ANÁLISE DE RIESGO

ALGUNAS RECOMENDACIONES

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PTH/HSGW

Mayo 2017

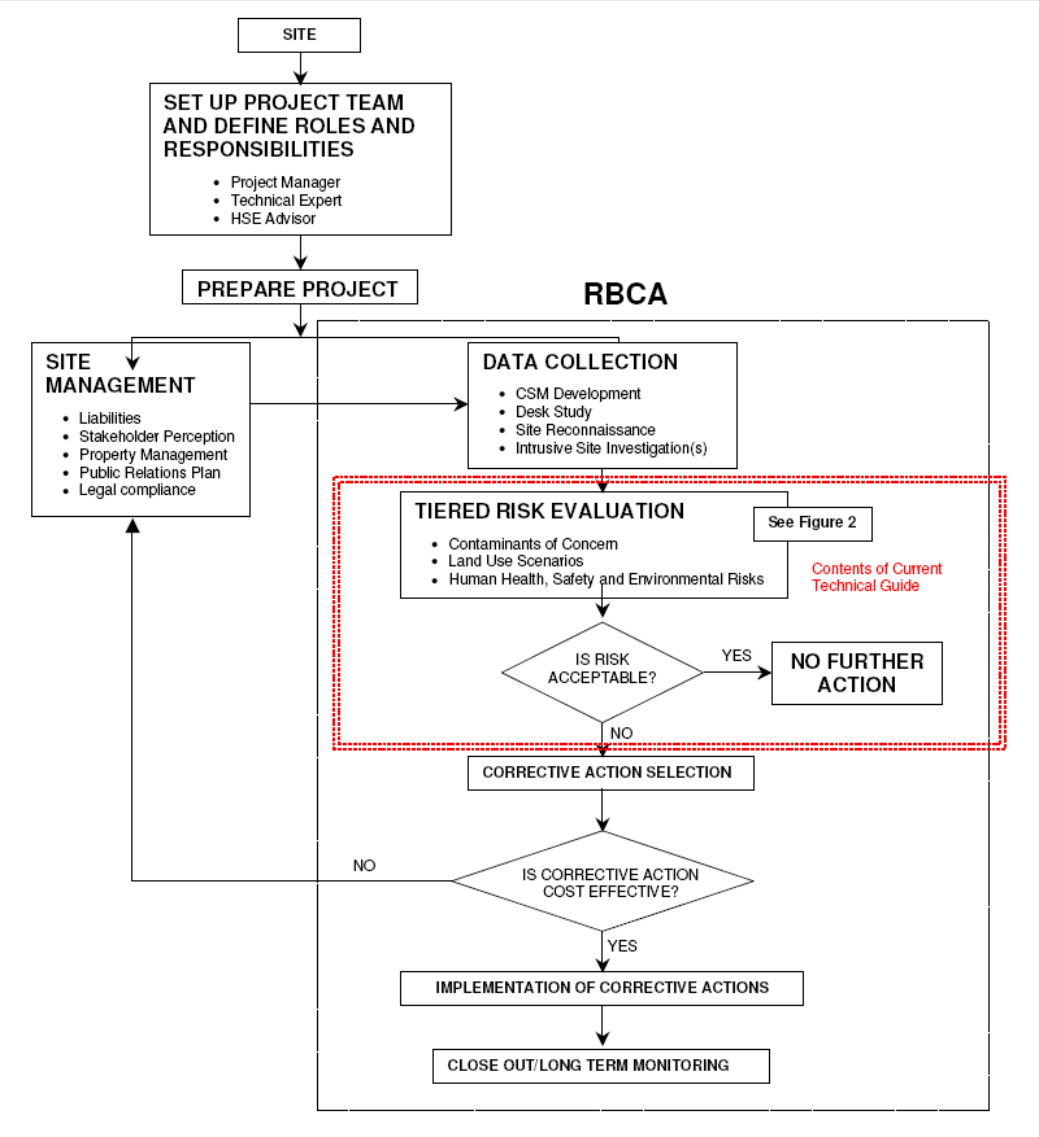
CONTENIDO DE LA PRESENTACIÓN

- 1. Objetivos del Análisis de Riesgo
- 2. Procedimiento de la Análisis de Riesgo (RBCA)
- 3. Ejemplo Chafariz
- 4. Recomendaciones

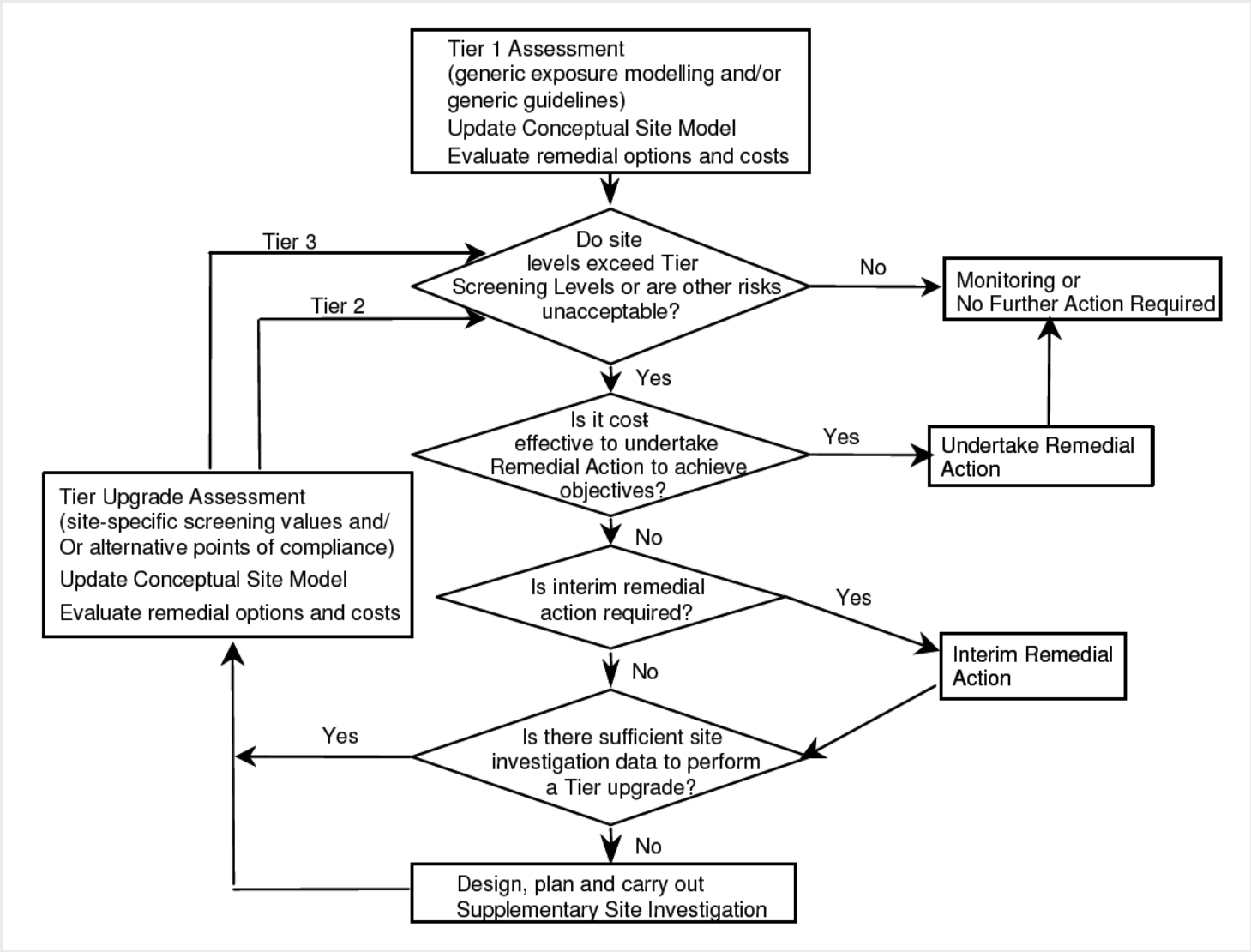
1. OBJETIVOS DE LA ANÁLISIS DE RIESGO

- Desenvolver un modelo conceptual para un dado sitio considerando, fuentes, receptores y caminos de exposición.
- Obtener informaciones sobre el riesgo a la salud humana necesarias para la tomada de decisiones cuanto a los procedimientos en un dado sitio contaminado.
- Fornecer una lista de riesgos existentes en el sitio contaminado.
- Fornecer el procedimiento para la determinación de las concentraciones de las sustancias químicas que posan permanecer en el sitio sin causar peligro.
- Fornecer una base de informaciones para evaluar el riesgo a la salud humana de las diversas medidas de remediación consideradas.

