ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

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

Jim Gibbons, Governor
Allen Biaggi,Director
Leo M. Drozdoff, P.E., Administrator

May 3, 2006

Mr. Mark Paris Basic Remediation Company 875 West Warm Springs Road Henderson, NV 89105	Ms. Susan Crowley Tronox LLC PO Box 55 Henderson, NV 89009	Mr. Sam Chamberlain Pioneer Companies, Inc. 700 Louisiana St, Suite 4300 Houston, TX 77002
Mr. Joe Kelly Montrose Chemical Corp of CA 600 Ericksen Ave NE, Suite 380 Bainbridge Island, WA 98110	Mr. George Crouse Syngenta Crop Protection, Inc. 410 Swing Road Greensboro, NC 27409	Mr. Craig Wilkinson Titanium Metals Corporation PO Box 2128 Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
NDEP Guidance on Data Validation

Dear Sirs and Madam:

Attachment A contains the NDEP's guidance on the level of data verification and validation that is required for your respective projects. Please be advised that this applies to all historic data that is planned to be used for any purpose as well as all data collected in the future. Your respective project schedules should reflect this effort and all companies are requested to initiate this effort as soon as possible. The NDEP is willing to meet with each company individually to discuss your specific questions and concerns.

If you have any questions, do not hesitate to contact me.

Sincerely,

Brian A. Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas

Shannon Harbour, NDEP, BCA, Las Vegas
Brian Rakvica, NDEP, BCA, Las Vegas (7 copies total)
Barry Conaty, Akin, Gump, Strauss, Hauer & Feld, L.L.P., 1333 New Hampshire Avenue, N.W.,
Washington, D.C. 20036
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5,
75 Hawthorne Street, San Francisco, CA 94105-3901
Rob Mrowka, Clark County Comprehensive Planning, PO Box 551741, Las Vegas, NV, 89155-1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89015
Craig Wilkinson, TIMET, PO Box 2128, Henderson, Nevada, 89009-7003
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Susan Crowley, Tronox, PO Box 55, Henderson, Nevada 89009
Keith Bailey, Tronox, Inc, PO Box 268859, Oklahoma City, Oklahoma 73126-8859
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Lee Erickson, Stauffer Management Company, 400 Ridge Rd, Golden, CO 80403
Chris Sylvia, Pioneer Americas LLC, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 3846 Estate Drive, Stockton, California
95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380,
Bainbridge Island, WA 98110
Jon Erskine, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA
94612
Karleen O'Connor, Cox Castle Nicholson, 555 Montgomery Street, Suite 1500, San Francisco, CA 94111
Brian Walsh, Centex Homes, 3606 North Rancho Drive, Suite 102, Las Vegas, NV 89130
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200, Phoenix, AZ 85004
Vincent Aiello, Beazer Homes, 4670 South Fort Apache, Suite 200, Las Vegas, NV
David Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544

Attachment A

NDEP Data Verification and Validation Requirements

The intent of this document is to specify the level of data verification and validation that is required for all data collected for the BMI Complex area. Data verification and validation fit into the USEPA overall Quality System as described in *Guidance on Environmental Data Verification and Data Validation, (QA/G-8) (EPA 2002).* Data verification and validation are performed using sample results and the process provides the output necessary to perform data quality assessment. This document only describes the verification and validation requirements and does not address data quality assessment further.

Data verification and validation should be performed in a manner that materially follows the Tiered approach outlined in the draft *Region 9 Superfund Data Evaluation/ Validation Guidance (R9QA/006.1).* More specifically, Tier 2 described in that document should be followed for the organic and inorganic data. In general, radiochemistry can only be reviewed at the Tier 1A level due to the lack of raw data. Following the Tier 2 approach, it is required that **100% of all data collected be reviewed** (per Tier 1A/1B) for the following components (where applicable):

- Completeness Check.
- Chain of Custody (signatures, sample conditions, preservatives, sampling handling/filtering).
- Holding Times.
- Random check (10-20%) of Initial and Continuing Calibration.
- Review of Quality Control Summaries including negative control (blanks) and positive control (LCS) along with Sample Specific Controls (replicates, matrix spikes, surrogates, tracers/ yields).
- Overall assessment.

In addition to this 100% review, **at least 10% of the data must be validated to the level of raw data**. Ideally this level of validation should be focused on a class of compounds that has been identified as significant for the area of interest, based upon previous data; or that represent special cases (e.g. non-standard methods specifically applied to the site). This validation should include the following items (in addition to those listed above):

- 100% validation of Initial and Continuing Calibration, including GC/MS tuning (data reporting forms).
- Random recalculation (10-20%) of reported results versus raw data.
- 100% validation of Interference Check Sample (data reporting forms), ICP Serial Dilution (data reporting forms), GC/MS instrument performance check, Reporting Limits (ensure they include appropriate sample weights, moisture, dilution).
- Internal Standards, Compound Identification, and TICs (where appropriate).
- Random check (5%) of integration and mass spectrum matches (where available and appropriate).
- When project or sampling specific items have been identified in the planning documents for review, these should be added.
- Overall assessment.

To clarify how the percentages should be calculated the following guidelines should be used. When determining the set of data that will meet the 10% requirement for raw data, this should be based on the number of data packages validated compared to the total number of data packages. This is advised since reviewing a complete data package to the raw data level requires a very similar amount of time than if only a part of a data package is validated to this raw data level.

When determining the percentage of a data package that should be randomly (5-20%) checked, this should be on a sample basis. For example, to check 5% of the mass spectrum matches, a single sample out of 20 would meet this criterion.

If full raw data validation activities indicate a systemic problem or repeated non-compliance the level of raw data validation should be increased to adequately determine the level of impact associated with the non-compliance. This increased validation activity should also be used to determine any root cause and necessary corrective actions.

The output of the data verification and validation process described above should include a detailed Data Validation Summary Report (DVSR) to include the following:

- Introduction with Purpose/Objective/Process.
- Applicable Samples, SDG ID, sample ID link to sample location, analyses.
- Level of validation for each sample or SDG and the calculation used to determine the percentage of data reviewed/validated.
- Data validation qualifier definition.
- Definitions for the reason codes that link results in the database to a specific qualifier logic.
- Data validation findings for each parameter based on the level of review. When non-conformances are identified they should be linked to the appropriate sample(s) and SDG.
- Evaluation of PARCCS parameters.
- Conclusions/Recommendations.
- References.
- Electronic database of the dataset that is being addressed by the report including all raw data and laboratory report (on CD in Microsoft Access database).

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

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

Jim Gibbons, Governor
Allen Biaggi, Director
Leo M. Drozdoff, P.E., Administrator

May 21, 2007

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Larry Landry
Pioneer Companies, Inc.
700 Louisiana St, Ste 4300
Houston, TX 77002

Mr. Joe Kelly
Montrose Chemical Corp of CA
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals Corporation
PO Box 2128
Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Additional Guidance on Completion of Quality Checks for Cation-Anion Balance

Dear Sirs and Madam:

In response to questions from several of the parties listed above, Attachment A is a document which provides additional guidance on the completion of quality checks for cation-anion balances. This guidance should be shared with your respective analytical laboratory and should be reflected in any data validation that is completed.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City

Barry Conaty, Akin, Gump, Strauss, Hauer & Feld, L.L.P., 1333 New Hampshire Avenue, N.W., Washington, D.C. 20036
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5, 75 Hawthorne Street, San Francisco, CA 94105-3901
Rob Mrowka, Clark County Comprehensive Planning, PO Box 551741, Las Vegas, NV, 89155-1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA 94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Tronox, Inc, PO Box 268859, Oklahoma City, Oklahoma 73126-8859
Jeff Gibson, AMPAC, 3770 Howard Hughes Parkway, Suite 300, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Chris Sylvia, Pioneer Americas LLC, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 3846 Estate Drive, Stockton, California 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380, Bainbridge Island, WA 98110
Jon Erskine, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 Montgomery Street, Suite 1500, San Francisco, CA 94111
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200, Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544
Paul Black, Neptune and Company, Inc., 8550 West 14th Street, Suite 100, Lakewood, CO 80215
Teri Copeland, 5737 Kanan Rd., #182, Agoura Hills, CA 91301
Paul Hackenberry, Hackenberry Associates, 550 West Plumb Lane, B425, Reno, NV, 89509

Attachment A

The analytical parameters that are included for the groundwater samples analyzed at the BMI complex include the major cation and anions along with a measured Total Dissolved Solids (TDS) value. Based on the evaluation of previous data collected at the site, using Standard Methods (Standard Methods for the Examination of Water and Wastewater, 20th Edition, January 1999) Section 1030 E for Correctness of Analyses, it appears numerous samples do not meet the quality checks. The quality checks employed included anion-cation balance, measured TDS to calculated TDS ratio, and measured TDS to EC ratio. These checks were made via the spreadsheet application that had previously been developed by Hackenberry Associates, LLC for the construction of Piper Trilinear diagrams.

Geochemical checks on correctness of analysis were made at three different sites at the BMI Complex. For the example herein, the analytical results were checked for 40 groundwater samples from the 2004 Hydrogeologic Characterization Summary (BRC, 2004, Table 3-24). The check for accuracy of analysis included 17 wells completed in the alluvial aquifer (Aa) and 23 wells completed in the Muddy Creek Formation (MCf).

The anion-cation balance check included major cations and anions as listed below:

1. calcium,
2. magnesium,
3. sodium,
4. potassium,
5. sulfate,
6. chloride,
7. bicarbonate and carbonate, and
8. hydroxide.

Hydroxide alkalinity, although uncommon in natural groundwater (Hem, 1992, p. 64), was added because the pH values were quite high for a number of samples and the hydroxide values were also very high. Fluoride, nitrate, and perchlorate were also included in the anion-cation balance calculation, but were not included in the calculation of percentages for the Piper Trilinear diagrams. The latter three analytes were added more for completeness based on site history than for contribution to the anion-cation balance, because their percentages were less than one percent of total anions. Trace metals were not included in the calculations for the same rationale. Analytes measured in the microgram per liter range would likely not significantly affect the balance outcome. Only four of the 17 samples from the Aa had anion-cation balances within the error limits specified in Standard Methods. Only seven of the 23 samples from the MCf had anion-cation balances within the error limits specified in Standard Methods. The anion-cation balance for three of the samples from the MCf was not verified because their anion sum was beyond the range provided in Standard Methods. Almost all the total dissolved solids values (40 of 49) in Table 3-24 were “J” flagged.

Based on the numerous instances in which the correctness of the analyses did not meet the Standard Method criteria it is recommended that in the future the laboratories performing these analyses also perform the correctness test.

When the correctness test is violated, the laboratory should follow the Standard Method recommendations and evaluate the data for error and, if necessary, re-analyze the samples. If the results of any corrective action are not sufficient, then the data that does not meet these quality checks should be qualified. For example, based on the electronuetrality and TDS checks there are four potential outcomes:

1. Cation-anion balance checks & TDS sum versus TDS measured checks.
2. Cation-anion balance checks & TDS sum versus TDS measured does not check.
3. Cation-anion balance does not check & TDS sum versus TDS measured checks.
4. Cation-anion balance does not check & TDS sum versus TDS measured does not check.

When the quality checks result in outcomes numbered 2 and 3, the data should be qualified using a designation that is specific to the quality issue. When the quality checks result in outcome number 4, the data should be qualified as unreliable. The following qualifier designations are recommended for outcomes 2, 3, and 4:

2. J-TDS
3. J-CAB
4. J-TDS&CAB

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

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

Jim Gibbons, Governor
Allen Biaggi,Director
Leo M. Drozdoff, P.E., Administrator

February 23, 2007

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Sam Chamberlain
Pioneer Companies, Inc.
700 Louisiana St, Ste 4300
Houston, TX 77002

Mr. Joe Kelly
Montrose Chemical Corp of CA
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals Corporation
PO Box 2128
Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Additional Guidance on Development of Data Validation Summary Reports (DVSRs)

Dear Sirs and Madam:

Based upon some recent submittals by the BMI Companies, the NDEP has noted some topics regarding DVSRs that require additional clarification. In addition, please note that it may be helpful to review the format and content of the DVSRs submitted by Basic Remediation Company (BRC) and the NDEP's comments on these reports. Generally, the format and content of the more recent BRC DVSRs has been acceptable to the NDEP.

In May 2006 the NDEP provided guidance on the Data Validation process as well as the items that are expected to be included in companies Data Validation Summary Reports.

In that memo, the following items were specified:

The output of the data verification and validation process described above should include a detailed Data Validation Summary Report to include the following:

- Introduction with Purpose/Objective/Process.
- Applicable Samples, SDG ID, that correspond to locations, analyses, level of validation.
- Data validation qualifier definition.
- Reason codes that link results in the database to specific qualifier logic.
- Data validation findings for each parameter based on the level of review. When non-conformances are identified they should be linked to the appropriate sample(s) and SDG.
- Evaluation of PARCCS parameters.
- Conclusions/Recommendations.
- References.

After reviewing a number of DVSRs as well as data usability reports NDEP is providing the following recommendations and additional details on the DVSRs. Each DVSR should include the following, in addition to those items specified above:

- If aqueous samples have been filtered or centrifuged prior to analysis this should be included in the report.
- The DVSRs should include tables that specify when a non-conformance has been identified during the data validation process. These tables should be categorized by issue, for example those samples qualified due to Laboratory Control Sample exceedances should be within the same table. Each table should specify the sample, SDG/lab package (if this is unclear from earlier information in the report), the analyte(s), the data quality indicator and objective (e.g. % Recovery, Limits of 85-115%), the sample result(s) and the data validation qualifier. This information is necessary to both properly evaluate the DVSR and will also facilitate data usability investigations. Each data quality indication, for example percent recovery, percent difference, precision (RPD), area (for internal standards), raw level of blank value that is used to compare with analyte levels in the native samples, cooler temperature, holding time days and exceedance, should be captured in these tables. Since this information is captured during the data validation steps and to minimize duplication of effort, it is recommended that this information be kept in a database (e.g. Excel, Access) to facilitate evaluating the results. However, only tables are required in the DVSR.
- Each DVSR should also be submitted with the original laboratory reports (including Chain-of-Custodies), the database for that set of results, and any data validation reports prepared by a third-party. Make sure the database includes, at a minimum, the sample ID (both field and laboratory), lab package/SDG, type of sample (soil, aqueous, native, QC), start and stop depth (where applicable), sample data, analytical method, chemical name, results, units, all qualifiers and reason codes, detection and reporting limits.

The NDEP would also like to note that if any of the BMI Companies have specific questions a meeting can be arranged between the Companies' data validation team and the NDEP's data validation team. Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov)

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Barry Conaty, Akin, Gump, Strauss, Hauer & Feld, L.L.P., 1333 New Hampshire Avenue, N.W., Washington, D.C. 20036
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009

Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5, 75 Hawthorne Street, San Francisco, CA 94105-3901
Rob Mrowka, Clark County Comprehensive Planning, PO Box 551741, Las Vegas, NV, 89155-1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA 94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Tronox, Inc, PO Box 268859, Oklahoma City, Oklahoma 73126-8859
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Chris Sylvia, Pioneer Americas LLC, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 3846 Estate Drive, Stockton, California 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380, Bainbridge Island, WA 98110
Jon Erskine, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 Montgomery Street, Suite 1500, San Francisco, CA 94111
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200, Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544

December 3, 2008

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Curt Richards
Olin Corporation
3855 North Ocoee Street, Suite 200,
Cleveland, TN 37312

Mr. Joe Kelly
Montrose Chemical Corp of CA
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals Corporation
PO Box 2128
Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Detection Limits and Data Reporting

Dear Sirs and Madam:

For the purposes of this letter the parties listed above shall be referred to as “the Companies”. Guidance on data reporting and detection limits is provided in Attachment A. These issues must be considered and addressed in all future Deliverables. Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City
Barry Conaty, Holland & Hart LLP, 975 F Street, N.W., Suite 900,Washington, D.C. 20004
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5,
75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County DAQEM, PO Box 551741, Las Vegas, NV, 89155-1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA
94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Drive, Edmond, OK 73013
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Susan Crowley, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Jeff Gibson, AMPAC, 3770 Howard Hughes Parkway, Suite 300, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Cindi Byrns, Olin Chlor Alkali, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 3846 Estate Drive, Stockton, California
95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380,
Bainbridge Island, WA 98110
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite
510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200,
Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544
Paul Black, Neptune and Company, Inc., 8550 West 14th Street, Suite 100, Lakewood, CO 80215
Teri Copeland, 5737 Kanan Rd., #182, Agoura Hills, CA 91301
Paul Hackenberry, Hackenberry Associates, 550 West Plumb Lane, B425, Reno, NV, 89509

Attachment A

Chemical concentration data used for human health and ecological risk assessment are often censored because of the difficulty of determining with sufficient confidence a reportable concentration. There are many types of censoring limits for chemical analytical data, however, they can usually be placed in a category of detection limit, reporting limit or quantification limit. A review of the Companies' databases shows that four terms have been used for censoring limits in the databases across the various projects (see Table 1 below):

- Method Detection Limit (MDL)
- Reporting Detection Limit (RDL)
- Quantitation Limit (QL)
- Reporting Limit (RL)

These are not the same terms that are used in the data validation summary reports (DVSRs), in which the following censoring limits are identified:

- Method Detection Limit (MDL)
- Sample Quantitation Limit (SQL)
- Practical Quantitation Limit (PQL)

The purpose of this guidance is to standardize the approach to reporting information for non-detects.

Table 1: Censoring limits in Companies' databases

Dataset	**MDL**	**RDL**	**QL**	**RL**
Suppl. Background Report	x	x	x	
Deep Background Report	x	x	x	
2005 Background Report	x	x	x	
TRECO	x	x	x	x
Borrow Pit	x	x		x
Parcel 4A	x			x
Parcels A & B (TRONOX)	x			x
Parcel 4B	x			x
Galleria				x
Mohawk (from June 2008 DB)	x			x
Southern RIBS				x
Sunset North	x			x
Western Hook				x

The DVSRs provide the following definitions:

- Method Detection Limit (MDL) – This limit was established by the laboratories according to the requirement in 40 CFR 136, Appendix B, and represents the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. MDLs are established using matrices with little or no interfering species using reagent matrices and are considered the lowest possible reporting limit. Often, the MDL is represented as the instrument detection limit. MDLs are included in data reports as well as the electronic data deliverables (EDDs).

- Sample Quantitation Limit (SQL) – The SQL is defined as the MDL adjusted to reflect sample-specific actions, such as dilution or use of smaller aliquot sizes, and takes into account sample characteristics, sample preparation, and analytical adjustments. It represents the sample-specific detection limit and all non-detected results are reported to this level.

- Practical Quantitation Limit (PQL) – This limit is defined as the lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point for the analyte, and includes the predicted effect of sample matrices with typical interfering species. The PQL is the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. PQLs are used to estimate or evaluate the minimum concentration at which the laboratory can be expected to reliably measure a specific chemical contaminant during day-to-day analyses of different sample matrices. Detected results greater than the SQL, but less than the PQL, were qualified by the laboratory as estimated.

SQLs are sample-specific detection limits. They are usually an adjustment from the MDL for sample specific reasons (e.g., dilution, interference). PQLs are greater than the SQLs and are similar to a reporting limit in that, in most cases, they are the lowest calibration level run or some multiple of the SQL.

The censoring limits in the EDDs (as loaded into the database), in most cases, include the MDL, the SQLs for metals and PQLs for all other stable chemistries. All results greater than the SQL and less than the PQL are qualified as estimated (J flag).

In effect, the DVSRs and databases, agree concerning the use of the term MDL; RDL appears to be the same as SQL; and RL appears to be the same as PQL. QL is also the same as PQL.

It is requested that the discrepancy in the nomenclature be resolved. Most sampling and analysis plans, risk assessment reports and other relevant documents describe the censoring limit to be used for statistical data analysis as the SQL. Consequently, NDEP suggests that the MDL, SQL, PQL nomenclature be adopted in the databases as well as in the DVSRs and all other Deliverables.

Of further concern is how the censoring limits have been used in statistical data analysis and risk assessment. Again, there have been inconsistencies. For some projects the SQL (RDL) has been used, and for others the PQL (RL or QL) has been used. There are also inconsistencies between use of censoring limits for inorganic chemicals (metals) and organic chemicals within the same database. NDEP prefers that the SQL is used for all statistical analysis and risk assessment. As noted above this a sample-specific detection limit. This approach allows for inclusion of more information in the statistical analysis, allows background comparisons to be performed more clearly, and removes unnecessary conservatism from the risk assessments.

To clarify, NDEP suggests the following courses of action to make use of censoring limits consistent and as useful as possible:

1. Make the nomenclature consistent between databases, DVSRs and all Deliverables.

2. Report the MDL, SQL and PQL in the databases. NDEP notes that the MDL and SQL are often the same. In those cases, reporting the SQL is sufficient.

3. Use the SQL in statistical analysis and risk assessment.

The situation is somewhat different for radionuclides. In this case, data can be reported regardless of the minimum detectable activity (MDA), which serves as a metric for evaluating sensitivity of the laboratory analysis. The MDA for radionuclides is the lowest level of activity in a given sample that is statistically distinguishable from a sample with no activity, at the 2-sigma confidence interval. The MDAs for radionuclide analysis are determined by a mathematical formula that takes into account sample volume, chemical recovery, instrument detection efficiency and background, and sample counting duration. The

MDA, therefore, is equivalent to the SQL for radiochemical analytes. For radiochemical analysis, no PQL is established as all results are reported to the MDA. In addition, the 2-sigma radiological error is reported for each analyte in each sample. Because a result that is not censored is available for all radionuclide analyses, NDEP prefers that the MDAs are reported in the databases, but are otherwise not used for statistical analysis or risk assessment, and that the raw data are used directly.

Asbestos also provides a unique case. Asbestos data should be reported in terms of the raw counts of asbestos fibers detected in a given sample. Analytical sensitivity and concentration of asbestos in soil can be calculated from the raw data if the other elutriator instrument parameters are also provided (e.g., area of the filter, area of the scanned part of the filter, volume of air passed through the filter). In effect there are no detection limits that can be used to censor the asbestos data.

February 6, 2009

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Curt Richards
Olin Corporation
3855 North Ocoee St., Suite 200,
Cleveland, TN 37312

Mr. Joe Kelly
Montrose Chemical Corp of CA
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals Corporation
PO Box 2128
Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Guidance for Evaluating Radionuclide Data for the BMI Plant Sites and Common Areas Projects

Dear Sirs and Madam:

All of the parties listed above shall be referred to as “the Companies” for the purposes of this letter. Guidance for evaluating radionuclide data is provided in Attachment A. This guidance is a supplement to the secular equilibrium tool issued via electronic mail on January 22, 2009 and the secular equilibrium guidance document issued on February 6, 2009.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City
Barry Conaty, Holland & Hart LLP, 975 F Street, N.W., Suite 900,Washington, D.C. 20004
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5,
75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County DAQEM, PO Box 551741, Las Vegas, NV, 89155-
1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA
94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Drive, Edmond, OK 73013
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Jeff Gibson, AMPAC, 3770 Howard Hughes Parkway, Suite 300, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Cindi Byrns, Olin Chlor Alkali, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 10733 Wave Crest Court
Stockton, CA 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380,
Bainbridge Island, WA 98110
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite
510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200,
Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544
Paul Black, Neptune and Company, Inc., 8550 West 14th Street, Suite 100, Lakewood, CO 80215
Teri Copeland, 5737 Kanan Rd., #182, Agoura Hills, CA 91301
Paul Hackenberry, Hackenberry Associates, 550 West Plumb Lane, B425, Reno, NV, 89509

ATTACHMENT A

Introduction

Issues were raised in the latter part of 2007 when datasets of radioactivity in soil samples from several of the BMI Companies (hereinafter "the Companies") continued to both pass and fail soil-based background comparisons for radionuclides in the same chain. This brought into question the appropriateness of some of the radionuclide data, since radionuclides in the same chain should obtain similar background comparison results under the assumption of secular equilibrium. The Nevada Division of Environmental Protection (NDEP) issued a letter to the Companies dated December 7, 2007 (BMI Plant Sites and Common Areas Projects, Henderson, Nevada: *Advisement Regarding Radionuclide Analysis for Uranium*) asking specific questions about radiochemical analysis methods for potentially affected projects and datasets. The Companies have provided responses, and all relevant issues within each correspondence are addressed as part of this report.

The goals of this guidance are to describe some of the chronology of how the issue arose and interactions and information shared with the Companies, evaluate analytical methods and data, and provide recommendations for recovering from historical issues that have caused apparent bias in the radionuclide data. There are three Companies involved that have submitted data to the NDEP thus far: Basic Remediation Company (BRC), Titanium Metals Corporation (TIMET) and TRONOX LLC (TRONOX) (collectively, also referred to as "the Companies" for the purposes of this letter). Several radionuclides from two radionuclide chains are of primary concern: The uranium (U)-238 chain (uranium chain) focusing on the long-lived radionuclides U-238, U-234, Thorium (Th)-230 and Ra-226; and, the thorium-232 chain (thorium chain) focusing on the long-lived radiounclides Th-232, Th-228 and Ra-228. These radionuclides are of interest because the projects require their data collection to support human health risk assessment. Other radionuclides, with the exception of U-235 are not included directly in these risk assessment. No evaluation of the U-235 decay chain data was performed since most radionuclides appear to be barely discernable from the minimum detectable concentration. Nevertheless, issues raised by the Companies pertaining to Polonium (Po)-210 and Lead (Pb)-210 are also discussed in this report.

Secular equilibrium (SE) exists when the quantity of a radioactive isotope remains constant because its production rate (due to the decay of a parent isotope) is equal to its decay rate. In theory, if secular equilibrium exists, the parent isotope activity should be equivalent to the activity of all daughter radionuclides. Pure secular equilibrium is not expected in environmental samples because of the effect of natural chemical and physical processes. For example, characteristics such as partitioning and solubility differ by element, and, for the entire uranium and thorium chains, radon is a gas that can escape the environmental system. In addition, differences in analytical methods could also cause minor effects or relative bias in the radionuclide data. However, approximate secular equilibrium is expected under background conditions. Natural abundance ratios of the uranium isotopes also offer a metric by which background radionuclide conditions can be evaluated. It should be noted that failure of secular equilibrium or natural abundance ratios implies contamination, whereas lack of failure does not imply lack of contamination; rather, it implies lack of contamination or contamination that maintains the relevant proportions. Although natural abundance ratios could be used to evaluate the presence of radionuclides, it is easier to perform the evaluation using secular equilibrium because the activities of isotopes within a chain should be approximately equivalent.

This memorandum is divided into three main sections[1]. The first section addresses some of the underlying historical radionuclide data assembled by BRC, TIMET and TRONOX. Of specific interest are the radiochemical analytical methods used in the different investigations. Background data sets are available from three investigations: the original 2005 BRC/TIMET background study; the 2008 supplemental BRC background study; and, the 2008 BRC deep background study. Site data sets are available from seven investigations: TRECO; TRONOX Parcels A/B and Parcels C/D/F/G; the BRC Utility Corridor; the BRC upgradient groundwater wells soil sampling; BRC's Parcel 4B; and the BRC northeast area wells soils investigation. The focus is the soil sampling and analysis that was performed for these 10 investigations. Exploratory data analyses are presented and secular equilibrium is evaluated using an equivalence testing procedure, which is described in NDEP's guidance *Statistical Methods for Secular Equilibrium: For Radionuclide Data from Soil Samples Collected at the BMI Complex and Common Areas in Henderson, Nevada* (Statistical Methods for Secular Equilibrium Guidance), document dated January, 2009. The second section addresses a TIMET technical memorandum concerning a methods comparison for estimating radium (Ra)-228. The third section addresses the concerns regarding polonium-210 and lead-210. The report concludes with recommendations on how questionable radionuclide activity data from these studies can be used to support background comparisons and risk assessment, and describes the radiochemical analytical methods that should be used for future investigations.

Evaluation of the Uranium and Thorium Radionuclide Chains

The December 2007 NDEP memorandum highlighted issues relating to radiochemical analytical methods used for isotopic uranium analysis. The primary issue at hand was whether laboratory preparation methods were performed using hydrofluoric acid (HF). The NDEP requested that the Companies identify datasets that were prepared using a non-HF procedure. The NDEP also requested the Companies propose a plan to rectify all affected datasets under the assumption that non-HF methods would yield low-bias radioactivities. In response to the NDEP request, BRC listed all affected datasets and proposed a plan to salvage those data that were compromised. These datasets included datasets associated with BRC investigations and TRONOX investigations. TIMET stated from a response to NDEP comments as recent as January 29, 2008 that isotopic uranium and thorium preparation used the same method employed for the 2005 BRC/TIMET Shallow Soils Background data. TIMET did however identify issues with the preparation and analytical methods for Ra-228 and Pb-210, which are discussed later in this report. The results of exploratory and statistical analyses are presented below that shed light on the identified datasets and evaluate the proposed correction measure proposed by BRC and TRONOX. Datasets for TIMET were not specifically evaluated as it was believed that this would not add value to the development of this guidance document.

---

[1] All references to the Henderson site datasets included in this analysis are provided at the end of this report in a section titled "References for the Henderson Site datasets".

Exploratory data analysis (EDA) performed on the BRC and TRONOX data includes box plots, correlation matrices, and summary statistics tables for the uranium and thorium radionuclide chains. These analyses were performed to qualitatively assess if the radionuclide data exhibit secular equilibrium. The EDA is followed by statistical analysis that involves equivalence testing for secular equilibrium, as described in NDEP's Statistical Methods for Secular Equilibrium Guidance (January 2009), and recommendations are made regarding recovery of historical data and radiochemical analysis for future studies.

Exploratory Data Analysis

Several of the soil datasets identified by BRC that were affected by the preparatory methods exhibited noticeable differences in the box plots and summary statistics between radionuclides within each chain (see Appendices A and B below). Some of the most noticeable differences between radionuclides (both thorium and uranium chains) were identified for datasets flagged by BRC as "requiring correction". These datasets include: BRC Parcel 4B, TRONOX Parcels C/D/F/G, BRC northeast area wells, and BRC upgradient groundwater wells. Comparison between radionuclides and comparison with the background data sets are helpful when interpreting the EDA.

Although there are some small differences in the box plots and summary statistics for the three background datasets, they appear to exhibit approximate secular equilibrium. They also show radioactivities that are a little greater than 1 pCi/g on average for radionuclides in the uranium chain, with high values around 3 pCi/g. Radioactivities in the thorium chain are a little greater than 1.5 pCi/g on average, with high values around 3 pCi/g again. Of further interest is that the correlations appear to be high within the uranium chain, but correlations with Ra-228 appear very low in the thorium chain (see Appendix C below). These are useful references for evaluation of the seven site datasets.

The BRC Parcel 4B data show clear differences in the uranium chain, with Ra-226 showing much higher activities than Th-230, which in turn are much higher than those for the uranium isotopes. Differences between Ra-228 and the thorium isotopes are also clear in the thorium chain (see Appendices A and B below). For both chains, the Ra results appear to be roughly in line with background. Hence, the uranium and thorium data appear to be too low.

The TRONOX Parcels A/B data exhibit noticeable differences in both radionuclide chains, however these data were identified in the BRC memorandum as not requiring further corrections because they were corrected for the No Further Action Determination (NFAD) for these parcels (see Appendices A and B below). The uranium chain box plot shows that the Ra-226 data are similar to background, and the Th-230 data are slightly higher than the Ra-226 data. However, the radioactivities for the uranium isotopes appear to be too low. Results for the thorium chain appear to be reasonable. Of interest again is that the correlations are low with Ra-228. The lack of correlation with Ra-228 is a recurring theme.

The BRC upgradient groundwater wells and the BRC northeast area wells data exhibit the same general pattern as the TRONOX Parcels A/B data. However, the correlations with Ra-228 are high for these two datasets, and are the exceptions in this regard across the 10 datasets evaluated.

The TRONOX Parcels C/D/F/G and the Utility Corridor data show similar patterns with respect to the uranium and thorium chains, although there is some greater variability in the TRONOX Parcels C/D/F/G data. The correlations with Ra-228 are again quite low.

The TRECO study was performed a few years earlier than the other site studies reported here. The uranium chain data appear to be in line with background with the exception of the Ra-226 data, which appear to be greater than the data for the other isotopes. The Ra-226 data also appear to be greater than background. The data imply either an analytical issue, or low levels of Ra-226 contamination at TRECO. For the thorium chain, the data appear to be similar to background and they are in approximate secular equilibrium. However, the mean for Ra-228 is lower than for the thorium isotopes. The correlations with Ra-228 again appear to be low.

The EDA and correlations suggest some potential issues with the radionuclide data. When the radioactivities are too low, the implication is an analytical issue, which has been traced back to the preparation method for uranium, and possibly for thorium, for some of the investigations. If the radionuclides are in secular equilibrium, then their correlations should be expected to be high. Consequently, the lack of correlation with Ra-228 is also of concern. Correlations in the uranium chain are generally high, but there are exceptions. For example, the correlations with Ra-226 at BRC Parcel 4B are negative, which further brings into question the analytical methods for that investigation. The correlations with Ra-226 at TRECO are also low.

Equivalence Test for Secular Equilibrium

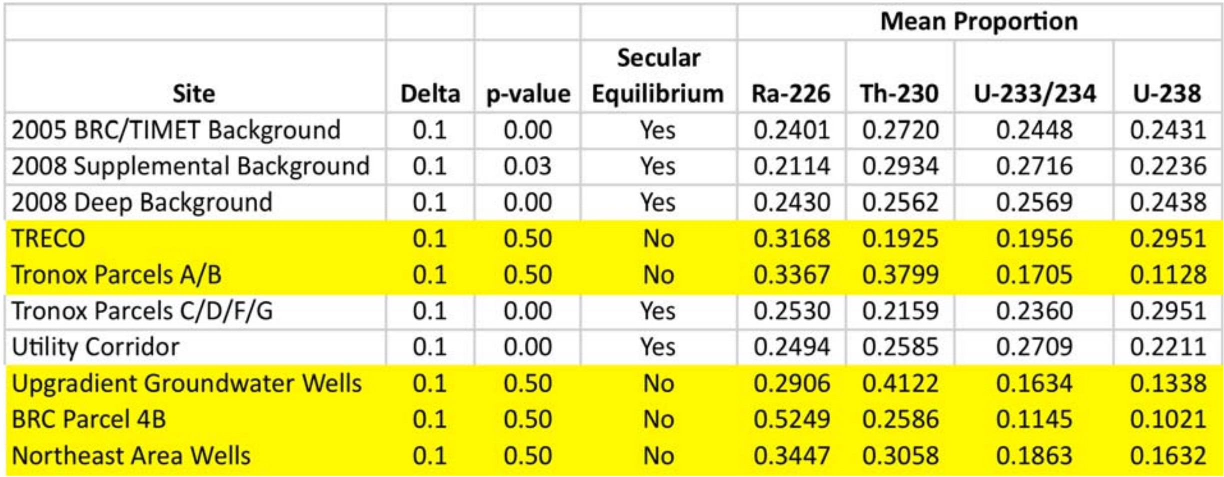
The EDA involves comparison of data in the box plots and summary statistics that does not address the inherent correlation if secular equilibrium holds. That is, distributions might appear to be similar, but lack of correlation is also a concern. Conversely, a strong correlation does not imply similar results for the radionuclides. For example, the correlations in the uranium chain for the BRC upgradient groundwater wells soil data are strong, but there are clear differences between the uranium isotopic activities and those of radium-226 and thorium-230. In other cases where differences occur, the correlations are also low. The comparison issues are, apparently, complex. To further the evaluation, equivalence tests are presented to evaluate secular equilibrium. Equivalence testing, unlike standard classical significance testing, evaluates whether means are approximately equal, as opposed to exactly equal. The equivalence testing approach compares mean radioactivities while accounting for the correlation in the data. The approach is described in NDEP’s Statistical Methods for Secular Equilibrium Guidance (January 2009).

