at the BMI Complex, and it is the appropriate soil type for ditch soils on TIMET Plant Site property. Soils from depths greater than 10 ft bgs were analyzed for inorganics for comparison to subsurface samples collected from the TIMET ditch network. The deep depth interval includes TIMET ditch samples from 10 ft bgs to the top of the Upper Muddy Creek Formation (UMCf).

**TIMET Ditch Data**

Site data collected during the TIMET ditch network investigation were compared to the McCullough Range soil background datasets. Field duplicates and TIMET ditch samples were treated as independent samples on the basis of preliminary evaluation, in consultation with NDEP guidance (NDEP 2008a), indicating that the variance of the duplicates was similar to the variance of the TIMET ditch samples. Non-detect results were set equal to half the sample quantitation limit (SQL) as per NDEP guidance (NDEP 2008b) by the software package program default settings.

**Exploratory Data Analysis**

The EDA was performed using summary statistics (*Guidance on the Development of Summary Statistics Tables for the BMI Plant Sites and Common Areas Projects, Henderson, Nevada*; NDEP 2008c) and quantile-quantile plots and side-by-side box-and-whisker plots to qualitatively evaluate whether the TIMET ditch and McCullough background dataset are representative of a single population. The summary statistics for the TIMET ditch and McCullough background data are presented in separate tables for shallow and deep (Tables D-1 and D-2) inorganics. Quantile-quantile plots and side-by-side box-and-whisker plots are included as an attachment to this appendix.

**Statistical Comparisons**

The web-based statistical software package, Guided Interactive Statistical Decision Tools (GiSdT®; Neptune and Company 2007), was used to perform all statistical comparisons. The most recent desktop version (based on the R code, version 2.15.1) of GiSdT was employed, which inherently specifies half the SQL as proxy values for all nondetects prior to comparisons as the default software assumption. Specifically, statistical background comparisons were performed using the Quantile test, Slippage test, t-test, and Wilcoxon Rank Sum test with Gehan modification. The t-test is parametric, which assumes that the data are normally distributed. In contrast, the Wilcoxon Rank Sum test, Quantile test, and Slippage test are non-parametric, which do not require an assumption of whether the data are normally or lognormally distributed (USEPA 2002; NDEP 2009). These non-parametric tests are described further below.

- The Wilcoxon Rank Sum test performs a test for a difference between the sums of the ranks for two populations. This is a non-parametric method for assessing differences in the centers of the distributions that relies on the relative rankings of data values. Knowledge of the precise form of the population distributions is not necessary. The Wilcoxon Rank Sum test has less power than the two-sample t-test when the data are normally distributed, but the assumptions are not as restrictive. The GiSdT® version of the Wilcoxon Rank Sum test uses the Mantel approach for ranking the data, which is equivalent to using the Gehan ranking system. The Gehan ranking system is used to rank non-detects with the rest of the data (NDEP 2009).
- The Quantile test addresses tail effects which are not addressed in the Wilcoxon Rank Sum test. The Quantile test looks for differences in the right tails (upper-end of the dataset) rather than central tendency like the Wilcoxon Rank Sum test. The Quantile test was performed using a defined (default) quantile = 0.90.
- The Slippage test looks for a shift to the right in the extreme right-tail of the background dataset versus the extreme right-tail of the TIMET ditch dataset. This test determines whether

the number of TIMET ditch samples that exceed the maximum background concentration for each metal is greater than would be expected, statistically, if the TIMET ditch and background distributions were the same.

Finally, an alpha = 0.05 is typically used to evaluate a statistically significant result (USEPA 2002). However, as more tests are performed, it is more likely that a statistically significant result will be obtained purely by chance. Given the use of multiple statistical tests, an alpha = 0.025 was selected as a significance level for determining if TIMET ditch data are different than background (NDEP 2009). Any analyte that resulted in a p-value less than 0.025 in one of four tests was flagged for further consideration in the COPC selection table. Additionally, because these tests are set up with one-sided hypotheses, not only are differences between the two samples able to be detected, a directional determination can be made as well (e.g., TIMET ditch is greater than background).

Results for the four statistical tests (p-values) are included in Tables D-1 and D-2, as well as a determination as to whether the TIMET ditch data are greater than background, considering the weight of evidence and the graphical displays. Analytes for which only one p-value was less than or equal to 0.025 are noted in the tables: these results were considered upon review of the weight of evidence and graphical displays in the background determination.

Based on the statistical comparisons provided in Tables D-1 and D-2, the analytes identified in TIMET ditch soils that are not listed below background levels will be identified as COPCs for the leaching evaluation, depending on depth at which they exceeded concentrations representative of the McCullough Range soils.

**Summary of Inorganic COPC Selection for Leaching Evaluation**

Upon evaluation of Table D-1, analytes eliminated as COPCs in the 0-10 ft bgs interval because Gilbert's toolbox confirms they are within the range of shallow McCullough soils background are aluminum, calcium, nickel, palladium, silicon, strontium and zirconium. The remainder of the analytes shown in Table D-1 will be carried forward as COPCs for the leaching evaluation: final COPCs for human health risk assessment will be selected after the post-removal data set is evaluated.

Finally, an additional deep (over 10 ft bgs interval) subsurface COPC determination for the leaching assessment indicates that aluminum, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, vanadium, and zinc do not exceed McCullough background concentrations (see Table D-2).

Remaining inorganic analytes listed in Table D-1 (0-10 ft bgs) or Table D-2 (>10 ft bgs) shown to be above McCullough Range background concentrations will be further assessed for leaching. Note, all other inorganics (i.e., radionuclides) were retained for further evaluation in a leaching evaluation, and similarly, organics detected above LBCL (DAF1) look-up defaults were retained for further leaching analysis. See main text for discussion of the site-specific leaching analysis for retained analytes.

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TABLE D-1, BACKGROUND METALS COMPARISONS (TIMET DITCH NETWORK, 0-10 FT BGS COMPARED TO MCCULLOUGH RANGE 0-10 FT BGS)

| | McCullough Background Data Set | | | | | | | | | | TIMET Ditch Network | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | Total Samples | No. of Detects | % Detects | Minimum ND | Maximum ND | Minimum Detect | Maximum Detect | Median Detect | Mean Detect | Standard Deviation | No. of Detects | Total Samples | % Detects | Minimum ND | Maximum ND | Minimum Detect | Maximum Detect | Median Detect | Mean Detect | Standard Deviation | Two-Sample T-test *p* | Gehan Test *p* | Quantile Test (0.9) *p* | Slippage Test *p* | Ditch Samples Greater than McCullough Background | Background Qualifier |
| Aluminum | 95 | 95 | 100% | NA | NA | 3740 | 15300 | 8400 | 8995 | 2678 | 132 | 132 | 100% | NA | NA | 4500 | 14000 | 8000 | 7944 | 1318 | 1.00E+00 | 9.72E-01 | 1.00E+00 | 1.00E+00 | No | 1 |
| Antimony | 95 | 43 | 45% | 0.04 | 0.33 | 0.12 | 0.5 | 0.22 | 0.24093 | 0.099 | 64 | 132 | 48% | 0.29 | 0.36 | 0.31 | 36 | 0.56 | 2.23 | 5.47 | **2.85E-03** | **3.61E-06** | **1.59E-06** | **3.23E-10** | Yes | |
| Arsenic | 95 | 95 | 100% | NA | NA | 2.5 | 7.2 | 4 | 4.209 | 1.103 | 132 | 132 | 100% | NA | NA | 2.6 | 210 | 4.1 | 12.38 | 32.05 | **2.02E-03** | 6.05E-02 | **1.59E-06** | **1.59E-06** | Yes | |
| Barium | 95 | 95 | 100% | NA | NA | 73 | 445 | 171 | 177.3 | 59.14 | 132 | 132 | 100% | NA | NA | 110 | 4700 | 175 | 370.5 | 707.4 | **1.10E-03** | **1.32E-02** | **9.00E-03** | **2.06E-04** | Yes | |
| Beryllium | 95 | 95 | 100% | NA | NA | 0.16 | 0.89 | 0.57 | 0.5899 | 0.1602 | 132 | 132 | 100% | NA | NA | 0.34 | 5.8 | 0.61 | 0.715 | 0.5457 | **6.91E-03** | **1.95E-02** | 4.30E-02 | **6.70E-04** | Yes | |
| Boron | 95 | 34 | 36% | 3.2 | 3.2 | 5.2 | 11.6 | 6.8 | 7.112 | 1.553 | 132 | 132 | 100% | NA | NA | 1.1 | 38 | 4.45 | 6.113 | 5.446 | **4.04E-06** | 1.68E-01 | **3.27E-04** | **3.73E-04** | Yes | |
| Cadmium | 95 | 0 | 0% | 0.13 | 0.13 | NA | NA | NA | NA | NA | 119 | 132 | 90% | 0.03 | 0.04 | 0.04 | 2 | 0.11 | 0.22 | 0.33 | **1.89E-06** | 1.00E+00 | **1.59E-06** | NA | Yes | |
| Calcium | 95 | 95 | 100% | NA | NA | 9440 | 82800 | 24500 | 29030 | 14960 | 132 | 132 | 100% | NA | NA | 9000 | 1.00E+05 | 26000 | 29250 | 15610 | 4.58E-01 | 3.85E-01 | 9.32E-01 | 1.95E-01 | No | 1 |
| Chromium VI | 95 | 0 | 0% | 0.25 | 0.32 | NA | NA | NA | NA | NA | 16 | 132 | 12% | 1.3 | 1.7 | 1.5 | 53 | 6.6 | 10.66 | 13.05 | **7.87E-04** | **7.37E-09** | **1.59E-06** | **9.33E-09** | Yes | |
| Chromium | 95 | 95 | 100% | NA | NA | 2.6 | 16.7 | 9 | 9.082 | 3.073 | 132 | 132 | 100% | NA | NA | 6 | 490 | 11 | 23.03 | 49.5 | **1.24E-04** | **0.00E+00** | **1.87E-05** | NA | Yes | |
| Cobalt | 95 | 95 | 100% | NA | NA | 3.7 | 16.3 | 9 | 8.784 | 2.308 | 132 | 132 | 100% | NA | NA | 4.4 | 84 | 7.8 | 10.68 | 11.38 | 3.27E-02 | 9.86E-01 | **2.03E-02** | **2.14E-03** | Yes | |
| Copper | 95 | 95 | 100% | NA | NA | 10.2 | 25.9 | 18.2 | 17.85 | 3.364 | 132 | 132 | 100% | NA | NA | 11 | 510 | 17 | 35.74 | 68.62 | **1.66E-03** | 9.38E-02 | **2.96E-06** | **2.47E-09** | Yes | |
| Iron | 95 | 95 | 100% | NA | NA | 5410 | 19700 | 13200 | 13140 | 3411 | 132 | 132 | 100% | NA | NA | 9200 | 23000 | 16000 | 16160 | 2442 | **4.07E-12** | **2.54E-11** | **9.00E-03** | **2.14E-03** | Yes | |
| Lead | 95 | 95 | 100% | NA | NA | 3 | 35.1 | 7.2 | 8.219 | 4.227 | 132 | 132 | 100% | NA | NA | 6.4 | 1300 | 9.25 | 70.97 | 220.8 | **7.01E-04** | **7.02E-14** | **1.59E-06** | **1.59E-06** | Yes | |
| Lithium | 95 | 95 | 100% | NA | NA | 7.5 | 26.5 | 12.9 | 14.04 | 4.439 | 132 | 132 | 100% | NA | NA | 8 | 79 | 13 | 15.23 | 9.406 | 1.03E-01 | 4.66E-01 | 7.99E-01 | **1.19E-02** | Yes | 2 |
| Magnesium | 95 | 95 | 100% | NA | NA | 4690 | 17500 | 10300 | 10310 | 2828 | 132 | 132 | 100% | NA | NA | 6800 | 59000 | 9600 | 10950 | 5727 | 1.36E-01 | 8.58E-01 | 5.57E-01 | **1.19E-02** | Yes | 2 |
| Manganese | 95 | 95 | 100% | NA | NA | 151 | 863 | 407 | 414.9 | 130 | 132 | 132 | 100% | NA | NA | 190 | 27000 | 445 | 1886 | 4347 | **8.06E-05** | **1.86E-04** | **1.59E-06** | **8.11E-11** | Yes | |
| Mercury | 95 | 73 | 77% | 0.01 | 0.01 | 0.0084 | 0.11 | 0.018 | 0.02252 | 0.01697 | 125 | 132 | 95% | 0.0017 | 0.0018 | 0.0021 | 1.4 | 0.020 | 0.061 | 0.148 | **1.15E-03** | **4.31E-05** | **2.04E-03** | **1.20E-03** | Yes | |
| Molybdenum | 95 | 95 | 100% | NA | NA | 0.3 | 2 | 0.49 | 0.5465 | 0.2533 | 124 | 132 | 94% | 0.11 | 0.12 | 0.12 | 37 | 0.655 | 2.511 | 5.086 | **2.48E-05** | 3.11E-01 | **1.59E-06** | **9.33E-09** | Yes | |
| Nickel | 95 | 95 | 100% | NA | NA | 7.9 | 30 | 16.4 | 16.23 | 4.017 | 132 | 132 | 100% | NA | NA | 8.2 | 51 | 15 | 16.73 | 6.111 | 2.27E-01 | 9.07E-01 | 3.11E-01 | 1.12E-01 | No | 1 |
| Niobium | 95 | 0 | 0% | 1.02 | 1.02 | NA | NA | NA | NA | NA | 27 | 27 | 100% | NA | NA | 0.87 | 120 | 3.5 | 9.962 | 22.62 | **1.96E-02** | **0.00E+00** | **1.83E-10** | NA | Yes | |
| Palladium | 95 | 95 | 100% | NA | NA | 0.16 | 1.5 | 0.42 | 0.4801 | 0.2433 | 5 | 27 | 19% | 0.03 | 0.03 | 0.03 | 0.12 | 0.042 | 0.057 | 0.036 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | No | 1 |
| Potassium | 95 | 95 | 100% | NA | NA | 625 | 3890 | 1580 | 1754 | 759.3 | 132 | 132 | 100% | NA | NA | 1300 | 3300 | 2200 | 2205 | 438.1 | **3.53E-07** | **1.06E-09** | 8.44E-01 | 1.00E+00 | Yes | |
| Selenium | 95 | 33 | 35% | 0.16 | 0.16 | 0.23 | 0.6 | 0.31 | 0.3285 | 0.07608 | 28 | 132 | 21% | 0.26 | 2.8 | 0.28 | 7.2 | 0.53 | 1.355 | 1.74 | **7.06E-04** | **3.61E-14** | **1.36E-02** | **5.33E-04** | Yes | |
| Silicon | 95 | 95 | 100% | NA | NA | 335 | 4150 | 721 | 1007 | 811.1 | 27 | 27 | 100% | NA | NA | 180 | 1400 | 320 | 407.8 | 257.6 | 1.00E+00 | 1.00E+00 | 9.68E-01 | 1.00E+00 | No | 1 |
| Silver | 95 | 0 | 0% | 0.26 | 0.26 | NA | NA | NA | NA | NA | 23 | 132 | 17% | 0.1 | 1.1 | 0.11 | 6.6 | 0.68 | 1.390 | 1.731 | **1.76E-02** | 1.00E+00 | **1.59E-06** | NA | Yes | |
| Sodium | 95 | 95 | 100% | NA | NA | 128 | 1320 | 487 | 498.4 | 284.7 | 132 | 132 | 100% | NA | NA | 240 | 2800 | 735 | 888.1 | 518.1 | **3.77E-12** | **1.16E-10** | **1.03E-04** | **1.02E-05** | Yes | |
| Strontium | 95 | 95 | 100% | NA | NA | 75.5 | 808 | 192 | 232.5 | 133.4 | 132 | 132 | 100% | NA | NA | 98 | 2300 | 170 | 234.2 | 252.9 | 4.75E-01 | 7.85E-01 | 9.85E-01 | 1.95E-01 | No | 1 |
| Thallium | 95 | 21 | 22% | 0.54 | 0.54 | 1.1 | 1.8 | 1.4 | 1.414 | 0.2516 | 132 | 132 | 100% | NA | NA | 0.07 | 21 | 0.13 | 0.7654 | 2.556 | 1.46E-01 | 1.00E+00 | 1.44E-01 | **1.20E-03** | Yes | 2 |
| Tin | 95 | 95 | 100% | NA | NA | 0.24 | 0.8 | 0.51 | 0.4985 | 0.112 | 98 | 132 | 74% | 0.29 | 5.9 | 0.31 | 58 | 0.785 | 2.857041 | 8.42 | **4.54E-03** | **1.17E-03** | **2.96E-06** | **8.12E-14** | Yes | |
| Titanium | 95 | 95 | 100% | NA | NA | 262 | 1010 | 539 | 560.9 | 150.5 | 132 | 132 | 100% | NA | NA | 290 | 8400 | 475 | 690.8 | 859.7 | 4.57E-02 | 9.94E-01 | 3.11E-01 | **1.20E-03** | Yes | 2 |
| Uranium | 94 | 94 | 100% | NA | NA | 0.62 | 2.7 | 0.97 | 1.032 | 0.3092 | 132 | 132 | 100% | NA | NA | 0.58 | 18 | 0.915 | 1.33 | 1.787 | 3.11E-02 | 8.83E-01 | 3.19E-02 | **2.17E-02** | Yes | 2 |
| Vanadium | 95 | 95 | 100% | NA | NA | 20.2 | 59.1 | 38.4 | 39.1 | 8.426 | 132 | 132 | 100% | NA | NA | 21 | 320 | 33 | 45.75 | 43.5 | 4.44E-02 | 9.99E-01 | 3.01E-02 | **2.06E-04** | Yes | 2 |
| Zinc | 95 | 95 | 100% | NA | NA | 15.4 | 121 | 37.9 | 37.84 | 12.99 | 132 | 132 | 100% | NA | NA | 21 | 460 | 32 | 60.01 | 81.34 | **1.26E-03** | 8.28E-01 | **3.32E-05** | **1.20E-03** | Yes | |
| Zirconium | 95 | 95 | 100% | NA | NA | 86.1 | 179 | 129 | 131.2 | 22.22 | 27 | 27 | 100% | NA | NA | 21 | 620 | 36 | 66.26 | 112.9 | 9.97E-01 | 1.00E+00 | 9.68E-01 | 2.21E-01 | No | 1 |

Notes:
TIMET Ditch dataset contains the BD and NW series. Trace nutrients chloride, fluoride, nitrate, nitrite, phosphorous, and sulfur were not plotted.
*p* values in **boldface** shaded cells indicate p <= 0.025 and are based on Neptune output dated 11/30/12
NA - Not applicable.
Background dataset is from the McCullough soils in the 2005 BRC/TIMET data set (0-10 ft bgs) and excludes six Environ samples removed by NDEP/Neptune from the 2005 dataset in fall 2012.
Background comparison tests use default GiSdT settings, including half sample quantitation limit (SQL) for non-detects.

Background Qualifiers:
[1] = Gilbert's Toolbox results imply TIMET 0-10 ft bgs Ditch data lower than the McCullough Range 0-10 ft bgs background data.
[2] = Failed Gilbert's Toolbox in only 1 out of 4 tests

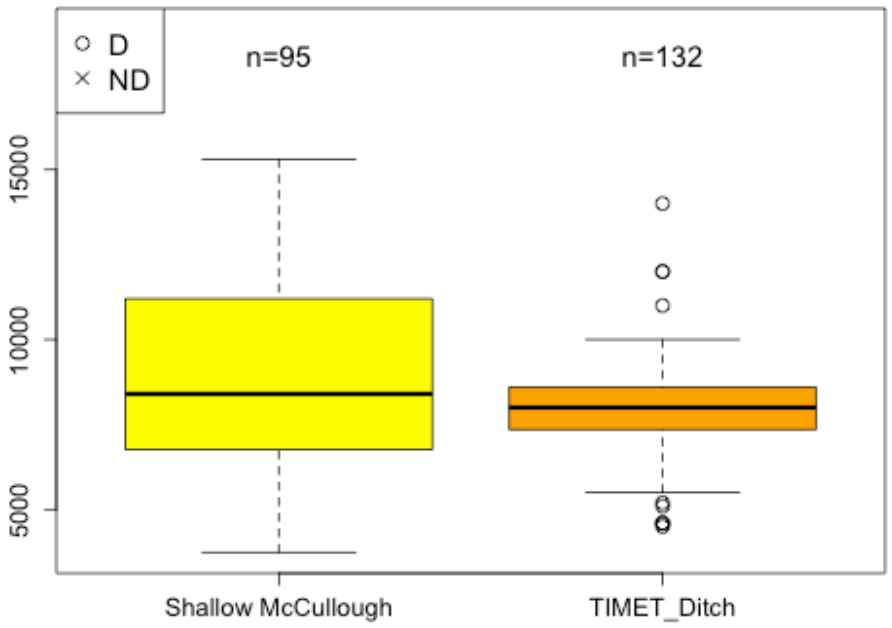
TABLE D-2, BACKGROUND METALS COMPARISONS (TIMET DITCH NETWORK, >10 FT BGS COMPARED TO MCCULLOUGH RANGE >10 FT BGS)

| | McCullough Background Data Set | | | | | | | | | | TIMET Ditch Network | | | | | | | | | | Two-Sample T-test | Gehan Test | Quantile Test (0.9) | Slippage Test | Ditch Samples Greater than McCullough Background | Background Qualifier |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | Total Samples | No. of Detects | % Detects | Minimum ND | Maximum ND | Minimum Detect | Maximum Detect | Median Detect | Mean Detect | Standard Deviation | Total Samples | No. of Detects | % Detects | Minimum ND | Maximum ND | Minimum Detect | Maximum Detect | Median Detect | Mean Detect | Standard Deviation | *p* | *p* | *p* | *p* | | |
| Aluminum | 79 | 79 | 100% | NA | NA | 5060 | 15100 | 8790 | 8693 | 1814 | 77 | 77 | 100% | NA | NA | 5100 | 14000 | 7800 | 7721 | 1164 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | No | 1 |
| Antimony | 79 | 73 | 92% | 0.105 | 0.105 | 0.089 | 0.22 | 0.15 | 0.148 | 0.026 | 77 | 18 | 23% | 0.3 | 0.49 | 0.33 | 0.6 | 0.39 | 0.417 | 0.078 | **1.64E-08** | **0.00E+00** | **5.15E-06** | **5.95E-20** | Yes | |
| Arsenic | 79 | 79 | 100% | NA | NA | 2.2 | 13.1 | 3.8 | 4.38 | 1.952 | 77 | 77 | 100% | NA | NA | 3.1 | 51 | 6.5 | 10.4 | 9.24 | **1.39E-07** | **2.95E-13** | **5.15E-06** | **2.25E-06** | Yes | |
| Barium | 79 | 79 | 100% | NA | NA | 84.7 | 539 | 138 | 156.2 | 69.62 | 77 | 77 | 100% | NA | NA | 36 | 270 | 140 | 141.9 | 40.56 | 9.40E-01 | 7.55E-01 | 9.13E-01 | 1.00E+00 | No | 1 |
| Beryllium | 79 | 79 | 100% | NA | NA | 0.29 | 0.67 | 0.55 | 0.556 | 0.063 | 77 | 77 | 100% | NA | NA | 0.37 | 0.85 | 0.56 | 0.559 | 0.078 | 3.87E-01 | 5.30E-01 | 3.55E-02 | 1.18E-01 | No | 1 |
| Boron | 79 | 20 | 25% | 2.824 | 2.824 | 3 | 7.6 | 5.600 | 5.355 | 1.441 | 77 | 77 | 100% | NA | NA | 1.2 | 20 | 4.8 | 5.714 | 3.24 | **1.38E-12** | **6.34E-12** | **1.10E-04** | **1.17E-05** | Yes | |
| Cadmium | 79 | 73 | 92% | 0.01 | 0.01 | 0.05 | 0.13 | 0.084 | 0.087 | 0.016 | 77 | 58 | 75% | 0.033 | 0.037 | 0.036 | 0.23 | 0.0805 | 0.082 | 0.034 | 9.96E-01 | 9.99E-01 | 7.40E-01 | 1.18E-01 | No | 1 |
| Calcium | 79 | 79 | 100% | NA | NA | 10700 | 46600 | 24500 | 24970 | 7156 | 77 | 77 | 100% | NA | NA | 7900 | 130000 | 30000 | 34780 | 19530 | **3.71E-05** | **9.19E-05** | **1.09E-03** | **5.90E-05** | Yes | |
| Chromium VI | 80 | 18 | 23% | 0.16 | 0.19 | 0.18 | 1.6 | 0.255 | 0.4089 | 0.408 | 77 | 2 | 3% | 1.4 | 2.3 | 2.4 | 2.9 | 2.65 | 2.65 | 0.354 | **1.46E-30** | **0.00E+00** | 1.00E+00 | 2.23E-01 | Yes | |
| Chromium | 79 | 79 | 100% | NA | NA | 7.1 | 16.6 | 10.3 | 10.62 | 1.823 | 77 | 77 | 100% | NA | NA | 6.7 | 44 | 9.8 | 12.57 | 7.135 | **1.13E-02** | 7.57E-01 | **6.56E-03** | **1.31E-04** | Yes | |
| Cobalt | 79 | 79 | 100% | NA | NA | 5.3 | 10.8 | 7.5 | 7.785 | 1.327 | 77 | 77 | 100% | NA | NA | 2.9 | 8.6 | 6.5 | 6.243 | 1.247 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | No | 1 |
| Copper | 79 | 79 | 100% | NA | NA | 8.8 | 24 | 16.4 | 16.33 | 2.069 | 77 | 77 | 100% | NA | NA | 6.9 | 69 | 14 | 15.36 | 8.742 | 8.26E-01 | 1.00E+00 | 9.99E-01 | 1.18E-01 | No | 1 |
| Iron | 79 | 79 | 100% | NA | NA | 11200 | 22500 | 14700 | 15350 | 2815 | 77 | 77 | 100% | NA | NA | 6700 | 19000 | 14000 | 13850 | 2735 | 1.00E+00 | 9.83E-01 | 1.00E+00 | 1.00E+00 | No | 1 |
| Lead | 79 | 79 | 100% | NA | NA | 4.9 | 15.8 | 7.1 | 7.439 | 1.577 | 77 | 77 | 100% | NA | NA | 3.7 | 16 | 6.9 | 7.001 | 1.7 | 9.51E-01 | 9.76E-01 | 9.99E-01 | 4.94E-01 | No | 1 |
| Lithium | 79 | 67 | 85% | 1.463 | 3.657 | 7.5 | 124 | 17.4 | 20.14 | 13.89 | 77 | 77 | 100% | NA | NA | 11 | 290 | 19 | 33.84 | 47.28 | **2.13E-03** | **7.97E-06** | **1.09E-03** | 1.18E-01 | Yes | |
| Magnesium | 79 | 79 | 100% | NA | NA | 4990 | 12500 | 9530 | 9553 | 1455 | 77 | 77 | 100% | NA | NA | 7700 | 47000 | 10000 | 12420 | 7596 | **8.25E-04** | **2.61E-03** | **2.32E-04** | **2.64E-05** | Yes | |
| Manganese | 79 | 79 | 100% | NA | NA | 217 | 579 | 319 | 342.9 | 83.71 | 77 | 77 | 100% | NA | NA | 110 | 1400 | 280 | 303.1 | 175.3 | 9.63E-01 | 1.00E+00 | 9.99E-01 | 1.18E-01 | No | 1 |
| Mercury | 79 | 35 | 44% | 0.007 | 0.007 | 0.007 | 0.024 | 0.013 | 0.013 | 0.004 | 77 | 67 | 87% | 0.002 | 0.002 | 0.003 | 0.049 | 0.010 | 0.012 | 0.007 | **2.81E-03** | **2.32E-02** | 1.99E-01 | 1.18E-01 | Yes | |
| Molybdenum | 79 | 62 | 78% | 0.105 | 0.105 | 0.31 | 1.9 | 0.575 | 0.670 | 0.309 | 77 | 63 | 82% | 0.11 | 0.14 | 0.12 | 13 | 0.32 | 0.601 | 1.616 | 5.80E-01 | 9.99E-01 | 9.91E-01 | 2.42E-01 | No | 1 |
| Nickel | 79 | 79 | 100% | NA | NA | 8.5 | 27.5 | 15.3 | 15.54 | 2.396 | 77 | 77 | 100% | NA | NA | 7.4 | 16 | 13 | 12.48 | 1.923 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | No | 1 |
| Potassium | 79 | 79 | 100% | NA | NA | 850 | 2450 | 1430 | 1499 | 356.8 | 77 | 77 | 100% | NA | NA | 1100 | 3900 | 1800 | 1804 | 379.2 | **3.49E-07** | **1.34E-07** | 6.11E-01 | 2.42E-01 | Yes | |
| Selenium | 79 | 0 | 0% | 0.32 | 0.32 | NA | NA | NA | NA | NA | 77 | 1 | 1% | 0.27 | 0.44 | 0.42 | 0.42 | 0.42 | 0.42 | NA | 9.96E-01 | 1.00E+00 | 2.42E-01 | NA | No | 1 |
| Silver | 79 | 79 | 100% | NA | NA | 0.074 | 2.2 | 0.15 | 0.251 | 0.377 | 77 | 0 | 0% | 0.11 | 0.18 | NA | NA | NA | NA | NA | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | No | 1 |
| Sodium | 79 | 79 | 100% | NA | NA | 428 | 3250 | 776 | 864.2 | 377.8 | 77 | 77 | 100% | NA | NA | 340 | 5300 | 1400 | 1530 | 820.6 | **1.44E-09** | **1.91E-10** | **4.83E-04** | 2.42E-01 | Yes | |
| Strontium | 79 | 79 | 100% | NA | NA | 123 | 793 | 250 | 274.6 | 104.3 | 77 | 77 | 100% | NA | NA | 60 | 1900 | 240 | 310.9 | 295.1 | 1.55E-01 | 7.94E-01 | 7.69E-01 | 5.70E-02 | No | 1 |
| Thallium | 79 | 4 | 5% | 0.2 | 0.2 | 0.15 | 0.34 | 0.21 | 0.228 | 0.081 | 77 | 77 | 100% | NA | NA | 0.059 | 0.24 | 0.087 | 0.095 | 0.033 | 9.81E-01 | 1.00E+00 | 6.80E-01 | 1.00E+00 | No | 1 |
| Tin | 79 | 76 | 96% | 0.053 | 0.053 | 0.25 | 0.78 | 0.55 | 0.549 | 0.096 | 77 | 37 | 48% | 0.29 | 0.37 | 0.31 | 6.2 | 0.45 | 0.653 | 0.963 | 9.46E-01 | 1.00E+00 | 6.87E-01 | 5.70E-02 | No | 1 |
| Titanium | 79 | 79 | 100% | NA | NA | 445 | 912 | 671 | 680.1 | 109.5 | 77 | 77 | 100% | NA | NA | 240 | 850 | 380 | 404 | 100.7 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | No | 1 |
| Uranium | 79 | 79 | 100% | NA | NA | 0.89 | 2.8 | 1.4 | 1.552 | 0.422 | 77 | 77 | 100% | NA | NA | 0.87 | 9.5 | 1.6 | 2.03 | 1.38 | **2.27E-03** | 3.26E-02 | **2.64E-05** | **2.64E-05** | Yes | |
| Vanadium | 79 | 79 | 100% | NA | NA | 26.7 | 73.3 | 43.2 | 45.99 | 10.06 | 77 | 77 | 100% | NA | NA | 24 | 72 | 31 | 32.32 | 6.392 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | No | 1 |
| Zinc | 79 | 79 | 100% | NA | NA | 18.1 | 41.2 | 32 | 31.87 | 3.799 | 77 | 77 | 100% | NA | NA | 15 | 93 | 26 | 27.47 | 9.515 | 1.00E+00 | 1.00E+00 | 9.97E-01 | 2.42E-01 | No | 1 |

Notes:
TIMET Ditch dataset contains the BD and NW series. Trace nutrients chloride, fluoride, nitrate, nitrite, and sulfate were not plotted.
*p* values in **boldface** shaded cells indicate p <= 0.025 based on Neptune output dated 12/7/12
NA - Not applicable
Background dataset is from the deep McCullough soils (over 10 ft bgs).
Background comparison tests use half the sample quantitation limit (SQL) for non-detects.

Background Qualifiers:
[1] = Gilbert's Toolbox results imply TIMET >10 ft bgs Ditch data are lower than the McCullough Range >10 ft bgs background data.

# BOX PLOTS AND QUANTILE-QUANTILE PLOTS: SHALLOW SOILS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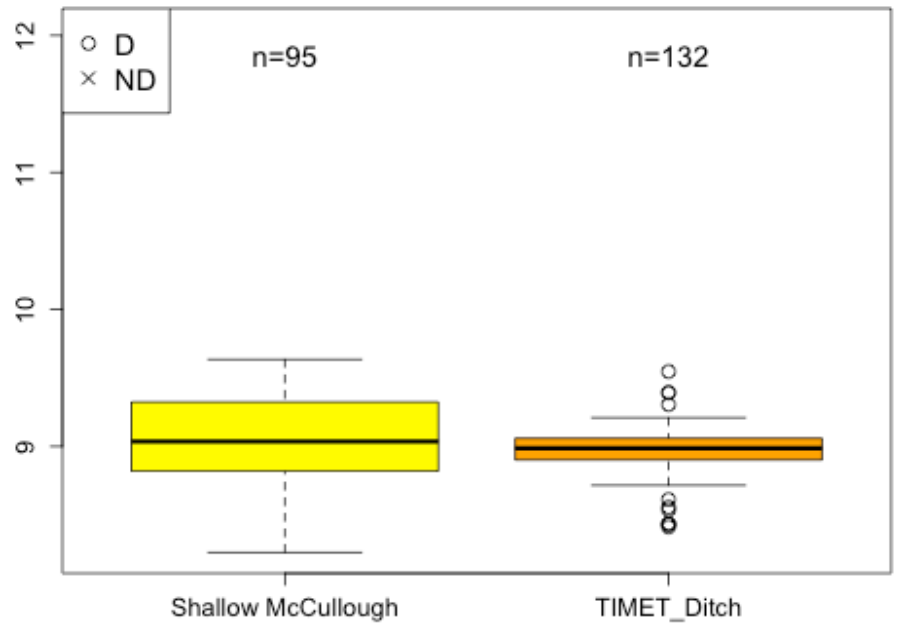
Shallow McCullough
TIMET_Ditch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ND
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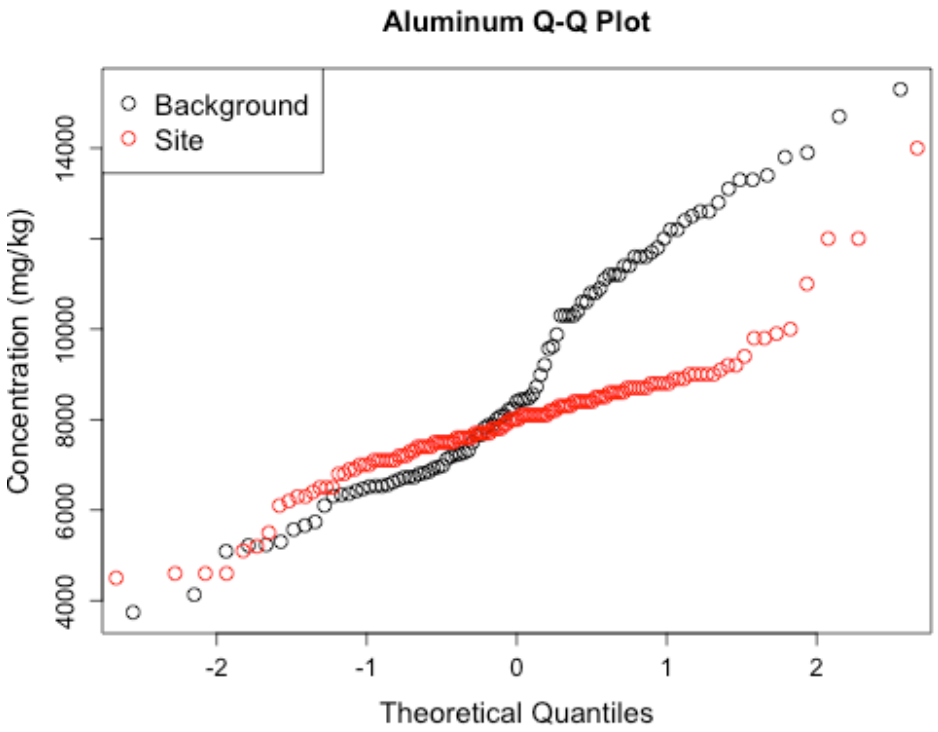
n=132
12
11
10
9
Shallow McCullough
TIMET_Ditch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Site
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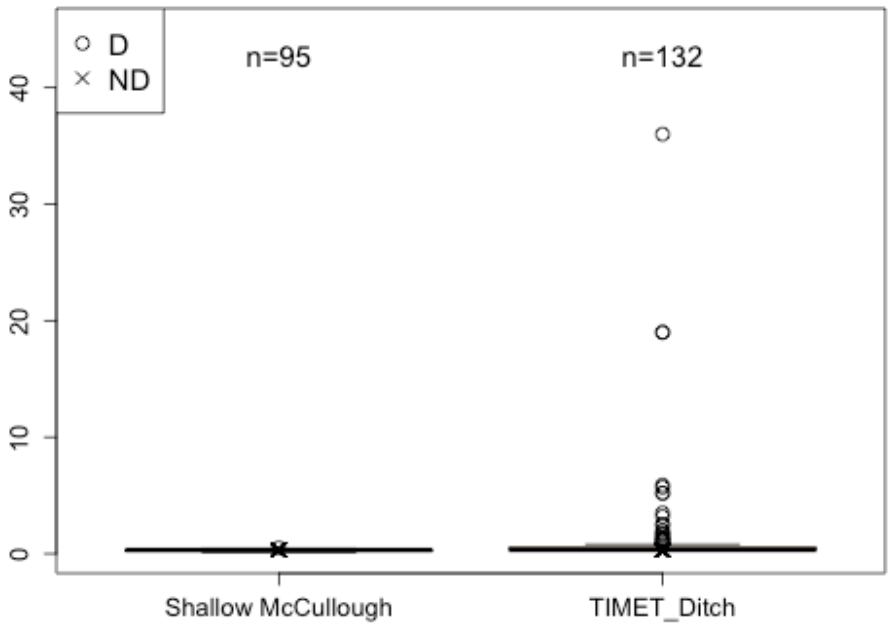
8000
6000
4000
-2
-1
0
1
2
Theoretical Quantiles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ND
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n=132
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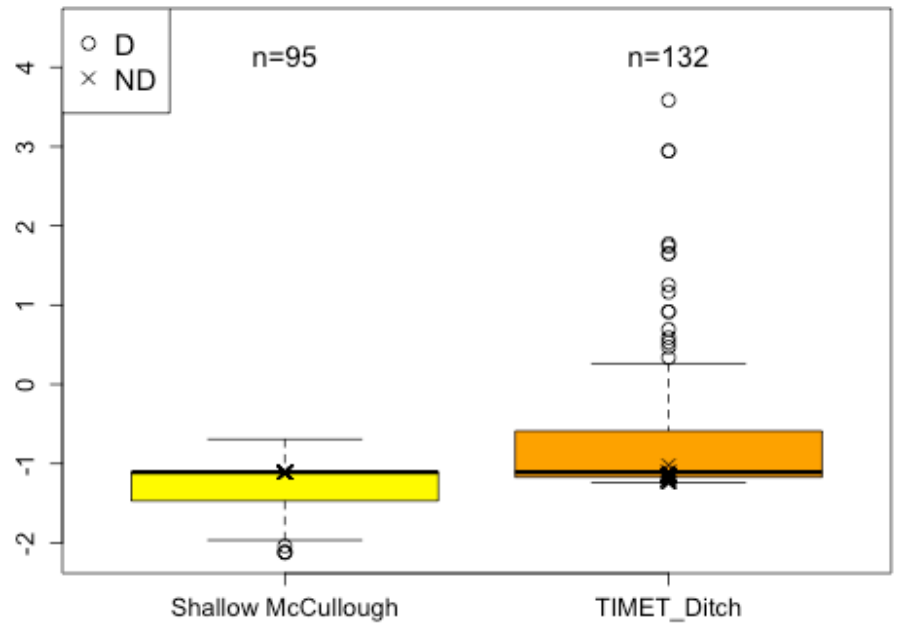
10
20
30
40
Shallow McCullough
TIMET_Ditch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ND
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n=132
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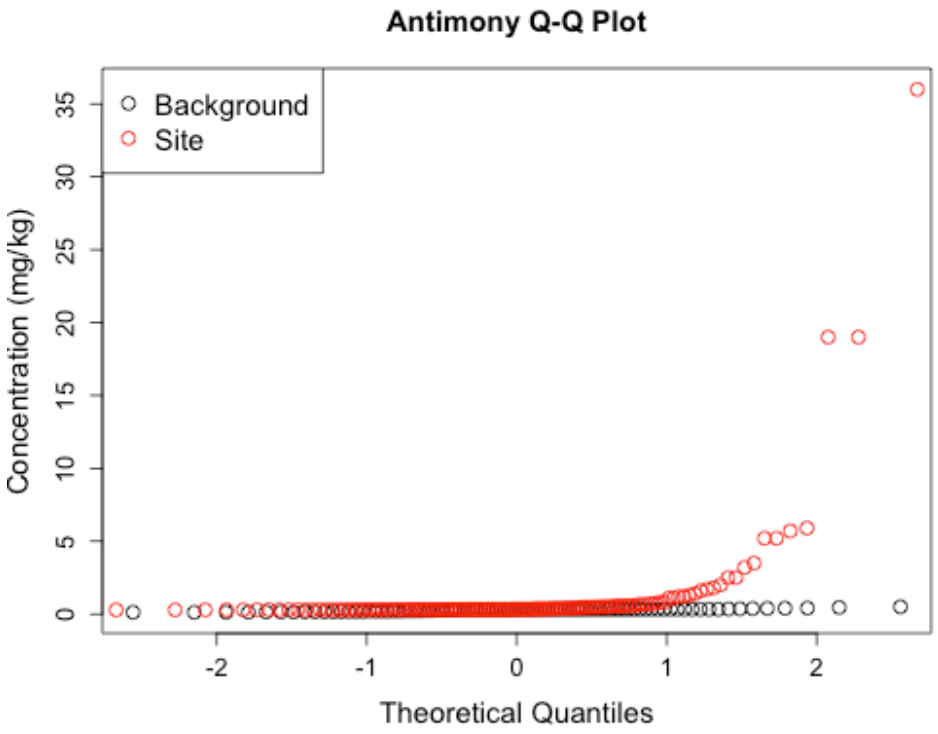
-1
0
1
2
3
4
Shallow McCullough
TIMET_Ditch


Antimony Q-Q Plot
Background
Site
Concentration (mg/kg)
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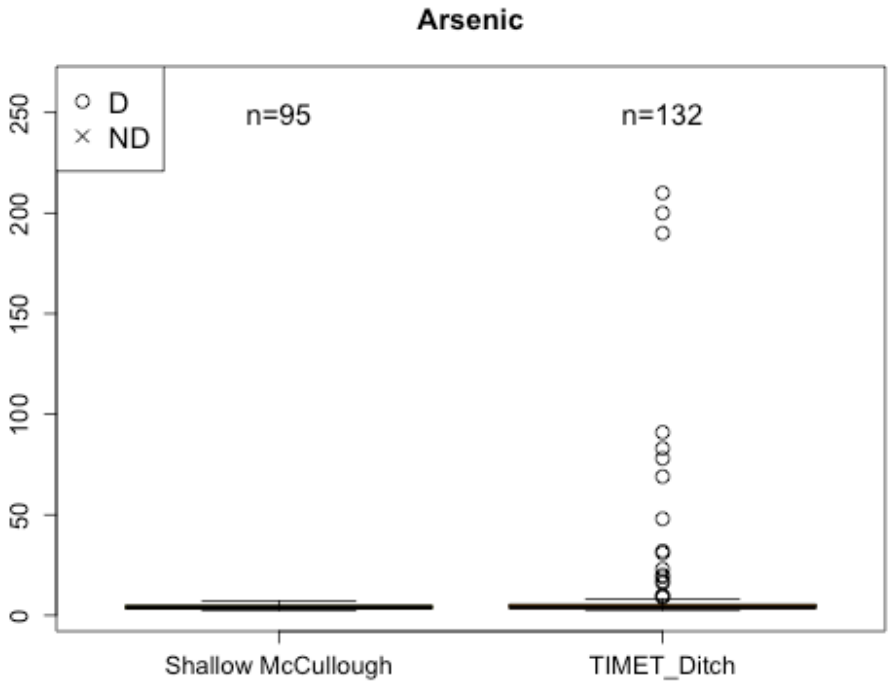
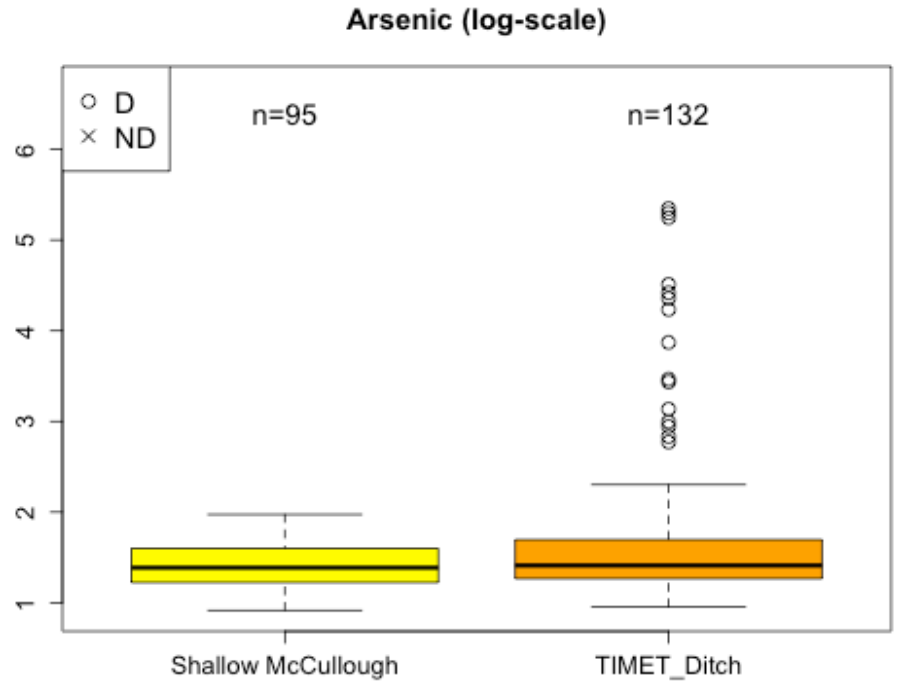
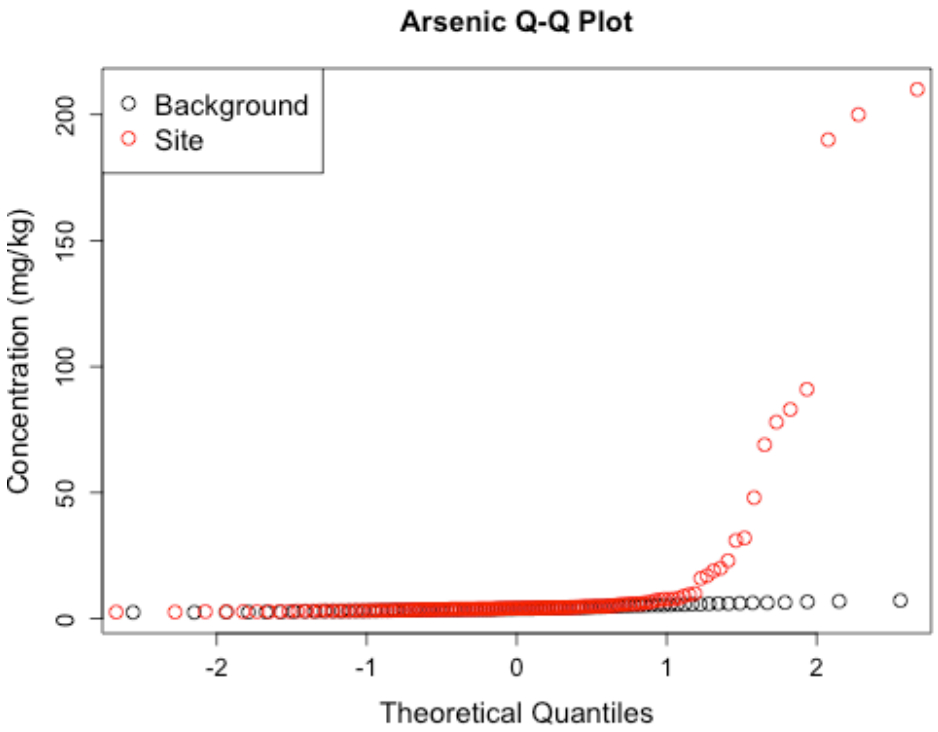
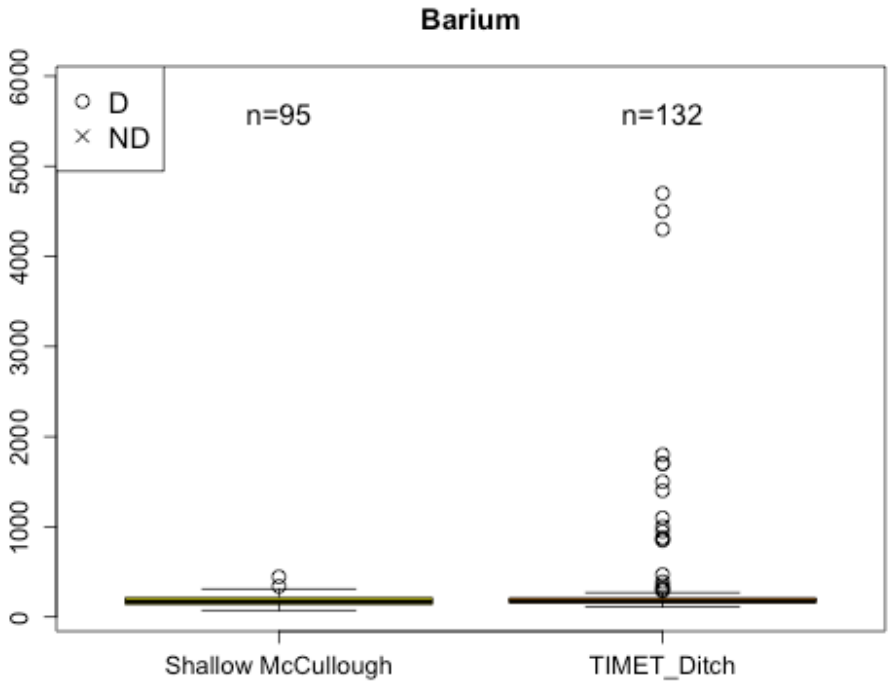
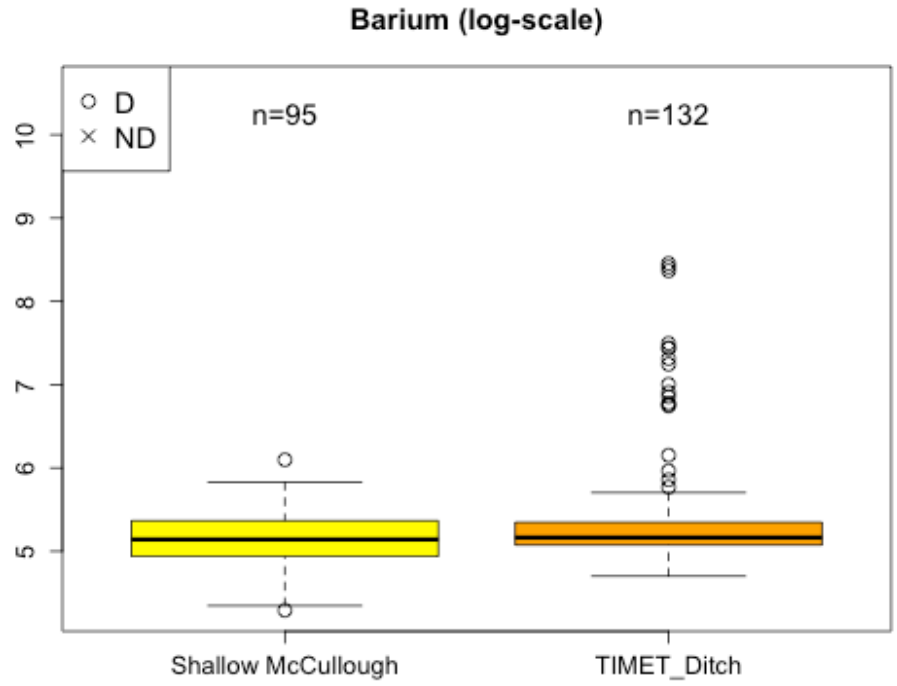
10
15
20
25
30
35
-2
-1
0
1
2
Theoretical Quantiles

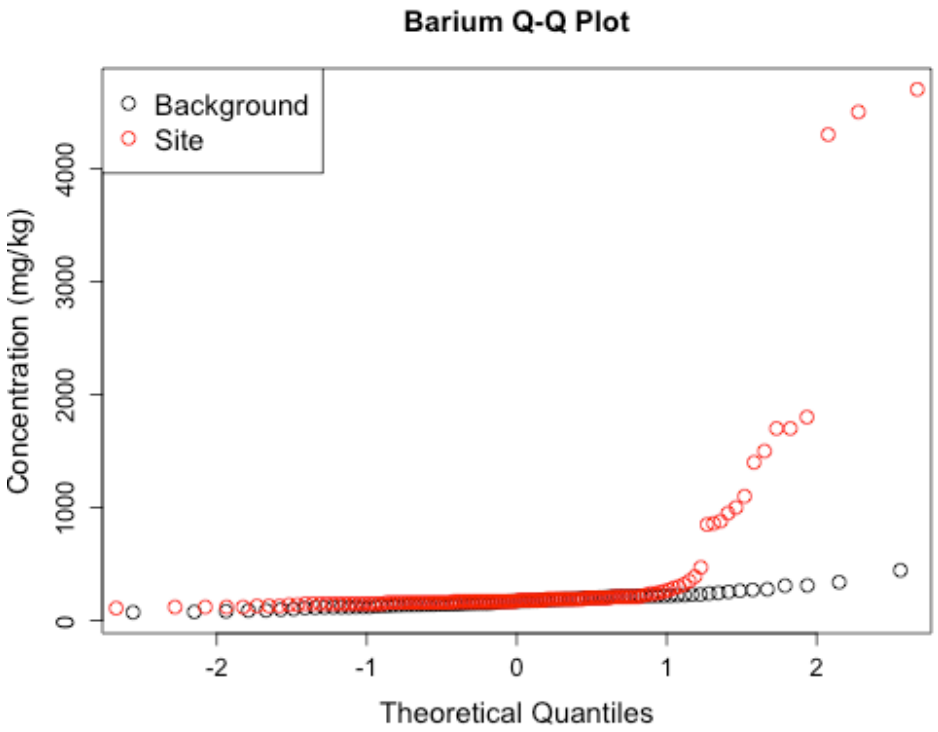

Arsenic
D
ND
n=95
n=132
0
50
100
150
200
250
Shallow McCullough
TIMET_Ditch

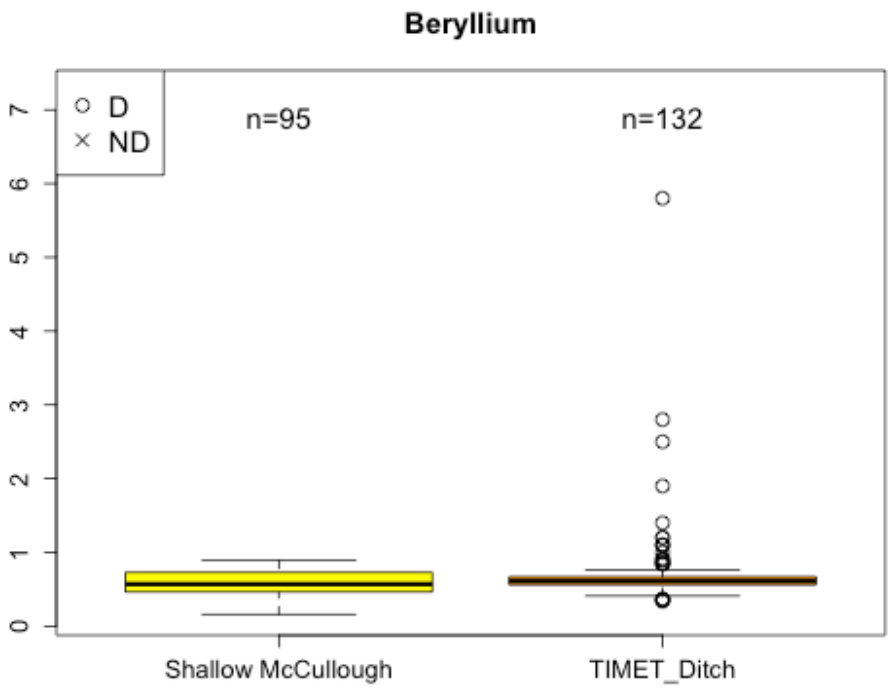

Arsenic (log-scale)
D
ND
n=95
n=132
1
2
3
4
5
6
Shallow McCullough
TIMET_Ditch

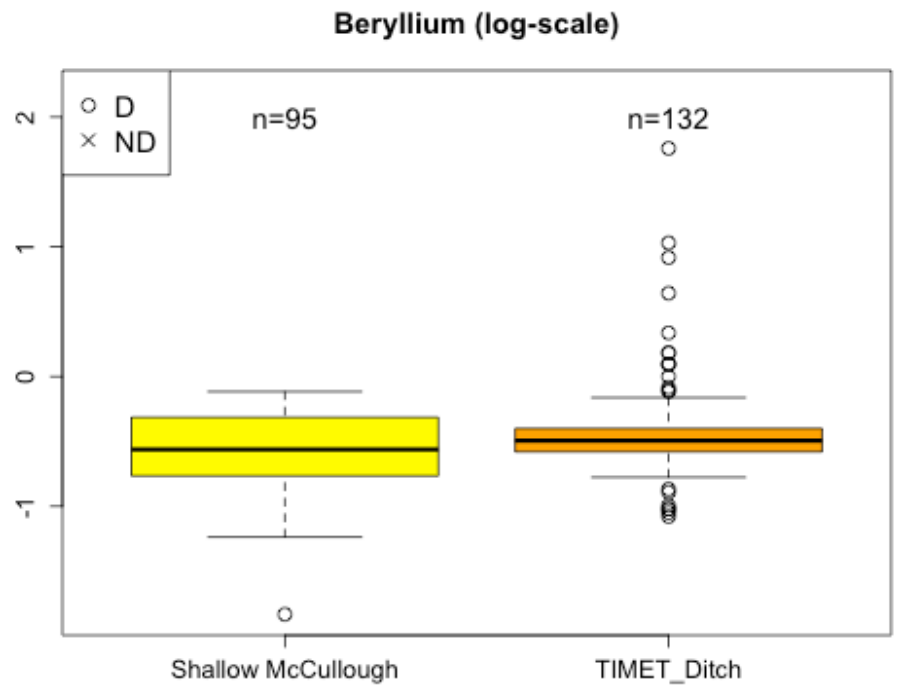

Arsenic Q-Q Plot
Background
Site
Concentration (mg/kg)
0
50
100
150
200
-2
-1
0
1
2
Theoretical Quantiles

