Technical Memorandum

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Prepared for: Greenfield Environmental Multistate Trust, LLC
Trustee of the Multistate Environmental Response Trust

Project Title: Caselton Mine Area OU-1 Remedial Investigation

Technical Memorandum

Subject: Risk-Based Concentrations for OU-1 Workers

Date: December 14, 2017

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Caselton Mine Area
Risk-Based Concentrations for OU-1 Workers
Technical Memorandum

Prepared for
Greenfield Environmental
Multistate Trust LLC, Trustee of the Multistate
Environmental Response Trust
December 14, 2017

Responsible CEM for this project

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

Penny Bassett

Penelope N. Bassett, CEM 1960 exp. Date 5/18/2018

Brown AND Caldwell

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List of Acronyms and Abbreviations

ALM	Adult Lead Model
BC	Brown and Caldwell
COC	Constituents of Concern
EF	Exposure Frequency
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
HHRA	Human Health Risk Assessment
HI	Hazard Index
NHANES	National Health and Nutrition Examination Survey
NDEP	Nevada Division of Environmental Protection
OU	Operable Unit
O&M	Operations and Maintenance
RBA	Relative Bioavailability
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goals
RBC	Risk-Based Concentrations
RI	Remedial Investigation
RSL	Regional Screening Level
TECH MEMO	Technical Memorandum
TSCA	Toxic Substance Control Act
UCL	Upper Concentration Limit
Multistate Trust	Trustee of the Multistate Environmental Response Trust

Units of Measurement

%	percent
cm^2	square centimeter
g/day	gram/day
kg	kilogram
kg/m^3	kilograms per cubic meter
mg	milligram
mg/cm^2	milligram/square centimeter
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram per day
mg/m	milligram/meter
µg/dL	micrograms per deciliter

Section 1: Introduction

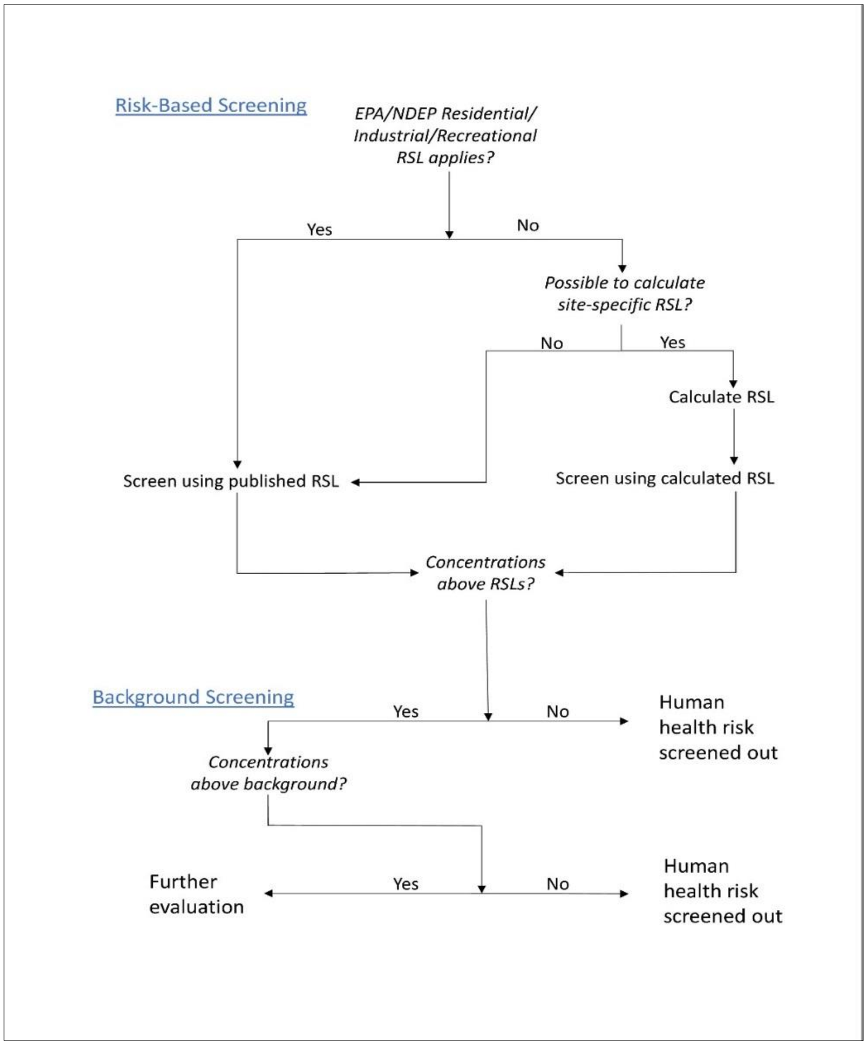
Brown and Caldwell (BC) has prepared this Technical Memorandum (Tech Memo) on behalf of the Greenfield Environmental Multistate Trust, LLC, not individually but solely in its representative capacity as Trustee of the Multistate Environmental Response Trust (Multistate Trust). This Tech Memo describes the use of risk-based concentrations (RBCs) for lead and arsenic to assess potential human health risks to workers who use manual and mechanized methods to clean up roadways in Pioche, Nevada. These metals are contained in transported sediment (i.e., eroded waste rock materials that range in grain size from fine silt to cobbles) from Treasure Hill after storm events. Run-off flows from the steep hillside along pathways between waste rock piles and dirt roads that connect to paved roadways (Highway 321 and Ely, Newark and Main Streets). Treasure Hill is an operable unit (OU-1) of the Caselton Mine Area (BC, 2015) that is being evaluated by the Multistate Trust with oversight provided by the Nevada Division of Environmental Protection (NDEP).

