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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY - REGION II
290 BROADWAY
NEW YORK, NEW YORK 10007-1866

May 10, 1995

Victor A. Cardona
Bureau of Eastern Remedial Action
Division of Hazardous Waste Remediation
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233-7010

Re: Draft Baseline Risk Assessment Addendum
Liberty Industrial Finishing Superfund Site
Farmingdale, NY

Dear Mr. Cardona:

Please find enclosed for your review and comment a copy of the Draft Baseline Risk Assessment Addendum for the Liberty Industrial Finishing Site in Farmingdale, New York. This document is an addendum to the Baseline Risk Assessment prepared as part of the Remedial Investigation Report dated January 1994.

We will appreciate receiving your comments no later than May 24, 1995.

Should you have any comments, need additional information, or can not meet this schedule, please contact me at (212) 637-4276 or Lorenzo Thantu at (212) 637-4240.

Sincerely,

Carlos R. Ramos
Remedial Project Manager
Eastern New York/Caribbean Superfund Section 1

Enclosure

DRAFT

Baseline Risk Assessment Addendum

Liberty Industrial Finishing Site

Farmingdale, New York

U.S. EPA Region II

May 1, 1995

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DRAFT

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1. INTRODUCTION TO THE BASELINE RISK ASSESSMENT ADDENDUM

This report has been prepared as an addendum to the Baseline Risk Assessment prepared by R.F. Weston, Inc. for the Liberty Industrial Finishing site (LIF). The Baseline Risk Assessment Addendum (BRAA) evaluates potential future health risks to site workers and recreational users of the western portion of the LIF site under the no-action alternative (i.e. in the absence of remedial activities at the site). The BRAA supplements the Baseline Risk Assessment performed at the site as part of the Remedial Investigation. In accordance with EPA's National Contingency Plan (USEPA 1990), the Baseline Risk Assessment will help to "...establish acceptable exposure levels for use in developing remedial alternatives...". The BRAA has been prepared according to USEPA guidance for the performance of Baseline Risk Assessments in the Superfund program, including the Risk Assessment Guidance for Superfund (RAGS) (USEPA 1989a) and Supplemental Guidance (USEPA 1991); and the Exposure Factors Handbook (USEPA 1989b).

The Remedial Investigation and Removal Assessment reports identified elevated levels of PCBs in soils at the site. PCBs are currently the subject of an ongoing removal action at LIF. PCBs will not contribute to potential future health risks at LIF, and will not be addressed in this report.

Four steps make up EPA's baseline risk assessment process:

Hazard Identification involves review of site data obtained in the Remedial Investigation to identify contaminated media and chemicals which may be of concern at the site.

Exposure Assessment involves the identification of populations, pathways and routes of exposure which are potentially of concern at the site.

Dose-response Assessment involves the review of toxicity data to determine the potential hazards associated with exposure to contaminants identified at the site.

Risk Characterization involves the integration of hazard identification, exposure assessment and dose response assessment to determine the potential cancer risks and noncarcinogenic hazards associated with exposures to contaminants present in site media.

Significant uncertainties are involved in each of the four steps of the baseline risk assessment. These uncertainties are discussed in detail in section 7 of this report. The conclusions of the baseline risk assessment are presented in section 8.

2. SITE HISTORY

The Liberty site is located in the Town of Farmingdale, Nassau County, New York. The site comprises approximately 30 acres and is bordered by Motor Avenue to the south, Main Street to the east, the Long Island Railroad to the north, and Ellsworth Allen Park to the West. The area surrounding the Liberty site is primarily residential with several commercial establishments.

LIF is the site of a former aircraft part manufacturing and metal plating facility. Activities at the site generated metal plating wastewaters, which were disposed of in three on-property disposal basins, a sludge drying bed and leaching fields at the facility. Impacts to ground water and surface water associated with these activities were identified as early as 1942. Limited cleanup activities were conducted at the site in 1978. The cleanup was limited to the excavation of 1.5 feet of soil from the bottom of disposal basin 1, removal of 6 inches of soil from the walls of basin 1, and removal of an unknown volume of soil from the bottom of basin 2. An interim removal action was conducted in 1987 upon completion of the remedial investigation to remove RCRA hazardous sludges from basins 2 and 3 and the sludge drying bed.

At present, the eastern portion of the site (approximately half of the total site area) is developed for commercial/industrial use. The developed portion of the site contains several large warehouses and remnants of past industrial activities including former foundations and slabs of industrial buildings and three partially excavated basins formerly used in the metal finishing operation. The western half of the site is currently undeveloped and contains a former waste disposal area on the northwest portion of the site. The site is not currently secured, and evidence of dumping of refuse and debris from off-site sources is present on the site. A more detailed history of activities and current conditions at LIF appears in the Remedial Investigation (RI) report for the site, prepared by R.F. Weston, Inc. The reader is referred to that document for more information regarding past activities at LIF.

3. HAZARD IDENTIFICATION - SELECTION OF THE CHEMICALS OF POTENTIAL CONCERN

The soil sampling data used in the BRAA were obtained from RI soil investigations conducted at the site from November 1991 to July 1992. A screening of all of the chemicals reported in surface soils at the site was conducted in the RI to focus the effort of the risk assessment on those chemicals in soils which are likely to present the greatest risks to human health. According to the criteria used in the screening process, a chemical was eliminated as a contaminant of potential concern (COPC) at the site if:

1) The substance was detected in less than 5% of the samples, and the substance was not reported at unusually high concentrations at any location on-site.

2) The substance does not contribute to more than 1% of the total score in a concentration-toxicity screen.

3) The substance was not detected above background concentrations (applicable to only to naturally occurring inorganic substances and possible laboratory contaminants). If the maximum detected concentration of a contaminant on-site was lower than the mean background concentration off-site, the contaminant was not considered a chemical of potential concern.

Details of the criteria used in the selection of contaminants of potential concern are provided in the baseline risk assessment. The substances selected as contaminants of concern in soils for the baseline risk assessment were initially considered as COPCs in the BRAA. Several of the COPCs in the baseline risk assessment were eliminated from the BRAA based on low concentrations in surface soils. A list of the contaminants of potential concern for on-site surface soils at LIF is provided in Table 1.

4. EXPOSURE ASSESSMENT

The exposure assessment estimates the frequency, duration and magnitude of potential exposures to chemicals released from the site. Potential exposures to future site workers and potential future recreational users of the site were estimated in accordance with EPA guidance documents, including RAGS and the Exposure Factors Handbook. Consistent with the RAGS guidance, this BRAA is focussed on the reasonable maximum exposure, which is the highest exposure that is reasonably expected to occur at a site (EPA, 1989a). The BRAA is being developed to supplement the exposure scenarios considered in the baseline risk assessment. The potential exposure pathways that will be quantified in this BRAA are discussed below.

4.1 *Selection of Exposure Pathways*

Populations considered in the baseline risk assessment included current on-site trespassers (10-18 year-olds) and future on-site residents (children and adults). It was subsequently determined that potential future populations at the site may also include future on-site workers on the western portion of the site, and potential users of the site following development of the property for recreational use. The BRAA is being conducted to evaluate potential health risks for these additional populations. The BRAA will evaluate pathways of exposure to on-site soils which are determined to be potentially complete for future on-site workers or future recreational users of the site. The following four characteristics of an exposure pathway must be present in order for the pathway to be considered potentially complete:

- A mechanism of release for the contaminant from site media
- A mechanism of transport for contaminants from site media to potential receptors
- A point of potential exposure to contaminants on-site
- A potential route of exposure to contaminants on-site

Historically, contamination was released into site media as part of the manufacturing processes conducted on-site. Currently, concentrations of materials are present at levels significantly above background in surface soils on-site. It is assumed that the western portion of the site may be developed for recreational or commercial/industrial use in the future. In the event of development of the western portion of the site, it is assumed that recreational users of the site or future site workers may come in contact with materials currently present in surface soils on-site. Several potential routes of exposure to site contaminants exist for recreational users or site workers, including dermal contact, incidental ingestion, and inhalation of dusts derived from contaminated site soils. The following exposure pathways will be considered as potentially complete and will be evaluated in the BRAA for the site:

Potential future site workers:

- Direct dermal contact with contaminated surface soils on-site
- Incidental ingestion of contaminated soils on-site
- Inhalation of windblown contaminated dusts on-site

Potential future recreational users of the site:

- Direct dermal contact with contaminated surface soils on-site
- Incidental ingestion of contaminated soils on-site
- Inhalation of windblown contaminated dusts on-site

TABLE 1

Contaminants of Potential Concern in On-site Surface Soils at LIF

Pesticides/PCBs

Endosulfan II
Endrin Aldehyde
Endrin Ketone

Semivolatiles

Bis(2-ethylhexyl)phthalate

Volatiles

1,2-dichloroethene
Tetrachloroethene
Trichloroethene

Inorganics

Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cyanide
Manganese
Nickel
Zinc

4.2 *Estimation of Exposure Point Concentrations*

Exposure point concentrations were calculated for contaminants selected as contaminants of potential concern in surface soils on-site. The exposure point concentrations were represented by the upper 95 percent confidence limit on the arithmetic mean of the log-transformed data (95% UCL), as outlined in the Supplemental Guidance to RAGS (EPA, 1992a). The 95% UCL was used in both the reasonable maximum and central tendency exposure scenarios at the site. The formula used to calculate the 95% UCL concentrations is shown below:

$$e^{\left(x_i + 0.5\, s^2 + \frac{SH}{\sqrt{n-1}}\right)}$$

Where:

e	= constant (natural log base 2.718)
x_i	= arithmetic mean of the log-transformed data for contaminant i
s	= standard deviation of the log-transformed data
H	= statistic determined by the standard deviation and sample size
n	= sample size for contaminant in the particular media set

In some cases, the value calculated for the 95% UCL may be greater than the maximum detected value at the site, due to small sample size, large variability in the data-set, or high sample quantitation limits. In the cases where the 95% UCL concentration exceeded the maximum detected concentration on-site, the maximum detected concentration was used for the reasonable maximum exposure calculation. The uncertainty associated with this approach will be discussed in section 7 of this report. The exposure concentrations for the contaminants of potential concern to be used in the BRAA are shown in Table 2.

4.3 *Estimation of Chronic Daily Intakes*

This section presents the methods used to estimate the chronic daily intakes (CDI) for potential future workers and recreational users of the western portion of the LIF site. In accordance with RAGS, the reasonable maximum exposure will be estimated for all of

TABLE 2

Exposure Point Concentrations (95% UCL) of Contaminants of Potential Concern in Surface Soils (0-2') on the Western Portion of the Liberty Industrial Finishing Site

Chemical	Exposure Point Concentration (Mg/Kg)
BEHP	19[a]
1,2-Dichloroethene	0.23
Endosulfan II	0.017[a]
Endrin Aldehyde	0.003[a]
Endrin Ketone	0.39[a]
Tetrachloroethene	0.35
Trichloroethene	0.32
Antimony	15
Arsenic	17
Barium	233
Beryllium	0.39
Cadmium	925[a]
Chromium	43,300[a]
Cyanide	1220[a]
Manganese	533
Nickel	793[a]
Zinc	136,000

a The UCL95% concentration exceeded the maximum value. The maximum detected concentration of the COPC in surface soils on-site is used as the exposure point concentration for the BRAA.

the potential receptors at the site. The CDIs are expressed in terms of milligrams chemical per kilogram body weight per day (mg/kg-d). The CDIs are estimated by combining 95% UCL exposure point concentrations with conservative estimates of intake for potentially exposed populations. The exposure parameters used to estimate CDIs are presented below.

Potential Future Site Workers

Dermal contact with contaminated soils by site workers

Workers are assumed to present on site 250 days/year for 25 years. Workers are assumed to conduct part of their work activities outdoors during half of their work days (125 days/year). It is assumed that worker's forearms and hands will be available for contact with site soils during 75% of the exposure events. During the remaining exposure events, only the hands are assumed to be available for contact with site soils. A soil-to-skin adherence factor (1mg/m^3) is used to estimate the amount of soil that will be in contact with worker's skin, and absorption factors are used to estimate the amount of contaminant that will pass through the skin into the body. Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils. Dioxins and PCBs are not contaminants of potential concern at LIF, and dermal exposures will be estimated for only cadmium on-site. The equation used for estimating dermal contact with contaminated soils by site workers is shown in Table 3.

