BROWN AND CALDWELL

ENVIRONMENTAL PROTECTION
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March 27, 1996

Ms. Madhulla Logan
Department of Environmental Health
Environmental Protection Division
1131 Harbor Bay Parkway, #250
Alameda, CA 94502-6577

Subject: Calculation of Cancer Risk from Inhalation of Indoor Air (Source Groundwater) Modelled with Equations Presented in "*Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*"
Former E-Z Serve Station #100877 Located at 525 West A Street Hayward, CA

Dear Ms. Logan:

This letter responds to your verbal request that the cancer risk for the indoor air pathway (source groundwater) for the Former E-Z Serve Hayward Site be calculated with equations presented in *"Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites"* (RBCA).

The following parameters were changed to site-specific values prior to running the model:

Depth to groundwater	488 cm from a default value of 300 cm
Thickness of capillary fringe	61 cm from a default value of 5 cm
Thickness of vadose zone	427 cm from a default value of 295 cm
Enclosed space air exchange rate	0.000183 s^{-1} from a default value of 0.00014 s^{-1}
	Average air exchange rate for a house in the western United States from *Exposure Factors Handbook,* USEPA/600/P-95/0002A, June 1995.

The cancer risk associated with indoor air using the USEPA toxicity factor of 0.1 $(mg/kg/day)^{-1}$ was calculated to be $1x10^{-5}$ (Appendix A). The cancer risk associated with indoor air using the California toxicity factor of 0.029 $(mg/kg/day)^{-1}$ was calculated to be $4x10^{-5}$ (Appendix A). Risk results using either toxicity factor are within the acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$.

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It is our understanding that the equations presented in RBCA are based on a conservative model developed by Johnson and Ettinger. It is important to note that there are several other models available which are routinely used to calculate risks from the indoor air pathway. We initially used the Karimi model in our risk assessment and calculated a risk of 2×10^{-6} (refer to Brown and Caldwell's letter dated September 12, 1995 which responded to your written comments of our risk assessment). In our experience, the Farmers model gives similar results to the Karimi model. The Thibodeaux-Hwang and Jury models are also available though less conservative than Karimi or Farmers.

If you have any questions please call me at (510) 210-2290.

Sincerely,

BROWN AND CALDWELL

Lynnette Gerbert

Lynnette Gerbert
Staff Toxicologist

Enclosures
TD:lkg

cc: Mr. Brian Cobb, E-Z Serve Petroleum Marketing Company of California
Mr. John Reeves, Attorney at Law

APPENDIX A
RISK CALCULATIONS USING EQUATIONS PRESENTED IN RBCA

Calculation of Risk Due to Inhalation of Indoor Air
Source: Groundwater
Chemical: Benzene
Toxicity Factor: USEPA
Former E-Z Serve Station #100877
525 West A Street, Hayward, California

Risk = (SFixIRairxETxEFxEDxVFwespxC)/(BWxATcx365days/year)

Concentration, mg/L	1 879	Chemical-Specific
VFwesp = See Below	0.002	See Below
BW = Body Weight, Kg	70	Default
ATc = Averaging time for carcinogens, years	70	Default
SFi = Inhalation slope factor, (mg/kg-day)-1	0.029	Chemical-Specific
IRair = Inhalation rate, m^3/hr	0.83	Default
ET = Exposure Time, hours/day	24	Default
EF = Exposure Frequency, days/year	350	Default
ED = Exposure Duration, years	30	Default
Risk	1E-05	

VFwesp = (Hx(Deffws/Lgw)/(ERxLb))/(1+((Deffws/Lgw)/(ERxLb))+((Deffws/Lgw)/(Deffcrack/Lcrack)xn))x1E+3

H = Henry's Law Constant, cm^3-H2O/cm^3-air	0.22	Chemical-Specific
Deffws = See below	0.0002	See Below
Lgw = Depth to groundwater, cm	488	Site-Specific
ER = Enclosed space air exchange rate, L/s	0.000183	Default
Lb = Enclosed space volume/infiltration area ratio, cm	200	Default
Deffcrack = See below	0.007	See Below
Lcrack = Enclosed space foundation/wall thichkness, cm	15	Default
n = Areal fraction of cracks in foundations/walls	0.01	Default
VFwesp	0.002	

