Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection

William F. Weld
Governor
Daniel S. Greenbaum
Commissioner

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8/18/92
MEMO TO ORS
ATTACHMENT [illegible]

MEMORANDUM

TO: Rich Gioiosa, Steve Lipman, Joel Hartley, Brian Moran, Rick Dunn, John Fitzgerald, Iris Davis, John Carrigan

FROM: Carol Rowan West CRW
Marion Harnois

DATE: August 19, 1992

SUBJECT: Evaluation of Landfill Soil Cover Criteria

A copy of the comparison of the Landfill Soil Cover Criteria and soil levels derived using risk assessment methodology is attached for your information and review.

Four Risk management criteria were used:

- Hazard Indices of 0.2 and 1 for consideration of noncancer effects
- Excess Lifetime Cancer Risks of 1/1,000,000 and 1/100,000 for consideration of cancer effects

Conservative assumptions regarding the toxicity of the chemicals and the exposure to soil were used in the calculations.

Comparison to soil levels derived in accordance with the most conservative risk management criteria of Excess Lifetime Cancer Risk of one in a million and a Hazard Index of 0.2 showed that the Criteria exceeded the calculated soil levels in 3 cases: arsenic, benzo-a-pyrene, and hexavalent chromium. There were no exceeding Criteria when soil levels calculated using a 30-year exposure period, an Excess Lifetime Cancer Risk of one in a hundred thousand and a Hazard Index of 1 were compared to one criteria.

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We recommend that the group meet to discuss this work and focus on these issues:

1. Should additional work be undertaken to refine the risk assessment for arsenic, benzo-a-pyrene and hexavalent chromium?

2. Should the Landfill Cover Criteria meet a particular set of risk management criteria?

3. Should future statewide policies for soil used as landfill cover incorporate changes based on risk assessment evaluations?

We would be pleased to meet with you to discuss these issues. Thank you.

COMPARISON OF LANDFILL SOIL COVER CRITERIA TO SOIL LEVELS DERIVED USING RISK ASSESSMENT METHODOLOGY

Prepared by the Office of Research and Standards, Massachusetts Department of Environmental Protection, One Winter St., Boston, MA 02108

I. Purpose

A request was received from the Bureau of Solid Waste for a comparison of the Landfill Soil Cover Criteria with soil levels derived for protection of human health using risk assessment methodology.

The approach used in the evaluation was to derive levels of chemicals in soil that would be without adverse effects for people living adjacent to the active portion of the landfill. The derivation included the use of conservative assumptions and a range of risk management criteria for considering cancer and noncancer effects. These derived levels were compared to the Landfill Soil Cover Criteria to determine the protectiveness of the Criteria. Additional work to incorporate more specific risk assessment assumptions to refine the derived soil levels could be undertaken if it is determined necessary.

II. Summary and conclusions

Soil levels were derived using risk assessment procedures and risk management criteria for arsenic, cadmium, trivalent chromium, hexavalent chromium, lead, inorganic mercury, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), selenium, vanadium, and vinyl chloride.

Risk management criteria used in that derivation were Hazard Indices (HI) of 1.0 and 0.2 and Excess Lifetime Cancer Risks (ELCR) of one in a million and one in a hundred thousand. It was assumed that exposure would be by inhalation of airborne soil from the landfill. It was also assumed that the U.S. EPA Air Quality Standards for particulates would not be exceeded. The analysis was conducted with consideration of various receptor age groups and exposure durations ranging from 90 days to 75 years. However, the exposure durations of 30 years or less are more realistic for landfill soil cover evaluations.

These soil levels were compared to the Landfill Soil Cover Criteria. Comparison to soil levels derived using a 30-year exposure period and in accordance with the most conservative risk management criteria of ELCR at one in a million and HI of 0.2 showed that the Criteria exceeded the calculated soil levels for arsenic, benzo(a)pyrene, and hexavalent chromium. There were no exceeding Criteria when comparisons were made to soil levels calculated using an exposure period of 30 years, an ELCR of one in a hundred thousand and a HI of one.

The results of critical analyses are summarized in the accompanying table.

DERIVED CHEMICAL LEVELS (MG/KG) FOR LANDFILL SOILS
WHICH WOULD BE WITHOUT ADVERSE EFFECTS AT AN ADJACENT RESIDENCE

CHEMICAL	LANDFILL COVER CRITERIA	THRESHOLD EFFECTS: LOWEST SOIL LEVEL		CANCER: AGE 2<5 YR EXPOSURE		CANCER: AGE 0<30 YEAR EXPOSURE	
		HI=1	HI=.2	ELCR=1E-5	ELCR=1E-6	ELCR=1E-5	ELCR=1E-6
	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil
ARSENIC	40	8621	1742	633	63	127	13
CADMIUM	25	7522	1504	5855	586	1171	117
TRIVALENT CHROMIUM	500	3E+07	6E+06				
HEXAVALENT CHROMIUM (20%)	500	1984	397	4355	436	871	87
LEAD	500		8282				
INORGANIC MERCURY	10	5943	1189				
PAH	100	2E+05	4E+05	3546	355	709	71
PCB	2	217	43	1015	102	203	20
SELENIUM	30	6E+04	1E+04				
VANADIUM	1000	25547	5109				
VINYL CHLORIDE	10	36680	7336	5040	504	1008	101

The shaded cells with derived soil levels show that the derived soil level was lower than the Landfill Criteria for the conditions specified.

This assessment indicates that the Landfill Soil Cover Criteria would be below the soil levels derived using risk management criteria generally used by regulatory agencies. However, under the conditions of the assumptions chosen, the Criteria do not meet the risk management criteria of the Bureau of Waste Site Cleanup Program.

For informational purposes, soil levels were similarly derived for a residential scenario. Results indicate that the Landfill Criteria represent concentrations of chemicals that would not be protective of human health if such soil were placed in residential areas.

The values presented here should not be taken as protective of the landfill worker. That type of exposure should be evaluated using an industrial scenario and the increased exposure to soil experienced by remaining in the dusty area for the entire shift.

III. Derivation of soil levels

A. Risk management criteria

Risk management criteria are values used in many environmental regulatory programs to determine that adverse health effects would be unlikely or are not significant when an individual's exposure and estimated risk is equal to or less than these criteria. The risk management criteria used include the Hazard Index (HI) and the Excess Lifetime Cancer Risk (ELCR).

For noncarcinogenic effects, it is assumed that a threshold dose is required before adverse effects result. The Hazard Index is the measure used for estimating the risk of potential noncarcinogenic health effects. It is based on the comparison of an individual's exposure to that chemical and the dose of the chemical at which no adverse health effects would be expected (Allowable Daily Intake or EPA Reference Dose).

For the estimation of cancer risk, it is generally assumed that there is no threshold dose, and that any exposure to a carcinogenic substance is associated with some risk. As exposure increases, the incidence of cancer is expected to increase. The Excess Lifetime Cancer Risk is the risk management criterion that is set for considering cancer risk and is considered to be an upper bound probability of the likelihood of developing cancer as a result of a given exposure. It is calculated as the product of an individual's quantified exposure and the carcinogenic potency of a chemical.

A total of four alternative risk management criteria for evaluating noncancer and cancer effects were utilized for deriving chemical specific soil levels:

- o Hazard Index - values of 1.0 and 0.2 for consideration of noncancer effects
- o Cancer Risk - one in a million and one in a hundred thousand for cancer effects

These risk management criteria are in accordance with current environmental regulatory programs. Currently, Massachusetts and U.S. EPA waste site cleanup programs use a Hazard Index of 0.2 and 1.0, respectively, for evaluating and remediating sites. In addition, ORS typically sets medium-specific guidelines at a one in a million cancer risk and the Massachusetts waste site cleanup program uses a total (or cumulative) site cancer risk of one in a hundred thousand.

B. Equations

For a given Hazard Index, the following equation was used to calculate a soil level based on noncancer or threshold effects of a chemical:

$$CHEMsoil = Hazard\ Index / [SUM\ \{(ADDsoil * AF) / ADI\}]$$

where:

ADI = Average daily rate of intake or absorbed dose of a chemical to which a person can be exposed over a defined period of time without suffering a deleterious effect.

ADDsoil = Average daily soil exposure rate to soil for a defined route over a defined period of time calculated with an averging period equal to the exposure period

AF = Adjustment factor required to relate the exposure conditions relative to the ADI and the ADDsoil calculation

To derive soil levels based on cancer or nonthreshold effects of a chemical for a given ELCR value, the following equation was used:

$$CHEMsoil = ELCR * \{1 / [SUM(CSF * LADDsoil * AF)\}$$

where:

ELCR = Specific Excess Lifetime Cancer Risk

CSF = The Cancer Slope Factor is a measure of the incidence of cancer per unit of dose. It is specific to the route and medium of exposure for a chemical.

LADDsoil = Average daily soil exposure rate to soil for a defined route over a defined period of time calculated with a lifetime averaging period.

AF = Adjustment factor required to relate the exposure conditions relative to the CSF and LADDsoil calculations

C. Toxicity data

Toxicity data provided by the U.S. EPA was given preference for use in these calculations. For noncancer effects, the Oral Reference Dose and Inhalation Reference Concentration listed in the U.S. EPA Integrated Risk Information System (IRIS) or in the U.S. EPA Health Effects Assessment Summary Tables (HEAST) were used when available. For cancer effects, the U.S. EPA Cancer Slope Factors (CSF) in IRIS and HEAST were used when available. When these toxicity values were not available in the U.S. EPA publications, values derived by ORS from toxicity information in the current literature were used.

Table 1 contains a summary of the toxicity values for the evaluated chemicals; the sources of these values are described in the Table footnotes.

TABLE 1. TOXICITY VALUES FOR EVALUATED CHEMICALS

	INHALATION			ORAL		
TOXICITY VALUE:	ADI	ADI	CSF	ADI	ADI	CSF
EXPOSURE PERIOD:	CHRONIC	SUBCHRONIC	LIFETIME	CHRONIC	SUBCHRONIC	LIFETIME
UNITS:	MG/KG/DAY	MG/KG/DAY	1/(MG/KG/DAY)	MG/KG/DAY	MG/KG/DAY	1/(MG/KG/DAY)
CHEMICAL:						
ARSENIC	8.6E-07 (d)	8.6E-07 (d)	50 (b)	3.0E-04 (a)	3.0E-04 (b)	1.8 (d)
BaP						5.8 (f)
CADMIUM	5.7E-06 (c)	5.7E-06 (c)	6.1 (a)	1.0E-03 (b)	1.0E-03 (b)	
CHROMIUM (TRI)				1.0E+00	1.0E+00	
CHROMIUM (HEX)	.57E-06 (d)	.57E-06 (d)	41 (a)	0.005 (a)	0.02 (b)	
LEAD: ADULT		1.0E-04 (e)			1.0E-04 (e)	
CHILD (2 YEAR OLD)		2.0E-04 (e)			2.0E-04 (e)	
MERCURY	8.6E-05 (METAL) (b)	8.6E-05 (METAL) (b)		3.0E-04 (INORGANIC) (b)	3.0E-04 INORGANIC (b)	
NAPHTHALENE	2.0E-02 (c)	2.0E-02 (c)		4.0E-03 (f)	4.0E-03 (f)	
PCBS				5.0E-06 (e)	5.0E-05 (e)	7.7 (a)
SELENIUM	8.6E-04 (c)	8.6E-04 (c)		5.0E-03 (a)	5.0E-03 (b)	
VANADIUM	3.0E-04 (c)	3.0E-04 (c)		7.0E-03 (b)	7.0E-03 (b)	
VINYL CHLORIDE	4.9E-03 (c)	8.6E-02 (b)	0.3 (b)	1.0E-03 (d)	1.0E-03 (d)	1.9 (b)

Notes for Table 1.

a). U.S. EPA IRIS database, 1992

b). U.S. EPA HEAST, (1992)

c). ORS Guidance Document, 1989

d). Prepared by ORS staff for use with the "Shortform" (ORS, 1992c). Inhalation ADI values were calculated from Inhalation Reference Concentrations by multiplying the Reference Concentration (mg/cu.m) by 1/70 kg and 20 cu.m/day.

e). Prepared by ORS staff for use in derivation of soil levels of PCBs and lead (ORS 1992 a, b). The lead value is based on the blood lead increment between the target blood lead level and the baseline blood lead level. The PCB ADI is based on immunological effects.

f). U.S. EPA OSWER directive (Poirier, 1992)

In the absence of data which would allow a more specific approach, the chronic ADI was used for subchronic exposures as well as for chronic exposures. In the absence of data for toxicity values for the inhalation route and no localized effects in the lung, the oral route toxicity data were applied.

The toxicity criteria values for some chemicals were calculated in a slightly different way from the U.S. EPA values. In the case of lead, the calculations are performed with an ADI based on incremental absorbed dose. This absorbed dose is already 0.2 times the target ADI for lead. The derived soil level corresponds to one at a Hazard Index of 0.2.

The cadmium ADI was calculated with consideration of all sources of exposure. The soil level derived using that ADI would not need to be adjusted further in order to compensate for off-site exposure.

In the case of arsenic, the inhalation route carcinogenicity data were derived from exposure to arsenic trioxide as a fine particle not adsorbed to soil. This is highly conservative in that arsenic pentoxide rather than trioxide is more likely to be the major form of arsenic in soil, and absorption of chemicals from soil may be less than if they are in the air as fine particles of the pure substance. The probable difference in absorption was not factored in. The cancer slope factor for arsenic trioxide was used for the pentoxide form of arsenic based upon EPA recommendations.

In two cases, chromium and PAHs, it was assumed that only a portion of the assayed chemical would produce specific toxic effects. In the case of chromium, a separate soil level was calculated for each of the following conditions: all trivalent chromium, noncarcinogenic effects; 20% hexavalent chromium, noncarcinogenic effects; 20% hexavalent chromium, cancer effects. In the case of PAHs, it was assumed that the mixture would be composed of 40% carcinogenic forms (represented by BaP) and 60% non-carcinogenic forms (represented by naphthalene). These variations in the concentration of the active form of the chemical are included in the calculations as Adjustment Factors (AF) together with factors used to adjust absorption efficiencies between media and route of exposure.