This RBC Tech Memo follows previous OU-1 HHRA evaluations that addressed two receptor types: 1) the screening level human health risk assessment (HHRA) in the *Remedial Investigation Report for Operable Units 1 and 2* dated December 31, 2015 described potential risks to recreational and other users with limited exposure to the OU-1 waste rock materials; and 2) local residents with yard soils impacted by the transported sediment, as described in the Tech Memo entitled *OU-1 Residential Yard Sampling and Human Health Risk Assessment* dated March 2, 2017 (BC, 2017). Potential health risks to recreational users on Treasure Hill from exposure to waste rock materials were determined to be negligible using the U.S. Environmental Protection Agency (EPA) regional screening level (RSL) calculator and the assumption of 75 visits per year: "*Overall, only lead, and to a lesser extent, arsenic, may pose a risk of unacceptable exposure to frequent recreational users. Transient receptors, such as tourists, are unlikely to be exposed at levels of concern due to limited duration and frequency of exposure.*" (BC, 2015). The screening level HHRA evaluation for downgradient residential yards described by BC (2017) defaulted to Site-specific action levels for both lead (conservative EPA action level of 400 milligrams per kilogram [mg/kg]) and arsenic (State-wide action level of 60mg/kg promulgated by NDEP) in the impacted yard soils.

The evaluation presented herein using RBCs is consistent with the prior HHRA evaluations described above and is summarized in the flow chart provided below. In general, for human health risk screening, the first step is to compare soil concentrations to EPA RSLs (and/or NDEP action levels) for residential, industrial and/or recreational receptors. Because of its widespread occurrence in Nevada soils at concentrations that exceed all RSLs, the 60-mg/kg default action level is used at a number of sites in Nevada that are comparable to the OU-1 area, in accordance with NDEP guidance. If needed, a second step would involve the comparison of impacted soils to background soil concentrations. For example, this comparison was performed by BC (2015) to assess potential risks to Caselton Heights (OU-2) residents with yard soil lead and arsenic values that were, respectively, less than the residential RSL for lead and less than the State-wide action level of 60mg/kg for arsenic promulgated by NDEP (BC, 2015).

The risk evaluation for OU-1 cleanup workers described in this RBC Tech Memo used the RSL calculator to develop a risk-based arsenic concentration based on reasonably anticipated exposures by workers. Lead was initially compared to the commercial/industrial RSL of 800 mg/kg. However, since the average value of lead in the roadway sediments exceeds the RSL and the average lead value in OU-1 background soils, as described in Section 2, an additional evaluation was performed for the OU-1 worker. Similarly, the average value of arsenic in the roadway sediments was greater than the commercial/industrial RSL and the NDEP action level, which required further evaluation.

The following chart illustrates the general risk screening process followed by BC for all OU-1 and OU-2 receptors, including the OU-1 cleanup worker discussed in the following sections of this RBC Tech Memo.



Section 2: Screening Evaluation

This section describes the screening evaluations for lead and arsenic for the OU-1 cleanup worker who uses manual and mechanized methods to clean up roadways in Pioche, Nevada on an infrequent basis. Based on information obtained from Mr. Cory Lytle (e-mail dated November 13, 2017) of the Lincoln County Planning and Building Department, the average annual number of days/hours for street cleanup is: 1) for major cleanup activities (higher intensity storm events), approximately three days per year and six hours per day; and 2) for minor cleanup activities (lower intensity storm events), approximately four days per year and two hours per day. These exposure frequencies provide context for the calculated RBCs described below for lead and arsenic based on the roadway sample analytical results described in BC (2017).

Figures 2-1 and 2-2 illustrate the OU-1 roadway sediment and background sample locations and analytical results for lead and arsenic, respectively. Tables 2-1 and 2-2, respectively, present the results and descriptive statistics for these samples. Background samples were collected as part of the OU-1 residential yard sampling performed in 2016 and described in the HHRA Tech Memo (BC, 2017).

Table 2-1. Roadway Sediment and Treasure Hill Background Lead Results

Newark and Ely Street Roadway Sediments		Treasure Hill Area Background	
Sample ID	Lead (mg/kg)	Sample ID	Lead (mg/kg)
THYD-2a	740	BKGD-01	21
THYD-2b	440	BKGD-02	54
THYD-12b	6,000	BKGD-03	160
THYD-12c	3,100	BKGD-04	62 J
THYD-13a	1,100	BKGD-05	34
THYD-14a	2,100	BKGD-06	80
THYD-15a	1,700	BKGD-07	30
THYD-15b	6,700	BKGD-08	140
THYD-16a	1,300	BKGD-09	610
THYD-17a	1,800	BKGD-10	54
THYD-18a	370	BKGD-11	340
THYD-18b	720	BKGD-12	480
THYD-19a	1,500	BKGD-13	350
THYD-20a	1,000	BKGD-14	240
THYD-21a	2,200	BKGD-15	450
THYD-26a	780		
THYD-26c	750		
THYD-27a	730		
THYD-27b	38		
THYD-28a	900		
THYD-28b	650		
THYD-29a	2,000		
THYD-29b	680		
THYD-31a	1,200		
THYD-31b	1,300		
THYD-32a	120		
THYD-33a	300		
THYD-34a	140		
THYD-35a	380		
THYD-35b	1,700		
THYD-36a	1,800		
THYD-36b	140		
THYD-39a	760		
THYD-40a	700		
THYD-41a	1,800		
Summary Statistics		Summary Statistics	
Minimum Value	38	Minimum Value	21
Average Value	1,308	Average Value	207
Maximum Value	6,700	Maximum Value	610

