Appendix G
Vapor Migration Model Results

SUMMARY OF VAPOR MIGRATION RESULTS - COMMERCIAL/LIGHT INDUSTRIAL SCENARIO
BRC Former C-6 Facility, Los Angeles, California

Groundwater

CAS No.	Chemical	Cancer Risk	Hazard Index	Groundwater Concentration (ug/L)
71-55-6	Chloroform	3.6E-08	6.1E-05	1.50E+03
79-01-6	Tetrachloroethylene (PCE)	5.2E-09	7.0E-05	5.50E+01
75-09-2	Methylene Chloride	1.1E-11	7.7E-08	4.00E+00

Soil

CAS No.	Chemical	Cancer Risk	Hazard Index	Soil Concentration (mg/kg)
75-09-2	Methylene Chloride	3.0E-10	2.2E-06	6.80E-03

Project Name: BRC Former Boeing C-6 Facility, Los Angeles, California

Chemical: Tetrachloroethylene (PCE)

Variable Descriptions				Units
CALCULATION OF SOIL GAS CONCENTRATION				
A. SOURCE - Free Product/Soil>100mg/kg.				
Mole fraction	MF	=	0.00E+00	dimensionless
Molecular weight	MW	=	1.70E+05	mg/mole
Vapor pressure	VP	=	2.43E-02	atm
Universal gas constant	R	=	8.20E-05	atm-m3/mole-K
Temperature	T	=	2.93E+02	K
Calculated soil gas concentration	**C_{sg}(fp)**	=	**0.00E+00**	**mg/m3**
B. SOURCE - Groundwater				
Water contamination level	C_w	=	5.50E+01	ug/l
Henry's Law Constant	H	=	7.50E-01	dimensionless
Calculated soil gas concentration	**C_{sg}(gw)**	=	**4.13E+01**	**mg/m3**
C. SOURCE - Soil < 100 mg/kg				
Soil contamination level	C_t	=		mg/kg
Henry's Law Constant	H	=	7.50E-01	dimensionless
Bulk density (dry)	ρ_b	=	1.50E+00	gm/cc
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Water-filled porosity	θ_w	=	1.50E-01	dimensionless
Weight fraction of organic carbon	f_{oc}	=	4.00E-03	dimensionless
Organic carbon partition coefficient	K_{oc}	=	2.70E+02	cm3/gm
Soil/water distribution coef.	K_d	=	**1.08E+00**	cm3/gm
Calculated soil gas concentration	**C_{sg}(s)**	=	**0.00E+00**	**mg/m3**
D. SOURCE - Measured Soil Gas				
Measured soil gas concentration	**C_{sg}(m)**	=		**mg/m3 (ug/l)**

E. SOIL GAS CONCENTRATION USED IN RISK CALCULATIONS >>>> 4.13E+01 mg/m3

DIFFUSIVE TRANSPORT UPWARD IN UNSATURATED ZONE				
Total porosity	θ	=	4.34E-01	dimensionless
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Diffusion coefficient in air	D_a	=	7.20E-02	cm2/sec
Effective diffusion coefficient	**D_e**	=	**5.78E-03**	cm2/sec
Depth of contamination or Csg	X	=	1.98E+01	m
Calculated Flux	**F_x**	=	**4.33E-03**	**mg/m2-hour**

CALCULATING VAPOR CONCENTRATION IN BUILDING

A. INDOOR AIR COMPONENT

Floor area of building	A	=	9.68E+02	m2
% of floor area that flux occurs			1.00E+00	dimensionless
Attenuation factor(Crack factor)	S_b	=	1.00E-02	dimensionless
Flux area within building	Af	=	**9.68E+00**	m2
Interior Height of building	R_h	=	2.44E+00	m
Volume of building	V	=	**2.36E+03**	m3
Exchange rate of air	E	=	8.30E-01	exchanges/hr
Ventilation rate	Q	=	**1.96E+03**	m3/hr
Indoor air component	C_i	=	**2.14E-05**	**mg/m3**

