RBCA

STATE RISK POLICY/ STRATEGY ISSUES

WORKBOOK

PREPARED BY

NAME

STATE AGENCY

DATE COMPLETED

RBCA STATE RISK POLICY / STRATEGY ISSUES WORKBOOK

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INSTRUCTIONS:

This Workbook is intended to assist the State Agency in formulating its position on various policy issues that relate to development of a risk-based corrective action (RBCA) program. The principal steps of the RBCA planning process and related terminology, as presented herein, are defined in ASTM ES 38-94 "Emergency Standard for Risk-Based Corrective Action at Petroleum Release Sites." In this Workbook, major risk policy issues are identified, and components of each issue are outlined for purpose of discussion. Technical references providing background information and/or guidance on the various issues are identified for further research (see Attachment A of this Workbook.) The Agency is encouraged to use the Workbook to help focus discussion and decisions on the various issues. Additional space for notes and comments is provided at the end of the document.

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SITE CLASSIFICATION SCHEME

To provide a rational basis for resource allocation, define a risk-based system which categorizes sites according to the relative risk posed to public health and the environment. In constructing the system, site classes (e.g., Class 1, 2, 3, etc.) are established according to the general magnitude and immediacy of potential threat (e.g., high-risk, near-term vs. low-risk, long-term). Within each class, sites are i) characterized based upon a descriptive scenario and ii) assigned an appropriate response action to be implemented on an expedited basis. The classification system must identify both acute ***(i.e., immediate) and*** chronic ***(i.e., long-term) hazards to life or health.***

Under the RBCA process, risk-based cleanup standards are developed to protect against chronic health or environmental impacts, i.e., carcinogenic or toxic effects caused by long-term exposure to low levels of contaminants. Such analysis is appropriate only after any and all acute hazards (e.g., fire, explosion, IDLH vapor levels) or near-term impacts (e.g., impending plume discharge to supply well) associated with the site have been identified and properly controlled. For this purpose, the site classification / response scheme must address all near-term or acute hazards prior to analysis of media cleanup standards (Tier 1, 2, 3 evaluation). Types of acute hazards (i.e., ASTM Class 1 condition) that might be encountered at a petroleum release site include explosive vapor levels, utility impacts, presence of free-phase hydrocarbon on soil or surface water, or contaminant release to a public water supply. Response actions should also be designated for near-term chronic hazards (Class 2 condition) and long-term chronic hazards (Class 3 condition) to ensure that pending impacts are properly managed during the period of additional site evaluation.

DESCRIPTION OF EXISTING AND / OR PROPOSED SYSTEM :

DISCUSSION/ACTION ITEMS :
(Adequacy of existing / proposed system for identifying high vs. low risk sites; definition of response actions for both acute and chronic hazards; necessary modifications, etc.) :

APPLICABLE REFERENCES: 1, Texas RBCA Program

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CHEMICALS OF CONCERN

Identify specific site constituents that must be evaluated in the risk assessment process due to their potential toxicity and environmental mobility (i.e., potential to reach receptors). Note that analytes for which toxicological data are not available will not serve to quantify risk. Define any other approaches (e.g., whole product toxicity) that may be employed.

SPECIFIC CONSTITUENT APPROACH:

- Chemicals of Concern (list analytes to quantify risk):

OTHER APPROACH (DISCUSS APPLICABILITY AND PROPOSED METHOD):

- Whole Product Toxicity:

- Surrogate Approach:

DISCUSSION / ACTION ITEMS:

APPLICABLE REFERENCES: 1 (Also, the states of NJ, CA, and MA have developed guidance on this issue.)

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TARGET RISK LIMITS

Establish the upper boundaries of acceptable excess cancer risk and toxic effects (above background). Based upon estimated exposure concentrations, carcinogenic risk is calculated as the potential for a person to develop cancer over a lifetime as a result of exposure to individual or multiple constituents. The target excess risk limit is typically specified in the range of 10^{-4} to 10^{-6}. For evaluation of possible effects of systemic toxicants, an upperbound hazard quotient (e.g., 1.0) is specified, defining the ratio of the anticipated intake rate to the threshold level for toxic effects. For multiple constituents, a hazard index (e.g., 1.0) is specified as the upperbound sum of hazard quotient values for compounds affecting the same organ. Health-based risk limits may be varied according to land use, type of carcinogen, probability of exposure, etc. In addition to target risks, the Agency may choose to apply upperbound limits for non-health-based criteria (e.g., aesthetic standards such as odor, appearance, etc.) that may affect the future utility of the property even if no health risk is posed.

TIER	INDIVIDUAL CONSTITUENTS		CUMULATIVE CONSTITUENTS	
	Carcinogenic Risk Limit	Hazard Quotient (HQ)	Carcinogenic Risk Limit	Hazard Index (HI)
■ Tier 1 RBCA:	❑ 10^{-4} ❑ 10^{-5} ❑ 10^{-6} ❑ Range: 10^{-4} - 10^{-6} (explain below)	❑ HQ ≤ 1 ❑ Other: HQ ≤ _____	Not applicable	Not applicable
■ Tier 2 RBCA:	❑ 10^{-4} ❑ 10^{-5} ❑ 10^{-6} ❑ Range: 10^{-4} - 10^{-6} (explain below)	❑ HQ ≤ 1 ❑ Other: HQ ≤ _____	❑ 10^{-4} ❑ 10^{-5} ❑ 10^{-6} ❑ Range: 10^{-4} - 10^{-6} (explain below) ❑ Not Applicable	❑ HI ≤ 1 ❑ Other: HI ≤_____ ❑ Not Applicable

TIER 1 LIMITS

- Allowable Variables:
  ❑ None ❑ Land Use ❑ Carcinogen Type ❑ Actual vs. Potential Receptor ❑ Other: _____
- Describe Criteria for Selection of Applicable Risk Limit:

TIER 2 LIMITS

- Allowable Variables:
  ❑ None ❑ Land Use ❑ Carcinogen Type ❑ Actual vs. Potential Receptor ❑ Other: _____
- Describe Criteria for Selection of Applicable Risk Limit:

APPLICABILITY OF NON-HEALTH-BASED CRITERIA

(Upperbound limits for aesthetic considerations, NAPL removal, etc.)

