Basic Remediation COMPANY

TECHNICAL MEMORANDUM

To: Brian Rakvica (NDEP)

From: Ranajit Sahu (BRC)

cc: Jim Najima (NDEP)
Mark Jones (ERM)

Date: February 1, 2010

Subject: Technical Memorandum – Development of Recreational Risk-Based Screening Levels (RBSLs), BMI Common Areas (Eastside) Site, Clark County, Nevada

Introduction

The Nevada Division of Environmental Protection (NDEP) has developed Basic Comparison Levels (BCLs) that address common human receptors and exposure pathways (NDEP 2009). These receptors include residential, and indoor and outdoor workers. Basic Remediation Company (BRC) has used these BCLs at the BMI Common Areas (Eastside) Site for the comparison of historical Site data in the development of Sampling and Analysis Plans (SAPs) for the project. However, one of the questions asked in the BCL User's Guide is whether there is potential for land use other than those covered by the BCLs. The objective of this technical memorandum is to address this issue. That is, there are portions of the project that will not be developed for unrestricted residential uses. Rather these areas will be developed for recreational purposes only (specifically, the Western Hook-Open Space sub-area of the project). It should be noted that although this land use will also include exposures to outdoor maintenance and construction workers, the focus of this technical memorandum is the development risk-based screening levels (RBSLs) for recreational user exposures. As noted below, risk assessment will be conducted at all areas of the Site, which will include outdoor maintenance and construction worker receptors.

This revision of the technical memorandum, Revision 2, incorporates 1) comments received from the NDEP, dated January 17, 2010, on Revision 1 of the technical memorandum, dated December 29, 2009, and 2) comments received from the NDEP, dated August 8, 2009, on Revision 0 of the technical memorandum, dated May 20, 2009. The NDEP comments and BRC's response to these comments are included in Attachment A. Also included in Attachment A is a redline/strikeout version of the text showing the revisions from the December 29, 2009 version of the technical memorandum. An electronic version of the entire technical memorandum, as well as original format files (MS Word and MS Excel) of all text, tables and calculations are included in Attachment B.

Therefore, this technical memorandum presents RBSLs for soil developed for a recreational exposure scenario; an exposure scenario not covered by NDEP's BCLs. It is important to note that these recreational RBSLs were not developed to represent action levels or final cleanup levels but rather as a simple screening tool to assist in site characterization activities only. The use of these recreational RBSLs is limited to the Western Hook-Open Space sub-area SAP to (1) provide context for historical data collected at this sub-area; and (2) evaluate new data collected as per the Western Hook-Open Space sub-area SAP. These recreational RBSLs will be used for internal BRC purposes only to determine if additional remediation is warranted prior to preparation of the human health risk assessment for this sub-area. Ultimately, risk assessments will be conducted at all areas of the Site, which will be used for decision-making purposes.

Similar to NDEP's BCLs, the recreational RBSLs contain current human health toxicity values that are combined with site-specific exposure factors (based on both standard practice and best professional judgment) to estimate contaminant concentrations in environmental soil that are considered to be protective of human exposures (including sensitive sub-groups) over a lifetime for typical recreational activities. The methodology, input factors, and equations used in the development of these recreational RBSLs are from the human health risk assessment methodology chapter of the BRC Closure Plan (BRC *et al*. 2007; Chapter 9 updated December 2009). For each of the chemicals on BRC's site-related chemical (SRC) list, recreational RBSLs are back-calculated from target risk levels. 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.

Conceptual Site Model

The conceptual site model (CSM) is a tool used in risk assessment to describe relationships between chemicals and potentially exposed human receptor populations, thereby delineating the relationships between the suspected sources of chemicals identified at the site, the mechanisms by which the chemicals might be released and transported in the environment, and the means by which the receptors could come in contact with the chemicals.

Under the current, prospective redevelopment plan, the Site will be used for a variety of purposes, including residential housing, parks, schools, places of worship, commercial and/or light industrial development, and streets. Many potential human receptors are possible at the Site in the period during and after redevelopment. Because the background general water quality (*i.e.*, high salt concentrations) of the groundwater beneath the Site and in the surrounding area is poor and because BRC will place institutional controls in the form of a deed restriction to prevent future users from utilizing groundwater beneath the Site, the use of private water wells by

residents, businesses, or parks for drinking water, irrigation water, or other non-potable uses (*e.g.*, washing cars, filling swimming pools) will not occur in the post-redevelopment phase. Therefore, exposure pathways relating to this type of use are incomplete and are not included in the development of recreational RBSLs. That is, recreational RBSLs have been developed for soil exposures only.

The following presents the primary exposure pathways to soil for potential recreational receptors at the Site.

- incidental soil ingestion
- external exposure from soil (radionuclides only)
- dermal contact with soil
- outdoor inhalation of dust

Exposure Parameters and Equations

As discussed above, all input factors and equations used in the development of these recreational RBSLs are from the human health risk assessment methodology chapter of the BRC Closure Plan (BRC *et al*. 2007; Chapter 9 updated December 2009).

U.S. Environmental Protection Agency (USEPA) standard exposure parameters are not generally available for recreational/trespasser exposure scenarios. The parameters listed in the table below have been developed jointly between BRC and NDEP in discussion during the development of the BRC Closure Plan. The parameters are based on, for example, USEPA (1989) statements such as "Consider population characteristics that might influence variable values. Exposure duration (ED) may be less for workers and recreational users." (regarding incidental ingestion exposures), and "Exposure duration (ED) and exposure frequency (EF) may be lower for workers and recreational users." (regarding dermal contact exposures). For this project, the recreational user/trespasser exposures are based on children from 7 to 12 years of age. Again, these parameters were developed in consultation with NDEP during the BRC Closure Plan development process. Although other recreational user/trespasser exposure parameters could certainly be used, these values are considered applicable and appropriate for the Site. The exposure factors used are:

Parameter	Abbrev.	Value	Units	Reference
Dermal absorption fraction	ABS	---chemical-specific---		NDEP 2009
Dermal adherence factor, adult	AF_a	0.07	mg/cm^2	USEPA 2002
Dermal adherence factor, child	AF_c	0.2	mg/cm^2	USEPA 2002
Averaging time, carcinogenic	AT_c	70	years	USEPA 2002
Averaging time, non-carcinogenic	AT_{nc}	6	years	Based on ED_t
Body weight, adult	BW_a	70	kg	USEPA 2002

Parameter	Abbrev.	Value	Units	Reference
Body weight, child	BW_c	15	kg	USEPA 2002
Exposure time	ET_r	4	hrs/day	Professional judgment
Exposure frequency	EF_r	50	days/year	USEPA 1997 (1)
Exposure duration	ED_r	30	years	USEPA 2002
Available skin surface area, adult	SA_a	5,700	cm^2	USEPA 2004
Available skin surface area, child	SA_c	2,800	cm^2	USEPA 2004
Soil ingestion rate, adult	IR_{sa}	100	mg/day	USEPA 1997
Soil ingestion rate, child	IR_{sc}	200	mg/day	USEPA 1997
Radionuclide-specific factors				
Inhalation rate, adult	IR_{aa}	1.6	m^3/hour	USEPA 1997 (2)
Inhalation rate, child	IR_{ac}	1.2	m^3/hour	USEPA 1997 (2)
Area correction factor	ACF	1.0	unitless	USEPA 2000

(1) Based on average of mean time spent in outdoor recreation for ages 5 to 11 and 18 to 64 (USEPA 1997; Table 5-86) and time spent in 'Other Locations' for both all and doers (USEPA 1997; Table 5-14).
(2) Based on short-term exposures, moderate activities (USEPA 1997; Table 5-23).

The equations for calculating the carcinogenic risk or non-cancer hazard by exposure pathway, as well as the combined risk from all exposures for the scenario, are provided below and electronically in Attachment B. Note that inhalation exposures of non-radionuclides were calculated based on USEPA's recent *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment*) (USEPA 2009).

