CAMBRIA

5TID 515

June 27, 1997

Mr. Kevin Tinsley
Hazardous Materials Specialist
Alameda County Environmental Health Services
1131 Harbor Bay Parkway, # 250
Alameda, California 94502-6577

Re: **Risk-Based Corrective Action Analysis**
Former Exxon Service Station
3055 35th Avenue
Oakland, California
Cambria Project No: 13-105

Dear Mr. Tinsley:

As requested by Mr. Dale Klettke of the Alameda County Environmental Health Services (ACEHS) in a August 26, 1996 letter, Cambria Environmental Technology, Inc (Cambria), prepared a Risk-Based Corrective Action (RBCA) analysis for the site referenced above. Cambria's analysis was based on RBCA guidelines for petroleum release sites set forth by the American Society for Testing and Materials (E-1739-95), utilizing the RBCA Spreadsheet System developed by Groundwater Services, Inc. (GSI, 1995). Presented below are a site background, our RBCA analysis, and our conclusions.

SITE BACKGROUND

Site Location: The site is a former Exxon Service Station located in a mixed commercial/residential area at the northeast corner of 35th Avenue and School Street in Oakland, California (Figure 1). Topography in the area slopes generally westward and ground water flows toward the northwest. The nearest surface water is Peralta Creek, which is about 0.1 miles north (cross gradient) of the site and flows westward.

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Adjacent Hydrocarbon Sources: Two active or former gasoline service stations are located within one block of the site. An active British Petroleum (BP) site is on 35th Avenue one block east (upgradient) of the site. A former Texaco station is located across School Street immediately east (upgradient) of the site. Texaco's underground storage tanks were removed about 15 years ago. No soil samples were collected during the tank removal and no investigation has been conducted at the former Texaco site.

Previous Investigations

October 1990 Geotechnical Investigation: In October 1990, Geotechnical Engineering of Fremont, California drilled two soil borings at the site for an engineering analysis.

January 1991 Tank Removal: In January 1991, Pacific Excavators removed four gasoline underground storage tanks and one 500-gallon waste oil underground storage tank from the site. The former gasoline

tanks appear to have had capacities between 4,000 and 6,000 gallons. According to a September 24, 1992 workplan prepared by Consolidated Technologies of San Jose, California (CT), soil samples were collected during the tank removal, but were not analyzed or reported by Pacific Excavators (CT, 1992).

November 1991 Subsurface Investigation: In November 1991, CT drilled twelve soil borings to depths of up to 35 ft (Figure 2). Total petroleum hydrocarbons as gasoline (TPHg) were detected in soil samples collected from 11 of the 12 soil borings, at up to 2,100 parts per million (ppm). No total petroleum hydrocarbons as diesel (TPHd) or oil and grease (O&G) were detected in boring B-7, which was drilled immediately downgradient of the former waste oil tank.

May 1994 Subsurface Investigation: Between May 5 and 9, 1994, Cambria drilled seven soil borings and installed three monitoring wells at the site. TPHg were detected in soil from six of the seven borings, at concentrations up to 2,900 ppm. TPHg and benzene were detected in ground water at a maximum concentration of 130,000 and 22,000 parts per billion (ppb), respectively.

February 1997 Subsurface Investigation: In February 1997, Cambria conducted a subsurface investigation at the site consisting of installation of monitoring well MW-4 at the northwestern corner of the property. Soil and ground water samples were collected in February and March 1996, respectively; in addition to petroleum hydrocarbons, soil physical parameters were also analyzed.

Quarterly Ground Water Monitoring: A quarterly ground water monitoring program began in May 1994 with all the wells sampled every quarter.

Site Geology and Hydrogeology

Site Hydrogeology: The site is underlain by interbedded clayey silts and sands to the maximum explored depth of 30 feet.

Ground Water Depth: The depth to ground water has ranged from approximately 8 to 22 ft. As of March 1997, ground water beneath the downgradient edge of the site was about 13.75 ft deep.