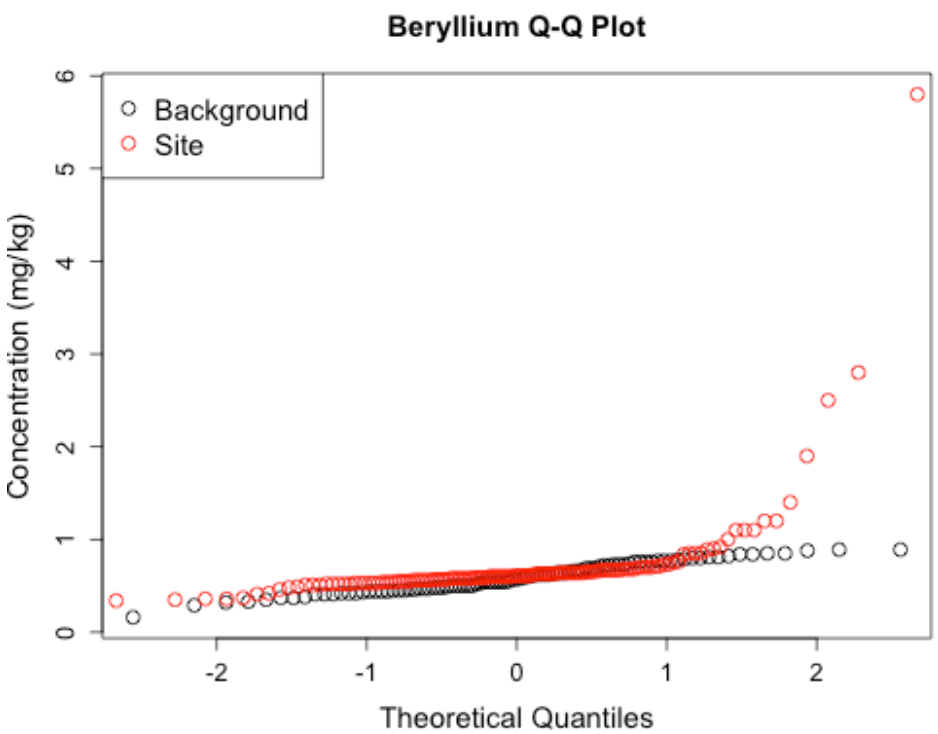

Barium
D
ND
n=95
n=132
0
1000
2000
3000
4000
5000
6000
Shallow McCullough
TIMET_Ditch

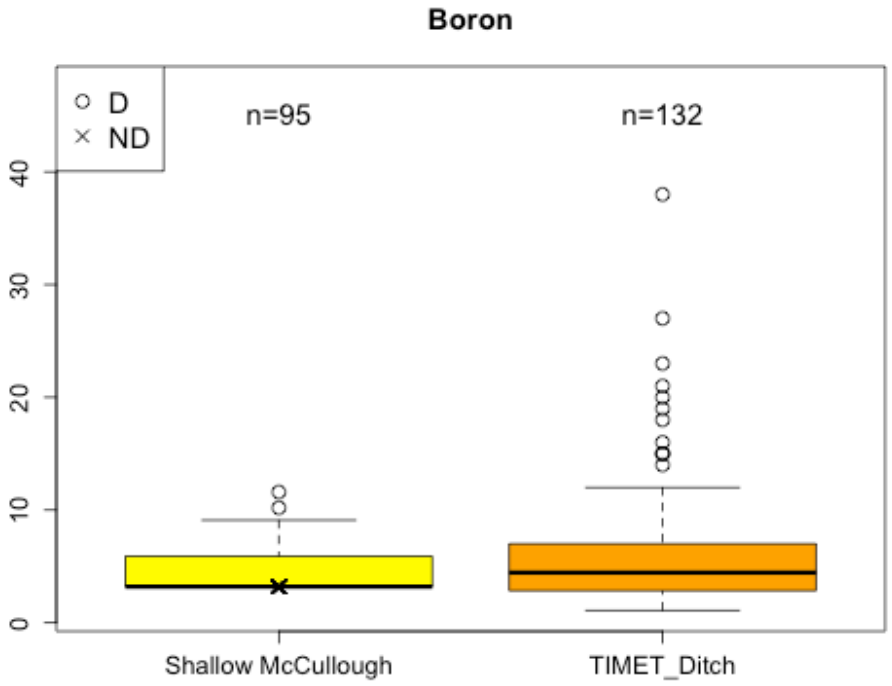

Barium (log-scale)
D
ND
n=95
n=132
5
6
7
8
9
10
Shallow McCullough
TIMET_Ditch

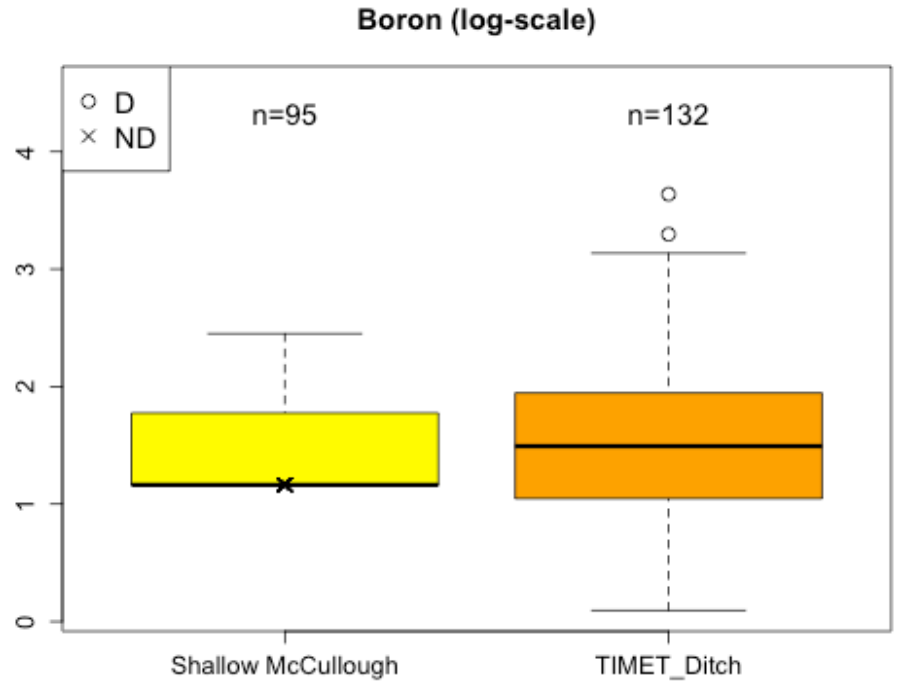

Barium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
1000
2000
3000
4000
-2
-1
0
1
2
Theoretical Quantiles

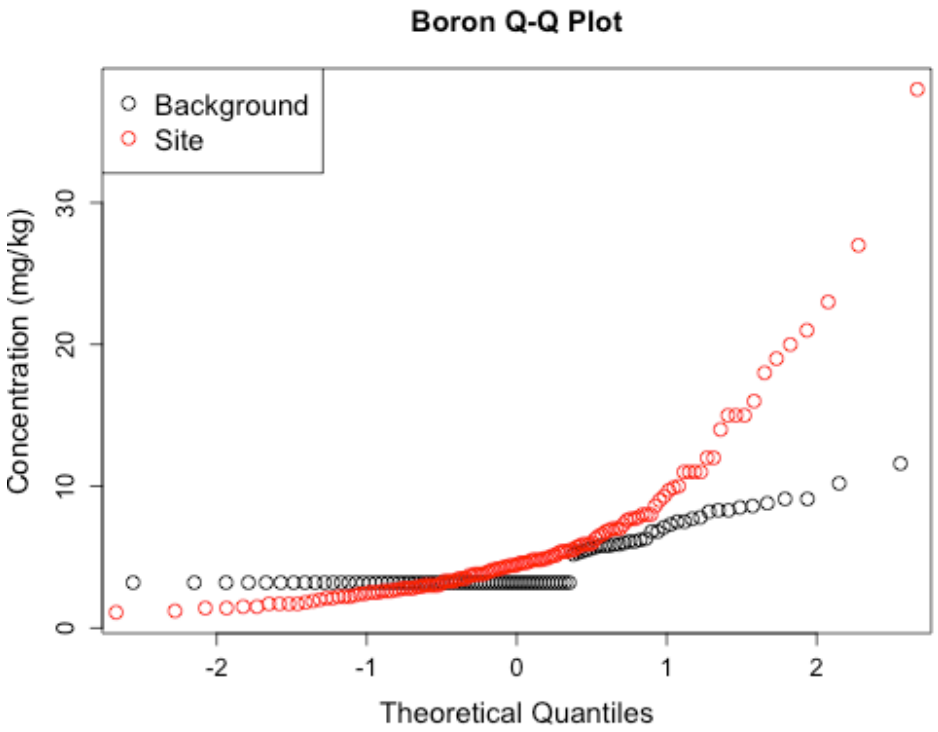

Beryllium
D
ND
n=95
n=132
0
1
2
3
4
5
6
7
Shallow McCullough
TIMET_Ditch

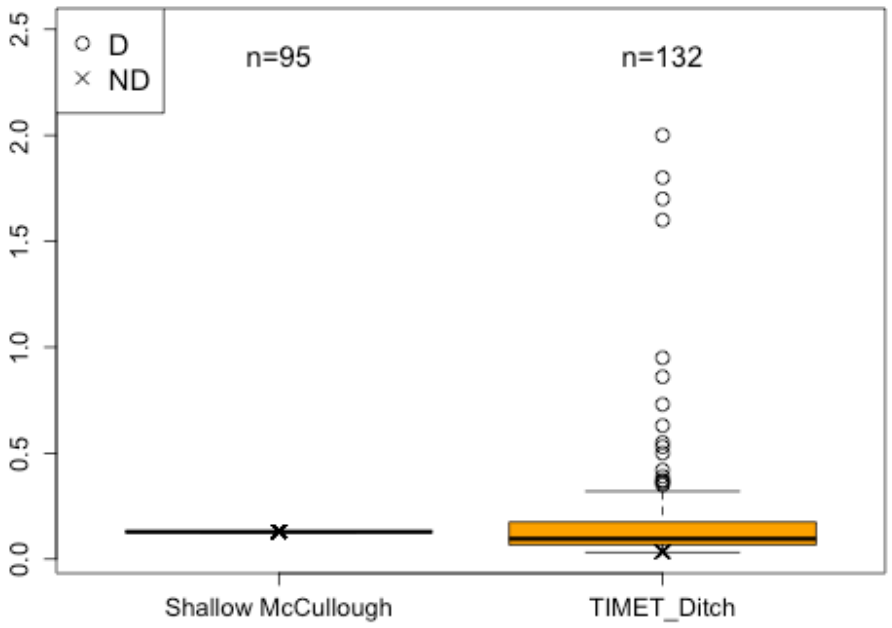

Beryllium (log-scale)
D
ND
n=95
n=132
-1
0
1
2
Shallow McCullough
TIMET_Ditch

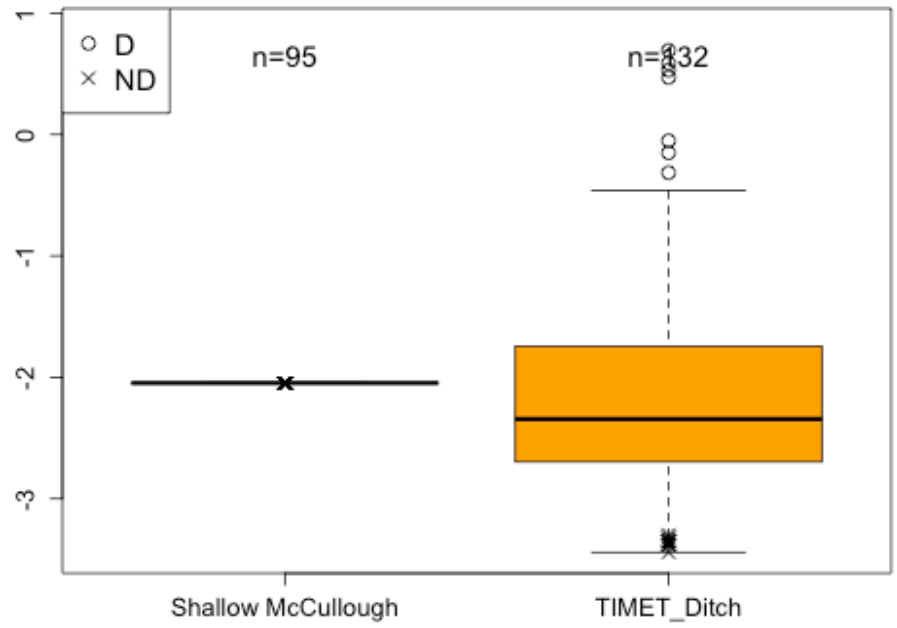

Beryllium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
1
2
3
4
5
6
-2
-1
0
1
2
Theoretical Quantiles

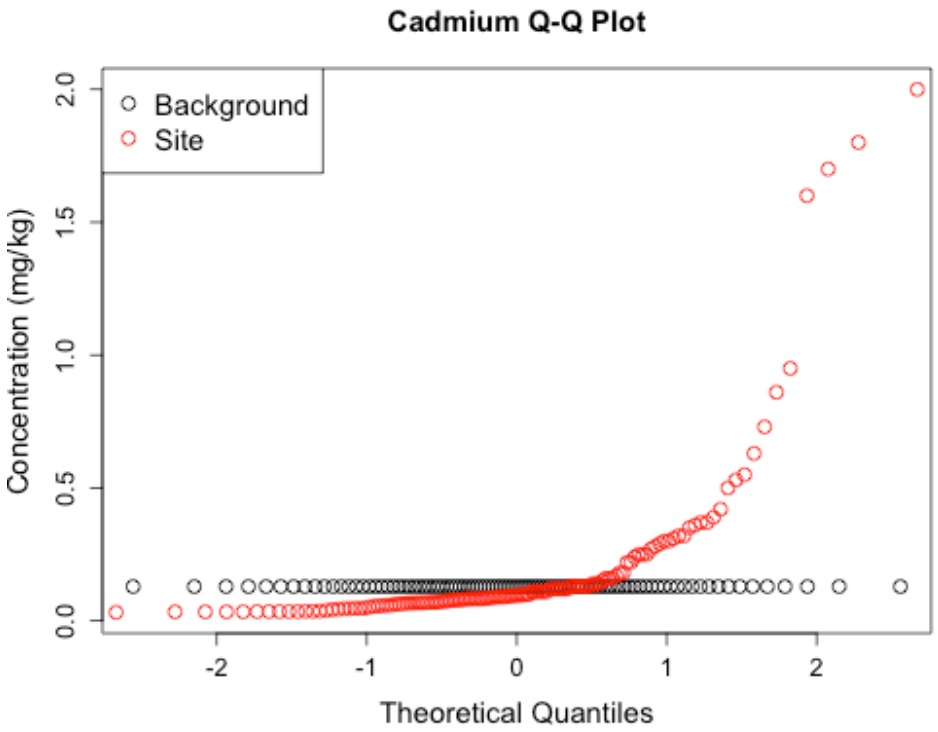

Boron
D
ND
n=95
n=132
0
10
20
30
40
Shallow McCullough
TIMET_Ditch

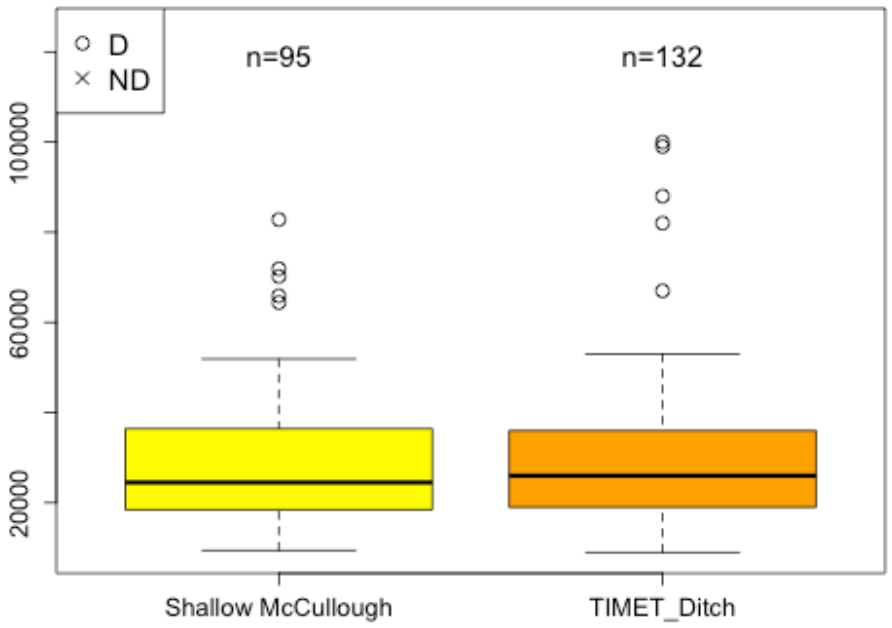

Boron (log-scale)
D
ND
n=95
n=132
0
1
2
3
4
Shallow McCullough
TIMET_Ditch

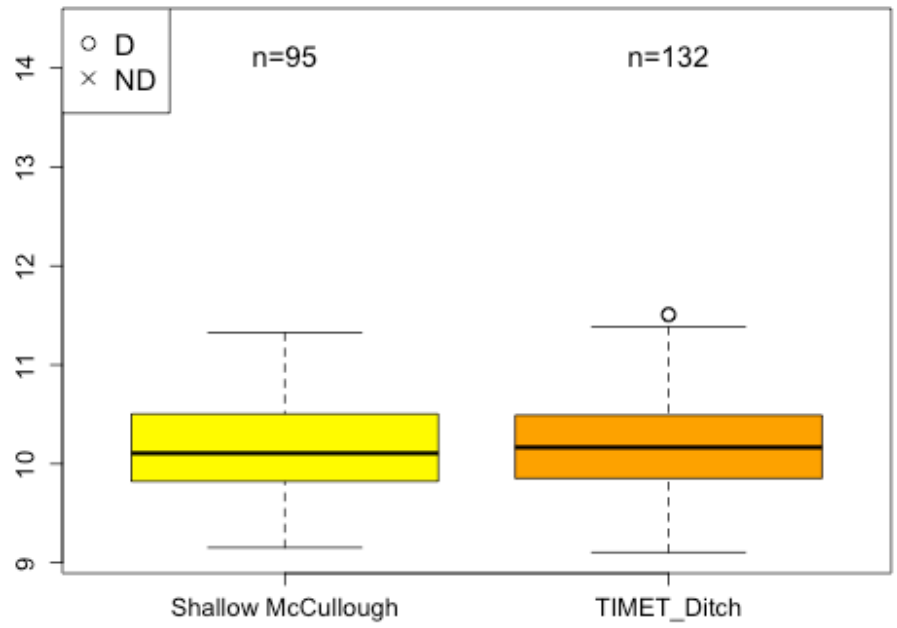

Boron Q-Q Plot
Background
Site
Concentration (mg/kg)
0
10
20
30
-2
-1
0
1
2
Theoretical Quantiles

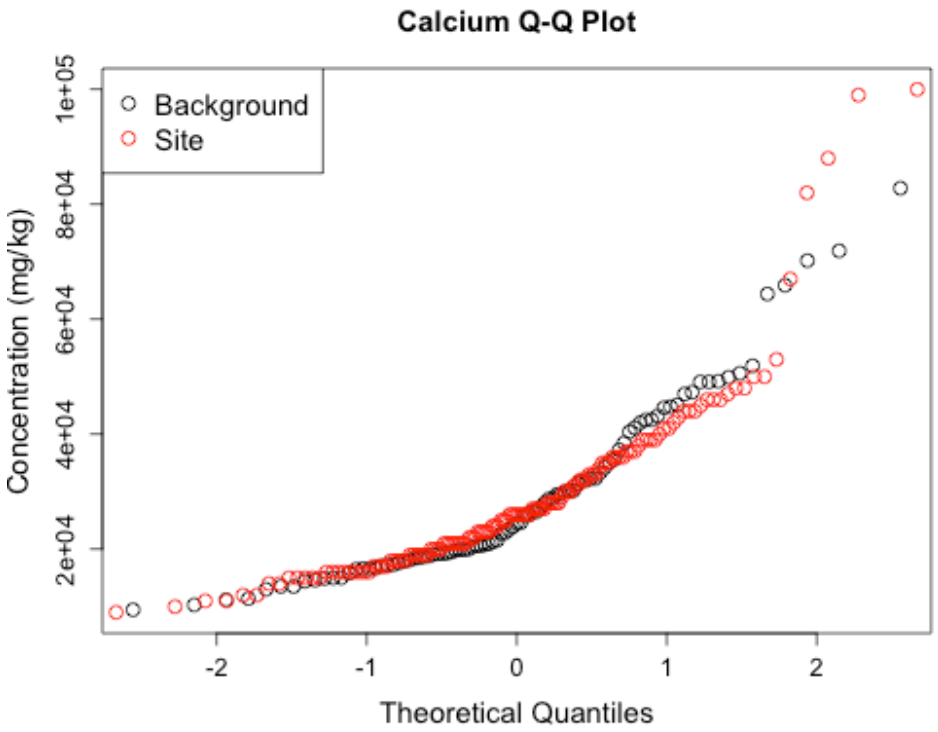

Cadmium
D
ND
n=95
n=132
0.0
0.5
1.0
1.5
2.0
2.5
Shallow McCullough
TIMET_Ditch

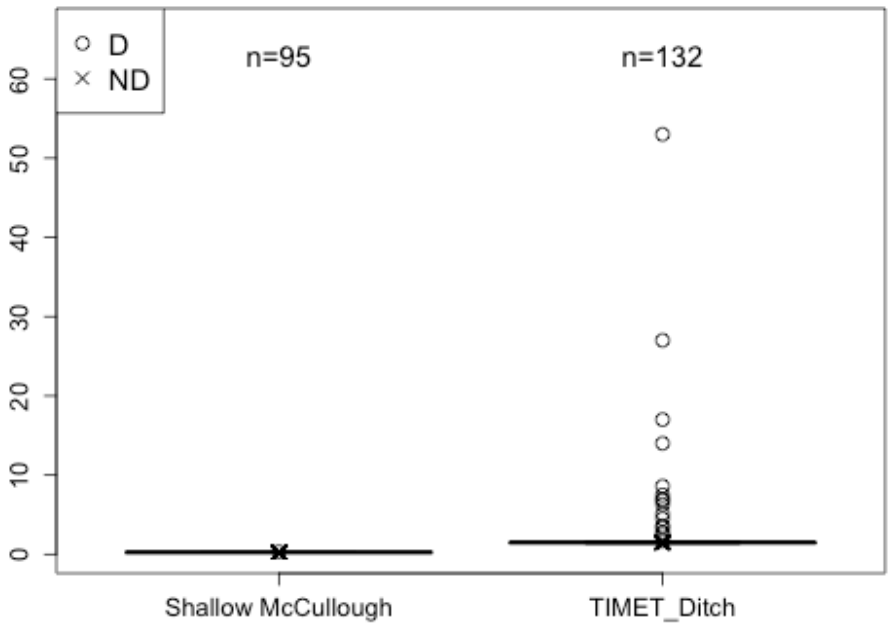

Cadmium (log-scale)
D
ND
n=95
n=132
1
0
-1
-2
-3
Shallow McCullough
TIMET_Ditch

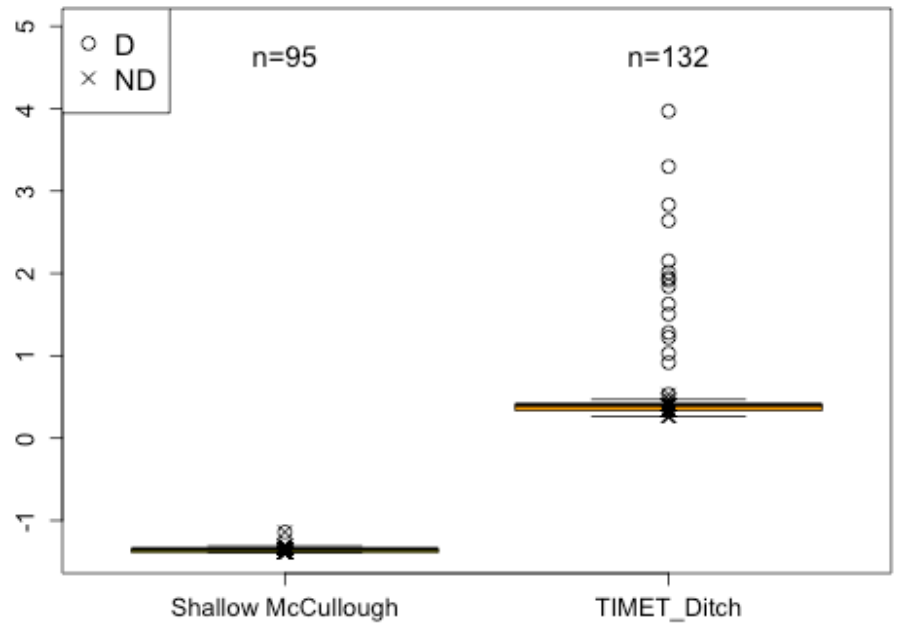

Cadmium Q-Q Plot
Background
Site
Concentration (mg/kg)
0.0
0.5
1.0
1.5
2.0
-2
-1
0
1
2
Theoretical Quantiles

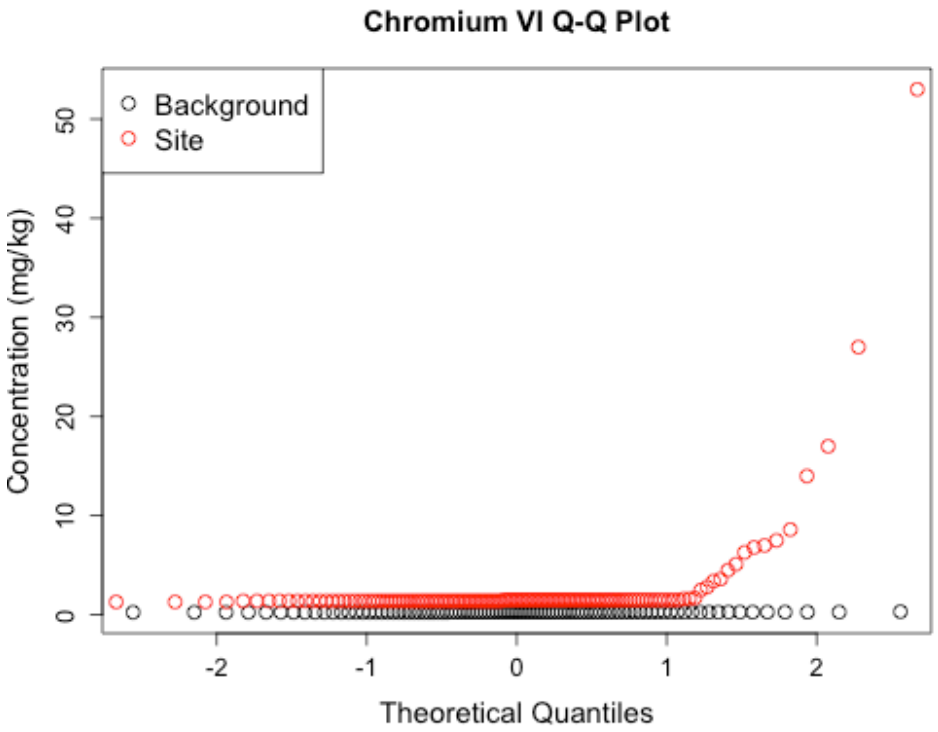

Calcium
D
ND
n=95
n=132
100000
60000
20000
Shallow McCullough
TIMET_Ditch

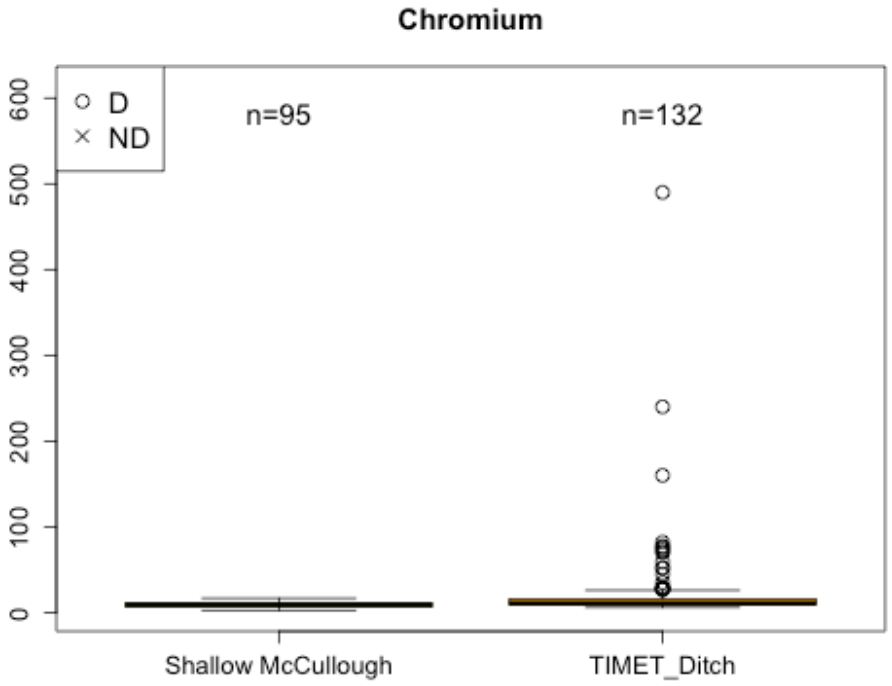

Calcium (log-scale)
D
ND
n=95
n=132
14
13
12
11
10
9
Shallow McCullough
TIMET_Ditch

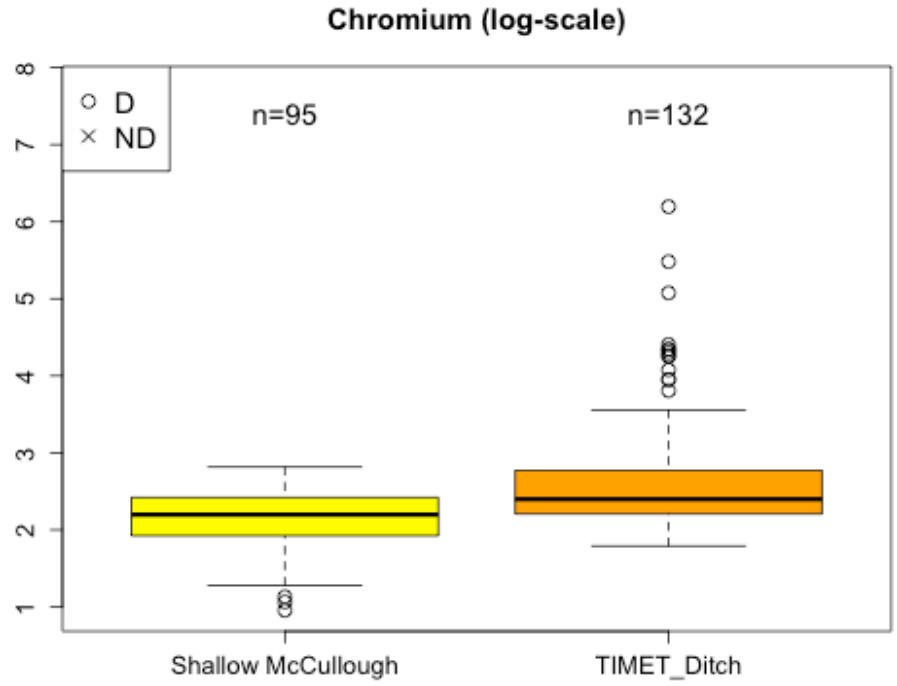

Calcium Q-Q Plot
Background
Site
Concentration (mg/kg)
1e+05
8e+04
6e+04
4e+04
2e+04
-2
-1
0
1
2
Theoretical Quantiles

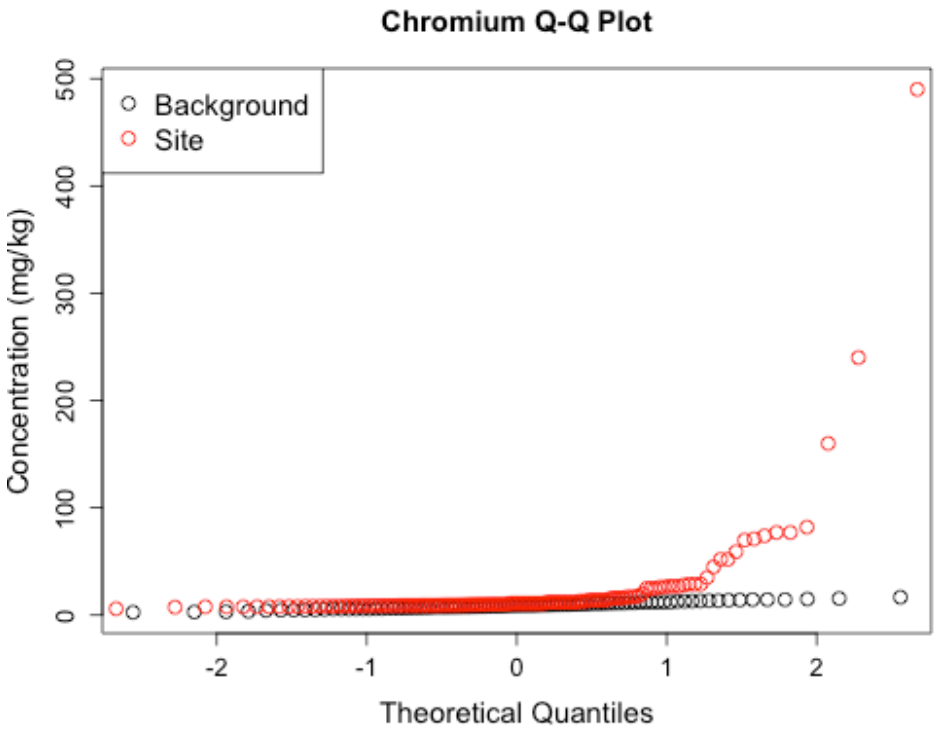

Chromium VI
D
ND
n=95
n=132
0
10
20
30
40
50
60
Shallow McCullough
TIMET_Ditch

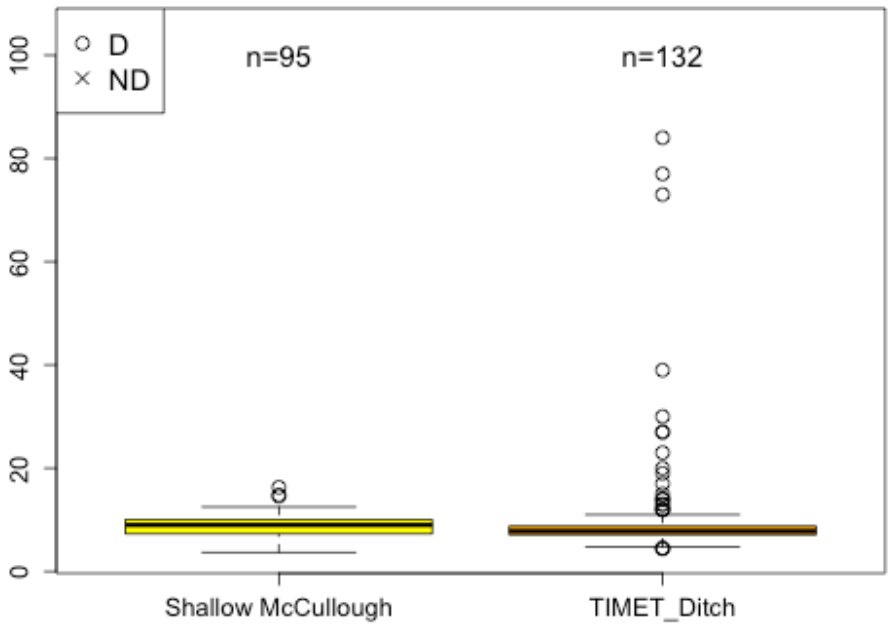

Chromium VI (log-scale)
D
ND
n=95
n=132
-1
0
1
2
3
4
5
Shallow McCullough
TIMET_Ditch

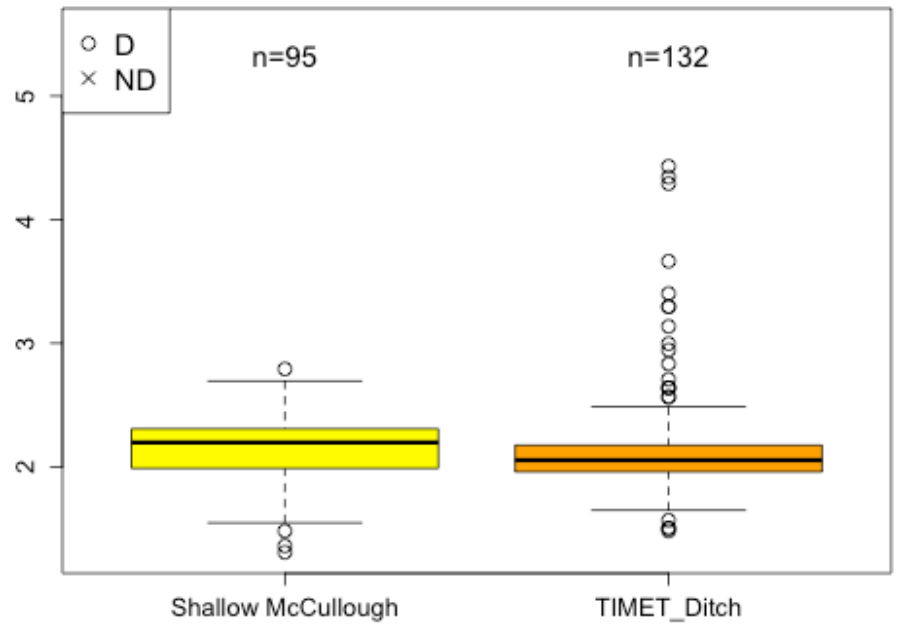

Chromium VI Q-Q Plot
Background
Site
Concentration (mg/kg)
0
10
20
30
40
50
-2
-1
0
1
2
Theoretical Quantiles

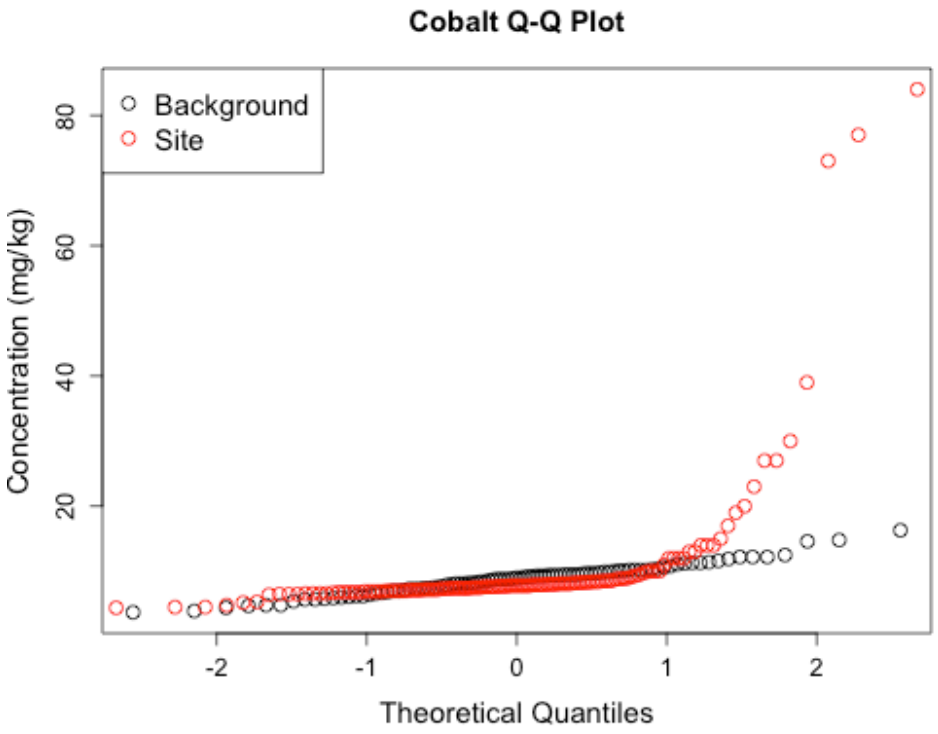

Chromium
D
ND
n=95
n=132
0
100
200
300
400
500
600
Shallow McCullough
TIMET_Ditch

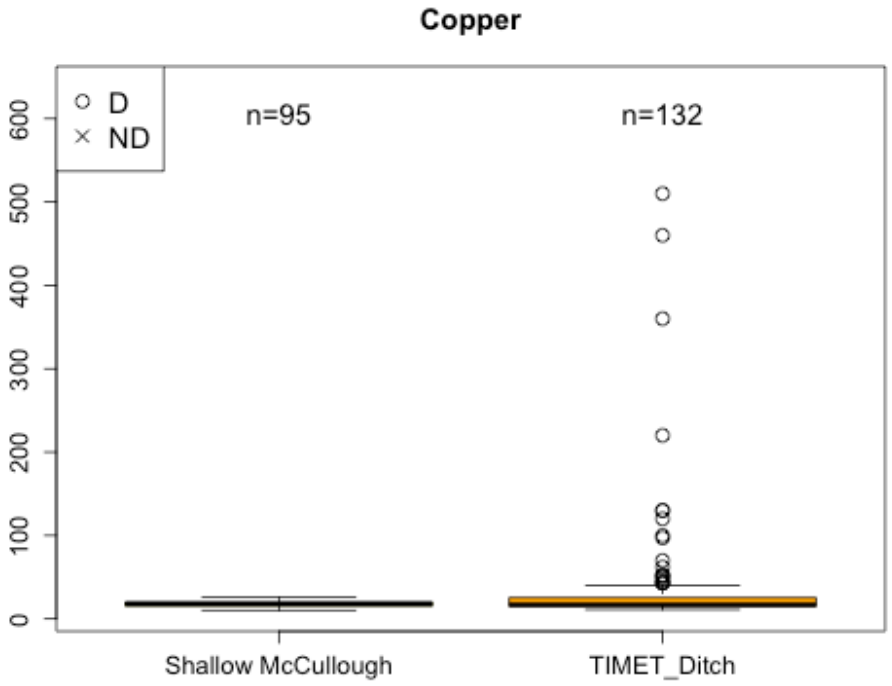

Chromium (log-scale)
D
ND
n=95
n=132
1
2
3
4
5
6
7
8
Shallow McCullough
TIMET_Ditch

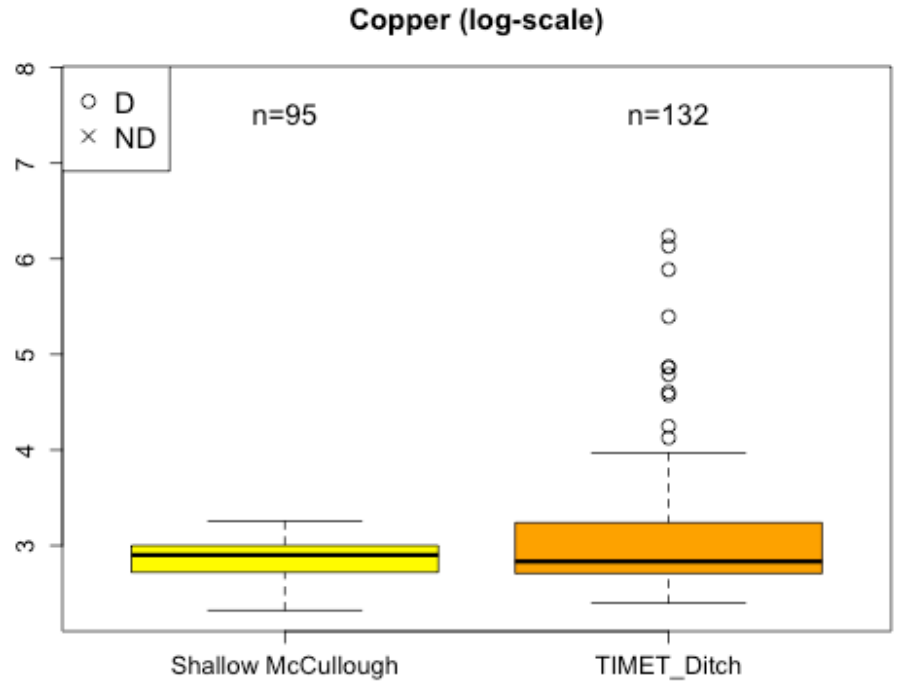

Chromium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
100
200
300
400
500
-2
-1
0
1
2
Theoretical Quantiles

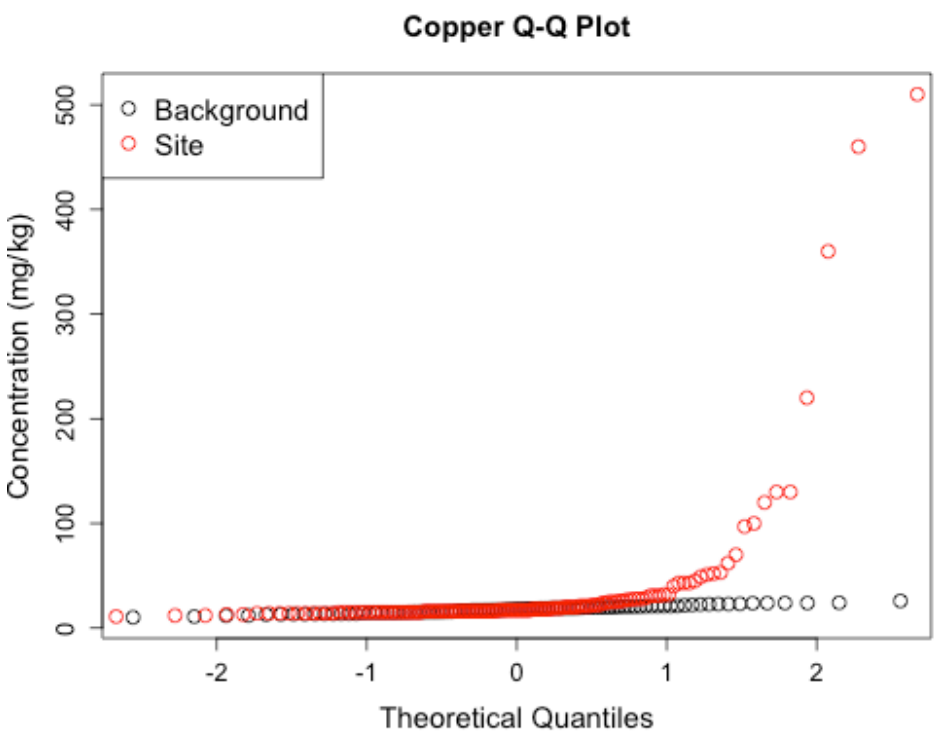

Cobalt
D
ND
n=95
n=132
0
20
40
60
80
100
Shallow McCullough
TIMET_Ditch

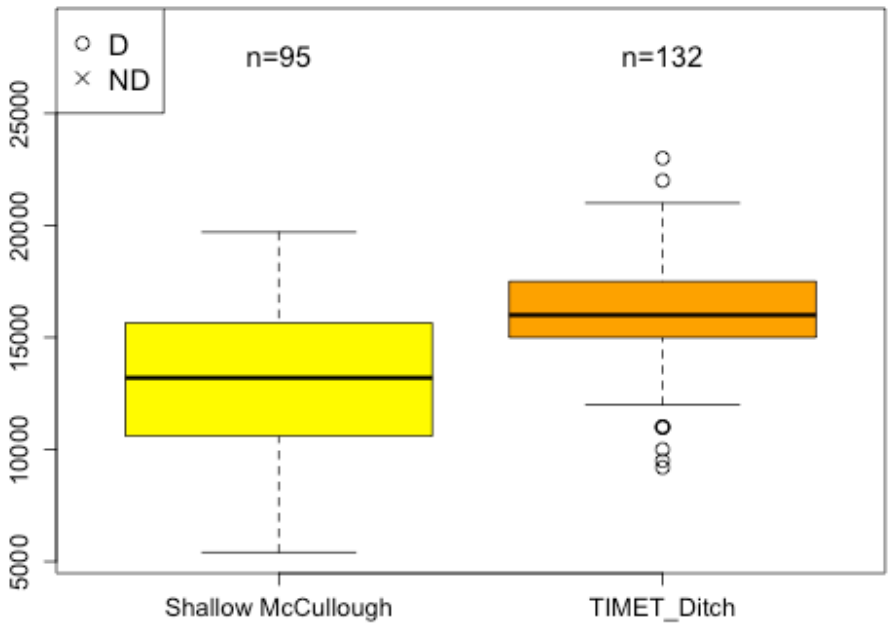

Cobalt (log-scale)
D
ND
n=95
n=132
2
3
4
5
Shallow McCullough
TIMET_Ditch

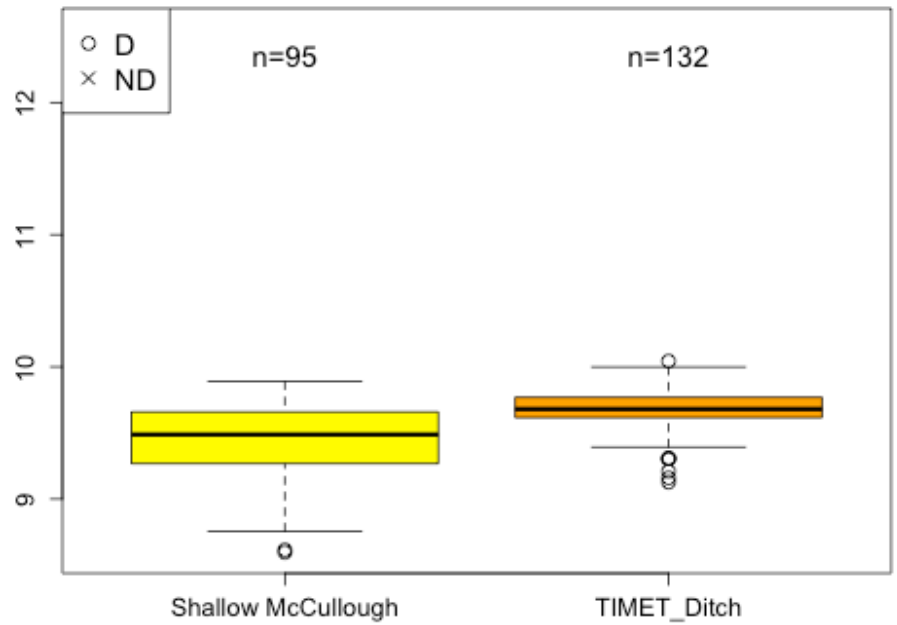

Cobalt Q-Q Plot
Background
Site
Concentration (mg/kg)
20
40
60
80
-2
-1
0
1
2
Theoretical Quantiles

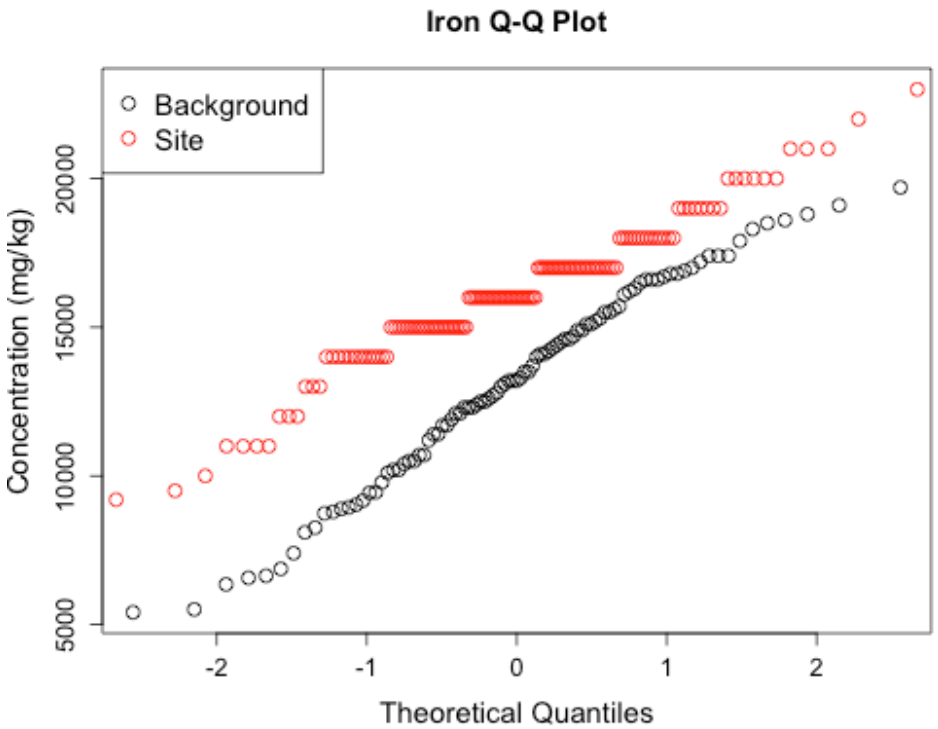

Copper
D
ND
n=95
n=132
0
100
200
300
400
500
600
Shallow McCullough
TIMET_Ditch

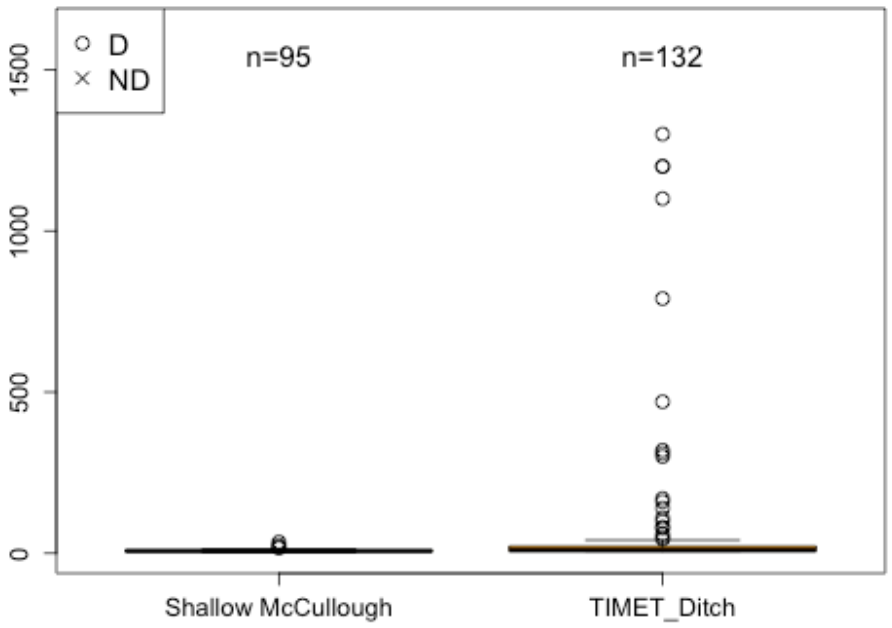

Copper (log-scale)
D
ND
n=95
n=132
3
4
5
6
7
8
Shallow McCullough
TIMET_Ditch

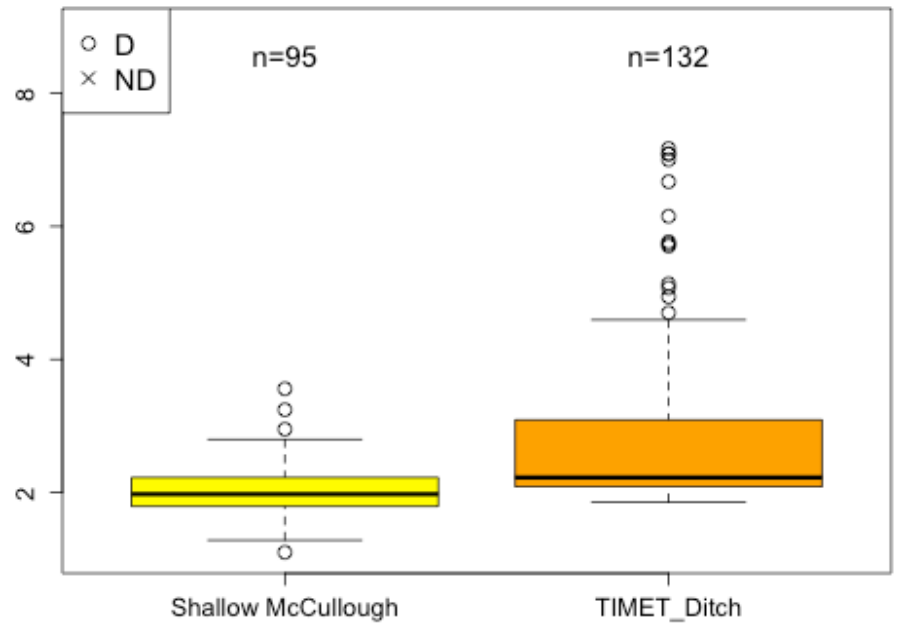

Copper Q-Q Plot
Background
Site
Concentration (mg/kg)
0
100
200
300
400
500
-2
-1
0
1
2
Theoretical Quantiles