B. OUTDOOR AIR COMPONENT

Downwind contamination length	L	=		m
Wind speed	u	=		m/hr
Height of building openings (or height of breathing zone)	h	=		m
Outdoor air component	C_o	=	**0.00E+00**	**mg/m3**
C. TOTAL INDOOR AIR CONCENTRATION	C_t	=	**2.14E-05**	**mg/m3**

EXPOSURE SCENARIO

Body weight	BW	=	7.00E+01	kg
Inhalation rate	IR	=	2.00E+01	m3/day
Exposure duration	ED	=	2.50E+01	yrs
Hours per day	conversion		8.00E+00	hr/day
Exposure time	ET	=	**3.33E-01**	hr/24 hours
Days per week	conversion		2.50E+00	days/week
Weeks per year	conversion		5.00E+01	weeks/yr
Exposure frequency	EF	=	**1.25E+02**	days/yr
Averaging Time (carc. risk)	AT	=	2.56E+04	days
Averaging Time (non-carc. risk)	AT	=	**9.13E+03**	days
Chemical Intake (carc. risk)	IT_c	=	**2.49E-07**	**mg/kg-day**
Chemical Intake (non-carc. risk)	IT_{nc}	=	**6.98E-07**	**mg/kg-day**

NON-CARCINOGENIC RISK (Chronic Risk)

Chemical Intake (non-carc. risk)	IT_{nc}	=	6.98E-07	mg/kg-day
Reference dose	RfD	=	1.00E-02	mg/kg-day
Hazard Index	**HI**	=	**6.98E-05**	

CARCINOGENIC RISK

Chemical Intake (carc. risk)	IT_c	=	2.49E-07	mg/kg-day
Slope factor (potency)	SF	=	2.10E-02	1/(mg/kg-day)
Cancer Risk	**Risk**	=	**5.22E-09**	

Project Name: BRC Former Boeing C-6 Facility, Los Angeles, California

Chemical: Methylene Chloride

Variable Descriptions				Units
CALCULATION OF SOIL GAS CONCENTRATION				
A. SOURCE - Free Product/Soil>100mg/kg.				
Mole fraction	MF	=	0.00E+00	dimensionless
Molecular weight	MW	=	8.50E+04	mg/mole
Vapor pressure	VP	=	5.72E-01	atm
Universal gas constant	R	=	8.20E-05	atm-m3/mole-K
Temperature	T	=	2.93E+02	K
Calculated soil gas concentration	**C_{sg}(fp)**	=	**0.00E+00**	**mg/m3**
B. SOURCE - Groundwater				
Water contamination level	C_w	=		ug/l
Henry's Law Constant	H	=	9.00E-02	dimensionless
Calculated soil gas concentration	**C_{sg}(gw)**	=	**0.00E+00**	**mg/m3**
C. SOURCE - Soil < 100 mg/kg				
Soil contamination level	C_t	=	6.80E-03	mg/kg
Henry's Law Constant	H	=	9.00E-02	dimensionless
Bulk density (dry)	ρ_b	=	1.50E+00	gm/cc
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Water-filled porosity	θ_w	=	1.50E-01	dimensionless
Weight fraction of organic carbon	f_{oc}	=	4.00E-03	dimensionless
Organic carbon partition coefficient	K_{oc}	=	1.00E+01	cm3/gm
Soil/water distribution coef.	K_d	=	**4.00E-02**	cm3/gm
Calculated soil gas concentration	**C_{sg}(s)**	=	**3.90E+00**	**mg/m3**
D. SOURCE - Measured Soil Gas				
Measured soil gas concentration	**C_{sg}(m)**	=		**mg/m3 (ug/l)**