Ground Water Flow Direction: Ground water is unconfined and flows consistently to the northwest at a gradient of 0.13 ft/ft.

Hydrocarbon Concentrations in Soil

Cambria collected soil samples at 10 and 15 ft bgs during the recent drilling of well MW-4. Since the water table in MW-4 was encountered at 13.75 bgs, unsaturated soil quality is defined by petroleum hydrocarbon concentrations detected at 10 ft depth. Hydrocarbon concentrations detected at 10 ft depth were 0.24 parts per million (ppm) benzene, 1.1 ppm toluene, 0.7 ppm ethylbenzene, and 2.6 ppm xylenes.

The highest hydrocarbon concentrations detected in the soil that is unsaturated for at least part of the year were detected in boring SB-F at 15 ft depth. The BTEX concentrations detected were 24 ppm benzene, 41 ppm toluene, 48 ppm ethylbenzene and 196 ppm xylenes. These values were used for the RBCA analysis.

Hydrocarbon Concentrations in Ground Water

Hydrocarbon concentrations in ground water underlying the site have generally decreased over the last three years indicating a stable plume. The highest BTEX concentrations recently detected were in well MW-4 at 11,000 parts per billion (ppb) benzene, 4,500 ppb toluene, 1,100 ppb ethylbenzene, and 5,200 xylenes. These values were used for the RBCA analysis.

OBJECTIVES

The need for a RBCA analysis at this site is driven by petroleum hydrocarbon compounds detected beneath the site. Specifically, Cambria's analysis addresses Mr. Klettke's concerns regarding elevated concentrations of hydrocarbons detected in soil and ground water along the northwestern edge of the property. Given the presence of residential properties directly adjacent to the northwestern edge of the site, Cambria analyzed the risk associated with potential exposure of residential property occupants to contaminants at the site.

Accordingly, Cambria's specific objectives for this study were:

- To quantify the potential human health risks to residential occupants posed by chemicals detected beneath the site; and
- If necessary, to define risk-based soil and/or ground water cleanup levels protective of target risk levels set forth by the US Environmental Protection Agency (USEPA).

RISK ASSESSMENT

As previously indicated, Cambria's risk assessment followed guidelines set forth by the ASTM RBCA at Petroleum Release Sites. The RBCA process is the integration of site assessment, remedial action selection,

and monitoring with USEPA-recommended risk and exposure assessment practices. This creates a process by which corrective action decisions are made in a consistent manner that is protective of human health and the environment. The RBCA process is implemented in a tiered approach, involving increasingly sophisticated levels of data collection and analysis. The general assumptions of earlier tiers are replaced with site-specific data and information. Upon evaluation of each tier, the user reviews the results and decides whether more site-specific analysis is warranted.

The following paragraphs document Cambria's approach to performing this risk assessment, including development of the site conceptual model for risk assessment, our Tier I and Tier II analyses, and our conclusions documenting the need, if any, for future corrective action at the site.

Conceptual Model

As the initial step in quantifying the human health risks associated with site contaminants, Cambria developed a conceptual model of contaminant occurrence, transport, and potential exposure. Consistent with Mr. Klettke's concerns, our conceptual model and risk evaluation was limited to addressing potential exposure of residential occupants to site contaminants. Our conceptual model is based on review of all available hydrogeologic data for the site, including soil and ground water quality, ground water level, and geologic data.

Given the close proximity of subsurface contaminants at the site to adjacent residential properties along the northwestern edge of the site, Cambria quantified the health risks associated with potential exposure of residential occupants to site contaminants. In doing so, Cambria conservatively assumed that a residential property directly overlies contaminants detected beneath the site. By accounting for residential land use, we quantified the risks associated with indoor and ambient air exposure to volatile emissions from underlying soil and ground water. Table 1 summarizes Cambria's conceptual model.