2. PROCEDIMIENTO RBCA



RBCA – TIER 1, TIER 2 Y TIER 3



TIER 1 – TAREAS A EJECUTAR

- Caracterización del sitio
- Evaluación de los caminos de exposición y de los datos disponibles
- Comparación con los limites RBSL (*Risk Based Screening Levels*)
- Respuesta Inicial, Clasificación del sitio
- Interdicción del sitio caso necesario
- Acciones de emergencia caso necesario
- Utilizar valores Tier 1 (RBSL) de APRA, de agencias ambientales, valores de referencia si no existieren otros menos restrictivos que por ley deben ser adoptados.

TIER 2 - TAREAS A EJECUTAR

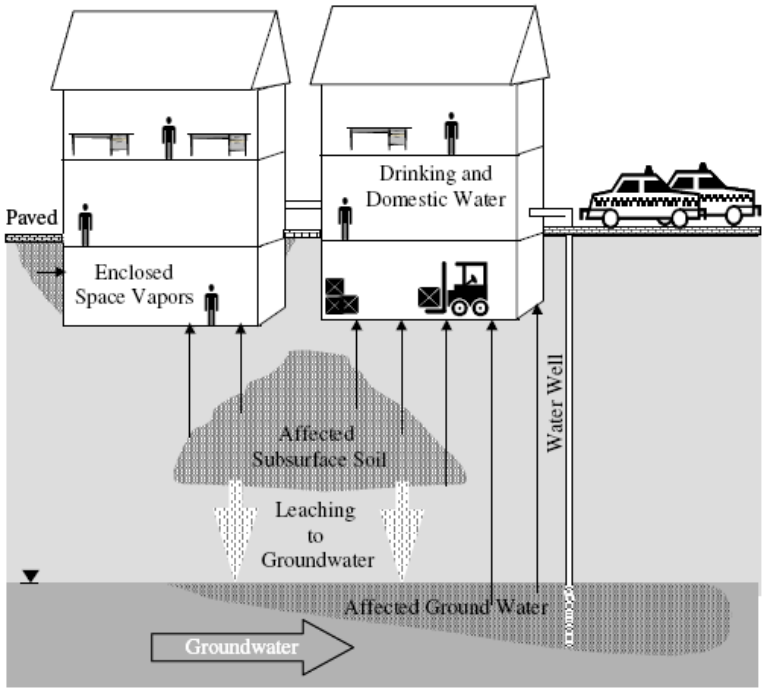
- Caracterización complementar del sitio
- Evaluación de los caminos de exposición y de los datos disponibles
- Modelamientos simples (analítico) del transporte de los compuestos de interés
- Evaluación del riesgo específico para el sitio
- Comparación con los limites SSTL (*Site Specific Target Level*)
- Interdicción del sitio caso necesario
- Acciones de emergencia si necesario
- Cálculo de los valores *target* para el sitio y definición de la medida de remediación, caso necesario.

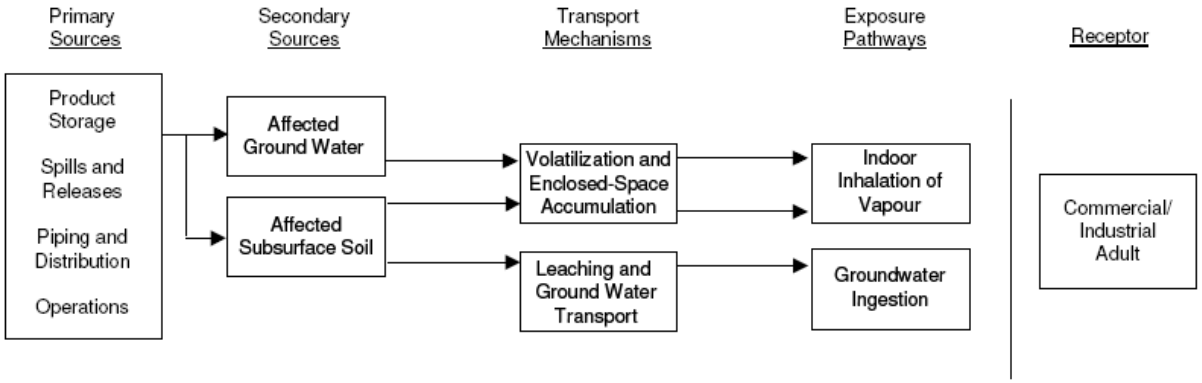
IDENTIFICACIÓN DE LOS COMPUESTOS DE INTERÉS

Compound	Gasoline		Kerosene Jet A, JP-4, JP-5, JP-8		Diesel		Heavy Fuel Oil		Lube Oil	
	Soil	GW	Soil	GW	Soil	GW	Soil	GW	Soil	GW
Benzene	X	X	X	X						
Toluene	X	X	X	X						
Ethyl benzene	X	X	X	X	X	X				
m-Xylene	X	X	X	X	X	X				
o-Xylene	X	X	X	X	X	X				
p-Xylene	X	X	X	X	X	X				
Mixed Xylenes	X	X	X	X	X	X				
Naphthalene	X	X	X	X	X	X	X		X	
Acenaphthalene							X		X	
Acenaphthene							X		X	
Fluorene							X		X	
Phenanthrene							X		X	
Anthracene							X		X	
Fluoranthene							X		X	
Pyrene							X		X	
Benzo(a)anthracene							X		X	
Chrysene							X		X	
Benzo(b)fluoranthene							X		X	
Beno(k)fluoranthene							X		X	
Benzo(a)pyrene							X		X	
Indeno(1,2,3-cd)pyrene							X		X	
Dibenzo(a,h)anthracene							X		X	
Benzo(g,h,i)perylene							X		X	
Ethanol	X	X								
Methanol	X	X								
Diisopropyl ether (DIPE)	X	X								
Methyl tertiary butyl ether (MTBE)	X	X								
Ethyl tertiary butyl ether (ETBE)	X	X								
Tertiary amyl methyl ether (TAME)	X	X								
Tertiary butyl alcohol (TBA)	X	X								
1,2-Dibromoethane (EDB)	X	X								
1,2-Dichloroethane (1,2-DCA)	X	X								
Inorganic lead (Pb)	X	X								
Total Petroleum Hydrocarbon (TPH)	X	X	X	X	X	X	X		X	