APPLICABLE REFERENCES: 7, 28

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LAND USE CRITERIA

Land use designations (e.g., residential, industrial, agricultural) define the types of activities likely to occur at a site and can therefore be used to characterize possible pathways of exposure to chemicals present at the site. To develop site-specific cleanup standards, the Agency must i) identify those land uses which warrant use of different target risks or exposure factors and ii) specify how current and anticipated future land use is to be established and documented for a given site. For some land use activities, exposure limits may exist under current state or federal regulations (e.g., OSHA Permissible Exposure limits for commercial/industrial workplace vapors, MCLs for public water supply point-of-use, etc.). For the purpose of consistency, agency may choose to apply such limits in place of the target risk goals, where applicable.

TIER 1 EVALUATION:

- **Land Uses Warranting Different Target Risks or Exposure Factors:**

  ❑ Residential ❑ Commercial / Industrial ❑ Agricultural ❑ Recreational ❑ Sensitive Habitat

- **Applicability of Other Use-Specific Exposure Limits**

  ❑ Commercial / Industrial OSHA PELS, TLVs ❑ Public Water Supply MCLs

  ❑ Other _____

TIER 2 ANALYSIS:

- **Land Uses Warranting Different Target Risks or Exposure Factors:**

  ❑ Residential ❑ Commercial / Industrial ❑ Agricultural ❑ Recreational ❑ Sensitive Habitat

- **Applicability of Other Use-Specific Exposure Limits**

  ❑ Commercial / Industrial OSHA PELS, TLVs ❑ Public Water Supply MCLs

  ❑ Other _____

DISCUSSION/ACTION ITEMS (Specify applicable risk limits, basis for land use designation, etc.):

APPLICABLE REFERENCES: 20, 21, 31

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ADDITIVITY OF RISKS OR TOXIC EFFECTS

Define a mechanism to account for exposure to multiple chemicals. Note, however, that additivity may not always be scientifically appropriate. For carcinogens, the potential for carcinogenic effects is typically added within a single pathway to give the total risk. For non-carcinogens, however, the effects of different chemicals should be added only if the chemicals act on the same target organ and/or by the same mechanism of action. For both carcinogens and non-carcinogens, summation of different exposure pathways (e.g., air inhalation vs. water ingestion) may not be deemed appropriate due to portal-of-entry concerns and differences in absorption in the gut versus the lungs.

GUIDELINES FOR ADDING CHEMICAL EFFECTS IN SAME PATHWAY:

GUIDELINES FOR ADDING SEPARATE PATHWAYS:

DISCUSSION/ACTION ITEMS:

APPLICABLE REFERENCES: 9

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POTENTIAL EXPOSURE PATHWAYS FOR GIVEN SOURCE MEDIUM

An exposure pathway is a step (direct exposure) or series of steps (indirect exposure) by which a chemical of concern present at a site can reach an individual or population. Each exposure pathway includes a source, an exposure point, and an exposure route. In order to pose risk, an exposure pathway must be complete, demonstrating the potential for a link between the chemical of concern and the receptor. Examples of potentially applicable pathways, organized according to the type of source media, are listed below. Selection of pathways that must be addressed under a Tier 1 or Tier 2 RBCA evaluation should be based on the Agency's experience with the types of exposure problems commonly encountered at sites. (Note that utility impacts, although common, do not represent a chronic health exposure and are therefore not listed below. Such acute explosion hazards should be addressed in the classification/interim response phase of the RBCA evaluation.)

SOURCE MEDIUM	EXPOSURE MEDIUM	EXPOSURE PATHWAY	TIER 1	TIER 2
Air	Air	• Inhalation of Ambient Vapors	❑	❑
Groundwater	GW	• Ingestion (Potable Groundwater Supply Only)	❑	❑
	Air	• Enclosed-Space (Indoor) Vapor Inhalation	❑	❑
	Air	• Ambient (Outdoor) Vapor Inhalation	❑	❑
Surficial Soil	Soil	• Ingestion of Soil	❑	❑
	Soil	• Dermal Contact	❑	❑
	Air	• Inhalation of Ambient Vapors and Particulates	❑	❑
	GW	• Leaching to Groundwater/Potable Water Ingestion	❑	❑
	Air/Soil	• Construction Worker: Ingestion of Soil, Inhalation of Vapors and Particulates, and Dermal Contact	❑	❑
Sub-Surface Soil	Air	• Ambient (Outdoor) Vapor Inhalation	❑	❑
	Air	• Enclosed Space (Indoor) Vapor Inhalation	❑	❑
	GW	• Leaching to Groundwater/Potable Water Ingestion	❑	❑
	Air/Soil	• Construction Worker: Ingestion of Soil, Inhalation of Vapors and Particulates, and Dermal Contact	❑	❑

EXPOSURE CONDITIONS

Define conditions under which chronic human exposure to affected soil or groundwater can be expected to occur.

Soil (Depth subject to contact, effect of pavement, etc.):

Groundwater (Definition of usable groundwater subject to ingestion, i.e., min. stratum yield, water quality):

DISCUSSION / ACTION ITEMS:

REFERENCES: 1, 19, 20, 21, 29, 31

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TIER 1 SCREENING LEVEL EQUATIONS

Establish equations to be used for calculation of risk-based screening levels, i.e., generic concentrations which may safely be left in soil or groundwater at any site. For a given target risk limit, the equations combine exposure factors (e.g., ingestion or inhalation rates) and toxicity parameters (RfD, RfC, or SF) to define corresponding constituent concentration limits in affected environmental media. The equations shown below are consistent with those presented in Appendix X.2 of ASTM E-1739. The agency may elect to use these generic expressions for relevant pathways or select an alternative expression.

1. CARCINOGENS

Type	ASTM Tier 1 Equation	State Equation
AIR:		
1) INHALATION *(Direct Exposure)*	$RBSL_{air}\left[\frac{\mu g}{m^3 - air}\right] = \frac{TRxBWxAT_c x365\frac{days}{y}x10^3\frac{\mu g}{mg}}{SF_i xIR_{air} xEFxED}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
GROUNDWATER:		
1) INGESTION (POTABLE GROUNDWATER SUPPLY ONLY) *(Direct Exposure)*	$RBSL_w\left[\frac{mg}{L - H_2 0}\right] = \frac{TRxBWxAT_c x365\frac{days}{y}}{SF_o xIR_w xEFxED}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
2) ENCLOSED-SPACE (INDOOR) VAPOR INHALATION *(Indirect Exposure)*	$RBSL_w\left[\frac{mg}{L - H_2 0}\right] = \frac{RBSL_{air}\left[\frac{\mu g}{m^3 - air}\right]}{VF_{wesp}}x10^{-3}\frac{mg}{\mu g}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
3) AMBIENT (OUTDOOR) VAPOR INHALATION *(Indirect Exposure)*	$RBSL_w\left[\frac{mg}{L - H_2 0}\right] = \frac{RBSL_{air}\left[\frac{\mu g}{m^3 - air}\right]}{VF_{wamb}}x10^{-3}\frac{mg}{\mu g}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER

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TIER 1 SCREENING LEVEL EQUATIONS *Continued*

1. CARCINOGENS Continued

Type	ASTM Tier 1 Equation	State Equation

SURFICIAL SOIL:

1) INGESTION OF SOIL, INHALATION OF VAPORS & PARTICULATES, AND DERMAL CONTACT *(Direct / Indirect Exposure)*	$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{TRxBWxAT_cx365\frac{days}{y}}{EFxED\left[\left(SF_o10^{-6}\frac{kg}{mg}x\left(IR_{soil}xRAF_o+SAxMxRAF_d\right)\right)+\left(SF_ixIR_{air}x\left(VF_{ss}+PEF\right)\right)\right]}$ *(Equation combines ingestion (IR_{soil}), dermal (SA), and inhalation (IR_{air}) intakes. To exclude any exposure element, set designated contact rate value (IR_{soil}, SA, or IR_{air}) equal to zero. For Construction Worker scenario, use short-term exposure factors and dose-response values.)* ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER

SUB-SURFACE SOIL:

1) AMBIENT (OUTDOOR) VAPOR INHALATION *(Indirect Exposure)*	$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{RBSL_{air}\left[\frac{\mu g}{m^3-air}\right]}{VF_{samb}}x10^{-3}\frac{mg}{\mu g}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
2) ENCLOSED SPACE (INDOOR) VAPOR INHALATION *(Indirect Exposure)*	$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{RBSL_{air}\left[\frac{\mu g}{m^3-air}\right]}{VF_{sesp}}x10^{-3}\frac{mg}{\mu g}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
3) LEACHING TO GROUNDWATER *(Indirect Exposure)*	$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{RBSL_w\left[\frac{mg}{L-H_20}\right]}{LF_{sw}}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER

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TIER 1 SCREENING LEVEL EQUATIONS ***Continued***

II. SYSTEMIC TOXICANTS

Type	ASTM Tier 1 Equation	State Equation
AIR:		
1) INHALATION *(Direct Exposure)*	$RBSL_{air}\left[\frac{\mu g}{m^3 - air}\right] = \frac{THQxRfD_i xBWxAT_n x365\frac{days}{y}x10^3\frac{\mu g}{mg}}{IR_{air}xEFxED}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
GROUNDWATER:		
1) INGESTION (POTABLE GROUNDWATER SUPPLY ONLY) *(Direct Exposure)*	$RBSL_w\left[\frac{mg}{L - H_2 0}\right] = \frac{THQxRfD_o xBWxAT_n x365\frac{days}{y}}{IR_w xEFxED}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
2) ENCLOSED-SPACE (INDOOR) VAPOR INHALATION *(Indirect Exposure)*	$RBSL_w\left[\frac{mg}{L - H_2 0}\right] = \frac{RBSL_{air}\left[\frac{\mu g}{m^3 - air}\right]}{VF_{wesp}}x10^{-3}\frac{mg}{\mu g}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
3) AMBIENT (OUTDOOR) VAPOR INHALATION *(Indirect Exposure)*	$RBSL_w\left[\frac{mg}{L - H_2 0}\right] = \frac{RBSL_{air}\left[\frac{\mu g}{m^3 - air}\right]}{VF_{wamb}}x10^{-3}\frac{mg}{\mu g}$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER

TIER 1 SCREENING LEVEL EQUATIONS ***Continued***

II. SYSTEMIC TOXICANTS Continued

Type	ASTM Tier 1 Equation	State Equation

SURFICIAL SOIL:

1) INGESTION OF SOIL, INHALATION OF VAPORS & PARTICULATES, AND DERMAL CONTACT *(Direct / Indirect Exposure)*	$$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{THQxBWxAT_nx365\frac{days}{y}}{EFxED\left[\frac{\left(10^{-6}\frac{kg}{mg}x\left(IR_{soil}xRAF_o+SAxMxRAF_d\right)\right)}{RfD_o}+\frac{\left(IR_{air}x\left(VF_{ss}+PEF\right)\right)}{RfD_i}\right]}$$ *(Equation combines ingestion (IR_{soil}), dermal (SA), and inhalation (IR_{air}) intakes. To exclude any exposure element, set designated contact rate value (IR_{soil}, SA, or IR_{air}) equal to zero. For Construction Worker scenario, use short-term exposure factors and dose-response values.)* ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER

SUB-SURFACE SOIL:

1) AMBIENT (OUTDOOR) VAPOR INHALATION *(Indirect Exposure)*	$$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{RBSL_{air}\left[\frac{\mu g}{m^3-air}\right]}{VF_{samb}}x10^{-3}\frac{mg}{\mu g}$$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
2) ENCLOSED SPACE (INDOOR) VAPOR INHALATION *(Indirect Exposure)*	$$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{RBSL_{air}\left[\frac{\mu g}{m^3-air}\right]}{VF_{sesp}}x10^{-3}\frac{mg}{\mu g}$$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER
3) LEACHING TO GROUNDWATER *(Indirect Exposure)*	$$RBSL_s\left[\frac{mg}{kg-soil}\right]=\frac{RBSL_w\left[\frac{mg}{L-H_20}\right]}{LF_{sw}}$$ ❑ SPECIFY OTHER	❑ USE ASTM ❑ USE OTHER

TIER 1 SCREENING LEVEL EQUATIONS *Continued*

EXPOSURE PARAMETER DEFINITIONS

AT_C	Averaging time for carcinogens (years)
AT_n	Averaging time for non-carcinogens (years)
BW	Adult body weight (kg)
ED	Exposure duration (years)
EF	Exposure frequency (days / years)
IR_{soil}	Soil ingestion rate (mg / day)
IR_{air}-indoor	Daily indoor inhalation rate (m^3 / day)
IR_{air}-outdoor	Daily outdoor inhalation rate (m^3 / day)
IR_w	Daily water ingestion rate (L / day)
M	Soil to skin adherence factor (mg / cm^2)
RAF_d	Dermal relative absorption factor (volatiles / PAHs)
RAF_o	Oral relative absorption factor
$RBSL_i$	Risk-based screening level for media i (mg / kg-soil, mg / L-H_2O or µg / m^3-air)
RfD_i	Inhalation chronic reference dose (mg / kg-day)
RfD_o	Oral chronic reference dose (mg / kg-day)
SA	Skin surface area (cm^2 / day)
SF_i	Inhalation cancer slope factor (mg / kg-day)$^{-1}$)
SF_o	Oral cancer slope factor (mg / kg-day)$^{-1}$)
THQ	Target hazard quotient for individual constituents (unitless)
TR	Target excess individual lifetime cancer risk (unitless)

