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Risk Assessment Plan for Petroleum Underground Storage Tanks in Kentucky, Part II: Diesel, Heating Oil, Other Middle Distillates and Waste Oil

Wesley J. Birge
University of Kentucky

A. J. Grant
University of Kentucky

J. R. Shaw
University of Kentucky

M. D. Kercher
University of Kentucky

D. P. Keogh
University of Kentucky

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Appendix II
Environmental Half-life and Ecological Effects of PAHs

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APPENDIX I

RISK ASSESSMENT PROCEDURES AND CALCULATIONS

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Assumptions and Procedures

A series of investigations has focused on the transport, fate and risk assessment of petroleum products that enter the environment from underground storage tanks (USTs). Risk from outfalls of gasoline was based on benzene, toluene, ethylbenzene and xylene (BTEX) and has been reported separately (Birge *et al.*, 1995). The present study concerns diesel oil, heating fuels, kerosene and waste oil. Risk was based primarily on a series of carcinogenic and non-carcinogenic polycyclic aromatic hydrocarbons (PAHs). The effect of lead also was addressed under separate cover (Birge *et al.*, 1995).

Unless stated otherwise, loss of fuel from defective USTs was treated as a subsurface outfall. The non-carcinogenic PAHs considered in assessing effects on human health included acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, and pyrene. Cancer risk was determined for the three carcinogenic PAHs most commonly detected in diesel and fuel oils and included benzo(a)pyrene, benzo(a)anthracene and chrysene. Physical and chemical characteristics of these compounds are given in Tables AI-1 and AI-2.

Formulae used in risk assessment calculations for defective USTs were based primarily on procedures recommended by the *Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual. Parts A and B.* (U.S. EPA, 1989b; 1991a) and *Exposure Factors Handbook* (U.S. EPA, 1990); hereafter referred to as RAGS Part A and B, and EFH, respectively. Parameter values were obtained from the ATSDR, Agency for Toxic Substances and Disease Registry (1994a,b); RAGS Parts A and B; EFH; SEAM, the *Superfund Exposure Assessment Manual* (U.S. EPA, 1988); and the *Dermal*

Exposure Assessment: Principles and Applications, Interim Report (U.S. EPA, 1992). Development of the risk assessment strategy and supporting documentation are given separately (Birge *et al.*, 1995). It should be reiterated that risk to residential households was based on distance from the UST (*i.e.* 0 to 100m, 100 to 300m, ≥300m).

Exposure Duration and Toxicity Values

In determining risk, an exposure duration of nine years was used (Birge *et al.*, 1995). This included five child and four adolescent years. In addition, cancer risk also was calculated for a 30-year period of exposure (*i.e.* child 2-6 years, adolescent 7-18 years, adult 19-31 years). The values for the body weight of children ages 2-6 of 16 kg, ages 7-18 of 41 kg and adults of 70 kg were from EFH. The average life expectancy was 70 years, in agreement with RAGS Parts A and B (U.S. EPA, 1989b; 1991a) and Ohio Department of Commerce (1992). Toxicity values for PAHs are given in Tables AI-1 and AI-2. Oral and inhalation reference doses (Rfd) and slope factors were those from the U.S. EPA Risk-Based Concentration Table (1995) and were taken from IRIS and HEAST, except for naphthalene. The naphthalene value was taken from U.S. EPA Region III, after consultation with U.S. EPA personnel in Region IV.

Soil Ingestion and Dermal Exposure

Soil ingestion was based on soil consumption rates of 200 mg/day for children ages 2-6, 100 mg/day for ages 7-18, and 100 mg/day for adults, listed in EFH and RAGS Part B. An oral absorption of 100 percent was selected for the calculations.

The values for dermal exposure to soil were taken from EFH and surface areas were 3910 cm^2 for children (50th percentile value for exposure to arms, hands and legs) and 3120 cm^2 for adults (50th percentile value for exposure to arms and hands). The soil to skin adherence factor of 1.0 mg/cm^2 was taken from U.S. EPA (1992) and the dermal absorption coefficient for PAHs of 10% was derived from the ATSDR profiles (1994a,b).

Inhalation of Soil Vapor

The inhalation rate was 20 m^3/day for all ages as observed by the Commonwealth of Kentucky (NREPC, 1995; U.S. EPA, 1991b). Inhalation exposure was based on the formula given in RAGS, Part B, with incorporation of the chemical-specific volatilization factors calculated in Section 3.3.1, equation 8. The calculations of volatilization factors for non-carcinogenic PAHs are given in Table AI-3. Modifications proposed in December, 1994 (U.S. EPA, 1994) for the determination of volatilization factors postdated the risk assessment calculations reported below and had not received final confirmation upon completion of this study. Two of the non-carcinogens (*i.e.* fluoranthene, pyrene) and three carcinogenic PAHs did not fit the guideline for volatility (molecular wt. <200 g/mol, Henry's Law constant $>1 \times 10^{-5}$; U.S. EPA, 1991a). Accordingly, volatilization factors were not calculated, and soil vapor inhalation and shower inhalation were excluded from the risk calculations for these compounds.

Dimensions of the air box were 45 meters x 45 meters and represented the U.S. EPA default values (1991a). This provided a good fit to the exposure scenarios used, particularly in determining the frequency at which residential receptors located at 100 to 300 meters and ≥300 meters visited the UST site. The use of a smaller box (*i.e.* 20 m x 20 m) also was considered. However, the volatilization factors were somewhat larger and inhalation exposure within the box was slightly reduced. Of greater importance, the smaller box would have reduced frequency and/or duration of exposure. Exposure frequencies for inhalation are discussed below (*i.e.* Exposure Scenarios for Soil). Absorption of PAH's from inhalation was set at 50% (ATSDR, 1994a,b). Exposure via vapor inhalation was based on steady state volatilization of the compounds and did not take into account wind dilution or decreases in soil concentration with time due to dispersion or biodegradation.

Exposure Scenarios for Soil

Air and soil exposures were based on proximity of the residence to the UST site. The three receptor zones selected included 0 to 100 meters (*i.e.* on-site, calculated at 0 m), 100 to 300 meters (calculated at 100 m) and 300 to 1000 meters (calculated at 300 m) from the UST site . All calculations for total exposure to contaminated soil (except where noted) included soil ingestion, soil dermal exposure, and vapor inhalation. The inhalation of particulates was excluded. For an on-site residence, it was assumed that the receptor visited the site and received soil exposure for 180 days of the year (Westerman, 1993). This also corresponded to the "best guess" exposure frequency in Section 6.6.2 of RAGS Part A (~143 days/year). Days were discounted for indoor time, inclement weather and time away. It was assumed that days in the area of contamination would decrease to 90 and 45 when the residence was located at 100 to 300 meters and at or beyond 300 meters, respectively. While visiting the site, it also was assumed that one-half of the soil ingested was contaminated based on the area of a UST site compared with residential lot size and total play area for children (Sendlein, 1994). CERCLA sources (U.S. EPA, 1990; 1991a) recommend that all soil should be considered as contaminated, assuming that residential soil contamination generally is not accurately localized. However, with respect to UST's, except for special circumstances that may require site-specific investigations, the area of contamination can be circumscribed with relative accuracy. Upon review of these conditions and best professional judgement, it was concluded that the maximum amount of a receptor's time in the contaminated area would be fifty percent.

Vapor inhalation was assumed to occur 350 days per year for a residence within 100 meters of a UST (U.S. EPA, 1990; 1991a), but the frequency was decreased to 250 and 150 days when dwellings (*i.e.* homes) were situated 100 to 300 meters and at or beyond 300 meters from the UST site, respectively. One-half of the air was assumed to be contaminated, based on the rationale stated above. Inhalation exposure included no contaminant dilution due to wind mixing, and PAH half-life in air was not considered.

Groundwater Consumption

Residential groundwater (GW) ingestion (*e.g.* well water) was assumed to occur 350 days per year. The value chosen for water consumption rate was 1.4 L/day. This was the average adult value given in EFH and is close to the upper-bound value for the five child years used with BTEX and the five child plus four adolescent years (*i.e.* 9 y duration of exposure) used with PAHs. The dietary fraction of 0.75 also was taken from EFH. The K_d value for transfer from soil pore water to GW was based on the K_{oc} for each PAH (Table AI-1; ATSDR, 1994a,b), multiplied by a soil organic carbon fraction of 0.005 (U.S. EPA, 1989a).

Shower Dermal and Inhalation Exposure

Dermal exposure from showering was based on the same values for dermal absorption and K_d as given above (Tables AI-1 and AI-2). Total skin surface area was 7200 cm^2 for children 2-6 years old, 13175 cm^2 for children 7-18 years old, and 18150 cm^2 for adults (U.S. EPA, 1990). Dermal permeability (K_P) values were those calculated by the U.S. EPA (1992) and included 0.36, fluoranthene; 0.069, naphthalene; 0.81, benzo(a)anthracene; 1.2 benzo(a)pyrene; and 0.81, chrysene. Using the formula of Potts and Guy (1992) as recommended by the U.S. EPA, values were calculated of 0.146, 0.225, 0.171 and 0.324 for acenaphthene, anthracene, fluorene and pyrene, respectively. Considering the large molecular weights and the highly skewed K_{ow}s of the carcinogenic PAHs, this formula may overestimate dermal permeability. Shower time was 12 minutes/day or 0.2 hour as given in EFH. Exposure frequency was 350 days/year. Shower inhalation exposure was based on shower time, exposure frequency and K_d. The inhalation rate of 0.6 m^3/hour was from EFH and the volatilization factor (K) was taken from RAGS Part B.

Soil Transport and Groundwater Attenuation

Standard risk assessment procedures do not allow for reductions in PAH concentrations that occur with migration through soil or during GW transport. Taking into account that the initial contaminated area at a given UST site is underground (*i.e.* subsurface), SESOIL was used to model changes in PAH soil concentrations resulting from vertical migration upward to the soil surface and downward to the saturated zone. For soil contamination only, SESOIL **soil multipliers** (McGinley, 1994a,b) were used to model the upward migration of PAH compounds to the surface. These multipliers were incorporated as transport factors (TR) into soil ingestion, soil dermal and vapor inhalation exposures. In modeling PAH transport, it was assumed that the contaminated zone was initially covered with 1.5 meters of clean soil and 2% soil organic carbon was used in risk calculations.

For soil and GW contamination, SESOIL **soil multipliers** and **GW multipliers** (McGinley, 1994a,b) were used in modeling transport from the UST to the receptor. The soil multipliers were used as described above. In addition, GW multipliers were entered into calculations of exposure due to GW consumption, shower inhalation and shower dermal contact. The GW multipliers represent 1) changes in PAH concentration that occur with downward movement through soil from the UST to the saturated zone (*i.e.* SESOIL) and 2) attenuation that results in GW, as determined with a simplified GW transport model. Soil organic carbon of 0.1% and local climatic conditions were used in the SESOIL model. In the GW pathway, biodegradation was based on 100-day or 700-day half-lives to correlate with different geologic conditions. Velocity was set at 0.1 meter/day and mixing in the GW was complete to a depth of 0.5 meter at the UST site. Attenuation was two dimensional from the UST to receptors at 100 meters and 300 meters, with only modest dilution in the transverse axis (McGinley, 1994a,b). In modeling the GW pathway in the karst system, half-life was set at 15-days, velocity was 10 meters/day and there was complete mixing in the vertical axis to a depth of 1 meter in the GW. Attenuation from the UST to the receptor was unidimensional.

The cleanup levels determined with the risk assessment strategy used were considered to be adequately conservative estimates of exposure. No decrease in the level of initial soil contamination was assumed to occur over the duration of exposure. However, it would be expected that a remediated UST site would have only a finite amount of contaminant remaining and that the concentration would decrease progressively due to volatilization, biodegradation or other processes. In addition, the GW transport model tended to minimize attenuation.

Description of Risk Data Sheets

As noted above, exposure calculations were based on U.S. EPA guidance (1989a,b; 1990; 1991a) for determining exposure at hazardous waste sites. The equations were formulated to isolate the concentration term from the other parameters so that the soil concentration could be back-calculated for a given level of risk. The risk calculations were obtained using a spreadsheet program created for Lotus 123® software. The spreadsheet consists of a title at the top which denotes the specific scenario. The left column shows calculations for seven types of exposure. The formula for each exposure calculation is given to the right of each dose/exposure line, and the abbreviations used are listed after the individual parameters. The soil contaminant concentration which results in the hazard index is shown individually for each dose and the combined result appears in the soil concentration box to the upper right. The upper right of the spreadsheet (*i.e.* on/off EXPOSURE) also shows those exposures that are on or off in the calculations. This binary system denotes those that are used to derive the total exposure and total risk for each scenario. Therefore, even though all exposures are listed in this section (*i.e.* upper right), only those preceded by a "1" are "on" and summed in the calculations of risk.

The decision box for transport (*i.e.* on/off TRANSPORT) also is at the top right of the spreadsheet. Of the three choices the first is for SESOIL TRs (*i.e.* Transport), the second is for coefficients (Kd) that represent partitioning between soil and pore water with or without attenuation, and the third is for other possible treatments of attenuation not used in these calculations. Options that are used in a given calculation are preceded by a "1", whereas "0" indicates "off".

Within the seven categories of exposure given in the left column there are factors which allow for the inclusion of transport multipliers (TR). The transport multipliers are listed above each dose exposure line and have a quantity of "1" if not used in the calculation (*i.e.* no attenuation). Actual transport multipliers used in determining dose are mostly decimal fractions less than "1". As noted above, there are two types, one for upward migration of compounds to the soil surface (SESOIL soil multiplier), and one for downward movement to the saturated zone, plus GW transport (SESOIL GW multiplier). Soil TRs are incorporated into calculations of soil ingestion, soil dermal exposure, and inhalation of vapors; whereas GW TRs are entered in those exposure categories associated with water use. A macro command series was constructed to expedite calculations that employed sets of transport multipliers with different soil types, soil depths and distances to receptors.

The inhalation of particulates was not considered to be a significant route of exposure, and therefore was not used. Formulae for the other six exposure categories are given below, wherein the "Transport" choice is represented by the abbreviation "TT" and the "Kd/Attenuation Factor" choice by "KT". In determining the risk associated with these exposures, the result was divided by a reference dose for non-carcinogens and multiplied by a slope factor for carcinogenic effects.

Soil Ingestion

$$Exposure = \frac{C \times ((TT \times TR) + KT) \times CR \times EF \times ED \times AF \times CF \times 1E\text{-}6}{BW \times L \times 365}$$

Soil Dermal Exposure

$$Exposure = \frac{C \times ((TT \times TR) + KT) \times SA \times AD \times ED \times EF \times AF \times CF}{BW \times L \times 365}$$

Groundwater Consumption

$$Exposure = \frac{C \times ((TT \times TR) + (KT \times 1/Kd \times AT)) \times CR \times EF \times ED \times DF}{BW \times L \times 365}$$

Inhalation of Vapors

$$Exposure = \frac{C \times ((TT \times TR) + KT) \times IR \times 1/VF \times EF \times ED \times AF \times CF}{BW \times L \times 365}$$

Dermal Exposure to Groundwater

$$Exposure = \frac{C \times ((TT \times TR) + (KT \times 1/Kd \times AT)) \times SA \times EF \times ED \times Kp \times SL \times AF \times 0.001}{BW \times L \times 365}$$

Inhalation of Vapors in the Shower

$$Exposure = \frac{C \times ((TT \times TR) + (KT \times 1/Kd \times AT)) \times IR \times SL \times EF \times ED \times K \times AF}{BW \times L \times 365}$$

Calculation of Risk and Hazard

$$Risk = Exposure \times Slope\ Factor$$

$$Hazard\ Quotient = \frac{Exposure}{Reference\ Dose}$$

Abbreviations:

Transport

TT Modeled Transport (*i.e.* SESOIL)(0 or 1)

KT Kd and attenuation factors for transport (0 or 1)

Soil Ingestion

C Soil concentration (mg/kg)

CR Soil consumption rate (mg/day)

EF Exposure frequency (days/year)

ED Exposure duration (years)

BW Average body weight (kg)

L Average life expectancy (years)

AF Absorption fraction (0-1)

CF Contaminated fraction (0-1)

TR Transport multiplier (soil)

Soil Dermal

SA Surface area exposed (cm^2)

AD Soil adherence factor (mg/cm^2)

Groundwater Consumption

CR GW consumption rate (L/day)

Kd Soil-water partitioning coefficient (L/kg)

DF Diet fraction (0-1)

AT Attenuation factor (0-1)

TR Transport multiplier (GW)

Inhalation of Vapors

IR Inhalation rate (m^3/day)

VF Volatilization factor (m^3/kg)

Dermal Contact in Shower

SA Surface area exposed (cm^2)

Kp Dermal permeability constant (cm/hour)

Inhalation in Shower

IR Hourly inhalation rate (m^3/hour)

SL Daily shower length (hours)

K Volatilization factor constant (0.5 L/m^3)

Reference doses and slope factors were collectively referred to as toxicity values. When toxicity values were missing for a specific route of exposure, available values were substituted (*e.g.* using an oral reference dose for dermal exposure). Oral toxicity values were used for the following routes of exposure: soil ingestion, dermal exposure to soil, GW consumption, and dermal exposure to GW. Inhalation toxicity values were used in calculating the risk associated with inhalation of vapors, and vapor inhalation while showering. The sum of the risks from the individual routes of exposure was considered the total risk.

Results of Risk Calculations

Initially, risk was calculated for each of the six non-carcinogenic PAHs for a hazard index (HI) of 1.0 and of 0.165. Summing the latter values gives a total HI=1, allowing for additive effects. These results are presented in Table AI-4, and the spreadsheets are on pages AI-31 to AI-102. Soil transport and GW attenuation **were not** incorporated into these calculations and only on-site conditions were considered. Soil exposure was based on surface contamination, whereas for soil and GW exposure contamination was considered to be uniform from the soil surface to the saturated zone. These results were intended to represent **worst case** exposure conditions and to provide baseline information for final selection of compounds and assessment scenarios to be used in developing recommendations on UST remediations. This information also may be directly applicable 1) to major site-specific remediations where large petroleum outfalls have contaminated surface and subsurface soils and 2) to establish guidelines for disposal of remediated soils.

Acenaphthene and naphthalene were the non-carcinogenic compounds selected for establishing UST cleanup guidelines. The first set of calculations performed involved subsurface soil (*i.e.* sand) contamination and employed the use of SESOIL soil multipliers. It was assumed that 1.5 meters of clean soil overlaid the contaminated area. The hazard index was set at 0.5 per compound to give a total HI=1. The results are given in Table AI-5, and the spreadsheets are on pages AI-103 to AI-120. Though considered to be the most mobile of the six non-carcinogenic PAHs, the soil values obtained with sand indicate little movement to the soil surface and essentially no exposure via soil ingestion, dermal uptake or vapor inhalation. In determining the final soil values to be used in cleanup guidelines with acenaphthene and naphthalene, calculations were performed in which SESOIL soil transport and GW attenuation were included for sand, silt and clay and receptor zones of 0 to 100 meters, 100 to 300 meters and ≥300 meters. Allowances also were made for varying depths from the UST contamination source to the saturated zone. Depths from 0 up to 9 meters to GW were included where mobility in soil warranted. These results are given in Tables AI-6 through AI-11 and were obtained using the macro command program with Lotus 123® software as described above. Sample spreadsheets are given on pages AI-121 to AI-138.

The results obtained with the carcinogenic PAHs, including benzo(a)pyrene, benzo(a)anthracene and chrysene were based on an exposure duration of 9 years. Calculations also were performed for an exposure duration of 30 years as a basis of comparison. Due to high K_{oc} values and other characteristics (Table AI-2), these PAHs exhibited little or no mobility in sand or other soils when transport was modeled with the SESOIL program. Therefore, risk from subsurface contamination was based on the GW pathway only. Contamination was assumed to occur at the saturated zone, allowing direct transfer of these compounds from soil pore water to GW. Even with this modification GW transport was highly restrictive, presumably due to extremely low water solubility, high adsorptive capacity and other characteristics. These results were considered highly conservative for typical site conditions at most UST installations (Table AI-12). Spreadsheets for benzo(a)pyrene, benzo(a)anthracene and chrysene for the GW pathway only are given on pages AI-139 to AI-192.

The last assessment attempted included a simulation of the GW pathway as given above, plus contamination at the soil surface (no soil transport). These results are presented in Table AI-13 and may be applicable to worst case, site-specific conditions involving high levels of contamination that include surface soils. Sample spreadsheets for benzo(a)pyrene for surface soil and GW contamination are given on pages AI-193 to AI-210.

Table AI-1. Characteristics of Noncarcinogenic Polycyclic Aromatic Hydrocarbons

Parameter	Acenaphthene	Anthracene	Fluoranthene	Fluorene	Naphthalene	Pyrene
[a]D_i (cm^2/s)	0.06805	0.06183	0.05700	0.06472	0.07265	0.05953
[b]K_{OC} (cm^3/g)	4600	14000	38000	7300	930	38000
[b]Henry's Law Constant (atm-m^3/mol)	[e]2.6×10^{-3}	8.6×10^{-5}	6.5×10^{-6}	6.4×10^{-5}	4.6×10^{-4}	[g]1.2×10^{-5}
[f]K_p (cm/hr)	0.146	0.225	0.36	0.171	0.069	0.324
[c]RfD (oral) (mg/kg/day)	0.06	0.3	0.04	0.04	0.04	0.03
[c]RfD (inhalation) (mg/kg/day)	0.06	0.3	0.04	0.04	0.04	0.03
[b]Vapor Pressure (mm Hg)	4.47×10^{-3}	7.5×10^{-6}	5.0×10^{-6}	6×10^{-4}	8.7×10^{-2}	2.5×10^{-6}
[d,f]Water Solubility (mg/L)	3.8	0.07	0.26	1.68 - 1.98	32	0.129 - 0.165
[d]Density (gm/cm^3 at 4°C)	1.225	1.25	1.252	1.203	1.145	1.271

[a] Evaluated using information from U.S. EPA SEAM (1988)
[b] ATSDR (1994a,b)
[c] U.S. EPA Risk Based Concentration Table (1995)
[d] Lide (1991)
[e] Fendinger and Glotfelty (1989)
[f] U.S. EPA (1992)
[g] Mackay *et al.* (1992)

Table AI-2. Characteristics of Carcinogenic Polycyclic Aromatic Hydrocarbons

Parameter	Benzo(a)pyrene	Benzo(a)anthracene	Chrysene
[a]D_i (cm^2/s)	0.05314	0.05473	0.05473
[b]K_{OC} (cm^3/g)	5,500,000	200,000	200,000
[b]Henry's Law Constant ($atm\text{-}m^3/mol$)	4.9×10^{-7}	1×10^{-6}	1.05×10^{-6}
[e]K_P (cm/hr)	1.2	0.81	0.81
[c]CPS (oral) (risk per mg/kg/day)	7.3	0.73	0.0073
[c]CPS (inhalation) (risk per mg/kg/day)	6.1	0.61	0.0061
[b]Vapor Pressure (mm Hg)	5.6×10^{-9}	2.2×10^{-8}	6.3×10^{-9}
[b]Water Solubility (mg/L)	3.8×10^{-3}	$9 - 14 \times 10^{-3}$	$1.5 - 2.2 \times 10^{-3}$
Density (gm/cm^3 at 4°C)	[b]1.35	[b]1.27	[d]1.252

[a] Calculated using information from U.S. EPA SEAM (1988)
[b] ATSDR (1994b)
[c] U.S. EPA Risk Based Concentration Table (1995)
[d] Lide (1991)
[e] U.S. EPA (1992)

Table AI-3.
Volatilization Factor Calculation for Noncarcinogenic Polycyclic Aromatic Hydrocarbons

	Acenaphthene	Anthracene	Fluoranthene	Naphthalene
<u>INPUT VALUES</u>				
side length (m)	45	45	45	45
wind speed (m/s)	2.25	2.25	2.25	2.25
diffusion height (m)	2	2	2	2
area of contamination (cm^2)	20250000	20250000	20250000	20250000
D_i diffusivity coeff. (cm^2/s)	0.06805	0.06183	0.06472	0.07265
soil porosity	0.35	0.35	0.35	0.35
cu. root of soil porosity	0.704	0.704	0.704	0.704
K_{oc} (cm^3/g)	4600	14000	7300	930
oc fraction	0.02	0.02	0.02	0.02
H Henry's Law const. (atm-m^3/mol)	2.60×10^{-3}	8.60×10^{-5}	6.40×10^{-5}	4.60×10^{-4}
soil/part. density (g/cm^3)	2.65	2.65	2.65	2.65
exposure interval (y)	9	9	9	9
<u>CALCULATED VALUES</u>				
D_{ei} (cm^2/s) effect. diffusivity	0.04790962	0.04352537	0.04556288	0.0511437837
K_d (cm^3/g)	92	280	146	18.6
K_{as} (g soil/cm^3 air)	0.0011587	1.259×10^{-5}	1.797×10^{-5}	0.0010139785
alpha (cm^2/s)	1.128×10^{-5}	1.114×10^{-7}	1.664×10^{-7}	1.05352×10^{-5}
exposure interval (s)	284018400	284018400	284018400	284018400
VF	25807.58	259752.96	212511.56	26701.70

Table AI-4.

Soil Values (mg/kg) for Noncarcinogenic Polycyclic Aromatic Hydrocarbons, 0-100 m from the Site[a]

	Soil Exposure		Soil and GW Exposure	
	HI= 1	HI= 0.165	HI= 1	HI= 0.165
Acenaphthene	4043.9779	677.2564	23.4318	3.8662
Anthracene	41589.7449	6862.3079	327.7520	54.0791
Fluoranthene	6277.1417	1035.7284	102.4179	16.8990
Fluorene	5405.2089	891.8595	23.9497	3.9517
Naphthalene	2748.4917	453.5011	3.5462	0.5851
Pyrene	4573.5704	754.6391	79.7273	13.1550

[a]No soil transport (*i.e.* SESOIL) or GW attenuation.

Table AI-5. Soil Values (mg/kg) for Acenaphthene and Naphthalene Determined with SESOIL, Soil Multipliers for Sand[a]

	Distance from Site		
	0 - 100	100 - 300	≥300
Acenaphthene[b]	51845.871	83319.786	147341.168
Naphthalene[c]	149374.551	240748.397	426318.353

[a] The HI equals 0.5 for each compound, assuming additivity.
[b] The soil multiplier was 0.039.
[c] The soil multiplier was 0.0092.

Table AI-6. ACENAPHTHENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION[a]. HI=0.5, SAND.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SAND	700	0-100	0	0.141	3.6565
			1	0.0641	8.0425
			3	0.042	12.2734
	100	0-100	0	0.147	3.5073
			1	0.0534	9.6537
			3	0.0287	17.9591
	15	0-100	0	0.00218	235.4422
			1	0.000953	535.4465
			3	0.000625	812.0476
	700	100-300	0	0.00392	131.3247
			1	0.00171	300.4365
			3	0.00112	457.8324
	100	100-300	0	0.0000296	14407.1088
			1	0.0000108	30350.6750
			3	5.780E-06	43081.0326
	15	100-300	0	0.000114	4289.9821
			1	0.0000763	6250.6526
			3	0.00005	9176.7859
	700	≥300	0	0.0000148	28176.0912
			1	6.440E-06	51874.9207
			3	4.230E-06	66707.0668
	100	≥300	0	6.350E-12	147340.9003
			1	2.310E-12	147341.0704
			3	1.240E-12	147341.1154
	15	≥300	0	1.370E-06	105886.8938
			1	4.870E-07	129341.1760
			3	3.190E-07	135031.8641

[a]5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-7. ACENAPHTHENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION[a]. HI=0.5, SILT.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SILT	700	0-100	0	0.14	3.6826
			1	0.0901	5.7220
			3	0.0467	11.0385
	100	0-100	0	0.14	3.6826
			1	0.017	30.3120
	15	0-100	0	0.00208	246.7077
			1	0.00134	381.9456
			3	0.000695	731.4125
	700	100-300	0	0.00374	137.6347
			1	0.0024	214.2831
			3	0.00125	410.4524
	100	100-300	0	0.0000285	14863.9727
			1	3.43000E-06	53606.8757
	15	100-300	0	0.000166	2994.4289
			1	0.000107	4555.2912
			3	0.0000503	9127.6563
	700	≥300	0	0.0000141	29296.7695
			1	9.06000E-06	41053.3606
			3	4.70000E-06	62883.3327
	100	≥300	0	6.06000E-12	147340.9125
			1	7.36000E-13	147341.1366
	15	≥300	0	1.06000E-06	113086.2938
			1	6.85000E-07	123220.9297
			3	3.55000E-07	133770.6695

[a]5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-8. ACENAPHTHENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION[a]. HI=0.5, CLAY.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
CLAY	700	0-100	0	0.14	3.6826
			1	0.0643	8.0175
	100	0-100	0	0.14	3.6826
			1	0.000167	2913.9316
	15	0-100	0	0.00208	246.7077
			1	0.000943	541.0654
	700	100-300	0	0.00374	137.6347
			1	0.00169	303.9790
	100	100-300	0	0.0000282	14993.6446
			1	3.6300E-08	82833.8878
	15	100-300	0	0.000166	2994.4289
			1	0.0000754	6319.6035
	700	≥300	0	0.0000141	29296.7695
			1	6.3800E-06	52189.9698
	100	≥300	0	6.0600E-12	147340.9125
			1	7.2100E-15	147341.1673
	15	≥300	0	1.6000E-06	113086.2938
			1	4.8000E-07	129503.6079

[a]5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-9. NAPHTHALENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION[a]. HI=0.5, SAND.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SAND	700	0-100	0	0.334	1.1431
			1	0.214	1.7841
			3	0.15	2.5453
			6	0.0961	3.9729
			9	0.0681	5.6063
	100	0-100	0	0.327	1.1676
			1	0.18	2.1211
			3	0.102	3.7431
			6	0.049	7.7915
			9	0.026	14.6832
	15	0-100	0	0.00496	76.9365
			1	0.0032	119.2178
			3	0.0022	173.3448
			6	0.0014	272.2185
	700	100-300	0	0.00891	42.8433
			1	0.0057	66.9641
			3	0.00401	95.1747
			6	0.00257	148.4693
			9	0.00182	209.5985
	100	100-300	0	0.0000678	5502.5835
			1	0.0000363	10077.6735
			3	0.0000206	17209.2079
			6	9.9000E-06	33240.9167
			9	5.2400E-06	55934.3030
	15	100-300	0	0.001	381.1971
			1	0.000598	636.7756
			3	0.000299	1270.1916
			6	0.000269	1411.0184
	700	≥300	0	0.0000336	11068.1337
			1	0.0000215	17048.0827
			3	0.0000115	30801.4402
			6	9.6700E-06	36136.3714
			9	6.8500E-06	49292.8533
	100	≥300	0	1.4100E-11	426311.6408
			1	7.8000E-12	426314.6397
			3	4.4000E-12	426316.2582
			6	2.1000E-12	426317.3530
			9	1.1300E-12	426317.8148
	15	≥300	0	0.0000409	9134.9777
			1	0.0000253	14575.0427
			3	0.0000203	18013.2698
			6	0.0000101	34723.1998

[a]5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-130 to A-138.