Statistical equivalence testing essentially involves reversing the standard null and alternative hypotheses used in analysis of variance (ANOVA), and, in the process, allowing for non-point valued null hypothesis statements. Equivalence testing allows some flexibility in how approximate secular equilibrium is defined. The hypotheses allow a family of possible options, instead of the point null hypothesis that is common in classical statistics, by specifying that the mean radioactivities can be close to the same as opposed to exactly equal. The result of equivalence testing for secular equilibrium will either indicate that the radionuclides are in approximate secular equilibrium (the alternative hypothesis), or that they are not (the null hypothesis). If the radionuclide data do not exhibit secular equilibrium, then there is some indication of radionuclide specific contamination. If the radionuclide data exhibit secular equilibrium, then either the data are similar to background, or there is more general contamination for all radionuclides in the decay chain.

The equivalence testing approach involves establishing an allowable difference between the mean activities for the radionuclides in the same decay chain. Specification of this difference is not necessarily straightforward. In this case, however, it seems reasonable to assume approximate secular equilibrium for the background data. Equivalence tests were performed on the background data for several possible allowable differences. The equivalence tests start to fail when the allowable difference is much less than 10%, in which case a difference of 10% was used to test the site data.

The results of the equivalence testing are presented in Table 1 (uranium chain) and Table 2 (thorium chain). Several sites did not meet the conditions of secular equilibrium (SE) for the uranium chain. These are TRECO, TRONOX Parcels A/B, the BRC upgradient groundwater wells, and the BRC northeast area wells. In BRC's response to a NDEP memorandum dated January 10, 2008, many of these datasets were flagged as requiring correction (with the exception of TRECO). The only site for which the conditions of secular equilibrium were not met was BRC Parcel 4B. Although the correlations with Ra-228 are often very low, the means are sufficiently close that the hypothesis of secular equilibrium is supported using the equivalence testing approach.

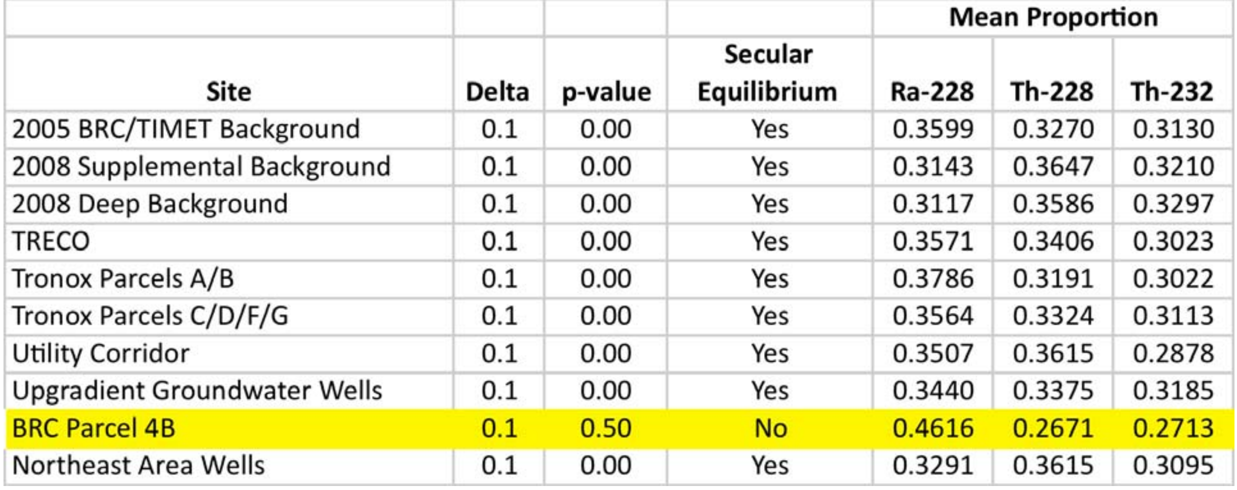
Table 1. Equivalence testing results for the uranium chain.



				Mean Proportion			
Site	Delta	p-value	Secular Equilibrium	Ra-226	Th-230	U-233/234	U-238
2005 BRC/TIMET Background	0.1	0.00	Yes	0.2401	0.2720	0.2448	0.2431
2008 Supplemental Background	0.1	0.03	Yes	0.2114	0.2934	0.2716	0.2236
2008 Deep Background	0.1	0.00	Yes	0.2430	0.2562	0.2569	0.2438
TRECO	0.1	0.50	No	0.3168	0.1925	0.1956	0.2951
Tronox Parcels A/B	0.1	0.50	No	0.3367	0.3799	0.1705	0.1128
Tronox Parcels C/D/F/G	0.1	0.00	Yes	0.2530	0.2159	0.2360	0.2951
Utility Corridor	0.1	0.00	Yes	0.2494	0.2585	0.2709	0.2211
Upgradient Groundwater Wells	0.1	0.50	No	0.2906	0.4122	0.1634	0.1338
BRC Parcel 4B	0.1	0.50	No	0.5249	0.2586	0.1145	0.1021
Northeast Area Wells	0.1	0.50	No	0.3447	0.3058	0.1863	0.1632

Results highlighted in yellow indicate that the uranium chain is not in secular equilibrium.
Note that p-values reported as 0.50 are greater than or equal to 0.50.

Table 2. Equivalence testing results for the thorium chain



				Mean Proportion		
Site	Delta	p-value	Secular Equilibrium	Ra-228	Th-228	Th-232
2005 BRC/TIMET Background	0.1	0.00	Yes	0.3599	0.3270	0.3130
2008 Supplemental Background	0.1	0.00	Yes	0.3143	0.3647	0.3210
2008 Deep Background	0.1	0.00	Yes	0.3117	0.3586	0.3297
TRECO	0.1	0.00	Yes	0.3571	0.3406	0.3023
Tronox Parcels A/B	0.1	0.00	Yes	0.3786	0.3191	0.3022
Tronox Parcels C/D/F/G	0.1	0.00	Yes	0.3564	0.3324	0.3113
Utility Corridor	0.1	0.00	Yes	0.3507	0.3615	0.2878
Upgradient Groundwater Wells	0.1	0.00	Yes	0.3440	0.3375	0.3185
BRC Parcel 4B	0.1	0.50	No	0.4616	0.2671	0.2713
Northeast Area Wells	0.1	0.00	Yes	0.3291	0.3615	0.3095

Results highlighted in yellow indicate that the Th-232 chain is not in secular equilibrium.
Note that p-values reported as 0.50 are greater than or equal to 0.50.

Preparation and Analysis Methods

The results of the secular equilibrium tests confirm some of the findings in the EDA and correlation analyses. Differences occur in the data for each radionuclide in the uranium chain for some sites, but the issue appears to be low radioactivities, implying an issue with the radiochemical analysis. However, secular equilibrium is observed in the thorium chain (with the exception of BRC Parcel 4B), despite the lack of correlation with Ra-228 in many of the datasets. After some investigation, the main issue appears to be associated with the preparation method used for the uranium and thorium analyses.

The methods and analyses used for isotopic uranium and thorium analysis for the sites that are addressed as part of this memorandum are presented in Table 3. There is some clear relationship between methods used and the statistical analysis results presented above. For example, the comparatively low uranium radioactivities correspond to investigations that did not use HF acid in the sample preparation (prep) step for dissolution of the sample. Results of the thorium analysis for BRC Parcel 4B might be a consequence of a similar issue. The data are compelling, but there is no other evidence to support the apparently low thorium activities at this site.

There are two reasons why it is recommended that all future isotopic uranium and thorium analysis for soils/sediments/solid samples should be digested using HF for total dissolution with subsequent analysis by alpha spectroscopy (spec). The first is that this is how the background data have been analyzed, and comparison of site and background data require comparability between datasets. The second is that based on the statistical analysis presented, it appears that this approach will provide the most reliable data for these radionuclides. This recommendation is consistent with how GEL and STL-Saint Louis have performed analysis for the thorium and uranium isotopes for the sampling events listed in Table 3, and is also consistent with how STL-Richland performed these analyses for the 2008 BRC deep soils background analysis.

Table 3. Radionuclide Methods.

Event	Pass U SE?	Pass Th SE?	Laboratory and Date	U preparation and analysis methods	Th preparation and analysis methods	Ra-226 preparation and analysis methods	Ra-228 preparation and analysis methods
2005 BRC/TIMET Background*	Y	Y	STL-SL, 2005	HF, alpha spec.	HF, alpha spec.	Prep acids unknown, Alpha spec. GFPC 9315.	Prep acids unknown, Beta spec, 9320.
2008 Supplemental Background	Y	Y	GEL, April 2008	HF, alpha spec.	HF, alpha spec.	Prep acids unknown, 903.1 Lucas cell alpha.	Prep acids unknown, 904.0 beta.
2008 Deep Background	Y	Y	STL-RICH, 2008	HF, alpha spec.	HF, alpha spec.	non-HF acids, 903.1, alpha scintillation counting.	non-HF acids, 904.0, GPC beta
TRECO	N	Y	STL-SL, 2005	Likely HF, alpha spec.	Likely HF, alpha spec.	Prep acids unknown, Alpha spec. GFPC 9315.	Prep acids unknown, Beta spec, 9320.
Tronox Parcels A/B (also #47)	N	Y	STL-RICH, 2007	Non HF, alpha spec.	HF**, alpha spec	gamma (soils)	gamma
Tronox Parcels C/D/F/G	Y	Y	STL-RICH, 2007	Non HF, alpha spec.	HF**, alpha spec	gamma	gamma
Utility Corridor (DVSR #50)	Y	Y	GEL, April 2008	HF, alpha spec.	HF, alpha spec.	Prep acids unknown, 903.1 Lucas cell alpha.	Prep acids unknown, 904.0 beta.
Upgradient Groundwater Wells (#47)	N	Y	STL-RICH, 2007	Non HF, alpha spec.	HF**, alpha spec	gamma	gamma
BRC Parcel 4B (#43)	N	N	STL-RICH, 2007	Non HF, alp ha spec.	HF**, alpha spec	gamma	gamma
Northeast Area Wells (#46)	N	N	STL-RICH, 2007	Non HF, alpha spec.	HF**, alpha spec	gamma	gamma

* Ra-226 and Ra-228 were re-analyzed at STL-Richland due to anomalies using isotopic barium carrier using the digestions prepared at STL-SL.

** Per email from Erika Jordan (Richland) all thorium used HF, uranium non-HF prior to 2008 Deep Background investigation. STL-ST: Severn Trent Laboratories, St. Louis. STL-RICH: Severn Trent Laboratories, Richland.

The issues regarding radium are less clear. Radium results often seem reasonable. However, a lack of correlation in some cases is of concern. For radium-226, correlations are highest at the BRC upgradient groundwater wells and the BRC northeast area wells sites, but neither of these sites demonstrates approximate secular equilibrium because of issues with the uranium analysis. Correlations are also quite high in the three background datasets and the BRC utility corridor data, all of which involves alpha spectroscopsy (spec) analysis following HF acid preparation. Although there is not much evidence of analytical issues with the gamma spectroscopy method for radium-226, the main reason for using alpha spectroscopy is that this is the method used for the background data, and comparability of data is important for background comparisons.

The same applies to the radium-228 analysis; that is, beta spectroscopy should be used for site investigations because this is the method that was used for the background data. However, there is some evidence in the radium-228 data, based on the correlation analysis, for the BRC upgradient groundwater wells and the BRC northeast area wells sites that the gamma spec method outperforms the beta emissions methods. The lack of correlation could also be related to lack of sensitivity of the methods at the radioactivity levels being reported.

For the BRC 2008 deep background data the preparation method for both radium isotopes involved non-HF acids, in which case underestimation of the radium data might be expected. The results seem reasonable, however. A possible explanation is that radium is more soluble than thorium and radium, and HF acid is not necessary to obtain reliable data. Further discussion of radium-228 analysis is presented in the next section in response to TIMET’s side-by-side study of gamma and beta spectroscopy analysis for this isotope.

Based on the observations made, and the analytical methods that were used for the background data, it is recommended that soils/sediments/solid being analyzed for Ra-226 should use alpha spectroscopy consistent with EPA methods 903.0/903.1 and 9315. It is recommended that isotopically labeled barium be used as the tracer. For Ra-228, soils/sediments/solid samples should be analyzed using beta spectroscopy consistent with EPA methods 904.0 and 9320. It is also recommended that isotopically labeled barium be used as the tracer.

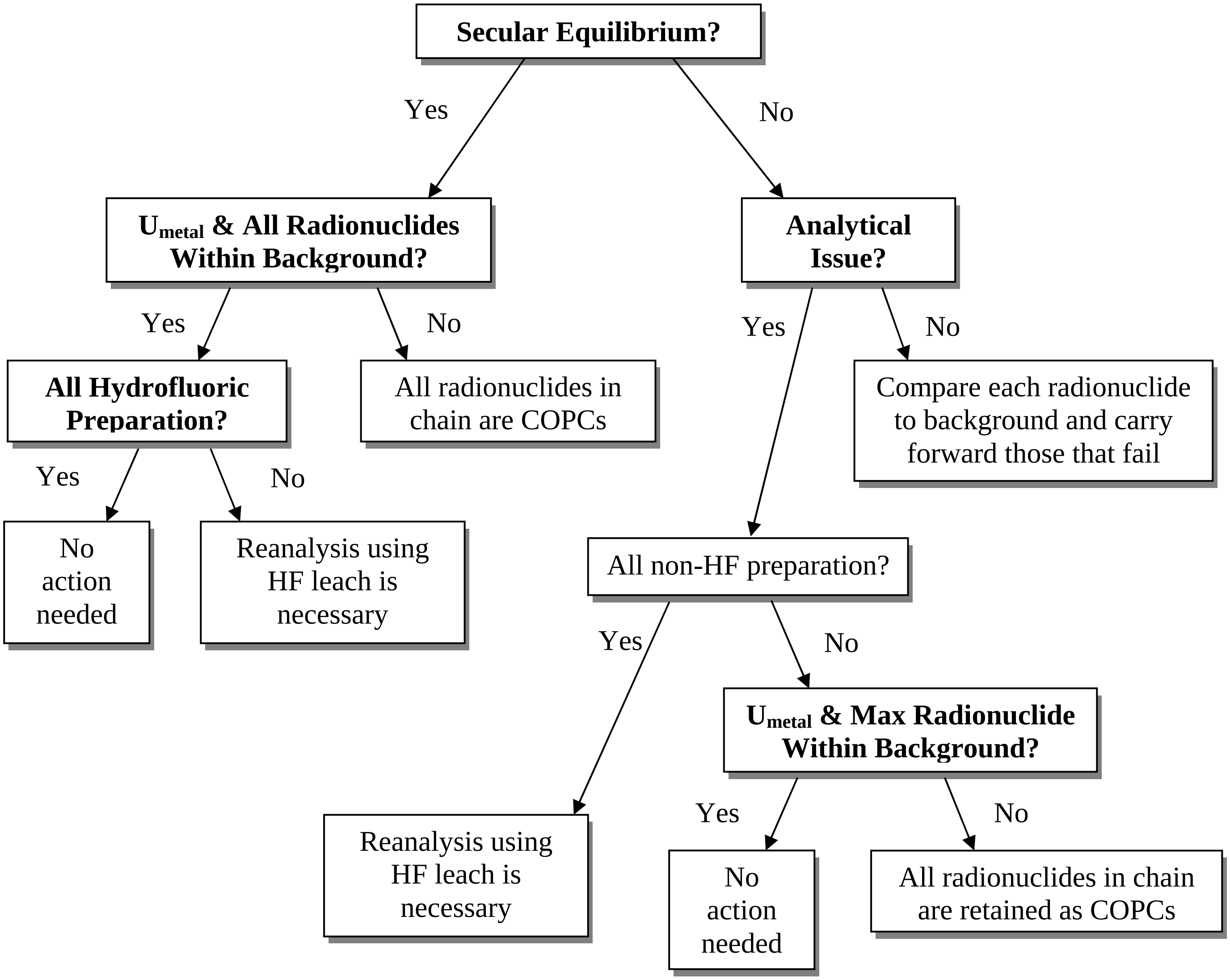
Evaluating BRC’s proposed correction approach and recommended decision logic

In BRC’s response to the NDEP memorandum dated January 10, 2008, BRC proposed a correction factor approach in an attempt to salvage existing data sets that were affected by differences in preparatory methods. BRC constructed a dataset of 14 randomly chosen samples from the BRC 2008 deep soil background dataset and five randomly chosen samples from the TRONOX Parcels A/B dataset that were digested using the HF procedure and then reanalyzed. A ratio was then calculated for each sample by taking the HF acid reanalysis result and dividing it by the initial non-HF result for U-238, U-235/236, and U-233/234. An average correction ratio was then calculated for each nuclide. The correction procedure is then accomplished by multiplying the existing U-238 and U-233/234 activities analyzed using non-HF acid dissolution methods by the nuclide-specific average ratio.

Based on the statistical analyses presented above, the correction factor approach is likely to provide unreliable and unsupportable results. The correction factor approach can only be applied if the data to which it is applied exhibits the same problem as the data on which the correction factor is based. The difference in data for the site datasets implies this is unlikely to be the case. For example, the mean uranium activity at the BRC Parcel 4B site is about 0.2 pCi/g, whereas at the BRC upgradient groundwater wells site, the mean is about 0.6 pCi/g. Although there are problems with the data, a single correction factor approach seems unreasonable. NDEP's recommended approach is presented in Figure 1. This flowchart describes a decision framework that is applicable to all metallic uranium and radionuclide datasets that have been collected to date.

If secular equilibrium is exhibited in the isotope chains, then background comparisons should be performed to confirm if all the radionuclides in a decay chain are similar to background. If they are greater than background, then all the radionuclides would be carried forward in a risk assessment. If they are not greater than background and HF acid dissolution was used, then no further action is needed. If HF acid dissolution was not used, however, then reanalysis is necessary because all the radionuclide activities are probably underestimated.

If secular equilibrium is not exhibited, but there are no analytical issues (e.g., use of non-NDEP-approved analytical methods, or non-HF acid dissolution for uranium and thorium), then background comparisons can be performed for each radionuclide separately and for uranium as a metal. If there are analytical issues for all the radionuclides then reanalysis is necessary. If the analytical issues apply only to some of the radionuclides (such as uranium in the case of several of the datasets studied in this report, and thorium in BRC Parcel 4B), then the approach that NDEP will support for the historical data is to perform background comparisons with metallic uranium concentrations (if such data were collected at the site), and with the radionuclide for which the analytical methods are reasonable (usually radium-226 and radium-228).



COPCs indicates "chemicals of potential concern".
U_{metal} denotes metallic uranium.

Figure 1. Flowchart describing the decision framework for radionuclide historical dataset usability for Sites within the BMI Complex and Common Areas, Henderson, NV.

Method comparison of radium-228 in soils (TIMET)

TIMET responded to an NDEP comment dated January 11, 2008 to identify all datasets that are not comparable. Specific to this section of the memorandum, TIMET identified differences in preparation and analytical methods for soil samples for Ra-228. To address this issue, a TIMET memorandum dated May 9, 2008 outlined method comparisons of gamma spectroscopy (Gamma Spec) to gas flow proportional counting (GFPC) for estimating Ra-228. The purpose of the TIMET memorandum was to provide a basis for using gamma spec Ra-228 data to support background comparisons, although it was clearly indicated that this approach had not previously been approved by the NDEP.

There are several issues brought to light by this TIMET memorandum. TIMET states that back quantitation of Ra-228 from parent radionuclide (Th-232) should not be performed because of issues of comparability between the TIMET Hydrogeologic Investigation and the TIMET Vertical Delineation Investigation data, and the BRC/TIMET shallow soil background data. Data was not presented to support these statements.

Instead, in order to use Ra-228 data from non-NDEP-approved gamma spectroscopy techniques, TIMET proposed using samples from four boring locations that were analyzed by both gamma spec and GFPC (the NDEP approved method) to predict Ra-228 activity based on the gamma spec results. This would potentially allow those data analyzed by gamma spec to be used in future background comparisons at the site.

Several concerns regarding this approach are as follows:

Regression equation

The regression equation (see Figure 2) is surprising perhaps in that the intercept is significant, implying that a value of zero from gamma spec would not predict a value near zero for GFPC. This is not necessarily a problem, provided the regression model is used only within the range of the experimental data. However, the positive intercept and the slope of about ½ demonstrate that the model under-predicts GFPC results at high gamma spec values, and over-predicts at low gamma spec values. There is some cause for concern because this implies that the predicted distribution will be tighter than the input gamma spec distribution (see below).

Range of the data

Regression analyses should only be used within the range of the available data. Extrapolation is rarely supported. The range of the gamma spec data is from a minimum of 0.4 pCi/g to a maximum of 1.9 pCi/g. The range of the GFPC data is from a minimum of 1.0 pCi/g to a maximum of 2.2 pCi/g. In both cases, this is a much tighter range than has been observed in the background data and in data from other BMI sites. The range of data for this study needs to be increased for potential use of the regression equation to predict GFPC results.

The removal of 'outlying' data

TIMET used three statistical criteria to evaluate whether or not "outliers" or "influential points" existed in the data in order to improve the fit of their ordinary least squares model. These criteria are studentized residuals, hat matrix diagonals, and Cook's D influence. From these three criteria, TIMET identified one residual as an outlier and two data points as influential. The outlier was the only point removed before TIMET revised the model. It is not clear that it is appropriate to remove an outlier without further justification simply to support an improved statistical model that is based on statistical assumptions that might not hold. Also, the difference between the two models is not sufficient to justify preference of the model without the outlier, and the regression lines are not very different. The small difference is probably because the outlier is not far outside the criteria used for its identification. Also, with 33 data points, identification of one outlier is not surprising. The unadjusted model should be used.

It is also not clear why a discussion of methods for identifying influential values is presented, when the TIMET memorandum does not include any regression analysis without these values.

Artificial tightening of post-hoc GFPC values, how will standard deviation / variance in prediction be addressed?

The issue here involves the fact that the original GFPC values in this data set had a standard deviation of 0.32 pCi/g where the gamma corrected GPFC predicted values have a standard deviation of about 0.16 pCi/g, or half that of the original data. This means that the confidence intervals constructed around these data will be much tighter and could have an effect on distributional background comparison tests, given the dependence of the distributional tests on the variance of the underlying data sets.

Heteroscedacity in variance around prediction line

This is likely a minor issue relative to the aforementioned, but there does appear to be heteroscedacity in the variance (i.e., different variances) around the prediction line as shown in Figure 2. Normally, this issue can be addressed by utilizing some form of a generalized linear model that accounts for the lack homogeneity in the residuals.

Variability between boring sites

There is some concern about the boring site variability. Figure 2 plots Ra-228 values from GFPC against those from gamma spec and clearly shows that grouping is occurring with respect to the boring site variable. Borings TMSB-131 and TMSB-135 are nearly always under-predicted while borings TMSB-132 and TMSB-133 are nearly always over-predicted. If all four borings can be assumed to be representative of the site then this is not a concern. The model accurately captures the "mean" behavior of the borings, however it cannot be applied to any particular boring and thus inferences should not be made about particular locations with this prediction model.

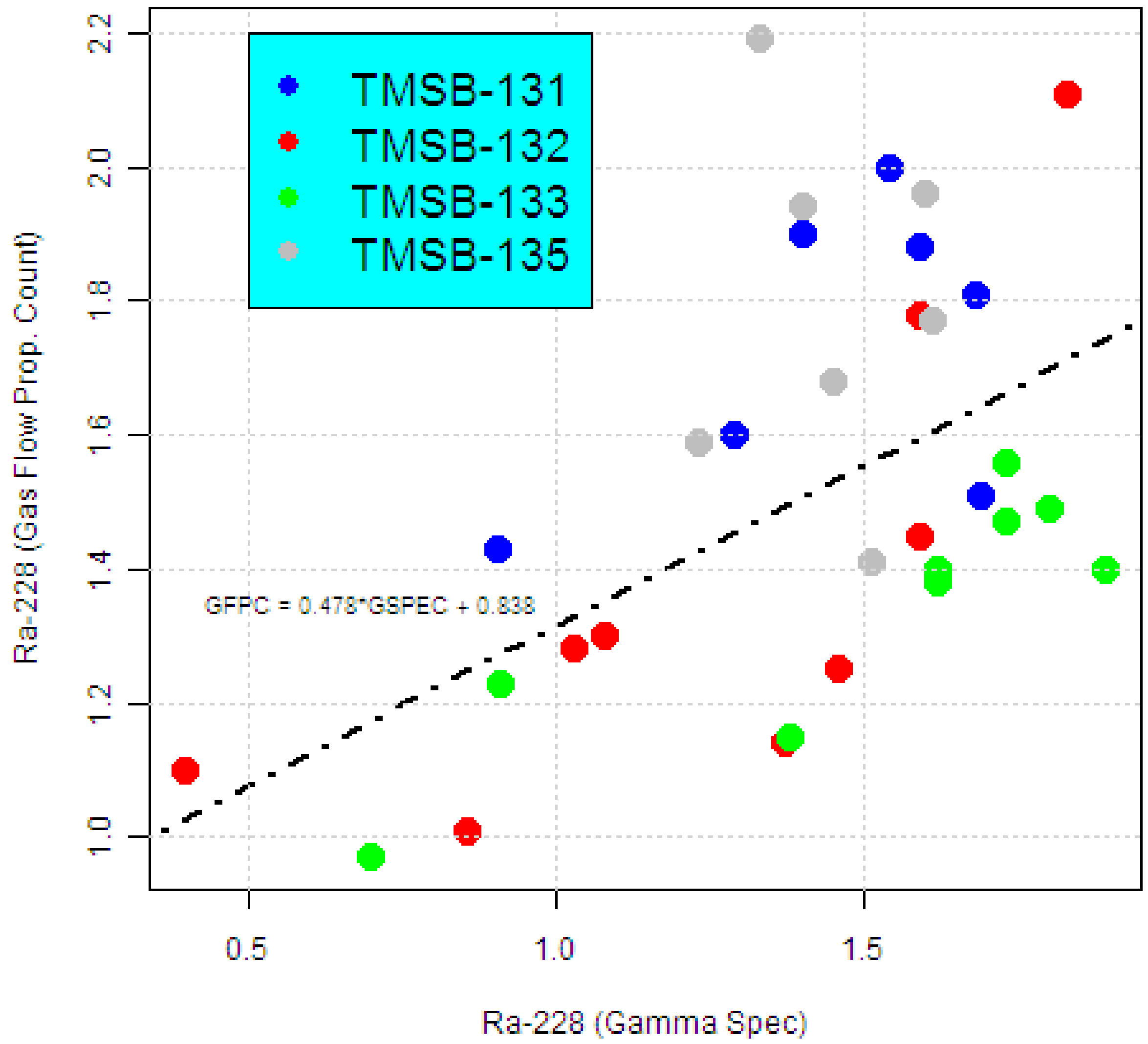
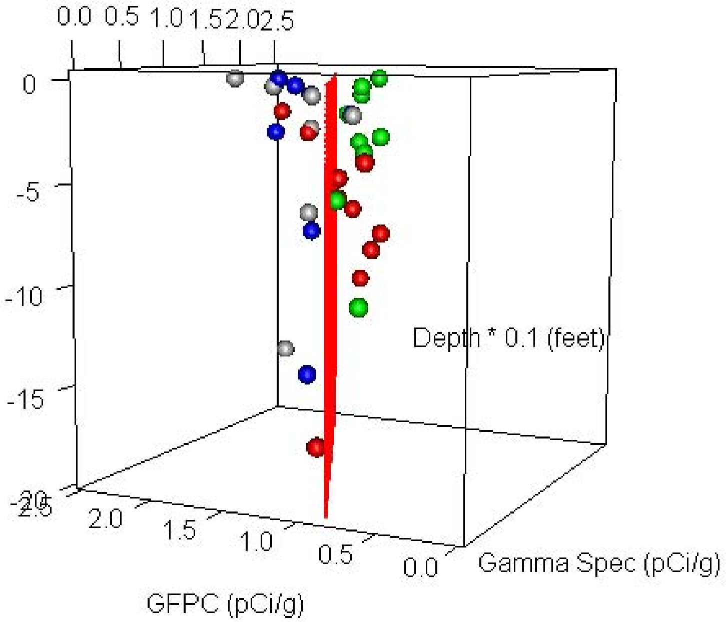


Figure 2: **Radium-228 data from GFPC and Gamma Spec analysis (including prediction line)**

Seemingly no relationship to depth

Diagnostically, from Figure 3, it appears that there is little relationship of prediction ability with depth of sample. A "side" shot, viewing down the prediction line (projected onto depth) shows that there is little deviation away from the prediction line as a function of depth. Therefore, these data do not support the inclusion of depth as part of the prediction model.



Color points share the same legend as presented in Figure 2.

Figure 3. **Radium-228 data from GFPC and Gamma Spec analysis (with the regression line projected onto depth).**

TIMET Lead-210 & Polonium-210 issues

TIMET proposed to conduct statistical correlations of results within the uranium decay chain to evaluate secular equilibrium for the analytical methods for Pb-210 and Po-210 (see TIMET's response to NDEP comments dated January 29, 2008). No further information has been provided. The most recent correspondence between TIMET and the NDEP dated April 11, 2008, indicates that TIMET has not yet completely resolved the Pb-210 and Po-210 analytical methods comparability issue, therefore we cannot comment further. If TIMET has conducted this analysis or have collected relevant data, then NDEP can perform a review. Otherwise, in light of the focus of human health risk assessment for the BMI sites on uranium, thorium and radium isotopes only, there is no need to pursue this issue further.

Summary

The path forward for radionuclide analysis seems clear based on the analysis presented in this report. Uranium and thorium isotopic analysis should be performed using alpha spectroscopy following HF acid dissolution. This approach is clearly more reliable than alternative approaches for these two elements, and is consistent with how the background data were obtained.

To resolve analytical issues with past data, BRC proposed a "correction factor" approach. Datasets flagged as potentially impacted by the analytical methods used for uranium and thorium were both qualitatively and quantitatively assessed to more comprehensively evaluate this proposed solution. The finding is that the proposed corrective factor approach should not be used. The side-by-side study that is used as the basis for the correction factor approach involved analysis of 19 samples for uranium isotopes. Although a simple correction factor approach was devised, the effect of method differences appears to be more complicated. Reported radioactivity for the uranium isotopes varies considerably when a non-HF acid dissolution was used. Possible explanations are the type of acid used and the amount of acid used for dissolution. Regardless, the correction factor estimated from the 19-sample study cannot be applied reliably to all affected datasets. In addition, correction factors were not developed for the thorium chain for BRC Parcel 4B and the BRC northeast area wells datasets, both of which failed the statistical test for secular equilibrium. An approach to resolving historical datasets is presented in Figure 1. NDEP requires that this approach be followed for historical data sets that are affected by analytical method issues. The approach basically allows the datasets to be evaluated (compared to background) based on uranium as a metal, and, usually, the radium isotopes. This is because the analytical problems are usually associated with the uranium and thorium analytical methods, whereas, the radium data, despite some analytical issues, appear to be comparatively reliable. NDEP also requires that appropriate methods as described in Table 4 are used for future investigations.

For the radium isotopes the situation is not as clear. It appears that Ra-226 analysis by alpha spectroscopy is marginally more reliable than analysis by gamma spectroscopy. The inter-isotope correlations within the uranium decay chain when alpha spectroscopy is used are often stronger than those when gamma spectroscopy is used. A more compelling argument to use alpha spectroscopy for Ra-226 is comparability with the background data. It should be noted, however, that HF acid dissolution was not used for the Ra-226 analyses in the background investigations. The Ra-226 results in background nevertheless seem reasonable (for example, they match results for other isotopes in the uranium chain). A possible explanation is that radium is more soluble than thorium and uranium, or that it is not so tightly bound in the soil matrix, so that a weaker acid dissolution is sufficient. It is not possible to draw firm conclusions in this regard without further information. For example, this could be achieved through a side-by-side study in which dissolution method is the variable of interest, including complete understanding of the acids used in the radiochemical analysis for radium. For radium-228 the situation is more difficult. The gamma spectroscopy results for the five sites included in this report seem reasonable, and, in two instances (BRC upgradient groundwater wells and BRC northeast area wells soils investigations) provide some of the highest correlations with the thorium isotopes from the thorium chain. However, the correlations are low in the other eight investigations presented in this report. In addition, the side-by-side study performed by TIMET does not provide a compelling argument for using gamma spectroscopy analysis for radium-228. The regression between the gamma spectroscopy results and the GFPC method does not provide a very good fit to the data, and the range of the data is smaller than the range of the background data, further reducing the effectiveness of the regression model for prediction from gamma spectroscopy data. The overriding issue again is that the background data were collected using beta spectroscopy, in which case this analytical method should also be applied to the site investigations.

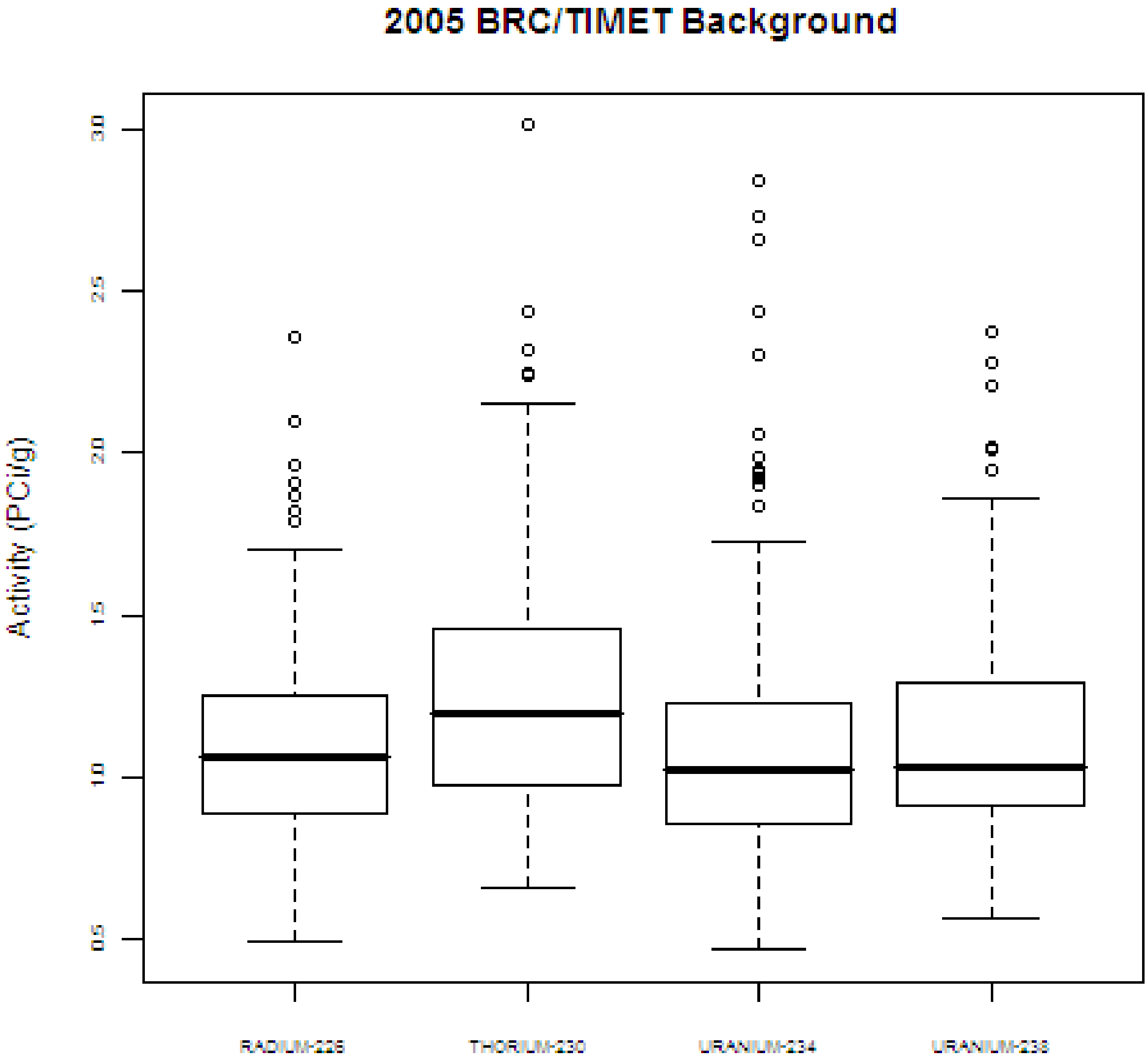
TIMET's side-by-side study for radium-228 analysis leads to a regression equation that relates gamma spectroscopy data to beta spectroscopy data. The regression model is not a very good fit to the data. The purpose of the investigation was to determine if beta spectroscopy data could be predicted from gamma spectroscopy data for radium-228. An implicit assumption was that the beta spectroscopy data are reliable. However, this assumption is not borne out by the analysis of the data from the three background and seven site investigations. The regression analysis and lack of correlation with radum-228 in many of the datasets might be suggestive of a sensitivity issue with the beta spectroscopy method. However, insufficient information is available to test this hypothesis. Also, the regression equation proposed is limited by the underlying data. The range of the radium-228 data in the side-by-side study is small compared to the range of the background and site investigations data. Extrapolation of regression equations is often difficult to defend. The regression proposed is not adequate for correcting existing gamma spectroscopy data without first addressing issues associated with the range of the data.