CROSS-MEDIA TRANSFER FACTOR DEFINITIONS

VF_{wesp}	Volatilization Factor: GW to enclosed space [(mg / m^3-air) / (mg / L-H_2O)]
VF_{wamb}	Volatilization Factor: GW to ambient air [(mg / m^3-air) / (mg / L-H_2O)]
VF_{ss}	Volatilization Factor: Surface soil to ambient air [(mg / m^3-air) / (mg / L-soil)]
PEF	Particulate Emission Factor: Surface soils to ambient air (g / cm^2-sec)
VF_{samb}	Volatilization Factor: Subgrade soils to ambient air [(mg / m^3-air) / (mg / L-soil)]
VF_{sesp}	Volatilization Factor: Subgrade soils to enclosed space [(mg / m^3-air) / (mg / L-soil)]
LF_{sw}	Leaching Factor: Soil to groundwater [(mg / L-H_2O) / (mg / kg-soil)]

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BASIS FOR SELECTION OF EXPOSURE FACTORS

Exposure factors define the types of activities to be protected by the risk-based cleanup standard (i.e., RBSL or SSTL). Such factors include the frequency and duration of exposure, assumed air or water intake rate, and the age and body weight of the population assumed to be exposed. Depending on the degree of conservatism desired, these factors may correspond to the average rates of exposure (Most Likely Exposure) or the upper 95% percentile rates of exposure (Reasonable Maximum Exposure) observed in the general population. Published exposure factors may need to be adjusted to fit actual site conditions. In general, the Agency may choose to specify a standard basis for exposure factor selection (e.g., RME or MLE) and allow use of alternate exposure factors, based on site-specific justification.

TIER 1 EXPOSURE FACTORS

❑ Reasonable Maximum Exposure (RME)

❑ Most Likely Exposure (MLE) ❑ Other (Specify) _____

TIER 2 EXPOSURE FACTORS

❑ Reasonable Maximum Exposure (RME)

❑ Most Likely Exposure (MLE) ❑ Other (Specify) _____

DISCUSSION/ACTION ITEMS:

APPLICABLE REFERENCES: 20, 21, 31

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STANDARD EXPOSURE ASSUMPTIONS

Define default values of key parameters to be used in estimating the intake (e.g., through ingestion or inhalation) of a particular chemical of concern. Parameters include ingestion rates, time/activity patterns, and physiological parameters. Exposure factors should be consistent with the degree of conservatism specified for the risk evaluation (e.g., RME, MLE, etc.).

EXPOSURE FACTORS	Units	ASTM Tier 1 Value	State Default Value	
			USE ASTM	USE OTHER (SPECIFY)
Averaging Time – Carcinogen (AT_C)	yr	70	❑	❑
Averaging Time – Non-Carcinogen (AT_n)				
On-Site Commercial Worker	yr	25	❑	❑
On / Off-Site Resident (adult)	yr	30	❑	❑
On / Off-Site Resident (child)	yr	6	❑	❑
Construction Worker	yr	1	❑	❑
Body Weight (BW)				
Adult Receptors	kg	70	❑	❑
Child Receptors	kg	15	❑	❑
Exposure Duration (ED)				
On-Site Commercial Worker	yr	25	❑	❑
On / Off-Site Resident (adult)	yr	30	❑	❑
On / Off-Site Resident (child)	yr	6	❑	❑
Construction Worker	yr	1	❑	❑
Exposure Frequency (EF)				
On / Off-Site Commercial Worker	days/yr	250	❑	❑
On / Off-Site Residents	days/yr	350	❑	❑
Construction Worker	days/yr	183	❑	❑
Soil Ingestion Rate (IR_{soil})				
On / Off-Site Commercial Worker	mg/day	50	❑	❑
On / Off-Site Resident (adult)	mg/day	100	❑	❑
On / Off-Site Resident (child)	mg/day	200	❑	❑
Construction Worker	mg/day	100	❑	❑
Daily Indoor Inhalation Rate (IR_{air} -*indoor*)				
On / Off-Site Resident (adult and child)	m^3/day	15	❑	❑
Commercial and Construction Worker	m^3/day	20	❑	❑
Daily Outdoor Inhalation Rate (IR_{air} -*outdoor*)				
On / Off-Site Resident (adult and child)	m^3/day	20	❑	❑
Commercial and Construction Worker	m^3/day	20	❑	❑
Daily Water Ingestion Rate (IR_w)				
On / Off-Site Resident (adult)	L/day	2	❑	❑
On / Off-Site Resident (child)	L/day	1	❑	❑
Commercial and Construction Worker	L/day	1	❑	❑
Soil - Skin Adherence Factor (M)	mg/cm^2	0.5	❑	❑
Oral Relative Absorption Factor (RAF_O)	---	1	❑	❑
Dermal Relative Absorption Factor (volatiles) (RAF_d)	---	0.5	❑	❑
Dermal Relative Absorption Factor (PAHs) (RAF_d)	---	0.05	❑	❑
Skin Surface Area for Dermal Contact with Water (SA)				
Construction Worker	cm^2	3160	❑	❑

APPLICABLE REFERENCES: 1, 8, 14, 19, 21, 29, 31, 55-58

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FATE AND TRANSPORT MODELING METHODS

Constituents of concern can both migrate (via leaching, advection, dispersion) and transform (via biodegradation, hydrolysis, photolysis) in the environment. These mitigating processes must be considered when determining constituent concentrations under indirect exposure conditions (i.e., point of exposure at different location or in different medium than source). For purpose of efficiency, simple analytical models are commonly recommended for use in Tier 1 and Tier 2 evaluation. More complex numerical modeling methods are reserved for Tier 3. In establishing a RBCA program, the Agency should identify acceptable models, specify approved chemical property references, and consider appropriate conditions and methods for modeling of natural attenuation effects.