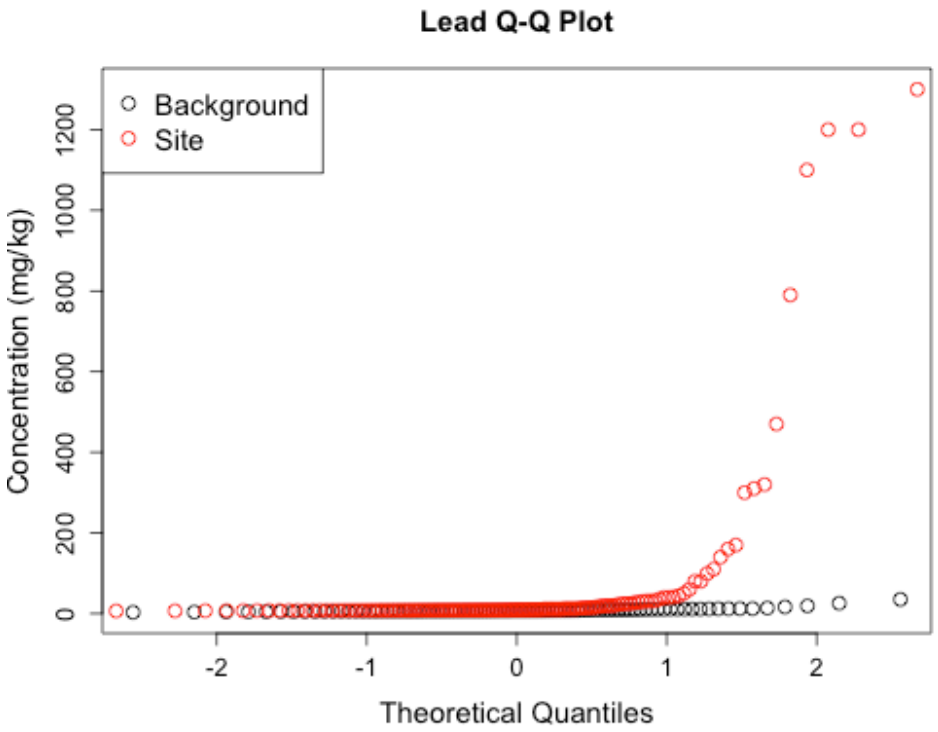

Iron
D
ND
n=95
n=132
25000
20000
15000
10000
5000
Shallow McCullough
TIMET_Ditch

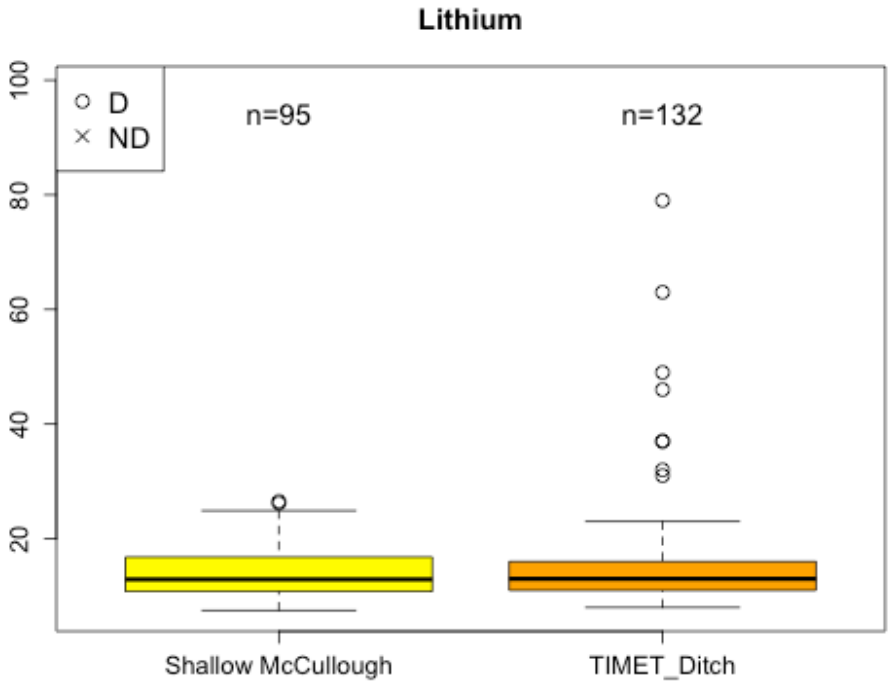

Iron (log-scale)
D
ND
n=95
n=132
12
11
10
9
Shallow McCullough
TIMET_Ditch

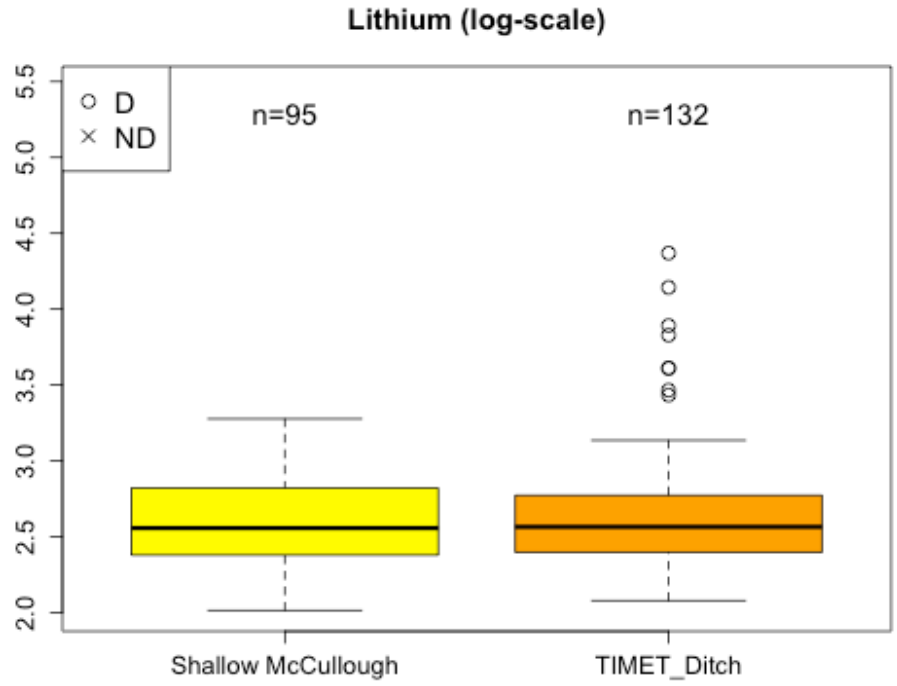

Iron Q-Q Plot
Background
Site
Concentration (mg/kg)
20000
15000
10000
5000
-2
-1
0
1
2
Theoretical Quantiles

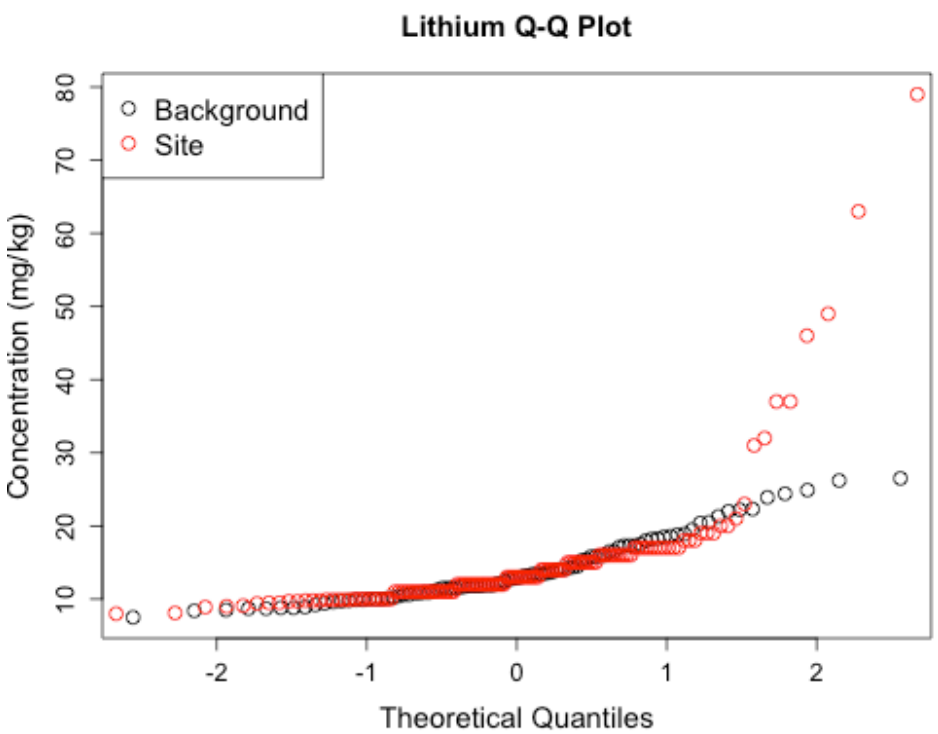

Lead
D
ND
n=95
n=132
0
500
1000
1500
Shallow McCullough
TIMET_Ditch

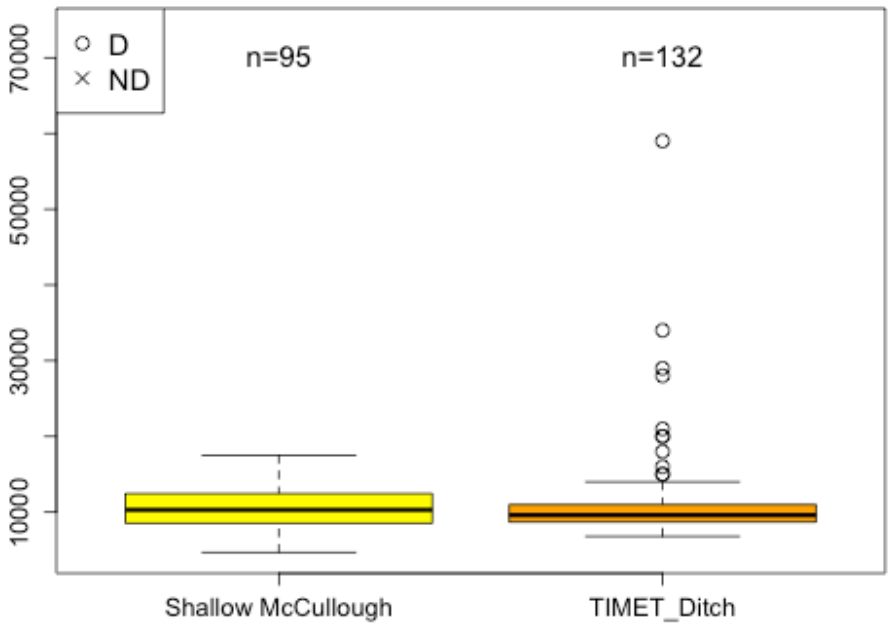

Lead (log-scale)
D
ND
n=95
n=132
2
4
6
8
Shallow McCullough
TIMET_Ditch

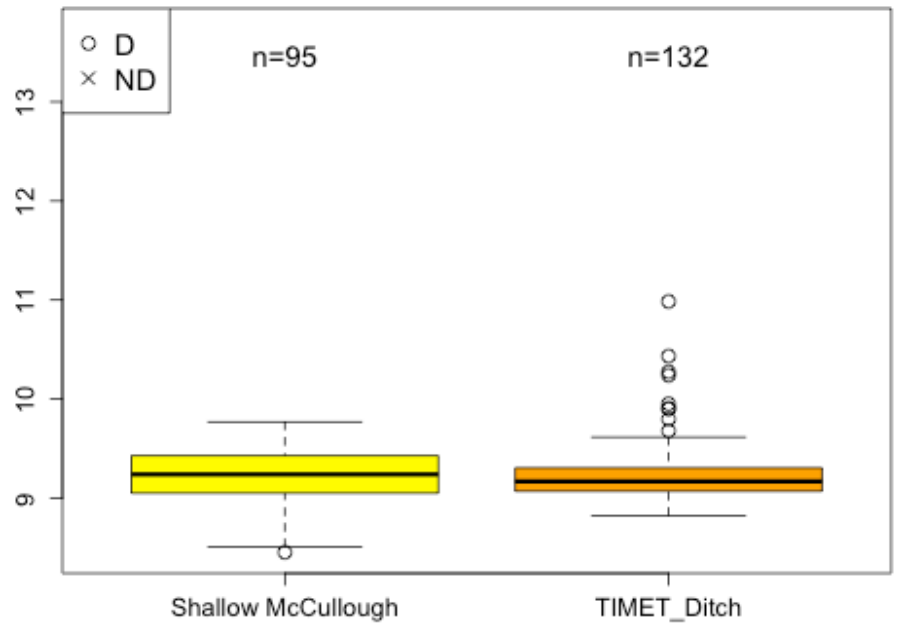

Lead Q-Q Plot
Background
Site
Concentration (mg/kg)
0
200
400
600
800
1000
1200
-2
-1
0
1
2
Theoretical Quantiles

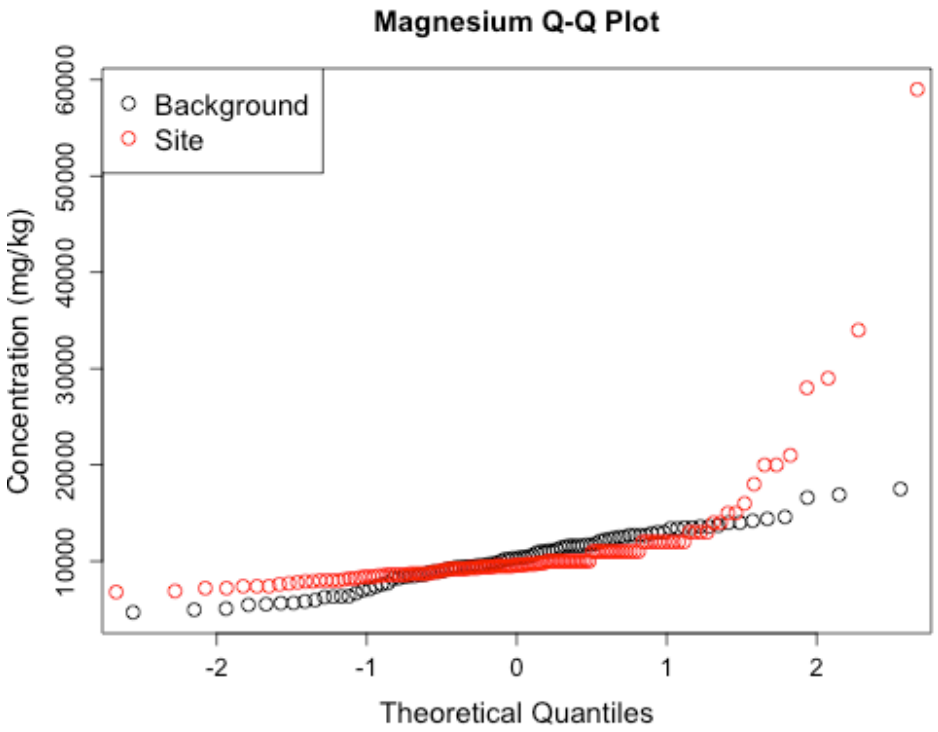

Lithium
D
ND
n=95
n=132
100
80
60
40
20
Shallow McCullough
TIMET_Ditch

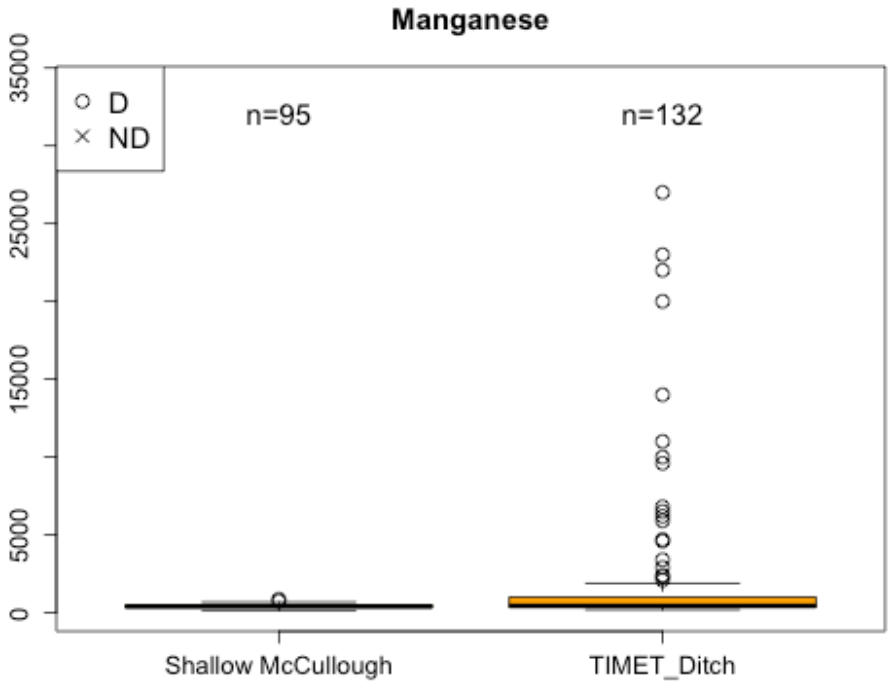

Lithium (log-scale)
D
ND
n=95
n=132
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
Shallow McCullough
TIMET_Ditch

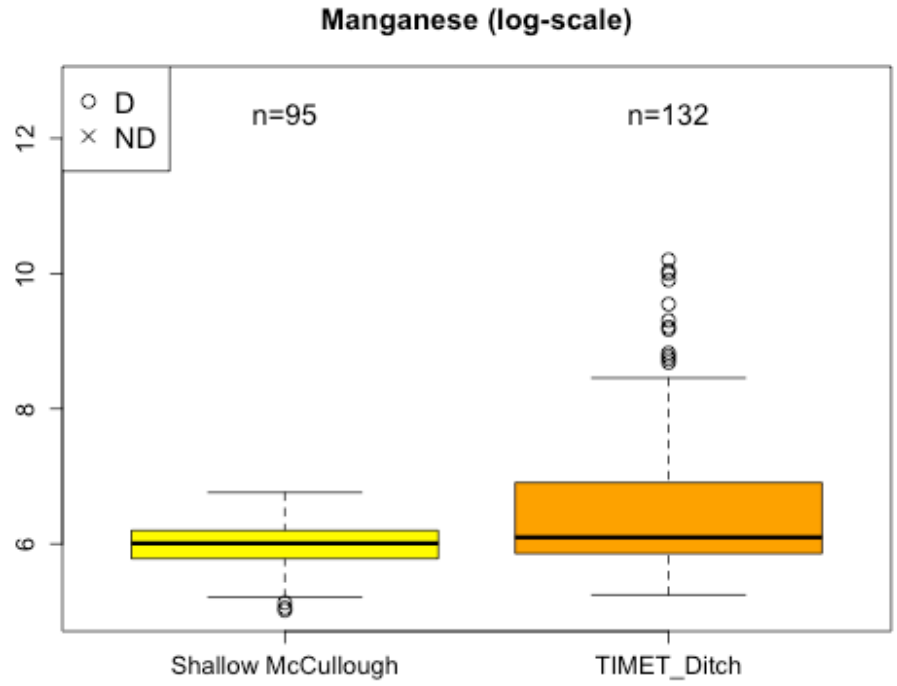

Lithium Q-Q Plot
Background
Site
Concentration (mg/kg)
80
70
60
50
40
30
20
10
-2
-1
0
1
2
Theoretical Quantiles

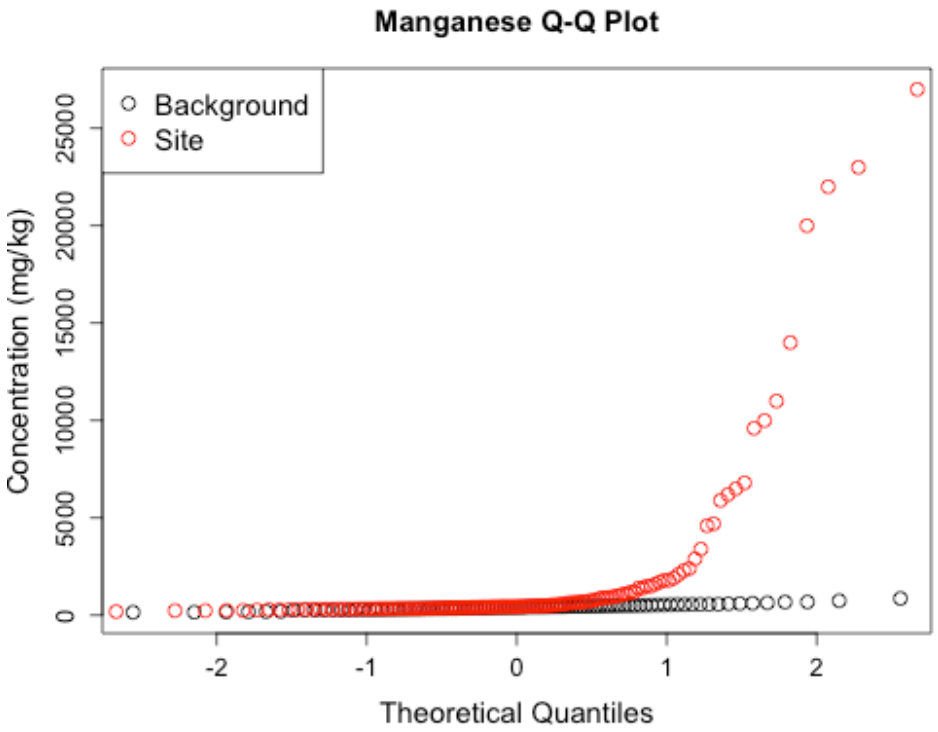

Magnesium
D
ND
n=95
n=132
70000
50000
30000
10000
Shallow McCullough
TIMET_Ditch

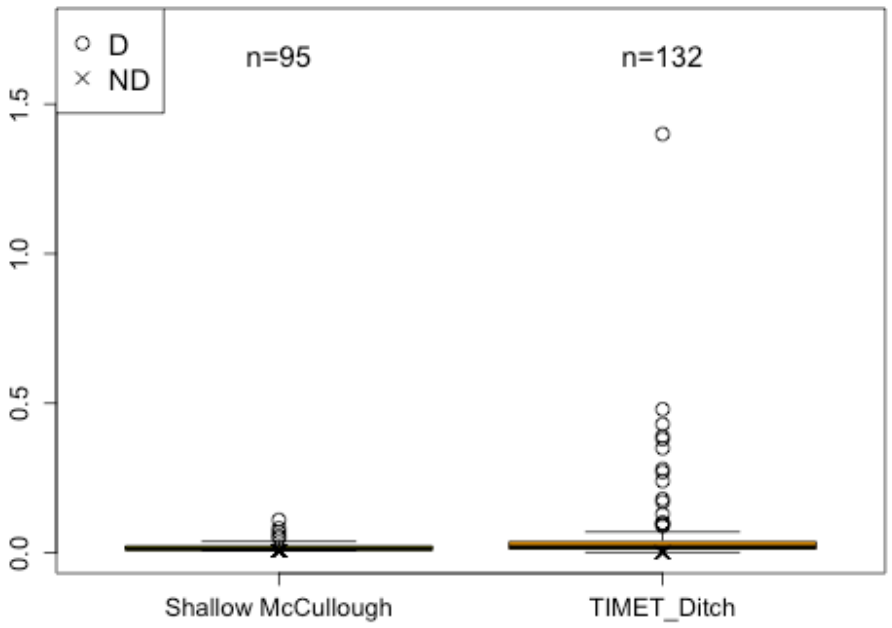

Magnesium (log-scale)
D
ND
n=95
n=132
13
12
11
10
9
Shallow McCullough
TIMET_Ditch

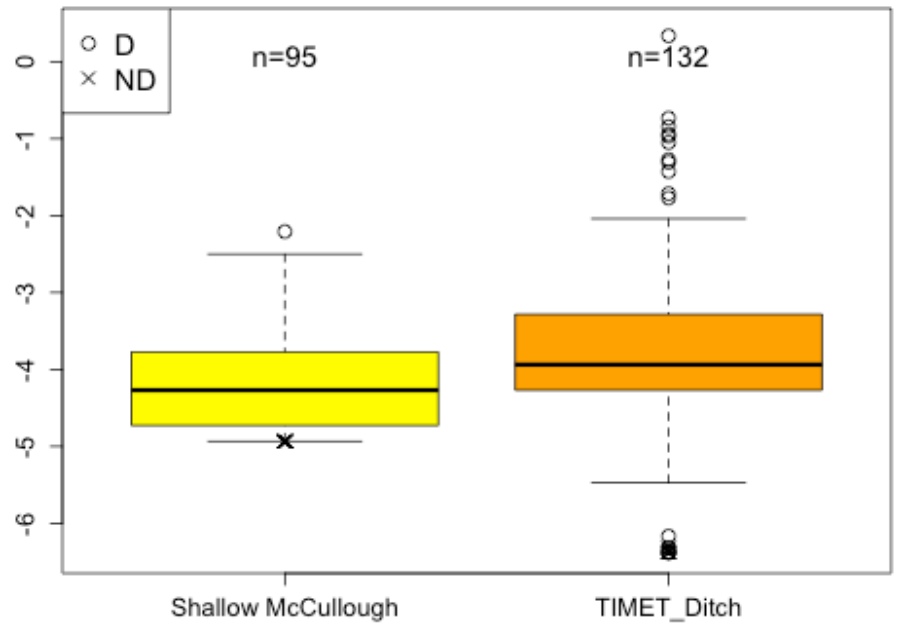

Magnesium Q-Q Plot
Background
Site
Concentration (mg/kg)
60000
50000
40000
30000
20000
10000
-2
-1
0
1
2
Theoretical Quantiles

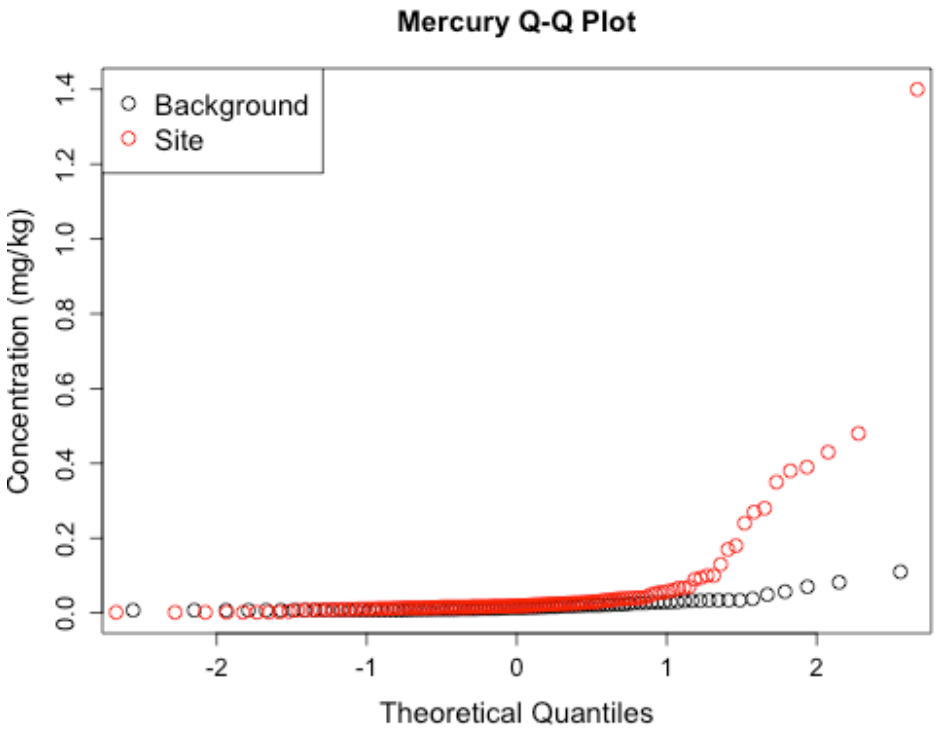

Manganese
D
ND
n=95
n=132
35000
25000
15000
5000
0
Shallow McCullough
TIMET_Ditch

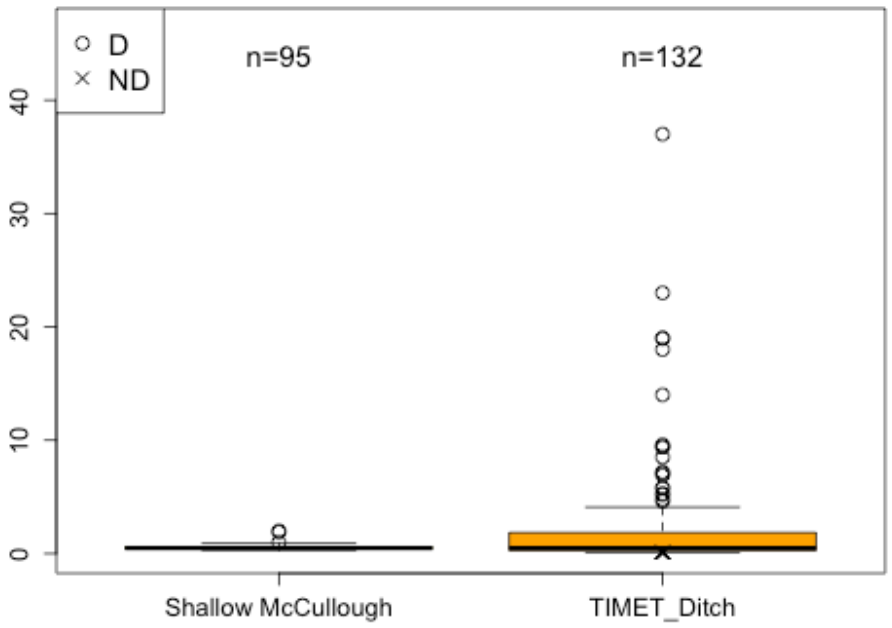

Manganese (log-scale)
D
ND
n=95
n=132
12
10
8
6
Shallow McCullough
TIMET_Ditch

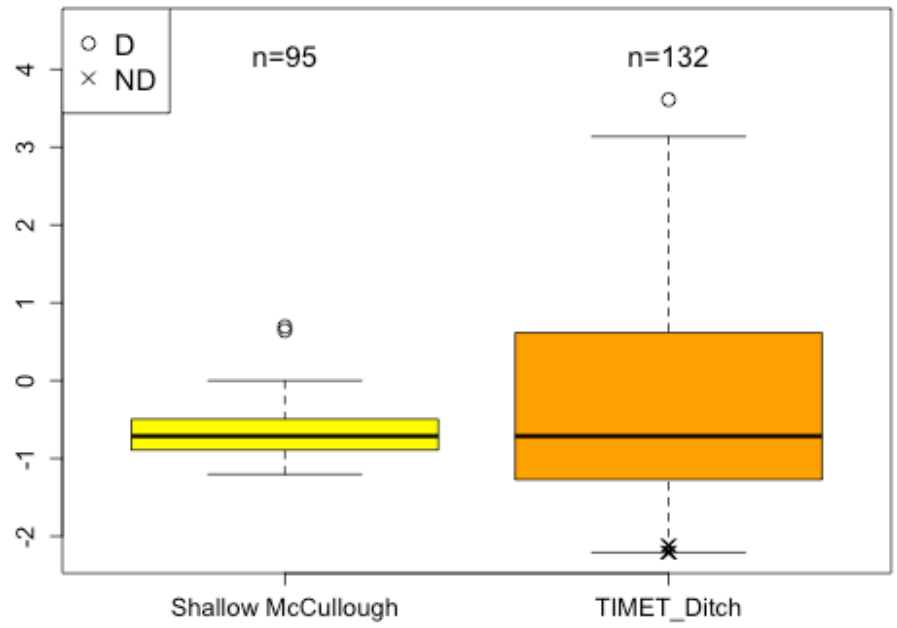

Manganese Q-Q Plot
Background
Site
Concentration (mg/kg)
25000
20000
15000
10000
5000
0
-2
-1
0
1
2
Theoretical Quantiles

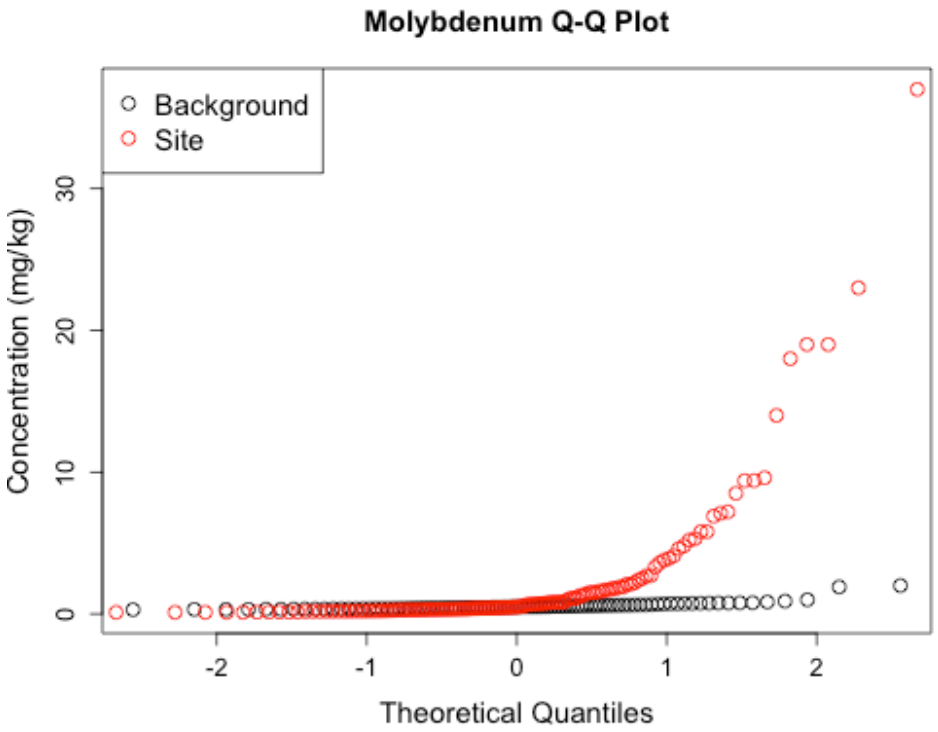

Mercury
D
ND
n=95
n=132
0.0
0.5
1.0
1.5
Shallow McCullough
TIMET_Ditch

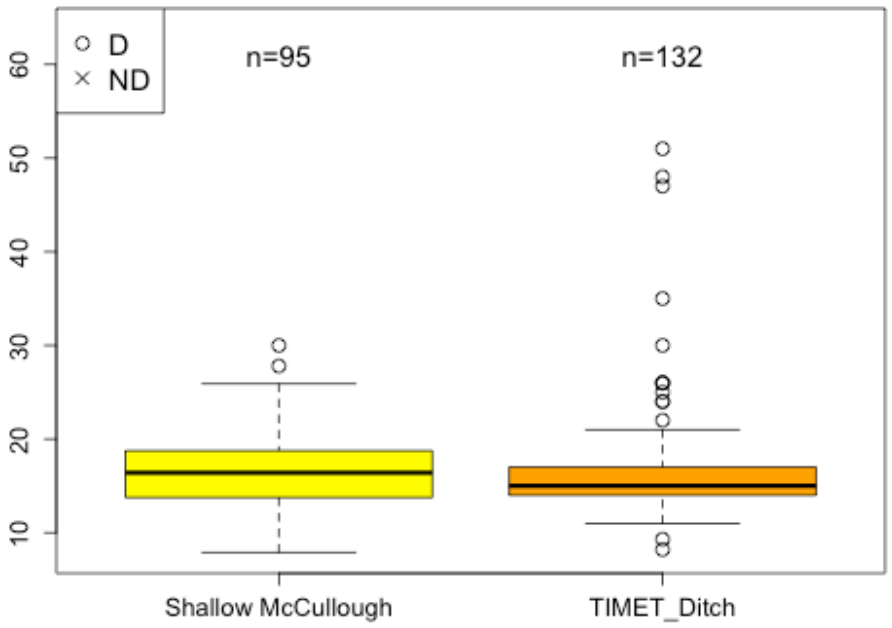

Mercury (log-scale)
D
ND
n=95
n=132
0
-1
-2
-3
-4
-5
-6
Shallow McCullough
TIMET_Ditch

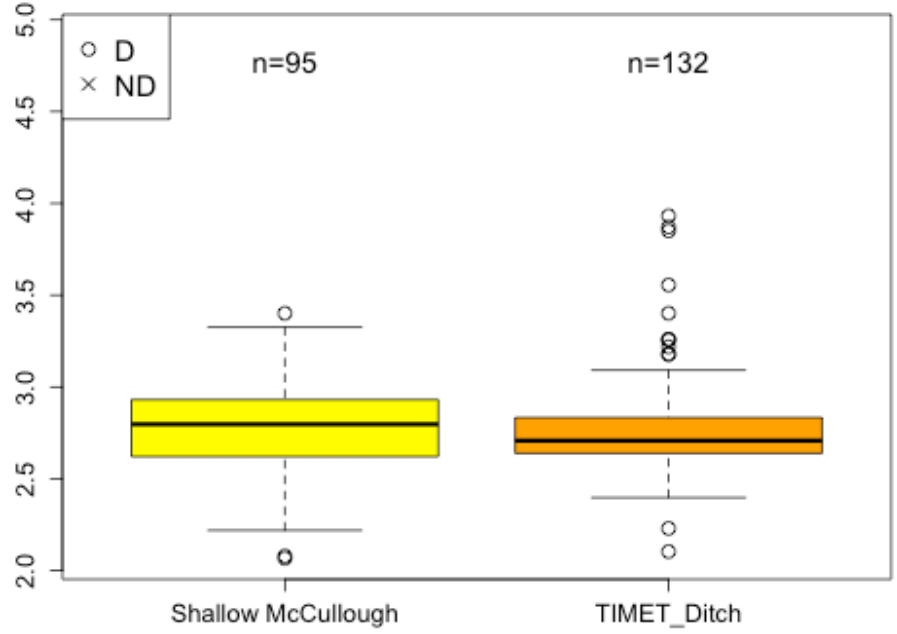

Mercury Q-Q Plot
Background
Site
Concentration (mg/kg)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
-2
-1
0
1
2
Theoretical Quantiles

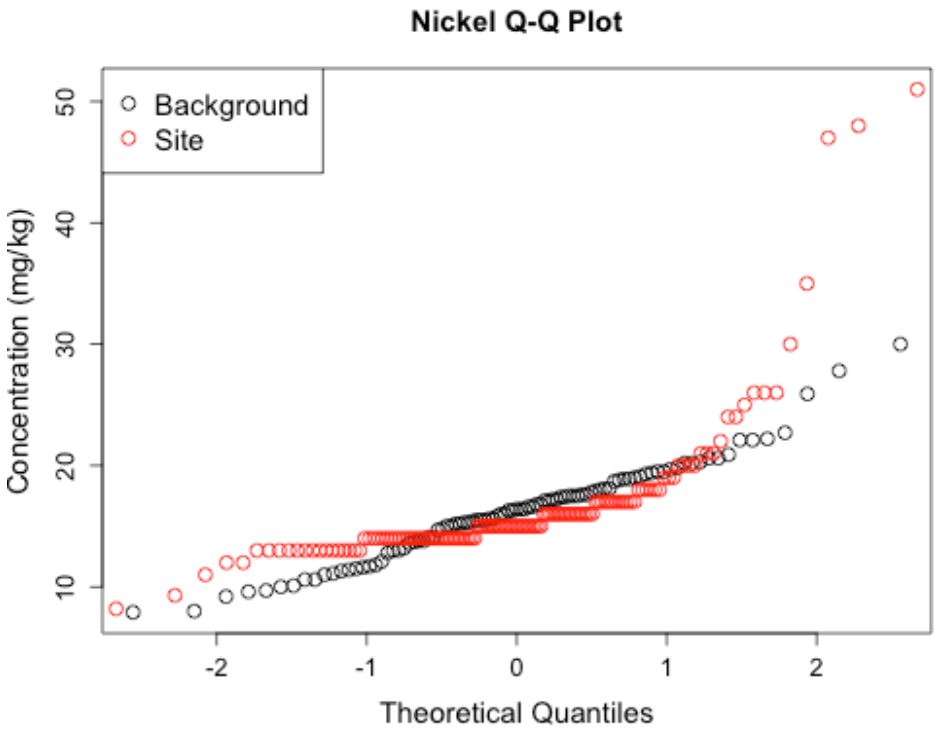

Molybdenum
D
ND
n=95
n=132
0
10
20
30
40
Shallow McCullough
TIMET_Ditch

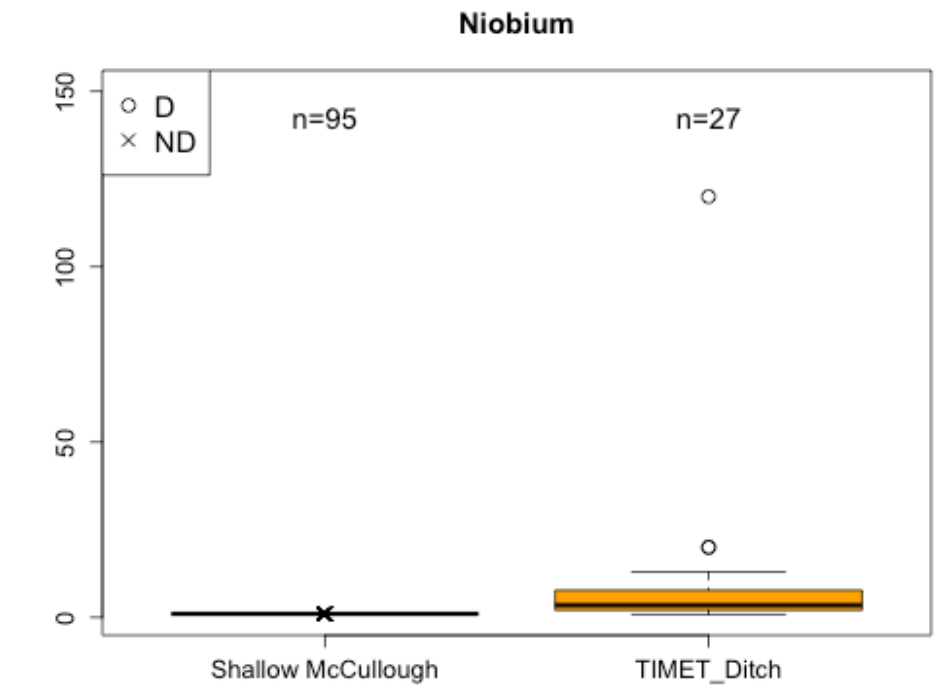

Molybdenum (log-scale)
D
ND
n=95
n=132
-2
-1
0
1
2
3
4
Shallow McCullough
TIMET_Ditch

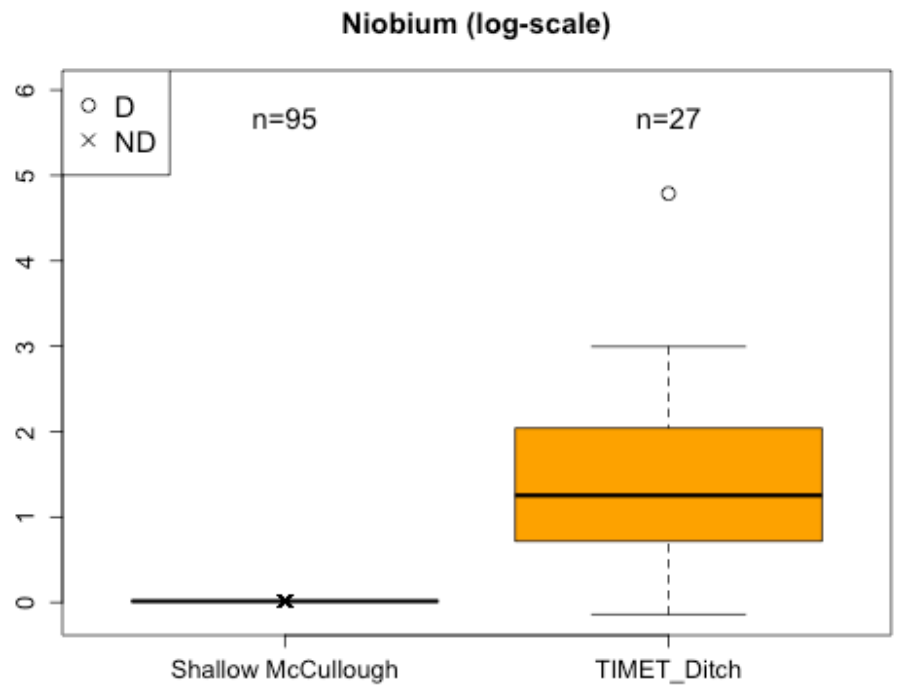

Molybdenum Q-Q Plot
Background
Site
Concentration (mg/kg)
0
10
20
30
-2
-1
0
1
2
Theoretical Quantiles

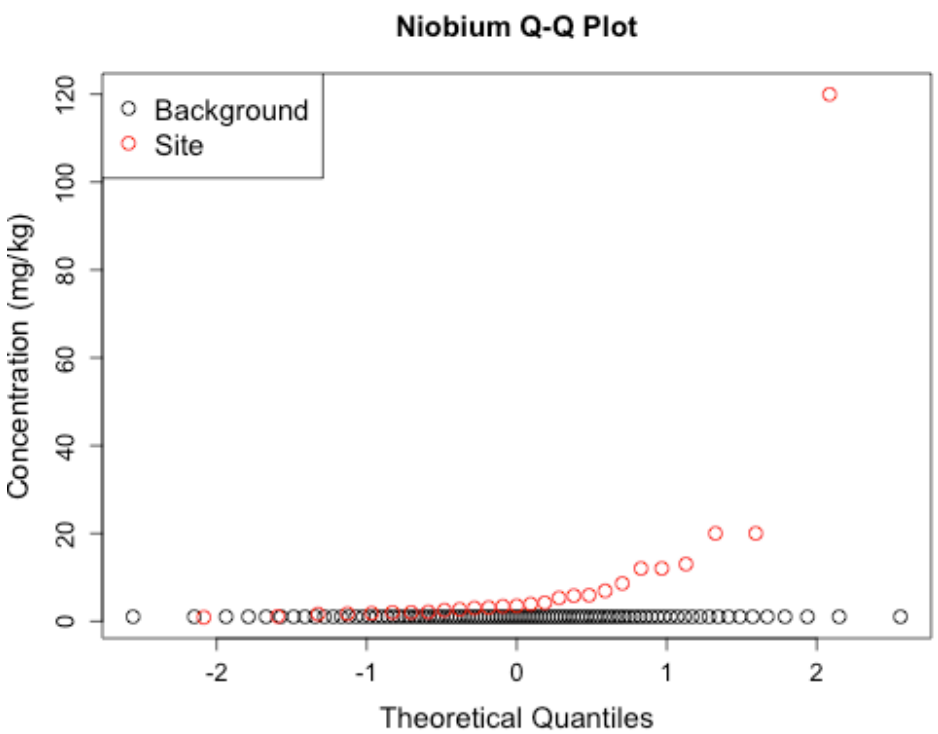

Nickel
D
ND
n=95
n=132
10
20
30
40
50
60
Shallow McCullough
TIMET_Ditch

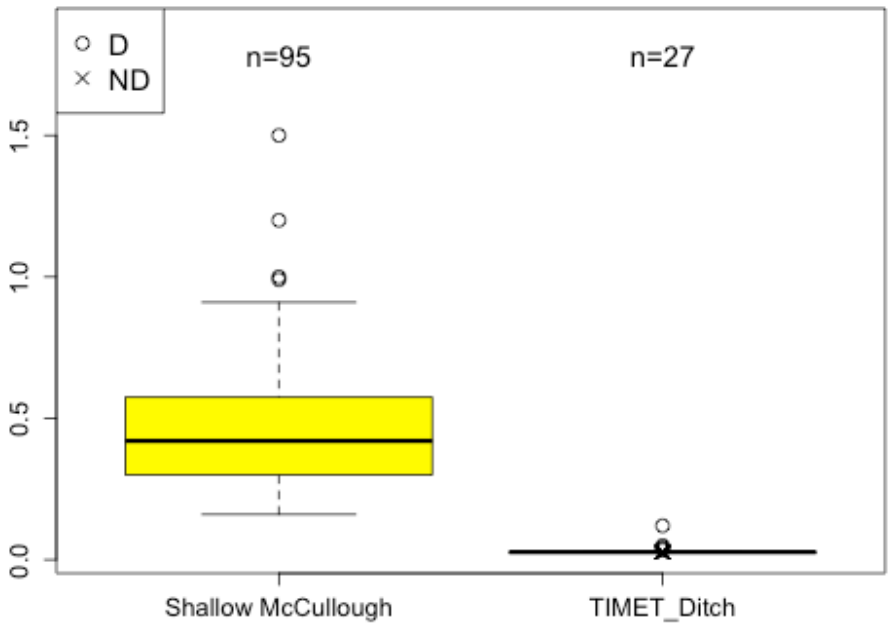

Nickel (log-scale)
D
ND
n=95
n=132
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Shallow McCullough
TIMET_Ditch

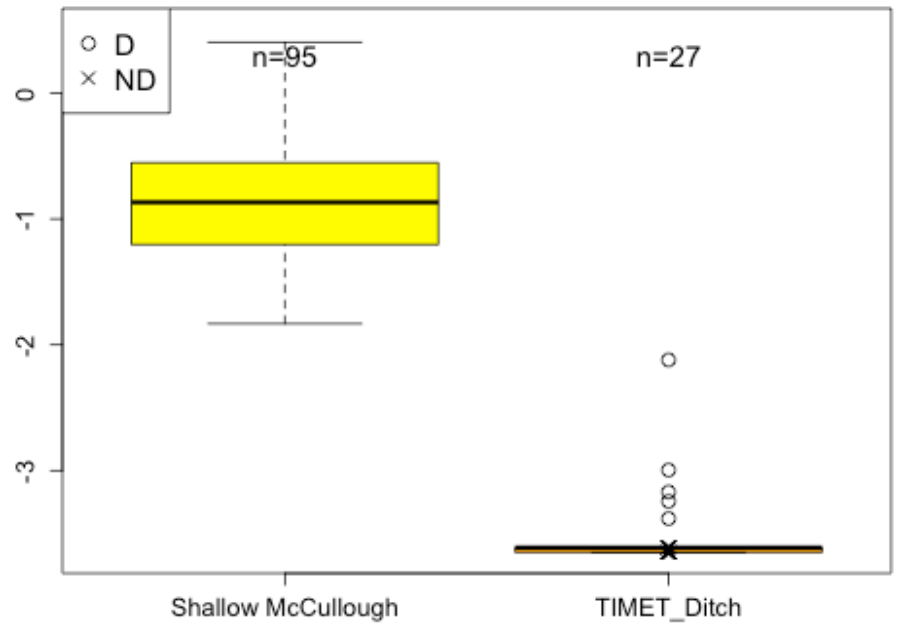

Nickel Q-Q Plot
Background
Site
Concentration (mg/kg)
10
20
30
40
50
-2
-1
0
1
2
Theoretical Quantiles

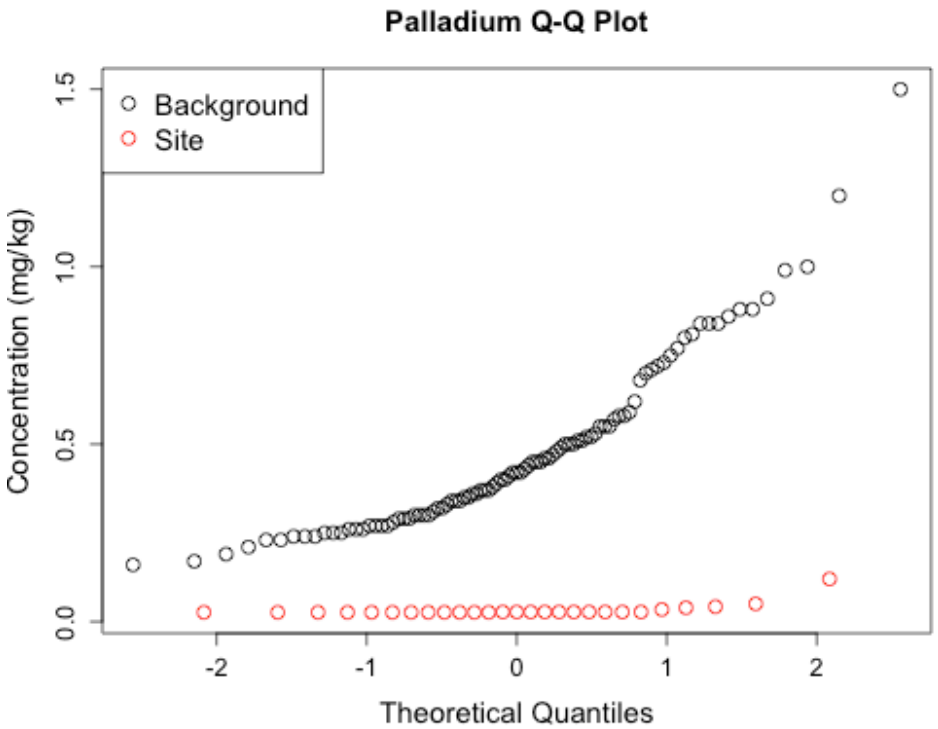

Niobium
D
ND
n=95
n=27
150
100
50
0
Shallow McCullough
TIMET_Ditch

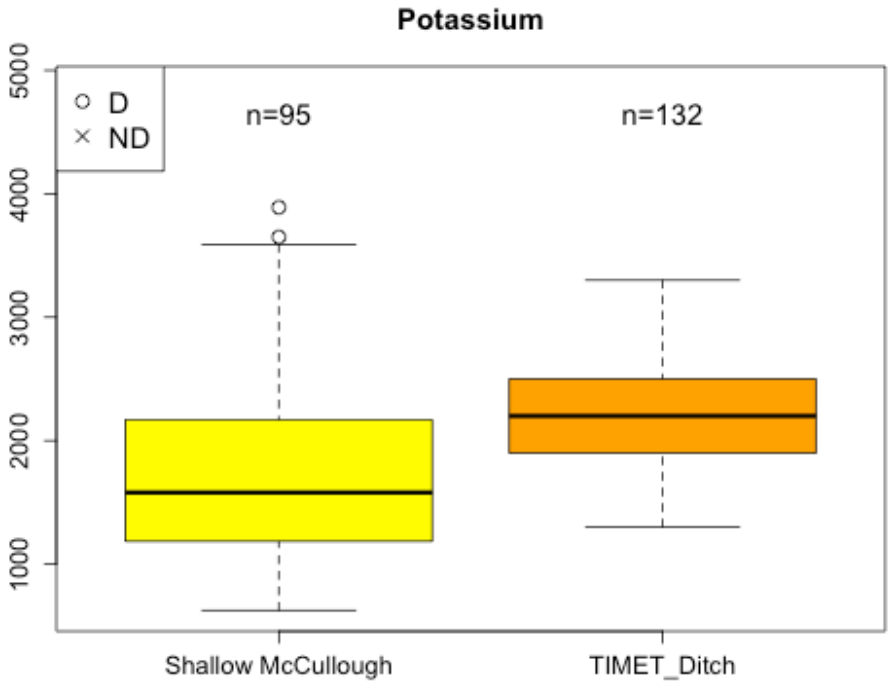

Niobium (log-scale)
D
ND
n=95
n=27
6
5
4
3
2
1
0
Shallow McCullough
TIMET_Ditch

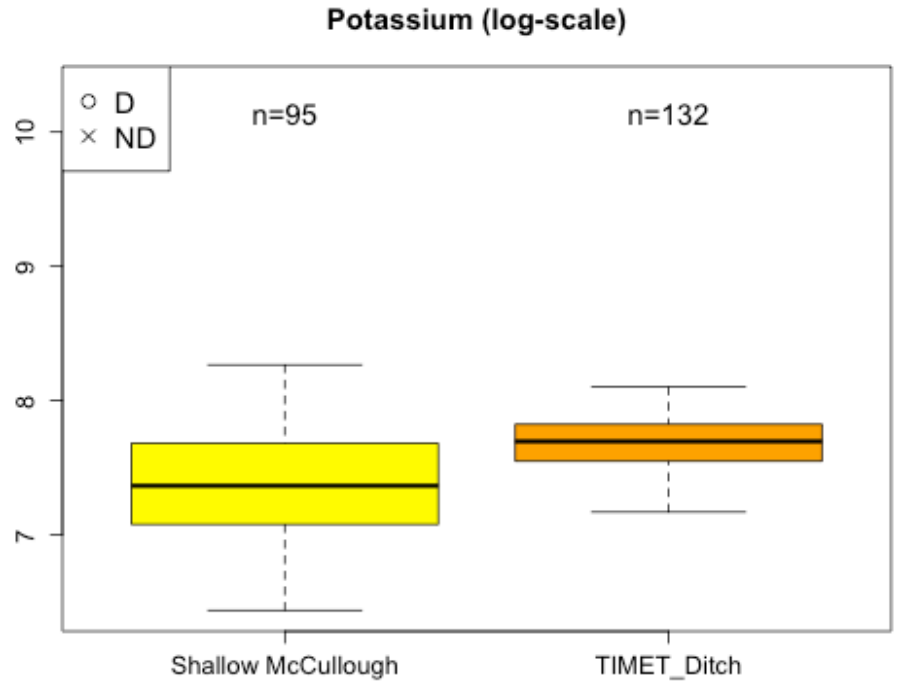

Niobium Q-Q Plot
Background
Site
Concentration (mg/kg)
120
100
80
60
40
20
0
-2
-1
0
1
2
Theoretical Quantiles

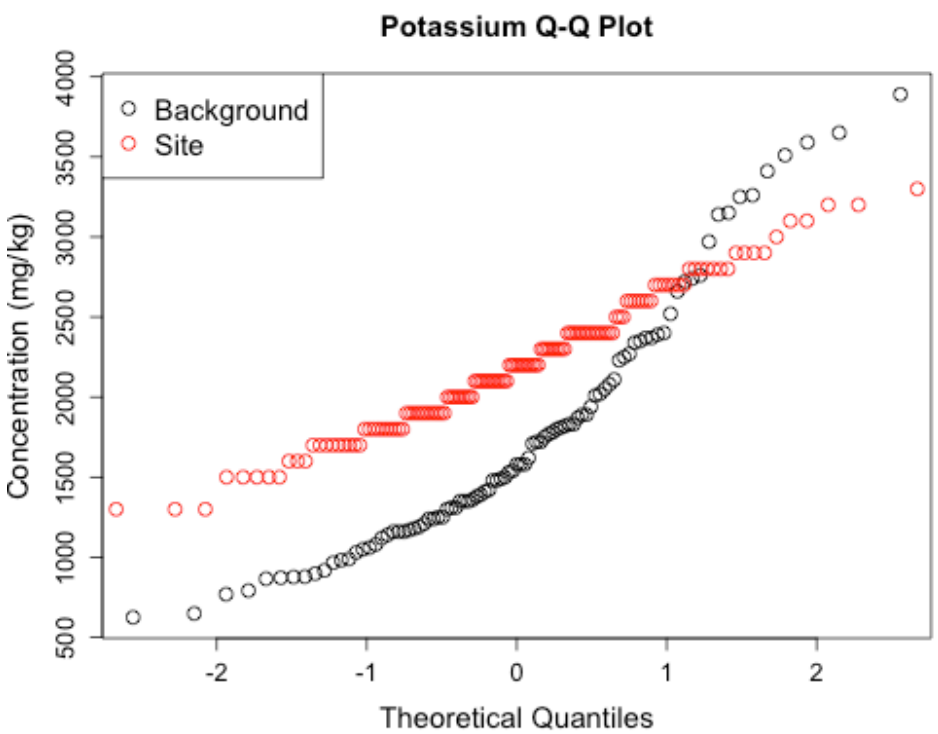

Palladium
D
ND
n=95
n=27
1.5
1.0
0.5
0.0
Shallow McCullough
TIMET_Ditch

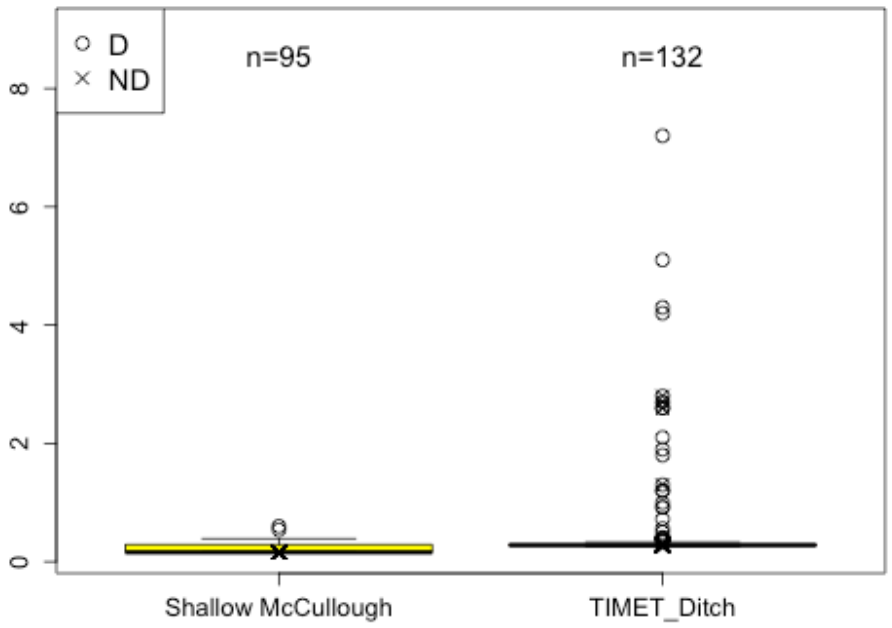

Palladium (log-scale)
D
ND
n=95
n=27
0
-1
-2
-3
Shallow McCullough
TIMET_Ditch

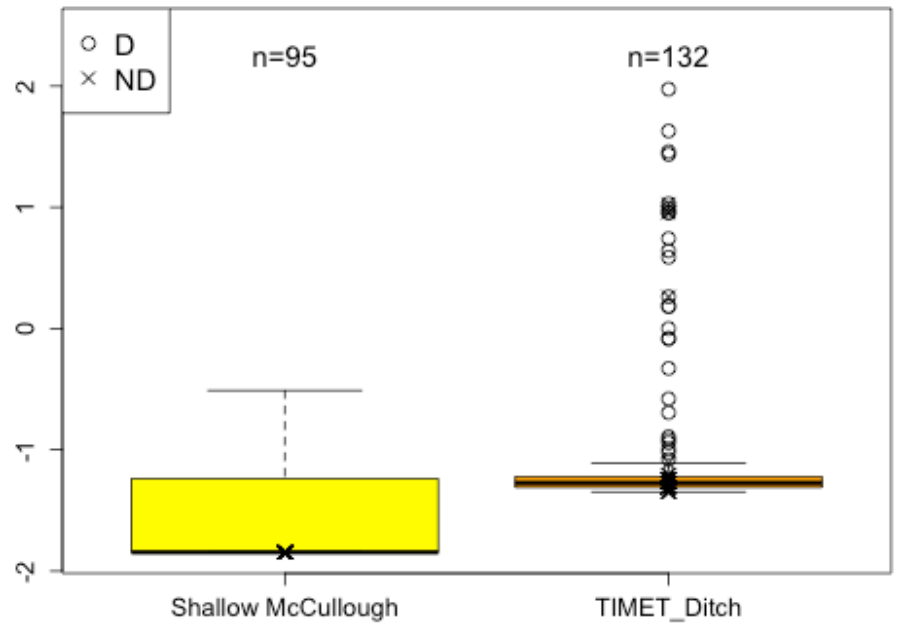

Palladium Q-Q Plot
Background
Site
Concentration (mg/kg)
1.5
1.0
0.5
0.0
-2
-1
0
1
2
Theoretical Quantiles

