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Date: February 18, 2025
Our Ref: 30251964
Subject: Risk Assessment and Status Report for Trotting Park Baseball Fields

Dear Peter McConarty,

This letter summarizes the results of a risk assessment conducted to evaluate the detection of metals and other constituents in soil samples collected from the Trotting Park Baseball Fields. The purpose of the risk assessment is to provide information that would support the Town of Falmouth's decisions regarding continued use of the ballfields in the near term (2025). Work was done in accordance with the Massachusetts Contingency Plan (MCP), a state regulation at 310 Code of Massachusetts Regulations (CMR) 40.0000.

**Soil Sample Results**

Soil samples were collected from two depth intervals (0 to 0.5 feet and 0.5 to 5 feet) below turf from Fields 1, 2 and 3. Samples were submitted to PACE, a licensed testing laboratory, for analysis of heavy metals, volatile organic compounds, petroleum hydrocarbon fractions, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Many of the analytes were either not detected, detected at concentrations less than natural background concentrations for metals, or less than soil standards established by the Massachusetts Department of Environmental Protection (MassDEP). Other constituents were detected at concentrations greater than natural background concentrations for metals and PAHs[1] including antimony, arsenic, barium, cadmium, chromium, lead, mercury, nickel, silver, zinc, benzo(b)fluoranthene, and benzo(g,h,i)perylene.

Of the detected constituents, lead is associated with the greatest potential risk to health due to the detected concentrations in surface soil samples collected from Field 1. The distribution of lead measured in soil samples collected from the three fields varied. Table 1 presents the lead concentrations measured in soil samples collected from below the turf and up to six inches in depth. Table 2 presents the lead concentrations from soil samples composited over a depth of six inches to five feet below the turf. Discrete samples were also collected at depth on Field 3.

[1] MassDEP. 2002. Background Concentrations Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil. Technical Update. May.

*Table 1. Distribution of lead in soil samples collected from 0-0.5 feet below turf on Trotting Park Baseball Fields*

| Field # | Date Developed | Boring ID's | Lead Concentration Range (mg/kg) | Natural Background Concentration (mg/kg) |
|---|---|---|---|---|
| Field 1 | 1977/1978 | B-6, -9, -10, -11, -12 | 41.8 – 601 | 100 |
| Field 2 | 1985-1991 | B-1, -2, -3, -4 | 7.53 – 190 | 100 |
| Field 3 | 2010-2014 | B-7, -8, -13, -14 | 12.3 – 45.2 | 100 |

The concentrations of lead in soil samples collected from Field 1 were higher than concentrations on Fields 2 and 3. The maximum detected concentration of lead in 0 to 0.5 feet samples collected on Field 1 was 601 milligrams per kilogram (mg/kg) as compared to 190 mg/kg on Field 2 and 45.2 mg/kg on Field 3. The MassDEP-identified background concentration of lead is 100 mg/kg in natural soil and 600 mg/kg in anthropogenic soils. At the fields, lead concentrations in soil samples collected from 0 to 0.5 feet can be compared to 100 mg/kg and lead concentrations in soil samples collected from deeper samples can be compared to 600 mg/kg if landfill materials were observed in the samples. Based on field observations, sample B-5 collected on Field 2 did not include landfill materials and is not included in the statistics shown in Tables 1 and 2. The maximum lead concentration in soil samples collected from 0 to 0.5 feet on Fields 1 and 2 is greater than the MassDEP natural background concentration. The maximum lead concentration in soil samples collected from 0.5 to 5 feet on Fields 1, 2, and 3 is greater than the MassDEP anthropogenic background concentration.

*Table 2. Distribution of lead in soil samples collected from 0.5-5 feet below turf on Trotting Park Baseball Fields*

| Field # | Date Developed | Boring ID's | Lead Concentration Range (mg/kg) | Anthropogenic Background Concentration (mg/kg) |
|---|---|---|---|---|
| Field 1 | 1977/1978 | B-6, -9, -10, -11, -12 | 4.59 – 1,610 | 600 |
| Field 2 | 1985-1991 | B-1, -2, -3, -4 | 225 – 1,710 | 600 |
| Field 3 | 2010-2014 | B-7, -8, -13, -14 | 31.1 – 755 | 600 |

**MassDEP Soil Standards**

The MassDEP has promulgated soil standards for the constituents detected in soil samples. The MassDEP soil standard for lead in soil is 200 mg/kg for unrestricted land uses including residential land uses (S-1 Soil Standard). The MassDEP soil standard for non-residential land uses where people can contact soil (for example, construction workers) is 600 mg/kg (S-2 and S-3 Soil Standard). There is not a promulgated standard specific to recreational use of the ballfields. The maximum lead concentration in surface soil (0 to 0.5 feet) on Field 2 and 3 is less than 200 mg/kg. The maximum lead concentration in surface soil on Field 1 and subsurface soil (0.5 to 5 feet) on all three fields is greater than 200 mg/kg and 600 mg/kg.

*Table 3. Comparison of maximum detected concentrations of lead in soil samples to MCP soil standards*

| | Maximum Lead Concentration (0-0.5 feet) (mg/kg) | Boring ID of Maximum Lead Concentration (0-0.5 feet) | Maximum Lead Concentration (0.5-5 feet) (mg/kg) | Boring ID of Maximum Lead Concentration (0.5-5 feet) |
|---|---|---|---|---|
| **MCP S-1 Soil Standard (mg/kg)** – Unrestricted land uses including residential | 200 | | 200 | |
| **MCP S-2/S-3 Soil Standard (mg/kg)** – Non-residential land uses (e.g., workers) | 600 | | 600 | |
| **Field #** | | | | |
| Field 1 | 601 | B-11 | 1,610 | B-12 |
| Field 2 | 190 | B-1 | 1,710 | B-3 |
| Field 3 | 45.2 | B-8 | 755 | B-13 |

Maximum concentrations of other metals detected in surface soil on Field 1 (antimony, arsenic, barium, cadmium, chromium, mercury, nickel, vanadium, and zinc) were less than the MassDEP S-1 soil standards. Maximum concentrations of most metals detected in subsurface soil on Field 1 (barium, cadmium, chromium, mercury, nickel, silver, and vanadium) were less than the MassDEP S-1 soil standards; however, concentrations of antimony, arsenic, lead, and zinc detected in subsurface soil on Field 1 were greater than the MassDEP S-1 soil standards. The maximum concentrations of metals detected in surface soil on Fields 2 and 3 (arsenic, barium, chromium, lead, mercury, nickel, vanadium, and zinc) were less than the MassDEP S-1 soil standards. Maximum concentrations of most metals detected in subsurface soil on Fields 2 and 3 (antimony, barium, cadmium, chromium, mercury, nickel, silver, and vanadium) were less than the MassDEP S-1 soil standards; however, concentrations of arsenic, lead, and zinc detected in subsurface soil on Fields 2 and 3 were greater than the MassDEP S-1 soil standards. Additionally, the maximum concentration of total PCBs detected in subsurface soil on Field 2 was greater than the MassDEP S-1 soil standard.

Maximum concentrations do not have to be used to compare to soil standards to evaluate potential risks to health. An average concentration among multiple samples can be used when the MCP performance standard for averaging has been met. Specifically, average concentrations can be used as exposure point concentrations (EPCs) when 75% of samples are not greater than the applicable standard or risk-based concentration limit and no individual result is ten times greater than the applicable standard or risk-based concentration limit.

In the available surface soil data set, less than 75 percent of the samples on Field 1 have lead concentrations that are less than the S-1 soil standard. Therefore, the EPC for lead in soil on Field 1 defaults to the maximum detected concentration. Other constituents were detected in surface soil on Field 1 at concentrations less than their respective S-1 soil standard and thus an average concentration is used as the EPC for these constituents to evaluate risk. Constituents were detected in surface soil samples collected on Fields 2 and 3 at concentrations

less than their respective S-1 soil standard and thus an average concentration is used as the EPC for these constituents to evaluate risk on these fields.

In the available subsurface data set, less than 75 percent of the samples collected on Fields 1, 2, and 3 have arsenic, lead, and zinc concentrations that are less than the S-1 soil standard. Additionally, one sample on Field 1 had a concentration of antimony greater than ten times the S-1 standard. Therefore, the EPCs for antimony (Field 1 only), arsenic, lead, and zinc in soil on Fields 1, 2, and 3 default to the maximum detected concentrations for the purposes of risk assessment.

**Risk Assessment Tasks Identified in Approved Scope of Work**

In accordance with the Scope of Work for Risk Assessment submitted to the Town January 13, 2025 for Task 7, Arcadis has conducted an Imminent Hazard Evaluation (IHE) for the Site to evaluate if site conditions pose an Imminent Hazard to safety, health, or the environment based upon the criteria established in 310 CMR 40.0955(1) through (3). Task 8 is a MCP Risk Characterization of long-term potential risks to health based on the data collected to date.

**Task 7.1 Imminent Hazard Evaluation for Safety**

Arcadis evaluated if release-related conditions at the Site pose a threat of physical harm or bodily injury or present dangerous or nuisance conditions in accordance with 310 CMR 40.0960. Exposed landfill waste material along the walking paths leading to the fields could pose a safety risk under current conditions. This conclusion is based on the visual observations of conditions along the walking path between fields.

As described in 310 CMR 40.0955(1), conditions at a disposal site pose an Imminent Hazard based on safety concerns if a condition of no significant risk to safety has not been achieved at the disposal site under conditions which exist or are about to occur. Therefore, there is an Imminent Hazard based on safety concerns along the walking paths that should be addressed to mitigate risks from physical hazards.

**Task 7.2 Imminent Hazard Evaluation for Human Health**

As described in 310 CMR 40.0955(2), Arcadis prepared a Method 3 Risk Characterization in accordance with the requirements of 310 CMR 40.0993 to evaluate whether site conditions pose an Imminent Hazard to human health. Components of the IHE for human health as applied to the subject site are summarized in Table 4 below.

*Table 4. Components of IHE to Human Health, according to the MCP*

| Component | Site-Specific Evaluation |
|---|---|
| Identification of Applicable Soil Categories | Consistent with categories defined in the MCP (Table 40.0933[9]), soil on the property is currently categorized as Category S-1 and S-2 because impacted soil is not more than 3 feet below ground surface and the surface is unpaved. |
| Exposure Points | Exposure points are areas where contact with soil could occur. For the IHE, the potential for exposure to constituents in surface soils from 0 to 12 inches below grade was evaluated. |
| Exposure Point Concentrations | Consistent with the requirements in 310 CMR 40.0953 for the evaluation of soil-related exposures, the concentrations of constituents detected in soil samples collected in December |

| | |
|---|---|
| | 2024 at the ground surface was considered in the development of soil EPCs for the IHE. Data are available for topsoil collected from 0 to 0.5 feet. |
| Receptors Evaluated | The IHE evaluated potential risks to recreators, including children, assumed to have contact with constituents detected in surface soil. Young children aged 1 to 2 years and 1 to 6 years were assumed to contact soil, consistent with MassDEP policy to evaluate sensitive receptors. |
| Risk Characterization Method | The MassDEP Park Visitor - Soil Imminent Hazard Evaluation Shortform (2024) is a Microsoft® Excel™ spreadsheet used by risk assessors to provide numerical estimates of potential risk to health based on standardized exposure assumptions and toxicity information. Arcadis used the Shortform for Imminent Hazards to provide numerical estimates of potential risk associated with recreators' presumed contact with the constituents detected in surface soil samples collected from the ballfields. Two measures of potential risk were estimated: (1) excess lifetime cancer risk (ELCR); and (2) non-cancer hazard index (HI). The numerical estimates were compared to MCP regulatory limits for evaluating Imminent Hazards to health. |
| Results | The ELCR estimate for Park Visitors contacting surface soil from 0 to 0.5 feet below the surface on Field 1 (4.6 E-08) is less than 1E-05 which is the MCP risk limit[2]. The total HI estimate for this scenario (2.20) is greater than the MCP risk limit of 1. Lead contributed 86 percent to the total HI estimate with an individual chemical Hazard Quotient of 1.9. This result assumes contact with lead at a concentration of 601 mg/kg measured in sample B-11 on Field 1 and could pose an Imminent Hazard to Health if access to this location is not restricted. The concentrations of lead and other constituents in soil from 0 to 0.5 feet on Fields 2 and 3 do not pose an Imminent Hazard to health.<br><br>The MassDEP Shortform for Park Visitor – Imminent Hazard Evaluation spreadsheets are provided as Attachment 1 to this letter. |

**Task 7.3 IHE for the Environment**

As described in 310 CMR 40.0955(3), the following conditions shall constitute an Imminent Hazard to the environment: (a) evidence of stressed biota attributable to the release at the disposal site, including, without limitation, fish kills or abiotic conditions; or (b) a release to the environment of oil or hazardous material which produces immediate or acute adverse impacts to freshwater or saltwater fish populations. These conditions are not present at Trotting Park Baseball Fields.