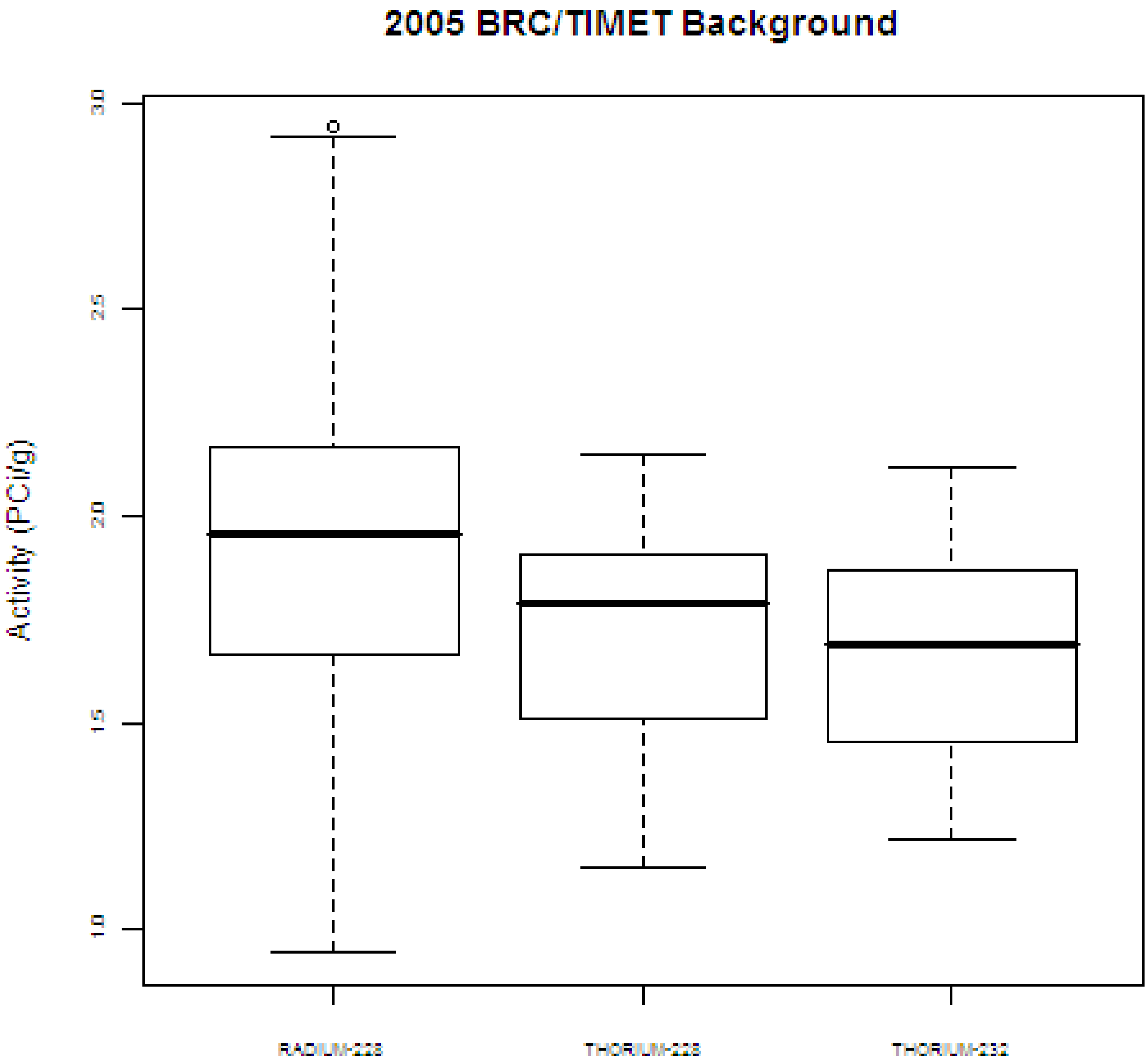
A full understanding of the analytical issues is not possible without recourse to some further information. Side-by-side studies across a greater range of radioactivities are needed to better form regression models and correlations between results. In addition, a study involving standards or performance evaluation samples would resolve many issues regarding the reliability of the analytical methods. Such a study should be performed blind to the laboratories involved. It also appears as though there are some sensitivity issues, at least for the radium-228 analytical methods. One issue with sensitivity that is always difficult is the role that ambient background subtractions play in the reported values. Ambient background data that are used in reporting data should also be reported and captured in the Companies databases. The following analytical methods are recommended for future site investigations:

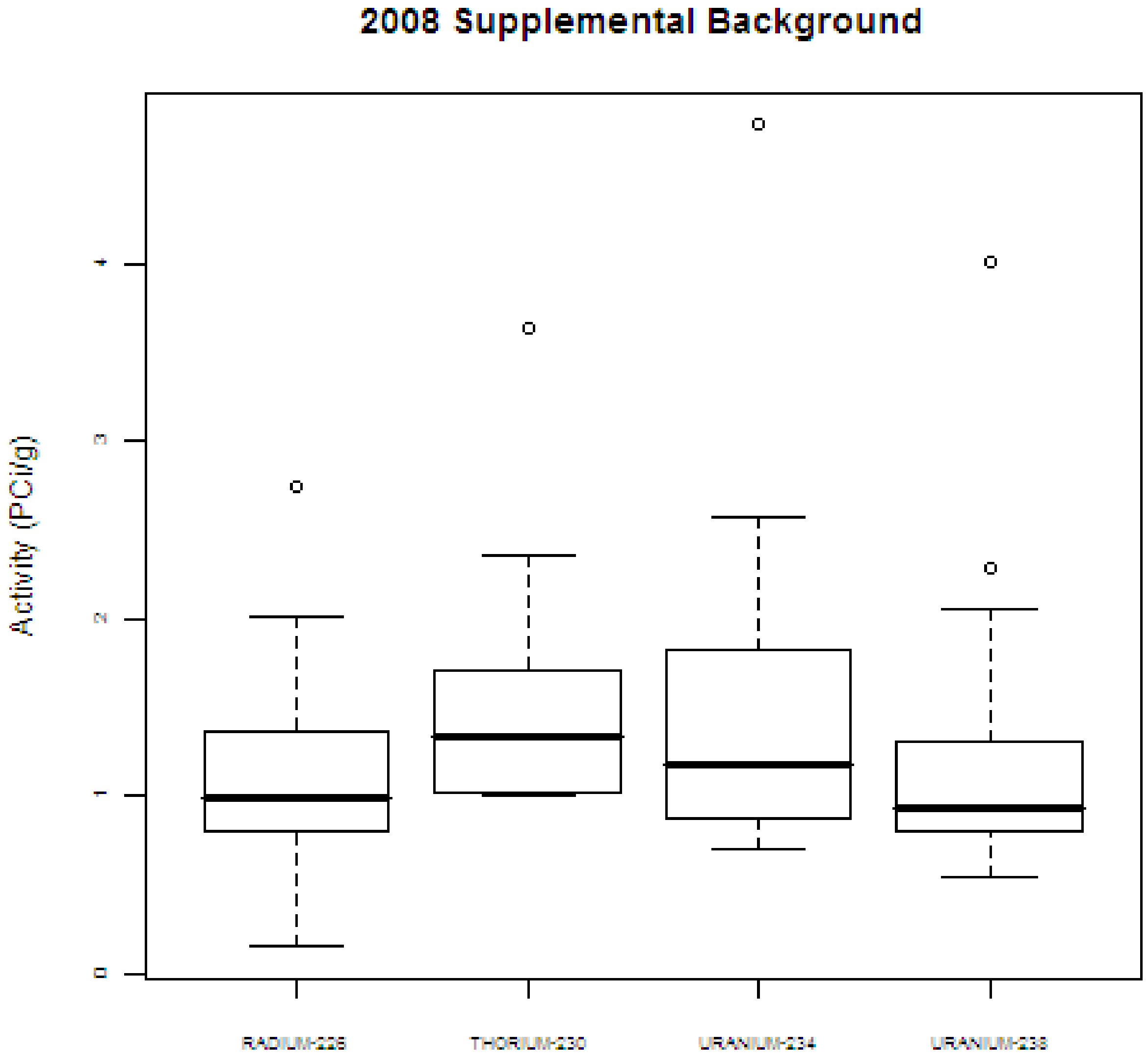
Table 4: Recommended Radiochemical Analytical Methods

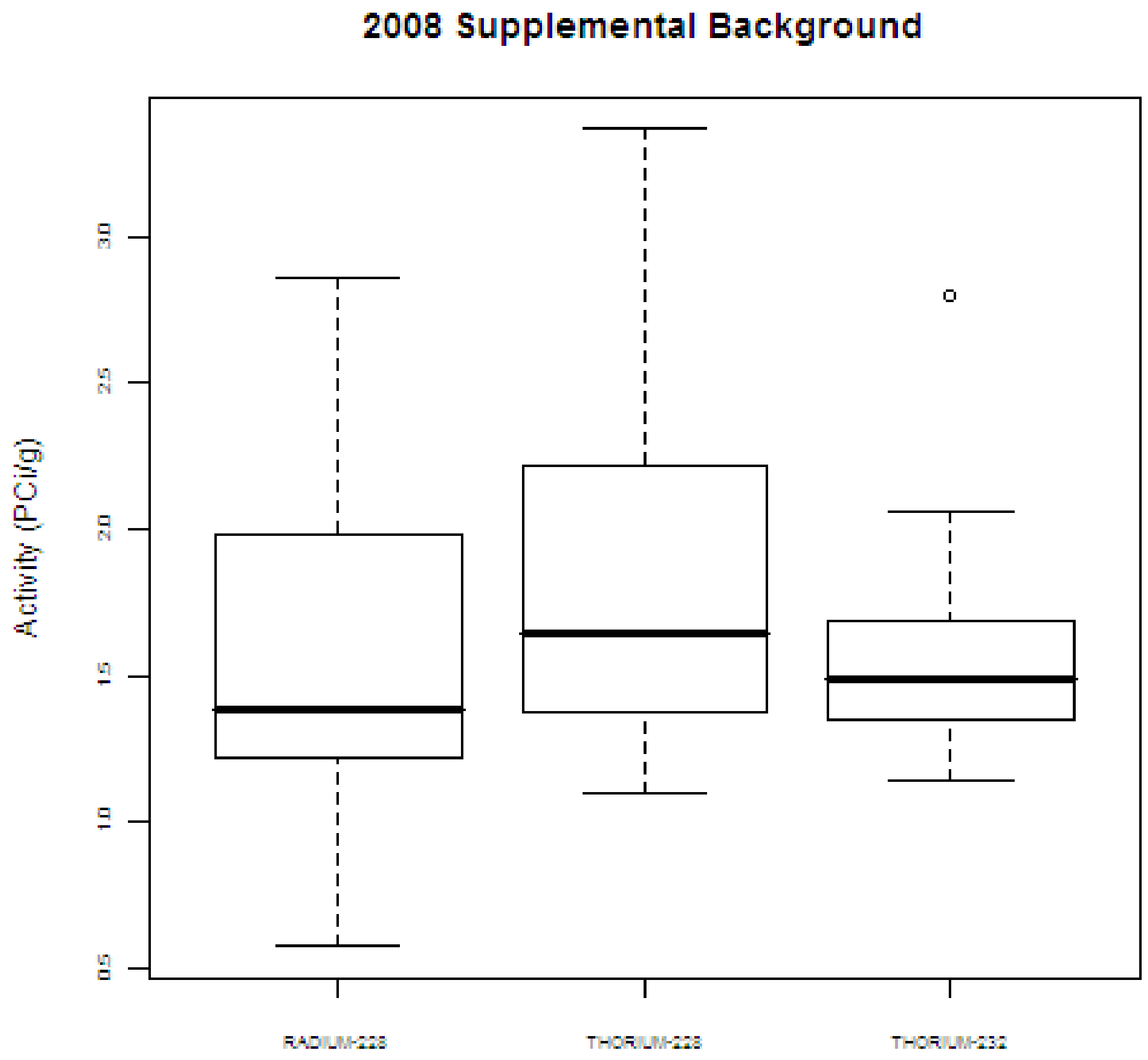
Radionuclide	Preparation Method	Analytical Method
Uranium isotopes	HF dissolution	Alpha spectroscopy consistent with DOE EML HASL-300 for isotopic uranium.
Thorium isotopes	HF dissolution	Alpha spectroscopy consistent with DOE EML HASL-300for isotopic thorium.
Radium-226	Requires further investigation	Alpha spectroscopy consistent with EPA methods 903.0/903.1 and 9315 with isotopically labeled barium as the tracer
Radium-228	Requires further investigation	Beta spectroscopy consistent with EPA methods 904.0 and 9320 with isotopically labeled barium as the tracer

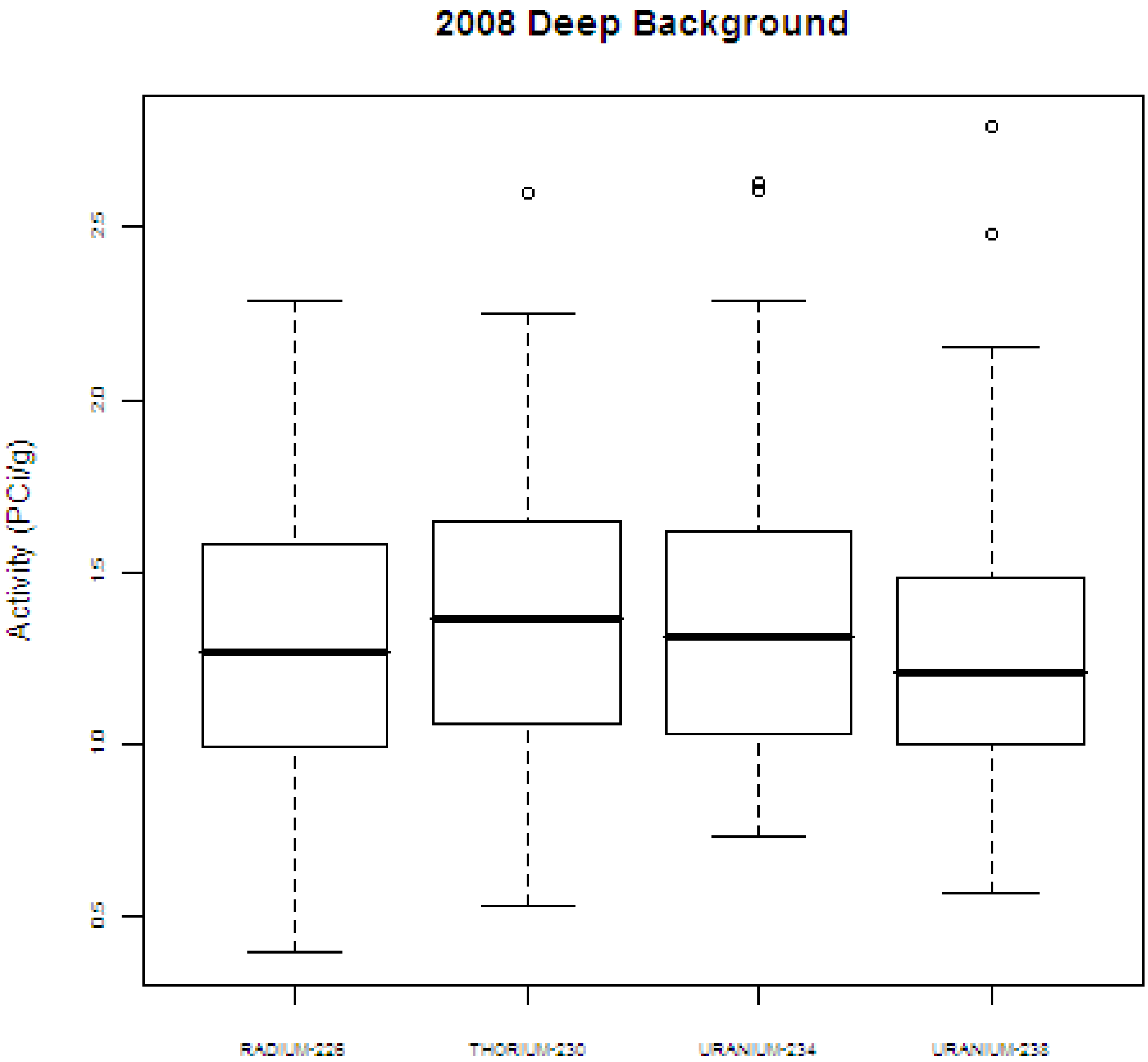
<u>Appendix A</u>

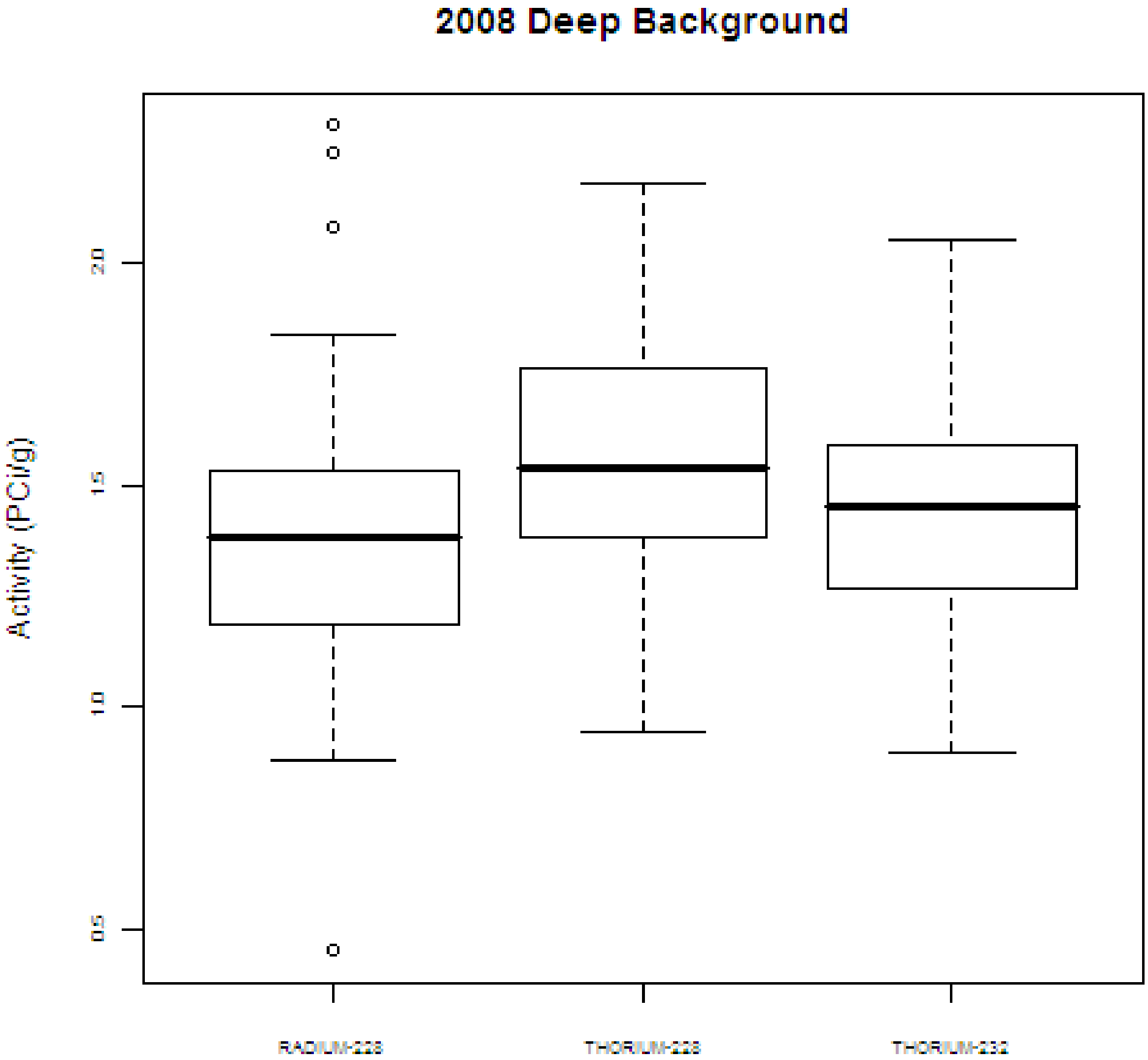

2005 BRC/TIMET Background
Activity (PCi/g)
3.0
2.5
2.0
1.5
1.0
0.5
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238