Table AI-10. NAPHTHALENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION[a]. HI=0.5, SILT.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SILT	700	0-100	0	0.314	1.2159
			1	0.274	1.3934
			3	0.137	2.7868
			6	0.0621	6.1479
			9	0.034	11.2286
	100	0-100	0	0.314	1.2159
			1	0.053	7.2035
			3	0.0073	52.2833
			6	0.000867	439.0766
			9	0.0001	3722.8604
	15	0-100	0	0.00466	81.8868
			1	0.004	95.3895
			3	0.002	190.6572
			6	0.0009	423.0227
	700	100-300	0	0.00837	45.6069
			1	0.0073	52.2902
			3	0.00365	104.5578
			6	0.00166	229.7815
			9	0.000908	419.7533
	100	100-300	0	0.0000632	5893.2840
			1	0.0000108	30825.5221
			3	1.48000E-06	124531.8836
			6	1.75000E-07	216822.5130
			9	2.02000E-08	237720.4829
	15	100-300	0	0.000943	404.2001
			1	0.000889	428.7084
			3	0.000299	1270.1916
			6	0.000179	2114.2387
	700	≥300	0	0.0000316	11749.3423
			1	0.0000275	13445.8143
			3	0.0000138	25980.7174
			6	6.24000E-06	53506.7568
			9	3.42000E-06	88470.5614
	100	≥300	0	1.36000E-11	426311.8788
			1	2.31000E-12	426317.2531
			3	3.17000E-13	426318.2018
			6	3.75000E-14	426318.3348
			9	4.33000E-15	426318.3506
	15	≥300	0	0.0000384	9716.1485
			1	0.0000305	12161.0015
			3	0.0000167	21698.7281
			6	7.60000E-06	44888.3831

[a]5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-11. NAPHTHALENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION[a]. HI=0.5, CLAY.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
CLAY	700	0-100	0	0.314	1.2159
			1	0.214	1.7841
			3	0.0621	6.1479
	100	0-100	0	0.307	1.2436
			1	0.000547	694.7457
			3	0.000015	21747.6436
			6	1.200E-07	142676.1457
	15	0-100	0	0.00466	81.8868
			1	0.00318	119.9670
			3	0.00092	413.8520
			6	0.000248	1523.8177
	700	100-300	0	0.00837	45.6069
			1	0.00573	66.6136
			3	0.0016	238.3898
	100	100-300	0	0.0000618	6023.4486
			1	1.170000E-07	224207.4110
			3	3.200000E-09	240263.5960
	15	100-300	0	0.000943	404.2001
			1	0.00064	595.0905
			3	0.000195	1942.1621
			6	0.00005	7401.2805
	700	≥300	0	0.0000316	11749.3423
			1	0.0000215	17048.0827
			3	6.240000E-06	53506.7568
	100	≥300	0	1.330000E-11	426312.0217
			1	2.370000E-14	426318.3414
			3	6.490000E-16	426318.3524
	15	≥300	0	0.000384	9716.1485
			1	0.0000253	14575.0427
			3	7.610000E-06	44888.3831
			6	2.180000E-06	124139.7812

[a]5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-130 to A-138.

Table AI-12. Soil Values (mg/kg) for Carcinogenic Polycyclic Aromatic Hydrocarbons Based on GW Pathway, 9 and 30 Years Exposure Duration[a,b]

	Distance from Site (m)					
	0 - 100		100 - 300		≥300	
	9 Years	30 Years	9 Years	30 Years	9 Years	30 Years
Benzo(a)pyrene	0.33077	0.13626	3.31×10^{5}	1.36×10^{5}	3.31×10^{5}	1.36×10^{5}
Benzo(a)anthracene	0.15334	0.06503	1.53×10^{5}	6.5×10^{4}	1.53×10^{5}	6.5×10^{4}
Chrysene	15.33412	6.50324	1.53×10^{7}	6.5×10^{6}	1.53×10^{7}	6.5×10^{6}

[a] Assessment assumed no migration of compounds to soil surface, based on SESOIL results.
[b] Calculations based on GW exposure only, applying an on-site mixing factor of 0.67 to soil pore water (complete mixing to 0.5 m depth, 0.1 m/d GW flow rate, 300d half-life). See pages AI-139 to AI-192 for spreadsheets.

Table AI-13. Soil Values (mg/kg) for Carcinogenic Polycyclic Aromatic Hydrocarbons Based on Surface Soil and GW Contamination, 9 and 30 Years Exposure Duration[a]

	Distance from Site (m)					
	0 - 100		100 - 300		≥300	
	9 Years	30 Years	9 Years	30 Years	9 Years	30 Years
Benzo(a)pyrene	0.111060	0.056335	0.334398	0.192087	0.668796	0.384173
Benzo(a)anthracene	0.140459	0.060908	3.343914	1.920813	6.687683	3.841513
Chrysene	14.045940	6.090820	334.391427	192.081334	668.768271	384.151321

[a] Assessment assumed contamination of surface soils and GW (complete mixing to 0.5 m depth, 0.1 m/d GW flow rate, 300d half-life). There was no SESOIL transport. Spreadsheets for benzo(a)pyrene are given on pages AI-193 to AI-210.

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ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                     2-6 yrs.   7-18   18+  ! on/off TRANSPORT                  HQ          1
.......................................                   !      0 Transport                RfDo       0.06
cont. [ ] (mg/kg)(ppm) C          4043.97791              !      1 Kd/Att. Fact.            RfDi       0.06
consumption rt. (mg/day) CR            200     100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                       ! on/off EXPOSURE
exposure freq. (d/yr) EF               180                !      1 soil ingest.
duration of exp. (yrs) ED                5       4      0 !      1 soil derm.      ***********************
avg. body wt. (kg) BW                   16      41     70 !      0 gwater cons.    * Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                             !      1 inh. vap.       *                     *
absorption factor (0-1) AF               1                !      0 shower derm.    * 4043.9779  mg/kg    *
contaminated fraction (0-1)CF          0.5                !      0 inh. shower     *                     *
Transport multiplier  TR                 1                !      0 inh. part.      ***********************

soil ingestion dose (mg/kg/d) 1.246E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C               4043.97791
skin surf. area(cm^2/d) SA            3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm^2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF               180
exposure duration (yrs) ED               5       4      0
avg. body wt. (kg) BW                   16      41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF          0.5
Transport multiplier  TR                 1

soil dermal dose (mg/kg/d)    2.437E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	4043.97791		
Consumption rate (L/day) CR	1.4		
Koc (L\kG)	4571		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 1.113E+01 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	4043.97791		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	25807.58		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 4.696E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	4043.97791		
Kd (L/kg) Kd	22.855		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	2.229E+00 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	4043.97791			
Kd (L/kg)	22.855			
inhalation rt.(0.6)(m^3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m^3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower inhalation exposure	3.181E-01 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m^3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	4043.97791			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

Soil Ingestion	2-6 yrs.	7-18	18+
cont. [ ] (mg/kg)(ppm) C	667.256356		
consumption rt. (mg/day) CR	200	100	100
(2-6 200, >6 100)			
exposure freq. (d/yr) EF	180		
duration of exp. (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
(2-6 16, 6-18 41, adult 70)			
absorption factor (0-1) AF	1		
contaminated fraction (0-1) CF	0.5		
Transport multiplier TR	1		

on/off	TRANSPORT
0	Transport
1	Kd/Att. Fact.
0	No Attenuation
on/off	**EXPOSURE**
1	soil ingest.
1	soil derm.
0	gwater cons.
1	inh. vap.
0	shower derm.
0	inh. shower
0	inh. part.

HQ	0.165
RfDo	0.06
RfDi	0.06

Soil Concentration: 667.2564 mg/kg

soil ingestion dose (mg/kg/d) 2.057E-03 mg/kg*day =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)

Soil Dermal Exposure			
cont. [ ] (mg/kg) C	667.256356		
skin surf. area(cm^2/d) SA	3910	3910	3120
(child 3910 adult 3120)			
soil to skin adher. factor AD	1		
(1) (mg/cm^2)			
absorption factor (0-1) AF	0.1		
exposure freq. (d/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
(2-6 16, 6-18 41, adult 70)			
contaminated fraction (0-1) CF	0.5		
Transport multiplier TR	1		

soil dermal dose (mg/kg/d) 4.021E-03 mg/kg*day =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)

Groundwater Consumption

soil cont. [ ] (mg/kg) C	667.256356		
Consumption rate (L/day) CR	1.4		
Koc (L\kG)	4571		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 1.837E+00 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	667.256356		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	25807.58		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 7.748E-03 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	667.256356		
Kd (L/kg) Kd	22.855		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 3.679E-01 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	667.256356		
Kd (L/kg)	22.855		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 5.249E-02 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	667.256356		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion        2-6 yrs.   7-18   18+  ! on/oTRANSPORT                     HQ         1
..............................               !   0 Transport                   RfDo      0.06
cont. [ ] (mg/kg)(pp23.4317685               !   1 Kd/Att. Fact.               RfDi      0.06
consumption rt. (mg/        200    100    100 !   0 No Attenuation
  (2-6 200, >6 100)                          ! on/oEXPOSURE
exposure freq. (d/yr        180              !   1 soil ingest.
duration of exp. (yr          5      4      0 !   1 soil derm.  ***************************
avg. body wt. (kg) B         16     41     70 !   1 gwater cons.* Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                !   1 inh. vap.   *                         *
absorption factor (0          1              !   1 shower derm.*      23.4318  mg/kg    *
contaminated fractio        0.5              !   1 inh. shower *                         *
Transport multiplier          1              !   0 inh. part.  ***************************

soil ingestion dose  7.222E-05 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
..............................
cont. [ ] (mg/kg) C 23.4317685
skin surf. area(cm2/      3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher.           1
  (1) (mg/cm2)
absorption factor (0        0.1
exposure freq. (d/yr        180
exposure duration (y          5      4      0
avg. body wt. (kg) B         16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fractio        0.5
Transport multiplier          1

soil dermal dose (mg 1.412E-04 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/k	23.4317685		
Consumption rate (L/	1.4		
Koc (L\kG)	4571		
Organic Carbon Fract	0.005		
exp. freq. (365)(day	350		
exposure duration (y	5		0
diet fraction (.75-1	0.75		
avg. body wt. (kg) B	16	41	70
Attenuation factor	1		
Transport multiplier	1		

water consumption ex 6.452E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/K	23.4317685		
inhalation rt. (m^3/d	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg)	25807.58		
exposure freq. (days	350		
exposure duration (y	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fractio	0.5		
Transport multiplier	1		

vapor inhalation dos 2.721E-04 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/k	23.4317685		
Kd (L/kg) Kd	22.855		
skin surface area (c	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days	350		
exposure duration (y	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/h	0.146		
length of shower (hr	0.2		

```
absorption factor AF          1
Attenuation factor            1
Transport multiplier          1

shower dermal dose   1.292E-02 mg/kg*day   =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
```

```
Inhalation in Shower
...............................
soil cont. [ ] (mg/k23.4317685
Kd (L/kg)               22.855
inhalation rt.(0.6)(       0.6
exposure freq. (days       350
exposure duration (y         5      4      0
shower length(hrs/da       0.2
avg. body wt. (kg) B        16     41     70
volat. factor (K)(.5       0.5
absorption factor  A       0.5
Attenuation factor           1
Transport multiplier         1

shower inhalation ex 1.843E-03 mg/kg*day   =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Particulates
...............................
inhalation rate (m3/        20     20     20
  (child<18 20 adult 20)
air particulate [](m         0
respirable part. fra         0
part. cont [ ] (mg/k23.4317685
exposure freq. (days       180
exposure duration (y         5      4      0
avg. body wt. (kg) B        16     41     70
Transport multiplier         1

part. inhalation exp 0.000E+00 mg/kg*day   =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
```

ACENAPHTHENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT               HQ      0.165
.....................................                  !      0 Transport             RfDo       0.06
cont. [ ] (mg/kg)(ppm) C      3.86624181               !      1 Kd/Att. Fact.         RfDi       0.06
consumption rt. (mg/day) CR          200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF             180               !      1 soil ingest.
duration of exp. (yrs) ED              5      4      0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                 16     41     70 !      1 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.      *                    *
absorption factor (0-1) AF             1               !      1 shower derm.   *    3.8662  mg/kg   *
contaminated fraction (0-1)CF        0.5               !      1 inh. shower    *                    *
Transport multiplier  TR               1               !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 1.192E-05 mg/kg*day    =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.....................................
cont. [ ] (mg/kg) C           3.86624181
skin surf. area(cm^2/d) SA          3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm^2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    2.330E-05 mg/kg*day    =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	3.86624181		
Consumption rate (L/day) CR	1.4		
Koc (L\kG)	4571		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 1.065E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	3.86624181		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	25807.58		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 4.489E-05 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	3.86624181		
Kd (L/kg) Kd	22.855		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	2.131E-03 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	3.86624181			
Kd (L/kg)	22.855			
inhalation rt.(0.6)(m^3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m^3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower inhalation exposure	3.041E-04 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m^3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	3.86624181			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ANTHRACENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                    2-6 yrs.   7-18   18+ ! on/off TRANSPORT                    HQ       1
......................................                  !      0 Transport                  RfDo     0.3
cont. [ ] (mg/kg)(ppm) C       41589.7449               !      1 Kd/Att. Fact.              RfDi     0.3
consumption rt. (mg/day) CR           200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                     ! on/off EXPOSURE
exposure freq. (d/yr) EF              180               !      1 soil ingest.
duration of exp. (yrs) ED               5      4      0 !      1 soil derm.      **********************
avg. body wt. (kg) BW                  16     41     70 !      0 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                           !      1 inh. vap.       *                    *
absorption factor (0-1) AF              1               !      0 shower derm.    * 41589.7449 mg/kg   *
contaminated fraction (0-1)CF         0.5               !      0 inh. shower     *                    *
Transport multiplier  TR                1               !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 1.282E-01 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C            41589.7449
skin surf. area(cm^2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm^2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF              180    180
exposure duration (yrs) ED              5      4      0
avg. body wt. (kg) BW                  16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF         0.5
Transport multiplier  TR                1

soil dermal dose (mg/kg/d)    2.506E-01 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	41589.7449		
Consumption rate (L/day) CR	1.4		
Koc (L\kG)	14125		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 3.706E+01 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	41589.7449		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	259752.96		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 4.798E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	41589.7449		
Kd (L/kg) Kd	70.625		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.225		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	1.143E+01 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	41589.7449			
Kd (L/kg)	70.625			
inhalation rt.(0.6)(m^3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m^3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower inhalation exposure	1.059E+00 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m^3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	41589.7449			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ANTHRACENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                   2-6 yrs.   7-18   18+  ! on/off TRANSPORT                    HQ  0.165
.......................................                 !      0 Transport                  RfDo    0.3
cont. [ ] (mg/kg)(ppm) C     6862.30791                 !      1 Kd/Att. Fact.              RfDi    0.3
consumption rt. (mg/day) CR         200    100    100   !      0 No Attenuation
  (2-6 200, >6 100)                                     ! on/off EXPOSURE
exposure freq. (d/yr) EF            180                 !      1 soil ingest.
duration of exp. (yrs) ED             5      4      0   !      1 soil derm.      ***********************
avg. body wt. (kg) BW                16     41     70   !      0 gwater cons.    * Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                           !      1 inh. vap.       *                     *
absorption factor (0-1) AF            1                 !      0 shower derm.    * 6862.3079   mg/kg   *
contaminated fraction (0-1)CF       0.5                 !      0 inh. shower     *                     *
Transport multiplier  TR              1                 !      0 inh. part.      ***********************

soil ingestion dose (mg/kg/d) 2.115E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C          6862.30791
skin surf. area(cm^2/d) SA         3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm^2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF            180    180
exposure duration (yrs) ED            5      4      0
avg. body wt. (kg) BW                16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR              1

soil dermal dose (mg/kg/d)    4.135E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
........................................
soil cont. [ ] (mg/kg) C      6862.30791
Consumption rate (L/day)  CR         1.4
Koc (L\kG)                         14125
Organic Carbon Fraction            0.005
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5            0
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41    70
Attenuation factor  AT                 1
Transport multiplier  TR               1

water consumption exposure    6.114E+00 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
........................................
soil cont. [ ] (mg/Kg) C      6862.30791
inhalation rt. (m^3/day) IR           20     20    20
  (child<18 20  adult 20  occ. 20)
volat.factor(m^3/kg)  VF       259752.96
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4     0
avg body wt. (kg) BW                  16     41    70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

vapor inhalation dose         7.917E-03 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
........................................
soil cont. [ ] (mg/kg) C      6862.30791
Kd  (L/kg) Kd                     70.625
skin surface area (cm^2) SA         7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4     0
avg body wt (kg) BW                   16     41    70
Kp(derm. perm.)(cm/hr)             0.225
length of shower (hr/day) SL         0.2
```

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	1.887E+00 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	6862.30791			
Kd (L/kg)	70.625			
inhalation rt.(0.6)(m^3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m^3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower inhalation exposure	1.747E-01 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [ ](mg/m^3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	6862.30791			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ANTHRACENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+ ! on/off TRANSPORT             HQ          1
.......................................               !      0 Transport           RfDo        0.3
cont. [ ] (mg/kg)(ppm) C      327.751955              !      1 Kd/Att. Fact.       RfDi        0.3
consumption rt. (mg/day) CR          200    100   100 !      0 No Attenuation
  (2-6 200, >6 100)                                   ! on/off EXPOSURE
exposure freq. (d/yr) EF             180              !      1 soil ingest.
duration of exp. (yrs) ED              5      4     0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                 16     41    70 !      1 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                         !      1 inh. vap.      *                    *
absorption factor (0-1) AF             1              !      1 shower derm.   *  327.7520   mg/kg  *
contaminated fraction (0-1)CF        0.5              !      1 inh. shower    *                    *
Transport multiplier  TR               1              !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 1.010E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           327.751955
skin surf. area(cm2/d) SA          3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180    180
exposure duration (yrs) ED             5      4     0
avg. body wt. (kg) BW                 16     41    70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    1.975E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	327.751955		
Consumption rate (L/day) CR	1.4		
Koc (L\kG)	14125		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 2.920E-01 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	327.751955		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	259752.96		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 3.781E-04 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	327.751955		
Kd (L/kg) Kd	70.625		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.225		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	9.011E-02 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	327.751955			
Kd (L/kg)	70.625			
inhalation rt.(0.6)(m^3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m^3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower inhalation exposure	8.344E-03 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m^3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	327.751955			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ANTHRACENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                      2-6 yrs.   7-18   18+  ! on/off TRANSPORT                HQ  0.165
.......................................                    !      0 Transport              RfDo    0.3
cont. [ ] (mg/kg)(ppm) C      54.0790726                   !      1 Kd/Att. Fact.          RfDi    0.3
consumption rt. (mg/day) CR          200    100     100    !      0 No Attenuation
  (2-6 200, >6 100)                                        ! on/off EXPOSURE
exposure freq. (d/yr) EF             180                   !      1 soil ingest.
duration of exp. (yrs) ED              5      4       0    !      1 soil derm.      **********************
avg. body wt. (kg) BW                 16     41      70    !      1 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                              !      1 inh. vap.       *                    *
absorption factor (0-1) AF             1                   !      1 shower derm.    *   54.0791  mg/kg   *
contaminated fraction (0-1)CF        0.5                   !      1 inh. shower     *                    *
Transport multiplier  TR               1                   !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 1.667E-04 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           54.0790726
skin surf. area(cm^2/d) SA          3910   3910    3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm^2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180    180
exposure duration (yrs) ED             5      4       0
avg. body wt. (kg) BW                 16     41      70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    3.259E-04 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C     54.0790726
Consumption rate (L/day)  CR        1.4
Koc (L\kG)                        14125
Organic Carbon Fraction           0.005
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5           0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16    41    70
Attenuation factor  AT                1
Transport multiplier  TR              1

water consumption exposure    4.819E-02 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/Kg) C     54.0790726
inhalation rt. (m3/day) IR           20    20    20
  (child<18 20  adult 20  occ. 20)
volat.factor(m3/kg)  VF      259752.96
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt. (kg) BW                 16    41    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR              1

vapor inhalation dose         6.239E-05 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C     54.0790726
Kd  (L/kg) Kd                    70.625
skin surface area (cm2) SA         7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt (kg) BW                  16    41    70
Kp(derm. perm.)(cm/hr)            0.225
length of shower (hr/day) SL        0.2
```

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	1.487E-02 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	54.0790726			
Kd (L/kg)	70.625			
inhalation rt.(0.6)(m^3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m^3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower inhalation exposure	1.377E-03 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m^3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	54.0790726			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORANTHENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                2-6 yrs.   7-18   18+  ! on/off TRANSPORT                HQ           1
                              ...........            !      0 Transport              RfDo        0.04
cont. [ ] (mg/kg)(ppm) C      6277.14168             !      1 Kd/Att. Fact.          RfDi        0.04
consumption rt. (mg/day) CR         200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                  ! on/off EXPOSURE
exposure freq. (d/yr) EF            180              !      1 soil ingest.
duration of exp. (yrs) ED             5      4      0 !      1 soil derm.      **********************
avg. body wt. (kg) BW                16     41     70 !      0 gwater cons.    * Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                        !      0 inh. vap.       *                     *
absorption factor (0-1) AF            1              !      0 shower derm.    * 6277.1417  mg/kg    *
contaminated fraction (0-1)CF       0.5              !      0 inh. shower     *                     *
Transport multiplier  TR              1              !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 1.935E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C           6277.14168
skin surf. area(cm2/d) SA          3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF            180
exposure duration (yrs) ED            5      4      0
avg. body wt. (kg) BW                16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR              1

soil dermal dose (mg/kg/d)    3.782E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
.....................................
soil cont. [ ] (mg/kg) C          6277.14168
Consumption rate (L/day)   CR            1.4
Koc (L/kg)                             38000
Organic Carbon Fraction                0.005
exp. freq. (365)(days/yr) EF             350
exposure duration (yrs) ED                 5      4      0
diet fraction (.75-1.0) DF              0.75
avg. body wt. (kg) BW                     16     41     70
Attenuation factor  AT                     1
Transport multiplier  TR                   1

water consumption exposure     2.079E+00 mg/kg*day    =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
.....................................
soil cont. [ ] (mg/Kg) C          6277.14168
inhalation rt. (m³/day) IR                20     20     20
  (child<18 20  adult 20   occ. 20)
volat.factor(m³/kg)   VF          1621188.50
exposure freq. (days/yr) EF              350
exposure duration (yrs) ED                 5      4      0
avg body wt. (kg) BW                      16     41     70
absorption factor AF                     0.5
contaminated fraction (0-1)CF            0.5
Transport multiplier   TR                  1

vapor inhalation dose     1.160E-03 mg/kg*day    =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
.....................................
soil cont. [ ] (mg/kg) C          6277.14168
Kd  (L/kg) Kd                            190
skin surface area (cm²) SA              7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF              350
exposure duration (yrs) ED                 5      4      0
avg body wt (kg) BW                       16     41     70
Kp(derm. perm.)(cm/hr)                  0.36
length of shower (hr/day) SL             0.2
```

FLUORANTHENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                      2-6 yrs.   7-18   18+  ! on/off TRANSPORT                  HQ  0.165
.......................................                    !      0 Transport                RfDo   0.04
cont. [ ] (mg/kg)(ppm) C       1035.72838                  !      1 Kd/Att. Fact.            RfDi   0.04
consumption rt. (mg/day) CR           200    100    100    !      0 No Attenuation
  (2-6 200, >6 100)                                        ! on/off EXPOSURE
exposure freq. (d/yr) EF              180                  !      1 soil ingest.
duration of exp. (yrs) ED               5      4      0    !      1 soil derm.      **********************
avg. body wt. (kg) BW                  16     41     70    !      0 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                              !      0 inh. vap.       *                    *
absorption factor (0-1) AF              1                  !      0 shower derm.    * 1035.7284  mg/kg   *
contaminated fraction (0-1)CF         0.5                  !      0 inh. shower     *                    *
Transport multiplier  TR                1                  !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 3.192E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C            1035.72838
skin surf. area(cm^2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm^2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF              180
exposure duration (yrs) ED              5      4      0
avg. body wt. (kg) BW                  16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF         0.5
Transport multiplier  TR                1

soil dermal dose (mg/kg/d)    6.241E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	1035.72838		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	38000		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 3.430E-01 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	1035.72838		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	1621188.50		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.914E-04 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	1035.72838		
Kd (L/kg) Kd	190		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.36		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	1.694E-01 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	1035.72838		
Kd (L/kg)	190		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 9.801E-03 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	1035.72838		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORANTHENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                   2-6 yrs.   7-18   18+  ! on/off TRANSPORT              HQ          1
.......................................                 !      0 Transport            RfDo       0.04
cont. [ ] (mg/kg)(ppm) C     102.417928                 !      1 Kd/Att. Fact.        RfDi       0.04
consumption rt. (mg/day) CR         200    100    100   !      0 No Attenuation
  (2-6 200, >6 100)                                     ! on/off EXPOSURE
exposure freq. (d/yr) EF            180                 !      1 soil ingest.
duration of exp. (yrs) ED             5      4      0   !      1 soil derm.      **********************
avg. body wt. (kg) BW                16     41     70   !      1 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                           !      0 inh. vap.       *                    *
absorption factor (0-1) AF            1                 !      1 shower derm.    *  102.4179  mg/kg   *
contaminated fraction (0-1)CF       0.5                 !      0 inh. shower     *                    *
Transport multiplier  TR              1                 !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 3.157E-04 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C          102.417928
skin surf. area(cm^2/d) SA         3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm^2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF            180
exposure duration (yrs) ED            5      4      0
avg. body wt. (kg) BW                16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR              1

soil dermal dose (mg/kg/d)    6.171E-04 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	102.417928		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	38000		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 3.392E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	102.417928		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	1621188.50		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.893E-05 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	102.417928		
Kd (L/kg) Kd	190		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.36		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 1.675E-02 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	102.417928		
Kd (L/kg)	190		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 9.692E-04 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	102.417928		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORANTHENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                      2-6 yrs.   7-18   18+ ! on/off TRANSPORT                  HQ  0.165
......................................                    !      0 Transport                RfDo   0.04
cont. [ ] (mg/kg)(ppm) C       16.8989581                 !      1 Kd/Att. Fact.            RfDi   0.04
consumption rt. (mg/day) CR           200    100    100   !      0 No Attenuation
  (2-6 200, >6 100)                                       ! on/off EXPOSURE
exposure freq. (d/yr) EF              180                 !      1 soil ingest.
duration of exp. (yrs) ED               5      4      0   !      1 soil derm.       **********************
avg. body wt. (kg) BW                  16     41     70   !      1 gwater cons.     * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                             !      0 inh. vap.        *                    *
absorption factor (0-1) AF              1                 !      1 shower derm.     *   16.8990  mg/kg   *
contaminated fraction (0-1)CF         0.5                 !      0 inh. shower      *                    *
Transport multiplier  TR                1                 !      0 inh. part.       **********************

soil ingestion dose (mg/kg/d) 5.209E-05 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C            16.8989581
skin surf. area(cm2/d) SA            3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF              180
exposure duration (yrs) ED              5      4      0
avg. body wt. (kg) BW                  16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF         0.5
Transport multiplier  TR                1

soil dermal dose (mg/kg/d)    1.018E-04 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	16.8989581		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	38000		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 5.597E-03 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	16.8989581		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	1621188.50		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 3.124E-06 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	16.8989581		
Kd (L/kg) Kd	190		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.36		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	2.763E-03 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	16.8989581		
Kd (L/kg)	190		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.599E-04 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	16.8989581		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT                HQ          1
.......................................                !      0 Transport              RfDo       0.04
cont. [ ] (mg/kg)(ppm) C      5405.20894               !      1 Kd/Att. Fact.          RfDi       0.04
consumption rt. (mg/day) CR          200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF             180               !      1 soil ingest.
duration of exp. (yrs) ED              5      4      0 !      1 soil derm.      **********************
avg. body wt. (kg) BW                 16     41     70 !      0 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.       *                    *
absorption factor (0-1) AF             1               !      0 shower derm.    * 5405.2089  mg/kg   *
contaminated fraction (0-1)CF        0.5               !      0 inh. shower     *                    *
Transport multiplier  TR               1               !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 1.666E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           5405.20894
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    3.257E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
........................................
soil cont. [ ] (mg/kg) C      5405.20894
Consumption rate (L/day)  CR         1.4
Koc (L/kg)                          7225
Organic Carbon Fraction            0.005
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5      4      0
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41     70
Attenuation factor  AT                 1
Transport multiplier  TR               1

water consumption exposure    9.416E+00 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
........................................
soil cont. [ ] (mg/Kg) C      5405.20894
inhalation rt. (m3/day) IR            20     20     20
  (child<18 20  adult 20  occ. 20)
volat.factor(m3/kg)  VF        212511.56
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt. (kg) BW                  16     41     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

vapor inhalation dose         7.622E-03 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
........................................
soil cont. [ ] (mg/kg) C      5405.20894
Kd  (L/kg) Kd                     36.125
skin surface area (cm2) SA          7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt (kg) BW                   16     41     70
Kp(derm. perm.)(cm/hr)             0.171
length of shower (hr/day) SL         0.2
```

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 2.208E+00 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	5405.20894		
Kd (L/kg)	36.125		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 2.690E-01 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR	20	20	20
(child<18 20 adult 20)			
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	5405.20894		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORENE RESIDENTIAL CHILD, SOIL EXPOSURE

0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                   2-6 yrs.   7-18   18+  ! on/off TRANSPORT                HQ  0.165
.......................................                 !      0 Transport              RfDo   0.04
cont. [ ] (mg/kg)(ppm) C       891.859476               !      1 Kd/Att. Fact.          RfDi   0.04
consumption rt. (mg/day) CR           200    100   100  !      0 No Attenuation
  (2-6 200, >6 100)                                     ! on/off EXPOSURE
exposure freq. (d/yr) EF              180               !      1 soil ingest.
duration of exp. (yrs) ED               5      4     0  !      1 soil derm.      **********************
avg. body wt. (kg) BW                  16     41    70  !      0 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                           !      1 inh. vap.       *                    *
absorption factor (0-1) AF              1               !      0 shower derm.    *  891.8595   mg/kg  *
contaminated fraction (0-1)CF         0.5               !      0 inh. shower     *                    *
Transport multiplier  TR                1               !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 2.749E-03 mg/kg*day    =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C            891.859476
skin surf. area(cm2/d) SA            3910   3910  3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF              180
exposure duration (yrs) ED              5      4     0
avg. body wt. (kg) BW                  16     41    70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF         0.5
Transport multiplier  TR                1

soil dermal dose (mg/kg/d)    5.374E-03 mg/kg*day    =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	891.859476		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	7225		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 1.554E+00 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	891.859476		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m3/kg) VF	212511.56		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.258E-03 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	891.859476		
Kd (L/kg) Kd	36.125		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.171		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 3.643E-01 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	891.859476		
Kd (L/kg)	36.125		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 4.439E-02 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	891.859476		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+ ! on/off TRANSPORT                HQ          1
......................................                ! 	    0 Transport               RfDo       0.04
cont. [ ] (mg/kg)(ppm) C     23.9497237              !      1 Kd/Att. Fact.           RfDi       0.04
consumption rt. (mg/day) CR         200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                   ! on/off EXPOSURE
exposure freq. (d/yr) EF            180               !      1 soil ingest.
duration of exp. (yrs) ED             5      4      0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                16     41     70 !      1 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                         !      1 inh. vap.      *                    *
absorption factor (0-1) AF            1               !      1 shower derm.   *   23.9497  mg/kg   *
contaminated fraction (0-1)CF       0.5               !      1 inh. shower    *                    *
Transport multiplier  TR              1               !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 7.382E-05 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C          23.9497237
skin surf. area(cm^2/d) SA         3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm^2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF            180
exposure duration (yrs) ED            5      4      0
avg. body wt. (kg) BW                16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR              1

soil dermal dose (mg/kg/d)    1.443E-04 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
.........................................
soil cont. [ ] (mg/kg) C      23.9497237
Consumption rate (L/day)  CR         1.4
Koc (L/kg)                          7225
Organic Carbon Fraction            0.005
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5      4      0
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41     70
Attenuation factor  AT                 1
Transport multiplier  TR               1

water consumption exposure    4.172E-02 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
.........................................
soil cont. [ ] (mg/Kg) C      23.9497237
inhalation rt. (m3/day) IR            20     20     20
  (child<18 20  adult 20  occ. 20)
volat.factor(m3/kg)  VF        212511.56
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt. (kg) BW                  16     41     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

vapor inhalation dose         3.377E-05 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
.........................................
soil cont. [ ] (mg/kg) C      23.9497237
Kd  (L/kg) Kd                     36.125
skin surface area (cm2) SA          7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt (kg) BW                   16     41     70
Kp(derm. perm.)(cm/hr)             0.171
length of shower (hr/day) SL         0.2
```

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	9.784E-03 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	23.9497237			
Kd (L/kg)	36.125			
inhalation rt.(0.6)(m^3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m^3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower inhalation exposure	1.192E-03 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m^3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	23.9497237			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                   2-6 yrs.   7-18   18+  ! on/off TRANSPORT                HQ  0.165
.......................................                 !      0 Transport              RfDo   0.04
cont. [ ] (mg/kg)(ppm) C      3.95170441                !      1 Kd/Att. Fact.          RfDi   0.04
consumption rt. (mg/day) CR          200     100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                     ! on/off EXPOSURE
exposure freq. (d/yr) EF             180                !      1 soil ingest.
duration of exp. (yrs) ED              5       4      0 !      1 soil derm.      **********************
avg. body wt. (kg) BW                 16      41     70 !      1 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                           !      1 inh. vap.       *                    *
absorption factor (0-1) AF             1                !      1 shower derm.    *    3.9517  mg/kg   *
contaminated fraction (0-1)CF        0.5                !      1 inh. shower     *                    *
Transport multiplier  TR               1                !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 1.218E-05 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           3.95170441
skin surf. area(cm2/d) SA           3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5       4      0
avg. body wt. (kg) BW                 16      41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    2.381E-05 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	3.95170441		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	7225		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 6.884E-03 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	3.95170441		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m3/kg) VF	212511.56		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 5.572E-06 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	3.95170441		
Kd (L/kg) Kd	36.125		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.171		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 1.614E-03 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	3.95170441		
Kd (L/kg)	36.125		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.967E-04 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	3.95170441		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE,
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                   2-6 yrs.   7-18   18+  ! on/off TRANSPORT              HQ         1
........................................                !      0 Transport            RfDo      0.04
cont. [ ] (mg/kg)(ppm) C      2748.49173                !      1 Kd/Att. Fact.        RfDi      0.04
consumption rt. (mg/day) CR          200    100    100  !      0 No Attenuation
  (2-6 200, >6 100)                                     ! on/off EXPOSURE
exposure freq. (d/yr) EF             180                !      1 soil ingest.
duration of exp. (yrs) ED              5      4      0  !      1 soil derm.     **********************
avg. body wt. (kg) BW                 16     41     70  !      0 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                           !      1 inh. vap.      *                    *
absorption factor (0-1) AF             1                !      0 shower derm.   * 2748.4917  mg/kg   *
contaminated fraction (0-1)CF        0.5                !      0 inh. shower    *                    *
Transport multiplier  TR               1                !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 8.471E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C           2748.49173
skin surf. area(cm^2/d) SA          3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm^2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    1.656E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	2748.49173		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	930		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 3.720E+01 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	2748.49173		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	26701.70		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 3.084E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	2748.49173		
Kd (L/kg) Kd	4.65		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.069		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 3.520E+00 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	2748.49173		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.063E+00 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	2748.49173		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE,
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                   2-6 yrs.  7-18   18+  ! on/off TRANSPORT                    HQ  0.165
.......................................                !      0 Transport                  RfDo   0.04
cont. [ ] (mg/kg)(ppm) C      453.501135               !      1 Kd/Att. Fact.              RfDi   0.04
consumption rt. (mg/day) CR          200   100    100  !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF             180               !      1 soil ingest.
duration of exp. (yrs) ED              5     4      0  !      1 soil derm.      ***********************
avg. body wt. (kg) BW                 16    41     70  !      0 gwater cons.    * Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.       *                     *
absorption factor (0-1) AF             1               !      0 shower derm.    *  453.5011  mg/kg    *
contaminated fraction (0-1)CF        0.5               !      0 inh. shower     *                     *
Transport multiplier  TR               1               !      0 inh. part.      ***********************

soil ingestion dose (mg/kg/d) 1.398E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           453.501135
skin surf. area(cm^2/d) SA          3910  3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm^2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5     4      0
avg. body wt. (kg) BW                 16    41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    2.733E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
.........................................
soil cont. [ ] (mg/kg) C     453.501135
Consumption rate (L/day)  CR        1.4
Koc (L/kg)                          930
Organic Carbon Fraction           0.005
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5           0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16     41     70
Attenuation factor  AT                1
Transport multiplier  TR              1

water consumption exposure    6.137E+00 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
.........................................
soil cont. [ ] (mg/Kg) C     453.501135
inhalation rt. (m^3/day) IR          20     20     20
  (child<18 20  adult 20  occ. 20)
volat.factor(m^3/kg)  VF       26701.70
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5      4      0
avg body wt. (kg) BW                 16     41     70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR              1

vapor inhalation dose         5.089E-03 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
.........................................
soil cont. [ ] (mg/kg) C     453.501135
Kd  (L/kg) Kd                      4.65
skin surface area (cm^2) SA        7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5      4      0
avg body wt (kg) BW                  16     41     70
Kp(derm. perm.)(cm/hr)            0.069
length of shower (hr/day) SL        0.2
```