Table 1
Conceptual Model for Risk Assessment

Item	Building Receptor	Outdoor Receptor	Comments
Contaminant Source Media	Underlying Soil and Ground Water	Underlying Soil and Ground Water	All contaminated media
Chemicals of Potential Concern (COC):	BTEX	BTEX	Chemicals detected in representative samples
Potential Exposure Pathways:	Volatiles from subsurface soils to building (on site residential receptor) Volatiles from ground water to building (on site residential receptor)	Volatiles from soil to ground surface (on site residential receptor) Volatiles from soil to ground surface (on site residential receptor)	Complete potential exposure pathways
Representative COC Source Concentrations in Soil:	benzene: 24 ppm toluene: 41 ppm ethylbenzene: 48 ppm xylenes: 196 ppm	benzene: 24 ppm toluene: 41 ppm ethylbenzene: 48 ppm xylenes: 196 ppm	Maximum BTEX concentrations in unsaturated soil
Representative COC Source Concentrations in Ground Water:	benzene: 11.0 ppm toluene: 4.5 ppm ethylbenzene: 1.1 ppm xylenes: 5.2 ppm	benzene: 11.0 ppm toluene: 4.5 ppm ethylbenzene: 1.1 ppm xylenes: 5.2 ppm	Maximum BTEX concentrations recently detected in ground water
Target Carcinogenic Risk Level:	This is not target level 1E-04 It is only what was exceeded in 2nd Qtr 1996 QMR.	1E-06	As stated in the letter by Mr. Klettke of the ACHCS on August 26, 1996
Non-Carcinogenic Hazard Quotient:	1.0	1.0	Consistent with ASTM default value
Benzene Slope Factor	0.1 $(mg/kg/day)^{-1}$	0.1 $(mg/kg/day)^{-1}$	Defined by Cal-EPA

Tier I Analysis

Consistent with the Tiered approach adopted by the ASTM RBCA guidelines, Cambria's initial attempt at quantifying the risk associated with the site COCs was based on a Tier 1 evaluation. The Tier 1 evaluation involves comparison of the site-specific COC source concentrations to highly conservative, generic Risk-Based Screening Levels (RBSLs) based on simplified equations and generalized site conditions. Table 2 depicts our comparison of the COC source concentrations for the site to Tier 1 RBSLs.

Table 2
Results of Tier I Analysis

Exposure Pathway	Receptor Scenario	Target Level	Benzene (1) (RBSL/COC)	Toluene (RBSL/COC)	Ethylbenzene (RBSL/COC)	Xylenes (RBSL/COC)
Soil volatilization to outdoor air	Residential	1E-06 HQ= 1	**0.079/ 24**	RES/ 41	RES/ 48	RES/ 196
Vapor intrusion from soil to buildings	Residential	1E-04 HQ=1	**0.16/ 24**	20.6/ 41	427/ 48	RES/ 196
Ground water volatilization to outdoor air	Residential	1E-06 HQ=1	**3.2/ 11.0**	>S/ 4.5	>S/ 1.1	>S/ 5.2
Vapor intrusion from ground water to buildings	Residential	1E-04 HQ=1	**0.69/ 11.0**	32.8/ 4.5	77.5/ 1.1	>S/ 5.2

Notes:
(1) The look-up table RBSL has been corrected for California specific criteria.
All concentrations in ppm
RES = Selected risk level is not exceeded for pure compound present at any concentration
>S = Selected risk level is not exceeded for all possible dissolved levels
COC = Chemical of potential concern source concentration

Exposure scenarios in which COC source concentrations exceed the highly conservative Tier 1 RBSLs include:

1) Benzene volatilization from subsurface soils and emission to ambient air (on site residential receptor);

2) Benzene volatilization from ground water and emission to ambient air (on site residential receptor);

3) Benzene volatilization from subsurface soils and intrusion into building (on site residential receptor); and,

4) Benzene volatilization from ground water and intrusion into building (on site residential receptor).

Accordingly, Cambria performed a Tier 2 analysis on these exposure scenarios.