SELECTION OF ACCEPTABLE MODELS
(Analytical vs. numerical, approved models, use of alternate models, etc.) :

ATTENUATION FACTORS
(Applicability, appropriate method, site calibration, etc.) :

CHEMICAL PROPERTY DATABASE
(Identify approved references and/or publish approved list for chemical property parameters, e.g., solubility, Henry's Law Constant) :

USE OF MEASURED VS. ESTIMATED DATA FOR CRITICAL PARAMETERS
(For Tier 2, identify parameters requiring site-specific measurement):

APPLICABLE REFERENCES: 1-6, 69-95

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FATE AND TRANSPORT EQUATIONS

Select analytical fate and transport equations to be used to estimate consistent concentrations at indirect points of exposure (POE) under Tiers 1 and 2 of the RBCA evaluation. Indirect exposure ***refers to those exposure pathways for which the POE occurs within a different medium or at a different location than the source. To estimate potential COC concentrations at an on-site or off-site POE, two categories of fate and transport equations are typically employed: i)*** cross-media transfer equations, ***used to estimate the rate of constituent transfer from one medium to another (e.g., soil-to-groundwater leaching factor; soil-to-air volatilization factor) and ii)*** contaminant transport equations, ***used to estimate dilution-attenuation effects during lateral transport from the source point to the POE within the same medium (e.g., air dispersion equation, groundwater advection-dispersion equation). Tier 1 evaluations involve only cross-media equations, as the POE is assumed to be located directly at the source. Under Tier 2, both types of equations are involved, as the POE may be located elsewhere than the source zone. Selection of these equations affects both the degree of inherent conservatism involved in estimation of exposure concentrations and the amount of site information required to complete the RBCA evaluation.***

I. TIER 1 AND TIER 2 CROSS-MEDIA TRANSFER EQUATIONS

Type	ASTM Equation	State Equation
Soil to Air		
1) SURFACE SOIL TO AMBIENT AIR VOLATILIZATION (FOR SOILS 0 - 3 FT BELOW GRADE)	$VF_{ss}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{2W\rho_s}{U_{air}\delta_{air}}\sqrt{\frac{D_s^{eff}H}{\pi\tau(\theta_{ws}+k_s\rho_s+H\theta_{as})}}\times 10^3$ *OR* $VF_{ss}=\frac{W\rho_s d}{U_{air}\delta_{air}\tau}\times 10^3$, whichever is less. $D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2}+\frac{D^{wat}}{H}\frac{\theta_{ws}^{3.33}}{\theta_T^2}$	❑ USE ASTM ❑ USE OTHER ❑ SPECIFY OTHER:
2) SURFACE SOIL TO AMBIENT AIR PARTICULATE EMISSION (FOR SOILS 0 - 3 FT BELOW GRADE)	$VF_p\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{PEF\cdot W}{U_{air}\delta_{air}}\times 10^3$	❑ USE ASTM ❑ USE OTHER ❑ SPECIFY OTHER:
3) SUBSURFACE SOIL TO AMBIENT AIR VOLATILIZATION (FOR SOILS > 3 FT BELOW GRADE)	$VF_{samb}\left[\frac{(mg/m^3-air)}{(mg/kg-soil)}\right]=\frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]\left[1+\frac{U_{air}\delta_{air}L_s}{D_s^{eff}W}\right]}\times 10^3$ $D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2}+\frac{D^{wat}}{H}\frac{\theta_{ws}^{3.33}}{\theta_T^2}$	❑ USE ASTM ❑ USE OTHER ❑ SPECIFY OTHER:
4) SUBSURFACE SOIL TO ENCLOSED SPACE VOLATILIZATION	$VF_{sesp}\left[\frac{(mg/m^3-air)}{(mg/kg-soil))}\right]=\frac{\frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]}\left[\frac{D_s^{eff}/L_s}{ER\ L_B}\right]}{1+\left[\frac{D_s^{eff}/L_s}{ER\ L_B}\right]+\left[\frac{D_s^{eff}/L_s}{(D_{crack}^{eff}/L_{crack})\eta}\right]}\times 10^3$ $D_{crack}^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{acrack}^{3.33}}{\theta_T^2}+\frac{D^{wat}}{H}\frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$	❑ USE ASTM ❑ USE OTHER ❑ SPECIFY OTHER:

Name: _____ Date Completed: _____

State Agency: _____ *16 of 26*

FATE AND TRANSPORT EQUATIONS ***Continued***

I. TIER 1 AND TIER 2 CROSS-MEDIA TRANSFER EQUATIONS Continued

Type	ASTM Equation	State Equation

GROUNDWATER TO AIR

1) GROUNDWATER TO AMBIENT AIR VOLATILIZATION

$$VF_{wamb}\left[\frac{\left(mg/m^3-air\right)}{\left(mg/L-H_2O\right)}\right]=\frac{H}{1+\left[\frac{U_{air}\delta_{air}L_{GW}}{WD_{ws}^{eff}}\right]}\times 10^3$$

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right]=\left(h_{cap}+h_v\right)\left[\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right]^{-1}$$

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{acap}^{3.33}}{\theta_T^2}+\frac{D^{wat}}{H}\frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

$$D_s^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2}+\frac{D^{wat}}{H}\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

❑ USE ASTM ❑ USE OTHER

❑ SPECIFY OTHER:

2) GROUNDWATER TO ENCLOSED SPACE VOLATILIZATION

$$VF_{wesp}\left[\frac{\left(mg/m^3-air\right)}{\left(mg/L-H_2O\right)}\right]=\frac{H\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\ L_B}\right]}{1+\left[\frac{D_{ws}^{eff}/L_{GW}}{ER\ L_B}\right]+\left[\frac{D_{ws}^{eff}/L_{GW}}{\left(D_{crack}^{eff}/L_{crack}\right)\eta}\right]}\times 10^3$$

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right]=\left(h_{cap}+h_v\right)\left[\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right]^{-1}$$

$$D_{crack}^{eff}\left[\frac{cm^2}{s}\right]=D^{air}\frac{\theta_{acrack}^{3.33}}{\theta_T^2}+\frac{D^{wat}}{H}\frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$$

❑ USE ASTM ❑ USE OTHER

❑ SPECIFY OTHER:

SOIL TO GROUNDWATER

1) SOIL TO GROUNDWATER LEACHING

Leachate Factor:

$$LF\left[\frac{\left(mg/L-H_2O\right)}{\left(mg/kg-soil\right)}\right]=K_{sw}/\alpha$$