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 5.808E-01 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	453.501135		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.753E-01 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	453.501135		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                      2-6 yrs.   7-18   18+  ! on/off TRANSPORT                       HQ          1
.......................................                    !      0 Transport                     RfDo       0.04
cont. [ ] (mg/kg)(ppm) C          3.54617434               !      1 Kd/Att. Fact.                 RfDi       0.04
consumption rt. (mg/day) CR              200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                        ! on/off EXPOSURE
exposure freq. (d/yr) EF                 180               !      1 soil ingest.
duration of exp. (yrs) ED                  5      4      0 !      1 soil derm.      **********************
avg. body wt. (kg) BW                     16     41     70 !      1 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                              !      1 inh. vap.       *                    *
absorption factor (0-1) AF                 1               !      1 shower derm.    *    3.5462  mg/kg   *
contaminated fraction (0-1)CF            0.5               !      1 inh. shower     *                    *
Transport multiplier  TR                   1               !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 1.093E-05 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C               3.54617434
skin surf. area(cm^2/d) SA              3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD              1
  (1) (mg/cm^2)
absorption factor (0-1) AF               0.1
exposure freq. (d/yr) EF                 180
exposure duration (yrs) ED                 5      4      0
avg. body wt. (kg) BW                     16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF            0.5
Transport multiplier  TR                   1

soil dermal dose (mg/kg/d)    2.137E-05 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C     3.54617434
Consumption rate (L/day)  CR        1.4
Koc (L/kg)                          930
Organic Carbon Fraction           0.005
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5     4     0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16    41    70
Attenuation factor  AT                1
Transport multiplier  TR              1

water consumption exposure    4.799E-02 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/Kg) C     3.54617434
inhalation rt. (m3/day) IR           20    20    20
  (child<18 20  adult 20  occ. 20)
volat.factor(m3/kg)  VF       26701.70
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt. (kg) BW                 16    41    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR              1

vapor inhalation dose         3.980E-05 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C     3.54617434
Kd  (L/kg) Kd                      4.65
skin surface area (cm2) SA         7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt (kg) BW                  16    41    70
Kp(derm. perm.)(cm/hr)            0.069
length of shower (hr/day) SL        0.2
```

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 4.541E-03 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	3.54617434		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.371E-03 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	3.54617434		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                    2-6 yrs.   7-18   18+  ! on/off TRANSPORT              HQ   0.165
.......................................                  !      0 Transport            RfDo    0.04
cont. [ ] (mg/kg)(ppm) C        0.58511877               !      1 Kd/Att. Fact.        RfDi    0.04
consumption rt. (mg/day) CR            200    100   100  !      0 No Attenuation
  (2-6 200, >6 100)                                      ! on/off EXPOSURE
exposure freq. (d/yr) EF               180               !      1 soil ingest.
duration of exp. (yrs) ED                5      4     0  !      1 soil derm.       ***********************
avg. body wt. (kg) BW                   16     41    70  !      1 gwater cons.     * Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                            !      1 inh. vap.        *                     *
absorption factor (0-1) AF               1               !      1 shower derm.     *    0.5851  mg/kg    *
contaminated fraction (0-1)CF          0.5               !      1 inh. shower      *                     *
Transport multiplier  TR                 1               !      0 inh. part.       ***********************

soil ingestion dose (mg/kg/d) 1.803E-06 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C             0.58511877
skin surf. area(cm2/d) SA             3910   3910  3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF               180
exposure duration (yrs) ED               5      4     0
avg. body wt. (kg) BW                   16     41    70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF          0.5
Transport multiplier  TR                 1

soil dermal dose (mg/kg/d)    3.526E-06 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.58511877		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	930		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 7.918E-03 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	0.58511877		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	26701.70		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 6.566E-06 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.58511877		
Kd (L/kg) Kd	4.65		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.069		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 7.493E-04 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	0.58511877		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 2.262E-04 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	0.58511877		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

PYRENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT             HQ          1
                               ...........             !      0 Transport           RfDo       0.03
cont. [ ] (mg/kg)(ppm) C       4573.5704               !      1 Kd/Att. Fact.       RfDi       0.03
consumption rt. (mg/day) CR          200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF             180               !      1 soil ingest.
duration of exp. (yrs) ED              5      4      0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                 16     41     70 !      0 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.      *                    *
absorption factor (0-1) AF             1               !      0 shower derm.   * 4573.5704  mg/kg   *
contaminated fraction (0-1)CF        0.5               !      0 inh. shower    *                    *
Transport multiplier  TR               1               !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 1.410E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C            4573.5704
skin surf. area(cm^2/d) SA          3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm^2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)     2.756E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
.........................................
soil cont. [ ] (mg/kg) C       4573.5704
Consumption rate (L/day)  CR         1.4
Koc (L/kg)                         38000
Organic Carbon Fraction            0.005
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5      4      0
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41     70
Attenuation factor  AT                 1
Transport multiplier  TR               1

water consumption exposure     1.515E+00 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
.........................................
soil cont. [ ] (mg/Kg) C       4573.5704
inhalation rt. (m3/day) IR            20     20     20
  (child<18 20  adult 20  occ. 20)
volat.factor(m3/kg)  VF       1167557.17
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt. (kg) BW                  16     41     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

vapor inhalation dose          1.174E-03 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
.........................................
soil cont. [ ] (mg/kg) C       4573.5704
Kd  (L/kg) Kd                        190
skin surface area (cm2) SA          7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt (kg) BW                   16     41     70
Kp(derm. perm.)(cm/hr)             0.324
length of shower (hr/day) SL         0.2
```

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	6.731E-01 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	4573.5704		
Kd (L/kg)	190		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 4.328E-02 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	4573.5704		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

PYRENE RESIDENTIAL CHILD, SOIL EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT              HQ  0.165
                               ...........             !      0 Transport            RfDo   0.03
cont. [ ] (mg/kg)(ppm) C       754.639117              !      1 Kd/Att. Fact.        RfDi   0.03
consumption rt. (mg/day) CR          200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF             180               !      1 soil ingest.
duration of exp. (yrs) ED              5      4      0 !      1 soil derm.     ***********************
avg. body wt. (kg) BW                 16     41     70 !      0 gwater cons.   * Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.      *                     *
absorption factor (0-1) AF             1               !      0 shower derm.   *  754.6391  mg/kg    *
contaminated fraction (0-1)CF        0.5               !      0 inh. shower    *                     *
Transport multiplier  TR               1               !      0 inh. part.     ***********************

soil ingestion dose (mg/kg/d) 2.326E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C            754.639117
skin surf. area(cm²/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm²)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

soil dermal dose (mg/kg/d)    4.547E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	754.639117		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	38000		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 2.499E-01 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	754.639117		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	1167557.17		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.937E-04 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	754.639117		
Kd (L/kg) Kd	190		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.324		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	1.111E-01 mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)		

Inhalation in Shower

soil cont. [ ] (mg/kg) C	754.639117		
Kd (L/kg)	190		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 7.141E-03 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	754.639117		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

PYRENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT              HQ            1
                               ...........             !      0 Transport            RfDo         0.03
cont. [ ] (mg/kg)(ppm) C       79.7273082              !      1 Kd/Att. Fact.        RfDi         0.03
consumption rt. (mg/day) CR           200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF              180              !      1 soil ingest.
duration of exp. (yrs) ED               5      4      0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                  16     41     70 !      1 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      0 inh. vap.      *                    *
absorption factor (0-1) AF              1              !      1 shower derm.   *   79.7273  mg/kg   *
contaminated fraction (0-1)CF         0.5              !      0 inh. shower    *                    *
Transport multiplier  TR                1              !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 2.457E-04 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C            79.7273082
skin surf. area(cm2/d) SA            3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF              180
exposure duration (yrs) ED              5      4      0
avg. body wt. (kg) BW                  16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF         0.5
Transport multiplier  TR                1

soil dermal dose (mg/kg/d)    4.804E-04 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	79.7273082		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	38000		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 2.641E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	79.7273082		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	1167557.17		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 2.046E-05 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	79.7273082		
Kd (L/kg) Kd	190		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.324		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	1.173E-02 mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)		

Inhalation in Shower

soil cont. [ ] (mg/kg) C	79.7273082		
Kd (L/kg)	190		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 7.544E-04 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [ ](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	79.7273082		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

PYRENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT               HQ  0.165
                               ...........             !      0 Transport             RfDo   0.03
cont. [ ] (mg/kg)(ppm) C       13.1550059              !      1 Kd/Att. Fact.         RfDi   0.03
consumption rt. (mg/day) CR           200    100   100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF              180              !      1 soil ingest.
duration of exp. (yrs) ED               5      4     0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                  16     41    70 !      1 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      0 inh. vap.      *                    *
absorption factor (0-1) AF              1              !      1 shower derm.   *   13.1550  mg/kg   *
contaminated fraction (0-1)CF         0.5              !      0 inh. shower    *                    *
Transport multiplier  TR                1              !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 4.055E-05 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C            13.1550059
skin surf. area(cm2/d) SA            3910   3910  3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF              180
exposure duration (yrs) ED              5      4     0
avg. body wt. (kg) BW                  16     41    70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF         0.5
Transport multiplier  TR                1

soil dermal dose (mg/kg/d)    7.927E-05 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
......................................
soil cont. [ ] (mg/kg) C      13.1550059
Consumption rate (L/day)  CR         1.4
Koc (L/kg)                         38000
Organic Carbon Fraction            0.005
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5      4      0
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41     70
Attenuation factor  AT                 1
Transport multiplier  TR               1

water consumption exposure    4.357E-03 mg/kg*day    =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
......................................
soil cont. [ ] (mg/Kg) C      13.1550059
inhalation rt. (m^3/day) IR           20     20     20
  (child<18 20  adult 20  occ. 20)
volat.factor(m^3/kg)  VF      1167557.17
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt. (kg) BW                  16     41     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR               1

vapor inhalation dose         3.376E-06 mg/kg*day    =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
......................................
soil cont. [ ] (mg/kg) C      13.1550059
Kd  (L/kg) Kd                        190
skin surface area (cm^2) SA         7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt (kg) BW                   16     41     70
Kp(derm. perm.)(cm/hr)             0.324
length of shower (hr/day) SL         0.2
```

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 1.936E-03 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	13.1550059		
Kd (L/kg)	190		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.245E-04 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	13.1550059		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

Soil Ingestion	2-6 yrs.	7-18	18+
cont. [ ] (mg/kg)(ppm) C	51845.8707		
consumption rt. (mg/day) CR (2-6 200, >6 100)	200	100	100
exposure freq. (d/yr) EF	180		
duration of exp. (yrs) ED	5	4	0
avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	16	41	70
absorption factor (0-1) AF	1		
contaminated fraction (0-1) CF	0.5		
Transport multiplier TR	0.039		

on/off	TRANSPORT		
1	Transport	RfDo	0.06
0	Kd/Att. Fact.	RfDi	0.06
0	No Attenuation		
on/off	EXPOSURE		
1	soil ingest.		
1	soil derm.		
0	gwater cons.		
1	inh. vap.		
0	shower derm.		
0	inh. shower		
0	inh. part.		

HQ 0.5

Soil Concentration: 51845.87 mg/kg

soil ingestion dose (mg/kg/d) 6.232E-03 mg/kg*day =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)

Soil Dermal Exposure			
cont. [ ] (mg/kg) C	51845.8707		
skin surf. area(cm^2/d) SA (child 3910 adult 3120)	3910	3910	3120
soil to skin adher. factor AD (1) (mg/cm^2)	1		
absorption factor (0-1) AF	0.1		
exposure freq. (d/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	16	41	70
contaminated fraction (0-1) CF	0.5		
Transport multiplier TR	0.039		

soil dermal dose (mg/kg/d) 1.218E-02 mg/kg*day =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)

Groundwater Consumption

soil cont. [ ] (mg/kg) C	51845.8707		
Consumption rate (L/day) CR	1.4		
Koc (L\kG)	4571		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 3.263E+03 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	51845.8707		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	25807.58		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.039		

vapor inhalation dose 2.348E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	51845.8707		
Kd (L/kg) Kd	22.855		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	1			
shower dermal dose	2.858E+01 mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)		

Inhalation in Shower

soil cont. [ ] (mg/kg) C	51845.8707		
Kd (L/kg)	22.855		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 4.079E+00 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [ ](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	51845.8707		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER 100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT              HQ          0.5
.......................................                !      1 Transport            RfDo         0.06
cont. [ ] (mg/kg)(ppm) C      83319.7859               !      0 Kd/Att. Fact.        RfDi         0.06
consumption rt. (mg/day) CR          200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF              90               !      1 soil ingest.
duration of exp. (yrs) ED              5      4      0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                 16     41     70 !      0 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.      *                    *
absorption factor (0-1) AF             1               !      0 shower derm.   *  83319.79  mg/kg   *
contaminated fraction (0-1)CF        0.5               !      0 inh. shower    *                    *
Transport multiplier  TR           0.039               !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 5.008E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           83319.7859
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              90
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR           0.039

soil dermal dose (mg/kg/d)    9.790E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	83319.7859		
Consumption rate (L/day) CR	1.4		
Koc (L\kG)	4571		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 5.243E+03 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	83319.7859		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	25807.58		
exposure freq. (days/yr) EF	250		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.039		

vapor inhalation dose 2.695E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	83319.7859		
Kd (L/kg) Kd	22.855		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 4.593E+01 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	83319.7859		
Kd (L/kg)	22.855		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 6.555E+00 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [ ](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	83319.7859		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER ≥300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

```
Soil Ingestion                      2-6 yrs.   7-18   18+  ! on/off TRANSPORT                  HQ          0.5
.......................................                    !      1 Transport                RfDo         0.06
cont. [ ] (mg/kg)(ppm) C       147341.168                  !      0 Kd/Att. Fact.            RfDi         0.06
consumption rt. (mg/day) CR           200    100    100    !      0 No Attenuation
  (2-6 200, >6 100)                                        ! on/off EXPOSURE
exposure freq. (d/yr) EF               45                  !      1 soil ingest.
duration of exp. (yrs) ED               5      4      0    !      1 soil derm.     **********************
avg. body wt. (kg) BW                  16     41     70    !      0 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                              !      1 inh. vap.      *                    *
absorption factor (0-1) AF              1                  !      0 shower derm.   * 147341.17  mg/kg   *
contaminated fraction (0-1)CF         0.5                  !      0 inh. shower    *                    *
Transport multiplier  TR            0.039                  !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 4.428E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C            147341.168
skin surf. area(cm^2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm^2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF               45
exposure duration (yrs) ED              5      4      0
avg. body wt. (kg) BW                  16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF         0.5
Transport multiplier  TR            0.039

soil dermal dose (mg/kg/d)    8.656E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	147341.168			
Consumption rate (L/day) CR	1.4			
Koc (L\kG)	4571			
Organic Carbon Fraction	0.005			
exp. freq. (365)(days/yr) EF	350			
exposure duration (yrs) ED	5		0	
diet fraction (.75-1.0) DF	0.75			
avg. body wt. (kg) BW	16	41	70	
Attenuation factor AT	1			
Transport multiplier TR	1			
water consumption exposure	9.272E+03 mg/kg*day			=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	147341.168			
inhalation rt. (m^3/day) IR	20	20	20	
(child<18 20 adult 20 occ. 20)				
volat.factor(m^3/kg) VF	25807.58			
exposure freq. (days/yr) EF	150			
exposure duration (yrs) ED	5	4	0	
avg body wt. (kg) BW	16	41	70	
absorption factor AF	0.5			
contaminated fraction (0-1)CF	0.5			
Transport multiplier TR	0.039			
vapor inhalation dose	2.859E-02 mg/kg*day			=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	147341.168		
Kd (L/kg) Kd	22.855		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 8.123E+01 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	147341.168		
Kd (L/kg)	22.855		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.159E+01 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	147341.168		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

Soil Ingestion	2-6 yrs.	7-18	18+
cont. [ ] (mg/kg)(ppm) C	149374.551		
consumption rt. (mg/day) CR	200	100	100
(2-6 200, >6 100)			
exposure freq. (d/yr) EF	180		
duration of exp. (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
(2-6 16, 6-18 41, adult 70)			
absorption factor (0-1) AF	1		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.0092		

on/off	TRANSPORT
1	Transport
0	Kd/Att. Fact.
0	No Attenuation
on/off	**EXPOSURE**
1	soil ingest.
1	soil derm.
0	gwater cons.
1	inh. vap.
0	shower derm.
0	inh. shower
0	inh. part.

HQ	0.5
RfDo	0.04
RfDi	0.04

Soil Concentration
149374.55 mg/kg

soil ingestion dose (mg/kg/d) 4.236E-03 mg/kg*day =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)

Soil Dermal Exposure			
cont. [ ] (mg/kg) C	149374.551		
skin surf. area(cm^2/d) SA	3910	3910	3120
(child 3910 adult 3120)			
soil to skin adher. factor AD	1		
(1) (mg/cm^2)			
absorption factor (0-1) AF	0.1		
exposure freq. (d/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
(2-6 16, 6-18 41, adult 70)			
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.0092		

2

soil dermal dose (mg/kg/d) 8.281E-03 mg/kg*day =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)

Groundwater Consumption

soil cont. [ ] (mg/kg) C	149374.551		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	930		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 9.400E+03 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	149374.551		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	26701.70		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.0092		

vapor inhalation dose 1.542E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	149374.551		
Kd (L/kg) Kd	4.65		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.069		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 1.913E+02 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....			
soil cont. [ ] (mg/kg) C	149374.551		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 5.776E+01 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....			
inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	149374.551		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER
100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT               HQ        0.5
.......................................                !      1 Transport             RfDo       0.04
cont. [ ] (mg/kg)(ppm) C      240748.397               !      0 Kd/Att. Fact.         RfDi       0.04
consumption rt. (mg/day) CR        200     100    100  !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF            90                 !      1 soil ingest.
duration of exp. (yrs) ED            5       4      0  !      1 soil derm.     **********************
avg. body wt. (kg) BW               16      41     70  !      0 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.      *                    *
absorption factor (0-1) AF           1                 !      0 shower derm.   * 240748.40  mg/kg   *
contaminated fraction (0-1)CF      0.5                 !      0 inh. shower    *                    *
Transport multiplier  TR        0.0092                 !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 3.413E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           240748.397
skin surf. area(cm^2/d) SA        3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD        1
  (1) (mg/cm^2)
absorption factor (0-1) AF         0.1
exposure freq. (d/yr) EF            90                   2
exposure duration (yrs) ED           5       4      0
avg. body wt. (kg) BW               16      41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF      0.5
Transport multiplier  TR        0.0092

soil dermal dose (mg/kg/d)    6.673E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	240748.397		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	930		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 1.515E+04 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	240748.397		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	26701.70		
exposure freq. (days/yr) EF	250		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1) CF	0.5		
Transport multiplier TR	0.0092		

vapor inhalation dose 1.775E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	240748.397		
Kd (L/kg) Kd	4.65		
skin surface area (cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.069		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 3.083E+02 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	240748.397		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 9.309E+01 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	240748.397		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER
≥300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

Soil Ingestion	2-6 yrs.	7-18	18+
....			
cont. [ ] (mg/kg)(ppm) C	426318.353		
consumption rt. (mg/day) CR	200	100	100
(2-6 200, >6 100)			
exposure freq. (d/yr) EF	45		
duration of exp. (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
(2-6 16, 6-18 41, adult 70)			
absorption factor (0-1) AF	1		
contaminated fraction (0-1) CF	0.5		
Transport multiplier TR	0.0092		

on/off	TRANSPORT
1	Transport
0	Kd/Att. Fact.
0	No Attenuation

on/off	EXPOSURE
1	soil ingest.
1	soil derm.
0	gwater cons.
1	inh. vap.
0	shower derm.
0	inh. shower
0	inh. part.

HQ	0.5
RfDo	0.04
RfDi	0.04

Soil Concentration
426318.35 mg/kg

soil ingestion dose (mg/kg/d) 3.022E-03 mg/kg*day =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)

Soil Dermal Exposure				
....				
cont. [ ] (mg/kg) C	426318.353			
skin surf. area(cm^2/d) SA	3910	3910	3120	
(child 3910 adult 3120)				
soil to skin adher. factor AD	1			
(1) (mg/cm^2)				
absorption factor (0-1) AF	0.1			
exposure freq. (d/yr) EF	45			2
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
(2-6 16, 6-18 41, adult 70)				
contaminated fraction (0-1) CF	0.5			
Transport multiplier TR	0.0092			

soil dermal dose (mg/kg/d) 5.908E-03 mg/kg*day =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)

Groundwater Consumption

soil cont. [ ] (mg/kg) C	426318.353		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	930		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5		0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	1		

water consumption exposure 2.683E+04 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	426318.353		
inhalation rt. (m^3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m^3/kg) VF	26701.70		
exposure freq. (days/yr) EF	150		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.0092		

vapor inhalation dose 1.886E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	426318.353		
Kd (L/kg) Kd	4.65		
skin surface area cm^2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.069		
length of shower (hr/day) SL	0.2		

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower dermal dose 5.459E+02 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	426318.353		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m^3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m^3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	1		

shower inhalation exposure 1.648E+02 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

....

inhalation rate (m^3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [ ](mg/m^3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	426318.353		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,
SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

```
Soil Ingestion                      2-6 yrs.   7-18   18+  ! on/off TRANSPORT                  HQ     0.5
.......................................                    !      1 Transport                RfDo   0.06
cont. [ ] (mg/kg)(ppm) C          8.04252033               !      0 Kd/Att. Fact.            RfDi   0.06
consumption rt. (mg/day) CR              200    100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                        ! on/off EXPOSURE
exposure freq. (d/yr) EF                 180               !      1 soil ingest.
duration of exp. (yrs) ED                  5      4      0 !      1 soil derm.      **********************
avg. body wt. (kg) BW                     16     41     70 !      1 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                              !      1 inh. vap.       *                    *
absorption factor (0-1) AF                 1               !      1 shower derm.    *    8.0425  mg/kg   *
contaminated fraction (0-1)CF            0.5               !      1 inh. shower     *                    *
Transport multiplier  TR               0.039               !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 9.668E-07 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C               8.04252033
skin surf. area(cm2/d) SA               3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD              1
  (1) (mg/cm2)
absorption factor (0-1) AF               0.1
exposure freq. (d/yr) EF                 180
exposure duration (yrs) ED                 5      4      0
avg. body wt. (kg) BW                     16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF            0.5
Transport multiplier  TR               0.039

soil dermal dose (mg/kg/d)    1.890E-06 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	8.04252033		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	4571		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	0.0641		

water consumption exposure 3.244E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	8.04252033		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m3/kg) VF	25807.58		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.039		

vapor inhalation dose 3.642E-06 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	8.04252033		
Kd (L/kg) Kd	22.855		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	0.0641			
shower dermal dose	4.434E-03 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	8.04252033			
Kd (L/kg)	22.855			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	0.0641			
shower inhalation exposure	6.327E-04 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	8.04252033			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)
100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,
SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

```
Soil Ingestion                     2-6 yrs.   7-18   18+  ! on/off TRANSPORT              HQ     0.5
.......................................                   !      1 Transport            RfDo    0.06
cont. [ ] (mg/kg)(ppm) C        300.436464                !      0 Kd/Att. Fact.        RfDi    0.06
consumption rt. (mg/day) CR            200    100    100  !      0 No Attenuation
  (2-6 200, >6 100)                                       ! on/off EXPOSURE
exposure freq. (d/yr) EF                90                !      1 soil ingest.
duration of exp. (yrs) ED                5      4      0  !      1 soil derm.      **********************
avg. body wt. (kg) BW                   16     41     70  !      1 gwater cons.    * Soil Concentration  *
  (2-6 16, 6-18 41, adult 70)                             !      1 inh. vap.       *                     *
absorption factor (0-1) AF               1                !      1 shower derm.    *  300.4365   mg/kg   *
contaminated fraction (0-1)CF          0.5                !      1 inh. shower     *                     *
Transport multiplier   TR            0.039                !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 1.806E-05 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C             300.436464
skin surf. area(cm2/d) SA             3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF                90
exposure duration (yrs) ED               5      4      0
avg. body wt. (kg) BW                   16     41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF          0.5
Transport multiplier   TR            0.039

soil dermal dose (mg/kg/d)    3.530E-05 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	300.436464		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	4571		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	0.00171		

water consumption exposure 3.233E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	300.436464		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m3/kg) VF	25807.58		
exposure freq. (days/yr) EF	250		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.039		

vapor inhalation dose 9.718E-05 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	300.436464		
Kd (L/kg) Kd	22.855		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.146		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	0.00171			
shower dermal dose	1.656E-01 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	300.436464		
Kd (L/kg)	22.855		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	0.00171		

shower inhalation exposure 2.363E-02 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	300.436464		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)
≥300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,
SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

```
Soil Ingestion                   2-6 yrs.   7-18   18+  ! on/off TRANSPORT                   HQ    0.5
.....................................                   !      1 Transport                 RfDo   0.06
cont. [ ] (mg/kg)(ppm) C        51874.9207              !      0 Kd/Att. Fact.             RfDi   0.06
consumption rt. (mg/day) CR          200     100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                     ! on/off EXPOSURE
exposure freq. (d/yr) EF              45                !      1 soil ingest.
duration of exp. (yrs) ED              5       4      0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                 16      41     70 !      1 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                           !      1 inh. vap.      *                    *
absorption factor (0-1) AF             1                !      1 shower derm.   *  51874.92  mg/kg   *
contaminated fraction (0-1)CF        0.5                !      1 inh. shower    *                    *
Transport multiplier  TR           0.039                !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 1.559E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.....................................
cont. [ ] (mg/kg) C             51874.9207
skin surf. area(cm2/d) SA           3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              45
exposure duration (yrs) ED             5       4      0
avg. body wt. (kg) BW                 16      41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR           0.039

soil dermal dose (mg/kg/d)    3.048E-03 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
........................................
soil cont. [ ] (mg/kg) C      51874.9207
Consumption rate (L/day)  CR         1.4
Koc (L/kg)                          4571
Organic Carbon Fraction            0.005
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5     4     0
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16    41    70
Attenuation factor  AT                 1
Transport multiplier  TR       6.440E-06

water consumption exposure     2.102E-02 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
........................................
soil cont. [ ] (mg/Kg) C      51874.9207
inhalation rt. (m3/day) IR            20    20    20
  (child<18 20 adult 20 occ. 20)
volat.factor(m3/kg)  VF         25807.58
exposure freq. (days/yr) EF          150
exposure duration (yrs) ED             5     4     0
avg body wt. (kg) BW                  16    41    70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier  TR           0.039

vapor inhalation dose          1.007E-02 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
........................................
soil cont. [ ] (mg/kg) C      51874.9207
Kd  (L/kg) Kd                     22.855
skin surface area (cm2) SA          7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5     4     0
avg body wt (kg) BW                   16    41    70
Kp(derm. perm.)(cm/hr)             0.146
length of shower (hr/day) SL         0.2
```

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	6.440E-06			
shower dermal dose	2.860E+01 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	51874.9207			
Kd (L/kg)	22.855			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	6.440E-06			
shower inhalation exposure	4.081E+00 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	51874.9207			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)
0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,
SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

```
Soil Ingestion                    2-6 yrs.   7-18   18+  ! on/off TRANSPORT                  HQ     0.5
........................................                 !      1 Transport                RfDo   0.04
cont. [ ] (mg/kg)(ppm) C        1.78409869               !      0 Kd/Att. Fact.            RfDi   0.04
consumption rt. (mg/day) CR            200    100   100  !      0 No Attenuation
  (2-6 200, >6 100)                                      ! on/off EXPOSURE
exposure freq. (d/yr) EF               180               !      1 soil ingest.
duration of exp. (yrs) ED                5      4     0  !      1 soil derm.      **********************
avg. body wt. (kg) BW                   16     41    70  !      1 gwater cons.    * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                            !      1 inh. vap.       *                    *
absorption factor (0-1) AF               1               !      1 shower derm.    *    1.7841  mg/kg   *
contaminated fraction (0-1)CF          0.5               !      1 inh. shower     *                    *
Transport multiplier  TR            0.0092               !      0 inh. part.      **********************

soil ingestion dose (mg/kg/d) 5.059E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C             1.78409869
skin surf. area(cm2/d) SA             3910   3910  3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF               180
exposure duration (yrs) ED               5      4     0
avg. body wt. (kg) BW                   16     41    70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF          0.5
Transport multiplier  TR            0.0092

soil dermal dose (mg/kg/d)    9.890E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	1.78409869		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	930		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	0.214		

water consumption exposure 2.403E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	1.78409869		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m3/kg) VF	26701.7		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.0092		

vapor inhalation dose 1.842E-07 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	1.78409869		
Kd (L/kg) Kd	4.65		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.069		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	0.214			
shower dermal dose	2.285E-03 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	1.78409869			
Kd (L/kg)	4.65			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor AT	1			
Transport multiplier TR	0.214			
shower inhalation exposure	6.898E-04 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR	20	20	20	
(child<18 20 adult 20)				
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	1.78409869			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)
100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,
SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