Ingestion of Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{TR \times AT_c \times 365\ days/year}{CSF \times EF_r \times CF \times ((\frac{24\,yrs \times IR_{sa}}{BW_a}) + (\frac{6\,yrs \times IR_{sc}}{BW_c})) \times BIO} \quad \text{or}$$

$$RBSL\,(pCi/g) = \frac{TR \times CF}{CSF \times EF_r \times ((24\,yrs \times IR_{sa}) + (6\,yrs \times IR_{sc}))}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (years)
BW = Body weight (kg)
BIO = Oral bioavailability factor (chemical specific)
CF = Conversion factor (1×10^{-6} kg/mg) or (1×10^{-3} g/mg for radionuclides)
CSF = Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$ or (risk/pCi for radionuclides)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
IR_s = Soil ingestion rate (mg/day)

Ingestion of Non-Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{THQ \times BW_c \times AT_{nc} \times 365\ days/year}{\frac{1}{RfD} \times EF_r \times ED_r \times IR_{sc} \times CF \times BIO}$$

where:

THQ	=	Target hazard quotient of 1
BW	=	Body weight (kg)
AT	=	Averaging time (years)
BIO	=	Oral bioavailability factor (chemical specific)
CF	=	Conversion factor (1×10^{-6} kg/mg)
RfD	=	Oral reference dose (mg/kg-day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
IRs	=	Soil ingestion rate (mg/day)

Inhalation of Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{TR \times AT_c \times 365\ days/year \times 24\ hrs/day}{IUR \times ET_r \times EF_r \times ED_r \times CF \times \left[\frac{1}{PEF}\ or\ \frac{1}{VF}\right]} \text{ or}$$

$$RBSL\,(pCi/g) = \frac{TR \times PEF \times CF}{CSF \times ET_r \times EF_r \times ((24\,yrs \times IR_{aa}) + (6\,yrs \times IR_{ac}))}$$

where:

TR	=	Target risk of 10^{-6}
AT	=	Averaging time (years)
IUR	=	Inhalation unit risk $(\mu g/m^3)^{-1}$ (non-radionuclides)
CSF	=	Cancer slope factor for inhalation exposure (risk/pCi) (radionuclides)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (1,000 µg/mg) or (0.001 kg/g for radionuclides)
IRa	=	Inhalation rate (m^3/hour)
PEF	=	Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF	=	Volatilization factor used for volatile organic chemicals (VOCs; m^3/kg)

Inhalation of Non-Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{THQ \times AT_{nc} \times 365\ days/year \times 24\ hrs/day}{\frac{1}{RfC} \times ET_r \times EF_r \times ED_r \times \left[\frac{1}{PEF}\ or\ \frac{1}{VF}\right]}$$

where:

THQ	=	Target hazard quotient of 1
AT	=	Averaging time (years)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
RfC	=	Inhalation reference concentration (mg/m^3)
PEF	=	Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF	=	Volatilization factor used for volatile organic chemicals (VOCs; m^3/kg)

Skin Contact with Carcinogenic Contaminants (Non-Radionuclides):

$$RBSL\,(mg/kg) = \frac{TR \times AT_c \times 365\ days/year}{CSF \times EF_r \times ((\frac{24\,yrs \times AF_a \times SA_a}{BW_a}) + (\frac{6\,yrs \times AF_c \times SA_c}{BW_c})) \times ABS \times 10^{-6}\,kg/mg}$$

where:

TR	=	Target risk of 10^{-6}
BW	=	Body weight (kg)
AT	=	Averaging time (years)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
CSF	=	Oral cancer slope factor (mg/kg-day)-1
SA	=	Surface area exposed (cm^2/day)
AF	=	Adherence factor (mg/cm^2)
ABS	=	Skin absorption (chemical specific)

Skin Contact with Non-Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{THQ \times BW_c \times AT_{nc} \times 365\ days/year}{\frac{1}{RfD} \times EF_r \times ED_r \times SA_c \times AF_c \times ABS \times 10^{-6}\,kg/mg}$$

where:

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

External Irradiation (Radionuclides Only):

$$RBSL\,(pCi/g) = \frac{TR}{CSF \times ET_r \times EF_r \times ED_r \times ACF}$$

where:

TR	=	Target risk of 10^{-6}
CSF	=	Cancer slope factor for external exposure (risk /yr per pCi/g)
CF	=	Conversion factor (0.000114 yr/hr)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
ACF	=	Area correction factor

Recreational Soil RBSLs for Combined Exposure Pathways:

$$RBSL\,(mg/kg) = \frac{1}{\frac{1}{ingestion} \times \frac{1}{dermal} \times \frac{1}{inhalation}} \text{ or } RBSL\,(pCi/g) = \frac{1}{\frac{1}{ingestion} \times \frac{1}{external} \times \frac{1}{inhalation}}$$

Volatilization factors, particulate emission factors, dermal absorption factors and soil saturation limits were obtained from NDEP's BCL table. When the RBSL for a VOC exceeds its soil saturation limit (as listed in NDEP's BCL tables), the recreational RBSL is based on the soil saturation limit.

Toxicity Values

Toxicity values were obtained from NDEP's BCL tables (NDEP 2009).

Special Considerations

There are several analytes for which there are special circumstances that were considered in the development of recreational RBSLs. These are as followings:

- Asbestos – Recreational RBSLs have not been developed for asbestos.
- Lead – The residential BCL for lead of 400 mg/kg is used as the recreational RBSL.
- Dioxins/Furans – The Agency for Toxic Substances and Disease Registry (ATSDR) screening value of 50 parts per trillion (ppt), and NDEP residential soil BCL, is used as the recreational RBSL for the dioxins/furans toxic equivalency (TEQ).

- Total Petroleum Hydrocarbons (TPH) – Recreational RBSLs have not been developed for TPH. This is consistent with NDEP's BCLs, in which the indicator chemicals for common petroleum hydrocarbon mixtures are evaluated, as is done in this technical memorandum.

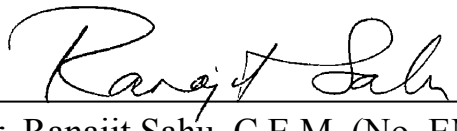
- Radionuclides - Recreational RBSLs have only been developed for the eight radionuclides on the current project analyte list (radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-233/234, uranium-235/236, and uranium-238).

Summary

In summary, this technical memorandum presents RBSLs developed for a recreational exposure scenario; an exposure scenario not covered by NDEP's BCLs. These recreational RBSLs were developed as a simple screening tool to assist in historical site characterization activities only. Table 1 presents the recreational RBSLs that have been developed for the project. Attachment B is an electronic version of the recreational RBSL calculation spreadsheet.

Attachments: Table 1 – Preliminary Recreational Risk-Based Screening Levels (RBSLs)
Attachment A – NDEP Comments and BRC's Response to Comments
Attachment B – Recreational RBSL Calculation Spreadsheets

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations and ordinances. I hereby certify that all laboratory analytical data was generated by a laboratory certified by the NDEP for each constituent and media presented herein.



February 1, 2010

Dr. Ranajit Sahu, C.E.M. (No. EM-1699, Exp. 10/07/2011) Date
BRC Project Manager

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TABLES

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)
(Page 1 of 8)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Ions	Bromide	24959-67-9	NE	--
	Bromine	7726-95-6	NE	--
	Chlorate	14866-68-3	NE	--
	Chloride	16887-00-6	NE	--
	Chlorine (soluble)	7782-50-5	54,000	N
	Chlorite	14998-27-7	NE	--
	Fluoride	16984-48-8	26,000	N
	Nitrate (as N)	14797-55-8	NE	--
	Nitrite (as N)	14797-65-0	NE	--
	Orthophosphate	14265-44-2	NE	--
	Sulfate	14808-79-8	NE	--
	Sulfite	14265-45-3	NE	--
	Perchlorate	14797-73-0	380	N
Chlorinated Compounds	Chloral	75-87-6	NE	--
	Dichloroacetaldehyde	79-02-7	NE	--
PCDDs/PCDFs	OCDF (see 2,3,7,8-TCDD TEQ)	39001-02-0	NE	--
	OCDD (see 2,3,7,8-TCDD TEQ)	3268-87-9	NE	--
	1,2,3,4,6,7,8-HpCDF (see 2,3,7,8-TCDD TEQ)	67562-39-4	NE	--
	1,2,3,4,6,7,8-HpCDD (see 2,3,7,8-TCDD TEQ)	35822-46-9	NE	--
	1,2,3,4,7,8,9-HpCDF (see 2,3,7,8-TCDD TEQ)	55673-89-7	NE	--
	1,2,3,4,7,8-HxCDF (see 2,3,7,8-TCDD TEQ)	70648-26-9	NE	--
	1,2,3,4,7,8-HxCDD (see 2,3,7,8-TCDD TEQ)	39227-28-6	NE	--
	1,2,3,6,7,8-HxCDF (see 2,3,7,8-TCDD TEQ)	57117-44-9	NE	--
	1,2,3,6,7,8-HxCDD (see 2,3,7,8-TCDD TEQ)	57653-85-7	NE	--
	1,2,3,7,8,9-HxCDF (see 2,3,7,8-TCDD TEQ)	72918-21-9	NE	--
	1,2,3,7,8,9-HxCDD (see 2,3,7,8-TCDD TEQ)	19408-74-3	NE	--
	1,2,3,7,8-PeCDF (see 2,3,7,8-TCDD TEQ)	57117-41-6	NE	--
	1,2,3,7,8-PeCDD (see 2,3,7,8-TCDD TEQ)	40321-76-4	NE	--
	2,3,4,6,7,8-HxCDF (see 2,3,7,8-TCDD TEQ)	60851-34-5	NE	--
	2,3,4,7,8-PeCDF (see 2,3,7,8-TCDD TEQ)	57117-31-4	NE	--
	2,3,7,8-TCDF (see 2,3,7,8-TCDD TEQ)	51207-31-9	NE	--
	2,3,7,8-TCDD (TEQ)	1746-01-6	50 ppt (a)	--
Asbestos	Asbestos	1332-21-4	NE	--
General Chemistry Parameters	Ammonia (as N)	7664-41-7	>100,000	N
	Cyanide (Total)	57-12-5	8,600	N
	Iodine	7553-56-2	NE	--
	pH in soil	pH	NE	--
	Percent moisture	%MOISTURE	NE	--
	Sulfide	18496-25-8	NE	--
	Total inorganic carbon	7440-44-0	NE	--
	Total Kjeldahl nitrogen (TKN)	TKN	NE	--
	Total organic carbon (TOC)	7440-44-0	NE	--
Metals	Aluminum	7429-90-5	>100,000	N
	Antimony	7440-36-0	220	N
	Arsenic	7440-38-2	7.5	C
	Barium	7440-39-3	>100,000	N
	Beryllium	7440-41-7	1,100	N
	Boron	7440-42-8	>100,000	N
	Cadmium	7440-43-9	270	N
	Calcium	7440-70-2	NE	--
	Chromium	7440-47-3	1,600	N
	Cobalt	7440-48-4	160	N