Deffws = (hcap+hv)*((hcap/Deffcap)+(hv/Deffs))$^{-1}$

hcap = Thickness of capillary fringe, cm	61	Default
hv = Thickness of vadose zone, cm	427	Default
Deffcap = See below	2 17E-05	See Below
Deffs = See below	0.007	See Below
Deffws	0.0002	

Deffcap = ((Dair*$O^{3.33}$acap)/O^2T)+((Dwat*$O^{3.33}$wcap)/(H*O^2T)

Dair = Diffusion coefficient in air, cm^2/s	0 093	Chemical-Specific
Oacap = Volumetric air content in capillary fringe soils, cm^3-air/cm^3-soil	0.038	Default
OT = Total soil porosity, cm^3/cm^3-soil	0.38	Default
Dwat = Diffusion coefficient in water, cm^2/s	1.10E-05	Chemical-Specific
Owcap = Volumetric water content in caspillary fringe soils, cm^3-h2o/cm^3-soil	0 342	Default
H = Henry's Law Constant (cm^3-H20/cm^3-air)	0.22	Chemical-Specific
Deffcap	2.17E-05	

Deffs = ((Dair*$O^{3.33}$ss)/O^2T)+((Dwat*$O^{3.33}$ws)/(H*O^2T)

Dair = Diffusion coefficient in air, cm^2/s	0 093	Chemical-Specific
Oss = Volumetric air content in vadose zone soils, cm^3-air/cm^3-soil	0.26	Default
OT = Total soil porosity, cm^3/cm^3-soil	0.38	Default
Dwat = Diffusion coefficient in water, cm^2/s	1.10E-05	Chemical-Specific
Ows = Volumetric water content in vadose zone soils, cm^3-h2o/cm^3-soil	0.12	Default
H = Henry's Law Constant (cm^3-H20/cm^3-air)	0 22	Chemical-Specific
Deffs	0 007	

Deffcrack = ((Dair*$O^{3.33}$acrack)/O^2T)+((Dwat*$O^{3.33}$wcrack)/(H*O^2T)

Dair = Diffusion coefficient in air, cm^2/s	0.093	Chemical-Specific
Oacrack = Volumetric air content in foundation/wall cracks, cm^3-air/cm^3-total volume	0.26	Default
OT = Total soil porosity, cm^3/cm^3-soil	0.38	Default
Dwat = Diffusion coefficient in water, cm^2/s	1.10E-05	Chemical-Specific
Owcrack = Volumetric water content in foundation/wall cracks, cm^3-h2o/cm^3-total volume	0.12	Default
H = Henry's Law Constant (cm^3-H20/cm^3-air)	0.22	Chemical-Specific
Deffcrack	0.007	

Calculation of Risk Due to Inhalation of Indoor Air
Source: Groundwater
Chemical: Benzene
Toxicity Factor: California
Former E-Z Serve Station #100877
525 West A Street, Hayward, California

Risk = (SFixIRairxETxEFxEDxVFwespxC)/(BWxATcx365days/year)

Concentration, mg/L	1.879	Chemical-Specific
VFwesp = See Below	0.002	See Below
BW = Body Weight, Kg	70	Default
ATc = Averaging time for carcinogens, years	70	Default
SFi = Inhalation slope factor, (mg/kg-day)-1	0.1	Chemical-Specific
IRair = Inhalation rate, m³/hr	0.83	Default
ET = Exposure Time, hours/day	24	Default
EF = Exposure Frequency, days/year	350	Default
ED = Exposure Duration, years	30	Default
Risk	4E-05	

VFwesp = (Hx(Deffws/Lgw)/(ERxLb))/(1+((Deffws/Lgw)/(ERxLb))+((Deffws/Lgw)/(Deffcrack/Lcrack)xn))x1E+3

H = Henry's Law Constant, cm³-H2O/cm³-air	0.22	Chemical-Specific
Deffws = See below	0.0002	See Below
Lgw = Depth to groundwater, cm	488	Site-Specific
ER = Enclosed space air exchange rate, L/s	0.000183	Default
Lb = Enclosed space volume/infiltration area ratio, cm	200	Default
Deffcrack = See below	0.007	See Below
Lcrack = Enclosed space foundation/wall thichkness, cm	15	Default
n = Areal fraction of cracks in foundations/walls	0.01	Default
VFwesp	0.002	