FUENTES, CAMINOS DE EXPOSICIÓN, RECEPTORES

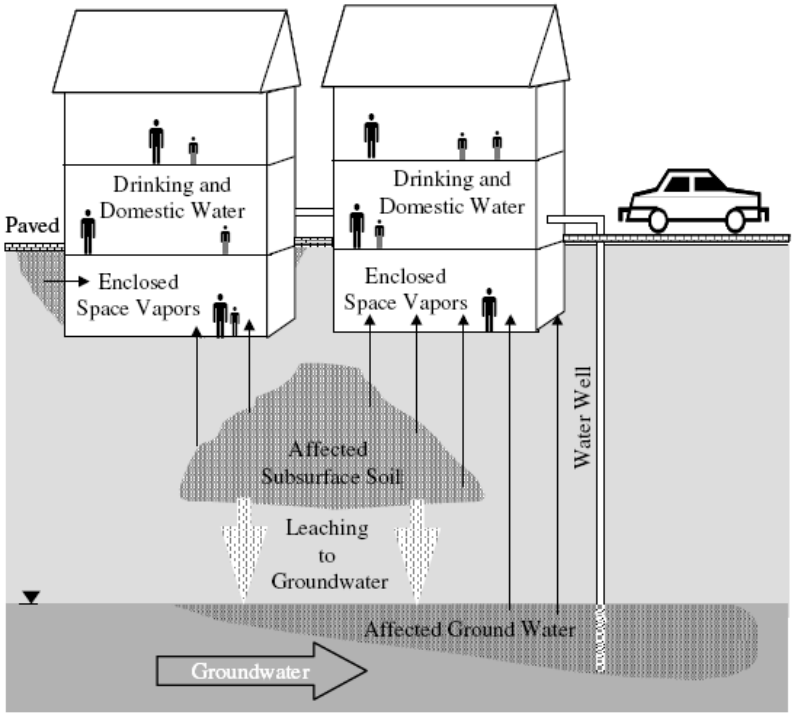
Figure B5.2: Generic CSM for commercial/industrial end use

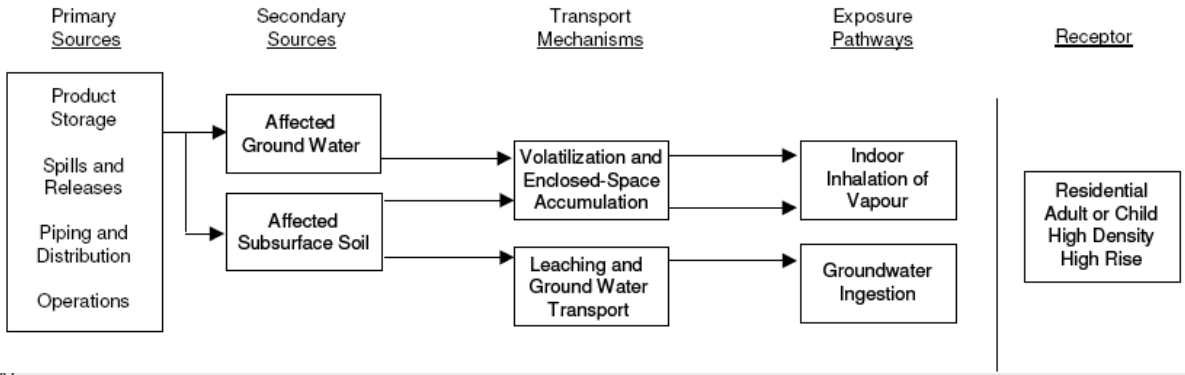




FUENTES , CAMINOS DE EXPOSICIÓN, RECEPTORES

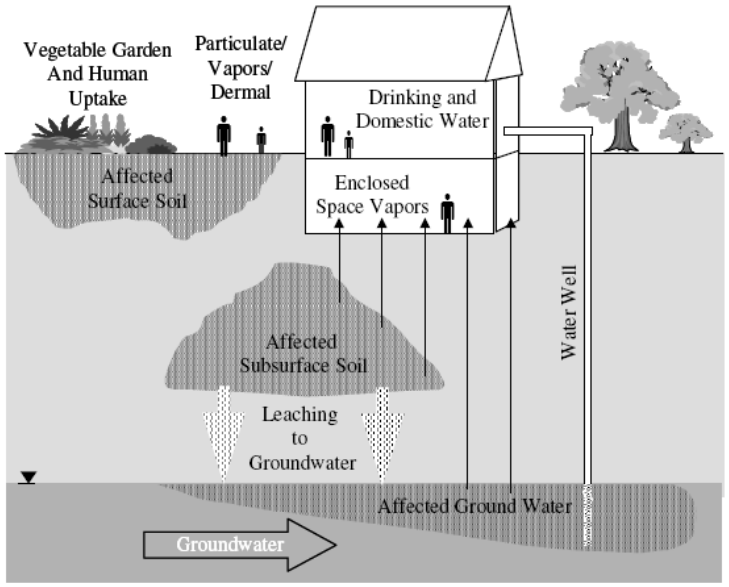
Figure B5.4: Generic CSM for high density/high rise residential end use

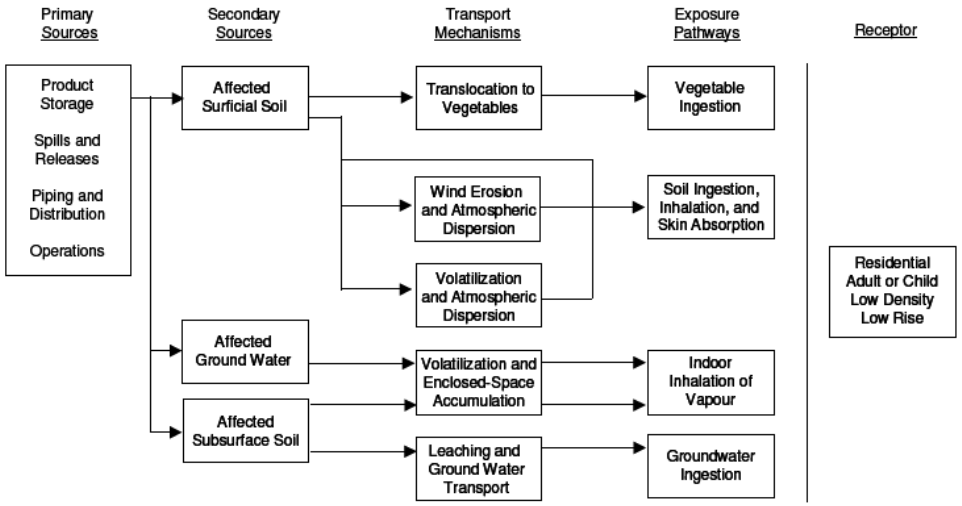




FUENTES, CAMINOS DE EXPOSICIÓN, RECEPTORES

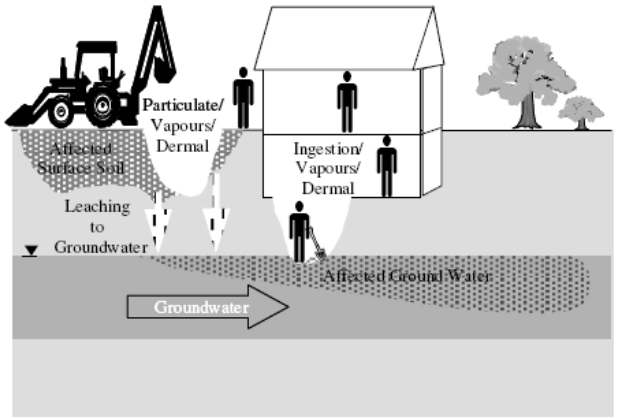
Figure B5.3: Generic CSM for Low density/low rise end use