E. SOIL GAS CONCENTRATION USED IN RISK CALCULATIONS >>>> 3.90E+00 mg/m3

DIFFUSIVE TRANSPORT UPWARD IN UNSATURATED ZONE				
Total porosity	θ	=	4.34E-01	dimensionless
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Diffusion coefficient in air	D_a	=	1.00E-01	cm2/sec
Effective diffusion coefficient	**D_e**	=	**8.03E-03**	cm2/sec
Depth of contamination or Csg	X	=	7.62E+00	m
Calculated Flux	**F_x**	=	**1.48E-03**	**mg/m2-hour**

CALCULATING VAPOR CONCENTRATION IN BUILDING

A. INDOOR AIR COMPONENT

Floor area of building	A	=	9.68E+02	m2
% of floor area that flux occurs			1.00E+00	dimensionless
Attenuation factor(Crack factor)	S_b	=	1.00E-02	dimensionless
Flux area within building	Af	=	**9.68E+00**	m2
Interior Height of building	R_h	=	2.44E+00	m
Volume of building	V	=	**2.36E+03**	m3
Exchange rate of air	E	=	8.30E-01	exchanges/hr
Ventilation rate	Q	=	**1.96E+03**	m3/hr
Indoor air component	**C_i**	=	**7.30E-06**	**mg/m3**

B. OUTDOOR AIR COMPONENT

Downwind contamination length	L	=	0.00E+00	m
Wind speed	u	=	0.00E+00	m/hr
Height of building openings (or height of breathing zone)	h	=	0.00E+00	m
Outdoor air component	**C_o**	=	**0.00E+00**	**mg/m3**
C. TOTAL INDOOR AIR CONCENTRATION	**C_t**	=	**7.30E-06**	**mg/m3**

EXPOSURE SCENARIO

Body weight	BW	=	7.00E+01	kg
Inhalation rate	IR	=	2.00E+01	m3/day
Exposure duration	ED	=	2.50E+01	yrs
Hours per day	conversion		8.00E+00	hr/day
Exposure time	ET	=	**3.33E-01**	hr/24 hours
Days per week	conversion		2.50E+00	days/week
Weeks per year	conversion		5.00E+01	weeks/yr
Exposure frequency	EF	=	**1.25E+02**	days/yr
Averaging Time (carc. risk)	AT	=	2.56E+04	days
Averaging Time (non-carc. risk)	AT	=	**9.13E+03**	days
Chemical Intake (carc. risk)	**IT_c**	=	**8.48E-08**	**mg/kg-day**
Chemical Intake (non-carc. risk)	**IT_{nc}**	=	**2.38E-07**	**mg/kg-day**

NON-CARCINOGENIC RISK (Chronic Risk)

Chemical Intake (non-carc. risk)	IT_{nc}	=	2.38E-07	mg/kg-day
Reference dose	RfD	=	1.10E-01	mg/kg-day
Hazard Index	**HI**	=	**2.16E-06**	

CARCINOGENIC RISK

Chemical Intake (carc. risk)	IT_c	=	8.48E-08	mg/kg-day
Slope factor (potency)	SF	=	3.50E-03	1/(mg/kg-day)
Cancer Risk	**Risk**	=	**2.97E-10**	