Inhalation of windblown dusts by site workers

Inhalation of windblown dust derived from site soils is assumed to be a possible exposure route for potential future workers on the western portion of the site. Much of the site is currently unvegetated, and it is possible that soils from the site may become entrained as dusts available for inhalation by site workers. The model used in the baseline risk assessment to estimate exposures to windblown dusts at LIF will be used in the BRAA, with several modifications. The Baseline Risk Assessment model assumed that the contaminant concentrations in airborne dust were the same as those estimated for surface soils on-site, and that all of the PM_{10} in air on-site is derived from surface soils on-site. The concentration of PM_{10} at the site was assumed to be equal to the average concentration detected at the

TABLE 3

Equation for estimation of dermal contact with contaminated soils by site workers
Reasonable maximum exposure scenario

$$CDI = (mg/kg\text{-}d) = \frac{CS \times CF \times SA \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface available for contact (cm^2/day)
AF	=	Solid to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure Assumptions (future site worker, dermal contact with soils)

CS	=	95% UCL soil concentration
SA	=	1695 cm^2 for the future site worker. This value represents the mean surface area for the forearms and hands for 75% of exposure events, and the hands for 25% of exposure events for an adult male (EPA, 1989b)
AF	=	1 mg/cm^2 (EPA, 1989a)
ABS	=	0.01 - cadmium (EPA 1992b)
EF	=	125 days/year
ED	=	25 years
BW	=	70 kg
AT	=	365 days/year x 70 years for carcinogens
	=	365 days/year x 25 years for noncarcinogens

monitoring station at Eisenhower park in Nassau county. For the reasonable maximum scenario in the BRAA, the soils on-site will be assumed to contribute 1/2 of the PM_{10} at the site. Based on an air quality report from the New York Department of Environmental Conservation, the annual arithmetic mean PM_{10} value at Eisenhower Park in 1991 was 26 ug/m^3. The concentration of respirable dusts derived from site soils will be assumed to be 13 ug/m^3. Workers are assumed to work 8 hour days at the site 250 days per year for 25 years, and are assumed to have a respiratory rate of 20m^3/day. Indoor respirable dust concentrations are assumed to be equal to those outdoors. The equation used for estimating worker exposures to site contaminants by inhalation is presented in Table 4.

Incidental ingestion of on-site surface soils by potential future on-site workers

Incidental ingestion of on-site surface soils may occur following direct contact with soils by potential future site workers. Workers are assumed to ingest soils from the site at a rate of 50 mg/d, 250 days/year for 25 years. Soil and dust contaminant concentrations are assumed to be equal whether the worker is indoors or outdoors. Ingestion is assumed to occur during every work day. The equation to determine potential chronic daily intakes by incidental ingestion is shown in Table 5.

Potential Future Recreational Users of Site

The BRAA assumes that the site may be developed in the future for recreational use. The BRAA assumes that the western portion of the site would become an extension of Ellsworth-Allen park, and would be an attractive area for children and young adults to frequent. Children from infancy until the age of 18 are assumed to be on the site for 2 hours/day, 172 days/year. Potential future recreational users of the site are assumed to be exposed to site contamination through dermal contact with site soils, incidental ingestion of site soils, and inhalation of contaminated dusts. The assumptions used for the estimation of chronic daily intakes for recreational users of the site are discussed below.

TABLE 4

Equation for estimation of inhalation of contaminated dusts by site workers
Reasonable maximum exposure scenario

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times RD \times FI \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
RD	=	Respirable dust concentration in air (ug/m^3)
FI	=	Fraction inhaled from the site (unitless)
IR	=	Inhalation rate (20 m^3/d)
CF	=	Conversion factor (10^{-9}kg/ug)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure assumptions (future site worker, dust inhalation)

CS	=	95% UCL concentration
RD	=	13 ug/m^3, 1/2 of PM_{10} value from Eisenhower Park, Nassau County (NYSDEC, 1992)
FI	=	0.33
EF	=	250 days/year
ED	=	25 years
BW	=	70kg
AT	=	365 days x 70 years for carcinogens
	=	365 days x 25 years for noncarcinogens

TABLE 5

Equation for estimation of incidental ingestion of contaminated soil (and dust) by site workers. Reasonable maximum exposure scenario

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
IR	=	soil ingestion rate
CF	=	conversion factor (10^{-6} kg/mg)
EF	=	exposure frequency
ED	=	exposure duration
BW	=	body weight
AT	=	averaging time

Exposure assumptions (future site worker, incidental soil ingestion)

CS	=	95% UCL soil concentration
IR	=	50 mg/day
EF	=	250 days/year
ED	=	25 years
BW	=	70 kg
AT	=	365 days x 70 years for carcinogens
	=	365 days x 25 years for noncarcinogens

Dermal contact with contaminated soils by recreational users of site

Recreational users of the site are assumed to present on site 172 days/year for 18 years. It is assumed that the hands, arms and lower legs will be available for contact with site soils during 75% of the exposure events. During the remaining exposure events, only the hands are assumed to be available for contact with site soils. A soil-to-skin adherence factor (1mg/m^3) is used to estimate the amount of soil that will be in contact with the recreational user's skin, and absorption factors are used to estimate the amount of contaminant that will pass through the skin into the body. Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils (EPA, 1992b). Dioxins and PCBs are not contaminants of potential concern at LIF, and dermal exposures will be estimated for only cadmium on-site. The equation used for estimating dermal contact with contaminated soils by recreational users of the site is shown in Table 6.

Inhalation of windblown dusts by recreational users of site

Inhalation of windblown dust derived from site soils is assumed to be a possible exposure route for potential recreational users of the western portion of the site. Much of the site is currently unvegetated, and it is possible that soils from the site may become entrained as dusts available for inhalation. A modification of the model used in the baseline risk assessment to estimate exposures to windblown dusts at LIF will be used in the BRAA. The BRAA assumes that the contaminant concentrations in airborne dust are the same as those estimated for surface soils on-site, and that 1/2 of the PM_{10} in air on-site is derived from on-site surface soils. The concentration of PM_{10} at the site was assumed to be equal to the average concentration detected at the monitoring station at Eisenhower park in Nassau county. Based on an air quality report from the New York Department of Environmental Conservation, the annual arithmetic mean PM_{10} value at Eisenhower Park in 1991 was 26 ug/m^3. The PM_{10} concentration assumed to be derived from site soils is 13 ug/m^3.

TABLE 6

Equation for estimation of dermal contact with contaminated soils by recreational users of LIF. Reasonable maximum exposure scenario

$$CDI = (mg/kg\text{-}d) = \frac{CS \times CF \times SA \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface available for contact (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure Assumptions (recreational user of site, dermal contact with soils)

CS	=	95% UCL soil concentration
SA	=	1735 cm^2 for the future child recreational user (0-6 years old). This value represents the mean surface area for the hands, arms and lower legs for 75% of exposure events, and the hands and arms for 25% of exposure events for a 1-6 year-old child (EPA 1989b).
	=	2800 cm^2 for the future recreational user (0-18 years old). This value represents the mean surface area for the hands, arms and lower legs for 75% of exposure events, and the hands and arms for 25% of exposure events for a 1-18 year-old child (EPA 1989b).
AF	=	1 mg/cm^2 (EPA, 1989a)
ABS	=	0.01 - cadmium (EPA 1992b)
EF	=	172 days/year
ED	=	6 years (noncarcinogens)
	=	18 years (carcinogens)
BW	=	14.5 kg (0-6 years)
	=	38 kg (0-18 years)
AT	=	365 days/year x 70 years for carcinogens
	=	365 days/year x 6 years for noncarcinogens

For recreational users of the site, noncarcinogenic hazards and cancer risks are evaluated separately. For determination of noncarcinogenic hazards, children from age 0-6 are assumed to be present at the site for 2 hours/day, 172 days per year, and are assumed to have a respiratory rate of 15 m^3/day. For determination of cancer risks, children from age 0-18 are assumed to be present at the site for 2 hours/day, 172 days per year, and are assumed to have a respiratory rate of 18 m^3/day. The equation used for estimating exposures to site contaminants by inhalation is shown in Table 7.

Incidental ingestion of on-site surface soils by potential future recreational users of site
Incidental ingestion of on-site surface soils may occur following direct contact with soils by potential future recreational users of the site. Recreational users of the site are assumed to ingest soils from the site at a rate of 200 mg/d, 172 days/year from age 0-6, and at a rate of 100 mg/d, 172 days/year from age 7-18 (this results in an age-adjusted soil ingestion rate of 133 mg/d from age 0-18). The equation to determine potential chronic daily intakes by incidental ingestion is shown in Table 8.

Chronic Daily Intakes - Potential Future Workers and Recreational Users at LIF
Chronic daily intakes for workers and recreational users of the site are determined using 95% UCL exposure point concentrations in conjunction with the exposures estimated from the equations in Tables 3-8. The chronic daily intakes by dermal contact, incidental ingestion and inhalation of carcinogenic compounds by potential future workers are shown in Table 9. Chronic daily intakes of noncarcinogens by potential future workers are shown in Table 10. Chronic daily intakes by dermal contact, incidental ingestion and inhalation of carcinogenic compounds by potential future recreational users of the site are shown in Table 11. Chronic daily intakes of noncarcinogens by potential future recreational users of the site are shown in Table 12.

TABLE 7

Equation for estimation of inhalation of contaminated dusts by recreational users of LIF site. Reasonable maximum exposure scenario

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times RD \times FI \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
RD	=	Respirable dust concentration in air (ug/m^3)
FI	=	Fraction inhaled from the site (unitless)
IR	=	Inhalation rate ($m^{3/d}$)
CF	=	Conversion factor (10^{-9}kg/ug)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure assumptions (recreational users of site, inhalation of dust)

CS	=	95% UCL concentration
RD	=	13 ug/m^3, 1/2 of PM_{10} value from Eisenhower Park, Nassau County (NYSDEC, 1992)
FI	=	0.083
IR	=	15 m^3/d for age 0-6; 18 m^3/d for age 0-18
EF	=	172 days/year
ED	=	6 years (noncarcinogens)
	=	18 years (carcinogens)
BW	=	14.5 kg (0-6 years)
	=	38 kg (0-18 years)
AT	=	365 days x 70 years for carcinogens
	=	365 days x 6 years for noncarcinogens

TABLE 8

Equation for estimation of incidental ingestion of contaminated soil by recreational users of LIF site. Reasonable maximum exposure scenario.