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Metals (Continued)	Copper	7440-50-8	20,000	N
	Iron	7439-89-6	>100,000	N
	Lead	7439-92-1	400 (a)	--
	Lithium	1313-13-9	1,100	N
	Magnesium	7439-95-4	>100,000	N
	Manganese	7439-96-5	7,600	N
	Molybdenum	7439-98-7	2,700	N
	Nickel	7440-02-0	11,000	N
	Niobium	7440-03-1	NE	--
	Palladium	7440-05-3	NE	--
	Phosphorus	7723-14-0	11	N
	Platinum	7440-06-4	NE	--
	Potassium	7440-09-7	NE	--
	Selenium	7782-49-2	2,700	N
	Silicon	7440-21-3	NE	--
	Silver	7440-22-4	2,700	N
	Sodium	7440-23-5	NE	--
	Strontium	7440-24-6	>100,000	N
	Sulfur	7704-34-9	NE	--
	Thallium	7440-28-0	38	N
	Tin	7440-31-5	>100,000	N
	Titanium	7440-32-6	>100,000	N
	Tungsten	7440-33-7	4,100	N
	Uranium	7440-61-1	1,600	N
	Vanadium	7440-62-2	2,700	N
	Zinc	7440-66-6	>100,000	N
	Zirconium	7440-67-7	NE	--
	Chromium (VI)	18540-29-9	1,600	N
	Mercury	7439-97-6	88	N
Organo-phosphorous Pesticides	Azinphos-ethyl	264-27-19	NE	--
	Azinphos-methyl	86-50-0	NE	--
	Carbophenothion	786-19-6	NE	--
	Chlorpyrifos	2921-88-2	1,300	N
	Coumaphos	56-72-4	NE	--
	Demeton-O	298-03-3	NE	--
	Demeton-S	126-75-0	NE	--
	Diazinon	333-41-5	380	N
	Dichlorvos	62-73-7	12	C
	Dimethoate	60-51-5	NE	--
	Disulfoton	298-04-4	17	N
	EPN	2104-64-5	NE	--
	Ethoprop	13194-48-4	NE	--
	Ethyl parathion	56-38-2	2,600	N
	Fampphur	52-85-7	NE	--
	Fenthion	55-38-9	NE	--
	Malathion	121-75-5	8,600	N
	Methyl carbophenothion	953-17-3	NE	--
	Methyl parathion	298-00-0	110	N
	Mevinphos	7786-34-7	NE	--
	Naled	300-76-5	860	N

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)
(Page 3 of 8)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Organo-phosphorous Pesticides (Continued)	O,O,O-Triethyl phosphorothioate (TEPP)	297-97-2	NE	--
	Phorate	298-02-2	NE	--
	Phosmet	732-11-6	NE	--
	Ronnel	299-84-3	21,000	N
	Stirophos (Tetrachlorovinphos)	22248-79-9	NE	--
	Sulfotep	3689-24-5	NE	--
Chlorinated Herbicides	2,4,5-T	93-76-5	4,300	N
	2,4,5-TP (Silvex)	93-72-1	3,400	N
	2,4-D	94-75-7	4,800	N
	2,4-DB	94-82-6	3,400	N
	Dalapon	75-99-0	13,000	N
	Dicamba	1918-00-9	13,000	N
	Dichloroprop	120-36-5	NE	--
	Dinoseb	88-85-7	430	N
	MCPA	94-74-6	210	N
	MCPP	93-65-2	430	N
Organic Acids	4-Chlorobenzene sulfonic acid	98-66-8	>100,000	N
	Benzenesulfonic acid	98-11-3	>100,000	N
	O,O-Diethylphosphorodithioic acid	298-06-6	44,000	N
	O,O-Dimethylphosphorodithioic acid	756-80-9	55,000	N
Nonhalogenated Organics	Ethylene glycol	107-21-1	>100,000	N
	Ethylene glycol monobutyl ether	111-76-2	>100,000	N
	Methanol	67-56-1	>100,000	N
	Propylene glycol	57-55-6	>100,000	N
Organochlorine Pesticides	2,4-DDD	53-19-0	NE	--
	2,4-DDE	3424-82-6	NE	--
	4,4-DDD	72-54-8	17	C
	4,4-DDE	72-55-9	12	C
	4,4-DDT	50-29-3	12	C
	Aldrin	309-00-2	0.2	C
	alpha-BHC	319-84-6	0.63	C
	alpha-Chlordane	5103-71-9	NE	--
	beta-BHC	319-85-7	2.2	C
	Chlordane	57-74-9	11	C
	delta-BHC	319-86-8	NE	--
	Dieldrin	60-57-1	0.21	C
	Endosulfan I	959-98-8	NE	--
	Endosulfan II	33213-65-9	NE	--
	Endosulfan sulfate	1031-07-8	NE	--
	Endrin	72-20-8	130	N
	Endrin aldehyde	7421-93-4	NE	--
	Endrin ketone	53494-70-5	NE	--
	gamma-BHC (Lindane)	58-89-9	3.1	C
	gamma-Chlordane	5103-74-2	NE	--
	Heptachlor	76-44-8	0.76	C
	Heptachlor epoxide	1024-57-3	0.37	C
	Methoxychlor	72-43-5	2,100	N
	Toxaphene	8001-35-2	3.1	C
Polychlorinated Biphenyls	Aroclor 1016	12674-11-2	28	N
	Aroclor 1221	11104-28-2	1.6	C
	Aroclor 1232	11141-16-5	1.6	C
	Aroclor 1242	53469-21-9	1.6	C

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)
(Page 4 of 8)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Polychlorinated Biphenyls (Continued)	Aroclor 1248	12672-29-6	1.6	C
	Aroclor 1254	11097-69-1	1.6	C
	Aroclor 1260	11096-82-5	1.6	C
	PCB-77 (see 2,3,7,8-TCDD TEQ)	32598-13-3	NE	--
	PCB-81 (see 2,3,7,8-TCDD TEQ)	70362-50-4	NE	--
	PCB-105 (see 2,3,7,8-TCDD TEQ)	32598-14-4	NE	--
	PCB-114 (see 2,3,7,8-TCDD TEQ)	74472-37-0	NE	--
	PCB-118 (see 2,3,7,8-TCDD TEQ)	31508-00-6	NE	--
	PCB-123 (see 2,3,7,8-TCDD TEQ)	65510-44-3	NE	--
	PCB-126 (see 2,3,7,8-TCDD TEQ)	57465-28-8	NE	--
	PCB-156 (see 2,3,7,8-TCDD TEQ)	38380-08-4	NE	--
	PCB-157 (see 2,3,7,8-TCDD TEQ)	69782-90-7	NE	--
	PCB-167 (see 2,3,7,8-TCDD TEQ)	52663-72-6	NE	--
	PCB-169 (see 2,3,7,8-TCDD TEQ)	32774-16-6	NE	--
	PCB-189 (see 2,3,7,8-TCDD TEQ)	39635-31-9	NE	--
	PCB-209	2051-24-3	NE	--
Polynuclear Aromatic Hydrocarbons	Acenaphthene	83-32-9	130	SAT
	Acenaphthylene	208-96-8	150	SAT
	Anthracene	120-12-7	6.1	SAT
	Benzo(a)anthracene	56-55-3	4.3	C
	Benzo(a)pyrene	50-32-8	0.43	C
	Benzo(b)fluoranthene	205-99-2	4.3	C
	Benzo(g,h,i)perylene	191-24-2	16,000	N
	Benzo(k)fluoranthene	207-08-9	43	C
	Chrysene	218-01-9	3.8	SAT
	Dibenzo(a,h)anthracene	53-70-3	0.43	C
	Indeno(1,2,3-cd)pyrene	193-39-5	4.3	C
	Phenanthrene	85-01-8	25	SAT
	Pyrene	129-00-0	55	SAT
Radionuclides	Gross alpha	G_Alpha	NE	--
	Gross beta	G_Beta	NE	--
	Radium-226	13982-63-3	0.17	C
	Radium-228	15262-20-1	0.28	C
	Thorium-228	14274-82-9	0.18	C
	Thorium-230	14269-63-7	27	C
	Thorium-232	7440-29-1	24	C
	Uranium-233/234	U-233/234	2.5	C
	Uranium-235/236	U-235/236	34	C
	Uranium-238	7440-61-1	8.6	C
	Actinium-228	14331-83-0	NE	--
	Bismuth-212	14913-49-6	NE	--
	Bismuth-214	14733-03-0	NE	--
	Cobalt-57	13981-50-5	NE	--
	Cobalt-60	10198-40-0	NE	--
	Lead-210	14255-04-0	NE	--
	Lead-211	015816-77-0	NE	--
	Lead-212	15092-94-1	NE	--
	Lead-214	15067-28-4	NE	--
	Potassium-40	13966-00-2	NE	--
	Thallium-208	14913-50-9	NE	--
	Thorium-227	15623-47-9	NE	--
	Thorium-234	15065-10-8	NE	--