Tier II Analysis

Cambria's Tier II analysis consisted of reevaluation of the four exposure scenarios in which COC concentrations exceeded Tier I RBSLs. This involved using site-specific data as input into the Tier II RBCA Spreadsheet System. Input data for our Tier II analysis are included as Appendix II. Table 3 depicts the results of our Tier II analysis.

Table 3
Results of Tier II Analysis

Exposure Scenario	Calculated Risk Level	Target Risk Level	Result
Benzene volatilization from subsurface soil and intrusion into building (residential receptor)	**5.5E-4**	1E-04	Soil benzene concentration exceeds target risk level: SSTL = 4.35 ppm
Benzene volatilization from ground water and intrusion into building (residential receptor)	**2.5E-04**	1E-04	Ground water benzene concentration exceeds target risk level: SSTL = 4.35 ppm
Benzene volatilization from subsurface soil and emission to ambient air (residential receptor)	**2.8E-06**	1E-06	Soil benzene concentration exceeds target risk level: SSTL = 8.41 ppm
Benzene volatilization from ground water and emission to ambient air (residential receptor)	3.4E-07	1E-06	Ground water benzene concentration is protective of target risk level
SSTL = Site-specific target level			

As indicated by the shaded parameter in Table 3, the risk associated with potential indoor air exposure to benzene vapors emanating from both, subsurface soil and ground water slightly exceeds the target risk level. Also, the risk associated with potential outdoor air exposure to benzene vapors emanating from subsurface soils slightly exceeds the target risk level. The benzene site-specific target level (SSTL) protective of the target risk level for indoor air exposure is 4.35 ppm for soil and 4,350 parts per billion (ppb) for ground water. The benzene SSTL protective of the target risk level for outdoor air exposure is 8.41 ppm for soil. Review of ground water analytic data indicates that benzene concentrations in site wells have consistently exceeded the SSTL of 4,350 ppb; however, in the absence of separate phase hydrocarbons (SPHs), ground water concentrations have steadily decreased during the last three years and benzene concentrations in ground water

are expected to further decline due to intrinsic biodegradation, thereby decreasing the risk associated with potential exposure.

Although the magnitude of the calculated risk slightly exceeds the target risk level for benzene volatilization from soil and ground water and intrusion into the residential building, the actual risk associated with potential exposure to the benzene source concentration is expected to be significantly less; this is due to the simplified, conservative nature of the ASTM RBCA formulation, conceptual model, and parameters selected by Cambria for input into the calculations. These are further discussed below.

DISCUSSION

Consistent with ASTM standards, Cambria's risk assessment employed a conservative approach to mathematical formulation and parameter estimation. The GSI RBCA Spreadsheet System used by Cambria employs a series of overly simplified fate and transport models for predicting COC concentrations at points of exposure. The simplified analytic nature of these models, particularly those used to simulate volatilization and transport of vapor emissions to indoor air, often result in grossly over-estimated COC exposure point concentrations (Sanders and Stern, 1994; GSI, 1995; AEHS, 1997; Javaherian, 1994 and 1997); in turn, these result in over-estimation of health risks. Physical and chemical processes ignored by the simplified ASTM vapor transport models include:

- COC Loss Mechanisms
- Water Movement
- Depleting COC Mass Source

In fact, GSI (1995) suggests that SSTLs calculated by the RBCA Spreadsheet System, representing cleanup levels for soil and/or ground water, should not be defined based on the indoor air inhalation exposure pathway; this is due to the aforementioned conservatism associated with the vapor transport formulation. The use of vapor sampling and/or more sophisticated models are needed for defining soil and ground water cleanup levels associated with the indoor air inhalation exposure pathway.

Standard exposure scenarios inherent to the ASTM risk evaluation employ additional conservative assumptions consistent with state and federal guidelines. Risk related input parameters such as duration and frequency are selected to represent the maximally exposed individual and are not an accurate portrayal of time spent at a place of residence or business. The quantitative effect of these uncertainties contributes to overestimation of the overall potential health risk.