The absorption efficiencies used in the calculations are summarized in Table 2. Absorption efficiencies included in Table 2 are derived from literature search or assumed as values protective of health. No adjustment was made for soil as a carrier medium unless data on absorption from soil was available.

TABLE 2. ABSORPTION EFFICIENCIES USED IN THE CALCULATION OF SOIL LEVELS

	ROUTE-SPECIFIC ABSORPTION EFFICIENCY		
	ORAL	ALVEOLAR	DERMAL
ARSENIC	0.98 a	0.85 c	0.03 a
BaP	0.91 a	0.70 c	0.18 a
CADMIUM	0.06 b	0.60 b	0.001 d
CHROMIUM (TRI)	0.11 a	0.10 c	0.01 a
CHROMIUM (HEX)	0.11 c	0.25 c	0.01 a
LEAD			
2-YEAR OLD CHILD:	0.50 b	1.00 b	0.0006 b
ADULT:	0.10 b	1.00 b	0.0006 b
MERCURY, ELEMENTAL		0.85 c	
INORGANIC	0.15 a	0.85 c	0.01 a
	0.075 (soil matrix)a		
NAPHTHALENE	1.00 a	1.00 d	0.1 a
PCBs	1.00 b	1.00 b	0.05 b
SELENIUM	0.60 c	0.70 c	0.01 d
VANADIUM	1.00 d	1.00 d	0.01 d
VINYL CHLORIDE	0.98 a	0.64 c	0.1 a

Notes for Table 2:

a ORS, 1992c Literature derived values for use in the "Shortform".
b ORS, 1992a,b Literature search for derivation of soil levels for these chemicals
c Owen, 1990
d Default assumption conservative of human health (ORS, 1989)

D. Exposure assumptions

1. Scenarios

Two exposure scenarios were evaluated. Scenario A is an evaluation for residential soils in cases where gardening is not performed in the soil. This scenario is included for informational purposes only. The receptor is a female who is exposed to chemicals in soil by direct ingestion, dermal contact, and inhalation of airborne soil particles.

Scenario B is a conservative evaluation for soils that would be used as landfill cover when there is the possibility of exposure of receptors in a residence adjacent to the landfill. The receptor evaluated is a female who lives in a residence adjacent to an operating landfill and who is exposed only by inhalation of airborne soil particles from the landfill. Airborne particulate material is assumed to be monitored and to not exceed the U.S EPA Air Quality Standards for particulate matter. These standards are set as 50 ug/m^3 (annual average) and 150 ug/m^3 (24-hour average).

2. Soil exposure

Details of the derivation of the assumptions are provided in another document (ORS,1991).

For both Scenarios, soil levels were calculated based on exposure during various periods of the lifetime. Exposure during Age 1 to 2 years (during three summer months), during Age 1 to 8 years, and during 0 to 75 years of age represent periods when maximum exposure is received from a subchronic, chronic and lifetime exposure, respectively. Soil levels based on exposure for three years and during Age 0 to 30 years were included at the request of the Bureau of Solid Waste.

As shown in Section III.B., the equations used for calculation of concentration of chemicals in soil contain the terms ADDsoil and LADDsoil. These terms represent the average daily dose of soil with which a receptor comes into contact by a particular pathway. ADDsoil represents the average daily dose when the averaging period is the period of exposure. LADDsoil represents the average daily dose when the averaging period is the lifetime. All other factors used in calculation of these terms are the same. Details of the calculation of the average daily dose are provided in another document (ORS, 1991). A brief description of the assumptions and procedures is included here for convenient reference.

a. Assumptions used in calculation of soil exposure by direct ingestion and dermal contact (Scenario A only)

Exposures by the soil ingestion and dermal contact routes are assumed to occur outdoors in that portion of the year when the receptor would be out of doors and not completely covered by clothing. Exposure is assumed to occur on an average of 5 out of 7 days. These considerations result in at most 153 days per year having exposure events. On these days, the average daily soil ingestion rate is assumed to be 100 mg/day for children under 6 years old, and 50 mg/day for other receptors. The average exposure by the dermal route varies in accordance with the size of the body exposed. The hands, feet, arms and legs were assumed to be all or partially exposed. Age-specific values were used for these surface areas. A soil mass of 0.51 mg per square centimeter of exposed skin is assumed.

Because the small child is also exposed by floor activity indoors, an estimate of indoor exposure is also given for children aged 1 to 6 years for the additional 212 days. Exposure events are assumed to occur on an average of 5 out of 7 days. The average daily soil intake is estimated by considering the duration of floor activity (7 hours for ages 1 to 6), the number of times the hand is mouthed per hour (9 times), the surface area mouthed (1/2 of 1 finger), and the amount of soil on the surface area mouthed (0.056 mg/cm^2 of dust, of which 80% is from soil).

b. Assumptions used for calculation of average daily intake of air (Scenarios A and B)

Exposure by the inhalation route is assumed to occur on every day. The receptor aged 0 to 6 years is assumed to be at home for 24 hours per day; aged 6 to 18 years, for an average of 12 hours per day; and aged 18 to 75 years, for an average of 16 hours per day. Air intake is assumed to vary with age, ranging from 0.21 cubic meters/hour for a 1 year old to 0.83 cubic meters/hour for an adult. Considering the time spent at home, the average hourly air intake, and the body weight, the average daily air intake (cubic meters/kg/day) was found to range from 0.16 for the 11 to 12 year old child to 0.46 for the 1 to 2 year old child.

c. Averaging procedures

For calculation of the average daily dose of soil or air received for the period, the total amount received is divided by the average body weight of the receptor in the exposure period and by the number of days in the averaging period. This results in an average daily soil intake expressed as mg soil per kg body weight per day or cubic meter of air per kg body weight per day.

For exposure periods of 1 year the yearly average for exposure by these pathways would be used. For periods over 1 year, the annual exposure rates are averaged using either the exposure period as the averaging period (to obtain ADD values) or the lifetime, 75 years, (to obtain LADD values). For periods under 1 year, exposure during 3 summer months is used, and the averaging period is either the 3 months (ADD values) or 75 years (LADD values). Because of the intensity of exposure during these summer months, this type of exposure results in the greatest ADD values for soil ingestion and dermal contact. Although the LADD values are calculated for a 3-month exposure for comparison purposes, their routine use in regulatory decisions is not advocated. This is because the Cancer Slope Factors are derived from a near-lifetime exposure of animals, and the extrapolation to an effect that could occur in 75 years to one that might occur in 3 months involves several assumptions that would result in a high rate of uncertainty.

d. Concentration of particles in the air

Discussion of the importance of different sized particles to human health is given in Casarett and Doull's Toxicology (Amdur et al., 1986) and is briefly summarized here. Particles having an aerodynamic diameter greater than 30um are not of importance in the inhalation exposure route. Those having an aerodynamic diameter between 5 and 20 um are trapped in the nasopharyngeal region, those with an aerodynamic diameter between 1 and 5 um may enter the bronchiolar region, and only those with diameters ≤ 1 enter the alveolar region. Particles with an aerodynamic diameter of less than 10 um (PM10) are considered of importance in regulation of air quality, and the U.S. Air Quality Standards apply to PM10.

The mass of soil as particles with aerodynamic diameters of 10-30 um is expected to be increased considerably in Scenario B because of the soil disturbance activity at the landfill. This will result in an increased exposure when particles cleared from the respiratory tract are swallowed. Particles with an aerodynamic diameter of less than 30 um (PM30) are therefore considered in the evaluation of Scenario B.

As a conservative assumption, it is assumed that the amount of soil in the air is the same whether the receptor is indoors or outdoors. Thus the following discussion on air-borne soil particles applies to both indoor and outdoor air.

Three situations are postulated for exposure by inhalation of soil particles. The first applies to Scenario A; relevant values are summarized in Table 3a. An average PM10 mass of 44 ug/m^3 of air was measured during air quality monitoring by the Division of Air Quality Control (DAQC, 1987). It was assumed that the proportion of particles from soil was 50% and the proportion of PM10 deposited in the pulmonary region was 50% (ORS, 1991). These values taken together give 11 ug/cubic meter of soil deposited in the pulmonary region.

Calculations were made to derive the proportion of mass between PM30 and PM10, and this was assumed to be incidentally ingested after inhalation. This is a highly conservative assumption. These values are also shown in Table 3a. Information from the Division of Air Quality Control showed that the PM10 was approximately 42% of the Total Suspended Particle (TSP) mass (Lane, 1991). Using this information and a PM10 mass of 44 ug/cubic meter, it was possible to calculate the TSP mass as 105 ug/cubic meter. A survey in the Boston area (Thurston and Spengler (1987) found that all of the soil mass in the sampled area was in particles less than 30 um in diameter (all PM30). This indicated that the total ambient TSP mass could be considered as PM30 in the absence of construction or other soil-disturbing activities. Subtraction of the PM10 mass gave the proportion of mass that would be between PM30 and PM10 as 58%. The PM10 that was not deposited in the lung was also assumed to be ingested. This gave a total of 42 ug ingested soil per cubic meter air inhaled. Since the impact of this amount of soil would be negligible when the direct ingestion of soil by the oral route is considered, it was not factored in for Scenario A.

The second situation applies to Scenario B when exposure is considered for over 1 year. Relevant values are summarized in Table 3b. In that case, it is assumed that the yearly average PM10 will be 50 ug/cubic meter of air. The proportion of TSP that is PM10 is assumed to be 0.42 in this case as well. However, the non-soil mass that is present in the absence of being adjacent to a landfill (as in Scenario A) is considered as baseline, and is subtracted from the total PM10 mass. This results in a PM10 mass from soil which is 50 * 0.56 or 28 ug/cubic meter; the proportion deposited in the lungs is assumed to be 0.5. The resultant mass deposited in the pulmonary region is 14 ug/cubic meter. The total

ingested soil was found to be 50 ug/m^3 and was included in the calculations for this scenario because in this case, ingested soil could have an influence on the calculated soil level.

The third situation applies to Scenario B when exposure is considered for less than 1 year. Values relevant to this are summarized in Table 3c. In that case, it is assumed that the yearly average PM10 of 50 ug/cubic meter of air will not be exceeded for the year in question. If it is assumed that the PM10 can reach an average of 150 ug/cubic meter of air on some days but averages 44 ug/cubic meter of air on all other days, then the number of days with an average of 150 ug/cubic meter of air can be approximately 20 without exceeding a yearly average of 50 ug/cubic meter. It is assumed that these 20 days are distributed over the 3 summer months, but that they are not consecutive.

When soil is disturbed, particles of varying sizes are released. The U.S. EPA model for size of particles released under soil tilling conditions indicates that the proportion of particles that is PM10 is 0.21, and the proportion that is PM30 is 0.33. It is assumed that these values may be used to estimate the soil exposure by inhalation on the days when the PM10 reaches 150 ug/m. In order to estimate the average for the 3-month period of exposure, it was assumed that the soil masses ingested or reaching the lung were as in Table 3a for 70 days, but that they were as shown in Table 3c for 20 days. This results in average values of 23 ug/cubic meter of air for PM10 and 36 ug/cubic meter of air for particles between PM30 and PM10.

TABLE 3a. ASSUMPTIONS FOR CALCULATION OF DISPOSITION OF AIR-BORNE SOIL PARTICLES IN THE ABSENCE OF LANDFILL EXPOSURE

PARTICLE SIZE	PROPORTION BY SIZE	UG/CU.M	PROPORTION FROM SOIL	PROPORTION DEPOSITED IN PULMONARY REGION	UG/CU.M DEPOSITED IN PULMONARY REGION	PROPORTION INGESTED	UG/CU.M INGESTED
PM10	0.42	44	0.5	0.5	11	0.5	11
PM30-PM10	0.58	61	0.5	0	0	1	31
PM30 (total)	1.0	105 (total)	0.5		11 (total)		42 (total)

It is assumed that TSP is equal to particles <30 um (Thurston and Spengler, 1983).
In Scenario A, all ingested soil is included in the 100 mg/day average daily intake. The amount swallowed after inhalation is therefore not factored in when the soil ingestion route is considered. The values are shown for comparative purposes only.

TABLE 3b. ASSUMPTIONS FOR CALCULATION OF DISPOSITION OF AIR-BORNE SOIL ,FROM THE LANDFILL WHEN EXPOSURE IS >1 YEAR

PARTICLE SIZE	PROPORTION BY SIZE	UG/CU.M	PROPORTION FROM SOIL	PROPORTION DEPOSITED IN PULMONARY REGION	UG/CU.M DEPOSITED IN PULMONARY REGION	PROPORTION INGESTED	UG/CU.M INGESTED
PM10	0.42	50	(50-22)/50 0.56	0.5	14	0.5	14
PM30-PM10	0.58	69	(69-31)/69 0.55	0	0	1	36
PM30	1.0	119 (total)			14 (total)		50 (total)

The PM10 value is set equal to the U.S. standard of 50 ug/m^3 (yearly average). The proportion of PM10 is left at the same level as the average exposure to be conservative of the amount of inhalation exposure.
It is assumed that the TSP is equal to the PM30 as a conservative measure.
The amount of non-soil particulate material from Table 3a is subtracted from the total mass in Table 3b to obtain the soil mass.

TABLE 3c. ASSUMPTIONS FOR CALCULATION OF DISPOSITION OF AIR-BORNE SOIL PARTICLES FROM A LANDFILL WHEN EXPOSURE IS FOR LESS THAN A YEAR

PARTICLE SIZE	PROPORTION BY SIZE	UG/CU.M	PROPORTION FROM SOIL	PROPORTION DEPOSITED IN PULMONARY REGION	UG SOIL/ CU.M AIR DEPOSITED IN PULMONARY REGION	PROPORTION INGESTED	UG SOIL/ CU.M AIR INGESTED	QUARTERLY AVERAGES: UG SOIL/CU.M AIR	
								IN LUNG	INGESTED
PM10	.21	150	(150-22)/ 150 .85	.5	64	.5	64	23	23
PM30-PM10	.33-.21= .12	86	(86-31)/86 .64	0	0	1	55	0	36
		714 (total TSP)			64 (total)		119 (total)	23 (total)	59 (total)

It is assumed that the PM30 is equal to 0.33 TSP, and that the PM10 is equal to 0.21 TSP in accordance with a soil tilling model used by the U.S. EPA (U.S. EPA, 1989).