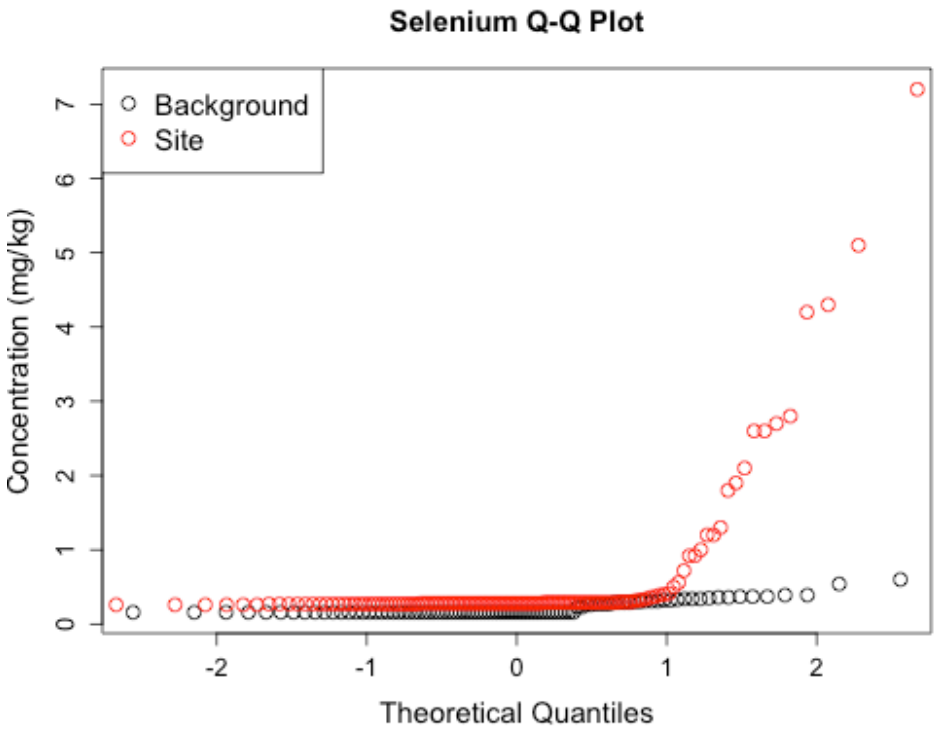

Potassium
D
ND
n=95
n=132
5000
4000
3000
2000
1000
Shallow McCullough
TIMET_Ditch

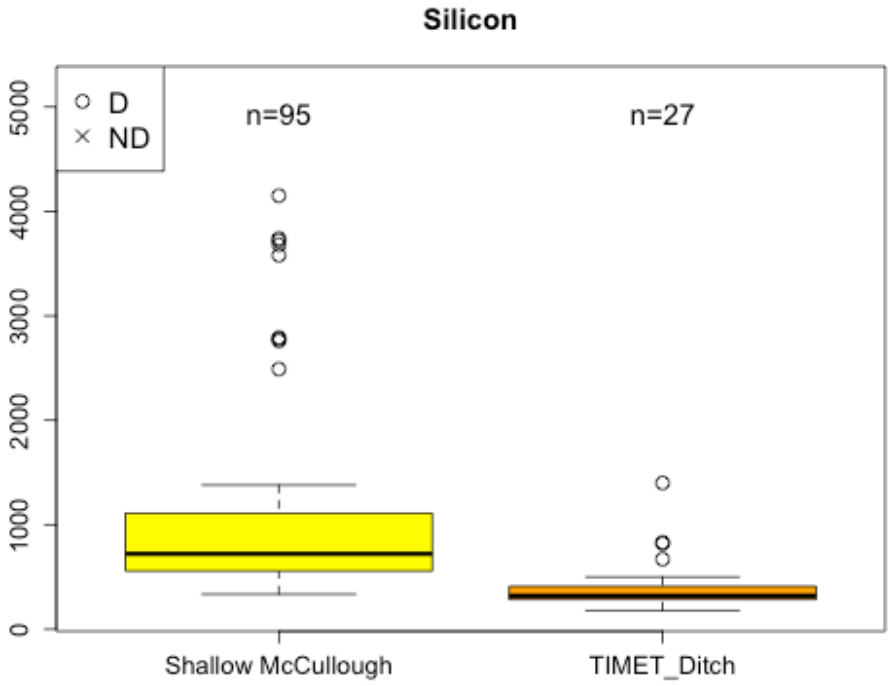

Potassium (log-scale)
D
ND
n=95
n=132
10
9
8
7
Shallow McCullough
TIMET_Ditch

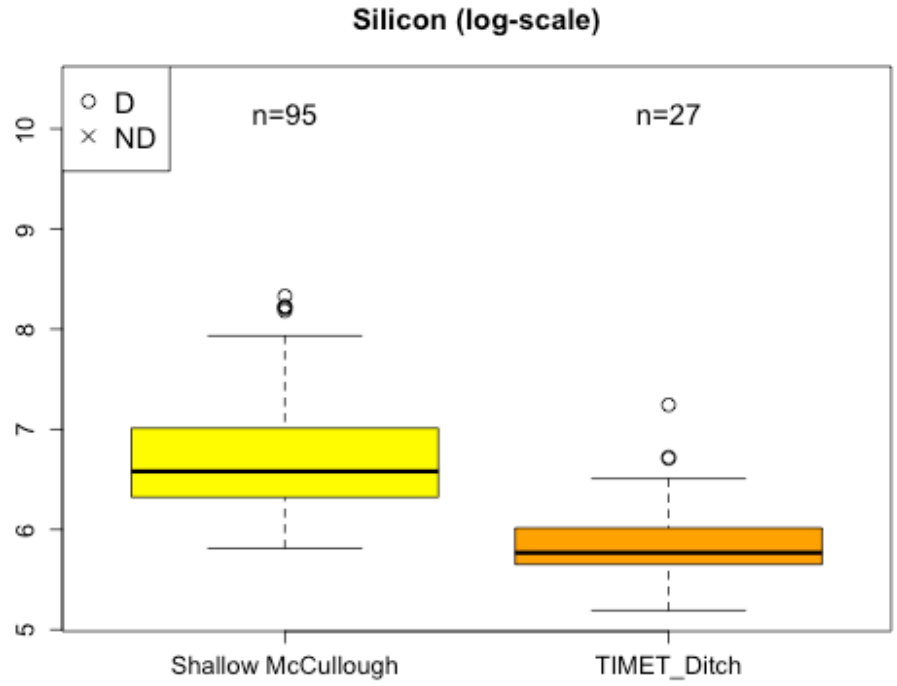

Potassium Q-Q Plot
Background
Site
Concentration (mg/kg)
4000
3500
3000
2500
2000
1500
1000
500
-2
-1
0
1
2
Theoretical Quantiles

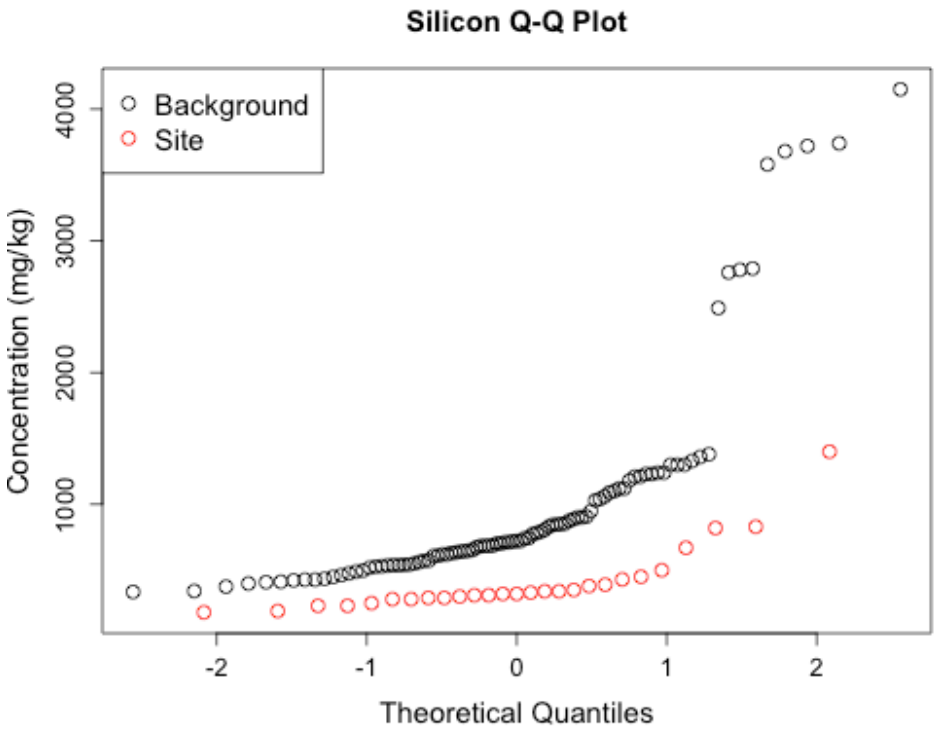

Selenium
D
ND
n=95
n=132
0
2
4
6
8
Shallow McCullough
TIMET_Ditch

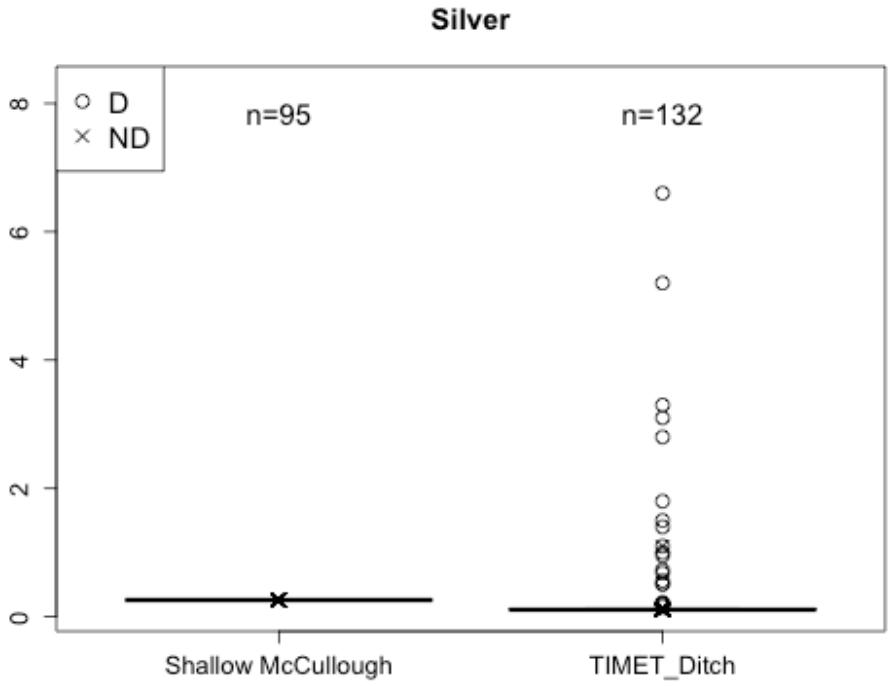

Selenium (log-scale)
D
ND
n=95
n=132
-2
-1
0
1
2
Shallow McCullough
TIMET_Ditch

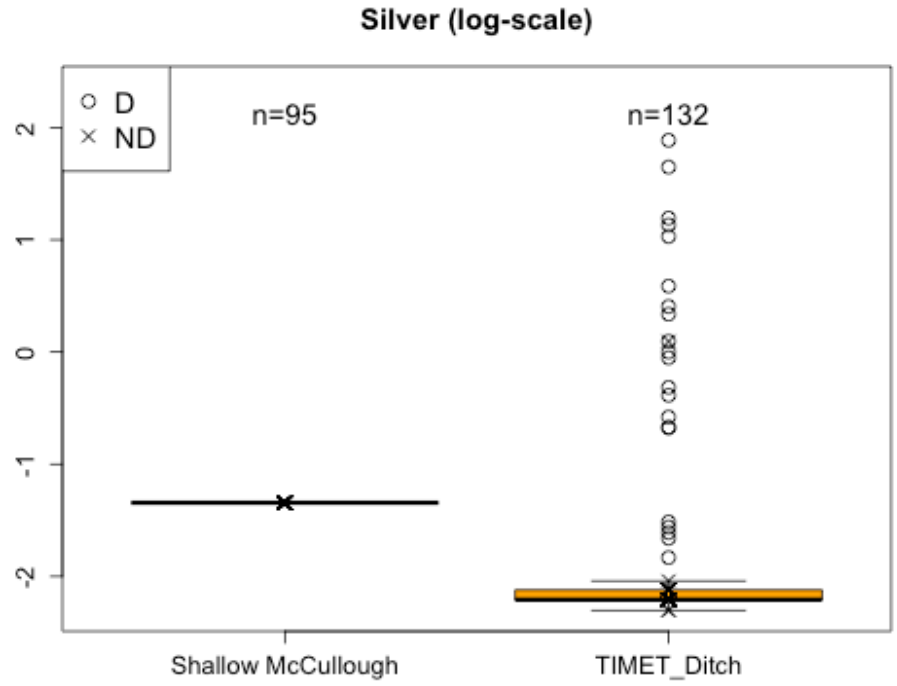

Selenium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
1
2
3
4
5
6
7
-2
-1
0
1
2
Theoretical Quantiles

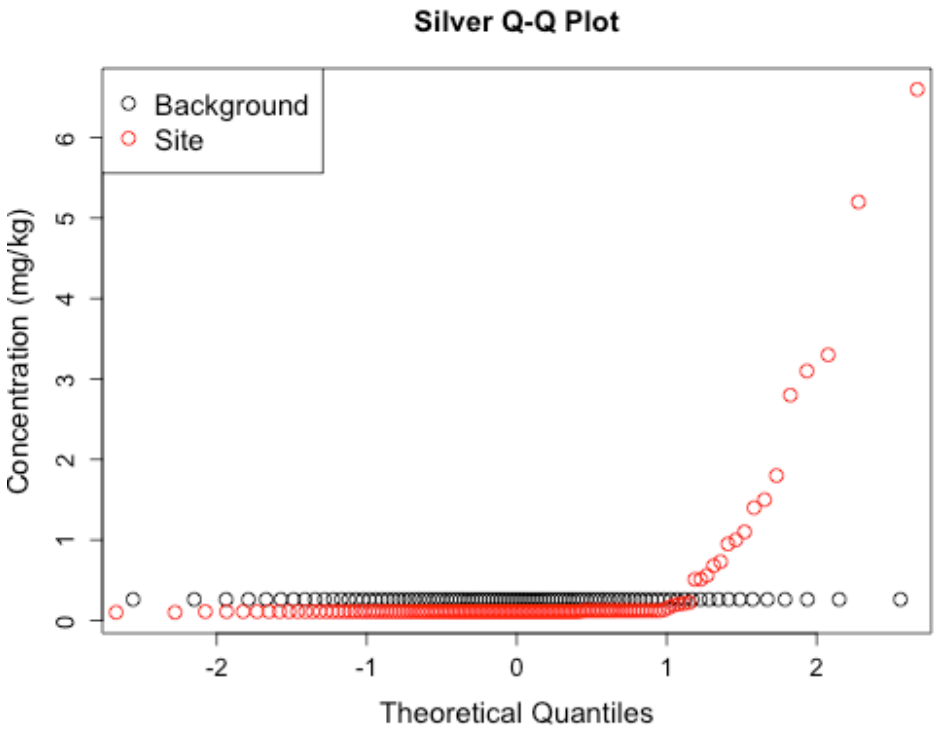

Silicon
D
ND
n=95
n=27
0
1000
2000
3000
4000
5000
Shallow McCullough
TIMET_Ditch

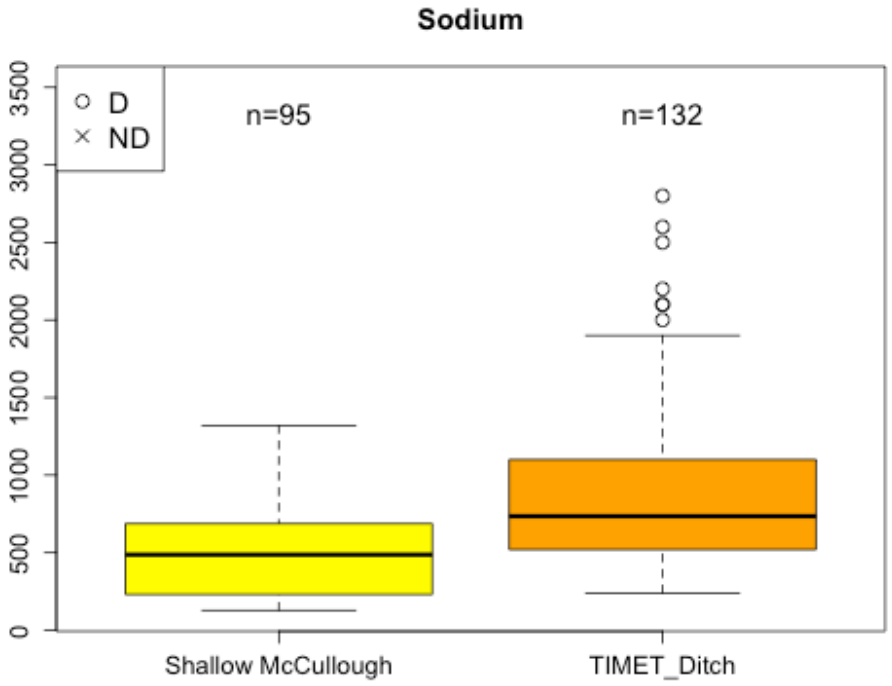

Silicon (log-scale)
D
ND
n=95
n=27
5
6
7
8
9
10
Shallow McCullough
TIMET_Ditch

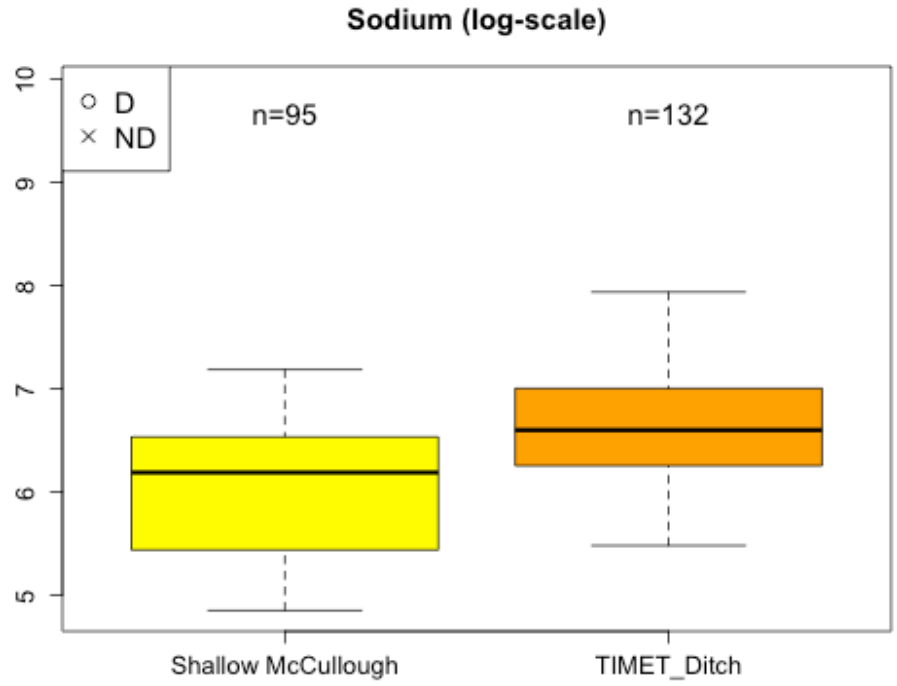

Silicon Q-Q Plot
Background
Site
Concentration (mg/kg)
1000
2000
3000
4000
-2
-1
0
1
2
Theoretical Quantiles

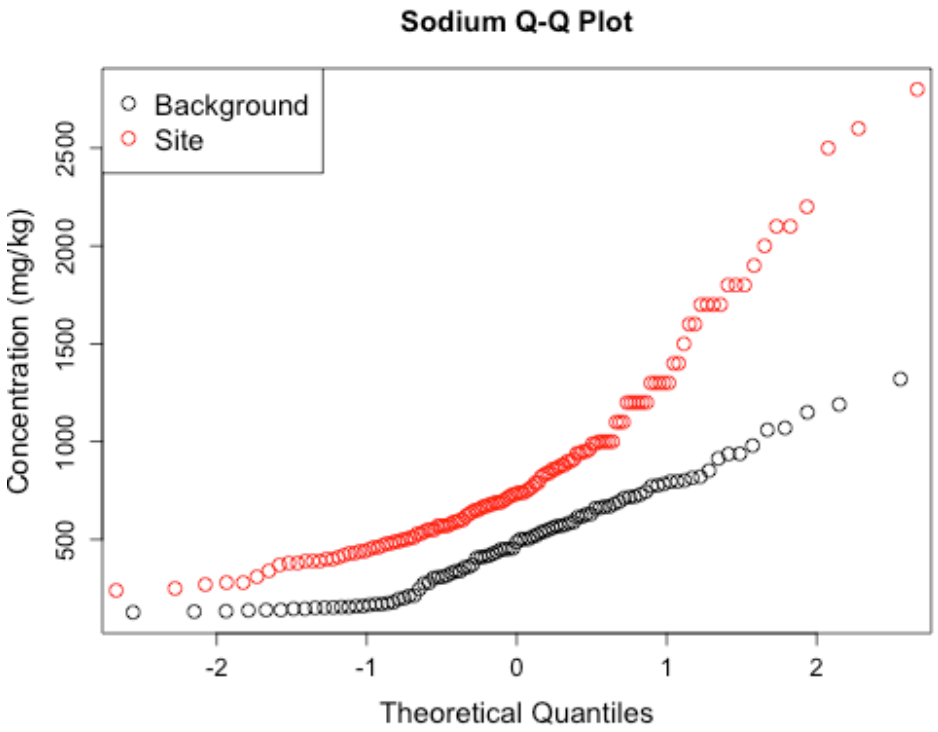

Silver
D
ND
n=95
n=132
0
2
4
6
8
Shallow McCullough
TIMET_Ditch

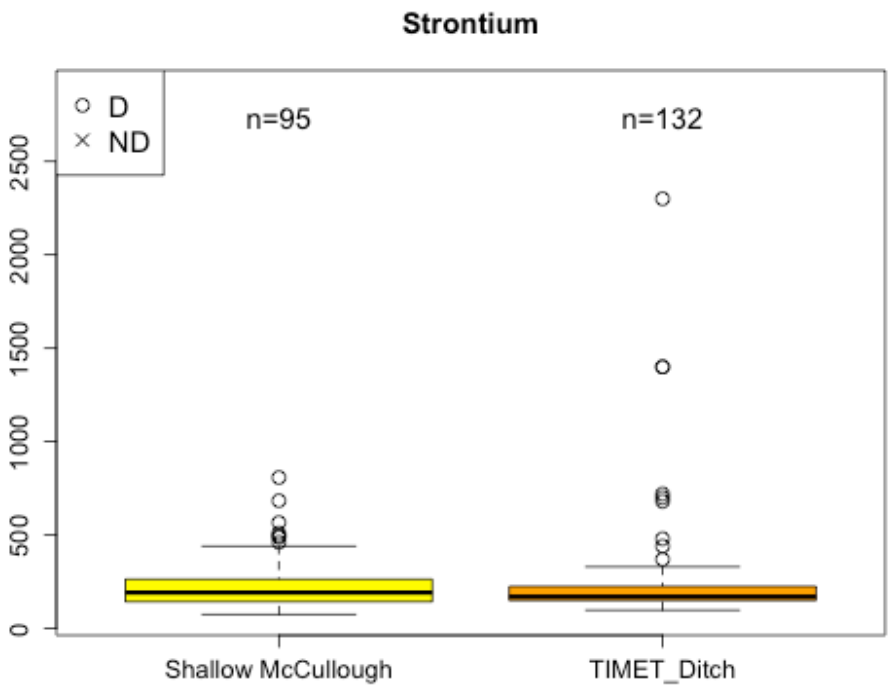

Silver (log-scale)
D
ND
n=95
n=132
-2
-1
0
1
2
Shallow McCullough
TIMET_Ditch

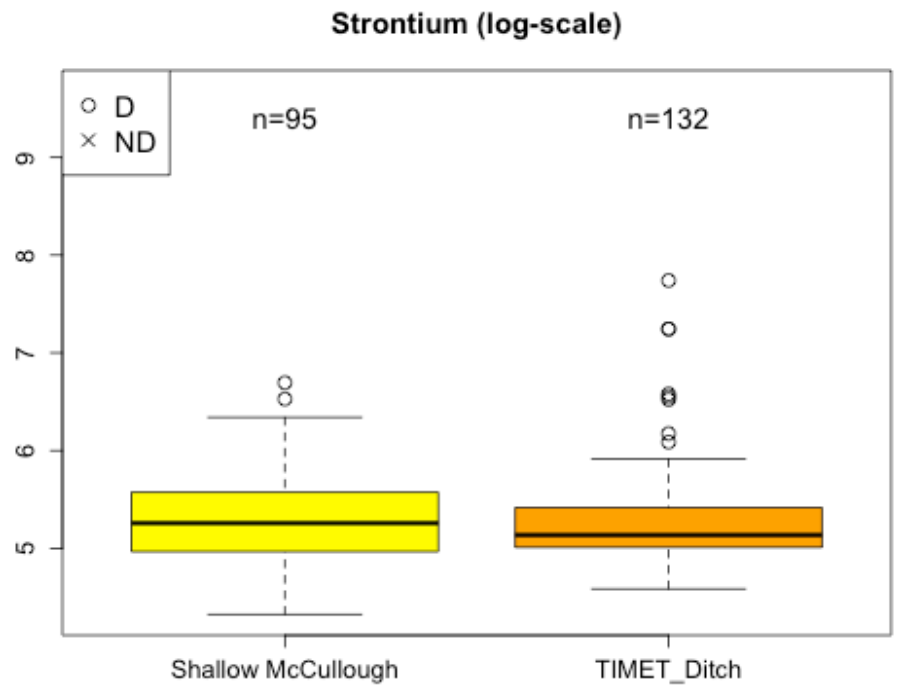

Silver Q-Q Plot
Background
Site
Concentration (mg/kg)
0
1
2
3
4
5
6
-2
-1
0
1
2
Theoretical Quantiles

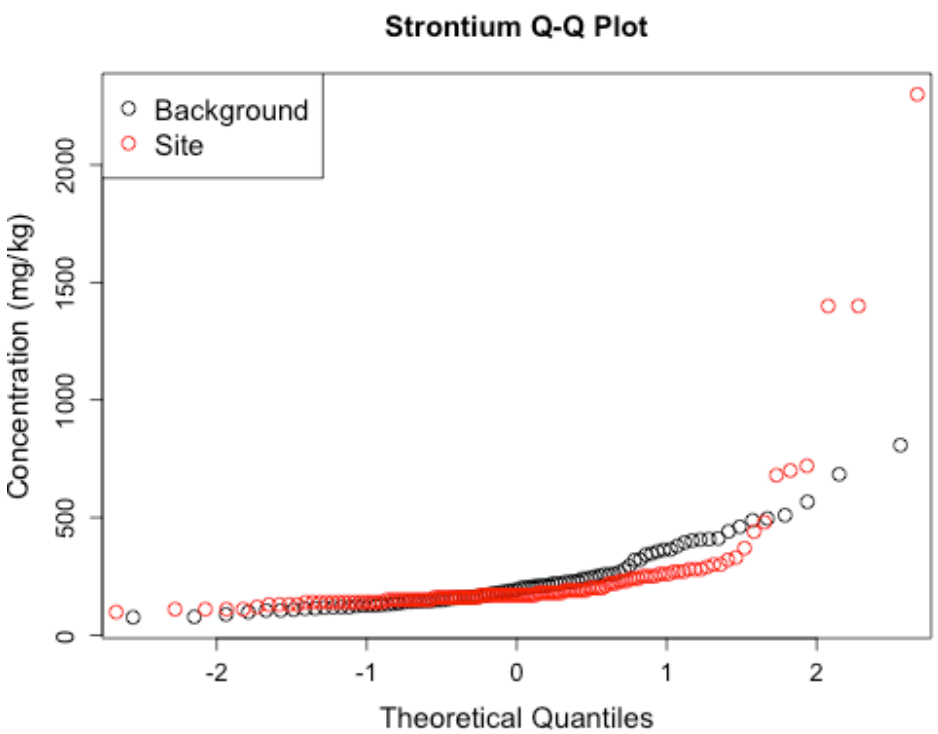

Sodium
D
ND
n=95
n=132
0
500
1000
1500
2000
2500
3000
3500
Shallow McCullough
TIMET_Ditch

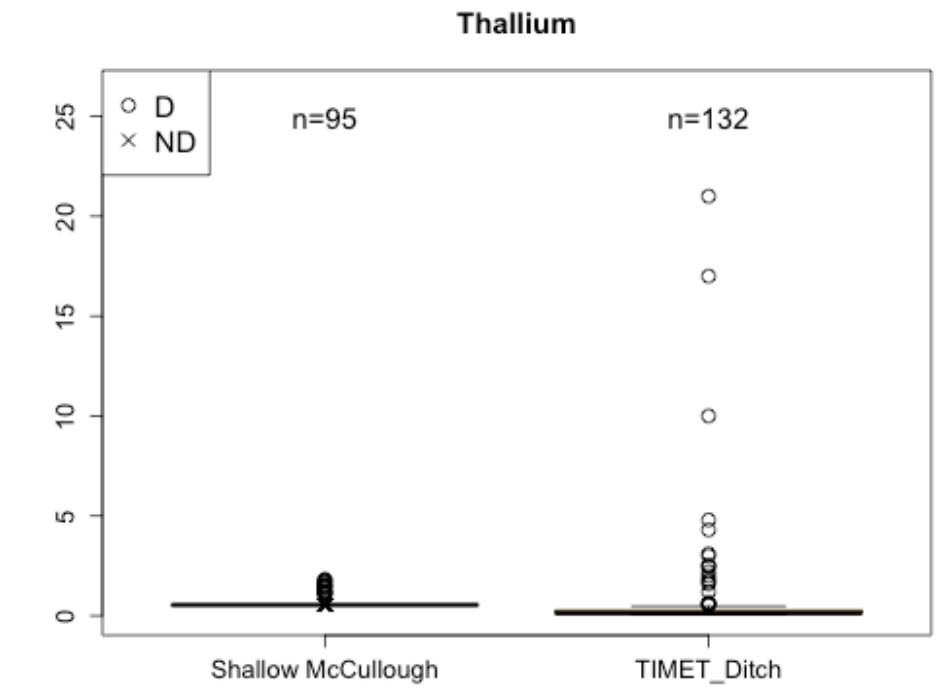

Sodium (log-scale)
D
ND
n=95
n=132
5
6
7
8
9
10
Shallow McCullough
TIMET_Ditch

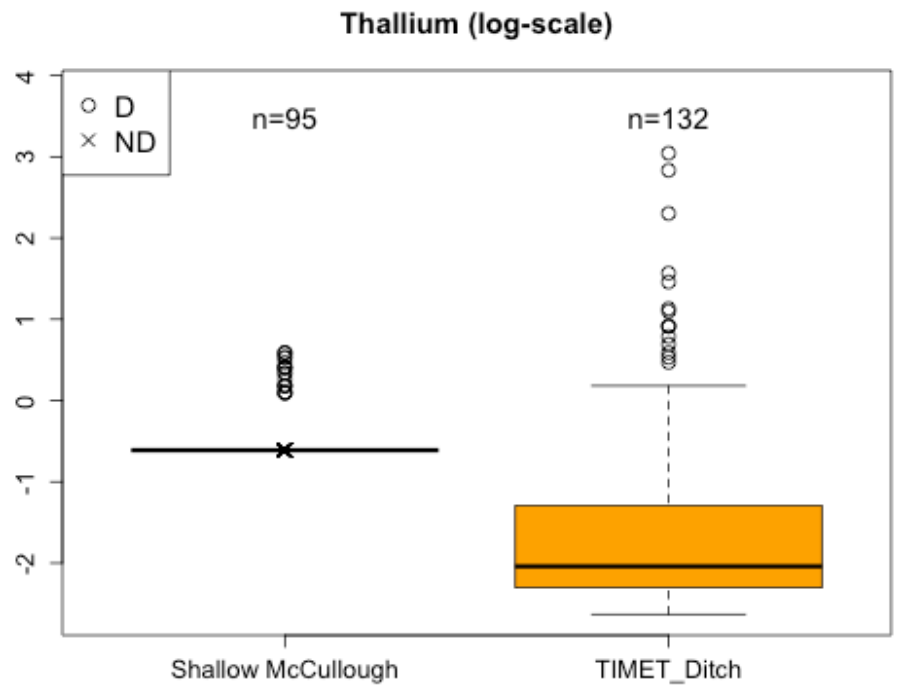

Sodium Q-Q Plot
Background
Site
Concentration (mg/kg)
500
1000
1500
2000
2500
-2
-1
0
1
2
Theoretical Quantiles

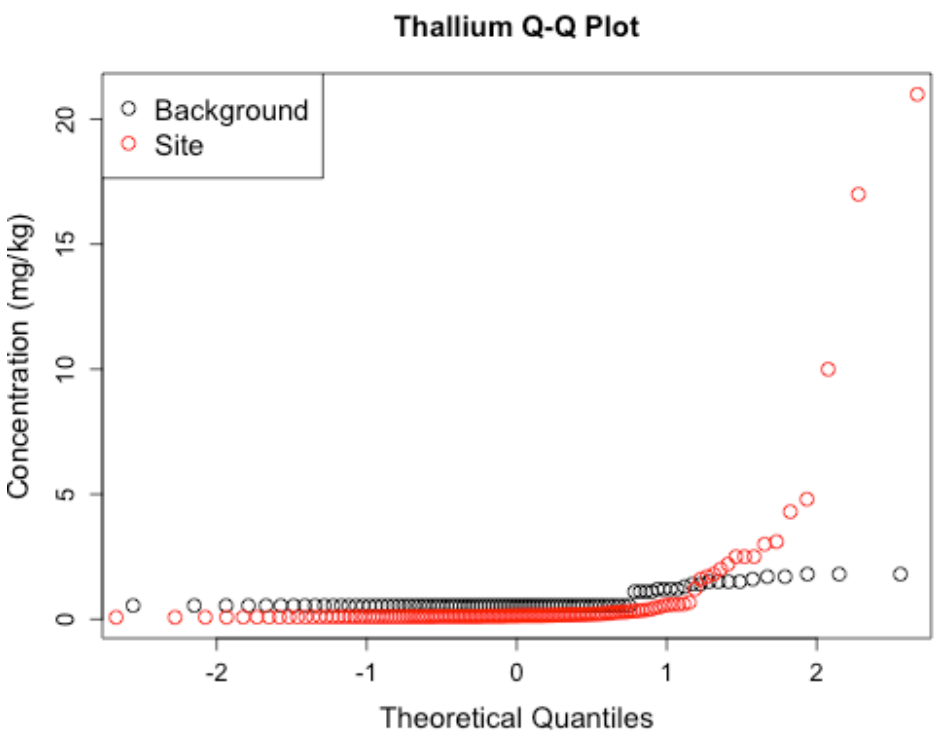

Strontium
D
ND
n=95
n=132
0
500
1000
1500
2000
2500
Shallow McCullough
TIMET_Ditch

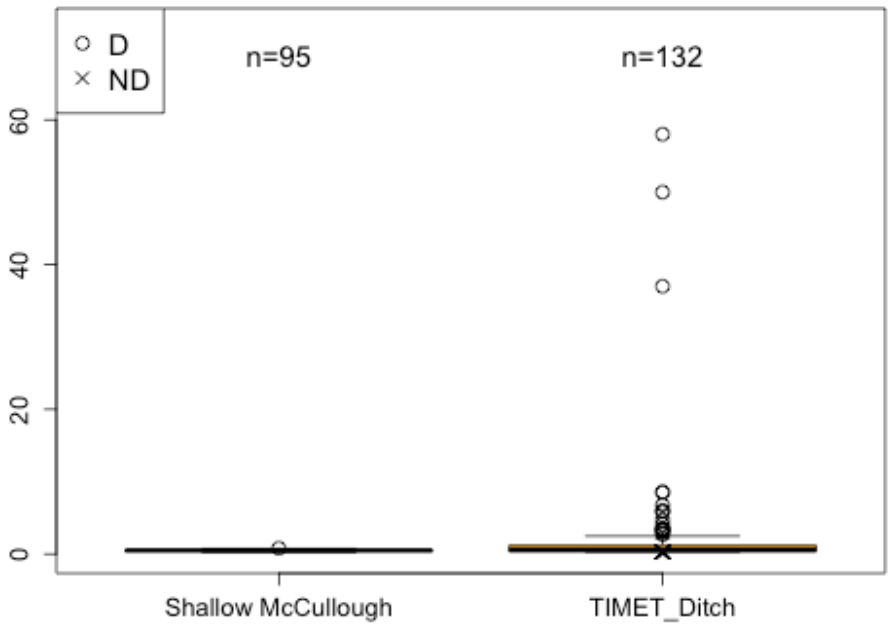

Strontium (log-scale)
D
ND
n=95
n=132
5
6
7
8
9
Shallow McCullough
TIMET_Ditch

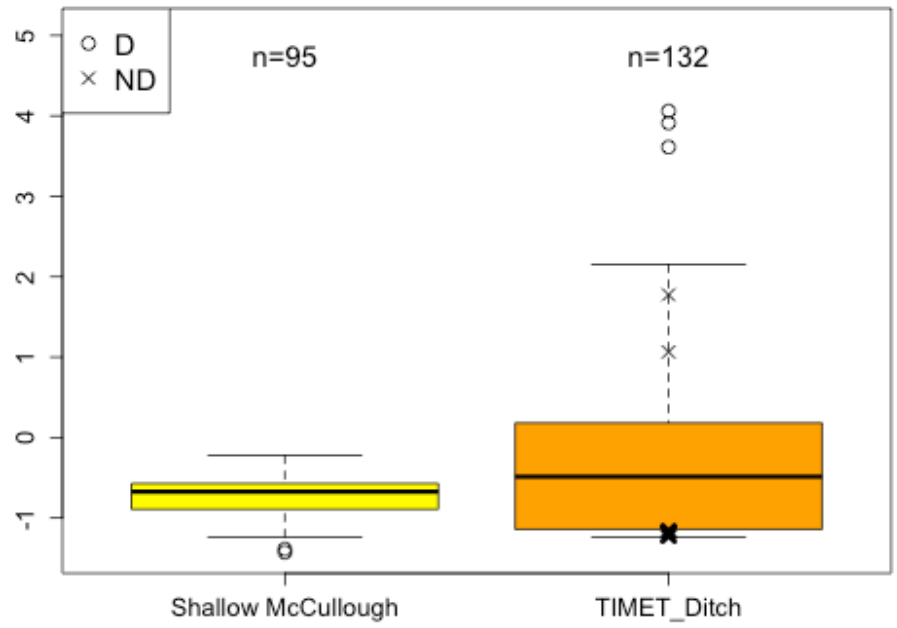

Strontium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
500
1000
1500
2000
-2
-1
0
1
2
Theoretical Quantiles

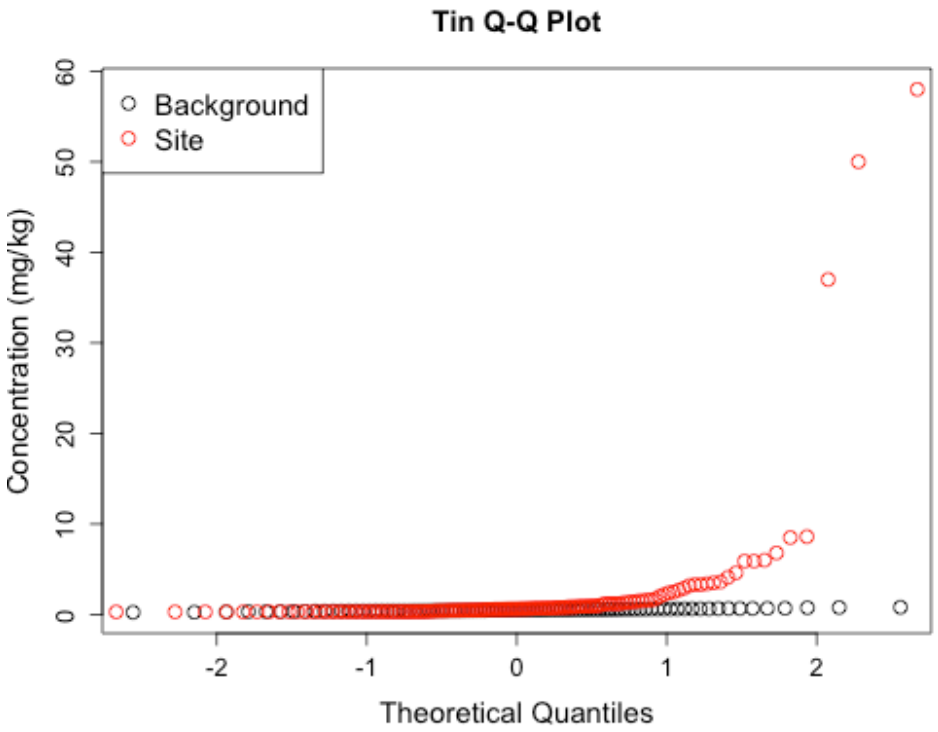

Thallium
D
ND
n=95
n=132
0
5
10
15
20
25
Shallow McCullough
TIMET_Ditch

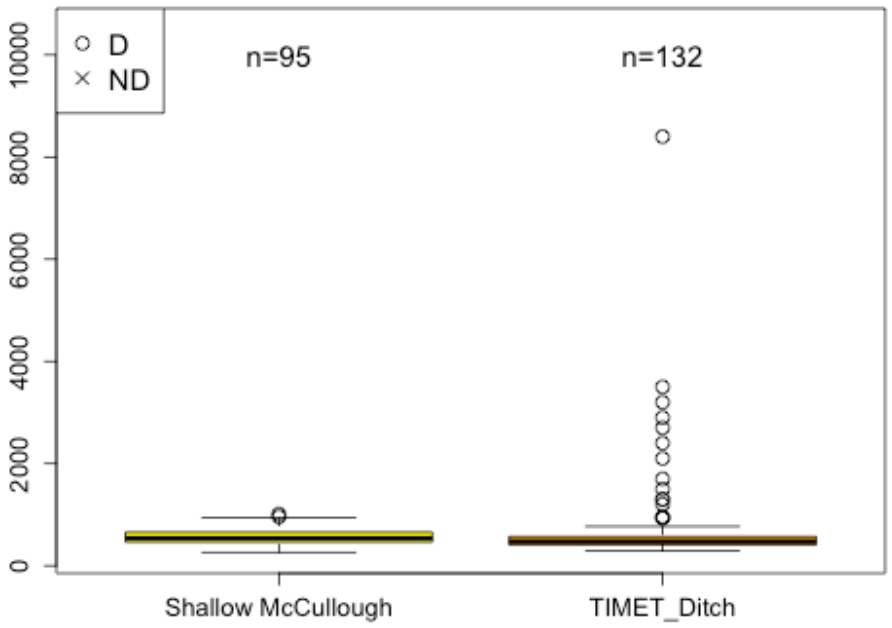

Thallium (log-scale)
D
ND
n=95
n=132
-2
-1
0
1
2
3
4
Shallow McCullough
TIMET_Ditch

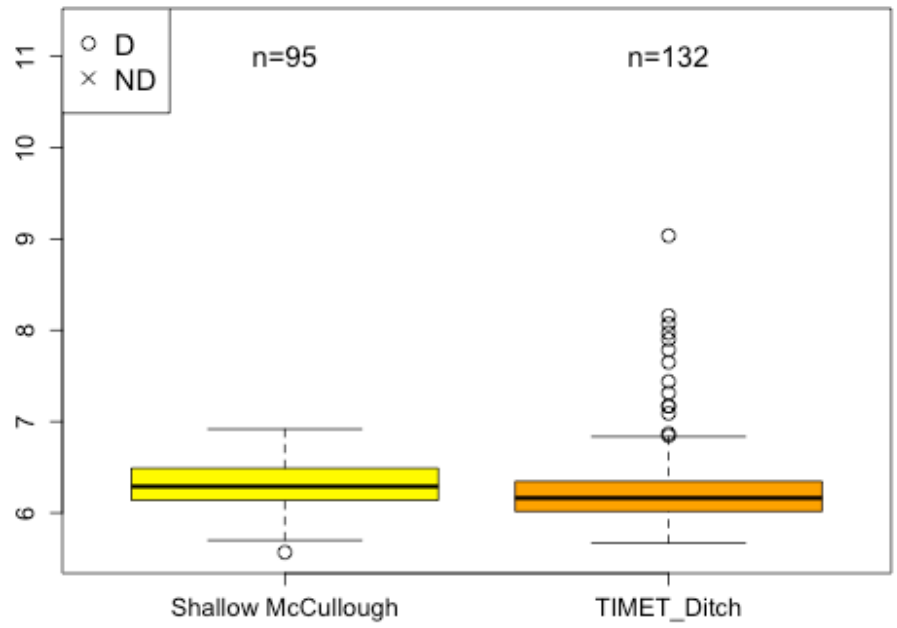

Thallium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
5
10
15
20
-2
-1
0
1
2
Theoretical Quantiles

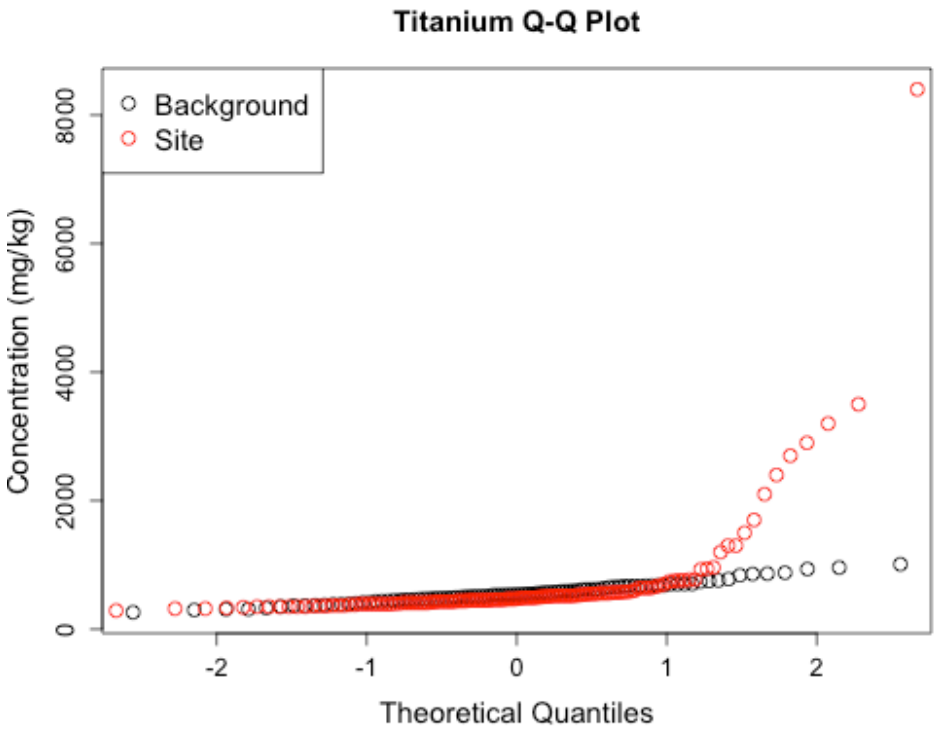

Tin
D
ND
n=95
n=132
0
20
40
60
Shallow McCullough
TIMET_Ditch

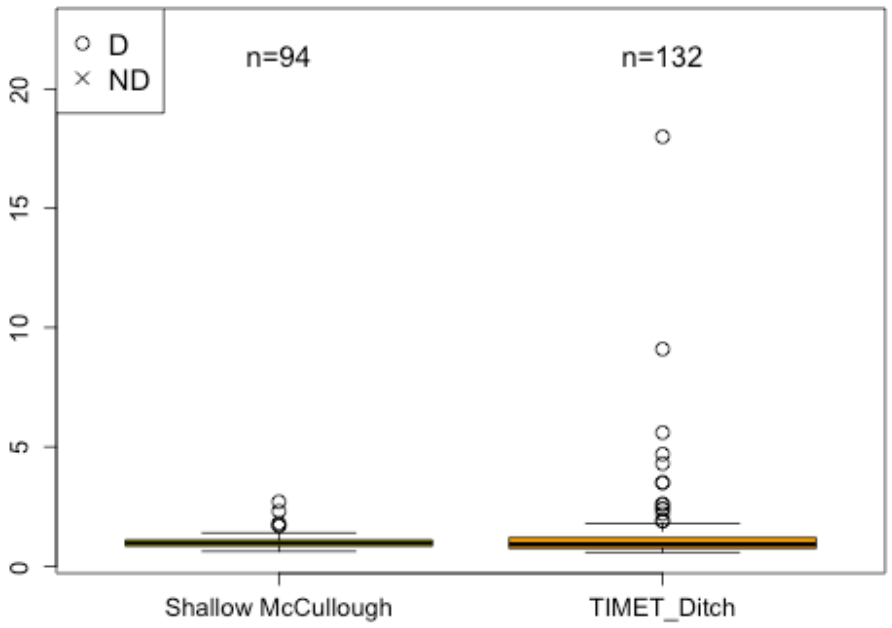

Tin (log-scale)
D
ND
n=95
n=132
-1
0
1
2
3
4
5
Shallow McCullough
TIMET_Ditch

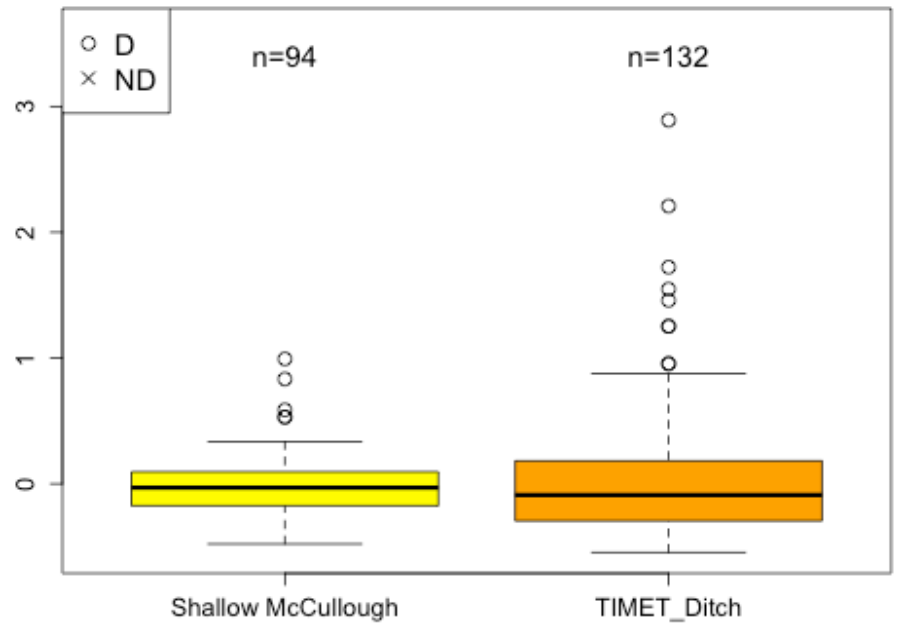

Tin Q-Q Plot
Background
Site
Concentration (mg/kg)
0
10
20
30
40
50
60
-2
-1
0
1
2
Theoretical Quantiles

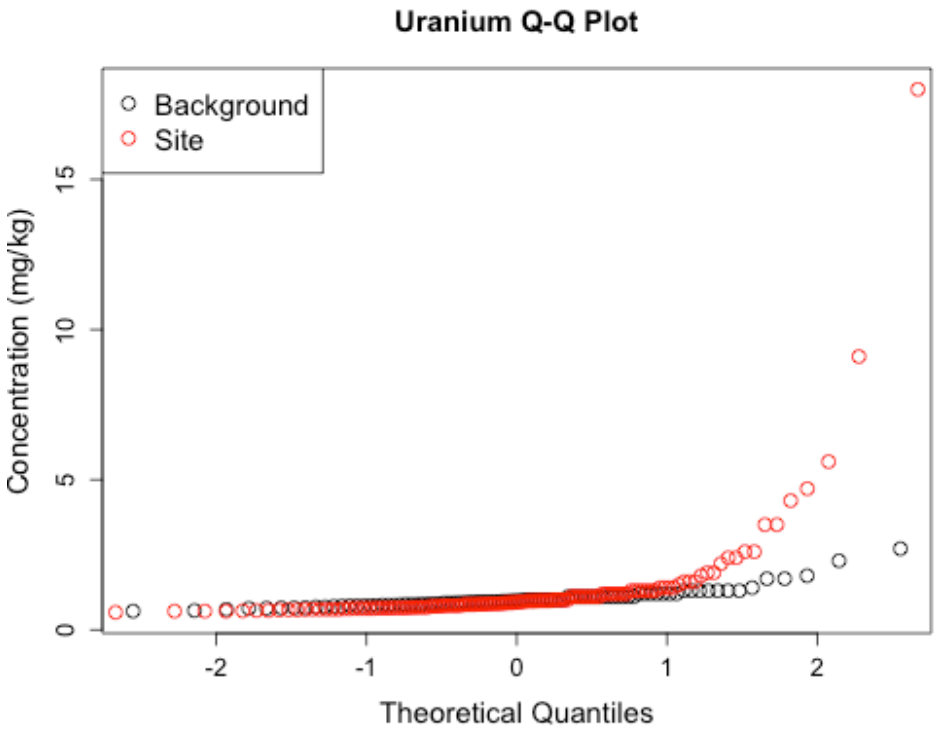

Titanium
D
ND
n=95
n=132
0
2000
4000
6000
8000
10000
Shallow McCullough
TIMET_Ditch

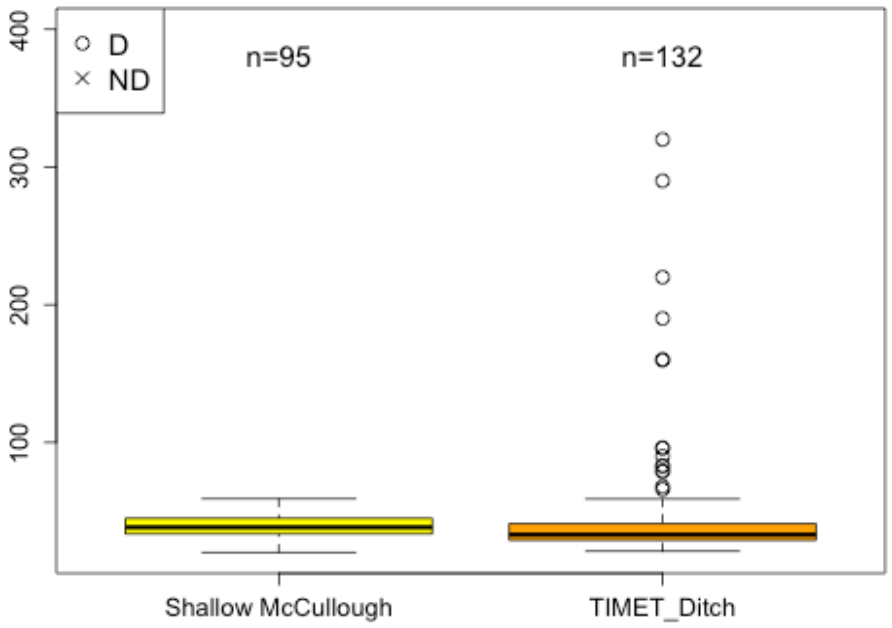

Titanium (log-scale)
D
ND
n=95
n=132
6
7
8
9
10
11
Shallow McCullough
TIMET_Ditch