Cambria's evaluation consistently incorporated conservative assumptions for selection of parameters used to calculate risk, while attempting to maintain a reasonable, site-specific evaluation. The overall effect of using conservative assumptions in each step of the risk assessment process is likely to result in significant

overestimation of potential risk. Thus, evaluation of results must be reviewed with an understanding of the uncertainties involved and how they effect risk estimations. Findings of insignificant risk may reflect conditions close to reality; however, findings of measurable risk reflect conditions that may result from the conservative nature of the evaluation and not due to actual risk.

CONCLUSION

The results of Cambria's ASTM RBCA analysis indicate that benzene concentrations in soil and ground water exceed the SSTLs for soil (4.35 ppm) and ground water (4,350 ppb) for the residential indoor air inhalation exposure pathway. Also, the risk assessment indicates that benzene concentrations in soil exceed the SSTLs (8.41 ppm) for the outdoor air inhalation exposure pathway. The health risks associated with all other chemicals and exposure pathways evaluated are protective of target risk levels.

Cambria believes that these SSTLs are highly conservative and should not be adopted as the actual cleanup level on which soil and ground water remediation will be based; however, these SSTLs do serve as a guideline for evaluation of declining hydrocarbon concentrations due to intrinsic biodegradation, as in monitoring well MW-2. Also, since the site specific BTEX concentrations in soil that were used in this analysis were historically the highest, from a soil boring in 1994 and since these hydrocarbons are below the water table for at least part of the year, the actual risk is likely less than the calculated.

RECOMMENDATIONS

Based on the RBCA results, it is unclear whether site remediation other than natural attenuation will be necessary. We recommend that you review these results and contact us to set up a meeting to discuss this project.

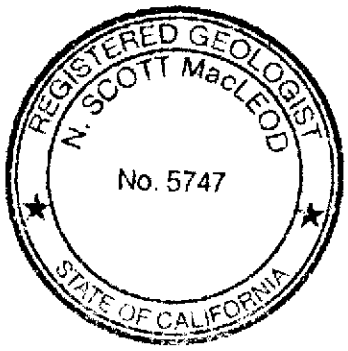
CAMBRIA

CLOSING

We appreciate your assistance to this case. Please call if you have any questions or comments.

Sincerely,
Cambria Environmental Technology, Inc.

Sampath Rangarajan
Hydrogeologist



N. Scott MacLeod, RG
Principal Geologist

Attachment: A - Tier II RBCA Results

cc: Mr. Lynn Worthington
Golden Empire Properties
5942 MacArthur Boulevard, Suite B
Oakland, California 94605

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CAMBRIA

ATTACHMENT A

Tier II RBCA Results

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Lynn Worthington Property Job Identification: 13-105
Site Location: 3055 35th Avenue, Oakland, CA Date Completed: 6/17/97
Completed By: Sam Rangarajan (CAMBRIA)

Software: GSI RBCA Spreadsheet
Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential			Commercial/Industrial	
		Adult	(1-6yrs)	(1-16 yrs)	Chronic	Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg*yr/kg*d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	5.8E+03		2.0E+03	5.8E+03	5.8E+03
SAadj	Adjusted dermal area (cm^2*yr/kg)	2.1E+03			1.7E+03	
M	Soil to Skin adherence factor	1				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	***TRUE***			***TRUE***	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial	
			Chronic	Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	FALSE	
GW.v	Volatilization to Outdoor Air	FALSE	FALSE	
GW.b	Vapor Intrusion to Buildings	TRUE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	TRUE	FALSE	