Soil to Leachate Partition:

$$K_{sw}\left[\frac{\left(mg/L-H_2O\right)}{\left(mg/kg-soil\right)}\right]=\frac{\rho_s}{\theta_{ws}+k_s\rho_s+H\theta_{as}}$$

Leachate to Groundwater Dilution Factor:

$$\alpha\left[dimensionless\right]=1+\frac{U_{gw}\delta_{gw}}{I\times W}$$

❑ USE ASTM ❑ USE OTHER

❑ SPECIFY OTHER:

Name: _____ Date Completed: _____

State Agency: _____ *17 of 26*

FATE AND TRANSPORT EQUATIONS *Continued*

PARAMETERS USED IN TIER 1 AND TIER 2 CROSS-MEDIA TRANSFER EQUATIONS

d	Lower depth of surficial soil zone (cm)
D^{air}	Diffusion coefficient in air (cm^2/s)
D^{eff}_{crack}	Effective Diffusivity through foundation cracks (cm^2/s)
D_s^{eff}	Effective Diffusivity through vadose zone soils (cm^2/s)
D^{eff}_{cap}	Effective Diffusivity through capillary zone soils (cm^2/s)
D_{ws}^{eff}	Effective Diffusivity from water table (cm^2/s)
D^{wat}	Diffusion coefficient in water (cm^2/s)
ER	Enclosed-space air exchange rate (L/s)
f_{oc}	Fraction of organic carbon in soil (g-C/g-soil)
H	Henry's law constant (cm^2-H_2O)/(cm^3-air)
h_{cap}	Thickness of capillary fringe (cm)
h_v	Thickness of vadose zone (cm)
I	Infiltration rate of water through soil (cm/years)
k_{oc}	Carbon-water sorption coefficient (g-H_2O/g-C)
k_s	Soil-water sorption coefficient (g-H_2O/g-soil) (= f_{oc} X k_{oc})
L_B	Enclosed space volume/infiltration area ratio (cm)
L_{crack}	Enclosed space foundation or wall thickness (cm)
L_{GW}	Depth to groundwater = h_{cap} + h_v (cm)
L_s	Depth to subsurface soil sources (cm)
PEF	Particulate emission rate (g/cm^2-s)
U_{air}	Wind speed above ground surface in ambient mixing zone (cm/s)
U_{gw}	Groundwater Darcy velocity (cm/s)
W	Width of source area parallel to wind, or groundwater flow direction (cm)
δ_{air}	Ambient air mixing zone height (cm)
δ_{gw}	Groundwater mixing zone thickness (cm)
η	Areal fraction of cracks in foundations/walls (cm^2-cracks/cm^2-total area)
θ_{acap}	Volumetric air content in capillary fringe soils (cm^2-air/cm^3-soil)
θ_{acrack}	Volumetric air content in foundation/wall cracks (cm^3-air/cm^3 total volume)
θ_{as}	Volumetric air content in vadose zone soils (cm^3-air/cm^3-soil)
θ_T	Total soil porosity (cm^3/cm^3-soil)
θ_{wcap}	Volumetric water content in capillary fringe soils (cm^3-H_2O/cm^3-soil)
θ_{wcrack}	Volumetric water content in foundation/wall cracks (cm^3H_2O)/cm^3 total volume)
θ_{ws}	Volumetric water content in vadose zone soils (cm^3-H_2O/cm^3-soil)
ρ_s	Soil bulk density (g-soil/cm^3-soil)
τ	Averaging time for vapor flux (s)

Name: _____ Date Completed: _____

State Agency: _____ *18 of 26*

FATE AND TRANSPORT EQUATIONS ***Continued***

II. TIER 2 TRANSPORT EQUATIONS

Type	ASTM Equation	State Equation

AIR

1) WIND-BORNE TRANSPORT OF VAPORS AND PARTICULATES

GAUSSIAN - DISPERSION AIR TRANSPORT MODEL:

$$\frac{C(x)}{C_{source}} = \frac{Q}{2\pi u_w \sigma_y \sigma_z} * \exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left(\exp\left(-\frac{(z-h)^2}{2\sigma_z^2}\right) + \exp\left(-\frac{(z+h)^2}{2\sigma_z^2}\right)\right)$$

where, $Q = \frac{u_w (h/2) A}{L}$

❑ SPECIFY OTHER

❑ USE ASTM ❑ USE OTHER

GROUNDWATER

1) DISSOLVED GROUNDWATER TRANSPORT

DOMENICO GROUNDWATER SOLUTE TRANSPORT MODEL:

$$\frac{C(x)}{C_{source}} = \exp\left(\frac{x}{2\alpha_x}\left[1-\sqrt{1+\frac{4\lambda\alpha_x}{v}}\right]\right) * erf\left(\frac{S_w}{4\sqrt{\alpha_y x}}\right) * erf\left(\frac{S_d}{4\sqrt{\alpha_z x}}\right)$$

where, $v = \frac{ki}{\theta}$

❑ SPECIFY OTHER

❑ USE ASTM ❑ USE OTHER

PARAMETERS USED IN TIER 2 FATE AND TRANSPORT EQUATIONS

C(x)	Concentration at a point downgradient (downwind) (mg/L) or (mg/m^3)
C_{source}	Concentration in Source Zone (mg/L) or (mg/m^3)
x	Distance downgradient or downwind (cm)
α_x	Longitudinal Groundwater Dispersivity (cm)
α_y	Transverse Groundwater Dispersivity (cm)
α_z	Vertical Groundwater Dispersivity (cm)
λ	First-Order Degradation Rate (day^{-1})
v	Groundwater Seepage Velocity (cm/day)
k	Hydraulic Conductivity (cm/day)
i	Hydraulic Gradient (cm/cm)
θ	Effective Soil Porosity
S_w	Groundwater Source Width (cm)
S_d	Groundwater Source Depth (cm)
Q	Flux Rate of Vapor/Particulate Emissions (g/day)
u_w	Mean Wind Speed (cm/sec)
σ_y	Horizontal Air Dispersion Coefficient (mg/m^3)
σ_z	Vertical Air Dispersion Coefficient (mg/m^3)
y	Horizontal Distance From Centerline of Air Plume (cm)
z	Vertical Distance from Centerline of Air Plume (cm)
h	Height of Center of Air Plume (cm)
A	Area of Air Emissions Source (cm^2)
L	Length of Air Emissions source (cm)