**Task 8 – MCP Risk Characterization**

Arcadis conducted a MCP Method 3 Risk Characterization to evaluate if site conditions pose a Significant Risk to health based upon the definitions and methods established in 310 CMR 40.0990. Method 3 is an accepted risk assessment approach as an alternative to comparing to MCP Method 1 Standards. As described in the MCP, Method 3 relies upon detailed information about the site, the constituents detected, and potential exposures to human and environmental receptors under current and reasonably

[2] 4.6E-08 is scientific notation and can also be written as $4.6 \times 10^{-8}$. The MCP ELCR limit is 1E-05, or $1 \times 10^{-5}$, or 1 in 100,000 excess lifetime cancer risk.

foreseeable site activities and uses to characterize the risk of harm. The primary differences between the IHE and the Method 3 Risk Characterization is the magnitude of exposure assumed to occur under current land uses. The IHE focused on short-term exposures to higher concentrations of constituents and to any hot spots of contamination, if present, whereas the evaluation of Significant Risk considered long-term contact with constituent concentrations in soil throughout the exposure point, relying on average concentrations where allowed by regulation.

*Table 5. Components of Significant Risk Evaluation to Human Health, according to the MCP*

| Component | Site-Specific Evaluation |
|---|---|
| Identification of Applicable Soil Categories | Consistent with categories defined in the MCP (Table 40.0933[9]), soil on the property is currently categorized as Category S-1 and S-2 because impacted soil is not more than 3 feet below ground surface and the surface is unpaved. Soil deeper than 3 feet bgs may also be impacted and could be categorized as S-1, S-2, or S-3 depending on future land uses. |
| Exposure Points | Exposure points are areas where contact with soil could occur. For the Significant Risk Evaluation, the potential for exposure to constituents in soils from 0 to 0.5 and 0.5 to 5 feet below the turf was evaluated. |
| Exposure Point Concentrations | The concentrations of constituents detected in soil samples collected in December 2024 at sampled depths of 0 to 0.5 and 0.5 to 5 feet below turf were considered in the development of soil EPCs for this evaluation. The MCP defines surface soil as soil from 0 to 3 feet below ground surface. The available data sets are 0 to 0.5 feet and 0.5 to 5 feet below ground surface. |
| Receptors Evaluated | Recreators, including children and adults, were assumed to have contact with constituents detected in soil. Young children aged 1 to 2 years and 1 to 6 years were assumed to contact soil, consistent with MassDEP policy to evaluate sensitive receptors. For the purposes of estimating future hypothetical cancer risk, a 30-year exposure period was assumed for people from age 1 to 31. |
| Risk Characterization Method | To estimate cumulative risk, Arcadis used the MassDEP 2024 Shortforms for Method 3 Risk Assessment for Park Visitor Exposed to Chemicals in Soil. The MassDEP standard exposure assumptions for this Shortform differ from the Imminent Hazard Shortform. Arcadis used the Shortform to provide numerical estimates of potential risk associated with recreators' presumed contact with the constituents detected in soil samples collected from the ballfields. Two measures of potential risk were estimated: (1) excess lifetime cancer risk; and (2) non-cancer hazard index. The numerical estimates were compared to MCP regulatory limits for evaluating Significant Risks to health. |
| Results | The ELCR estimate for Park Visitors contacting soil from 0 to 0.5 feet below the turf on Field 1 (6.6 E-08) does not exceed the MCP risk limit[3] of 1E-05. The chronic HI estimate for this scenario (0.63) based on a young child aged 1 to 8 years does not exceed the MCP HI limit of 1. The subchronic HI estimate for this scenario (2.1) based on a young child aged 1 to 2 years is greater than the MCP HI limit of 1. Lead contributed 90 percent to the total HI estimate with |

[3] 6.6E-08 is scientific notation and can also be written as $6.6 \times 10^{-8}$. The MCP ELCR limit is 1E-05, or $1 \times 10^{-5}$, or 1 in 100,000 excess lifetime cancer risk.

an individual chemical Hazard Quotient of 1.9. This result assumes contact with lead at a concentration of 601 mg/kg measured in sample B-11 on Field 1. The concentrations of lead and other constituents in soil from 0 to 0.5 feet on Field 2 and 3 do not pose a Significant Risk to health.

The ELCR estimate for Park Visitors contacting soil from 0.5 to 5 feet below the turf on Field 1 (6.4 E-06) does not exceed the MCP risk limit of 1E-05. The chronic HI estimate for this scenario (17.6) based on a young child aged 1 to 8 years and the subchronic HI estimate for this scenario (54.4) based on a young child aged 1 to 2 years is greater than the MCP HI limit of 1. Antimony contributed 90 percent to the total HI estimate with an individual chemical Subchronic Hazard Quotient of 49 and lead contributed 9 percent to the total HI estimate with an individual chemical subchronic Hazard Quotient of 5.2. This result assumes contact with antimony at a maximum concentration of 2,660 mg/kg measured in sample B-11 on Field 1 and lead at a maximum concentration of 1,610 mg/kg measured in sample B-12 on Field 1. Maximum concentrations were used as EPCs for antimony and lead because the data set did not meet the requirements for averaging as described in the MCP.

The ELCR estimate for Park Visitors contacting soil from 0.5 to 5 feet below the turf on Field 2 (3.8 E-06) does not exceed the MCP risk limit of 1E-05. The chronic HI estimate for this scenario (1.98) based on a young child aged 1 to 8 years and the subchronic HI estimate for this scenario (6.27) based on a young child aged 1 to 2 years is greater than the MCP HI limit of 1. Lead contributed 88 percent to the total HI estimate with an individual chemical Subchronic Hazard Quotient of 5.5. This result assumes contact with lead at a concentration of 1,710 mg/kg measured in sample B-3 (0.5 to 5 feet) in Field 2.

The ELCR estimate for Park Visitors contacting soil from 0.5 to 5 feet below the turf on Field 3 (3.4 E-06) does not exceed the MCP risk limit of 1E-05. The chronic HI estimate for this scenario (0.83) based on a young child aged 1 to 8 years does not exceed the MCP HI limit of 1. The subchronic HI estimate for this scenario (2.77) based on a young child aged 1 to 2 years is greater than the MCP HI limit of 1. Lead contributed 86 percent to the total HI estimate with an individual chemical Subchronic Hazard Quotient of 2.4. This result assumes contact with lead at a concentration of 755 mg/kg measured in sample B-13 (0.5 to 5 feet) in Field 3.

The Method 3 Human Health Risk Assessment Shortform spreadsheets are provided as Attachment 2 to this letter.

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**Interpretation of Risk Assessment Results**

Contact with lead contributed most to the total cumulative receptor risk estimates except for the antimony hot spot in subsurface soils on Field 1 (sample B-11). Other constituents were detected in the soil samples and included in the total risk estimates; the presence of these other constituents is considered to pose relatively less risk from contact with soil. Thus, based on the limited data collected to date, decisions about the use of the fields in the near term will be driven primarily by the presence of lead in soil.

Lead is the constituent in soil that could pose the highest potential risk to health for young children if they had unlimited contact with soil on the fields because of the elevated concentration measured on Field 1. The maximum lead concentrations in topsoil from 0 to 0.5 feet below turf on Fields 2 and 3 were less than 200 mg/kg,

the MCP Soil Standard for unrestricted land use ("S-1 Soil Standards"). The maximum lead concentrations in deeper soil from 0.5 to 5 feet below turf on Field 2 and 3 (1,710 and 755 mg/kg, respectively) were greater than the S-1 and S-2/S-3 Soil Standards. The antimony concentration in deeper soil on Field 1 is greater than the MCP soil standards.

**Recommendations for Temporary Continued Use of Ballfields**

The landfill material contains lead that presents a potential risk if users of the field were exposed to lead-impacted soil through dermal contact, ingestion, or inhalation. To prevent contact with soil, the typical remedial response action that has been used at comparable sites is to place an Activity and Use Limitation (AUL) on the site that restricts disturbance of the underlying soil. In addition to the AUL, there needs to be a physical barrier that prevents users of the field from being able to readily access the impacted soil. This is usually done with a clean soil cover, asphalt paving, or a building, or a combination of those items.

Based on data collected to date, Arcadis makes the following specific recommendations regarding use of Fields 1, 2 and 3.

- The topsoil samples from Field 1 contain concentrations of lead that indicate a short-term risk from repeated exposure. Arcadis recommends that this field be closed and not used for recreational purposes until a remedy can by implemented. Our understanding is that fencing surrounds Field 1 and with gates can be used to restrict access. The concentrations of constituents in the material below the topsoil also indicates a long-term risk from repeated exposure. A possible remedy is to place 2 to 3 feet of clean cover over a geotextile membrane over the landfill material and provide notice of the requirements to maintain the cover through an AUL.
- The topsoil samples from Fields 2 and 3 did not contain concentrations of lead that indicate a short-term risk from repeated exposure. However, the concentration of lead in the material below the topsoil indicates a potential long-term risk from repeated exposure. On these fields, the topsoil was approximately 6 inches thick with an established grass layer approximately 2 inches thick. The topsoil and grass layer will reduce exposure to the underlying landfill material. However, the landfill material immediately below the topsoil presents a potential long-term risk. Under the MCP, the top three feet of soil are considered accessible and must meet the S-1 standards or show No Significant Risk from long-term exposure under current and future land uses. Otherwise, an AUL would be required to restrict access to soils from 0 to 3 feet.
- The current topsoil layer on Field 2 and 3 is not of sufficient thickness to be considered an adequate prevention of exposure to underlying landfill material for the long term. Arcadis recommends the field use for recreation only be allowed for the next 12 months. The fields should be maintained during this time and no excavation or exposure of the subsurface soil should be done without the proper safety precautions, health and safety plan and soil management plan prepared by an LSP.
- A response action consisting of placing a geotextile membrane over the landfill material with 2 to 3 feet of clean cover with an AUL is a possible remedy. The AUL will restrict exposing the underlying landfill material without the proper safety precautions and a soil management plan prepared by a Licensed Site Professional (LSP).
- The pathways between Fields 1 and 2 had landfill material (broken glass) at the surface. To mitigate an Imminent Hazard to Safety, a temporary measure for this area should be to cover the pathways with geotextile material and have clean cover placed over the geotextile to prevent exposure.

- Fields 2 and 3 should be inspected before the start of the playing season and periodically inspected to ensure the grass cover is intact and no landfill material is exposed.

**Next Steps**

Under the MCP, there are several requirements to allow the site to be closed with a permanent solution.

The additional investigation to support closure will include but may not be limited to the following:

- Geophysical study to determine the extent of the landfill
- Groundwater assessment (installation of six monitoring wells) to determine groundwater flow and the groundwater quality. The assessment will also include testing of the irrigation supply well for the soccer field.
- Additional soil borings to verify lateral and vertical extent of the landfill. Includes the parking lot area.
- Phase I Initial Investigation and Tier Classification under the MCP
- Phase II Comprehensive Site Investigation (establish the nature and extent of the release).

The additional investigation can be completed in one year or less.

Once the additional investigation has been completed, a response action similar to those detailed above can be implemented with a remedial response plan.

**Limitations**

The recommendations included in this report were based on limited data and those recommendations could change if new data becomes available that is significantly different or other contaminants are identified.

A Permanent Solution to close the site with MassDEP will depend on the additional investigation results and therefore cannot be guaranteed.

We look forward to discussing the information presented in this Status Report with your team. Please reach out with any questions.

Sincerely,
Arcadis U.S., Inc.