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)
(Page 5 of 8)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Radionuclides (Continued)	Actinium-227 (from Th-227)	14952-40-0	NE	--
	Bismuth-210 (from Pb-210)	14331-79-4	NE	--
	Bismuth-211 (from Pb-211)	15229-37-5	NE	--
	Polonium-210 (from Pb-210)	13981-52-7	NE	--
	Polonium-212 (from Bi-212)	13981-52-7	NE	--
	Polonium-214 (from Bi-214)	15735-67-8	NE	--
	Polonium-216 (from Pb-212)	15756-58-8	NE	--
	Polonium-218 (from Pb-214)	15422-74-9	NE	--
	Protactinium-231 (from U-235)	14331-85-2	NE	--
	Protactinium-234 (from Th-234)	15100-28-4	NE	--
	Radium-223 (from Th-227)	15623-45-7	NE	--
	Radium-224 (from Pb-212)	13233-32-4	NE	--
	Thallium-207 (from Pb-211)	14133-67-6	NE	--
	Thorium-231 (from U-235)	14932-40-2	NE	--
Radon	Radon-220	22481-48-7	NE	--
	Radon-222	14859-67-7	NE	--
Aldehydes	Acetaldehyde	75-07-0	600	C
	Chloroacetaldehyde	107-20-0	NE	--
	Dichloroacetaldehyde	79-02-7	NE	--
	Formaldehyde	50-00-0	67	C
	Trichloroacetaldehyde	75-87-6	NE	--
Dissolved Gases	Ethane	74-84-0	NE	--
	Ethylene	74-85-1	NE	--
	Methane	74-82-8	NE	--
Semivolatile Organic Compounds	1,2,4,5-Tetrachlorobenzene	95-94-3	130	N
	1,2-Diphenylhydrazine	122-66-7	4.2	C
	1,4-Dioxane	123-91-1	310	C
	2,4,5-Trichlorophenol	95-95-4	43,000	N
	2,4,6-Trichlorophenol	88-06-2	310	C
	2,4-Dichlorophenol	120-83-2	1,300	N
	2,4-Dimethylphenol	105-67-9	8,600	N
	2,4-Dinitrophenol	51-28-5	860	N
	2,4-Dinitrotoluene	121-14-2	11	C
	2,6-Dinitrotoluene	606-20-2	430	N
	2-Chloronaphthalene	91-58-7	44,000	N
	2-Chlorophenol	95-57-8	2,700	N
	2-Methylnaphthalene	91-57-6	NE	--
	2-Nitroaniline	88-74-4	1,300	N
	2-Nitrophenol	88-75-5	NE	--
	3,3-Dichlorobenzidine	91-94-1	7.6	C
	3-Nitroaniline	99-09-2	NE	--
	4,4'-Dichlorobenzil	3457-46-3	160	N
	4-Bromophenyl phenyl ether	101-55-3	NE	--
	4-Chloro-3-methylphenol	59-50-7	NE	--
	4-Chlorophenyl phenyl ether	7005-72-3	NE	--
	4-Chlorothioanisole	123-09-1	NE	--
	4-Chlorothiophenol	106-54-7	NE	--
	4-Nitroaniline	100-01-6	NE	--
	4-Nitrophenol	100-02-7	3,400	N
	Acetophenone	98-86-2	1,700	SAT
	Aniline	62-53-3	600	C
	Azobenzene	103-33-3	31	C

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)
(Page 6 of 8)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Semivolatile Organic Compounds (Continued)	Benzoic acid	65-85-0	>100,000	N
	Benzyl alcohol	100-51-6	>100,000	N
	bis(2-Chloroethoxy)methane	111-91-1	NE	--
	bis(2-Chloroethyl) ether	111-44-4	3.3	C
	bis(2-Chloroisopropyl) ether	108-60-1	50	C
	bis(2-Ethylhexyl) phthalate	117-81-7	240	C
	bis(Chloromethyl) ether	542-88-1	0.0072	C
	bis(p-Chlorophenyl) sulfone	80-07-9	NE	--
	bis(p-Chlorophenyl)disulfide	1142-19-4	NE	--
	Butylbenzyl phthalate	85-68-7	240	SAT
	Carbazole	86-74-8	170	C
	Dibenzofuran	132-64-9	1,100	N
	Dichloromethyl ether	542-88-1	0.0072	C
	Diethyl phthalate	84-66-2	>100,000	N
	Dimethyl phthalate	131-11-3	>100,000	N
	Di-n-butyl phthalate	84-74-2	43,000	N
	Di-n-octyl phthalate	117-84-0	NE	--
	Diphenyl disulfide	882-33-7	NE	--
	Diphenyl sulfide	139-66-2	NE	--
	Diphenyl sulfone	127-63-9	1,300	N
	Fluoranthene	206-44-0	16,000	N
	Fluorene	86-73-7	90	SAT
	Hexachlorobenzene	118-74-1	2.1	C
	Hexachlorobutadiene	87-68-3	44	C
	Hexachlorocyclopentadiene	77-47-4	2,600	N
	Hexachloroethane	67-72-1	240	C
	Hydroxymethyl phthalimide	118-29-6	NE	--
	Isophorone	78-59-1	3,600	C
	m,p-Cresol	106-44-5	2,100	N
	Naphthalene	91-20-3	220	SAT
	Nitrobenzene	98-95-3	1000	SAT
	N-nitrosodi-n-propylamine	621-64-7	0.49	C
	N-nitrosodiphenylamine	86-30-6	690	C
	o-Cresol	95-48-7	21,000	N
	Octachlorostyrene	29082-74-4	NE	--
	p-Chloroaniline (4-Chloroaniline)	106-47-8	1,700	N
	Pentachlorobenzene	608-93-5	340	N
	Pentachlorophenol	87-86-5	21	C
	Phenol	108-95-2	>100,000	N
	Phthalic acid	88-99-3	>100,000	N
	Pyridine	110-86-1	430	N
	Thiophenol	108-98-5	NE	--
	Tentatively Identified Compounds (TICs)		NE	--
Volatile Organic Compounds	1,1,1,2-Tetrachloroethane	630-20-6	88	C
	1,1,1-Trichloroethane	71-55-6	1,400	SAT
	1,1,2,2-Tetrachloroethane	79-34-5	11	C
	1,1,2-Trichloroethane	79-00-5	30	C
	1,1-Dichloroethane	75-34-3	150	C
	1,1-Dichloroethene	75-35-4	1,600	SAT
	1,1-Dichloropropene	563-58-6	NE	--
	1,2,3-Trichlorobenzene	87-61-6	NE	--
	1,2,3-Trichloropropane	96-18-4	2.2	C