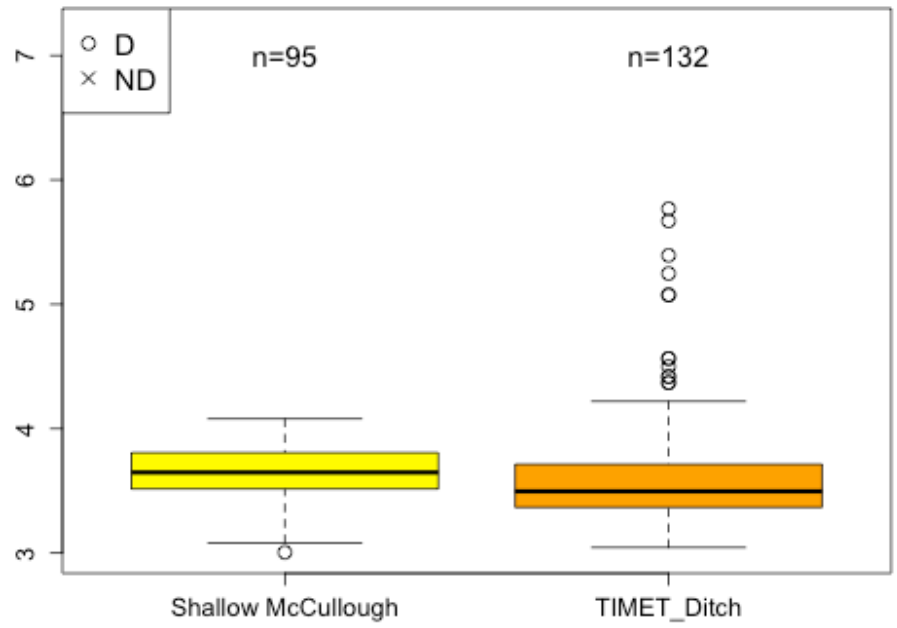

Titanium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
2000
4000
6000
8000
-2
-1
0
1
2
Theoretical Quantiles

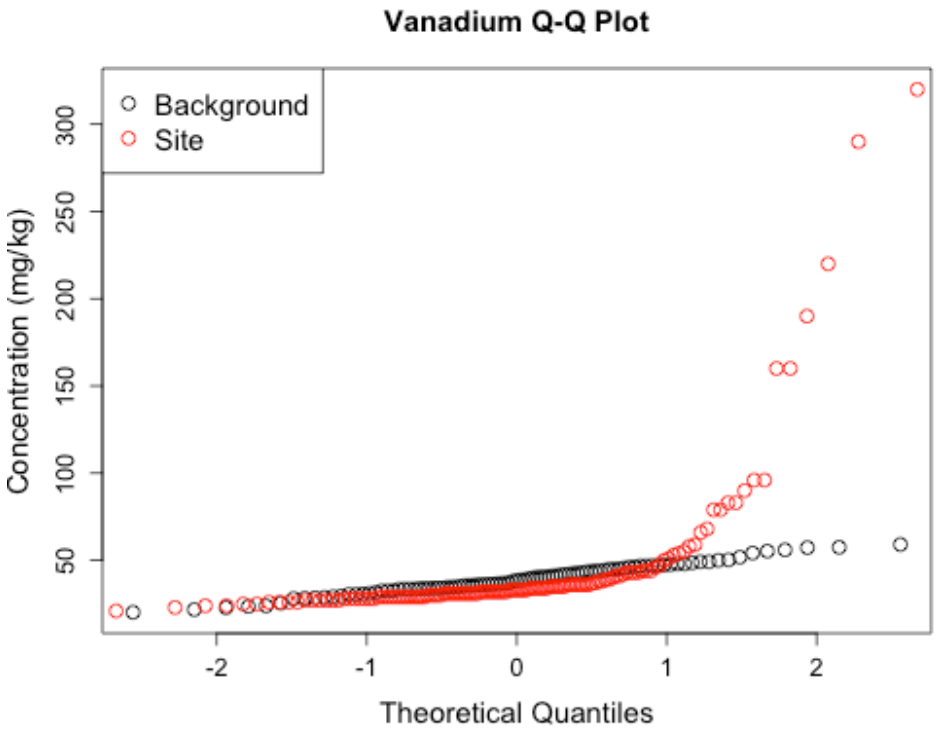

Uranium
D
ND
n=94
n=132
0
5
10
15
20
Shallow McCullough
TIMET_Ditch

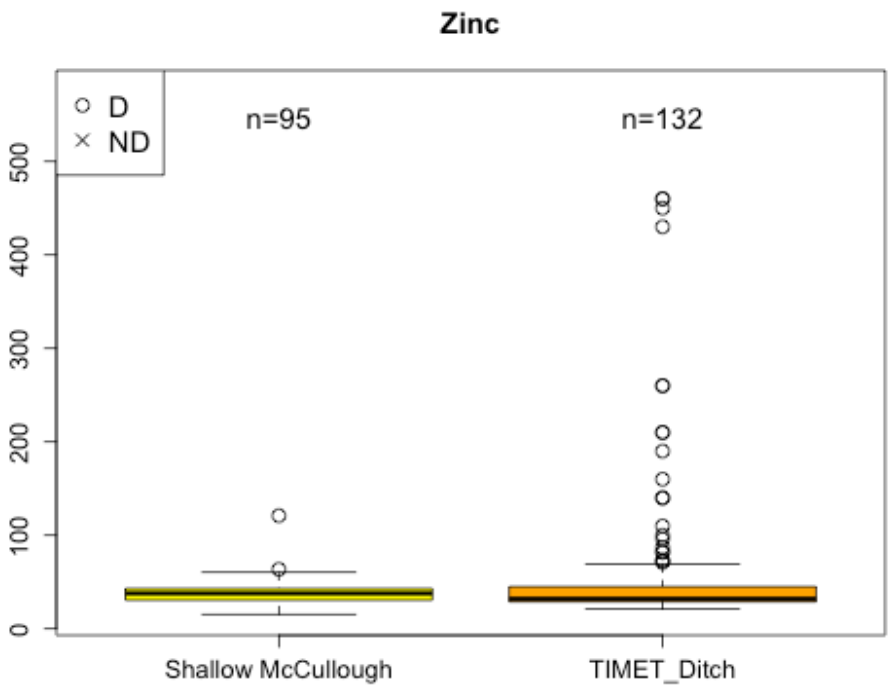

Uranium (log-scale)
D
ND
n=94
n=132
0
1
2
3
Shallow McCullough
TIMET_Ditch

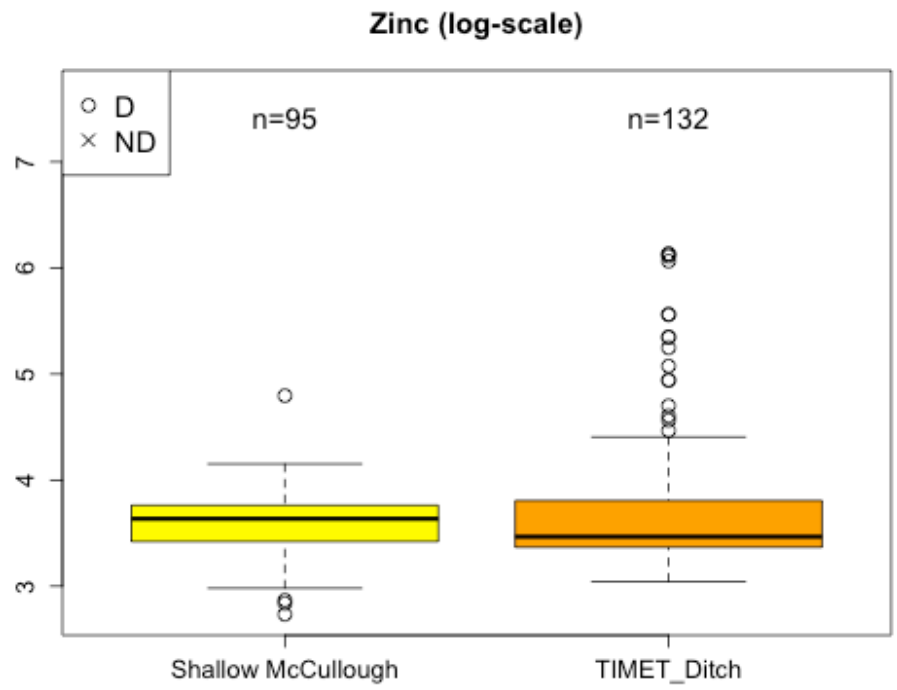

Uranium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
5
10
15
-2
-1
0
1
2
Theoretical Quantiles

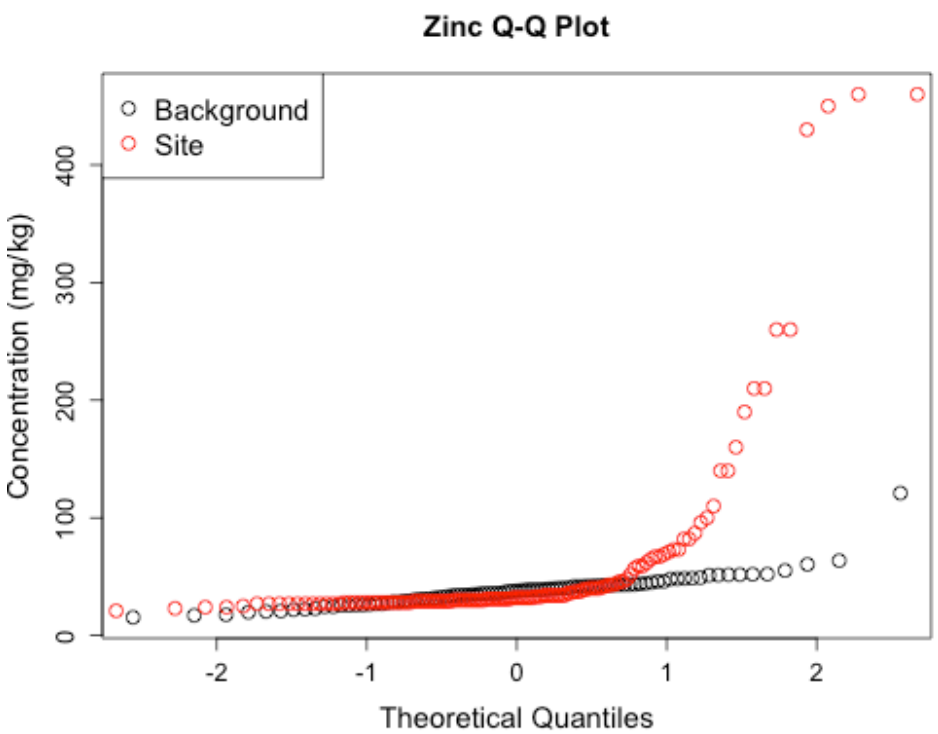

Vanadium
D
ND
n=95
n=132
400
300
200
100
Shallow McCullough
TIMET_Ditch

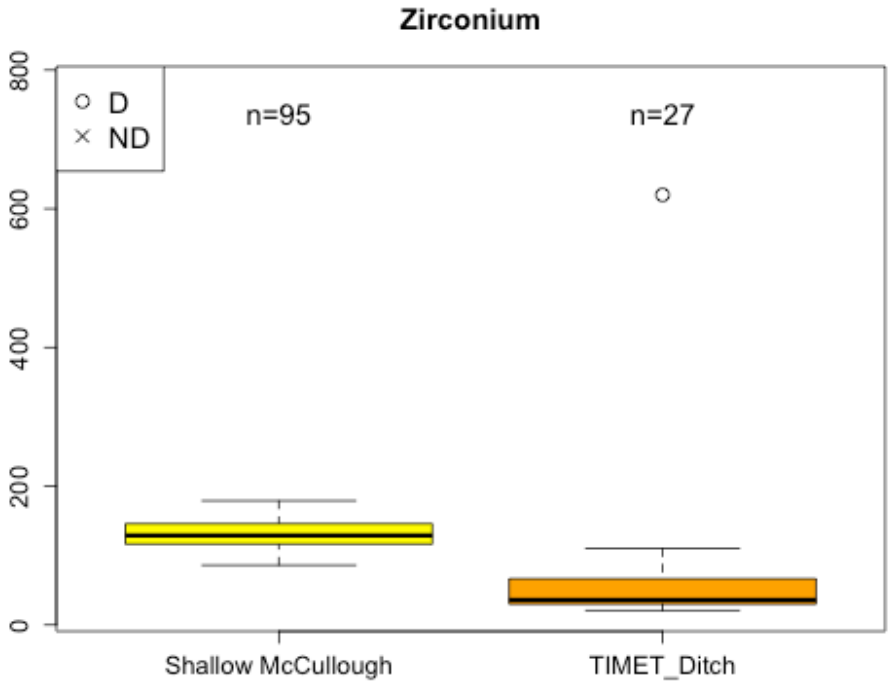

Vanadium (log-scale)
D
ND
n=95
n=132
7
6
5
4
3
Shallow McCullough
TIMET_Ditch

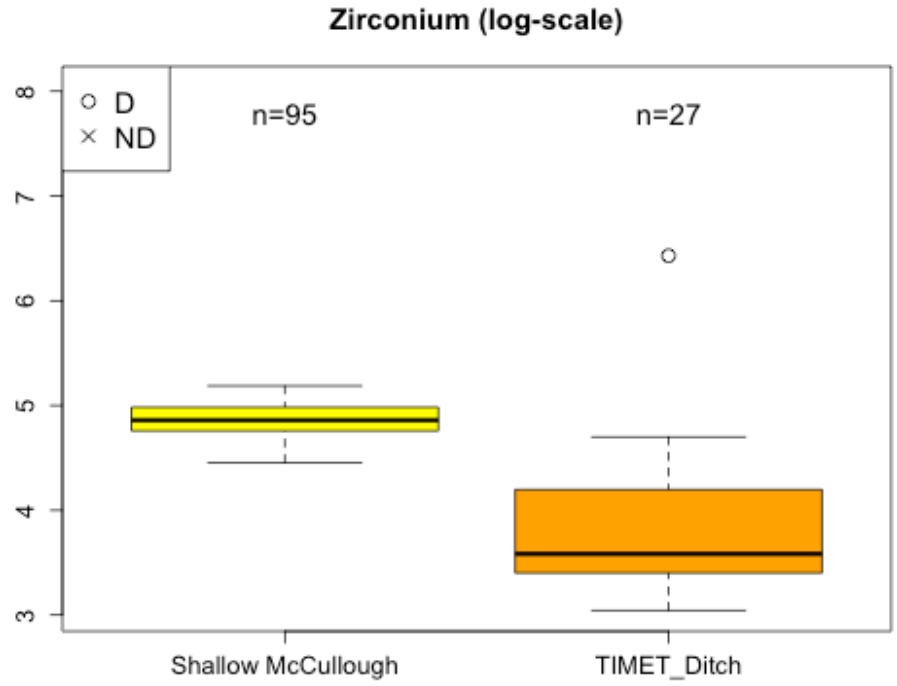

Vanadium Q-Q Plot
Background
Site
Concentration (mg/kg)
300
250
200
150
100
50
-2
-1
0
1
2
Theoretical Quantiles

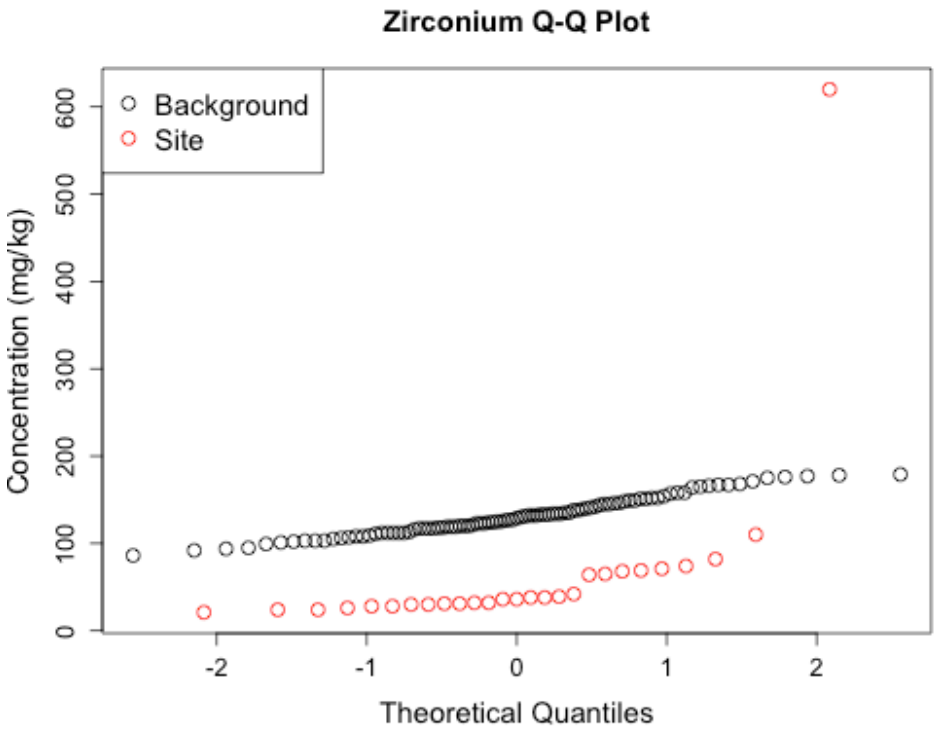

Zinc
D
ND
n=95
n=132
0
100
200
300
400
500
Shallow McCullough
TIMET_Ditch


Zinc (log-scale)
D
ND
n=95
n=132
3
4
5
6
7
Shallow McCullough
TIMET_Ditch

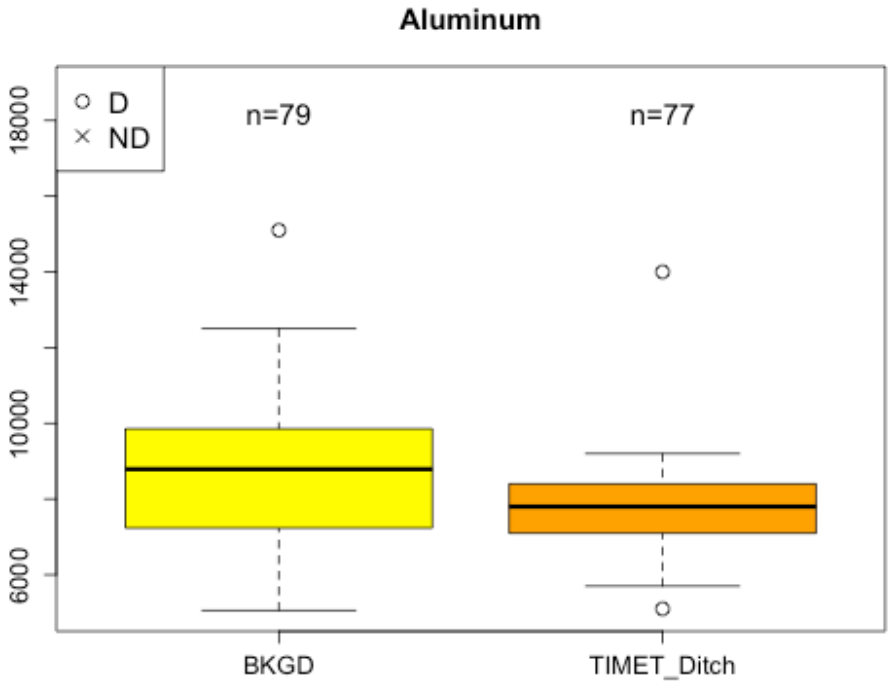

Zinc Q-Q Plot
Background
Site
Concentration (mg/kg)
0
100
200
300
400
-2
-1
0
1
2
Theoretical Quantiles

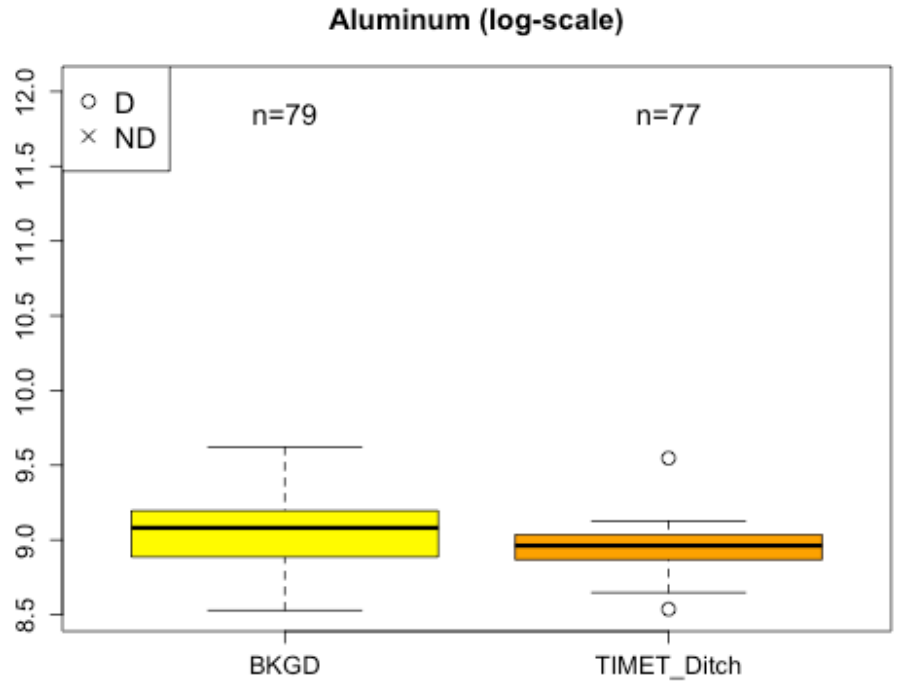

Zirconium
D
ND
n=95
n=27
0
200
400
600
800
Shallow McCullough
TIMET_Ditch

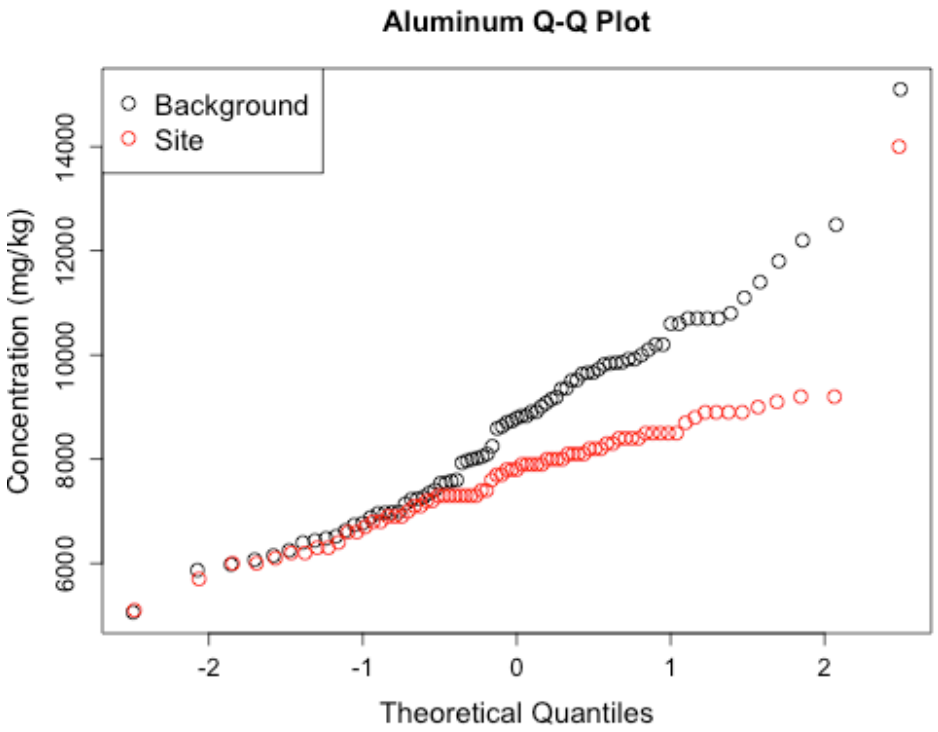

Zirconium (log-scale)
D
ND
n=95
n=27
3
4
5
6
7
8
Shallow McCullough
TIMET_Ditch

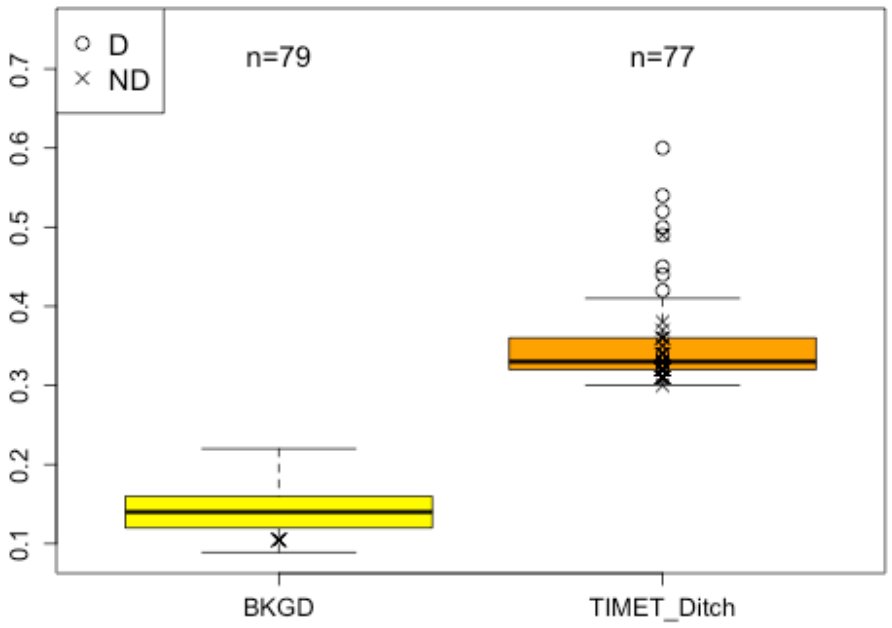

Zirconium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
100
200
300
400
500
600
-2
-1
0
1
2
Theoretical Quantiles

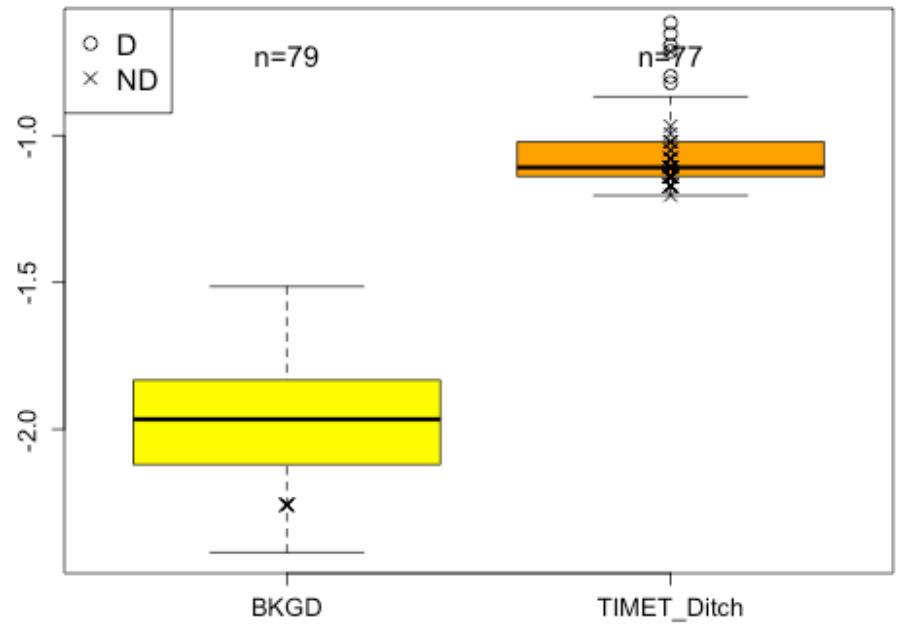
# BOX PLOTS AND QUANTILE-QUANTILE PLOTS: DEEP SOILS

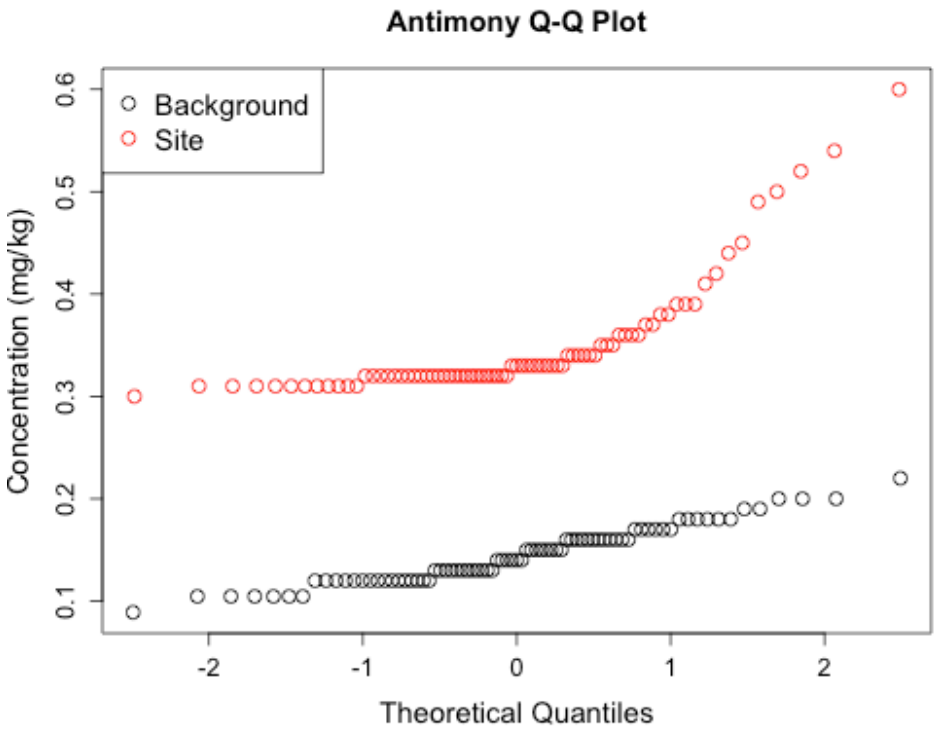

Aluminum
D
ND
n=79
n=77
18000
14000
10000
6000
BKGD
TIMET_Ditch

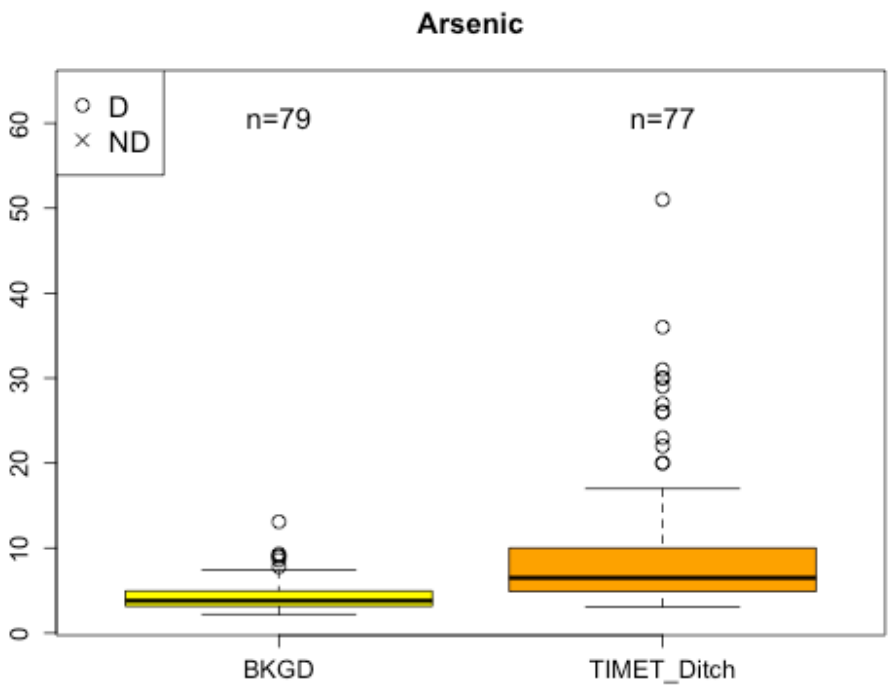

Aluminum (log-scale)
D
ND
n=79
n=77
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
BKGD
TIMET_Ditch

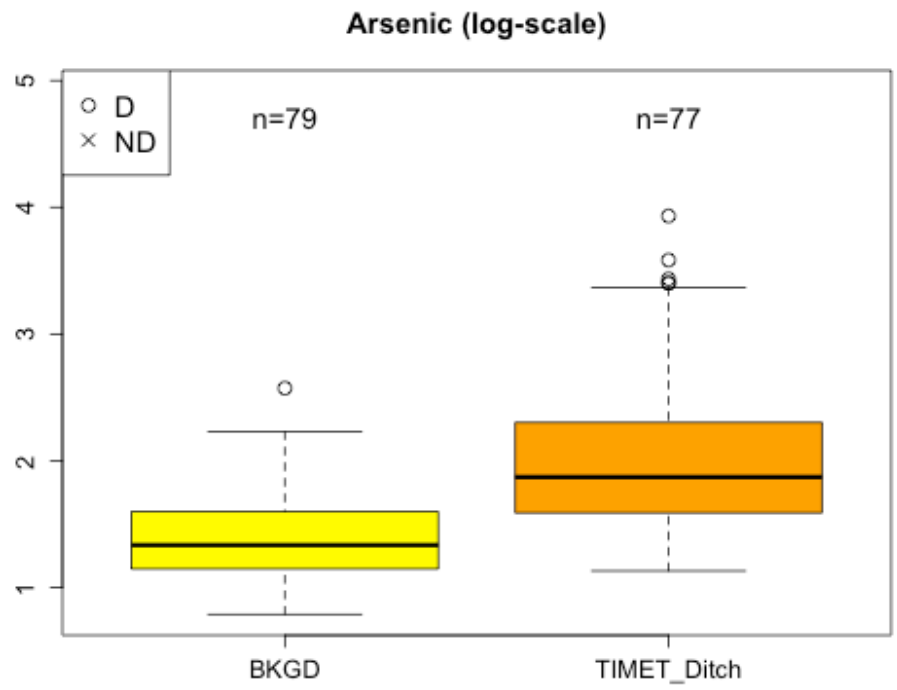

Aluminum Q-Q Plot
Background
Site
Concentration (mg/kg)
14000
12000
10000
8000
6000
-2
-1
0
1
2
Theoretical Quantiles

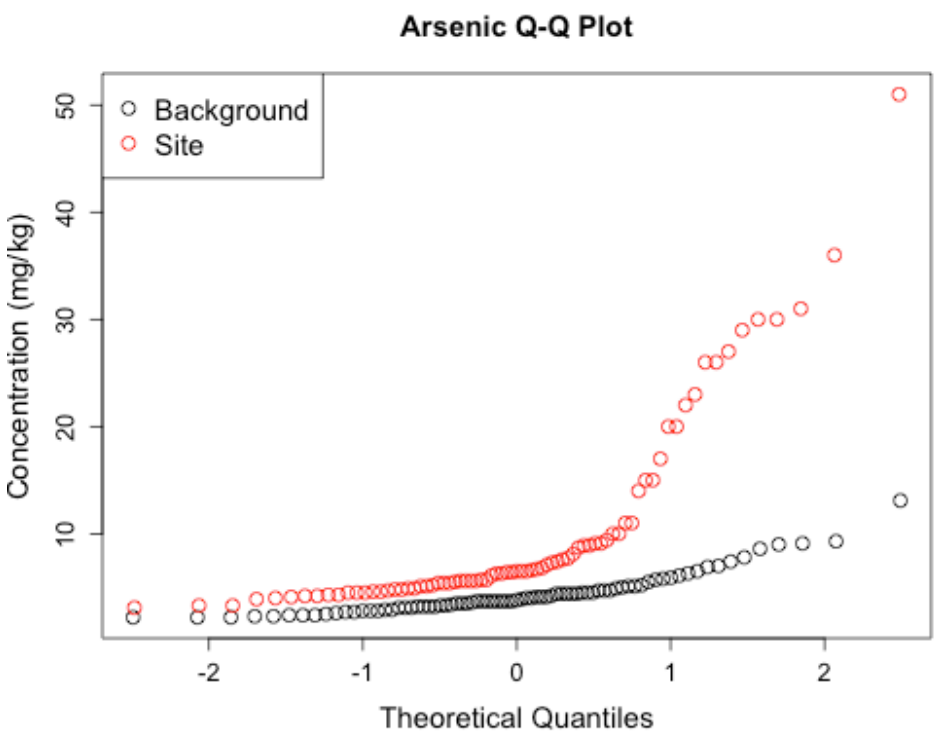

Antimony
D
ND
n=79
n=77
0.1
0.2
0.3
0.4
0.5
0.6
0.7
BKGD
TIMET_Ditch

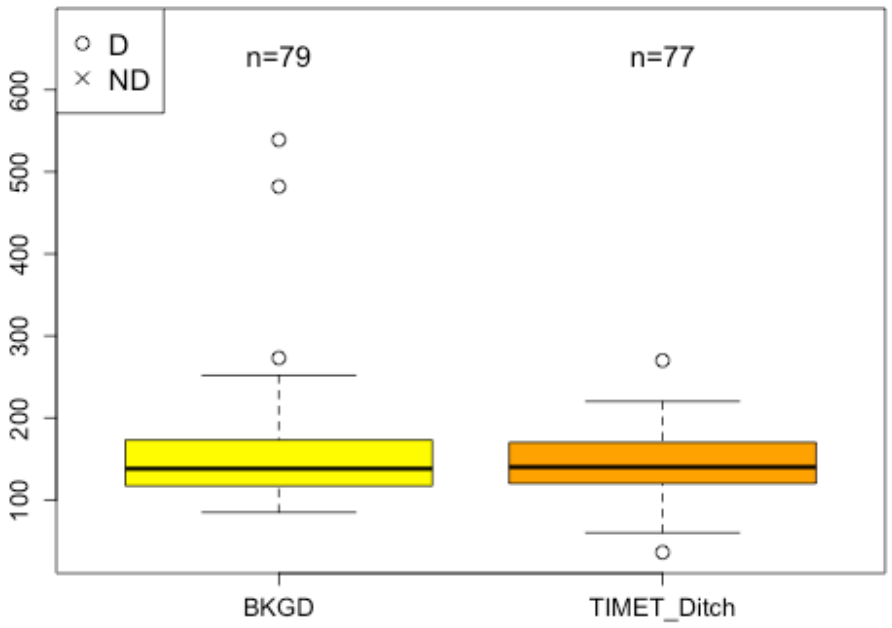

Antimony (log-scale)
D
ND
n=79
n=77
-2.0
-1.5
-1.0
BKGD
TIMET_Ditch

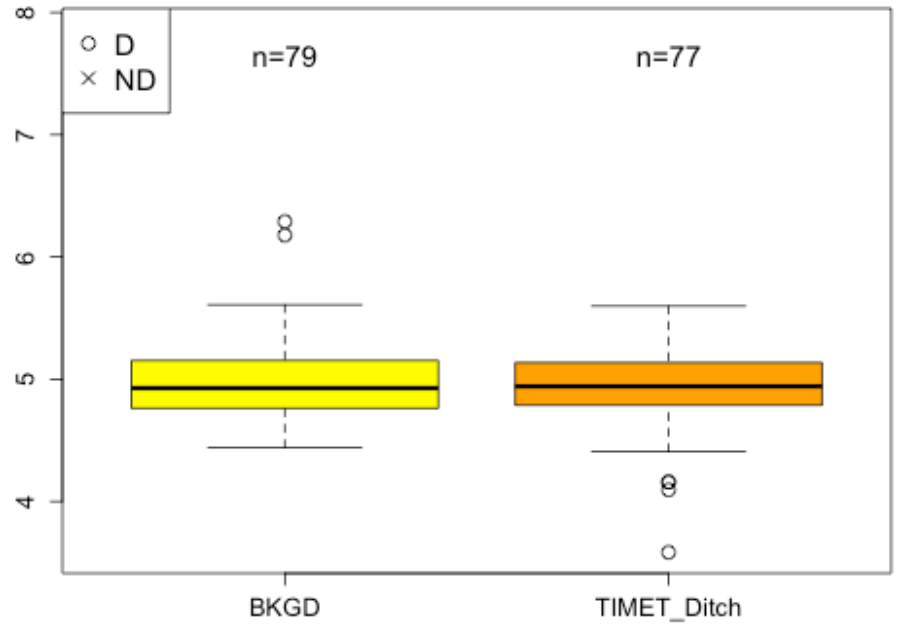

Antimony Q-Q Plot
Background
Site
Concentration (mg/kg)
0.1
0.2
0.3
0.4
0.5
0.6
-2
-1
0
1
2
Theoretical Quantiles

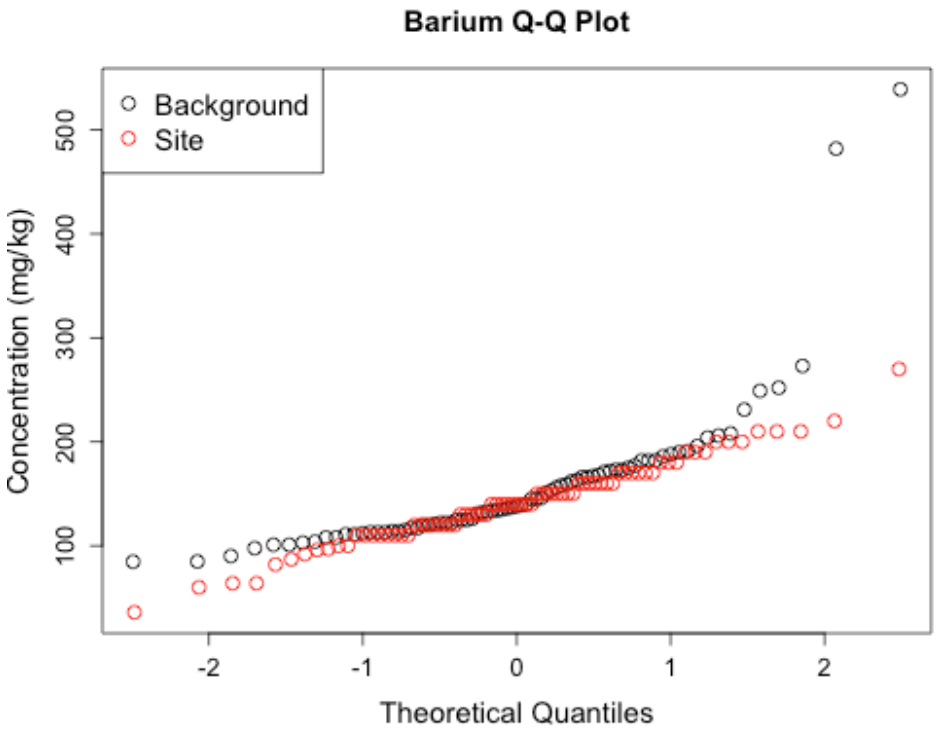

Arsenic
D
ND
n=79
n=77
0
10
20
30
40
50
60
BKGD
TIMET_Ditch

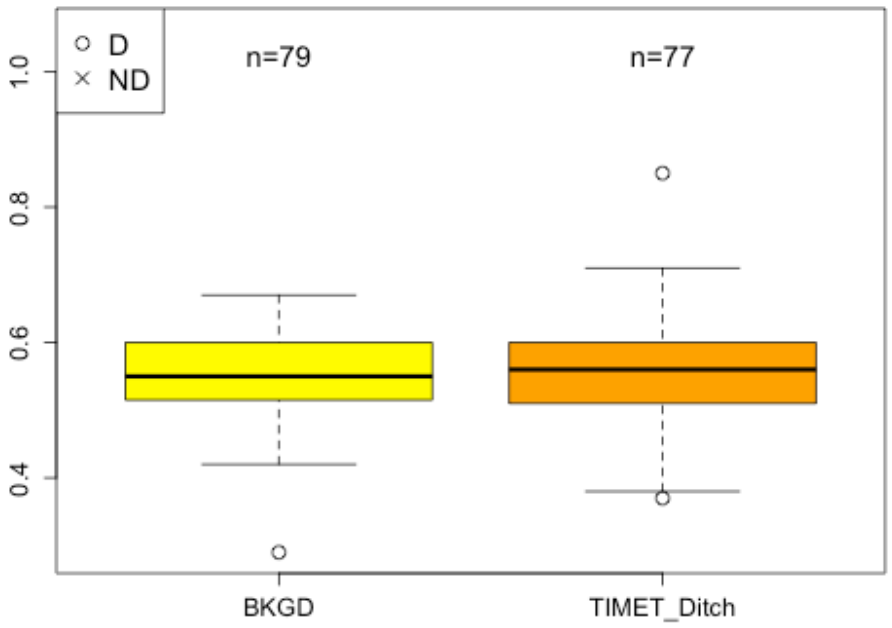

Arsenic (log-scale)
D
ND
n=79
n=77
1
2
3
4
5
BKGD
TIMET_Ditch

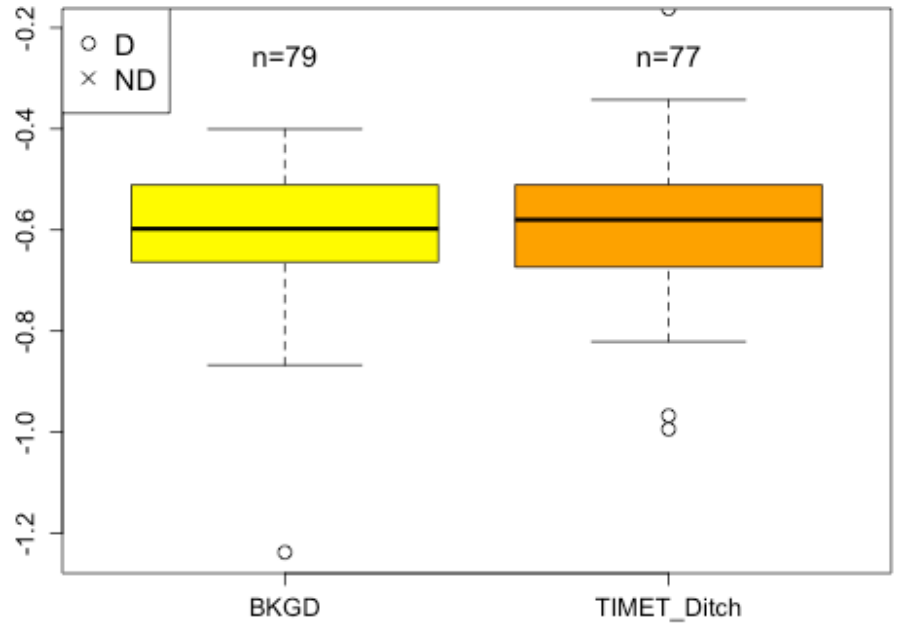

Arsenic Q-Q Plot
Background
Site
Concentration (mg/kg)
10
20
30
40
50
-2
-1
0
1
2
Theoretical Quantiles

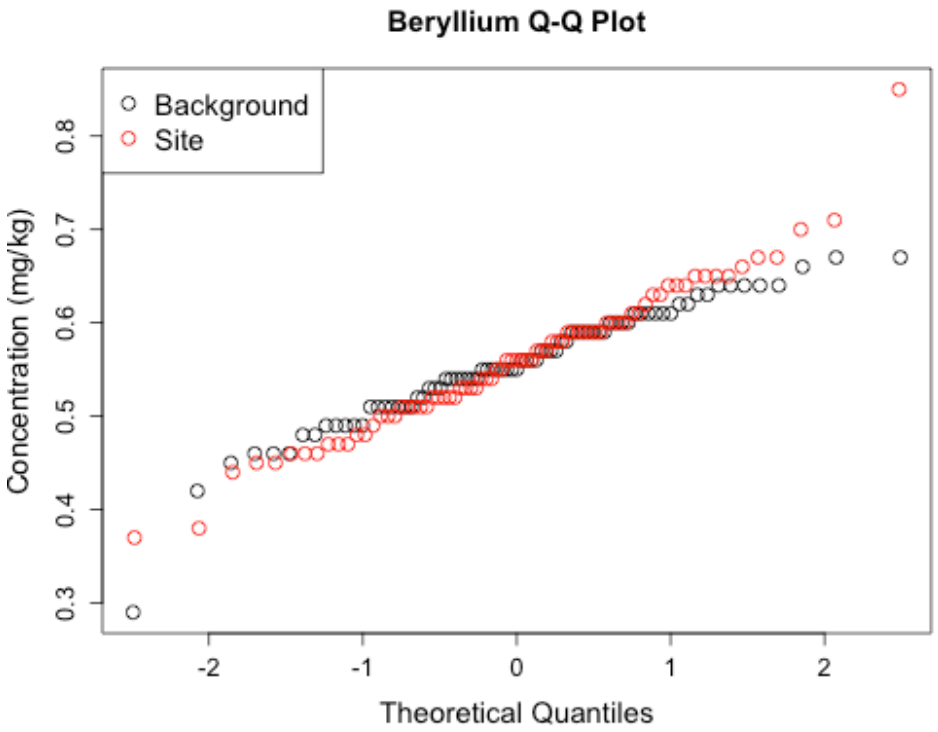

Barium
D
ND
n=79
n=77
600
500
400
300
200
100
BKGD
TIMET_Ditch

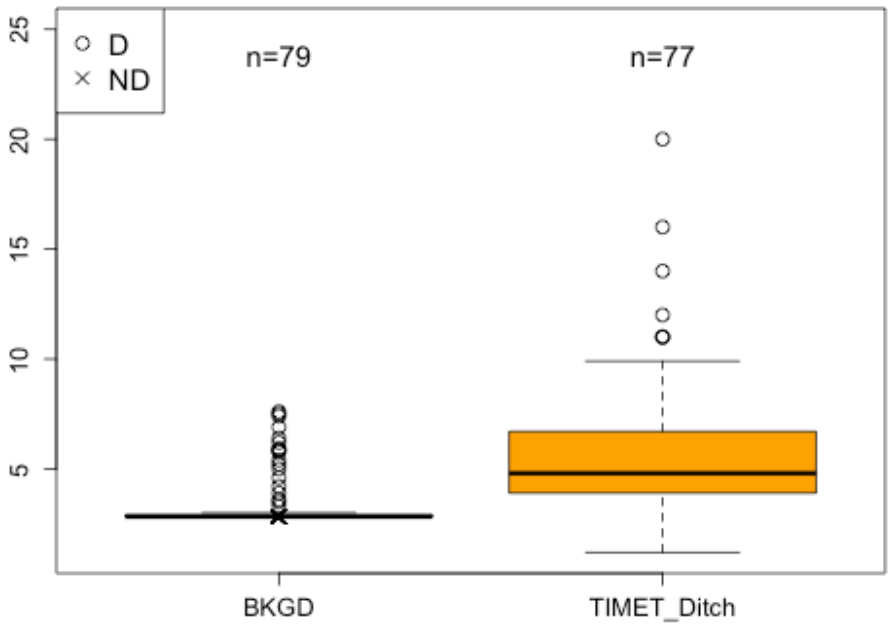

Barium (log-scale)
D
ND
n=79
n=77
8
7
6
5
4
BKGD
TIMET_Ditch

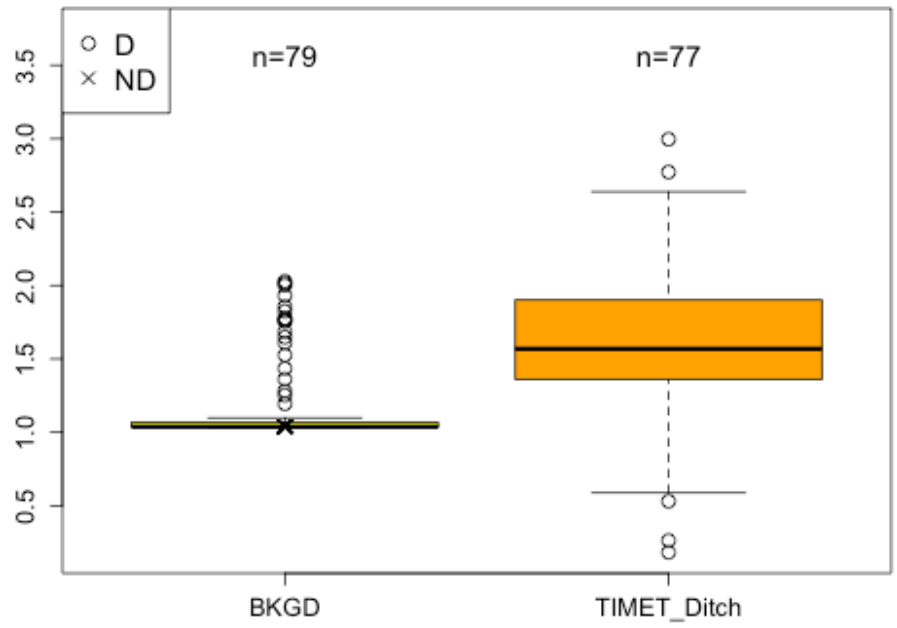

Barium Q-Q Plot
Background
Site
Concentration (mg/kg)
500
400
300
200
100
-2
-1
0
1
2
Theoretical Quantiles

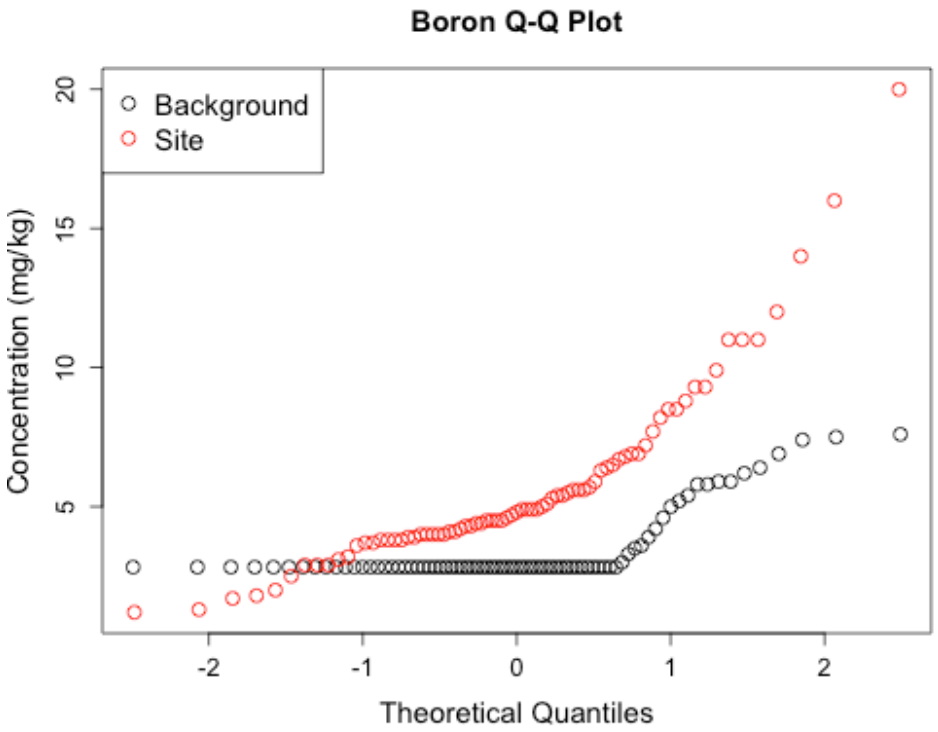

Beryllium
D
ND
n=79
n=77
1.0
0.8
0.6
0.4
BKGD
TIMET_Ditch

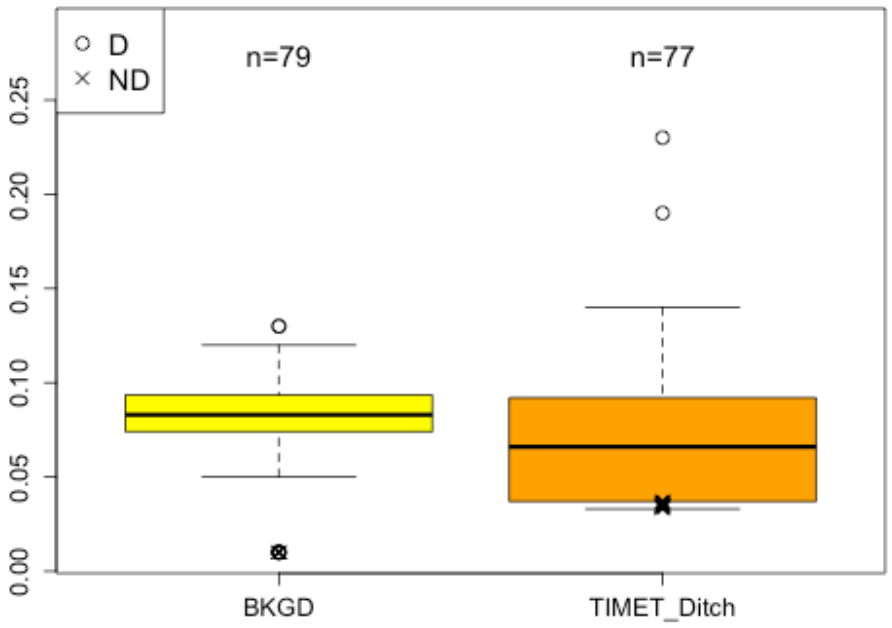

Beryllium (log-scale)
D
ND
n=79
n=77
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
BKGD
TIMET_Ditch

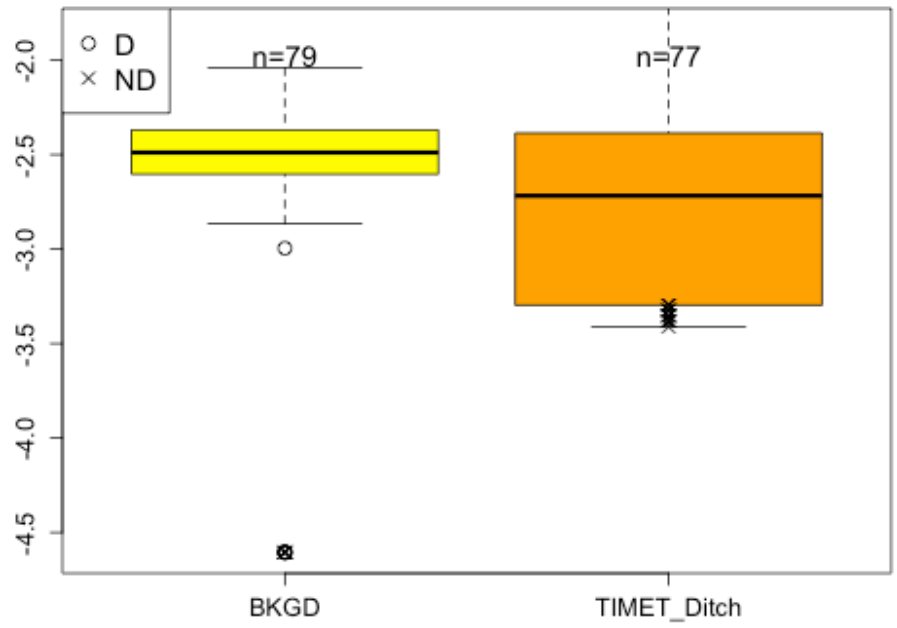

Beryllium Q-Q Plot
Background
Site
Concentration (mg/kg)
0.8
0.7
0.6
0.5
0.4
0.3
-2
-1
0
1
2
Theoretical Quantiles