Table 2-2. Roadway Sediment and Treasure Hill Background Arsenic Results

Newark and Ely Street Roadway Sediments		Treasure Hill Area Background	
Sample ID	Arsenic (mg/kg)	Sample ID	Arsenic (mg/kg)
THYD-2a	62	BKGD-01	7.8
THYD-2b	35	BKGD-02	6
THYD-12b	240	BKGD-03	44
THYD-12c	110	BKGD-04	5.7
THYD-13a	64	BKGD-05	3.8
THYD-14a	130	BKGD-06	6.9
THYD-15a	110	BKGD-07	< 12
THYD-15b	150	BKGD-08	16
THYD-16a	73	BKGD-09	9.3
THYD-17a	140	BKGD-10	6.4
THYD-18a	28	BKGD-11	30
THYD-18b	52	BKGD-12	32
THYD-19a	100	BKGD-13	20
THYD-20a	62	BKGD-14	22
THYD-21a	64	BKGD-15	29
THYD-26a	49		
THYD-26c	57		
THYD-27a	48		
THYD-27b	12		
THYD-28a	55		
THYD-28b	45		
THYD-29a	110		
THYD-29b	36		
THYD-31a	73		
THYD-31b	71		
THYD-32a	9.9		
THYD-33a	19		
THYD-34a	14		
THYD-35a	24		
THYD-35b	88		
THYD-36a	120		
THYD-36b	11		
THYD-39a	70		
THYD-40a	61		
THYD-41a	150		
Summary Statistics		**Summary Statistics**	
Minimum Value	10	Minimum Value	6
Average Value	71	Average Value	17
Maximum Value	240	Maximum Value	32

Lead and arsenic concentrations in the roadside sediments exceed the default commercial/industrial RSLs, which are based on exposure daily for 25 years, and are not representative of exposure to workers that may contact these materials several days a year, as described above for the OU-1 cleanup worker. Therefore, the EPA RSL calculator was used to develop RBCs that would reflect realistic exposure scenarios for the OU-1 cleanup worker (i.e., be consistent with Lincoln County estimates of worker exposure in terms of days and hours per day). Section 3 of this RBC Tech Memo describes the development of conservative Site-specific RBCs for the OU-1 worker.

Section 3: Calculation of Risk-Based Sediment Concentrations

The two key metals, arsenic and lead, that were previously identified by BC (2015 and 2017) for OU-1 are known human health risk hazards. As described in Section 1, the development of RBCs for the OU-1 worker for arsenic and lead is the next step in the risk assessment process following the comparisons to RSLs and background soil values.

3.1 Arsenic

Arsenic RBCs were calculated using the EPA (2017b) RSL calculator, which includes a construction worker module. However, the OU-1 worker differs from a typical construction worker as follows: 1) OU-1 workers are exposed intermittently but have potential exposures over a number of years to remove the sediments activities (the EPA calculator for a typical worker includes an assumption of 120 days of exposure per year, which cannot be changed); and 2) the calculator addresses specific activities such as tilling, driving heavy vehicles on unpaved roads, and excavation by acreage that do not represent the type of exposure that would occur during the removal of sediments from Newark, Ely and Main Streets and Highway 321.

The RSL module for a recreator evaluates standard pathways of incidental ingestion of, and dermal contact with, soils in addition to the inhalation of particulates (i.e., soils suspended as dust). Because the OU-1 worker will only be cleaning up wet or moist sediments after storm events, dust inhalation is not likely and the inhalation pathway would not be complete. The inputs for exposure duration and frequency can be modified in the calculator, and the receptors can be limited to adults by zeroing out child and adolescent inputs. This module was used to generate customized arsenic RBCs for OU-1 workers. Table 3-1 summarizes the assumptions used in the model. Attachment A presents the RSL calculator outputs.

The arsenic RBCs, provided to two significant figures in this RBC Tech Memo for detail, were calculated for exposure frequencies (EFs) of four and eight days, as follows:

- assuming four days of clean-up work per year (EF = 4), the RBC is approximately 120 mg/kg
- assuming four days of clean-up work per year (EF = 8), the RBC is approximately 60 mg/kg

Given that the average value of arsenic in the roadway sediments was 71 mg/kg and the annual average level of effort described by Lincoln County, the OU-1 worker would not be exposed to an unacceptable level of arsenic up to and including at least seven 8-hour work days per year. Note that the calculated arsenic RBC of approximately 60 mg/kg is close to, but unrelated to the EPA/NDEP action level of 60 mg/kg based on soil chemical concentrations within the State of Nevada. The NDEP background-based action level for arsenic is discussed further in Section 4.