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)
(Page 7 of 8)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Volatile Organic Compounds (Continued)	1,2,4-Trichlorobenzene	120-82-1	3,000	SAT
	1,2,4-Trimethylbenzene	95-63-6	5.7	SAT
	1,2-Dichlorobenzene	95-50-1	370	SAT
	1,2-Dichloroethane	107-06-2	14.0	C
	1,2-Dichloropropane	78-87-5	24	C
	1,3,5-Trichlorobenzene	108-70-3	3,000	SAT
	1,3,5-Trimethylbenzene	108-67-8	250	SAT
	1,3-Dichlorobenzene	541-73-1	370	SAT
	1,3-Dichloropropane	142-28-9	1,100	SAT
	1,4-Dichlorobenzene	106-46-7	73	C
	2,2-Dichloropropane	594-20-7	NE	--
	2,2-Dimethylpentane	590-35-2	NE	--
	2,2,3-Trimethylbutane	464-06-2	NE	--
	2,3-Dimethylpentane	565-59-3	NE	--
	2,4-Dimethylpentane	108-08-7	NE	--
	2-Chlorotoluene	95-49-8	510	SAT
	2-Hexanone	591-78-6	NE	--
	2-Methylhexane	591-76-4	NE	--
	2-Nitropropane	79-46-9	0.5	C
	3,3-Dimethylpentane	562-49-2	NE	--
	3-Ethylpentane	617-78-7	NE	--
	3-Methylhexane	589-34-4	NE	--
	4-Chlorotoluene	106-43-4	NE	--
	4-Methyl-2-pentanone (MIBK)	108-10-1	17,000	SAT
	Acetone	67-64-1	100,000	SAT
	Acetonitrile	75-05-8	60,000	N
	Benzene	71-43-2	25	C
	Bromobenzene	108-86-1	690	SAT
	Bromodichloromethane	75-27-4	72	C
	Bromoform	75-25-2	430	C
	Bromomethane	74-83-9	260	N
	Carbon disulfide	75-15-0	720	SAT
	Carbon tetrachloride	56-23-5	9.8	C
	Chlorobenzene	108-90-7	690	SAT
	Chlorobromomethane	74-97-5	NE	--
	Chlorodibromomethane	124-48-1	27	C
	Chloroethane	75-00-3	1,500	C
	Chloroform	67-66-3	12	C
	Chloromethane	74-87-3	4000	SAT
	cis-1,2-Dichloroethene	156-59-2	1,200	SAT
	cis-1,3-Dichloropropene	10061-01-5	NE	--
	Cymene (Isopropyltoluene)	99-87-6	NE	--
	Dibromochloroethane	73506-94-2	NE	--
	Dibromochloropropane	96-12-8	0.41	C
	Dibromomethane	74-95-3	5,500	N
	Dichloromethane (Methylene chloride)	75-09-2	280	C
	Dimethyldisulfide	624-92-0	NE	--
	Ethanol	64-17-5	NE	--
	Ethylbenzene	100-41-4	120	C
	Freon-11 (Trichlorofluoromethane)	75-69-4	2,000	SAT
	Freon-113 (1,1,2-Trifluoro-1,2,2-trichloroethane)	76-13-1	5,600	SAT
	Freon-12 (Dichlorodifluoromethane)	75-71-8	340	SAT

TABLE 1
PRELIMINARY RECREATIONAL RISK-BASED SCREENING LEVELS (RBSLs)
(Page 8 of 8)

Parameter of Interest	Compound List	CAS Number	Recreational RBSL	
			mg/kg or pCi/g	Basis
Volatile Organic Compounds (Continued)	Heptane	142-82-5	NE	--
	Isoheptane	31394-54-4	NE	--
	Isopropylbenzene	98-82-8	650	SAT
	m,p-Xylene	mp-XYL	210	SAT
	Methyl ethyl ketone (2-Butanone)	78-93-3	34,000	SAT
	Methyl iodide	74-88-4	NE	--
	MTBE (Methyl tert-butyl ether)	1634-04-4	1100	C
	n-Butylbenzene	104-51-8	240	SAT
	n-Propylbenzene	103-65-1	240	SAT
	Nonanal	124-19-6	NE	--
	o-Xylene	95-47-6	280	SAT
	sec-Butylbenzene	135-98-8	220	SAT
	Styrene	100-42-5	1,700	SAT
	tert-Butylbenzene	98-06-6	390	SAT
	Tetrachloroethene	127-18-4	7.2	C
	Toluene	108-88-3	520	SAT
	trans-1,2-Dichloroethene	156-60-5	2500	SAT
	trans-1,3-Dichloropropene	10061-02-6	NE	--
	Trichloroethene	79-01-6	10	C
	Vinyl acetate	108-05-4	2,700	SAT
	Vinyl chloride	75-01-4	4.9	C
	Xylenes (total)	1330-20-7	210	SAT
	Tentatively Identified Compounds (TICs)		NE	--
Water Quality Parameters	Conductivity	COND	NE	--
	Hardness, total	Hardness	NE	--
	Total dissolved solids	TDS	NE	--
	Total suspended solids	TSS	NE	--
	Alkalinity, Total (as $CACO_3$)	ALK	NE	--
	Bicarbonate alkalinity	71-52-3	NE	--
	Carbonate alkalinity	3812-32-6	NE	--
	Hydroxide alkalinity	OH-ALK	NE	--
Flashpoint	Flammables	NA	NE	--
Total Petroleum Hydrocarbons	Diesel	64742-46-7	NE	--
	Mineral Spirits	8006-61-9	NE	--
	Gasoline	68153-81-1	NE	--
	Oil/Grease	NA	NE	--
White Phosphorus	White phosphorus	12185-10-3	NE	--
Methyl Mercury	Methyl mercury	22967-92-6	43	N

Note: RBSLs are based methods and exposure factors in Chapter 9 of the BRC Closure Plan (BRC *et al* . 2007), using the most recent toxicity criteria. RBSLs are the lower of either non-cancer (HI equals 1.0) or cancer (1×10^{-6}) risks for each receptor and each compound (see text).

(a) - These values are chemical-specific remediation goals, as specified in the BRC Closure Plan (BRC *et al* . 2007).

Basis: C = carcinogenicity; N = non-carcinogenicity; SAT = soil saturation.

NE = Not established (no toxicity criteria available or see text).

ATTACHMENT A

NDEP COMMENTS AND
BRC'S RESPONSE TO COMMENTS

Attachment A-1

Response to NDEP Comments Received January 17, 2010 on the Technical Memorandum Development of Recreational Risk-Based Screening Levels (RBSLs) dated December 29, 2009

1. General comment, the equations for the inhalation pathway were modified to incorporate the USEPA RAGS Part F guidance, however, it was found that the non-radionuclide equations on page 5 of the document require the following corrections in order for the units to match:
   a. The averaging time (AT) must be in units of "hours".
   b. The conversion factor of 365 days/year needs to be deleted from the numerator.
   c. Please make these corrections to the text and EXCEL calculation workbook and update Table 1 accordingly.

Response: *The term '24 hours/day' has been added to the non-radionuclide inhalation equations, consistent with RAGS Part F. This same term has been added to the calculation workbook and Table 1 has been updated accordingly.*

2. General comment, it is suggested that the recreational RBSLs for those chemical compounds listed in Table 1 that are based on special considerations be included in Table 1 and a footnote added. Currently, Table 1 does not include those values (e.g., TCDD TEQs of 50 ppt). It would provide for clarity purposes a more complete recreational RBSL table.

Response: *These values have been added to Table 1, along with a footnote explanation.*

3. General comment, a spot check of the toxicity criteria for the inhalation pathway was conducted since the calculation was modified to meet USEPA's RAGS Part F guidance. It is acknowledged that BRC used the latest version of the Basic Comparison Level (BCL) table for the toxicity criteria used in this document. No response is required.

Response: *Agreed.*

4. Introduction, paragraph 1, last sentence, and Comments #2 and #7, and response-to-comment (RTC) to both comments. The intent of this sentence is not clear. The term "this land use" appears to refer to a recreational land use (see previous sentence). Consequently, it is not correct to state "that this land use includes exposures to outdoor and construction workers". This raises much larger issues of the basis for the RBSLs. According to the formulas and spreadsheets, they appear to be based on potential 6-year exposures to children aged 7-12. Presumably the time frame of exposure can be greater than 6 years. This is the intent of previous Comment #7 (and to some extent previous Comment #5). To be more explicit, it is important to document the conceptual basis for the scenario for the calculations to be useful. What are the expected characteristics of the recreational scenario? It would seem that what is proposed limits the scenario to one of 7-12 year olds trespassing on the site. Given the proposed land use, this does not seem sufficient. The land use as presented in the Western Hook Open Spaces sampling and analysis plan (SAP) appears to be based on development of a public park. This would imply that trespassing is not the scenario of interest (unless the park will be fenced and closed to any unpaying public, for example). Instead, general public use would appear to be a more reasonable land use, which would imply a recreational scenario that covers people of all ages. Given that the park is meant to serve the local

residential area, it would seem that a more reasonable scenario is recreational to includes 6 years of a child and 24 years of an adult, consistent with the residential scenario for the surrounding areas. Regarding previous Comment #2, and given the above discussion, it seems reasonable that a risk assessment at this sub-area will involve evaluation of recreational, outdoor maintenance worker, and construction workers scenarios. This does not mean that the recreational land use includes exposures to outdoor and construction workers. In which case, the sentence that is the initial subject of this comment needs to be revised. Preferably it will be revised with a discussion of the land use and scenario of interest here that would provide defense for the inputs to the RBSLs calculations (this should be included in the CSM section).

Response: *A recreational land use does not preclude exposures to receptors beyond a recreational user at the site. Other receptors may also be exposed, included, as noted in the text, construction workers and outdoor maintenance workers. This is consistent with the conceptual site model for the project. The sentence has been revised to read "It should be noted that although this land use will also include exposures to outdoor maintenance and construction workers, the focus of this technical memorandum is the development risk-based screening levels (RBSLs) for recreational user exposures."*

Regarding the exposure duration, the recreational exposure scenario has been revised to reflect a 30 year exposure duration; six years as a child and 24 years as an adult, similar to the residential exposure scenario.