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February 18, 2025

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Enclosures:

Figure 1 – Boring Locations on Trotting Park Little League Baseball Field
Attachment 1 – MassDEP Shortform for Park Visitor – Imminent Hazard Evaluation
Attachment 2 – MassDEP Shortform for Park Visitor – Significant Risk Evaluation

# Figure

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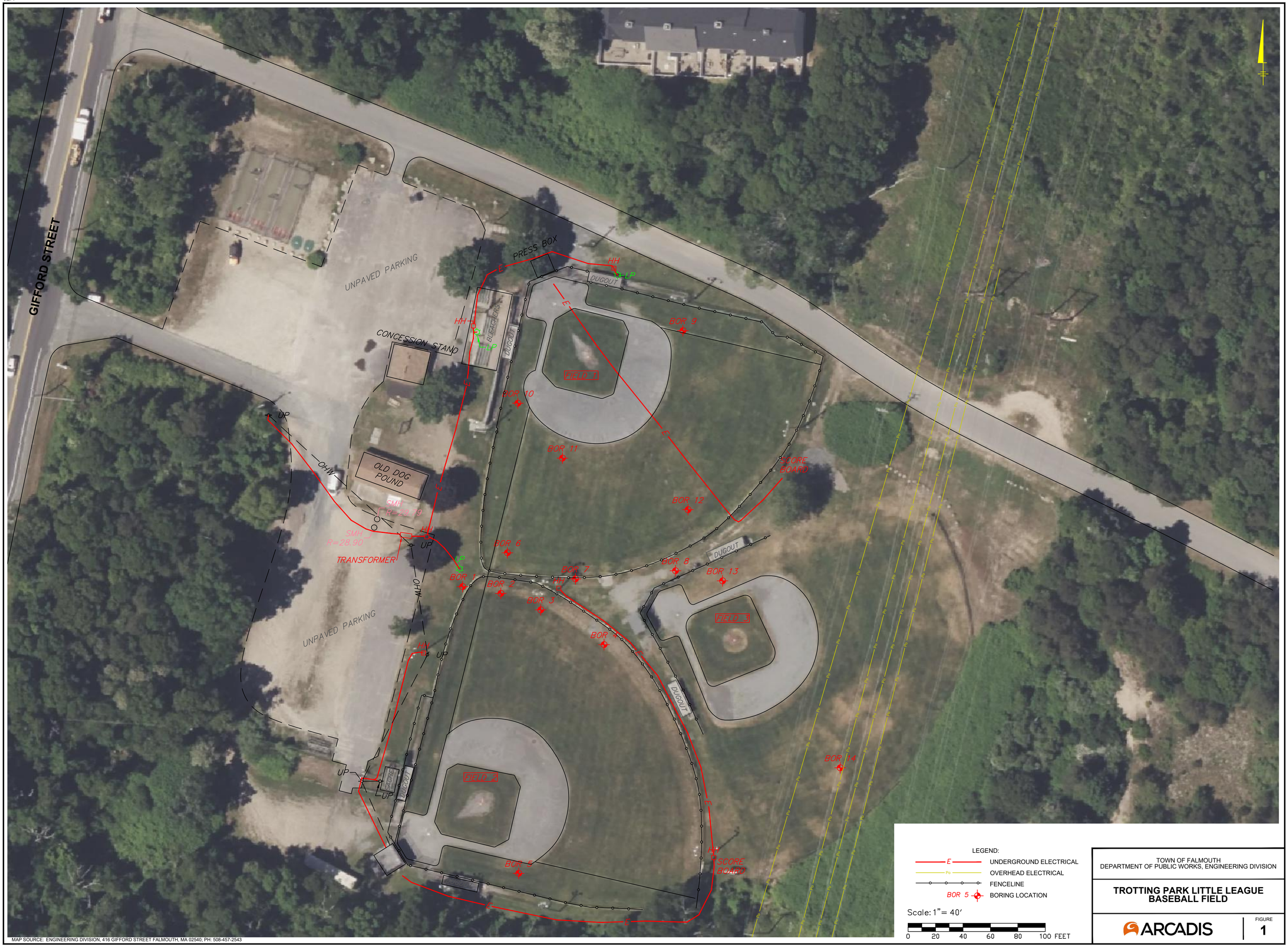


MAP SOURCE: ENGINEERING DIVISION, 416 GIFFORD STREET FALMOUTH, MA 02540; PH: 508-457-2543

TOWN OF FALMOUTH
DEPARTMENT OF PUBLIC WORKS, ENGINEERING DIVISION

# TROTTING PARK LITTLE LEAGUE BASEBALL FIELD

ARCADIS

FIGURE 1

# Attachment 1

## MassDEP Shortform for Park Visitor – Imminent Hazard Evaluation

# Park Visitor - Soil Imminent Hazard Evaluation: Table PSIH-1
## Exposure Point Concentration (EPC)
### Based on Visitor Ages 1-6 (Cancer) and 1-2 (Noncancer)

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = 4.6E-08**

**Subchronic HI (all chemicals) = 2.20**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|
| ANTIMONY | 12.4 | | | | 1.4E-01 | 8.9E-02 | 2.3E-01 | |
| BARIUM | 169 | | | | 3.8E-03 | 2.4E-03 | 6.2E-03 | |
| CADMIUM | 2.36 | | | | 1.1E-02 | 1.4E-03 | 1.2E-02 | |
| LEAD | 601 | | | | 1.8E+00 | 1.4E-01 | 1.9E+00 | **Lead IH HQ limit is 1, not 10.** |
| MERCURY | 0.615 | | | | | | | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 30.2 | | | | 1.4E-04 | 2.9E-04 | 4.2E-04 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | 28.5 | | | | 2.1E-05 | 2.7E-05 | 4.9E-05 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 0.122 | 2.6E-08 | 2.0E-08 | 4.6E-08 | 1.1E-02 | 7.0E-03 | 1.8E-02 | |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-2
# Equations to Calculate Cancer Risk for Visitor (Age 1-6 Years)



## Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF$$

$$LADD_{ing} = \frac{[OHM]_{soil} * IR_{x} * RAF_{c\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP_{lifetime}}$$

## Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{c\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP_{lifetime}}$$

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ and $EF_{derm}$ = $EF_{Cancer}$ | 0.25 | event/day |
| ED | 1 | day/event |
| EP | 5 | years |
| C | 0.000001 | kg/mg |
| BW | 16.4 | kg |
| $AP_{lifetime}$ | 70 | years |
| SA | 2032 | $cm^2$/day |
| SAF | 0.3742 | $mg/cm^2$ |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-3

## Equations to Calculate Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

### Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

### Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing,derm}$ | 0.428571429 | event/day |
| ED | 1 | day/event |
| EP | 0.575 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| AP | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3742 | $mg/cm^2$ |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-4
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PSIH-5 and PSIH-5b. |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific - sees Table PSIH-2, PSIH-2-a, PSIH-2-b, and PSIH-2c. |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) - see Table PSIH-3. |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Tables PSIH-5 and PSIH-5b. |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| IR - Soil Ingestion Rate | 100 | mg/day | MADEP 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects (exposure route specific) | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PSIH-5 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects (exposure route specific) | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PSIH-5 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{cancer}$ - Exposure Frequency for cancer effects | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc(1-2)}$ - Exposure Period for age group 1-2 for non-cancer | 0.575 | years | 30 weeks |
| $EP_{cancer\text{-}(1-2)}$ - Exposure Period for age group 1-2 for cancer | 1 | years | |
| $EP_{cancer\text{-}(2-6)}$ - Exposure Period for age group 2-6 for cancer | 4 | years | |
| $EP_{(1-6)}$ - Exposure Period for age group 1-6 | 5 | years | |
| $BW_{(1-2)}$ - Body Weight for age group 1-2 | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(1-6)}$ - Body Weight for age group 1-6 | 16.4 | kg | Ibid $BW_{(1-2)}$ Note. |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-4
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{lifetime}$ - Averaging Period for cancer (lifetime) | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females) |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$ /day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(1-6)}$ - Surface Area for age group 1-6 | 2032 | $cm^2$ / day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(1-6)}$ - Surface Adherence Factor for age group 1-6 | 0.3742 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-5
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Subchronic RfD mg/kg-day | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|
| ANTIMONY | | | | 4.0E-04 | 1 | 0.1 | |
| BARIUM | | | | 2.0E-01 | 1 | 0.1 | |
| CADMIUM | | | | 5.0E-04 | 0.5 | 0.01 | |
| LEAD | | | | 7.5E-04 | 0.5 | 0.006 | |
| MERCURY | | | | 3.0E-04 | 0.5 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-01 | 0.3 | 0.1 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | | | | 6.0E+00 | 1 | 0.2 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 2.0E+00 | 1 | 0.1 | 5.0E-05 | 1 | 0.1 | |

# Park Visitor - Soil Imminent Hazard Evaluation: Table PSIH-1
## Exposure Point Concentration (EPC)
### Based on Visitor Ages 1-6 (Cancer) and 1-2 (Noncancer)

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = NA**

**Subchronic HI (all chemicals) = 0.64**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|
| BARIUM | 95.7 | | | | 2.1E-03 | 1.4E-03 | 3.5E-03 | |
| CHROMIUM (TOTAL) | 41.3 | | | | 9.3E-03 | 5.9E-03 | 1.5E-02 | **Cr(VI) limit is 200 mg/kg due to contact dermatitis.** |
| LEAD | 190 | | | | 5.7E-01 | 4.4E-02 | 6.1E-01 | **Lead IH HQ limit is 1, not 10.** |
| ZINC | 228 | | | | 3.4E-03 | 2.2E-03 | 5.6E-03 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 12.2 | | | | | | | |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-2
# Equations to Calculate Cancer Risk for Visitor (Age 1-6 Years)



## Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF$$

$$LADD_{ing} = \frac{[OHM]_{soil} * IR_{x} * RAF_{c\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP_{lifetime}}$$

## Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{c\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP_{lifetime}}$$

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ and $EF_{derm}$ = $EF_{Cancer}$ | 0.25 | event/day |
| ED | 1 | day/event |
| EP | 5 | years |
| C | 0.000001 | kg/mg |
| BW | 16.4 | kg |
| $AP_{lifetime}$ | 70 | years |
| SA | 2032 | $cm^2$/day |
| SAF | 0.3742 | $mg/cm^2$ |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-3

## Equations to Calculate Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

### Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

### Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing,derm}$ | 0.428571429 | event/day |
| ED | 1 | day/event |
| EP | 0.575 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| AP | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3742 | $mg/cm^2$ |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-4
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PSIH-5 and PSIH-5b. |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific - sees Table PSIH-2, PSIH-2-a, PSIH-2-b, and PSIH-2c. |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) - see Table PSIH-3. |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Tables PSIH-5 and PSIH-5b. |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| IR - Soil Ingestion Rate | 100 | mg/day | MADEP 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects (exposure route specific) | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PSIH-5 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects (exposure route specific) | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PSIH-5 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{cancer}$ - Exposure Frequency for cancer effects | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc(1-2)}$ - Exposure Period for age group 1-2 for non-cancer | 0.575 | years | 30 weeks |
| $EP_{cancer\text{-}(1-2)}$ - Exposure Period for age group 1-2 for cancer | 1 | years | |
| $EP_{cancer\text{-}(2-6)}$ - Exposure Period for age group 2-6 for cancer | 4 | years | |
| $EP_{(1-6)}$ - Exposure Period for age group 1-6 | 5 | years | |
| $BW_{(1-2)}$ - Body Weight for age group 1-2 | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(1-6)}$ - Body Weight for age group 1-6 | 16.4 | kg | Ibid $BW_{(1-2)}$ Note. |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-4
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{lifetime}$ - Averaging Period for cancer (lifetime) | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females) |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$ /day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(1-6)}$ - Surface Area for age group 1-6 | 2032 | $cm^2$ / day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(1-6)}$ - Surface Adherence Factor for age group 1-6 | 0.3742 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-5
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Subchronic RfD mg/kg-day | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|
| BARIUM | | | | 2.0E-01 | 1 | 0.1 | |
| CHROMIUM (TOTAL) | | | | 2.0E-02 | 1 | 0.1 | |
| LEAD | | | | 7.5E-04 | 0.5 | 0.006 | |
| ZINC | | | | 3.0E-01 | 1 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-01 | 0.3 | 0.1 | |

# Park Visitor - Soil Imminent Hazard Evaluation: Table PSIH-1
## Exposure Point Concentration (EPC)
### Based on Visitor Ages 1-6 (Cancer) and 1-2 (Noncancer)

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = NA**

**Subchronic HI (all chemicals) = 0.18**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|
| BARIUM | 91.6 | | | | 2.1E-03 | 1.3E-03 | 3.4E-03 | |
| CHROMIUM (TOTAL) | 54.3 | | | | 1.2E-02 | 7.8E-03 | 2.0E-02 | **Cr(VI) limit is 200 mg/kg due to contact dermatitis.** |
| LEAD | 45.2 | | | | 1.4E-01 | 1.0E-02 | 1.5E-01 | **Lead IH HQ limit is 1, not 10.** |
| NICKEL | 24.2 | | | | 5.4E-03 | 6.9E-03 | 1.2E-02 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 10.1 | | | | | | | |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-2
# Equations to Calculate Cancer Risk for Visitor (Age 1-6 Years)



## Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF$$

$$LADD_{ing} = \frac{[OHM]_{soil} * IR_{x} * RAF_{c\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP_{lifetime}}$$

## Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{c\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP_{lifetime}}$$

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ and $EF_{derm}$ = $EF_{Cancer}$ | 0.25 | event/day |
| ED | 1 | day/event |
| EP | 5 | years |
| C | 0.000001 | kg/mg |
| BW | 16.4 | kg |
| $AP_{lifetime}$ | 70 | years |
| SA | 2032 | $cm^2$/day |
| SAF | 0.3742 | $mg/cm^2$ |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-3