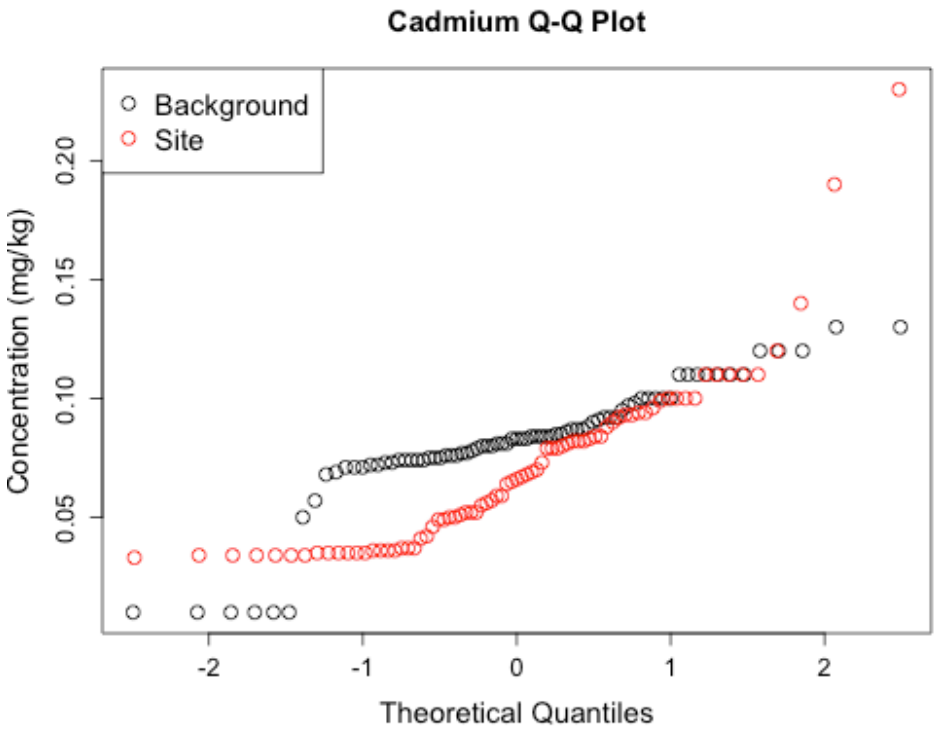

Boron
D
ND
n=79
n=77
25
20
15
10
5
BKGD
TIMET_Ditch

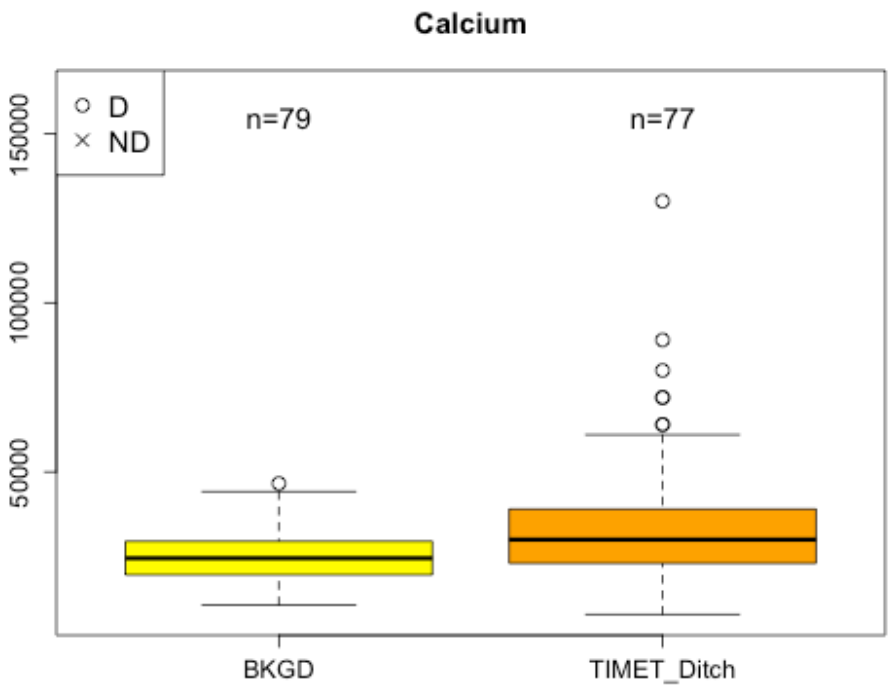

Boron (log-scale)
D
ND
n=79
n=77
3.5
3.0
2.5
2.0
1.5
1.0
0.5
BKGD
TIMET_Ditch

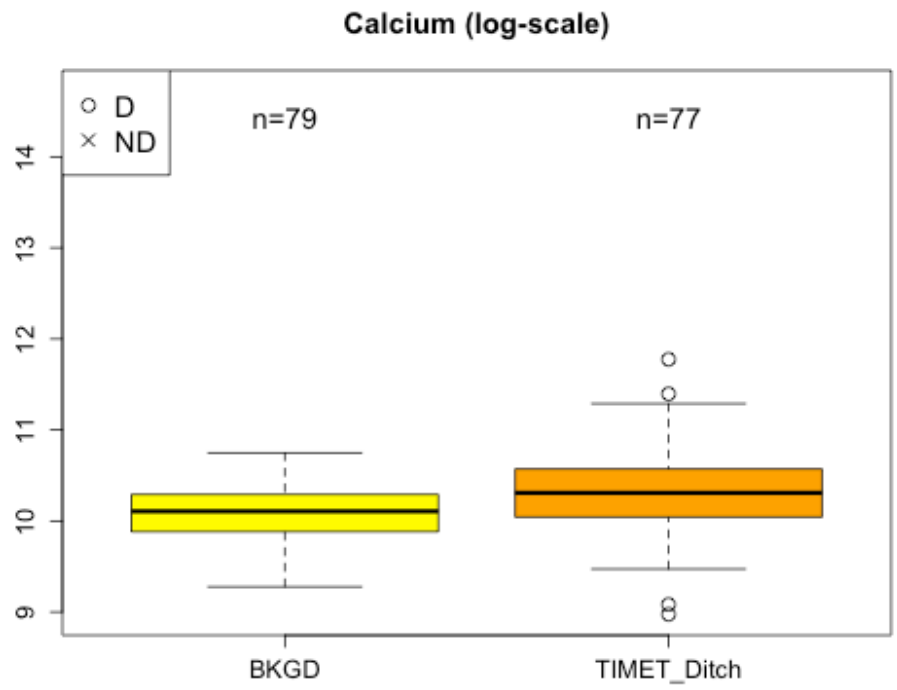

Boron Q-Q Plot
Background
Site
Concentration (mg/kg)
20
15
10
5
-2
-1
0
1
2
Theoretical Quantiles

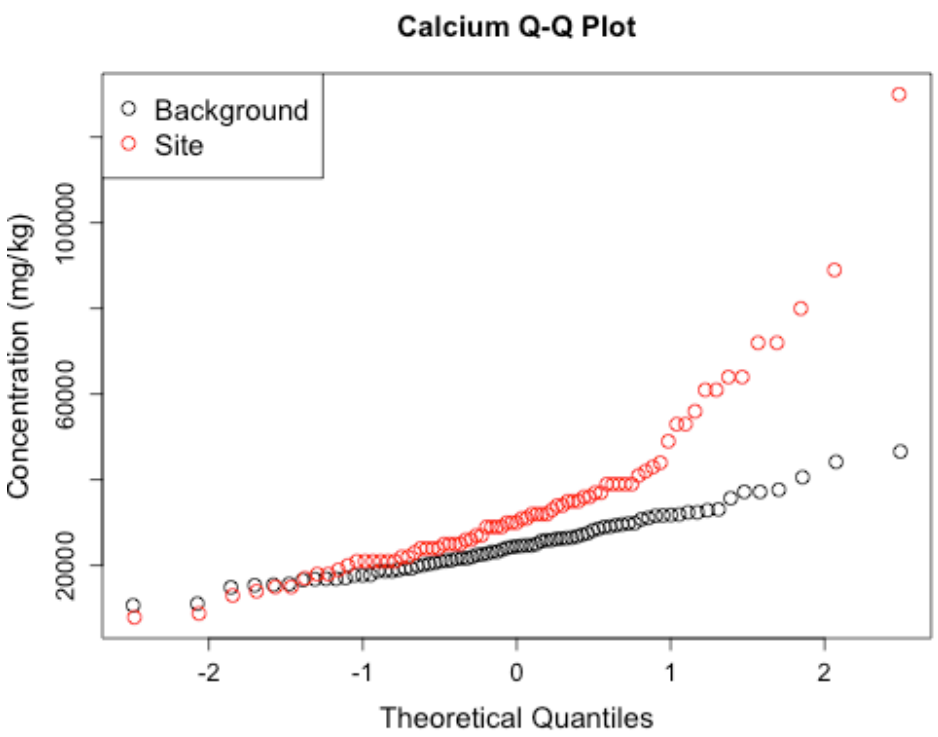

Cadmium
D
ND
n=79
n=77
0.00
0.05
0.10
0.15
0.20
0.25
BKGD
TIMET_Ditch

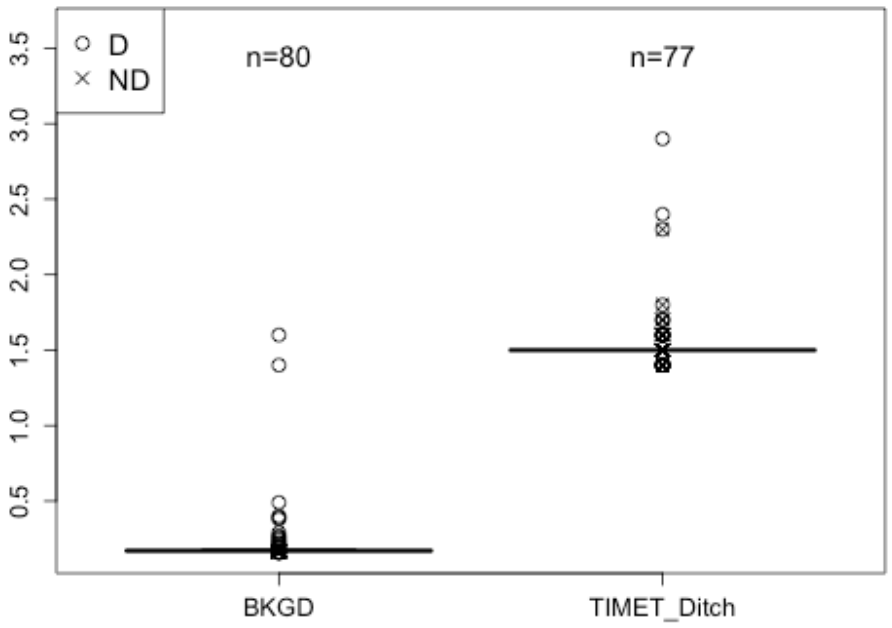

Cadmium (log-scale)
D
ND
n=79
n=77
-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
BKGD
TIMET_Ditch

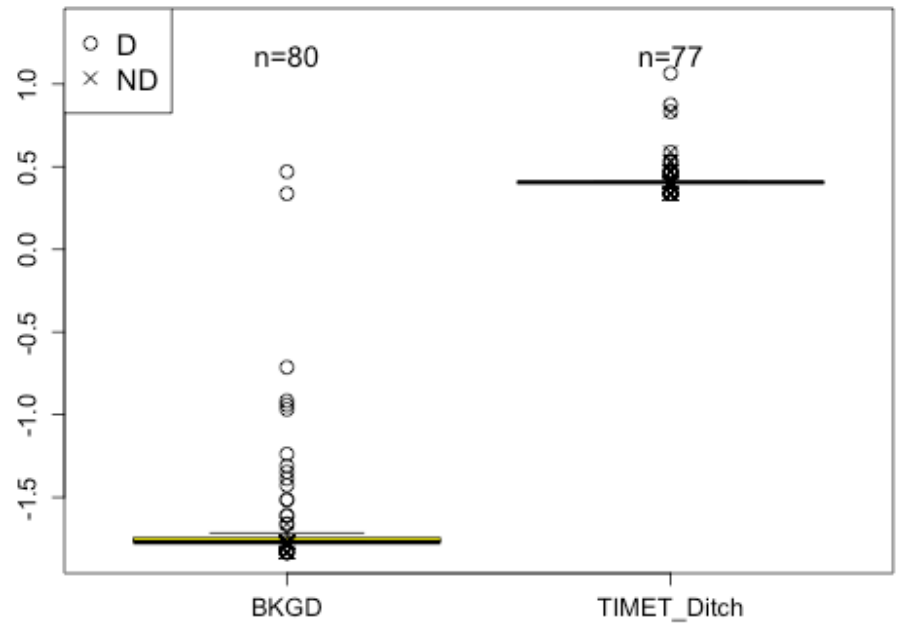

Cadmium Q-Q Plot
Background
Site
Concentration (mg/kg)
0.05
0.10
0.15
0.20
-2
-1
0
1
2
Theoretical Quantiles

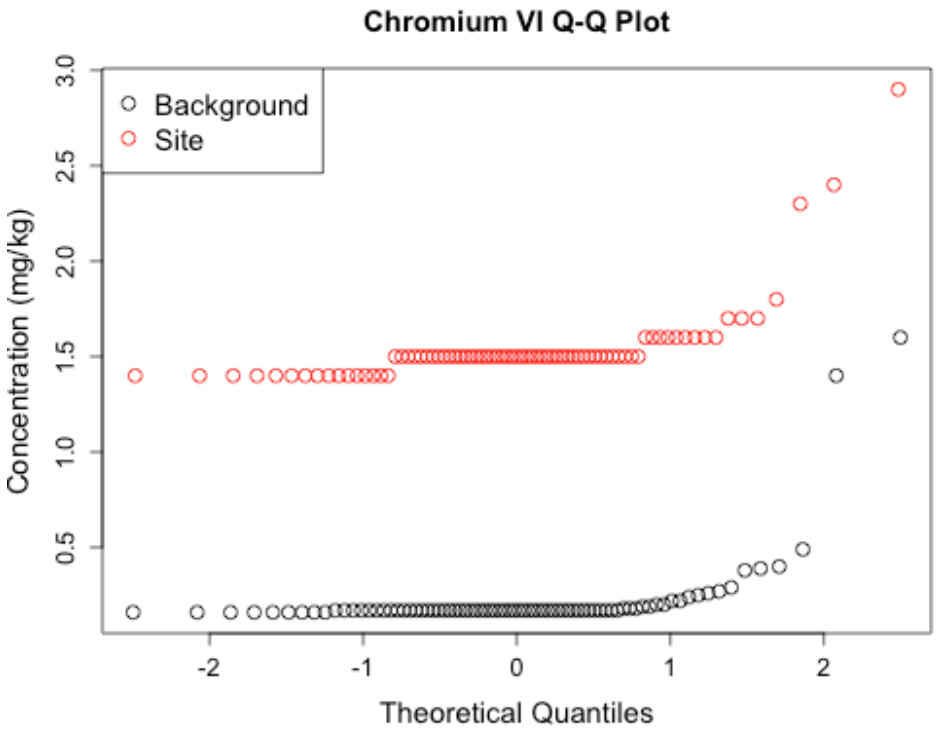

Calcium
D
ND
n=79
n=77
150000
100000
50000
BKGD
TIMET_Ditch

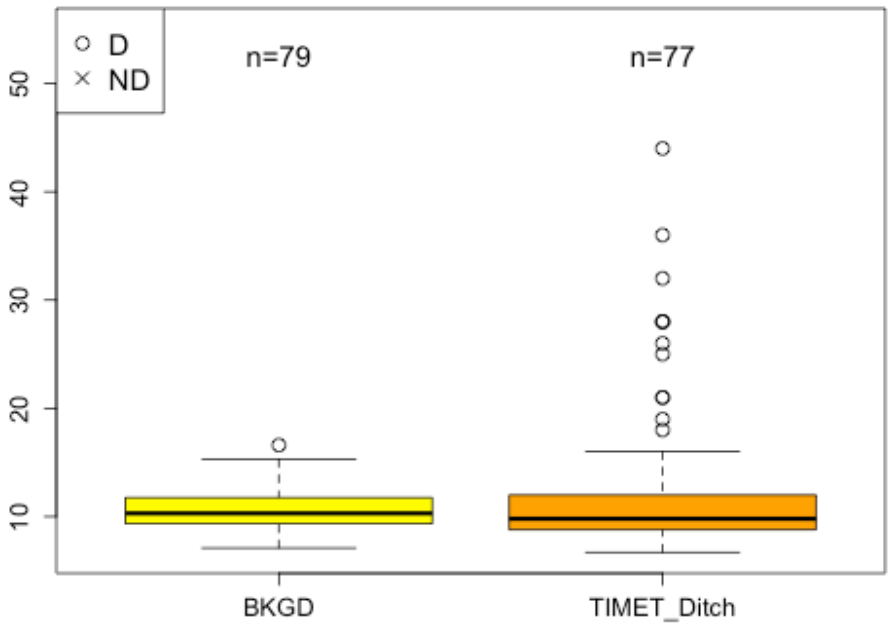

Calcium (log-scale)
D
ND
n=79
n=77
14
13
12
11
10
9
BKGD
TIMET_Ditch

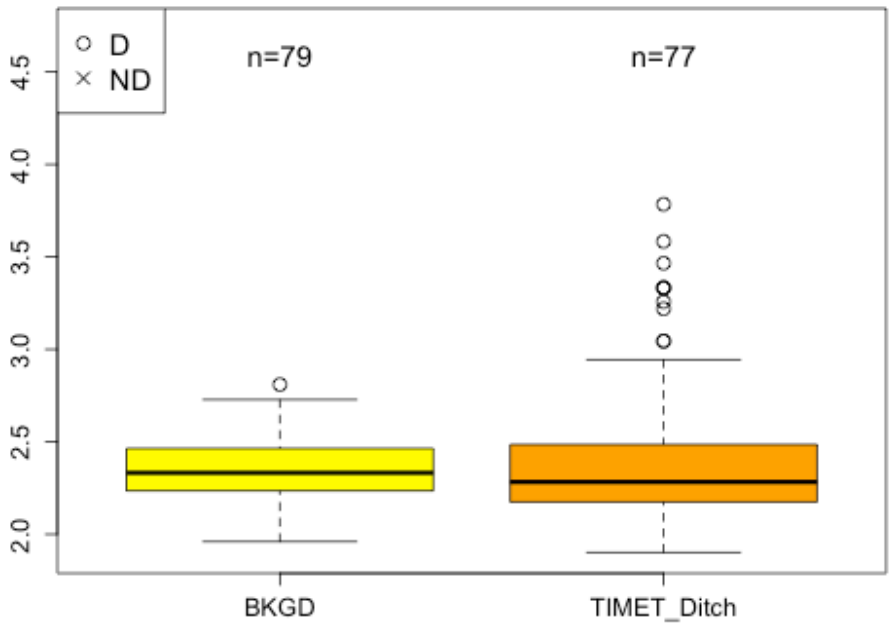

Calcium Q-Q Plot
Background
Site
Concentration (mg/kg)
100000
60000
20000
-2
-1
0
1
2
Theoretical Quantiles

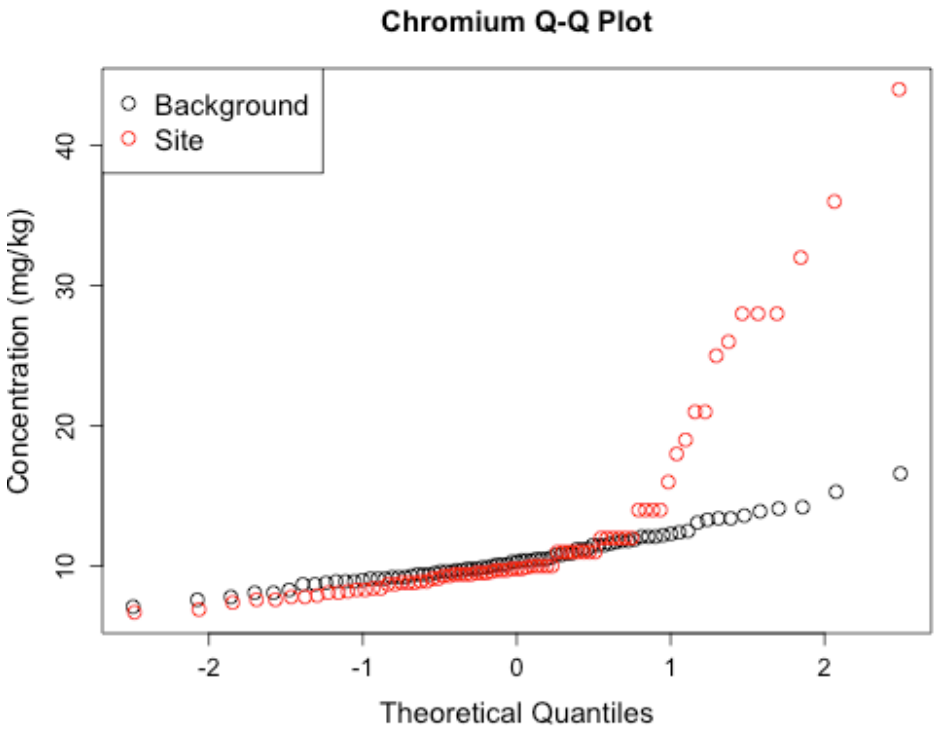

Chromium VI
D
ND
n=80
n=77
0.5
1.0
1.5
2.0
2.5
3.0
3.5
BKGD
TIMET_Ditch

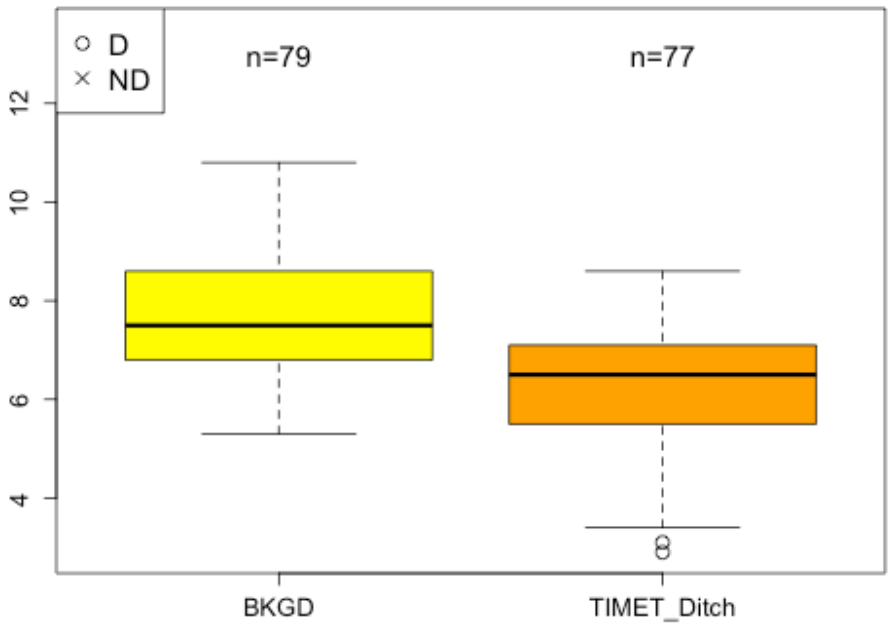

Chromium VI (log-scale)
D
ND
n=80
n=77
-1.5
-1.0
-0.5
0.0
0.5
1.0
BKGD
TIMET_Ditch

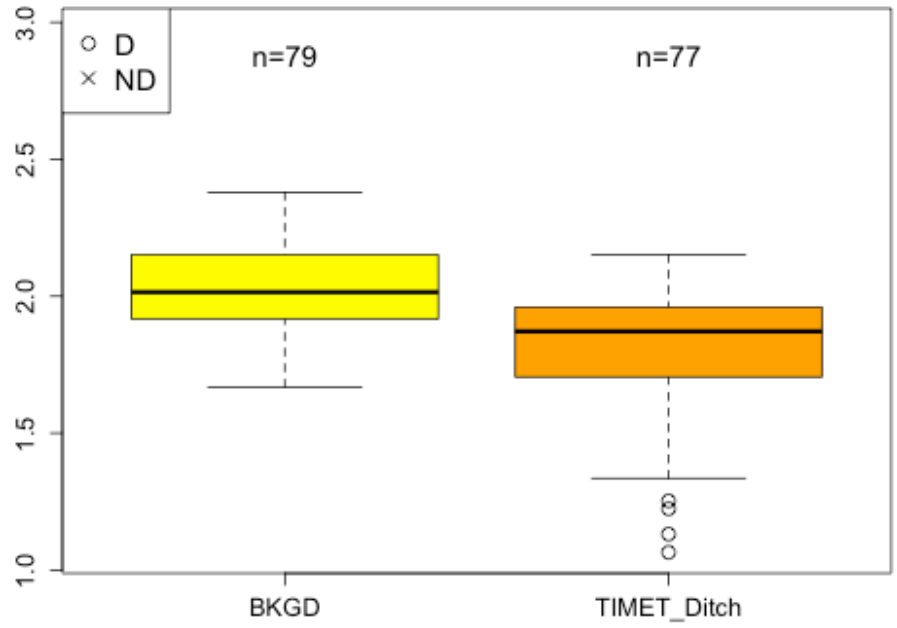

Chromium VI Q-Q Plot
Background
Site
Concentration (mg/kg)
0.5
1.0
1.5
2.0
2.5
3.0
-2
-1
0
1
2
Theoretical Quantiles

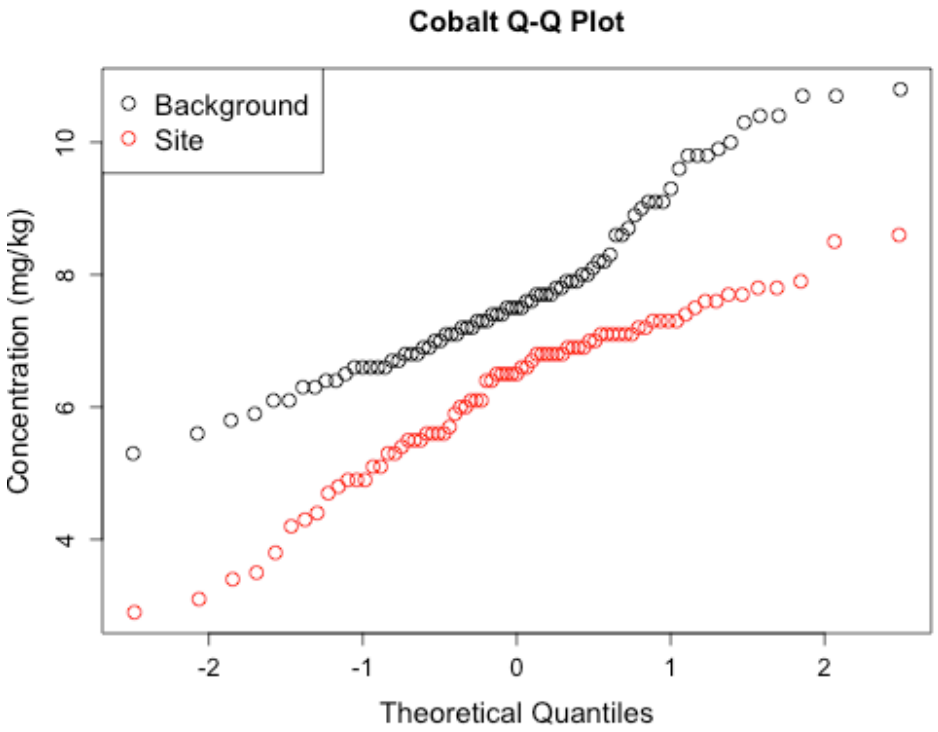

Chromium
D
ND
n=79
n=77
50
40
30
20
10
BKGD
TIMET_Ditch

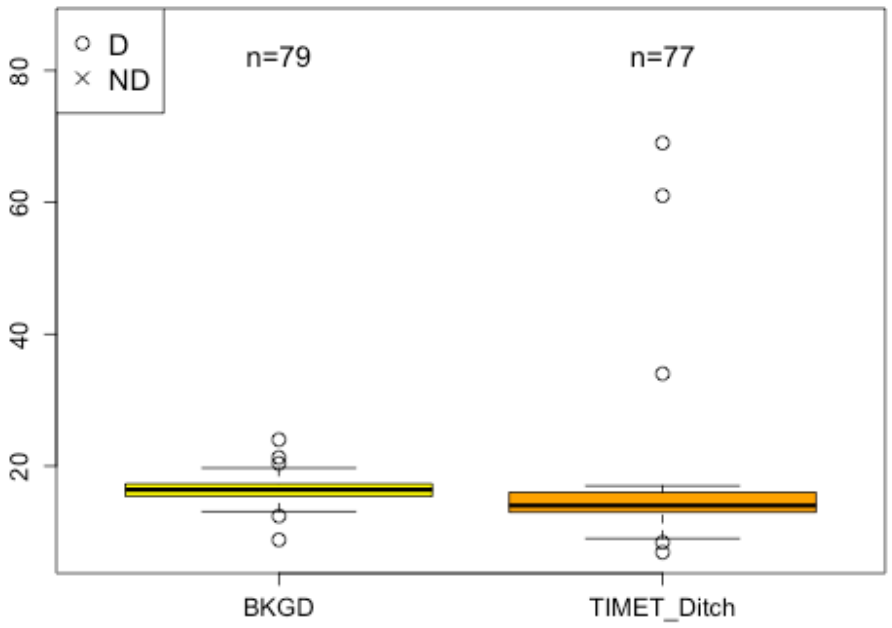

Chromium (log-scale)
D
ND
n=79
n=77
4.5
4.0
3.5
3.0
2.5
2.0
BKGD
TIMET_Ditch

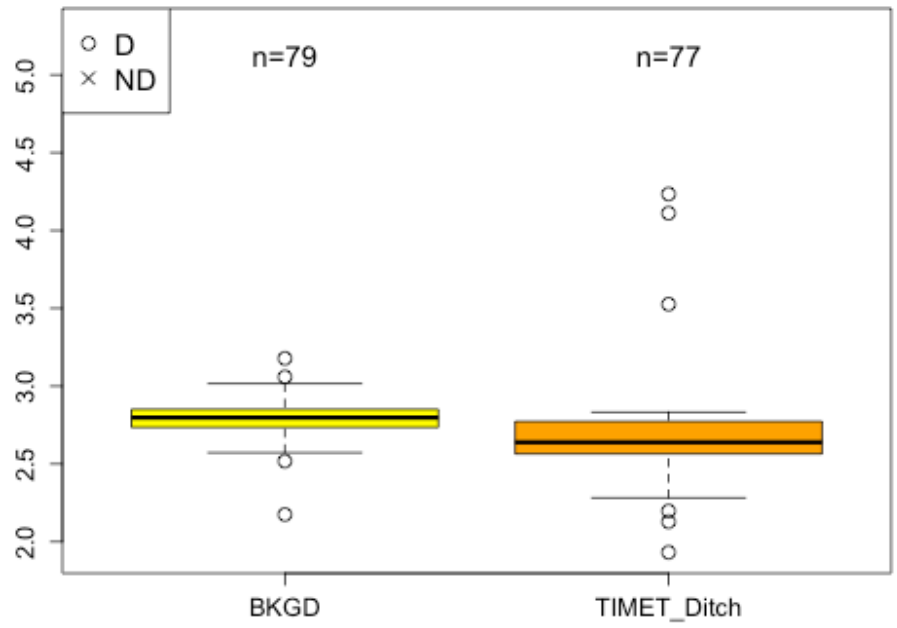

Chromium Q-Q Plot
Background
Site
Concentration (mg/kg)
40
30
20
10
-2
-1
0
1
2
Theoretical Quantiles

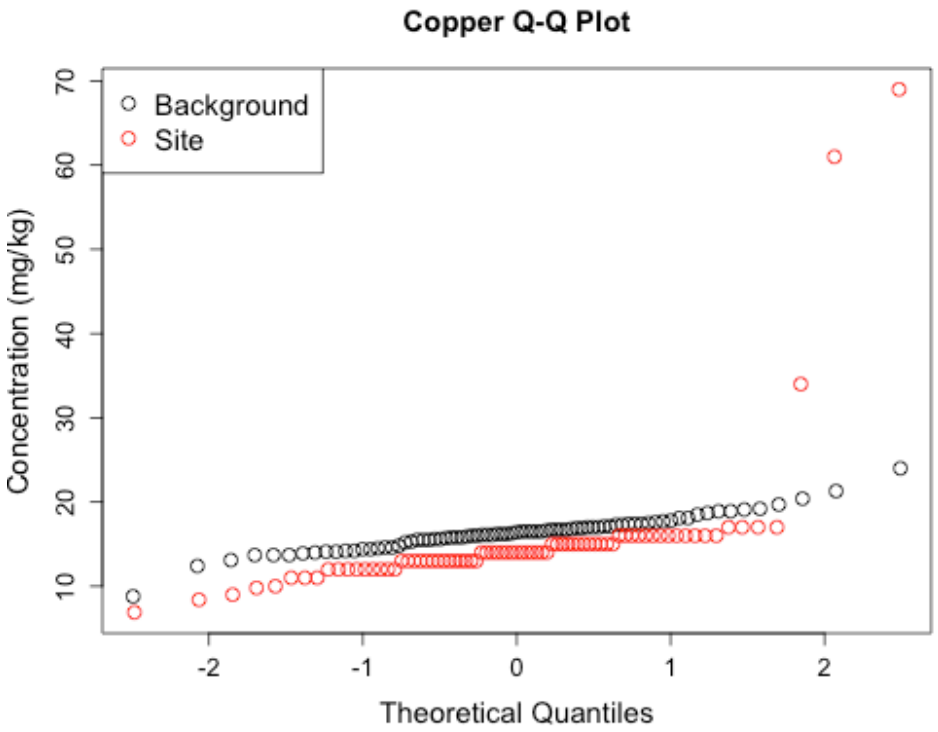

Cobalt
D
ND
n=79
n=77
12
10
8
6
4
BKGD
TIMET_Ditch

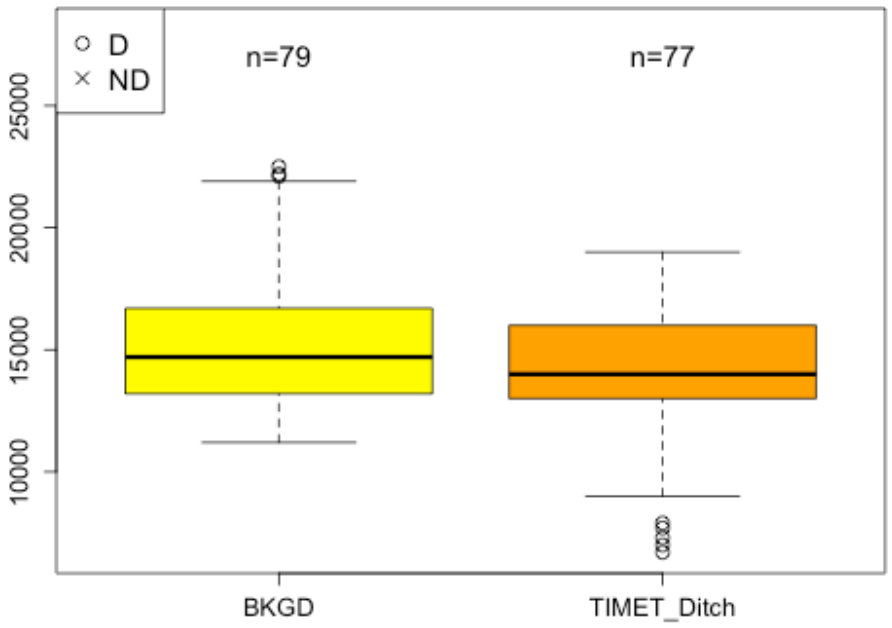

Cobalt (log-scale)
D
ND
n=79
n=77
3.0
2.5
2.0
1.5
1.0
BKGD
TIMET_Ditch

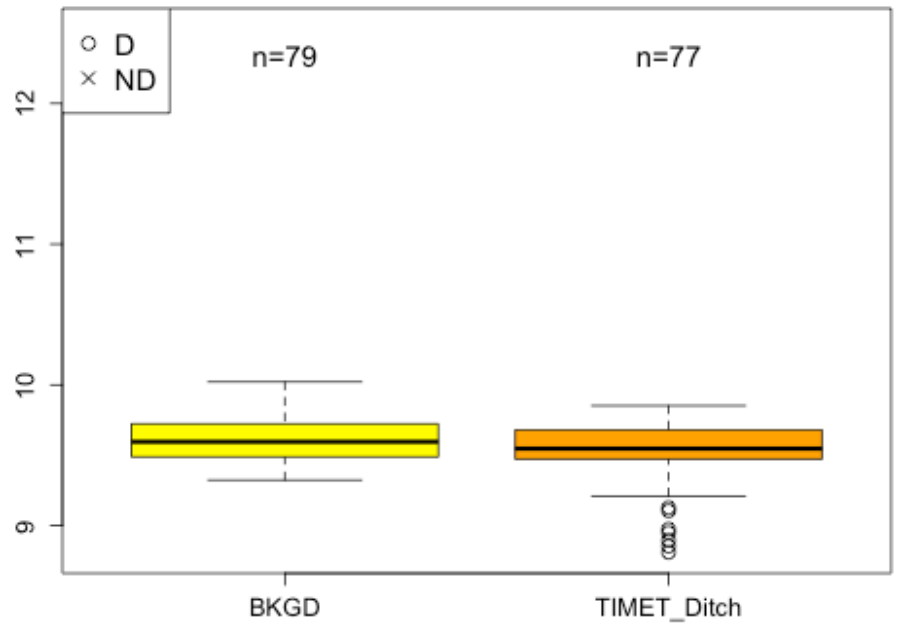

Cobalt Q-Q Plot
Background
Site
Concentration (mg/kg)
10
8
6
4
-2
-1
0
1
2
Theoretical Quantiles

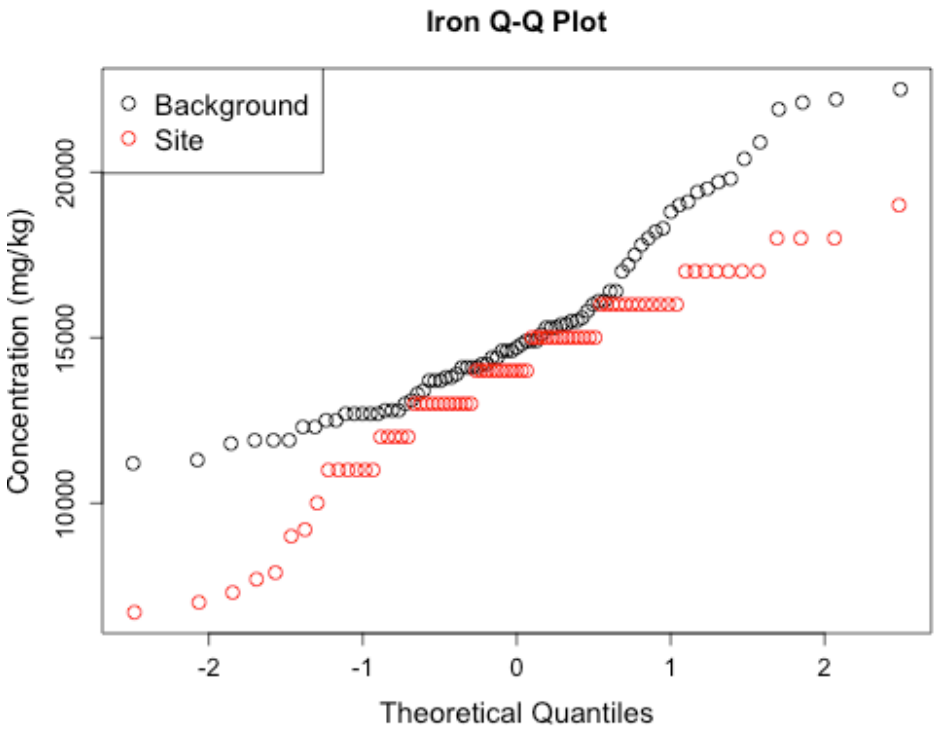

Copper
D
ND
n=79
n=77
80
60
40
20
BKGD
TIMET_Ditch

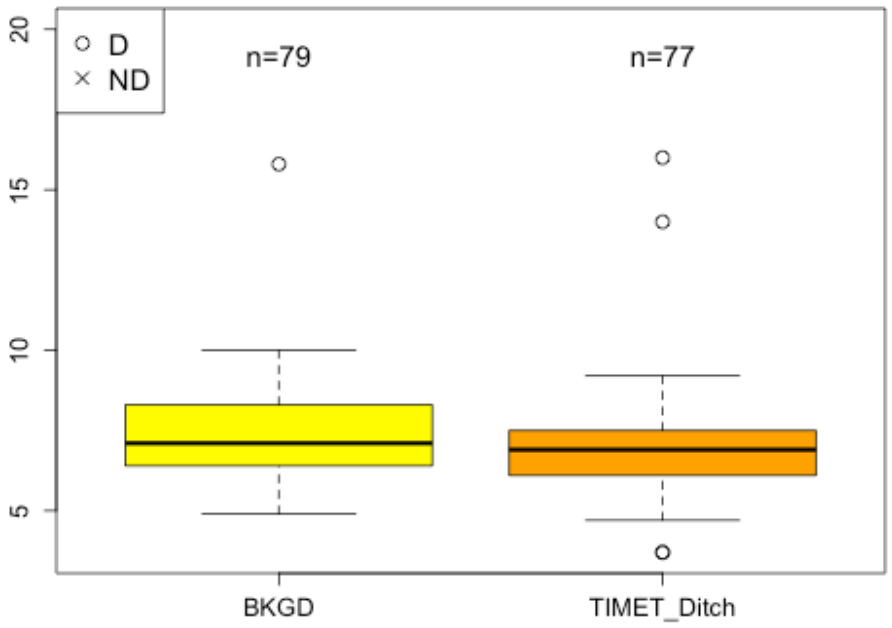

Copper (log-scale)
D
ND
n=79
n=77
5.0
4.5
4.0
3.5
3.0
2.5
2.0
BKGD
TIMET_Ditch

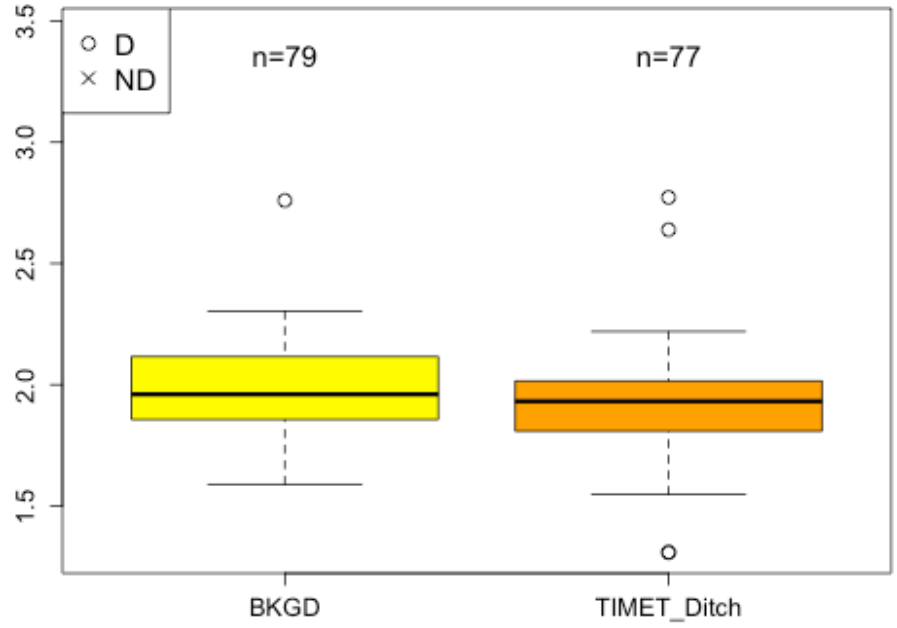

Copper Q-Q Plot
Background
Site
Concentration (mg/kg)
70
60
50
40
30
20
10
-2
-1
0
1
2
Theoretical Quantiles

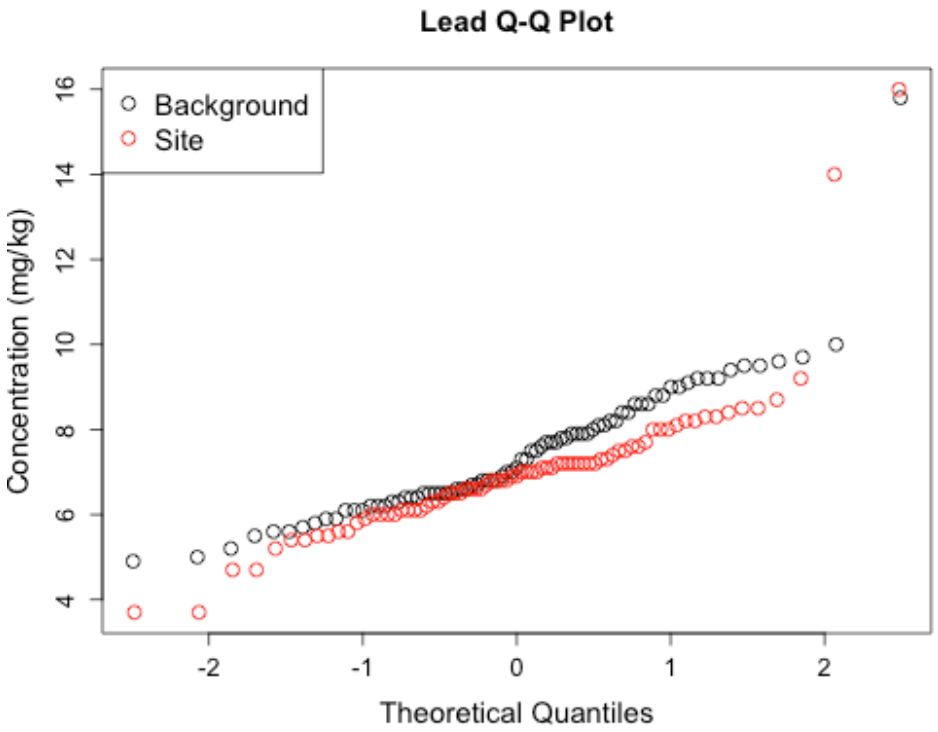

Iron
D
ND
n=79
n=77
25000
20000
15000
10000
BKGD
TIMET_Ditch

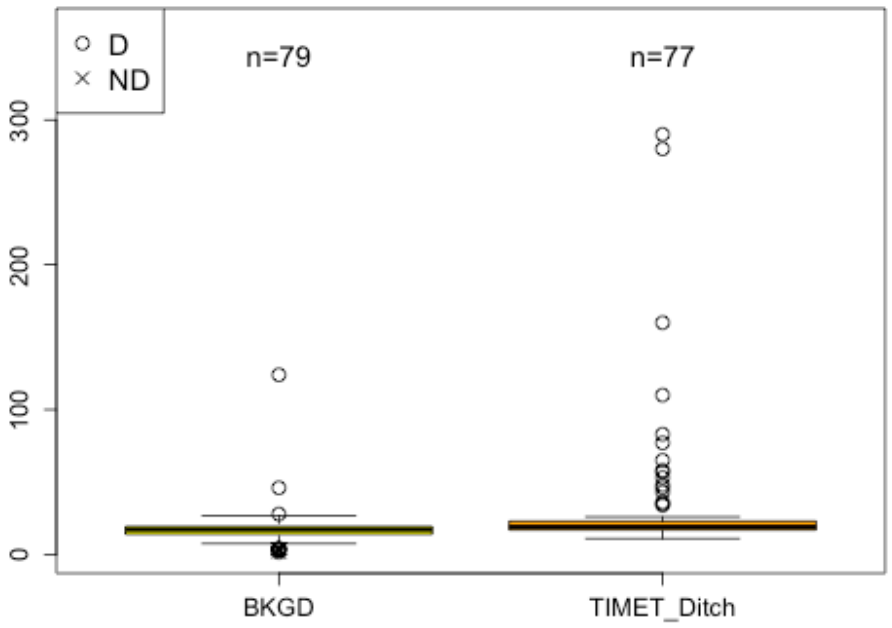

Iron (log-scale)
D
ND
n=79
n=77
12
11
10
9
BKGD
TIMET_Ditch

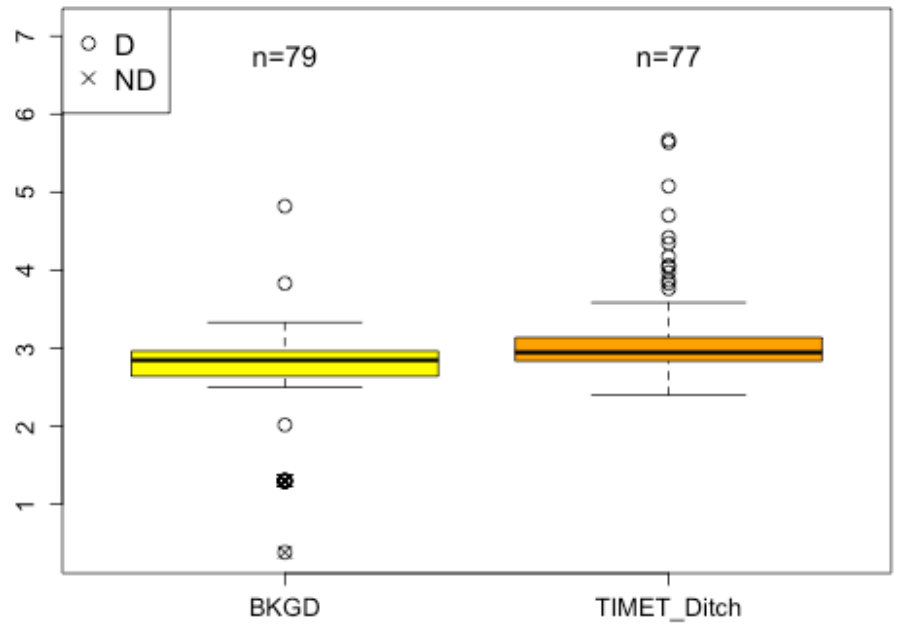

Iron Q-Q Plot
Background
Site
Concentration (mg/kg)
20000
15000
10000
-2
-1
0
1
2
Theoretical Quantiles

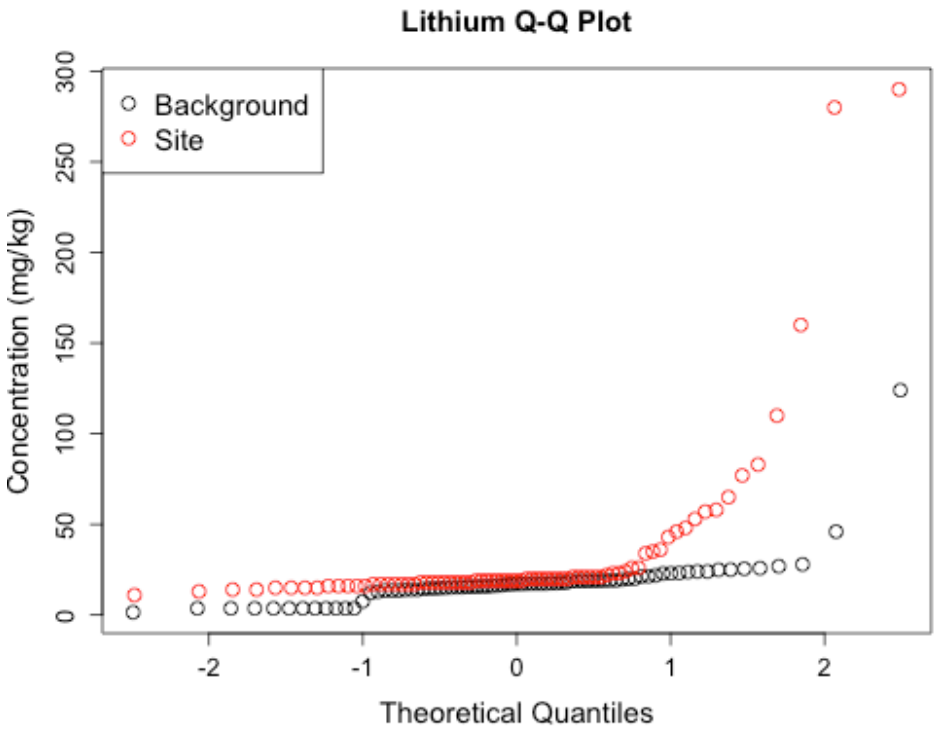

Lead
D
ND
n=79
n=77
20
15
10
5
BKGD
TIMET_Ditch

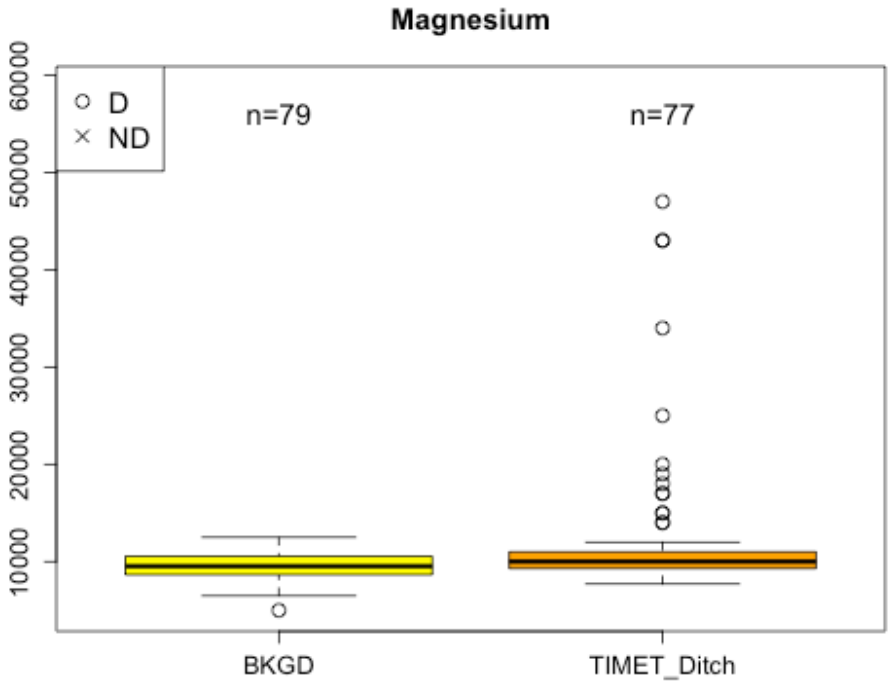

Lead (log-scale)
D
ND
n=79
n=77
3.5
3.0
2.5
2.0
1.5
BKGD
TIMET_Ditch

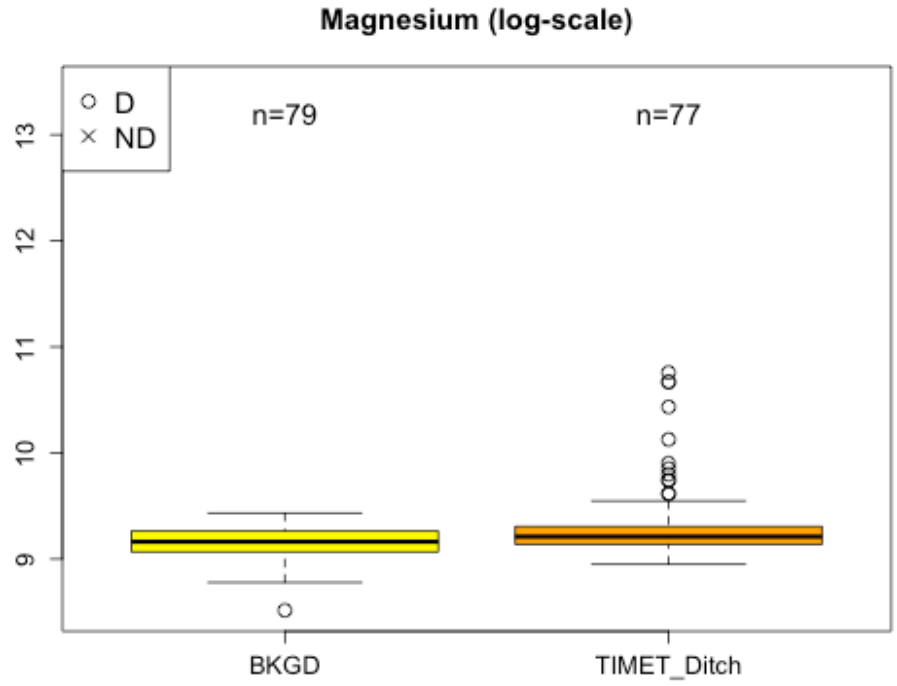

Lead Q-Q Plot
Background
Site
Concentration (mg/kg)
16
14
12
10
8
6
4
-2
-1
0
1
2
Theoretical Quantiles