```
Soil Ingestion                  2-6 yrs.   7-18   18+  ! on/off TRANSPORT                HQ    0.5
......................................                 !      1 Transport              RfDo   0.04
cont. [ ] (mg/kg)(ppm) C     66.9641196                !      0 Kd/Att. Fact.          RfDi   0.04
consumption rt. (mg/day) CR         200     100    100 !      0 No Attenuation
  (2-6 200, >6 100)                                    ! on/off EXPOSURE
exposure freq. (d/yr) EF             90                !      1 soil ingest.
duration of exp. (yrs) ED             5       4      0 !      1 soil derm.     **********************
avg. body wt. (kg) BW                16      41     70 !      1 gwater cons.   * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                          !      1 inh. vap.      *                    *
absorption factor (0-1) AF            1                !      1 shower derm.   *   66.9641  mg/kg   *
contaminated fraction (0-1)CF       0.5                !      1 inh. shower    *                    *
Transport multiplier  TR         0.0092                !      0 inh. part.     **********************

soil ingestion dose (mg/kg/d) 9.494E-07 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C          66.9641196
skin surf. area(cm2/d) SA          3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF             90
exposure duration (yrs) ED            5       4      0
avg. body wt. (kg) BW                16      41     70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR         0.0092

soil dermal dose (mg/kg/d)    1.856E-06 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C     66.9641196
Consumption rate (L/day)  CR        1.4
Koc (L/kg)                          930
Organic Carbon Fraction           0.005
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5     4     0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16    41    70
Attenuation factor  AT                1
Transport multiplier  TR         0.0057

water consumption exposure    2.402E-02 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/Kg) C     66.9641196
inhalation rt. (m3/day) IR           20    20    20
  (child<18 20 adult 20 occ. 20)
volat.factor(m3/kg)  VF         26701.7
exposure freq. (days/yr) EF         250
exposure duration (yrs) ED            5     4     0
avg body wt. (kg) BW                 16    41    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier  TR         0.0092

vapor inhalation dose         4.938E-06 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C     66.9641196
Kd  (L/kg) Kd                      4.65
skin surface area (cm2) SA         7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt (kg) BW                  16    41    70
Kp(derm. perm.)(cm/hr)            0.069
length of shower (hr/day) SL        0.2
```

absorption factor AF	1		
Attenuation factor AT	1		
Transport multiplier TR	0.0057		

shower dermal dose 8.575E-02 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	66.9641196		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	0.0057		

shower inhalation exposure 2.589E-02 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	66.9641196		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)
≥300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,
SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

```
Soil Ingestion                      2-6 yrs.  7-18  18+  ! on/off TRANSPORT                HQ    0.5
.......................................                  !      1 Transport              RfDo   0.04
cont. [ ] (mg/kg)(ppm) C          17048.0827             !      0 Kd/Att. Fact.          RfDi   0.04
consumption rt. (mg/day) CR              200   100   100 !      0 No Attenuation
  (2-6 200, >6 100)                                      ! on/off EXPOSURE
exposure freq. (d/yr) EF                  45             !      1 soil ingest.
duration of exp. (yrs) ED                  5     4     0 !      1 soil derm.       **********************
avg. body wt. (kg) BW                     16    41    70 !      1 gwater cons.     * Soil Concentration *
  (2-6 16, 6-18 41, adult 70)                            !      1 inh. vap.        *                    *
absorption factor (0-1) AF                 1             !      1 shower derm.     *  17048.08   mg/kg  *
contaminated fraction (0-1)CF            0.5             !      1 inh. shower      *                    *
Transport multiplier  TR              0.0092             !      0 inh. part.       **********************

soil ingestion dose (mg/kg/d) 1.209E-04 mg/kg*day   =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C               17048.0827
skin surf. area(cm2/d) SA               3910  3910  3120
  (child 3910  adult 3120)
soil to skin adher. factor AD              1
  (1) (mg/cm2)
absorption factor (0-1) AF               0.1
exposure freq. (d/yr) EF                  45
exposure duration (yrs) ED                 5     4     0
avg. body wt. (kg) BW                     16    41    70
  (2-6 16, 6-18 41, adult 70)
contaminated fraction (0-1)CF            0.5
Transport multiplier  TR              0.0092

soil dermal dose (mg/kg/d)    2.363E-04 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	17048.0827		
Consumption rate (L/day) CR	1.4		
Koc (L/kg)	930		
Organic Carbon Fraction	0.005		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
Attenuation factor AT	1		
Transport multiplier TR	0.0000215		

water consumption exposure 2.307E-02 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)

Inhalation of Vapors

soil cont. [ ] (mg/Kg) C	17048.0827		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat.factor(m3/kg) VF	26701.7		
exposure freq. (days/yr) EF	150		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	0.0092		

vapor inhalation dose 7.543E-04 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	17048.0827		
Kd (L/kg) Kd	4.65		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
Kp(derm. perm.)(cm/hr)	0.069		
length of shower (hr/day) SL	0.2		

absorption factor AF	1			
Attenuation factor AT	1			
Transport multiplier TR	0.0000215			
shower dermal dose	2.183E+01 mg/kg*day			=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	17048.0827		
Kd (L/kg)	4.65		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	0.0000215		

shower inhalation exposure 6.592E+00 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	17048.0827		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                     2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
.......................................                       0 SESOIL            Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C       0.33077387                     1 Kd/Att. Factor    Inh. Slope     6.1
consumption rt. (mg/day) CR         200     100    100        0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF            180                  on/off EXPOSURE
duration of exp. (yrs) ED             5       4      0        0 soil ing.        *******************
avg. body wt. (kg) BW                16      41     70        0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                 1 gwater cons.     *                  *
avg. life expectancy (74.6) L        70                       0 inh. vap.        *  0.33077 mg/kg   *
absorption factor (0-1) AF            1                       1 derm. gwater     *                  *
contaminated fraction (0-1)CF       0.5                       0 inh. shower      *******************
Transport multiplier TR               1                       0 inh. part.

soil ingestion dose (mg/kg/d) 7.282E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [`] (mg/kg) C            0.33077387
skin surf. area(cm2/d) SA          3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF            180
exposure duration (yrs) ED            5       4      0
avg. body wt. (kg) BW                16      41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                    70
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

soil dermal dose (mg/kg/d)    1.424E-07 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.33077387		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	27500		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	0.65		
Transport multiplier TR	1		

water consumption exposure 3.514E-08 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	0.33077387		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	5.48E+07		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.291E-10 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.33077387		
Kd (L/kg) Kd	27500		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	1.2		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	0.65		
Transport multiplier TR	1		

shower dermal dose 5.783E-08 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	0.33077387		
Kd (L/kg)	27500		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	0.65		
Transport multiplier TR	1		

shower inhalation exposure 1.004E-09 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

....

inhalation rate (m3/day) IR	20	20	20
(child<18 20 adult 20)			
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	0.33077387		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                     2-6 yrs   7-18   18+  on/off TRANSPORT        Risk Level 1.0E-06
......................................                        0 SESOIL           Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C          330773.87                   1 Kd/Att. Factor   Inh. Slope     6.1
consumption rt. (mg/day) CR             200    100    100     0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF                 90                  on/off EXPOSURE
duration of exp. (yrs) ED                 5      4      0     0 soil ing.       *******************
avg. body wt. (kg) BW                    16     41     70     0 soil derm.      *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                 1 gwater cons.    *                 *
avg. life expectancy (74.6) L            70                   0 inh. vap.       * 3.31E+05 mg/kg  *
absorption factor (0-1) AF                1                   1 derm. gwater    *                 *
contaminated fraction (0-1)CF           0.5                   0 inh. shower     *******************
Transport multiplier TR                   1                   0 inh. part.

soil ingestion dose (mg/kg/d) 3.641E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C               330773.87
skin surf. area(cm2/d) SA              3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD             1
  (1) (mg/cm2)
absorption factor (0-1) AF              0.1
exposure freq. (d/yr) EF                 90
exposure duration (yrs) ED                5      4      0
avg. body wt. (kg) BW                    16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                        70
contaminated fraction (0-1)CF           0.5
Transport multiplier TR                   1

soil dermal dose (mg/kg/d)    7.118E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
......................................
soil cont. [ ] (mg/kg) C        330773.87
consumption rt. (L/day) CR            1.4
Kd  (L/kg) Kd                       27500
exp. freq. (365)(days/yr) EF          350
exposure duration (yrs) ED              5      4      0
diet fraction (.75-1.0) DF           0.75
avg. body wt. (kg) BW                  16     41     70
lifetime (74.6) L                      70
Attenuation factor(0-1) AT      6.500E-07
Transport multiplier TR                 1

water consumption exposure      3.514E-08 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
......................................
soil cont. [ ] (mg/kg) C        330773.87
inhalation rt. (m3/day) IR             20     20     20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF         5.48E+07
exposure freq. (days/yr) EF           250
exposure duration (yrs) ED              5      4      0
avg body wt. (kg) BW                   16     41     70
lifetime (74.6) L                      70
absorption factor AF                  0.5
contaminated fraction (0-1)CF         0.5
Transport multiplier TR                 1

vapor inhalation dose           9.222E-05 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
......................................
soil cont. [ ] (mg/kg) C        330773.87
Kd  (L/kg) Kd                       27500
skin surface area (cm2) SA           7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF           350
exposure duration (yrs) ED              5      4      0
avg body wt (kg) BW                    16     41     70
lifetime (74.6) L                      70
```

Kp(derm. perm. const.)(cm/hr)	1.2			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	5.783E-08	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	330773.87			
Kd (L/kg)	27500			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower inhalation exposure	1.004E-09	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	330773.87			
exposure freq. (days/yr) EF	90			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE,
9 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                      2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
.........................................                      0 SESOIL            Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C           330773.87                   1 Kd/Att. Factor    Inh. Slope     6.1
consumption rt. (mg/day) CR            200     100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF                45                on/off EXPOSURE
duration of exp. (yrs) ED                5       4      0      0 soil ing.        ********************
avg. body wt. (kg) BW                   16      41     70      0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                  1 gwater cons.     *                  *
avg. life expectancy (74.6) L           70                     0 inh. vap.        * 3.31E+05 mg/kg   *
absorption factor (0-1) AF               1                     1 derm. gwater     *                  *
contaminated fraction (0-1)CF          0.5                     0 inh. shower      ********************
Transport multiplier TR                  1                     0 inh. part.

soil ingestion dose (mg/kg/d) 1.821E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.........................................
cont. [ ] (mg/kg) C                330773.87
skin surf. area(cm2/d) SA             3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF                45
exposure duration (yrs) ED               5       4      0
avg. body wt. (kg) BW                   16      41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                       70
contaminated fraction (0-1)CF          0.5
Transport multiplier TR                  1

soil dermal dose (mg/kg/d)    3.559E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	330773.87		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	27500		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	6.500E-07		
Transport multiplier TR	1		

water consumption exposure 3.514E-08 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	330773.87		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	5.48E+07		
exposure freq. (days/yr) EF	150		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 5.533E-05 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	330773.87		
Kd (L/kg) Kd	27500		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	1.2			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	5.783E-08	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	

Inhalation in Shower

soil cont. [ ] (mg/kg) C	330773.87			
Kd (L/kg)	27500			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower inhalation exposure	1.004E-09	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)	

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	330773.87			
exposure freq. (days/yr) EF	45			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day	=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)	

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE,
9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                   2-6 yrs   7-18  18+  on/off TRANSPORT        Risk Level 1.0E-06
.......................................                    0 SESOIL           Oral Slope    0.73
cont. [ ] (mg/kg)(ppm) C     0.15334116                    1 Kd/Att. Factor   Inh. Slope    0.61
consumption rt. (mg/day) CR         200   100   100        0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF            180               on/off EXPOSURE
duration of exp. (yrs) ED             5     4     0        0 soil ing.       *******************
avg. body wt. (kg) BW                16    41    70        0 soil derm.      *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                              1 gwater cons.    *                  *
avg. life expectancy (74.6) L        70                    0 inh. vap.       *  0.15334 mg/kg   *
absorption factor (0-1) AF            1                    1 derm. gwater    *                  *
contaminated fraction (0-1)CF       0.5                    0 inh. shower     *******************
Transport multiplier TR               1                    0 inh. part.

soil ingestion dose (mg/kg/d) 3.376E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C          0.15334116
skin surf. area(cm2/d) SA          3910  3910  3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF            180
exposure duration (yrs) ED            5     4     0
avg. body wt. (kg) BW                16    41    70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                    70
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

soil dermal dose (mg/kg/d)    6.600E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.........................................
soil cont. [ ] (mg/kg) C       0.15334116
consumption rt. (L/day) CR            1.4
Kd  (L/kg) Kd                        1000
exp. freq. (365)(days/yr) EF          350
exposure duration (yrs) ED              5     4     0
diet fraction (.75-1.0) DF           0.75
avg. body wt. (kg) BW                  16    41    70
lifetime (74.6) L                      70
Attenuation factor(0-1) AT           0.65
Transport multiplier TR                 1

water consumption exposure    4.480E-07 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.........................................
soil cont. [ ] (mg/kg) C       0.15334116
inhalation rt. (m3/day) IR             20    20    20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF       7212513.43
exposure freq. (days/yr) EF           350
exposure duration (yrs) ED              5     4     0
avg body wt. (kg) BW                   16    41    70
lifetime (74.6) L                      70
absorption factor AF                  0.5
contaminated fraction (0-1)CF         0.5
Transport multiplier TR                 1

vapor inhalation dose         4.551E-10 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.........................................
soil cont. [ ] (mg/kg) C       0.15334116
Kd  (L/kg) Kd                        1000
skin surface area (cm2) SA           7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF           350
exposure duration (yrs) ED              5     4     0
avg body wt (kg) BW                    16    41    70
lifetime (74.6) L                      70
```

```
Kp(derm. perm. const.)(cm/hr)      0.81
length of shower (hr/day) SL        0.2
absorption factor AF                  1
Attenuation factor (0-1) AT        0.65
Transport multiplier TR               1

shower dermal dose             4.977E-07 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)
```

```
Inhalation in Shower
........................................
soil cont. [ ] (mg/kg) C     0.15334116
Kd (L/kg)                          1000
inhalation rt.(0.6)(m3/hr) IR       0.6
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
shower length(hrs/day)(.2) SL       0.2
avg. body wt. (kg) BW                16    41    70
lifetime (74.6) L                    70
volat. factor (K)(.5 L/m3)          0.5
absorption factor  AF               0.5
Attenuation factor (0-1) AT        0.65
Transport multiplier TR               1

shower inhalation exposure     1.280E-08 mg/kg*day   =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)
```

```
Inhalation of Particulates
........................................
inhalation rate (m3/day) IR          20    20    20
  (child<18 20 adult 20)
air particulate [](mg/m3) AP          0
respirable part. fraction RF          0
part. cont [ ] (mg/kg) C     0.15334116
exposure freq. (days/yr) EF         180
exposure duration (yrs) ED            5     4     0
avg. body wt. (kg) BW                16    41    70
lifetime (74.6) L                    70
absorption factor  AF               0.5
Transport multiplier TR               1

part. inhalation exposure      0.000E+00 mg/kg*day   =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
```

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                   2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
...................................                         0 SESOIL            Oral Slope    0.73
cont. [ ] (mg/kg)(ppm) C     153341.157                     1 Kd/Att. Factor    Inh. Slope    0.61
consumption rt. (mg/day) CR        200    100    100        0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF            90                 on/off EXPOSURE
duration of exp. (yrs) ED            5      4      0        0 soil ing.        *******************
avg. body wt. (kg) BW               16     41     70        0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                               1 gwater cons.     *                  *
avg. life expectancy (74.6) L       70                      0 inh. vap.        * 1.53E+05 mg/kg   *
absorption factor (0-1) AF           1                      1 derm. gwater     *                  *
contaminated fraction (0-1)CF      0.5                      0 inh. shower      *******************
Transport multiplier TR              1                      0 inh. part.

soil ingestion dose (mg/kg/d) 1.688E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
...................................
cont. [ ] (mg/kg) C          153341.157
skin surf. area(cm2/d) SA         3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD        1
  (1) (mg/cm2)
absorption factor (0-1) AF         0.1
exposure freq. (d/yr) EF            90
exposure duration (yrs) ED           5      4      0
avg. body wt. (kg) BW               16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                   70
contaminated fraction (0-1)CF      0.5
Transport multiplier TR              1

soil dermal dose (mg/kg/d)    3.300E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C      153341.157
consumption rt. (L/day) CR           1.4
Kd  (L/kg) Kd                       1000
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5      4      0
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41     70
lifetime (74.6) L                     70
Attenuation factor(0-1) AT     6.500E-07
Transport multiplier TR                1

water consumption exposure     4.480E-07 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/kg) C      153341.157
inhalation rt. (m3/day) IR            20     20     20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF      7212513.43
exposure freq. (days/yr) EF          250
exposure duration (yrs) ED             5      4      0
avg body wt. (kg) BW                  16     41     70
lifetime (74.6) L                     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

vapor inhalation dose          3.250E-04 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C      153341.157
Kd  (L/kg) Kd                       1000
skin surface area (cm2) SA          7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      4      0
avg body wt (kg) BW                   16     41     70
lifetime (74.6) L                     70
```

Kp(derm. perm. const.)(cm/hr)	0.81			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	4.977E-07	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	153341.157			
Kd (L/kg)	1000			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower inhalation exposure	1.280E-08	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	153341.157			
exposure freq. (days/yr) EF	90			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE,
9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                    2-6 yrs   7-18   18+  on/off TRANSPORT        Risk Level 1.0E-06
.......................................                     0 SESOIL           Oral Slope    0.73
cont. [ ] (mg/kg)(ppm) C      153341.157                    1 Kd/Att. Factor   Inh. Slope    0.61
consumption rt. (mg/day) CR          200    100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF              45                on/off EXPOSURE
duration of exp. (yrs) ED              5      4      0      0 soil ing.        *******************
avg. body wt. (kg) BW                 16     41     70      0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                               1 gwater cons.     *                  *
avg. life expectancy (74.6) L         70                    0 inh. vap.        * 1.53E+05 mg/kg   *
absorption factor (0-1) AF             1                    1 derm. gwater     *                  *
contaminated fraction (0-1)CF        0.5                    0 inh. shower      *******************
Transport multiplier TR                1                    0 inh. part.

soil ingestion dose (mg/kg/d) 8.440E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           153341.157
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              45
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

soil dermal dose (mg/kg/d)    1.650E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
........................................
soil cont. [ ] (mg/kg) C     153341.157
consumption rt. (L/day) CR          1.4
Kd  (L/kg) Kd                      1000
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5     4     0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16    41    70
lifetime (74.6) L                    70
Attenuation factor(0-1) AT    6.500E-07
Transport multiplier TR               1

water consumption exposure    4.480E-07 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
........................................
soil cont. [ ] (mg/kg) C     153341.157
inhalation rt. (m3/day) IR           20    20    20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF     7212513.43
exposure freq. (days/yr) EF         150
exposure duration (yrs) ED            5     4     0
avg body wt. (kg) BW                 16    41    70
lifetime (74.6) L                    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

vapor inhalation dose         1.950E-04 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
........................................
soil cont. [ ] (mg/kg) C     153341.157
Kd  (L/kg) Kd                      1000
skin surface area (cm2) SA         7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt (kg) BW                  16    41    70
lifetime (74.6) L                    70
```

Kp(derm. perm. const.)(cm/hr)	0.81			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	4.977E-07	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)		

Inhalation in Shower

soil cont. [ ] (mg/kg) C	153341.157		
Kd (L/kg)	1000		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 1.280E-08 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	153341.157		
exposure freq. (days/yr) EF	45		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE,
9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                        2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
.......................................                          0 SESOIL            Oral Slope  0.0073
cont. [ ] (mg/kg)(ppm) C        15.3341157                       1 Kd/Att. Factor    Inh. Slope  0.0061
consumption rt. (mg/day) CR            200    100    100         0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF               180                  on/off EXPOSURE
duration of exp. (yrs) ED                5      4      0         0 soil ing.        ********************
avg. body wt. (kg) BW                   16     41     70         0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                    1 gwater cons.     *                  *
avg. life expectancy (74.6) L           70                       0 inh. vap.        * 15.33412 mg/kg   *
absorption factor (0-1) AF               1                       1 derm. gwater     *                  *
contaminated fraction (0-1)CF          0.5                       0 inh. shower      ********************
Transport multiplier TR                  1                       0 inh. part.

soil ingestion dose (mg/kg/d) 3.376E-06 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C             15.3341157
skin surf. area(cm2/d) SA             3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF               180
exposure duration (yrs) ED               5      4      0
avg. body wt. (kg) BW                   16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                       70
contaminated fraction (0-1)CF          0.5
Transport multiplier TR                  1

soil dermal dose (mg/kg/d)    6.600E-06 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	15.3341157			
consumption rt. (L/day) CR	1.4			
Kd (L/kg) Kd	1000			
exp. freq. (365)(days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
diet fraction (.75-1.0) DF	0.75			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
Attenuation factor(0-1) AT	0.65			
Transport multiplier TR	1			
water consumption exposure	4.480E-05 mg/kg*day			=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	15.3341157			
inhalation rt. (m3/day) IR	20	20	20	
(child<18 20 adult 20 occ. 20)				
volat. factor (m3/kg) VF	7038701.01			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
avg body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
contaminated fraction (0-1)CF	0.5			
Transport multiplier TR	1			
vapor inhalation dose	4.663E-08 mg/kg*day			=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	15.3341157		
Kd (L/kg) Kd	1000		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	0.81			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	0.65			
Transport multiplier TR	1			
shower dermal dose	4.977E-05	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	15.3341157			
Kd (L/kg)	1000			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	0.65			
Transport multiplier TR	1			
shower inhalation exposure	1.280E-06	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	15.3341157			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE,
9 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                        2-6 yrs   7-18   18+  on/off TRANSPORT       Risk Level 1.0E-06
.......................................                          0 SESOIL          Oral Slope  0.0073
cont. [ ] (mg/kg)(ppm) C      15334115.7                         1 Kd/Att. Factor  Inh. Slope  0.0061
consumption rt. (mg/day) CR          200    100    100           0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF              90                    on/off EXPOSURE
duration of exp. (yrs) ED              5      4      0           0 soil ing.       *******************
avg. body wt. (kg) BW                 16     41     70           0 soil derm.      *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                    1 gwater cons.    *                  *
avg. life expectancy (74.6) L         70                         0 inh. vap.       * 1.53E+07 mg/kg   *
absorption factor (0-1) AF             1                         1 derm. gwater    *                  *
contaminated fraction (0-1)CF        0.5                         0 inh. shower     *******************
Transport multiplier TR                1                         0 inh. part.

soil ingestion dose (mg/kg/d) 1.688E+00 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           15334115.7
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              90
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

soil dermal dose (mg/kg/d)    3.300E+00 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C     15334115.7
consumption rt. (L/day) CR          1.4
Kd  (L/kg) Kd                      1000
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5     4     0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16    41    70
lifetime (74.6) L                    70
Attenuation factor(0-1) AT    6.500E-07
Transport multiplier TR               1

water consumption exposure    4.480E-05 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/kg) C     15334115.7
inhalation rt. (m3/day) IR           20    20    20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF     7038701.01
exposure freq. (days/yr) EF         250
exposure duration (yrs) ED            5     4     0
avg body wt. (kg) BW                 16    41    70
lifetime (74.6) L                    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

vapor inhalation dose         3.331E-02 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C     15334115.7
Kd  (L/kg) Kd                      1000
skin surface area (cm2) SA         7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt (kg) BW                  16    41    70
lifetime (74.6) L                    70
```

Kp(derm. perm. const.)(cm/hr)	0.81		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower dermal dose 4.977E-05 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	15334115.7		
Kd (L/kg)	1000		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 1.280E-06 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

....

inhalation rate (m3/day) IR	20	20	20
(child<18 20 adult 20)			
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	15334115.7		
exposure freq. (days/yr) EF	90		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE,
9 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                     2-6 yrs   7-18   18+  on/off TRANSPORT        Risk Level 1.0E-06
.......................................                      0 SESOIL           Oral Slope  0.0073
cont. [ ] (mg/kg)(ppm) C        15334115.7                   1 Kd/Att. Factor   Inh. Slope  0.0061
consumption rt. (mg/day) CR           200     100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF               45                on/off EXPOSURE
duration of exp. (yrs) ED               5       4      0      0 soil ing.       ********************
avg. body wt. (kg) BW                  16      41     70      0 soil derm.      *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                 1 gwater cons.    *                  *
avg. life expectancy (74.6) L          70                     0 inh. vap.       * 1.53E+07 mg/kg   *
absorption factor (0-1) AF              1                     1 derm. gwater    *                  *
contaminated fraction (0-1)CF         0.5                     0 inh. shower     ********************
Transport multiplier TR                 1                     0 inh. part.

soil ingestion dose (mg/kg/d) 8.440E-01 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C             15334115.7
skin surf. area(cm2/d) SA            3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF               45
exposure duration (yrs) ED              5       4      0
avg. body wt. (kg) BW                  16      41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                      70
contaminated fraction (0-1)CF         0.5
Transport multiplier TR                 1

soil dermal dose (mg/kg/d)    1.650E+00 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.........................................
soil cont. [ ] (mg/kg) C     15334115.7
consumption rt. (L/day) CR          1.4
Kd  (L/kg) Kd                      1000
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5     4     0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16    41    70
lifetime (74.6) L                    70
Attenuation factor(0-1) AT    6.500E-07
Transport multiplier TR               1

water consumption exposure    4.480E-05 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.........................................
soil cont. [ ] (mg/kg) C     15334115.7
inhalation rt. (m3/day) IR           20    20    20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF     7038701.01
exposure freq. (days/yr) EF         150
exposure duration (yrs) ED            5     4     0
avg body wt. (kg) BW                 16    41    70
lifetime (74.6) L                    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

vapor inhalation dose         1.998E-02 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.........................................
soil cont. [ ] (mg/kg) C     15334115.7
Kd  (L/kg) Kd                      1000
skin surface area (cm2) SA         7200 13175 18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     4     0
avg body wt (kg) BW                  16    41    70
lifetime (74.6) L                    70
```

Kp(derm. perm. const.)(cm/hr)	0.81			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	4.977E-05	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	15334115.7			
Kd (L/kg)	1000			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower inhalation exposure	1.280E-06	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	15334115.7			
exposure freq. (days/yr) EF	45			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE,
30 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                       2-6 yrs   7-18   18+  on/off TRANSPORT        Risk Level 1.0E-06
........................................                        0 SESOIL           Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C        0.13626206                      1 Kd/Att. Factor   Inh. Slope     6.1
consumption rt. (mg/day) CR            200    100    100        0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF               180                 on/off EXPOSURE
duration of exp. (yrs) ED                5     12     13        0 soil ing.       *******************
avg. body wt. (kg) BW                   16     41     70        0 soil derm.      *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                   1 gwater cons.    *                  *
avg. life expectancy (74.6) L           70                      0 inh. vap.       *  0.13626 mg/kg   *
absorption factor (0-1) AF               1                      1 derm. gwater    *                  *
contaminated fraction (0-1)CF          0.5                      0 inh. shower     *******************
Transport multiplier TR                  1                      0 inh. part.

soil ingestion dose (mg/kg/d) 3.000E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C             0.13626206
skin surf. area(cm2/d) SA             3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF               180
exposure duration (yrs) ED               5     12     13
avg. body wt. (kg) BW                   16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                       70
contaminated fraction (0-1)CF          0.5
Transport multiplier TR                  1

soil dermal dose (mg/kg/d)    5.865E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.13626206		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	27500		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	0.65		
Transport multiplier TR	1		

water consumption exposure 1.448E-08 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	0.13626206		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	5.48E+07		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 5.319E-11 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.13626206		
Kd (L/kg) Kd	27500		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	1.2		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	0.65		
Transport multiplier TR	1		

shower dermal dose 2.382E-08 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	0.13626206		
Kd (L/kg)	27500		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	0.65		
Trnasport multiplier TR	1		

shower inhalation exposure 4.136E-10 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

....

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	0.13626206		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE,
30 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                    2-6 yrs   7-18   18+  on/off TRANSPORT          Risk Level 1.0E-06
.......................................                      0 SESOIL             Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C      136262.059                     1 Kd/Att. Factor     Inh. Slope     6.1
consumption rt. (mg/day) CR          200     100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF              90                on/off EXPOSURE
duration of exp. (yrs) ED              5      12     13      0 soil ing.         ********************
avg. body wt. (kg) BW                 16      41     70      0 soil derm.        *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                1 gwater cons.      *                  *
avg. life expectancy (74.6) L         70                     0 inh. vap.         * 1.36E+05 mg/kg   *
absorption factor (0-1) AF             1                     1 derm. gwater      *                  *
contaminated fraction (0-1)CF        0.5                     0 inh. shower       ********************
Transport multiplier TR                1                     0 inh. part.

soil ingestion dose (mg/kg/d) 1.500E-02 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           136262.059
skin surf. area(cm2/d) SA           3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              90
exposure duration (yrs) ED             5      12     13
avg. body wt. (kg) BW                 16      41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

soil dermal dose (mg/kg/d)    2.932E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
......................................
soil cont. [ ] (mg/kg) C     136262.059
consumption rt. (L/day) CR          1.4
Kd  (L/kg) Kd                     27500
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5     12     13
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16     41     70
lifetime (74.6) L                    70
Attenuation factor(0-1) AT    6.500E-07
Transport multiplier TR               1

water consumption exposure    1.448E-08 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
......................................
soil cont. [ ] (mg/kg) C     136262.059
inhalation rt. (m3/day) IR           20     20     20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF       5.48E+07
exposure freq. (days/yr) EF         250
exposure duration (yrs) ED            5     12     13
avg body wt. (kg) BW                 16     41     70
lifetime (74.6) L                    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

vapor inhalation dose         3.799E-05 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
......................................
soil cont. [ ] (mg/kg) C     136262.059
Kd  (L/kg) Kd                     27500
skin surface area (cm2) SA         7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     12     13
avg body wt (kg) BW                  16     41     70
lifetime (74.6) L                    70
```

Kp(derm. perm. const.)(cm/hr)	1.2		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower dermal dose 2.382E-08 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	136262.059		
Kd (L/kg)	27500		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 4.136E-10 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

....

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	136262.059		
exposure freq. (days/yr) EF	90		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+
cont. [ ] (mg/kg)(ppm) C	136262.059		
consumption rt. (mg/day) CR (2-6 200, >6 100)	200	100	100
exposure freq. (d/yr) EF	45		
duration of exp. (yrs) ED	5	12	13
avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	16	41	70
avg. life expectancy (74.6) L	70		
absorption factor (0-1) AF	1		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

on/off	TRANSPORT
0	SESOIL
1	Kd/Att. Factor
0	No Attenuation

on/off	EXPOSURE
0	soil ing.
0	soil derm.
1	gwater cons.
0	inh. vap.
1	derm. gwater
0	inh. shower
0	inh. part.

Risk Level	1.0E-06
Oral Slope	7.3
Inh. Slope	6.1

Soil Concentration: 1.36E+05 mg/kg

soil ingestion dose (mg/kg/d) 7.500E-03 mg/kg*day =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)

Soil Dermal Exposure	2-6 yrs	7-18	18+
cont. [ ] (mg/kg) C	136262.059		
skin surf. area(cm2/d) SA (child 3910 adult 3120)	3910	3910	3120
soil to skin adher. factor AD (1) (mg/cm2)	1		
absorption factor (0-1) AF	0.1		
exposure freq. (d/yr) EF	45		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	16	41	70
lifetime (74.6) L	70		
contaminated fraction (0-1)CF	0.5		
Transport mutliplier TR	1		

soil dermal dose (mg/kg/d) 1.466E-02 mg/kg*day =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)

```
Groundwater Consumption
.........................................
soil cont. [ ] (mg/kg) C      136262.059
consumption rt. (L/day) CR           1.4
Kd  (L/kg) Kd                      27500
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5     12     13
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41     70
lifetime (74.6) L                     70
Attenuation factor(0-1) AT     6.500E-07
Transport multiplier TR                1

water consumption exposure     1.448E-08 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.........................................
soil cont. [ ] (mg/kg) C      136262.059
inhalation rt. (m3/day) IR            20     20     20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF        5.48E+07
exposure freq. (days/yr) EF          150
exposure duration (yrs) ED             5     12     13
avg body wt. (kg) BW                  16     41     70
lifetime (74.6) L                     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

vapor inhalation dose          2.279E-05 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.........................................
soil cont. [ ] (mg/kg) C      136262.059
Kd  (L/kg) Kd                      27500
skin surface area (cm2) SA          7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5     12     13
avg body wt (kg) BW                   16     41     70
lifetime (74.6) L                     70
```

Kp(derm. perm. const.)(cm/hr)	1.2			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	2.382E-08	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	136262.059			
Kd (L/kg)	27500			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	12	13	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower inhalation exposure	4.136E-10	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	136262.059			
exposure freq. (days/yr) EF	45			
exposure duration (yrs) ED	5	12	13	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                     2-6 yrs   7-18   18+  on/off TRANSPORT          Risk Level 1.0E-06
......................................                        0 SESOIL             Oral Slope    0.73
cont. [ ] (mg/kg)(ppm) C        0.06503238                    1 Kd/Att. Factor     Inh. Slope    0.61
consumption rt. (mg/day) CR            200    100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF               180                on/off EXPOSURE
duration of exp. (yrs) ED                5     12     13      0 soil ing.         *******************
avg. body wt. (kg) BW                   16     41     70      0 soil derm.        *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                 1 gwater cons.      *                  *
avg. life expectancy (74.6) L           70                    0 inh. vap.         *  0.06503 mg/kg   *
absorption factor (0-1) AF               1                    1 derm. gwater      *                  *
contaminated fraction (0-1)CF          0.5                    0 inh. shower       *******************
Transport multiplier TR                  1                    0 inh. part.

soil ingestion dose (mg/kg/d) 1.432E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C             0.06503238
skin surf. area(cm2/d) SA             3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF               180
exposure duration (yrs) ED               5     12     13
avg. body wt. (kg) BW                   16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                       70
contaminated fraction (0-1)CF          0.5
Transport multiplier TR                  1

soil dermal dose (mg/kg/d)    2.799E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.06503238		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	1000		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	0.65		
Transport multiplier TR	1		

water consumption exposure 1.900E-07 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	0.06503238		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	7212513.43		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.930E-10 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.06503238		
Kd (L/kg) Kd	1000		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	0.81			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	0.65			
Transport multiplier TR	1			
shower dermal dose	2.111E-07	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	0.06503238			
Kd (L/kg)	1000			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	12	13	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	0.65			
Transport multiplier TR	1			
shower inhalation exposure	5.429E-09	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	0.06503238			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	12	13	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE,
30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                     2-6 yrs   7-18   18+  on/off TRANSPORT          Risk Level 1.0E-06
......................................                        0 SESOIL             Oral Slope    0.73
cont. [ ] (mg/kg)(ppm) C       65032.3755                     1 Kd/Att. Factor     Inh. Slope    0.61
consumption rt. (mg/day) CR           200     100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF               90                on/off EXPOSURE
duration of exp. (yrs) ED               5      12     13      0 soil ing.         *******************
avg. body wt. (kg) BW                  16      41     70      0 soil derm.        *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                 1 gwater cons.      *                  *
avg. life expectancy (74.6) L          70                     0 inh. vap.         * 6.50E+04 mg/kg   *
absorption factor (0-1) AF              1                     1 derm. gwater      *                  *
contaminated fraction (0-1)CF         0.5                     0 inh. shower       *******************
Transport multiplier TR                 1                     0 inh. part.

soil ingestion dose (mg/kg/d) 7.159E-03 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C            65032.3755
skin surf. area(cm2/d) SA            3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD           1
  (1) (mg/cm2)
absorption factor (0-1) AF            0.1
exposure freq. (d/yr) EF               90
exposure duration (yrs) ED              5      12     13
avg. body wt. (kg) BW                  16      41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                      70
contaminated fraction (0-1)CF         0.5
Transport multiplier TR                 1

soil dermal dose (mg/kg/d)    1.400E-02 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C     65032.3755
consumption rt. (L/day) CR          1.4
Kd  (L/kg) Kd                      1000
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5     12     13
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16     41     70
lifetime (74.6) L                    70
Attenuation factor(0-1) AT    6.500E-07
Transport mutliplier TR               1

water consumption exposure    1.900E-07 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/kg) C     65032.3755
inhalation rt. (m3/day) IR           20     20     20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF     7212513.43
exposure freq. (days/yr) EF         250
exposure duration (yrs) ED            5     12     13
avg body wt. (kg) BW                 16     41     70
lifetime (74.6) L                    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

vapor inhalation dose         1.379E-04 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C     65032.3755
Kd  (L/kg) Kd                      1000
skin surface area (cm2) SA         7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5     12     13
avg body wt (kg) BW                  16     41     70
lifetime (74.6) L                    70
```

Kp(derm. perm. const.)(cm/hr)	0.81		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	6.500E-07		
Transport mutliplier TR	1		

shower dermal dose 2.111E-07 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	65032.3755		
Kd (L/kg)	1000		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 5.429E-09 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

....