Table 3-1. Summary of OU-1 Worker Arsenic Risk Modeling Assumptions				
Variable		Value	Units	Reference/Rationale
RBC	Risk-based concentration	calculated	mg/kg	
IRs	Soil Ingestion rate	330	mg/day	Enhanced rate for construction workers (EPA 2017b)
SA	Surface area	3527	cm^2	Default for construction worker (EPA 2017b) assumes head and hands plus forearms. Accounts for short sleeves part of the time, which leaves the forearm and part of the upper arm exposed, and long sleeves part of the time, which assumes no arm exposure.
AF	Adherence factor	0.3	mg/cm^2	Construction worker default (EPA 2017b)
PEF	Particulate emission factor		kg/m^3	
ABS	Dermal absorption factor	0.03	Unitless	EPA 2017b
ED	Exposure duration	25	Years	EPA default for nonresidential exposures (2017b)
EF	Exposure frequency	4 to 8	days per year	Site specific based on frequency of storm events requiring clean-up
ET	Exposure time	8	hours/day	Standard work day
RBAf	Relative bioavailability factor scaling factor	2.4	Unitless	Adjusts the RBC from the EPA RSL default RBA of 60% to the NDEP RBA of 25%; applies to ingestion component only
BW	Body weight	80	kg	EPA default for an adult (EPA 2017)
CSF_o	Oral carcinogenic slope factor	1.5	$(mg/kg\text{-}day)^{-1}$	EPA 2017b
IUR	Inhalation unit risk	4.3E-03	$(mg/m^3)^{-1}$	EPA 2017b
RfD	Reference dose	3.0E-04	mg/kg-day	EPA 2017b
RfC	Reference concentration	1.5E-05	mg/m^3	EPA 2017b
Target ELCR	Excess lifetime carcinogenic risk	1E-06	Unitless	NDEP default (one in a million)
Target HQ	Hazard quotient	1	Unitless	NDEP default

3.2 Lead

Although the human health risk effects for lead cannot be evaluated with the RSL calculator, EPA has published an Adult Lead Model (ALM; most recently updated in 2017), which is intended to protect the fetus of a pregnant worker from an unacceptable increase in the blood lead level. The ALM adds potential site-related exposure to background lead intake. The variables and assumptions used in the lead model are summarized in Table 3-2. Attachment B presents the outputs from the ALM calculator. The lead RBCs (provided to two significant figures) were calculated for EFs of four and eight days, as follows:

- assuming four days of clean-up work per year (EF = 4), the lead RBC is approximately 8,700 mg/kg
- assuming eight days of clean-up work per year (EF = 8), the lead RBC is approximately 4,400 mg/kg

Given that the average value of lead in the roadway sediments was 1,308 mg/kg and the annual average level of effort would be less than eight days, as described by Lincoln County, the OU-1 worker would not be exposed to an unacceptable level of lead for the modeled number of eight-hour work days per year.

Table 3-2. Summary of OU-1 Worker Lead Risk Modeling Assumptions				
Variable		Value	Units	Reference/Rationale
RBC	Risk-based concentration	calculated	mg/kg	
$PbB_{fetal, 0.95}$	Target PbB in fetus (e.g., 2-8)	5	µg/dL	Model default based on Centers for Disease Control (2012) target
$R_{fetal/maternal}$	Fetal/maternal blood lead (PbB) ratio	0.9	unitless	Model default
BKSF	Biokinetic slope factor	0.4	µg/dL per µg/day	Model default
GSD_i	Geometric standard deviation PbB	1.8	Unitless	Model default based on most recent (2014)
IR_s	Soil ingestion rate	0.330	g/day	Same as RSL calculator value
PbB_o	Baseline PbB	0.6	µg/dL	Model default based on analysis of most recent National Health and Nutrition Examination Survey
ED	Exposure duration	25	Years	EPA default for nonresidential exposures (2017b)
$EF_{s,d}$	Exposure frequency (soil and dust)	4 to 8	days per year	Site specific based on frequency of storm events requiring clean-up
$AF_{s,d}$	Absorption fraction (soil and dust)	0.12	Unitless	Model default based on analysis of most recent NHANES data (2009-2014)

Section 4: Evaluation of Roadway Sediment Concentrations

BC (2017) collected 40 samples along the Pioche roadways affected by run-off from Treasure Hill. The analytical data were evaluated using EPA (2016) ProUCL software to estimate the upper 95th percentile confidence limit on the mean (UCL95). Attachment C provides the statistical computations and results for the RBCs. The UCL95 represents the number that the mean (average) concentration of the sample population is below with 95% confidence. The UCL95 provides a conservative estimate of central tendency and not the upper end of the range, and is the most frequently used statistic in risk assessment to calculate exposure point concentrations. Table 4-1 summarizes the average roadway sediment value, and calculated RBCs for arsenic and lead for both 4- and 8-day exposure scenarios (the longer exposure time period lowers the RBC and the potential human health risk).

Table 4-1. Summary of Roadway Sediment Concentrations and Risk-Based Concentrations		
	Arsenic (mg/kg)	Lead (mg/kg)
Average Roadway Sediment Value	71	1,308
UCL95	85	1,600
RBC (four days per year)	120	8,700
RBC (eight days per year)	60	4,400

The average and UCL lead values in roadway sediments are well below the calculated RBCs for both four and eight days of exposure per year. Therefore, BC concludes that lead values in roadway sediments do not represent a concern for workers and no further evaluation is required.