## Equations to Calculate Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

### Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

### Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing,derm}$ | 0.428571429 | event/day |
| ED | 1 | day/event |
| EP | 0.575 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| AP | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3742 | $mg/cm^2$ |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-4
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PSIH-5 and PSIH-5b. |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific - sees Table PSIH-2, PSIH-2-a, PSIH-2-b, and PSIH-2c. |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) - see Table PSIH-3. |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Tables PSIH-5 and PSIH-5b. |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| IR - Soil Ingestion Rate | 100 | mg/day | MADEP 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects (exposure route specific) | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PSIH-5 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects (exposure route specific) | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PSIH-5 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{cancer}$ - Exposure Frequency for cancer effects | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc(1-2)}$ - Exposure Period for age group 1-2 for non-cancer | 0.575 | years | 30 weeks |
| $EP_{cancer\text{-}(1-2)}$ - Exposure Period for age group 1-2 for cancer | 1 | years | |
| $EP_{cancer\text{-}(2-6)}$ - Exposure Period for age group 2-6 for cancer | 4 | years | |
| $EP_{(1-6)}$ - Exposure Period for age group 1-6 | 5 | years | |
| $BW_{(1-2)}$ - Body Weight for age group 1-2 | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(1-6)}$ - Body Weight for age group 1-6 | 16.4 | kg | Ibid $BW_{(1-2)}$ Note. |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-4
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{lifetime}$ - Averaging Period for cancer (lifetime) | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females) |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$ /day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(1-6)}$ - Surface Area for age group 1-6 | 2032 | $cm^2$ / day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(1-6)}$ - Surface Adherence Factor for age group 1-6 | 0.3742 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor Imminent Hazard - Soil: Table PSIH-5
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Subchronic RfD mg/kg-day | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|
| BARIUM | | | | 2.0E-01 | 1 | 0.1 | |
| CHROMIUM (TOTAL) | | | | 2.0E-02 | 1 | 0.1 | |
| LEAD | | | | 7.5E-04 | 0.5 | 0.006 | |
| NICKEL | | | | 2.0E-02 | 1 | 0.2 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-01 | 0.3 | 0.1 | |

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# Attachment 2

## MassDEP Shortform for Park Visitor – Significant Risk Evaluation

## Park Visitor - Soil: Table PS-1
## Exposure Point Concentration (EPC)
**Based on Visitor Ages 1-31 (Cancer), 1-8 (Chronic Noncancer), and 1-2 (Subchronic Noncancer)**

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = 6.6E-08**

**Chronic HI (all chemicals) = 0.63**

**Subchronic HI (all chemicals) = 2.1**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Chronic $HQ_{ing}$ | Chronic $HQ_{derm}$ | Chronic $HQ_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | 7.52 | | | | 2.4E-02 | 2.0E-02 | 4.5E-02 | 8.4E-02 | 5.3E-02 | 1.4E-01 | |
| BARIUM | 83.8 | | | | 5.4E-04 | 4.6E-04 | 1.0E-03 | 1.9E-03 | 1.2E-03 | 3.1E-03 | |
| CADMIUM | 1.52 | | | | 2.0E-03 | 3.3E-04 | 2.3E-03 | 6.8E-03 | 8.7E-04 | 7.7E-03 | |
| LEAD | 601 | | | | 5.2E-01 | 5.2E-02 | 5.7E-01 | 1.8E+00 | 1.4E-01 | 1.9E+00 | **Lead IH HQ limit is 1, not 10.** |
| MERCURY | 0.365 | | | | 7.9E-04 | 1.3E-03 | 2.1E-03 | 2.7E-03 | 3.5E-03 | 6.2E-03 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 16.5 | | | | 2.1E-04 | 6.0E-04 | 8.1E-04 | 7.4E-05 | 1.6E-04 | 2.3E-04 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | 13.4 | | | | 8.7E-06 | 1.5E-05 | 2.3E-05 | 1.0E-05 | 1.3E-05 | 2.3E-05 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 0.087 | 3.5E-08 | 3.1E-08 | 6.6E-08 | 5.6E-03 | 4.7E-03 | 1.0E-02 | 7.8E-03 | 5.0E-03 | 1.3E-02 | |

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# Park Visitor - Soil: Table PS-2

## Equations to Calculate Cancer Risk for Visitor (Age 1-31 Years)

### Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1\text{-}31)} * CSF$$

$$LADD_{ing\ (1\text{-}31)} = LADD_{ing\ (1\text{-}8)} + LADD_{ing\ (8\text{-}15)} + LADD_{ing\ (15\text{-}31)}$$

$$LADD_{ing\ x} = \frac{[OHM]_{soil} * IR_x * RAF_{c\text{-}ing} * EF_{ing} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

### Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm\ (1\text{-}31)} = LADD_{derm\ (1\text{-}8)} + LADD_{derm\ (8\text{-}15)} + LADD_{derm\ (15\text{-}31)}$$

$$LADD_{derm\ x} = \frac{[OHM]_{soil} * SA_x * RAF_{c\text{-}derm} * SAF_x * EF_{derm} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

Method 3 Lookup Tables Version v0624

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| $IR_{(1\text{-}8)}$ | 100 | mg/day |
| $IR_{(8\text{-}15)}$ | 50 | mg/day |
| $IR_{(15\text{-}31)}$ | 50 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| $EP_{(1\text{-}8)}$ | 7 | years |
| $EP_{(8\text{-}15)}$ | 7 | years |
| $EP_{(15\text{-}31)}$ | 16 | years |
| C | 0.000001 | kg/mg |
| $BW_{(1\text{-}8)}$ | 19.0 | kg |
| $BW_{(8\text{-}15)}$ | 46.1 | kg |
| $BW_{(15\text{-}31)}$ | 64.5 | kg |
| $AP_{lifetime} = AP_{cancer}$ | 70 | years |
| $SA_{(1\text{-}8)}$ | 2244 | $cm^2/day$ |
| $SA_{(8\text{-}15)}$ | 4051 | $cm^2/day$ |
| $SA_{(15\text{-}31)}$ | 5322 | $cm^2/day$ |
| $SAF_{(1\text{-}8)}$ | 0.3740 | $mg/cm^2$ |
| $SAF_{(8\text{-}15)}$ | 0.1365 | $mg/cm^2$ |
| $SAF_{(15\text{-}31)}$ | 0.0829 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-3

# Equations to Calculate Chronic Noncancer Risk for Visitor (Age 1-8 Years)

Method 3 Lookup Tables Version v0624

## Chronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Chronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{ing,derm}}{RfD}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm}$ = $EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| EP | 7 | years |
| C | 0.000001 | kg/mg |
| BW | 19.0 | kg |
| AP | 7 | year |
| SA | 2244 | $cm^2$/day |

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# Park Visitor - Soil: Table PS-4
# Equations to Calculate Subchronic Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

## Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.429 | event/day |
| ED | 1 | day/event |
| $EP = EP_{sc\ (1\text{-}2)}$ | 0.575342466 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| $AP = AP_{subchronic}$ | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3740 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PS-6 and PS-6c |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Table PS-6 |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| $IR_{(1-2)}$ - Soil Ingestion Rate for age group 1-2 | 100 | mg/day | MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $IR_{(1-8)}$ - Soil Ingestion Rate for age group 1-8 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(8-15)}$ - Soil Ingestion Rate for age group 8-15 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(15-31)}$ - Soil Ingestion Rate for age group 15-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(2-6)}$ - Soil Ingestion Rate for age group 2-6 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(6-16)}$ - Soil Ingestion Rate for age group 6-16 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(16-31)}$ - Soil Ingestion Rate for age group 16-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PS-6 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PS-6 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{chronic}$ and $EF_{cancer}$ - Exposure Frequency for chronic ~~or~~ and Exposure Frequency for lifetime cancer | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc\ (1-2)}$ - Exposure Period for age group 1-2 for Subchronic exposure | 0.575 | years | 30 weeks |
| $EP_{(1-8)}$ - Exposure Period for age group 1-8 | 7 | years | |
| $EP_{(8-15)}$ - Exposure Period for age group 8-15 | 7 | years | |
| $EP_{(15-31)}$ - Exposure Period for age group 15-31 | 16 | years | |
| $EP_{(1-2)}$ - Exposure Period for age group 1-2 (mutagenic effects) | 1 | years | |
| $EP_{(2-6)}$ - Exposure Period for age group 2-6 (mutagenic effects) | 4 | years | |
| $EP_{(6-16)}$ - Exposure Period for age group 6-16 (mutagenic effects) | 10 | years | |
| $EP_{(16-31)}$ - Exposure Period for-age group 16-31 (mutagenic effects) | 15 | years | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $BW_{(1-2)}$ - Body Weight for age group 1-2, (subchronic, and mutagenic) | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(1-8)}$ - Body Weight for age group 1-8 | 19.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(8-15)}$ - Body Weight for age group 8-15 | 46.1 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(15-31)}$ - Body Weight for age group 15-31 | 64.5 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(6-16)}$ - Body Weight for age group 6-16 | 43.2 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(16-31)}$ - Body Weight for age group 16-31 | 65.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{chronic}$ - Averaging Period for chronic noncancer | 7 | years | |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{cancer}$ - Averaging Period for cancer/lifetime | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $ADAF_{(6-16)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 6-16 | 3 | dimensionless | |
| $ADAF_{(16-31)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 16-31 | 1 | dimensionless | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females.) |
| $SA_{(1-8)}$ - Surface Area for age group 1-8 | 2244 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(8-15)}$ - Surface Area for age group 8-15 | 4051 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(15-31)}$ - Surface Area for age group 15-31 | 5322 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(6-16)}$ - Surface Area for age group 6-16 | 3875 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(16-31)}$ - Surface Area for age group 16-31 | 5354 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(1-8)}$ - Surface Adherence Factor for age group 1-8 | 0.3740 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(8-15)}$ - Surface Adherence Factor for age group 8-15 | 0.1365 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(15-31)}$ - Surface Adherence Factor for age group 15-31 | 0.0829 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg/cm^4$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(6-16)}$ - Surface Adherence Factor for age group 6-16 | 0.1702 | $mg/cm^5$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(16-31)}$ - Surface Adherence Factor for age group 16-31 | 0.0826 | $mg/cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor - Soil: Table PS-6
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Chronic RfD mg/kg-day | Subchronic RfD mg/kg-day | Chronic $RAF_{nc\text{-}ing}$ | Chronic $RAF_{nc\text{-}derm}$ | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | | | | 4.0E-04 | 4.0E-04 | 1 | 0.1 | 1 | 0.1 | |
| BARIUM | | | | 2.0E-01 | 2.0E-01 | 1 | 0.1 | 1 | 0.1 | |
| CADMIUM | | | | 5.0E-04 | 5.0E-04 | 0.5 | 0.01 | 0.5 | 0.01 | |
| LEAD | | | | 7.5E-04 | 7.5E-04 | 0.5 | 0.006 | 0.5 | 0.006 | |
| MERCURY | | | | 3.0E-04 | 3.0E-04 | 0.5 | 0.1 | 0.5 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-02 | 3.0E-01 | 0.3 | 0.1 | 0.3 | 0.1 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | | | | 2.0E+00 | 6.0E+00 | 1 | 0.2 | 1 | 0.2 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 2.0E+00 | 1 | 0.1 | 2.0E-05 | 5.0E-05 | 1 | 0.1 | 1 | 0.1 | |

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## Park Visitor - Soil: Table PS-1
## Exposure Point Concentration (EPC)
**Based on Visitor Ages 1-31 (Cancer), 1-8 (Chronic Noncancer), and 1-2 (Subchronic Noncancer)**

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = 6.4E-06**

**Chronic HI (all chemicals) = 17.6**

**Subchronic HI (all chemicals) = 54.4**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Chronic $HQ_{ing}$ | Chronic $HQ_{derm}$ | Chronic $HQ_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | 2,660 | | | | 8.6E+00 | 7.2E+00 | 1.6E+01 | 3.0E+01 | 1.9E+01 | 4.9E+01 | |
| ARSENIC | 27.3 | 4.1E-06 | 2.2E-06 | 6.3E-06 | 5.9E-02 | 3.0E-02 | 8.9E-02 | 2.0E-01 | 7.8E-02 | 2.8E-01 | |
| BARIUM | 288 | | | | 1.9E-03 | 1.6E-03 | 3.4E-03 | 6.5E-03 | 4.1E-03 | 1.1E-02 | |
| CADMIUM | 3.61 | | | | 4.7E-03 | 7.9E-04 | 5.5E-03 | 1.6E-02 | 2.1E-03 | 1.8E-02 | |
| CHROMIUM (TOTAL) | 19.4 | | | | 8.4E-03 | 7.0E-03 | 1.5E-02 | 4.3E-03 | 2.8E-03 | 7.1E-03 | **Cr(VI) limit is 200 mg/kg due to contact dermatitis.** |
| LEAD | 1,610 | | | | 1.4E+00 | 1.4E-01 | 1.5E+00 | 4.8E+00 | 3.7E-01 | 5.2E+00 | **Lead IH HQ limit is 1, not 10.** |
| NICKEL | 17.5 | | | | 1.1E-03 | 1.9E-03 | 3.0E-03 | 3.9E-03 | 5.0E-03 | 8.9E-03 | |
| ZINC | 4,150 | | | | 1.8E-02 | 1.5E-02 | 3.3E-02 | 6.2E-02 | 3.9E-02 | 1.0E-01 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 21.6 | | | | 2.8E-04 | 7.8E-04 | 1.1E-03 | 9.7E-05 | 2.0E-04 | 3.0E-04 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | 21.0 | | | | 1.4E-05 | 2.3E-05 | 3.6E-05 | 1.6E-05 | 2.0E-05 | 3.6E-05 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 0.157 | 6.3E-08 | 5.6E-08 | 1.2E-07 | 1.0E-02 | 8.5E-03 | 1.9E-02 | 1.4E-02 | 8.9E-03 | 2.3E-02 | |