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	65032.3755		
exposure freq. (days/yr) EF	90		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                       2-6 yrs   7-18   18+  on/off TRANSPORT          Risk Level 1.0E-06
.......................................                         0 SESOIL             Oral Slope    0.73
cont. [ ] (mg/kg)(ppm) C          65032.3755                    1 Kd/Att. Factor     Inh. Slope    0.61
consumption rt. (mg/day) CR            200     100    100       0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF                45                 on/off EXPOSURE
duration of exp. (yrs) ED                5      12     13       0 soil ing.         ********************
avg. body wt. (kg) BW                   16      41     70       0 soil derm.        *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                   1 gwater cons.      *                  *
avg. life expectancy (74.6) L           70                      0 inh. vap.         * 6.50E+04 mg/kg   *
absorption factor (0-1) AF               1                      1 derm. gwater      *                  *
contaminated fraction (0-1)CF          0.5                      0 inh. shower       ********************
Transport multiplier TR                  1                      0 inh. part.

soil ingestion dose (mg/kg/d) 3.579E-03 mg/kg*day    =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C               65032.3755
skin surf. area(cm2/d) SA             3910    3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF                45
exposure duration (yrs) ED               5      12     13
avg. body wt. (kg) BW                   16      41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                       70
contaminated fraction (0-1)CF          0.5
Transport multiplier TR                  1

soil dermal dose (mg/kg/d)     6.998E-03 mg/kg*day    =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	65032.3755			
consumption rt. (L/day) CR	1.4			
Kd (L/kg) Kd	1000			
exp. freq. (365)(days/yr) EF	350			
exposure duration (yrs) ED	5	12	13	
diet fraction (.75-1.0) DF	0.75			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
Attenuation factor(0-1) AT	6.500E-07			
Transport multiplier TR	1			
water consumption exposure	1.900E-07	mg/kg*day		=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	65032.3755			
inhalation rt. (m3/day) IR	20	20	20	
(child<18 20 adult 20 occ. 20)				
volat. factor (m3/kg) VF	7212513.43			
exposure freq. (days/yr) EF	150			
exposure duration (yrs) ED	5	12	13	
avg body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
contaminated fraction (0-1)CF	0.5			
Transport multiplier TR	1			
vapor inhalation dose	8.271E-05	mg/kg*day		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	65032.3755		
Kd (L/kg) Kd	1000		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	0.81		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		
shower dermal dose	2.111E-07	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	65032.3755		
Kd (L/kg)	1000		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 5.429E-09 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	65032.3755		
exposure freq. (days/yr) EF	45		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE,
30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                 2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
......................................                    0 SESOIL            Oral Slope  0.0073
cont. [ ] (mg/kg)(ppm) C     6.50323755                   1 Kd/Att. Factor    Inh. Slope  0.0061
consumption rt. (mg/day) CR         200    100    100     0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF            180              on/off EXPOSURE
duration of exp. (yrs) ED             5     12     13     0 soil ing.        *******************
avg. body wt. (kg) BW                16     41     70     0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                             1 gwater cons.     *                 *
avg. life expectancy (74.6) L        70                   0 inh. vap.        *  6.50324 mg/kg  *
absorption factor (0-1) AF            1                   1 derm. gwater     *                 *
contaminated fraction (0-1)CF       0.5                   0 inh. shower      *******************
Transport multiplier TR               1                   0 inh. part.

soil ingestion dose (mg/kg/d) 1.432E-06 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
......................................
cont. [ ] (mg/kg) C          6.50323755
skin surf. area(cm2/d) SA          3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF            180
exposure duration (yrs) ED            5     12     13
avg. body wt. (kg) BW                16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                    70
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

soil dermal dose (mg/kg/d)    2.799E-06 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	6.50323755		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	1000		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	0.65		
Transport multiplier TR	1		

water consumption exposure 1.900E-05 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	6.50323755		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	7038701.01		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.978E-08 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	6.50323755		
Kd (L/kg) Kd	1000		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	0.81			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	0.65			
Transport multiplier TR	1			
shower dermal dose	2.111E-05	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	

Inhalation in Shower

soil cont. [ ] (mg/kg) C	6.50323755		
Kd (L/kg)	1000		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	0.65		
Transport multiplier TR	1		

shower inhalation exposure 5.429E-07 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	6.50323755		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE,
30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                      2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
.........................................                      0 SESOIL            Oral Slope  0.0073
cont. [ ] (mg/kg)(ppm) C        6503237.55                     1 Kd/Att. Factor    Inh. Slope  0.0061
consumption rt. (mg/day) CR            200    100    100       0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF                90                on/off EXPOSURE
duration of exp. (yrs) ED                5     12     13       0 soil ing.        ********************
avg. body wt. (kg) BW                   16     41     70       0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                  1 gwater cons.     *                  *
avg. life expectancy (74.6) L           70                     0 inh. vap.        * 6.50E+06 mg/kg   *
absorption factor (0-1) AF               1                     1 derm. gwater     *                  *
contaminated fraction (0-1)CF          0.5                     0 inh. shower      ********************
Transport multiplier TR                  1                     0 inh. part.

soil ingestion dose (mg/kg/d) 7.159E-01 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.........................................
cont. [ ] (mg/kg) C             6503237.55
skin surf. area(cm2/d) SA             3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD            1
  (1) (mg/cm2)
absorption factor (0-1) AF             0.1
exposure freq. (d/yr) EF                90
exposure duration (yrs) ED               5     12     13
avg. body wt. (kg) BW                   16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                       70
contaminated fraction (0-1)CF          0.5
Trasnport multiplier TR                  1

soil dermal dose (mg/kg/d)    1.400E+00 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C      6503237.55
consumption rt. (L/day) CR           1.4
Kd  (L/kg) Kd                       1000
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5     12     13
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16     41     70
lifetime (74.6) L                     70
Attenuation factor(0-1) AT     6.500E-07
Transport multiplier TR                1

water consumption exposure     1.900E-05 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/kg) C      6503237.55
inhalation rt. (m3/day) IR            20     20     20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF      7038701.01
exposure freq. (days/yr) EF          250
exposure duration (yrs) ED             5     12     13
avg body wt. (kg) BW                  16     41     70
lifetime (74.6) L                     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

vapor inhalation dose          1.413E-02 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C      6503237.55
Kd  (L/kg) Kd                       1000
skin surface area (cm2) SA          7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5     12     13
avg body wt (kg) BW                   16     41     70
lifetime (74.6) L                     70
```

Kp(derm. perm. const.)(cm/hr)	0.81		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower dermal dose 2.111E-05 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	6503237.55		
Kd (L/kg)	1000		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 5.429E-07 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

....

inhalation rate (m3/day) IR	20	20	20
(child<18 20 adult 20)			
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	6503237.55		
exposure freq. (days/yr) EF	90		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                  2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
........................................                   0 SESOIL            Oral Slope  0.0073
cont. [ ] (mg/kg)(ppm) C     6503237.55                    1 Kd/Att. Factor    Inh. Slope  0.0061
consumption rt. (mg/day) CR         200    100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF             45               on/off EXPOSURE
duration of exp. (yrs) ED             5     12     13      0 soil ing.        *******************
avg. body wt. (kg) BW                16     41     70      0 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                              1 gwater cons.     *                 *
avg. life expectancy (74.6) L        70                    0 inh. vap.        * 6.50E+06 mg/kg  *
absorption factor (0-1) AF            1                    1 derm. gwater     *                 *
contaminated fraction (0-1)CF       0.5                    0 inh. shower      *******************
Transport multiplier TR               1                    0 inh. part.

soil ingestion dose (mg/kg/d) 3.579E-01 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
........................................
cont. [ ] (mg/kg) C          6503237.55
skin surf. area(cm2/d) SA          3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD         1
  (1) (mg/cm2)
absorption factor (0-1) AF          0.1
exposure freq. (d/yr) EF             45
exposure duration (yrs) ED            5     12     13
avg. body wt. (kg) BW                16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                    70
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

soil dermal dose (mg/kg/d)    6.998E-01 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	6503237.55		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	1000		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	6.500E-07		
Transport multiplier TR	1		

water consumption exposure 1.900E-05 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	6503237.55		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	7038701.01		
exposure freq. (days/yr) EF	150		
exposure duration (yrs) ED	5	12	13
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 8.475E-03 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	6503237.55		
Kd (L/kg) Kd	1000		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	0.81			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	2.111E-05	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	6503237.55		
Kd (L/kg)	1000		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 5.429E-07 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	6503237.55		
exposure freq. (days/yr) EF	45		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 0 to 100 METERS FROM SITE,
9-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                   2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
.........................................                   0 SESOIL            Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C      0.11106055                    1 Kd/Att. Factor    Inh. Slope     6.1
consumption rt. (mg/day) CR          200    100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF             180                on/off EXPOSURE
duration of exp. (yrs) ED              5      4      0      1 soil ing.        *******************
avg. body wt. (kg) BW                 16     41     70      1 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                               1 gwater cons.     *                  *
avg. life expectancy (74.6) L         70                    0 inh. vap.        *  0.11106 mg/kg   *
absorption factor (0-1) AF             1                    1 derm. gwater     *                  *
contaminated fraction (0-1)CF        0.5                    0 inh. shower      *******************
Transport multiplier TR                1                    0 inh. part.

soil ingestion dose (mg/kg/d) 2.445E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.........................................
cont. [ ] (mg/kg) C           0.11106055
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

soil dermal dose (mg/kg/d)    4.780E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.11106055		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	27500		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	0.65		
Transport multiplier TR	1		

water consumption exposure 1.180E-08 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	0.11106055		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	5.48E+07		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 4.335E-11 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.11106055		
Kd (L/kg) Kd	27500		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	1.2			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	0.65			
Transport multiplier TR	1			
shower dermal dose	1.942E-08	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	

Inhalation in Shower

soil cont. [ ] (mg/kg) C	0.11106055		
Kd (L/kg)	27500		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	0.65		
Transport multiplier TR	1		

shower inhalation exposure 3.371E-10 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	0.11106055		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 100 to 300 METERS FROM SITE, 9-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                   2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
.......................................                     0 SESOIL            Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C      0.33439838                    1 Kd/Att. Factor    Inh. Slope     6.1
consumption rt. (mg/day) CR          200    100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF              90                on/off EXPOSURE
duration of exp. (yrs) ED              5      4      0      1 soil ing.        *******************
avg. body wt. (kg) BW                 16     41     70      1 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                               1 gwater cons.     *                  *
avg. life expectancy (74.6) L         70                    0 inh. vap.        * 3.34E-01 mg/kg   *
absorption factor (0-1) AF             1                    1 derm. gwater     *                  *
contaminated fraction (0-1)CF        0.5                    0 inh. shower      *******************
Transport multiplier TR                1                    0 inh. part.

soil ingestion dose (mg/kg/d) 3.681E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           0.33439838
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              90
exposure duration (yrs) ED             5      4      0
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

soil dermal dose (mg/kg/d)    7.196E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C     0.33439838
consumption rt. (L/day) CR          1.4
Kd  (L/kg) Kd                     27500
exp. freq. (365)(days/yr) EF        350
exposure duration (yrs) ED            5      4      0
diet fraction (.75-1.0) DF         0.75
avg. body wt. (kg) BW                16     41     70
lifetime (74.6) L                    70
Attenuation factor(0-1) AT    6.500E-07
Transport multiplier TR               1

water consumption exposure    3.553E-14 mg/kg*day   =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/kg) C     0.33439838
inhalation rt. (m3/day) IR           20     20     20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF       5.48E+07
exposure freq. (days/yr) EF         250
exposure duration (yrs) ED            5      4      0
avg body wt. (kg) BW                 16     41     70
lifetime (74.6) L                    70
absorption factor AF                0.5
contaminated fraction (0-1)CF       0.5
Transport multiplier TR               1

vapor inhalation dose         9.323E-11 mg/kg*day   =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C     0.33439838
Kd  (L/kg) Kd                     27500
skin surface area (cm2) SA         7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF         350
exposure duration (yrs) ED            5      4      0
avg body wt (kg) BW                  16     41     70
lifetime (74.6) L                    70
```

Kp(derm. perm. const.)(cm/hr)	1.2			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	5.847E-14	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	0.33439838			
Kd (L/kg)	27500			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	4	0	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	6.500E-07			
Transport mutliplier TR	1			
shower inhalation exposure	1.015E-15	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	0.33439838			
exposure freq. (days/yr) EF	90			
exposure duration (yrs) ED	5	4	0	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, ≥300 METERS FROM SITE, 9-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	
....				0	SESOIL	Risk Level 1.0E-06
cont. [ ] (mg/kg)(ppm) C	0.66879609			1	Kd/Att. Factor	Oral Slope 7.3
consumption rt. (mg/day) CR	200	100	100	0	No Attenuation	Inh. Slope 6.1
(2-6 200, >6 100)						
exposure freq. (d/yr) EF	45			on/off	EXPOSURE	
duration of exp. (yrs) ED	5	4	0	1	soil ing.	********************
avg. body wt. (kg) BW	16	41	70	1	soil derm.	*Soil Concentration*
(2-6 16, 6-18 41, adult 70)				1	gwater cons.	* *
avg. life expectancy (74.6) L	70			0	inh. vap.	* 6.69E-01 mg/kg *
absorption factor (0-1) AF	1			1	derm. gwater	* *
contaminated fraction (0-1)CF	0.5			0	inh. shower	********************
Transport multiplier TR	1			0	inh. part.	

soil ingestion dose (mg/kg/d) 3.681E-08 mg/kg*day =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)

Soil Dermal Exposure	2-6 yrs	7-18	18+
....			
cont. [ ] (mg/kg) C	0.66879609		
skin surf. area(cm2/d) SA	3910	3910	3120
(child 3910 adult 3120)			
soil to skin adher. factor AD	1		
(1) (mg/cm2)			
absorption factor (0-1) AF	0.1		
exposure freq. (d/yr) EF	45		
exposure duration (yrs) ED	5	4	0
avg. body wt. (kg) BW	16	41	70
(2-6 16, 6-18 41, adult 70)			
lifetime (74.6) L	70		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

soil dermal dose (mg/kg/d) 7.196E-08 mg/kg*day =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.66879609		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	27500		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	6.500E-07		
Transport multiplier TR	1		

water consumption exposure 7.105E-14 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	0.66879609		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	5.48E+07		
exposure freq. (days/yr) EF	150		
exposure duration (yrs) ED	5	4	0
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 1.119E-10 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.66879609		
Kd (L/kg) Kd	27500		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	4	0
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

```
Kp(derm. perm. const.)(cm/hr)          1.2
length of shower (hr/day) SL           0.2
absorption factor AF                     1
Attenuation factor (0-1) AT    6.500E-07
Transport multiplier TR                  1

shower dermal dose             1.169E-13 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)
```

```
Inhalation in Shower
.......................................
soil cont. [ ] (mg/kg) C      0.66879609
Kd (L/kg)                          27500
inhalation rt.(0.6)(m3/hr) IR        0.6
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5     4     0
shower length(hrs/day)(.2) SL        0.2
avg. body wt. (kg) BW                 16    41    70
lifetime (74.6) L                     70
volat. factor (K)(.5 L/m3)           0.5
absorption factor  AF                0.5
Attenuation factor (0-1) AT    6.500E-07
Transport multiplier TR                1

shower inhalation exposure     2.030E-15 mg/kg*day   =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)
```

```
Inhalation of Particulates
.......................................
inhalation rate (m3/day) IR           20    20    20
  (child<18 20 adult 20)
air particulate [](mg/m3) AP           0
respirable part. fraction RF           0
part. cont [ ] (mg/kg) C      0.66879609
exposure freq. (days/yr) EF           45
exposure duration (yrs) ED             5     4     0
avg. body wt. (kg) BW                 16    41    70
lifetime (74.6) L                     70
absorption factor  AF                0.5
Transport multiplier TR                1

part. inhalation exposure      0.000E+00 mg/kg*day   =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
```

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 0 to 100 METERS FROM SITE,
30-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                   2-6 yrs   7-18   18+  on/off TRANSPORT          Risk Level 1.0E-06
.......................................                     0 SESOIL             Oral Slope      7.3
cont. [ ] (mg/kg)(ppm) C      0.05633565                    1 Kd/Att. Factor     Inh. Slope      6.1
consumption rt. (mg/day) CR          200    100    100      0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF             180                on/off EXPOSURE
duration of exp. (yrs) ED              5     12     13      1 soil ing.         ********************
avg. body wt. (kg) BW                 16     41     70      1 soil derm.        *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                               1 gwater cons.      *                  *
avg. life expectancy (74.6) L         70                    0 inh. vap.         *  0.05634 mg/kg   *
absorption factor (0-1) AF             1                    1 derm. gwater      *                  *
contaminated fraction (0-1)CF        0.5                    0 inh. shower       ********************
Transport multiplier TR                1                    0 inh. part.

soil ingestion dose (mg/kg/d) 1.240E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           0.05633565
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF             180
exposure duration (yrs) ED             5     12     13
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

soil dermal dose (mg/kg/d)    2.425E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.05633565			
consumption rt. (L/day) CR	1.4			
Kd (L/kg) Kd	27500			
exp. freq. (365)(days/yr) EF	350			
exposure duration (yrs) ED	5	12	13	
diet fraction (.75-1.0) DF	0.75			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
Attenuation factor(0-1) AT	0.65			
Transport multiplier TR	1			
water consumption exposure	5.985E-09	mg/kg*day		=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	0.05633565			
inhalation rt. (m3/day) IR	20	20	20	
(child<18 20 adult 20 occ. 20)				
volat. factor (m3/kg) VF	5.48E+07			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	12	13	
avg body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
contaminated fraction (0-1)CF	0.5			
Transport multiplier TR	1			
vapor inhalation dose	2.199E-11	mg/kg*day		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.05633565		
Kd (L/kg) Kd	27500		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	1.2			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	0.65			
Transport multiplier TR	1			
shower dermal dose	9.850E-09	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	0.05633565			
Kd (L/kg)	27500			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	12	13	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	0.65			
Trnasport multiplier TR	1			
shower inhalation exposure	1.710E-10	mg/kg*day		=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	0.05633565			
exposure freq. (days/yr) EF	180			
exposure duration (yrs) ED	5	12	13	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00	mg/kg*day		=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 100 to 300 METERS FROM SITE,
30-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                     2-6 yrs   7-18   18+  on/off TRANSPORT         Risk Level 1.0E-06
.......................................                       0 SESOIL            Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C      0.19208674                      1 Kd/Att. Factor    Inh. Slope     6.1
consumption rt. (mg/day) CR          200    100    100        0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF              90                 on/off EXPOSURE
duration of exp. (yrs) ED              5     12     13        1 soil ing.        ********************
avg. body wt. (kg) BW                 16     41     70        1 soil derm.       *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                 1 gwater cons.     *                  *
avg. life expectancy (74.6) L         70                      0 inh. vap.        * 1.92E-01 mg/kg   *
absorption factor (0-1) AF             1                      1 derm. gwater     *                  *
contaminated fraction (0-1)CF        0.5                      0 inh. shower      ********************
Transport multiplier TR                1                      0 inh. part.

soil ingestion dose (mg/kg/d) 2.114E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.......................................
cont. [ ] (mg/kg) C           0.19208674
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              90
exposure duration (yrs) ED             5     12     13
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

soil dermal dose (mg/kg/d)    4.134E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

Groundwater Consumption

soil cont. [ ] (mg/kg) C	0.19208674		
consumption rt. (L/day) CR	1.4		
Kd (L/kg) Kd	27500		
exp. freq. (365)(days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
diet fraction (.75-1.0) DF	0.75		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
Attenuation factor(0-1) AT	6.500E-07		
Transport multiplier TR	1		

water consumption exposure 2.041E-14 mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)

Inhalation of Vapors

soil cont. [ ] (mg/kg) C	0.19208674		
inhalation rt. (m3/day) IR	20	20	20
(child<18 20 adult 20 occ. 20)			
volat. factor (m3/kg) VF	5.48E+07		
exposure freq. (days/yr) EF	250		
exposure duration (yrs) ED	5	12	13
avg body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
contaminated fraction (0-1)CF	0.5		
Transport multiplier TR	1		

vapor inhalation dose 5.356E-11 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)

Dermal Contact in Shower

soil cont. [ ] (mg/kg) C	0.19208674		
Kd (L/kg) Kd	27500		
skin surface area (cm2) SA	7200	13175	18150
(<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)			
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
avg body wt (kg) BW	16	41	70
lifetime (74.6) L	70		

Kp(derm. perm. const.)(cm/hr)	1.2		
length of shower (hr/day) SL	0.2		
absorption factor AF	1		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower dermal dose 3.359E-14 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

....

soil cont. [ ] (mg/kg) C	0.19208674		
Kd (L/kg)	27500		
inhalation rt.(0.6)(m3/hr) IR	0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED	5	12	13
shower length(hrs/day)(.2) SL	0.2		
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor (0-1) AT	6.500E-07		
Transport multiplier TR	1		

shower inhalation exposure 5.831E-16 mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

....

inhalation rate (m3/day) IR	20	20	20
(child<18 20 adult 20)			
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0		
part. cont [ ] (mg/kg) C	0.19208674		
exposure freq. (days/yr) EF	90		
exposure duration (yrs) ED	5	12	13
avg. body wt. (kg) BW	16	41	70
lifetime (74.6) L	70		
absorption factor AF	0.5		
Transport multiplier TR	1		

part. inhalation exposure 0.000E+00 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, ≥300 METERS FROM SITE,
30-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

```
Soil Ingestion                    2-6 yrs   7-18   18+  on/off TRANSPORT        Risk Level 1.0E-06
.....................................                        0 SESOIL           Oral Slope     7.3
cont. [ ] (mg/kg)(ppm) C      0.38417293                     1 Kd/Att. Factor   Inh. Slope     6.1
consumption rt. (mg/day) CR          200    100    100       0 No Attenuation
  (2-6 200, >6 100)
exposure freq. (d/yr) EF              45                on/off EXPOSURE
duration of exp. (yrs) ED              5     12     13       1 soil ing.       ********************
avg. body wt. (kg) BW                 16     41     70       1 soil derm.      *Soil Concentration*
  (2-6 16, 6-18 41, adult 70)                                1 gwater cons.    *                  *
avg. life expectancy (74.6) L         70                     0 inh. vap.       * 3.84E-01 mg/kg   *
absorption factor (0-1) AF             1                     1 derm. gwater    *                  *
contaminated fraction (0-1)CF        0.5                     0 inh. shower     ********************
Transport multiplier TR                1                     0 inh. part.

soil ingestion dose (mg/kg/d) 2.114E-08 mg/kg*day   =(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365)
```

```
Soil Dermal Exposure
.....................................
cont. [ ] (mg/kg) C           0.38417293
skin surf. area(cm2/d) SA           3910   3910   3120
  (child 3910  adult 3120)
soil to skin adher. factor AD          1
  (1) (mg/cm2)
absorption factor (0-1) AF           0.1
exposure freq. (d/yr) EF              45
exposure duration (yrs) ED             5     12     13
avg. body wt. (kg) BW                 16     41     70
  (2-6 16, 6-18 41, adult 70)
lifetime (74.6) L                     70
contaminated fraction (0-1)CF        0.5
Transport mutliplier TR                1

soil dermal dose (mg/kg/d)    4.134E-08 mg/kg*day   =(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
```

```
Groundwater Consumption
.......................................
soil cont. [ ] (mg/kg) C      0.38417293
consumption rt. (L/day) CR           1.4
Kd  (L/kg) Kd                      27500
exp. freq. (365)(days/yr) EF         350
exposure duration (yrs) ED             5      12      13
diet fraction (.75-1.0) DF          0.75
avg. body wt. (kg) BW                 16      41      70
lifetime (74.6) L                     70
Attenuation factor(0-1) AT     6.500E-07
Transport multiplier TR                1

water consumption exposure     4.082E-14 mg/kg*day    =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)
```

```
Inhalation of Vapors
.......................................
soil cont. [ ] (mg/kg) C      0.38417293
inhalation rt. (m3/day) IR            20      20      20
  (child<18 20 adult 20 occ. 20)
volat. factor (m3/kg) VF        5.48E+07
exposure freq. (days/yr) EF          150
exposure duration (yrs) ED             5      12      13
avg body wt. (kg) BW                  16      41      70
lifetime (74.6) L                     70
absorption factor AF                 0.5
contaminated fraction (0-1)CF        0.5
Transport multiplier TR                1

vapor inhalation dose          6.427E-11 mg/kg*day    =(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)
```

```
Dermal Contact in Shower
.......................................
soil cont. [ ] (mg/kg) C      0.38417293
Kd  (L/kg) Kd                      27500
skin surface area (cm2) SA          7200  13175  18150
 (<2 4000 2-6 7200 6-12 13175
   15-18 17000 adult 18150)
exposure freq. (days/yr) EF          350
exposure duration (yrs) ED             5      12      13
avg body wt (kg) BW                   16      41      70
lifetime (74.6) L                     70
```

Kp(derm. perm. const.)(cm/hr)	1.2			
length of shower (hr/day) SL	0.2			
absorption factor AF	1			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower dermal dose	6.717E-14	mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)

Inhalation in Shower

soil cont. [ ] (mg/kg) C	0.38417293			
Kd (L/kg)	27500			
inhalation rt.(0.6)(m3/hr) IR	0.6			
exposure freq. (days/yr) EF	350			
exposure duration (yrs) ED	5	12	13	
shower length(hrs/day)(.2) SL	0.2			
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
volat. factor (K)(.5 L/m3)	0.5			
absorption factor AF	0.5			
Attenuation factor (0-1) AT	6.500E-07			
Transport multiplier TR	1			
shower inhalation exposure	1.166E-15 mg/kg*day			=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)

Inhalation of Particulates

inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20	
air particulate [](mg/m3) AP	0			
respirable part. fraction RF	0			
part. cont [ ] (mg/kg) C	0.38417293			
exposure freq. (days/yr) EF	45			
exposure duration (yrs) ED	5	12	13	
avg. body wt. (kg) BW	16	41	70	
lifetime (74.6) L	70			
absorption factor AF	0.5			
Transport multiplier TR	1			
part. inhalation exposure	0.000E+00 mg/kg*day			=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

RISK ASSESSMENT PLAN FOR PETROLEUM UNDERGROUND STORAGE TANKS IN KENTUCKY PART II: DIESEL, HEATING OIL, OTHER MIDDLE DISTILLATES AND WASTE OIL

D.P. Keogh, M.D. Kercher, and W.J. Birge

APPENDIX II

ENVIRONMENTAL HALF-LIFE AND ECOLOGICAL EFFECTS OF PAHs

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Introduction and Objectives

Information on the environmental fate and ecological toxicity of polynuclear aromatic hydrocarbons (PAHs) in diesel fuel is essential to develop accurate fate models and risk-based assessment programs, to undertake remediation protective of human health and biota, and to comply with existing regulations. This document presents information concerning the PAHs considered to be most important and representative among those occurring in diesel fuel (Birge *et al.*, 1995). Discussed are six non-carcinogenic compounds (naphthalene, acenaphthene, anthracene, fluorene, fluoranthene, pyrene) and five carcinogenic compounds (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene).

The principal objectives of this document are: 1) to present information regarding the physical and chemical characteristics; environmental half-lives in air, surface water, soil and ground water, ecotoxicology, and bioaccumulation tendencies of these PAHs; 2) to assess the potential environmental and ecological effects of these compounds upon the aquatic ecosystems of surface waters and wetlands subsequent to UST leakage of diesel; and 3) to provide appropriate recommendations based upon the information available.

PAHs in the Environment

PAHs comprise a group of over one hundred aromatic chemical compounds having two or more rings which are formed during the incomplete combustion of coal, oil, gas, garbage, or other organic substances (ATSDR, 1994a,b). Chemically pure PAHs are crystalline solids. Naphthalene is used extensively as a moth repellant and as an intermediate in the synthesis of phthalic anhydride, carbaryl, dispersants and wetting agents, dyes, and resins. Likewise, anthracene is used in the synthesis of medicines, dyes, smoke screens, scintillation counter crystals, and in organic semiconductor research. Acenaphthene is used in dyes, plastics, insecticides and fungicides. Fluorene serves as a chemical intermediate in many chemical processes and in the formation of polyradicals, while fluoranthene is used to line iron and steel water pipes and storage tanks. For pyrene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene and benzo(k)fluoranthene there is no known use except as research chemicals.