Project Name: BRC Former Boeing C-6 Facility, Los Angeles, California

Chemical: Methylene Chloride

Variable Descriptions				**Units**
CALCULATION OF SOIL GAS CONCENTRATION				
A. SOURCE - Free Product/Soil>100mg/kg.				
Mole fraction	MF	=	0.00E+00	dimensionless
Molecular weight	MW	=	8.50E+04	mg/mole
Vapor pressure	VP	=	5.72E-01	atm
Universal gas constant	R	=	8.20E-05	atm-m3/mole-K
Temperature	T	=	2.93E+02	K
Calculated soil gas concentration	**C_{sg}(fp)**	=	**0.00E+00**	**mg/m3**
B. SOURCE - Groundwater				
Water contamination level	C_w	=	4.00E+00	ug/l
Henry's Law Constant	H	=	9.00E-02	dimensionless
Calculated soil gas concentration	**C_{sg}(gw)**	=	**3.60E-01**	**mg/m3**
C. SOURCE - Soil < 100 mg/kg				
Soil contamination level	C_t	=		mg/kg
Henry's Law Constant	H	=	9.00E-02	dimensionless
Bulk density (dry)	ρ_b	=	1.50E+00	gm/cc
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Water-filled porosity	θ_w	=	1.50E-01	dimensionless
Weight fraction of organic carbon	f_{oc}	=	4.00E-03	dimensionless
Organic carbon partition coefficient	K_{oc}	=	1.00E+01	cm3/gm
Soil/water distribution coef.	K_d	=	**4.00E-02**	cm3/gm
Calculated soil gas concentration	**C_{sg}(s)**	=	**0.00E+00**	**mg/m3**
D. SOURCE - Measured Soil Gas				
Measured soil gas concentration	**C_{sg}(m)**	=		**mg/m3 (ug/l)**

E. SOIL GAS CONCENTRATION USED IN RISK CALCULATIONS >>>> 3.60E-01 mg/m3

DIFFUSIVE TRANSPORT UPWARD IN UNSATURATED ZONE				
Total porosity	θ	=	4.34E-01	dimensionless
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Diffusion coefficient in air	D_a	=	1.00E-01	cm2/sec
Effective diffusion coefficient	**D_e**	=	**8.03E-03**	cm2/sec
Depth of contamination or Csg	X	=	1.98E+01	m
Calculated Flux	**F_x**	=	**5.25E-05**	**mg/m2-hour**

CALCULATING VAPOR CONCENTRATION IN BUILDING

A. INDOOR AIR COMPONENT

Floor area of building	A	=	9.68E+02	m2
% of floor area that flux occurs			1.00E+00	dimensionless
Attenuation factor(Crack factor)	S_b	=	1.00E-02	dimensionless
Flux area within building	Af	=	**9.68E+00**	m2
Interior Height of building	R_h	=	2.44E+00	m
Volume of building	V	=	**2.36E+03**	m3
Exchange rate of air	E	=	8.30E-01	exchanges/hr
Ventilation rate	Q	=	**1.96E+03**	m3/hr
Indoor air component	**C_i**	=	**2.59E-07**	**mg/m3**

B. OUTDOOR AIR COMPONENT

Downwind contamination length	L	=	0.00E+00	m
Wind speed	u	=	0.00E+00	m/hr
Height of building openings (or height of breathing zone)	h	=	0.00E+00	m
Outdoor air component	**C_o**	=	**0.00E+00**	**mg/m3**

C. TOTAL INDOOR AIR CONCENTRATION **C_t** = **2.59E-07** **mg/m3**

EXPOSURE SCENARIO

Body weight	BW	=	7.00E+01	kg
Inhalation rate	IR	=	2.00E+01	m3/day
Exposure duration	ED	=	2.50E+01	yrs
Hours per day	conversion		8.00E+00	hr/day
Exposure time	ET	=	**3.33E-01**	hr/24 hours
Days per week	conversion		2.50E+00	days/week
Weeks per year	conversion		5.00E+01	weeks/yr
Exposure frequency	EF	=	**1.25E+02**	days/yr
Averaging Time (carc. risk)	AT	=	2.56E+04	days
Averaging Time (non-carc. risk)	AT	=	**9.13E+03**	days
Chemical Intake (carc. risk)	**IT_c**	=	**3.01E-09**	**mg/kg-day**
Chemical Intake (non-carc. risk)	**IT_{nc}**	=	**8.46E-09**	**mg/kg-day**

NON-CARCINOGENIC RISK (Chronic Risk)

Chemical Intake (non-carc. risk)	**IT_{nc}**	=	8.46E-09	mg/kg-day
Reference dose	RfD	=	1.10E-01	mg/kg-day
Hazard Index	**HI**	=	**7.69E-08**	