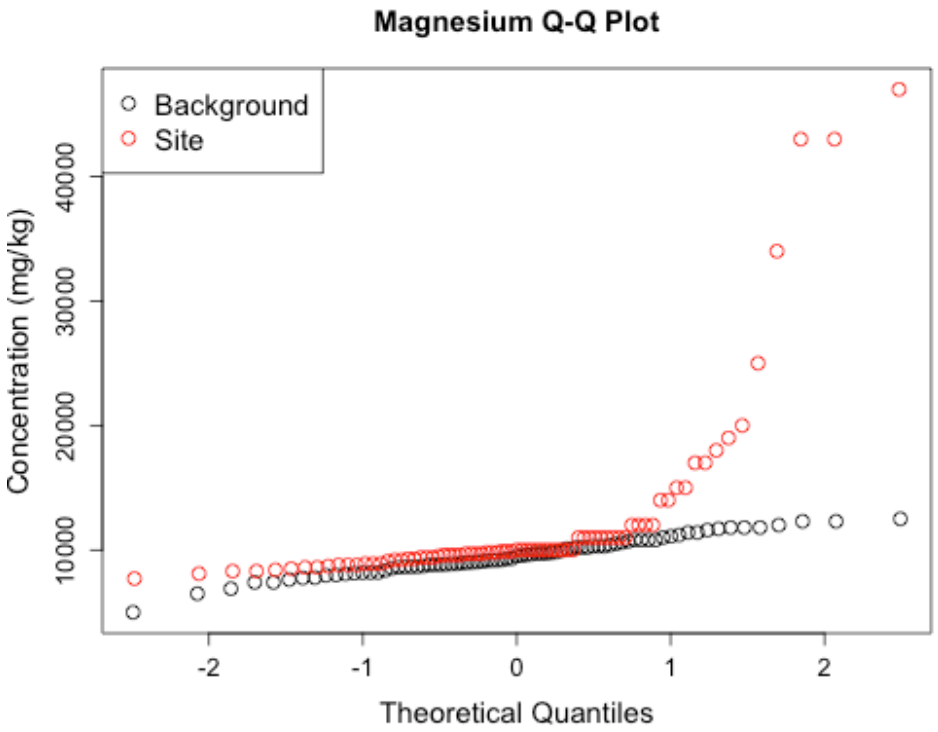

Lithium
D
ND
n=79
n=77
0
100
200
300
BKGD
TIMET_Ditch

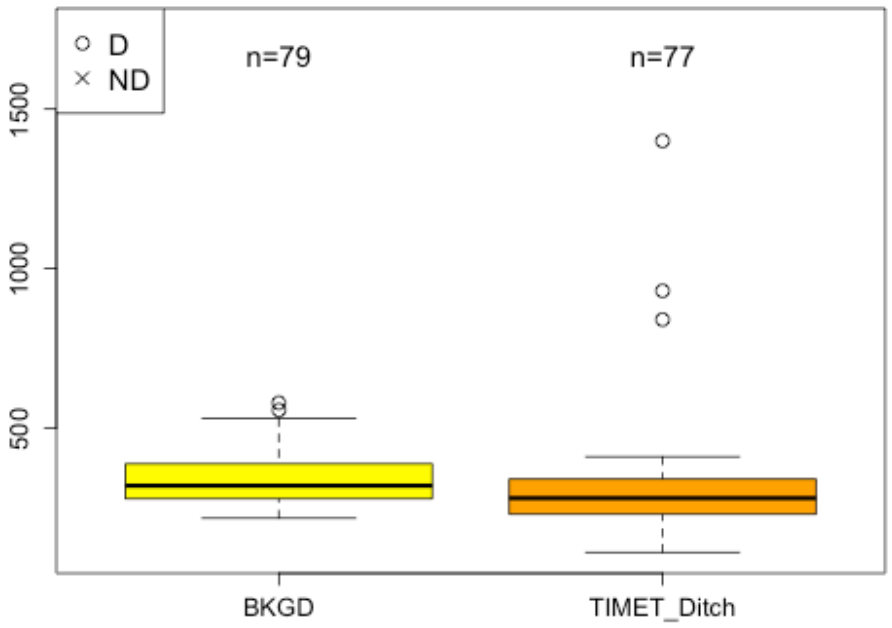

Lithium (log-scale)
D
ND
n=79
n=77
1
2
3
4
5
6
7
BKGD
TIMET_Ditch

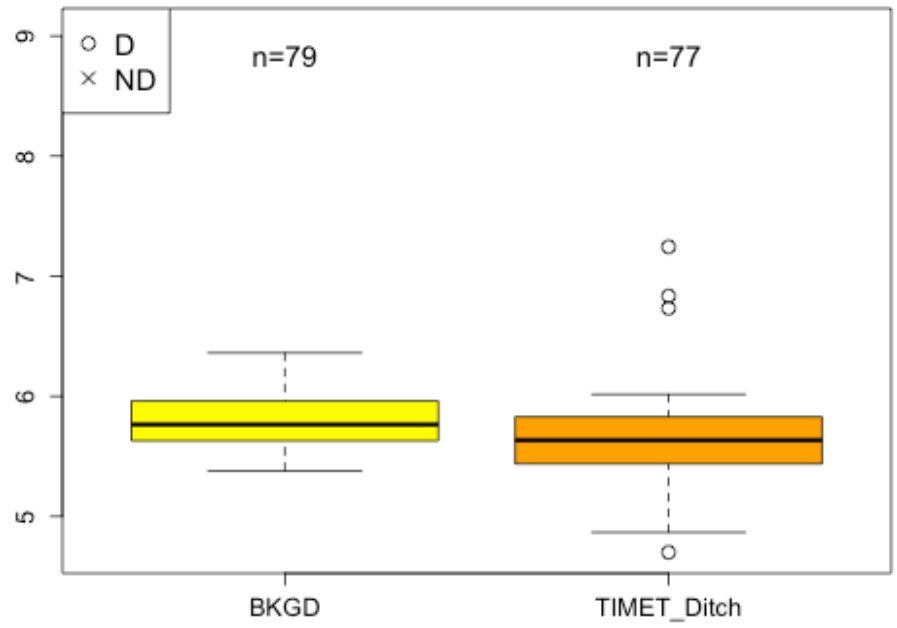

Lithium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
50
100
150
200
250
300
-2
-1
0
1
2
Theoretical Quantiles

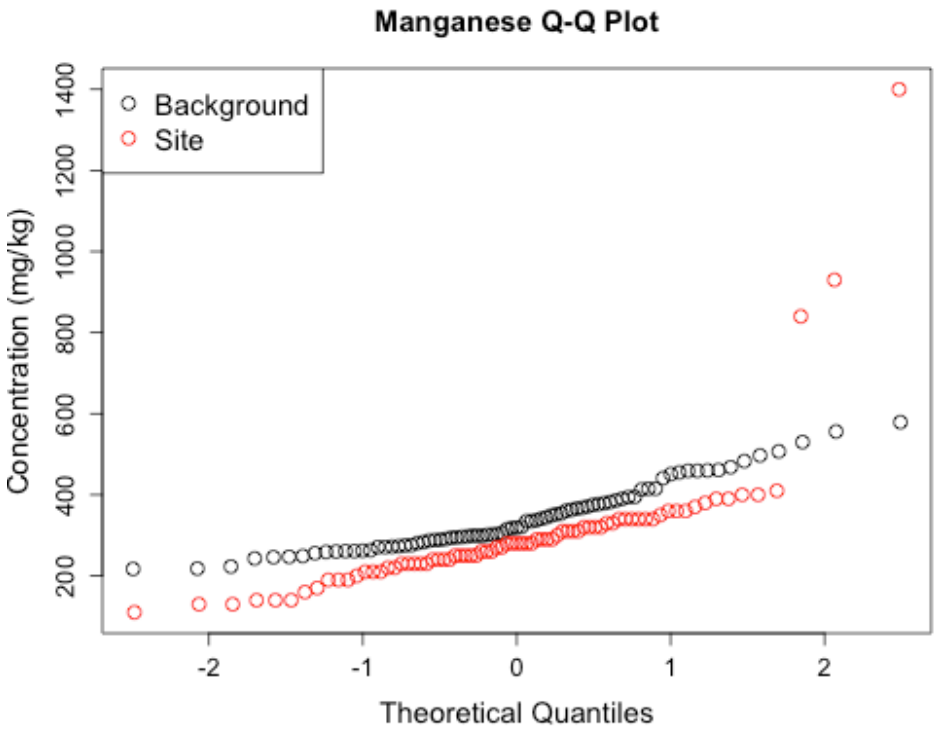

Magnesium
D
ND
n=79
n=77
10000
20000
30000
40000
50000
60000
BKGD
TIMET_Ditch

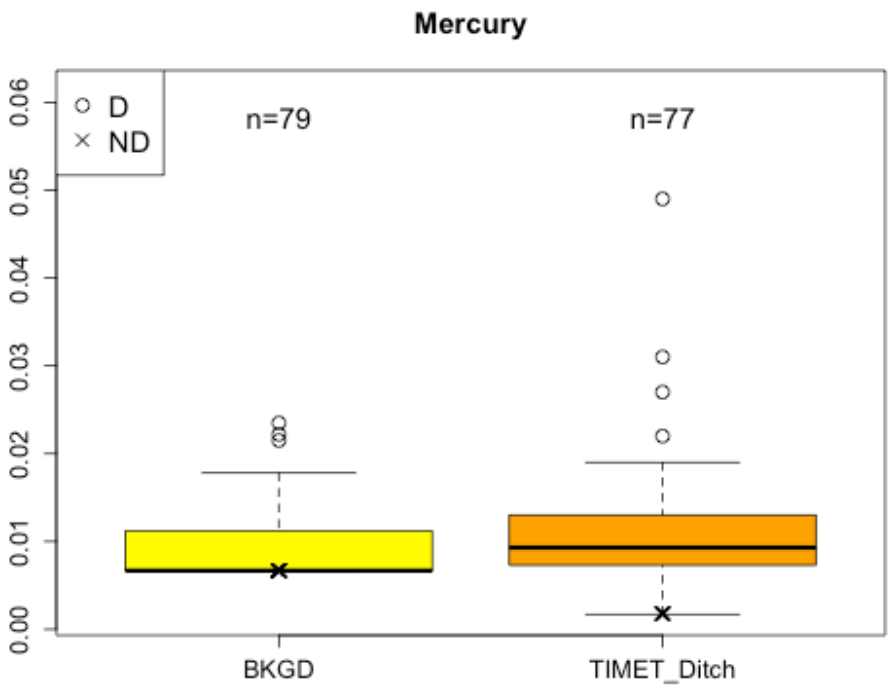

Magnesium (log-scale)
D
ND
n=79
n=77
9
10
11
12
13
BKGD
TIMET_Ditch

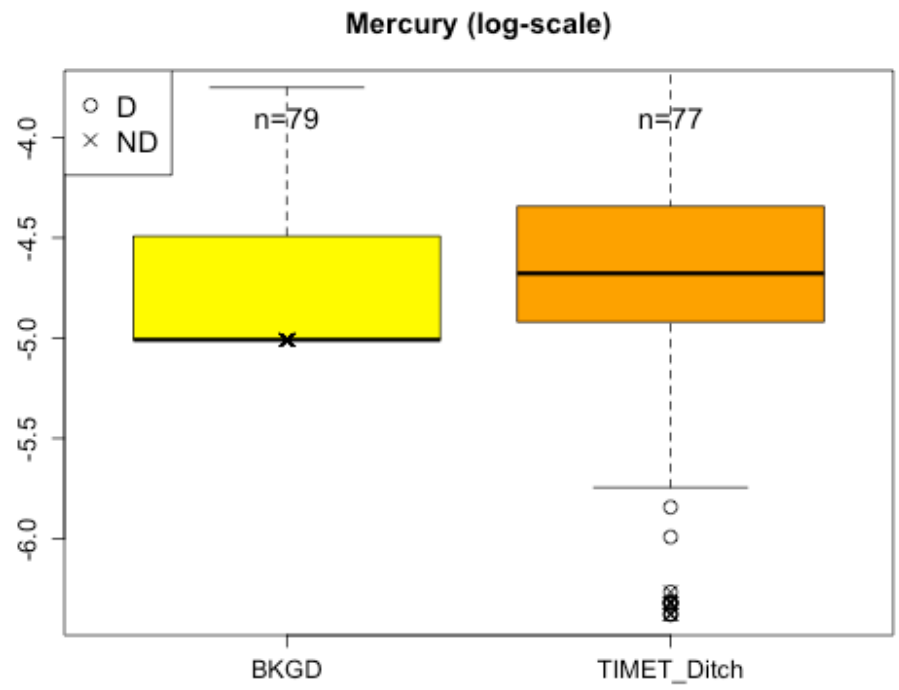

Magnesium Q-Q Plot
Background
Site
Concentration (mg/kg)
10000
20000
30000
40000
-2
-1
0
1
2
Theoretical Quantiles

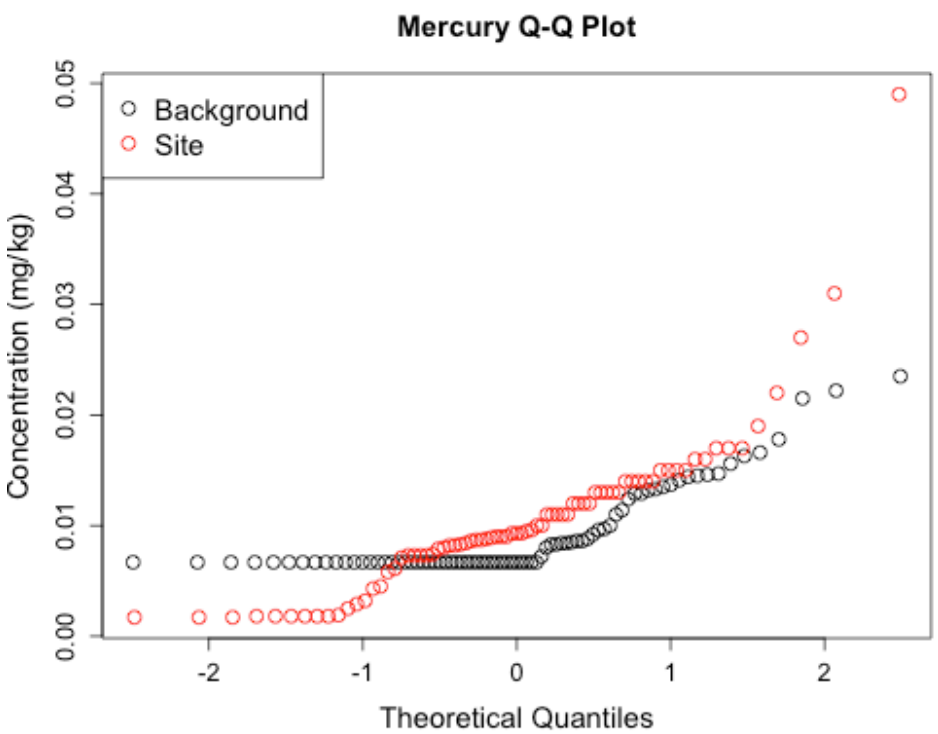

Manganese
D
ND
n=79
n=77
1500
1000
500
BKGD
TIMET_Ditch

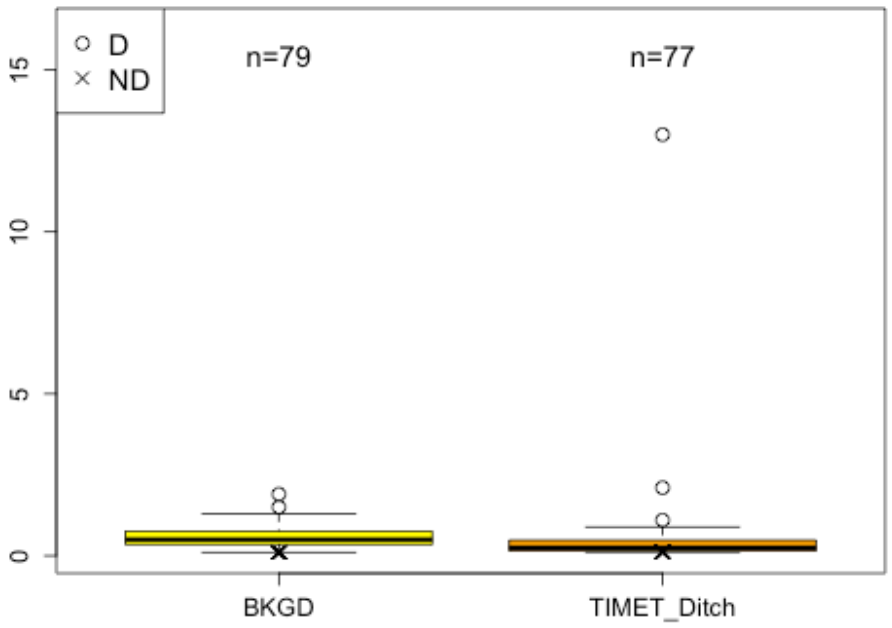

Manganese (log-scale)
D
ND
n=79
n=77
9
8
7
6
5
BKGD
TIMET_Ditch

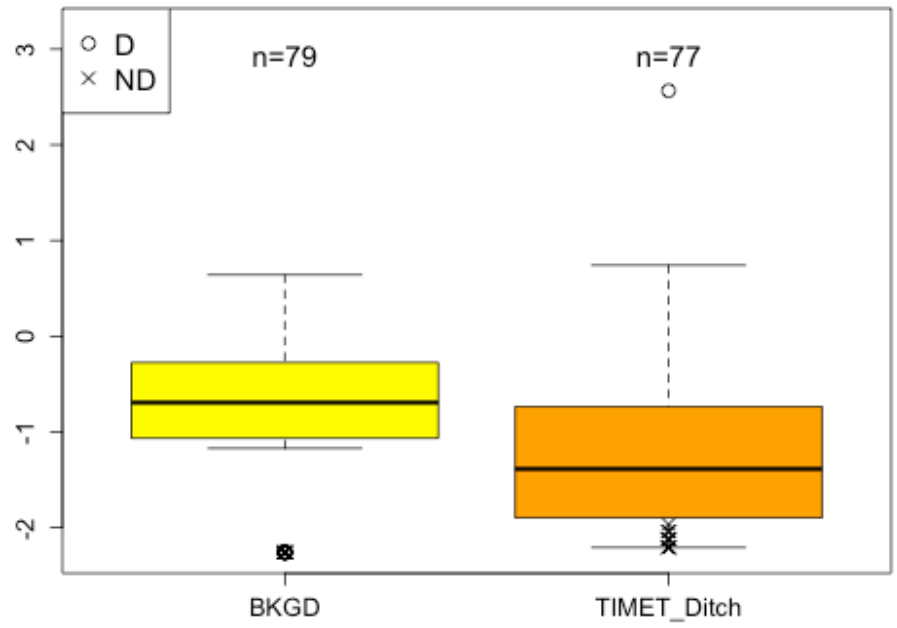

Manganese Q-Q Plot
Background
Site
Concentration (mg/kg)
1400
1200
1000
800
600
400
200
-2
-1
0
1
2
Theoretical Quantiles

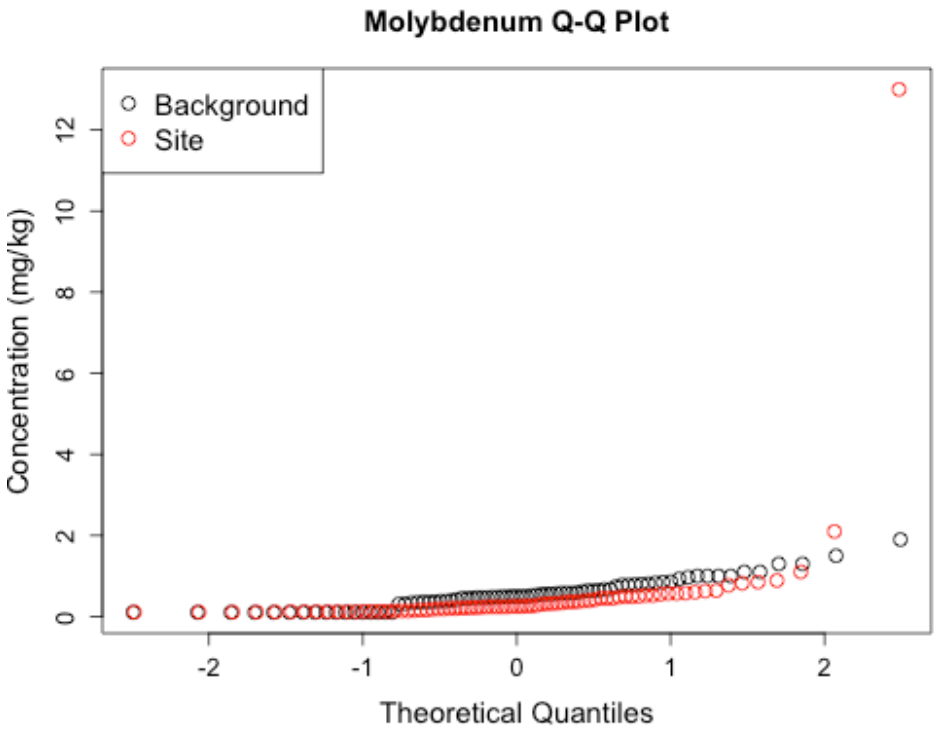

Mercury
D
ND
n=79
n=77
0.00
0.01
0.02
0.03
0.04
0.05
0.06
BKGD
TIMET_Ditch

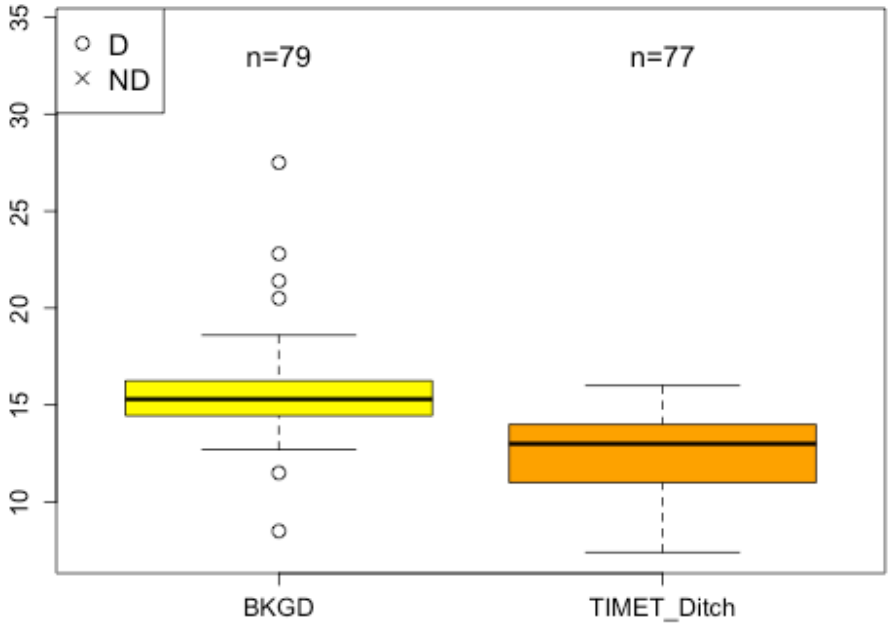

Mercury (log-scale)
D
ND
n=79
n=77
-4.0
-4.5
-5.0
-5.5
-6.0
BKGD
TIMET_Ditch

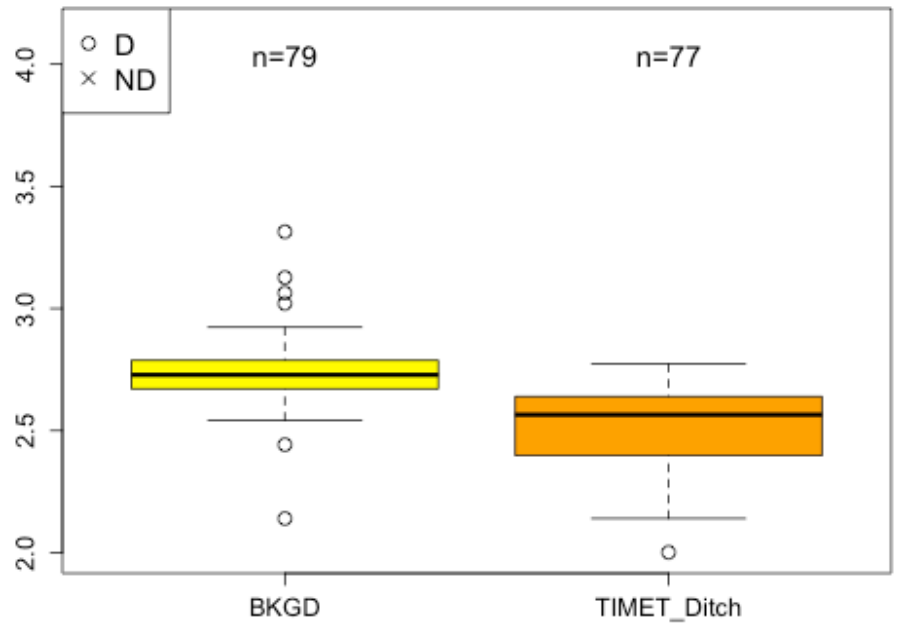

Mercury Q-Q Plot
Background
Site
Concentration (mg/kg)
0.00
0.01
0.02
0.03
0.04
0.05
-2
-1
0
1
2
Theoretical Quantiles

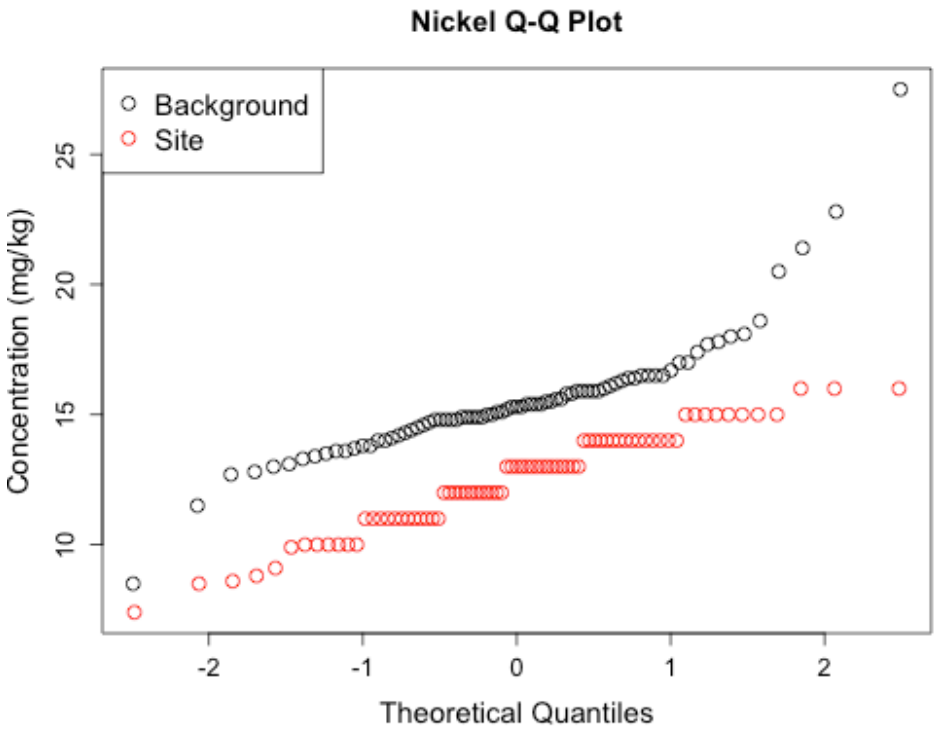

Molybdenum
D
ND
n=79
n=77
0
5
10
15
BKGD
TIMET_Ditch

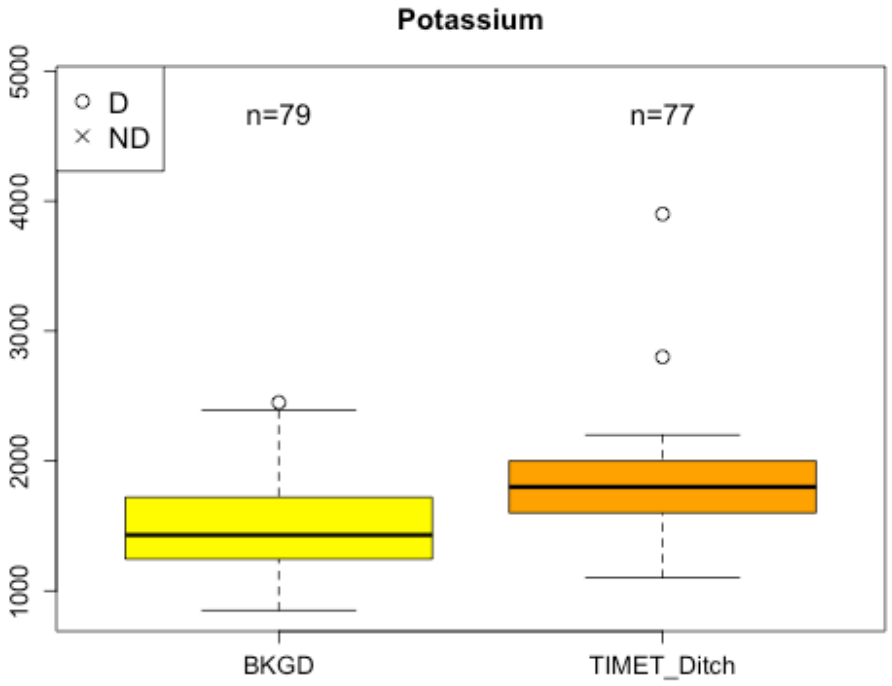

Molybdenum (log-scale)
D
ND
n=79
n=77
-2
-1
0
1
2
3
BKGD
TIMET_Ditch

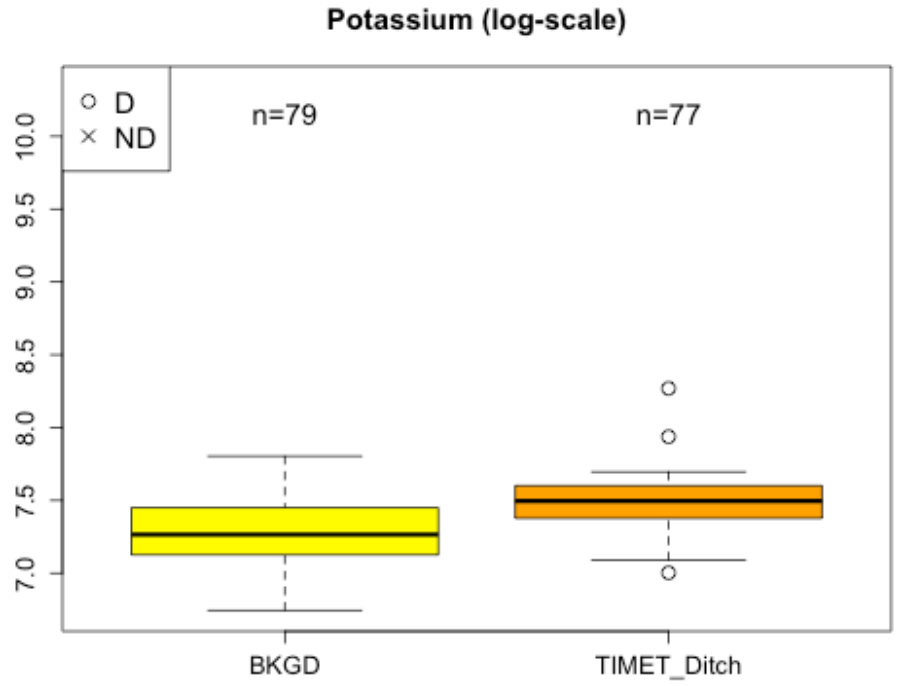

Molybdenum Q-Q Plot
Background
Site
Concentration (mg/kg)
0
2
4
6
8
10
12
-2
-1
0
1
2
Theoretical Quantiles

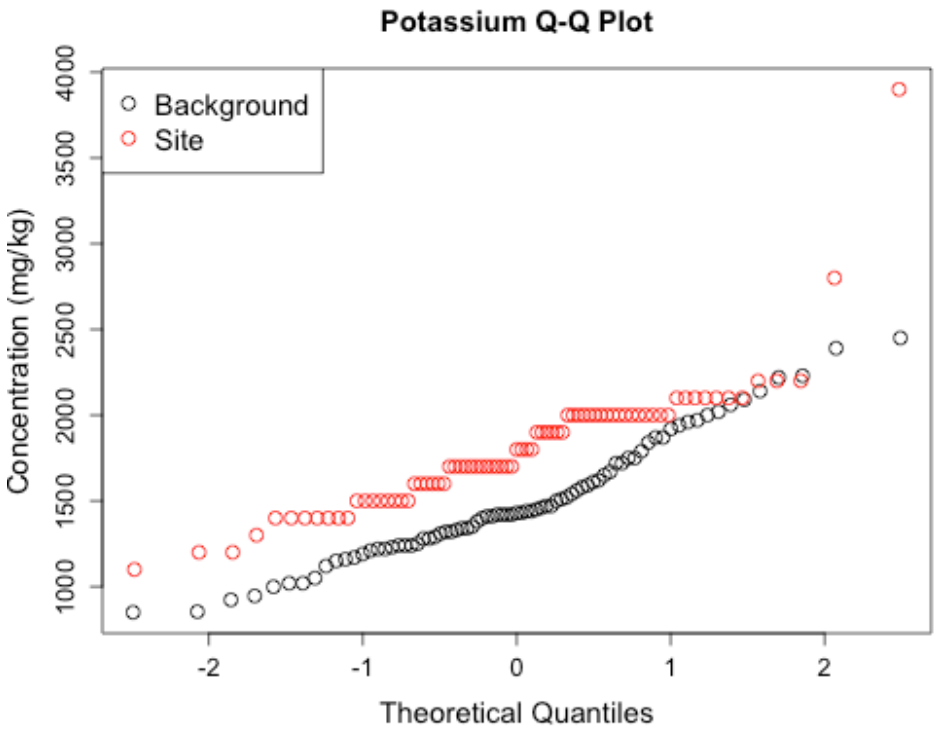

Nickel
D
ND
n=79
n=77
35
30
25
20
15
10
BKGD
TIMET_Ditch

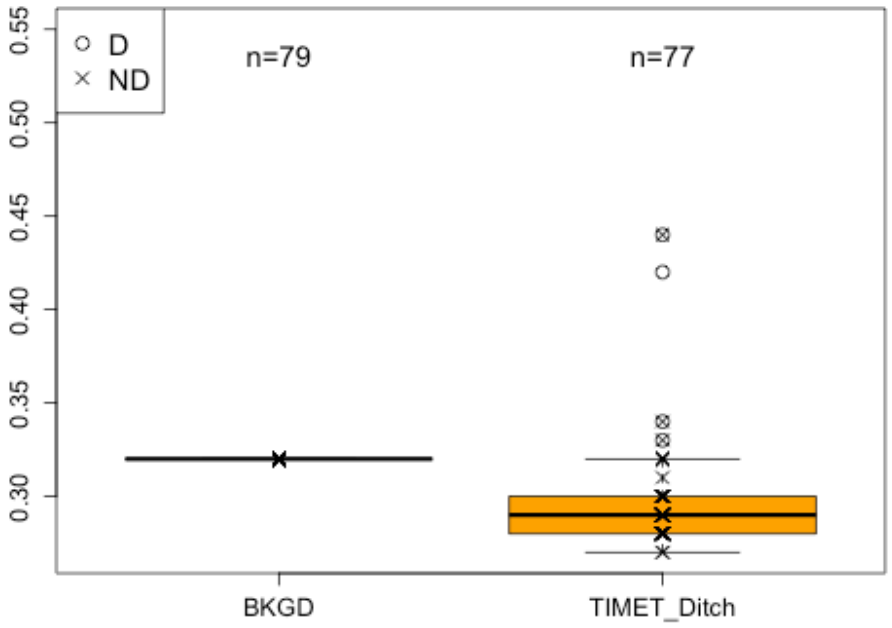

Nickel (log-scale)
D
ND
n=79
n=77
4.0
3.5
3.0
2.5
2.0
BKGD
TIMET_Ditch

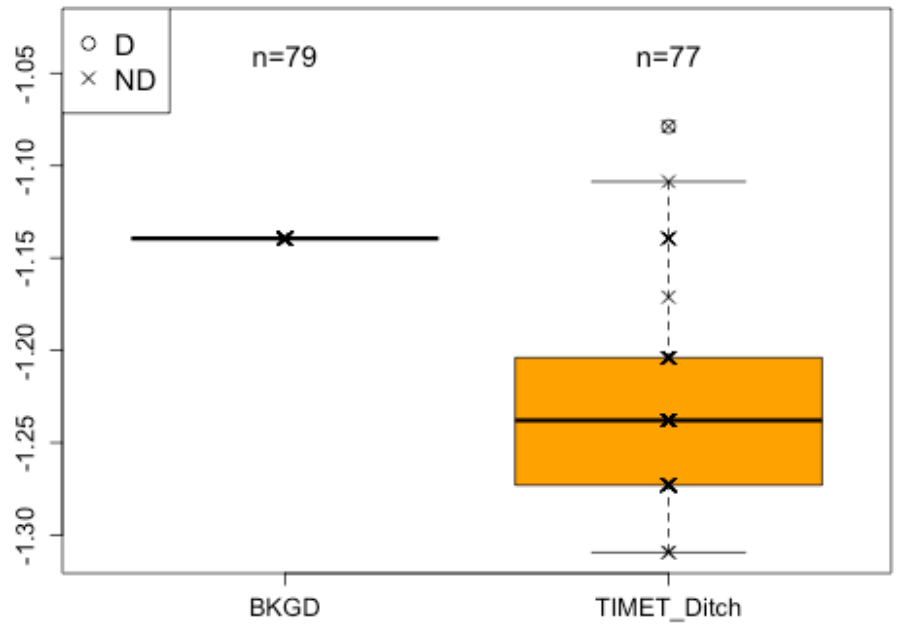

Nickel Q-Q Plot
Background
Site
Concentration (mg/kg)
25
20
15
10
-2
-1
0
1
2
Theoretical Quantiles

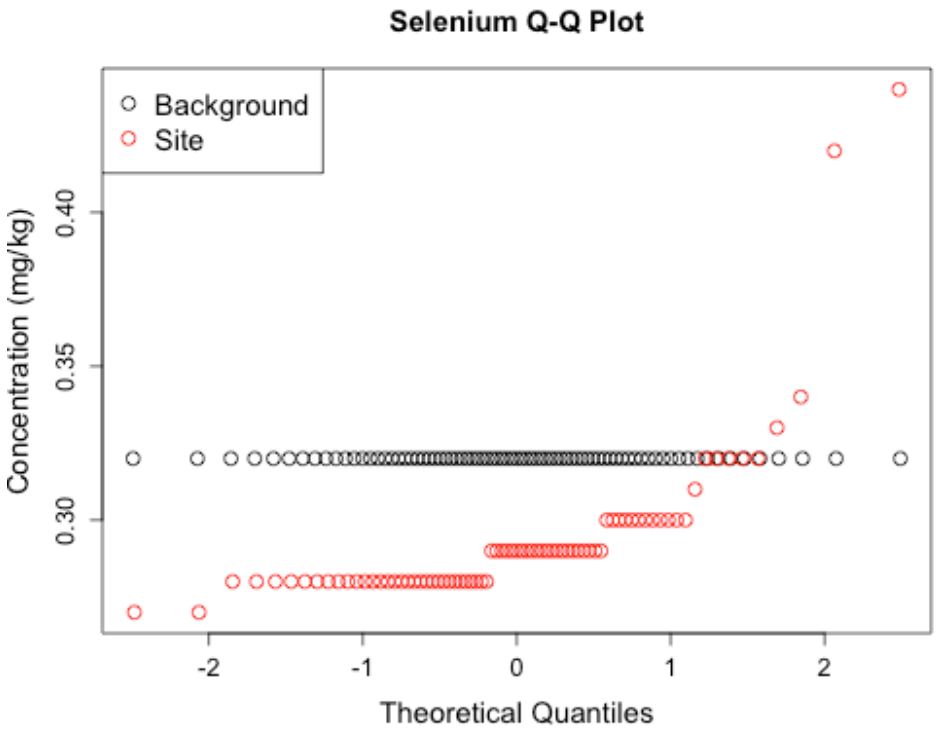

Potassium
D
ND
n=79
n=77
5000
4000
3000
2000
1000
BKGD
TIMET_Ditch

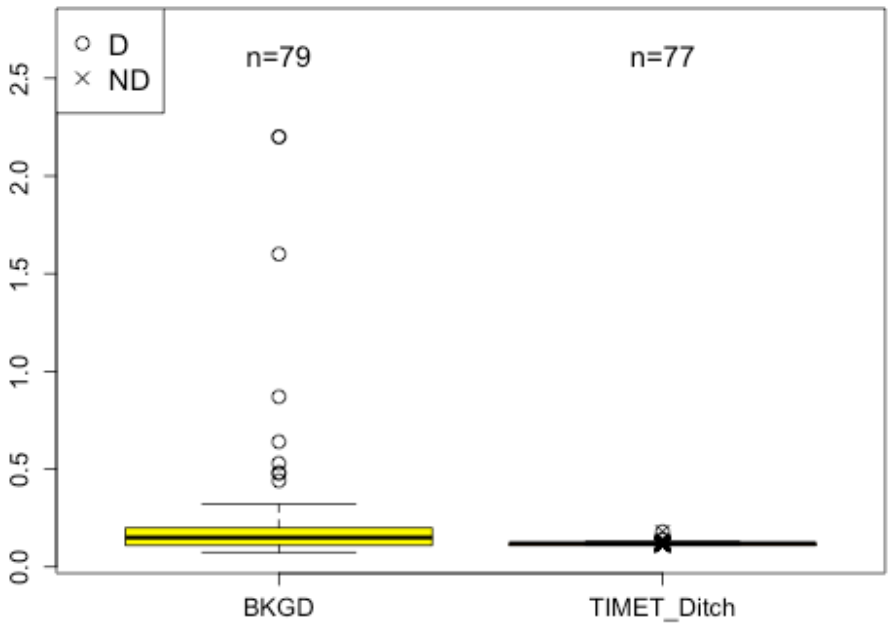

Potassium (log-scale)
D
ND
n=79
n=77
10.0
9.5
9.0
8.5
8.0
7.5
7.0
BKGD
TIMET_Ditch

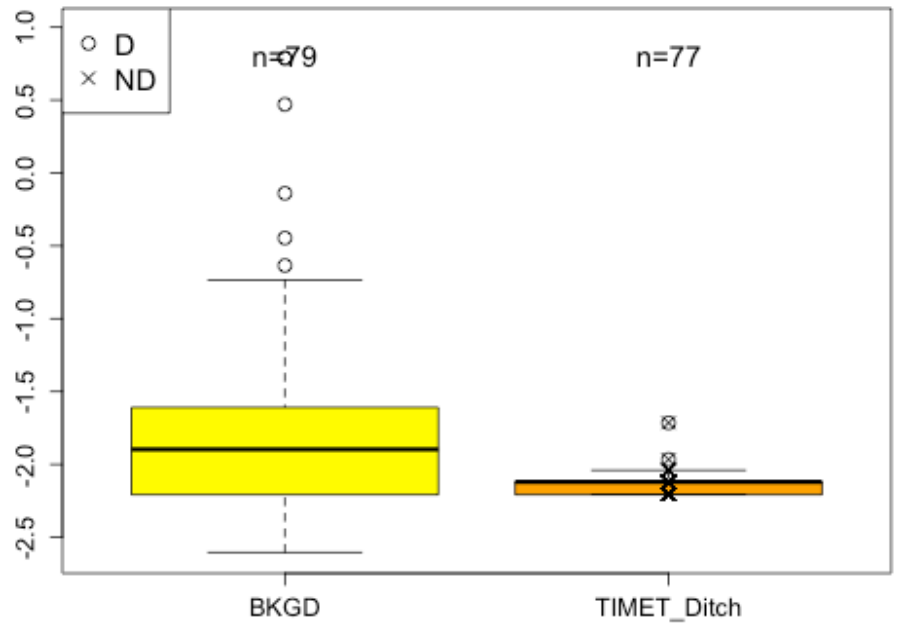

Potassium Q-Q Plot
Background
Site
Concentration (mg/kg)
4000
3500
3000
2500
2000
1500
1000
-2
-1
0
1
2
Theoretical Quantiles

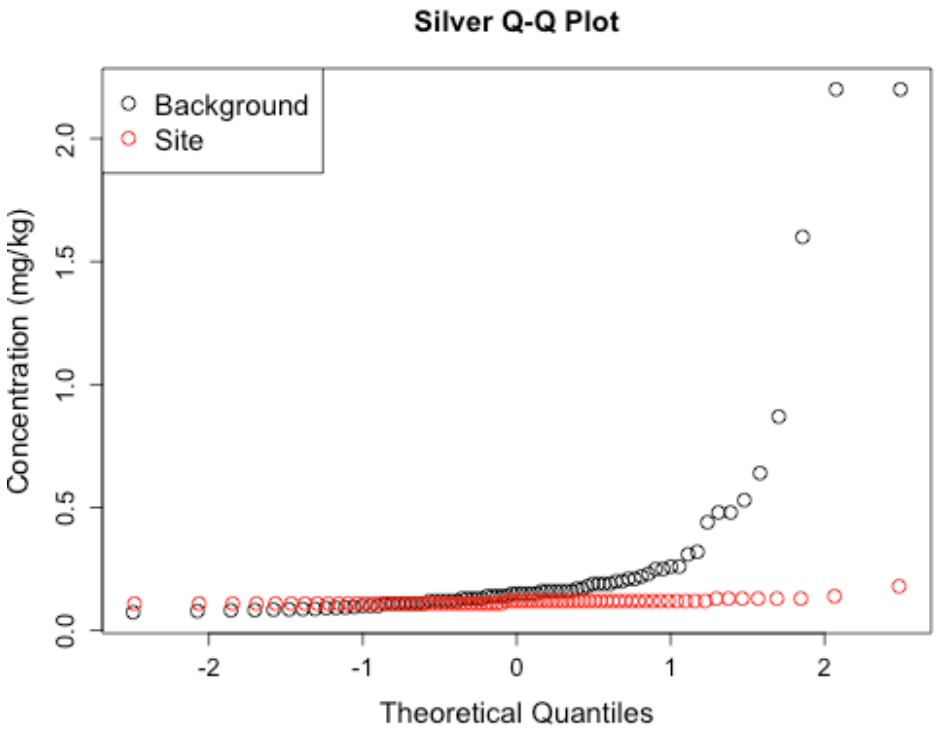

Selenium
D
ND
n=79
n=77
0.30
0.35
0.40
0.45
0.50
0.55
BKGD
TIMET_Ditch

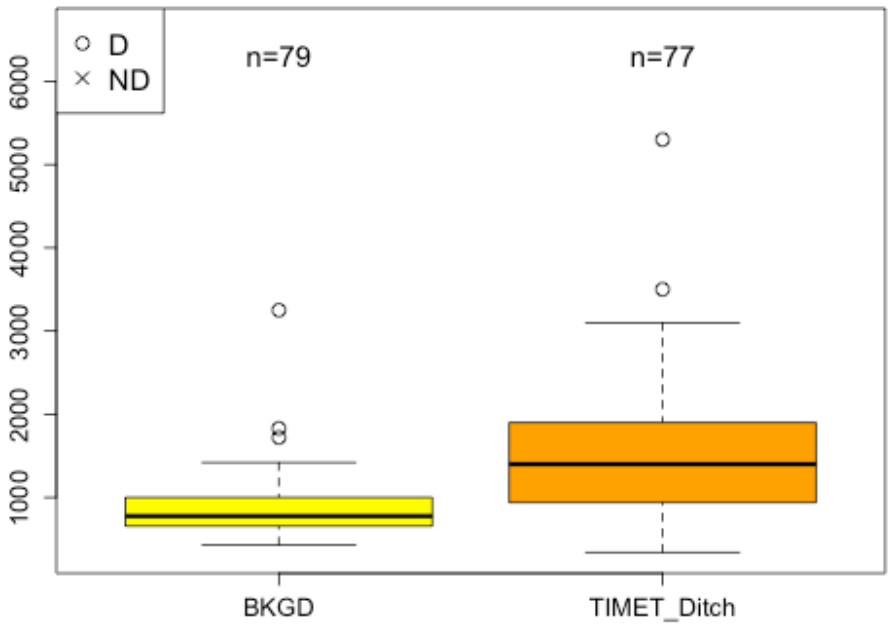

Selenium (log-scale)
D
ND
n=79
n=77
-1.05
-1.10
-1.15
-1.20
-1.25
-1.30
BKGD
TIMET_Ditch

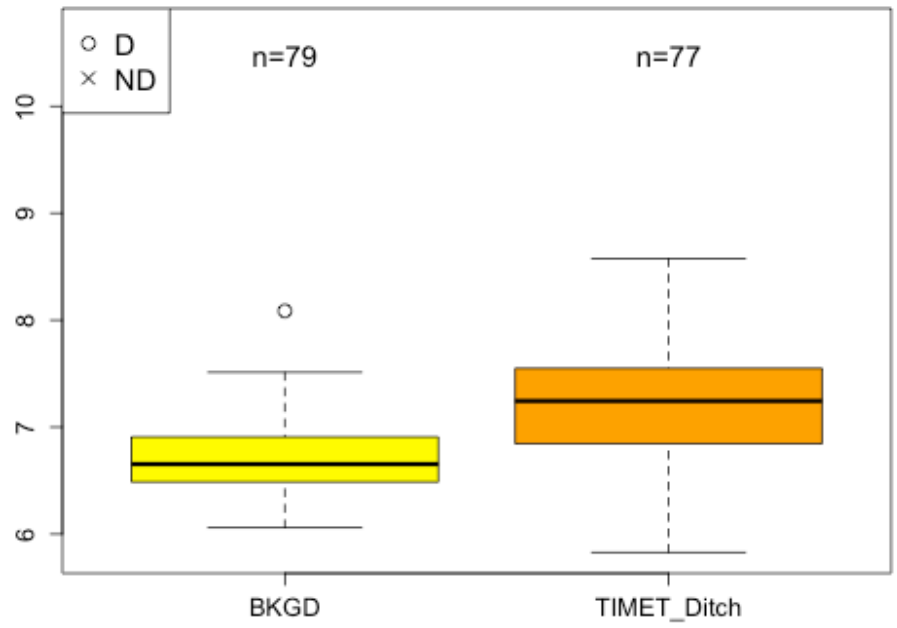

Selenium Q-Q Plot
Background
Site
Concentration (mg/kg)
0.30
0.35
0.40
-2
-1
0
1
2
Theoretical Quantiles

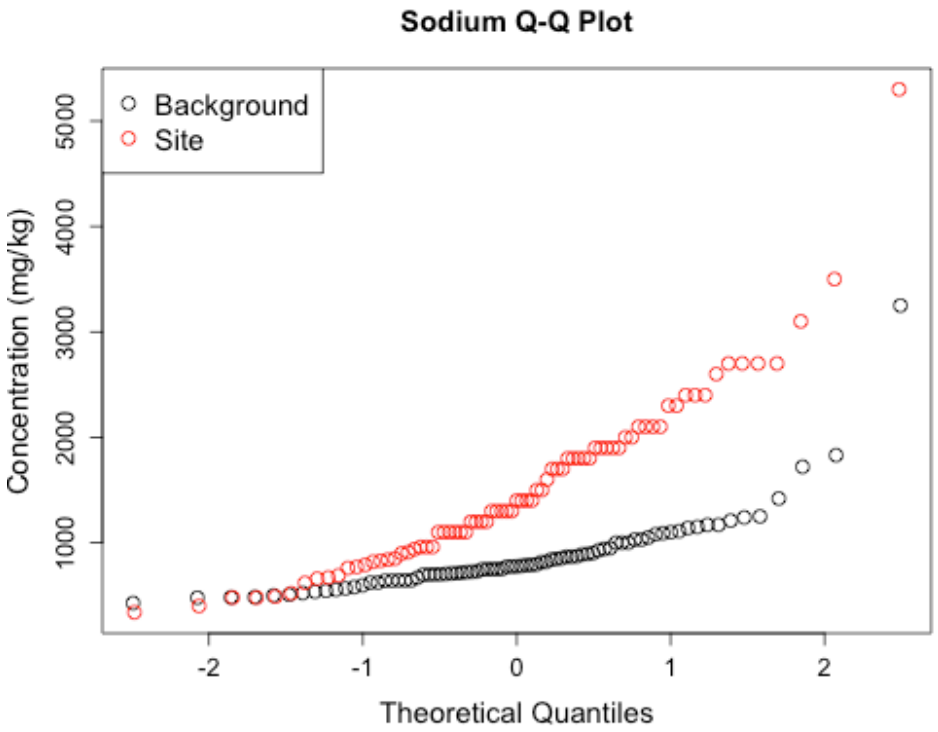

Silver
D
ND
n=79
n=77
0.0
0.5
1.0
1.5
2.0
2.5
BKGD
TIMET_Ditch

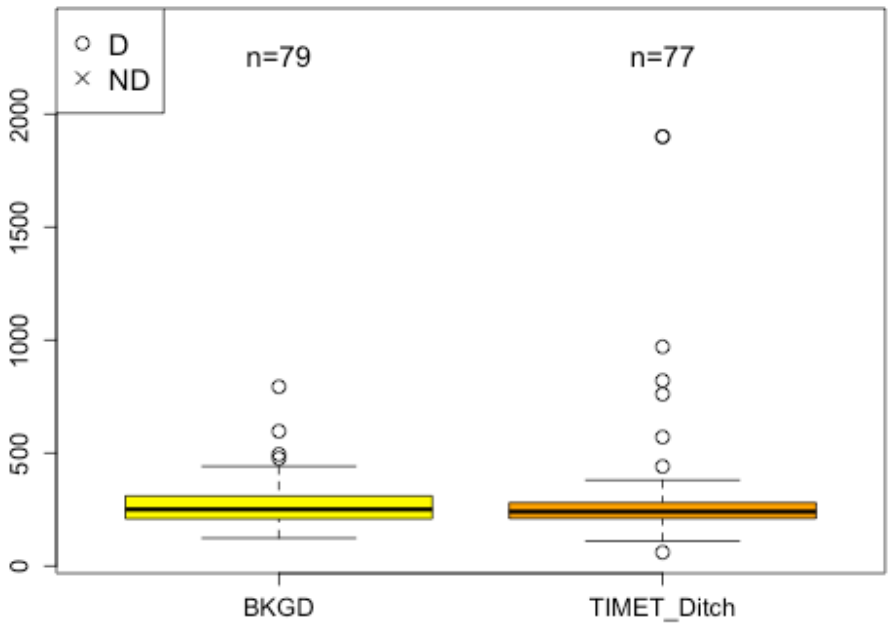

Silver (log-scale)
D
ND
n=79
n=77
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
BKGD
TIMET_Ditch

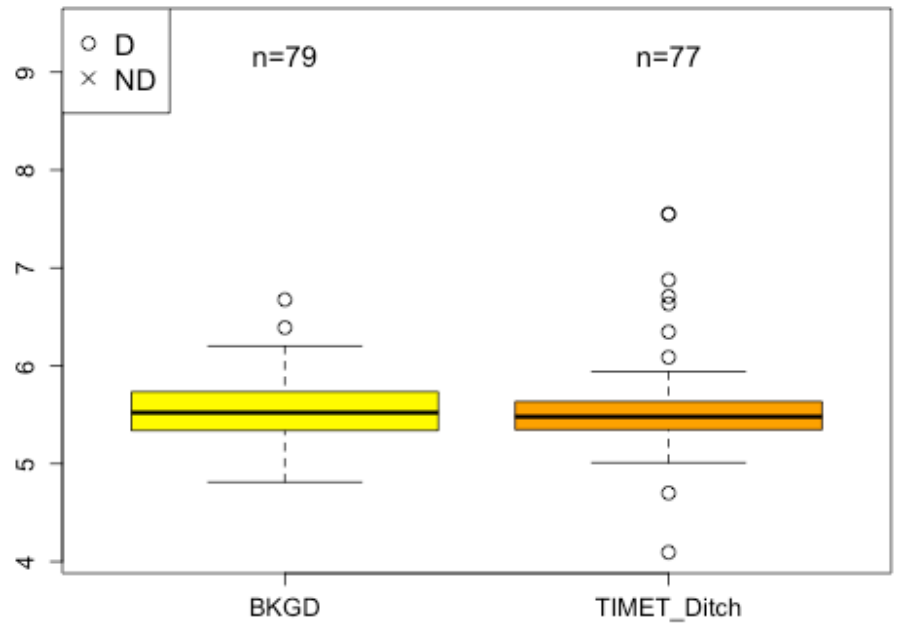

Silver Q-Q Plot
Background
Site
Concentration (mg/kg)
0.0
0.5
1.0
1.5
2.0
-2
-1
0
1
2
Theoretical Quantiles

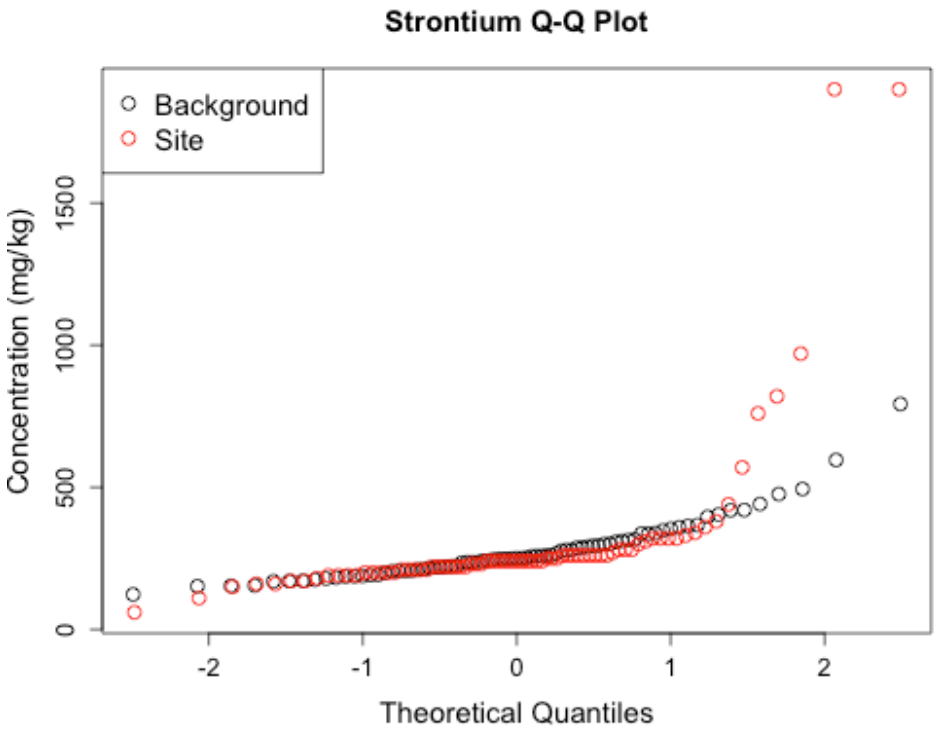

Sodium
D
ND
n=79
n=77
1000
2000
3000
4000
5000
6000
BKGD
TIMET_Ditch

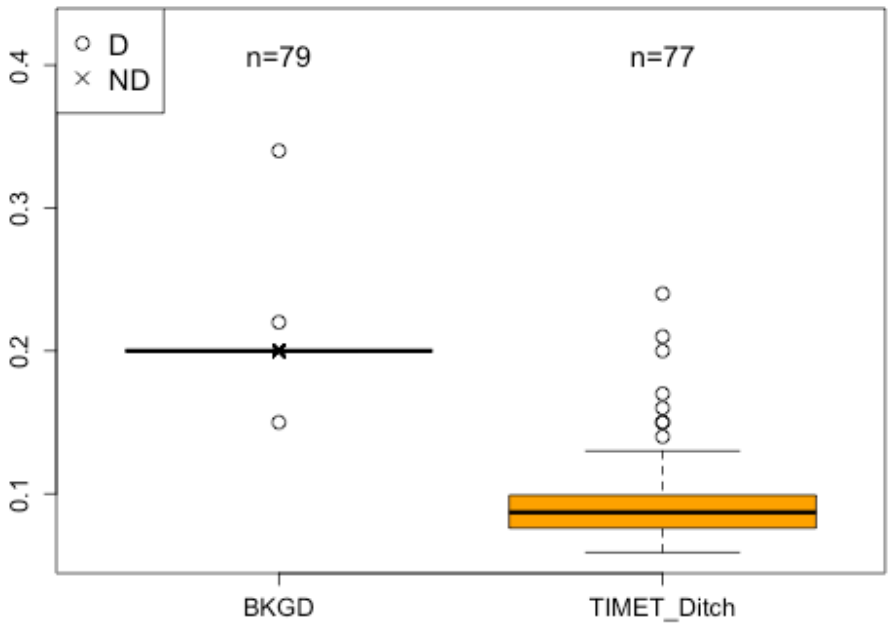

Sodium (log-scale)
D
ND
n=79
n=77
6
7
8
9
10
BKGD
TIMET_Ditch

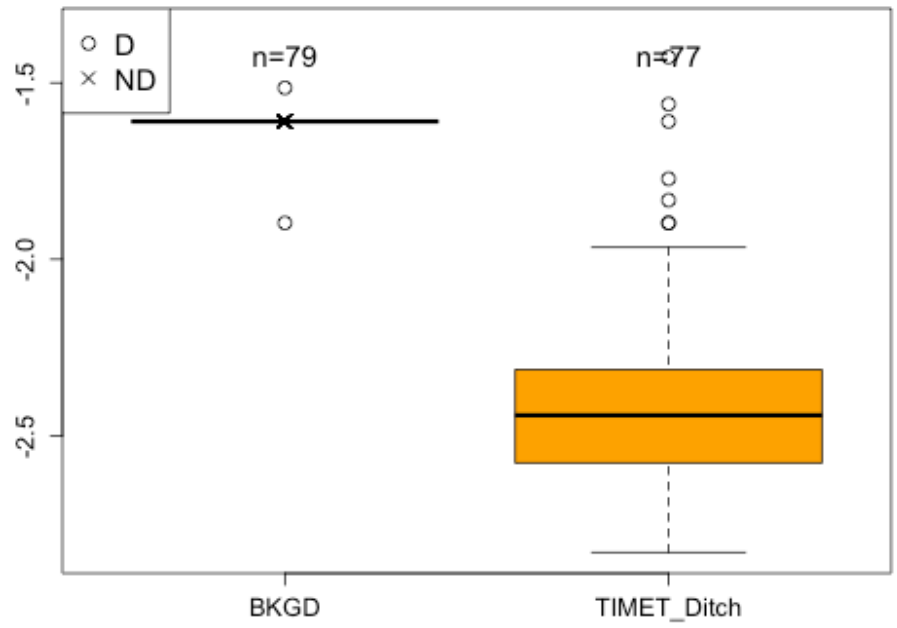

Sodium Q-Q Plot
Background
Site
Concentration (mg/kg)
1000
2000
3000
4000
5000
-2
-1
0
1
2
Theoretical Quantiles