PAHs occur ubiquitously within the environment, usually as mixtures of two or more compounds (ATSDR, 1994a,b). They enter into the atmosphere primarily from pyrolysis of wood and fuels, and may be found in vehicle exhausts, coal tar pitch, creosote, road roofing tar, and hazardous waste sites. Natural sources of PAHs include volcanoes, forest fires, coal, crude oil and shale oil. Once released into the atmosphere, they may exist as vapors or sorbed to suspended particles. Subsequently, PAHs may undergo photooxidation, chemical oxidation, and extensive transport and removal through precipitation and dry deposition, as evidenced by the occurrence of PAHs in soils remote from heavy automobile traffic and industry (Wild *et al.*, 1991). PAHs enter into surface waters in industrial effluent discharges, municipal wastewater, spills, and by atmospheric deposition. Subsequently, they may undergo volatilization, transformation by photooxidation, chemical oxidation, microbial metabolism, and sorption to sediments. Branson (1978) noted that chemicals most likely to be associated with sediments were those with low vapor pressures and low water solubilities. These properties are especially evident among the higher molecular weight PAHs having four or five rings. Thus, sorption to particles in the water column, microbial degradation and photolysis are important removal processes for these compounds; whereas volatilization, microbial degradation and photolysis are more important for naphthalene and the substituted PAHs. PAHs enter into soil from atmospheric deposition, sludge, irrigation using effluents, composts and fertilizers, and spills. In both sediments and soils, the principal removal process is microbial degradation. Volatilization may also be important for naphthalene and the substituted PAHs. PAHs enter groundwater by spills and migration from contaminated surface waters and soils. Partitioning into the particulate soil phase and microbial degradation are the principal removal processes (Wilson and Jones, 1993; Kan *et al.*, 1994).

Inhalation of air containing PAHs is a principal route of exposure. The primary sources for exposure are factories, auto exhausts, and hazardous waste sites (ATSDR, 1994a,b). Other avenues for exposure include various foods (*e.g.* grilled or charred meats, refined fats and oils, processed or pickled foods, produce grown in contaminated soil or air, cereals, grains, flour, bread, vegetables, fruits, beverages), contaminated dust or drinking water, tobacco smoke, smoke from burning wood used in home heating, creosote-treated wood products, and dermal contact with soot or tars. Total PAHs in the typical American diet are less than two parts per billion parts of food (ATSDR, 1994b).

Physical/Chemical Characteristics

Ultimately, the environmental fates of the PAHs (*i.e.* half-life, ecotoxicity, and bioaccumulation) will depend greatly upon their intrinsic physical and chemical characteristics. These tend to vary according to number of rings and molecular weight (Table AII-1). Compounds comprised of two or three rings have properties intermediate between those of BTEX and the higher molecular weight PAHs. As a group, the PAHs with four and five rings tend to be more lipid soluble, less water soluble and less volatile than the low molecular weight compounds or BTEX. Four important physical/chemical properties are considered below (Table AII-1):

Water Solubility

Water solubilities of naphthalene, acenaphthene, and fluorene (32, 3.8 and 1.9 mg/L, respectively; U.S. EPA, 1986) are more similar to those of BTEX than of the higher molecular weight PAHs. The latter compounds are only slightly soluble or insoluble in water (0.26 mg/L for fluoranthene to 8.1×10^{-4} mg/L for benzo(k)fluoranthene; U.S. EPA, 1986).

Henry's Law Constant, H

The tendency of a compound to volatilize from water into air is expressed by the magnitude of Henry's Law constant (H). Smith *et al.* (1980) considered chemicals to have high volatility if H > 4.6 x 10^{-3} atm-m^3/mol. Lyman *et al.* (1982) associated values from 10^{-3} to 10^{-5} with significant volatilization and values <10^{-5} with limited volatilization. Accordingly, volatility of naphthalene, acenaphthene, fluorene, and anthracene from water would be significant (Table AII-1). Values of Henry's Law constant for fluoranthene, benzo(a)anthracene, chrysene, and benzo(a)pyrene are one or two orders of magnitude less (10^{-6} to 10^{-7}), indicating that volatilization of these PAHs from water would be limited.

Soil Sorption Coefficient, K_{oc}

According to Kenaga (1980a,b), compounds with a K_{oc} <100 are considered moderately to highly mobile. The K_{oc} values for naphthalene and the PAHs exceed 100 (Table AII-1). The K_{oc} of 930 L/kg for naphthalene is more similar to the K_{oc}s for BTEX than to the other PAHs, whose K_{oc} values increase greatly with ring number and molecular weight (from 4,571 L/kg for acenaphthene to 5,495,409 L/kg for benzo(a)pyrene). Therefore, PAHs in soils would be considered slightly mobile to immobile with little tendency to leach and a strong tendency to bind to organic carbon. Sorption of PAHs to organic carbon would increase as organic carbon content increases and soil particle size decreases (Karickhoff *et al.*, 1979).

Octanol-Water Partition Coefficient, K_{ow}

The *n*-octanol-water partition coefficient of naphthalene is 1900, similar to that for *o*-xylene (Table AII-1). However, K_{ow} values for the other PAHs are considerably greater, ranging from 9,550 for acenaphthene to 1,148,154 for benzo(a)pyrene and benzo(k)fluoranthene. These high K_{ow} values indicate that the other PAHs, especially the higher molecular weight compounds, strongly partition from water into lipids in agreement with their low water solubilities. This indicates the potential for PAHs to bioaccumulate within the tissue lipids of biota as discussed below.

In summary, the combined properties of low water solubility, moderate volatility, high soil sorption, and high lipid solubility have the greatest influence upon the environmental transport, partitioning and fate of PAHs. These include half-lives in air, soil and water, ecotoxicology, and bioaccumulation, which are treated below.

Environmental Half-life

Introduction

An important parameter related to environmental persistence of BTEX is environmental half-life, the time it takes for half an initial concentration of a compound to disappear following release into the environment. A short environmental half-life can minimize the deleterious effects of a toxic compound, while a long environmental half-life can potentiate possible effects of less toxic compounds. The measured half-life would take into account all degradative processes, both chemical and biological, and factors of dilution/attenuation.

Tables AII-2 through AII-12 present a compilation of half-life values in soil, groundwater, surface waters, and air obtained from a survey of the literature for representative PAHs. Literature sources and experimental conditions accompany the tabular values. The half-life values are derived from five categories: 1) measured half-lives observed in the field under natural, adverse (metal contamination) or enhanced remediating conditions (*e.g.* microbes, surfactant, nutrient enriched); 2) half-lives derived from laboratory biodegradation studies under a variety of circumstances (*e.g.* natural, varied temperature regimes, aerobic, anaerobic, enhanced conditions); 3) calculated values projected from degradation rate constants measured during field or laboratory studies; 4) scientific judgement derived from half-lives estimated in another medium; and 5) estimated values from calculated reaction rates. Greatest emphasis was given to the first category, and whenever possible field studies were used in selecting values appropriate for geological conditions in Kentucky.

Two different methods were commonly used in PAH half-life determinations. The first was the measurement of complete mineralization. This process involved spiking the medium with a known quantity of radio-labelled PAH and calculating the half-life by quantifying the amount of labelled CO_2 produced. One study which incorporated measurements of metabolic intermediates and cellular bound ^{14}C fractions in addition to labelled CO_2 determined that half-life values based on $^{14}CO_2$ evolution grossly underestimated transformation rates of PAHs (Herbes and Schwall, 1978). The second method measured the percent of PAH recovered over time. The accuracy of this procedure may be questionable because of the ability of PAHs to complex with soil or sediment components and therefore avoid detection during chemical analysis. Additional problems arose in field evaluations because of further deposition from uncontrolled sources (Wild *et al.*, 1991). The variety of test conditions and methods noted above resulted in a wide range of half-life estimations (Wild and Jones, 1993).

PAH Half-life Duration and Molecular Size

PAHs can be classified into two distinct categories based on their half-lives and molecular size. The lower molecular weight two and three-ringed PAHs (*i.e.* naphthalene, acenaphthene and fluorene) are characterized by relatively short half-lives (approximately two years or less under the most adverse conditions tested); while the larger four through six-ringed PAHs (*i.e.* benzo(a)pyrene, benzo(a)anthracene, the benzofluoranthenes, and chrysene) are more persistent in the environment. Half-lives of these compounds may approach twenty years under certain adverse soil conditions (Wild *et al.*, 1991). Differences between the low and high molecular weight groups may be attributed primarily to two interrelated factors: solubility and bioavailability.

It is well established that there is a general decrease in water solubility as molecular weight and ring number increase (Srivastava *et al.*, 1990; Wilson and Jones, 1993). Driving this partitioning are the hydrophobic forces associated with the higher molecular weight PAHs (Kan *et al.*, 1994). In terms of potential environmental hazard posed by soil contamination, the extremely low solubility of the four to six-ringed PAHs is beneficial because it inhibits migration of these compounds into groundwater (Srivastava *et al.*, 1990). However, insolubility contributes directly to the persistence of the larger PAHs. It is known that, like BTEX compounds, two and three-ringed PAHs are readily degraded by microorganisms. PAHs of four or more rings are more resistant, especially when adsorbed onto soil (Sherman *et al.*, 1990; Srivastava *et al.*, 1990; Wilson and Jones, 1993). Microbes essentially lack the capability to break down the non-aqueous phase complexes and, therefore, the higher molecular weight PAHs are relatively unavailable to biodegradation unless first solubilized. Because biodegradation of PAHs often is limited by low water solubility and dissolution rates, recent research has emphasized the use of surfactants to increase bioavailability (Srivastava *et al.*, 1990; Wilson and Jones, 1993; Tiehm, 1994). The enhanced bioavailability is reflected in the short half-life estimates observed in some studies using surfactants. These values should not be considered appropriate for use in PAH fate modeling under ambient conditions, but would be of value in planning remedial measures.

An additional factor contributing to variation in soil and groundwater half-life values is previous exposure of the microbial flora to PAHs (Wilson *et al.*, 1985; Herbes and Schwall, 1978; Heitkamp and Cerniglia, 1988; Heitkamp *et al.*, 1988; Sherman *et al.*, 1990). Soil organisms inhabiting pristine conditions prior to contamination must undergo an acclimatization period that may last from two weeks for two and three-ringed PAHs to several months for four to six-ringed PAHs. Projected half-life values resulting from studies which used acclimated soils or groundwater may be inappropriate for some environmental fate models, while estimates based on degradation rates during the initial acclimatization period (*e.g.* Herbes and Schwall, 1978) are invalid predictions of PAH transformation in nature.

An area of concern in evaluating half-life estimates based on scientific judgement for soil and groundwater (*i.e.* Howard *et al.*, 1991) is the assumption that predominantly anaerobic conditions slow biodegradation rates, thus increasing the half-life as observed for the BTEX compounds. While some studies indicate this may be the case for two and three-ringed PAHs (Mihalcic and Luthy 1988a), other studies suggest that oxygen availability may not be a big factor. In a study specifically designed to examine factors affecting biodegradation of phenanthrene, soil aeration was noted to enhance the mineralization rate only slightly (Manilal and Alexander, 1991). Additionally, the anaerobic degradation of naphthalene in sulfate reducing groundwater was approximately five times faster than that predicted in a computer model (Thierrin *et* *al.*, 1993). McFarland and Sims (1991) used a method to evaluate redox conditions during mineralization of PAHs in soil and groundwater based on free energy liberated from heterotrophic PAH metabolism. The resulting microbial yields determined that Mn^{+4} was a preferred electron acceptor over O_2, and that NO_3^{-1} and Fe^{+3} approximated O_2 in energy yield from PAH oxidation. A study of PAH degradation in soil following chemical oxidant pretreatment supported the concept that manganese is a favorable electron acceptor (Srivastava *et al.*, 1990). This is one area where further research is necessary.

Evaluation of a Soil Study

The British study by Wild *et al.* (1991) warrants examination prior to further discussion of soil half-lives because the resulting estimates were extraordinarily higher than those of other studies (by a factor of 1 to >10). This was a long-term project examining the effects of four metals (Cu, Cr, Ni, Zn) on PAH degradation in municipal waste-fertilized soils. PAH and metal laden sludge was applied to pristine (Luddington) and previously exposed (Lee Valley) soils. Though metals (especially nickel) inhibited PAH degradation at both sites, the magnitude of inhibition differed sharply. While the Lee Valley half-lives were reported to be comparable to values from a literature data base, those from Luddington ranged from 1 to >10 years longer. The authors noted that several complicating variables were involved (Wild *et al.*, 1991; Wild and Jones, 1993).

First, total PAH concentrations at both control sites more than doubled between the initial (1968) and the final (1988) measurement as a result of atmospheric deposition. Their calculations of half-life estimates factored this out, and therefore uncontrolled contamination probably did not contribute to PAH longevity. A follow-up study demonstrated that the four year duration between post-treatment sample analyses was a major cause of the high estimates. The use of spatial moments analysis in calculating half-lives from the twenty-year data set was most likely a major contributor to the overestimation of half-life values. This method fails to factor out the persistence of residual amounts of PAHs. Though the authors ruled out differences in microbial degradative competency, they did believe differences in physical/chemical parameters between soil types to be major contributors to the variations in the overall degradation rates of PAHs (Wild and Jones, 1993).

As a result, the 1991 study was considered anomalous and was not utilized in determining appropriate expected PAH half-life estimates for Kentucky soil contaminated by UST leaks. However, two observations from this research should be considered important to the initial location and ultimate remediation of UST sites: 1) metals or other non-PAH contaminants may adversely affect environmental conditions, compounding problems resulting from UST leakage; and 2) unrecognized ambient conditions may drastically alter the longevity of these compounds.

Half-lives for Two and Three-Ringed PAHs

The two and three-ringed PAHs (Tables AII-2 to AII-5) naphthalene, acenaphthene, anthracene, and fluorene are considered together in this document because of similarities in water solubility, half-life, and non-carcinogenicity. Half-life values in air and surface water are typically short (hours to days), and the degradation rate is influenced primarily by abiotic processes. Values in soil and groundwater are longer (weeks), and microbial degradation is the principal determinant of half-life duration. Volatilization of PAHs from soils appears to be a negligible process for all compounds except naphthalene and the substituted PAHs (Park *et al.*, 1990; Wild *et al.*, 1991).

Air and Surface Water

Atmospheric half-lives of two and three-ringed PAHs are influenced by rapid degradation, which occurs primarily by photo-oxidation with hydroxyl radicals or through photolysis. Half-life values for the representative compounds ranged from 0.58 hours for the photolytic rate of anthracene (Mackay *et al.*, 1992) to 68.1 hours for the photooxidation of fluorene (Howard *et al.*, 1991).

Half-life estimates for these compounds in surface water ranged from 0.58 hours for the photolysis of anthracene to 60 days for the biodegradation of fluorene. Values for naphthalene ranged from <1 day for field observation data in the Rhine River (Zoeteman *et al.*, 1981), to 53 days for a biodegradation study using filtered harbor and river water inoculated with acclimated bacteria

(Vaishnav and Babeu, 1987). Considering that the accepted volatilization half-life for this compound is 16 hours (Mackay *et al.*, 1992), a one day estimate for fifty percent degradation is reasonable. Based on the literature for acenaphthene and anthracene (Tables AII-3 and AII-4), a half-life estimate of 1 week would be considered conservative. Because of the paucity of information for fluorene, the 32-60 day estimate based on a soil die-away test (Howard *et al.*, 1991) should be adopted.

Soil

Given that underground storage tanks typically leak diesel fuel directly into soil, and that movement of PAHs in soil is inhibited by low water solubility, soil half-life estimates of PAHs are most relevant. Biodegradation is the primary transformation mechanism of two and three-ringed PAHs. Half-life values of the representative two and three-ringed PAHs in soil ranged from a low value of 0.02 weeks to a maximum of 6 months. The low value was determined for the degradation of naphthalene in stream sediments that had been previously exposed to PAHs (Shiaris *et al.*, 1989). The high estimate was calculated from the December transformation rate constant of naphthalene degradation in stream sediments that had no prior contamination history (Herbes and Schwall, 1978). Most values for naphthalene, acenaphthene, anthracene, and fluorene fell between 2 days for acclimated soil and 102 days for unacclimated soil.

Environmental half-life estimates for naphthalene in soil

(Table AII-2) ranged from approximately 5 hours in acclimated stream sediments in October and November (Herbes and Schwall, 1978) to approximately 6 months for pristine stream sediments based on the mineralization rate constant in December (Herbes and Schwall, 1978). One estimate of 46 weeks (Wild *et al.*, 1991) apparently was a typographical error in the journal article and pertained to the 6 month rate mentioned above. The majority of values noted in the literature were less than two months. The 35 ± 17 day value from a data base (Sherman *et al.*, 1990) appears to be an appropriate half-life for most circumstances encountered.

Reported half-life estimates for acenaphthene (Table AII-3) ranged from 0.04 week for a contaminated soil column pretreated with a chemical oxidant (Sherman *et al.*, 1990; Wild *et al.*, 1991) to a maximum between 2 and 3.2 years averaged from 5 unacclimated sandy loam fields, 4 of which were contaminated by metals (Wild *et al.* 1991). The Sherman *et al.* (1990) value of 51 ± 19 days, a mean value of studies through 1988, appears to be a representative half-life estimate for acenaphthene.

Soil half-life estimates for anthracene (Table AII-4) ranged from 2.3 days in acclimated stream sediment during October (Herbes and Schwall, 1978) to <7.9 years for unacclimated fields contaminated with heavy metals (Wild *et al.*, 1991). Though most soil half-life estimates were less than 90 days, it should be noted that the value obtained from a 0.5% organic matter sandy loam static flask test was 134 days with 95% confidence interval between

106-182 days (Park *et al.*, 1990). Overall, anthracene appears to be more persistent than other two and three ring PAHs, so use of the latter half-life estimate for predicting the environmental fate of this compound is conservatively appropriate.

Soil estimates for fluorene (Table AII-5) were least variable of all PAHs, and ranged from >1 day for an acclimated soil column pretreated with chemical oxidants to a maximum of 2.3 years for copper contaminated soil (Wild *et al.*, 1991). In the latter study, fluorene was almost completely degraded in the nine other fields when they were first sampled two years after application. The only half-life value >60 days for fluorene was that for the copper contaminated soil. The 41 day half-life (with a 95% confidence interval of 35-52 days) taken from a data base (Sherman *et al.*, 1990) appears inclusive for all except the most adverse conditions.

Groundwater

The half-life estimates for naphthalene in groundwater (Table AII-2) ranged from less than one week for a biologically remediated acclimated aquifer (Wilson *et al.*, 1985) and for an aerobic static flask test (Tabak *et al.*, 1981) to 258 days for a theoretical estimate based on the mineralization rate constant for pristine sediments in December noted previously (Howard *et al.*, 1991). Upon considering three studies which actually measured naphthalene degradation in aquifers (Wilson *et al.*, 1985; Boggs *et al.*, 1993; Thierrin *et al.*, 1993), the half-life of 76 ± 23 days (Boggs *et al*, 1993) would be an appropriate predictive estimate for most circumstances.

PAHs adsorb to the soil phase of the subsurface environment in so strong a manner that the measured desorption rate may be twenty-fold less than that predicted by their water solubility values (Wilson and Jones, 1993; Kan *et al.*, 1994). The few available studies of PAHs in groundwater reflect the limited occurrence of and/or the lack of importance that has been placed on this phenomenon. Despite this, the possibility of PAH groundwater contamination exists, especially by the more soluble two and three-ringed PAHs. Biodegradation is the primary transformation process in groundwater (Srivastava *et al.*, 1990; Wilson and Jones, 1993). Half-life values for the low molecular weight PAHs ranged from less than 1 week for naphthalene, acenaphthene and fluorene to 900 days for anthracene.

The half-life estimates for acenaphthene presented in Table AII-3 ranged from less than 1 week (Wilson *et al.*, 1985) in an acclimated aquifer to 204 days estimated from a Derby soil column (Howard *et al.*, 1991). The only reported field values of untreated groundwater were 5.5 - 7.5 weeks for an unacclimated aquifer (Wilson *et al.*, 1985). The fact that this estimate is for an aquifer without either previous exposure to PAHs or enhanced conditions for biodegradation makes it a good representative half-life for predicting acenaphthene transformation rates.

Groundwater estimates presented in Table AII-4 for anthracene were 1-4 weeks for 5-10 mg/L of compound in an inoculated aerobic static flask test (Tabak *et al.*, 1981) and 100 - 900 days representing scientific judgements based on the results of a die-away test for soil (Howard *et al.*, 1991). Given that anthracene soil half-life values and those observed in the static flask test above were longer than those observed for the other two and three-ringed PAHs, it is expected that anthracene may be degraded at a slower rate than comparably sized PAHs. The lower transformation rates predicted by Howard *et al.* (1991) typically were more comparable to the observed norm than were high estimates. Therefore, it is reasonable to anticipate natural groundwater anthracene values ranging between 100-250 days.

Half-life estimates presented in Table AII-5 for fluorene ranged from <1 week for a biologically treated aerobic aquifer (Wilson *et al.*, 1985) to 120 days calculated from a soil die-away test (Howard *et al.*, 1991). In the sole field study of a contaminated unacclimated aquifer, half-lives of 5 to 8 weeks were observed (Wilson *et al.*, 1985). This 5 to 8 week range seems appropriate for use in predicting environmental fate for fluorene under most natural circumstances.

Half-lives for Four and Five-Ringed PAHs

The representative four and five-ringed PAHs considered in this document are fluoranthene, pyrene, chrysene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene (Tables AII-6 through AII-12). With the exceptions of fluoranthene and pyrene, these compounds are carcinogenic, making their half-lives of particular concern. In the discussion which follows, the higher molecular weight PAHs have been grouped together because they share characteristics influencing their environmental fate and longevity. Because of their large size and hydrophobic properties (*e.g.* high K_{ow}s and K_{oc}s), water solubility is low to negligible and a hysteretic effect is exhibited as a result of the high degree of binding to soil particles. These properties are fortuitous in that they render four and five-ringed PAHs immobile, thus greatly limiting any environmental hazard they may pose to the immediate depositional area. Recalcitrant biodegradation is characteristic of these PAHs, as they are not readily bioavailable and their large molecular size may inhibit bacterial assimilation. Ultimately, these compounds are more persistent within soil than the lower molecular weight PAHs.

Air and Surface Water

Half-life estimates for the four and five-ringed PAHs (Tables AII-6 through AII-12) in air ranged from 0.33 to 34.9 hours. These were based on estimated photooxidation rate constants for the reaction with hydroxyl radicals in air (Howard *et al.* 1991), ozone in a simulated atmosphere (IRIS, 1991) or photolytic rate derived from irradiated degradation in either aqueous or methanolic medium (Howard *et al.*, 1991). Because of the insignificant volatilization of most PAHs from soil (Park *et al.*, 1990) and the short half-life in air, potential atmospheric hazard of diesel fuel leakage from a

UST would be negligible. Photolytic half-life values of the higher molecular weight PAHs in surface waters ranged from 0.33 day for benzo(a)pyrene (Miller *et al.*, 1988) to 200 days at 5-meter depth for fluoranthene (Mackay *et al.*, 1992). Biodegradation rates in water ranged from less than a day for aerobic bacterial culture medium for fluoranthene and pyrene, (Heitkamp and Cerniglia, 1988) to 11 years based on a theoretical judgement derived from an unacclimated anaerobic soil half-life for chrysene (Howard *et al.*, 1991). The majority of estimates predicted complete degradation within a few days. Photolysis and particulate adsorption are likely the dominant fate mechanisms in surface waters, with microbial degradation having a minor role in deeper water. Because of low solubility, concentrations of four and five-ringed PAHs in water receiving contaminated effluents were difficult to distinguish from baseline and were between 600 to 1000 times greater in the underlying sediments (Herbes and Schwall, 1978). Therefore, it may be concluded that these compounds do not persist in surface water.

Soil

The literature half-life values for the four and five-ringed PAHs were highly variable and ranged from less than one day for pyrene and fluoranthene in surfactant treated acclimated soil columns (Srivastava *et al.*, 1990; Tiehm, 1994) to 14.2 years for benzo(a)anthracene calculated from the mineralization rate constant observed in unacclimated stream sediments in December (Herbes and Schwall, 1978). Overall, these compounds tend to persist significantly longer than the smaller two and three-ringed PAHs, and this longevity increases with size and ring number.

Half-life values for fluoranthene (Table AII-6) ranged from <1 day (Srivastava *et al.*, 1990) to 7.8 years for unacclimated metal contaminated soils (Wild *et al.*, 1991). The Kidman sandy loam values derived in the study by Park *et al.* (1990) were of particular interest as reliable half-life predictors. The organic carbon content of 0.5% was similar to that expected for the Kentucky UST subsurface soil depths. Half-life estimates from this triplicate, 196 day, unacclimated soil static flask test were calculated using first order kinetics. This is a conservative approach considering the extensive acclimation periods that exist for larger PAHs. The fluoranthene half-life estimated from this study was 377 days with 95% confidence intervals of 277 to 578 days. This result fell within the middle of the confidence intervals derived from the data base developed by Sherman *et al.* (1990) for a variety of conditions. Therefore, it was reasonable to assume that, for most UST-associated circumstances, fluoranthene half-life would coincide with the Kidman sandy loam study. It is likely that only the most extreme and adverse conditions would result in half-lives exceeding the 880-day upper limit noted by Sherman *et al.* (1990).

Half-life estimates for pyrene (Table AII-7) ranged from less than one day for surfactant (Tiehm, 1994) and oxidant (Srivastava *et al.*, 1990) treated soils to 8.5 years for Luddington soils contaminated with metals (Wild *et al.*, 1991). Values observed in other studies were scattered throughout this range. The Kidman sandy loam had one of the higher estimates, 260 days, with 95% confidence limits of 193 to 408 days (Park *et al.*, 1990). Two sources had greater estimates. The Luddington study produced anomalous results under adverse conditions (metal toxicity) (Wild *et al.*, 1991), and the upper end of the range noted by Howard *et al.* (1991) represented unfavorable temperature extremes for bacterial metabolic activity. Therefore, the Kidman sandy loam half-life of 260 days was selected as the value most applicable to the majority of situations.

Half-life estimates for chrysene (Table AII-8), the final four-ringed PAH considered in this study, ranged from approximately four days for a treated, acclimated soil column (Sims and Overcash, 1983) to 8.1 years for metal treated Luddington soils (Wild *et al.*, 1991). Most other observations from the literature fell within the range of 100 to 400 days. The Kidman sandy loam value of 371 days (with a 95% confidence interval of 289 to 531 days) is considered the most appropriate half-life for the majority of environmental circumstances. The upper end of the McLaurin sandy loam 95% confidence intervals from the same study (Park *et al.*, 1990) should include all except the most extraordinary conditions for chrysene degradation in soil.

The literature values for benzo(a)anthracene ranged from 0.6 weeks for a treated acclimated soil column (Sims and Overcash,

1983) to ~8 years estimated from the mineralization rate constant of unacclimated stream sediments in December (Herbes and Schwall, 1978) and the unacclimated metal contaminated Luddington fields (Wild *et al.*, 1991). Most studies in which the ambient environmental conditions were not unnecessarily manipulated resulted in half-lives between 100 and 300 days. The Kidman sandy loam estimate of 261 days with 95% confidence intervals of 210 to 347 days (Park *et al.*, 1990) was one of the highest noted for benzo(a)anthracene. In all except the most unusual circumstances, half-lives for benzo(a)anthracene in soils should be <347 days. Because of the duration of acclimation and the adverse temperatures for microbial metabolic activity, the calculated 8 year half-life from the rate constant of December unacclimated stream sediments (Herbes and Schwall, 1978) is unrealistic for conditions in Kentucky.

Benzo(a)pyrene in contaminated soils (Table AII-10) appeared to be more recalcitrant than the four and five-ringed PAHs previously discussed. Estimates ranged from 2 days (Wild *et al.*, 1991) for a treated acclimated soil column to 39.6 years calculated from the mineralization rate constant for unacclimated December stream sediments (Herbes and Schwall, 1978). The 309 day half-life with 95% confidence limits of 239-462 days for Kidman sandy loam approximated the median value. Because of the number of elevated values, 900 days is considered an appropriate upper limit. Half-lives for benzo(b)fluoranthene and benzo(k)fluoranthene (Tables AII-10 and AII-11) approximate those found for benzo(b)pyrene. A half-life estimate of 300 days would include approximately half of all circumstances, and 900 days would cover all except the most unusual conditions.

Groundwater

Two sources for groundwater half-lives of the four and five-ringed PAHs were found in the literature. Howard *et al.* (1991) provided a theoretical scientific judgement based on a soil die-away test, while Tabak *et al.* (1981) examined biodegradation in an aerobic static flask test inoculated with bacteria and 5-10 mg/L of compound. Because of the extremely low water solubility and tight adsorptive binding of the larger molecular weight PAHs, the groundwater half-lives of these hydrocarbons may be essentially inconsequential. PAH remediation research has focused recently upon the use of surfactant to increase bioavailability (Sherman *et al.*, 1990; Srivastava *et al.*, 1990; Aronstein *et al.*, 1991; Wilson and Jones, 1993; Kan *et al.*, 1994; Tiehm, 1994).

Ecotoxicology

Toxicity is an important consideration when assessing the environmental and ecological effects of chemicals. The environmental toxicology of many substances has been investigated using toxicity tests which expose a sensitive species to incremental concentrations of a given substance under acute or chronic conditions. An important parameter derived from these tests is the median lethal concentration (LC_{50}), the concentration at which 50% of the experimental population dies. This is used to compare the toxic effects of different compounds under a given set of conditions.

Naphthalene, acenaphthene, fluoranthene, and PAHs have been designated priority pollutants by the U.S. EPA which has promulgated quality criteria for water and human health protection for these compounds. These values are presented in Table AII-13, and U.S. EPA drinking water standards are provided in Table AII-14. For comparison, this table includes Commonwealth of Kentucky ambient water criteria and drinking water criteria. In addition, the U.S. EPA (1984) has designated benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and chrysene as B2 (probable) human carcinogens. Likewise, the International Agency for Research on Cancer (IARC, 1973; 1983) has designated these compounds as 2A (probable) or 2B (possible) human carcinogens.

The fresh water acute LOEL values for naphthalene, acenaphthene, and fluoranthene are 2.3, 1.7, and 3.96 mg/L, respectively. Fresh water chronic LOEL values for naphthalene and acenaphthene are 620 and 520 μg/L (U.S. EPA, 1986), respectively (Table AII-13). Although somewhat lower, the acute values above are in the same range (mg/L) as the freshwater acute LOELs for BTEX (Kercher *et al.*, 1995).

Criteria for the protection of human health from water and fish ingestion for acenaphthene, fluoranthene, and PAHs (10^{-6} cancer risk) are 20, 42, and 0.0028 μg/L, respectively (Table AII-13). The latter value also is equivalent to the Commonwealth of Kentucky drinking water maximum contaminant level (MCL) for PAHs (KDEP, 1990). For fish consumption only, the values for fluorene and PAHs are 54 and 0.0311 μg/L, respectively, for both the U.S. EPA and the Commonwealth of Kentucky.

According to the U.S. EPA Drinking Water Standards presented in Table AII-14, the MCL for benzo(a)anthracene is 0.0001 μg/L and that for benzo(b)fluoranthene, benzo(k)fluoranthene and chrysene is 0.0002 μg/L. No other MCLs were given. As indicated above, for PAHs the Commonwealth of Kentucky drinking water MCL is 0.0028 μg/L (Table AII-13). For PAHs in general, the water quality criterion for human health protection at 10^{-6} cancer risk is 0.0031 μg/L for drinking water; 0.0028 μg/L for drinking water and aquatic organisms; and 0.031 μg/L for aquatic organisms. These values also were used for the carcinogens benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene.

Animal testing of PAHs has been performed primarily to determine carcinogenicity and other hazards to human health. Aquatic ecotoxicity studies were found in the literature only for naphthalene, acenaphthene, and benzo(a)anthracene (Table AII-15). Acute and chronic LC_{50} values were determined from toxicity tests conducted in freshwater or saltwater. Both the acute and chronic LC_{50} values for the three compounds were in the mg/L range. By comparison, aquatic LC_{50} values for highly toxic metals generally are in the $\mu g/L$ range. Freshwater acute LC_{50} values for naphthalene ranged from 2.3 mg/L to 150 mg/L, while for acenaphthene the range was from 0.6 to 1.7 mg/L (72-hour freshwater LC_{50}s). For salt water species, the LC_{50}s ranged from 2.4 to 199 mg/L and 0.5 to 2.2 mg/L for naphthalene and acenaphthene, respectively. The chronic values of 0.62 mg/L for naphthalene (freshwater) and 0.71 mg/L for acenaphthene (saltwater) were approximately an order of magnitude less than acute values determined for these compounds with the same species. The third chronic value, an LC_{87} of 1 mg/L for benzo(a)anthracene, was comparable to the two LC_{50} chronic values.