CARCINOGENIC RISK

Chemical Intake (carc. risk)	IT_c	=	3.01E-09	mg/kg-day
Slope factor (potency)	SF	=	3.50E-03	1/(mg/kg-day)
Cancer Risk	**Risk**	=	**1.06E-11**	

Project Name: BRC Former Boeing C-6 Facility, Los Angeles, California

Chemical: Chloroform

Variable Descriptions				Units
CALCULATION OF SOIL GAS CONCENTRATION				
A. SOURCE - Free Product/Soil>100mg/kg.				
Mole fraction	MF	=	0.00E+00	dimensionless
Molecular weight	MW	=	1.20E+05	mg/mole
Vapor pressure	VP	=	2.59E-01	atm
Universal gas constant	R	=	8.20E-05	atm-m3/mole-K
Temperature	T	=	2.93E+02	K
Calculated soil gas concentration	**C_{sg}(fp)**	=	**0.00E+00**	**mg/m3**
B. SOURCE - Groundwater				
Water contamination level	C_w	=	1.50E+03	ug/l
Henry's Law Constant	H	=	1.50E-01	dimensionless
Calculated soil gas concentration	**C_{sg}(gw)**	=	**2.25E+02**	**mg/m3**
C. SOURCE - Soil < 100 mg/kg				
Soil contamination level	C_t	=		mg/kg
Henry's Law Constant	H	=	1.50E-01	dimensionless
Bulk density (dry)	ρ_b	=	1.50E+00	gm/cc
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Water-filled porosity	θ_w	=	1.50E-01	dimensionless
Weight fraction of organic carbon	f_{oc}	=	4.00E-03	dimensionless
Organic carbon partition coefficient	K_{oc}	=	5.30E+01	cm3/gm
Soil/water distribution coef.	K_d	=	**2.12E-01**	cm3/gm
Calculated soil gas concentration	**C_{sg}(s)**	=	**0.00E+00**	**mg/m3**
D. SOURCE - Measured Soil Gas				
Measured soil gas concentration	**C_{sg}(m)**	=		**mg/m3 (ug/l)**

E. SOIL GAS CONCENTRATION USED IN RISK CALCULATIONS >>>> 2.25E+02 mg/m3

DIFFUSIVE TRANSPORT UPWARD IN UNSATURATED ZONE				
Total porosity	θ	=	4.34E-01	dimensionless
Air-filled porosity	θ_a	=	2.84E-01	dimensionless
Diffusion coefficient in air	D_a	=	1.00E-01	cm2/sec
Effective diffusion coefficient	**D_e**	=	**8.03E-03**	cm2/sec
Depth of contamination or Csg	X	=	1.98E+01	m
Calculated Flux	**F_x**	=	**3.28E-02**	**mg/m2-hour**

CALCULATING VAPOR CONCENTRATION IN BUILDING

A. INDOOR AIR COMPONENT

Floor area of building	A	=	9.68E+02	m2
% of floor area that flux occurs			1.00E+00	dimensionless
Attenuation factor(Crack factor)	S_b	=	1.00E-02	dimensionless
Flux area within building	Af	=	**9.68E+00**	m2
Interior Height of building	R_h	=	2.44E+00	m
Volume of building	V	=	**2.36E+03**	m3
Exchange rate of air	E	=	8.30E-01	exchanges/hr
Ventilation rate	Q	=	**1.96E+03**	m3/hr
Indoor air component	**C_i**	=	**1.62E-04**	**mg/m3**

B. OUTDOOR AIR COMPONENT

Downwind contamination length	L	=	0.00E+00	m
Wind speed	u	=	0.00E+00	m/hr
Height of building openings (or height of breathing zone)	h	=	0.00E+00	m
Outdoor air component	**C_o**	=	**0.00E+00**	**mg/m3**
C. TOTAL INDOOR AIR CONCENTRATION	**C_t**	=	**1.62E-04**	**mg/m3**