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
IR	=	soil ingestion rate
CF	=	conversion factor (10^{-6} kg/mg)
EF	=	exposure frequency
ED	=	exposure duration
BW	=	body weight
AT	=	averaging time

Exposure assumptions (recreational users of site, incidental ingestion of soil)

CS	=	95% UCL soil concentration
IR	=	200 mg/day (0-6 years)
	=	133 mg/day (0-18 years)
EF	=	172 days/year
ED	=	6 years (noncarcinogens)
	=	18 years (noncarcinogens)
BW	=	14.5 kg (0-6 years)
	=	38 kg (0-18 years)
AT	=	365 days x 70 years for carcinogens
	=	365 days x 6 years for noncarcinogens

TABLE 9

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over a Lifetime for Carcinogens
Based on Upper 95% Confidence Limit Concentration
Future Commercial/Industrial Use - RME
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	3.3 E-06	‡	5.8 E-09
Trichloroethene	6.1 E-08	‡	1 E-10
Arsenic	5.8 E-08	‡	5.2 E-09
Beryllium	6.9 E-08	‡	1.2 E-10
Cadmium	†	†	2.8 E-07
Chromium	†	‡	1.3 E-05

† = A cancer slope factor for the chemical is not available for this route of exposure
‡ = A dermal absorption factor from soil is not available for this chemical

TABLE 10

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over the Exposure Period for Noncarcinogens
Based on Upper 95% Confidence Limit Concentration
Future Commercial/Industrial Use - RME
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	9.3 E-06	‡	1.6 E-08
1,2-Dichloroethene	1.1 E-07	‡	1.9 E-10
Endosulfan II	8.3 E-09	‡	1.4 E-11
Endrin Aldehyde	1.4 E-09	‡	2.5 E-12
Endrin Ketone	1.9 E-07	‡	3.3 E-10
Tetrachloroethene	1.7 E-07	‡	3 E-10
Trichloroethene	1.6 E-07	‡	2.8 E-10
Antimony	7.3 E-06	‡	1.3 E-08
Arsenic	8.3 E-06	‡	1.5 E-08
Barium	1.1 E-04	‡	2 E-07
Beryllium	1.9 E-07	‡	3.3 E-10
Cadmium	4.5 E-04	7.7 E-05	7.8 E-07
Chromium	2.1 E-02	‡	3.7 E-05
Cyanide	6 E-04	‡	1 E-06
Manganese	2.6 E-04	‡	4.5 E-07
Nickel	3.9 E-04	‡	6.7 E-07
Zinc	6.7 E-02	‡	1.2 E-04

‡ = A dermal absorption factor from soil is not available for this chemical

TABLE 11

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over a Lifetime for Carcinogens
Based on Upper 95% Confidence Limit Concentration
Future Recreational Use - RME
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	8.1 E-06	‡	1.2 E-09
Tetrachloroethene	1.5 E-07	‡	2.2 E-11
Trichloroethene	1.4 E-07	‡	2 E-11
Arsenic	7.3 E-06	‡	1.1 E-08
Beryllium	1.7 E-07	‡	2.4 E-11
Cadmium	†	†	5.8 E-08
Chromium	†	†‡	2.7 E-06

† = A cancer slope factor for the chemical is not available for this route of exposure
‡ = A dermal absorption factor from soil is not available for this chemical

TABLE 12

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over the Exposure Period for Noncarcinogens
Based on Upper 95% Confidence Limit Concentration
Future Recreational Use - RME
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	1.2 E-04	‡	1 E-08
1,2-Dichloroethene	1.5 E-06	‡	1.2 E-10
Endosulfan II	1.1 E-07	‡	9 E-12
Endrin Aldehyde	1.9 E-08	‡	1.5 E-12
Endrin Ketone	2.5 E-06	‡	2 E-10
Tetrachloroethene	2.3 E-06	‡	1.9 E-10
Trichloroethene	2.2 E-06	‡	1.8 E-10
Antimony	9.8 E-05	‡	7.9 E-09
Arsenic	1.1 E-04	‡	9 E-09
Barium	1.5 E-03	‡	1.2 E-07
Beryllium	2.6 E-06	‡	2 E-10
Cadmium	6 E-03	5.2 E-04	4.9 E-07
Chromium	2.8 E-01	‡	2.3 E-05
Cyanide	7.9 E-03	‡	6.4 E-07
Manganese	3.5 E-03	‡	2.8 E-07
Nickel	5.2 E-03	‡	4.2 E-07
Zinc	8.8 E-01	‡	7.2 E-05

‡ = A dermal absorption factor from soil is not available for this chemical

5. TOXICITY ASSESSMENT

This section reviews the data which are currently available on the carcinogenic and noncarcinogenic toxicity of the chemicals which have been selected as chemicals of potential concern (COPC)s for the BRAA. The hazard identification step of the BRAA identified chemicals of potential concern at the site, based on several factors such as toxicity, frequency of occurrence, and concentration. The purpose of the toxicity assessment step of the BRAA is to determine the types of adverse health effects associated with potential exposures to the COPCs and the relationship between magnitude of exposure (dose) and severity of the resulting adverse effects (response).

In accordance with current EPA risk assessment guidance (EPA 1989a), toxicity data on the COPCs were obtained from EPA's Integrated Risk Information System (USEPA, 1995). In cases where data were not available on the IRIS database, data were obtained from EPA's Health Effects Assessment Summary Tables (USEPA, 1994). If data were unavailable from either IRIS or HEAST, EPA's Environmental Criteria and Assessment Office (ECAO) in Cincinnati, Ohio was consulted for guidance on toxicity values. Toxicity data for several COPCs were unavailable from any of the above sources. Potential health effects associated with exposures to these chemicals will be discussed in the uncertainty section of the BRAA.

It is assumed that the toxic effects of the site-related chemicals are additive. The likelihood of carcinogenic (cancer-causing) and noncarcinogenic effects due to exposure to site chemicals are considered separately. Thus, carcinogenic and noncarcinogenic risks associated with exposures to individual compounds of concern are summed to indicate the potential risks associated with mixtures of potential carcinogens and noncarcinogens, respectively.

5.1 *Toxicity Criteria for the Assessment of Potential Carcinogenic Effects*

Potential carcinogenic risks are evaluated using the cancer slope factors developed by EPA for the contaminants of concern. Cancer slope factors (SFs) have been developed by EPA's Carcinogenic Risk Assessment Verification Endeavor for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. EPA uses an alphanumeric weight of evidence classification scheme to characterize the likelihood of a chemical's carcinogenic potential based on results from animal and epidemiologic studies. The classification scheme is presented below:

A - Known human carcinogen

B1 - Probable human carcinogen based on limited human data

B2 - Probable human carcinogen based on sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as to human carcinogenicity

E - Evidence of noncarcingenicity for humans

If a chemical is classified as a known human carcinogen (class A), probable human carcinogen (class B1 or B2) or possible human carcinogen (class C), then a SF is developed for the chemical. SFs are generally developed through extrapolation of the dose-response relationship determined under relatively high dose levels to the relatively low dose levels which are expected in the general population at a Superfund site. The slope factors for the COPCs are shown in Table 13.

5.2 *Toxicity Criteria for the Assessment of Potential Noncarcinogenic Effects*

Potential noncarcinogenic risks are evaluated using the reference doses (RfDs) developed by EPA for the contaminants of concern. RfDs, which are expressed in units of milligrams/kilogram-day (mg/kg-day), are estimates of daily exposure levels for humans which are thought to be safe over a lifetime (including sensitive individuals).

RfDs are derived from animal studies conducted in the laboratory or human epidemiological studies. In the absence of human data, EPA generally selects the study on the most sensitive animal species as the critical basis for determination of the RfD. The effect characterized by

Table 13

Carcinogenic Slope Factors for the Chemicals of Potential Concern at LIF

Chemical	Oral SF $(mg/kg\text{-}d)^{-1}$	WOE	Inhalation SF $(mg/kg\text{-}d)^{-1}$	WOE
BEHP	0.014 (I)	B2	NA	NA
1,2-Dichloroethene	NA	D	NA	NA
Endosulfan II	NA	NA	NA	NA
Endrin Aldehyde	NA	D	NA	NA
Endrin Ketone	NA	D	NA	NA
Tetrachloroethene	5.2 E-02 (E)	NA	2 E-03 (E)	NA
Trichloroethene	0.011 (E)	NA	6 E-03 (E)	NA
Antimony	NA	NA	NA	NA
Arsenic	1.75 (I)	A	15.1 (I)[a]	A
Barium	NA	NA	NA	NA
Beryllium	4.3(I)	B2	8.4 (I)[a]	B2
Cadmium	NA	B1	6.3 (I)[a]	B1
Chromium	NA	NA	7 (I)[a,b]	A
Cyanide	NA	D	NA	D
Manganese	NA	D	NA	D
Nickel	NA	NA	NA	NA
Zinc	NA	D	NA	D

Notes:

I Data obtained from EPA's IRIS database (USEPA, 1995)
H Data obtained from EPA's Health Effects Assessment Summary Tables (USEPA, 1994)
E Data obtained through consultation with EPA's Environmental Criteria and Assessment Office (ECAO) in Cincinnati, Ohio
NA No data were available
WOE Weight of Evidence Classification
a The inhalation slope factor was calculated from an inhalation unit risk value assuming an inhalation rate of 20 M^3/day and a body weight of 70 kg
b The slope factor was based on an assumption of a 6:1 chromium III:chromium VI ratio

Table 14

Reference Doses for the Chemicals of Potential Concern at LIF

Chemical	Oral RfD (mg/kg-d)	Dermal RfD (mg/kg-d)	Inhalation RfD (mg/kg-d)
BEHP	0.02 (I)	NA	NA
1,2-Dichloroethene	9 E-03 (H)	NA	NA
Endosulfan II	6 E-03 (I)	NA	NA
Endrin Aldehyde	3 E-04 (I)	NA	NA
Endrin Ketone	3 E-04 (I)	NA	NA
Tetrachloroethene	0.01 (I)	NA	NA
Trichloroethene	6 E-03 (E)	NA	NA
Antimony	4 E-04 (I)	NA	NA
Arsenic	3 E-04 (I)	NA	NA
Barium	0.07 (I)	NA	NA
Beryllium	5 E-03 (I)	NA	NA
Cadmium	1 E-03 (I)	5 E-05[b]	NA
Chromium	0.03 (I)[a]	NA	NA
Cyanide	0.02 (I)	NA	NA
Manganese	5 E-03 (I)	NA	1.45 E-05 (I)[c]
Nickel	0.02 (I)	NA	NA
Zinc	0.3 (I)	NA	NA

I Data obtained from EPA's IRIS database (USEPA, 1995)
H Data obtained from EPA's Health Effects Assessment Summary Tables (USEPA, 1994)
E Data obtained through consultation with EPA's Environmental Criteria and Assessment Office (ECAO) in Cincinnati, Ohio
NA No data were available
a The reference dose was based on a 6:1 chromium III:chromium VI ratio
b Derived from the oral reference dose. Absorption of cadmium in food from the gut was assumed to be 5%, and the oral administered reference dose was modified accordingly, to generate an absorbed reference dose
c The inhalation reference dose was calculated from an inhalation reference concentration assuming an inhalation rate of 20 M^3/day and a body weight of 70 kg

the no-observed-adverse-effect-level (NOAEL) or lowest-observed-adverse-effect-level (LOAEL) is selected as the critical toxic effect. Uncertainty factors are applied to the NOAEL or LOAEL for the critical toxic effect to account for uncertainty related to variation within the human population, extrapolation from animals to humans and derivation of an RfD from a LOAEL. Additional modifying factors may be used to account for other sources of uncertainty in the critical study. The RfDs for the COPCs are shown in Table 14.

6. RISK CHARACTERIZATION

The final step in the Baseline Risk Assessment process is risk characterization. Risk characterization combines information generated during hazard identification, exposure assessment and dose response assessment to determine the potential cancer risks and noncarcinogenic hazards associated with exposures to contaminants present at the site in the absence of remediation.

6.1 *Methods for estimating Noncarcinogenic Hazards and Carcinogenic Risks*

Under current EPA guidelines, it is assumed that the toxic effects of the site-related chemicals are additive. The likelihood of carcinogenic (cancer-causing) and noncarcinogenic effects due to exposure to site chemicals are considered separately. Thus, carcinogenic and noncarcinogenic risks associated with exposures to individual compounds of concern are summed to indicate the potential risks associated with mixtures of potential carcinogens and noncarcinogens, respectively.

Noncarcinogenic Hazards

Noncarcinogenic hazards are assessed using a hazard index (HI) approach, based on a comparison of expected contaminant intakes and safe levels of intake (Reference Doses). Estimated intakes of chemicals from environmental media (*e.g.*, the amount of a chemical ingested from contaminated surface soil) are compared to the RfD to derive the hazard quotient for the contaminant in the particular medium as shown below.

$$HQ_i = \frac{CDI_i}{RfD_i}$$

where:

HQ_i = Hazard Quotient for chemical i (unitless)
CDI_i = Chronic Daily Intake for chemical i (mg/kg-d)
RfD_i = Reference Dose for chemical i (mg/kg-d)

Hazard quotients for all compounds across all media are summed to obtain the noncarcinogenic hazard index (HI) for a specific receptor population. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. The initial calculation of the hazard index serves as a screen for potential noncarcinogenic effects at the site. An assumption is made that the effects of individual noncarcinogenic chemicals are additive only if they act on the same target organ. In cases where the HI exceeds 1, chemicals affecting the same target organ are selected and used to re-calculate the HI. A re-calculated HI greater than 1 indicates that the potential exists for noncarcinogenic health effects to occur as a result of site-related exposures.