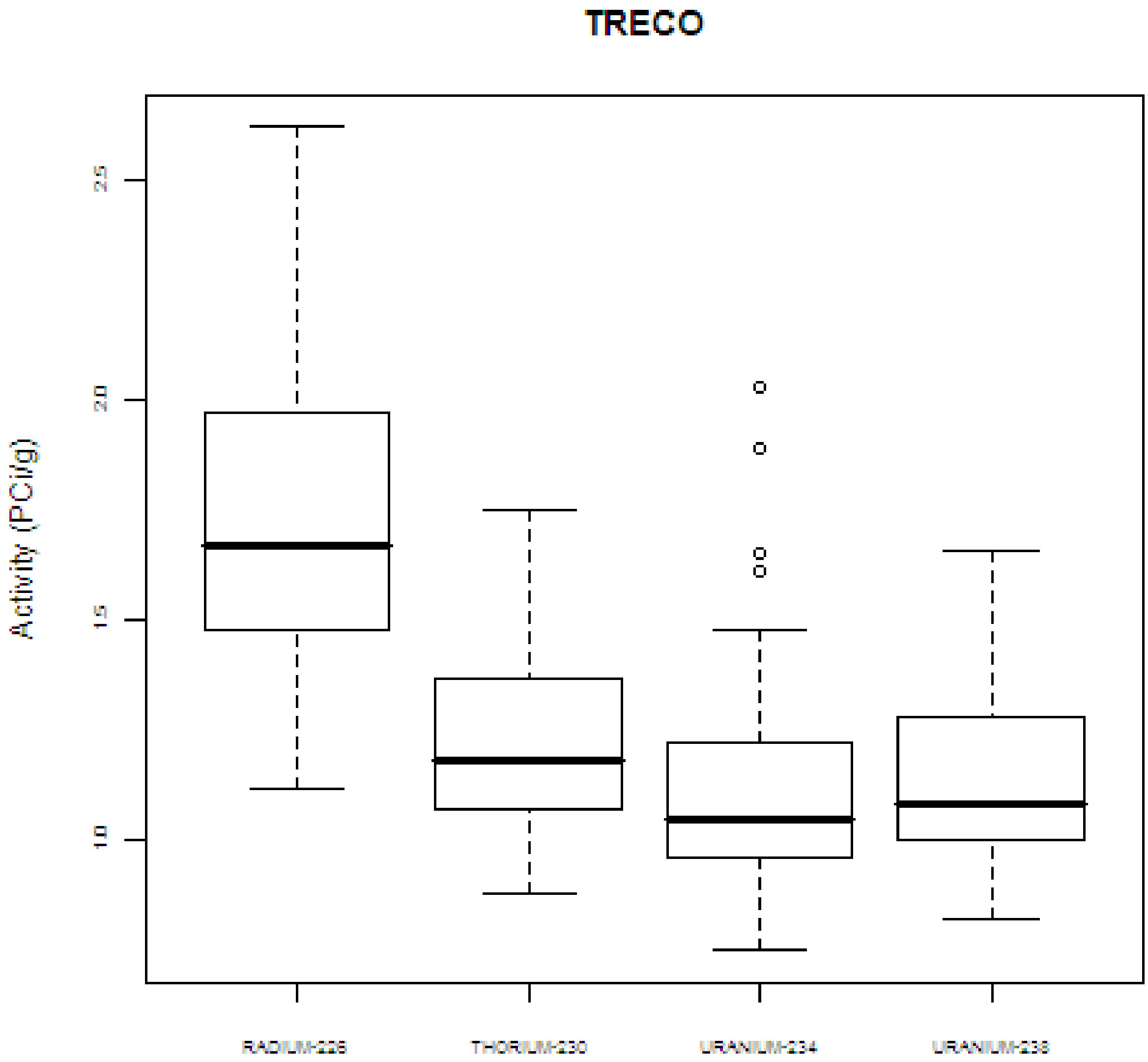

2005 BRC/TIMET Background
Activity (PCi/g)
3.0
2.5
2.0
1.5
1.0
RADIUM-228
THORIUM-228
THORIUM-232

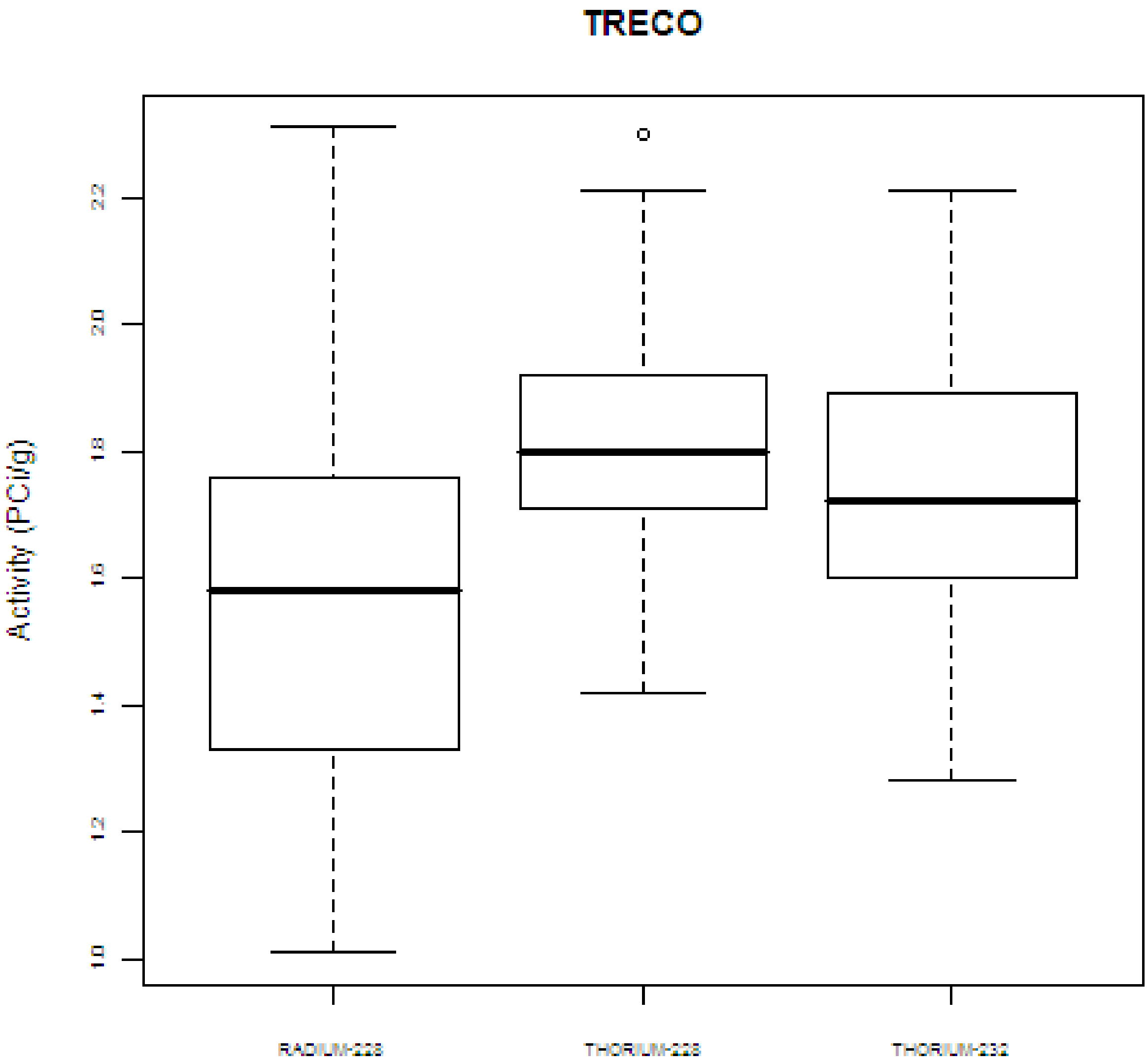

2008 Supplemental Background
Activity (PCi/g)
0
1
2
3
4
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238

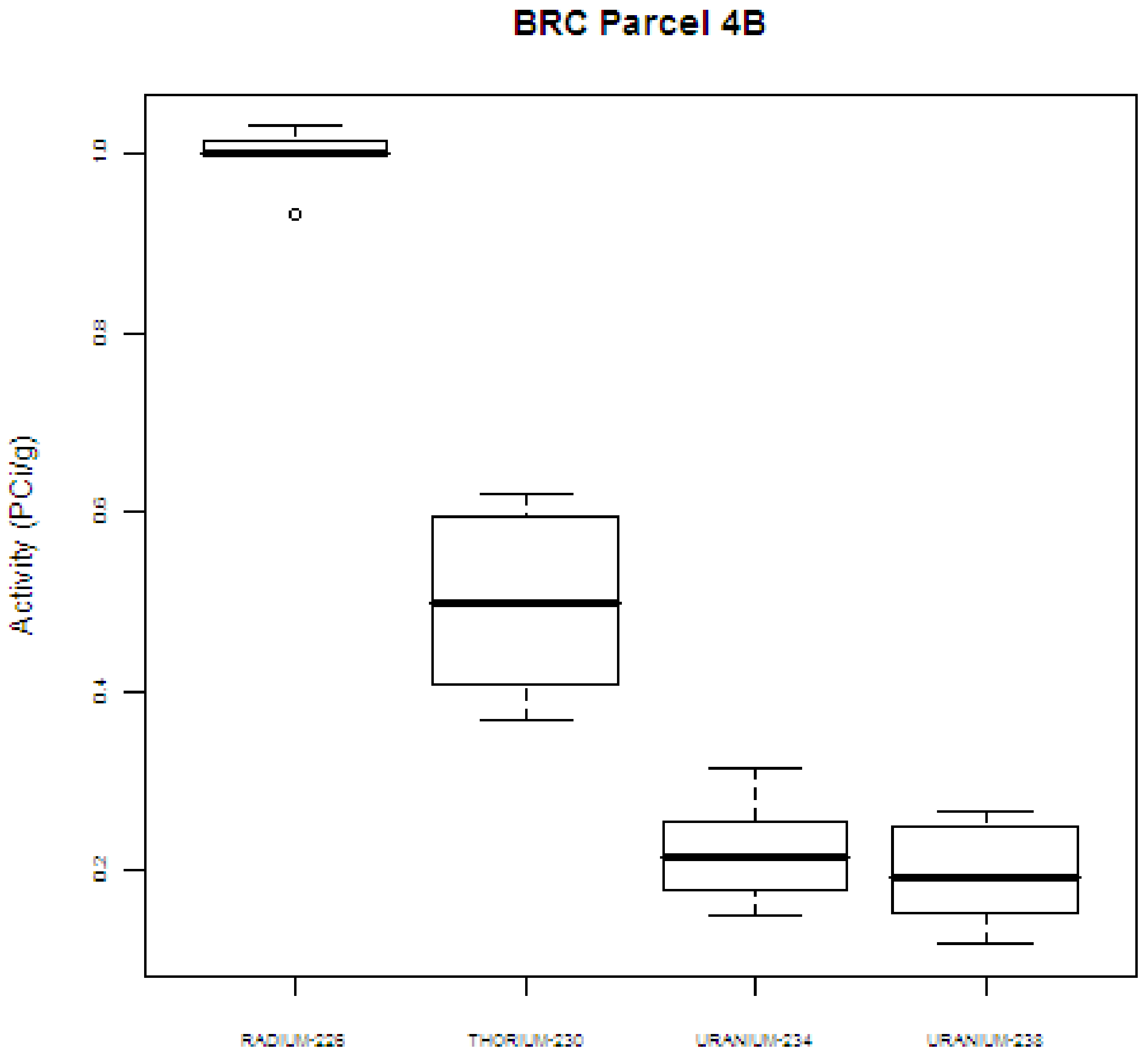

2008 Supplemental Background
Activity (PCi/g)
0.5
1.0
1.5
2.0
2.5
3.0
RADIUM-228
THORIUM-228
THORIUM-232

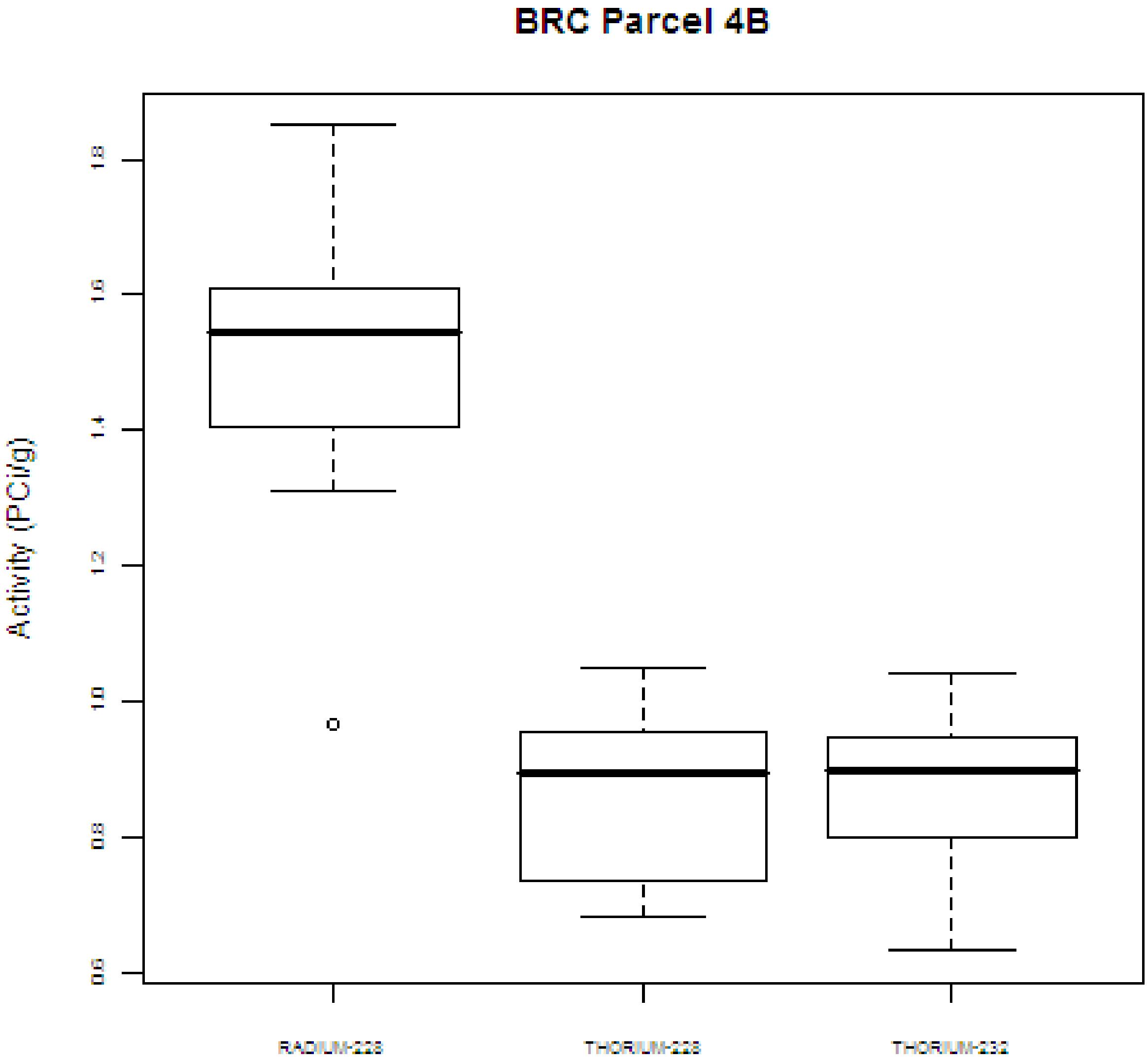

2008 Deep Background
Activity (PCi/g)
2.5
2.0
1.5
1.0
0.5
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238

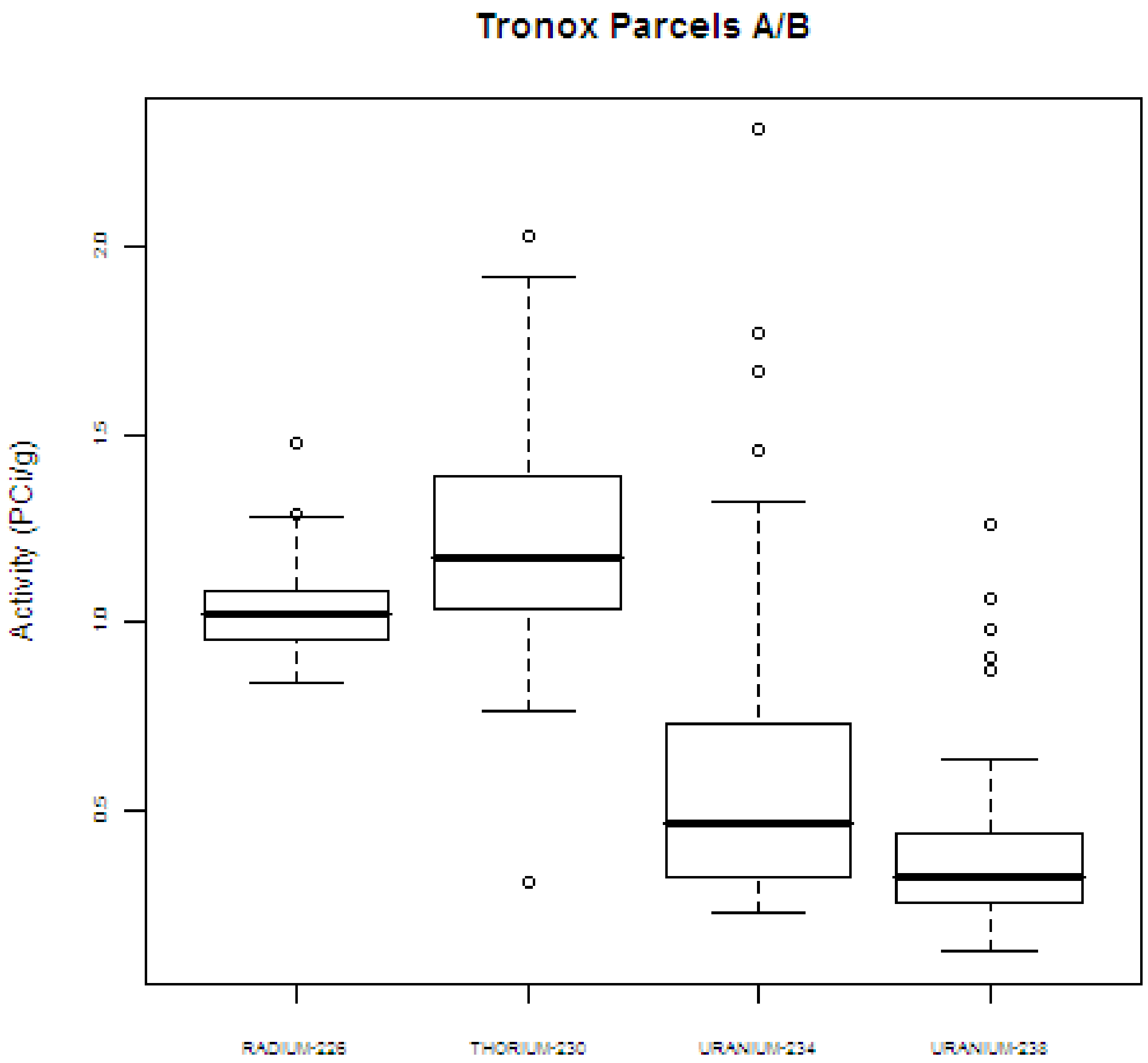

2008 Deep Background
Activity (PCi/g)
0.5
1.0
1.5
2.0
RADIUM-228
THORIUM-228
THORIUM-232

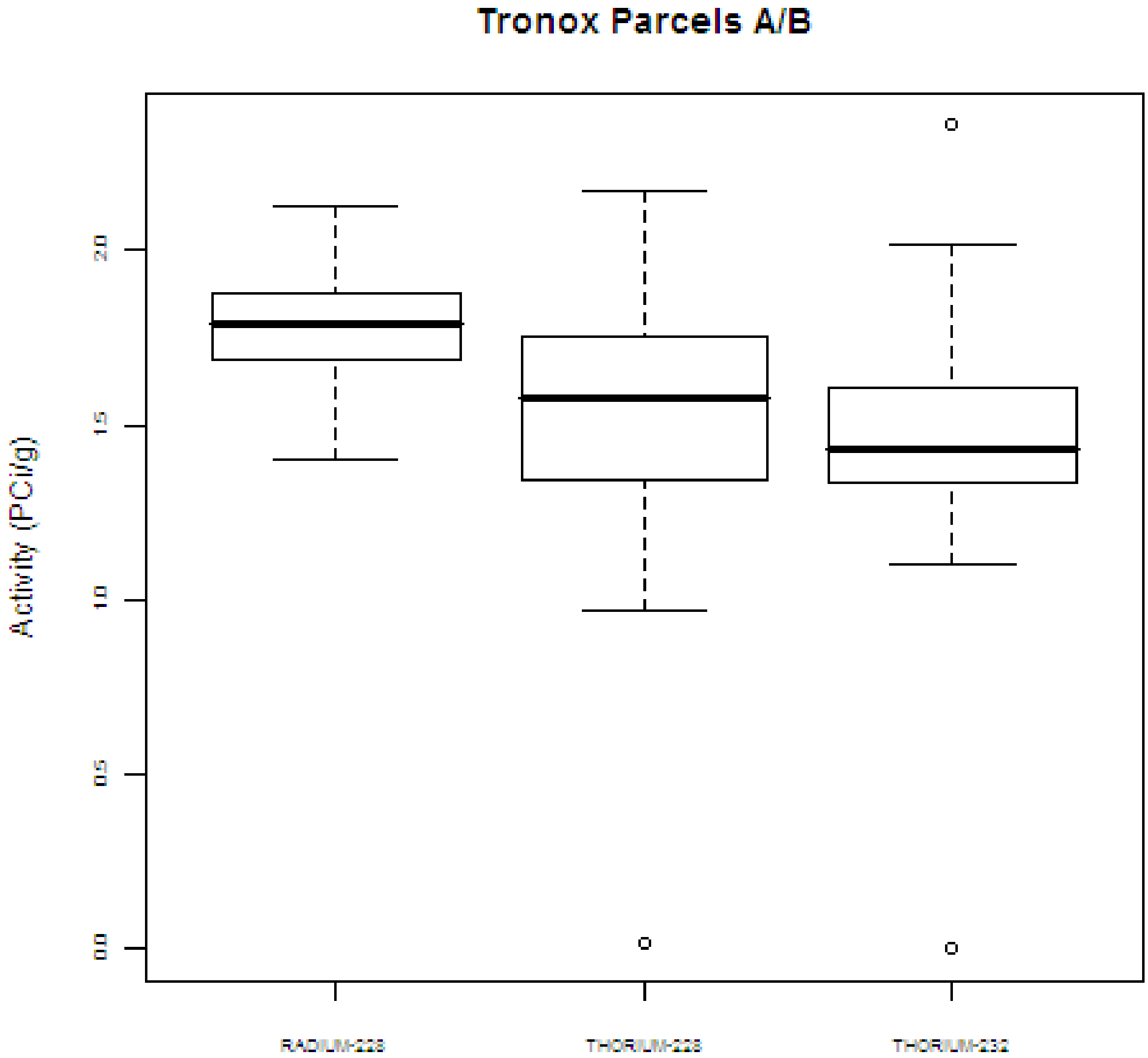

TRECO
Activity (PCi/g)
2.5
2.0
1.5
1.0
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238

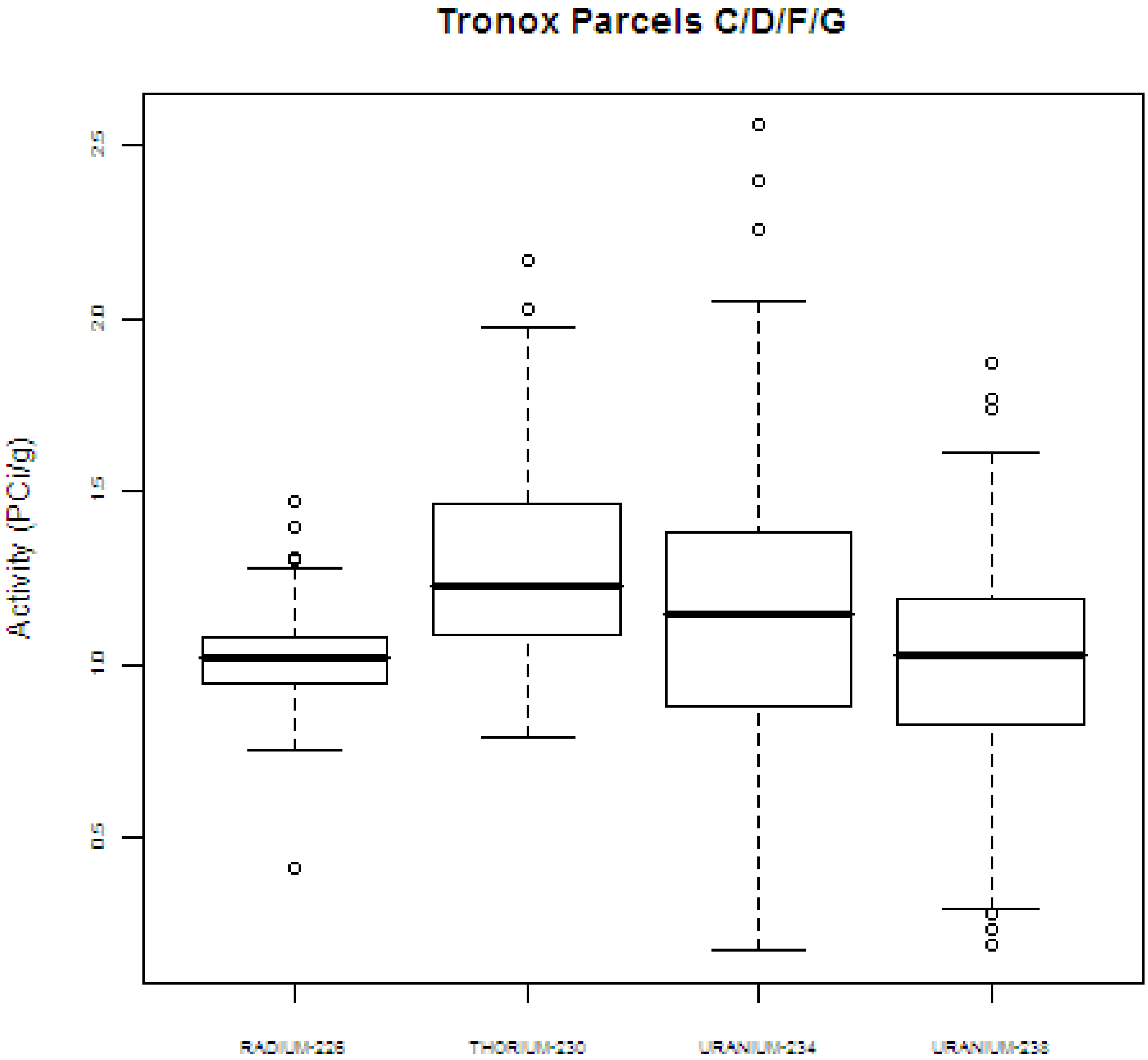

TRECO
Activity (PCi/g)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
RADIUM-228
THORIUM-228
THORIUM-232

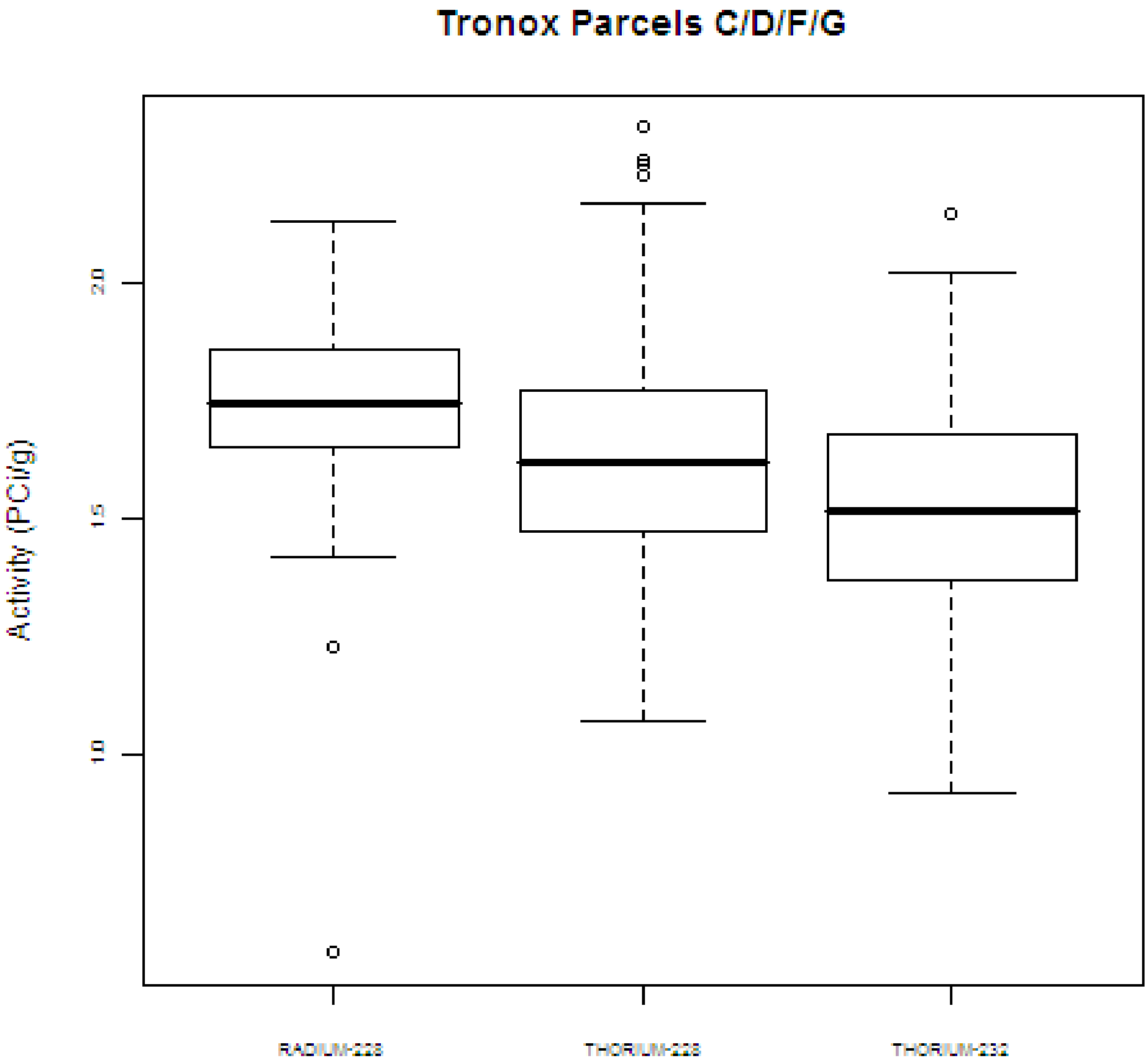

BRC Parcel 4B
Activity (PCi/g)
0.2
0.4
0.6
0.8
1.0
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238

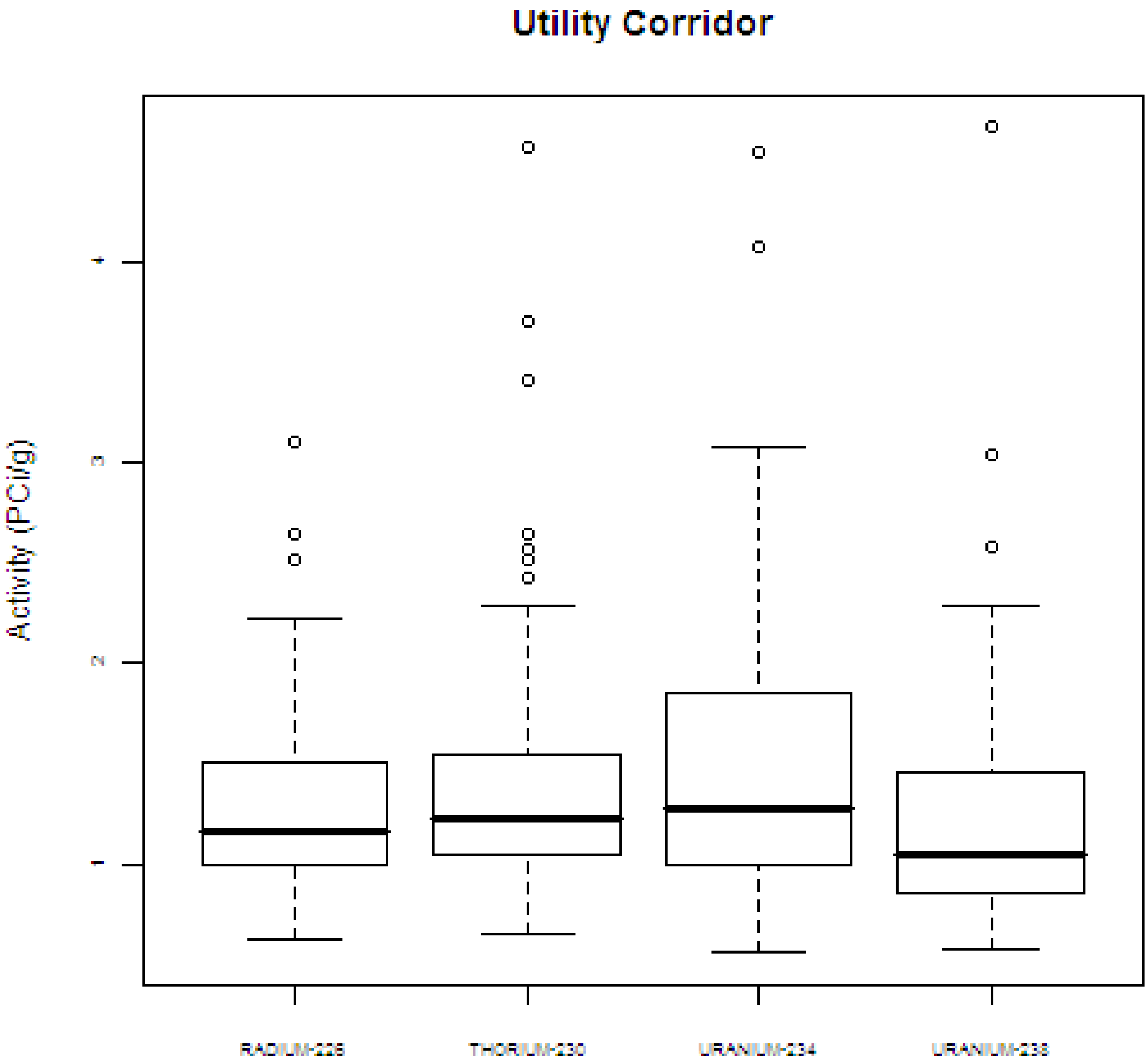

BRC Parcel 4B
Activity (PCi/g)
0.6
0.8
1.0
1.2
1.4
1.6
1.8
RADIUM-228
THORIUM-228
THORIUM-232

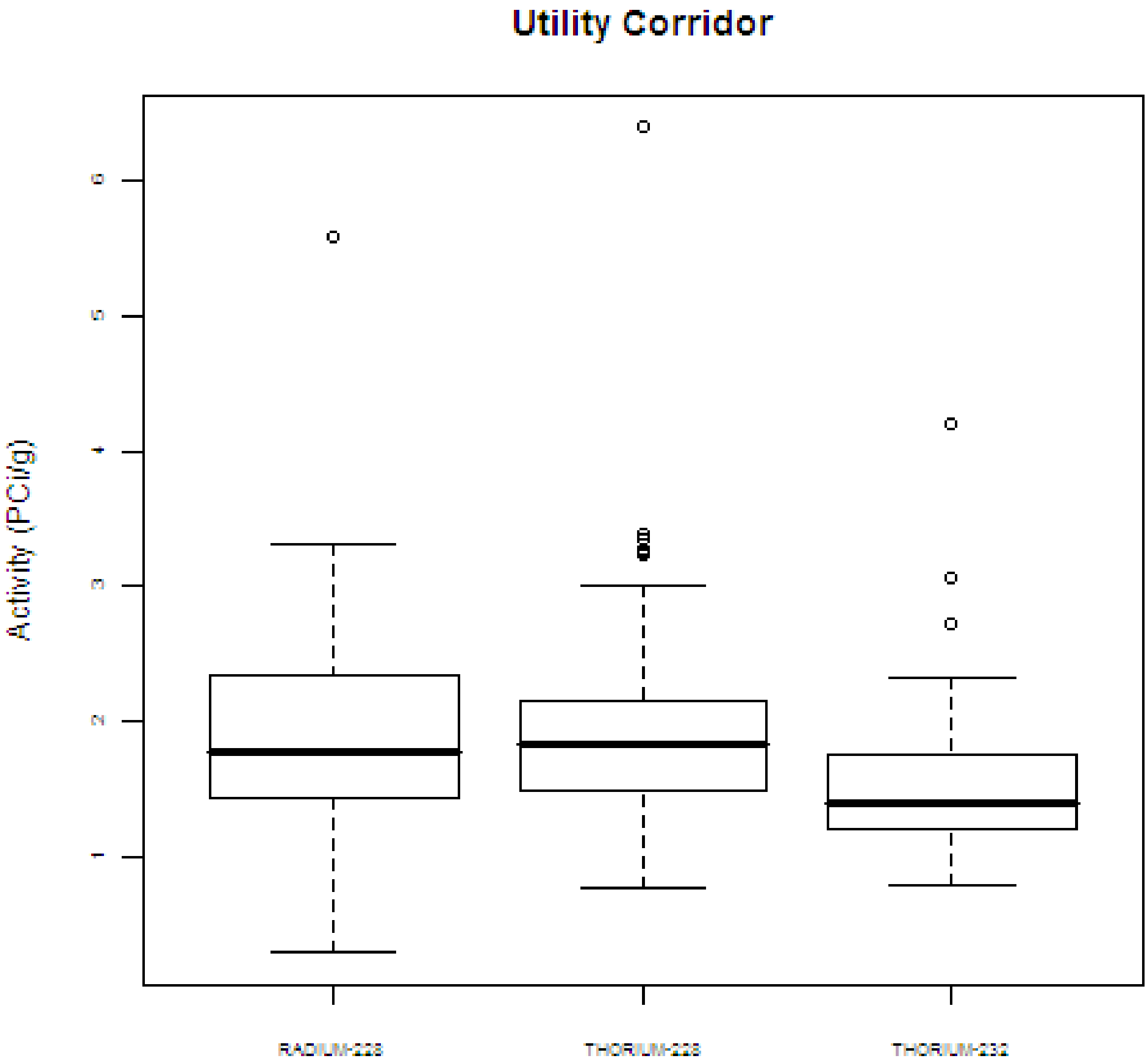

Tronox Parcels A/B
Activity (PCi/g)
0.5
1.0
1.5
2.0
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238

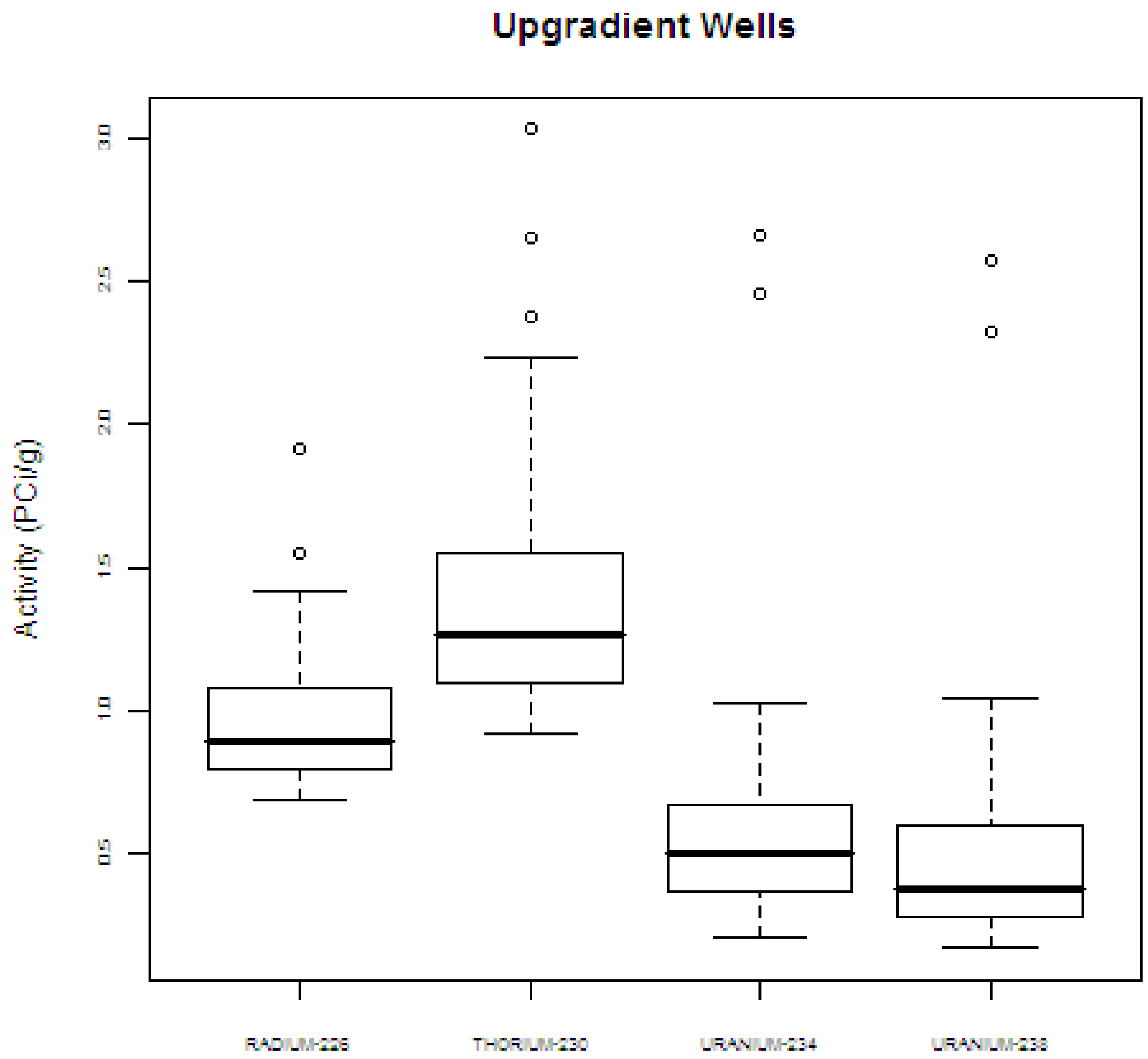

Tronox Parcels A/B
Activity (PCi/g)
0.0
0.5
1.0
1.5
2.0
RADIUM-228
THORIUM-228
THORIUM-232

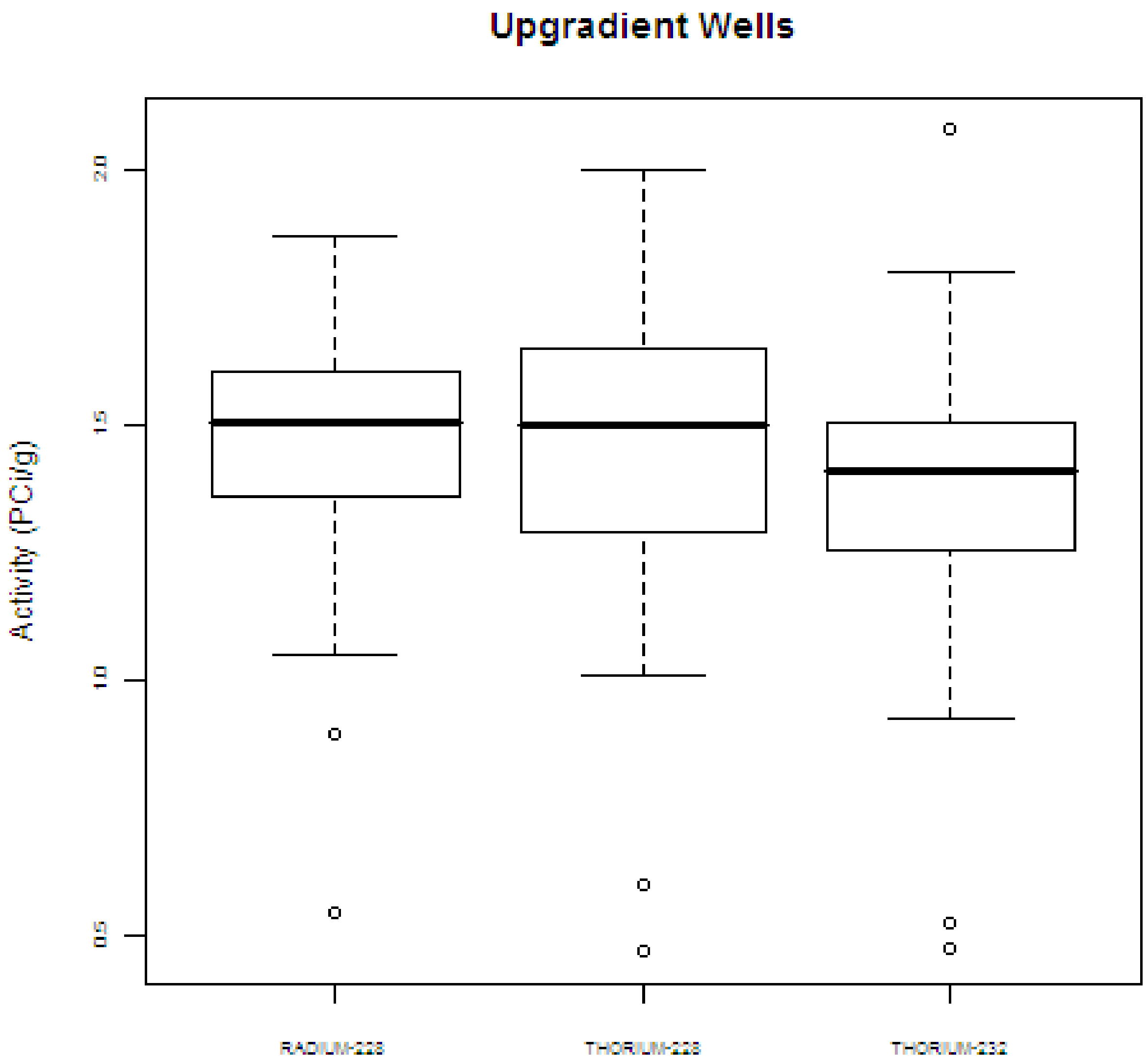

Tronox Parcels C/D/F/G
Activity (PCi/g)
0.5
1.0
1.5
2.0
2.5
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238


Tronox Parcels C/D/F/G
Activity (PCi/g)
2.0
1.5
1.0
RADIUM-228
THORIUM-228
THORIUM-232

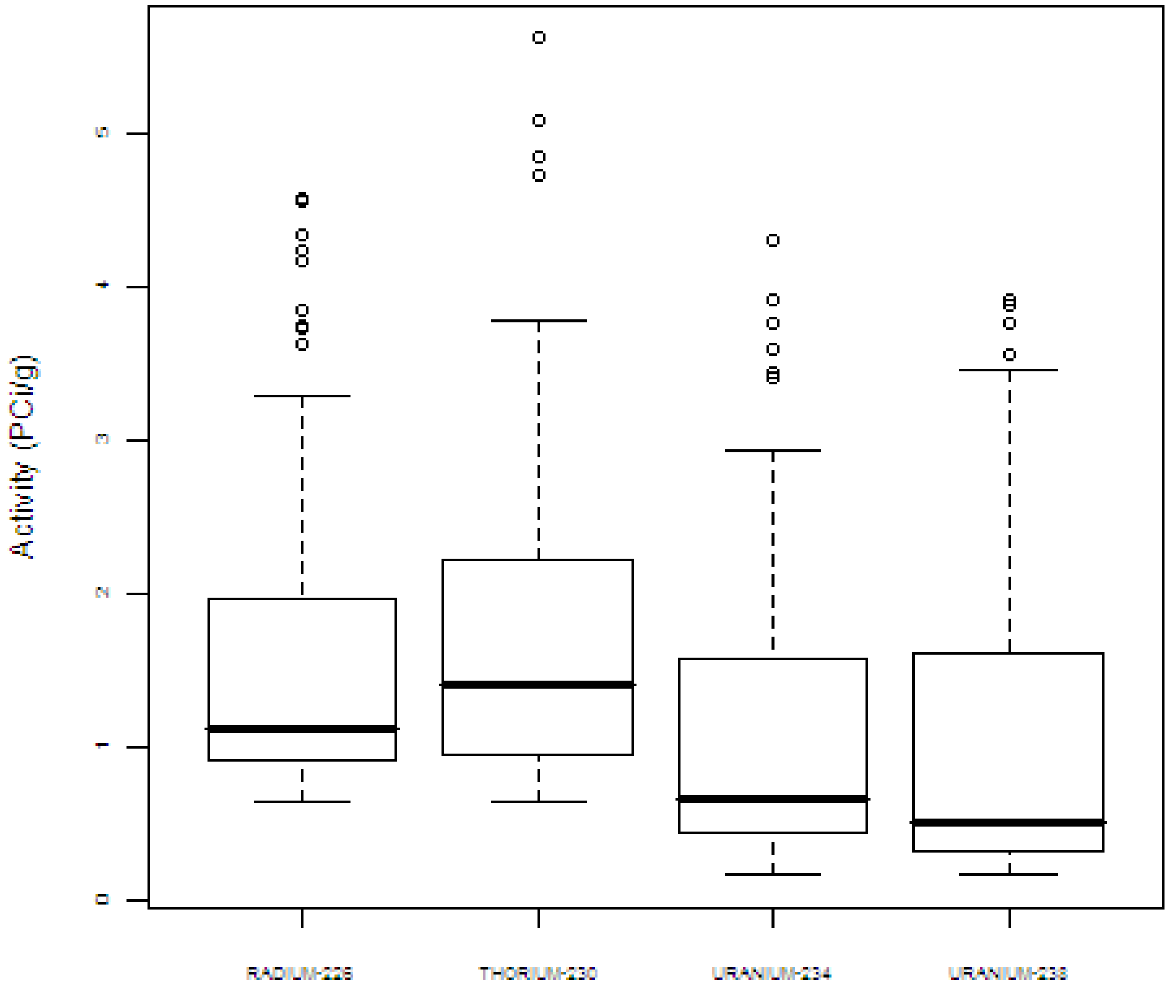

Utility Corridor
Activity (PCi/g)
1
2
3
4
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238