5. Introduction, 3rd paragraph, inserted redline sentence, NDEP comments as follows:
   a. Please change "are" to "is" in the 1st sentence (change "The use of these recreational RBSLs are…" to "The use of these recreational RBSLs is…").
   b. In Item #2 change "as per this SAP" It is not clear to which SAP this sentence is referring – for example, "this" is not a SAP, "this" is an RBSLs document. Please clarify.
   c. Item #2 states "evaluate new data collected as per this SAP, which will be used for internal BRC purposes….". What will be "used". There are options – it could be the new data, it could be this SAP, but it is probably meant to be the RBSLs. Please clarify.
   d. This sentence goes on to refer to a "closure report" – such reports are not part of the Closure Plan process. Reference should be made instead to a human health risk assessment report

Response: *These edits have been made to the text on page 2.*

6. Introduction, 4th paragraph, 1st sentence. The reference to "standard exposure factors" is potentially misleading. There are no standard assumptions regarding key factors such as daily time and annual frequency of exposure for recreational activities. The table of exposure parameters in the memo lists "professional judgment" as the basis for these values. Please clarify that the exposure factors are site-specific, based on both standard practice and best professional judgment.

Response: *These edits have been made to the text on page 2.*

7. Page 8, perhaps a reason can be noted for why RBSLs have not been developed for TPH, specifically the changes that have been made recently to the Nevada Revised Statutes.

Response: *The following text has been added to this bullet: "This is consistent with NDEP's BCLs, in which the indicator chemicals for common petroleum hydrocarbon mixtures are evaluated, as is done in this technical memorandum."*

8. Page 8, Summary, 2nd last sentence. Change "development" to "develop".

Response: *This edit has been made to the text on page 7.*

9. Tables and Equations. Subscripts are used on various factors in the exposure parameters Table starting on Page 3. However, the same subscripts are not used in the Equations. In some cases subscripts have been changed to lower case characters, and in other cases different subscripts have been used. Please make consistent.

Response: *The exposure parameter abbreviations have been made consistent between the table and equations.*

10. Exposure parameters Table. The units for "available skin surface area" should be cm^2, rather than cm^2/day.

Response: *This edit has been made to the text on page 4.*

11. The ingestion equations (non-radionuclides) do not include a factor for bioavailability. However, a bioavailability factor is used in the RBSL spreadsheet. The value is 1 for all chemicals expect arsenic, for which it is 0.3. Note that the NDEP BCLs do not include a bioavailability factor for arsenic, so that effectively the value is 1 for all chemicals. For consistency, it is preferable that the bioavailability factor not be included in the RBSL calculations.

Response: *The bioavailability term has been added to the non-radionuclide soil ingestion equations. As discussed and agreed with NDEP in the teleconference on January 21, because the RBSLs are project-specific and are based on the BRC Closure Plan, the bioavailability value for arsenic cited in the Closure Plan is used for the RBSL calculations.*

12. In the ingestion carcinogenic equation 10^{-6} kg/mg is also a conversion factor and should be listed as such for consistency with other uses of the term CF.

Response: *This edit has been made to the text on pages 4 and 5.*

13. For the non-radionuclide inhalation equations there is a problem with the units. Because ET is included at 4 hours/day, a further factor is needed in the numerator (24 hours/day) to put overall averaging time on an hourly basis.

Response: *The exposure time parameter, in hours per day, is accounted for by the inhalation rate, which is in units of cubic meters per hour.*

Attachment A-2

Response to NDEP Comments Received August 8, 2009 on the Technical Memorandum – Development of Recreational Risk-Based Screening Levels (RBSLs) dated May 20, 2009

1. General comment, the document provides insufficient detail to permit a thorough review. Additional documentation regarding the application of the RBSLs, potentially complete exposure pathways and receptors, and rationale for the selection of exposure parameter values is needed.

Response: *As noted in the second paragraph of the technical memorandum: "…this technical memorandum presents risk-based screening levels (RBSLs) developed for a recreational exposure scenario; an exposure scenario not covered by NDEP's BCLs. It is important to note that these recreational RBSLs were not developed to represent action levels or final cleanup levels but rather as a simple screening tool to assist in site characterization activities only. Risk assessments will be conducted at all areas of the Site, which will be used for decision-making purposes." As noted in the cover letter to this revision of the technical memorandum, and based on discussions between BRC and the NDEP, BRC is not providing significant textual additional information in this technical memorandum regarding the application of the recreational RBSLs.*

2. Page 1, Introduction, recreational risk-based screening levels (RBSLs) are appropriate as a screening tool for scenarios where, of all potential receptors, recreational receptors would have the highest exposure. Please document whether the described recreational scenarios would include an outdoor worker receptor such as a landscape or maintenance worker (e.g., installing and maintaining trails, foliage, etc.).

Response: *Agreed. The following has been added to the end of the first paragraph: "It should be noted that this land use will also include exposures to outdoor and construction workers. As noted below, risk assessment will be conducted at all areas of the Site, which will include these receptors."*

3. Page 1, Introduction, 1st and 2nd paragraphs, the intended uses of the RBSLs ("for the comparison of historical Site data in the development of Sampling and Analysis Plans" and "to assist in site characterization activities") are vague. Please discuss if the RBSLs are to be used to screen historical data in order to determine whether residual concentrations warrant additional site characterization. Though not stated, perhaps a second use is to establish analytical quantitation limits for new sampling. To facilitate review of the methodology, please be explicit about how the RBSLs are intended to be used.

Response: *These RBSLs will <u>not</u> be used to establish different analytical quantitation limits than those that have already been established in the project QAPP. The following sentence has been added to the second paragraph: "The use of these recreational RBSLs are limited to the Western Hook-Open Space sub-area SAP to (1) provide context for historical data collected at this sub-area; and (2) evaluate new data collected as per this SAP, which will be used for internal BRC purposes only to determine if additional remediation is warranted prior to preparation of the closure report for this sub-area." It should be noted that the Open Space SAP has already been approved and implemented. Therefore, these recreational RBSL will now only be used for (2).*

4. Page 2, Conceptual Site Model, according to the document, groundwater exposure was considered an incomplete pathway for recreational users because groundwater will not be used as a potable or non-potable water source on-site in the post-redevelopment stage. Therefore, the recreational RBSLs were developed for soil exposures only. However, the Closure Plan (BRC, 2007) identifies inhalation of volatile organic compounds (VOCs) and radon emitted from groundwater as a potentially complete exposure pathway for recreational users. In addition, the Closure Plan identifies surface water exposure as a potentially complete pathway for recreational receptors. Please provide in the narrative of the document supporting rationale for the elimination of these additional exposure pathways that are identified in the Closure Plan but not addressed by the proposed RBSLs (e.g., inhalation of VOCs and radon from groundwater and surface water exposures).

Response: *These RBSLs have been developed for soil exposures only. The phase 'for soil' has been added to the first sentence of the second paragraph. The inhalation of VOCs and radon emitted from groundwater will be evaluated via either surface flux or soil gas measurements. Therefore, although this pathway will factor into cumulative risks evaluated in the risk assessment for the site, it does not factor into the development of recreational RBSLs for soil. No on-site surface waters exist or are proposed as part of the development for the site. Therefore, this is considered an incomplete exposure pathway and does not factor into the development of recreational RBSLs for soil.*

5. Page 2, Exposure Parameters and Pathways, according to the document, the exposure pathway equations from the Closure Plan were used to derive the proposed recreational RBSLs. However, the RBSLs are derived based on modifications to the Closure Plan equations similar to those found in the NDEP Basic Comparison Levels (BCLs) Guidance Document (June 2009). Accordingly, please provide in the text the specific equations used to derive the RBSLs. Also, please include the age of the recreational receptor and provide rationale that this recreational receptor would have the highest exposure. In addition, since the development of the Closure Plan, the United States Environmental Protection Agency (USEPA) has published recent guidance on quantifying inhalation exposures (Risk Assessment Guidance for Superfund, (RAGS) Part F) (USEPA, 2009a). The BCLs have been updated to incorporate this approach. It is recommended that future documents incorporate USEPA's latest guidance.

Response: *The equations for the recreational RBSLs have been provided on pages 4 through 7. The exposure parameters are based on children from 7 to 12 years of age. This age range and the exposure factors are based on professional judgment and extensive discussions with NDEP during the Closure Plan development process. The following has been added to page 3:*

> *U.S. Environmental Protection Agency (USEPA) standard exposure parameters are not generally available for recreational/trespasser exposure scenarios. The parameters listed in the table below have been developed jointly between BRC and NDEP in discussion during the development of the BRC Closure Plan. The parameters are based on, for example, USEPA (1989) statements such as "Consider population characteristics that might influence variable values. Exposure duration (ED) may be less for workers and recreational users." (regarding incidental ingestion exposures), and "Exposure duration (ED) and exposure frequency (EF) may be lower for workers and recreational users." (regarding dermal contact exposures). For this project, the recreational user/trespasser exposures are based on children from 7 to 12 years of age. Again, these parameters were developed in consultation*

with NDEP during the BRC Closure Plan development process. Although other recreational user/trespasser exposure parameters could certainly be used, these values are considered applicable and appropriate for the Site.

In addition, the inhalation exposures have been revised to reflect recent USEPA's guidance (RAGS Part F).

6. Page 3; parameter value table, body weight, the value of 31 kg is not explained. Presumably, this indicates that the recreational receptor is an older child, however, this requires clarification.