Carcinogenic Risks

Potential carcinogenic risks are expressed as an increase in the probability of an individual to develop cancer over a lifetime as a result of exposures to site-related contaminants. For example, a cancer risk of 10^{-5} indicates that an individual has an increased risk of 1 in 100,000 of developing cancer as a result of exposures to site chemicals according to the exposure scenarios defined in the risk assessment.

Potential carcinogenic risks are evaluated using the cancer slope factors developed by EPA for the contaminants of concern. SFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to generate an upper-bound estimate of the excess lifetime cancer risk associated with exposure to the compound at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes the underestimation of the risk highly unlikely. Potential cancer risks at the site are calculated according to the equation shown below:

$$Cancer\ Risk_i = CDI_i * SF_i$$

where:

Cancer Risk$_i$	=	Potential carcinogenic risks associated with potential exposures to chemical i (unitless)
CDI$_i$	=	Chronic Daily Intake of chemical i as defined in the exposure assessment for the site (mg/kg-d)
SF$_i$	=	Carcinogenic slope factor for chemical i estimated by EPA $(mg/kg\text{-}d)^{-1}$

For known or suspected carcinogens, EPA considers excess upper-bound individual lifetime cancer risks of between 10^{-4} to 10^{-6} to be acceptable. This level indicates that an individual has not greater than a one in ten thousand to one in a million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year period under the specific exposure conditions at the site.

Due to the uncertainty inherent in the estimation of the potential future reasonable maximum exposures and associated health risks, it is useful to describe the range of potential exposures and health risks associated with future activities at the LIF site. For those exposure pathways that result in health risks in excess of EPA's acceptable levels (i.e., cancer risk of 10-4 and hazard index of 1) potential exposures and associated health risks will be re-calculated using central tendency exposure assumptions. This analysis is presented in the uncertainty section of the BRAA.

The following sections present the noncarcinogenic hazards and lifetime carcinogenic risks associated with reasonable maximum estimates of potential future recreational or industrial use of LIF.

6.2 *Potential Future Recreational use of LIF - Reasonable Maximum Exposures*

The BRAA assumes that the LIF site may be developed in the future for recreational use. According to this scenario, the western portion of the site would become an extension of Ellsworth-Allen park, and would be an attractive area for children and young adults to frequent. While on site, it is assumed that children my be exposed to site contaminants through dermal contact with contaminated soils, incidental ingestion of contaminated soils, and inhalation of dust generated from contaminated on-site soils. Noncarcinogenic hazards and carcinogenic risks associated with each of these exposure pathways are discussed below. Children from infancy to 6 years of age were considered to be the most sensitive receptor for noncarinogenic hazards during recreational activities at the site. The hazard quotients and hazard indices discussed below were determined for this population. The most sensitive receptor for carcinogenic risks during recreational activities at the site are children exposed from infancy to 18 years of age. The cancer risks reported below were determined for this population.

6.2.1 Dermal Exposures to Contaminants in Site Soils by Recreational Users of LIF

Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils. Dioxins and PCBs are not contaminants of potential concern at LIF, and dermal exposures will be estimated for only cadmium on-site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with dermal contact with contaminants in site soils are presented in Table 15.

The noncarcinogenic hazard quotient for dermal contact with cadmium is 10. The elevated hazard quotient indicates that cadmium has potential to cause adverse health impacts through dermal contact with soils during potential future recreational activity on site.

The carcinogenic risk associated with dermal contact with soils on site during potential future recreational activity at the site cannot be determined. No dermal absorption factors are available for site contaminants known or thought to be carcinogens. The uncertainty associated with the dermal pathway will be addressed in Section 7 of this report.

6.2.2 *Inhalation of windblown dusts by recreational users of the LIF site*

Inhalation of airborne dust derived from site soils is assumed to be a possible exposure route for potential future recreational users of the western portion of the site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with inhalation of contaminants in dusts derived from site soils are presented in Tables 15 and 16.

Manganese was the only COPC in site soils for which an inhalation reference dose was available, and the estimation of hazards associated with inhalation of contaminated dusts on site could only be completed for manganese. The hazard quotient for inhalation of dusts derived from site soils containing manganese is 0.02, suggesting that inhalation of dusts containing manganese at the site is unlikely to be of concern. However, numerous contaminants are present in site soils at which are potentially of concern by the inhalation route, including chromium and cadmium. Potential noncarcinogenic hazards associated with inhalation of soils containing these contaminants will be addressed in the uncertainty section of this report.

The carcinogenic risk associated with inhalation of windblown dust by potential future recreational users of the site is 2×10^{-5}, due almost exclusively to inhalation of chromium in site soils. This risk level is within EPA's acceptable cancer risk range of 10^{-4} - 10^{-6}, and is unlikely to be of concern. Inhalation slope factors for most of the contaminants of concern were unavailable. The uncertainty associated with this pathway will be addressed in section 7 of this report.

6.2.3 *Incidental ingestion of surface soils by potential future recreational users of site*

Incidental ingestion of on-site surface soils may occur following direct contact with soils by potential future recreational users of the site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with incidental ingestion of contaminants in site soils are presented in Table 15.

The HI for incidental ingestion of site soils during potential future recreational use of the site by children is 19, indicating potential hazard associated with incidental ingestion of soils at the site. This elevated HI primarily reflects the contribution of cadmium (6), chromium (9.4), and zinc (2.9). However, it is inappropriate to sum hazard quotients for individual contaminants having different toxic endpoints. The toxicity of cadmium and chromium target the kidney, and addition of the hazard quotients for cadmium and chromium yields a HI of 15.4. The elevated combined hazard index related to cadmium and chromium and the elevated hazard quotient for zinc at the site indicate that incidental ingestion of these compounds during potential future recreational activity is of concern at the site.

The carcinogenic risk associated with incidental ingestion of site soils by potential future recreational users of the site is 1×10^{-5}, which is within EPA's acceptable carcinogenic risk range.

6.2.4 Combined Noncarcinogenic Hazards and Carcinogenic Risks to Potential Future Recreational Users of LIF

A potential future recreational user of the site is assumed to be simultaneously exposed through multiple exposure pathways at the site. Noncarcinogenic hazards and carcinogenic risks associated with dermal contact with site soils, incidental ingestion of site soils and inhalation of dusts derived from site soils are combined to determine the cumulative risk to the receptor. The noncarcinogenic hazards and carcinogenic risks from the three exposure pathways are summed in Table 15. The total noncarcinogenic hazard index to the recreational user is 25 (due to cadmium and chromium).. The total carcinogenic risk to the recreational user is 3×10^{-5} (due primarily to chromium and arsenic). This risk level is within EPA's acceptable risk of 10^{-4} - 10^{-6}.

Central tendency estimates of the noncancer hazard indices for potential future recreational users of the LIF site are presented in section 7 of this report.

6.3 *Potential Future Commercial/Industrial Use - Reasonable Maximum Exposures*

The BRAA assumes that the LIF site may be developed in the future for commercial/industrial use. While on site, it is assumed that workers may be exposed to site contaminants through dermal contact with contaminated soils, incidental ingestion of contaminated soils, and inhalation of dust generated from contaminated on-site soils. Noncarcinogenic hazards and carcinogenic risks associated with each of these exposure pathways are discussed below.

6.3.1 Dermal Exposures to Contaminants in Site Soils by Workers

Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils. Dioxins and PCBs are not contaminants of potential concern at LIF, and dermal exposures were estimated for only cadmium on-site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with dermal contact with contaminants in site soils are presented in Table 16.

The noncarcinogenic hazard quotient for dermal contact with cadmium is 1.5. The elevated hazard quotient indicates that cadmium has potential to cause adverse health impacts through dermal contact with soils by potential future site workers.

The carcinogenic risk associated with dermal contact with soils on site by potential future site workers cannot be determined. No dermal absorption factors are available for site contaminants known or thought to be carcinogens. The uncertainty associated with the dermal pathway will be addressed in Section 7 of this report.

Table 15.

Combined Noncancer Hazards and Carcinogenic Risks to Potential Future Recreational Users of LIF

Exposure Pathway	Hazard Index	Carcinogenic Risk
Dermal Exposure to Site Soils	10	0[a]
Inhalation of Contaminated Dust	0.02[b]	2×10^{-5}
Ingestion of Contaminated Soil	15	1×10^{-5}
Total	25	3×10^{-5}

a Dermal absorption factors are not available for any of the carcinogens present in site soils.

b An inhalation reference dose was available for only manganese. The hazard index for this pathway represents the hazard quotient for manganese.

6.3.2 Inhalation of windblown dusts by potential future site workers

Inhalation of windblown dust derived from site soils is assumed to be a possible exposure route for potential future workers on the western portion of the site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with inhalation of contaminants in dusts derived from site soils are presented in Table 16.

Manganese was the only chemical of potential concern in site soils for which an inhalation reference dose was available and the estimation of hazards associated with inhalation of contaminated dusts on site could only be completed for manganese. The hazard quotient for inhalation of dusts derived from site soils containing manganese is 0.03, suggesting that inhalation of dusts containing manganese at the site is unlikely to be of concern. However, numerous contaminants are present in site soils at which are potentially of concern by the inhalation route, including chromium and cadmium. Potential noncarcinogenic hazards associated with inhalation of soils containing these contaminants will be addressed in the uncertainty section of this report.

The carcinogenic risk associated with inhalation of windblown dust by potential future recreational users of the site is 1×10^{-4}, due almost exclusively to inhalation of chromium in site soils. This risk level is within EPA's acceptable cancer risk range of 10^{-4} - 10^{-6}. Inhalation slope factors for most of the contaminants of concern were unavailable and the cancer risks for most of the COPCs could not be determined. The uncertainty associated with this pathway will be addressed in section 7 of this report.

6.3.3 Incidental ingestion of on-site surface soils by potential future site workers

Incidental ingestion of on-site surface soils may occur following direct contact with soils by potential future site workers. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with inhalation of contaminants in dusts derived from site soils are presented in Table 16.

The HI for incidental ingestion of site soils by potential future site workers is 1.2, indicating potential hazard associated with incidental ingestion of soils at the site. This elevated HI primarily reflects the contribution of cadmium (0.5) and chromium (0.7). The toxicity of cadmium and chromium target the kidney, and addition of the hazard quotients for cadmium and chromium yields a HI of 1.2. The hazard index for the combined effects of cadmium and chromium at the site indicate that incidental ingestion of these compounds by potential future site workers may be of concern at the site.

The carcinogenic risk associated with incidental ingestion of site soils by potential future site workers is 5×10^{-6}. This risk level is within EPA's acceptable carcinogenic risk range.

6.4 *Combined Noncarcinogenic Hazards and Carcinogenic Risks to Potential Future Recreational Users of LIF*

A potential future worker at the site is assumed to be simultaneously exposed through multiple exposure pathways at the site. Noncarcinogenic hazards and carcinogenic risks associated with dermal contact with site soils, incidental ingestion of site soils and inhalation of dusts derived from site soils were combined to determine the cumulative risk to the receptor. The noncarcinogenic hazards and carcinogenic risks from the three exposure pathways are summed in Table 16. The total noncarcinogenic hazard index to the potential future site worker is 2.7 (due to cadmium and chromium). This hazard index exceeds EPA's target HI 1. The total carcinogenic risk to the potential site worker is 1×10^{-4} (due primarily to chromium and arsenic), a level which is within EPA's acceptable risk range.

Central tendency estimates of the noncancer hazard indices and cancer risks for potential future site workers at LIF are presented in section 7 of this report.

Table 16.

Combined Noncancer Hazards and Carcinogenic Risks to Potential Future Site Workers

Exposure Pathway	Hazard Index	Carcinogenic Risk
Dermal Exposure to Site Soils	1.5	0[a]
Inhalation of Contaminated Dust	0.03[b]	1×10^{-4}
Ingestion of Contaminated Soil	1.2	5×10^{-6}
Total	2.7	1×10^{-4}

a Dermal absorption factors are not available for any of the carcinogens present in site soils

b An inhalation reference dose was available for only manganese. The hazard index for this pathway represents the hazard quotient for manganese.