Although the average and UCL average arsenic values (roadway sediments and UCL95) are above the calculated 8-day per year RBC, they are less than the 4-day per year RBC (as shown in Table 4-1, the average arsenic values are approximately midway between the 4- and 8-hour exposure scenarios). Given that the average annual cleanup effort described by Lincoln County is approximately seven days per year, BC concludes that the arsenic in the sediments is not a health concern to the OU-1 cleanup worker.

Section 5: Summary and Conclusions

The use of RBCs in determining potential OU-1 worker risks during sediment removal activities is an EPA-approved method that is consistent with: 1) the HHRA screening process using RSLs, background soil values and/or default action levels approved by EPA and NDEP in the State of Nevada; and 2) previous OU-1 HHRA screening level results for the recreational visitor on Treasure Hill who may infrequently (i.e., 75 days per year) be exposed to waste rock piles that are the source of the transported sediments. EPA developed reference doses (i.e., a chronic dose without an adverse effect) or slope factor (upper bound lifetime cancer risk) for many constituents of concern including arsenic and lead (Smith, 1996). RBCs combine these reference doses (i.e., toxicological constants) with predetermined risk levels (e.g., a 10^{-6} cancer risk or a chronic intake equal to the reference dose) and protective human exposure assumptions (e.g., 70-kg body mass, 30-year exposure time frame, dermal contact or inhalation, etc.) to produce RBCs (Smith, 1996).

Site-specific RBCs for OU-1 cleanup workers that may be exposed to arsenic and lead in sediments deposited on roadways below Treasure Hill were developed using: 1) standard EPA methods in conjunction with conservative EPA and NDEP exposure assumptions; and 2) information from Lincoln County as to the frequency and duration of cleanup activities. RBCs for the OU-1 clean-up worker were calculated based on four and eight worker days per year (each worker day is an 8-hour day).

For lead, the RBCs were determined to be well above the observed concentrations and lead therefore presents no unacceptable risk to workers (even pregnant workers). For arsenic, the RBCs were determined to be in the range of the observed concentrations. Because the RBC models are conservative and assume a greater-than-expected degree of exposure (other than frequency), and because risk assessment results are generally expressed to only one significant figure, the most conservative RBC and the UCL values for arsenic are both equivalent to 100 mg/kg when expressed to one significant figure.

As noted above, the 8-day/year RBC for arsenic of approximately 60 mg/kg is effectively the same as the EPA/NDEP action level in the State of Nevada. Therefore, the RBC range of 60 to 120 mg/kg for arsenic is appropriate for soil risk management for the OU-1 cleanup workers. For context, the RBCs applied to the other OU-1 receptors described in Section 1 (BC, 2015 and 2017) are summarized along with the OU-1 worker in Table 5-1. For each type of receptor evaluated in each of the OU-1 screening level risk assessments, the risk management value for arsenic defaults to the NDEP action level (i.e., the 60 mg/kg screening/action level applies to all potential OU-1 human receptors).

The RBC approach differed for two other Caselton Mine Area OUs with respect to arsenic screening levels: 1) OU-2 (residential yards) utilized Site-specific background values for risk screening, which were very similar to the yard soil values, but referenced the NDEP action level for context; and 2) because of the very elevated arsenic values in the OU-4 tailings, the risk screening level for arsenic was multiplied by 2.4 to adjust the EPA default relative bioavailability factor of 0.6 to the NDEP-accepted factor of 0.25 (the screening level was well below the average arsenic value of the tailings).

Table 5-1. Risk Based Concentrations for OU-1 Receptors

Receptor	Arsenic RBC (mg/kg)	Lead RBC (mg/kg)	Comments
Default Residential RSL	1.6	400	
Default Industrial RSL	7.2	800	
Recreator/Trespasser	30	400	Based on 75 days per year of exposure for a recreator for arsenic; the lead RBC is the residential RSL recommended for non-commercial settings
Local Resident	1.6	400	Default RSLs
Clean-up Worker	60-120	4,400-8,700	Calculated in this RBC Tech Memo assuming conservative contact rates and four to eight clean-up workdays per year
EPA- and NDEP-Approved Action Level for Nevada Sites	60	NA	Regional background not established for lead