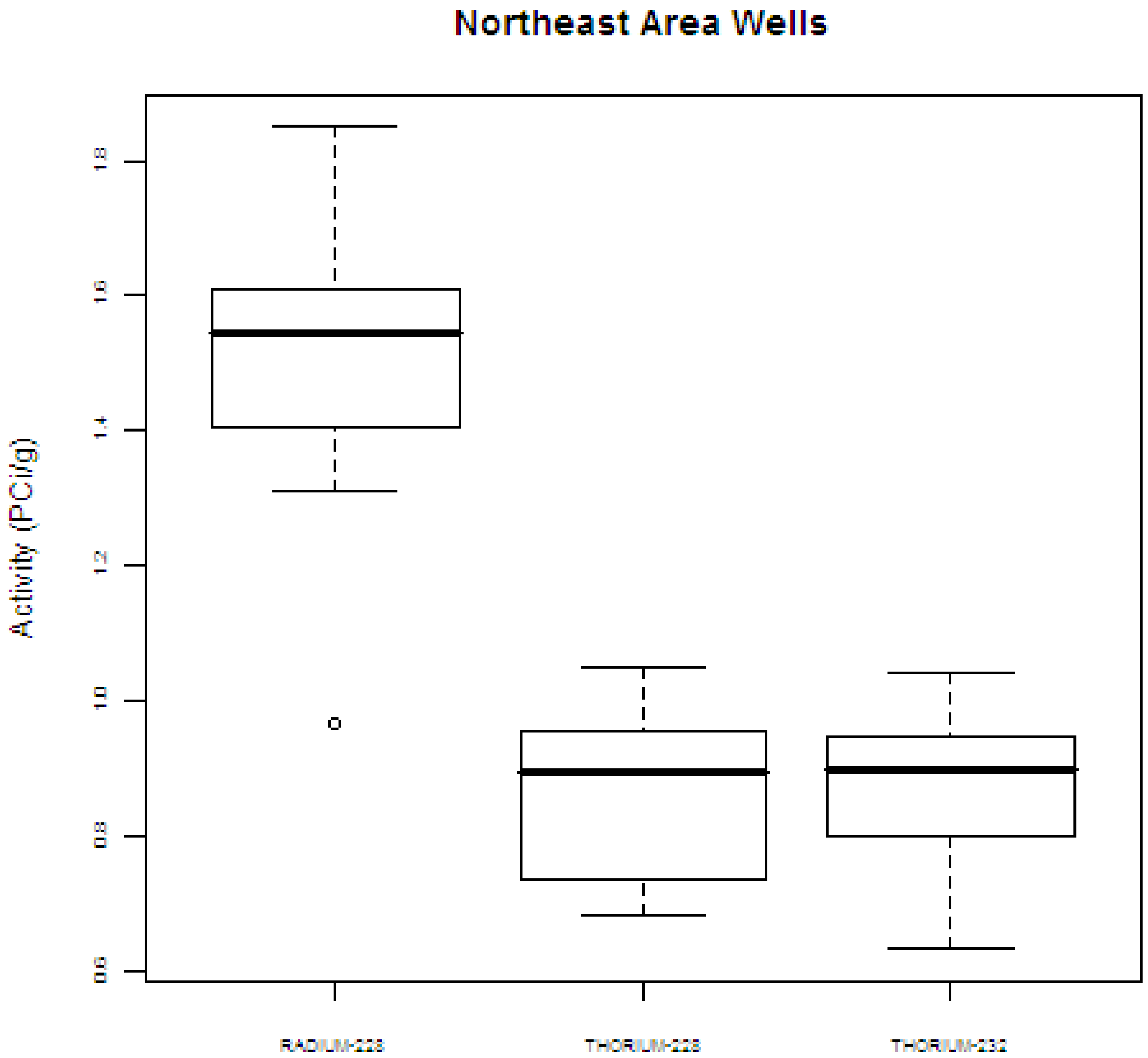

Utility Corridor
Activity (PCi/g)
1
2
3
4
5
6
RADIUM-228
THORIUM-228
THORIUM-232


Upgradient Wells
Activity (PCi/g)
3.0
2.5
2.0
1.5
1.0
0.5
RADIUM-226
THORIUM-230
URANIUM-234
URANIUM-238


Upgradient Wells
Activity (PCi/g)
0.5
1.0
1.5
2.0
RADIUM-228
THORIUM-228
THORIUM-232

Northeast Area Wells




Northeast Area Wells
Activity (PCi/g)
0.6
0.8
1.0
1.2
1.4
1.6
1.8
RADIUM-228
THORIUM-228
THORIUM-232

Appendix B – Summary Statistics for the Uranium and Thorium Chains

	N	Mean	Std.Dev.	Min	Median	Max
2005 BRC/TIMET Shallow Background						
Radium-226	104	1.1122	0.3472	0.4940	1.0650	2.3600
Thorium-230	104	1.2651	0.4034	0.6600	1.2000	3.0100
Uranium-233/234	104	1.1607	0.4659	0.4700	1.0250	2.8400
Uranium-238	104	1.1352	0.3706	0.5700	1.0350	2.3700
Radium-228	84	1.9157	0.4046	0.9460	1.9600	2.9400
Thorium-228	84	1.7290	0.2552	1.1500	1.7900	2.1500
Thorium-232	84	1.6563	0.2553	1.2200	1.6900	2.1200
2008 Supplemental Shallow Background						
Radium-226	33	1.1008	0.5054	0.1530	0.9920	2.7500
Thorium-230	33	1.4948	0.5693	1.0000	1.3400	3.6400
Uranium-233/234	33	1.4618	0.8145	0.7000	1.1700	4.7800
Uranium-238	33	1.1976	0.6718	0.5450	0.9380	4.0100
Radium-228	33	1.5450	0.5490	0.5730	1.3800	2.8600
Thorium-228	33	1.7855	0.5074	1.1000	1.6400	3.3700
Thorium-232	33	1.5448	0.3228	1.1400	1.4900	2.8000
2008 Deep Soil Background						
Radium-226	92	1.2974	0.4232	0.3940	1.2650	2.2900
Thorium-230	92	1.3670	0.4254	0.5300	1.3650	2.6000
Uranium-233/234	92	1.3620	0.3938	0.7290	1.3150	2.6300
Uranium-238	92	1.2890	0.3745	0.5700	1.2050	2.7900
Radium-228	99	1.3744	0.2903	0.4520	1.3800	2.3100
Thorium-228	99	1.5820	0.2772	0.9440	1.5400	2.1800
Thorium-232	99	1.4546	0.2561	0.8980	1.4500	2.0500
TRECO						
Radium-226	57	1.7333	0.3927	1.1200	1.6700	2.6200
Thorium-230	57	1.2142	0.2061	0.8800	1.1800	1.7500
Uranium-233/234	57	1.1279	0.2549	0.7500	1.0500	2.0300
Uranium-238	57	1.1400	0.1854	0.8200	1.0800	1.6600
Radium-228	57	1.5602	0.2751	1.0100	1.5800	2.3100
Thorium-228	57	1.8333	0.1839	1.4200	1.8000	2.3000
Thorium-232	57	1.7519	0.2104	1.2800	1.7200	2.2100
Tronox Parcels A/B						
Radium-226	64	1.0376	0.1295	0.8370	1.0200	1.4800
Thorium-230	64	1.2070	0.3035	0.3080	1.1700	2.0300
Uranium-233/234	64	0.5908	0.4021	0.2250	0.4670	2.3100
Uranium-238	64	0.3832	0.2227	0.1250	0.3260	1.2600
Radium-228	64	1.7777	0.1560	1.4000	1.7900	2.1300
Thorium-228	64	1.5508	0.3327	0.0167	1.5800	2.1700
Thorium-232	64	1.4630	0.2983	0.0000	1.4300	2.3600

Appendix B (continued) – Summary Statistics for the U-238 and Th-232 Chains

	N	Mean	Std.Dev.	Min	Median	Max
Tronox Parcels C/D/F/G						
Radium-226	104	1.0179	0.1382	0.4120	1.0200	1.4700
Thorium-230	104	1.2972	0.2966	0.7920	1.2250	2.1700
Uranium-233/234	104	1.1701	0.4463	0.1730	1.1450	2.5600
Uranium-238	104	0.9907	0.34768	0.186	1.03	1.87
Radium-228	104	1.7425	0.1912	0.5800	1.7450	2.1300
Thorium-228	104	1.6340	0.2552	1.0700	1.6200	2.3300
Thorium-232	104	1.5296	0.2318	0.9200	1.5150	2.1500
Utility Corridor						
Radium-226	70	1.3517	0.5398	0.6240	1.1650	3.1000
Thorium-230	70	1.4361	0.7061	0.6440	1.2300	4.5700
Uranium-233/234	70	1.5353	0.7762	0.5570	1.2750	4.5500
Uranium-238	70	1.2404	0.6534	0.5700	1.0500	4.6700
Radium-228	70	1.8969	0.7880	0.2860	1.7700	5.5900
Thorium-228	70	1.9655	0.8309	0.7640	1.8200	6.4000
Thorium-232	70	1.5237	0.5442	0.7910	1.3950	4.2100
Upgradient Groundwater Wells						
Radium-226	44	0.9836	0.2834	0.6850	0.8950	1.9100
Thorium-230	44	1.4171	0.4756	0.9150	1.2650	3.0300
Uranium-233/234	44	0.6211	0.4782	0.2100	0.5035	2.6600
Uranium-238	44	0.5268	0.4749	0.1710	0.3745	2.5700
Radium-228	44	1.4574	0.2369	0.5440	1.5050	1.8700
Thorium-228	44	1.4442	0.2931	0.4680	1.5000	2.0000
Thorium-232	44	1.3643	0.2874	0.4720	1.4100	2.0800
BRC Parcel 4B						
Radium-226	8	0.9989	0.0306	0.9310	1.0000	1.0300
Thorium-230	8	0.4983	0.0983	0.3670	0.4970	0.6210
Uranium-233/234	8	0.2201	0.0550	0.1510	0.2155	0.3150
Uranium-238	8	0.1968	0.0558	0.1180	0.1930	0.2670
Radium-228	8	1.4918	0.2607	0.9640	1.5450	1.8500
Thorium-228	8	0.8616	0.1310	0.6810	0.8930	1.0500
Thorium-232	8	0.8700	0.1294	0.6320	0.8985	1.0400
Northeast Area Wells						
Radium-226	141	1.5190	0.8963	0.6400	1.1200	4.5700
Thorium-230	141	1.7226	0.9858	0.6300	1.4100	5.6200
Uranium-233/234	141	1.1061	0.9381	0.1700	0.6500	4.3100
Uranium-238	141	1.0252	0.9499	0.1600	0.5000	3.9200
Radium-228	59	1.1702	0.3201	0.3300	1.2700	1.7200
Thorium-228	59	1.1068	0.3723	0.1500	1.2100	1.8900

Appendix C – Correlation Matrices for the U-238 and Th-232 Chains

2005 BRC/TIMET Shallow Background

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.6632	0.6911	0.7068
Th-230	0.6632	1.0000	0.7838	0.7796
U-233/234	0.6911	0.7838	1.0000	0.8763
U-238	0.7068	0.7796	0.8763	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.2967	0.3049
Th-228	0.2967	1.0000	0.7323
Th-232	0.3049	0.7323	1.0000

2008 Supplemental Soil Background

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.7019	0.7857	0.8115
Th-230	0.7019	1.0000	0.8305	0.8393
U-233/234	0.7857	0.8305	1.0000	0.9314
U-238	0.8115	0.8393	0.9314	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.0101	-0.1041
Th-228	0.0101	1.0000	0.5484
Th-232	-0.1041	0.5484	1.0000

2008 Deep Soil Background

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.7550	0.7646	0.7508
Th-230	0.7550	1.0000	0.8300	0.8024
U-233/234	0.7646	0.8300	1.0000	0.9335
U-238	0.7508	0.8024	0.9335	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.2016	0.2570
Th-228	0.2016	1.0000	0.6722
Th-232	0.2570	0.6722	1.0000

TRECO

	Ra-226	*Th-230*	*U-234*	*U-238*
Ra-226	1.0000	0.3294	0.1671	0.1148
Th-230	0.3294	1.0000	0.5555	0.5760
U-234	0.1671	0.5555	1.0000	0.6645
U-238	0.1148	0.5760	0.6645	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.2316	0.2295
Th-228	0.2316	1.0000	0.5647
Th-232	0.2295	0.5647	1.0000

Tronox Parcels A/B

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.6548	0.4585	0.4636
Th-230	0.6548	1.0000	0.5058	0.5069
U-233/234	0.4585	0.5058	1.0000	0.9819
U-238	0.4636	0.5069	0.9819	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.2626	0.0036
Th-228	0.2626	1.0000	0.6560
Th-232	0.0036	0.6560	1.0000

Tronox Parcels C/D/F/G

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.4141	0.3186	0.2439
Th-230	0.4141	1.0000	0.4961	0.3746
U-233/234	0.3186	0.4961	1.0000	0.9028
U-238	0.2439	0.3746	0.9028	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.2062	0.2237
Th-228	0.2062	1.0000	0.5664
Th-232	0.2237	0.5664	1.0000

Utility Corridor

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.6224	0.5992	0.5520
Th-230	0.6224	1.0000	0.7368	0.7290
U-233/234	0.5992	0.7368	1.0000	0.8330
U-238	0.5520	0.7290	0.8330	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.3163	0.1109
Th-228	0.3163	1.0000	0.6544
Th-232	0.1109	0.6544	1.0000

Upgradient Wells

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.8075	0.8322	0.8423
Th-230	0.8075	1.0000	0.7793	0.7995
U-233/234	0.8322	0.7793	1.0000	0.9850
U-238	0.8423	0.7995	0.9850	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.7280	0.6814
Th-228	0.7280	1.0000	0.7009
Th-232	0.6814	0.7009	1.0000

BRC Parcel 4B

	Ra-226	*Th-230*	*U-234*	*U-238*
Ra-226	1.0000	-0.2998	-0.4563	-0.0389
Th-230	-0.2998	1.0000	0.3565	0.3748
U-234	-0.4563	0.3565	1.0000	0.0298
U-238	-0.0389	0.3748	0.0298	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.6190	0.1974
Th-228	0.6190	1.0000	0.8198
Th-232	0.1974	0.8198	1.0000

Northeast Area Wells

	Ra-226	*Th-230*	*U-233/234*	*U-238*
Ra-226	1.0000	0.9349	0.9208	0.9206
Th-230	0.9349	1.0000	0.9038	0.9072
U-233/234	0.9208	0.9038	1.0000	0.9859
U-238	0.9206	0.9072	0.9859	1.0000

	Ra-228	*Th-228*	*Th-232*
Ra-228	1.0000	0.8674	0.8154
Th-228	0.8674	1.0000	0.9047
Th-232	0.8154	0.9047	1.0000

References for the Henderson Site Datasets

2005 BRC/TIMET background

Background Shallow Soil Summary Report, BMI Complex and Common Areas Vicinity, TIMET and BRC, July 2007. Approved by NDEP on July 26, 2007.

2008 supplemental shallow background

Data Validation Summary Report, SUPPLEMENTAL SHALLOW SOIL BACKGROUND SAMPLING EVENT, APRIL 2008 (DATASET 34b), BMI COMMON AREAS, CLARK COUNTY, NEVADA, ERM, June 2008. Approved by NDEP on June 9, 2008.

2008 deep background

Data Validation Summary Report, DEEP BACKGROUND SOIL INVESTIGATION, AUGUST-OCTOBER 2007 (DATASET 34c), BMI COMMON AREAS (EASTSIDE), CLARK COUNTY, NEVADA, ERM, JUNE 2008. Approved by NDEP on June 25, 2008.

TRECO

Basic Environmental Company's (BEC) submittals dated March 10, 2006 and April 5, 2006 regarding: *Risk Assessment Report– TRECO Property*. Approved by NDEP on April 19, 2006

TRX Parcels A/B

Data Validation Summary Report, Parcels A/B Investigation, August – September 2007, BMI Industrial Complex, Clark County, Nevada Dated November 28, 2007. Approved by NDEP on December 6, 2007.

TRX Parcels C/D/F/G

Data Validation Summary Report (DVSR), *Tronox Parcels C, D, F, G and H Supplemental Investigations, - June-July 2008, BMI Industrial Complex, Clark County, Nevada*, Dated January 7, 2009. Approved by NDEP on January 12, 2009

Utility Corridor

Data Validation Summary Report, SEWER ALIGNMENT EXCAVATION SOIL INVESTIGATION, APRIL AND AUGUST 2008 (DATASET 50), BMI COMMON AREAS (EASTSIDE), CLARK COUNTY, NEVADA, ERM, October 2008. Approved by NDEP on October 17, 2008

Data Validation Summary Report, SEWER ALIGNMENT EXCAVATION SOIL INVESTIGATION RE-ANALYSIS –AUGUST AND OCTOBER 2008 (DATASET 50a), BMI COMMON AREAS (EASTSIDE), CLARK COUNTY, NEVADA, ERM, January 2009. Approved by NDEP on January 8, 2009.

Upgradient Groundwater Wells

Data Validation Summary Report, UPGRADIENT WELL INSTALLATION INVESTIGATION, JULY-AUGUST 2007 (DATASET 47), BMI COMMON AREAS (EASTSIDE), CLARK COUNTY, NEVADA, ERM, December 2007. Approved by NDEP on February 22, 2008

BRC Parcel 4B4b

Data Validation Summary Report, 2007 PARCEL 4A/4B INVESTIGATION (DATASET 43), BMI COMMON AREAS EASTSIDE, CLARK COUNTY NEVADA, ERM, August 2007. Approved by NDEP on August 21, 2007.

Data Validation Summary Report, 2006-2007 VARIOUS SUPPLEMENTAL INVESTIGATIONS, (DATASET 45), BMI COMMON AREAS, CLARK COUNTY, NEVADA, ERM, October 2007. Approved by NDEP on October 22, 2007

Data Validation Summary Report, 2008 SUPPLEMENTAL PARCEL 4A/4B INVESTIGATION, (DATASET 45e, BMI COMMON AREAS (EASTSIDE), CLARK COUNTY, NEVADA, ERM, June 2008. Approved by NDEP on June 6, 2008.

Northeast Area Wells

Data Validation Summary Report, *NORTHEAST AREA INVESTIGATION JUNE-JULY 2007 (DATASET 46),BMI COMMON AREAS, CLARK COUNTY, NEVADA, ERM, November 2008.* Approved by NDEP on December 6, 2007.

NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

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

Jim Gibbons, Governor
Allen Biaggi, Director
Leo M. Drozdoff, P.E., Administrator

February 17, 2009

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Curt Richards
Olin Corporation
3855 North Ocoee Street, Suite 200,
Cleveland, TN 37312

Mr. Joe Kelly
Montrose Chemical Corp of CA
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals Corporation
PO Box 2128
Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Basic Comparison Levels User's Guide and Tables

Dear Sirs and Madam:

All of the parties listed above shall be referred to as "the Companies" for the purposes of this letter. Attachment A provides the User's Guide and Table for the revised Basic Comparison Levels (BCLs). Please utilize this guidance and these tables in the development of all future Deliverables. These BCLs are to supersede the previously issued version of the BCLs dated December 18, 2008.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas

Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City
Barry Conaty, Akin, Gump, Strauss, Hauer & Feld, L.L.P., 1333 New Hampshire Avenue, N.W., Washington, D.C. 20036
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5, 75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County DAQEM, PO Box 551741, Las Vegas, NV, 89155-1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA 94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Drive, Edmond, OK 73013
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Jeff Gibson, AMPAC, 3770 Howard Hughes Parkway, Suite 300, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Cindi Byrns, Olin Chlor Alkali, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 3846 Estate Drive, Stockton, California 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380, Bainbridge Island, WA 98110
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200, Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544
Paul Black, Neptune and Company, Inc., 8550 West 14th Street, Suite 100, Lakewood, CO 80215
Teri Copeland, 5737 Kanan Rd., #182, Agoura Hills, CA 91301
Paul Hackenberry, Hackenberry Associates, 550 West Plumb Lane, B425, Reno, NV, 89509

Attachment A

February 27, 2009

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Suite 200,
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Curt Richards
Olin Corporation
3855 North Ocoee Street,
Cleveland, TN 37312

Mr. Joe Kelly
Montrose Chemical Corp of CA
Corporation
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110
89009

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals
PO Box 2128
Henderson, NV

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Guidance on Uniform Electronic Data Deliverables

Dear Sirs and Madam:

All of the parties listed above shall be referred to as "the Companies" for the purposes of this letter. Attached is a document which prescribes the format of electronic data deliverables that the Nevada Division of Environmental protection (NDEP) expects from the Companies. NDEP would like to solicit input from the Companies on this proposed format. Please provide all comments to the NDEP **by April 10, 2009**.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions
Fax: (702) 486-5733

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City
Barry Conaty, Holland & Hart LLP, 975 F Street, N.W., Suite 900,Washington, D.C. 20004
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5,
75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County DAQEM, PO Box 551741, Las Vegas, NV, 89155-
1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA
94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Drive, Edmond, OK 73013
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Jeff Gibson, AMPAC, 3770 Howard Hughes Parkway, Suite 300, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Cindi Byrns, Olin Chlor Alkali, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 10733 Wave Crest Court
Stockton, CA 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380,
Bainbridge Island, WA 98110
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite
510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200,
Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544
Paul Black, Neptune and Company, Inc., 8550 West 14th Street, Suite 100, Lakewood, CO 80215
Teri Copeland, 5737 Kanan Rd., #182, Agoura Hills, CA 91301
Paul Hackenberry, Hackenberry Associates, 550 West Plumb Lane, B425, Reno, NV, 89509

Attachment A

Uniform Electronic Data Deliverable (EDD)

The objective of this guidance is to specify the design of the format for the submission of electronic data from the Companies to NDEP. The goal is to streamline the uploading of the Companies electronic data into the Regional Database. This task requires defining each element of the EDD(s) so that they are provided in a consistent format. Provided below are the required elements of the EDD format and descriptions of the elements. Recommended formats and codes are provided in appendices, which should be followed to the extent possible. Additions to the fields should be provided as comments to this guidance or in formal communications if they are developed later in the project. Each field and record should contain either a specified value or "N/A" (i.e., blanks should be populated with N/A).

The EDD should be delivered as a Microsoft Access database with the data organized into several tables. The fields to be included in each table are described in the Appendices.
It is understood that the database developed for the data validation summary report (DVSR) will include additional fields and records (e.g. quality control (QC) data). However, these additional fields and records should be provided in a separate table from the format described here. All native samples, including replicates should be included in this EDD but QC results will not be incorporated into the Regional Database at this time.

EDD Requirements

Required Fields:

Critical Field	Field Name	Description
DVSR Identification	dvsr_id	A unique ID for each DVSR, from each company. The ID should contain elements that make it clear which company supplied the DVSR, the year of submittal, and a unique number designation. Format: ZZZZZ-YYYY-XXXX where ZZZZZ = company, or background (BKG), YYYY = number of the DVSR, XXXX = year.
Sub-area or parcel designation	sub_area	A unique designation for each sub-area or parcel.
LOU designation	lou	A designation for LOU associated with the sample. If no LOU is associated with the sample this field should be N/A.
Sample depth	sample_depth	Sample depth in feet
Northing Coordinate	northing	Northing coordinate of the sample in NAD 1983 State Plane Nevada East feet

Critical Field	**Field Name**	**Description**
Easting Coordinate	easting	Easting coordinate of the sample in NAD 1983 State Plane Nevada East feet
Sample Identification - Field	sample_id_field	The ID used on the Chain of Custody, or similar field record. This ID should be unique to the sample and also consistent (identical) for all records associated with that sample. For example, where multiple analytes are reported the sample ID should be identical for all.
Sample Identification - Laboratory	sample_id_lab	The ID of the sample used at the laboratory. This ID should be unique to the sample and also consistent (identical) for all records associated with that sample. For example, where multiple analytes are reported the sample ID should be identical for all.
Laboratory Identification/ code	lab_id	A unique identification of each laboratory, down to the laboratory location. For example, TestAmerica-Richland, Washington should have a designation that differs from other TestAmerica locations. Companies should provide a recommended ID for each laboratory currently used or expected. A designation for field analysis should be included.
SDG- Sample Delivery Group	sdg_id	The Sample Delivery Group identification supplied by the laboratory.
Analytical Batch Identification	batch_id	The analytical batch identification supplied by the laboratory.
Location Identification	location_id	An identification of the well or location where the sample was taken, when applicable. The ID should be unique to that well or location and should be used in all future reports and EDDs.
hydrogeologic	hydro	The designation of the water-bearing zone associated with the sample: Shallow Zone, Middle Zone, or Deep Zone. This hydrogeologic nomenclature is described in the January 6, 2009 letter (*Hydrogeologic and Lithologic Nomenclature Unification)* from NDEP to the Companies.
lithologic	litho	The designation of the lithologic nomenclature tags: Qal (Quaternary Alluvium), xMCf (transitional Muddy Creek formation), or UMCf (Upper Muddy Creek formation). This lithologic nomenclature is described in the January 6, 2009 letter (*Hydrogeologic and Lithologic Nomenclature Unification)* from NDEP to the Companies.
Sample Matrix Identification/ code	matrix	A short code that designates the matrix of the sample. A recommended set is provided in Appendix B.

Critical Field	Field Name	Description
Sample Type Identification/ code	sample_type	A short code that designates the sample type (e.g. Field Duplicate as FD). A recommended set is provided in Appendix C.
Analytical Method Name/code	analytical_method	An identifier for the analytical method used for that suite of analyses. The identifier should include the version of the method. For example, many of the SW-846 methods have a letter at the end to indicate the version (e.g. 8330B). A recommended format is provided in Appendix D.
Preparation Method Name/code	preparation_method	An identifier for the preparation method used for that suite of analyses. Use the same guidelines as found in Appendix D.
Analytical Suite	analytical_suite	A short code that designates the analytical suite, such as SVOC. A recommended list is provided in Appendix E.
Analyst Name	analyst_name	The name of the analyst that performed the analysis. This field is required for asbestos results.
Total or Dissolved	filtered_flag	A flag T (true) or F (false) indicating whether the sample was filtered. T indicates the aqueous sample was filtered and is dissolved.
Asbestos Type	asbestos_type	Amphibole, Amisite, Chrysotile, Actinolite, N/A
Sample Date	sample_date	The Year, Month, and Day of sample collection. Requested format: XXXXYYZZ, where XXXX=year, YY= month, and ZZ = day of month. This same format shall be used for all dates.
Sample Time	sample_time	The Hour:Minute:Seconds sample was collected. A 24 hour format is requested: 12:15:00 indicates 15 minutes after Noon. One hour later would be 13:15:00.
Preparation Date	prep_date	The Year, Month, and Day of sample preparation. Requested format: XXXXYYZZ, where XXXX=year, YY= month, and ZZ = day of month. This same format shall be used for all dates.
Preparation Time	prep_time	The Hour:Minute:Seconds the sample was prepared. A 24 hour format is requested: 12:15:00 indicates 15 minutes after Noon. One hour later would be 13:15:00.
Analysis Date	analysis_date	The Year, Month, and Day of sample analysis. Requested format: XXXXYYZZ, where XXXX=year, YY= month, and ZZ = day of month. This same format shall be used for all dates.
Analysis Time	analysis_time	The Hour:Minute: Seconds the sample was analyzed. A 24 hour format is requested: 12:15:00 indicates 15 minutes after Noon. One hour later would be 13:15:00.

Critical Field	**Field Name**	**Description**
Chemical Name	analyte_name	A unique name for the analyte. This should indicate a single unique chemical with few exceptions (acceptable exceptions include Aroclor congeners that coelute, U-233/234, etc). For asbestos this field should contain one of the following six types: Total Chrysotile Protocol Structure, Long Chrysotile Protocol Structure, Long Amphibole Protocol Structure, Total Amphibole Protocol Structure, Long Asbestos Protocol Structure, Total Asbestos Protocol Structure. This field is also used to capture physical parameters. Appropriate physical parameters are provided in Appendix F.
CAS	cas_id	The Chemical Abstracts Society designation for the analyte (N/A if no CAS designation for the analyte in question).
Result Type Code	result_type	A short code to indicate the type of result for this record. Acceptable values include: TG (Target), SURR (Surrogate), IS (Internal Standard), SC (Spike Compound), TIC (tentatively Identified Compound). Others should be recommended by the Companies during review of this EDD guidance.
Initial or Reanalysis	reanalysis_flag	The field should contain either “Initial” or “Reanalysis” or similar designations to indicate whether the result is from the initial analysis or reanalysis.
Lab Reported Result	result_reported	The analytical value for that analyte (or physical parameter) as reported by the laboratory. For asbestos, this is the number of structures.
Result Units	result_units	Units associated with the reported value.
Reported Results Uncertainty	result_uncertainty	The uncertainty value associated with the laboratory reported results. This will apply to radionuclides and possibly other analytes (e.g. XRF analysis results). This field is not applicable to asbestos. The DVSR (or laboratory report within the DVSR) should define the uncertainty (e.g. one sigma).
Asbestos Sensitivity	asbestos_sensitivity	The analytical sensitivity associated with the asbestos results.
Asbestos Sensitivity Units	asbestos_sensitivity_units	The units associated with the asbestos sensitivity value (e.g. structures/area or volume).

Critical Field	Field Name	Description
Detect Flag	detect_flag	A flag, T (true) or F (false), to indicate whether the value is considered a detection or not. Values less than the Sample Quantitation Limit (SQL) are generally considered Not Detected. Radionuclides and other reported values that are not censored at the laboratory will be reported as T. For all radionuclide results, the flag will always equal T (true) indicating a value (positive or negative) was reported, regardless of the value relative to the MDA.
Method Detection Limit	method_detection_limit	The Method Detection Limit for the analyte. This definition should follow the December 3, 2008 guidance entitled *Detection Limits and Data Reporting*
Sample Quantitation Limit	sample_quantitation_limit	The SQL for the analytes. This definition should follow the December 3, 2008 NDEP guidance entitled *Detection Limits and Data Reporting*
Practical Quantitation Limit	practical_quantitation_limit	The Practical Quantitation Limit (PQL) for the analyte. This definition should follow the December 3, 2008 NDEP guidance entitled *Detection Limits and Data Reporting*
Minimum Detectable Activity	minimum_detectable_activity	The Minimum Detectable Activity, also known as Minimum Detectable Concentration. This is used for radionuclide results.
Percent Moisture	percent_moisture	The percentage of moisture of a solid sample.
Dilution Factor	dilution_factor	Any dilution factor used to arrive at the final reported value.
Laboratory Qualifier	lab_qualifier	The qualifier that may have been assigned to a reported value by the laboratory that performed the analysis.
Was result validated	validation_flag	A flag, T (true) or F (false). T indicates the value was validated after the laboratory reported the value.
Validation Level	validation_level	The level of data validation that was performed. Acceptable values are: “none”, III, IV, Tier 1A, 1B, 2, 3. The terms used need to be defined in the DVSR.
First Validation Qualifier	first_validation_qualifier	The non-laboratory qualifier applied to a value, other than the Level IV qualifier. For example, if the data was assessed as Level III, this is the qualifier that was applied.
Level IV Validation Qualifier	level4_validation_qualifier	The non-laboratory qualified applied as a result of level IV review.
Final Validation Qualifier	final_validation_qualifier	The final non-laboratory qualifier applied to the value.

Critical Field	**Field Name**	**Description**
Final Validation Reason Code	final_validation_reason_code	The reason code(s) that corresponds to the final Validation Qualifier. At this point there is no specified set of values. The companies may use their codes as long as all values are defined in the DVSR. All validation values should be consistent with the December 3, 2008 guidance entitled *Detection Limits and Data Reporting* document. For example, any reference to a sensitivity indicator (SQL, PQL etc) should be consistent with that guidance and only those sensitivity indicators should be used.
Final Validation Reason Description	final_validation_reason	The description of the reason code. For example, Holding Time Exceeded. The description should be consistent with the DVSR.
Comment Field (Sample)	sample_comment	A field to include comments associated with a specific sample.
Comment Field (Result)	result_comment	A field to include comments associated with a specific result.

Appendix A: EDD Database Tables

The EDD should be a Microsoft Access database containing at least three tables: a samples table, a results table, and a validation_reason table. The samples table will contain sample metadata and will have field_sample_id as its primary key. The results table will link to the samples table using field_sample_id as a foreign key. The validation reason will have rows consisting of the dvsr_id, the company-specific final_validation_reason_code, and the corresponding reason description.

For convenience, the EDD database should also contain a view that links the three tables, allowing a "flat-file" view of the data.

Details of the fields included in each table are shown in the table below. The data type of all fields should be text, except where indicated below

Field Name	Table(s)
dvsr_id	**samples**(foreign key, references validation_reason table) **validation_reason**(forms primary key in combination with final_validation_reason_code)
final_validation_reason	**validation_reason**
final_validation_reason_code (number)	**validation_reason** (forms primary key in combination with dvsr_id) **results**(foreign key, references validation_reason table)
sub_area lou sample_depth (number) northing (number) easting (number) sample_id_lab lab_id sdg_id batch_id location_id hydro litho matrix sample_type filtered_flag sample_date (date) sample_time (time) prep_date (date) prep_time (time) percent_moisture (number) sample_comment	**samples**

Field Name	Table(s)
sample_id_field	**samples**(primary key) **results**(foreign key, references sample_id field in samples table)
analytical_method preparation_method analytical_suite analyst_name asbestos_type analysis_date (date) analysis_time (time) analyte_name cas_id result_type reanalysis_flag result_reported (number) result_units result_uncertainty (number) asbestos_sensitivity (number) asbestos_sensitivity_units detect_flag method_detection_limit (number) sample_quantitation_limit (number) practical_quantitation_limit (number) minimum_detectable_activity (number) dilution_factor (number) lab_qualifier validation_flag validation_level first_validation_qualifier level4_validation_qualifier final_validation_qualifier result_comment	**results**

Appendix B: Sample Matrix Identification/Code

matrix	Sample Matrix Identification
AO	Outdoor Air
AI	Indoor Air
AG	Soil Gas
AF	Flux Chamber Air
SD	Sediment
SO	Soil
SW	Swab or Wipe
TA	Animal Tissue
TP	Plant Tissue
WS	Surface Water
WG	Ground Water

Appendix C: Sample Type Identification/Code

Sample Type Code	Description
AB	Ambient Conditions Blank
BD	Blank Spike Duplicate
BS	Blank Spike
DIL	Diluted Sample
DIL2	Additional Diluted Sample
DUPDATA	Duplicate Data Entry
EB	Equipment Blank
FB	Field Blank
FD	Field Duplicate Sample
FR	Field Replicate
FS	Field Spike
KD	Known (External Reference Material) Duplicate
LB	Lab Blank
LCS	Lab Control Spike
LCSD	Lab Control Spike Duplicate
LR	Lab Replicate
MB	Material Blank
MBD	Material Blank Duplicate
MS	Lab Matrix Spike
MSD	Lab Matrix Spike and Spike Duplicate pair considered as one sample
N	Normal Environmental Sample
ORIG	Original analysis
PB	Prep Blank
RB	Material Rinse Blank
RD	Regulatory Duplicate
RE	Re-analysis
RM	Known (External Reference Material) Rinsate
RN	Rinsate
SD	Lab Matrix Spike Duplicate considered as separate from spike
TB	Trip Blank
TBD	Trip Blank Duplicate
WT	Waste

Appendix D: Analytical Method Name/Code Guidance

Recommended format and guidance for analytical names:

- If the method is based on the United Stated Environmental Protection Agency (EPA) SW-846, start the name with "SW-" followed by the number and any applicable letter: XXXXc such as 8260b (SW-8260b).
- If the method is based on an EPA method that includes a digit after the period (e.g. Clean Water Act methods), be sure to include that, even if the digit is zero. Start the name with EPA: EPA 300.0
- If the method is based on an EPA document and citing that document is sufficient to understand the method used, include the document number: EPA-540-R97-028.
- If the method is based on an ASTM method, include ASTM- prior to the letter and number designation: ASTM D5755-03. Be sure to include the Based Designation (D5755) and Edition-Version (-03).
- If the method is based on Standard Methods for the Examination of Water and Wastewater, include "SM" prior to the number along with the Base Designation (7500) and the method version (-Ra). The results would be "SM7500-Ra." The DVSR should include the edition (e.g. 18th edition) or year the method was approved.
- Proprietary methods specific to a laboratory should have a designation that can be traced to the DVSR and method SOP. The version of the method needs be included in the DVSR and may also be incorporated into the EDD.