The quarterly averages were calculated assuming exposure for 70 days as in Table 3a and for 20 days as in Table 3c. The calculations are shown below:

PM10 deposited in lungs: [(11*70)+(64*20)]/90 = 23 ug soil/cu.m air.

PM30 swallowed: PM10 not in lungs (23) + {[(31*70)+(55*20)]/90} = 59 ug soil/cu.m air.

IV. Calculation

Spreadsheets showing how the soil levels were calculated using a computerized process are reproduced in the Appendix. Tables in the Appendix with the prefix "1" contain the calculations for soil levels based on threshold effects (noncarcinogenic) of the chemicals, and those with the prefix "2" contain the calculations for soil levels based on cancer effects (nonthreshold effects) of the chemical.

V. Results and discussion

A. Scenario A, residential soil levels

For the residential exposure conditions (Scenario A), the soil levels based on cancer and non-cancer effects are summarized in Table 4 in the unshaded columns. The source of the toxicity data, Cancer Slope Factor (CSF) and Acceptable Daily Intake (ADI) is shown so that reference to the other tables and spreadsheets may be made more easily. The values in Table 4 represent the best estimates under health-conservative exposure conditions. Where values based on cancer risk are absent, it is because the chemicals are not known to induce cancer.

The lowest derived soil level of the various exposure durations considered and for each type of effect is given under the shaded columns marked "Lowest Value". The values are shown as calculated using a Hazard Index (HI) of 1 and an Excess Lifetime Cancer Risk (ELCR) of one in a hundred thousand (1E-05). Also shown are the Lowest Values after adjustment to meet the risk management criteria HI of 0.2 and ELCR of 1 in a million (1E-06). The Landfill Cover Criteria suggested by the Department are included in the last (shaded) column.

The soil level derived using an exposure period of 90 days for the 1 to 2 year old is the critical calculation for threshold or noncarcinogenic effects in most cases. This is because the exposure is concentrated in the summer months, because the child is a smaller receptor to a larger dose, and because similar ADI values are used for chronic and subchronic exposures. An execption is the PCB mixture, for which different ADI chronic and subchronic values are used, and the critical exposure period is the one between ages 1 and 8 years.

A lifetime exposure provides the lowest soil level for cancer effects but the soil levels associated with specific risk when other exposure periods are used are also included. These periods include one between 0 and 30 years of age recently suggested by the

U.S. EPA, and a three year period of exposure between 2 and 5 years of age. The 3-month exposure period is included for comparison, but is not recommended for use because of the high degree of uncertainty in the extrapolation of results from a lifetime animal test to a 3-month human exposure.

The DEP Landfill Cover Criteria are generally greater than a residential soil level, indicating that use of these soils would be inappropriate as soil cover in a residential area. There the exposure by soil ingestion, dermal contact and inhalation would result in adverse health effects. The exceptions are cadmium, trivalent chromium and selenium.

TABLE 4. SCENARIO A: SUMMARY OF DERIVED SOIL LEVELS (MG/KG)

AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22		LOWEST VALUE	DEP
EXPOSURE PERIOD	3 Y	7 Y	30 Y	75 Y	90 D	90 D	AT RI=1 OR ELCR=1E-5	AT RI=.2 OR ELCR=1E-6	
ARSENIC									40
THRESHOLD EFFECTS (ORAL ADI)	54	65	149	226	31	186	31	6.2	
CANCER EFFECTS (SPEC.CSF)	24	13	6.6	4.0	169	985	4	0.4	
PAH									100
CANCER EFFECTS (ORAL ADI for BaP)	13	6.6	3.0	1.8	1.8	403	1.8	0.18	
									100
THRESHOLD EFFECTS (SPEC.ADI for Naphthalene)	726	830	1569	2246	429	1679	429	85.8	
CADMIUM									25
THRESHOLD EFFECTS (ORAL ADI)	204	251	620	965	117	842	117	(23.4)	
CANCER EFFECTS (INHAL. CSF)	7452	4516	1490	648	95533	191066	648	64.8	
CHROMIUM, TRIVALENT									500
THRESHOLD EFFECTS (ORAL ADI)	114766	131698	252549	362713	67710	272764	67710	13542	
CHROMIUM, 20% HEXAVALENT									500
THRESHOLD EFFECTS (SPEC.ADI)	7693	1430	2308	2754	5045	16146	1430	286	
CANCER EFFECTS (INHAL. CSF)	5543	3360	1109	482	71067	142134	482	48	
LEAD									500
THRESHOLD EFFECTS (ABS. ADI)					56	1209		56	
INORGANIC MERCURY									10
THRESHOLD EFFECTS (SPEC.ADI)	55	62	113	159	33	117	33	6.6	
PCBs									2
THRESHOLD EFFECTS (ORAL ADI)	7.6	0.9	1.9	2.8	4.4	21.9	0.9	0.18	
CANCER EFFECTS (ORAL CSF)	4.9	2.5	1.2	0.7	34	169	0.7	0.07	
SELENIUM									
THRESHOLD EFFECTS (SPEC.ADI)	1023	1260	3122	4874	586	4250	586	117	
VANADIUM									1000
THRESHOLD EFFECTS (SPEC.ADI)	1516	1886	4872	7662	868	7028	868	174	
VINYL CHLORIDE									10
THRESHOLD EFFECTS (SPEC.ADI)	108	124	235	337	64	252	64	12.8	
CANCER EFFECTS (SPEC.CSF)	14	7	3	2	101	39	2	0.2	

Soil levels identified as being of particular interest for comparison to the Landfill Cover Criteria are summarized in Table 5. These values are not the lowest; they are provided here for comparative purposes only.

TABLE 5. SUMMARY OF PROTECTIVE DERIVED SOIL LEVELS FOR SCENARIO A (RESIDENTIAL EXPOSURE): MG/KG CHEMICAL IN SOIL FOR SPECIFIC EXPOSURE CONDITIONS

CHEMICAL	LANDFILL COVER CRITERIA	THRESHOLD EFFECTS: LOWEST VALUE		CANCER: AGE 2<5 YR EXPOSURE		CANCER: AGE 0<30 YEAR EXPOSURE	
		HI=1	HI=.2	ELCR=1E-5	ELCR=1E-6	ELCR=1E-5	ELCR=1E-6
	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil
ARSENIC	40	31	6.2	24	2.4	7	0.7
CADMIUM	25	117		7452	745.2	1490	149.0
TRIVALENT CHROMIUM	500	67710	13542				
HEXAVALENT CHROMIUM (20%)	500	1430	286	5543	554	1109	111
LEAD	500		55				
INORGANIC MERCURY	10	33	6.6				
PAH	100	429	85.8	13	1.3	3	0.3
PCB	2	0.9	0.18	5	0.5	1.2	0.1
SELENIUM	30	586	137				
VANADIUM	1000	868	173.6				
VINYL CHLORIDE	10	64	12.8	14	1.4	3	0.3

B. Scenario B, landfill soil cover levels

Soil levels derived for Scenario B are summarized in Table 6. Some of the soil levels are high values so that scientific notation is used. The process of calculating a soil level using a risk factor and an exposure rate is valid only when the ratio (ADI*AF)/(ADDsoil*AF) is less than 1 in a million. When this is exceeded, the derived soil level would contain 100% or more of chemical which is impossible. Therefore, the high levels simply indicate that under the specified conditions, no adverse effects on health would be anticipated.

The Lowest Values from evaluations of all exposure durations and risk management criteria are compared with DEP Landfill Cover Criteria in the shaded columns. Those chemicals which would not present a hazard under any of the risk management criteria are: cadmium, trivalent chromium, lead, inorganic mercury, naphthalene, PCBs, selenium, vanadium and vinyl chloride. Risks from exposure to arsenic, BaP and hexavalent chromium would exceed some of the specified management criteria.

Additional consideration and evaluation of the assumptions used to derive soils levels for arsenic, BaP and hexavalent chromium may be warranted. For example, the concentrationos of BaP and hexavalent chromium were requested to be 40% and 20%, respectively. Additional study of soil levels of these chemicals could be used to refine these assumptions. Others have used 3% total chromium as representing the portion that might be hexavalent in soil for risk assessment purposes (Microenvironmental Analysis of Residential Exposure in Chromium-Laden Wastes in and Around New Jersey Homes by P.J. Lioy et al., Risk Analysis, June, 1992). Also, the BaP was used as representing all carcinogens in PAH. Since the other carcinogens are of lower potency (to our current knowledge) this results in a strong conservative bias. Finally, it was assumed that carcinogenic effect from arsenic in soil would be the same as from arsenic trioxide in air or water. The absorption efficiencies from these media are likely to differ, and the mechanism of arsenic carcinogenicity is still under review. However, the U.S. EPA treats does not distinguish between arsenic chemical forms in carcinogenicity potency, so no distinction was made here.

TABLE 6. SCENARIO B: SUMMARY OF DERIVED SOIL LEVELS (MG/KG)

AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22	LOWEST VALUE		DEP
EXPOSURE PERIOD	3 Y	7 Y	30 Y	75 Y	90 D	90 D	AT RISK=1 OR HI=1E-5	AT RISK=2 OR HI=1E-6	
ARSENIC									40
THRESHOLD EFFECTS (ORAL ADI)	12378	13410	19310	20990	8621	16521	8621	1724	
CANCER EFFECTS (SPEC.CSF)	633	384	127	55	5103	10206	55	6	
PAH									100
CANCER EFFECTS (ORAL ADI for BaP)	3546	2149	709	308	36028	72055	308	31	
									100
THRESHOLD EFFECTS (SPEC.ADI)	3E+05	4E+05	5E+05	6E+05	2E+05	5E+05	OVER 100		
CADMIUM									25
THRESHOLD EFFECTS (ORAL ADI)	13495	14620	21053	22883	7522	15044	7522	(1504)	
CANCER EFFECTS (INHAL. CSF)	5855	3548	1171	509	45690	91379	509	51	
CHROMIUM, TRIVALENT									500
THRESHOLD EFFECTS (ORAL ADI)	4E+07	4E+07	6E+07	7E+07	3E+07	5E+07	OVER 500		
CHROMIUM, 20% HEXAVALENT									500
THRESHOLD EFFECTS (SPEC.ADI)	18314	1984	2857	3106	9451	18903	1984	397	
CANCER EFFECTS (INHAL. CSF)	4355	2640	871	379	33989	67977	379	38	
LEAD									500
THRESHOLD EFFECTS (ABS. ADI)					8282	8282		8282	
INORGANIC MERCURY									10
THRESHOLD EFFECTS (SPEC.ADI)	10417	11286	16252	17665	5943	11886	5943	1189	
PCBs									2
THRESHOLD EFFECTS (ORAL ADI)	2003	217	313	340	1326	2651	217	43.4	
CANCER EFFECTS (ORAL CSF)	1015	615	203	88	10152	20305	88	9	
SELENIUM									
THRESHOLD EFFECTS (SPEC.ADI)	1E+05	1E+05	2E+05	2E+05	6E+04	1E+05	OVER 30		
VANADIUM									1000
THRESHOLD EFFECTS (SPEC.ADI)	47651	51622	74336	80800	25547	51094	25547	5109	
VINYL CHLORIDE									10
THRESHOLD EFFECTS (SPEC.ADI)	51116	52553	75676	82256	36680	73359	36680	7336	
CANCER EFFECTS (SPEC.CSF)	5040	3055	1008	438	53868	107735	438	44	

Table 7 contains data for only shorter exposure periods. The shaded boxes show soil levels lower than the Landfill Cover Criteria. These results should be interpreted with consideration of the concentration of the toxic form of the chemical in the soil.

TABLE 7. DERIVED CHEMICAL LEVELS (MG/KG) FOR SCENARIO B: LANDFILL SOILS WHICH WOULD BE WITHOUT ADVERSE EFFECTS AT AN ADJACENT RESIDENCE

CHEMICAL	LANDFILL COVER CRITERIA	THRESHOLD EFFECTS: LOWEST SOIL LEVEL		CANCER: AGE 2<5 YR EXPOSURE		CANCER: AGE 0<30 YEAR EXPOSURE	
		HI=1	HI=.2	ELCR=1E-5	ELCR=1E-6	ELCR=1E-5	ELCR=1E-6
	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil	mg/kg in soil
ARSENIC	40	8621	1724	633	63	127	13
CADMIUM	25	7522	(1504)	5855	586	1171	117
TRIVALENT CHROMIUM	500	3E+07	6E+06				
HEXAVALENT CHROMIUM (20%)	500	1984	397	4355	436	871	87
LEAD	500		8282				
INORGANIC MERCURY	10	5943	1189				
PAH	100	2E+05	4E+05	3546	355	709	71
PCB	2	217	43	1015	102	203	20
SELENIUM	30	6E+04	1E+04				
VANADIUM	1000	25547	5109				
VINYL CHLORIDE	10	36680	7336	5040	504	1008	101

VII. References

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APPENDIX
CALCULATION OF CHEMICAL SOIL LEVELS FOR SCENARIOS A AND B

CALCULATION OF CHEMICAL SOIL LEVELS FOR SCENARIOS A AND B

The calculations of the soil levels are shown as spreadsheets in Tables 1 and 2. The results for each chemical are shown on separate pages. An index of the Tables and the toxicity values used in the calculations are presented below.

CHEMICAL	THRESHOLD EFFECTS RESULTS TABLE AND ADI	CANCER EFFECTS RESULTS TABLE AND CSF
ARSENIC	1a: ROUTE-SPECIFIC ADI	2a: ROUTE-SPECIFIC CSF
	1aa: ORAL ADI	
PAH AS 40% BaP		2b: ORAL CSF
CADMIUM	1c: ORAL ADI	2c: INHALATION CSF
TRIVALENT CHROMIUM	1d: ORAL ADI	
HEXAVALENT CHROMIUM (20%)	1dd: ROUTE-SPECIFIC ADI	2dd: INHALATION CSF
LEAD	1e: ABSORBED INCREMENT ADI	
INORGANIC MERCURY	1f: ROUTE-SPECIFIC ADI	
PAH AS 60% NAPHTHALENE	1g: ROUTE-SPECIFIC ADI	
PCBs	1h: ORAL ADI	2h: ORAL CSF
SELENIUM	1i: ROUTE-SPECIFIC ADI	
VANADIUM	1j: ROUTE-SPECIFIC ADI	
VINYL CHLORIDE	1k: ROUTE-SPECIFIC ADI	2k: ROUTE-SPECIFIC CSF

In each table, the soil level (CHEMsoil) for Scenario A is shown in the upper half of the Table and for Scenario B in the lower half. The proportion of exposure from each pathway is also included.