Matrix of Receptor Distance and Location on- or off-site		Residential		Commercial/Industrial	
		Distance	On-Site	Distance	On-Site
GW	Groundwater receptor (cm)		FALSE		FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	***1.0E-04***	
TRc	Target Risk (class C carcinogens)	***1.0E-04***	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	2.2E+06		1.0E+06
W	Length of affected soil parallel to wind (cm)	1.5E+03		1.0E+03
W.gw	Length of affected soil parallel to groundwater (cn	1.5E+03		
Uair	Ambient air velocity in mixing zone (cm/s)	2.3E+02		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	***9.1E+01***		
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	***9.1E+01***
I	Groundwater infiltration rate (cm/yr)	***3.0E+01***
Ugw	Groundwater Darcy velocity (cm/yr)	***1.5E+01***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***4.3E+01***
Ks	Saturated Hydraulic Conductivity(cm/s)	1.0E-04
grad	Groundwater Gradient (cm/cm)	5.0E-03
Sw	Width of groundwater source zone (cm)	3.0E+03
Sd	Depth of groundwater source zone (cm)	9.1E+01
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	***2.0E-02***

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	***6.1E+01***		
hv	Vadose zone thickness (cm)	***3.4E+02***		
rho	Soil density (g/cm^3)	***1.5***		
foc	Fraction of organic carbon in vadose zone	***0.03***		
phi	Soil porosity in vadose zone	***0.43***		
Lgw	Depth to groundwater (cm)	***4.0E+02***		
Ls	Depth to top of affected soil (cm)	***9.1E+01***		
Lsubs	Thickness of affected subsurface soils (cm)	***2.7E+02***		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	***0.38***	***0.22***	***0.22***
phi.a	Volumetric air content	***0.05***	***0.21***	***0.21***

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	***2.8E-04***	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	***0.001***	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		
ay	Transverse dispersion coefficient (cm)		
az	Vertical dispersion coefficient (cm)		
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

RBCA.xls 10^{-4}; Residential

Site Name: Lynn Worthington Property
Site Location: 3055 35th Avenue, Oakland, CA

Completed By: Sam Rangarajan (CAMBRIA)
Date Completed: 6/17/1997

SUBSURFACE SOIL SSTL VALUES (> 3 FT BGS)

Target Risk (Class A & B) 1.0E-4
Target Risk (Class C) 1.0E-4
Target Hazard Quotient 1.0E+0

☐ MCL exposure limit?
☐ PEL exposure limit?

Calculation Option: 2

SSTL Results For Complete Exposure Pathways ("x" if Complete)

CONSTITUENTS OF CONCERN		Representative Concentration		Soil Leaching to Groundwater			X	Soil Volatilization to Indoor Air			Soil Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/kg)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)		Residential: (on-site)	Commercial: (on-site)		Residential: (on-site)	Commercial: (on-site)	(mg/kg)	"■" If yes	Only if "yes" left
71-43-2	Benzene	2.4E+1	NA	NA	NA		1.5E+1	NA		NA	NA	1.5E+1	■	2.0E+00
100-41-4	Ethylbenzene	4.8E+1	NA	NA	NA		>Res	NA		NA	NA	>Res	☐	<1
108-88-3	Toluene	4.1E+1	NA	NA	NA		>Res	NA		NA	NA	>Res	☐	<1
1330-20-7	Xylene (mixed isomers)	2.0E+2	NA	NA	NA		>Res	NA		NA	NA	>Res	☐	<1

RBCA SITE ASSESSMENT | **Tier 2 Worksheet 9.3**

Site Name: Lynn Worthington Property
Site Location: 3055 35th Avenue, Oakland, CA

Completed By: Sam Rangarajan (CAMBRIA)
Date Completed: 6/17/1997

GROUNDWATER SSTL VALUES

Target Risk (Class A & B) 1.0E-4
Target Risk (Class C) 1.0E-4
Target Hazard Quotient 1.0E+0

☐ MCL exposure limit?
☐ PEL exposure limit?