NA = Not Available

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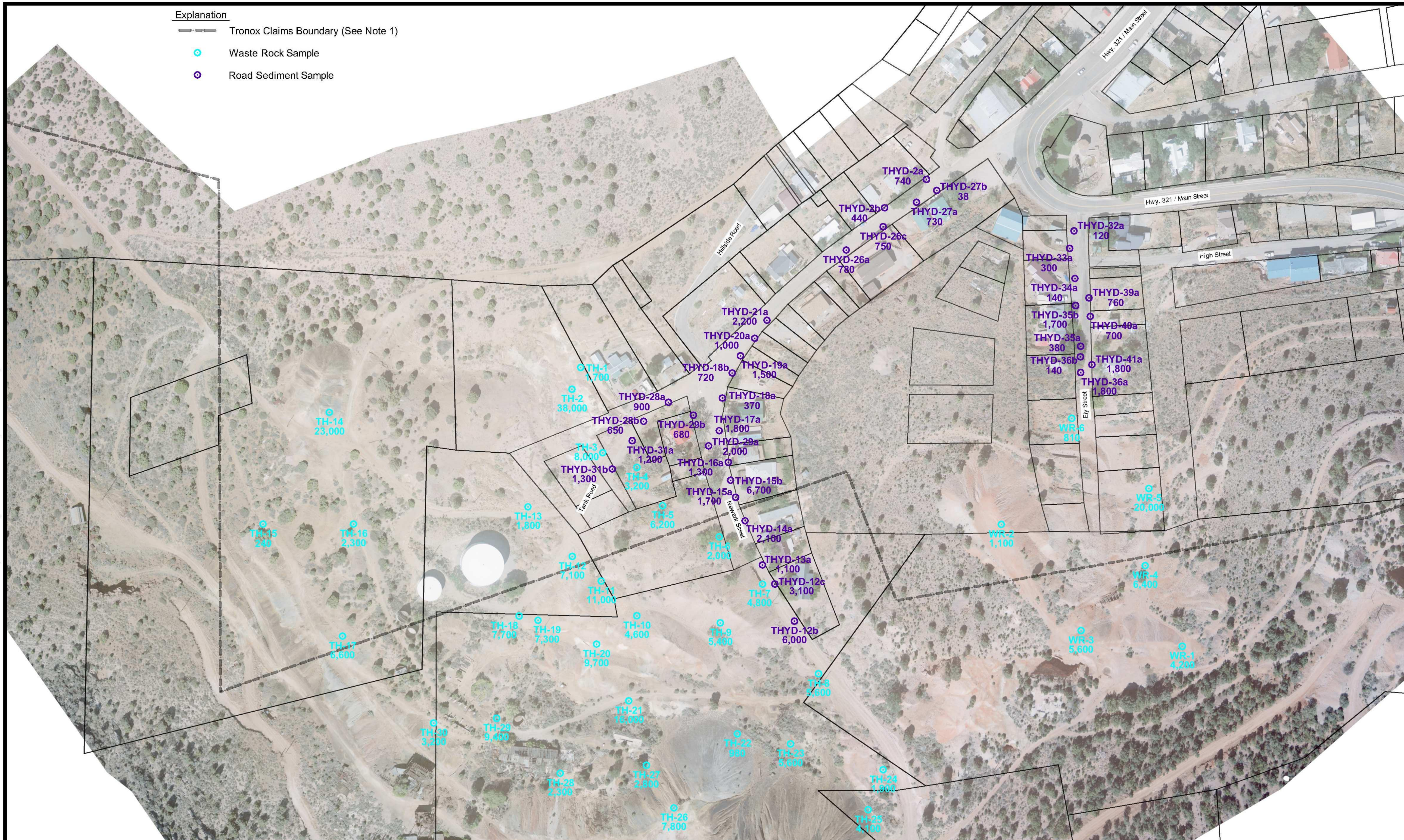
Figures



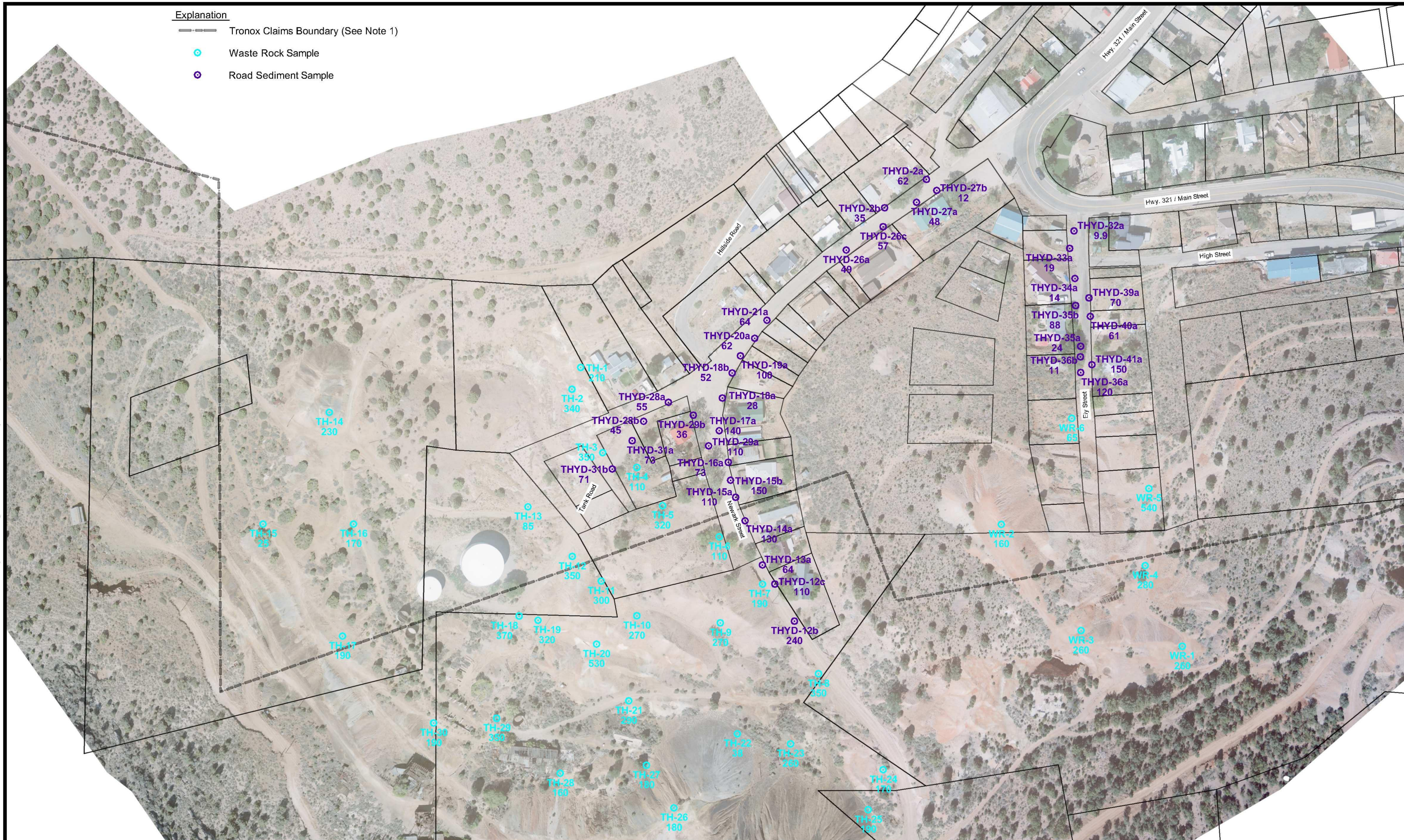
Brown AND Caldwell	Greenfield Environmental Multistate Trust, LLC.	Date: September 2017 Project: 150318	75 0 75 150 FEET	Notes:	Figure 1 Treasure Hill (OU-1) Lead Sample Results