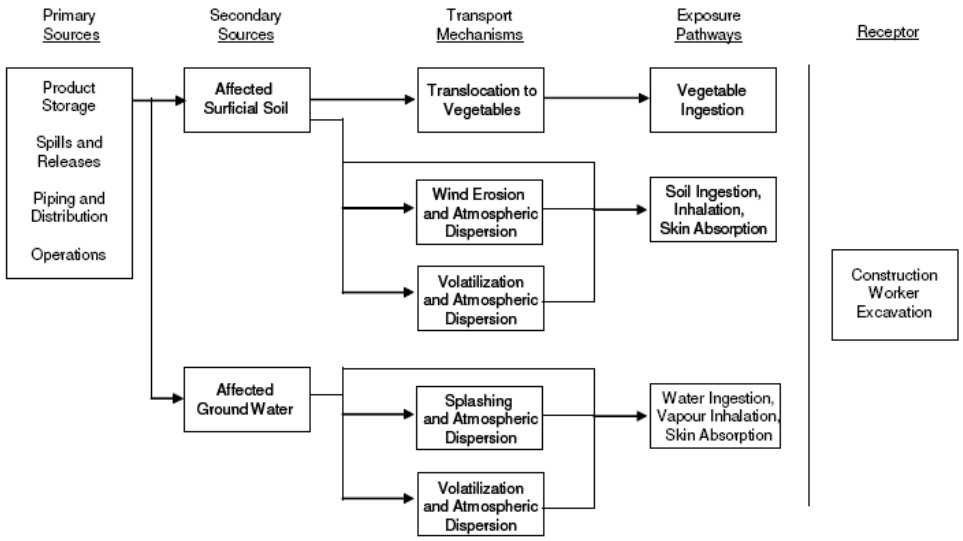




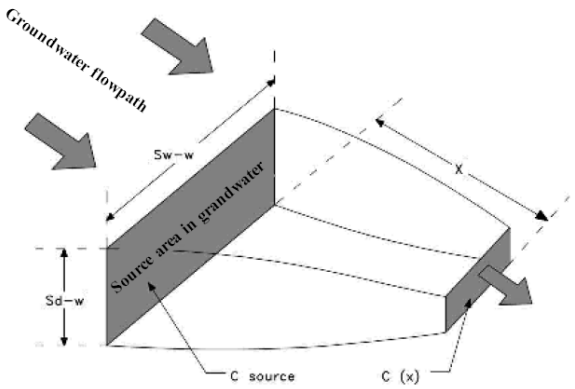
FUENTES, CAMINOS DE EXPOSICIÓN, RECEPTORES

Figure B5.5: Generic CSM for construction workers

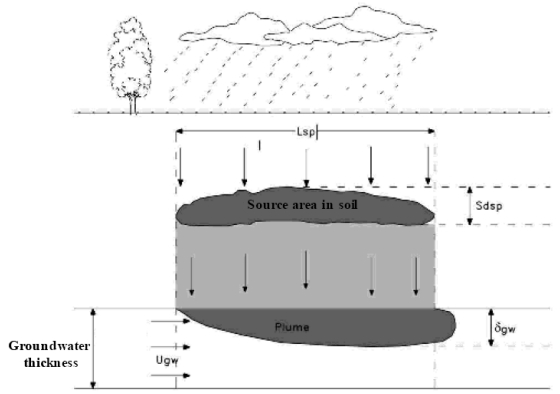




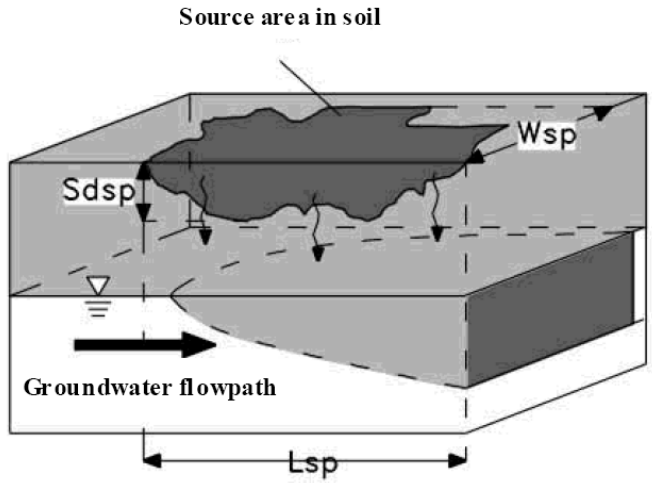
CÁLCULOS



Sd-w = Source area thickness in groundwater
Sw-w = Source area width in groundwater
X= Distance from "compliance point"
Csource= Source area concentration
C(x) = "Compliance point" concentration

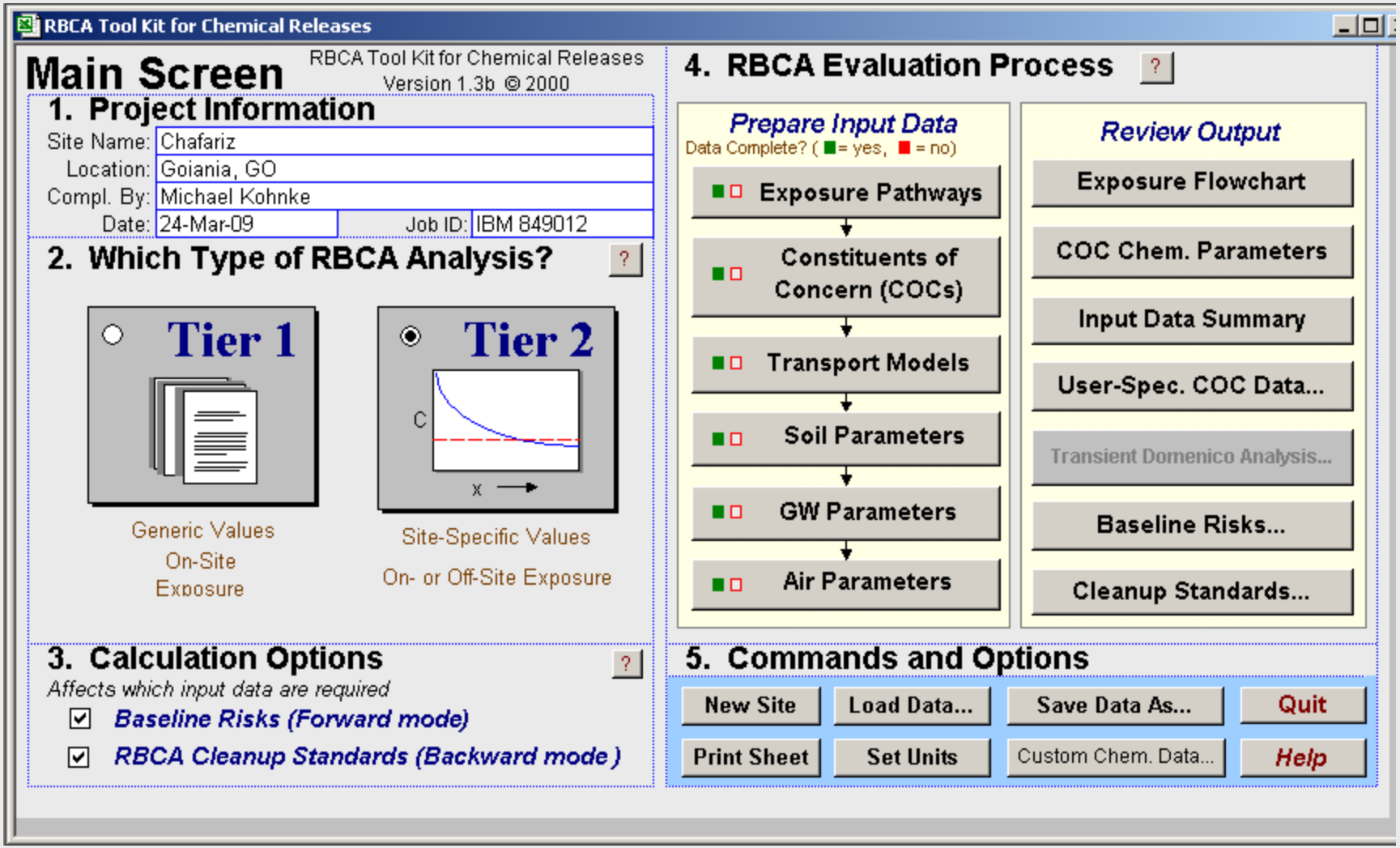


Lsp = Source area length in deep soil
Sdsp = Source area thickness in deep soil
Ugw= Groundwater velocity
δgw= Thickness of groundwater mixing zone



Wsp = Source area width in deep soil
Lsp = Source area length in deep soil
Sdsp = Source area thickness in deep soil

3. EJEMPLO CHAFARIZ



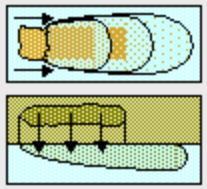
EJEMPLO CHAFARIZ – IDENTIFICACIÓN EXPOSICIÓN