Name: _____ Date Completed: _____

State Agency: _____ *19 of 26*

FATE AND TRANSPORT DEFAULT PARAMETERS

PARAMETER	Units	ASTM Default Value	State Default Value: ASTM	State Default Value: OTHER (SPECIFY)	Tier 2 Measurement Required? ■ =Yes
Lower Depth of Surficial Soil Zone	cm	100	❑	❑	❑
Enclosed Space Air Exchange Rate					
On / Off-Site Resident (adult and child)	1/s	0.00014	❑	❑	❑
Commercial or Construction Worker	1/s	0.00023	❑	❑	❑
Fraction of Organic Carbon in Soil	g-C/g-soil	0.01	❑	❑	❑
Thickness of Capillary Fringe	cm	5	❑	❑	❑
Thickness of Vadose Zone	cm	295	❑	❑	❑
Infiltration Rate of Water Through Soil	cm/yr	30	❑	❑	❑
Enclosed Space Volume / Infiltration Area Ratio	cm	200	❑	❑	❑
Enclosed Space Foundation / Wall Thickness	cm	15	❑	❑	❑
Depth to Groundwater	cm	300	❑	❑	❑
Depth to Subsurface Soil Sources	cm	100	❑	❑	❑
Particulate Emission Factor (PEF)					
On / Off-Site Resident and Commercial Worker	g/cm^2-s	6.00E-14	❑	❑	❑
Construction Worker	g/cm^2-s	6.90E-09	❑	❑	❑
Wind Speed Above Ground Surface in Ambient Mixing Zone	cm/s	225	❑	❑	❑
Groundwater Darcy Velocity	cm/yr	2500	❑	❑	❑
Width of Source Area Parallel to Wind or Groundwater Flow	cm	1500	❑	❑	❑
Ambient Air Mixing Zone Height	cm	200	❑	❑	❑
Groundwater Mixing Zone Height	cm	200	❑	❑	❑
Areal Fraction of Foundation / Walls	cm^2/cm^2	0.01	❑	❑	❑
Volumetric Air Content in Capillary Fringe Soil	cc/cc	0.038	❑	❑	❑
Volumetric Air Content In foundation / Wall cracks	cc/cc	0.26	❑	❑	❑
Volumetric Air Content in Zone Soil	cc/cc	0.26	❑	❑	❑
Total Soil Porosity	cc/cc-soil	0.38	❑	❑	❑
Volumetric Water Content in Capillary Fringe Soil	cc/cc	0.342	❑	❑	❑
Volumetric Water Content In foundation / Wall Cracks	cc/cc	0.12	❑	❑	❑
Volumetric Water Content in Vadose Zone Soil	cc/cc	0.12	❑	❑	❑
Soil Bulk Density	gm/cc	1.7	❑	❑	❑
Averaging Time for Vapor Flux (Construction Worker)	sec	3.15E+7	❑	❑	❑

APPLICABLE REFERENCES: 1-6, 69-95

Name: _____ Date Completed: _____

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APPLICABLE POINTS OF EXPOSURE AND COMPLIANCE

Establish guidelines for defining the applicable point of exposure and point of compliance at a given site. The point of exposure (POE) is an existing or potential receptor location where the target risk goal must be achieved. A point of compliance (POC) is a location in proximity to the source area where concentrations of the chemical(s) of concern must be at or below risk-based cleanup limits (e.g., Tier 2 SSTL values) in order to prevent exceedance of target risk goals at the downgradient (or downwind) point of exposure. Compliance monitoring may also be conducted at a location between the source area and the receptor, termed an "alternate point of compliance" (APOC). At the APOC, constituent concentrations must not exceed action levels which are protective of target risk limits at the POE.

Assumptions regarding POE locations may differ between Tiers 1 and 2. Under Tier 1, risk-based screening levels are based on exposure at the source (i.e., POE = POC). Under Tier 2, if institutional controls are applied (e.g., land use restriction), the reasonable POE may be located off-site, beyond the area of land use control. Definition of POE assumptions is critical to calculation of risk-based cleanup standards. POC and APOC options must be specified for the purpose of compliance monitoring.

TIER 1 EVALUATION **(Identify allowable options.)**

	POC	APOC	POE
■ Point of Contamination	❑		❑
■ Property Boundary	❑	❑	❑
■ Other (specify below)	❑	❑	❑

TIER 2 EVALUATION **(Identify allowable options.)**

	POC	APOC	POE	
			Allowable Option	Requires Institutional Control?
■ Point of Contamination	❑		❑	❑
■ Property Boundary	❑	❑	❑	❑
■ Nearest Potential Receptor		❑	❑	❑
■ Nearest Actual Receptor		❑	❑	❑
■ Edge of Institutional Control Zone		❑	❑	❑
■ Point of Contamination	❑	❑	❑	❑

DISCUSSION / ACTION ITEMS:

APPLICABLE REFERENCES: 1 (and references therein)

APPLICATION OF INSTITUTIONAL CONTROLS

Discuss applicability of institutional controls for management of future site risks. Institutional controls, primarily zoning requirements and deed restrictions (including use restrictions), can play an important role in maintaining present land use into the future. Access controls (fencing and gates, security, posting or warnings) can be used to limit exposure to those receptors specified in defining cleanup levels.

APPLICABILITY (current use, feasibility for on-site vs. off-site areas):

TYPES TO BE ALLOWED (e.g., deed restriction, deed record, notification list, etc.):

REFERENCES: 1 (& references therein)

APPLICATION OF LONG-TERM ENGINEERING CONTROLS

Address use of long-term site modifications (e.g., slurry walls, capping, point of use treatment) that could be implemented to reduce or eliminate the potential for exposure to chemicals of concern, as an alternative to source removal or treatment.

USE OF LONG-TERM CONTAINMENT / CONTROL MEASURES VS. REMOVAL / TREATMENT ACTIONS (DISCUSSION):

APPLICABLE REFERENCES: 1 (& references therein)

SUPPLEMENTAL SITE ASSESSMENT DATA REQUIREMENTS

Identify data needs for the risk-based corrective action process. Such information includes definition of source zones, exposure pathways, and contaminant transport parameters. Compare these data requirements to current site assessment guidelines and identify necessary modifications.