Notes:
1. Tronox claims boundary from Tronox map entitled "Caselton Patented Mining Claims", dated June 16, 2010, and Tronox map entitled "Kerr-McGee Mining Claims and Town Parcels", dated May 8, 2006.
2. Projection: Nevada State Plane, Eastern Zone, 1983 North American Datum (Feet).
3. Base Photo Taken: September 1, 2015.

Figure 1

Treasure Hill (OU-1) Lead Sample Results

Sep 26, 2017 - 3:56pm rjohnson
P:\Caselton Mine - Greenfield Env Trust\150318 - 2017 Caselton Mine RIFS\CAD\Sept 2017\Figure 1 - Lead Sample Results.dwg



rjohnson
Sep 26, 2017 - 3:58pm
P:\Caselton Mine - Greenfield Env Trust\150318 - 2017 Caselton Mine RIFS\CAD\Sept 2017\Figure 2 - Arsenic Sample Results.dwg

Brown AND Caldwell

Greenfield Environmental Multistate Trust, LLC.

Date: September 2017

Project: 150318

Notes:
1. Tronox claims boundary from Tronox map entitled "Caselton Patented Mining Claims", dated June 16, 2010, and Tronox map entitled "Kerr-McGee Mining Claims and Town Parcels", dated May 8, 2006.
2. Projection: Nevada State Plane, Eastern Zone, 1983 North American Datum (Feet).
3. Base Photo Taken: September 1, 2015.

Figure 2

Treasure Hill (OU-1) Arsenic Sample Results

Attachment A: Arsenic Regional Screening Level Calculator Outputs

Site-specific
Screening Levels (RSL) for Soil

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #27); H = HEAST; F = See FAQ; J = New Jersey; E = see user guide Section 2.3.5; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on D

Chemical	CAS Number	Mutagen?	VOC ?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	Chronic RfD (mg/kg-day)	Chronic RfD Ref	Chronic RfC (mg/m^3)	Chronic RfC Ref	GIABS	ABS	RBA	Particulate Emission Factor (m^3/kg)	Ingestion SL TR=1.0E-6 (mg/kg)	RBA_s	Adjusted Ingestion SL TR = 1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	EPA Carcinogenic SL TR=1.0E-6 (mg/kg)	NDEP Carinogenic SL (TR=1.0E-6) (mg/kg)	Ingestion SL THQ=1 (mg/kg)	RBA_s	Adjusted Ingestion SL TQ = 1 (mg/kg)	Dermal SL Adult THQ=1 (mg/kg)	Inhalation SL Adult THQ=1 (mg/kg)	EPA Noncarcinogenic SL Adult THI=1 (mg/kg)	NDEP Noncarcinogenic SL Adult THI=1 (mg/kg)	Final NDEP SL (mg/kg)
Arsenic, Inorganic	7440-38-2	No	No	1.5	I	0.0043	I	0.0003	IR	1.5E-05	CA	1	0.03	0.6	1360000000	68.8	2.4	165.12	429	242000	59.3	119.2	11100	2.4	26640	69000	5580000	9520	19154	120
Arsenic, Inorganic	7440-38-2	No	No	1.5	I	0.0043	I	0.0003	IR	1.5E-05	CA	1	0.03	0.6	1360000000	34.4	2.4	82.56	215	121000	29.6	59.6	5530	2.4	13272	34500	2790000	4760	9552	60

Attachment B: Adult Lead Model Outputs

Calculations of Preliminary Remediation Goals (PRGs) for Soil in Nonresidential Areas