RBCA Tool Kit for Chemical Releases

Exposure Pathway Identification

Site Name: Chafariz
Location: Goiania, GO
Compl. By: Michael Kohnke
Job ID: IBM 849012 Date: 24-Mar-09

1. Groundwater Exposure



Groundwater Ingestion/ Surface Water Impact

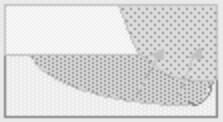
Receptor	None	None	None
Type:	On-site	Off-site1	Off-site2

Source Media:

Distance to GW receptors

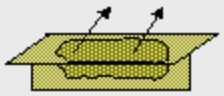
	On-site	Off-site1	Off-site2	
☐ Affected Groundwater	0	0	0	(m)
☐ Affected Soils Leaching to Groundwater	0	0	0	(m)

GW Discharge to Surface Water Exposure



☐ Swimming
☐ Fish Consumption
☐ Aquatic Life Protection
Enter ALP Criteria

2. Surface Soil Exposure

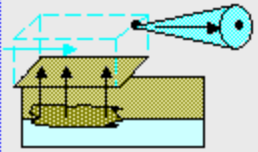


Direct Ingestion and Dermal Contact

Receptor	None	No off-site receptors
Type:	On-site	

Construction Worker ☐

3. Air Exposure

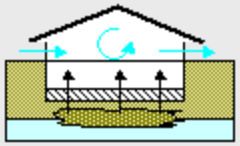


Volatilization and Particulates to Outdoor Air Inhalation

Receptor	None	None	None
Type:	On-site	Off-site1	Off-site2
	0	0	0 (m)

Construction worker ☐

☐ Affected Soils--Volatilization to Ambient Outdoor Air
☐ Affected Groundwater--Volatilization to Ambient Outdoor Air
☐ Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor	Com.	No off-site receptors
Type:	On-site	

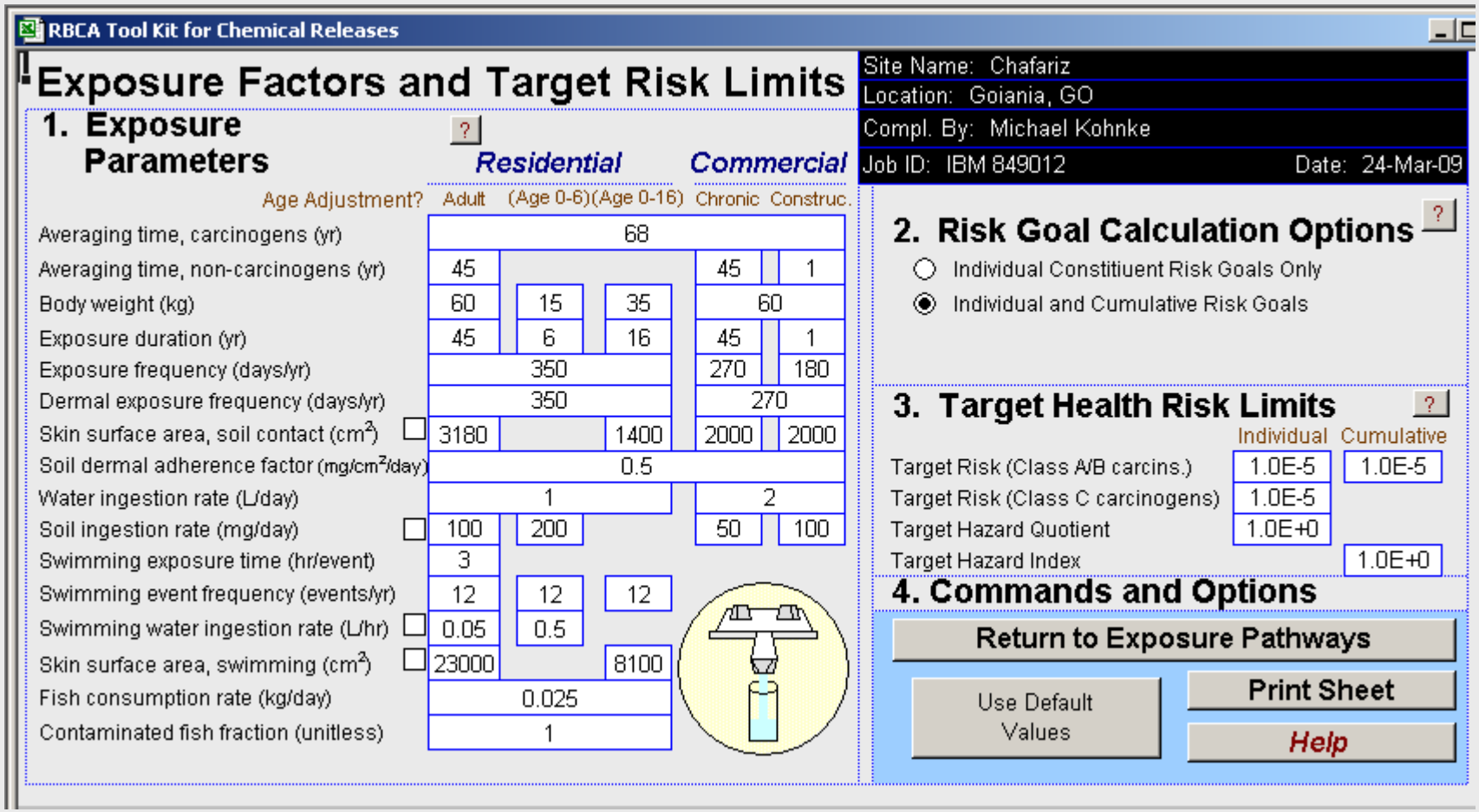
☑ Affected Soils--Volatilization to Enclosed Space
☑ Affected Groundwater--Volatilization to Enclosed Space

4. Commands and Options

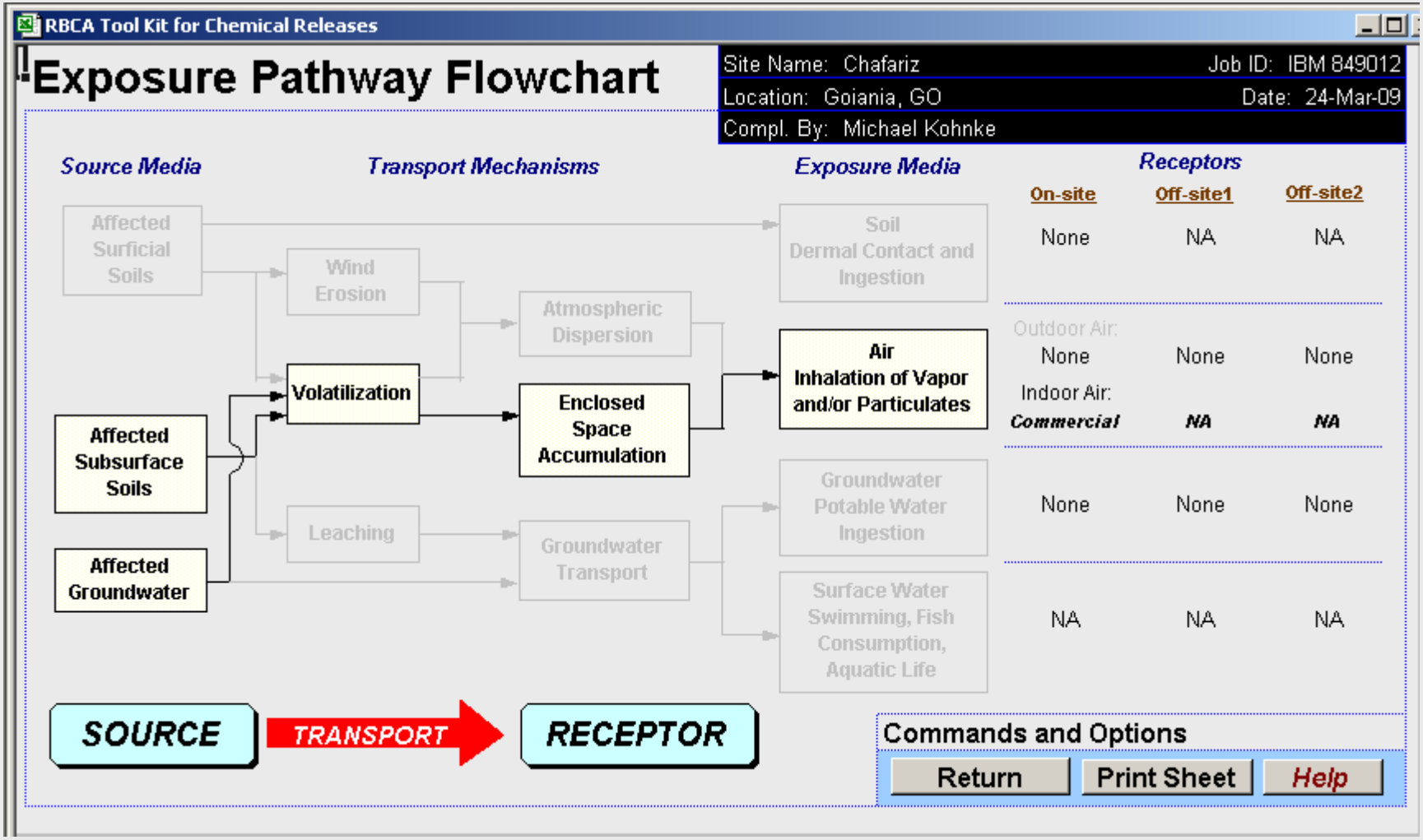
Main Screen | Print Sheet | Set Units | Help