7. UNCERTAINTIES

The procedures and inputs used to assess risks in this evaluation, as in all such assessments, are subject to a wide variety of uncertainties. In general, the main sources of uncertainty include:

- environmental chemistry sampling and analysis
- environmental parameter measurement
- fate and transport modeling
- exposure parameter estimation
- toxicological data
- exposures from sources unrelated to site

Uncertainty in environmental sampling arises in part from the potentially uneven distribution of chemicals in the media sampled. At LIF, elevated contaminant concentrations were detected primarily in the former lagoon areas and the northwest disposal area. There is a considerable range in contaminant concentrations detected across the 30 acre site. Consequently, there is significant uncertainty as to the actual levels present. The RME exposure scenario in the BRAA utilizes the 95% upper confidence limit on the arithmetic mean of the log-transformed sampling data in the concentration term. In cases where there is a wide variability in the contaminant concentrations at the site, the 95%UCL may exceed the maximum detected concentration at the site. In this instance, the maximum detected concentration in soils on-site is used as the concentration term in the BRAA risk calculations. This is the case at LIF for cadmium and chromium, which are the greatest contributors to the noncarcinogenic hazards and carcinogenic risks determined for the site. As a result, the BRAA may significantly overestimate health risks for the LIF site.

Additional uncertainty in environmental sampling at LIF relates to the speciation of metals present at the site. In particular, chromium VI is considered to be significantly more toxic than chromium III (USEPA, 1995). Historical records at the site suggest that considerable amounts of chromic acid (chromium VI) was deposited at the site during manufacturing operations. However, environmental conditions generally favor reduction of chromium VI to chromium III (U.S. Department of Health and Human Services, 1993a). Speciation data for chromium was not collected during the RI, and the actual concentrations of Chromium III and Chromium VI at the site are unknown. The BRAA made the conservative assumption that chromium at the site exists in a 6:1 chromium III:chromium VI ratio.

The impact of this assumption on the final noncancer hazards and cancer risks determined for chromium at the site can be demonstrated by re-calculation of the risks assuming chromium is present as 100% chromium VI or 100% chromium III. The hazard index associated with incidental ingestion of chromium in soils by children recreating at the site assuming a chromium was present at a 6:1 chromium III:chromium VI ratio was 9.4 (approximately 10 times the acceptable level). If the chromium were assumed to be present as 100% chromium VI, the hazard quotient for this pathway would increase to approximately 56 (nearly 60 times the acceptable level). In contrast, if the chromium on-site is assumed to be present entirely as chromium III, the hazard quotient for incidental ingestion by children recreating at the site would decrease to 0.3, a level that would be considered acceptable at the site. This analysis demonstrates that the assumption regarding the speciation of chromium alone contributes a 200-fold uncertainty to the noncancer hazards associated with incidental ingestion of chromium by children recreating at the site.

The assumption of a 6:1 chromium III:chromium VI ratio at the site is conservative, but is considered to be consistent with Agency guidance to evaluate the reasonable maximum exposure at the site.

Uncertainties in the exposure assessment are related to estimates of how often an individual would actually come in contact with the chemicals of concern, the period of time over which such exposure would occur, and in the models used to estimate the concentrations of the chemicals of concern at the point of exposure. There is considerable uncertainty in the exposure scenarios developed in the BRAA, as both of the scenarios involve estimations of exposures to populations which are not currently in existence. These uncertainties are addressed by making conservative assumptions concerning exposure parameters throughout the assessment. The BRAA assumed that exposures at the site could occur through dermal contact with contaminants in soil, incidental ingestion of contaminated soils, and inhalation of dusts generated from site soils. While all of these exposure pathways are possible at the site, there is considerable uncertainty regarding the magnitude and frequency of potential exposures. For example, the BRAA assumes that children using the site for recreational purposes will visit the site one half of the days every year for 18 years. The dust inhalation scenario makes highly conservative estimates of the amount of dust available for inhalation on a regular basis. These types of conservative exposure estimates are unlikely to underestimate, and may significantly overestimate the actual risks associated with the site.

Uncertainties in toxicological data occur in extrapolating both from animals to humans and from high to low doses of exposure, as well as from the difficulties in assessing the toxicity of a mixture of chemicals. Toxicological data were not available for a number of potentially important chemicals and exposure pathways at the site. Dermal absorption values were available for only cadmium at the site, and risks related to dermal absorption of numerous potentially important chemicals could not be evaluated in the BRAA. Similarly, inhalation reference concentrations were unavailable only for most of the COPCs at the site, and noncancer hazards associated with inhalation of most of the compounds at the site could not be determined. Noncancer hazards associated with chromium are of particular concern, as this compound was detected at very high concentrations in site soils and is known to exert highly toxic noncarcinogenic effects by inhalation. Inhalation slope factors were also unavailable for many of the contaminants at the site. The inability to calculate noncancer hazards and cancer risks for most of the chemicals detected at the site by the dermal and inhalation exposure routes may result in a significant underestimation of risks associated with these exposures.

Additional uncertainty in the BRAA derives from potential contributions from the diet to total exposures to metals at the site. In particular, dietary intakes of cadmium have been reported to be approximately 30 ug/day for adults (U.S. Department of Health and Human Services, 1993b; Gartrell et al., 1986a) and approximately 10 ug/d for infants and toddlers (Gartrell et al., 1986b). Dietary intakes were not considered in determination of the noncancer hazards associated with cadmium at LIF. The impact of dietary intakes of cadmium on the noncancer hazards at LIF is demonstrated below.

The total hazard index due to cadmium for children recreating at the site was 16. If dietary intakes of cadmium were included in this calculation, the hazard index for cadmium would increase to approximately 17. For site workers, the total hazard index due to cadmium was 2. If dietary intakes of cadmium are included in this calculation, the hazard index increases to approximately 2.4. As dietary intakes contribute less than 20% to the total noncancer hazard for cadmium, the uncertainty related to this factor is relatively small. The conservative assumptions made throughout the BRAA regarding potential exposures to potential future populations are thought to more than account for the uncertainty related to dietary intakes of contaminants at the site.

7.1 Central Tendency Exposure and Risk Estimates

EPA policy states that when risk estimates exceed acceptable levels as defined by the Agency, exposure levels and risk estimates should be recalculated using central tendency estimates of exposure in order to describe the range of possible risks related to the exposure scenarios at the site. Exposure parameters which are considered to be representative of the 50th percentile exposure group are selected for the central tendency analysis. The 95% UCL estimates of contaminant concentration in site soils are used in both the RME and the central tendency analyses. The central tendency estimates for the potential exposures at the site are presented below.

7.2 *Estimation of Chronic Daily Intakes - Central Tendency Exposures.*

This section presents the methods used to generate central tendency estimates of the chronic daily intakes (CDI) for potential future workers and recreational users on the western portion of the LIF site. The CDIs are expressed in terms of milligrams chemical per kilogram body weight per day (mg/kg-d). The CDIs are estimated by combining 95% UCL exposure point concentrations with central tendency estimates of intake for potentially exposed populations.

The exposure parameters used to estimate central tendency CDIs are presented below.

Potential Future Site Workers

Dermal contact with contaminated soils by site workers - Central Tendency Estimate

Workers are assumed to present on site 250 days/year for 9 years. Workers are assumed to conduct part of their work activities outdoors during 1/5th of their work days (50 days/year). It is assumed that worker's hands will be available for contact with site soils during work outdoors. A soil-to-skin adherence factor (1mg/m^3) is used to estimate the amount of soil that will be in contact with worker's skin, and absorption factors are used to estimate the amount of contaminant that will pass through the skin into the body. Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils. Dioxins and PCBs are not contaminants of potential concern at LIF, and dermal exposures will be estimated for only cadmium on-site. The equation used for developing central tendency estimates of dermal contact with contaminated soils by site workers is shown in Table 17.

Inhalation of windblown dusts by site workers - Central tendency estimate

Inhalation of windblown dust derived from site soils is assumed to be a possible exposure route for potential future workers on the western portion of the site under the central tendency exposure scenario. A modification of the model used in the baseline risk assessment to estimate exposures to windblown dusts at LIF will be used for the central tendency analysis. The central tendency estimate will assume that the contaminant concentrations in airborne dust are the same as those estimated for surface soils on-site, and that 1/4 of the PM_{10} in air on-site is derived from on-site surface soils. The concentration of PM_{10} at the site was assumed to be equal to the average concentration detected at the monitoring station at Eisenhower park in Nassau county (26 ug/m^3). Workers are assumed to work 8 hour days at the site 250 days per year for 9 years, and are assumed to have a respiratory rate of 18m^3/day. Indoor respirable dust concentrations are assumed to be equal to those outdoors. The equation used for estimating worker exposures to site contaminants by inhalation in Table 18.

TABLE 17

Equation for estimation of dermal contact with contaminated soils by site workers
Central tendency exposure scenario

$$CDI = (mg/kg\text{-}d) = \frac{CS \times CF \times SA \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface available for contact (cm^2/day)
AF	=	Solid to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure Assumptions (future site worker, dermal contact with soils)

CS	=	95% UCL soil concentration
SA	=	840 cm^2 for the future site worker. This value represents the mean surface area for the hands (EPA, 1989b).
AF	=	1 mg/cm^2 (EPA, 1989a)
ABS	=	0.01 - cadmium (EPA 1992b)
EF	=	50 days/year
ED	=	9 years
BW	=	70 kg
AT	=	365 days/year x 70 years for carcinogens
	=	365 days/year x 25 years for noncarcinogens

Incidental ingestion of on-site surface soils by potential future on-site workers

The central tendency assessment assumes that incidental ingestion of on-site surface soils may occur following direct contact with soils by potential future site workers. Workers are assumed to ingest soils from the site during every working day at a rate of 35 mg/d, 250 days/year for 9 years. Soil and dust contaminant concentrations are assumed to be equal whether the worker is indoors or outdoors. Ingestion is assumed to occur during every work day. The equation to determine potential chronic daily intakes by incidental ingestion is shown in Table 19.

Potential Future Recreational Users of Site - Central Tendency Exposure Estimate

The central tendency assessment assumes that the site may be developed in the future for recreational use. The central tendency assessment assumes that the western portion of the site would become an extension of Ellsworth-Allen park, and would be an attractive area for children and young adults to frequent. Children from are assumed to be on the site for 2 hours/day, 73 days/year for 6 years. Potential future recreational users of the site are assumed to be exposed to site contamination through dermal contact with site soils, inhalation of contaminated dusts and incidental ingestion of site soils. The assumptions used for the estimation of chronic daily intakes for recreational users of the site are discussed below.

Dermal contact with contaminated soils by recreational users of site - Central Tendency exposure

The central tendency assessment assumes that recreational users of the site are present on the site 73 days/year for 6 years. It is assumed that the hands, arms and lower legs will be available for contact with site soils during 75% of the exposure events. During the remaining exposure events, only the hands and arms are assumed to be available for contact with site soils. A soil-to-skin adherence factor (1mg/m^3) is used to estimate the amount of soil that will be in contact with recreational user's skin, and absorption factors are used to estimate the amount of contaminant that will pass through the skin into the body. Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils. Dioxins and

TABLE 18

Equation for estimation of inhalation of contaminated dusts by site workers
Central tendency exposure scenario

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times RD \times FI \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
RD	=	Respirable dust concentration in air (ug/m^3)
FI	=	Fraction inhaled from the site (unitless)
IR	=	Inhalation rate (m^3/d)
CF	=	Conversion factor (10^{-9}kg/ug)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure assumptions (future site worker, dust inhalation)

CS	=	95% UCL concentration
RD	=	6.5 ug/m^3, 1/4 of PM_{10} value from Eisenhower Park, Nassau County (NYSDEC, 1992)
FI	=	0.33
IR	=	18 m^3/d
EF	=	250 days/year
ED	=	9 years
BW	=	70kg
AT	=	365 days x 70 years for carcinogens
	=	365 days x 25 years for noncarcinogens

TABLE 19

Equation for estimation of incidental ingestion of contaminated soil (and dust) by site workers. Central tendency exposure scenario

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
IR	=	soil ingestion rate (mg/d)
CF	=	conversion factor (10^{-6} kg/mg)
EF	=	exposure frequency
ED	=	exposure duration
BW	=	body weight
AT	=	averaging time

Exposure assumptions (future site worker, incidental soil ingestion)

CS	=	95% UCL soil concentration
IR	=	35 mg/day
EF	=	250 days/year
ED	=	9 years
BW	=	70 kg
AT	=	365 days x 70 years for carcinogens
	=	365 days x 25 years for noncarcinogens

PCBs are not contaminants of potential concern at LIF, and dermal exposures will be estimated for only cadmium on-site. The equation used for estimating dermal contact with contaminated soils by recreational users of the site is shown in Table 20.