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# Park Visitor - Soil: Table PS-2

## Equations to Calculate Cancer Risk for Visitor (Age 1-31 Years)

### Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1\text{-}31)} * CSF$$

$$LADD_{ing\ (1\text{-}31)} = LADD_{ing\ (1\text{-}8)} + LADD_{ing\ (8\text{-}15)} + LADD_{ing\ (15\text{-}31)}$$

$$LADD_{ing\ x} = \frac{[OHM]_{soil} * IR_x * RAF_{c\text{-}ing} * EF_{ing} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

### Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm\ (1\text{-}31)} = LADD_{derm\ (1\text{-}8)} + LADD_{derm\ (8\text{-}15)} + LADD_{derm\ (15\text{-}31)}$$

$$LADD_{derm\ x} = \frac{[OHM]_{soil} * SA_x * RAF_{c\text{-}derm} * SAF_x * EF_{derm} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

Method 3 Lookup Tables Version v0624

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| $IR_{(1\text{-}8)}$ | 100 | mg/day |
| $IR_{(8\text{-}15)}$ | 50 | mg/day |
| $IR_{(15\text{-}31)}$ | 50 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| $EP_{(1\text{-}8)}$ | 7 | years |
| $EP_{(8\text{-}15)}$ | 7 | years |
| $EP_{(15\text{-}31)}$ | 16 | years |
| C | 0.000001 | kg/mg |
| $BW_{(1\text{-}8)}$ | 19.0 | kg |
| $BW_{(8\text{-}15)}$ | 46.1 | kg |
| $BW_{(15\text{-}31)}$ | 64.5 | kg |
| $AP_{lifetime} = AP_{cancer}$ | 70 | years |
| $SA_{(1\text{-}8)}$ | 2244 | $cm^2/day$ |
| $SA_{(8\text{-}15)}$ | 4051 | $cm^2/day$ |
| $SA_{(15\text{-}31)}$ | 5322 | $cm^2/day$ |
| $SAF_{(1\text{-}8)}$ | 0.3740 | $mg/cm^2$ |
| $SAF_{(8\text{-}15)}$ | 0.1365 | $mg/cm^2$ |
| $SAF_{(15\text{-}31)}$ | 0.0829 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-3

# Equations to Calculate Chronic Noncancer Risk for Visitor (Age 1-8 Years)

Method 3 Lookup Tables Version v0624

## Chronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Chronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{ing,derm}}{RfD}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm}$ = $EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| EP | 7 | years |
| C | 0.000001 | kg/mg |
| BW | 19.0 | kg |
| AP | 7 | year |
| SA | 2244 | $cm^2$/day |

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# Park Visitor - Soil: Table PS-4
# Equations to Calculate Subchronic Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

## Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.429 | event/day |
| ED | 1 | day/event |
| $EP = EP_{sc\ (1\text{-}2)}$ | 0.575342466 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| $AP = AP_{subchronic}$ | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3740 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PS-6 and PS-6c |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Table PS-6 |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| $IR_{(1-2)}$ - Soil Ingestion Rate for age group 1-2 | 100 | mg/day | MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $IR_{(1-8)}$ - Soil Ingestion Rate for age group 1-8 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(8-15)}$ - Soil Ingestion Rate for age group 8-15 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(15-31)}$ - Soil Ingestion Rate for age group 15-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(2-6)}$ - Soil Ingestion Rate for age group 2-6 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(6-16)}$ - Soil Ingestion Rate for age group 6-16 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(16-31)}$ - Soil Ingestion Rate for age group 16-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PS-6 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PS-6 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{chronic}$ and $EF_{cancer}$ - Exposure Frequency for chronic ~~or~~ and Exposure Frequency for lifetime cancer | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc\ (1-2)}$ - Exposure Period for age group 1-2 for Subchronic exposure | 0.575 | years | 30 weeks |
| $EP_{(1-8)}$ - Exposure Period for age group 1-8 | 7 | years | |
| $EP_{(8-15)}$ - Exposure Period for age group 8-15 | 7 | years | |
| $EP_{(15-31)}$ - Exposure Period for age group 15-31 | 16 | years | |
| $EP_{(1-2)}$ - Exposure Period for age group 1-2 (mutagenic effects) | 1 | years | |
| $EP_{(2-6)}$ - Exposure Period for age group 2-6 (mutagenic effects) | 4 | years | |
| $EP_{(6-16)}$ - Exposure Period for age group 6-16 (mutagenic effects) | 10 | years | |
| $EP_{(16-31)}$ - Exposure Period for-age group 16-31 (mutagenic effects) | 15 | years | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $BW_{(1-2)}$ - Body Weight for age group 1-2, (subchronic, and mutagenic) | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(1-8)}$ - Body Weight for age group 1-8 | 19.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(8-15)}$ - Body Weight for age group 8-15 | 46.1 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(15-31)}$ - Body Weight for age group 15-31 | 64.5 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(6-16)}$ - Body Weight for age group 6-16 | 43.2 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(16-31)}$ - Body Weight for age group 16-31 | 65.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{chronic}$ - Averaging Period for chronic noncancer | 7 | years | |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{cancer}$ - Averaging Period for cancer/lifetime | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $ADAF_{(6-16)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 6-16 | 3 | dimensionless | |
| $ADAF_{(16-31)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 16-31 | 1 | dimensionless | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females.) |
| $SA_{(1-8)}$ - Surface Area for age group 1-8 | 2244 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(8-15)}$ - Surface Area for age group 8-15 | 4051 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(15-31)}$ - Surface Area for age group 15-31 | 5322 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(6-16)}$ - Surface Area for age group 6-16 | 3875 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(16-31)}$ - Surface Area for age group 16-31 | 5354 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(1-8)}$ - Surface Adherence Factor for age group 1-8 | 0.3740 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(8-15)}$ - Surface Adherence Factor for age group 8-15 | 0.1365 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(15-31)}$ - Surface Adherence Factor for age group 15-31 | 0.0829 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg/cm^4$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(6-16)}$ - Surface Adherence Factor for age group 6-16 | 0.1702 | $mg/cm^5$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(16-31)}$ - Surface Adherence Factor for age group 16-31 | 0.0826 | $mg/cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor - Soil: Table PS-6
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Chronic RfD mg/kg-day | Subchronic RfD mg/kg-day | Chronic $RAF_{nc\text{-}ing}$ | Chronic $RAF_{nc\text{-}derm}$ | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | | | | 4.0E-04 | 4.0E-04 | 1 | 0.1 | 1 | 0.1 | |
| ARSENIC | 1.5E+00 | 0.5 | 0.03 | 3.0E-04 | 3.0E-04 | 0.5 | 0.03 | 0.5 | 0.03 | |
| BARIUM | | | | 2.0E-01 | 2.0E-01 | 1 | 0.1 | 1 | 0.1 | |
| CADMIUM | | | | 5.0E-04 | 5.0E-04 | 0.5 | 0.01 | 0.5 | 0.01 | |
| CHROMIUM (TOTAL) | | | | 3.0E-03 | 2.0E-02 | 1 | 0.1 | 1 | 0.1 | |
| LEAD | | | | 7.5E-04 | 7.5E-04 | 0.5 | 0.006 | 0.5 | 0.006 | |
| NICKEL | | | | 2.0E-02 | 2.0E-02 | 1 | 0.2 | 1 | 0.2 | |
| ZINC | | | | 3.0E-01 | 3.0E-01 | 1 | 0.1 | 1 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-02 | 3.0E-01 | 0.3 | 0.1 | 0.3 | 0.1 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | | | | 2.0E+00 | 6.0E+00 | 1 | 0.2 | 1 | 0.2 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 2.0E+00 | 1 | 0.1 | 2.0E-05 | 5.0E-05 | 1 | 0.1 | 1 | 0.1 | |

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## Park Visitor - Soil: Table PS-1
## Exposure Point Concentration (EPC)
**Based on Visitor Ages 1-31 (Cancer), 1-8 (Chronic Noncancer), and 1-2 (Subchronic Noncancer)**

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = NA**

**Chronic HI (all chemicals) = 0.09**

**Subchronic HI (all chemicals) = 0.23**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Chronic $HQ_{ing}$ | Chronic $HQ_{derm}$ | Chronic $HQ_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BARIUM | 70.1 | | | | 4.5E-04 | 3.8E-04 | 8.4E-04 | 1.6E-03 | 1.0E-03 | 2.6E-03 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 9.79 | | | | 1.3E-04 | 3.6E-04 | 4.8E-04 | 4.4E-05 | 9.3E-05 | 1.4E-04 | |
| CHROMIUM (TOTAL) | 29.3 | | | | 1.3E-02 | 1.1E-02 | 2.3E-02 | 6.6E-03 | 4.2E-03 | 1.1E-02 | **Cr(VI) limit is 200 mg/kg due to contact dermatitis.** |
| LEAD | 66.8 | | | | 5.8E-02 | 5.8E-03 | 6.4E-02 | 2.0E-01 | 1.5E-02 | 2.1E-01 | **Lead IH HQ limit is 1, not 10.** |
| ZINC | 97.5 | | | | 4.2E-04 | 3.5E-04 | 7.8E-04 | 1.5E-03 | 9.2E-04 | 2.4E-03 | |

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# Park Visitor - Soil: Table PS-2

## Equations to Calculate Cancer Risk for Visitor (Age 1-31 Years)

### Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1\text{-}31)} * CSF$$

$$LADD_{ing\ (1\text{-}31)} = LADD_{ing\ (1\text{-}8)} + LADD_{ing\ (8\text{-}15)} + LADD_{ing\ (15\text{-}31)}$$

$$LADD_{ing\ x} = \frac{[OHM]_{soil} * IR_x * RAF_{c\text{-}ing} * EF_{ing} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

### Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm\ (1\text{-}31)} = LADD_{derm\ (1\text{-}8)} + LADD_{derm\ (8\text{-}15)} + LADD_{derm\ (15\text{-}31)}$$

$$LADD_{derm\ x} = \frac{[OHM]_{soil} * SA_x * RAF_{c\text{-}derm} * SAF_x * EF_{derm} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

Method 3 Lookup Tables Version v0624

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| $IR_{(1\text{-}8)}$ | 100 | mg/day |
| $IR_{(8\text{-}15)}$ | 50 | mg/day |
| $IR_{(15\text{-}31)}$ | 50 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| $EP_{(1\text{-}8)}$ | 7 | years |
| $EP_{(8\text{-}15)}$ | 7 | years |
| $EP_{(15\text{-}31)}$ | 16 | years |
| C | 0.000001 | kg/mg |
| $BW_{(1\text{-}8)}$ | 19.0 | kg |
| $BW_{(8\text{-}15)}$ | 46.1 | kg |
| $BW_{(15\text{-}31)}$ | 64.5 | kg |
| $AP_{lifetime} = AP_{cancer}$ | 70 | years |
| $SA_{(1\text{-}8)}$ | 2244 | $cm^2/day$ |
| $SA_{(8\text{-}15)}$ | 4051 | $cm^2/day$ |
| $SA_{(15\text{-}31)}$ | 5322 | $cm^2/day$ |
| $SAF_{(1\text{-}8)}$ | 0.3740 | $mg/cm^2$ |
| $SAF_{(8\text{-}15)}$ | 0.1365 | $mg/cm^2$ |
| $SAF_{(15\text{-}31)}$ | 0.0829 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-3

# Equations to Calculate Chronic Noncancer Risk for Visitor (Age 1-8 Years)

Method 3 Lookup Tables Version v0624

## Chronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Chronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{ing,derm}}{RfD}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm}$ = $EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| EP | 7 | years |
| C | 0.000001 | kg/mg |
| BW | 19.0 | kg |
| AP | 7 | year |
| SA | 2244 | $cm^2$/day |

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# Park Visitor - Soil: Table PS-4
# Equations to Calculate Subchronic Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

## Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.429 | event/day |
| ED | 1 | day/event |
| $EP = EP_{sc\ (1\text{-}2)}$ | 0.575342466 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| $AP = AP_{subchronic}$ | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3740 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PS-6 and PS-6c |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Table PS-6 |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| $IR_{(1-2)}$ - Soil Ingestion Rate for age group 1-2 | 100 | mg/day | MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $IR_{(1-8)}$ - Soil Ingestion Rate for age group 1-8 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(8-15)}$ - Soil Ingestion Rate for age group 8-15 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(15-31)}$ - Soil Ingestion Rate for age group 15-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(2-6)}$ - Soil Ingestion Rate for age group 2-6 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(6-16)}$ - Soil Ingestion Rate for age group 6-16 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(16-31)}$ - Soil Ingestion Rate for age group 16-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PS-6 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PS-6 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{chronic}$ and $EF_{cancer}$ - Exposure Frequency for chronic ~~or~~ and Exposure Frequency for lifetime cancer | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc\ (1-2)}$ - Exposure Period for age group 1-2 for Subchronic exposure | 0.575 | years | 30 weeks |
| $EP_{(1-8)}$ - Exposure Period for age group 1-8 | 7 | years | |
| $EP_{(8-15)}$ - Exposure Period for age group 8-15 | 7 | years | |
| $EP_{(15-31)}$ - Exposure Period for age group 15-31 | 16 | years | |
| $EP_{(1-2)}$ - Exposure Period for age group 1-2 (mutagenic effects) | 1 | years | |
| $EP_{(2-6)}$ - Exposure Period for age group 2-6 (mutagenic effects) | 4 | years | |
| $EP_{(6-16)}$ - Exposure Period for age group 6-16 (mutagenic effects) | 10 | years | |
| $EP_{(16-31)}$ - Exposure Period for-age group 16-31 (mutagenic effects) | 15 | years | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $BW_{(1-2)}$ - Body Weight for age group 1-2, (subchronic, and mutagenic) | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(1-8)}$ - Body Weight for age group 1-8 | 19.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(8-15)}$ - Body Weight for age group 8-15 | 46.1 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(15-31)}$ - Body Weight for age group 15-31 | 64.5 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(6-16)}$ - Body Weight for age group 6-16 | 43.2 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(16-31)}$ - Body Weight for age group 16-31 | 65.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{chronic}$ - Averaging Period for chronic noncancer | 7 | years | |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{cancer}$ - Averaging Period for cancer/lifetime | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $ADAF_{(6-16)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 6-16 | 3 | dimensionless | |
| $ADAF_{(16-31)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 16-31 | 1 | dimensionless | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females.) |
| $SA_{(1-8)}$ - Surface Area for age group 1-8 | 2244 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(8-15)}$ - Surface Area for age group 8-15 | 4051 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(15-31)}$ - Surface Area for age group 15-31 | 5322 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(6-16)}$ - Surface Area for age group 6-16 | 3875 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(16-31)}$ - Surface Area for age group 16-31 | 5354 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(1-8)}$ - Surface Adherence Factor for age group 1-8 | 0.3740 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(8-15)}$ - Surface Adherence Factor for age group 8-15 | 0.1365 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(15-31)}$ - Surface Adherence Factor for age group 15-31 | 0.0829 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg/cm^4$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(6-16)}$ - Surface Adherence Factor for age group 6-16 | 0.1702 | $mg/cm^5$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(16-31)}$ - Surface Adherence Factor for age group 16-31 | 0.0826 | $mg/cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor - Soil: Table PS-6
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Chronic RfD mg/kg-day | Subchronic RfD mg/kg-day | Chronic $RAF_{nc\text{-}ing}$ | Chronic $RAF_{nc\text{-}derm}$ | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| BARIUM | | | | 2.0E-01 | 2.0E-01 | 1 | 0.1 | 1 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-02 | 3.0E-01 | 0.3 | 0.1 | 0.3 | 0.1 | |
| CHROMIUM (TOTAL) | | | | 3.0E-03 | 2.0E-02 | 1 | 0.1 | 1 | 0.1 | |
| LEAD | | | | 7.5E-04 | 7.5E-04 | 0.5 | 0.006 | 0.5 | 0.006 | |
| ZINC | | | | 3.0E-01 | 3.0E-01 | 1 | 0.1 | 1 | 0.1 | |

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## Park Visitor - Soil: Table PS-1
## Exposure Point Concentration (EPC)
**Based on Visitor Ages 1-31 (Cancer), 1-8 (Chronic Noncancer), and 1-2 (Subchronic Noncancer)**

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = 3.77E-06**

**Chronic HI (all chemicals) = 1.98**

**Subchronic HI (all chemicals) = 6.27**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Chronic $HQ_{ing}$ | Chronic $HQ_{derm}$ | Chronic $HQ_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | 17.2 | | | | 5.6E-02 | 4.7E-02 | 1.0E-01 | 1.9E-01 | 1.2E-01 | 3.1E-01 | |
| ARSENIC | 13.1 | 2.0E-06 | 1.0E-06 | 3.0E-06 | 2.8E-02 | 1.4E-02 | 4.3E-02 | 9.8E-02 | 3.7E-02 | 1.4E-01 | |
| BARIUM | 293 | | | | 1.9E-03 | 1.6E-03 | 3.5E-03 | 6.6E-03 | 4.2E-03 | 1.1E-02 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 12.3 | | | | 1.6E-04 | 4.4E-04 | 6.0E-04 | 5.5E-05 | 1.2E-04 | 1.7E-04 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | 16.4 | | | | 1.1E-05 | 1.8E-05 | 2.8E-05 | 1.2E-05 | 1.6E-05 | 2.8E-05 | |
| CHROMIUM (TOTAL) | 40.9 | | | | 1.8E-02 | 1.5E-02 | 3.3E-02 | 9.2E-03 | 5.8E-03 | 1.5E-02 | **Cr(VI) limit is 200 mg/kg due to contact dermatitis.** |
| LEAD | 1,710 | | | | 1.5E+00 | 1.5E-01 | 1.6E+00 | 5.1E+00 | 3.9E-01 | 5.5E+00 | **Lead IH HQ limit is 1, not 10.** |
| NICKEL | 54.9 | | | | 3.6E-03 | 6.0E-03 | 9.5E-03 | 1.2E-02 | 1.6E-02 | 2.8E-02 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 1.01 | 4.0E-07 | 3.6E-07 | 7.6E-07 | 6.5E-02 | 5.5E-02 | 1.2E-01 | 9.0E-02 | 5.7E-02 | 1.5E-01 | |
| TETRACHLOROETHYLENE | 0.000777 | 3.1E-12 | 8.2E-13 | 3.9E-12 | 1.7E-07 | 4.2E-08 | 2.1E-07 | 5.8E-07 | 1.1E-07 | 6.9E-07 | |
| ZINC | 4,781 | | | | 2.1E-02 | 1.7E-02 | 3.8E-02 | 7.1E-02 | 4.5E-02 | 1.2E-01 | |

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# Park Visitor - Soil: Table PS-2

## Equations to Calculate Cancer Risk for Visitor (Age 1-31 Years)

### Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1\text{-}31)} * CSF$$

$$LADD_{ing\ (1\text{-}31)} = LADD_{ing\ (1\text{-}8)} + LADD_{ing\ (8\text{-}15)} + LADD_{ing\ (15\text{-}31)}$$

$$LADD_{ing\ x} = \frac{[OHM]_{soil} * IR_x * RAF_{c\text{-}ing} * EF_{ing} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

### Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm\ (1\text{-}31)} = LADD_{derm\ (1\text{-}8)} + LADD_{derm\ (8\text{-}15)} + LADD_{derm\ (15\text{-}31)}$$

$$LADD_{derm\ x} = \frac{[OHM]_{soil} * SA_x * RAF_{c\text{-}derm} * SAF_x * EF_{derm} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

Method 3 Lookup Tables Version v0624

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| $IR_{(1\text{-}8)}$ | 100 | mg/day |
| $IR_{(8\text{-}15)}$ | 50 | mg/day |
| $IR_{(15\text{-}31)}$ | 50 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| $EP_{(1\text{-}8)}$ | 7 | years |
| $EP_{(8\text{-}15)}$ | 7 | years |
| $EP_{(15\text{-}31)}$ | 16 | years |
| C | 0.000001 | kg/mg |
| $BW_{(1\text{-}8)}$ | 19.0 | kg |
| $BW_{(8\text{-}15)}$ | 46.1 | kg |
| $BW_{(15\text{-}31)}$ | 64.5 | kg |
| $AP_{lifetime} = AP_{cancer}$ | 70 | years |
| $SA_{(1\text{-}8)}$ | 2244 | $cm^2/day$ |
| $SA_{(8\text{-}15)}$ | 4051 | $cm^2/day$ |
| $SA_{(15\text{-}31)}$ | 5322 | $cm^2/day$ |
| $SAF_{(1\text{-}8)}$ | 0.3740 | $mg/cm^2$ |
| $SAF_{(8\text{-}15)}$ | 0.1365 | $mg/cm^2$ |
| $SAF_{(15\text{-}31)}$ | 0.0829 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-3

# Equations to Calculate Chronic Noncancer Risk for Visitor (Age 1-8 Years)

Method 3 Lookup Tables Version v0624

## Chronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Chronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{ing,derm}}{RfD}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm}$ = $EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| EP | 7 | years |
| C | 0.000001 | kg/mg |
| BW | 19.0 | kg |
| AP | 7 | year |
| SA | 2244 | $cm^2$/day |

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# Park Visitor - Soil: Table PS-4
# Equations to Calculate Subchronic Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

## Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.429 | event/day |
| ED | 1 | day/event |
| $EP = EP_{sc\ (1\text{-}2)}$ | 0.575342466 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| $AP = AP_{subchronic}$ | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3740 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PS-6 and PS-6c |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Table PS-6 |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| $IR_{(1-2)}$ - Soil Ingestion Rate for age group 1-2 | 100 | mg/day | MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $IR_{(1-8)}$ - Soil Ingestion Rate for age group 1-8 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(8-15)}$ - Soil Ingestion Rate for age group 8-15 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(15-31)}$ - Soil Ingestion Rate for age group 15-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(2-6)}$ - Soil Ingestion Rate for age group 2-6 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(6-16)}$ - Soil Ingestion Rate for age group 6-16 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(16-31)}$ - Soil Ingestion Rate for age group 16-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PS-6 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PS-6 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{chronic}$ and $EF_{cancer}$ - Exposure Frequency for chronic ~~or~~ and Exposure Frequency for lifetime cancer | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc\ (1-2)}$ - Exposure Period for age group 1-2 for Subchronic exposure | 0.575 | years | 30 weeks |
| $EP_{(1-8)}$ - Exposure Period for age group 1-8 | 7 | years | |
| $EP_{(8-15)}$ - Exposure Period for age group 8-15 | 7 | years | |
| $EP_{(15-31)}$ - Exposure Period for age group 15-31 | 16 | years | |
| $EP_{(1-2)}$ - Exposure Period for age group 1-2 (mutagenic effects) | 1 | years | |
| $EP_{(2-6)}$ - Exposure Period for age group 2-6 (mutagenic effects) | 4 | years | |
| $EP_{(6-16)}$ - Exposure Period for age group 6-16 (mutagenic effects) | 10 | years | |
| $EP_{(16-31)}$ - Exposure Period for-age group 16-31 (mutagenic effects) | 15 | years | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $BW_{(1-2)}$ - Body Weight for age group 1-2, (subchronic, and mutagenic) | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(1-8)}$ - Body Weight for age group 1-8 | 19.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(8-15)}$ - Body Weight for age group 8-15 | 46.1 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(15-31)}$ - Body Weight for age group 15-31 | 64.5 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(6-16)}$ - Body Weight for age group 6-16 | 43.2 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(16-31)}$ - Body Weight for age group 16-31 | 65.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{chronic}$ - Averaging Period for chronic noncancer | 7 | years | |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{cancer}$ - Averaging Period for cancer/lifetime | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $ADAF_{(6-16)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 6-16 | 3 | dimensionless | |
| $ADAF_{(16-31)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 16-31 | 1 | dimensionless | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females.) |
| $SA_{(1-8)}$ - Surface Area for age group 1-8 | 2244 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(8-15)}$ - Surface Area for age group 8-15 | 4051 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(15-31)}$ - Surface Area for age group 15-31 | 5322 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(6-16)}$ - Surface Area for age group 6-16 | 3875 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(16-31)}$ - Surface Area for age group 16-31 | 5354 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(1-8)}$ - Surface Adherence Factor for age group 1-8 | 0.3740 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(8-15)}$ - Surface Adherence Factor for age group 8-15 | 0.1365 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(15-31)}$ - Surface Adherence Factor for age group 15-31 | 0.0829 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg/cm^4$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(6-16)}$ - Surface Adherence Factor for age group 6-16 | 0.1702 | $mg/cm^5$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(16-31)}$ - Surface Adherence Factor for age group 16-31 | 0.0826 | $mg/cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor - Soil: Table PS-6
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Chronic RfD mg/kg-day | Subchronic RfD mg/kg-day | Chronic $RAF_{nc\text{-}ing}$ | Chronic $RAF_{nc\text{-}derm}$ | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | | | | 4.0E-04 | 4.0E-04 | 1 | 0.1 | 1 | 0.1 | |
| ARSENIC | 1.5E+00 | 0.5 | 0.03 | 3.0E-04 | 3.0E-04 | 0.5 | 0.03 | 0.5 | 0.03 | |
| BARIUM | | | | 2.0E-01 | 2.0E-01 | 1 | 0.1 | 1 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-02 | 3.0E-01 | 0.3 | 0.1 | 0.3 | 0.1 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | | | | 2.0E+00 | 6.0E+00 | 1 | 0.2 | 1 | 0.2 | |
| CHROMIUM (TOTAL) | | | | 3.0E-03 | 2.0E-02 | 1 | 0.1 | 1 | 0.1 | |
| LEAD | | | | 7.5E-04 | 7.5E-04 | 0.5 | 0.006 | 0.5 | 0.006 | |
| NICKEL | | | | 2.0E-02 | 2.0E-02 | 1 | 0.2 | 1 | 0.2 | |
| POLYCHLORINATED BIPHENYLS (PCBs) | 2.0E+00 | 1 | 0.1 | 2.0E-05 | 5.0E-05 | 1 | 0.1 | 1 | 0.1 | |
| TETRACHLOROETHYLENE | 2.0E-02 | 1 | 0.03 | 6.0E-03 | 6.0E-03 | 1 | 0.03 | 1 | 0.03 | |
| ZINC | | | | 3.0E-01 | 3.0E-01 | 1 | 0.1 | 1 | 0.1 | |