Response: *As noted above, this is based on children from 7 to 12 years of age. This value has been changed to 32.9 kg, consist with USEPA guidance (that is, average body weights for both males and females from USEPA's 1997 Exposure Factors Handbook).*

7. Page 3; parameter value table, exposure duration. The accompanying Microsoft Excel workbook indicates the value of 6 years is also used for carcinogenic effects. This does not appear appropriate for computing recreational RBSLs for carcinogenic effects. If a residential scenario exposure duration is 30 years, and if nearby residents are (presumably) the population from which recreational receptors are drawn, why is the recreational exposure duration for carcinogenic effects only 6 years?

Response: *See response to comment #5 above.*

8. Page 3; parameter value table, inhalation rate. Current USEPA guidance (RAGS Part F) for calculating chemical hazard and cancer risk for inhalation exposures does not employ an inhalation rate term.

Response: *See response to comment #5 above.*

9. Page 3; parameter value table, area correction factor, please provide supporting information for this parameter.

Response: *This value has been changed to 1.0, to reflect recent changes to the Closure Plan.*

10. Page 3; parameter value table, gamma shielding factor, please discuss what structure is assumed to exist that would provide shielding for a recreational receptor.

Response: *This value has been removed from the calculations.*

11. Page 3; Exposure Parameters and Equations section; last sentence, please explain if this sentence implies that a calculated Volatilization Factor (VF) that exceeds the soil saturation concentration (Csat) was used to compute RBSLs. If so, such an approach would be indefensible because the calculated value has no validity. USEPA methodology for developing Regional Screening Levels uses this approach: SSL = Csat for VOCs with VF > Csat that are liquids at ambient temperatures. SSL excludes the inhalation pathway for

VOCs with VF > Csat that are solids at ambient temperatures. This is also the method described in NDEP's BCL User's Guide. Please clarify.

Response: *The sentence (and approach) regarding soil saturation concentration has been changed to: "When the RBSL for a volatile organic compound (VOC) exceeds its soil saturation limit (as listed in NDEP's BCL tables), the recreational RBSL is based on the soil saturation limit."*

12. Page 3; Toxicity Values section. This section does not address criteria for radionuclides.

Response: *Toxicity values from NDEP's BCL tables have been used in the revised report. Reference to the NDEP BCL table is provided on page 7.*

13. Page 3, Toxicity Values, in future submittals, please provide a table within the main body of the document that identifies the toxicity criteria for the site-related chemicals (SRCs) as well as the appropriate citation. We were unable to verify several of the chemical-specific toxicity criteria based on a comparison to the latest BCL table (e.g., ethylbenzene, magnesium, manganese, mercury).

Response: *Toxicity values from NDEP's BCL tables have been used in the revised report. Reference to the NDEP BCL table is provided on page 7.*

14. Page 4; Special Considerations, 5th bullet. California EPA has published carcinogenic equivalency factors for PAHs in 2005, which is considerably more recent than the 1993 USEPA provisional factors. Adoption of these more recent values for risk assessment related to carcinogenic PAHs should be considered. Please discuss.

Response: *Toxicity values from NDEP's BCL tables have been used in the revised report. Reference to the NDEP BCL table is provided on page 7. The 'Special Considerations' section has been revised accordingly.*

REDLINE/STRIKE-OUT TEXT

Basic Remediation COMPANY

TECHNICAL MEMORANDUM

To: Brian Rakvica (NDEP)

From: Ranajit Sahu (BRC)

cc: Jim Najima (NDEP)
Mark Jones (ERM)

Date: February 1, 2010~~December 29, 2009~~

Subject: Technical Memorandum – Development of Recreational Risk-Based Screening Levels (RBSLs), BMI Common Areas (Eastside) Site, Clark County, Nevada

Introduction

The Nevada Division of Environmental Protection (NDEP) has developed Basic Comparison Levels (BCLs) that address common human receptors and exposure pathways (NDEP 2009). These receptors include residential, and indoor and outdoor workers. Basic Remediation Company (BRC) has used these BCLs at the BMI Common Areas (Eastside) Site for the comparison of historical Site data in the development of Sampling and Analysis Plans (SAPs) for the project. However, one of the questions asked in the BCL User's Guide is whether there is potential for land use other than those covered by the BCLs. The objective of this technical memorandum is to address this issue. That is, there are portions of the project that will not be developed for unrestricted residential uses. Rather these areas will be developed for recreational purposes only (specifically, the Western Hook-Open Space sub-area of the project). It should be noted that although this land use will also include exposures to outdoor maintenance and construction workers, the focus of this technical memorandum is the development risk-based screening levels (RBSLs) for recreational user exposures. As noted below, risk assessment will be conducted at all areas of the Site, which will include outdoor maintenance and construction worker ~~these~~ receptors.

This revision of the technical memorandum, Revision 2~~1~~, incorporates 1) comments received from the NDEP, dated January 17, 2010, on Revision 1 of the technical memorandum, dated December 29, 2009, and 2) comments received from the NDEP, dated August 8, 2009, on Revision 0 of the technical memorandum, dated May 20, 2009. The NDEP comments and BRC's response to these comments are included in Attachment A. Also included in Attachment A is a redline/strikeout version of the text showing the revisions from the December 29~~May 20~~, 2009 version of the technical memorandum. An electronic version of the entire technical memorandum, as well as original format files (MS Word and MS Excel) of all text, tables and calculations are included in Attachment B.

Therefore, this technical memorandum presents ~~risk-based screening levels (~~RBSLs~~)~~ for soil developed for a recreational exposure scenario; an exposure scenario not covered by NDEP's BCLs. It is important to note that these recreational RBSLs were not developed to represent action levels or final cleanup levels but rather as a simple screening tool to assist in site characterization activities only. The use of these recreational RBSLs is ~~are~~ limited to the Western Hook-Open Space sub-area SAP to (1) provide context for historical data collected at this sub-area; and (2) evaluate new data collected as per the Western Hook-Open Space sub-area ~~this~~ SAP. These recreational RBSLs~~, which~~ will be used for internal BRC purposes only to determine if additional remediation is warranted prior to preparation of the human health risk assessment~~closure report~~ for this sub-area. Ultimately, risk assessments will be conducted at all areas of the Site, which will be used for decision-making purposes.

Similar to NDEP's BCLs, the recreational RBSLs contain current human health toxicity values that are combined with site-specific ~~standard~~ exposure factors (based on both standard practice and best professional judgment) to estimate contaminant concentrations in environmental soil that are considered to be protective of human exposures (including sensitive sub-groups) over a lifetime for typical recreational activities. The methodology, input factors, and equations used in the development of these recreational RBSLs are from the human health risk assessment methodology chapter of the BRC Closure Plan (BRC *et al*. 2007; Chapter 9 updated December 2009). For each of the chemicals on BRC's site-related chemical (SRC) list, recreational RBSLs are back-calculated from target risk levels. 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.

Conceptual Site Model

The conceptual site model (CSM) is a tool used in risk assessment to describe relationships between chemicals and potentially exposed human receptor populations, thereby delineating the relationships between the suspected sources of chemicals identified at the site, the mechanisms by which the chemicals might be released and transported in the environment, and the means by which the receptors could come in contact with the chemicals.

Under the current, prospective redevelopment plan, the Site will be used for a variety of purposes, including residential housing, parks, schools, places of worship, commercial and/or light industrial development, and streets. Many potential human receptors are possible at the Site in the period during and after redevelopment. Because the background general water quality (*i.e.*, high salt concentrations) of the groundwater beneath the Site and in the surrounding area is poor

and because BRC will place institutional controls in the form of a deed restriction to prevent future users from utilizing groundwater beneath the Site, the use of private water wells by residents, businesses, or parks for drinking water, irrigation water, or other non-potable uses (*e.g.*, washing cars, filling swimming pools) will not occur in the post-redevelopment phase. Therefore, exposure pathways relating to this type of use are incomplete and are not included in the development of recreational RBSLs. That is, recreational RBSLs have been developed for soil exposures only.

The following presents the primary exposure pathways to soil for potential recreational receptors at the Site.

- incidental soil ingestion
- external exposure from soil (radionuclides only)
- dermal contact with soil
- outdoor inhalation of dust

Exposure Parameters and Equations

As discussed above, all input factors and equations used in the development of these recreational RBSLs are from the human health risk assessment methodology chapter of the BRC Closure Plan (BRC *et al*. 2007; Chapter 9 updated December 2009).