Exposure Factors & Target Risks | Exposure Flowchart

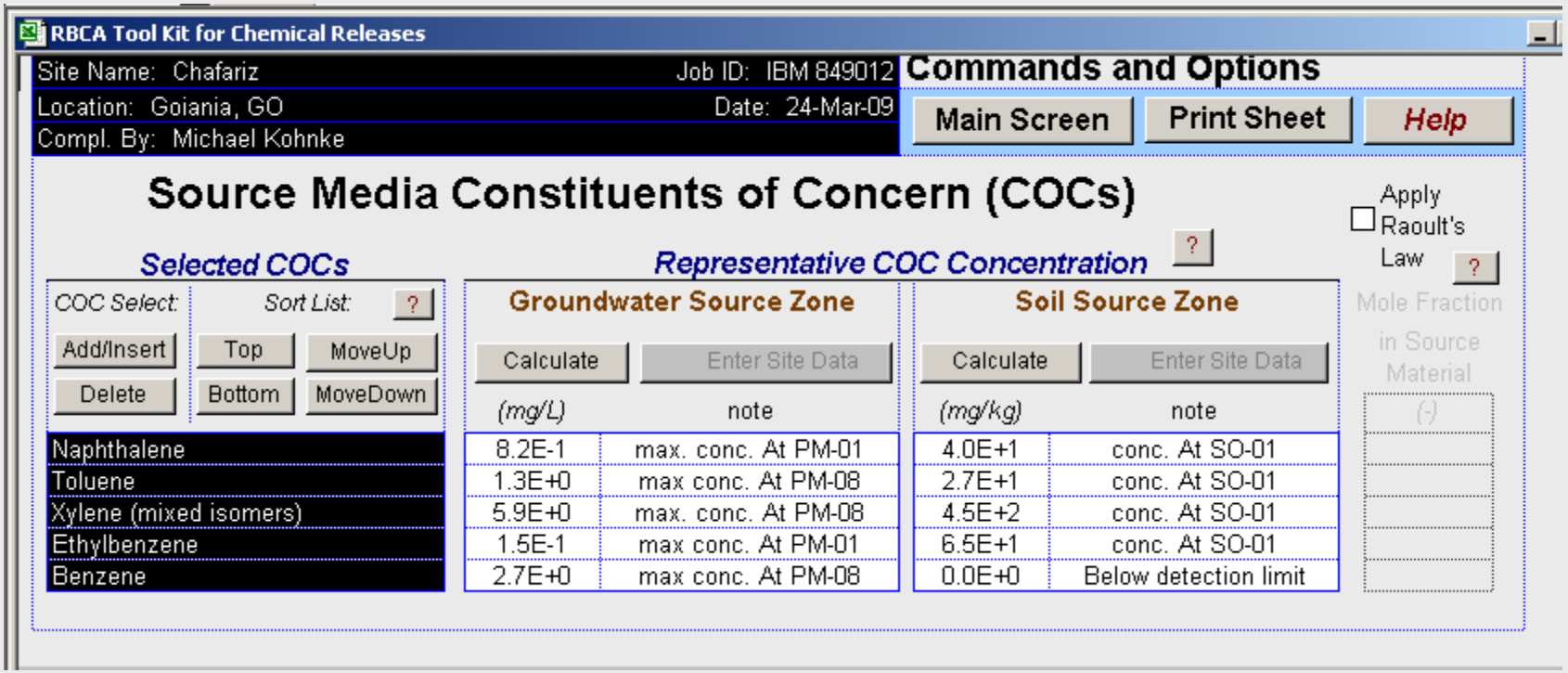
EJEMPLO CHAFARIZ – FACTORES DE EXPOSICIÓN/RIESGO



EJEMPLO CHAFARIZ – CAMINOS DE EXPOSICIÓN



EJEMPLO CHAFARIZ - COMPUESTOS DE INTERÉS



RBCA Tool Kit for Chemical Releases

Site Name: Chafariz | Job ID: IBM 849012
Location: Goiania, GO | Date: 24-Mar-09
Compl. By: Michael Kohnke

Commands and Options: Main Screen | Print Sheet | Help

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Mole Fraction in Source Material

Selected COCs

COC Select: | Sort List: ?

Add/Insert | Top | MoveUp
Delete | Bottom | MoveDown

Representative COC Concentration ?

Selected COCs	Groundwater Source Zone		Soil Source Zone		Mole Fraction in Source Material
	Calculate / Enter Site Data		Calculate / Enter Site Data		
	(mg/L)	note	(mg/kg)	note	(-)
Naphthalene	8.2E-1	max. conc. At PM-01	4.0E+1	conc. At SO-01	
Toluene	1.3E+0	max conc. At PM-08	2.7E+1	conc. At SO-01	
Xylene (mixed isomers)	5.9E+0	max. conc. At PM-08	4.5E+2	conc. At SO-01	
Ethylbenzene	1.5E-1	max conc. At PM-01	6.5E+1	conc. At SO-01	
Benzene	2.7E+0	max conc. At PM-08	0.0E+0	Below detection limit	

EJEMPLO CHAFARIZ – OPCIONES PARA EL TRANSPORTE

RBCA Tool Kit for Chemical Releases

Transport Modeling Options

Site Name: Chafariz — Job ID: IBM 849012
Location: Goiania, GO — Date: 24-Mar-09
Compl. By: Michael Kohnke

1. Vertical Transport, Surface Soil Column

Outdoor Air Volatilization Factors ?

- ○ Surface soil volatilization model only
- ○ Combination surface soil/Johnson & Ettinger models
  Thickness of surface soil zone [1] (m)
- ○ User-specified VF from other model — Enter VF Values

Indoor Air Volatilization Factors ?

- ◉ Johnson & Ettinger model
- ○ User-specified VF from other model — Enter VF Values

Soil-to-Groundwater Leaching Factor

- ○ ASTM Model ?
  - ☐ Apply Soil Attenuation Model (SAM)
  - ☐ Allow first-order biodecay — Enter Decay Rates
- ○ User-specified LF from other model — Enter LF Values

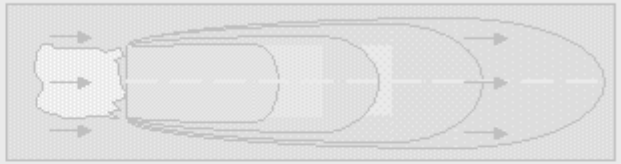
2. Lateral Air Dispersion Factor

?