Preparation methods are not required in the EDD. However, all preparation methods that are distinct from the determination method must be included in the DVSR report. If preparation methods are included in the EDD they need to be in a separate column.

A designation indicating that method is a modified version (e.g. mod) is recommended but not required. However, the DVSR should indicate if the method is a modified version of a published method.

Appendix E: Analytical Suite Name/Code

Analytical Method Code	Description
ALDH	Aldehyde analysis
ASB	Asbestos
CRVL	Hexavalent chromium
CYAN	Cyanide
DIO_FUR	Dioxin and Furan
FIELD	Field measurements
GENERAL	Wet chemistry type measurements such as pH, anions, hardness, bicarbonate, alkalinity, perchlorate, ammonia, bromide, TKN, etc
HERB	Herbicides
METALS	Metals and elements using ICP, AA, ICP-MS
ORG_ACID	Organic Acids analysis
PCB	PCB analysis, aroclors or congeners.
PCTMST	Percentage of Moisture
OCPEST	Organo-chlorine pesticide
OPPEST	Organo-phosphate pesticide
SOLIDS	TDS, TSS
SVOC	Semi-Volatile Organic Compounds, exclusive of Pesticides, PCBs, and PAHs.
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons, all molecular weights
VOC	Volatile Organic Compounds
XRFMetals	Metals and elements using XRF.
RADS	Radionuclides
PAH	Polyaromatic Hydrocarbon
TEM	Transmission Electron Microscopy (asbestos)
PLM	Polarized Light Microscopy (asbestos)
XRD	X-ray Diffraction (asbestos and metals)

Appendix F: Physical and Field Parameters

analyte_name	Physical Parameters
DBD	Dry Bulk Density
VMC	Volumetric Moisture Content
FOC	Fraction Organic Carbon
CEC	Cation Exchange Capacity
SPH	Soil pH
DETWA	Depth to Water
TRANS	Transmissivity
HYCO	Hydraulic Conductivity
STOR	Storativitity
DO	Dissolved Oxygen
ORP	Oxidation Reduction Potential - Redox
SGR	Specific Gravity
TOP	Total Porosity
VWC	Volumetric Water Content

USER'S GUIDE AND BACKGROUND TECHNICAL DOCUMENT FOR NEVADA DIVISION OF ENVIRONMENTAL PROTECTION (NDEP) BASIC COMPARISON LEVELS (BCLs) FOR HUMAN HEALTH FOR THE BMI COMPLEX AND COMMON AREAS

Nevada Division of Environmental Protection
Bureau of Corrective Actions
Special Projects Branch
2030 East Flamingo Road, Suite 230
Las Vegas, NV 89119

December 2008

Revision 1 – February 2009

TABLE OF CONTENTS

DISCLAIMER

The Nevada Division of Environmental Protection (NDEP) Basic Comparison Levels (BCLs) address common human health exposure pathways. They consider neither all potential human health exposure pathways nor do they address ecological concerns. The comparison of site characterization data against these risk-based media concentrations provides for an initial screening evaluation to assist users in risk assessment components such as the evaluation of data usability, determination of extent of contamination, identification of chemicals of potential concern, and identification of preliminary remediation goals. The values are derived using equations from U.S. Environmental Protection Agency (USEPA) guidance, USEPA toxicity criteria, and USEPA exposure factors. NDEP officials may decide to follow the guidance provided herein or act at variance with the guidance, based on analysis of site-specific circumstances or availability of new or more relevant data or regulatory policies. NDEP also reserves the right to change this guidance at any time without public notice. Every effort has been made to ensure accuracy in these tables; however, if an error is found, please send an e-mail to brakvica@ndep.nv.gov.

These BCLs are designed for use at the BMI Complex and Common Areas in Henderson, Nevada. The applicability of the BCLs should be verified prior to use at any other site.

The guidance set out in this document is not final NDEP action. It is neither intended to nor can it be relied upon, to create any rights enforceable by a party in litigation with the state of Nevada.

1.0 BACKGROUND ON NDEP BASIC COMPARISON LEVELS (BCLs)

The Internet version of the Nevada Division of Environmental Protection (NDEP) Basic Comparison Levels (BCLs) can be found at the worldwide web address http://ndep.nv.gov/bmi/technical.htm.

Users are advised to employ these BCLs only after fully understanding this guidance. The BCL Table was not generated to represent action levels or final cleanup levels but rather as a technical screening tool to assist users in risk assessment components such as the evaluation of data usability, determination of extent of contamination, identifying chemicals of potential concern, and identifying preliminary remediation goals. The BCL Table contains current human health toxicity values that are combined with standard exposure factors to estimate contaminant concentrations in environmental media (air, soil, and water) that are considered by NDEP to be protective of human exposures (including sensitive sub-groups) over a lifetime. Chemical concentrations above the relevant BCLs do not automatically designate the site as needing a response action. However, exceeding a BCL may suggest that further evaluation of the potential risks posed by site contaminants is appropriate. Further evaluation might include additional sampling, consideration of ambient levels in the environment, or a reassessment of assumptions contained in these screening-level estimates (e.g., appropriateness of route-to-route extrapolations, of using chronic toxicity values to evaluate sub-chronic exposures, refining exposure factors, and/or fate and transport modeling).

For each chemical, BCLs are back-calculated from target risk levels. For the inhalation and direct contact pathways, target risk levels for soil exposures are set at a cumulative one-in-a-million (1×10^{-6}) incremental lifetime cancer risk for the cancer endpoint and a hazard quotient (HQ) of one (1) for the non-cancer endpoint. BCLs for the migration-to-groundwater pathway are back-calculated from the following groundwater concentration limits (in order of preference): non-zero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or health-based limits (based on a cancer risk of 1×10^{-6} or an HQ of 1), with the exception of lead (see Section 3.6.3) and the residential water BCL for perchlorate. The residential water BCL for perchlorate is the provisional Nevada action level of 18 ppb.

BCLs are intended to provide health protection without knowledge of the specific exposure conditions at the site under study. BCLs are applicable when the exposure factors based on site-specific considerations are likely to be more conservative than the default exposure assumptions used in the BCL Table. BCLs are media contaminant concentrations below which no further action or study at a site is generally warranted, provided that specified application conditions associated with the BCLs are met. In general, if adequate site data collection shows that the measured maximum or 95% upper confidence level (UCL) (where appropriate) concentration of a particular contaminant is below the relevant BCL (see Section 3.6.1 for addressing multiple chemicals), then decisions regarding data usability, extent of contamination, chemicals of potential concern, and/or the need for remediation may be supported. If the maximum or the 95% UCL concentration for relevant media is at or above the BCL, further study, though not necessarily a cleanup action, is warranted. When considering BCLs as initial cleanup goals, it is recommended that the residential BCL be used, unless agreement has been reached with NDEP officials that a non-residential land use assumption can be justified.

The responsibility for using the BCL Table, and for determining its relevance to site-specific circumstances, lies with the person recommending the values to be used and the user of the table. Before using the BCLs at a particular site, the user should consider whether the exposure pathways and exposure scenarios at the site are fully accounted for in the BCL calculations. NDEP BCLs are based on direct contact pathways (i.e., ingestion, dermal contact, and inhalation) for which generally accepted methods, models, and assumptions have been developed for specific land uses and do not consider impact to ecological receptors [see Conceptual Site Model (CSM) section below]. The BCL table contains guidance on soil chemical impacts to groundwater by identifying chemical-specific dilution-attenuation factors (DAF), which can be multiplied by relevant soil concentrations to obtain a leaching-based BCL (LBCL) for comparison to water standards.

The BCLs will be updated over time, as appropriate (once a year at a minimum), to reflect evolving USEPA guidance, changes in toxicological data, and derivation of toxicological surrogates (as applicable) for BMI Complex and Common Areas compounds of interest. There are a number of exotic chemicals associated with the BMI Complex and Common Areas and the need for surrogate derivation will be completed on a case-by-case basis. Interim changes and special considerations identified by NDEP and users will be posted in Appendix A of the User's Guide, and will be integrated into the BCL Table as needed. Therefore, users are urged to check this appendix for any changes relevant to their site-specific/media-specific chemicals.

1.1 Conceptual Site Model

Developing a CSM is a critical step in properly implementing the soil screening process at a site. The CSM is a comprehensive representation of the site that documents current site conditions. It characterizes the distribution of contaminant concentrations across the site in three dimensions and identifies all potential exposure pathways, migration routes, and potential receptors. The CSM is initially developed from existing site data. Where relevant, these site data should include input from community members about their site knowledge, concerns, and interests, and should be revised continually as new site investigations produce updated or more accurate information. The final CSM represents links among contaminant sources, release mechanisms, exposure pathways, and routes and receptors based on historical information. It summarizes the understanding of the contamination problem.

As an initial check, the CSM should answer the following questions:

- Are there potential ecological concerns?
- Is there potential for land use other than those covered by the screening levels (i.e., residential and commercial/industrial)?
- Are there other likely human exposure pathways that were not considered in development of the BCLs (e.g., impacts on areas used for gardens, farming, fishing, or raising beef, dairy, or other livestock)?
- Are there unusual site conditions (e.g., large areas of contamination, high fugitive dust levels, or wetland or floodplain issues)?

- Is there a probable source of vapor emissions from volatile soil or groundwater contaminants that may affect indoor air?
- Is there potential for a short-term construction scenario to result in higher risks than those associated with the long-term scenarios assumed for the BCLs?

If the answer to any of the questions is yes, then the BCLs may not be applicable to a site.

1.2 Application of the Comparison Levels Table

The decision to use the screening levels at a site will be driven by the potential benefits of having generic risk-based concentrations in the absence of site-specific risk assessments. Potential benefits are as follows:

- Supporting quality assurance programs and data usability evaluations;
  Limiting the number of chemicals of potential concern (COPCs) evaluated in risk assessments;
- Screening sites to determine the need for further evaluation;
- Prioritizing multiple "hot spots" within a facility or exposure realm; and
- Focusing future risk assessment efforts.

In general, screening-level concentrations provided in the Table are risk-based. However, for soil there are two important exceptions: (1) for several volatile chemicals, screening levels are based on the soil saturation equation ("sat"), and (2) for relatively less toxic inorganic and semi-volatile contaminants, a non-risk-based "ceiling limit" concentration is given as 10^{+5} mg/kg ("max"). The pathways addressed by the BCLs and those not addressed are summarized below.

Environmental Media	**Pathways Addressed by BCLs**		**Pathways not Addressed by BCLs**	
	Residential	**Industrial/ Commercial**	**Residential**	**Industrial/ Commercial**
Soil	• Ingestion • Inhalation of Particulates • Inhalation of VOCs • Dermal Contact	• Ingestion • Inhalation of Particulates • Inhalation of VOCs • Dermal Contact	• Intrusion of VOCs into Indoor Air • Groundwater contact from soil-leached chemicals • Ingestion of Livestock or Produce	• Intrusion of VOCs into Indoor Air • Groundwater contact from soil-leached chemicals • Particulate Emission During Construction/Excavations Activities
Groundwater	• Ingestion from Drinking • Inhalation of VOCs	• None	• Dermal Absorption while Bathing • Intrusion of VOCs into Indoor Air	• Ingestion from Drinking • Inhalation of VOCs • Dermal Absorption • Intrusion of VOCs into Indoor Air

VOC – volatile organic compound

1.3 Potential Issues and Misapplication of BCLs

As discussed previously, the BCLs should be used only when the conditions at the site being screened are similar to those under which the BCLs were derived for use. Special care should be exercised to prevent misuse of the BCLs and to protect human health. Specifically, the following should be avoided:

- Applying screening levels to a site without adequately developing a conceptual site model that identifies relevant exposure pathways and exposure scenarios.
- Not considering background concentrations when choosing screening levels.
- Use of screening levels as cleanup levels without considering other relevant criteria.
- Use of screening levels as cleanup levels without verifying applicability with a qualified risk assessment toxicologist.
- Use of outdated screening-level tables that have been superseded by more recent publications.
- Not considering the effects of the presence of multiple chemicals.

2.0 NDEP BASIC COMPARISON LEVELS (BCLs)

The BCL Table was generated using equations incorporated into a calculation spreadsheet, except for the column "DAF" [the dilution-attenuation factor for use in calculating leaching-based BCLs]. Toxicity values, as well as physical and chemical parameters, are input into the spreadsheet. There are seven primary sections of the spreadsheet: 1) toxicity values, 2) physical/chemical input parameters, 3) BCLs for exposure-specific/scenario-specific risks and hazards for residential land use scenarios, 4) BCLs for industrial/commercial land use scenarios, 5) BCLs for ambient air, 6) BCLs for residential water, and 7) the final integrated BCLs. The "printable" version of the BCL Table contains only the toxicity values, volatile organic compound (VOC) designation, skin absorption value, and final comparison levels. The default values and equations used in developing the table are discussed below.

2.1 Toxicity Values

EPA toxicity values, known as non-carcinogenic reference doses (RfDs), non-carcinogenic reference concentrations (RfCs), and cancer slope factors (SFs) were obtained from USEPA's Integrated Risk Information System (IRIS) on-line database (USEPA, 2008a), EPA's Provisional Peer-Reviewed Toxicity Values Database (PPRTV) (USEPA, 2008b), USEPA's National Center for Environmental Assessment (NCEA), USEPA's Health Effects Assessment Summary Table (HEAST) (USEPA, 1997a), and other sources. The hierarchy for the sources of the toxicity values used to develop the NDEP screening table is as follows: (1) IRIS (indicated by "i" in the table), (2) PPRTV ("p") and (3) NCEA ("n"), HEAST ("h"), and other documents ("o"). The OSWER Directive 9285.7-53 (dated December 5, 2003) (USEPA, 2003a) designates the hierarchy for toxicity criteria above. It should be noted that the USEPA has withdrawn toxicity values for certain chemicals. These are designated with an "x" in the BCL table and should be discussed in the uncertainty section if used in a risk assessment.

The IRIS, PPRTV, and NCEA values are current as of 2008. HEAST has not been updated since the last screening-value table released in 1997 (USEPA, 1997a). HEAST values that have been externally peer reviewed are now in the PPRTV database and are noted by the letter “p” in the key column of the screening table next to the toxicity value. The PPRTV values currently represent the second tier of human health toxicity values for the USEPA Superfund and hazardous waste programs.

Route-to-route extrapolations (“r”) were used when toxicity values were not available for a given route of exposure. Oral cancer slope factors (“SFo”) and reference doses (“RfDo”) were used for both oral and inhalation exposures for organic compounds lacking inhalation values, where applicable. Inhalation cancer slope factors (“SFi”) and inhalation reference doses (“RfDi”) were used for both inhalation and oral exposures for organic compounds lacking oral values, unless the toxicity data indicated otherwise. An additional route extrapolation that was applied is the use of oral toxicity values to evaluate dermal exposures.

In addition, due to the vast number of specialized compounds and analytical issues associated with the BMI Complex and Common Areas, toxicological surrogates have been derived for several compounds. The derivations for the toxicological surrogates are summarized in Appendix B.

2.2 Physical/Chemical Parameters

The physical/chemical data section of the spreadsheet provides the information needed to calculate the volatilization factors (VFs) and the saturation limits for the contaminants. Volatile chemicals are defined as those that have a Henry’s Law constant greater than 10^{-5} (atm-m^3/mol) and a molecular weight less than 200 g/mole (USEPA, 1991). The emission terms used in the VFs are chemical specific and were calculated from physical/chemical information obtained from several sources: the 1996 *Soil Screening Guidance* (USEPA, 1996a, b), the 1996 *Superfund Chemical Data Matrix* (USEPA, 1996c), and the 1988 *Superfund Exposure Assessment Manual* (USEPA, 1988). The VF used to calculate the soil screening levels is derived in the physical/chemical data section of the spreadsheet, using the equation below, which is from the USEPA’s Soil Screening Guidance (USEPA, 1996a, b). The volatilization factor for water is not derived but is a constant.

2.3 Soil-to-Air Volatilization Factors (VFs)

Derivation of the Volatilization Factor

$$VF_s\left(\frac{m^3}{kg}\right) = \left(\frac{Q}{C}\right) x \ \frac{(3.14\ \times\ D_A\ \times\ T)^{1/2}}{(2\ \rho_b\ \times\ D_A)}\ \times\ 10^{-4}\left(\frac{m^2}{cm^2}\right)$$

where:

$$D_A = \frac{(\Theta_a{}^{10/3}\ DiH' +\ \Theta_w{}^{10/3} Dw)/n^2}{p_b K_d +\ \Theta_w +\ \Theta_\mathrm{a}\mathrm{H}'}$$

Parameter	Definition (units)	Value
VF	Volatilization factor (m^3/kg)	Chemical specific
D_A	Apparent diffusivity (cm^2/s)	Chemical specific
Q/C	Inverse of the mean concentrate at the center of a 0.5-acre square source (g/m^2-s per kg/m^3)	68.81
T	Exposure interval (s)	9.5×10^8
ρ_b	Dry soil bulk density(g/cm^3)	1.5
Θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.28 or $n - \Theta_w$
n	Total soil porosity (L_{pore}/L_{soil})	0.43 or $1 - (\rho_b/\ \rho_s)$
Θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15
ρ_s	Soil particle density (g/cm^3)	2.65
Di	Diffusivity in air (cm^2/s)	Chemical specific
H	Henry's Law constant	Chemical specific
H'	Dimensionless Henry's Law constant	Calculated from H by multiplying by 41 (USEPA, 1991)
D_w	Diffusivity in water (cm^2/s)	Chemical specific
K_d	Soil/water partition coefficient (cm^3/g) = $K_{oc}f_{oc}$	Chemical specific
K_{oc}	Soil organic carbon/water partition coefficient (cm^3/g)	Chemical specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.006 (0.6%)

Soil Saturation

The soil saturation concentration "sat" corresponds to the contaminant concentration in soil at which the absorptive limits of the soil particles, the solubility limits of the soil pore water, and saturation of soil-pore air have been reached. Above this concentration, the soil contaminant may be present in free phase (i.e., nonaqueous-phase liquids [NAPLs]) for contaminants that are liquid at ambient soil temperatures and in pure solid phases for compounds that are solid at ambient soil temperatures.

The equation below is used to calculate "sat" for each volatile contaminant. As an update to RAGS HHEM, Part B (USEPA 1991), this equation takes into account the amount of contaminant that is in the vapor phase in soil, in addition to the amount dissolved in the soil's pore water and sorbed to soil particles. The volatilization model is not applicable when free-phase contaminants are present. How these cases are handled depends on whether the contaminant is liquid or solid at ambient temperatures. Liquid contaminants for which screening levels exceed the "sat" concentration are set equal to "sat," whereas for solids (e.g., polycyclic aromatic hydrocarbons [PAHs]), soil screening decisions are based on other appropriate pathways of concern at the site (e.g., ingestion and dermal contact).

2.4 Soil Saturation Concentration (sat)

Derivation of the Soil Saturation Limit

$$Sat = \frac{S}{\rho b}\,(\mathrm{K_d}\,\rho b\ +\ \Theta w\ +\ H'\Theta a)$$

Parameter	Definition (units)	Value
Sat	Soil saturation concentration (mg/kg)	Calculated
S	Solubility in water (mg/L-water)	Chemical specific
ρ_b	Dry soil bulk density (kg/L)	1.5
K_d	Soil-water partition coefficient (L/kg)	K_{oc} x f_{oc} (chemical specific)
K_{oc}	Soil organic carbon/water partition coefficient (L/kg)	Chemical specific
f_{oc}	Fraction organic carbon content of soil (g/g)	0.006 or site specific
Θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15
Θ_a	Air-filled soil porosity (L_{air}/L_{soil})	0.28 or n – Θ_w
n	Total soil porosity (L_{pore}/L_{soil})	0.43 or 1 – (ρ_b/ ρ_s)
ρ_s	Soil particle density (g/cm^3)	2.65
w	Average soil moisture content (kg_{water}/kg_{soil} or L_{water}/kg_{soil})	0.1
H	Henry's Law constant	Chemical specific
H'	Dimensionless Henry's Law constant	Calculated from H by multiplying by 41 (USEPA, 1991)

The physical/chemical parameters section of the spreadsheet also includes information on molecular weight and skin absorption factors used to calculate the dermal portion of the equations.

2.5 Dermal Absorption Factors

Chemical-specific dermal absorption factors for contaminants in soil and dust based on USEPA (2004; RAGS Part E, *Supplemental Guidance for Dermal Risk Assessment*) are presented in the BCL Table for arsenic, cadmium, chlordane, 2,4-D, DDT, Lindane, PAHs, pentachlorophenol, polychlorinated biphenyls (PCBs), and polychlorinated dibenzo-p-dioxins and dibenzofurans (collectively referred to as "dioxins"). For other chemicals, USEPA (2004) recommends using a default dermal absorption factor of 0.10 for semi-volatile organic chemicals. A default absorption factor for inorganics and volatile organic chemicals is no longer recommended. These USEPA dermal guidelines were applied to the BCLs.

2.6 Default Factors for Volatilization from Residential Water and Particulate Emissions from Soils

The physical/chemical data section of the spreadsheet does not calculate the particulate emission factor or the volatilization factor for residential water. Default values are used for these parameters which can be found in the spreadsheet above the header in the electronic table.

Volatilization Factor for Residential Water

For residential water, an upper-bound volatilization constant (VFw) is used that is based on all uses of household water (e.g., showering, laundering, and dish washing). Certain assumptions were made. For example, it is assumed that the volume of water used in a residence for a family of four is 720 L/day, the volume of the dwelling is 150,000 L, and the air exchange rate is 0.25 air changes/hour (Andelman, cited in USEPA, 1991; USEPA *Exposure Factors Handbook*, USEPA, 1997b). Furthermore, it is assumed that the average transfer efficiency, weighted by water use, is 50% (i.e., half the concentration of each chemical in water will be transferred into air by all water uses). The range of transfer efficiencies extends from 30% for toilets to 90% for dishwashers (Andelman, cited in USEPA, 1991). Volatilization was included in the residential water equations only for compounds with a “1” in the “VOC” column. The value used in calculating the screening level for residential water is 0.5 L/m^3.

Particulate Emission Factor for Soils

To address the soil-to-air pathway for particulate emission, the screening-level calculations incorporate particulate emission factors (PEFs) for nonvolatile contaminants. The PEF relates the contaminant concentration in soil to the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils. The generic PEF was derived using default values that correspond to a receptor-point concentration of approximately 0.76 µg/m^3. The relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface contamination provides a relatively continuous and constant potential for emission over an extended period of time (e.g., years). This represents an annual average emission rate based on wind erosion, which should be compared with chronic health criteria; it is not appropriate for evaluating the potential for acute exposures.

The USEPA methodology to derive a PEF for Las Vegas was followed (UESPA, 1996a). Specifically, all standard default parameters were use with the exception of air dispersion modeling constants for the climate zone of Las Vegas (e.g., PEF calculation parameters “A”, “B”, and “C” as obtained from USEPA, 1996a[1]). The resulting PEF of 1.2×10^9 m^3/kg (USEPA, 1996a) was used. The PEF and associated inhalation dose do not appear to affect most soil screening levels significantly with the exception of specific metals. For more details regarding specific parameters used in the PEF model, the reader is referred to *Soil Screening Guidance: Technical Background Document* (USEPA 1996a).

---

[1] See Exhibits D-1, D-2 and D-4 of USEPA, 1996a.

Note: The PEF evaluates windborne emissions only and does not consider dust emissions from traffic, or other forms of mechanical disturbance that are typical of short-term construction scenarios.

2.7 Age-Adjustment Factors

Because contact rates may be different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age-adjusted factors ("adj"). Use of age-adjusted factors is especially important for soil ingestion exposures, which are higher during childhood and decrease with age. For purposes of combining exposures across pathways, additional age-adjusted factors are used for inhalation and dermal exposures. These factors approximate the integrated exposure from birth until age 30, combining contact rates, body weights, and exposure durations for two age groups small children and adults. Age-adjusted factors were obtained from USEPA RAGS Part B (USEPA, 1991) or developed by analogy. The equations depicted below are for carcinogens.

(1) ingestion for soil ([mg × yr]/[kg × d]:

$$IFS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{ED_r - ED_C \times IRS_a}{BW_a}$$

(2) skin contact ([mg × yr]/[kg × d]:

$$SFS_{adj} = \frac{ED_c \times \mathrm{AF} \times SA_c}{BW_c} + \frac{(ED_r - ED_c) \times AF \times SA_a}{BW_a}$$

(3) inhalation ([m^3 × yr]/[kg × d]):

$$InhF_{adj} = \frac{ED_c \times IRA_c}{BW_c} + \frac{(ED_r - ED_c) \times IRA_a}{BW_a}$$

(4) ingestion for water ([l × yr]/[kg × d])

$$IFW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{(ED_r - ED_c) \times IRW_a}{BW_a}$$

The acronyms and their values are provided in Table 1. These values can also be found in the exposure default section of the BCL Table.

3.0 EXPOSURE-SPECIFIC/SCENARIO-SPECIFIC COMPARISON LEVELS

A BCL for each exposure pathway (ingestion, inhalation, and dermal), where applicable, is calculated separately for carcinogens and non-carcinogens, and is listed under the appropriate heading of residential, industrial-indoor, industrial-outdoor, ambient air, or residential water. Individual pathway values can provide important information with regard to risk drivers by comparing measurement data to relevant BCLs based on the carcinogenic risk and non-carcinogenic hazard. For the end user who may be using a cancer target risk level greater than 1×10^{-6}, the exposure-specific/scenario-specific section of the spreadsheet can be used to determine whether the carcinogenic endpoint is more stringent than the non-carcinogenic endpoint, which is based on a hazard quotient of 1. The carcinogenic endpoint is not always the most conservative.

Default exposure factors used to develop the BCL values were obtained primarily from the USEPA Exposure Factors Handbook (USEPA, 1997b) and the USEPA Supplemental Soil Screening Guidance (USEPA, 2002). Table 1 lists all exposure factors used, their abbreviations used in the equations in this text, and the source. The equations for calculating the risk or hazard by exposure pathway, as well as the combined risk from all exposures for the scenario, are provided below.

3.1 Equations for Residential Land Use Scenario

Ingestion of Carcinogenic Contaminants in Soil

<u>Eq. 1</u>

$$Comparison\ Level\ \text{mg/kg} = \frac{\text{TR} \times \text{AT} \times 365\ \text{days/year}}{SF_{\text{o}} \times 10^{-6}\ \text{kg/mg} \times EF \times IFS_{adj}}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (70 years)
SF_o = Oral cancer slope factor
EF = Exposure frequency (350 days)
IFS_adj = Adjusted soil ingestion (mg-year)/(kg-day) = 114

Ingestion of Non-carcinogenic Contaminants

<u>Eq. 2</u>

$$Comparison\ Level\ \text{mg/kg} = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\frac{1}{\text{RfD}_\text{o}} \times 10^{-6}\ \text{kg/mg} \times EF \times ED \times IRS}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of child (15 kg)
AT = Averaging time for child (6 years)
RfD_o = Oral reference dose
EF = Exposure frequency (350 days/year)
ED = Exposure duration of child (6 years)
IRS = Soil ingestion rate for child (200 mg/day)

Inhalation of Carcinogenic Contaminants

Eq. 3

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{TR} \times \text{AT} \times 365\ \text{days/year}}{SF_{\text{i}} \times \text{EF} \times InhF_{\text{adj}} \times [(\frac{1}{\text{PEF}})\ \text{or}\ (\frac{1}{\text{VF}})]}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (70 years)
SF_i = Inhalation cancer slope factor (chemical-specific)
EF = Exposure frequency (350 days/year)
$InhF_{adj}$ = Adjusted inhalation factor 11(m^3-year)/(kg-day)
PEF = Particulate emission factor used for dusts (1.2×10^9 mg^3/kg)
VF = Volatilization factor used for volatile organic chemicals (mg^3/kg)

Inhalation of Non-carcinogenic Contaminants

Eq. 4

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\text{EF} \times \text{ED} \times \frac{1}{RfD_i} \times \text{IRA} \times [(\frac{1}{\text{PEF}})\ \text{or}\ (\frac{1}{\text{VF}})]}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of child (15 kg)
AT = Averaging time for child (6 years)
EF = Exposure frequency (350 days/year)
ED = Exposure duration for child (6 years)
RfD_i = Inhalation reference dose in mg/kg/day (chemical specific)
IRA = Inhalation rate for child (10 m^3/day)
PEF = Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF = Volatilization factor used for volatile organic chemicals (m^3/kg)

Skin Contact of Carcinogenic Contaminants

Eq. 5

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{TR} \times \text{AT} \times 365\ \text{days/year}}{SF_{\text{o}} \times \text{EF} \times SFS_{\text{adj}} \times \text{ABS} \times 10^{-6}\ \text{kg/mg}}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (70 years)

SF_o = Oral cancer slope factor (chemical specific)
EF = Exposure frequency (350 days/year)
SFS_{adj} = Skin contact factor for soils (361 mg-year/kg-day)
ABS = Skin absorption (chemical specific)

Skin Contact of Non-carcinogenic Contaminants

Eq. 6

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{day/year}}{\text{EF} \times \text{ED} \times \frac{1}{\text{RfD}_\text{o}} \times 10^{-6}\ \text{kg/mg} \times \text{SA} \times \text{AF} \times \text{ABS}}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of child (15 kg)
AT = Averaging time of child (6 years)
EF = Exposure frequency (350 days/year)
ED = Exposure duration of child (6 years)
RfD_o = Oral reference dose (chemical-specific)
SA = Surface area of child (2800 cm^2/day)
AF = Adherence factor of child (0.2 mg/cm^2)
ABS = Skin absorption (chemical specific)

Comparison Level for Combined Exposure Pathways for Carcinogenic Contaminants for Residential Receptor

Eq. 7

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{1}{\frac{1}{\text{Eq. 1}} + \frac{1}{\text{Eq. 3}} + \frac{1}{\text{Eq. 5}}}$$

Comparison Level for Combined Exposure Pathways for Non-carcinogenic Contaminants for Residential Receptor-

Eq. 8

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{1}{\frac{1}{\text{Eq. 2}} + \frac{1}{\text{Eq. 4}} + \frac{1}{\text{Eq. 6}}}$$

Equation 4 for uses the PEF approach for solids and the VF approach for volatile compounds.