Table 1 contains the calculations for soil levels derived using noncancer (threshold) effects of the designated chemicals. In some cases where the toxicity data based on an inhalation route were not available or considered inappropriate, the exposure by inhalation was converted to absorbed dose and compared to an absorbed dose derived from the Oral ADI. These adjustments are shown as "AF" in the Tables. This adjustment was made for all exposures received by the dermal route.

In two cases (chromium and PAH), an additional adjustment was

made since the toxic chemicals would not be 100% of the assayed chemical. An adjustment factor of 20% was used for hexavalent chromium; 40% was used for carcinogens (BaP) in PAH; and 60% for noncarcinogens (naphthalene) in PAH. These adjustments are shown in the "AF" line. These adjustments were made for illustrative purposes; the soil levels derived do not apply to mixtures having other proportions of the toxic forms.

In the case of lead, the calculations are performed with an ADI based on incremental absorbed dose. This absorbed dose is already 0.2 times the target absorbed dose. The derived soil level corresponds to one at a Hazard Index of 0.2. The cadmium ADI was calculated with consideration of all sources of exposure and receptors.

In the case of arsenic, two methods of calculation were used to derive soil levels from threshold effects. The reason for this is that the Inhalation Reference Concentrations from which an Inhalation ADI was derived were based on inhalation of arsenic trioxide in water and on industrial exposure to fine particles in air. It was questionable if the the threshold effects from these exposures would be seen after exposure of arsenic in soil. Table 1a contains calculations made with these Inhalation ADIs. As an alternative, the dose from an inhalation exposure was compared to the ADI for oral route exposure. These calculations are shown in Table 1aa. When the soil levels in these two Tables are compared, there is little difference in the soil levels for Scenario A, where inhalation contributes a small proportion of the dose. However, the results in Scenario B are markedly different. The results from Table 1aa are considered more representative of the toxicity of soil arsenic and are included in the text in Tables 4-7.

Because of the uncertainties in cancer induction by arsenic, this adjustment was not made for the calculation of soil levels based on arsenic's carcinogenic effect. Arsenic induces cancer after exposure by either the inhalation or the oral routes. These cancer effects were evaluated using the route-specific cancer slope factors. The results are shown in Table 2a; these are included in the text in Tables 4-7. Although the nature of the carcinogenic effect of arsenic is still under discussion, the U.S. EPA considers both the trivalent and pentavalent forms equally carcinogenic.

TABLE 1a. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR ARSENIC AND ROUTE-SPECIFIC ADIs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (.98/.98)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	1.3E-02	1.0E-02	3.5E-03	2.1E-03	2.4E-02	2.0E-03
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.03/.98)	0.03	0.03	0.03	0.03	0.03	0.03
	ADDsoil * AF	1.6E-06	1.5E-06	9.6E-07	7.0E-07	2.5E-06	1.0E-06
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	5.2E-03	4.9E-03	3.2E-03	2.3E-03	8.4E-03	3.4E-03
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (.85/.85)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	ADI (MG/KG/DAY), INHAL	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07
	(ADDsoil * AF)/ADI	5.0E-03	4.6E-03	3.2E-03	2.9E-03	5.9E-03	2.9E-03
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	2.4E-02	2.0E-02	9.9E-03	7.4E-03	3.8E-02	8.3E-03
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	43	50	101	136	26	120
	PROPORTION FROM SOIL INGESTION:	0.57	0.52	0.35	0.28	0.62	0.24
	PROPORTION FROM DERMAL CONTACT:	0.22	0.25	0.32	0.32	0.22	0.41
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.21	0.23	0.32	0.40	0.15	0.35
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.85/.85)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	ADI (MG/KG/DAY), INHAL	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07	8.6E-07
	(ADDsoil * AF)/ADI	6.3E-03	5.9E-03	4.1E-03	3.7E-03	1.2E-02	6.2E-03
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		158	171	246	267	81	163
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.98/.98)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	6.5E-05	6.0E-05	4.2E-05	3.8E-05	9.0E-05	4.5E-05
SUM ((ADDsoil * AF)/ADI) AS KG/MG		6.4E-03	5.9E-03	4.1E-03	3.8E-03	1.2E-02	6.2E-03
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		156	169	243	264	81	161
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.99	0.99	0.99	0.99	0.99	0.99
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.01	0.01	0.01	0.01	0.01	0.01

TABLE 1aa. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR: ARSENIC AND ORAL ADI

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (.98/.98)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	1.3E-02	1.0E-02	3.5E-03	2.1E-03	2.4E-02	2.0E-03
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.03/.98)	0.03	0.03	0.03	0.03	0.03	0.03
	ADDsoil * AF	1.6E-06	1.5E-06	9.6E-07	7.0E-07	2.5E-06	1.0E-06
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	5.2E-03	4.9E-03	3.2E-03	2.3E-03	8.4E-03	3.4E-03
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (.85/.98)	0.87	0.87	0.87	0.87	0.87	0.87
	ADDsoil * AF	3.7E-09	3.4E-09	2.4E-09	2.2E-09	4.4E-09	2.2E-09
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	1.2E-05	1.1E-05	8.0E-06	7.3E-06	1.5E-05	7.3E-06
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	1.9E-02	1.5E-02	6.7E-03	4.4E-03	3.2E-02	5.4E-03
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	54	65	149	226	31	186
	PROPORTION FROM SOIL INGESTION:	0.72	0.68	0.52	0.47	0.74	0.37
	PROPORTION FROM DERMAL CONTACT:	0.28	0.32	0.48	0.53	0.26	0.63
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.00	0.00	0.00	0.00	0.00	0.00
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.85/.98)	0.87	0.87	0.87	0.87	0.87	0.87
	ADDsoil * AF	4.7E-09	4.4E-09	3.0E-09	2.8E-09	9.2E-09	4.6E-09
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	1.6E-05	1.5E-05	1.0E-05	9.3E-06	3.1E-05	1.5E-05
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		63348	68627	98824	107417	32692	65384
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.98/.98)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY), ORAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	6.5E-05	6.0E-05	4.2E-05	3.8E-05	9.0E-05	4.5E-05
SUM ((ADDsoil * AF)/ADI) AS KG/MG		8.1E-05	7.5E-05	5.2E-05	4.8E-05	1.2E-04	6.1E-05
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		12378	13410	19310	20990	8261	16521
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.20	0.20	0.20	0.20	0.25	0.25
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.80	0.80	0.80	0.80	0.75	0.75

TABLE 1c. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR CADMIUM AND AN ORAL ADI

		AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
		EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
		HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:								
SOIL INGESTION:	ADDsoil (KG/KG/DAY)		4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (.06/.06)		1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF		4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY), ORAL		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI		4.0E-03	3.1E-03	1.1E-03	6.2E-04	7.1E-03	6.0E-04
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)		5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.001/.06)		0.02	0.02	0.02	0.02	0.02	0.02
	ADDsoil * AF		8.6E-07	8.2E-07	5.3E-07	3.9E-07	1.4E-06	5.6E-07
	ADI (MG/KG/DAY) (ORAL)		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI		8.6E-04	8.2E-04	5.3E-04	3.9E-04	1.4E-03	5.6E-04
INHALATION	ADDair (CU.M/KG/DAY)		3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)		11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):		4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (.6/.06)		10.00	10.00	10.00	10.00	10.00	10.00
	ADDsoil * AF		4.3E-08	4.0E-08	2.8E-08	2.5E-08	5.1E-08	2.5E-08
	ADI (MG/KG/DAY), ORAL		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI		4.3E-05	4.0E-05	2.8E-05	2.5E-05	5.1E-05	2.5E-05
SUM OF 3 PATHWAYS								
	SUM ((ADDsoil * AF)/ADI) AS KG/MG		4.9E-03	4.0E-03	1.6E-03	1.0E-03	8.6E-03	1.2E-03
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		204	251	620	965	117	842
	PROPORTION FROM SOIL INGESTION:		0.82	0.78	0.65	0.60	0.83	0.51
	PROPORTION FROM DERMAL CONTACT:		0.18	0.21	0.33	0.38	0.16	0.47
	PROPORTION FROM PARTICLE INHALATION (LUNG):		0.01	0.01	0.02	0.02	0.01	0.02
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:								
AIR INTAKE	ADDair (CU.M/KG/DAY)		3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)		14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):		5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.6/.06)		10.00	10.00	10.00	10.00	10.00	10.00
	ADDsoil * AF		5.5E-08	5.0E-08	3.5E-08	3.2E-08	1.1E-07	5.3E-08
	ADI (MG/KG/DAY) (ORAL)		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI		5.5E-05	5.0E-05	3.5E-05	3.2E-05	1.1E-04	5.3E-05
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:			18315	19841	28571	31056	9452	18904
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)		14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)		36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)		2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.06/.06)		1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF		2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY) (ORAL)		1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI		2.0E-05	1.8E-05	1.3E-05	1.2E-05	2.7E-05	1.4E-05
SUM ((ADDsoil * AF)/ADI) AS KG/MG			7.4E-05	6.8E-05	4.8E-05	4.4E-05	1.3E-04	6.6E-05
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:			13495	14620	21053	22883	7522	15044
	PROPORTION FROM PARTICLE INHALATION (LUNG):		0.74	0.74	0.74	0.74	0.80	0.80
	PROPORTION FROM SWALLOWED INHALED PARTICLES:		0.26	0.26	0.26	0.26	0.20	0.20

TABLE 1d. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR TRIVALENT CHROMIUM AND AN ORAL ADI

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (.11/.11)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY),ORAL	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
	(ADDsoil * AF)/ADI	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.01/.11)	0.09	0.09	0.09	0.09	0.09	0.09
	ADDsoil * AF	4.7E-06	4.5E-06	2.9E-06	2.1E-06	7.7E-06	3.1E-06
	ADI (MG/KG/DAY) (ORAL)	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
	(ADDsoil * AF)/ADI	4.7E-06	4.5E-06	2.9E-06	2.1E-06	7.7E-06	3.1E-06
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (.6/.6)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	ADI (MG/KG/DAY),ORAL	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
	(ADDsoil * AF)/ADI	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	8.7E-06	7.6E-06	4.0E-06	2.8E-06	1.5E-05	3.7E-06
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	114766	131698	252549	362713	67710	272764
	PROPORTION FROM SOIL INGESTION:	0.4591	0.4120	0.2660	0.2248	0.4807	0.1637
	PROPORTION FROM DERMAL CONTACT:	0.5404	0.5875	0.7334	0.7743	0.5189	0.8357
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0005	0.0005	0.0007	0.0009	0.0003	0.0007
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.6/.6)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	ADI (MG/KG/DAY) (ORAL)	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
	(ADDsoil * AF)/ADI	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		2E+08	2E+08	3E+08	3E+08	9E+07	2E+08
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.11/.11)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY) (ORAL)	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
	(ADDsoil * AF)/ADI	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
SUM ((ADDsoil * AF)/ADI) AS KG/MG		2.5E-08	2.3E-08	1.6E-08	1.5E-08	3.8E-08	1.9E-08
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		4E+07	4E+07	6e+07	7E+07	3E+07	5E+07
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.22	0.22	0.22	0.22	0.28	0.28
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.78	0.78	0.78	0.78	0.72	0.72

TABLE 1dd. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR 20% HEXAVALENT CHROMIUM AND ROUTE-SPECIFIC ADIs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (.2*.11)/.11	0.20	0.20	0.20	0.20	0.20	0.20
	ADDsoil * AF	8.0E-07	6.3E-07	2.1E-07	1.2E-07	1.4E-06	1.2E-07
	ADI (MG/KG/DAY),ORAL	2.0E-02	5.0E-03	5.0E-03	5.0E-03	2.0E-02	2.0E-02
	(ADDsoil * AF)/ADI	4.0E-05	1.3E-04	4.2E-05	2.5E-05	7.1E-05	6.0E-06
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (0.2*.01)/.11	0.02	0.02	0.02	0.02	0.02	0.02
	ADDsoil * AF	9.4E-07	8.9E-07	5.8E-07	4.3E-07	1.5E-06	6.1E-07
	ADI (MG/KG/DAY) (ORAL)	2.0E-02	5.0E-03	5.0E-03	5.0E-03	2.0E-02	2.0E-02
	(ADDsoil * AF)/ADI	4.7E-05	1.8E-04	1.2E-04	8.5E-05	7.7E-05	3.1E-05
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (.2*.25)/.25	0.20	0.20	0.20	0.20	0.20	0.20
	ADDsoil * AF	8.6E-10	7.9E-10	5.5E-10	5.1E-10	1.0E-09	5.1E-10
	ADI (MG/KG/DAY),INHAL FOR HEX	2.0E-05	2.0E-06	2.0E-06	2.0E-06	2.0E-05	2.0E-05
	(ADDsoil * AF)/ADI	4.3E-05	4.0E-04	2.8E-04	2.5E-04	5.1E-05	2.5E-05
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	1.3E-04	7.0E-04	4.3E-04	3.6E-04	2.0E-04	6.2E-05
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	7692.8	1429.5	2308.0	2753.5	5044.5	16145.6
	PROPORTION FROM SOIL INGESTION:	0.3077	0.1789	0.0972	0.0683	0.3582	0.0969
	PROPORTION FROM DERMAL CONTACT:	0.3623	0.2551	0.2681	0.2351	0.3866	0.4946
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.3300	0.5661	0.6347	0.6966	0.2553	0.4085
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.2*.25/.25)	0.20	0.20	0.20	0.20	0.20	0.20
	ADDsoil * AF	1.1E-09	1.0E-09	7.0E-10	6.4E-10	2.1E-09	1.1E-09
	ADI (MG/KG/DAY) (INHAL FOR HEX)	2.0E-05	2.0E-06	2.0E-06	2.0E-06	2.0E-05	2.0E-05
	(ADDsoil * AF)/ADI	5.5E-05	5.0E-04	3.5E-04	3.2E-04	1.1E-04	5.3E-05
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		18315	1984	2857	3106	9452	18904
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.2*.11/.11)	0.20	0.20	0.20	0.20	0.20	0.20
	ADDsoil * AF	3.9E-09	3.6E-09	2.5E-09	2.3E-09	5.4E-09	2.7E-09
	ADI (MG/KG/DAY) (ORAL)	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
	(ADDsoil * AF)/ADI	3.9E-09	3.6E-09	2.5E-09	2.3E-09	5.4E-09	2.7E-09
SUM ((ADDsoil * AF)/ADI) AS KG/MG		5.5E-05	5.0E-04	3.5E-04	3.2E-04	1.1E-04	5.3E-05
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		18314	1984	2857	3106	9451	18903
	PROPORTION FROM PARTICLE INHALATION (LUNG):	1.00	1.00	1.00	1.00	1.00	1.00
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 1e. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR LEAD AND AN ABSORBED ADI