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 06/14/2017

EDIT RED CELLS

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014	GSDi and PbBo from Analysis of NHANES 2007-2010	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
$PbB_{fetal, 0.95}$	Target PbB in fetus (e.g., 2-8 µg/dL)	µg/dL	5	5	5	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.7	1.8	2.1
PbB_0	Baseline PbB	µg/dL	0.6	0.7	1.0	1.5
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330	0.330	0.330	0.330
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	4	4	4	4
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PRG in Soil for no more than 5% probability that fetal PbB exceeds target PbB		**ppm**	**8,713.32**	**9,337.04**	**6,409.03**	**802.87**

Calculations of Preliminary Remediation Goals (PRGs) for Soil in Nonresidential Areas

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 06/14/2017

EDIT RED CELLS

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014	GSDi and PbBo from Analysis of NHANES 2007-2010	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
$PbB_{fetal,\ 0.95}$	Target PbB in fetus (e.g., 2-8 µg/dL)	µg/dL	5	5	5	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.7	1.8	2.1
PbB_0	Baseline PbB	µg/dL	0.6	0.7	1.0	1.5
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330	0.330	0.330	0.330
$AF_{S,\ D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S,\ D}$	Exposure frequency (same for soil and dust)	days/yr	8	8	8	8
$AT_{S,\ D}$	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PRG in Soil for no more than 5% probability that fetal PbB exceeds target PbB		**ppm**	**4,356.66**	**4,668.52**	**3,204.51**	**401.43**

Attachment C: EPA ProUCL Outputs

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.19/5/2017 1:52:16 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	36
		Number of Missing Observations	0
Minimum	9.8	Mean	70.22
Maximum	240	Median	61
SD	50.04	Std. Error of Mean	7.46
Coefficient of Variation	0.713	Skewness	1.247

Normal GOF Test

Shapiro Wilk Test Statistic	0.897	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	82.75	95% Adjusted-CLT UCL (Chen-1995)	83.97
		95% Modified-t UCL (Johnson-1978)	82.98

Gamma GOF Test

A-D Test Statistic	0.368	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.761	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0957	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.133	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.977	k star (bias corrected MLE)	1.86
Theta hat (MLE)	35.52	Theta star (bias corrected MLE)	37.75
nu hat (MLE)	177.9	nu star (bias corrected)	167.4
MLE Mean (bias corrected)	70.22	MLE Sd (bias corrected)	51.49
		Approximate Chi Square Value (0.05)	138.5
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	137.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	84.88	95% Adjusted Gamma UCL (use when n<50)	85.41

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.136	**Lilliefors Lognormal GOF Test**

5% Lilliefors Critical Value	0.131	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.282	Mean of logged Data	3.978
Maximum of Logged Data	5.481	SD of logged Data	0.805

Assuming Lognormal Distribution

95% H-UCL	96.06	90% Chebyshev (MVUE) UCL	102.6
95% Chebyshev (MVUE) UCL	116	97.5% Chebyshev (MVUE) UCL	134.5
99% Chebyshev (MVUE) UCL	170.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	82.49	95% Jackknife UCL	82.75
95% Standard Bootstrap UCL	82.6	95% Bootstrap-t UCL	85.12
95% Hall's Bootstrap UCL	84.28	95% Percentile Bootstrap UCL	82.97
95% BCA Bootstrap UCL	83.66		
90% Chebyshev(Mean, Sd) UCL	92.6	95% Chebyshev(Mean, Sd) UCL	102.7
97.5% Chebyshev(Mean, Sd) UCL	116.8	99% Chebyshev(Mean, Sd) UCL	144.4

Suggested UCL to Use

95% Adjusted Gamma UCL	85.41

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	35
		Number of Missing Observations	0
Minimum	33	Mean	1263
Maximum	6700	Median	780
SD	1336	Std. Error of Mean	199.1
Coefficient of Variation	1.057	Skewness	2.663

Normal GOF Test

Shapiro Wilk Test Statistic	0.715	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1598	95% Adjusted-CLT UCL (Chen-1995)	1675
		95% Modified-t UCL (Johnson-1978)	1611

Gamma GOF Test

A-D Test Statistic	0.529	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.773	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.104	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.135	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.19	k star (bias corrected MLE)	1.125
Theta hat (MLE)	1062	Theta star (bias corrected MLE)	1123
nu hat (MLE)	107.1	nu star (bias corrected)	101.3
MLE Mean (bias corrected)	1263	MLE Sd (bias corrected)	1191
		Approximate Chi Square Value (0.05)	79.05
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	78.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1618	95% Adjusted Gamma UCL (use when n<50)	1632

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.497	Mean of logged Data	6.666
Maximum of Logged Data	8.81	SD of logged Data	1.104

Assuming Lognormal Distribution

95% H-UCL	2187	90% Chebyshev (MVUE) UCL	2254
95% Chebyshev (MVUE) UCL	2634	97.5% Chebyshev (MVUE) UCL	3161
99% Chebyshev (MVUE) UCL	4198		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1591	95% Jackknife UCL	1598
95% Standard Bootstrap UCL	1593	95% Bootstrap-t UCL	1782
95% Hall's Bootstrap UCL	1981	95% Percentile Bootstrap UCL	1617
95% BCA Bootstrap UCL	1700		
90% Chebyshev(Mean, Sd) UCL	1861	95% Chebyshev(Mean, Sd) UCL	2131
97.5% Chebyshev(Mean, Sd) UCL	2507	99% Chebyshev(Mean, Sd) UCL	3245

Suggested UCL to Use

95% Adjusted Gamma UCL	1632

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.