Inhalation of windblown dusts by recreational users of site

The central tendency assessment assumes that inhalation of windblown dust derived from site soils is a possible exposure route for potential recreational users of the western portion of the site. A modification of the model used in the baseline risk assessment to estimate exposures to windblown dusts at LIF will be used for the central tendency analysis. The central tendency estimate will assume that the contaminant concentrations in airborne dust are the same as those estimated for surface soils on-site, and that 1/4 of the PM_{10} in air on-site is derived from on-site surface soils. The concentration of PM_{10} at the site was assumed to be equal to the average concentration detected at the monitoring station at Eisenhower park in Nassau county (26 ug/m^3). Recreational users are assumed to be present on the site for 2 hours/day, 73 days per year for 6 years, and are assumed to have a respiratory rate of 12 m^3/day. The equation used for estimating exposures to site contaminants by inhalation is shown in Table 21.

Incidental ingestion of on-site surface soils by potential future recreational users of site - central tendency estimate

The central tendency assessment assumes that incidental ingestion of on-site surface soils may occur following direct contact with soils and dusts by potential future recreational users of the site. Recreational users of the site are assumed to ingest soils from the site at a rate of 45 mg/d, 73 days/year from age 0-6, and at a rate of 45 mg/d, 73 days/year from age 10-18. The equation to determine potential chronic daily intakes by incidental ingestion is shown in Table 22.

TABLE 20

Equation for estimation of dermal contact with contaminated soils by recreational users of LIF. Central Tendency exposure scenario

$$CDI = (mg/kg\text{-}d) = \frac{CS \times CF \times SA \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface available for contact (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure Assumptions (recreational user of site, dermal contact with soils)

CS	=	95% UCL soil concentration
SA	=	1735 cm^2 for the future child recreational user (0-6 years old). This value represents the mean surface area for the arms, hands, and lower legs for 75% of exposure events, and the arms and hands for 25% of exposure events for a 1-6 year-old child (EPA 1989b).
AF	=	1 mg/cm^2 (EPA, 1989a)
ABS	=	0.01 - cadmium (EPA 1992b)
EF	=	73 days/year
ED	=	6 years
BW	=	14.5 kg (0-6 years)
AT	=	365 days/year x 70 years for carcinogens
	=	365 days/year x 6 years for noncarcinogens

TABLE 21

Equation for estimation of inhalation of contaminated dusts by recreational users of LIF site. Central Tendency exposure scenario

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times RD \times FI \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
RD	=	Respirable dust concentration in air (ug/m^3)
FI	=	Fraction inhaled from the site (unitless)
IR	=	Inhalation rate ($m^{3/d}$)
CF	=	Conversion factor (10^{-9}kg/ug)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure assumptions (recreational users of site, inhalation of dust)

CS	=	95% UCL concentration
RD	=	6.5 ug/m^3, 1/4 of PM_{10} value from Eisenhower Park, Nassau County (NYSDEC, 1992)
FI	=	0.083
IR	=	12 m^3/d for age 0-6
EF	=	73 days/year
ED	=	6 years
BW	=	14.5 kg (0-6 years)
AT	=	365 days x 70 years for carcinogens
	=	365 days x 6 years for noncarcinogens

TABLE 22

Equation for estimation of incidental ingestion of contaminated soil by recreational users of LIF site. Central Tendency exposure scenario.

$$CDI\ (mg/kg\text{-}d) = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

Where:

CS	=	Chemical concentration in soil (mg/kg)
IR	=	soil ingestion rate
CF	=	conversion factor (10^{-6} kg/mg)
EF	=	exposure frequency
ED	=	exposure duration
BW	=	body weight
AT	=	averaging time

Exposure assumptions (recreational users of site, incidental ingestion of soil)

CS	=	95% UCL soil concentration
IR	=	45 mg/day (0-6 years)
EF	=	73 days/year
ED	=	6 years (noncarcinogens)
BW	=	14.5 kg (1-6 years)
AT	=	365 days x 70 years for carcinogens
	=	365 days x 6 years for noncarcinogens

7.3 *Chronic Daily Intakes For Potential Future Workers and Recreational Users at LIF - Central Tendency Estimates*

Chronic daily intakes for workers and recreational users of the site are determined using 95% UCL exposure point concentrations in conjunction with the exposures estimated from the equations in Tables 17-22. The central tendency estimates of the chronic daily intakes by dermal contact, incidental ingestion and inhalation of carcinogenic compounds by potential future workers are shown in Table 23. Central tendency estimates of chronic daily intakes of noncarcinogens by potential future workers are shown in Table 24. Central tendency estimates of the chronic daily intakes by dermal contact, incidental ingestion and inhalation of carcinogenic compounds by potential future recreational users of the site are shown in Table 25. Central tendency estimates of chronic daily intakes of noncarcinogens by potential future recreational users of the site are shown in Table 26.

7.4 *Potential Future Recreational use of LIF - Central Tendency Estimates of Noncancer Hazards and Cancer Risks*

The BRAA assumes that the LIF site may be developed in the future for recreational use. According to this scenario, the western portion of the site would become an extension of Ellsworth-Allen park, and would be an attractive area for children and young adults to frequent. Noncarcinogenic hazards and carcinogenic risks associated with each of these exposure pathways are discussed below.

7.4.1 Dermal Exposures to Contaminants in Site Soils by Recreational Users of LIF - Central Tendency Exposure Estimate

Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils. Dioxins and PCBs are not contaminants of potential concern at LIF, and dermal exposures were estimated for only cadmium on-site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report.

TABLE 23

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over a Lifetime for Carcinogens
Based on Upper 95% Confidence Limit Concentration
Future Commercial/Industrial Use - Central Tendency Estimate
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	8.4 E-07	‡	9.3 E-10
Tetrachloroethene	1.5 E-08	‡	1.7 E-11
Trichloroethene	1.5 E-08	‡	1.6 E-11
Arsenic	7.5 E-07	‡	8.4 E-10
Beryllium	1.7 E-08	‡	1.9 E-11
Cadmium	†	†	4.5 E-08
Chromium	†	‡	2.1 E-06

† = A cancer slope factor for the chemical is not available for this route of exposure
‡ = A dermal absorption factor from soil is not available for this chemical

TABLE 24

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over the Exposure Period for Noncarcinogens
Based on Upper 95% Confidence Limit Concentration
Future Commercial/Industrial Use - Central Tendency Estimate
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	2.3 E-06	‡	2.6 E-09
1,2-Dichloroethene	2.8 E-08	‡	3.1 E-11
Endosulfan II	2.1 E-09	‡	2.3 E-12
Endrin Aldehyde	3.6 E-10	‡	4 E-13
Endrin Ketone	4.8 E-08	‡	5.4 E-11
Tetrachloroethene	4.3 E-08	‡	4.8 E-11
Trichloroethene	4.1 E-08	‡	4.6 E-11
Antimony	1.9 E-06	‡	2 E-09
Arsenic	2.1 E-06	‡	2.4 E-09
Barium	2.9 E-05	‡	3.2 E-08
Beryllium	4.8 E-08	‡	5.4 E-11
Cadmium	1.1 E-04	5.5 E-06	1.2 E-07
Chromium	5.3 E-03	‡	6 E-06
Cyanide	1.5 E-04	‡	1.7 E-07
Manganese	6.6 E-05	‡	7.3-08
Nickel	9.8 E-05	‡	1 E-07
Zinc	1.7 E-02	‡	1.9 E-05

‡ = A dermal absorption factor from soil is not available for this chemical

TABLE 25

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over a Lifetime for Carcinogens
Based on Upper 95% Confidence Limit Concentration
Future Recreational Use - Central Tendency Estimate
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	1 E-06	‡	1.5 E-10
Tetrachloroethene	1.9 E-08	‡	2.7 E-12
Trichloroethene	1.8 E-08	‡	2.6 E-12
Arsenic	9.1 E-07	‡	1.3 E-10
Beryllium	2.1 E-08	‡	3 E-12
Cadmium	†	†	7.1 E-09
Chromium	†	†‡	3.3 E-07

† = A cancer slope factor for the chemical is not available for this route of exposure
‡ = A dermal absorption factor from soil is not available for this chemical

TABLE 26

Soils 0-2 feet
Doses Through All Exposure Routes Averaged Over the Exposure Period for Noncarcinogens
Based on Upper 95% Confidence Limit Concentration
Future Recreational Use - Central Tendency Estimate
Liberty Industrial Finishing Site

Chemical	Incidental Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Windblown Dust (mg/kg-d)
BEHP	1.2 E-05	‡	1.7 E-09
1,2-Dichloroethene	1.4 E-07	‡	2 E-11
Endosulfan II	1.1 E-08	‡	1.5 E-12
Endrin Aldehyde	1.8 E-09	‡	2.6 E-13
Endrin Ketone	2.4 E-07	‡	3.5 E-11
Tetrachloroethene	2.2 E-07	‡	3.1 E-11
Trichloroethene	2.1 E-07	‡	3 E-11
Antimony	9.3 E-06	‡	1.3 E-09
Arsenic	1.1 E-05	‡	1.5 E-09
Barium	1.5 E-04	‡	2.1 E-08
Beryllium	2.4 E-07	‡	3.5 E-11
Cadmium	5.7 E-04	2.2 E-04	8.3 E-08
Chromium	2.7 E-02	‡	3.9 E-06
Cyanide	7.6 E-04	‡	1.1 E-07
Manganese	3.3 E-04	‡	4.8 E-08
Nickel	4.9 E-04	‡	7.1 E-08
Zinc	8.4 E-02	‡	1.2 E-05

‡ = A dermal absorption factor from soil is not available for this chemical

Potential noncarcinogenic hazards and carcinogenic risks associated with dermal contact with contaminants in site soils are presented in Table 27.

The noncarcinogenic hazard quotients for dermal contact with cadmium is 4. Using central tendency assumptions, the elevated hazard quotient indicates that cadmium has potential to cause adverse health impacts through dermal contact with soils during potential future recreational activity on site.

The carcinogenic risk associated with dermal contact with soils on-site cannot be determined. No dermal absorption factors are available for site contaminants known or thought to be carcinogens. The uncertainty associated with the dermal pathway will be addressed in Section 7 of this report.

7.4.2 Inhalation of windblown dusts by recreational users of the LIF site - central tendency exposure estimate

The central tendency assessment assumed that inhalation of airborne dust derived from site soils is a possible exposure route for potential future recreational users of the western portion of the site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with inhalation of contaminants in dusts derived from site soils are presented in Table 27.

Manganese was the only chemical of potential concern in site soils for which an inhalation reference dose was available and the estimation of hazards associated with inhalation of contaminated dusts on site could only be completed for manganese. The hazard quotient for inhalation of dusts derived from site soils containing manganese is 0.003, suggesting that inhalation of dusts containing manganese at the site is highly unlikely to be of concern. However, numerous contaminants are present in site soils at which are potentially of concern by the inhalation route, including chromium and cadmium. Potential noncarcinogenic hazards associated with inhalation of soils containing these contaminants were discussed in section 7.0 of this report.

The carcinogenic risk associated with inhalation of windblown dust by potential future recreational users of the site is 2 x 10^{-6}, due almost exclusively to inhalation of chromium in site soils. This risk level is within EPA's acceptable cancer risk range of 10^{-4} - 10^{-6}, and is unlikely to be of concern. Inhalation slope factors for most of the contaminants of concern were unavailable. The uncertainty associated with this pathway was discussed in section 7.0 of this report.

7.4.3 Incidental ingestion of surface soils by potential future recreational users of site - central tendency exposure estimate

The central tendency assessment assumed that incidental ingestion of on-site surface soils may occur following direct contact with soils by potential future recreational users of the site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with incidental ingestion of contaminants in site soils are presented in Table 27.

The hazard index for ingestion of contaminated surface soils by potential future recreational users of the site is 1.5 (due to cadmium and chromium). The elevated combined hazard index related to cadmium and chromium at the site indicates that incidental ingestion of these compounds during potential future recreational activity is of may be of concern at the site.