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## Park Visitor - Soil: Table PS-1
## Exposure Point Concentration (EPC)
**Based on Visitor Ages 1-31 (Cancer), 1-8 (Chronic Noncancer), and 1-2 (Subchronic Noncancer)**

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = NA**

**Chronic HI (all chemicals) = 0.04**

**Subchronic HI (all chemicals) = 0.10**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Chronic $HQ_{ing}$ | Chronic $HQ_{derm}$ | Chronic $HQ_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BARIUM | 41.8 | | | | 2.7E-04 | 2.3E-04 | 5.0E-04 | 9.4E-04 | 5.9E-04 | 1.5E-03 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 8.76 | | | | 1.1E-04 | 3.2E-04 | 4.3E-04 | 3.9E-05 | 8.3E-05 | 1.2E-04 | |
| CHROMIUM (TOTAL) | 20.6 | | | | 8.9E-03 | 7.5E-03 | 1.6E-02 | 4.6E-03 | 2.9E-03 | 7.5E-03 | **Cr(VI) limit is 200 mg/kg due to contact dermatitis.** |
| LEAD | 25.5 | | | | 2.2E-02 | 2.2E-03 | 2.4E-02 | 7.6E-02 | 5.8E-03 | 8.2E-02 | **Lead IH HQ limit is 1, not 10.** |
| NICKEL | 9.76 | | | | 6.3E-04 | 1.1E-03 | 1.7E-03 | 2.2E-03 | 2.8E-03 | 5.0E-03 | |

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# Park Visitor - Soil: Table PS-2

## Equations to Calculate Cancer Risk for Visitor (Age 1-31 Years)

### Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1\text{-}31)} * CSF$$

$$LADD_{ing\ (1\text{-}31)} = LADD_{ing\ (1\text{-}8)} + LADD_{ing\ (8\text{-}15)} + LADD_{ing\ (15\text{-}31)}$$

$$LADD_{ing\ x} = \frac{[OHM]_{soil} * IR_x * RAF_{c\text{-}ing} * EF_{ing} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

### Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm\ (1\text{-}31)} = LADD_{derm\ (1\text{-}8)} + LADD_{derm\ (8\text{-}15)} + LADD_{derm\ (15\text{-}31)}$$

$$LADD_{derm\ x} = \frac{[OHM]_{soil} * SA_x * RAF_{c\text{-}derm} * SAF_x * EF_{derm} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

Method 3 Lookup Tables Version v0624

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| $IR_{(1\text{-}8)}$ | 100 | mg/day |
| $IR_{(8\text{-}15)}$ | 50 | mg/day |
| $IR_{(15\text{-}31)}$ | 50 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| $EP_{(1\text{-}8)}$ | 7 | years |
| $EP_{(8\text{-}15)}$ | 7 | years |
| $EP_{(15\text{-}31)}$ | 16 | years |
| C | 0.000001 | kg/mg |
| $BW_{(1\text{-}8)}$ | 19.0 | kg |
| $BW_{(8\text{-}15)}$ | 46.1 | kg |
| $BW_{(15\text{-}31)}$ | 64.5 | kg |
| $AP_{lifetime} = AP_{cancer}$ | 70 | years |
| $SA_{(1\text{-}8)}$ | 2244 | $cm^2/day$ |
| $SA_{(8\text{-}15)}$ | 4051 | $cm^2/day$ |
| $SA_{(15\text{-}31)}$ | 5322 | $cm^2/day$ |
| $SAF_{(1\text{-}8)}$ | 0.3740 | $mg/cm^2$ |
| $SAF_{(8\text{-}15)}$ | 0.1365 | $mg/cm^2$ |
| $SAF_{(15\text{-}31)}$ | 0.0829 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-3

# Equations to Calculate Chronic Noncancer Risk for Visitor (Age 1-8 Years)

Method 3 Lookup Tables Version v0624

## Chronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Chronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{ing,derm}}{RfD}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm}$ = $EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| EP | 7 | years |
| C | 0.000001 | kg/mg |
| BW | 19.0 | kg |
| AP | 7 | year |
| SA | 2244 | $cm^2$/day |

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# Park Visitor - Soil: Table PS-4
# Equations to Calculate Subchronic Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

## Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.429 | event/day |
| ED | 1 | day/event |
| $EP = EP_{sc\ (1\text{-}2)}$ | 0.575342466 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| $AP = AP_{subchronic}$ | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3740 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PS-6 and PS-6c |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Table PS-6 |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| $IR_{(1-2)}$ - Soil Ingestion Rate for age group 1-2 | 100 | mg/day | MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $IR_{(1-8)}$ - Soil Ingestion Rate for age group 1-8 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(8-15)}$ - Soil Ingestion Rate for age group 8-15 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(15-31)}$ - Soil Ingestion Rate for age group 15-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(2-6)}$ - Soil Ingestion Rate for age group 2-6 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(6-16)}$ - Soil Ingestion Rate for age group 6-16 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(16-31)}$ - Soil Ingestion Rate for age group 16-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PS-6 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PS-6 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{chronic}$ and $EF_{cancer}$ - Exposure Frequency for chronic ~~or~~ and Exposure Frequency for lifetime cancer | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc\ (1-2)}$ - Exposure Period for age group 1-2 for Subchronic exposure | 0.575 | years | 30 weeks |
| $EP_{(1-8)}$ - Exposure Period for age group 1-8 | 7 | years | |
| $EP_{(8-15)}$ - Exposure Period for age group 8-15 | 7 | years | |
| $EP_{(15-31)}$ - Exposure Period for age group 15-31 | 16 | years | |
| $EP_{(1-2)}$ - Exposure Period for age group 1-2 (mutagenic effects) | 1 | years | |
| $EP_{(2-6)}$ - Exposure Period for age group 2-6 (mutagenic effects) | 4 | years | |
| $EP_{(6-16)}$ - Exposure Period for age group 6-16 (mutagenic effects) | 10 | years | |
| $EP_{(16-31)}$ - Exposure Period for-age group 16-31 (mutagenic effects) | 15 | years | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $BW_{(1-2)}$ - Body Weight for age group 1-2, (subchronic, and mutagenic) | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(1-8)}$ - Body Weight for age group 1-8 | 19.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(8-15)}$ - Body Weight for age group 8-15 | 46.1 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(15-31)}$ - Body Weight for age group 15-31 | 64.5 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(6-16)}$ - Body Weight for age group 6-16 | 43.2 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(16-31)}$ - Body Weight for age group 16-31 | 65.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{chronic}$ - Averaging Period for chronic noncancer | 7 | years | |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{cancer}$ - Averaging Period for cancer/lifetime | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $ADAF_{(6-16)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 6-16 | 3 | dimensionless | |
| $ADAF_{(16-31)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 16-31 | 1 | dimensionless | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females.) |
| $SA_{(1-8)}$ - Surface Area for age group 1-8 | 2244 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(8-15)}$ - Surface Area for age group 8-15 | 4051 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(15-31)}$ - Surface Area for age group 15-31 | 5322 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(6-16)}$ - Surface Area for age group 6-16 | 3875 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(16-31)}$ - Surface Area for age group 16-31 | 5354 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(1-8)}$ - Surface Adherence Factor for age group 1-8 | 0.3740 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(8-15)}$ - Surface Adherence Factor for age group 8-15 | 0.1365 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(15-31)}$ - Surface Adherence Factor for age group 15-31 | 0.0829 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg/cm^4$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(6-16)}$ - Surface Adherence Factor for age group 6-16 | 0.1702 | $mg/cm^5$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(16-31)}$ - Surface Adherence Factor for age group 16-31 | 0.0826 | $mg/cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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# Park Visitor - Soil: Table PS-6
# Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Chronic RfD mg/kg-day | Subchronic RfD mg/kg-day | Chronic $RAF_{nc\text{-}ing}$ | Chronic $RAF_{nc\text{-}derm}$ | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| BARIUM | | | | 2.0E-01 | 2.0E-01 | 1 | 0.1 | 1 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-02 | 3.0E-01 | 0.3 | 0.1 | 0.3 | 0.1 | |
| CHROMIUM (TOTAL) | | | | 3.0E-03 | 2.0E-02 | 1 | 0.1 | 1 | 0.1 | |
| LEAD | | | | 7.5E-04 | 7.5E-04 | 0.5 | 0.006 | 0.5 | 0.006 | |
| NICKEL | | | | 2.0E-02 | 2.0E-02 | 1 | 0.2 | 1 | 0.2 | |

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## Park Visitor - Soil: Table PS-1
## Exposure Point Concentration (EPC)
**Based on Visitor Ages 1-31 (Cancer), 1-8 (Chronic Noncancer), and 1-2 (Subchronic Noncancer)**

Shortforms Version June 2024

Method 3 Lookup Tables Version v0624

**ELCR (all chemicals) = 3.41E-06**

**Chronic HI (all chemicals) = 0.83**

**Subchronic HI (all chemicals) = 2.77**

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

| Oil or Hazardous Material | EPC (mg/kg) | $ELCR_{ingestion}$ | $ELCR_{dermal}$ | $ELCR_{total}$ | Chronic $HQ_{ing}$ | Chronic $HQ_{derm}$ | Chronic $HQ_{total}$ | Subchronic $HQ_{ing}$ | Subchronic $HQ_{derm}$ | Subchronic $HQ_{total}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | 7.76 | | | | 2.5E-02 | 2.1E-02 | 4.6E-02 | 8.7E-02 | 5.5E-02 | 1.4E-01 | |
| ARSENIC | 14.9 | 2.2E-06 | 1.2E-06 | 3.4E-06 | 3.2E-02 | 1.6E-02 | 4.8E-02 | 1.1E-01 | 4.2E-02 | 1.5E-01 | |
| BARIUM | 186 | | | | 1.2E-03 | 1.0E-03 | 2.2E-03 | 4.2E-03 | 2.6E-03 | 6.8E-03 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | 17.7 | | | | 2.3E-04 | 6.4E-04 | 8.7E-04 | 7.9E-05 | 1.7E-04 | 2.5E-04 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | 13.6 | | | | 8.8E-06 | 1.5E-05 | 2.4E-05 | 1.0E-05 | 1.3E-05 | 2.3E-05 | |
| CADMIUM | 1.94 | | | | 2.5E-03 | 4.2E-04 | 2.9E-03 | 8.7E-03 | 1.1E-03 | 9.8E-03 | |
| LEAD | 755 | | | | 6.5E-01 | 6.6E-02 | 7.2E-01 | 2.3E+00 | 1.7E-01 | 2.4E+00 | **Lead IH HQ limit is 1, not 10.** |
| MERCURY | 0.528 | | | | 1.1E-03 | 1.9E-03 | 3.1E-03 | 3.9E-03 | 5.0E-03 | 9.0E-03 | |
| NICKEL | 14.2 | | | | 9.2E-04 | 1.5E-03 | 2.5E-03 | 3.2E-03 | 4.0E-03 | 7.2E-03 | |
| TETRACHLOROETHYLENE | 0.00135 | 5.4E-12 | 1.4E-12 | 6.8E-12 | 2.9E-07 | 7.3E-08 | 3.7E-07 | 1.0E-06 | 1.9E-07 | 1.2E-06 | |
| ZINC | 547 | | | | 2.4E-03 | 2.0E-03 | 4.3E-03 | 8.2E-03 | 5.2E-03 | 1.3E-02 | |

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# Park Visitor - Soil: Table PS-2

## Equations to Calculate Cancer Risk for Visitor (Age 1-31 Years)

### Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1\text{-}31)} * CSF$$

$$LADD_{ing\ (1\text{-}31)} = LADD_{ing\ (1\text{-}8)} + LADD_{ing\ (8\text{-}15)} + LADD_{ing\ (15\text{-}31)}$$

$$LADD_{ing\ x} = \frac{[OHM]_{soil} * IR_x * RAF_{c\text{-}ing} * EF_{ing} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

### Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm\ (1\text{-}31)} = LADD_{derm\ (1\text{-}8)} + LADD_{derm\ (8\text{-}15)} + LADD_{derm\ (15\text{-}31)}$$

$$LADD_{derm\ x} = \frac{[OHM]_{soil} * SA_x * RAF_{c\text{-}derm} * SAF_x * EF_{derm} * ED * EP_x * C}{BW_x * AP_{lifetime}}$$