$Deffws = (hcap+hv)*((hcap/Deffcap)+(hv/Deffs))^{-1}$

hcap = Thickness of capillary fringe, cm	61	Default
hv = Thickness of vadose zone, cm	427	Default
Deffcap = See below	2.17E-05	See Below
Deffs = See below	0.007	See Below
Deffws	0.0002	

$Deffcap = ((Dair*O^{3.33}acap)/O^2T)+((Dwat*O^{3.33}wcap)/(H*O^2T)$

Dair = Diffusion coefficient in air, cm²/s	0.093	Chemical-Specific
Oacap = Volumetric air content in capillary fringe soils, cm³-air/cm³-soil	0.038	Default
OT = Total soil porosity, cm³/cm³-soil	0.38	Default
Dwat = Diffusion coefficient in water, cm²/s	1.10E-05	Chemical-Specific
Owcap = Volumetric water content in caspillary fringe soils, cm³-h2o/cm³-soil	0.342	Default
H = Henry's Law Constant (cm³-H20/cm³-air)	0.22	Chemical-Specific
Deffcap	2.17E-05	

$Deffs = ((Dair*O^{3.33}ss)/O^2T)+((Dwat*O^{3.33}ws)/(H*O^2T)$

Dair = Diffusion coefficient in air, cm²/s	0.093	Chemical-Specific
Oss = Volumetric air content in vadose zone soils, cm³-air/cm³-soil	0.26	Default
OT = Total soil porosity, cm³/cm³-soil	0.38	Default
Dwat = Diffusion coefficient in water, cm²/s	1.10E-05	Chemical-Specific
Ows = Volumetric water content in vadose zone soils, cm³-h2o/cm³-soil	0.12	Default
H = Henry's Law Constant (cm³-H20/cm³-air)	0.22	Chemical-Specific
Deffs	0.007	

$Deffcrack = ((Dair*O^{3.33}acrack)/O^2T)+((Dwat*O^{3.33}wcrack)/(H*O^2T)$

Dair = Diffusion coefficient in air, cm²/s	0.093	Chemical-Specific
Oacrack = Volumetric air content in foundation/wall cracks, cm³-air/cm³-total volume	0.26	Default
OT = Total soil porosity, cm³/cm³-soil	0.38	Default
Dwat = Diffusion coefficient in water, cm²/s	1.10E-05	Chemical-Specific
Owcrack = Volumetric water content in foundation/wall cracks, cm³-h2o/cm³-total volume	0.12	Default
H = Henry's Law Constant (cm³-H20/cm³-air)	0.22	Chemical-Specific
Deffcrack	0.007	

CHAIN OF CUSTODY RECORD

G97-04-221 2/2

BCA Log Number _____

Client name: Brown & Caldwell	Project or PO#: 5172-10
Address: 3480 Buskirk Avenue	Phone #: (510) 937-9010
City, State, Zip: Pleasant Hill, CA 94523	Report attention: Todd Miller

Lab Sample number	Date sampled	Time sampled	Type* See key below	Sampled by: J. LaPlante / Sample description	Number of containers	TPH-g/BTEX/MTBE	Hazardous sample Special handling required	Remarks: G97-04-221
	4/9/97	10:20	GW	100877-MW-4	2	X		
	"	11:03	"	100877-MW-2	2	X		
	"	11:03	"	100877-MW-2-D	2	X		
	4/9/97	11:03	GW	100877-MW-2-FB	2	X		

	Signature	Print Name	Company	Date	Time
Relinquished by	J. LaPlante	J. LaPlante	Brown & Caldwell	4/9/97	13:30
Received by	Donna Mather	Donna Mather	VOC	4/9/97	1330
Relinquished by					
Received by					
Relinquished by					
Received by Laboratory					

B C ANALYTICAL

[ ] 1085 Shary Circle Concord, CA 94518 (510) 825-3894

[ ] 801 Western Avenue, Glendale, CA 91201 (818) 247-5737

[ ] [illegible] CA 92805 (714) 978-0113

Note. Samples are discarded 30 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client's expense

Disposal arrangements. _____

*KEY: AQ—Aqueous NA—Nonaqueous SL—Sludge GW—Groundwater SO—Soil PE—Petroleum WW—Wastewater