U.S. Environmental Protection Agency (USEPA) standard exposure parameters are not generally available for recreational/trespasser exposure scenarios. The parameters listed in the table below have been developed jointly between BRC and NDEP in discussion during the development of the BRC Closure Plan. The parameters are based on, for example, USEPA (1989) statements such as "Consider population characteristics that might influence variable values. Exposure duration (ED) may be less for workers and recreational users." (regarding incidental ingestion exposures), and "Exposure duration (ED) and exposure frequency (EF) may be lower for workers and recreational users." (regarding dermal contact exposures). For this project, the recreational user/trespasser exposures are based on children from 7 to 12 years of age. Again, these parameters were developed in consultation with NDEP during the BRC Closure Plan development process. Although other recreational user/trespasser exposure parameters could certainly be used, these values are considered applicable and appropriate for the Site. The exposure factors used are:

Parameter	Abbrev.	Value	Units	Reference
Dermal absorption fraction	ABS	---chemical-specific---		NDEP 2009
Dermal adherence factor, adult	AF_a	0.07~~2~~	mg/cm^2	USEPA 2002
Dermal adherence factor, child	AF_c	0.2	mg/cm^2	USEPA 2002
Averaging time, carcinogenic	AT_c	70	years	USEPA 2002
Averaging time, non-carcinogenic	AT_{nc}	6	years	Based on ED_t
Body weight, adult	BW_a~~BW_r~~	70~~32.9~~	kg	USEPA 2002~~(1)~~
Body weight, child~~Exposure time~~	BW_c~~ET~~	15~~4~~	kg~~hrs/day~~	USEPA 2002~~Professional judgment~~
Exposure time~~frequency~~	ET_r~~EF_r~~	~~4~~50	hrs/day~~days/year~~	Professional judgment
Exposure frequency~~duration~~	EF_r~~ED_r~~	50~~6~~	days/year~~years~~	USEPA 1997 (1)
Exposure duration~~Available skin surface area~~	ED_r~~SA_r~~	30~~,200~~	years~~cm^2/day~~	USEPA 2002~~2004~~
Available skin surface area, adult~~Soil ingestion rate~~	SA_a~~$IR_{s,r}$~~	5,700~~100~~	cm^2~~mg/day~~	USEPA 2004~~1997~~
Available skin surface area, child	SA_c	2,800	cm^2	USEPA 2004
Soil ingestion rate, adult	IR_{sa}	100	mg/day	USEPA 1997
Soil ingestion rate, child	IR_{sc}	200	mg/day	USEPA 1997
Radionuclide-specific factors				
Inhalation rate, adult	$IR_{aa,r}$	1.6~~0.833~~	m^3/hour	USEPA 1997 (2)~~2002~~
Inhalation rate, child	IR_{ac}	1.2	m^3/hour	USEPA 1997 (2)
Area correction factor	ACF	1.0	unitless	USEPA 2000

(1) Based on average of mean time spent in outdoor recreation for ages 5~~children aged 7~~ to 11 and 18 to 64 (USEPA 1997; Table 5-86) and time spent in 'Other Locations' for both all and doers (USEPA 1997; Table 5-14).

(2) Based on short-term exposures, moderate activities (USEPA 1997; Table 5-23).~~12 years. Average body weight from USEPA (1997).~~

The equations for calculating the carcinogenic risk or non-cancer hazard by exposure pathway, as well as the combined risk from all exposures for the scenario, are provided below and electronically in Attachment B. Note that inhalation exposures of non-radionuclides were calculated based on USEPA's recent *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment*) (USEPA 2009).

Ingestion of Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{TR \times BW \times AT \times 365 days/year}{CSF \times EF \times ED \times IRs \times 10^{-6} kg/mg} \quad \text{or}$$

$$RBSL\,(pCi/g) = \frac{TR \times CF}{CSF \times EF \times ED \times IRs}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (years)
BW = Body weight (kg)
BIO = Oral bioavailability factor (chemical specific)
CF = Conversion factor (1×10^{-6} kg/mg) or (1×10^{-3} g/mg for radionuclides)
CSF = Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$ or (risk/pCi for radionuclides)
~~CF = Conversion factor (1,000 mg/g)~~
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
IRs = Soil ingestion rate (mg/day)

Ingestion of Non-Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{THQ \times BW \times AT \times 365 days/year}{\frac{1}{RfD} \times EF \times ED \times IRs \times 10^{-6}\,kg/mg}$$

where:

THQ = Target hazard quotient of 1
BW = Body weight (kg)
AT = Averaging time (years)
BIO = Oral bioavailability factor (chemical specific)
CF = Conversion factor (1×10^{-6} kg/mg)
RfD = Oral reference dose (mg/kg-day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
IRs = Soil ingestion rate (mg/day)

Inhalation of Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{TR \times AT \times 365 days/year}{IUR \times ET \times EF \times ED \times CF \times \left[\frac{1}{PEF}\ or\ \frac{1}{VF}\right]} \text{ or}$$

$$RBSL\,(pCi/g) = \frac{TR \times PEF \times CF}{CSF \times ET \times EF \times ED \times IRa}$$

where:

TR = Target risk of 10^{-6}
AT = Averaging time (years)
IUR = Inhalation unit risk $(\mu g/m^3)^{-1}$ (non-radionuclides)
CSF = Cancer slope factor for inhalation exposure (risk/pCi) (radionuclides)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)

ED = Exposure duration (years)
CF = Conversion factor (1,000 µg/mg) or (0.001 kg/g for radionuclides)
IRa = Inhalation rate (m^3/hour)
PEF = Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF = Volatilization factor used for volatile organic chemicals (VOCs; m^3/kg)

Inhalation of Non-Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{THQ \times AT \times 365 days/year}{\frac{1}{RfC} \times ET \times EF \times ED \times \left[\frac{1}{PEF} \text{ or } \frac{1}{VF}\right]}$$

where:

THQ = Target hazard quotient of 1
AT = Averaging time (years)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
RfC = Inhalation reference concentration (mg/m^3)
PEF = Particulate emission factor used for dusts (1.2×10^9 m^3/kg)
VF = Volatilization factor used for volatile organic chemicals (VOCs; m^3/kg)

Skin Contact with Carcinogenic Contaminants (Non-Radionuclides):

$$RBSL\,(mg/kg) = \frac{TR \times BW \times AT \times 365 days/year}{CSF \times EF \times ED \times SA \times AF \times ABS \times 10^{-6} kg/mg}$$

where:

TR = Target risk of 10^{-6}
BW = Body weight (kg)
AT = Averaging time (years)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CSF = Oral cancer slope factor (mg/kg-day)-1
SA = Surface area exposed (cm^2/day)
AF = Adherence factor (mg/cm^2)
ABS = Skin absorption (chemical specific)

Skin Contact with Non-Carcinogenic Contaminants:

$$RBSL\,(mg/kg) = \frac{THQ \times BW \times AT \times 365 days/year}{\frac{1}{RfD} \times EF \times ED \times SA \times AF \times ABS \times 10^{-6} kg/mg}$$

where:

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

External Irradiation (Radionuclides Only):

$$RBSL\ (\ pCi/g) = \frac{TR}{CSF \times ET \times EF \times ED \times ACF}$$

where:

TR	=	Target risk of 10^{-6}
CSF	=	Cancer slope factor for external exposure (risk /yr per pCi/g)
CF	=	Conversion factor (0.000114 yr/hr)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
ACF	=	Area correction factor

Recreational Soil RBSLs for Combined Exposure Pathways:

$$RBSL\ (\ mg/kg) = \frac{1}{\frac{1}{ingestion} \times \frac{1}{dermal} \times \frac{1}{inhalation}} \text{ or } RBSL\ (\ pCi/g) = \frac{1}{\frac{1}{ingestion} \times \frac{1}{external} \times \frac{1}{inhalation}}$$

Volatilization factors, particulate emission factors, dermal absorption factors and soil saturation limits were obtained from NDEP's BCL table. When the RBSL for a VOC exceeds its soil saturation limit (as listed in NDEP's BCL tables), the recreational RBSL is based on the soil saturation limit.

Toxicity Values

Toxicity values were obtained from NDEP's BCL tables (NDEP 2009).

Special Considerations

There are several analytes for which there are special circumstances that were considered in the development of recreational RBSLs. These are as followings:

- Asbestos – Recreational RBSLs have not been developed for asbestos.
- Lead – The residential BCL for lead of 400 mg/kg is used as the recreational RBSL.
- Dioxins/Furans – The Agency for Toxic Substances and Disease Registry (ATSDR) screening value of 50 parts per trillion (ppt), and NDEP residential soil BCL, is used as the recreational RBSL for the dioxins/furans toxic equivalency (TEQ).
- Total Petroleum Hydrocarbons (TPH) – Recreational RBSLs have not been developed for TPH. This is consistent with NDEP's BCLs, in which the indicator chemicals for common petroleum hydrocarbon mixtures are evaluated, as is done in this technical memorandum.
- Radionuclides - Recreational RBSLs have only been developed for the eight radionuclides on the current project analyte list (radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-233/234, uranium-235/236, and uranium-238).

Summary

In summary, this technical memorandum presents RBSLs developed for a recreational exposure scenario; an exposure scenario not covered by NDEP's BCLs. These recreational RBSLs were developed as a simple screening tool to assist in historical site characterization activities only. Table 1 presents the recreational RBSLs that have been developed~~development~~ for the project. Attachment B is an electronic version of the recreational RBSL calculation spreadsheet.

ATTACHMENT B

RECREATIONAL RBSL CALCULATION SPREADSHEETS