EXPOSURE SCENARIO

Body weight	BW	=	7.00E+01	kg
Inhalation rate	IR	=	2.00E+01	m3/day
Exposure duration	ED	=	2.50E+01	yrs
Hours per day	conversion		8.00E+00	hr/day
Exposure time	ET	=	**3.33E-01**	hr/24 hours
Days per week	conversion		2.50E+00	days/week
Weeks per year	conversion		5.00E+01	weeks/yr
Exposure frequency	EF	=	**1.25E+02**	days/yr
Averaging Time (carc. risk)	AT	=	2.56E+04	days
Averaging Time (non-carc. risk)	AT	=	**9.13E+03**	days
Chemical Intake (carc. risk)	**IT_c**	=	**1.88E-06**	**mg/kg-day**
Chemical Intake (non-carc. risk)	**IT_{nc}**	=	**5.29E-06**	**mg/kg-day**

NON-CARCINOGENIC RISK (Chronic Risk)

Chemical Intake (non-carc. risk)	IT_{nc}	=	5.29E-06	mg/kg-day
Reference dose	RfD	=	8.60E-02	mg/kg-day
Hazard Index	**HI**	=	**6.15E-05**	

CARCINOGENIC RISK

Chemical Intake (carc. risk)	IT_c	=	1.88E-06	mg/kg-day
Slope factor (potency)	SF	=	1.90E-02	1/(mg/kg-day)
Cancer Risk	**Risk**	=	**3.58E-08**	

CHEMICAL PARAMETERS

CAS No.		MW (mg/mole)		H' (dimension-less)		Da (cm^2/sec)		VP (atm)	Temp. (°C)		K_{oc} (cm^3/g)		Water Solubility (mg/L-water)		CSF (inh) $(mg/kg\text{-}day)^{-1}$		Chronic RfD (inh) (mg/kg-day)	
127-18-4	Tetrachloroethylene (PCE)	1.7E+05	a	7.5E-01	a	7.2E-02	a	2.4E-02	25	b	2.7E+02	a	2.0E+02	a	2.1E-02	c	1.0E-02	e
75-09-2	Methylene Chloride	8.5E+04	a	9.0E-02	a	1.0E-01	a	5.7E-01	25	b	1.0E+01	a	1.3E+04	a	3.5E-03	c	1.1E-01	e
67-66-3	Chloroform	1.2E+05	a	1.5E-01	a	1.0E-01	a	2.6E-01	25	b	5.3E+01	a	7.9E+03	a	1.9E-02	c	8.6E-02	e

References:

a EPA Region 9, Preliminary Remediation Goals (PRGs), 2000.
b U.S. National Library of Medicine Hazardous Substance Data Bank (HSDB), http://www.nlm.nih.gov/pubs/factsheets/hsdbfs.html
c Cal-EPA Office of Environmental Health Hazard Assessment (OEHHA), Toxicity Criteria Database and December 2000 California Cancer Potency Values, http://www.oehha.ca.gov/risk/chemicalDB/index.asp
d Risk Assessment Information System (RAIS) Toxicity & Chemical-Specific Factors Data Base, January 2001, http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_select?select=csf
e Cal-EPA, Air Resources Board (ARB), Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, October 10, 2000, http://www.arb.ca.gov/ab2588/riskassess.htm

Toxicity Value reference priority:
1. Cal-EPA Office of Environmental Health Hazard Assessment (OEHHA), Toxicity Criteria Database and December 2000 California Cancer Potency Values, http://www.oehha.ca.gov/risk/chemicalDB/index.asp
2. Cal-EPA, Air Resources Board (ARB), Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, October 10, 2000, http://www.arb.ca.gov/ab2588/riskassess.htm
3. EPA Region 9, Preliminary Remediation Goals (PRGs), 2000.

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