Method 3 Lookup Tables Version v0624

| Parameter | Value | Units |
|---|---|---|
| CSF | OHM specific | $(mg/kg\text{-}day)^{-1}$ |
| LADD | age/OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| $IR_{(1\text{-}8)}$ | 100 | mg/day |
| $IR_{(8\text{-}15)}$ | 50 | mg/day |
| $IR_{(15\text{-}31)}$ | 50 | mg/day |
| $RAF_{c\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{c\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| $EP_{(1\text{-}8)}$ | 7 | years |
| $EP_{(8\text{-}15)}$ | 7 | years |
| $EP_{(15\text{-}31)}$ | 16 | years |
| C | 0.000001 | kg/mg |
| $BW_{(1\text{-}8)}$ | 19.0 | kg |
| $BW_{(8\text{-}15)}$ | 46.1 | kg |
| $BW_{(15\text{-}31)}$ | 64.5 | kg |
| $AP_{lifetime} = AP_{cancer}$ | 70 | years |
| $SA_{(1\text{-}8)}$ | 2244 | $cm^2/day$ |
| $SA_{(8\text{-}15)}$ | 4051 | $cm^2/day$ |
| $SA_{(15\text{-}31)}$ | 5322 | $cm^2/day$ |
| $SAF_{(1\text{-}8)}$ | 0.3740 | $mg/cm^2$ |
| $SAF_{(8\text{-}15)}$ | 0.1365 | $mg/cm^2$ |
| $SAF_{(15\text{-}31)}$ | 0.0829 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-3

# Equations to Calculate Chronic Noncancer Risk for Visitor (Age 1-8 Years)

Method 3 Lookup Tables Version v0624

## Chronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Chronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{ing,derm}}{RfD}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm}$ = $EF_{cancer}$ | 0.247 | event/day |
| ED | 1 | day/event |
| EP | 7 | years |
| C | 0.000001 | kg/mg |
| BW | 19.0 | kg |
| AP | 7 | year |
| SA | 2244 | $cm^2$/day |

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# Park Visitor - Soil: Table PS-4
# Equations to Calculate Subchronic Noncancer Risk for Visitor (Age 1-2 Years)

Method 3 Lookup Tables Version v0624

## Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

## Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

| Parameter | Value | Units |
|---|---|---|
| RfD | OHM specific | mg/kg-day |
| ADD | OHM specific | mg/kg-day |
| $[OHM]_{soil}$ | OHM specific | mg/kg |
| IR | 100 | mg/day |
| $RAF_{nc\text{-}ing}$ | OHM specific | dimensionless |
| $RAF_{nc\text{-}derm}$ | OHM specific | dimensionless |
| $EF_{ing}$ or $EF_{derm} = EF_{cancer}$ | 0.429 | event/day |
| ED | 1 | day/event |
| $EP = EP_{sc\ (1\text{-}2)}$ | 0.575342466 | years |
| C | 0.000001 | kg/mg |
| BW | 9.6 | kg |
| $AP = AP_{subchronic}$ | 0.575 | year |
| SA | 1708 | $cm^2$/day |
| SAF | 0.3740 | $mg/cm^2$ |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| ELCR - Excess Lifetime Cancer Risk | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| CSF - Cancer Slope Factor | chemical specific | $(mg/kg\text{-}day)^{-1}$ | See Tables PS-6 and PS-6c |
| LADD - Lifetime Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| HQ - Hazard Quotient | chemical specific | dimensionless | Pathway specific (ing =ingestion, derm=dermal) |
| RfD - Reference Dose | chemical specific | mg/kg-day | See Table PS-6 |
| ADD - Average Daily Dose | chemical specific | mg/kg-day | Pathway specific |
| EPC - Exposure Point Concentration | chemical specific | mg/kg | |
| $IR_{(1-2)}$ - Soil Ingestion Rate for age group 1-2 | 100 | mg/day | MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-3. |
| $IR_{(1-8)}$ - Soil Ingestion Rate for age group 1-8 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(8-15)}$ - Soil Ingestion Rate for age group 8-15 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(15-31)}$ - Soil Ingestion Rate for age group 15-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(2-6)}$ - Soil Ingestion Rate for age group 2-6 | 100 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(6-16)}$ - Soil Ingestion Rate for age group 6-16 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $IR_{(16-31)}$ - Soil Ingestion Rate for age group 16-31 | 50 | mg/day | Ibid $IR_{(1-2)}$ Note. |
| $RAF_c$ - Relative Absorption Factor for Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant CSF. See Table PS-6 |
| $RAF_{NC}$ - Relative Absorption Factor for non-Cancer Effects | chemical specific | dimensionless | Adjusts estimated dose to conform to the revelant RfD. See Table PS-6 |
| $EF_{subchronic}$ - Exposure Frequency for subchronic exposure | 0.429 | event/day | 3 events/week |
| $EF_{chronic}$ and $EF_{cancer}$ - Exposure Frequency for chronic ~~or~~ and Exposure Frequency for lifetime cancer | 0.247 | event/day | 3 events/week, 30 weeks/year |
| ED - Exposure Duration | 1 | day/event | |
| $EP_{sc\ (1-2)}$ - Exposure Period for age group 1-2 for Subchronic exposure | 0.575 | years | 30 weeks |
| $EP_{(1-8)}$ - Exposure Period for age group 1-8 | 7 | years | |
| $EP_{(8-15)}$ - Exposure Period for age group 8-15 | 7 | years | |
| $EP_{(15-31)}$ - Exposure Period for age group 15-31 | 16 | years | |
| $EP_{(1-2)}$ - Exposure Period for age group 1-2 (mutagenic effects) | 1 | years | |
| $EP_{(2-6)}$ - Exposure Period for age group 2-6 (mutagenic effects) | 4 | years | |
| $EP_{(6-16)}$ - Exposure Period for age group 6-16 (mutagenic effects) | 10 | years | |
| $EP_{(16-31)}$ - Exposure Period for-age group 16-31 (mutagenic effects) | 15 | years | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $BW_{(1-2)}$ - Body Weight for age group 1-2, (subchronic, and mutagenic) | 9.6 | kg | 50th percentile female body weight from US Department of Health and Human Services (USDHHS), adjusted according to the MassDEP risk assessment methodology. (See MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download.) Data source: USDHHS: Margaret A. McDowel, M.A, et al., "Anthropometric reference data for children and adults: United States, 2003-2006," National Health Statistics Reports, Number 10, October 22, 2008, Table 1, p 5. (https://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf). |
| $BW_{(1-8)}$ - Body Weight for age group 1-8 | 19.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(8-15)}$ - Body Weight for age group 8-15 | 46.1 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(15-31)}$ - Body Weight for age group 15-31 | 64.5 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(2-6)}$ - Body Weight for age group 2-6 | 17.6 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(6-16)}$ - Body Weight for age group 6-16 | 43.2 | kg | Ibid $BW_{(1-2)}$ Note. |
| $BW_{(16-31)}$ - Body Weight for age group 16-31 | 65.0 | kg | Ibid $BW_{(1-2)}$ Note. |
| $AP_{subchronic}$ - Averaging Period for subchronic noncancer | 0.575 | years | 30 weeks |
| $AP_{chronic}$ - Averaging Period for chronic noncancer | 7 | years | |
| $AP_{C\ (1-2)}$ - Averaging Period for cancer for the age group 1-2 for vinyl chloride mutagenic effects | 1 | years | |
| $AP_{cancer}$ - Averaging Period for cancer/lifetime | 70 | years | |
| $ADAF_{(1-2)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 1-2 | 10 | dimensionless | |
| $ADAF_{(2-6)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 2-6 | 3 | dimensionless | |
| $ADAF_{(6-16)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 6-16 | 3 | dimensionless | |
| $ADAF_{(16-31)}$ - Age Defined Adjustment Factor for mutagenic effects for age group 16-31 | 1 | dimensionless | |

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# Park Visitor - Soil: Table PS-5
# Definitions and Exposure Factors



| Parameter | Value | Units | Notes |
|---|---|---|---|
| $SA_{(1-2)}$ - Surface Area for age group 1-2 | 1708 | $cm^2$/day | SSA - 50th percentile female body surface area from EPA EFH 2011, adjusted by MassDEP risk characterication methodology. (See MassDEP MCP Method 1 Forms and documentation, https://www.mass.gov/doc/summary-of-proposed-mcp-method-1-standards-revisions/download..) Sources of data: (1) EPA Exposure Factors Handbook, 2011 Edition (EPA EFH 2011), Chapter 7, "Table 7-11. Mean and Percentile Skin Surface Area (m2) Derived From U.S. EPA Analysis of NHANES 1999–2006 for Children <21 Years and NHANES 2005–2006 for Adults >21 Years, Females", p 7-43. EPA/600/R-090/052F, September 2011. (https://rais.ornl.gov/documents/EFH_2011.pdf); and (2) EPA Exposure Factors Handbook (1997, Final Report), Table 6-7 (child), and Table 6-3 (age 18+) (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=12464). (50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females.) |
| $SA_{(1-8)}$ - Surface Area for age group 1-8 | 2244 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(8-15)}$ - Surface Area for age group 8-15 | 4051 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(15-31)}$ - Surface Area for age group 15-31 | 5322 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(2-6)}$ - Surface Area for age group 2-6 | 2113 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(6-16)}$ - Surface Area for age group 6-16 | 3875 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SA_{(16-31)}$ - Surface Area for age group 16-31 | 5354 | $cm^2$/day | Ibid $SA_{(1-2)}$ Note. |
| $SAF_{(1-2)}$ - Surface Adherence Factor for age group 1-2 | 0.3717 | $mg_{soil}$ / $cm^2$ | SAF developed for Short Forms according to procedures outlined in MassDEP MCP Risk Characterization Guidance for Disposal Sites, 2024. See SSA tab in Method 3 Lookup Tables Version v0624.xlsx. |
| $SAF_{(1-8)}$ - Surface Adherence Factor for age group 1-8 | 0.3740 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(8-15)}$ - Surface Adherence Factor for age group 8-15 | 0.1365 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(15-31)}$ - Surface Adherence Factor for age group 15-31 | 0.0829 | $mg_{soil}$ / $cm^2$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(2-6)}$ - Surface Adherence Factor for age group 2-6 | 0.3747 | $mg/cm^4$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(6-16)}$ - Surface Adherence Factor for age group 6-16 | 0.1702 | $mg/cm^5$ | Ibid $SAF_{(1-2)}$ Note. |
| $SAF_{(16-31)}$ - Surface Adherence Factor for age group 16-31 | 0.0826 | $mg/cm^2$ | Ibid $SAF_{(1-2)}$ Note. |

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## Park Visitor - Soil: Table PS-6
## Chemical-Specific Data

Method 3 Lookup Tables Version v0624

| Oil or Hazardous Material | CSF $(mg/kg\text{-}day)^{-1}$ | $RAF_{c\text{-}ing}$ | $RAF_{c\text{-}derm}$ | Chronic RfD mg/kg-day | Subchronic RfD mg/kg-day | Chronic $RAF_{nc\text{-}ing}$ | Chronic $RAF_{nc\text{-}derm}$ | Subchronic $RAF_{nc\text{-}ing}$ | Subchronic $RAF_{nc\text{-}derm}$ | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| ANTIMONY | | | | 4.0E-04 | 4.0E-04 | 1 | 0.1 | 1 | 0.1 | |
| ARSENIC | 1.5E+00 | 0.5 | 0.03 | 3.0E-04 | 3.0E-04 | 0.5 | 0.03 | 0.5 | 0.03 | |
| BARIUM | | | | 2.0E-01 | 2.0E-01 | 1 | 0.1 | 1 | 0.1 | |
| PETROLEUM HYDROCARBONS: AROMATICS - C11 to C22 | | | | 3.0E-02 | 3.0E-01 | 0.3 | 0.1 | 0.3 | 0.1 | |
| PETROLEUM HYDROCARBONS: ALIPHATICS - C19 to C36 | | | | 2.0E+00 | 6.0E+00 | 1 | 0.2 | 1 | 0.2 | |
| CADMIUM | | | | 5.0E-04 | 5.0E-04 | 0.5 | 0.01 | 0.5 | 0.01 | |
| LEAD | | | | 7.5E-04 | 7.5E-04 | 0.5 | 0.006 | 0.5 | 0.006 | |
| MERCURY | | | | 3.0E-04 | 3.0E-04 | 0.5 | 0.1 | 0.5 | 0.1 | |
| NICKEL | | | | 2.0E-02 | 2.0E-02 | 1 | 0.2 | 1 | 0.2 | |
| TETRACHLOROETHYLENE | 2.0E-02 | 1 | 0.03 | 6.0E-03 | 6.0E-03 | 1 | 0.03 | 1 | 0.03 | |
| ZINC | | | | 3.0E-01 | 3.0E-01 | 1 | 0.1 | 1 | 0.1 | |

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