3.2 Equations for the Industrial Indoor Worker Scenario

Ingestion of Carcinogenic Contaminants

Eq. 9

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{TR} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{SF_o \times 10^{-6}\ \text{kg/mg} \times \text{EF} \times \text{ED} \times \text{IRS}}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (70 years)
BW = Body weight of adult (70 kg)
SF_o = Oral cancer slope factor (chemical specific)
EF = Exposure frequency (250 days/year)
ED = Exposure duration (25 years)
IRS = Soil ingestion rate for adult (50 mg/day)

Ingestion of Non-carcinogenic Contaminants

Eq. 10

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\frac{1}{\text{RfD}_o} \times 10^{-6}\ \text{kg/mg} \times \text{EF} \times \text{ED} \times \text{IRS}}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of adult (70 kg)
AT = Averaging time (25 years)
RfD_o = Oral reference dose (chemical specific)
EF = Exposure frequency (250 days/year)
ED = Exposure duration (25 years)
IRS = Ingestion rate for soil (50 mg/day)

Inhalation of Carcinogenic Contaminants

Eq. 11

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{TR} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\text{SFi} \times \text{EF} \times \text{ED} \times \text{IRA} \times [(\frac{1}{\text{PEF}})\ \text{or}\ (\frac{1}{\text{VF}})]}$$

where:

TR = Target risk of 10^{-6}
BW = Body weight of adult (70kg)
AT = Averaging time (70 years)
SF_i = Inhalation cancer slope factor (chemical-specific)

EF = Exposure frequency (250 days/year)
ED = Exposure duration (25 years)
IRA = Inhalation rate (20 m^3/day)
PEF = Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF = Volatilization factor used for volatile organic chemicals (m^3/kg)

Inhalation of Non-carcinogenic Contaminants

Eq. 12

$$Comparison\ Level \text{ mg/kg} = \frac{\text{THQ x BW x AT x 365 days/year}}{\text{EF x ED x } (\frac{1}{\text{RfD}_\text{i}}) \text{ x IRA x } [(\frac{1}{\text{PEF}}) \text{ or } (\frac{1}{\text{VF}})]}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of adult (70 kg)
AT = Averaging time (25 years)
EF = Exposure frequency (250 days/year)
ED = Exposure duration (25 years)
RfD_i = Inhalation reference dose in mg/kg/day (chemical specific)
IRA = Inhalation rate of adult (20 m^3/day)
PEF = Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF = Volatilization factor used for volatile organic chemicals (mg^3/kg)

Comparison Level for Combined Exposure Pathways for Carcinogenic Contaminants for Indoor Industrial Worker

Eq. 13

$$Comparison\ Level \text{ mg/kg} = \frac{1}{\frac{1}{\text{Eq. 9}} + \frac{1}{\text{Eq. 11}}}$$

Comparison Level for Combined Exposure Pathways for Non-carcinogenic Contaminants for Indoor Industrial Worker-

Eq. 14

$$Comparison\ Level \text{ mg/kg} = \frac{1}{\frac{1}{\text{Eq. 10}} + \frac{1}{\text{Eq. 12}}}$$

3.3 Equations for the Industrial -Outdoor Worker Scenario

Ingestion of Carcinogenic Contaminants

Eq. 15 Screening

$$Comparison\ Level\ \text{mg/kg} = \frac{\text{TR} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{SF_{\text{o}} \times 10^{-6}\ \text{kg/mg} \times \text{EF} \times \text{ED} \times \text{IRS}}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (70 years)
BW = Body weight of adult (70kg)
SF_o = Oral cancer slope factor (chemical-specific)
EF = Exposure frequency (225 days/year)
ED = Exposure duration (25 years)
IRS = Soil ingestion rate for adult (100 mg/day)

Ingestion of Non-carcinogenic Contaminants

Eq. 16

$$Comparison\ Level\ \text{mg/kg} = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\frac{1}{\text{RfD}_{\text{o}}} \times 10^{-6}\ \text{kg/mg} \times \text{EF} \times \text{ED} \times \text{IRS}}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of adult (70 kg)
AT = Averaging time (25 years)
RfD_o = Oral reference dose (chemical-specific)
EF = Exposure frequency (225 days/year)
ED = exposure duration (25 years)
IRS = Soil ingestion rate for adult (100 mg/day)

Inhalation of Carcinogenic Contaminants

Eq. 17

$$Comparison\ Level\ \text{mg/kg} = \frac{\text{TR} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{SF_{\text{i}} \times \text{EF} \times \text{ED} \times \text{IRA} \times [(\frac{1}{\text{PEF}})\ \text{or}\ (\frac{1}{\text{VF}})]}$$

where:

TR = Target risk of 10^{-6}
BW = Body weight of adult (70 kg)
AT = Averaging time (70 years)

SF_i = Inhalation cancer slope factor (chemical specific)
EF = Exposure frequency (225 days/year)
ED = Exposure duration (25 years)
IRA = Inhalation rate for adult (20 m^3/day)
PEF = Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF = Volatilization factor used for volatile organic chemicals (m^3/kg)

Inhalation of Non-carcinogenic Contaminants

Eq.18

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\text{EF} \times \text{ED} \times (\frac{1}{\text{RfD}_\text{i}}) \times \text{IRA} \times [(\frac{1}{\text{PEF}})\ \text{or}\ (\frac{1}{\text{VF}})]}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of adult (70 kg)
AT = Averaging time (25 years)
EF = Exposure frequency (225 days/year)
ED = Exposure duration (25 years)
RfD_i = Inhalation reference dose in mg/kg/day (chemical specific)
IRA = Inhalation rate of adult (20 m^3/day)
PEF = Particulate emission factor used for dusts ($1.2\times10^9 m^3$/kg)
VF = Volatilization factor used for volatile organic chemicals (m^3/kg)

Skin Contact with Carcinogenic Contaminants

Eq. 19

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{TR} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\text{EF} \times \text{ED} \times SF_\text{o} \times 10^{-6}\ \text{kg/mg} \times \text{SA} \times \text{AF} \times \text{ABS}}$$

where:

TR = Target risk of 10^{-6}
BW = Body weight of adult (70 kg)
AT = Averaging time of worker (25 years)
EF = Exposure frequency (225 days/year)
ED = Exposure duration of worker (25 years)
SF_o = Oral cancer slope factor (chemical specific)
SA = Surface area exposed for adult (3300 cm^2/day)
AF = Adherence factor (0.2 mg/cm^2)
ABS = Skin absorption (chemical specific)

Skin Contact with Non-carcinogenic Contaminants

Eq. 20

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{days/year}}{\text{EF} \times \text{ED} \times \frac{1}{\text{RfD}_\text{o}} \times 10^{-6}\ \text{kg/mg} \times \text{SA} \times \text{AF} \times \text{ABS}}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of adult (70 kg)
AT = Averaging time of outdoor worker (25 years)
EF = Exposure frequency (225 days/year)
ED = Exposure duration of worker (25 years)
RfD_o = Oral reference dose (chemical specific)
SA = Surface area exposed for adult (3300 cm^2/day)
AF = Adherence factor (0.2 mg/cm^2)
ABS = Skin absorption (chemical-specific)

Comparison Level for Combined Exposure Pathways for Carcinogenic Contaminants for Outdoor Industrial Worker

Eq. 21

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{1}{\frac{1}{Eq.15} + \frac{1}{Eq.17} + \frac{1}{Eq.19}}$$

Comparison Level for Combined Exposure Pathways for Non-carcinogenic Contaminants for Outdoor Industrial Worker

Eq.22

$$\mathit{Comparison\ Level}\ \text{mg/kg} = \frac{1}{\frac{1}{Eq.16} + \frac{1}{Eq.18} + \frac{1}{Eq.20}}$$

3.4 Ambient Air Equations

Inhalation of Carcinogenic Contaminants

<u>Eq. 23</u>

$$\mathit{Comparison\ Level}\ (\mu\text{g/m}^3) = \frac{\text{TR} \times \text{AT} \times 365\ \text{days/year} \times 1{,}000\ \mu\text{g/mg}}{\text{EF} \times \mathit{InhF}_{\text{adj}} \times \mathit{SF}_{\text{o}}}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (70 years)
EF = Exposure frequency (350 days/year)
InhF_{adj} = Adjusted inhalation factor (11 m^3-year/kg-day)
SF_{o} = Oral cancer slope factor (chemical specific)

Inhalation of Non-carcinogenic Contaminants

<u>Eq.24</u>

$$\mathit{Comparison\ Level}\ (\mu\text{g/m}^3) = \frac{\text{THQ} \times \text{BW} \times \text{AT} \times 365\ \text{days/year} \times 1{,}000\ \mu\text{g/mg}}{\text{EF} \times \text{ED} \times \text{IRA} \times \frac{1}{\text{RfD}_{\text{i}}}}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of adult (70 kg)
AT = Averaging time of resident (30 years)
EF = Exposure frequency (350 days/year)
ED = Exposure duration (30 years)
IRA = Inhalation rate (20 m^3/day)
RfD_{i} = Inhalation reference dose (chemical-specific)

3.5 Residential Water Equations

Ingestion and Inhalation of Carcinogenic Contaminants

<u>Eq. 25</u>

$$\mathit{Comparison\ Level}\ (\mu\text{g/l}) = \frac{\text{TR} \times \text{AT} \times 365\ \text{days/year} \times 1{,}000\ \mu\text{g/mg}}{\text{EF} \times [(\mathit{IFW}_{\text{adj}} \times \mathit{SF}_{\text{o}}) + (\text{VF} \times \mathit{InhF}_{\text{adj}} \times \mathit{SF}_{\text{i}})^{*}]}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (70 years)

EF = Exposure frequency (350 days/year)
IFW_{adj} = Ingestion factor for water (1.1 L-year/kg-day)
SF_o = Oral cancer slope factor (chemical specific)
VF = Volatilization factor for water (0.5 L/m^3)
$InhF_{adj}$ = Adjusted inhalation factor (11 m^3-yr/kg-day)
SF_i = Inhalation cancer slope factor (chemical specific)
* Inhalation component of the equation is calculated only for volatile organic chemicals.

Ingestion and Inhalation of Non-carcinogenic Contaminants

Eq. 26

$$\mathit{Comparison\ Level}\ \mu g/L = \frac{\mathrm{THQ} \times \mathrm{BW} \times \mathrm{AT} \times 365\ \mathrm{days/year} \times 1{,}000\ \mu g/mg}{\mathrm{EF} \times \mathrm{ED}\ [(\frac{IRW}{\mathrm{RfD_o}}) + (\mathrm{VF} \times \mathrm{IRA} \times \frac{1}{\mathrm{RfD_i}})^*]}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight of adult (70 kg)
AT = Averaging time of resident (30 years)
EF = Exposure frequency (350 days/year)
ED = Exposure duration (30 years)
IRW = Drinking water ingestion (2 L/day)
RfD_o = Oral reference dose (chemical specific)
VF = Volatilization factor for water (0.5 L/m^3)
IRA = Inhalation rate (20 m^3/day)
RfD_i = Inhalation reference dose (chemical specific)
* Inhalation part of equation only calculated for volatile organic chemicals

Table 1 provides the Standard Default Exposure Factors used in the preceding equations.

Development of Final Residential Soil BCLs in the Absence of an RfC

Several values are compared in order to develop the final comparison level. These include the comparison to a maximum of 100,000 for the less toxic chemicals, and to the soil saturation limit. These equations are listed below.

If the contaminant is a solid, the following applies:

Eq. 27a: Comparison Level (mg/kg) = Minimum value from Eq. 7, Eq. 8*, or 100,000
*Equation 8 uses the Eq. 4 option.

If the contaminant is not a solid, the following applies:

Eq. 27b Comparison Level (mg/kg) = Minimum value from saturation, Eq. 7, Eq. 8*, or 100,000
*Equation 8 uses the Eq. 4 option.

Residential Soil Value when RfC is Available

If the contaminant is a solid, the following applies:

Eq. 27a Comparison Level (mg/kg) = Minimum value from Eq. 7, Eq. 8*, or 100,000
*Equation 8 uses the Eq. 4 option.

If the contaminant is not a solid, then the following applies:

Eq. 27b Comparison Level (mg/kg) = Minimum value from saturation, Eq. 7, Eq. 8*, or 100,000
*Equation 8 uses the Eq. 4 option.

Industrial Soil Indoor Worker

If the contaminant is a solid, the following applies:

Eq. 28a Comparison Level (mg/kg) = Minimum value from Eq. 13, Eq. 14, or 100,000

If the contaminant is not a solid, the following applies:

Eq. 28b Comparison Level (mg/kg) =
Minimum value from saturation, Eq. 13, Eq. 14, or 100,000

Industrial Soil Outdoor Worker

If the contaminant is a solid, the following applies:

Eq. 29a Comparison Level (mg/kg) = Minimum value from Eq. 21, Eq. 22, or 100,000

If the contaminant is not a solid, the following applies:

Eq. 29b Comparison Level (mg/kg) = Minimum value from saturation, Eq. 21, Eq. 22, or 100,000

Ambient Air

Eq. 30 Comparison Level ($\mu g/m^3$) = Minimum value from Eq. 23 or Eq. 24

Residential Water

Eq. 31 Comparison Level (µg/L) = Minimum value from Eq. 25 or Eq. 26

3.6 Special Considerations

3.6.1 Screening with Multiple Contaminants

A suggested stepwise approach for BCL-screening of sites with multiple pollutants is as follows:

- Perform an extensive records search and compile existing data.
- Use the CSM to identify all known and potential site contaminants in the BCL Table. Record the BCL concentrations for various media and note whether the chemical has been assigned cancer (indicated by "ca") and/or non-cancer (indicated by "nc") toxicological criteria. Segregate cancer BCLs from non-cancer BCLs and exclude (but do not eliminate) non-risk based BCLs ("sat" or "max").
- For cancer risk estimates, take the site-specific concentration (maximum or 95 UCL) and divide by the BCL concentration designated for cancer evaluation ("ca"). Multiply this ratio by 10^{-6} to estimate chemical-specific risk for a reasonable maximum exposure (RME). For multiple pollutants, simply add this risk estimate for each chemical as follows:

$$Risk = \left[\left(\frac{Conc_x}{BCL_x}\right) + \left(\frac{Conc_y}{BCL_y}\right) + \ldots + \left(\frac{Conc_z}{BCL_z}\right)\right] \times 10^{-6}$$

- For non-cancer hazard estimates, divide the site exposure point concentration term by the respective non-cancer BCL (designated as "nc") and sum the ratios for multiple contaminants. The cumulative ratio represents a screening non-cancer hazard index (HI). A screening hazard index of 1 or less is considered "safe". A ratio greater than 1 suggests further evaluation (see USEPA, 1989, page 8-14 for segregation of hazard indices by effect and mechanism of action). [Note that carcinogens may also have an associated non-cancer BCL that is not listed in the BCL Table. To obtain these values, the user should view or download the BCL Detail Tables at the BCL website and display the appropriate sections.]

$$Hazard\ Index = \left[\left(\frac{Conc_x}{BCL_x}\right) + \left(\frac{Conc_y}{BCL_y}\right) + \ldots + \left(\frac{Conc_z}{BCL_z}\right)\right]$$

For initial screening of data when multiple chemicals have been released, a simplified conservative approach of employing one-tenth of the BCL can be applied.

3.6.2 Evaluating Migration of Soil Chemicals to Groundwater: Leaching-Based BCLs (LBCLs)

The method for calculating leaching-based soil screening levels (LBCLs) for migration to groundwater was developed to identify chemical concentrations in soil that have the potential to contaminate groundwater. Migration of contaminants from soil to groundwater is evaluated as a two-stage process: (1) release of contaminant in soil leachate, and (2) transport of the contaminant through the underlying soil and aquifer to a receptor well. The LBCL methodology considers both of these transport mechanisms.

LBCLs are back-calculated from acceptable groundwater concentrations (i.e., non-zero MCLGs, MCLs, or risk-based screening levels). Residential exposure scenarios are assumed based on a fixed upper-bound risk of 10^{-6} or a fixed hazard quotient of 1. First, the acceptable groundwater concentration is multiplied by a dilution factor to obtain a target leachate concentration. For example, if the dilution factor is 10 and the acceptable groundwater concentration is 0.05 mg/L, the target soil leachate concentration would be 0.5 mg/L. The partition equation (presented in USEPA, 1996a) is then used to calculate the total soil concentration that corresponds to this soil leachate concentration. The BCL Table presents the dilution-attenuation factors (DAF) for relevant chemicals, which can be used to calculate the LBCL. Due to rounding, there may be some slight difference in the Table values and the values found in the *Soil Screening Guidance* (USEPA, 1996a).

3.6.3 BCLs for Chemicals with Special Considerations

Polycyclic aromatic hydrocarbons, and polychlorinated dibenzo-p-dioxins, dibenzofurans, and dioxin-like (coplanar) polychlorinated biphenyls, are chemical mixtures for which alternative approaches have been developed by USEPA to simplify risk calculations using a toxicity-equivalence factor approach. In addition, special conditions for certain metals, inorganics, total petroleum hydrocarbons, and vinyl chloride have been adopted by USEPA Region 9 (USEPA, 2004b, 2008c) and are also considered appropriate with respect to BCLs, as explained below.

Cadmium

Because IRIS provides different oral RfDs for cadmium in water and in foods, the BCL for cadmium in water is based on the oral RfD for water, and the BCL for soil ingestion is based on the RfD for foods.

Lead

The residential soil value for lead is based on the Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead in children developed using default parameters (USEPA, 1994). More information on this model and other lead risk assessment guidance can be found at http://www.epa.gov/superfund/health/contaminants/lead/index.htm. The industrial BCL is based on equations developed by the technical review group (adult lead model), as described below.

The Adult Lead Model (ALM) is a tool for assessing risks associated with **non-residential** adult exposures to lead in soil. The ALM focuses on estimating fetal blood lead concentrations in pregnant women exposed to lead-containing soils in a commercial/industrial setting. It is the product of extensive evaluations by the Technical Review Workgroup for Lead (TRW). In December 1996, the TRW released the document *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (*TRWR*; USEPA, 1996d), which describes the equations and default parameters that can be used with the ALM.

Manganese

The IRIS RfD (0.14 mg/kg-day) includes manganese from all sources, including the diet. The IRIS assessment on manganese recommends that the dietary contribution from the normal U.S. diet (an upper limit of 5 mg/day) be subtracted when evaluating non-food (e.g., drinking water or soil) exposures to manganese, leading to an RfD of 0.071 mg/kg-day for non-food items. The explanatory text in IRIS further recommends using a modifying factor of 3 when calculating risks associated with non-food sources, due to a number of uncertainties that are discussed in the IRIS file for manganese, leading to an RfD of 0.024 mg/kg-day. This modified RfD is applied in the derivation of manganese BCLs for soil and water.

Nitrates/Nitrites

Tap-water BCLs for nitrates/nitrites are based on the MCL, because there is no available RfD for these compounds. For more information, please see IRIS (USEPA, 2008a) at: http://www.epa.gov/iris.

Perchlorate

The residential drinking water BCL for perchlorate is based upon the provisional Nevada Action Level of 18 ppb.

Polychlorinated Dibenzo-p-dioxins, Dibenzofurans, and Some Polychlorinated Biphenyls

USEPA has developed a toxicity equivalence factor (TEF) approach for calculating the potential health risks from “dioxin-like” chemicals that are assumed to elicit the same range of toxic effects as those observed for the most potent member of these chemical families—2,3,7,8-tetra chlorodibenzo-p-dioxin(TCDD). These dioxin-like compounds must be multiplied by their appropriate TEFs, and the resulting toxicity equivalents (TEQs) must be summed before comparing to the BCLs. NDEP has adopted the 1997 World Health Organization (WHO) TEFs. For more information on the TEFs, please see the working group summary article (Van den Berg et al., 1998) at the following Internet address:
http://www.ehponline.org/members/1998/106p775-792vandenberg/vandenberg-full.html

Polycyclic Aromatic Hydrocarbons (PAHs)

USEPA has developed potency factors approach for calculating the potential health risks from PAHs with the characteristic “Bay-K region,” a structural distinction that defers carcinogenic properties to benzo-a-pyrene (BaP) and the other carcinogenic PAHs (USEPA, 1993). BaP is the best characterized and most potent of the carcinogenic PAH compounds, and hence, the slope factors for BaP are used in conjunction with the potency factor approach to calculate benozo-a-pyrene equivalents (BaPEq). Accordingly, each of the carcinogenic PAHs must be multiplied by its associated potency factor to calculate the BaPEq, and the summed BaPEq across all carcinogenic PAHs at the site is compared to the BCL for BaP. The TEFs are as follows: benzo-a-pyrene (1.0), benzo-a-anthracene (0.1), benzo-b-fluoranthene (0.1), benzo-k-fluoranthene (0.01), chrysene (0.001), dibenzo-a,h-anthracene (1.0), and indeno-1,2,3,-cd-pyrene (0.1) (USEPA, 1993).

Thallium

IRIS has many values for the different salts of thallium. However, analytical data packages typically report only total thallium. Therefore, a BCL based on total thallium was derived for practical purposes by adjusting the thallium sulfate RfD by the molecular weight of thallium to derive a thallium-only RfD of 6.6 x 10^{-5} mg/kg-day.

Total Petroleum Hydrocarbons

Petroleum hydrocarbon mixtures in soils, such as gasoline, kerosene, diesel, or waste oils, are relatively common, and some groups have attempted to develop non-cancer toxicity criteria based on selected petroleum fractions such as gasoline- or diesel-range hydrocarbons. At present, NDEP does not recommend using these petroleum fraction toxicity criteria. Instead, the indicator chemicals for common petroleum hydrocarbon mixtures should be evaluated, including benzene, toluene, ethylbenzene, and total xylenes (BTEX); MTBE (and other oxygenates and/or additives, where relevant); and PAHs. Demonstrating compliance with respect to these indicator compounds will be assumed to also minimize any risks attributable to other petroleum-fraction components in soils.

Vinyl Chloride

IRIS (USEPA, 2008a) presents two cancer slope factors for vinyl chloride—one for adult exposures and a second, more protective, slope factor to account for the unique susceptibility identified in young animals that suggests a greater susceptibility to vinyl chloride carcinogenicity in young children. The more conservative factor for children is applied for the BCL corresponding to residential vinyl chloride exposure scenarios, and includes an assumption of lifetime (70 years) exposure for residential receptors as an added conservative measure based on USEPA Region 9 recommendations. The adult exposure cancer slope factor is used as the basis for the commercial/industrial BCL.

Chemicals for Which the BCL is Based on a Toxicological Surrogate

BCLs for the following chemicals are based on a toxicological surrogate approach:

- Acenaphthalene
- Benzo[g,h,i]perylene
- Phenanthrene
- Diethyl phosphorodithioate(DEPT)
- Dimethyl phosphorodithioate (DMPT)
- m-Phthalic acid
- o-Phthalic acid
- p-Chlorobenzene sulfonic acid (pCBSA)
- Benzene sulfonic acid (BSA)

Documentation of the basis of the surrogate selection for each of these chemicals is provided in Appendix B.

Six chemicals in the table did not have toxicity criteria from any of the USEPA hierarchy of sources used in this guidance (USEPA, 2003). Therefore, other sources were used. Table C-1 provides a listing of these chemicals and the source of the toxicity values used to calculate the BCLs.

4.0 REFERENCES

Cowherd, C., G. Muleski, P. Engelhart, and D. Gillette. 1985. *Rapid Assessment of Exposure to Particulate Emission from Surface Contamination*. EPA/600/8-85/002. Prepared for Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Washington, DC. NTIS PB85-192219 7AS.

USEPA, 1988. *Superfund Exposure Assessment Manual* (SEAM). Office of Emergency and Remedial Response (OSWER Directive 9285.5-1).

USEPA. 1989. *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual (Part A).* U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, December. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm

USEPA. 1991. Risk *Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*. Publication 9285.7-01B. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. NTIS PB92-963333.

USEPA. 1993. *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons*. U.S. Environmental Protection Agency, Office of Research and Development, July. http://www.epa.gov/oswer/riskassessment/pdf/1993_epa_600_r-93_c89.pdf

USEPA. 1994. *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK).* U.S. Environmental Protection Agency, Office of Research and Development. http://www.epa.gov/superfund/lead/products.htm

USEPA. 1996a. *Soil Screening Guidance: Technical Background Document*. EPA/540/R95/128. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. PB96-963502. http:www.epa.gov/superfund/resources/soil/index.htm

USEPA. 1996b. *Soil Screening Guidance: User's Guide*. EPA/540/R-96/018. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. PB96-963505. http:www.epa.gov/superfund/resources/soil/index.htm

USEPA 1996c. *Superfund Chemical Data Matrix*. EPA/540/R-96/028. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. PB94-963506.

USEPA. 1996d. *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*. U.S. Environmental Protection Agency Technical Workgroup for Lead. December. http://www.epa.gov/superfund/lead/products/adultpb.pdf

USEPA. 1997a. *Health Effects Assessment Summary Tables* (HEAST): Annual Update, FY 1997. National Center for Environmental Assessment (NCEA), Office of Research and Development and Office of Emergency and Remedial Response, Washington, DC.

USEPA. 1997b. *Exposure Factors Handbook, Vol. I-III.* Office of Research and Development. August.
http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12464&CFID=1397947&CFTOKEN=85996170

USEPA, 2001. Risk Assessment Issue Paper for: Derivation of the Provisional RfD for Iron (CASRN 7439-89-6) and Compounds. NCEA, November 14. (SRC SF 01-021a/11-14-01).

USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.* OSWER 9355.4-24, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.
http://www.epa.gov/superfund/resources/soil/ssg_main.pdf

USEPA. 2003. *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER Directive 9285.7-53, December 5. http://www.epa.gov/oswer/riskassessment/pdf/hhmemo.pdf

USEPA, 2004a. *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*. EPA/540/R/99/005. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. PB99-963312.
http://www.epa.gov/superfund/programs/risk/ragse/index.htm

USEPA, 2004. *Preliminary Remediation Goals (PRGs), Region 9, User's Guide*. http://www.epa.gov/region09/waste/sfund/prg/files/04usersguide.pdf

USEPA, 2008a. *Integrated Risk Information System (IRIS).* Online database of USEPA toxicity criteria. www.epa.gov/iris/

USEPA, 2008b. *Quarterly Distribution of the PPRTV Status Table of Provisional Peer Reviewed Toxicity Values Developed by the Superfund Health Risk Technical Support Center (STSC).* Office of Research and Development, July 23.

USEPA, 2008c. *Preliminary Remediation Goals (PRGs), Region 9.*
http://www.epa.gov/region09/waste/sfund/prg/

USEPA, 2008d. Risk-Based Concentration Table, Mid-Atlantic Risk Assessment, User's Guide, September 18.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Van den Berg et al. 1998. Van den Berg, M., Birnbaum, L. Bosveld, B.T.C., Brunstrom, B., Cook, P., Feeley, M., Giesy, J.P., Hanberg, A., Hasagawa, R., Kennedy, S.W., Kubiak, T., Larsen, J.C., van Leeuwen, F.X.R., Liem, A.K.D., Nolt, C., Peterson, R.E., Poellinger, L., Safe, S., Schrenk, D., Tillitt, D., Tysklind, M., Younes, M., Waern, F., Zacharewski, T., 1998. Toxic Equivalency

Factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environmental Health Perspectives, 106(12):775-792. (cited on World Health Organization [WHO] http://www.ehponline.org/members/1998/106p775-792vandenberg/vandenberg-full.html

ADDITIONAL RECOMMENDED REFERENCES

Howard, P.H. 1990. *Handbook of Environmental Fate and Exposure Data for Organic Chemicals*. Lewis Publishers, Chelsea, Michigan.

USEPA. 1986. *Proposed Guidelines for Carcinogen Risk Assessment*. Federal Register, Vol. 51, No. 185, September 24. U.S. Environmental Protection Agency. http://www.epa.gov/ncea/raf/car2sab/guidelines_1986.pdf#search=%221986.%20%20Proposed%20Guidelines%20for%20Carcinogen%20Risk%20Assessment%22

USEPA. 1986. *Guidelines for the Health Risk Assessment of Chemical Mixtures*. Federal Register 51(185):34014-34025, September 24. U.S. Environmental Protection Agency. www.epa.gov/ncea/raf/pdfs/chem_mix/chemmix_1986.pdf

USEPA. 1992. *Guidance for Data Usability in Risk Assessment (Part A), Final*. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, April. http://www.epa.gov/oswer/riskassessment/datause/parta.htm

USEPA. 1992. *Guidance for Data Usability in Risk Assessment (Part B), Final*. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, May. http://www.epa.gov/oswer/riskassessment/datause/partb.htm

USEPA. 1992. *Guidelines for Exposure Assessment*. Federal Register 57 (104):22888-22938. U.S. Environmental Protection Agency. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=15263

USEPA. 1994. *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry,* U.S. Environmental Protection Agency.

USEPA. 1994. *Superfund Chemical Data Matrix*. EPA/540/R-94/009. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC. PB94-963506.

USEPA. 1995. *Land Use in the CERCLA Remedy Selection Process*. OSWER Directive from Elliott Laws, Assistant Administrator, May 25. OSWER 9355.7-04. U.S. Environmental Protection Agency.

USEPA. 2000. *Soil Screening Guidance for Radionuclides: User's Guide*. U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Office of Solid Waste and Emergency Response, October. http://www.epa.gov/superfund/resources/radiation/radssg.htm#user

USEPA. 2000. *Soil Screening Guidance for Radionuclides: Technical Background Document.* U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Office of Solid Waste and Emergency Response, October. http://www.epa.gov/superfund/resources/radiation/radssg.htm#user

USEPA. 2000. *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures*. U.S. Environmental Protection Agency, Risk Assessment Forum, August. www.epa.gov/ncea/raf/pdfs/chem_mix/chem_mix_08_2001.pdf

USEPA. 2000. *Draft Final Guidelines for Carcinogen Risk Assessment*. U.S. Environmental Protection Agency, Risk Assessment Forum, February. EPA/630/P-03/001A. http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=54932&CFID=1320953&CFTOKEN=65054591&jsessionid=4c30bc86523e776fdf602b78363d3a17162cTR

USEPA. 2005. *Guidelines for Carcinogen Risk Assessment, Risk Assessment Forum, March*. EPA/630/P-03/001F. U.S. Environmental Protection Agency. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=116283

USEPA, 2006. *Science Policy Council Cancer Guidelines Implementation Workgroup. FACT SHEET: Implementation of the Supplemental Guidance in Cancer Risk Assessment*, June. http://www.epa.gov/osa/spc/pdfs/CGIWG_factsheet.pdf

USEPA. 2008. *Drinking Water Contaminants*. Updated June 5. U.S. Environmental Protection Agency. http://www.epa.gov/safewater/contaminants/index.html

USEPA. 2008. *Preliminary Remediation Goals (PRGs)*. U.S. Environmental Protection Agency Region 9. http://www.epa.gov/region09/waste/sfund/prg/

Table 1. **Standard Default Exposure Parameters**
NDEP Basic Comparison Levels

Abbreviation	Definition	Parameter Value	Reference
Sfo	Cancer slope factor, oral; $(mg/kg\text{-}d)^{-1}$	Chemical Specific	IRIS, PPRTV, NCEA, HEAST or Other Document
SFi	Cancer slope factor inhalation $(mg/kg\text{-}d)^{-1}$	Chemical Specific	IRIS, PPRTV, NCEA, HEAST or Other Document
RfDo	Reference dose oral (mg/kg-d)	Chemical Specific	IRIS, PPRTV, NCEA, HEAST or Other Document
RfDi	Reference dose inhalation (mg/kg-d)	Chemical Specific	IRIS, PPRTV, NCEA, HEAST or Other Document
RfC	Reference concentration (mg/m^3)	Chemical Specific	IRIS, PPRTV, NCEA, HEAST or Other Document
TR	Target cancer risk	10^{-6}	--
THQ	Target hazard quotient	1	--
BWa	Body weight, adult (kg)	70	RAGS Part A, USEPA 1989
BWc	Body weight, child (kg)	15	Exposure Factors Handbook USEPA, 1997b
ATc	Averaging time - carcinogens (days)	25550	RAGS Part A, USEPA 1989
ATn	Averaging time - noncarcinogens (days)	ED*365	
SAa	Exposed surface area, adult (cm2/day)	5700	RAGS Part E, USEPA 2004
SAc	Exposed surface area, child (cm2/day)	2800	RAGS Part E, USEPA 2004
SAao	Exposed surface area, outdoor worker (cm2/day)	3300	RAGS Part E, USEPA 2004
AFa	Adherence factor, adult (mg/cm^2)	0.07	RAGS Part E, USEPA 2004
AFw	Adherence factor, adult-work (mg/cm^2)	0.2	RAGS Part E, USEPA 2004
AFc	Adherence factor, child (mg/cm^2)	0.2	RAGS Part E, USEPA 2004
ABS	Skin absorption (unit less):		
	– volatile organics/inorganics	none	RAGS Part E, USEPA 2004
	-- semi-volatile organics	0.1	RAGS Part E, USEPA 2004
IRAa	Inhalation rate - adult (m^3/day)	20	Exposure Factors Handbook USEPA, 1997b
IRAc	Inhalation rate - child (m^3/day)	10	Exposure Factors Handbook USEPA, 1997b
IRWa	Drinking water ingestion - adult (L/day)	2	RAGS Part A, USEPA 1989
IRWc	Drinking water ingestion - child (L/day)	1	Exposure Factors Handbook USEPA, 1997b
IRSa	Soil ingestion - adult		
	(resident and outdoor worker-mg/day)	100	Exposure Factors Handbook USEPA, 1997b
IRSc	Soil ingestion - child (mg/day),	200	Exposure Factors Handbook USEPA, 1997b
IRSo	Soil ingestion - indoor worker (mg/day)	50	Exposure Factors Handbook USEPA, 1997b
EFr	Exposure frequency - residential (d/y)	350	Exposure Factors Handbook USEPA, 1997b
EFo	Exposure frequency - outdoor worker (d/y)	250	Exposure Factors Handbook USEPA, 1997b
EFout	Exposure frequency- outdoor worker (d/y)	225	Supplemental Soil Screening Guidance, USEPA 2002
EDr	Exposure duration - residential (years)	30[a]	Exposure Factors Handbook USEPA, 1997b
EDc	Exposure duration - child (years)	6	Exposure Factors Handbook USEPA, 1997b
EDo	Exposure duration - occupational (years)	25	Exposure Factors Handbook USEPA, 1997b
VFw	Volatilization factor for water (L/m^3)	0.5	RAGS Part B, USEPA 1991
PEF	Particulate emission factor (m^3/kg)	1.32E+09	Soil Screening Guidance USEPA 1996a
VFs	Volatilization factor for soil (m^3/kg)	Chemical Specific	Soil Screening Guidance USEPA 1996a
sat	Soil saturation concentration (mg/kg)	Chemical Specific	Soil Screening Guidance USEPA 1996a
	Age-adjusted factors for carcinogens:		
IFSadj	Ingestion factor, soils ([mg × yr]/ [kg × d])	114	RAGS Part B, USEPA 1991
SFSadj	Skin contact factor, soils ([mg × yr]/ [kg × d])	361	By analogy to RAGS Part B, USEPA, 1991
InhFadj	Inhalation factor ([m^3 × yr]/ [kg × d])	11	By analogy to RAGS Part B, USEPA, 1991
IFWadj	Ingestion factor, water ([l × yr]/ [kg × d])	1.1	By analogy to RAGS Part B, USEPA, 1991

Footnote:

[a] Exposure duration for lifetime residents is assumed to be 30 years total (USEPA, 1989). For carcinogens, exposures are combined for children (6 years) and adults (24 years).

Appendix A

Annotation of Updates to the BCL Table

February 2009

1. Corrections to Equations 1 and 4 under Section 2.7.
2. Addition of an Indoor Worker screening values to the BCL table.
3. Addition of BCLs for lithium, titanium, tungsten, and uranium.
4. Correlation of the “a” footnote in the BCL table to lead.
5. Update to the PEF to reflect the Las Vegas meteorological zone per USEPA (1996a) guidance.
6. Update to the iron oral reference dose from 0.003 to 0.7 mg/kg-day.
7. Removal of the cancer classification for 1,2-dibromoethane from the BCL table.
8. Oral SF for dicofol added to BCL table.
9. Inhalation RfD updated for ethylene glycol.
10. Inhalation RfD for tetrachloroethylene removed from BCL table.
11. Appendix C and Table C-1 added to present source of “other” toxicity criteria.

Appendix B

Documentation for Toxicological Surrogates

TABLE B-1 TOXICOLOGICAL SURROGATES APPLIED FOR BCLS

Chemical	CAS #	Surrogate	Surrogate CAS Number	Oral RfD (mg/kg-day)	Inhalation RfD (mg/kg-day)
Acenaphthalene	208-96-8	pyrene	129-00-0	3.0 x 10^{-2} (IRIS)	3.0 x 10^{-2} (route extrapolation)
Benzo[g,h,i]perylene	191-24-2	pyrene	129-00-0	3.0 x 10^{-2} (IRIS)	3.0 x 10^{-2} (route extrapolation)
Phenanthrene	85-01-8	pyrene	129-00-0	3.0 x 10^{-2} (IRIS)	3.0 x 10^{-2} (route extrapolation)
Diethyl phosphorodithioate (DEPT)	298-06-6	diisopropyl methylphosphonate (DIMP)	1445-75-6	8.0 x 10^{-2} (Integral, 2006; NDEP, 2007)	8.0 x 10^{-2} (route extrapolation)
Dimethyl phosphorodithioate (DMPT)	756-80-9	isopropyl methylphosphonate (IMPA)	1832-54-8	1.0 x 10^{-1} (Integral, 2006; NDEP, 2007)	1.0 x 10^{-1} (route extrapolation)
m-Phthalic acid	121-91-5	phthalic anhydride	85-44-9	2.0 x 10^{0} (IRIS)	3.4 x 10^{-2} (HEAST)
o-Phthalic acid	88-99-3	phthalic anhydride	85-44-9	2.0 x 10^{0} (IRIS)	3.4 x 10^{-2} (HEAST)
p-Chlorobenzene sulfonic acid (pCBSA)	98-66-8	NA (RfD based on pCBSA study)	NA	1.0 x 10^{0} (derived by Integral, 2007)	1.0 x 10^{0} (route extrapolation)
Benzene sulfonic acid (BSA)	98-11-3	p-toluenesulfonic acid (pTSA)	104-15-4	5.0 x 10^{-1} (derived by Integral, 2007)	5.0 x 10^{-1} (route extrapolation)

Integral Consulting, Inc., 2006. Development of Human Health Toxicological Criteria for DMPT and DEPT, October 31.
http://ndep.nv.gov/bmi/docs/061031%20surrogate_toxicity_report_20061031_final_integral.pdf

Integral Consulting, Inc., 2007.   Toxicological Profiles for Three Organic Acids, November 16, 2007 (p. 3-3).
http://ndep.nv.gov/bmi/docs/071116-organicacidprofiles.pdf

TABLE B-1 TOXICOLOGICAL SURROGATES APPLIED FOR BCLS

NDEP, 2007. NDEP concurrence regarding the derivation of toxicological surrogates for DEPT and DMPT, February 12.
http://ndep.nv.gov/bmi/docs/070212_dmpt_dept.pdf

Note: all surrogate derivations can be found at http://ndep.nv.gov/bmi/technical.htm under “Toxicology”.

Appendix C

Documentation of “Other” Toxicological Value

Table C-1 Source of "Other" Toxicological Values

Chemical	CAS #	Toxicological Value	Source
p-Chlorobenzene sulfonic acid	98-66-8	Oral RfD	Integral, 2007
4-Chlorobenzotrifluoride	98-56-6	Missing RfDi ref	
Methyl terbutyl ether (MTBE)	1634-04-4	Oral and Inhalation SF	CalEPA, 2009
Tetrachloroethylene (PCE)	127-18-4	Oral and Inhalation SF	CalEPA, 2009
Titanium	N/A	Oral and Inhalation RfD	USEPA (Region 9), 2008 Kerger, 2008
Tungsten	N/A	RfD	Kerger, 2008

CalEPA, 2009. Toxicity Criteria Database, Office of Environmental Health Hazard Assessment. http://oehha.ca.gov/risk/ChemicalDB/index.asp

Integral Consulting, Inc., 2007. Toxicological Profiles for Three Organic Acids, November 16, 2007 (p.3-3). http://ndep.nv.gov/bmi/docs/071116-organicacidprofiles.pdf

Kerger, B.D., 2008. Toxicity Criteria for Titanium and Compounds, and for Tungsten and Compounds. December 19. (http://ndep.nv.gov/bmi/docs/ndeptechmemotitaniumtungsten.pdf)

USEPA Region 9, 2008. Risk Assessment Issue Paper for: derivation of interim oral and inhalation toxicity values for titanium (CAS No. 7440-32-6) and compounds, especially titanium dioxide (CAS No. 13463-67-7), but excluding titanium tetrachloride (CAS No. 7550-45-0_, titanium dichloride and organic complexes of titanium such as titanocenes. DRAFT document; 95-019/05-26-95).