The central tendency carcinogenic risk associated with incidental ingestion of site soils by potential future recreational users of the site is 1 x 10^{-6}, which is considered by EPA to be an insignificant risk.

7.4.4 Combined Noncarcinogenic Hazards and Carcinogenic Risks to Potential Future Recreational Users of LIF - Central Tendency Exposure Estimate

The central tendency assessment assumes that a potential future recreational user of the site is simultaneously exposed through multiple exposure pathways at the site. Noncarcinogenic hazards and carcinogenic risks associated with dermal contact with site soils, incidental ingestion of site soils and inhalation of dusts derived from site soils are combined to determine the cumulative risk to the receptor. The noncarcinogenic hazards and carcinogenic risks from the three exposure pathways are summed in Table 27. Using central tendency assumptions, the total noncarcinogenic hazard index to the recreational user is 5.5 (due to cadmium and chromium). This level exceeds EPA's target hazard index of 1. The total carcinogenic risk to the recreational user is 4×10^{-6} (due primarily to chromium and arsenic). This risk is within EPA's acceptable risk range of 10^{-4} - 10^{-6}.

7.5 *Potential Future Commercial/Industrial use of LIF - Central Tendency Estimates of Noncancer Hazards and Cancer Risks*

The central tendency assessment assumes that LIF may be developed in the future for commercial/industrial use. While on site, it is assumed that workers may be exposed to site contaminants through dermal contact with contaminated soils, incidental ingestion of contaminated soils, and inhalation of dust generated from contaminated on-site soils. Noncarcinogenic hazards and carcinogenic risks associated with each of these exposure pathways are discussed below.

7.5.1 Dermal Exposures to Contaminants in Site Soils by Workers - Central Tendency Exposure Estimate

Current EPA guidance for dermal exposure assessment suggests that adequate data exist for estimation of dermal absorption of only cadmium, PCBs and dioxin from soils. Dioxins and PCBs are not contaminants of potential concern at LIF, and dermal exposures will be estimated for only cadmium. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with dermal contact with contaminants in site soils are presented in Table 28.

Table 27

Combined Noncancer Hazards and Carcinogenic Risks to Potential Future Recreational Users of LIF Central Tendency Assessment

Exposure Pathway	Hazard Index	Carcinogenic Risk
Dermal Exposure to Site Soils	4	0[a]
Inhalation of Contaminated Dust	0.003[b]	2×10^{-6}
Ingestion of Contaminated Soil	1.5	2×10^{-6}
Total	5.5	4×10^{-6}

a Dermal absorption factors are not available for any of the carcinogens present in site soils.

b An inhalation reference dose was available for only manganese. The hazard index for this pathway represents the hazard quotient for manganese.

Using central tendency exposure estimates, the noncarcinogenic hazard quotients for dermal contact with cadmium is 0.1. This level suggests that dermal contact with cadmium in soils at the site is unlikely to present a noncarcinogenic hazard to potential future workers.

The carcinogenic risk associated with dermal contact with soils on site by potential future site workers could not be determined. No dermal absorption factors are available for site contaminants known or thought to be carcinogens. The uncertainty associated with the dermal pathway will be addressed in Section 7 of this report.

7.5.2 *Inhalation of windblown dusts by potential future site workers - Central Tendency Exposure Estimate*

The central tendency assessment assumed that inhalation of airborne dust derived from site soils is a possible exposure route for potential future workers on the western portion of the site. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with inhalation of contaminants in dusts derived from site soils are presented in Table 28.

Manganese was the only chemical of potential concern in site soils for which an inhalation reference dose was available and the estimation of hazards associated with inhalation of contaminated dusts on site could only be completed for manganese. The hazard quotient for inhalation of dusts derived from site soils containing manganese is 0.005, suggesting that inhalation of dusts containing manganese at the site is unlikely to be of concern. However, numerous contaminants are present in site soils at which are potentially of concern by the inhalation route, including chromium and cadmium. Potential noncarcinogenic hazards associated with inhalation of soils containing these contaminants was discussed in section 7.1 of this report.

The carcinogenic risk associated with inhalation of windblown dust by potential future recreational users of the site is 2×10^{-5}, due almost exclusively to inhalation of chromium in site soils. This risk level is within EPA's acceptable cancer risk range of 10^{-4} - 10^{-6}. Inhalation slope factors for most of the contaminants of concern were unavailable and the cancer risks for most of the COPCs could not be determined. The uncertainty associated with this pathway was discussed in section 7.0 of this report.

7.5.3 Incidental ingestion of on-site surface soils by potential future site workers

The central tendency assessment assumed that incidental ingestion of on-site surface soils may occur following direct contact with soils by potential future site workers. The spreadsheets showing the exposure doses, hazard quotients, hazard indices and cancer risks are presented the Appendix of this report. Potential noncarcinogenic hazards and carcinogenic risks associated with inhalation of contaminants in dusts derived from site soils are presented in Table 28.

The HI for incidental ingestion of site soils by potential future site workers using central tendency assumptions is 0.3 (due to cadmium and chromium). The hazard index for the combined effects of cadmium and chromium suggest that incidental ingestion of these compounds by potential future site workers is unlikely to be of concern at the site.

The carcinogenic risk associated with incidental ingestion of site soils by potential future site workers is 1 x 10^{-6}. This risk level is considered to be insignificant by the EPA.

7.5.4 Combined Noncarcinogenic Hazards and Carcinogenic Risks to Potential Future Recreational Users of LIF - Central Tendency Exposure Scenario

The central tendency assessment assumed that a potential future worker at the site is simultaneously exposed through multiple exposure pathways. Noncarcinogenic hazards and carcinogenic risks associated with dermal contact with site soils, inhalation of dusts derived from site soils and incidental ingestion of site soils were combined to determine the cumulative risk to the receptor. The noncarcinogenic hazards and carcinogenic risks from the three exposure pathways are summed in Table 28. The total noncarcinogenic hazard index to the potential future site worker is 0.4 (due to cadmium and chromium), suggesting that these exposures are unlikely to present a significant noncancer hazard to potential future site workers. The total carcinogenic risk to the potential site worker is 2 x 10^{-5} (due primarily to chromium and arsenic). The cancer risk is within EPA's acceptable risk range.

Table 28

Combined Noncancer Hazards and Carcinogenic Risks to Potential Future Site Workers Central Tendency Exposures

Exposure Pathway	Hazard Index	Carcinogenic Risk
Dermal Exposure to Site Soils	0.1	0[a]
Inhalation of Contaminated Dust	0.005[b]	2×10^{-5}
Ingestion of Contaminated Soil	0.3	1×10^{-6}
Total	0.4	2×10^{-5}

a Dermal absorption factors are not available for any of the carcinogens present in site soils.

b An inhalation reference dose was not available for chromium or cadmium. As a result, the hazard quotient for this exposure pathway could not be quantified.

8. SUMMARY AND CONCLUSIONS

Based upon the results of the RI, a Baseline Risk Assessment Addendum was prepared to estimate the risks associated with potential future recreational and commercial/industrial use of LIF. The BRAA estimated the human health noncancer hazards and cancer risks which could result from the contamination at the site if no remedial action were taken in the future.

The Risk Assessment focused on contaminants in the site soils which have the potential to pose risks to human health. The most important contaminants identified at the site included cadmium, chromium, and zinc.

The BRAA addressed the potential health risks during potential future recreational or commercial/industrial use of the site by identifying several potential exposure pathways by which receptors may be exposed to contaminants in site soils. Exposure pathways included dermal contact with contaminants in site soils, incidental ingestion of site soils and inhalation of contaminated dusts derived from site soils. The BRAA utilized reasonable maximum exposure scenarios in order to generate conservative estimates which would not underestimate health risks to potential future receptors at the site.

The likelihood of carcinogenic (cancer-causing) and noncarcinogenic effects due to exposure to site chemicals were considered separately, and it was assumed that the toxic effects of the site-related chemicals would be additive. Thus, carcinogenic and noncarcinogenic risks associated with exposures to individual compounds of concern were summed to indicate the potential risks associated with mixtures of potential carcinogens and noncarcinogens, respectively.

Noncarcinogenic risks were assessed using a hazard index (HI) approach, based on a comparison of expected contaminant intakes and safe levels of intake (Reference Doses). Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects. Estimated intakes of chemicals from site soils were compared to the RfD to derive the hazard quotient for the contaminant in the particular medium. The HI is obtained by adding the hazard quotients for all compounds across all media that impact a particular receptor population. An HI greater than 1.0 indicates that the potential exists for noncarcinogenic health effects to occur as a result of site-related exposures. A summary of the noncarcinogenic risks associated with these chemicals across various exposure pathways is presented in Tables 15 and 16.

The HI for noncarcinogenic effects to potential recreational users of the site is 25 (due to cadmium and chromium). Incidental ingestion of contaminated soil makes the greatest contribution to the HI for recreational users of the site. The HI for noncarcinogenic effects to potential future site workers is 5 (due primarily to cadmium and chromium). Dermal contact with and incidental ingestion of contaminated soil make nearly equal contributions to the HI for potential future workers at the site.

Potential carcinogenic risks were evaluated using the cancer slope factors developed by EPA for the contaminants of concern. SFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to generate an upper-bound estimate of the excess lifetime cancer risk associated with exposure to the compound at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes the underestimation of the risk highly unlikely.

For known or suspected carcinogens, EPA considers excess upper-bound individual lifetime cancer risks of between 10^{-4} to 10^{-6} to be acceptable. This level indicates that an individual has not greater than a one in ten thousand to one in a million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year period under specific exposure conditions at the site.

The cancer risk to potential recreational users of the site is 3.2×10^{-5} (due primarily to cadmium, chromium and arsenic). Dermal contact with and incidental ingestion of contaminated soil make the greatest contribution to the cancer risks for recreational users of the site. The cancer risk to potential future site workers is 2 x 10^{-4} (due primarily to cadmium and chromium). Inhalation of contaminated dusts accounts for most of the cancer risk for potential future workers at the site. Cancer risks to potential future site workers are within the upper end of EPA's acceptable risk range.

Cancer risks and noncancer hazards were subsequently recalculated using central tendency estimates of exposure to provide information regarding the range of uncertainty in the risk estimates. Using central tendency exposure estimates, the cancer risk to potential recreational users of the site is 3 x 10^{-6} (due primarily to cadmium, chromium and arsenic). The central tendency assessment revealed that dermal contact with and incidental ingestion of contaminated soil make the greatest contribution to the cancer risks for recreational users of the site. The cancer risk to potential future site workers under the central tendency exposure scenarios is 1.6 x 10^{-5} (due primarily to cadmium and chromium). The central tendency assessment revealed that inhalation of contaminated dusts accounts for most of the cancer risk for potential future workers at the site. Using central tendency exposure scenarios, cancer risks to potential future site workers are within EPA's acceptable risk range.

The procedures and inputs used to assess risks in this evaluation, as in all such assessments, are subject to a wide variety of uncertainties. In general, the main sources of uncertainty include environmental chemistry sampling and analysis, environmental parameter measurement, fate and transport modeling, exposure parameter estimation and toxicological data.

At LIF there is a considerable range in contaminant concentrations detected across the 30 acre site. The BRAA used conservative estimates of the actual contaminant concentrations present in site soils. This likely leads to overestimation of health risks related to much of the western portion of the LIF site. Uncertainties in the frequency and magnitude of exposures at the site were addressed by making conservative assumptions concerning risk and exposure parameters throughout the assessment. The use of conservative exposure estimates may overestimate the actual risks associated with the site. Toxicological data were not available for a number of potentially important chemicals and exposure pathways at the site. Risks related to dermal absorption of numerous potentially important chemicals could not be evaluated in the BRAA. Similarly, inhalation reference concentrations and slope factors were unavailable for most of the chemicals detected at the site. Chromium is of particular concern, as this compound was detected at very high concentrations in site soils and is known to be highly toxic by inhalation. The inability to calculate noncancer hazards and cancer risks for many of the chemicals detected at the site may result in an underestimation of risks at the site.