Calculation Option: 2

SSTL Results For Complete Exposure Pathways ("x" If Complete)

CONSTITUENTS OF CONCERN		Representative Concentration	Groundwater Ingestion			X Groundwater Volatilization to Indoor Air		Groundwater Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/L)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site)	Residential (on-site)	Commercial: (on-site)	(mg/L	"■" If yes	Only if "yes" left
71-43-2	Benzene	1.1E+1	NA	NA	NA	1.5E+1	NA	NA	NA	1.5E+1	☐	<1
100-41-4	Ethylbenzene	1.1E+0	NA	NA	NA	>Sol	NA	NA	NA	>Sol	☐	<1
108-88-3	Toluene	4.5E+0	NA	NA	NA	>Sol	NA	NA	NA	>Sol	☐	<1
1330-20-7	Xylene (mixed isomers)	5.2E+0	NA	NA	NA	>Sol	NA	NA	NA	>Sol	☐	<1

Software: GSI RBCA Spreadsheet
Version: v 1.0

Serial: G-273-IBX-894

RBCA TIER 1/TIER 2 EVALUATION

Output Table 1

Site Name: Lynn Worthington Property Job Identification: 13-105
Site Location: 3055 35th Avenue, Oakland, CA Date Completed: 6/17/97
Completed By: Sam Rangarajan (CAMBRIA)

Software: GSI RBCA Spreadsheet
Version: v 1.0

NOTE: values which differ from Tier 1 default values are shown in bold italics and underlined.

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing. rate (mg-yr/kg-d)	1.1E+02			9.4E+01	
IRa.in	Inhalation rate indoor (m^3/day)	15			20	
IRa.out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	5.8E+03		2.0E+03	5.8E+03	5.8E+03
SAadj	Adjusted dermal area (cm^2-yr/kg)	2.1E+03			1.7E+03	
M	Soil to Skin adherence factor	1				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	***TRUE***			***TRUE***	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
Groundwater Pathways:				
GW.i	Groundwater Ingestion	FALSE	FALSE	
GW.v	Volatilization to Outdoor Air	TRUE	FALSE	
GW.b	Vapor Intrusion to Buildings	FALSE	FALSE	
Soil Pathways				
S.v	Volatiles from Subsurface Soils	TRUE	FALSE	
SS.v	Volatiles and Particulate Inhalation	FALSE	FALSE	FALSE
SS.d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S.l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S.b	Intrusion to Buildings - Subsurface Soils	FALSE	FALSE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)		FALSE		FALSE
S	Inhalation receptor (cm)		TRUE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	1.0E-06	
TRc	Target Risk (class C carcinogens)	***1.0E-06***	
THQ	Target Hazard Quotient	1.0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	2.2E+06		1.0E+06
W	Length of affected soil parallel to wind (cm)	1.5E+03		1.0E+03
W.gw	Length of affected soil parallel to groundwater (cn	1.5E+03		
Uair	Ambient air velocity in mixing zone (cm/s)	***3.3E+02***		
delta	Air mixing zone height (cm)	2.0E+02		
Lss	Definition of surficial soils (cm)	***9.1E+01***		
Pe	Particulate areal emission rate (g/cm^2/s)	2.2E-10		

Groundwater	Definition (Units)	Value
delta.gw	Groundwater mixing zone depth (cm)	***9.1E+01***
I	Groundwater infiltration rate (cm/yr)	***3.0E+01***
Ugw	Groundwater Darcy velocity (cm/yr)	***1.5E+01***
Ugw.tr	Groundwater Transport velocity (cm/yr)	***4.3E+01***
Ks	Saturated Hydraulic Conductivity(cm/s)	1.0E-04
grad	Groundwater Gradient (cm/cm)	5.0E-03
Sw	Width of groundwater source zone (cm)	3.0E+03
Sd	Depth of groundwater source zone (cm)	9.1E+01
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi.eff	Effective Porosity in Water-Bearing Unit	3.8E-01
foc.sat	Fraction organic carbon in water-bearing unit	***2.0E-02***

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	***6.1E+01***		
hv	Vadose zone thickness (cm)	***3.4E+02***		
rho	Soil density (g/cm^3)	***1.5***		
foc	Fraction of organic carbon in vadose zone	***0.03***		
phi	Soil porosity in vadose zone	***0.43***		
Lgw	Depth to groundwater (cm)	***4.0E+02***		
Ls	Depth to top of affected soil (cm)	***9.1E+01***		
Lsubs	Thickness of affected subsurface soils (cm)	***2.7E+02***		
pH	Soil/groundwater pH	6.5		
		capillary	vadose	foundation
phi.w	Volumetric water content	***0.38***	***0.22***	***0.22***
phi.a	Volumetric air content	***0.05***	***0.21***	***0.21***