March 19, 2009

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Curt Richards
Olin Corporation
3855 North Ocoee Street, Suite 200,
Cleveland, TN 37312

Mr. Joe Kelly
Montrose Chemical Corp of CA
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals Corporation
PO Box 2128
Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Supplemental Guidance on Data Validation

Dear Sirs and Madam:

All of the parties listed above shall be referred to as “the Companies” for the purposes of this letter. As the Companies should be aware, the United Stated Environmental Protection Agency (USEPA) has issued revisions to the National Functional Guidelines. In response to questions and comments received from the Companies, the NDEP has revisited the NDEP’s *Supplemental Guidance on Data Validation* issued on February 26, 2009. The Nevada Division of Environmental Protection (NDEP) provides guidance in Attachment A regarding how these revisions should be applied to data validated for the BMI Complex and Common Areas projects. In addition, a red-line strike-out version of the document will be provided electronically so that the changes made be distinguished more easily.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions
Fax: (702) 486-5733

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City
Barry Conaty, Holland & Hart LLP, 975 F Street, N.W., Suite 900,Washington, D.C. 20004
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5, 75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County DAQEM, PO Box 551741, Las Vegas, NV, 89155-1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA 94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Drive, Edmond, OK 73013
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Jeff Gibson, AMPAC, 3770 Howard Hughes Parkway, Suite 300, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Cindi Byrns, Olin Chlor Alkali, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 10733 Wave Crest Court Stockton, CA 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380, Bainbridge Island, WA 98110
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200, Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544
Paul Black, Neptune and Company, Inc., 8550 West 14th Street, Suite 100, Lakewood, CO 80215
Teri Copeland, 5737 Kanan Rd., #182, Agoura Hills, CA 91301
Paul Hackenberry, Hackenberry Associates, 550 West Plumb Lane, B425, Reno, NV, 89509

Attachment A

Revisions to Data Validation of Organic Data based on June 2008 National Functional Guidelines for Superfund Organic Methods Data Review – USEPA-540-R-08-01.

The USEPA Office of Superfund Remediation and Technology Innovation released an updated version of the National Functional Guidelines (NFG) for Superfund Organic Methods Data Review in June, 2008. These updated guidelines contain several revisions with respect to how data is to be validated under the USEPA Contract Laboratory Program. The Companies currently collecting and validating data at the BMI Complex and Common Areas projects have generally followed these NFGs, though in general earlier versions of the guidance have been followed.

Significant changes to the NFGs are discussed below.

Holding Times

The new USEPA guidance revises the period of time allowed before data are qualified when a holding time has been exceeded.

If VOC data are one day past holding time, non-detects are qualified as unusable (R). Previously this was applied if the holding time was exceeded by a factor of two. The new guidance does not necessarily apply the same level of qualification to semi-volatile, pesticides, and Aroclor fractions. For these analyses the guidance is to qualify as estimated (UJ) or unusable, based on professional judgment, if holding times are exceeded by one day or more.

At this time NDEP recommends the current qualification algorithm (twice the holding time) continue to be used. Studies have shown that most chemicals are stable for that period if the samples are kept cold and preserved where applicable (aqueous samples). However, each time a batch of samples are analyzed past holding time, professional judgment should be used to arrive at the qualification and usability assessment. It is recommended that the Companies use historic results, where holding times were met, along with evidence from compound stability studies to arrive at the final usability assessment.

Sample Receipt Temperatures

The new guidance, which applies to all organic suites (volatile organic compounds (VOCs), semi-VOCs (SVOC), pesticides, and polychlorinated biphenyls (PCBs)), is to use professional judgment if sample coolers arrive at the laboratory below 2 °C or above 6 °C.

No change in the current qualification and usability is proposed by NDEP. Professional judgment should guide this assessment. It is noted that stability studies of volatile compounds indicate a number of the compounds at the site (e.g. chlorinated benzenes) can degrade when not kept cold and preserved. Again, the use of historic results, where cooler temperatures were met, is the best approach for arriving at the final data usability assessment.

Blank Contamination

The new guidance for qualifying VOC results based on blank contamination is provided in the table below. This table is generally consistent with the logic described in Section E of the Low/Medium Volatiles Data Review. Qualification is based upon a comparison with the associated blank. When professional judgment is used to censor a sample value, that logic used needs to be described in the Data Validation Summary Report. If an analyte is found in a blank but not in associated samples no qualification is required.

Blank Type	**Blank Result**	**Sample Result**	**Action for Samples**
If sample result is < SQL, Report SQL value with a U.			
Method, Storage, Field, Trip, Instrument	≤ PQL *	< PQL (down to SQL)*	If Blank ≥ Sample, Report Sample value with a U. If Blank < Sample, use professional judgment. Default is to Report Sample Result.
		≥ PQL*	Use professional judgment. Default is to Report Sample Result.
	> PQL *	< PQL (down to SQL)*	Report Sample value with a U.
		≥PQL* and < blank result	Use professional judgment. Default is to report the Sample result with a U.
		≥PQL* and ≥ blank result	Use professional judgment. Default is to Report Sample Result.

Report all detects down to the SQL in accordance with the NDEP Memo on Detection Limits and Data Reporting dated December 3, 2008.

* 2x the SQL for methylene chloride, 2-butanone and acetone.

NDEP recommends that this approach to qualifying VOCs be adopted. It is also important to compare any potential censored results, due to blank contamination, with the applicable standard such as USEPA maximum contaminant levels (MCLs) or NDEP Basic Comparison Levels (BCLs), during the data usability assessment.

Note that if other sensitivity indicators than SQL/PQL are used by the laboratories or validators the following substitutions should be made in this table. In place of SQL, use the applicable sensitivity indicator that is analogous to the Method Detection Limit that has been adjusted to reflect sample-specific actions, such as dilutions or use of smaller aliquot sizes, and take into account sample characteristics, sample preparation, and analytical adjustments. All sample-specific detection limit and all non-detected results are to be reported to this value. In place of PQL, use the applicable limit that is greater than the SQL analog and is generally described as a quantitation limit such as a QL and in some cases an RL. All detected results greater than the SQL analog (e.g. MDL), but less than the PQL analog (e.g. QL) can be qualified as estimated but are still reported.

The same approach is provided in the guidance for SVOC and other organic blank assessment and this also should be adopted with the same general steps outline in the table above. For SVOCs, 5 times the SQL for bis(2-ethylhexyl)phthalate is used. The pesticides and PCB blank analysis does not use a 2X/5X common contaminant factor but promotes professional judgment for any blank value above the CRQL (SQL is the appropriate indicator for the BMI Complex) with the potential for qualifying data as unusable (R).

System Monitoring Compounds

The new guidance revises the level where VOC surrogate recovery results in data qualification. If the recovery of a surrogate is < 20%, the "not-detected" results associated with the surrogate are considered unusable (R) and positive results are qualified as estimated. If the recovery is > 20%, but < lower QC limit, the "not-detected" and positive results are qualified as estimated. In the prior guidance the cutoff was 10%.

At this point NDEP does not require changing the cutoff from 10% to 20%. However, professional judgment should be used and problems with system monitoring compounds should be investigated when the recovery is less than 20%.

Matrix Spike/ Matrix Spike Duplicate (MS/MSD)

The prior USEPA guidance did not provide any substantive guidance for a usability assessment based on MS/MSD results. The new USEPA guidance does not recommend qualification based solely on MS/MSD results. However, professional judgment in conjunction with other quality control (QC) results should be considered to qualify results as follows:

The new guidance for VOCs is as follows:

> For any recovery or RPD **greater** than the upper QC limit: qualify positive results with a "J". "Not-detected" results should not be qualified.

For any recovery ≥ 20%, and less than the lower QC limit: qualify positive results with a "J". "Not-detected" results should be qualified "UJ".

For any recovery < 20%: qualify positive results with a "J." Not-detected" results use professional judgment.

At this point NDEP does not require changing the steps for qualifying VOC data based on these revisions to the MS/MSD assessment. Again, professional judgment is important and other QC results should be considered along with MS/MSD results.

Internal Standards

The revision to assessment of internal standards applies to all organics suites in the guidance (VOC, SVOC, pesticides, PCBs) where internal standards are utilized. The changes to the guidance are as follows:

If the sample internal standard area is 60% of the associated continuing calibration verification (CCV) internal standard area, positive sample results are qualified as estimated, and "not-detected" sample results are qualified as **unusable (R)**. Also, if the Retention Time of the internal standard differs by more than 20 seconds from the associated CCV, all positive and "not-detected" sample results should be qualified as unusable (R). However, caveats can be used based upon mass spectra criteria and partial rejection.

Internal standards are not always included in data validation but are required to be validated for at least 10% of the samples reported in a DVSR. At this point NDEP feels the cutoff of 60% is not warranted. However, a cutoff point of 25%, using the same logic as above, is recommended.

In cases where high resolution mass spectrometry is employed, such as for dioxin/furan and congener PCB analysis, we are not advocating the new internal standard rule be applied. At this time these results should continue to be validated using guidance most applicable to high-resolution MS. Applicable guidance includes the 2005 Dioxin National Functional Guidelines where ion abundance ratios and signal to noise ratios are considered.

Percent Moisture

The steps to qualify data based on high levels of percent moisture apply to all organic analysis in the new guidance. The 1999 USEPA guidance had no assessment with respect to percent moisture. The new guidance is:

If the sample percent moisture is >70% but <90%, qualify positive samples as estimated "J" and "not-detected" samples as estimated "UJ." If the sample percent moisture is ≥90%, qualify positive samples as estimated "J" and "not-detected" samples as unusable "R."

NDEP believes this approach is supported and should be utilizable for all analyses including metals, radionuclides and other inorganic analytes.

April 13, 2009

Mr. Mark Paris Basic Remediation Company 875 West Warm Springs Road Henderson, NV 89011	Ms. Susan Crowley Tronox LLC PO Box 55 Henderson, NV 89009	Mr. Curt Richards Olin Corporation 3855 North Ocoee Street, Suite 200, Cleveland, TN 37312
Mr. Joe Kelly Montrose Chemical Corp of CA 600 Ericksen Ave NE, Suite 380 Bainbridge Island, WA 98110	Mr. Brian Spiller Stauffer Management Co LLC 1800 Concord Pike Wilmington, DE 19850-6438	Mr. Craig Wilkinson Titanium Metals Corporation PO Box 2128 Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Supplemental Guidance on Data Validation

Dear Sirs and Madam:

All of the parties listed above shall be referred to as “the Companies” for the purposes of this letter. The Nevada Division of Environmental Protection (NDEP) provides supplemental guidance on data validation in Attachment A.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions
Fax: (702) 486-5733

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City
Barry Conaty, Holland & Hart LLP, 975 F Street, N.W., Suite 900,Washington, D.C. 20004
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5,
75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County DAQEM, PO Box 551741, Las Vegas, NV, 89155-
1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA
94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Drive, Edmond, OK 73013
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Jeff Gibson, AMPAC, 3770 Howard Hughes Parkway, Suite 300, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Cindi Byrns, Olin Chlor Alkali, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 10733 Wave Crest Court
Stockton, CA 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380,
Bainbridge Island, WA 98110
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite
510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200,
Phoenix, AZ 85004
Dave Gratson, Neptune and Company, 1505 15th Street, Suite B, Los Alamos, NM 87544
Paul Black, Neptune and Company, Inc., 8550 West 14th Street, Suite 100, Lakewood, CO 80215
Teri Copeland, 5737 Kanan Rd., #182, Agoura Hills, CA 91301
Paul Hackenberry, Hackenberry Associates, 550 West Plumb Lane, B425, Reno, NV, 89509

Attachment A

NDEP Data Verification and Validation Requirements – Supplement April, 2009

This supplemental guidance combines all previous data verification and validation guidance associated with the BMI Complex and Common Areas work and also incorporates recent United States Environmental Protection Agency (USEPA) guidance into a single document. This document supersedes the prior NDEP guidance: May 3, 2006, *Guidance on Data Validation Procedures* (1), and February 23, 2007, *Additional Guidance on Data Validation Procedures* (2). It also incorporates the *Supplemental Guidance on Data Validation* (3), dated February 26 and March 19, 2009.

The new guidance that is incorporated here is based on the USEPA document, *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use* (4), OSWER January, 2009. This new USEPA guidance is being incorporated into the verification and validation steps at the BMI Complex and Common Areas because it provides a consistent set of terms for each stage of data validation (DV). The prior BMI Complex and Common Areas DV guidance used terms based on the DRAFT *EPA Region 9 Superfund Data Evaluation/Validation Guidance* (5). This guidance has never been finalized since the 2001 draft.

New Guidance for Data Validation:

There are many terms used in verifying and validating environmental data that have an historical origin that are imprecise and in some cases outdated. These terms may be generally understood but no longer have a current reference point. The USEPA Guidance (1) incorporates terminology correlated with verification and validation steps that provide transparency and consistency in the DV process. For example, the new guidance categorizes DV Stages based upon sample specific and instrument specific quality control (QC). It provides explicit details as to what needs to be reported and what is to be validated at each Stage. There are differences between the analytical methods in the USEPA Contract Laboratory Program (CLP) Program (from which this new USEPA Guidance is derived) and the methods used at the BMI Complex and Common Areas (e.g. Resource Conservation and Recovery Act (RCRA) based), however, there is sufficient overlap such that the DV language is applicable to the BMI Complex and Common Areas methods and the use of the Stages language in this new USEPA guidance will be valuable to the BMI Complex and Common Areas quality assurance (QA) program.

This guidance does not propose any significant revisions with how data are validated, but we request use of the terminology in this new USEPA Guidance (4) as a common lexicon of terms to be used by the Companies when reporting validated data. Additional details are provided below describing how to use this new guidance for data collected at the BMI Complex and Common Areas.

We request that the Companies begin using the following Stages terminology in their Data Validation Summary Reports (DVSR) and electronic data deliverables (EDD) reports (where applicable):

Stages and Processes Used to Verify and Validate Lab Analytical Data:

Stage 1: Verification and validation based only on completeness and compliance of sample receipt conditions, sample characteristics, and basic analytical results

Stage 2A: Verification and validation based on completeness and compliance checks of sample receipt conditions and ONLY sample-related QC results

Stage 2B: Verification and validation based on completeness and compliance checks of sample receipt conditions and BOTH sample-related and instrument-related QC results

Stage 3: A verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, AND recalculation checks against the laboratory reported results

Stage 4: A verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, recalculation checks, AND the review of actual instrument outputs

The recommended minimum baseline checks that are to be followed for each stage of analytical data are shown in Appendix A of the USEPA Guidance. Using this new language, all data collected at the BMI Complex and Common Areas should be validated at least to Stage 2B . Also, items of particular note found in Appendix A of the USEPA Guidance (4) are identified below.

> The QC acceptance criteria that are to be used in evaluation of the data will come from the NDEP Guidance [e.g. *Supplemental Guidance on Data Validation* (3)] along with Companies Work Plans, Quality Assurance Project Plans (QAPPs), standard operating procedures (SOPs), or Laboratory established criteria as described in the analytical methods. The origin of these criteria should be clearly documented in the data validation summary report (DVSR). For example, the DVSR should cite the document (e.g. SOP) that describes the specific acceptance criteria for continuing calibration.
>
> For Requested Reporting Limits discussion in Section 1.1(5) of Appendix A of the USEPA Guidance (1). The Companies should ensure that the reporting limits are consistent with the NDEP Guidance *Detection Limits and Data Report* (December 3, 2008).

In addition, at least 10% of all data within a DVSR should be validated to Stage 4. Our 2006 guidance (1) on DV indicated this is calculated based on the number of data packages validated within a DVSR. To clarify, the criterion to use is calculated based on the total number of samples times the total number of analytical suites [e.g. semi-volatile organic compounds (SVOCs), radionuclides, organochlorine (OC) Pesticides]. If at least 10% of the samples with a similar number of analytical suites are chosen, this criterion is achieved.

This Updated Guidance is consistent with the NDEP's May 3, 2006 Guidance:

The requirement that all sample results be validated to Stage 2B and at least 10% are to be validated to Stage 4 is consistent with our prior guidance. Note that Stage 2B includes, among others items, the check of initial and continuing calibration information. Our guidance does not require 100% of this to be validated. Consistent with the previous guidance only a random check of 10-20% is required. The USEPA guidance uses the term Deuterated Monitoring Compound (DMC), which is analogous to a surrogate compound as applied in most instances under the methods used at the BMI Complex and Common Areas. Also note that providing the reports specified in Stage 4 (instrument reports) in an electronic format for all results is requested to minimize the length of the DVSR hard copy reports.

At least 10% of all data are to be validated to Stage 4. Consistent with our previous guidance, only 10-20% of these samples need to have the recalculation checks (described in Stage 3 of the new USEPA guidance), and 5% of those samples should have the integration and mass spectrum match comparisons (described in Stage 4 of the new guidance). When calculating the percentage of data that need to be validated for recalculation and integration or mass spectrum matches, the algorithm is also based on the number of samples times the number of analytical suites. To meet this, choose a group of samples with a similar number of analytical suites and validate the appropriate percentage. The Companies are also encouraged to select data based upon historical results where a historically higher number of qualified data were observed.

This Updated Guidance is consistent with the NDEP's February 23, 2007 Guidance:

Validated data are to be provided in a summary report (hard copy and electronic format) along with a database (EDD) and laboratory reports (electronic format, include Chain-of-Custodies) for all samples validated. All laboratory reports should include a Case Narrative and other required reporting items consistent with the Nevada Laboratory Certification program. Any third party validation that was used to prepare the summary report should also be provided in electronic format. The database supplied with the summary report should only include the results that were validated (i.e., do not include historical data) and should also follow the *Guidance on Uniform Electronic Data Deliverables* (6). The data should also include the QC results (blanks, spikes, surrogates, etc) and other information desired by the Companies in separate database table(s).   The EDD should specify the Stage of validation for each record in the validation level field. Please note that the revised EDD format is being developed by the NDEP based upon comments from the Companies. The revised EDD format will address this issue.

The following information is requested with the data validation summary reports:

- An Introduction with Purpose/Objective/Process. The report should describe the matrices sampled, along with the applicable sampling techniques or a reference to the exact work plan where this information can be found.
- Complete descriptions of the sensitivity indicator terms (sample quantitation limit (SQL), practical quantitation limit (PQL), quantitation limit (QL), etc.,) used in the report and EDD. See additional information on this topic in the NDEP *Guidance on Detection Limits and Data Reporting* (7), dated December 3, 2008.

- Details on the applicable samples and sample delivery group (SDG) identification numbers (IDs), that correspond to locations and sampling time, analyses performed (analytical suites), stage of validation performed (e.g.: 2B, 4). Any non-typical sampling or sample handling that was performed should be described (e.g. filtering).
- A data validation qualifier definition
- Reason codes that link results in the database to specific qualifier logic
- Data validation findings for each parameter based on the level of review. When non-conformances are identified they should be linked to the appropriate sample(s) and SDG.

When professional judgment is used to arrive at a decision, the logic should be clearly described. Please justify decisions (use of professional judgment) that don't follow the typical data validation algorithms.

- Evaluation of the Precision, Accuracy, Reproducibility, Comparability, Completeness, and Sensitivity (PARCCS) parameters
- Conclusions/Recommendations
- References
- The DVSRs should include tables that specify when a non-conformance has been identified during the data validation process. Providing these tables in both hardcopy and electronic (ideally in a spreadsheet or database format) will facilitate review of the DVSR and subsequent usability evaluation. These tables should be categorized by issue, for example, those samples qualified due to Laboratory Control Sample exceedances should be within the same table. Each table should specify the sample, SDG/lab package, the analyte(s), the data quality indicator and objective (e.g., % Recovery, Limits of 85-115%), the sample result(s) and the data validation qualifier(s). Both the qualifier based on this non-conformance issue and the overall qualifier applied to this datum should be provided to help understand the qualifiers supplied in the QC database table and EDD. This information is necessary to both properly evaluate the DVSR and will also facilitate data usability investigations. Each data quality indication, for example, percent recovery, percent difference, precision (relative percent difference (RPD)), area (for internal standards), raw level of blank value that is used to compare with analyte levels in the native samples, cooler temperature, holding time days and exceedance should be captured in these tables.

References

1) NDEP *Guidance on Data Validation Procedures*. May 3, 2006.
2) NDEP *Additional Guidance on Data Validation Procedures*. February 23, 2007,
3) NDEP *Supplemental Guidance on Data Validation*. February 26 and March 19, 2009
4) USEPA *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use,* OSWER January, 2009. EPA 540-R-08-005.
5) USEPA *Region 9 Superfund Data Evaluation/Validation Guidance* (DRAFT). December 2001. R9QA/006.1.
6) NDEP *Guidance on Uniform Electronic Data Deliverables*. February 27, 2009 (revision pending).
7) NDEP *Guidance on Detection Limits and Data Reporting.* December 3, 2008.

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

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

Jim Gibbons, Governor
Allen Biaggi, Director
Leo M. Drozdoff, P.E., Administrator

April 29, 2009

Mr. Mark Paris
Basic Remediation Company
875 West Warm Springs Road
Henderson, NV 89011

Ms. Susan Crowley
Tronox LLC
PO Box 55
Henderson, NV 89009

Mr. Curt Richards
Olin Corporation
3855 North Ocoee Street, Suite 200,
Cleveland, TN 37312

Mr. Joe Kelly
Montrose Chemical Corp of CA
600 Ericksen Ave NE, Suite 380
Bainbridge Island, WA 98110

Mr. Brian Spiller
Stauffer Management Co LLC
1800 Concord Pike
Wilmington, DE 19850-6438

Mr. Craig Wilkinson
Titanium Metals Corporation
PO Box 2128
Henderson, NV 89009

Re. **BMI Plant Sites and Common Areas Projects, Henderson, Nevada**
Supplement to the Guidance for Evaluating Radionuclide Data for the BMI Plant Sites and Common Areas Projects dated February 6, 2009

Dear Sirs and Madam:

All of the parties listed above shall be referred to as “the Companies” for the purposes of this letter.

This guidance provides supplemental information associated with the use of preparation methods for radium analysis. On February 6, 2009 NDEP provided the *Guidance for Evaluating Radionuclide Data for the BMI Plant Sites and Common Areas Projects.* Table 4 of that document indicated the Recommended Preparation Methods for Radium-226 and Radium-228 were under further investigation. After additional review of historic data sets and discussions with the laboratories associated with those data it is recommended that all future preparation methods for these two analytes include hydrofluoric acid (complete dissolution). This recommendation is based on the appearance that the majority of the historic data is based on use of these complete dissolution steps for preparation of soil samples for these analytes. In addition, it is believed that this is a conservative recommendation (in that it avoids low bias in the analyses). In particular, both the 2005 Basic Remediation Company and Titanium Metals Corporation Shallow Background Study (analyses completed by STL-St. Louis) and the 2008 Supplemental Background Study (analyses completed by GEL) appear to have used hydrofluoric acid (HF) for preparing samples for Radium-226 and Radium-228 analysis. The 2008 Deep Background study (analyses completed by STL-Richland) apparently did not include HF, but use of the Figure 1 flowchart in the *Guidance for Evaluating Radionuclide Data for the BMI Plant Sites and Common Areas Projects* provides a pathway for comparing data to this historic background dataset.

Please contact me with any questions (tel: 702-486-2850 x247; e-mail: brakvica@ndep.nv.gov).

Sincerely,

Brian A Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions
Fax: (702) 486-5733

BAR:s

CC: Jim Najima, NDEP, BCA, Carson City
Marysia Skorska, NDEP, BCA, Las Vegas
Shannon Harbour, NDEP, BCA, Las Vegas
Todd Croft, NDEP, BCA, Las Vegas
Greg Lovato, NDEP, BCA, Carson City
Barry Conaty, Holland & Hart LLP, 975 F Street, N.W., Suite 900,Washington, D.C. 20004
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5, 75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County DAQEM, PO Box 551741, Las Vegas, NV, 89155-1741
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA 94947-7021
Lee Erickson, Stauffer Management Company LLC, P.O. Box 18890 Golden, CO 80402
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Drive, Edmond, OK 73013
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Jeff Gibson, AMPAC, 3883ward Hughes Parkway, Suite 70, Las Vegas, Nevada 89109
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Cindi Byrns, Olin Chlor Alkali, PO Box 86, Henderson, Nevada 89009
Paul Sundberg, Montrose Chemical Corporation, 10733 Wave Crest Court Stockton, CA 95209
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA 94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200, Phoenix, AZ 85004

ndep
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
protecting the future for generations

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

Jim Gibbons, Governor
Allen Biaggi, Director
Leo M. Drozdoff, P.E., Administrator

May 11, 2009

Mr. Mark Paris
Basic Remediation Company (BRC)
875 West Warm Springs
Henderson, NV 89011

Re.: Nevada Division of Environmental Protection Response to:
BRC Standard Operating Procedure (SOP) 40, Data Review/Validation, Revision 4
dated May 7, 2009
NDEP Facility ID# H-000688

Dear Mr. Paris:

The NDEP has received and reviewed BRC's document identified above and finds that the document is acceptable.

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

Sincerely,

Brian A. Rakvica, P.E.
Supervisor, Special Projects Branch
Bureau of Corrective Actions
Fax: (702) 486-5733

BAR:s

cc: Jim Najima, NDEP, BCA, Carson City
Barry Conaty, Holland & Hart LLP, 975 F Street, N.W., Suite 900,Washington, D.C. 20004
Brenda Pohlmann, City of Henderson, PO Box 95050, Henderson, NV 89009
Mitch Kaplan, U.S. Environmental Protection Agency, Region 9, mail code: WST-5,
75 Hawthorne Street, San Francisco, CA 94105-3901
Ebrahim Juma, Clark County Comprehensive Planning, PO Box 551741, Las Vegas, NV, 89155-1741
Robert Williams, Clark County Fire Department, 575 East Flamingo Road, Las Vegas, Nevada 89119
Ranajit Sahu, BRC, 311 North Story Place, Alhambra, CA 91801
Rick Kellogg, BRC, 875 West Warm Springs, Henderson, NV 89011
Rex Heppe, 2925 East Patrick Lane, Suite M, Las Vegas, NV 89120-2457
David Sadoff, AIG Consultants, Inc., 121 Spear Street, 3rd Floor, San Francisco, CA 94105
Leslie Hill, U.S. Department of Justice, PO Box 23896, Washington, DC 20026-3986
Craig Wilkinson, TIMET, PO Box 2128, Henderson, Nevada, 89009-7003
Kirk Stowers, Broadbent & Associates, 8 West Pacific Avenue, Henderson, Nevada 89015
George Crouse, Syngenta Crop Protection, Inc., 410 Swing Road, Greensboro, NC 27409
Nicholas Pogoncheff, PES Environmental, Inc., 1682 Novato Blvd., Suite 100, Novato, CA 94947-7021
Susan Crowley, Crowley Environmental LLC, 366 Esquina Dr., Henderson, NV 89014
Susan Crowley, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Mike Skromyda, Tronox LLC, PO Box 55, Henderson, Nevada 89009
Keith Bailey, Environmental Answers, 3229 Persimmon Creek Dr, Edmond, Oklahoma 73013
Sally Bilodeau, ENSR, 1220 Avenida Acaso, Camarillo, CA 93012-8727
Lee Erickson, Stauffer Management Company, P.O. Box 18890, Golden, Co 80402
Michael Bellotti, Olin Corporation, 3855 North Ocoee Street, Suite 200, Cleveland, TN 37312
Curt Richards, Olin Corporation, 3855 North Ocoee Street, Suite 200, Cleveland, TN 37312
Paul Sundberg, Montrose Chemical Corporation, 10733 Wave Crest Court
Stockton, CA 95209
Joe Kelly, Montrose Chemical Corporation of CA, 600 Ericksen Avenue NE, Suite 380,
Bainbridge Island, WA 98110
Deni Chambers, Northgate Environmental Management, Inc., 300 Frank H. Ogawa Plaza, Suite 510, Oakland, CA
94612
Robert Infelise, Cox Castle Nicholson, 555 California Street, 10th Floor, San Francisco, CA 94104-1513
Michael Ford, Bryan Cave, One Renaissance Square, Two North Central Avenue, Suite 2200, Phoenix, AZ 85004

Revisions to Data Validation of Organic Data based on June 2008 National Functional Guidelines for Superfund Organic Methods Data Review – USEPA-540-R-08-01.

The USEPA Office of Superfund Remediation and Technology Innovation released an updated version of the National Functional Guidelines (NFG) for Superfund Organic Methods Data Review in June, 2008. These updated guidelines contain several revisions with respect to how data is to be validated under the EPA Contract Laboratory Program. The Companies currently collecting and validating data at the BMI Complex have generally followed these NFGs, though in general earlier versions of the guidance have been followed.

Significant changes to the NFGs are discussed below.

Holding Times

The new EPA guidance revises the period of time allowed before data are qualified when a holding time has been exceeded.

If VOC data are one day past holding time, non detects are qualified as unusable (R). Previously this was applied if the holding time was exceeded by a factor of 2. The new guidance does not necessarily apply the same level of qualification to semivolatile, pesticides, and aroclor fractions. For these analyses the guidance is to qualify as estimated (UJ) or unusable, based on professional judgment, if holding times are exceeded by 1 day or more.

At this time NDEP recommends the current qualification algorithm (twice the holding time) continue to be used. Studies have shown that most chemicals are stable for that period if the samples are kept cold and preserved where applicable (aqueous samples). However, each time a batch of samples are analyzed past holding time, professional judgment should be used to arrive at the qualification and usability assessment. It is recommended that the companies use historic results, where holding times were met, along with evidence from compound stability studies to arrive at the final usability assessment.

Sample Receipt Temperatures

The new guidance, which applies to all organic suites (VOC, SVOC, pesticide, PCBs), is to use professional judgment if sample coolers arrive at the laboratory below 2 °C or above 6 °C.

No change in the current qualification and usability is proposed by NDEP. Professional judgment should guide this assessment. It is noted that stability studies of volatile compound indicate a number of the compounds at the site (e.g. chlorinated benzenes) can degrade when not kept cold and preserved. Again, the use of historic results, where cooler temperatures were met, is the best approach for arriving at the final data usability assessment.

Blank Contamination

The new guidance for qualifying VOC results based on blank contamination is provided in the table below. This table is generally consistent with the logic described in Section E of the Low/Medium Volatiles Data Review. Qualification is based upon a comparison with the associated blank. When professional judgment is used to censor a sample value, that logic used needs to be described in the Data Validation Summary Report. If an analyte is found in a blank but not in associated samples no qualification is required.

Blank Type	Blank Result	Sample Result	Action for Samples
If sample result is < SQL, Report SQL value with a U.			
Method, Storage, Field, Trip, Instrument	≤ PQL *	< PQL (down to SQL)*	If Blank ≥ Sample, Report Sample value with a U. If Blank < Sample, use professional judgment. Default is to Report Sample Result.
		≥ PQL*	Use professional judgment. Default is to Report Sample Result.
	> PQL *	< PQL (down to SQL)*	Report Sample value with a U.
		≥PQL* and < blank result	Use professional judgment. Default is to report the Sample result with a U.
		≥PQL* and ≥ blank result	Use professional judgment. Default is to Report Sample Result.

Report all detects down to the SQL in accordance with the NDEP Memo on Detection Limits and Data Reporting dated December 3, 2008.

* 2x the SQL for methylene chloride, 2-butanone and acetone.

NDEP recommends that this approach to qualifying VOCs be adopted. It is also important to compare any potential censored results, due to blank contamination, with the applicable standard such as MCLs or BCLs, during the data usability assessment.

Note that if other sensitivity indicators than SQL/PQL are used by the laboratories or validators the following substitutions should be made in this table. In place of SQL, use the applicable sensitivity indicator that is analogous to the Method Detection Limit that has been adjusted to reflect sample-specific actions, such as dilutions or use of smaller aliquot sizes, and take into account sample characteristics, sample preparation, and analytical adjustments. All sample-specific detection limit and all non-detected results are to be reported to this value. In place of PQL, use the applicable limit that is greater than the SQL analog and is generally described as a quantitation limit such as a QL and in some cases an RL. All detected results greater than the SQL analog (e.g. MDL), but less than the PQL analog (e.g. QL) can be qualified as estimated but are still reported.

The same approach is provided in the guidance for SVOC and other organic blank assessment and this also should be adopted with the same general steps outlined in the table above. For SVOCs, 5 times the SQL for bis(2-ethylhexyl)phthalate is used. The Pesticides and PCB blank analysis does not use a 2X/5X common contaminant factor but promotes professional judgment for any blank value above the CRQL (SQL is the appropriate indicator for the BMI Complex) with the potential for qualifying data as unusable (R).

System Monitoring Compounds

The new guidance revises the level where VOC surrogate recovery results in data qualification. If the recovery of a surrogate is < 20%, the “not-detected” results associated with the surrogate are considered unusable (R) and positive results are qualified as estimated. If the recovery is > 20%, but < lower QC limit, the ”not-detected” and positive results are qualified as estimated. In the prior guidance the cutoff was 10%.

At this point NDEP does not require changing the cutoff from 10% to 20%. However, professional judgment should be used and problems with system monitoring compounds should be investigated when the recovery is less than 20%.

Matrix Spike/ Matrix Spike Duplicate

The prior guidance did not provide any substantive guidance for a usability assessment based on MS/MSD results. The new guidance does not recommend qualification based solely on MS/MSD results. However, professional judgment in conjunction with other QC results should be considered to qualify results as follows:

The new guidance for VOCs is as follows:

> For any recovery or RPD **greater** than the upper QC limit: qualify positive results with a “J”. “Not-detected” results should not be qualified.

For any recovery ≥ 20%, and less than the lower QC limit: qualify positive results with a "J". "Not-detected" results should be qualified "UJ".

For any recovery < 20%: qualify positive results with a "J." Not-detected" results use professional judgment.

At this point NDEP does not require changing the steps for qualifying VOC data based on these revisions to the MS/MSD assessment. Again, professional judgment is important and other QC results should be considered along with MS/MSD results.

Internal Standards

The revision to assessment of internal standards applies to all organics suites in the guidance (VOC, SVOC, pesticides, PCBs) where internal standards are utilized. The changes to the guidance are:

If the sample internal standard area is 60% of the associated CCV internal standard area, positive sample results are qualified as estimated, and "not-detected" sample results are qualified as **unusable (R)**. Also, if the Retention Time of the internal standard differs by more than 20 seconds from the associated CCV, all positive and "not-detected" sample results should be qualified as unusable (R). However, caveats can be used based upon mass spectra criteria and partial rejection.

Internal standards are not always included in data validation but are required to be validated for at least 10% of the samples reported in a DVSR. At this point NDEP feels the cutoff of 60% is not warranted. However, a cutoff point of 25%, using the same logic as above, is recommended.

In cases where high resolution mass spectrometry is employed, such as for dioxin/furan and congener PCB analysis, we are not advocating the new internal standard rule be applied. At this time these results should continue to be validated using guidance most applicable to high-resolution MS. Applicable guidance includes the 2005 Dioxin National Functional Guidelines where ion abundance ratios and signal to noise ratios are considered.

Percent Moisture

The steps to qualify data based on high levels of percent moisture apply to all organic analysis in the new guidance. The 1999 guidance had no assessment with respect to percent moisture. The new guidance is:

If the sample percent moisture is >70% but <90%, qualify positive samples as estimated "J" and "not-detected" samples as estimated "UJ." If the sample percent moisture is ≥90%, qualify positive samples as estimated "J" and "not-detected" samples as unusable "R."

NDEP believes this approach is supported and should be utilizable for all analyses including metals, radionuclides and other inorganic analytes.