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06		NOT		7.1E-06	6.0E-07
	AF (PROPORTION ABSORBED)	0.50		CRITICAL		0.50	0.10
	ADDsoil * AF	2.0E-06		PERIODS		3.6E-06	6.0E-08
	ADI (MG/KG/DAY) ABSORBED INCREMENT	2.0E-04				2.0E-04	1.0E-04
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05				8.4E-05	3.4E-05
	AF (PROPORTION ABSORBED)	0.0006				0.0006	0.0006
	ADDsoil * AF	3.1E-08				5.1E-08	2.0E-08
	ADI (MG/KG/DAY) ABSORBED INCREMENT	2.0E-04				2.0E-04	1.0E-04
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01				4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11				11	11
	ADDsoil (KG/KG/DAY):	4.3E-09				5.1E-09	2.5E-09
	AF (PROPORTION ABSORBED)	1.00				1.00	1.00
	ADDsoil * AF	4.3E-09				5.1E-09	2.5E-09
	ADI (MG/KG/DAY) ABSORBED INCREMENT	2.0E-04				2.0E-04	1.0E-04
SUM OF 3 PATHWAYS							
	SUM (ADDsoil * AF) AS KG/KG/DAY	2.0E-06				3.6E-06	8.3E-08
	CHEMsoil = ADI/(ADDsoil * AF) AS MG/KG:	98.3	(APPROX)			55.5	1208.5
	PROPORTION FROM SOIL INGESTION:	0.9826				0.9846	0.7251
	PROPORTION FROM DERMAL CONTACT:	0.0153				0.0140	0.2444
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0021				0.0014	0.0306
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01				4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14				23	23
	ADDsoil (KG/KG/DAY):	5.5E-09				1.1E-08	5.3E-09
	AF (PROPORTION ABSORBED)	1.00				1.00	1.00
	ADDsoil * AF	5.5E-09				1.1E-08	5.3E-09
	ADI (MG/KG/DAY) ABSORBED INCREMENT	2.0E-04				2.0E-04	1.0E-04
CHEMsoil = ADI/(ADDsoil * AF) AS MG/KG:		36630.0				18903.6	18903.6
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14				23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36				36	36
	ADDsoil (KG/KG/DAY)	2.0E-08				2.7E-08	1.4E-08
	AF (PROPORTION ABSORBED)	0.50				0.50	0.50
	ADDsoil * AF	9.8E-09				1.4E-08	6.8E-09
	ADI (MG/KG/DAY) ABSORBED INCREMENT	2.0E-04				2.0E-04	1.0E-04
SUM (ADDsoil * AF) KG/KG/DAY		1.5E-08				2.4E-08	1.2E-08
CHEMsoil = ADI/(ADDsoil * AF) AS MG/KG:		13149.2	(APPROX.)			8281.6	8281.6
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.36				0.44	0.44
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.64				0.56	0.56

TABLE 1f. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR INORGANIC MERCURY AND ROUTE-SPECIFIC ADIs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (0.075/0.15)	0.50	0.50	0.50	0.50	0.50	0.50
	ADDsoil * AF	2.0E-06	1.6E-06	5.3E-07	3.1E-07	3.6E-06	3.0E-07
	ADI (MG/KG/DAY)	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	6.7E-03	5.2E-03	1.8E-03	1.0E-03	1.2E-02	1.0E-03
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.0.01/0.15)	0.07	0.07	0.07	0.07	0.07	0.07
	ADDsoil * AF	3.5E-06	3.3E-06	2.1E-06	1.6E-06	5.6E-06	2.2E-06
	ADI (MG/KG/DAY) (ORAL)	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	1.2E-02	1.1E-02	7.1E-03	5.2E-03	1.9E-02	7.5E-03
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (0.85/0.85)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	ADI (MG/KG/DAY) INHAL	8.6E-05	8.6E-05	8.6E-05	8.6E-05	8.6E-05	8.6E-05
	(ADDsoil * AF)/ADI	5.0E-05	4.6E-05	3.2E-05	2.9E-05	5.9E-05	2.9E-05
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	1.8E-02	1.6E-02	8.9E-03	6.3E-03	3.1E-02	8.5E-03
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	54.9	61.9	112.5	159.2	32.7	117.4
	PROPORTION FROM SOIL INGESTION:	0.3657	0.3225	0.1975	0.1645	0.3864	0.1174
	PROPORTION FROM DERMAL CONTACT:	0.6315	0.6746	0.7989	0.8309	0.6117	0.8792
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0027	0.0028	0.0036	0.0047	0.0019	0.0035
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.85/.85)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	ADI (MG/KG/DAY) (INHAL)	8.6E-05	8.6E-05	8.6E-05	8.6E-05	8.6E-05	8.6E-05
	(ADDsoil * AF)/ADI	6.3E-05	5.9E-05	4.1E-05	3.7E-05	1.2E-04	6.2E-05
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		15750.9	17063.5	24571.4	26708.1	8128.5	16257.1
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.075/.15)	0.50	0.50	0.50	0.50	0.50	0.50
	ADDsoil * AF	9.8E-09	9.0E-09	6.3E-09	5.8E-09	1.4E-08	6.8E-09
	ADI (MG/KG/DAY) (ORAL)	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	3.3E-05	3.0E-05	2.1E-05	1.9E-05	4.5E-05	2.3E-05
SUM ((ADDsoil * AF)/ADI) AS KG/MG		9.6E-05	8.9E-05	6.2E-05	5.7E-05	1.7E-04	8.4E-05
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		10417	11286	16252	17665	5943	11886
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.66	0.66	0.66	0.66	0.73	0.73
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.34	0.34	0.34	0.34	0.27	0.27

TABLE 1g. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR NAPHTHALENE AND ROUTE-SPECIFIC ADIs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (.6*1/1)	0.60	0.60	0.60	0.60	0.60	0.60
	ADDsoil * AF	2.4E-06	1.9E-06	6.3E-07	3.7E-07	4.3E-06	3.6E-07
	ADI (MG/KG/DAY) ORAL	4.0E-03	4.0E-03	4.0E-03	4.0E-03	4.0E-03	4.0E-03
	(ADDsoil * AF)/ADI	6.0E-04	4.7E-04	1.6E-04	9.3E-05	1.1E-03	9.0E-05
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.6*.1/1)	0.06	0.06	0.06	0.06	0.06	0.06
	ADDsoil * AF	3.1E-06	2.9E-06	1.9E-06	1.4E-06	5.1E-06	2.0E-06
	ADI (MG/KG/DAY) (ORAL)	4.0E-03	4.0E-03	4.0E-03	4.0E-03	4.0E-03	4.0E-03
	(ADDsoil * AF)/ADI	7.8E-04	7.4E-04	4.8E-04	3.5E-04	1.3E-03	5.1E-04
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY)	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (.6*1/1)	0.60	0.60	0.60	0.60	0.60	0.60
	ADDsoil * AF	2.6E-09	2.4E-09	1.7E-09	1.5E-09	3.0E-09	1.5E-09
	ADI (MG/KG/DAY) INHAL	2.0E-02	2.0E-02	2.0E-02	2.0E-02	2.0E-02	2.0E-02
	(ADDsoil * AF)/ADI	1.3E-07	1.2E-07	8.3E-08	7.6E-08	1.5E-07	7.6E-08
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	1.4E-03	1.2E-03	6.4E-04	4.5E-04	2.3E-03	6.0E-04
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	726.1	829.6	1569.4	2245.9	429.2	1679.0
	PROPORTION FROM SOIL INGESTION:	0.4357	0.3893	0.2479	0.2088	0.4571	0.1511
	PROPORTION FROM DERMAL CONTACT:	0.5642	0.6106	0.7520	0.7911	0.5428	0.8488
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY)*.6	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.6*1/1)	0.60	0.60	0.60	0.60	0.60	0.60
	ADDsoil * AF	3.3E-09	3.0E-09	2.1E-09	1.9E-09	6.3E-09	3.2E-09
	ADI (MG/KG/DAY) (INHAL)	2.0E-02	2.0E-02	2.0E-02	2.0E-02	2.0E-02	2.0E-02
	(ADDsoil * AF)/ADI	1.6E-07	1.5E-07	1.1E-07	9.7E-08	3.2E-07	1.6E-07
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		6105006	6613757	9523810	10351967	3150599	6301197
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.6*1/1)	0.60	0.60	0.60	0.60	0.60	0.60
	ADDsoil * AF	1.2E-08	1.1E-08	7.5E-09	6.9E-09	1.6E-08	8.1E-09
	ADI (MG/KG/DAY) (ORAL)	4.0E-03	4.0E-03	4.0E-03	4.0E-03	4.0E-03	4.0E-03
	(ADDsoil * AF)/ADI	2.9E-06	2.7E-06	1.9E-06	1.7E-06	4.1E-06	2.0E-06
SUM ((ADDsoil * AF)/ADI) AS KG/MG		3.1E-06	2.9E-06	2.0E-06	1.8E-06	4.4E-06	2.2E-06
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		323750	350730	505051	548968	227873	455747
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.05	0.05	0.05	0.05	0.07	0.07
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.95	0.95	0.95	0.95	0.93	0.93

TABLE 1h. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR PCBS AND AN ORAL ADI

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY) ORAL	5.0E-05	5.0E-06	5.0E-06	5.0E-06	5.0E-05	5.0E-05
	(ADDsoil * AF)/ADI	8.0E-02	6.3E-01	2.1E-01	1.2E-01	1.4E-01	1.2E-02
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.05/1)	0.05	0.05	0.05	0.05	0.05	0.05
	ADDsoil * AF	2.6E-06	2.5E-06	1.6E-06	1.2E-06	4.2E-06	1.7E-06
	ADI (MG/KG/DAY) (ORAL)	5.0E-05	5.0E-06	5.0E-06	5.0E-06	5.0E-05	5.0E-05
	(ADDsoil * AF)/ADI	5.2E-02	4.9E-01	3.2E-01	2.3E-01	8.4E-02	3.4E-02
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	ADI (MG/KG/DAY)ORAL	5.0E-05	5.0E-06	5.0E-06	5.0E-06	5.0E-05	5.0E-05
	(ADDsoil * AF)/ADI	8.6E-05	7.9E-04	5.5E-04	5.1E-04	1.0E-04	5.1E-05
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	1.3E-01	1.1E+00	5.3E-01	3.6E-01	2.3E-01	4.6E-02
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	7.6	0.9	1.9	2.8	4.4	21.9
	PROPORTION FROM SOIL INGESTION:	0.6066	0.5600	0.3970	0.3450	0.6272	0.2623
	PROPORTION FROM DERMAL CONTACT:	0.3928	0.4393	0.6020	0.6536	0.3723	0.7366
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0007	0.0007	0.0010	0.0014	0.0004	0.0011
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	ADI (MG/KG/DAY) ORAL	5.0E-05	5.0E-06	5.0E-06	5.0E-06	5.0E-05	5.0E-05
	(ADDsoil * AF)/ADI	1.1E-04	1.0E-03	7.0E-04	6.4E-04	2.1E-04	1.1E-04
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		9157.5	992.1	1428.6	1552.8	4725.9	9451.8
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY) (ORAL)	5.0E-05	5.0E-06	5.0E-06	5.0E-06	5.0E-05	5.0E-05
	(ADDsoil * AF)/ADI	3.9E-04	3.6E-03	2.5E-03	2.3E-03	5.4E-04	2.7E-04
SUM ((ADDsoil * AF)/ADI) AS KG/MG		5.0E-04	4.6E-03	3.2E-03	2.9E-03	7.5E-04	3.8E-04
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		2003.2	217.0	312.5	339.7	1325.6	2651.1
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.22	0.22	0.22	0.22	0.28	0.28
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.78	0.78	0.78	0.78	0.72	0.72

TABLE 11. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR SELENIUM AND ROUTE-SPECIFIC ADIs

		AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
		EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
		HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:								
SOIL INGESTION:	ADDsoil (KG/KG/DAY)		4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (0.6/0.6)		1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF		4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY)ORAL		5.0E-03	5.0E-03	5.0E-03	5.0E-03	5.0E-03	5.0E-03
	(ADDsoil * AF)/ADI		8.0E-04	6.3E-04	2.1E-04	1.2E-04	1.4E-03	1.2E-04
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)		5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.01/0.6)		0.02	0.02	0.02	0.02	0.02	0.02
	ADDsoil * AF		8.6E-07	8.2E-07	5.3E-07	3.9E-07	1.4E-06	5.6E-07
	ADI (MG/KG/DAY) (ORAL)		5.0E-03	5.0E-03	5.0E-03	5.0E-03	5.0E-03	5.0E-03
	(ADDsoil * AF)/ADI		1.7E-04	1.6E-04	1.1E-04	7.8E-05	2.8E-04	1.1E-04
INHALATION	ADDair (CU.M/KG/DAY)		3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)		11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):		4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (0.7/0.7)		1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF		4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	ADI (MG/KG/DAY)INHAL		8.6E-04	8.6E-04	8.6E-04	8.6E-04	8.6E-04	8.6E-04
	(ADDsoil * AF)/ADI		5.0E-06	4.6E-06	3.2E-06	2.9E-06	5.9E-06	2.9E-06
SUM OF 3 PATHWAYS								
	SUM ((ADDsoil * AF)/ADI) AS KG/MG		9.8E-04	7.9E-04	3.2E-04	2.1E-04	1.7E-03	2.4E-04
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		1023	1260	3122	4874	586	4250
	PROPORTION FROM SOIL INGESTION:		0.8183	0.7881	0.6576	0.6041	0.8319	0.5100
	PROPORTION FROM DERMAL CONTACT:		0.1766	0.2061	0.3324	0.3815	0.1646	0.4775
	PROPORTION FROM PARTICLE INHALATION (LUNG):		0.0051	0.0058	0.0100	0.0143	0.0034	0.0125
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:								
AIR INTAKE	ADDair (CU.M/KG/DAY)		3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)		14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):		5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (0.7/0.7)		1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF		5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	ADI (MG/KG/DAY) (INHAL)		8.6E-04	8.6E-04	8.6E-04	8.6E-04	8.6E-04	8.6E-04
	(ADDsoil * AF)/ADI		6.3E-06	5.9E-06	4.1E-06	3.7E-06	1.2E-05	6.2E-06
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:			157509	170635	245714	267081	81285	162571
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)		14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)		36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)		2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (0.6/0.6)		1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF		2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY) (ORAL)		5.0E-03	5.0E-03	5.0E-03	5.0E-03	5.0E-03	5.0E-03
	(ADDsoil * AF)/ADI		3.9E-06	3.6E-06	2.5E-06	2.3E-06	5.4E-06	2.7E-06
SUM ((ADDsoil * AF)/ADI) AS KG/MG			1.0E-05	9.5E-06	6.6E-06	6.0E-06	1.8E-05	8.9E-06
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:			97572	105703	152212	165448	56401	112801
	PROPORTION FROM PARTICLE INHALATION (LUNG):		0.62	0.62	0.62	0.62	0.69	0.69
	PROPORTION FROM SWALLOWED INHALED PARTICLES:		0.38	0.38	0.38	0.38	0.31	0.31

TABLE 1j. DERIVED SOIL LEVELS BASED ON THRESHOLD EFFECTS FOR VANADIUM AND ROUTE-SPECIFIC ADIs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY) ORAL	7.0E-03	7.0E-03	7.0E-03	7.0E-03	7.0E-03	7.0E-03
	(ADDsoil * AF)/ADI	5.7E-04	4.5E-04	1.5E-04	8.9E-05	1.0E-03	8.6E-05
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.01/1)	0.01	0.01	0.01	0.01	0.01	0.01
	ADDsoil * AF	5.2E-07	4.9E-07	3.2E-07	2.3E-07	8.4E-07	3.4E-07
	ADI (MG/KG/DAY) (ORAL)	7.0E-03	7.0E-03	7.0E-03	7.0E-03	7.0E-03	7.0E-03
	(ADDsoil * AF)/ADI	7.4E-05	7.0E-05	4.6E-05	3.4E-05	1.2E-04	4.8E-05
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	ADI (MG/KG/DAY) INHAL	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	1.4E-05	1.3E-05	9.2E-06	8.4E-06	1.7E-05	8.4E-06
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	6.6E-04	5.3E-04	2.1E-04	1.3E-04	1.2E-03	1.4E-04
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	1516	1886	4872	7662	868	7028
	PROPORTION FROM SOIL INGESTION:	0.8662	0.8429	0.7330	0.6784	0.8808	0.6024
	PROPORTION FROM DERMAL CONTACT:	0.1122	0.1322	0.2223	0.2570	0.1046	0.3383
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0217	0.0249	0.0447	0.0646	0.0146	0.0593
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	ADI (MG/KG/DAY) (INHAL)	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04	3.0E-04
	(ADDsoil * AF)/ADI	1.8E-05	1.7E-05	1.2E-05	1.1E-05	3.5E-05	1.8E-05
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		54945	59524	85714	93168	28355	56711
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY) (ORAL)	7.0E-03	7.0E-03	7.0E-03	7.0E-03	7.0E-03	7.0E-03
	(ADDsoil * AF)/ADI	2.8E-06	2.6E-06	1.8E-06	1.6E-06	3.9E-06	1.9E-06
SUM ((ADDsoil * AF)/ADI) AS KG/MG		2.1E-05	1.9E-05	1.3E-05	1.2E-05	3.9E-05	2.0E-05
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		47651	51622	74336	80800	25547	51094
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.87	0.87	0.87	0.87	0.90	0.90
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.13	0.13	0.13	0.13	0.10	0.10

TABLE 1k. SOIL ADVISORY LEVELS BASED ON THRESHOLD EFFECTS FOR VINYL CHLORIDE AND ROUTE-SPECIFIC ADIs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	HI FOR CALCULATION:	1	1	1	1	1	1
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	ADDsoil (KG/KG/DAY)	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	AF (.98/.98)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.0E-06	3.1E-06	1.1E-06	6.2E-07	7.1E-06	6.0E-07
	ADI (MG/KG/DAY) ORAL	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI	4.0E-03	3.1E-03	1.1E-03	6.2E-04	7.1E-03	6.0E-04
DERMAL CONTACT:	ADDsoil (KG/KG/DAY)	5.2E-05	4.9E-05	3.2E-05	2.3E-05	8.4E-05	3.4E-05
	AF (.1/.98)	0.10	0.10	0.10	0.10	0.10	0.10
	ADDsoil * AF	5.3E-06	4.9E-06	3.2E-06	2.3E-06	8.4E-06	3.4E-06
	ADI (MG/KG/DAY) (ORAL)	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI	5.3E-03	4.9E-03	3.2E-03	2.3E-03	8.4E-03	3.4E-03
INHALATION	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	11	11	11	11	11	11
	ADDsoil (KG/KG/DAY):	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	AF (.64/.64)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	4.3E-09	4.0E-09	2.8E-09	2.5E-09	5.1E-09	2.5E-09
	ADI (MG/KG/DAY) INHAL	8.6E-02	4.9E-03	4.9E-03	4.9E-03	8.6E-02	8.6E-02
	(ADDsoil * AF)/ADI	5.0E-08	8.1E-07	5.6E-07	5.2E-07	5.9E-08	2.9E-08
SUM OF 3 PATHWAYS							
	SUM ((ADDsoil * AF)/ADI) AS KG/MG	9.3E-03	8.0E-03	4.2E-03	3.0E-03	1.6E-02	4.0E-03
	CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:	108	124	235	337	64	252
	PROPORTION FROM SOIL INGESTION:	0.4308	0.3893	0.2479	0.2088	0.4572	0.1511
	PROPORTION FROM DERMAL CONTACT:	0.5692	0.6106	0.7520	0.7911	0.5428	0.8489
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	ADDair (CU.M/KG/DAY)	3.9E-01	3.6E-01	2.5E-01	2.3E-01	4.6E-01	2.3E-01
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	ADDsoil (KG/KG/DAY):	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	AF (.64/.64)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	5.5E-09	5.0E-09	3.5E-09	3.2E-09	1.1E-08	5.3E-09
	ADI (MG/KG/DAY) (INHAL)	8.6E-02	4.9E-03	4.9E-03	4.9E-03	8.6E-02	8.6E-02
	(ADDsoil * AF)/ADI	6.3E-08	1.0E-06	7.1E-07	6.6E-07	1.2E-07	6.2E-08
CHEMsoil = 1/((ADDsoil * AF)/ADI) AS MG/KG:		15750916	972222	1400000	1521739	8128544	16257089
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	ADDsoil (KG/KG/DAY)	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	AF (.98/.98)	1.00	1.00	1.00	1.00	1.00	1.00
	ADDsoil * AF	2.0E-08	1.8E-08	1.3E-08	1.2E-08	2.7E-08	1.4E-08
	ADI (MG/KG/DAY) (ORAL)	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.0E-03
	(ADDsoil * AF)/ADI	2.0E-05	1.8E-05	1.3E-05	1.2E-05	2.7E-05	1.4E-05
SUM ((ADDsoil * AF)/ADI) AS KG/MG		2.0E-05	1.9E-05	1.3E-05	1.2E-05	2.7E-05	1.4E-05
CHEMsoil = 1/[SUM ((ADDsoil * AF)/ADI)] AS MG/KG:		51116	52553	75676	82256	36680	73359
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.00	0.05	0.05	0.05	0.00	0.00
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	1.00	0.95	0.95	0.95	1.00	1.00

Table 2 contains the calculations for soil levels derived using noncancer (threshold) effects of the designated chemicals. In some cases where the toxicity data based on an inhalation route were considered inappropriate, the exposure by inhalation was converted to absorbed dose and compared to an absorbed dose derived from the Oral ADI. These adjustments are shown as "AF" in the Tables. This adjustment was made for all exposures received by the dermal route since no ADIs have been identified for that route.

In two cases (chromium and PAH), an additional adjustment was made since the toxic chemicals would not be 100% of the assayed chemical. An adjustment factor of 20% was used for hexavalent chromium; 40% was used for carcinogens (BaP) in PAH; and 60% for noncarcinogens (naphthalene) in PAH. These adjustments are shown in the "AF" line.

TABLE 2a. DERIVED SOIL LEVELS BASED ON CARCINOGENIC EFFECTS FOR ARSENIC AND ROUTE-SPECIFIC CSFs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	ELCR FOR CALCULATION PURPOSES:	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	LADDsoil (KG/KG/DAY)	1.6E-07	2.9E-07	4.2E-07	6.2E-07	2.4E-08	2.0E-09
	AF (.98/.98)	1	1	1	1	1	1
	LADDsoil * AF	1.6E-07	2.9E-07	4.2E-07	6.2E-07	2.4E-08	2.0E-09
	CSF (ORAL)	1.8	1.8	1.8	1.8	1.8	1.8
	LADDsoil * AF * CSF	2.9E-07	5.2E-07	7.6E-07	1.1E-06	4.3E-08	3.6E-09
DERMAL CONTACT:	LADDsoil (KG/KG/DAY)	2.1E-06	4.6E-06	1.3E-05	2.3E-05	2.8E-07	1.1E-07
	AF (0.03/.98)	0.03	0.03	0.03	0.03	0.03	0.03
	LADDsoil * AF	6.3E-08	1.4E-07	3.9E-07	6.9E-07	8.5E-09	3.4E-09
	CSF (ORAL)	1.8	1.8	1.8	1.8	1.8	1.8
	LADDsoil * AF * CSF	1.1E-07	2.5E-07	7.0E-07	1.2E-06	1.5E-08	6.1E-09
INHALATION	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01
	LADDsoil (KG/KG/DAY)	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	AF (.85/.85)	1	1	1	1	1	1
	LADDsoil * AF	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	CSF (INHAL)	50	50	50	50	50	50
	LADDsoil * AF * CSF	1.1E-08	1.8E-08	5.5E-08	1.3E-07	8.6E-10	4.3E-10
SUM OF 3 PATHWAYS:							
	SUM (LADDsoil * AF * CSF)	4.1E-07	7.9E-07	1.5E-06	2.5E-06	5.9E-08	1.0E-08
	CHEMsoil = ELCR /(SUM (LADDsoil*AF*CSF))	24.2	12.7	6.6	4.0	168.5	985.2
	PROPORTION FROM SOIL INGESTION:	0.70	0.66	0.50	0.45	0.73	0.35
	PROPORTION FROM DERMAL CONTACT:	0.27	0.32	0.46	0.50	0.26	0.60
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.03	0.02	0.04	0.05	0.01	0.04
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	LADDsoil (KG/KG/DAY)	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	AF (.85/.85)	1	1	1	1	1	1
	LADDsoil * AF	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	CSF (INHAL)	50	50	50	50	50	50
	LADDsoil * AF * CSF	1.4E-08	2.3E-08	7.0E-08	1.6E-07	1.8E-09	9.0E-10
CHEMsoil = ELCR /	(LADDsoil * AF * CSF)	714	433	143	62	5574	11148
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	LADDsoil (KG/KG/DAY)	1.0E-09	1.7E-09	5.0E-09	1.2E-08	9.2E-11	4.6E-11
	AF (.98/.98)	1	1	1	1	1	1
	LADDsoil * AF	1.0E-09	1.7E-09	5.0E-09	1.2E-08	9.2E-11	4.6E-11
	CSF (ORAL)	1.8	1.8	1.8	1.8	1.8	1.8
	LADDsoil * AF * CSF	1.8E-09	3.0E-09	9.0E-09	2.1E-08	1.7E-10	8.3E-11
SUM (LADDsoil * AF * CSF)		1.6E-08	2.6E-08	7.9E-08	1.8E-07	2.0E-09	9.8E-10
CHEMsoil = ELCR /(SUM (LADDsoil * AF * CSF)) AS MG/KG:		633	384	127	55	5103	10206
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.89	0.89	0.89	0.89	0.92	0.92
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.11	0.11	0.11	0.11	0.08	0.08