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2.0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	***2.8E-04***	2.3E-04
Lcrk	Foundation crack thickness (cm)	1.5E+01	
eta	Foundation crack fraction	***0.001***	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		
ay	Transverse dispersion coefficient (cm)		
az	Vertical dispersion coefficient (cm)		
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

RBCA1.XLS 10^{-6}; Residential

Site Name: Lynn Worthington Property
Site Location: 3055 35th Avenue, Oakland, CA

Completed By: Sam Rangarajan (CAMBRIA)
Date Completed: 6/17/1997

SUBSURFACE SOIL SSTL VALUES (> 3 FT BGS)

Target Risk (Class A & B) 1.0E-6
Target Risk (Class C) 1.0E-6
Target Hazard Quotient 1.0E+0

☐ MCL exposure limit?
☐ PEL exposure limit?

Calculation Option: 2

SSTL Results For Complete Exposure Pathways ("x" if Complete)

CONSTITUENTS OF CONCERN		Representative Concentration		Soil Leaching to Groundwater				Soil Volatilization to Indoor Air		X	Soil Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/kg)		Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)		Residential: (on-site)	Commercial: (on-site)		Residential: (on-site)	Commercial: (on-site)	(mg/kg)	"■" If yes	Only if "yes" left
71-43-2	Benzene	2.4E+1		NA	NA	NA		NA	NA		2.9E+1	NA	2.9E+1	☐	<1
100-41-4	Ethylbenzene	4.8E+1		NA	NA	NA		NA	NA		>Res	NA	>Res	☐	<1
108-88-3	Toluene	4.1E+1		NA	NA	NA		NA	NA		>Res	NA	>Res	☐	<1
1330-20-7	Xylene (mixed isomers)	2.0E+2		NA	NA	NA		NA	NA		>Res	NA	>Res	☐	<1

Software: GSI RBCA Spreadsheet Serial: G-273-IBX-894
Version: v 1.0

Site Name: Lynn Worthington Property
Site Location: 3055 35th Avenue, Oakland, CA

Completed By: Sam Rangarajan (CAMBRIA)
Date Completed: 6/17/1997

GROUNDWATER SSTL VALUES

Target Risk (Class A & B) 1.0E-6
Target Risk (Class C) 1.0E-6
Target Hazard Quotient 1.0E+0

☐ MCL exposure limit?
☐ PEL exposure limit?

Calculation Option: 2

SSTL Results For Complete Exposure Pathways ("x" if Complete)

CONSTITUENTS OF CONCERN		Representative Concentration	Groundwater Ingestion			Groundwater Volatilization to Indoor Air		X Groundwater Volatilization to Outdoor Air		Applicable SSTL	SSTL Exceeded ?	Required CRF
CAS No.	Name	(mg/L)	Residential: (on-site)	Commercial: (on-site)	Regulatory(MCL): (on-site)	Residential: (on-site)	Commercial: (on-site)	Residential (on-site)	Commercial: (on-site)	(mg/L	"■" If yes	Only if "yes" left
71-43-2	Benzene	1.1E+1	NA	NA	NA	NA	NA	1.1E+2	NA	1.1E+2	☐	<1
100-41-4	Ethylbenzene	1.1E+0	NA	NA	NA	NA	NA	>Sol	NA	>Sol	☐	<1
108-88-3	Toluene	4.5E+0	NA	NA	NA	NA	NA	>Sol	NA	>Sol	☐	<1
1330-20-7	Xylene (mixed isomers)	5.2E+0	NA	NA	NA	NA	NA	>Sol	NA	>Sol	☐	<1

Software: GSI RBCA Spreadsheet
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