RBCA SITE CLASSIFICATION

- Site Classification (e.g., affected media, applicable exposure pathways, acute vs. chronic hazards, time to impact, receptor survey, land use):

TIER 1 DATA REQUIREMENTS

- Source Characterization (e.g., chemicals of concern, number and location of samples, laboratory methods):

TIER 2 DATA REQUIREMENTS

- Exposure Pathway Screening (e.g., identification of complete pathways):

- Extent of Migration (e.g., concentration limits, number and location of samples, laboratory methods):

- Site-Specific Data (e.g., parameters requiring site-specific measurement, number of measurements, methods):

APPLICABLE REFERENCES: 20, 21, 26, 27, 30, 35, 70

Name: _____ Date Completed: _____

State Agency: _____ *23 of 26*

SOURCE CONCENTRATION CHARACTERIZATION

Specify the database to be used to define the representative concentration of each constituent of concern in affected media (groundwater, soil, air, etc.). Representative values may be characterized as the maximum, mean, upper confidence limit, or other statistical measure of the sample population.

DATABASE SELECTION **(Check Applicable Options for Affected Media.)**

	Soil	Vapor	Groundwater
■ All previous sampling events:	❑	❑	❑
■ Most recent sampling event:	❑	❑	❑
■ Last two sampling events:	❑	❑	❑
■ Last year of data:	❑	❑	❑
■ Other: _____	❑	❑	❑

STATISTICAL EVALUATION (Check Applicable Method(s).)

■ **TIER 1**

- Soils: ❑ Average ❑ Maximum ❑ Upper Confidence Limit on Mean (UCL): _____ 90% _____ 95%
- Groundwater: ❑ Average ❑ Maximum ❑ Upper Confidence Limit on Mean (UCL): _____ 90% _____ 95%

■ **TIER 2**

- Soils: ❑ Average ❑ Maximum ❑ Upper Confidence Limit on Mean (UCL): _____ 90% _____ 95%
- Groundwater: ❑ Average ❑ Maximum ❑ Upper Confidence Limit on Mean (UCL): _____ 90% _____ 95%

❑ Other: _____

DISCUSSION:

APPLICABLE REFERENCES: 11, 12, 20, 21

Name: _____ Date Completed: _____

State Agency: _____ *24 of 26*

COMPLIANCE MONITORING SPECIFICATIONS

Describe a monitoring program demonstrating compliance with the risk-based cleanup standards. Typically, this will include sampling one or more locations, on a established schedule, until compliance with risk-based concentration limits in the affected media zone(s) can be confirmed. Guidelines should be provided regarding the minimum "level of proof," in terms of the frequency and duration of sampling required to demonstrate satisfactory achievement of cleanup goal. (NOTE: Compliance Monitoring used to demonstrate project completion, should be distinguished from Corrective Action Monitoring, used to track the progress of the site remediation effort.) Compliance monitoring must be designed to identify an exceedance of a risk-based concentration limit or a change of condition which might invalidate the basis for remedy selection. If, upon completion of the compliance monitoring period, compliance with applicable remediation goals is confirmed, no further action is required at the site.

TIER 1 EVALUATION

AFFECTED MEDIUM	Duration of Monitoring Period	Required Sampling Frequency	Min. No. of Samples / Locations
■ Air			
■ Soil			
■ Groundwater			

DISCUSSION/ACTION ITEMS

TIER 2 EVALUATION

AFFECTED MEDIUM	Duration of Monitoring Period	Required Sampling Frequency	Min. No. of Samples / Locations
■ Air			
■ Soil			
■ Groundwater			

DISCUSSION/ACTION ITEMS:

APPLICABLE REFERENCES: 1 (and references therein)

Name: _____ Date Completed: _____

State Agency: _____ *25 of 26*

DATA SOURCES AND UNCERTAINTY

SOURCE OF TOXICITY DATA:

❑ IRIS ❑ HEAST ❑ EPA Criteria Documents ❑ Other (Specify): _____

- Prioritization of Data Sources:

- Maintenance of State Database:

- Approved References:

MANAGEMENT OF PARAMETER UNCERTAINTY (DISCUSSION):

- Required Sensitivity Analyses:

- Use of Probabilistic Methods:

APPLICABLE REFERENCES: 1-6, 69-95

Name: _____ Date Completed: _____

State Agency: _____ *26 of 26*

RBCA PROGRAM IMPLEMENTATION: ACTION ITEM CHECKLIST

PROGRAM DESIGN TASKS	Complete	Incomplete	Assigned To	Deadline
■ Site Classification System	❑	❑		
■ Chemicals of Concern List	❑	❑		
■ Target Risk Limits	❑	❑		
■ Applicable Exposure Factors	❑	❑		
■ Tier 1 RBCA Equations	❑	❑		
■ Tier 2 RBCA Modeling Requirements	❑	❑		
■ Point of Compliance Definitions	❑	❑		
■ Compliance Monitoring Specifications	❑	❑		
■ Risk Management Options (Institutional controls, long-term engineering controls)	❑	❑		
■ Min. Site Assessment Data Requirements	❑	❑		
■ Source Characterization Requirements	❑	❑		
■ Data Sources and Uncertainty Guidelines	❑	❑		

AGENCY GUIDANCE DOCUMENTS	Complete	Incomplete	Assigned To	Deadline
■ RBCA Guidance Manual (includes all of the following)	❑	❑		
■ Tier 1 Look-Up Table and Instructions	❑	❑		
■ Tier 2 Modeling Guidance (default parameters, approved analytical models, etc.)	❑	❑		
■ Tier 3 Modeling Guidance	❑	❑		
■ Standardized Report Formats	❑	❑		
■ Customized Tier 1 / Tier 2 Software	❑	❑		
■ RBCA Application Review Checklist	❑	❑		

ADMINISTRATIVE / INSTITUTIONAL TASKS	Complete	Incomplete	Assigned To	Deadline
■ Legislative Action	❑	❑		
■ Regulatory Action	❑	❑		
■ Coordination / Review with Stakeholders	❑	❑		
■ Agency Staff Training	❑	❑		
■ Education / Outreach to Regulated Community and Contractors	❑	❑		
■ RBCA Demonstration Studies	❑	❑		

Name: _____ Date Completed: _____

State Agency: _____

NOTES

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Attachment A

SELECTED LIST OF REFERENCES FOR RISK-BASED CORRECTIVE ACTION

SELECTED REFERENCES

RISK-BASED CORRECTIVE ACTION

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5. Stanley, C. C., P. C. Johnson, et al., 1993. Worksheets and Users Manual for An Exposure/Risk-Based Corrective Action Approach for Underground Storage Tank Sites. Shell Oil Company. Houston, TX.

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RISK ASSESSMENTS *Continued*

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