TABLE 2b DERIVED SOIL LEVELS BASED ON CARCINOGENIC EFFECTS FOR BaP AND AN ORAL CSF

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	ELCR FOR CALCULATION PURPOSES:	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	LADDsoil (KG/KG/DAY)	1.6E-07	2.9E-07	4.2E-07	6.2E-07	2.4E-06	2.0E-09
	AF (.4*.91)/.91	0.40	0.40	0.40	0.40	0.40	0.40
	LADDsoil * AF	6.4E-08	1.2E-07	1.7E-07	2.5E-07	9.6E-07	8.0E-10
	CSF (ORAL)	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00
	LADDsoil * AF * CSF	3.7E-07	6.7E-07	9.7E-07	1.4E-06	5.6E-06	4.6E-09
DERMAL CONTACT:	LADDsoil (KG/KG/DAY)	8.4E-07	1.8E-06	5.2E-06	9.2E-06	1.1E-07	4.4E-08
	AF (.4*.18)/.91	0.08	0.08	0.08	0.08	0.08	0.08
	LADDsoil * AF	6.6E-08	1.5E-07	4.1E-07	7.3E-07	8.9E-09	3.5E-09
	CSF(ORAL)	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00
	LADDsoil * AF * CSF	3.9E-07	8.4E-07	2.4E-06	4.2E-06	5.1E-08	2.0E-08
INHALATION	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01
	LADDsoil (KG/KG/DAY)	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	AF (.4*.7)/.91	0.31	0.31	0.31	0.31	0.31	0.31
	LADDsoil * AF	6.8E-11	1.1E-10	3.4E-10	7.8E-10	5.3E-12	2.6E-12
	CSF (ORAL)	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00
	LADDsoil * AF * CSF	3.9E-10	6.5E-10	2.0E-09	4.5E-09	3.1E-11	1.5E-11
SUM OF 3 PATHWAYS:							
	SUM (LADDsoil * AF * CSF)	7.6E-07	1.5E-06	3.4E-06	5.7E-06	5.6E-06	2.5E-08
	CHEMsoil = ELCR /(SUM (LADDsoil*AF*CSF))	13.2	6.6	3.0	1.8	1.8	402.5
	PROPORTION FROM SOIL INGESTION:	0.4903	0.4433	0.2898	0.2539	0.9908	0.1867
	PROPORTION FROM DERMAL CONTACT:	0.5092	0.5563	0.7096	0.7453	0.0091	0.8126
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0005	0.0004	0.0006	0.0008	0.0000	0.0006
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	LADDsoil (KG/KG/DAY)	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	AF (.4*.7/.91)	0.31	0.31	0.31	0.31	0.31	0.31
	LADDsoil * AF	8.6E-11	1.4E-10	4.3E-10	9.9E-10	1.1E-11	5.5E-12
	CSF (ORAL)	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00
	LADDsoil * AF * CSF	5.0E-10	8.2E-10	2.5E-09	5.7E-09	6.4E-11	3.2E-11
	CHEMsoil = ELCR / (LADDsoil * AF * CSF)	20012	12129	4002	1740	156172	312344
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	LADDsoil (KG/KG/DAY)	1.0E-09	1.7E-09	5.0E-09	1.2E-08	9.2E-11	4.6E-11
	AF (.4*.91/.91)	0.40	0.40	0.40	0.40	0.40	0.40
	LADDsoil * AF	4.0E-10	6.6E-10	2.0E-09	4.6E-09	3.7E-11	1.8E-11
	CSF (ORAL)	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00	5.8E+00
	LADDsoil * AF * CSF	2.3E-09	3.8E-09	1.2E-08	2.7E-08	2.1E-10	1.1E-10
SUM (LADDsoil * AF * CSF)		2.8E-09	4.7E-09	1.4E-08	3.2E-08	2.8E-10	1.4E-10
CHEMsoil = ELCR /(SUM (LADDsoil * AF * CSF)) AS MG/KG:		3546	2149	709	308	36028	72055
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.18	0.18	0.18	0.18	0.23	0.23
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.82	0.82	0.82	0.82	0.77	0.77

TABLE 2c. DERIVED SOIL LEVELS BASED ON CARCINOGENIC EFFECTS FOR CADMIUM AND AN INHALATION ROUTE CSF

AGE (YEARS):		2<5	1<8	0<30	0<75	1<2	22
EXPOSURE PERIOD:		3Y	7Y	30Y	75Y	90D	90D
ELCR FOR CALCULATION PURPOSES:		1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
NOTE THAT CADMIUM IS CARCINOGENIC ONLY WHEN INHALED							
INHALATION	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01
	LADDsoil (KG/KG/DAY)	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	AF (0.6/0.6)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	CSF (INHAL)	6.1E+00	6.1E+00	6.1E+00	6.1E+00	6.1E+00	6.1E+00
	LADDsoil * AF * CSF	1.3E-09	2.2E-09	6.7E-09	1.5E-08	1.0E-10	5.2E-11
CHEMsoil = ELCR /(SUM (LADDsoil*AF*CSF))		7452	4516	1490	648	95533	191066
PROPORTION FROM PARTICLE INHALATION (LUNG):		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	LADDsoil (KG/KG/DAY)	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	AF (.6/.6)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	CSF (INHAL)	6.1E+00	6.1E+00	6.1E+00	6.1E+00	6.1E+00	6.1E+00
	LADDsoil * AF * CSF	1.7E-09	2.8E-09	8.5E-09	2.0E-08	2.2E-10	1.1E-10
CHEMsoil = ELCR / (LADDsoil * AF * CSF)		5855	3548	1171	509	45690	91379
PROPORTION FROM PARTICLE INHALATION (LUNG):		1.00	1.00	1.00	1.00	1.00	1.00
PROPORTION FROM SWALLOWED INHALED PARTICLES:		0.00	0.00	0.00	0.00	0.00	0.00

TABLE 2dd. SOIL ADVISORY LEVELS BASED ON CARCINOGENIC EFFECTS FOR 20% HEXAVALENT CHROMIUM AND ROUTE-SPECIFIC CSFs

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	ELCR FOR CALCULATION PURPOSES:	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05
	SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:						
	HEXAVALENT CHROMIUM IS CARCINOGENIC BY THE INHALATION ROUTE						
INHALATION	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01
	LADDsoil (KG/KG/DAY)	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	AF (.2*.25)/.25	0.20	0.20	0.20	0.20	0.20	0.20
	LADDsoil * AF	4.4E-11	7.3E-11	2.2E-10	5.1E-10	3.4E-12	1.7E-12
	CSF (INHALATION)	4.1E+01	4.1E+01	4.1E+01	4.1E+01	4.1E+01	4.1E+01
	LADDsoil * AF * CSF	1.8E-09	3.0E-09	9.0E-09	2.1E-08	1.4E-10	7.0E-11
	SUM (LADDsoil * AF * CSF)	1.8E-09	3.0E-09	9.0E-09	2.1E-08	1.4E-10	7.0E-11
	CHEMsoil = ELCR /(SUM (LADDsoil*AF*CSF))	5543	3360	1109	482	71067	142134
	PROPORTION FROM SOIL INGESTION:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	PROPORTION FROM DERMAL CONTACT:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	PROPORTION FROM PARTICLE INHALATION (LUNG):	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:						
	HEXAVALENT CHROMIUM IS CARCINOGENIC (LUNGS) BY THE INHALATION ROUTE						
AIR INTAKE	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	LADDsoil (KG/KG/DAY)	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	AF (.2*.6)/.6	0.20	0.20	0.20	0.20	0.20	0.20
	LADDsoil * AF	5.6E-11	9.2E-11	2.8E-10	6.4E-10	7.2E-12	3.6E-12
	CSF (ORAL)	4.1E+01	4.1E+01	4.1E+01	4.1E+01	4.1E+01	4.1E+01
	LADDsoil * AF * CSF	2.3E-09	3.8E-09	1.1E-08	2.6E-08	2.9E-10	1.5E-10
	CHEMsoil = ELCR / (LADDsoil * AF * CSF)	4355	2640	871	379	33989	67977
	PROPORTION FROM PARTICLE INHALATION (LUNG):	1.00	1.00	1.00	1.00	1.00	1.00
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 2h. DERIVED SOIL LEVELS BASED ON CARCINOGENIC EFFECTS FOR PCBS AND AN ORAL CSF

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	ELCR FOR CALCULATION PURPOSES:	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	LADDsoil (KG/KG/DAY)	1.6E-07	2.9E-07	4.2E-07	6.2E-07	2.4E-08	2.0E-09
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	1.6E-07	2.9E-07	4.2E-07	6.2E-07	2.4E-08	2.0E-09
	CSF (ORAL)	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00
	LADDsoil * AF * CSF	1.2E-06	2.2E-06	3.2E-06	4.8E-06	1.8E-07	1.5E-08
DERMAL CONTACT:	LADDsoil (KG/KG/DAY)	2.1E-06	4.6E-06	1.3E-05	2.3E-05	2.8E-07	1.1E-07
	AF (0.05/1)	0.05	0.05	0.05	0.05	0.05	0.05
	LADDsoil * AF	1.1E-07	2.3E-07	6.5E-07	1.2E-06	1.4E-08	5.7E-09
	CSF (ORAL)	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00
	LADDsoil * AF * CSF	8.1E-07	1.8E-06	5.0E-06	8.9E-06	1.1E-07	4.4E-08
INHALATION	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01
	LADDsoil (KG/KG/DAY)	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	CSF (ORAL)	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00
	LADDsoil * AF * CSF	1.7E-09	2.8E-09	8.5E-09	1.9E-08	1.3E-10	6.6E-11
SUM OF 3 PATHWAYS:							
	SUM (LADDsoil * AF * CSF)	2.0E-06	4.0E-06	8.2E-06	1.4E-05	2.9E-07	5.9E-08
	CHEMsoil = ELCR /(SUM (LADDsoil*AF*CSF))	4.9	2.5	1.2	0.7	34.0	169.2
	PROPORTION FROM SOIL INGESTION:	0.6033	0.5573	0.3921	0.3498	0.6285	0.2605
	PROPORTION FROM DERMAL CONTACT:	0.3959	0.4420	0.6069	0.6488	0.3711	0.7383
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0008	0.0007	0.0010	0.0014	0.0004	0.0011
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	LADDsoil (KG/KG/DAY)	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	CSF (ORAL)	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00
	LADDsoil * AF * CSF	2.2E-09	3.6E-09	1.1E-08	2.5E-08	2.8E-10	1.4E-10
	CHEMsoil = ELCR / (LADDsoil * AF * CSF)	4638	2811	928	403	36196	72391
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	LADDsoil (KG/KG/DAY)	1.0E-09	1.7E-09	5.0E-09	1.2E-08	9.2E-11	4.6E-11
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	1.0E-09	1.7E-09	5.0E-09	1.2E-08	9.2E-11	4.6E-11
	CSF (ORAL)	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00	7.7E+00
	LADDsoil * AF * CSF	7.7E-09	1.3E-08	3.9E-08	8.9E-08	7.1E-10	3.5E-10
SUM (LADDsoil * AF * CSF)		9.9E-09	1.6E-08	4.9E-08	1.1E-07	9.8E-10	4.9E-10
CHEMsoil = ELCR /(SUM (LADDsoil * AF * CSF)) AS MG/KG:		1015	615	203	88	10152	20305
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.22	0.22	0.22	0.22	0.28	0.28
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.78	0.78	0.78	0.78	0.72	0.72

TABLE 2k. DERIVED SOIL LEVELS BASED ON CARCINOGENIC EFFECTS FOR VINYL CHLORIDE

	AGE (YEARS):	2<5	1<8	0<30	0<75	1<2	22
	EXPOSURE PERIOD:	3Y	7Y	30Y	75Y	90D	90D
	ELCR FOR CALCULATION PURPOSES:	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05	1.0E-05
SCENARIO A, AVERAGE RESIDENTIAL EXPOSURE:							
SOIL INGESTION:	LADDsoil (KG/KG/DAY)	1.6E-07	2.9E-07	4.2E-07	6.2E-07	2.4E-08	2.0E-09
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	1.6E-07	2.9E-07	4.2E-07	6.2E-07	2.4E-08	2.0E-09
	CSF (1.9)	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
	LADDsoil * AF * CSF	3.0E-07	5.5E-07	8.0E-07	1.2E-06	4.6E-08	3.8E-09
DERMAL CONTACT:	LADDsoil (KG/KG/DAY)	2.1E-06	4.6E-06	1.3E-05	2.3E-05	2.8E-07	1.1E-07
	AF (.1/1)	0.10	0.10	0.10	0.10	0.10	0.10
	LADDsoil * AF	2.1E-07	4.6E-07	1.3E-06	2.3E-06	2.8E-08	1.1E-08
	CSF (ORAL)	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
	LADDsoil * AF * CSF	4.0E-07	8.7E-07	2.5E-06	4.4E-06	5.4E-08	2.2E-08
INHALATION	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01	1.1E+01
	LADDsoil (KG/KG/DAY)	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	2.2E-10	3.6E-10	1.1E-09	2.5E-09	1.7E-11	8.6E-12
	CSF (INHAL)	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01
	LADDsoil * AF * CSF	6.6E-11	1.1E-10	3.3E-10	7.6E-10	5.1E-12	2.6E-12
SUM OF 3 PATHWAYS:							
	SUM (LADDsoil * AF * CSF)	7.0E-07	1.4E-06	3.3E-06	5.5E-06	9.9E-08	2.5E-08
	CHEMsoil = ELCR /(SUM (LADDsoil*AF*CSF))	14	7	3	2	101	395
	PROPORTION FROM SOIL INGESTION:	0.4324	0.3866	0.2442	0.2123	0.4585	0.1500
	PROPORTION FROM DERMAL CONTACT:	0.5675	0.6133	0.7557	0.7876	0.5414	0.8499
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
SCENARIO B, ENHANCED EXPOSURE BY INHALATION OF PARTICLES ONLY:							
AIR INTAKE	LADDair (CU.M/KG/DAY)	2.0E-02	3.3E-02	1.0E-01	2.3E-01	1.6E-03	7.8E-04
LUNG DEPOSIT	PM10 SOIL MASS DEPOSITED PER CU.M (UG)	14	14	14	14	23	23
	LADDsoil (KG/KG/DAY)	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	2.8E-10	4.6E-10	1.4E-09	3.2E-09	3.6E-11	1.8E-11
	CSF (INHAL)	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01	3.0E-01
	LADDsoil * AF * CSF	8.4E-11	1.4E-10	4.2E-10	9.7E-10	1.1E-11	5.4E-12
	CHEMsoil = ELCR / (LADDsoil * AF * CSF)	119048	72150	23810	10352	929023	1858045
GI TRACT DEPOSIT	PM10 SOIL INGESTED (UG/CU.M AIR)	14	14	14	14	23	23
	NON-PM10 SOIL MASS INGESTED (UG/CU.M AIR)	36	36	36	36	36	36
	LADDsoil (KG/KG/DAY)	1.0E-09	1.7E-09	5.0E-09	1.2E-08	9.2E-11	4.6E-11
	AF (1/1)	1.00	1.00	1.00	1.00	1.00	1.00
	LADDsoil * AF	1.0E-09	1.7E-09	5.0E-09	1.2E-08	9.2E-11	4.6E-11
	CSF (ORAL)	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00	1.9E+00
	LADDsoil * AF * CSF	1.9E-09	3.1E-09	9.5E-09	2.2E-08	1.7E-10	8.7E-11
SUM (LADDsoil * AF * CSF)		2.0E-09	3.3E-09	9.9E-09	2.3E-08	1.9E-10	9.3E-11
CHEMsoil = ELCR /(SUM (LADDsoil * AF * CSF)) AS MG/KG:		5040	3055	1008	438	53868	107735
	PROPORTION FROM PARTICLE INHALATION (LUNG):	0.04	0.04	0.04	0.04	0.06	0.06
	PROPORTION FROM SWALLOWED INHALED PARTICLES:	0.96	0.96	0.96	0.96	0.94	0.94

Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Protection

William F. Weld
Governor
Daniel S. Greenbaum
Commissioner

8/18/93
MEMO TO ONS
ATTACHMENT
IV 6

MEMORANDUM

TO: Elizabeth Callahan, BWSC PPD
Brian Moran, BWSC PPD

FROM: Paul W. Locke, ORS

CC: Carol Rowan West, Director ORS
Marion Harnois, ORS

DATE: October 15, 1993

SUBJECT: Landfill Daily Cover

This memorandum is in response to questions which have arisen concerning the chemical-specific concentrations which appear in the draft Division of Solid Waste Management (DSWM) policy *Requirements for Contaminated Soil Use as Landfill Cover* (last update 6/23/93). The discussion which follows relies heavily upon previous work conducted by Marion Harnois and Carol Rowan West of the Office of Research and Standards.