Bioaccumulation

The tendency of a compound to partition from water into the tissue lipids of aquatic animals is termed bioconcentration. Continued bioconcentration of a substance over time can lead to bioaccumulation of the substance within an organism. Neely *et al.* (1974) demonstrated the relationship between bioconcentration and the *n*-octanol-water partition coefficient, P (or K_{ow}). The more lipophilic a compound, the greater its tendency to bioaccumulate which was not considered significant when P <1000 (Veith *et al.*, 1980). The ratio between the concentration of a substance in tissue lipids of an organism versus the ambient concentration in the water surrounding the organism is known as the bioconcentration factor (BCF). Veith *et al.* (1980) expressed the relationship between the BCF and P as the following modification of the original formula by Neely *et al.* (1974):

$$\log BCF = 0.76 \log P - 0.23$$

BCFs can be used to estimate the bioaccumulation potential of chemicals.

BCFs for the non-carcinogenic PAHs are presented in Table AII-16, and for carcinogenic PAHs in Table AII-17. Most bioconcentration measurements were made under equilibrium conditions. However, it is possible that biotransformation products of the parent PAH also were measured in some studies using radiolabeled compounds (Spacie *et al.*, 1983; ATSDR, 1994a,b), thus overestimating the BCF. Eisler (1987) reported BCFs for PAHs in crustaceans and fish to range between 100 and 2000. Although most BCF values in Tables AII-16 and AII-17 are <2000, values >2000 were observed in some species, especially for the higher molecular weight PAHs.

In a careful study conducted by the U.S. EPA (1980a), a BCF of 387 was determined for acenaphthene in *Lepomis macrochirus*. This value is probably representative for the lower molecular weight compounds because PAHs undergo biotransformation in fish (Eisler, 1987) and other estimates may include metabolic degradation products. This BCF value slightly exceeds those for BTEX (Kercher *et al.*, 1995). Freshwater and saltwater BCF values for naphthalene are uniformly low except for those in the algae *Selenastrum capricornutum*, which range from 6,918.3 to 17,728.8. However, with regard to the four-ringed non-carcinogenic PAHs which have higher

K_{ow}s than naphthalene, several BCFs exceed 2,000. These range from 2,691.2 for pyrene in *Daphnia magna* to 79,432.8 for fluoranthene in *Pontoporeia hoyi*.

The higher molecular weight carcinogenic PAHs with four to five rings have considerably higher K_{ow} values, ranging from 407,380 for benzo(a)anthracene and chrysene to 1,148,154 for benzo(a)pyrene and benzo(k)fluoranthene (Table AII-1). Many of the BCFs for these compounds in freshwater species exceed 2000 (3,162.3 for benzo(a)anthracene in algae to 141,253.8 for benzo(a)pyrene and benzo(b)fluoranthene in microorganisms). The low BCFs for saltwater species were measured in short-term experiments under non-equilibrium conditions and should be regarded as underestimates.

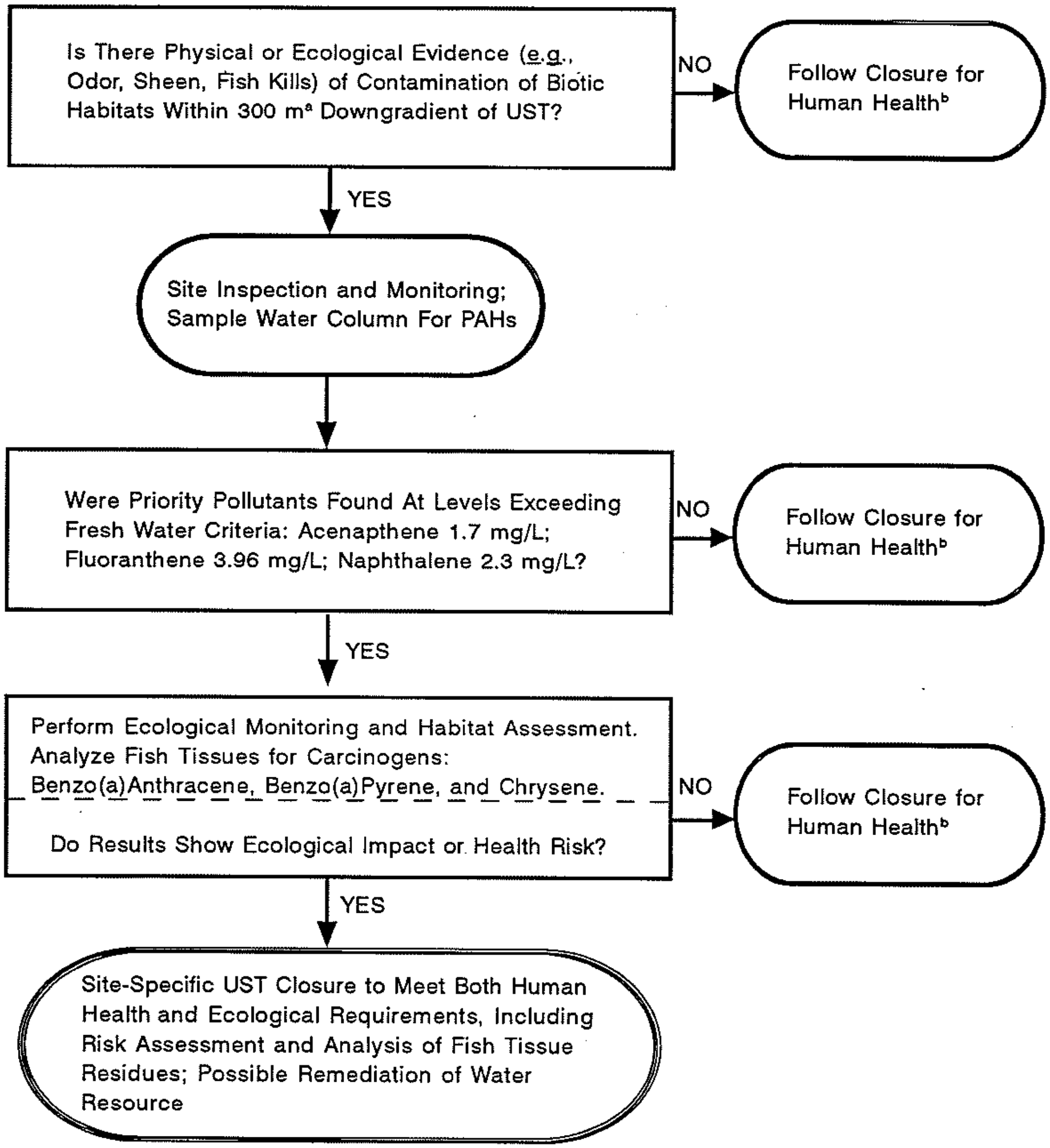
Although exceptions are evident (Tables AII-16 and AII-17), the PAHs tend to accumulate most in organisms associated with lower trophic levels (e.*g*. bacteria, microorganisms, algae, amphipods, cladocerans). Though bioaccumulation in these organisms indicates potential for biomagnification, it does not occur within food chains at higher trophic levels, according to a study by Eisler (1987). It was suggested that in many species rapid metabolism and biotransformation preclude extensive bioaccumulation. Likewise, reduced metabolism may contribute to bioaccumulation when it does occur in certain species.

Ecological Considerations for UST Remediation

Diesel fuel (herein represented by PAHs) leaking from a UST most commonly enters directly into the soil adjacent to the tank. Further migration from the site into surface waters, surface soil, groundwater or the atmosphere may become complex and involve many factors (McGinley, 1994). Available data suggests that, given the immobility of most PAHs in soil and the relatively small soil surface area involved (Sendlein *et al.*, 1994), contamination of terrestrial ecosystems beyond a UST site would be unlikely. Contamination of GW would be minimal unless leakage occurred directly into the saturated zone or an aquifer. However, the aquatic ecosystems of surface waters and wetlands could be at risk under certain conditions. In the aquatic environment, most PAHs are not highly water soluble or toxic and have short half-lives. Therefore, small releases of PAHS likely would not significantly impact surficial aqueous systems. Only entry of substantial quantities of PAHs as free-standing petroleum product potentially could have significant environmental impact. Such entry of large amounts of PAHs into surface waters and wetland systems could occur if 1) the UST were in close proximity (<300 meters; or <1000 meters if a karst conduit is near) and 2) some avenue for bulk transport existed. Possible avenues of bulk transport could include 1) karst systems or 2) man-made conduits (*e.g.* storm sewers, drainage ditches).

During remediation of a UST, surface waters within 300 meters downgradient of the site (within 1000 meters downgradient if near a karst conduit) should be evaluated according to the scheme presented in Figure AII-1. Any petroleum spill should be contained and removed as provided under State guidance (NREPC, 1992; 1995). Evidence of oil sheens, odors, biotic impact (*e.g.* fish kills) or PAH contamination within the freshwater system would trigger monitoring of the water column. If exceedences of acute aquatic criteria for naphthalene, acenaphthene, or fluoranthene occurred (Table AII-13), the site should be identified for continued monitoring at monthly or bimonthly intervals. If the contamination does not meet specified guidelines (Figure AII-1) within six months to one year after the UST remediation has been undertaken, a site-specific ecological assessment should be considered depending upon the use classification of the resource. This would include habitat assessment and chemical monitoring continued according to criterion specifications (*e.g.* 96 hours). Also, fish tissues would be analyzed for the carcinogens benzo(a)pyrene, benzo(a)anthracene, and chrysene. If there were ecological impact, or health risk, closure would be site-specific and entail a more comprehensive ecological study with risk assessment and analyses of fish tissue residues. Otherwise, closure for human health would proceed based on distance to receptor (*e.g.* 0-100, 100-300, >300 meters). UST closure information is provided in the text of *Risk Assessment Plan for Petroleum Underground Storage Tanks (USTs) in Kentucky, Part II: Diesel, Heating Oil, Other Middle Distillates and Waste Oil* (Birge *et al.*, 1995).

FIGURE AII-1
DECISION TREE FOR UST CONTAMINATION OF SURFACE WATER SYSTEMS - PAHs



[a] If UST Near Karst Conduit, Survey Freshwater System up to 1000 m Downgradient.

[b] Use Matrix Values Based On Distance to Receptors (i.e., 0-100 m, 100-300 m, >300 m).

Conclusions and Recommendations

- Conclusion: In their physical and chemical properties, PAHs tend to form two groups, compounds with two or three rings and compounds with four or more rings. PAHs with two or three rings and lower molecular weights have properties intermediate between BTEX compounds and the PAHs with four or more rings.

- Conclusion: PAHs with two or three rings have low water solubility, moderate volatility, and moderate to high soil adsorption and lipid solubility. PAHs with four or more rings tend to be essentially insoluble, with low volatility, high lipid solubility and high soil sorption. This combination of properties makes the high molecular weight PAHs less mobile and less bioavailable in the environment than the low molecular weight compounds.

- Conclusion: The lower molecular weight two and three-ringed compounds have relatively short half-lives of days to weeks, whereas the higher molecular weight four or five-ringed compounds have longer half-lives of weeks to years.

- Conclusion: Half-lives of all PAHs in air and surface waters generally are short (hours to days) due to abiotic forces (*e.g.* adsorption to particulates, photooxidation, photolysis, volatilization).

- Conclusion: Generally, PAH half-lives in soil and groundwater increase as size and ring number increase. Greater adsorption of the compounds to soil particles effectively eliminates their bioavailability to microorganisms. Volatilization from soil is inconsequential in all PAHs considered except naphthalene.

- Conclusion: Microfaunal communities must develop metabolic capabilities during an acclimation period. Therefore, PAH half-lives generally are lower in soils and sediments with a prior history of PAH contamination.

- Conclusion: Groundwater contamination potentially could occur by two and three-ringed PAHs leaking from a UST if it were located within proximity of an aquifer or karst system. Despite their long half-lives, PAHs of four or more rings are immobile with essentially no potential for groundwater contamination.

- Conclusion: Based upon the available toxicity values, which are in the mg/L range similar to those for BTEX, PAHs are slightly to moderately toxic in the aquatic environment. It is likely that only releases in quantities sufficient to sustain ambient PAH concentrations exceeding the acute freshwater criteria would have significant environmental impact.

- Conclusion: Based upon the available data for the aquatic environment, the higher molecular weight, more lipophilic PAHs may bioconcentrate in some species. However, bioconcentration of PAHs in general is not considered to be important in the environment. Biomagnification within food chains does not occur to any great extent because PAHs are readily metabolized in many species.

- Recommendation: Clean-up and remediation of diesel fuel leaks based on the more conservative human health criteria for PAHs should be protective of freshwater biota as well. Such efforts should minimally meet the acute freshwater criteria, which are respectively: naphthalene, 2.3 mg/L; acenaphthene, 1.7 mg/L; and fluoranthene, 3.96 mg/L.

- Recommendation: Surface water and wetland ecosystems significantly contaminated by diesel fuel likely would represent complex situations which should be evaluated on a site-specific basis.

Table AII-1. Physical-Chemical Constants[a] for Selected PAHs/BTEX

	RFD_{oral} mg/kg/D[b]	H_2O Sol mg/L	K_{oc} L/kg	H atm-m^3/mol	V_p mm Hg	K_{ow}
Naphthalene	$4x10^{-2}$ (w)	[e]32	[e]930	[e]$4.6x10^{-4}$	[e]$8.7x10^{-2}$	[e]1,900
Acenaphthene	$6x10^{-2}$	[c]3.8	4,571	[d]$2.6x10^{-3}$	$4.5x10^{-3}$	9,550
Fluorene	$4x10^{-2}$	[c]1.90	7,224	$6.4x10^{-5}$	$7.1x10^{-4}$	15,136
Anthracene	$3x10^{-1}$	[c]0.07	14,125	$8.6x10^{-5}$	[c]$7.5x10^{-6}$	28,184
Pyrene	$3x10^{-2}$	0.132	38,019	[c]$1.2x10^{-5}$	$2.5x10^{-6}$	75,858
Fluoranthene	$4x10^{-2}$	[c]0.26	38,019	$6.5x10^{-6}$	$5x10^{-6}$	79,433
Benzo(a)anthracene	--	[c]$1.1x10^{-2}$	199,526	$1x10^{-6}$	[c]$2.1x10^{-7}$	407,380
Benzo(b)fluoranthene	--	[c]$1.2x10^{-3}$	549,541	$1.2x10^{-5}$	[c]$1.6x10^{-7}$	1,096,478
Benzo(k)fluoranthene	--	$8.1x10^{-4}$	549,541	$3.9x10^{-5}$	$5x10^{-7}$	1,148,154
Benzo(a)pyrene	--	$3.8x10^{-3}$	5,495,409	$4.9x10^{-7}$	$5.6x10^{-9}$	1,148,154
Chrysene	--	$2x10^{-3}$	199,526	$1.1x10^{-6}$	$6.3x10^{-9}$	407,380
O-Xylene	2	[c]175	[c]48-68	[c]$5x10^{-3}$	[c]6.6	[c]1,318
Toluene	$2x10^{-1}$	[c]534.8	[c]37-160	[c]$5.9x10^{-3}$	[c]28.2	[c]537

[a]ATSDR, 1994b. Toxicological Profile for PAHs.
[b]U.S. EPA, 1995. Risk-based Concentration Table. (w) = value withdrawn.
[c]Mackay *et al.*, 1992.
[d]Fendinger and Glotfelty, 1989.
[e]ATSDR, 1994a. Toxicological Profile for Naphthalene.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Soil

Study	Half life Estimates:	Notes:
Sherman *et al.* 1990	35 ± 17 days	Mean and standard deviation from data base of half-life literature to 1988.
Wild *et al.* 1991	< 2.1 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 contaminated by 1 metal each.
	0.02 - 46 weeks	Range from 5 studies between 1978-90 and Lee Valley soil. 46 weeks is typographical error in journal article (See Herbes and Schwall 1978).
Heitkamp *et al.*, 1988	< 2 weeks	Sediment-water microcosm inoculated with *Mycobacterium*.
	~24 days, average of 4 tests	Aqueous Soil- Organic content= 2.9%. Lab test, denitrifying conditions. Barnes-Hamerly soil, unacclimated soil.
Shiaris, 1989	6.5 - 17.5 days	Contaminated estuarine sediments (Range of 3 studies)
	10 - 143 days	Non-contaminated estuarine sediments (2 studies)
	0.2 days	Contaminated stream sediment.
	> 21 days	Non-contaminated stream sediment.
	22.5 - 31 days	Reservoir sediment (2 studies)
Wild and Jones, 1993	28 ± 16 days	Mean from four soil types. Sludge application aerobic microcosm.
	15 days	Spiked soil aerobic microcosm.
Herbes and Schwall, 1978	~5.0 hours	Calculated from rate constant for PAH-contaminated stream sediments in October and November.
	~16 weeks	Calculated from same stream in December.
	~6 months	Calculated from rate constant for uncontaminated stream sediment in December.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Soil (cont.)

Study	Half-life Estimates:	Notes:
Mihelcic and Luthy, 1988a	~3 days	Aqueous mixture. Aerobic Microbial.
	No degradation after 65 days	Aqueous mixture. Anaerobic Microbial.
	23 - 35 days	Aqueous mixture. Varied denitrifying conditions.
Herbes, 1981	8.9 hours	Calculated from mean rate constant over 2-year period. Stream sediments below coal-coking plant.
Walker *et al.*, 1975	42 days	South Louisiana mixture from estuary sediments.
Al-Bashir *et al.*, 1990	~43 days	Aerobic marine sediment slurry.
	~25 days	50 ppm naphthalene in soil/water slurry - denitrifying conditions.
	33 days	200 ppm naphthalene in soil/water slurry - denitrifying conditions.
	33 days	500 ppm naphthalene in soil/water slurry - deniftrifying conditions.
Park *et al.*, 1990	2.1 days; 1.7 - 2.7 days, 95% C.I.	Kidman sandy loam. Organic content 0.5%, pH= 7.9, unsaturated, 25°C, aerobic. Soil die-away test.
	1.7 - 3.4 days, 95% C.I.	McLaurin sandy loam. 1.1% organic content, pH= 4.8, 25°C, aerobic, unsaturated. Soil die-away test.
Howard *et al.*, 1991	16.6 - 48 days	Estimate based on soil die-away test.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Surface Water

Study	Half-life Estimates:	Notes:
Walker *et al.*, 1975	20.6 days	South Louisiana crude mixture from estuary.
Heitkamp *et al.*, 1988	2.4 weeks	Sediment from estuary with previous petrochemical contamination.
	3.5 weeks	Sediments from estuary not previously exposed to petrochemicals; with agri-chemicals.
	4.4 weeks	Pristine sediments.
Srivastava *et al.*, 1990	15 minutes	Liquid culture with PAH-degrading bacteria.
ATSDR, 1994a	7 days	Polluted water, biodegradation rate.
ATSDR, 1994a	~1 days	Estimated based on biodegradation by bacteria and multicellular animals.
Vaishnav and Babeu, 1987	39 days	Filtered harbor and river water with nutrients and acclimated microbes added, static aerobic flask.
	43 - 53 days	Filtered harbor and river water with only acclimated microbes added.
Arvin *et al.*, 1989	<5 days	100% degradation prior to end of aerobic static flask test in mineral basal salt medium with acclimated bacteria added.
Zoeteman *et al.*, 1981	<1 day	Field observation data from Rhine River water.
Mackay *et al.*, 1992	16 hours	Volatilization at 0.5m depth, wind velocity 1m/sec.
Howard *et al.*, 1991	12 hours - 20 days	Theoretical estimate based on aqueous die-away test.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Wilson *et al.*, 1985	< 1 week 4 - 14 weeks	Below 1 ng/g at time of first sampling interval; contaminated aquifer (creosote). Untreated contaminated pristine aquifer.
Boggs *et al.*, 1993	76 days (99 + 53 days)	Mean from spatial moments and time-series analyses following injection of radiolabelled naphthalene into aquifer.
Thierrin *et al.*, 1993	33 ± 6 days 160 ± 20 days	Anaerobic half-life, groundwater tracer test in sulfate reducing Bassendean sands. Preliminary data, computer modelled prediction.
Vaishnar and Babeu, 1987	28 days	Filtered groundwater with acclimate bacteria and nutrients added. Static flask, pH= 8.7, aerobic conditions.
Tabak *et al.*, 1981	<1 week	100% degradation after 1 week, aerobic static flask test.
Zoeteman *et al.*, 1981	0.6 year	Estimated from groundwater data beneath waste dump site based on adsorption behavior.
Howard *et al.*, 1991	24 hours - 258 days	Theoretical estimate, based on unacclimated aerobic and anaerobic biodegradation half-lives of sediments.

Environmental Half-life Estimates for Naphthalene: Air

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	2.96 - 29.6 hours	Theoretical estimate based on photooxidation rate constant for reaction with hydroxyl radical.

Table AII-3. Environmental Half-life Estimates for Acenaphthene: Soil

Study	Half-life Estimates:	Notes:
Walker *et al.*, 1975	28 days	South Louisiana crude mixture from estuary.
Sherman *et al.*, 1990	51 ± 19 days	Mean and standard deviation from data base of half-life literature to 1988.
Wild *et al.*, 1991	< 3.2 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 contaminated by 1 metal each.
	0.04 - 6 weeks	Range from 5 studies between 1978-90.
		Half-lives were for fluorene and acenaphthene combined.
Mihelcic and Luthy, 1988a	6 days	Aqueous mixture. Aerobic microbial degradation.
	No degradation after 65 days	Aqueous mixture. Anaerobic microbial degradation.
	~30 days	Aqueous mixture. Denitrifying conditions.
Mihelcic and Luthy, 1988b	~54 days	Aqueous soil- Organic content= 2.9%. Lab test, denitrifying conditions; Barnes-Hamerly soil, unacclimated soil.
IRIS, 1994	10 - 60 days	Sandy loam. Aerobic soil column test.
	42.5 - 102.2 days	Oil sludge in Derby soil column. These are same studies that produced Howard *et al.* half-life values.
Wild and Jones, 1993	65 ± 14.3 days	Mean of four soil types. Sludge application aerobic microcosm.
	28 days	Spiked soil aerobic microcosm.
		Half-lives were for fluorene and acenaphthene combined.
Howard *et al.*, 1991	12.3 - 102 days	Aerobic soil column test.

Table AII-3. Environmental Half-life Estimates for Acenaphthene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
Walker *et al.*, 1975	>28 days	South Louisiana crude mixture from estuary sediments.
IRIS, 1994	24.8 days	Water without suspended solids. Biodegradation.
	0.83 - 4.91 days	Water with suspended solids. Biodegradation.
Howard *et al.*, 1991	3 hours - 12.5 days	Scientific judgement based on estimate rate of photolysis in water.

Table AII-3. Environmental Half-life Estimates for Acenaphthene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
IRIS, 1994	<1 week	Acclimated groundwater aquifer soil, 25°C. Average rate was 130% degradation/week.
	~8 weeks	Unacclimated groundwater soil, 25°C.
Tabak *et al.*, 1981	<1 week	95-100% biodegradation after 1 week in aerobic static flask test with groundwater.
Wilson *et al.*, 1985	5.5 - 7.5 weeks	Untreated contaminated aquifer.
	<1 week	Treated acclimated creosote contaminated aquifer. Below 1 ng/g at the time of first sampling interval.
Howard *et al.*, 1991	24.6 - 204 days	Scientific judgement based on estimated aqueous aerobic biodegradation from soil die-away test.

Environmental Half-life Estimates for Acenaphthene: Air

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	0.879 - 8.79 hours	Scientific judgement based on estimated photooxidation rate in air.

Table AII-4. Environmental Half-life Estimates for Anthracene: Soil

Study	Half-life Estimates:	Notes:
Sherman *et al.*, 1990	31 days; 23 - 40 days, 95% C.I.	Mean and confidence intervals from data base.
Tiehm, 1994	3 weeks	Aerobic soil medium, *Mycobacterium sp.* treatment; 30°C, pH= 7.0, PAHs only source of carbon and energy.
	5 - 12 weeks	Same condition, treated with surfactants at various concentrations (0.5 - 4 mM).
Mackay *et al.*, 1992	17 - 45 days	5 mg/kg and 50 mg/kg treatment.
	3.3 - 175 days	Aerobic soil die-away test.
Park *et al.*, 1990	134 days; 106 - 182 days; 95% C.I.	Kidman sandy loam, 0.5% organic matter, -0.33 bar soil moisture, pH=7.9, 25°C.
	50 days; 42 - 61 days; 95% C.I.	McLaurin sand loam, 1.1% organic matter, -0.33 bar soil moisture, pH= 4.9, 25°C.
Herbes, 1981	7 - 28.5 days	Calculated from mineralization rate of acclimated and unacclimated sediments.
	10 days	Calculated from mean mineralization rate in sediments from 3 site collected year round.
Herbes and Schwall, 1978	2.3 - 4.2 days	Transformation in acclimated stream sediment (200g/L H_2O) in October and November.
	8.33 days	Calculated from acclimated stream sediments (200g/L H_2O) in December.
	83.3 days	Calculated from rate constant anthracene mineralization in pristine stream sediments (200g/L H_2O) in December.
Wild and Jones, 1993	141 ± 77.9 days	Mean from four soil types. Sludge application aerobic microcosm.
	48 days	Spiked soil aerobic microcosm.
Howard *et al.*, 1991	50 - 450 days	Aerobic soil die-away test.

Table AII-4. Environmental Half-life Estimates for Anthracene: Surface Water

Study	Half-life Estimates:	Notes:
Mackay *et al.*, 1992	1.4 - 3.5 hours	Degradation under midsummer light conditions in shallow, fast, clear water.
	8.5 - 21.6 hours	Degradation under midsummer light conditions in deep, slow-moving, clear and muddy waters.
	0.75 hours	Photochemical transformation rate in midsummer, midday sunlight at surface.
	4.5 days	Photolysis rate at 5m depth in midsummer sunlight.
Howard *et al.*, 1991 Mackay *et al.*, 1992	0.879 - 8.79 hours 0.58 - 1.7 hours	Photolytic rate in water. Photolytic rate in air.

Environmental Half-life Estimates for Anthracene: Ground Water

Study	Half-life Estimates:	Notes:
Tabak *et al.*, 1981	1 - 2 weeks	Aerobic static flask following inoculated with bacteria; 5 mg/L.
	3 - 4 weeks	Same conditions; 10 mg/L concentration anthracene.
Howard *et al.*, 1991	100 - 900 days	Scientific judgement based on aqueous aerobic biodegradation estimated from soil die-away test.

Environmental Half-life Estimates for Anthracene: Air

Study	Half-life Estimates:	Notes:
Howard *et al.*, 1991	0.879 - 8.79 hours	Based on photolytic half-life in water.
Mackay *et al.*, 1992	0.58 - 1.7 hours	Photolytic half-life in air

Table AII-5. Environmental Half-life Estimates for Fluorene: Soil

Study	**Half-life Estimates:**	**Notes:**
Sherman *et al.*, 1990	41 days; 35 - 52 days, 95% C.I.	Compiled data base.
Tiehm, 1994	5 - 7 days <3 days	Bacteria without surfactant. Bacteria with surfactant.
Srivastava *et al.*, 1990	~4 days <1 day	Soil-water column. Soil-water column pretreated with oxidant.
Wild *et al.*, 1991	<2.0 years 3 days - 6 weeks	Mean half-life from 4 metal contaminated and 1 rural Luddington soils. Range from 5 studies in literature 1978-1990 and Lee Valley soils. Half-lives were for fluorene and acenaphthene combined.
Wild and Jones, 1993	65 ± 14.3 days 28 days	Mean from four soil types. Sludge application aerobic microcosm. Spiked soil microcosm. Half-lives were for fluorene and acenaphthene combined.
Howard *et al.*, 1991	32 - 60 days	Based on aerobic soil die-away test.

Table AII-5. Environmental Half-life Estimates for Fluorene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
Weissenfels *et al.*, 1990	36 - 48 hours	Aqueous aerobic mineral salt medium, pH= 7.2, 30°C, inoculated with *Pseudomonas vesicularis*.
Howard *et al.*, 1991	32 - 60 days	Based upon aerobic soil die-away test.

Environmental Half-life Estimates for Fluorene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Tabak *et al.*, 1981	<1 week	Calculated from static flask degradation of aquifer material.
Mackay *et al.*, 1992	~1.7 weeks	Calculated from degradation rate in aquifer material by bacteria.
Wilson *et al.*, 1985	<1 week 5 - 8 weeks	Biologically treated contaminated aquifer. Untreated contaminated pristine aquifer.
Howard *et al.*, 1991	64 - 120 days	Scientific judgement based upon estimated unacclimated aerobic soil die-away test.

Environmental Half-life Estimates for Fluorene: Air

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	6.81 - 68.1 hours	Scientific judgement based upon estimated photooxidation half-life in air.

Table AII-6. Environmental Half-life Estimates for Fluoranthene: Soil

Study	Half-life Estimates:	Notes:
Sherman *et al.*, 1990	75 days; 68 - 72 days, 95% C.I.	Mean and confidence intervals derived from data base.
Mackay *et al.*, 1992	34 - 39 days	50 mg/kg and 5 mg/kg treatments.
Park *et al.*, 1990	268 days; 173 - 630 days, 95% C.I.	McLaurin sandy loam.
	377 days; 277 - 578 days, 95% C.I.	Kidman sandy loam.
Tiehm, 1994	39 - 45 hours	Different treatments of surfactant and bacteria. Aerobic soil medium; 30°C, pH= 7.0, PAHs only source of carbon and energy.
	11 days	Same condition without surfactant and bacteria.
Srivastava *et al.*, 1990	<1 day	Soil-water column with oxidant and emulsifier.
	<2 days	Soil-water column with emulsifier pretreatment.
Wild *et al.*, 1991	18 weeks	Average from 5 studies and Lee Valley soils.
	7.8 years	Mean from 4 metal contaminated and 1 rural Luddington soils.
Wild and Jones, 1993	137 ± 35.1 days	Mean from four soil types. Sludge application aerobic microcosm.
	16 days	Spiked soil microcosm.
Howard *et al.*, 1991	140 - 440 days	Based on aerobic soil die-away test.

Table AII-6. Environmental Half-life Estimates for Fluoranthene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
Heitkamp and Cerniglia, 1988	<1 day	Mineralization in minimal basal salt medium inoculated with *Mycobacterium sp.*, aerobic conditions.
Weissenfels *et al.*, 1990	48 - 72 hours	Aqueous aerobic mineral salt medium, pH= 7.2, 30°C, inoculated with *Acaligenes denitrificans*.
Mackay *et al.*, 1992	21 hours - 200 days	Near surface and 5m depth photolysis rates.
Howard *et al.*, 1991	21 - 63 hours	Based upon photolysis half-life in water.

Environmental Half-life Estimates for Fluoranthene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Tabak *et al.*, 1981	1 - 2 weeks No degradation after 3 weeks	Aerobic static flask test inoculated with microbes; 5 mg/L. Aerobic static flask test inoculated with microbes; 10 mg/L.
Howard *et al.*, 1991	280 days - 2.41 years	Scientific judgement based upon estimated unacclimated aerobic soil die-away test.

Environmental Half-life Estimates for Fluoranthene: Air

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	2.02 - 20.0 hours	Scientific judgement based upon estimated sunlight photolysis half-life in water.

Table AII-7. Environmental Half-life Estimates for Pyrene: Soil

Study	Half-life Estimates:	Notes:
Sherman *et al.*, 1990	74 days; 63 - 83 days, 95% C.I.	Mean and confidence intervals derived from data base.
Heitkamp and Cerniglia, 1989	35 days	Calculated from mineralization rate during sediment-water microcosm test treated with *Mycobacterium sp.*, 24°C.
Mackay *et al.*, 1992	48 -58 days 500 days	50 mg/kg and 5 mg/kg treatments. Unacclimated soil column.
Park *et al.*, 1990	260 days; 193 - 408 days, 95% C.I. 199 days; 131 - 408 days, 95% C.I.	Kidman sandy loam, 0.5% organic matter, pH= 7.9, -0.33 bar moisture, 25°C. McLaurin sandy loam, 1.1% organic matter, pH= 4.8, -0.33 bar moisture, 25°C.
Tiehm, 1994	~5 weeks <1 day - 8 days	Bacteria without surfactant. Bacteria with surfactant treatment.
Srivastava *et al.*, 1990	<1 day <1 day	Soil-water column pretreated with emulsifier. Soil-water column pretreated with emulsifier, oxidant added.
Wild *et al.*, 1991	8.5 years 3 days - >90 weeks	Mean half-life from 4 metal contaminated and 1 rural Luddington soils. Range from 5 studies in literature 1978-90 and Lee Valley soils.
Wild and Jones, 1993	225 ± 92.4 days 51 days	Mean from four soil types. Sludge application aerobic microcosm. Spiked soil aerobic microcosm.
Howard *et al.*, 1991	210 days - 5.2 years	Based on aerobic soil die-away test.