- ○ 3-D Gaussian dispersion model
- ○ User-Specified ADF

Off-site 1	Off-site 2	
1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model ?

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay — Enter Decay Rates
- ○ Modified Domenico equation using electron acceptor superposition — Enter Site Data

Enter Directly — Biodegradation Capacity [NC] (mg/L)

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data — Enter DAF Values

4. Commands and Options

Main Screen | Print Sheet | Help

EJEMPLO CHAFARIZ – PARÁMETROS SUELO

RBCA Tool Kit for Chemical Releases

Site-Specific Soil Parameters

Site Name: Chafariz | Job ID: IBM 849012
Location: Goiania, GO | Date: 24-Mar-09
Compl. By: Michael Kohnke

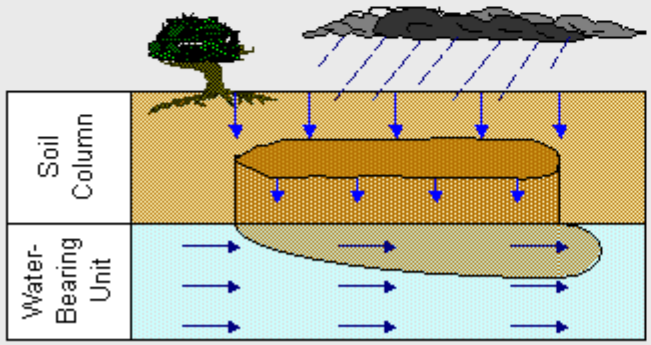
1. Soil Source Zone Characteristics

Hydrogeology — General Case Construction

Depth to water-bearing unit	9.6	(m)
Capillary zone thickness	0.21	(m)
Soil column thickness	9.39	(m)

Affected Soil Zone

Depth to top of affected soils	0.1		(m)
Depth to base of affected soils	9.6		(m)
Affected soil area	350	350	(m^2)
Length of affected soil parallel to assumed wind direction			(m)
Length of affected soil parallel to assumed GW flow direction			(m)



2. Surface Soil Column

Vadose Zone | Capillary Fringe

Predominant USCS Soil Type — or — Calculate

Total porosity	0.46		(-)
Volumetric water content	0.323	0.4149	(-)
Volumetric air content	0.137	0.0451	(-)
Dry bulk density	1.8		(kg/L)
Vertical hydraulic conductivity	1.0E-5		(cm/s)
Vapor permeability	1.0E-15		(m^2)
Capillary zone thickness	2.1E-1		(m)

Net Rainfall Infiltration

Net infiltration estimate		(in/yr)
or NA or		
Average annual precipitation		(in/yr)

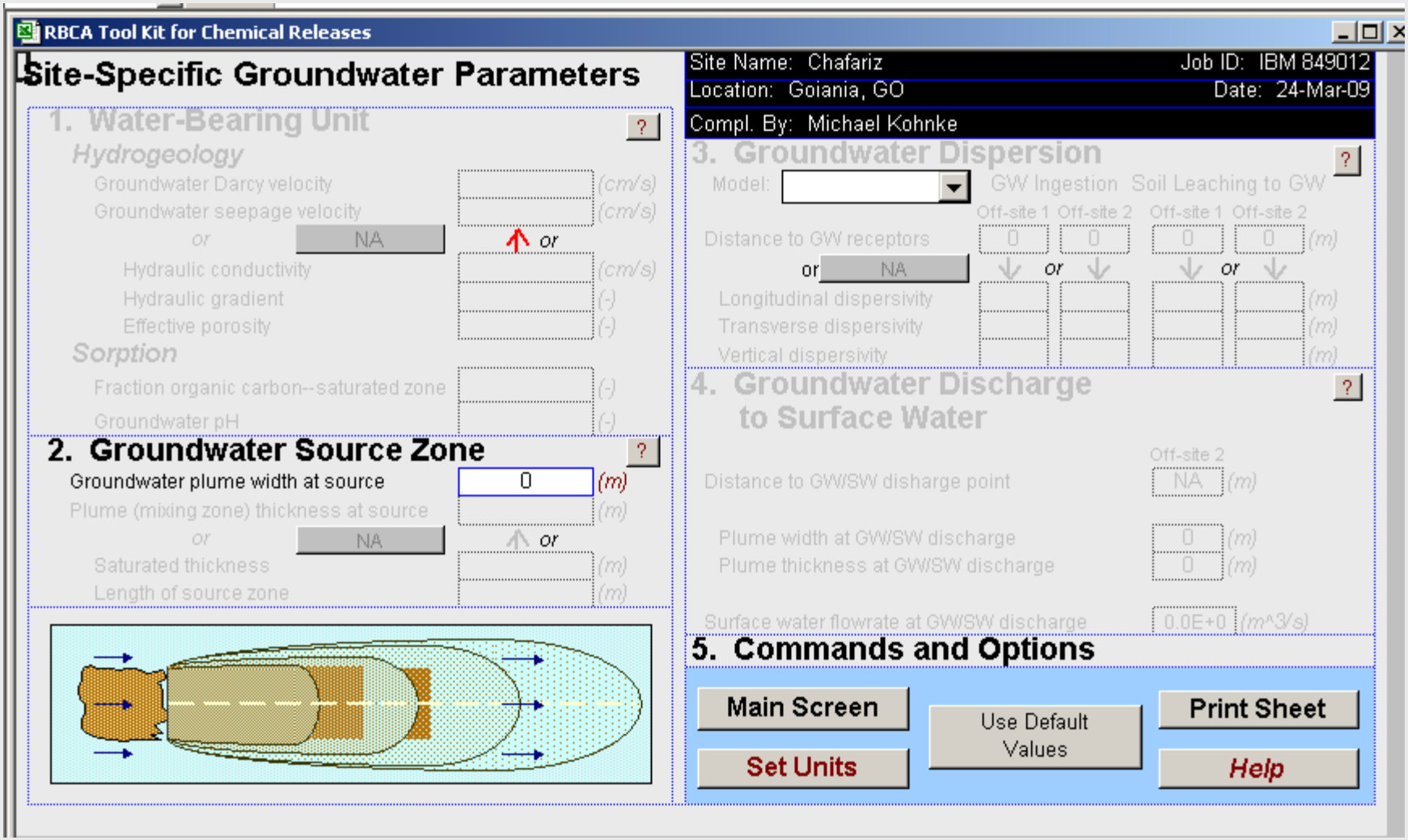
Partitioning Parameters

Fraction organic carbon	0.0055	(-)
Soil/water pH	6.8	(-)

3. Commands and Options

Main Screen | Use Default Values | Print Sheet
Set Units | | Help

EJEMPLO CHAFARIZ – PARÁMETROS AGUAS SUBTERRÁNEAS



EJEMPLO CHAFARIZ – PARÁMETROS AIRE

RBCA Tool Kit for Chemical Releases

Site-Specific Air Parameters

Site Name: Chafariz | Job ID: IBM 849012
Location: Goiania, GO | Date: 24-Mar-09
Compl. By: Michael Kohnke

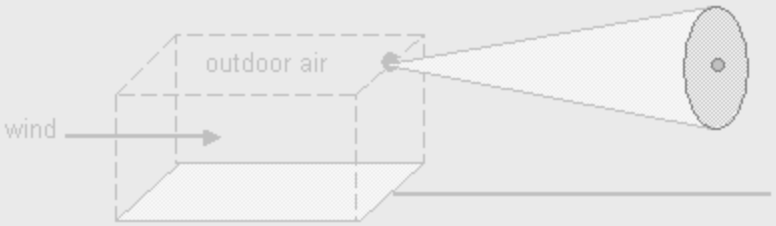
1. Outdoor Air Pathway

Dispersion in Air

	Off-site 1	Off-site 2	
Distance to offsite air receptor			(m)
or NA		or	
Horizontal dispersivity			(m)
Vertical dispersivity			(m)