SUMMARY

- The chemical-specific concentrations contained in the draft policy were not derived using quantitative risk assessment.

- The distinction between proposed values for Category A (lined) and Category B (unlined) landfills is based on the potential that the material leaching from the soil. Since the primary concern for Category A landfills is the potential direct contact exposures associated with the cover material, this memorandum focuses on the Category A numbers and does <u>not</u> make a proposal concerning the Category B landfill criteria.

- Some of the chemical-specific concentrations proposed fall below the most stringent (category S-1) MCP Method 1 soil standards and more fall below the category S-3 standards. As a result, the proposed values would minimize or eliminate the

beneficial reuse or recycling of slightly contaminated soils from c.21E disposal sites.

- Based upon the exposure scenario previously used to evaluate the draft cover criteria[1], the chemical-specific concentrations associated with typical regulatory risk criteria (an Excess Lifetime Cancer Risk of one-in-one million and/or a noncancer risk expressed as a Hazard Index of 0.2) are generally *higher* than the values proposed in the draft policy. In other words, soil containing oil or hazardous material in concentrations higher than those proposed could be used without significant risk of harm to the health of neighboring residents.

- Alternative chemical-specific concentrations are proposed (Table 1) which are protective of public health, generally consistent with the promulgated MCP soil standards and which would increase the opportunities to beneficially reuse contaminated soils.

Table 1

DSWM DRAFT VALUES and PROPOSED LANDFILL COVER CRITERIA

	DSWM Draft Policy 6/23/93 LANDFILLS CATEGORY A mg/kg	**PROPOSED CRITERIA** LANDFILLS CATEGORY A mg/kg
ARSENIC (TOTAL)	40	40
CADMIUM (TOTAL)	25	80
CHROMIUM (TOTAL)	500	500
LEAD (TOTAL)	500	600
MERCURY (TOTAL)	10	60
SODIUM (TOTAL)	4,000	4,000
PCBs (TOTAL)	2	2
PAHs (TOTAL) Assumes 40% Carcinogens	100	200
TPH	1,500	5,000
TCLP	pass	pass
VOCs (TOTAL)	10	10

[1] Evaluation of Landfill Soil Cover Criteria. Memorandum from Marion Harnois and Carol Rowan West (ORS) to Rich Gioisa, Steve Lipman, Joel Hartley, Brian Moran, Rick Dunn, John Fitzgerald, Iris Davis and John Carrigan. August 19, 1992.

BACKGROUND

In the summer of 1992, the Office of Research and Standards (ORS) was asked to review a list of numerical standards being proposed to identify soil containing oil or hazardous material (OHM) which could be used as daily cover at landfills. The numerical criteria had been identified by an internal DEP workgroup representing the various programs involved in soils management. The resulting memorandum[2] compared the proposed criteria to risk assessment-derived concentrations and concluded that the proposed criteria "*would be below the soil levels derived using risk management criteria generally used by regulatory agencies.*" This conclusion was somewhat qualified by conservative assumptions made about assumed exposures and assumed mixtures of PAHs and chromium species. (These results are summarized in Table 2.)

Table 2 - ORS 8/19/93 Analysis

	DSWM Draft Policy 6/23/93 LANDFILLS CATEGORY:		ORS 8/19/92 Analysis Landfill Cover Scenario ("B" - Inhalation Only/Residential)					
			ELCR				Hazard Index	
			2 - 5 yr		30 yr			
	A	B	1E-06	1E-05	1E-06	1E-05	0.2	1
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ARSENIC (TOTAL)	40	40	63	633	13	127	1,724	8,621
CADMIUM (TOTAL)	25	14	586	5,855	117	1171	1,504	7,522
CHROMIUM (TOTAL)	500	100	-	-	-	-	-	-
Cr VI	-	-	436	4,355	87	871	397	1,984
Cr III	-	-	na	na	na	na	> 1E+06	> 1E+06
LEAD (TOTAL)	500	500	na	na	na	na	8,282	nc
MERCURY (TOTAL)	10	2	-	-	-	-	-	-
Hg Inorganic	-	-	na	na	na	na	1,189	5,943
Hg Organic	-	-	na	na	na	na	nc	nc
SODIUM (TOTAL)	4,000	4,000	-	-	-	-	-	-
PCBs (TOTAL)	2	2	102	1,015	20	203	43	217
PAHs (TOTAL)	100	100	355	3,546	71	709	40,000	200,000
Benzo[a]pyrene	-	-	-	-	-	-	-	-
Naphthalene	-	-	-	-	-	-	-	-
SELENIUM (TOTAL)	-	-	na	na	na	na	10,000	60,000
TPH	1,500	1,000	-	-	-	-	-	-
TCLP	pass	pass	-	-	-	-	-	-
VANADIUM (TOTAL)	-	-	na	na	na	na	5,109	25,547
VOCs (TOTAL)	10	4	-	-	-	-	-	-
Vinyl Chloride	-	-	504	5,040	101	-	-	-

[2] ibid.

Subsequent to this work, the Bureau of Waste Site Cleanup promulgated soil standards as part of the revised Massachusetts Contingency Plan (310 CMR 40). Soil standards were set based upon three exposure scenarios:

S-1 - High Exposure Potential, consistent with residential (or unrestricted) use of a property;
S-2 - Medium Exposure Potential
S-3 - Low Exposure Potential, consistent with many industrial uses.

These standards consider exposures associated with direct contact with the soil as well as the potential for the material to leach to groundwater.

A comparison (Table 3) of the MCP Method 1 Standards and the proposed Landfill Cover (Category A) concentrations indicates that 2 of the proposed values (total cadmium and total chromium) are less than the promulgated MCP Method 1 S-1 standards and 6 of the proposed values (Cd, Cr, Pb, Hg, PAHs and TPH) are less than the MCP Method 1 S-3 standards.

Table 3

	DSWM Draft Policy 6/23/93	MCP Standards			
		Direct Contact Only		Direct Contact + Leaching	
	LANDFILLS CATEGORY A	S-1	S-3	S-1/GW-1	S-3/GW-1
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ARSENIC (TOTAL)	40	30	30	30	30
CADMIUM (TOTAL)	25	30	80	30	80
CHROMIUM (TOTAL)	500	1,000	5,000	1,000	5,000
Cr VI	-	200	1,000	200	1,000
Cr III	-	1,000	5,000	1,000	5,000
LEAD (TOTAL)	500	300	600	300	600
MERCURY (TOTAL)	10	-	-	-	-
Hg Inorganic	-	10	60	10	60
Hg Organic	-	7	20	7	20
SODIUM (TOTAL)	4,000	-	-	-	
PCBs (TOTAL)	2	2	2	2	2
PAHs (TOTAL)	100	-	-	-	-
Benzo[a]pyrene	-	0.7	0.7	0.7	0.7
Naphthalene	-	100	2,500	4	4
TPH	1,500	500	5,000	500	5,000
TCLP	pass	-	-	-	-
VOCs (TOTAL)	10	-	-	-	-
Vinyl Chloride	-	0.3	2	0.3	0.4

DISCUSSION

1. *What is the purpose of the landfill cover policy?*

By identifying levels of oil or hazardous material representative of mildly contaminated soil which could be used as daily cover, intermediate cover and/or grading material at landfills, the proposed policy would extend landfill capacity: such use of this soil would eliminate the need to *dispose* of this material in the landfill and directly reduce the amount of *clean* soil which would otherwise be needed as cover material. In addition, the policy would be a basis of regional and program consistency. The purpose of the draft policy is consistent with the BWSC's preference for the reuse or recycling of contaminated material written into the MCP.

2. *What is the relationship between the landfill cover criteria and the MCP standards?*

In general, soils which are at or below the applicable Method 1 standards do not pose a significant risk of harm to health, safety, public welfare or the environment. Only soils which *exceed* these standards must be addressed under the MCP, and in many cases this will mean the excavation and removal of the contaminated material. If the goal is to maximize the reuse and recycling of this excavated material the landfill cover criteria should be set at concentrations greater than the Method 1 standards *as long as the levels do not result in significant risk at or near the landfill.*

Note that if the landfill cover criteria were less than the Method 1 standards, soils meeting the S-1 standards would be acceptable as surficial soil in a residential area, but if the soil were excavated it would not be clean enough to be used as cover at a landfill. Such a result would make sense only if the exposures associated with the landfill use were different and/or greater than the assumed residential exposures.

3. *What are the highest possible concentrations which could be used as landfill cover criteria without causing a condition of significant risk?*

As noted above, ORS has already reviewed the proposed landfill cover criteria and concluded that those concentrations would not pose a significant risk of harm to the health of adjacent residents. In fact, the same analysis pointed out that *higher* concentrations of these materials may also be safely used as cover.

Table 4 compares risk-based[3] landfill cover concentrations to the values in the proposed policy.

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[3] The risk assessment assumes a chronic (7 year) exposure to fugitive dust (assumed to be continuously at the PM_{10} standard) in a home at the fence-line of the operating landfill. This scenario evaluated the risk of noncancer health effects by focusing on the exposures experienced by a young child (age 1-2 years) during the summer months. The risk management criterion used was a Hazard Index equal to 0.2 (consistent with the target noncancer risk level of the Method 1 standards). The excess lifetime cancer risk (ELCR) associated with a chronic (7 year) exposure was based

Based solely upon the results of the risk assessment, soil containing significantly higher concentrations of cadmium, lead, mercury, TPH and total VOCs could be used as cover material at a landfill. In addition, slightly higher concentrations of PAHs and PCBs could be used.

Table 4
COMPARISON: DSWM Proposed Values to Risk-based Values

	DSWM Draft Policy 6/23/93 LANDFILLS CATEGORY A mg/kg	Risk-Based Concentrations (7 year residential exposure at the fence-line) Inhalation Exposures mg/kg
ARSENIC (TOTAL)	40	40
CADMIUM (TOTAL)	25	400
CHROMIUM (TOTAL):	500	-
20% Cr VI	-	300
100% Cr III	-	> 10,000
LEAD (TOTAL)	500	8,000
MERCURY (TOTAL)	10	1,000
SODIUM (TOTAL)	4,000	-
PCBs (TOTAL)	2	43
PAHs (TOTAL) Assumes 40% Carcinogens	100	200
TPH	1,500	500,000
TCLP	pass	-
VOCs (TOTAL)	10	-
Vinyl Chloride	-	300

4. *Are the risks associated with the landfill cover use of these materials the only factor to be considered in determining the acceptable criteria?*

No. The risk-derived concentrations are but one factor which should be considered in identifying the landfill cover criteria. This memorandum explicitly answers the question which was not asked in August, 1992: *What are the highest allowable concentrations which would not pose a significant risk given a specific use scenario.* The results of the risk assessment indicate that, in general, the assumed exposures to the nearest residents are relatively low and that the risks associated with those exposures may not be the most critical factor in setting the landfill cover criteria.

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upon the exposures experienced by the residential receptor during the period of highest exposure: ages 1 - 8 years. The risk management criteria used is an ELCR equal to one-in one million (again consistent with the cancer risk goal of the Method 1 standards). Details of the risk assessment can be found in the August 19, 1992 memorandum. No additional risk assessment was performed for this memorandum except to extend the same analysis to the Total Petroleum Hydrocarbon measure.

The final policy should be crafted so that the criteria work to promote all of the purposes expressed in the policy. Other factors to be considered include: how the numbers will be implemented; who will be making the decisions about the disposal of this material; what percentage of this material DEP wants to divert to use as landfill cover compared to other forms of reuse or recycling; and how to best coordinate the soil management practices of numerous DEP programs. That is **risk management.**

Table 1 contains a list of criteria developed in consideration of the "*new*" risk-based concentrations identified in this memorandum. It is offered as a point of departure for further discussions. These values are *not* simply the risk-based numbers of Table 4, but are proposed considering the criteria contained in the draft DSWM policy (reflecting the collective wisdom of many DEP staff) and the Method 1 soil standards as well.

In creating the list, the following rules were used:

1. If the MCP S-3 direct contact standard is less than the DSWM values, or if there is no MCP standard for that material, then the DSWM value was retained. (Arsenic, Sodium, TCLP and Total VOCs fall into this category.)

2. If the MCP S-3 direct contact standard is less than the calculated risk-based standard then the MCP S-3 direct contact standard was proposed. (Cadmium, lead, mercury, PCBs and TPH fall into this category.)

3. If the risk-based concentration is greater than the DSWM value but less than the S-3 standard, then the risk-based concentration was proposed. (The PAH value is the only example of this category.)

4. If the risk-based concentration is less than both the DSWM value and the MCP S-3 standard then the chemical must be considered specifically. The only example of this is chromium. The risk-based value is more stringent than the MCP S-3 standard due to the high inhalation exposures assumed for this scenario: hexavalent chromium is considered carcinogenic *only* via inhalation. Another complicating factor is the fact that Total Chromium is a mixture of trivalent (III) and hexavalent (VI) chromium, and the risk-based value depends upon the percentage of hexavalent chromium assumed to be in the mixture. The DSWM value is only slightly higher than the risk-based number derived assuming 20% Cr (VI) mixture. For the purpose of this discussion the DSWM value has been retained .

These rules result in a list of criteria which are generally consistent with both the original list proposed by the Division of Solid Waste Management and the MCP soil standards.

If you would like to discuss this material in more detail, please feel free to contact me at 617-556-1160.