Table AII-7. Environmental Half-life Estimates for Pyrene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
Mackay *et al.*, 1992	0.58 hours 4.2 days	Midday, midsummer photochemical transformation rate near surface. Photolytic rate at 5m depth.
Heitkamp and Cerniglia, 1988	<1 day	Aqueous aerobic *Mycobacterium sp.* culture medium; mineralization rate in PAH mixture.
Howard *et al.*, 1991	0.68 - 2.04 hours	Scientific judgement based upon estimated photolysis in water.

Environmental Half-life Estimates for Pyrene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Tabak *et al.*, 1981	<1 week >4 weeks	Aerobic static flask test inoculated with bacteria; 5 mg/L. Same conditions as listed above. No significant degradation at the end of test; 10 mg/L pyrene.
Howard *et al.*, 1991	1.15 - 10.4 years	Scientific judgement based upon estimated unacclimated aerobic soil die-away test.

Environmental Half-life Estimates for Pyrene: Air

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	0.68 - 2.04 hours	Scientific judgement based upon estimated photolysis in water.

Table AII-8. Environmental Half-life Estimates for Chrysene: Soil

Study	**Half-life Estimates:**	**Notes:**
Walker *et al.*, 1975	>28 days	South Louisiana crude mixture. Sediments from estuary.
Sherman *et al.*, 1990	114 ± 12 days	Mean and standard deviation from data base of half-life literature to 1988.
Srivastava *et al.*, 1990	No degradation after 20 days	Sand-water soil column.
Wild *et al.*, 1991	8.1 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean value from 5 fields, 4 were metal-contaminated.
	0.6 weeks - 3 years	Range from 5 studies from 1987-90 and Lee Valley soils; estimates for benzo(a)anthracene and chrysene combined.
Park *et al.*, 1990	371; 289 - 533, 95% C.I.	Kidman sandy loam, 0.5% organic content, pH= 7.9.
	387; 257 - 866, 95% C.I.	McLaurin sandy loam, 1.1% organic content, pH= 4.8.
Bossert *et al.*, 1984	150 - 300 days Acclimated - unacclimated	Oily sludge-treated field, pH= 6.6 - 7.5, 1.7% organic content.
Mackay *et al.*, 1992	224 - 328 days	Chrysene concentrations of 50 mg/kg and 5 mg/kg; treated soil.
Wild and Jones, 1993	215 ± 86.3 days	Mean from four soil types. Sludge application aerobic microcosm.
	84 days	Spiked soil aerobic microcosm.
		Half-lives were for chrysene and benzo(a)anthracene combined.
Howard *et al.*, 1991	1 - 2.7 years	Scientific judgement, estimate based on aerobic soil die-away test data.

Table AII-8. Environmental Half-life Estimates for Chrysene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
Walker *et al.*, 1975	28 days	South Louisiana crude mixture from estuary.
Srivastava *et al.*, 1990	~5 days	Liquid culture with PAH degrading bacteria.
Mackay *et al.*, 1992	4.4 - 13 hours	Calculated photolytic half-life near surface and 5m deep at midday in mid-summer.
Howard *et al.*, 1991	4.4 - 13 hours	Photolytic half-life in water.
	1.02 - 2.72 years	Theoretical, based on aerobic soil die-away test; aerobic.
	4.06 - 11.0 years	Scientific judgement based upon estimated unacclimated aqueous anaerobic biodegradation half-life (Park *et al.*, 1990 for soil).

Environmental Half-life Estimates for Chrysene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Tabak *et al.*, 1981	14 - 21 days	Static flask test inoculated with microbes.
Howard *et al.*, 1991	2 - 5 years	Theoretical, based on estimated unacclimated aqueous aerobic biodegradation half-life (Park *et al.*, 1990 for soil).

Environmental Half-life Estimates for Chrysene: Air

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	0.03 - 0.3 day	Theoretical, based on estimated photooxidation half-life in air.

Table AII-9. Environmental Half-life Estimates for Benzo(a)anthracene: Soil

Study	Half-life Estimates:	Notes:
Sherman *et al.*, 1990	114 ± 6 days	Mean and standard deviation from data base of half-life literature to 1988.
Herbes and Schwall, 1978	208 days	Calculated using mineralization rate constant from PAH-contaminated previously exposed stream sediments in November.
	14 - 27 days	Transformation half-life under same conditions.
	8 years	Theoretical estimate calculated from mineralization rate constant in previously uncontaminated stream sediments in December.
Herbes, 1981	8.75 days	Calculated using mean rate constant over 2-year period. Stream sediments downstream from coal-coking plant.
Wild *et al.*, 1991	8.1 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 were metal-contaminated.
	0.6 weeks - 3 years	Range from 5 studies (1978-90) and Lee Valley soils; estimates for benzo(a)anthracene and chrysene combined.
Park *et al.*, 1990	261 days; 210 - 347 days, C.I.	Soil die-away test, 25°C, unsaturated. Kidman sandy loam, 0.5% organic content, pH= 7.9.
	162 days; 131 - 217 days, C.I.	McLaurin sandy loam, 1.1% organic content, pH= 4.8.
Bossert *et al.*, 1984	89 - 270 days, range acclimated - unacclimated	Oily sludge-treated field monitored for 3.5 years, 1.7% organic content, pH= 6.6 - 7.5.
Mackay *et al.*, 1992	130 - 240 days	50 and 5 mg/kg treated soil.
Wild and Jones, 1993	215 ± 86.3 days	Mean from four soil types. Sludge application aerobic microcosm.
	84 days	Spiked soil aerobic microcosm.
		Half-lives were for chrysene and benzo(a)anthracene combined.
Howard *et al.*, 1991	102 - 680 days	Scientific judgement based on estimate from aerobic soil die-away test.

Table AII-9. Environmental Half-life Estimates for Benzo(a)anthracene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
IRIS, 1994	5 hours	Photolysis in water.
	2.9 hours	Summer.
	7.8 hours	Winter.
	0.6 hours	Mid-summer.
ATSDR, 1994b IRIS, 1994	90 hours	Estimate based on volatilization rate in water.
ATSDR, 1979b	10 - 50 hours	Estimate based on rate of photolysis in water.
	38 hours	Estimate based on oxidation rate in water.
	13 hours	Computer model for stream.
	22 hours	Computer model for eutrophic pond or lake.
	8 hours	Computer model for oligotrophic lake.
Howard *et al.*, 1991	1 - 3 hours	Scientific judgement based upon estimated photolysis rate constant.

Table AII-9. Environmental Half-life Estimates for Benzo(a)anthracene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	204 days - 3.5 years	Scientific judgement based upon estimated aqueous soil die-away.

Environmental Half-life Estimates for Benzo(a)anthracene: Air

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	1 - 3 hours	Estimate based upon rate constant for photolysis.

Table AII-10. Environmental Half-life Estimates for Benzo(a)pyrene: Soil

Study	Half-life Estimates:	Notes:
Sherman *et al.*, 1990	57.5 ± 12.5 days	Mean and standard deviation from data base of half-life literature values to 1988.
IRIS, 1994	54.16 days	Stream sediment 0.5 km downstream from coke effluent.
	> 833 days	Stream sediment 0.3 km below petroleum storage.
	> 833 days	Uncontaminated stream sediment.
Wild *et al.*, 1991	8.2 years	Sandy loam 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 were metal-contaminated.
	2 days - 6 years	Range from 5 studies between 1978-90 and Lee Valley soil.
Herbes and Schwall, 1978	~2.3 years	Calculated using rate constant from PAH-contaminated sediments in December.
	~39.6 years	Calculated using rate constant from previously uncontaminated stream sediments in winter.
Herbes, 1981	84.9 days	Calculated using mean rate constant over 2-year period. Stream sediments downstream from coal-coking plant.
Shiaris, 1989	27 - >1400 days	Previously contaminated and uncontaminated estuarine sediment.
	> 625 days	Previously contaminated and uncontaminated stream sediments.
Miller *et al.*, 1988	105 days	Estimate based on 21-day test; un-photolyzed sample.
	42 days	Estimate based on 21-day test; pre-photolyzed and 0.1M H_2O_2.
Park *et al.*, 1990	309 days; 239 - 462 days, 95% C.I.	Aerobic soil die-away test, 25°c, unsaturated. Kidman sandy loam, 0.5% organic carbon, pH= 7.9.
	229 days; 178 - 315 days, 95% C.I.	McLaurin sandy loam, 1.1% organic carbon, pH= 4.8.
Wild and Jones, 1993	211 ± 68.7 days	mean from four soil types. Sludge application aerobic microcosm.
	112 days	Spiked soil aerobic microcosm.
Howard *et al.*, 1991	1 - 2.5 years	Estimate based on aerobic die-away test.

Table AII-10. Environmental Half-life Estimates for Benzo(a)pyrene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
ATSDR, 1994b	1 - 2 hours	Estimate based on rate of photolysis in water.
	96 hours	Estimate based on rate of oxidation in water.
	22 hours	Estimate based on volatilization in water.
Miller *et al.*, 1988	0.33 - 1.5 hours	300 nm light: based on photolytic half-life in methanol with and without H_2O_2.
	4 - 6 hours	sunlight: without H_2O_2.
Heitkamp and Cerniglia, 1989	~1 year	Sediment mixture from pristine reservoir ecosystem with *Mycobacterium* added.
Srivastava *et al.*, 1990	~5 days	Liquid culture with PAH-degrading bacteria.
Mackay *et al.*, 1992	2 hours	254 nm light; photolytic half-life in methanol solution.
	1.1 hours	Estimated photolytic half-life near surface in mid-December.
	0.54 - 76.8 hours	Estimated photolytic half-life at surface and 5m depth at midday in mid-summer.
Howard *et al.*, 1991	0.37 - 1.1 hours	Scientific judgement based on photolysis rate in 20% aqueous acetonitrile.

Table AII-10. Environmental Half-life Estimates for Benzo(a)pyrene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Howard *et al.*, 1991	114 days - 2.9 years	Scientific judgement based on aerobic soil die-away test.

Environmental Half-life Estimates for Benzo(a)pyrene: Air

Study	**Half-life Estimates:**	**Notes:**
Miller *et al.*, 1988	0.33 - 4 hours	Based on photolytic half-life in methanol with H_2O_2 exposed to 300 nm light or sunlight.
Howard *et al.*, 1991	0.37 - 1.1 hours	Scientific judgement based on photolysis rate in 20% aqueous acetonitrile.

Table AII-11. Environmental Half-life Estimates for Benzo(b)fluoranthene: Soil

Study	Half-life Estimates:	Notes:
Sherman *et al.*, 1990	140 ± 10 days	Data base, mean and standard deviation.
Wild *et al.*, 1991	9 years	Mean from 4 soils (sandy loam, pH= 5.8, 1.8% organic content) each contaminated with 1 metal and a rural soil.
	42 weeks	Value from study (1987-90) and Lee Valley soil.
Park *et al.*, 1990	294 days; 231 - 385 days, 95% C.I.	Aerobic soil die-away test. Kidman sandy loam, 0.5% organic content, pH= 7.9, 25°C.
	211 days; 169 - 277 days, 95% C.I.	McLaurin sandy loam, 1.1% organic content, pH= 4.8, 25°C.
Bossert *et al.*, 1984	~340 days	Oily sludge-treated field, 1.7% organic content, pH= 6.6 - 7.5.
Wild and Jones, 1993	202 ± 90.8 days	Mean from four soil types. Sludge application aerobic microcosm.
	334 days	Spiked soil aerobic microcosm.
Howard *et al.*, 1991	360 days - 1.67 years	Aerobic die-away test.

Table AII-11. Environmental Half-life Estimates for Benzo(b)fluoranthene: Surface Water

Study	**Half-life Estimates:**	**Notes:**
Howard *et al*., 1991	8.7 hours - 30 days	Scientific judgement based on estimated aqueous photolysis in haptene irradiated light > 290 nm.

Environmental Half-life Estimates for Benzo(b)fluoranthene: Ground Water

Study	**Half-life Estimates:**	**Notes:**
Howard *et al*., 1991	1.97 - 3.34 years	Scientific judgement based on estimated aqueous aerobic biodegradation estimation - no data.

Environmental Half-life Estimates for Benzo(b)fluoranthene: Air

Study	**Half-life Estimates:**	**Notes:**
IRIS, 1994	1.9 - 4.2 hours	Irradiated in presence of ozone.
Howard *et al*., 1991	1.43 - 14.3 hours	Scientific judgement based on estimated rate constant for reaction with hydroxyl radical.

Table AII-12. Environmental Half-life Estimates for Benzo(k)fluoranthene: Soil

Study	**Half-life Estimates:**	**Notes:**
Sherman *et al.*, 1990	123 ± 11.5 days	Mean and standard deviation from data base of half-life literature to 1988.
Wild *et al.*, 1991	8.7 years	Mean value from 5 different soils; 4 contaminated with a single metal each, and a rural soil.
Wild and Jones, 1993	301 ± 105.2 days 55 days	Mean from four soil types. Sludge application aerobic microcosm. Spiked soil aerobic microcosm.
Howard *et al.*, 1991	2.49 - 5.86 years	Aerobic die-away test data.

Table AII-12. Environmental Half-life Estimates for Benzo(k)fluoranthene: Surface Water

Study	Half-life Estimates:	Notes:
Howard *et al.*, 1991	3.8 hours - 21 days	Scientific judgement based on photolysis in haptene and adjusted by ratio of photolysis in water vs. haptene for benzo(a)anthracene.

Environmental Half-life Estimates for Benzo(k)fluoranthene: Ground Water

Study	Half-life Estimates:	Notes:
Howard *et al.*, 1991	4.99 - 11.7 years	Scientific judgement based on estimated unacclimated aqueous aerobic biodegradation.

Environmental Half-life Estimates for Benzo(k)fluoranthene: Air

Study	Half-life Estimates:	Notes:
IRIS, 1994	14.1 hours	Sunlight, without ozone. Laboratory simulated atmosphere.
	3.9 hours	Sunlight, with ozone. Laboratory simulated atmosphere.
	34.9 hours	Dark, no ozone. Laboratory simulated atmosphere.
	111 minutes	Irradiated. Laboratory simulated atmosphere.
Howard *et al.*, 1991	1.1 - 11 hours	Scientific judgement based on photooxidation rate constant for reaction with hydroxyl radical.

Table AII-13. U.S. EPA[a] and Commonwealth of Kentucky[b] Quality Criteria for Water ($\mu g/L$)

	Priority Pollutant	Carcinogen	FW Acute LOEL $\mu g/L$	FW Chronic LOEL $\mu g/L$	Water and Fish Ingestion (10^{-6} Cancer Risk) $\mu g/L$	Fish Consumption (10^{-6} Cancer Risk) $\mu g/L$		Drinking Water MCL $\mu g/L$	
						EPA	KY		KY
Naphthalene	Yes	No	2,300	620	--	--	--	--	--
Acenaphthene	Yes	No	1,700	520	20	--	--	--	--
Fluoranthene	Yes	No	3,960	--	42	54	54	--	--
PAHs	Yes	Yes	--	--	0.0028[c]	0.0311	0.0311	(WHO European) 0.2	0.0028

[a]U.S. EPA, 1986. Quality Criteria for Water.
[b]KDEP, 1990. Kentucky Water Quality Standards.
[c]WHO, 1977. International Standards for Drinking Water.

Table AII-14. U.S. EPA Drinking Water Standards, Criteria and Human Health Advisories ($\mu g/L$)

	Quantification Limits	MCL	MCLG	Water Quality Criteria, Human Health Protection						Human Health Advisories	
				Drinking Water		Drinking Water and Aquatic Organisms		Aquatic Organisms		70kg Adult	
				Threshold Toxicity Protection	10^{-6} Cancer Risk	Threshold Toxicity Protection	10^{-6} Cancer Risk	Threshold Toxicity Protection	10^{-6} Cancer Risk	Rfd (mg/kg/day)	Lifetime (mg/L)
Naphthalene	--	--	--	--	--	--	--	--	--	0.004[b]	0.02[b]
Acenaphthene	10[a]	--	--	20[a]	--	--	--	--	--	0.6[b]	--
PAHs	--	--	--	--	0.0031[a]	--	0.0028[a]	--	0.031[a]	--	--
Anthracene	10[a]	--	--	--	--	--	--	--	--	0.3[b]	--
Pyrene	10[a]	--	--	--	--	--	--	--	--	0.03[b]	--
Fluorene	10[a]	--	--	--	--	--	--	--	--	0.04[b]	--
Fluoranthene	10[a]	--	--	188[a]	--	42[a]	--	54[a]	--	--	--
Benzo(a)anthracene	10[a]	0.0001[b]	zero[b]	--	0.0031[a]	--	0.0028[a]	--	0.031[a]	--	--
Benzo(a)pyrene	10[a]	--	--	--	0.0031[a]	--	0.0028[a]	--	0.031[a]	--	--
Benzo(b)fluoranthene	10[a]	0.0002[b]	zero[b]	--	0.0031[a]	--	0.0028[a]	--	0.031[a]	--	--
Benzo(k)fluoranthene	10[a]	0:0002[b]	zero[b]	--	0.0031[a]	--	0.0028[a]	--	0.031[a]	--	--
Chrysene	10[a]	0.0002[b]	zero[b]	--	0.0031[a]	--	0.0028[a]	--	0.031[a]	--	--

[a]U.S. EPA., 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater: A Compendium of Examples.
[b]U.S. EPA., 1992. Drinking Water Regulations and Health Advisories.

Table AII-15. PAH Toxicity Values ($\mu g/L$)

Acenapthene		Napthalene
Fresh Water Acute Value		
Fathead Minnow *Pimephales promelas* 72-HR LC_{50} 1,700[c] 96-HR LC_{50} 1,600[c]	Channel Catfish *Ictalurus punctatus* 96-HR LC_{50} 1,720[c]	Fathead Minnow *Pimephales promelas* 6,600[b]
Bluegill Sunfish *Lepomis macrochirus* 96-HR LC_{50} 1,700[h]	Water Flea *Daphnia magna* 41,200[h]	Rainbow Trout *Onchorhynchus mykiss* 2,300[b]
Rainbow Trout *Onchorhynchus mykiss* 24-HR LC_{50} 1,570[c] 48-HR LC_{50} 1,130[c] 72-HR LC_{50} 800[c] 96-HR LC_{50} 670[c]	Snail *Aplexa hynorum* 96-HR LC_{50} 2,040[c]	Mosquitofish *Gambusia affinis* 150,000[i]
Brown Trout *Salmo trutta* 24-HR LC_{50} 840[c] 48-HR LC_{50} 650[c] 72-HR LC_{50} 600[c] 96-HR LC_{50} 580[c]	Alga *Selenastrum capricornutum* 530[h]	Water Flea *Daphnia magna* 8,750[g]
Salt Water Acute Value		
Sheepshead Minnow *Cyprinodon variegatus* 96-HR LC_{50} 2,230[h]		Pacific Oyster *Crassostrea gigas* 199,000[d]
Alga *Skeletonema costatum* 500[h]		Polychaete Worm *Neanthes arenaceodentata* 3,800[e]
Mysid Shrimp *Mysidopsis bahia* 96-HR LC_{50} 970[h]		Grass Shrimp *Palaemonetes pugio* 2,350[f]

Table AII-15. PAH Toxicity Values ($\mu g/L$) (continued)

Acenapthene	Napthalene	Benzo(a)Anthracene
Salt Water Chronic Value	Fresh Water Chronic Value	
Sheepshead Minnow *Cyprinodon varigatus* 710[b]	Fathead Minnow *Pimephales promelas* 620[b]	Bluegill *Lepomis macrochirus* 6-month LC_{87} 1,000[a]

[a]Brown *et al.*, 1975.
[b]DeGraeve *et al.*, *in*: U.S. EPA, 1980c.
[c]Holcombe *et al.*, 1983.
[d]Le Gore, 1974.
[e]Rossi and Neff, 1978.
[f]Tatem, 1975.
[g]U.S. EPA, 1978.
[h]U.S. EPA, 1980a.
[i]Wallen *et al.*, 1957.

Table AII-16. BCF Values, Non-carcinogenic PAHs

Naphthalene	Anthracene	Pyrene
Freshwater Species		
Rainbow Trout *Oncorhynchus mykiss* 40 - 300[z] (4 weeks)	Rainbow Trout *Oncorhynchus mykiss* 9,120.1[v]	Goldfish *Crassius auratus* 457.1[cc]
Bluegill Sunfish *Lepomis macrochirus* 316.2[aa]; 302[aa]	Bluegill Sunfish *Lepomis macrochirus* 676.1[hh]; 891.3[hh]; 1,202.3[hh]	Water Flea *Daphnia magna* 2,691.2[bb]
Fathead Minnow *Pimephales promelas* 426.6[mm]	Fathead Minnow *Pimephales promelas* 478.6[jj]	Water Flea *Daphnia pulex* 2,691.2[x,ii]
Fish 426.6[y]; 36.2[h]	Fish 7,762.4[ll]	Scud *Pontoporeia hoyi* 44,668.3[g]
Water Flea *Daphnia pulex* 131.8[ii]; 117.5[t]	Goldfish *Crassius auratus* 162.2[cc]	Alga *Selenustrum capricornutum* 36,307.8[e]; 16,595.9[e]; 56,234.1[e]
Algae *Selenastrum capricornutum* 12,589.3[c]; 6,918.3[c]; 17,728.8[e]	Water Flea *Daphnia pulex* 758.6[q]; 712[ii]; 912[x]; 1,202.3[jj]	Microorganisms 12,022.6[w]; 23,988.3[kk]
Algae *Chlorella fusca* 128.8[i]	Water Flea *Daphnia magna* 977.2[bb]	
Algae 125.9[h]	Scud *Pontoporeia hoyi* 16,595.9[g]	
Microorganisms 416.9[w]	Algae 7,762.5[i,k]; 6,760.8[h]	
	Microorganisms 4,677.4[w]	

Table AII-16. BCF Values, Non-carcinogenic PAHs (continued)

Naphthalene	Anthracene	Pyrene
10.5[mm] (weighted) Theoretical 60 - 1,000[a] Theoretical 426.6[m] Theoretical 60 - 1,000[e] Theoretical 60 - 1,000[d] 269.2[i] 93.3[ff] 1,000[h] (activated sludge)	1,202.3[ii] (kinetic estimation) 3,548[g] (calculated) 1,047[y] 6,760.8[h] 3,715.4[ff] (calculated-x) 912[r] (calculated)	3,311.3[ii,mm] (calculated) (kinetic estimation) 1,949.8[g] (calculated) 3,630.8[y] (calculated-K_{ow}) 2,691.5[m] (calculated) 2,691.2[r,ff] (calculated) (quoted exponential) 3,090.3[a] (calculated-K_{ow})
	Saltwater Species	
Coho Salmon *Oncorhynchus kisutch* 12[cc] (5 weeks); 40[dd] (6 weeks)	Sand Dab *Citharichthys stigmacus* 77[t] (1 hour)	Mussel 4,466.8[l]
Crustacean *Calanus helgolandicus* 60[o]; 50[p] (1 day)	Starry Flounder *Platyichthys stellatus* 270[dd] (2 weeks)	Clam 6,456.5[l]
Mussel *Mytilus edulis* 44[u] (4 hours); 60 - 1,000[j]; 30.9[n]	Worm *Polychaeta sp.* 6.6[c]	Shrimp 223.9[l]; 501.2[l]
Sand Goby *Gillichthys mirabilis* 63[t] (1 hour)	Polychaete Worm *Capitella capitata* 23.6[c]	Worm *Polychaeta sp.* 707.9[l]; 1.179[c]
Sculpin *Oligocottus maculosus* 32[t] (3 hours)		Polychaete Worm *Capitella capitata* 13.305[c]

Table AII-16. BCF Values, Non-carcinogenic PAHs (continued)

Fluorene	Fluoranthene	Acenaphthalene	Acenaphthene
1,288.3[w] (calculated-K_{ow}) 2,454.7[ff] (calculated-x) 1,288.3[r] (calculated) 416.9[a] (calculated-K_{ow})	1,513.6[g]	301[ll] 380.2[r]	1,202.3[mm] 389[w] 389.1[ff,gg] 1,995.3[ff] 380.2[r] 281.8[r]
	Freshwater Species		
Water Flea *Daphnia magna* 501.2[bb]	Water Flea *Daphnia magna* 1,737.8[bb]	Copepod *Eurytemora affinis* 5,000[p] (9 days); 350[p]	Bluegill Sunfish *Lepomis macrochirus* 389[b,f,nn]
Microorganisms 4,677.4[w]	Worm *Polychaeta sp.* 45.72[e]	Microorganisms 1,000[w]	
	Polychaete Worm *Capitella capitata* 11.995[e]		
	Scud *Pontoporeia hoyi* 79,432.8[g]		
	Microorganisms 12,022.6[w]		

[a]Banerjee, J. and Baughman, 1991.
[b]Barrow *et al.*, 1980.
[c]Bayona *et al.*, 1991.
[d]Bysshe, 1982.
[e]Casserly *et al.*, 1983.
[f]Davis and Dobbs, 1984.
[g]Eadie *et al.*, 1982.
[h]Freitag *et al.*, 1985.
[i]Geyer *et al.*, 1984.
[j]Geyer *et al.*, 1982.
[k]Geyer *et al.*, 1981.
[l]Gobas *et al.*, 1987.
[m]Govers *et al.*, 1984.
[n]Hansen *et al.*, 1978 *in*: Howard *et al.*, 1989.
[o]Harris *et al.*, 1977a.
[p]Harris *et al.*, 1977b.
[q]Herbes and Risi, 1978.
[r]Isnard and Lambert, 1988.
[s]Kenaga, 1980b.
[t]Lee *et al.*, 1972a.
[u]Lee *et al.*, 1972b.
[v]Linder *et al.*, 1985.
[w]Mabey *et al.*, 1982.
[x]Mackay and Hughes, 1984.
[y]Mackay, 1982.
[z]Melancon and Lech, 1978.
[aa]McCarthy and Jimenez, 1985.
[bb]Newsted and Giesy, 1987.
[cc]Ogata *et al.*, 1984.
[dd]Roubal *et al.*, 1978.
[ee]Roubal *et al.*, 1977.
[ff]Sabljic, 1987.
[gg]Schüürmann and Klein, 1988.
[hh]Spacie *et al.*, 1983.
[ii]Southworth *et al.*, 1978.
[jj]Southworth, 1977.
[kk]Steen and Karickhoff, 1981.
[ll]US EPA, 1980d.
[mm]U.S. EPA, 1980c.
[nn]Veith *et al.*, 1979.

Table AII-17. BCF Values, Carcinogenic PAHs

Benzo(k)fluoranthene	Benzo(b)fluoranthene	Chrysene
28,200[a] calculated-K_{ow} 11,100[a] weighted average	28,200[a] calculated-K_{ow} 11,100[a] weighted average	11,700[a] calculated-K_{ow} 4,620[a] weighted average
Freshwater Species		
Water Flea *Daphnia magna* 13,182.6[k]	Water Flea *Daphnia magna* 10,000[k]	Water Flea *Daphnia magna* 6,095.4[k]
Microorganisms 141,253.8[i]	Microorganisms 141,253.8[i]	Microoganisms 52,480.7[i]
		Scud *Pontoporeia hoyi* 21,877.6[j]; 20,417.4[j]
Saltwater Species		
Diatoms 0.02[m]	Diatoms 0.01[m]	Diatoms 0.03[m]
Worm *Polychaeta sp.* 14.1[l]	Worm *Polychaeta sp.* 9.1[l]	Clam *Rangia cuneata* 8.2[e]
Polychaete Worm *Capitella capitata* 1.8[l]	Polychaete Worm *Capitella capitata* 1.7[l]	Worm *Polychaeta sp.* 14.8[l]
		Polychaete Worm *Capitella capitata* 6.2[l]

Table AII-17. BCF Values, Carcinogenic PAHs (continued)

Benzo(a)pyrene		Benzo(a)anthracene
Freshwater Species		
Bluegill Sunfish *Lepomis macrochirus* 12.6[s]; 2,630.3[v]; 223.9[v] 4,897.8[u]; 28,183.8[u]; 4,897.8[u]; 489.8[u];	Scud *Amphipoda sp.* 48,977.9[cc]	Fathead minnow *Pimephales promelas* 10,000[aa]
Scud *Pontoporeia hoyi* 54,954.1[j]; 8,912,509.4[y]; 35,936.6[y]; 40,738[z]	*Stylodrilus heringianus* 7,413.1[z]	Fish 346.7[w]
Mosquitofish *Gambusia affinis* 930[b] (3 days)	Snail *Physa sp.* 82,231[b] (3 days)	Water Flea *Daphnia pulex* 10,000[h,cc,dd]
Fish 478.6[w]	Worms 3,235.9[x]	Algae 3,162.3[w]
Water Flea *Daphnia pulex* 134,248[b] (3 days)	Mayfly *Hexagenia limbata* 5,888.4[z]	Microorganisms 52,480.7[i]
Water Flea *Daphnia magna* 2,818.4[s]; 7,943.3[t]; 12,882.5[k]	Blue-green Alga *Oedogonium cardiacum* 5,258[b] (3 days)	Bacteria 36,307.8[bb]; 100,000[bb]
Mosquito *Culex pipiens quinquefasceatus* 11,536[b] (3 days)	Algae 3,311.3[w]	
Mysid Crustacean *Mysis relicta* 7,413.1[z]; 8,511.4[ee]	Microorganisms 141,253.8[i]	
Saltwater Species		
Clam *Rangia cuneata* 8.66[e]; 236[f]	Mudsucker *Gillichthys mirabilis* 0.048[g] (Edible Tissue)	Diatoms 0.02[m]
Eastern Oyster *Crassostrea virginica* 3000[c] (8 days); 242[d]	Diatoms 0.01[m]	
Sand Dab *Citharichthys stigmacus* 0.20[g]	Worm *Polychaete sp.* 13.8[l]	
Tidepool Sculpin *Oligocottus maculosus* 0.13[g]	Polychaete Worm *Capitella capitata* 0.7[l]	

Table AII-17. BCF Values, Carcinogenic PAHs (continued)

Benzo(a)pyrene		Benzo(a)anthracene
28,200[a] calculated-K_{ow}; 11,100[a] weighted average	446,683.6[q] (calculated); 489.8[r] (calculated); 5,011.9[p]; 63,095.7[p] (calculated); 10,000[w] (activated sludge)	11,700[a] calculated-K_{ow}; 4,620[a] weighted average; 4,677.4[h] (calculated); 36,307.8[n] (calculated) 19,498.4[o] (calculated); 25,704[p] (calculated) 24,547.1[w] (activated sludge)

[a]US EPA, 1980d.
[b]Lu *et al.*, 1977.
[c]Lee *et al.*, 1978.
[d]Couch, 1980.
[e]Neff *et al.*, 1976a.
[f]Neff *et al.*, 1976b.
[g]Lee *et al.*, 1972a.
[h]Southworth *et al.*, 1978.
[i]Mabey *et al.*, 1982.
[j]Eadie *et al.*, 1982.
[k]Newsted and Giesy, 1987.
[l]Bayona *et al.*, 1991.
[m]Stronkhorst *et al.*, 1994.
[n]Smith *et al.*, 1978.
[o]Mackay, 1982.
[p]Sabljic, 1987.
[q]Kenaga and Goring, 1980.
[r]Gobas *et al.*, 1987.
[s]Leversee *et al.*, 1981.
[t]McCarthy, 1983.
[u]Spacie *et al.*, 1983.
[v]McCarthy and Jimenez, 1985.
[w]Freitag *et al.*, 1985.
[x]Frank *et al.*, 1986.
[y]Landrum *et al.*, 1985.
[z]Landrum and Poore, 1988.
[aa]Veith *et al.*, 1979.
[bb]Baughman and Paris, 1981.
[cc]Mackay and Hughes, 1984.
[dd]Hawker and Connell, 1986.
[ee]Evans and Landrum, 1989.

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