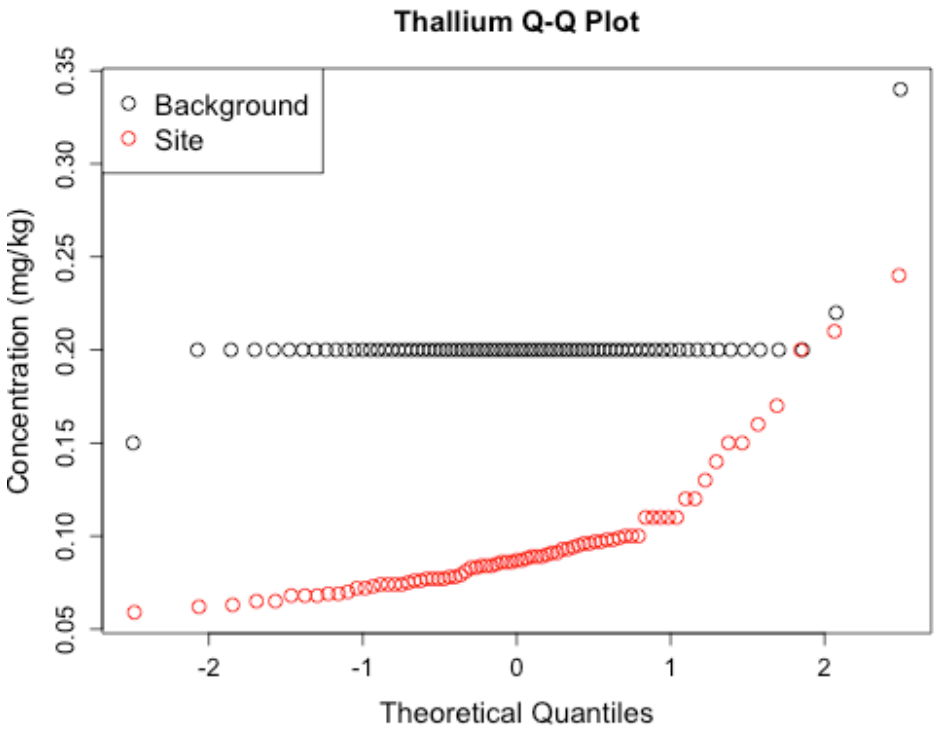

Strontium
D
ND
n=79
n=77
0
500
1000
1500
2000
BKGD
TIMET_Ditch

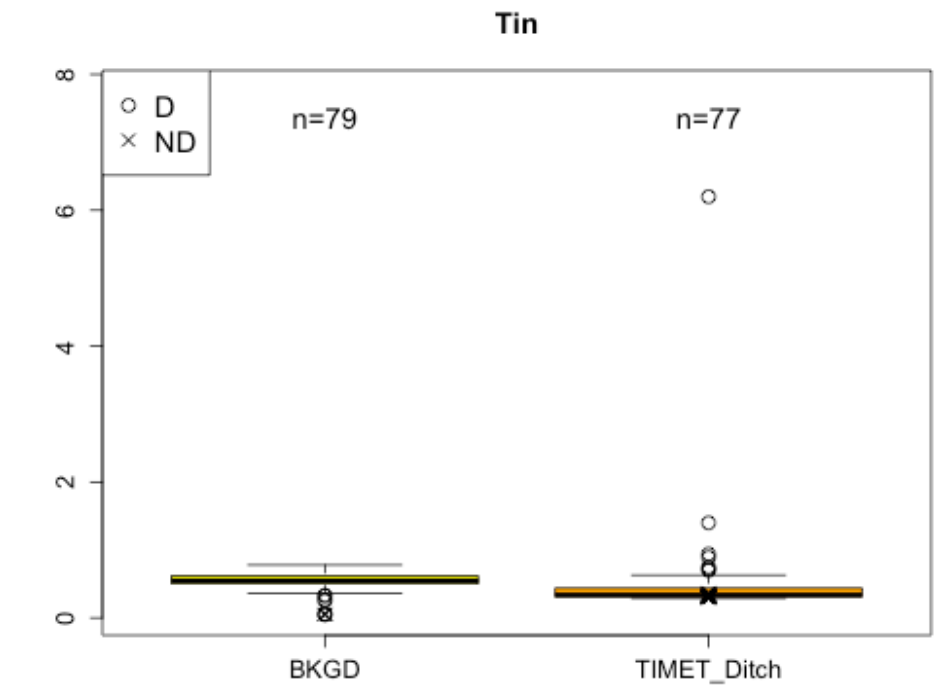

Strontium (log-scale)
D
ND
n=79
n=77
4
5
6
7
8
9
BKGD
TIMET_Ditch

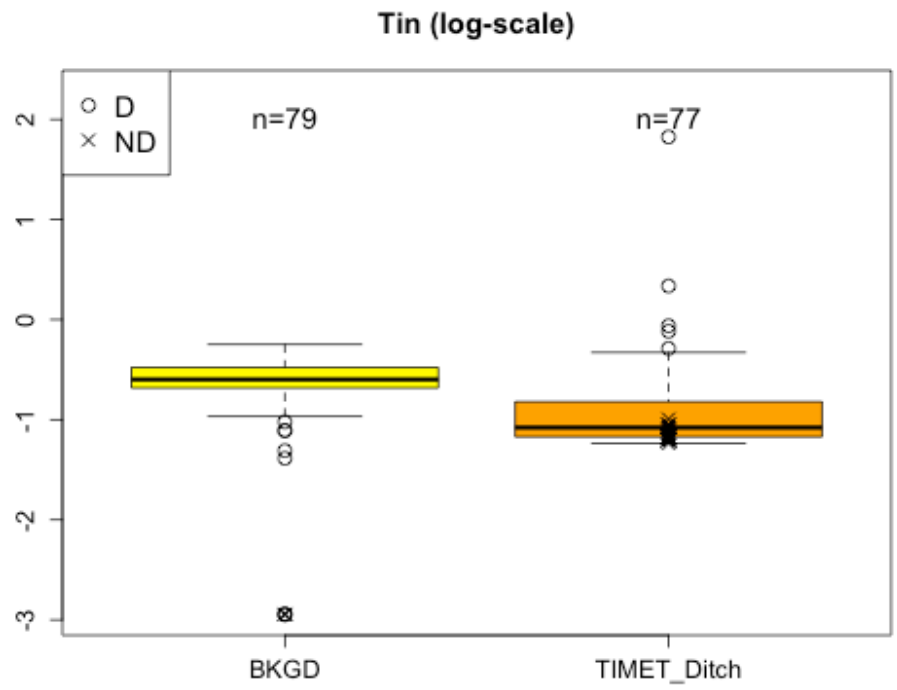

Strontium Q-Q Plot
Background
Site
Concentration (mg/kg)
0
500
1000
1500
-2
-1
0
1
2
Theoretical Quantiles

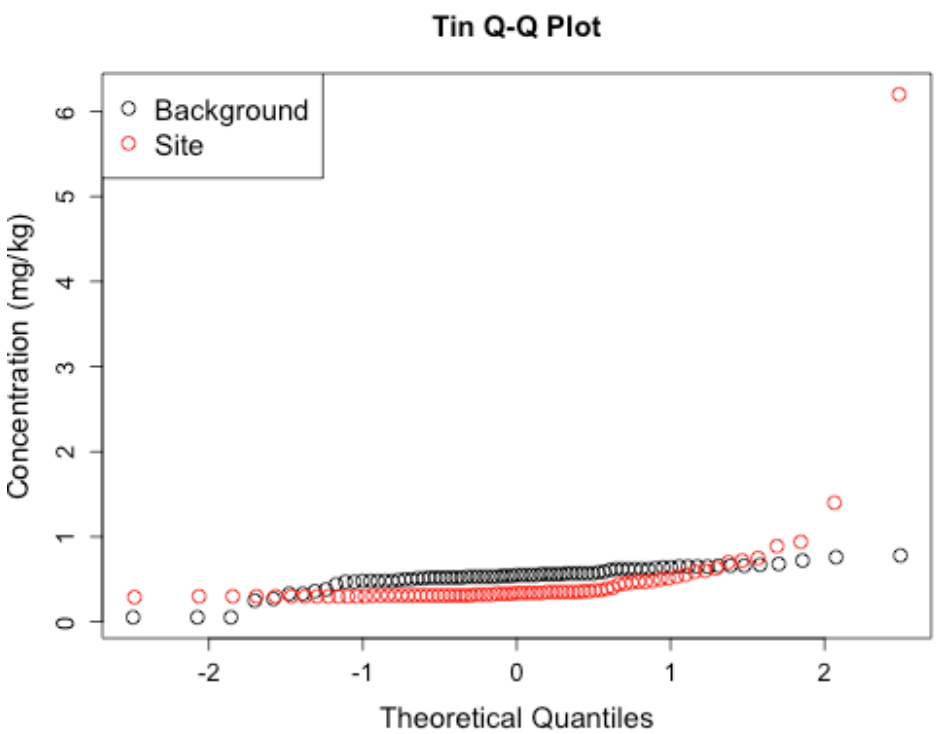

Thallium
D
ND
n=79
n=77
0.4
0.3
0.2
0.1
BKGD
TIMET_Ditch

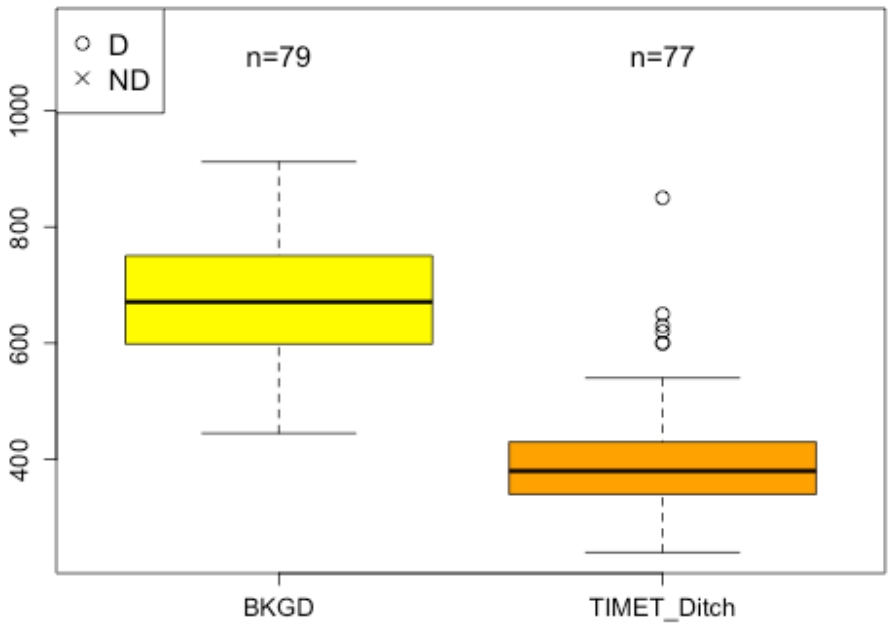

Thallium (log-scale)
D
ND
n=79
n=77
-1.5
-2.0
-2.5
BKGD
TIMET_Ditch

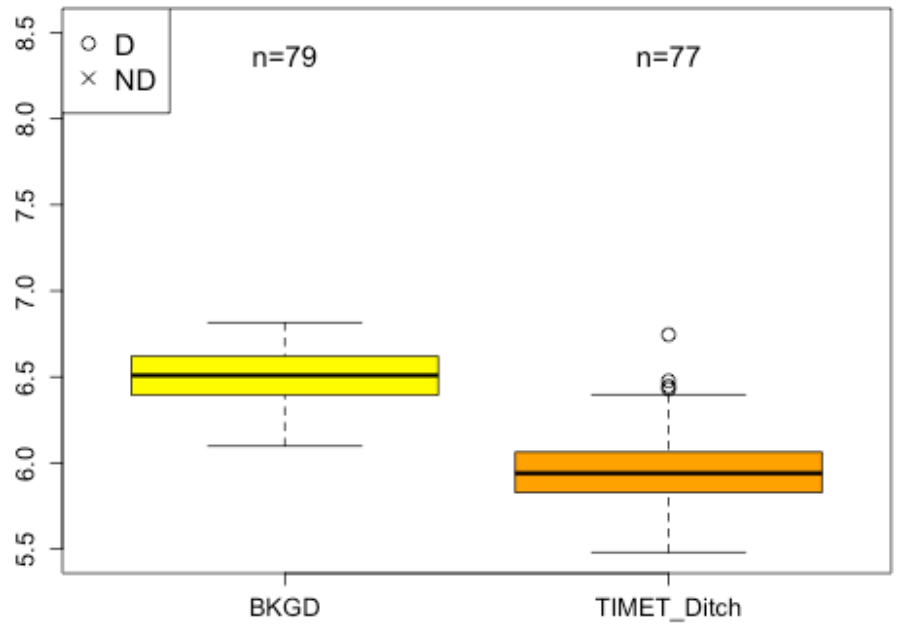

Thallium Q-Q Plot
Background
Site
Concentration (mg/kg)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-2
-1
0
1
2
Theoretical Quantiles

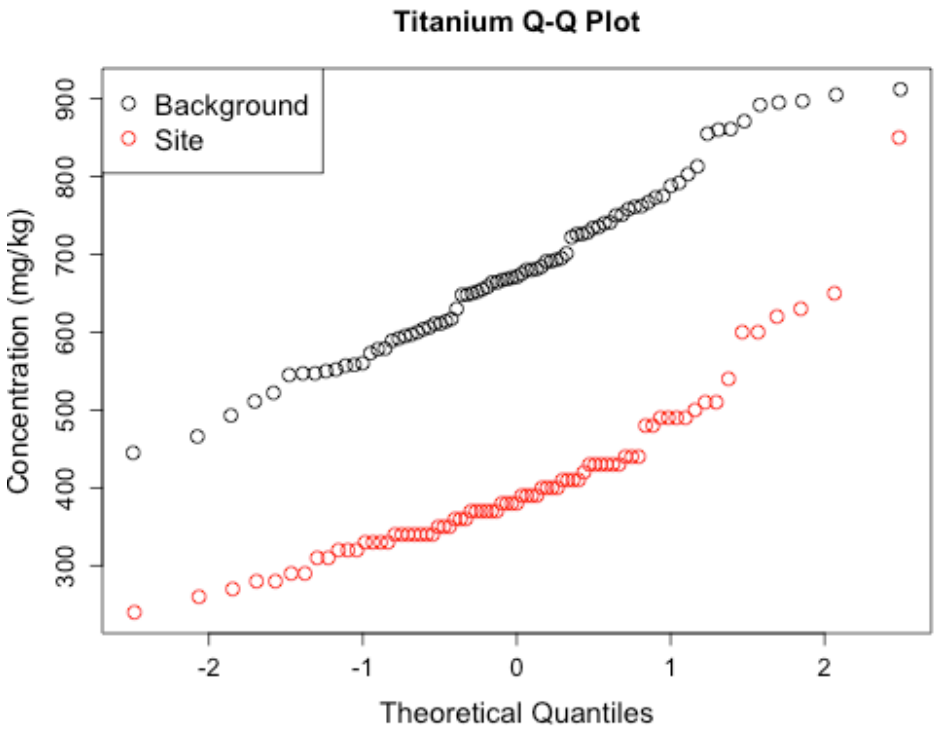

Tin
D
ND
n=79
n=77
0
2
4
6
8
BKGD
TIMET_Ditch

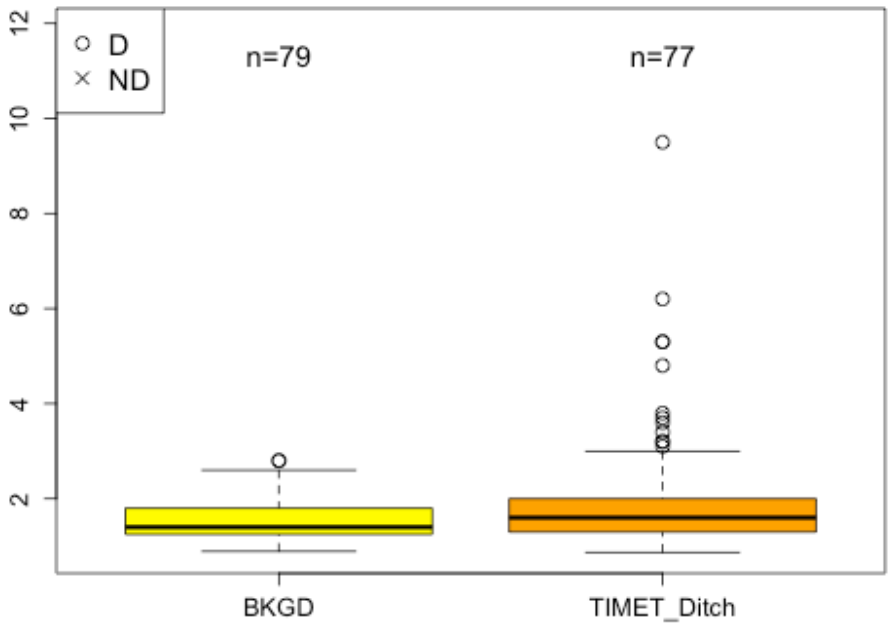

Tin (log-scale)
D
ND
n=79
n=77
-3
-2
-1
0
1
2
BKGD
TIMET_Ditch

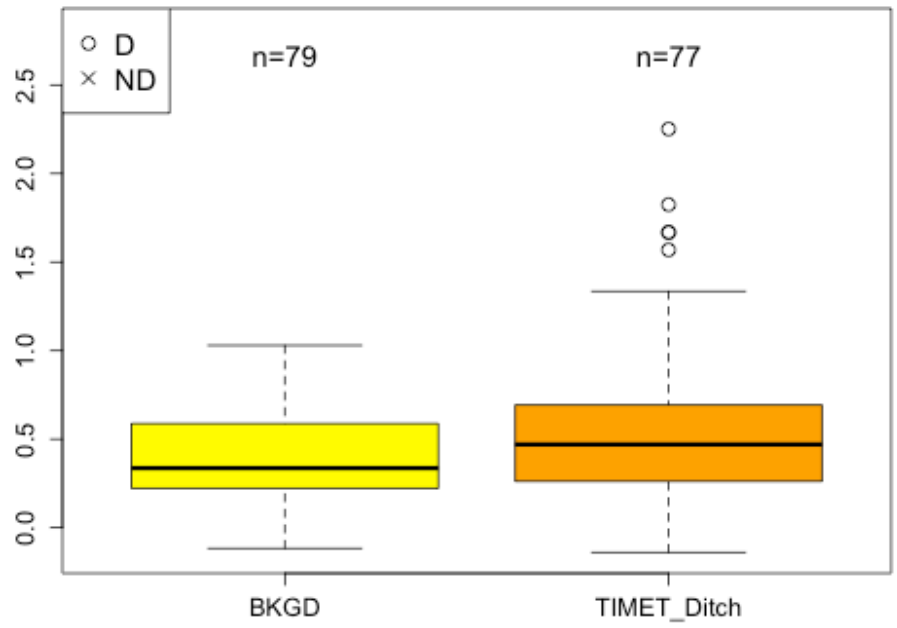

Tin Q-Q Plot
Background
Site
Concentration (mg/kg)
0
1
2
3
4
5
6
-2
-1
0
1
2
Theoretical Quantiles

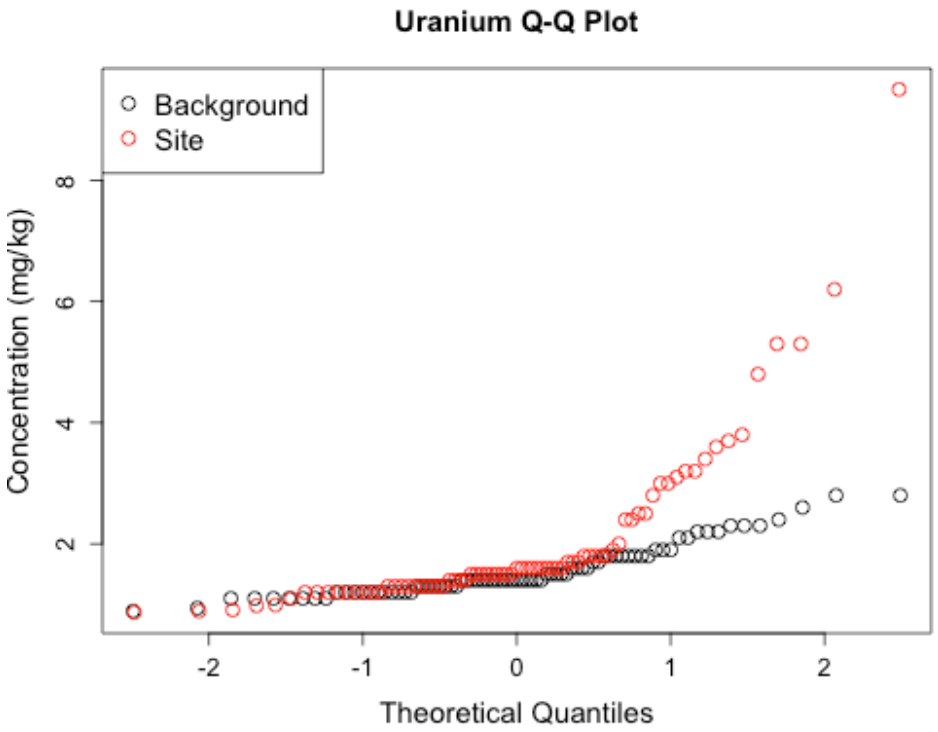

Titanium
D
ND
n=79
n=77
1000
800
600
400
BKGD
TIMET_Ditch

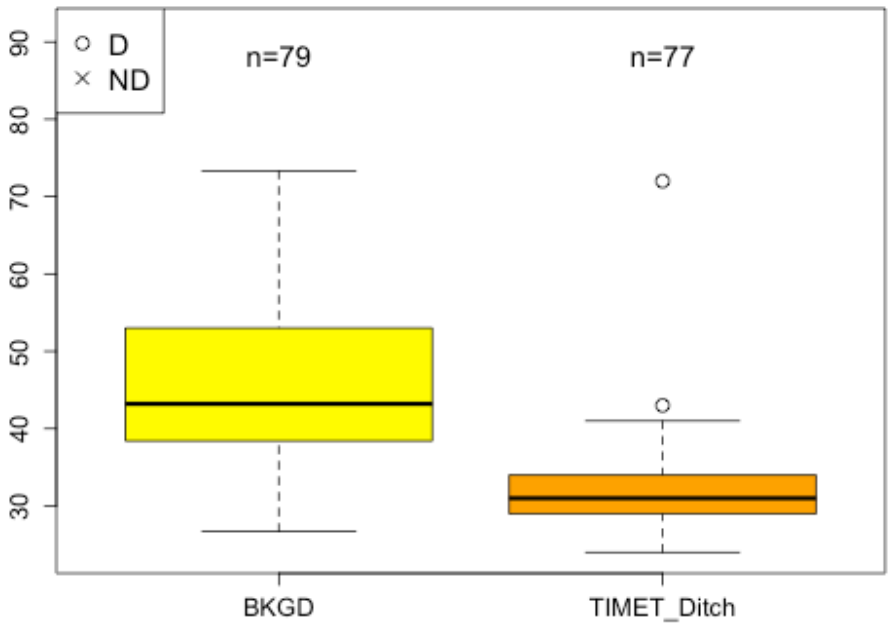

Titanium (log-scale)
D
ND
n=79
n=77
8.5
8.0
7.5
7.0
6.5
6.0
5.5
BKGD
TIMET_Ditch

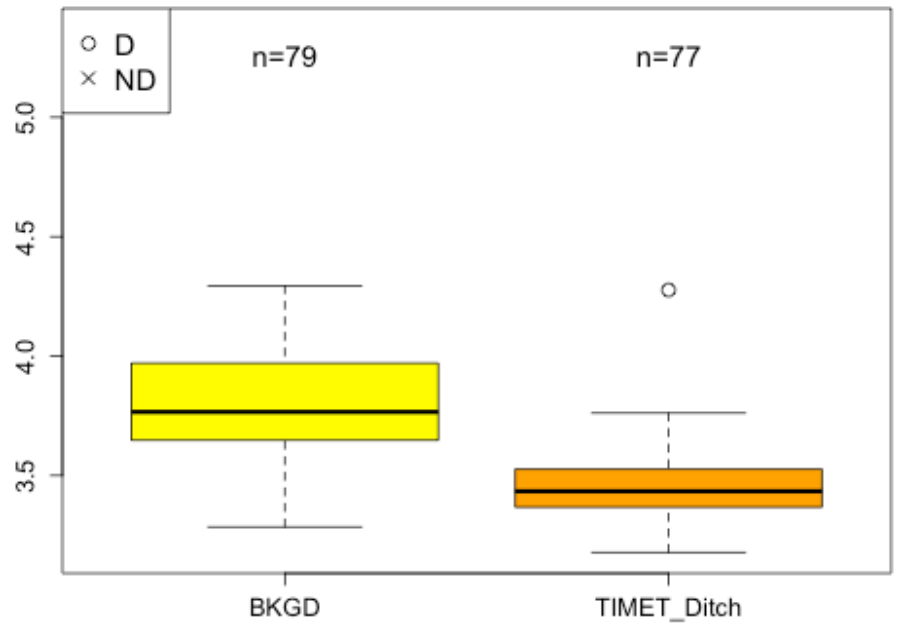

Titanium Q-Q Plot
Background
Site
Concentration (mg/kg)
900
800
700
600
500
400
300
-2
-1
0
1
2
Theoretical Quantiles

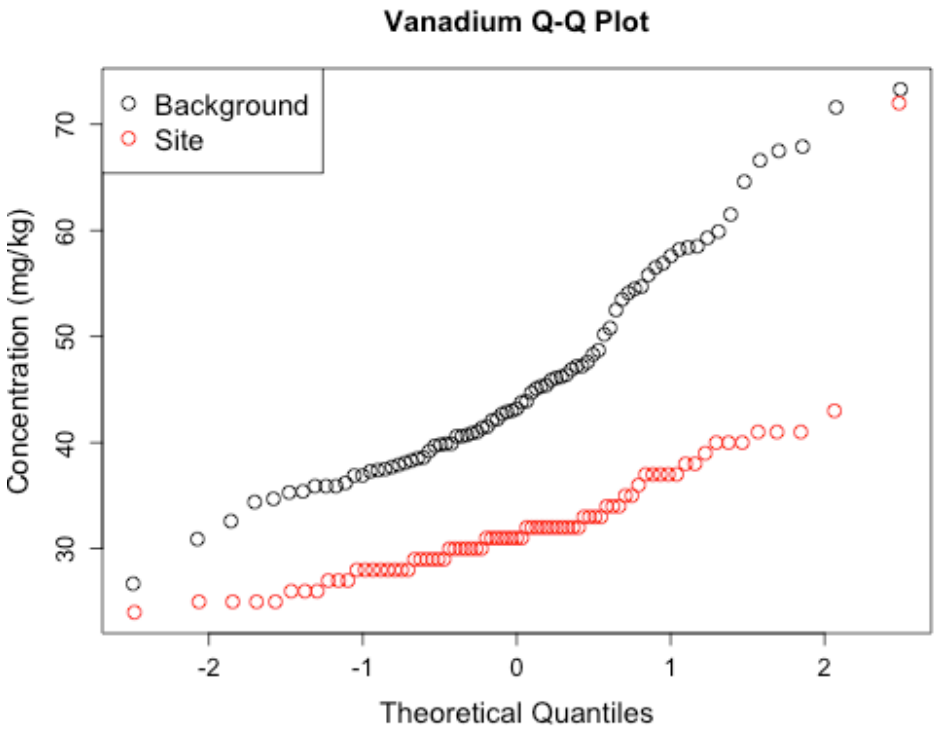

Uranium
D
ND
n=79
n=77
12
10
8
6
4
2
BKGD
TIMET_Ditch

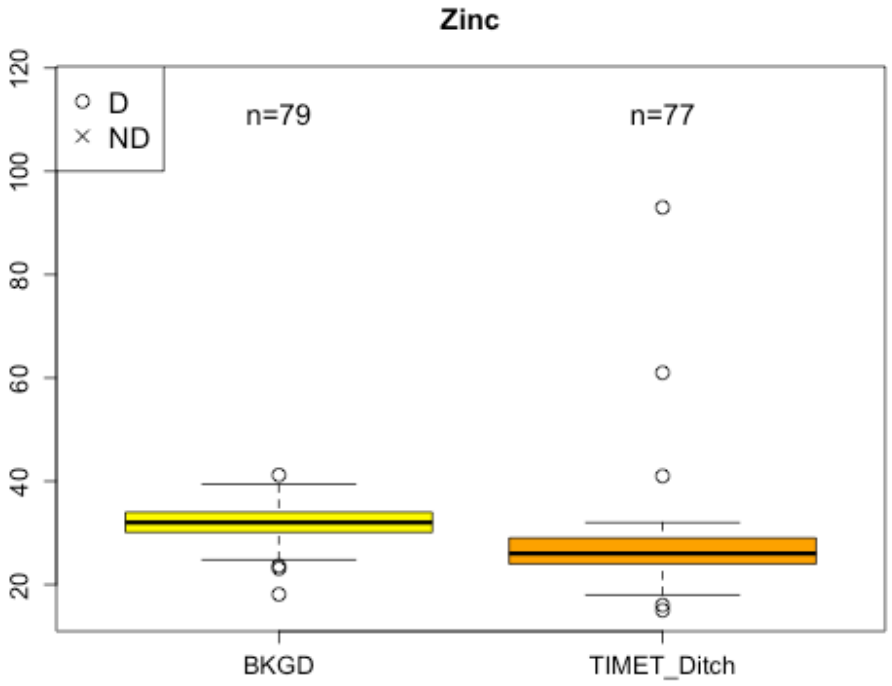

Uranium (log-scale)
D
ND
n=79
n=77
2.5
2.0
1.5
1.0
0.5
0.0
BKGD
TIMET_Ditch

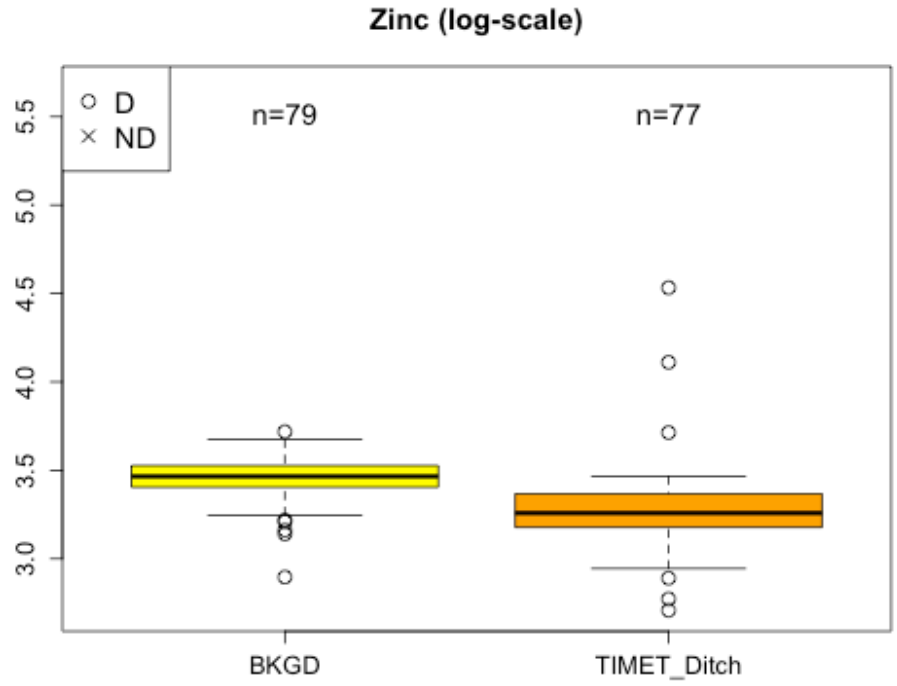

Uranium Q-Q Plot
Background
Site
Concentration (mg/kg)
8
6
4
2
-2
-1
0
1
2
Theoretical Quantiles

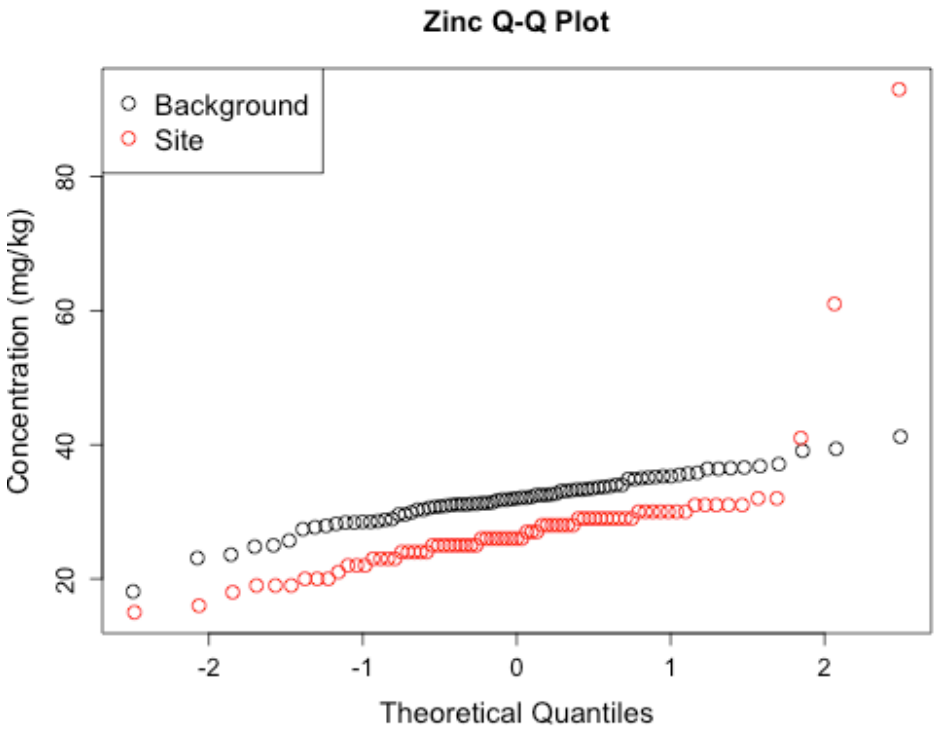

Vanadium
D
ND
n=79
n=77
90
80
70
60
50
40
30
BKGD
TIMET_Ditch


Vanadium (log-scale)
D
ND
n=79
n=77
5.0
4.5
4.0
3.5
BKGD
TIMET_Ditch


Vanadium Q-Q Plot
Background
Site
Concentration (mg/kg)
70
60
50
40
30
-2
-1
0
1
2
Theoretical Quantiles


Zinc
D
ND
n=79
n=77
120
100
80
60
40
20
BKGD
TIMET_Ditch


Zinc (log-scale)
D
ND
n=79
n=77
5.5
5.0
4.5
4.0
3.5
3.0
BKGD
TIMET_Ditch


Zinc Q-Q Plot
Background
Site
Concentration (mg/kg)
80
60
40
20
-2
-1
0
1
2
Theoretical Quantiles

# APPENDIX E
# SOIL DATA COMPARED TO LBCL DAF VALUES

**TABLE E-1**
**INORGANIC CONCENTRATIONS COMPARED TO LBCL DAF**
**BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| GROUP | Analyte | Sample Count | LBCL DAF1 (pCi/kg or mg/kg) | LBCL DAF20 (pCi/kg or mg/kg) | Detected Count | Max Conc Of Detected (pCi/kg or mg/kg) | Count That Exceed DAF1 | Count That Exceed DAF20 | Screening Decision |
|---|---|---|---|---|---|---|---|---|---|
| GENERAL | NITRATE NITROGEN | 209 | 7 | 140 | 175 | 550 | 111 | 9 | Develop LSSL |
| GENERAL | PERCHLORATE | 209 | 0.0263165 | 0.52633 | 201 | 95 | 201 | 140 | Develop LSSL |
| RADIO | RADIUM-226 | 209 | 0.016 | 0.32 | 209 | 3.34 | 209 | 209 | Develop LSSL |
| RADIO | RADIUM-228 | 209 | 0.016 | 0.32 | 165 | 3.87 | 165 | 165 | Develop LSSL |
| RADIO | THORIUM-228 | 209 | 0.0023 | 0.045 | 209 | 2.48 | 209 | 209 | Develop LSSL |
| RADIO | THORIUM-230 | 209 | 0.00084 | 0.017 | 209 | 8.16 | 209 | 209 | Develop LSSL |
| RADIO | THORIUM-232 | 209 | 0.0029 | 0.058 | 209 | 2.52 | 209 | 209 | Develop LSSL |
| RADIO | URANIUM-234 | 209 | | | 209 | 11.7 | | | Develop LSSL |
| RADIO | URANIUM-235 | 209 | | | 166 | 0.591 | | | Develop LSSL |
| RADIO | URANIUM-238 | 209 | | | 209 | 8.58 | | | Develop LSSL |
| TMETAL | ALUMINUM | 209 | 75.01 | 1500.2 | 209 | 14000 | 209 | 209 | No LSSL (Background) |
| TMETAL | ANTIMONY | 209 | 0.3 | 6 | 82 | 36 | 82 | 3 | Develop LSSL |
| TMETAL | ARSENIC | 209 | 1 | 20 | 209 | 210 | 209 | 22 | Develop LSSL |
| TMETAL | BARIUM | 209 | 82 | 1640 | 209 | 4700 | 204 | 6 | Develop LSSL |
| TMETAL | BERYLLIUM | 209 | 3 | 60 | 194 | 5.8 | 1 | | Develop LSSL |
| TMETAL | BORON | 209 | 23.36 | 467.2 | 209 | 38 | 2 | | Develop LSSL |
| TMETAL | CADMIUM | 209 | 0.4 | 8 | 164 | 2 | 12 | | Develop LSSL |
| TMETAL | CALCIUM | 209 | | | 209 | 130000 | | | No LSSL (Nutrient) |
| TMETAL | CHROMIUM | 209 | | | 209 | 490 | | | Develop LSSL |
| TMETAL | CHROMIUM HEXAVALENT | 209 | 2 | 40 | 18 | 53 | 17 | 1 | Develop LSSL |
| TMETAL | COBALT | 209 | 0.49494 | 9.8988 | 209 | 84 | 209 | 26 | Develop LSSL |
| TMETAL | COLUMBIUM | 27 | | | 27 | 120 | | | LSSL (Provided by NDEP) |
| TMETAL | COPPER | 209 | 45.76 | 915.2 | 209 | 510 | 17 | | Develop LSSL |
| TMETAL | IRON | 209 | 7.56 | 151.2 | 209 | 23000 | 209 | 209 | Develop LSSL |
| TMETAL | LEAD | 209 | | | 209 | 1300 | | | Develop LSSL |
| TMETAL | LITHIUM | 209 | 21.9146 | 438.292 | 209 | 290 | 31 | | Develop LSSL |
| TMETAL | MAGNESIUM | 209 | 972.6885 | 19453.77 | 209 | 59000 | 209 | 13 | Develop LSSL |
| TMETAL | MANGANESE | 209 | 1.304 | 26.08 | 209 | 27000 | 209 | 209 | Develop LSSL |
| TMETAL | MERCURY | 209 | 0.10448147 | 2.089629333 | 113 | 1.4 | 12 | | Develop LSSL |
| TMETAL | MOLYBDENUM | 209 | 3.6865 | 73.73 | 180 | 37 | 23 | | Develop LSSL |
| TMETAL | NICKEL | 209 | 7 | 140 | 209 | 51 | 209 | | No LSSL (Background) |

**TABLE E-1**
**INORGANIC CONCENTRATIONS COMPARED TO LBCL DAF**
**BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| GROUP | Analyte | Sample Count | LBCL DAF1 (pCi/kg or mg/kg) | LBCL DAF20 (pCi/kg or mg/kg) | Detected Count | Max Conc Of Detected (pCi/kg or mg/kg) | Count That Exceed DAF1 | Count That Exceed DAF20 | Screening Decision |
|---|---|---|---|---|---|---|---|---|---|
| TMETAL | PALLADIUM | 27 | | | 5 | 0.12 | | | No LSSL (Background) |
| TMETAL | POTASSIUM | 209 | | | 209 | 3900 | | | No LSSL (Nutrient) |
| TMETAL | SELENIUM | 209 | 0.3 | 6 | 29 | 7.2 | 24 | 1 | Develop LSSL |
| TMETAL | SILICON | 27 | | | 27 | 1400 | | | No LSSL (Background) |
| TMETAL | SILVER | 209 | 0.85 | 17 | 23 | 6.6 | 10 | | Develop LSSL |
| TMETAL | SODIUM | 209 | | | 209 | 5300 | | | No LSSL (Nutrient) |
| TMETAL | STRONTIUM | 209 | | | 209 | 2300 | | | No LSSL (Background) |
| TMETAL | THALLIUM | 209 | 0.4 | 8 | 209 | 21 | 24 | 3 | Develop LSSL |
| TMETAL | TIN | 209 | | | 135 | 58 | | | Develop LSSL |
| TMETAL | TITANIUM | 209 | 146029.2 | 2920584 | 209 | 8400 | | | No LSSL (below DAF 1) |
| TMETAL | TOTAL SULFUR | 27 | | | 27 | 2700 | | | No LSSL |
| TMETAL | URANIUM | 209 | 13.506 | 270.12 | 209 | 18 | 1 | | Develop LSSL |
| TMETAL | VANADIUM | 209 | 300 | 6000 | 209 | 320 | 1 | | Develop LSSL |
| TMETAL | ZINC | 209 | 620 | 12400 | 209 | 460 | | | No LSSL (below DAF 1) |
| TMETAL | ZIRCONIUM | 27 | | | 27 | 620 | | | No LSSL (Background) |

Notes:
Blank cells indicate that there is no LBCL DAF1 or DAF20 for the individual chemical.
Screening Decisions:
Develop LSSL: LSSL Developed as described in body of report
No LSSL (Nutrient): Chemical is a nutrient, No LSSL Required
No LSSL (Background): Chemical not above background as evaluated in Appendix D
No LSSL (Below LBCL DAF-1): Chemical not above LBCL DAF-1

**TABLE E-2**
**ORGANIC CONCENTRATIONS COMPARED TO LBCL DAF**
**BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| GROUP | Analyte | Sample Count | LBCL DAF1 (mg/kg) | LBCL DAF20 (mg/kg) | Detected Count | Max Conc Of Detected (mg/kg) | Count That Exceed DAF1 | Count That Exceed DAF20 | Frequency of Detection | Screening Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| PEST | 2,4'-DDD | 47 | 0.8 | 16 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | 2,4'-DDE | 47 | 3 | 60 | 13 | 1.9 | | | 27.7% | No LSSL (No Exceedance of LBCLs) |
| PEST | 4,4'-DDD | 47 | 0.8 | 16 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | 4,4'-DDE | 47 | 3 | 60 | 27 | 2.8 | | | 57.4% | No LSSL (No Exceedance of LBCLs) |
| PEST | 4,4'-DDT | 47 | 2 | 40 | 28 | 1.3 | | | 59.6% | No LSSL (No Exceedance of LBCLs) |
| PEST | ALDRIN | 47 | 0.02 | 0.4 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | ALPHA-BHC | 47 | 0.0291274 | 0.58254826 | 4 | 0.071 | 1 | | 8.5% | Develop LSSL |
| PEST | ALPHA-CHLORDANE | 47 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | BETA-BHC | 47 | 0.0059568 | 0.11913612 | 31 | 9.2 | 25 | 4 | 66.0% | Develop LSSL |
| PEST | beta-Chlordane | 6 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | CHLORDANE | 47 | 0.5 | 10 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | DELTA-BHC | 47 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | DIELDRIN | 47 | 0.0002 | 0.004 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | ENDOSULFAN I | 47 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | ENDOSULFAN II | 47 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | ENDOSULFAN SULFATE | 47 | 4.4 | 88 | 1 | 0.09 | | | 2.1% | No LSSL (No Exceedance of LBCLs) |
| PEST | ENDRIN | 47 | 0.05 | 1 | 1 | 0.067 | 1 | | 2.1% | Develop LSSL |
| PEST | ENDRIN ALDEHYDE | 47 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | ENDRIN KETONE | 47 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | GAMMA-BHC (LINDANE) | 47 | 0.0005 | 0.01 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | GAMMA-CHLORDANE | 41 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | HEPTACHLOR | 47 | 1 | 20 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | HEPTACHLOR EPOXIDE | 47 | 0.03 | 0.6 | 1 | 0.0022 | | | 2.1% | No LSSL (No Exceedance of LBCLs) |
| PEST | METHOXYCHLOR | 47 | 8 | 160 | 0 | | | | 0.0% | No LSSL (No Detections) |
| PEST | TOXAPHENE | 47 | 2 | 40 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 1,2,4,5-Tetrachlorobenzene | 248 | | | 19 | 3 | | | 7.7% | Develop LSSL |
| SVOA | 1,2-Diphenylhydrozine/Azobenze | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 1,4-DIOXANE | 213 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2,4,5-TRICHLOROPHENOL | 248 | 14 | 280 | 2 | 0.18 | | | 0.8% | No LSSL (No Exceedance of LBCLs) |
| SVOA | 2,4,6-TRICHLOROPHENOL | 243 | 0.008 | 0.16 | 10 | 1.3 | 10 | 4 | 4.1% | Develop LSSL |
| SVOA | 2,4'-DDE | 9 | 3 | 60 | 9 | 1.4 | | | 100.0% | No LSSL (No Exceedance of LBCLs) |
| SVOA | 2,4'-DDT | 1 | 2 | 40 | 1 | 0.45 | | | 100.0% | No LSSL (No Exceedance of LBCLs) |
| SVOA | 2,4-DICHLOROPHENOL | 248 | 0.05 | 1 | 3 | 0.23 | 3 | | 1.2% | Develop LSSL |
| SVOA | 2,4-DIMETHYLPHENOL | 248 | 0.4 | 8 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2,4-DINITROPHENOL | 247 | 0.01 | 0.2 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2,4-DINITROTOLUENE | 248 | 0.00004 | 0.0008 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2,6-DINITROTOLUENE | 248 | 0.00003 | 0.0006 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2-CHLORONAPHTHALENE | 248 | | | 1 | 0.1 | | | 0.4% | No LSSL (Detection Frequency <5%) |
| SVOA | 2-CHLOROPHENOL | 248 | 0.2 | 4 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2-METHYLNAPHTHALENE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |

**TABLE E-2**
**ORGANIC CONCENTRATIONS COMPARED TO LBCL DAF**
**BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| GROUP | Analyte | Sample Count | LBCL DAF1 (mg/kg) | LBCL DAF20 (mg/kg) | Detected Count | Max Conc Of Detected (mg/kg) | Count That Exceed DAF1 | Count That Exceed DAF20 | Frequency of Detection | Screening Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| SVOA | 2-METHYLPHENOL | 248 | 0.8 | 16 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2-NITROANILINE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 2-NITROPHENOL | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 3,3'-DICHLOROBENZIDINE | 248 | 0.0003 | 0.006 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 3,4-METHYLPHENOL | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 3-NITROANILINE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 4,4'-DDE | 6 | 3 | 60 | 6 | 5.2 | 1 | | 100.0% | No LSSL (Based on Pesticide Analyses) |
| SVOA | 4-BROMOPHENYL PHENYL ETHER | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 4-CHLORO-3-METHYLPHENOL | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 4-CHLOROANILINE | 248 | 0.03 | 0.6 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 4-CHLOROPHENYL PHENYL ETHER | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 4-NITROANILINE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | 4-NITROPHENOL | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | ACENAPHTHENE | 248 | 29 | 580 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | ACENAPHTHYLENE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | ACETOPHENONE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | ANILINE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | ANTHRACENE | 248 | 590 | 11800 | 4 | 0.23 | | | 1.6% | No LSSL (No Exceedance of LBCLs) |
| SVOA | BENZO(A)ANTHRACENE | 245 | 0.08 | 1.6 | 63 | 0.36 | 4 | | 25.7% | Develop LSSL |
| SVOA | BENZO(A)PYRENE | 245 | 0.4 | 8 | 46 | 0.12 | | | 18.8% | No LSSL (No Exceedance of LBCLs) |
| SVOA | BENZO(B)FLUORANTHENE | 245 | 0.2 | 4 | 58 | 0.3 | 1 | | 23.7% | Develop LSSL |
| SVOA | BENZO(G,H,I)PERYLENE | 248 | | | 7 | 0.28 | | | 2.8% | No LSSL (Detection Frequency <5%) |
| SVOA | BENZO(K)FLUORANTHENE | 245 | 2 | 40 | 55 | 0.18 | | | 22.4% | No LSSL (No Exceedance of LBCLs) |
| SVOA | BENZOIC ACID | 215 | 20 | 400 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | BENZYL ALCOHOL | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | BIS(1-CHLOROISOPROPYL) ETHER | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | BIS(2-CHLOROETHOXY)METHANE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | BIS(2-CHLOROETHYL) ETHER | 248 | 0.00002 | 0.0004 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | BIS(2-ETHYLHEXYL) PHTHALATE | 248 | 180 | 3600 | 14 | 2.6 | | | 5.6% | No LSSL (No Exceedance of LBCLs) |
| SVOA | BUTYL BENZYL PHTHALATE | 248 | 810 | 16200 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | CARBAZOLE | 248 | 0.03 | 0.6 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | CHRYSENE | 245 | 8 | 160 | 69 | 1.1 | | | 28.2% | No LSSL (No Exceedance of LBCLs) |
| SVOA | DIBENZO(A,H)ANTHRACENE | 245 | 0.08 | 1.6 | 13 | 0.033 | | | 5.3% | No LSSL (No Exceedance of LBCLs) |
| SVOA | DIBENZOFURAN | 248 | | | 2 | 0.073 | | | 0.8% | No LSSL (Detection Frequency <5%) |
| SVOA | DIETHYL PHTHALATE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | DIMETHYL PHTHALATE | 248 | | | 2 | 0.068 | | | 0.8% | No LSSL (Detection Frequency <5%) |
| SVOA | DI-N-BUTYL PHTHALATE | 248 | 270 | 5400 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | DI-N-OCTYL PHTHALATE | 248 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | FLUORANTHENE | 248 | 210 | 4200 | 32 | 2.4 | | | 12.9% | No LSSL (No Exceedance of LBCLs) |
| SVOA | FLUORENE | 248 | 28 | 560 | 0 | | | | 0.0% | No LSSL (No Detections) |

**TABLE E-2**
**ORGANIC CONCENTRATIONS COMPARED TO LBCL DAF**
**BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| GROUP | Analyte | Sample Count | LBCL DAF1 (mg/kg) | LBCL DAF20 (mg/kg) | Detected Count | Max Conc Of Detected (mg/kg) | Count That Exceed DAF1 | Count That Exceed DAF20 | Frequency of Detection | Screening Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| SVOA | HEXACHLOROBENZENE | 241 | 0.1 | 2 | 142 | 550 | 72 | 30 | 58.9% | Develop LSSL |
| SVOA | HEXACHLOROBUTADIENE | 248 | 0.1 | 2 | 21 | 5.6 | 7 | 3 | 8.5% | Develop LSSL |
| SVOA | HEXACHLOROCYCLOPENTADIENE | 248 | 20 | 400 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | HEXACHLOROETHANE | 248 | 0.02 | 0.4 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | INDENO(1,2,3-CD)PYRENE | 245 | 0.7 | 14 | 46 | 0.092 | | | 18.8% | No LSSL (No Exceedance of LBCLs) |
| SVOA | ISOPHORONE | 248 | 0.03 | 0.6 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | NAPHTHALENE | 233 | 4 | 80 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | NITROBENZENE | 213 | 0.007 | 0.14 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | N-NITROSO-DI-N-PROPYLAMINE | 248 | 0.000002 | 0.00004 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | N-NITROSODIPHENYLAMINE | 248 | 0.06 | 1.2 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | OCTACHLOROSTYRENE | 242 | 0.42 | 8.4 | 41 | 100 | | | 16.9% | Develop LSSL |
| SVOA | Pentachlorobenzene | 249 | | | 52 | 110 | | | 20.9% | Develop LSSL |
| SVOA | PENTACHLOROPHENOL | 247 | 0.001 | 0.02 | 1 | 1.4 | 1 | 1 | 0.4% | Develop LSSL |
| SVOA | PHENANTHRENE | 248 | | | 12 | 0.54 | | | 4.8% | No LSSL (Detection Frequency <5%) |
| SVOA | PHENOL | 213 | 5 | 100 | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | PYRENE | 248 | 210 | 4200 | 29 | 1.2 | | | 11.7% | No LSSL (No Exceedance of LBCLs) |
| SVOA | PYRIDINE | 247 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| SVOA | TENTATIVELY IDENTIFIED COMPOUND | 40 | | | 40 | 1.5 | | | 100.0% | No LSSL (Not Applicable) |
| VOA | 1,1,1,2-TETRACHLOROETHANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,1,1-TRICHLOROETHANE | 182 | 0.1 | 2 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,1,2,2-TETRACHLOROETHANE | 182 | 0.0002 | 0.004 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,1,2-TRICHLOROETHANE | 182 | 0.0009 | 0.018 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,1-DICHLOROETHANE | 182 | 1 | 20 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,1-DICHLOROETHENE | 182 | 0.003 | 0.06 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,1-DICHLOROPROPENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,2,3-TRICHLOROBENZENE | 182 | 0.3 | 6 | 4 | 0.012 | | | 2.2% | No LSSL (No Exceedance of LBCLs) |
| VOA | 1,2,3-TRICHLOROPROPANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,2,4-TRICHLOROBENZENE | 182 | 0.3 | 6 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,2,4-TRIMETHYLBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,2-DICHLOROBENZENE | 182 | 0.9 | 18 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,2-DICHLOROETHANE | 162 | 0.001 | 0.02 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,2-DICHLOROPROPANE | 182 | 0.001 | 0.02 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,3,5-TRIMETHYLBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,3-DICHLOROBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,3-DICHLOROPROPANE | 182 | 0.001 | 0.02 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 1,4-DICHLOROBENZENE | 182 | 0.1 | 2 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 2,2-DICHLOROPROPANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 2-BUTANONE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 2-CHLOROTOLUENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |

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**ORGANIC CONCENTRATIONS COMPARED TO LBCL DAF**
**BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| GROUP | Analyte | Sample Count | LBCL DAF1 (mg/kg) | LBCL DAF20 (mg/kg) | Detected Count | Max Conc Of Detected (mg/kg) | Count That Exceed DAF1 | Count That Exceed DAF20 | Frequency of Detection | Screening Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| VOA | 2-HEXANONE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 4-CHLOROTOLUENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | 4-METHYL-2-PENTANONE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | ACETONE | 182 | 0.8 | 16 | 6 | 0.027 | | | 3.3% | No LSSL (No Exceedance of LBCLs) |
| VOA | ACETONITRILE | 171 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | BENZENE | 182 | 0.002 | 0.04 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | BROMOBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | BROMOCHLOROMETHANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | BROMODICHLOROMETHANE | 182 | 0.03 | 0.6 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | BROMOFORM | 182 | 0.04 | 0.8 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | BROMOMETHANE | 182 | 0.01 | 0.2 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | CARBON DISULFIDE | 182 | 2 | 40 | 2 | 0.0087 | | | 1.1% | No LSSL (No Exceedance of LBCLs) |
| VOA | CARBON TETRACHLORIDE | 182 | 0.003 | 0.06 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | CHLOROBENZENE | 182 | 0.07 | 1.4 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | CHLOROETHANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | CHLOROFORM | 182 | 0.03 | 0.6 | 5 | 0.11 | 2 | | 2.7% | Develop LSSL |
| VOA | CHLOROMETHANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | CIS-1,2-DICHLOROETHENE | 182 | 0.02 | 0.4 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | CIS-1,3-DICHLOROPROPENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | DIBROMOCHLOROMETHANE | 182 | 0.02 | 0.4 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | DICHLORODIFLUOROMETHANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | ETHANOL | 11 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | ETHYLBENZENE | 182 | 0.7 | 14 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | HEXACHLOROBUTADIENE | 11 | 0.1 | 2 | 11 | 0.034 | | | 100.0% | No LSSL (No Exceedance of LBCLs) |
| VOA | ISOPROPYLBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | METHYL IODIDE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | METHYLENE BROMIDE | 162 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | METHYLENE CHLORIDE | 182 | 0.001 | 0.02 | 58 | 0.013 | 58 | | 31.9% | Develop LSSL |
| VOA | METHYL-T-BUTYL ETHER | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | NAPHTHALENE | 182 | 4 | 80 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | N-BUTYLBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | N-PROPYLBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | P-ISOPROPYLTOLUENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | SEC-BUTYLBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | STYRENE | 182 | 0.2 | 4 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | TERT-BUTYLBENZENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | TETRACHLOROETHENE | 182 | 0.003 | 0.06 | 9 | 0.037 | 9 | | 4.9% | Develop LSSL |
| VOA | TOLUENE | 162 | 0.6 | 12 | 6 | 0.0038 | | | 3.7% | No LSSL (No Exceedance of LBCLs) |
| VOA | TRANS-1,2-DICHLOROETHENE | 182 | 0.03 | 0.6 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | TRANS-1,3-DICHLOROPROPENE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |

**TABLE E-2**
**ORGANIC CONCENTRATIONS COMPARED TO LBCL DAF**
**BETA / NORTHWESTERN DITCHES**
**TITANIUM METALS CORPORATION PLANT SITE**
**HENDERSON, NEVADA**


| GROUP | Analyte | Sample Count | LBCL DAF1 (mg/kg) | LBCL DAF20 (mg/kg) | Detected Count | Max Conc Of Detected (mg/kg) | Count That Exceed DAF1 | Count That Exceed DAF20 | Frequency of Detection | Screening Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| VOA | TRICHLOROETHENE | 182 | 0.003 | 0.06 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | TRICHLOROFLUOROMETHANE | 182 | | | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | VINYL ACETATE | 182 | 8 | 160 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | VINYL CHLORIDE | 182 | 0.0007 | 0.014 | 0 | | | | 0.0% | No LSSL (No Detections) |
| VOA | XYLENE (TOTAL) | 181 | 10 | 200 | 0 | | | | 0.0% | No LSSL (No Detections) |

Blank cells indicate that there is no LBCL DAF1 or DAF20 for the individual chemical.

# APPENDIX F
# LAB DATA REPORTS (AVAILABLE ON COMPACT DISC)