Air Source Zone

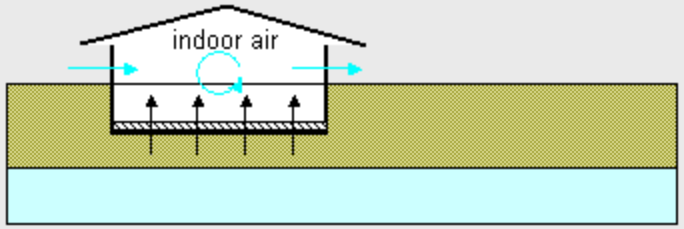
Air mixing zone height	2	(m)
Ambient air velocity in mixing zone	2.25	(m/s)
Areal particulate emission flux	6.9E-14	(g/cm^2/s)



2. Indoor Air Pathway

Building Parameters

	Residential	Commercial	
Building volume/area ratio	2	3	(m)
Foundation area	70	70	(m^2)
Foundation perimeter	34	34	(m)
Building air exchange rate	1.4E-4	2.3E-4	(1/s)
Depth to bottom of foundation slab	0.15	0.15	(m)
Convective air flow through cracks	0.0E+0	0.0E+0	(m^3/s)
Foundation thickness	0.15		(m)
Foundation crack fraction	0.01		(-)
Volumetric water content of cracks	0.12		(-)
Volumetric air content of cracks	0.26		(-)
Indoor/Outdoor differential pressure	0		(psi)



3. Commands and Options

Main Screen | Use Default Values | Print Sheet
Set Units | | Help

EJEMPLO CHAFARIZ – RESUMEN DEL RIESGO

Return | Print Sheet | RBCA SITE ASSESSMENT | Baseline Risk Summary-All Pathways

Site Name: Chafariz
Site Location: Goiania, GO
Completed By: Michael Kohnke
Date Completed: 24-Mar-09

TIER 2 BASELINE RISK SUMMARY TABLE

	BASELINE CARCINOGENIC RISK					BASELINE TOXIC EFFECTS				
	Individual COC Risk		Cumulative COC Risk		Risk	Hazard Quotient		Hazard Index		Toxicity
EXPOSURE PATHWAY	Maximum Value	Target Risk	Total Value	Target Risk	Limit(s) Exceeded?	Maximum Value	Applicable Limit	Total Value	Applicable Limit	Limit(s) Exceeded?
OUTDOOR AIR EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
INDOOR AIR EXPOSURE PATHWAYS										
Complete:	1.3E-5	1.0E-5	1.3E-5	1.0E-5	■	7.8E-1	1.0E+0	2.0E+0	1.0E+0	■
SOIL EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
GROUNDWATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
SURFACE WATER EXPOSURE PATHWAYS										
Complete:	NA	NA	NA	NA	☐	NA	NA	NA	NA	☐
CRITICAL EXPOSURE PATHWAY (Maximum Values From Complete Pathways)										
	1.3E-5	*1.0E-5*	*1.3E-5*	*1.0E-5*	■	*7.8E-1*	*1.0E+0*	*2.0E+0*	*1.0E+0*	■
	Indoor Air		*Indoor Air*			*Indoor Air*		*Indoor Air*		

EJEMPLO CHAFARIZ – VALORES SSTL

Return | Print Sheet

RBCA SITE ASSESSMENT

Site Name: Chafariz
Site Location: Goiania, GO

Completed By: Michael Kohnke
Date Completed: 24-Mar-09

Job ID: IBM 849012

SOIL (0.1 - 9.6 m) SSTL VALUES

Target Risk (Class A & B) 1.0E-5
Target Risk (Class C) 1.0E-5
Target Hazard Quotient 1.0E+0

Groundwater DAF Option:

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

CONSTITUENTS OF CONCERN		Representative Concentration	Soil Leaching to Groundwater Ingestion / Discharge to Surface Water			X Soil Vol. to Indoor Air	Soil Volatilization and Surface Soil Particulates to Outdoor Air				Surface Soil Ingestion and Dermal Contact		Applicable SSTL	SSTL Exceeded ?
			On-site (0 m)	Off-site 1 (0 m)	Off-site 2 (0 m)	On-site (0 m)	On-site (0 m)		Off-site 1 (0 m)	Off-site 2 (0 m)	On-site (0 m)			
CAS No.	Name	(mg/kg)	None	None	None	Commercial	None	Construction Worker	None	None	None	Construction Worker	(mg/kg)	"■" if yes
91-20-3	Naphthalene	4.0E+1	NA	NA	NA	>3.5E+2	NA	NA	NA	NA	NA	NA	>3.5E+2	☐
108-88-3	Toluene	2.7E+1	NA	NA	NA	3.4E+1	NA	NA	NA	NA	NA	NA	3.4E+1	☐
1330-20-7	Xylene (mixed isomers)	4.5E+2	NA	NA	NA	>3.0E+2	NA	NA	NA	NA	NA	NA	>3.0E+2	☐
100-41-4	Ethylbenzene	6.5E+1	NA	NA	NA	1.8E+2	NA	NA	NA	NA	NA	NA	1.8E+2	☐
71-43-2	Benzene	0.0E+0	NA	NA	NA	1.4E-1	NA	NA	NA	NA	NA	NA	1.4E-1	☐

">" indicates risk-based target concentration greater than constituent residual saturation value. NA = Not applicable. NC = Not calculated.

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RBCA SITE ASSESSMENT

Site Name: Chafariz
Site Location: Goiania, GO

Completed By: Michael Kohnke
Date Completed: 24-Mar-09

Job ID: IBM 849012

GROUNDWATER SSTL VALUES

Target Risk (Class A & B) 1.0E-5
Target Risk (Class C) 1.0E-5
Target Hazard Quotient 1.0E+0

Groundwater DAF Option:

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

CONSTITUENTS OF CONCERN		Representative Concentration	Groundwater Ingestion / Discharge to Surface Water			X GW Vol. to Indoor Air	Groundwater Volatilization to Outdoor Air			Applicable SSTL	SSTL Exceeded ?	Required CRF
			On-site (0 m)	Off-site 1 (0 m)	Off-site 2 (0 m)	On-site (0 m)	On-site (0 m)	Off-site 1 (0 m)	Off-site 2 (0 m)			Only if "yes" left
CAS No.	Name	(mg/L)	None	None	None	Commercial	None	None	None	(mg/L)	"■" if yes	
91-20-3	Naphthalene	8.2E-1	NA	NA	NA	>3.1E+1	NA	NA	NA	>3.1E+1	☐	NA
108-88-3	Toluene	1.3E+0	NA	NA	NA	4.2E+2	NA	NA	NA	4.2E+2	☐	<1
1330-20-7	Xylene (mixed isomers)	5.9E+0	NA	NA	NA	>2.0E+2	NA	NA	NA	>2.0E+2	☐	NA
100-41-4	Ethylbenzene	1.5E-1	NA	NA	NA	>1.7E+2	NA	NA	NA	>1.7E+2	☐	NA
71-43-2	Benzene	2.7E+0	NA	NA	NA	2.0E+0	NA	NA	NA	2.0E+0	■	1.3E+0

">" indicates risk-based target concentration greater than constituent solubility value. NA = Not applicable. NC = Not calculated.

4. RECOMENDACIONES

- 1. Siempre evaluar los compuestos y seleccionar los que son realmente de interés.
- 2. Determinar los caminos de exposición y seleccionar para cálculo solo los reales y no los hipotéticos.
- 3. Averiguar si los datos disponibles permiten una evaluación de un cierto escenario, si no recomendar la adquisición de tales informaciones
- 4. Considerar las leyes existentes
- 5. Solo en algunos casos especiales será necesario incluir el TPH en el análisis. En general no es necesario.
- 6. Siempre considerar los valores de PID medidos en el suelo para dimensionar la posible extensión de la contaminación en los suelos.