The uncertainties inherent in the risk assessment process and specific to LIF must be acknowledged when considering the results of the BRAA. The noncancer hazards and cancer risks generated in the BRAA should not be viewed as predictions of health outcomes at the site. Rather, the risk evaluation conducted in the BRAA are best used as a tool to put the site risks in perspective and to assist in decision-making regarding selection of remedial alternatives at LIF.

9.0 REFERENCES

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APPENDIX

SPREADSHEETS FOR NONCANCER HAZARD AND CANCER RISK CALCULATIONS

WORKER SOIL INGESTION SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:	CANCER RISK	HAZARD INDEX		
EXPOSURE DURATION (YEARS)	25	25	TOTAL CANCER RISK:	5.57E-06
EXPOSURE FREQUENCY (DAYS/Y)	250	250		
INGESTION RATE (MG/D)	50	50	TOTAL HI:	1.53E+00
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06		
DAYS PER YEAR	365	365		
AVERAGING TIME (YR)	70	25		
BODY WEIGHT (KG)	70	70		

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG-D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
BEHP	1.90E+01	3.32E-06	1.40E-02	4.65E-08	9.30E-06	2.00E-02	4.65E-04
1,2-dichloroethene	2.28E-01	3.98E-08		0.00E+00	1.12E-07	9.00E-03	1.24E-05
Endosulfan II	1.70E-02	2.97E-09		0.00E+00	8.32E-09	6.00E-03	1.39E-06
Endrin Aldehyde	2.90E-03	5.07E-10		0.00E+00	1.42E-09	3.00E-04	4.73E-06
Endrin Ketone	3.90E-01	6.81E-08		0.00E+00	1.91E-07	3.00E-04	6.36E-04
Tetrachloroethene	3.50E-01	6.12E-08	5.20E-02	3.18E-09	1.71E-07	1.00E-02	1.71E-05
Trichloroethene	3.32E-01	5.80E-08	1.10E-02	6.38E-10	1.62E-07	6.00E-03	2.71E-05
Antimony	1.50E+01	2.62E-06		0.00E+00	7.34E-06	4.00E-04	1.83E-02
Arsenic	1.71E+01	2.99E-06	1.75E+00	5.23E-06	8.37E-06	3.00E-04	2.79E-02
Barium	2.33E+02	4.07E-05		0.00E+00	1.14E-04	7.00E-02	1.63E-03
Beryllium	3.92E-01	6.85E-08	4.30E+00	2.95E-07	1.92E-07	5.00E-03	3.84E-05
Cadmium	9.25E+02	1.62E-04		0.00E+00	4.53E-04	1.00E-03	4.53E-01
Chromium	4.33E+04	7.57E-03		0.00E+00	2.12E-02	3.00E-02	7.06E-01
Cyanide	1.22E+03	2.13E-04		0.00E+00	5.97E-04	2.00E-02	2.98E-02
Manganese	5.33E+02	9.31E-05		0.00E+00	2.61E-04	5.00E-03	5.22E-02
Nickel	7.93E+02	1.39E-04		0.00E+00	3.88E-04	2.00E-02	1.94E-02
Zinc	1.36E+05	2.38E-02		0.00E+00	6.65E-02	3.00E-01	2.22E-01

WORKER DERMAL EXPOSURE SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:

	CANCER RISK	HAZARD INDEX
EXPOSURE DURATION (YEARS)	25	25
EXPOSURE FREQUENCY (DAYS/Y)	125	125
ADHERENCE FACTOR (MG/CM2)	1	1
SKIN SURFACE AREA (CM2)	1695	1695
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06
DAYS PER YEAR	365	365
AVERAGING TIME (YR)	70	25
BODY WEIGHT (KG)	70	70
ABSORPTION FACTOR PCBS	0.06	0.06
ABSORPTION FACTOR CADMIUM	0.01	0.01

TOTAL CANCER RISK: 0.00E+00

TOTAL HI: 1.53E+00

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
CADMIUM	9.25E+02	2.74E-05	0.00E+00	0.00E+00	7.67E-05	5.00E-05	1.53E+00

WORKER SOIL INHALATION SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:

	CANCER RISK	HAZARD INDEX
EXPOSURE DURATION (YEARS)	25	25
EXPOSURE FREQUENCY (DAYS/Y)	250	250
INHALATION RATE (M3/D)	20	20
CONVERSION FACTOR (KG/UG)	1.00E-09	1.00E-09
DAYS PER YEAR	365	365
AVERAGING TIME (YR)	70	25
BODY WEIGHT (KG)	70	70
FRACTION INHALED ONSITE	3.33E-01	3.33E-01
RESPIRABLE DUST CONC UG/M3	13	13

TOTAL CANCER RISK: 9.36E-05

TOTAL HI: 3.12E-02

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
BEHP	1.90E+01	5.75E-09			1.61E-08		
1,2-dichloroethene	2.28E-01	6.91E-11			1.93E-10		
Endosulfan II	1.70E-02	5.15E-12			1.44E-11		
Endrin Aldehyde	2.90E-03	8.78E-13			2.46E-12		
Endrin Ketone	3.90E-01	1.18E-10			3.31E-10		
Tetrachloroethene	3.50E-01	1.06E-10	2.00E-03	2.12E-13	2.97E-10		
Trichloroethene	3.32E-01	1.01E-10	6.00E-03	6.03E-13	2.82E-10		
Antimony	1.50E+01	4.54E-09			1.27E-08		
Arsenic	1.71E+01	5.18E-09	1.51E+01	7.82E-08	1.45E-08		
Barium	2.33E+02	7.06E-08			1.98E-07		
Beryllium	3.92E-01	1.19E-10	8.40E+00	9.97E-10	3.32E-10		
Cadmium	9.25E+02	2.80E-07	6.30E+00	1.76E-06	7.84E-07		
Chromium	4.33E+04	1.31E-05	7.00E+00	9.18E-05	3.67E-05		
Cyanide	1.22E+03	3.69E-07			1.03E-06		
Manganese	5.33E+02	1.61E-07			4.52E-07	1.45E-05	3.12E-02
Nickel	7.93E+02	2.40E-07			6.72E-07		
Zinc	1.36E+05	4.12E-05			1.15E-04		

RECREATIONAL SOIL INGESTION SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:	CANCER RISK	HAZARD INDEX		
EXPOSURE DURATION (YEARS)	18	6	TOTAL CANCER RISK:	1.35E-05
EXPOSURE FREQUENCY (DAYS/Y)	172	172		
INGESTION RATE (MG/D)	133	200	TOTAL HI:	2.03E+01
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06		
DAYS PER YEAR	365	365		
AVERAGING TIME (YR)	70	6		
BODY WEIGHT (KG)	38	14.5		

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
BEHP	1.90E+01	8.06E-06	1.40E-02	1.13E-07	1.23E-04	2.00E-02	6.17E-03
1,2-dichloroethene	2.28E-01	9.67E-08		0.00E+00	1.48E-06	9.00E-03	1.65E-04
Endosulfan II	1.70E-02	7.21E-09		0.00E+00	1.10E-07	6.00E-03	1.84E-05
Endrin Aldehyde	2.90E-03	1.23E-09		0.00E+00	1.88E-08	3.00E-04	6.28E-05
Endrin Ketone	3.90E-01	1.65E-07		0.00E+00	2.53E-06	3.00E-04	8.45E-03
Tetrachloroethene	3.50E-01	1.48E-07	5.20E-02	7.72E-09	2.27E-06	1.00E-02	2.27E-04
Trichloroethene	3.32E-01	1.41E-07	1.10E-02	1.55E-09	2.16E-06	6.00E-03	3.60E-04
Antimony	1.50E+01	6.36E-06		0.00E+00	9.75E-05	4.00E-04	2.44E-01
Arsenic	1.71E+01	7.25E-06	1.75E+00	1.27E-05	1.11E-04	3.00E-04	3.70E-01
Barium	2.33E+02	9.88E-05		0.00E+00	1.51E-03	7.00E-02	2.16E-02
Beryllium	3.92E-01	1.66E-07	4.30E+00	7.15E-07	2.55E-06	5.00E-03	5.10E-04
Cadmium	9.25E+02	3.92E-04		0.00E+00	6.01E-03	1.00E-03	6.01E+00
Chromium	4.33E+04	1.84E-02		0.00E+00	2.81E-01	3.00E-02	9.38E+00
Cyanide	1.22E+03	5.17E-04		0.00E+00	7.93E-03	2.00E-02	3.96E-01
Manganese	5.33E+02	2.26E-04		0.00E+00	3.46E-03	5.00E-03	6.93E-01
Nickel	7.93E+02	3.36E-04		0.00E+00	5.15E-03	2.00E-02	2.58E-01
Zinc	1.36E+05	5.77E-02		0.00E+00	8.84E-01	3.00E-01	2.95E+00

RECREATIONAL USE DERMAL EXPOSURE SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:

	CANCER RISK	HAZARD INDEX
EXPOSURE DURATION (YEARS)	18	6
EXPOSURE FREQUENCY (DAYS/Y)	172	172
ADHERENCE FACTOR (MG/CM2)	1	1
SKIN SURFACE AREA (CM2)	2800	1735
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06
DAYS PER YEAR	365	365
AVERAGING TIME (YR)	70	6
BODY WEIGHT (KG)	38	14.5
ABSORPTION FACTOR PCBS	0.06	0.06
ABSORPTION FACTOR CADMIUM	0.01	0.01

TOTAL CANCER RISK: 0.00E+00

TOTAL HI: 1.04E+01

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
CADMIUM	9.25E+02	8.26E-05	0.00E+00	0.00E+00	5.22E-04	5.00E-05	1.04E+01

RECREATIONAL SOIL INHALATION SCENARIO (0-2′ SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:

	CANCER RISK	HAZARD INDEX		
EXPOSURE DURATION (YEARS)	18	6	TOTAL CANCER RISK:	1.92E-05
EXPOSURE FREQUENCY (DAYS/Y)	172	172		
INHALATION RATE (M3/D)	18	15	TOTAL HI:	1.94E-02
CONVERSION FACTOR (KG/UG)	1.00E-09	1.00E-09		
DAYS PER YEAR	365	365		
AVERAGING TIME (YR)	70	6		
BODY WEIGHT (KG)	38	14.5		
FRACTION INHALED ONSITE	8.33E-02	8.33E-02		
RESPIRABLE DUST CONC	13	13		

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
BEHP	1.90E+01	1.18E-09		0.00E+00	1.00E-08		
1,2-dichloroethene	2.28E-01	1.42E-11		0.00E+00	1.20E-10		
Endosulfan II	1.70E-02	1.06E-12		0.00E+00	8.98E-12		
Endrin Aldehyde	2.90E-03	1.80E-13		0.00E+00	1.53E-12		
Endrin Ketone	3.90E-01	2.43E-11		0.00E+00	2.06E-10		
Tetrachloroethene	3.50E-01	2.18E-11	2.00E-03	4.35E-14	1.85E-10		
Trichloroethene	3.32E-01	2.06E-11	6.00E-03	1.24E-13	1.75E-10		
Antimony	1.50E+01	9.33E-10			7.92E-09		
Arsenic	1.71E+01	1.06E-09	1.51E+01	1.61E-08	9.03E-09		
Barium	2.33E+02	1.45E-08		0.00E+00	1.23E-07		
Beryllium	3.92E-01	2.44E-11	8.40E+00	2.05E-10	2.07E-10		
Cadmium	9.25E+02	5.75E-08	6.30E+00	3.62E-07	4.88E-07		
Chromium	4.33E+04	2.69E-06	7.00E+00	1.88E-05	2.29E-05		
Cyanide	1.22E+03	7.59E-08		0.00E+00	6.44E-07		
Manganese	5.33E+02	3.31E-08		0.00E+00	2.81E-07	1.45E-05	1.94E-02
Nickel	7.93E+02	4.93E-08		0.00E+00	4.19E-07		
Zinc	1.36E+05	8.46E-06		0.00E+00	7.18E-05		

RECREATIONAL CENTRAL TENDENCY SOIL INGESTION SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:	CANCER RISK	HAZARD INDEX		
EXPOSURE DURATION (YEARS)	6	6	TOTAL CANCER RISK:	1.70E-06
EXPOSURE FREQUENCY (DAYS/Y)	73	73		
INGESTION RATE (MG/D)	45	45	TOTAL HI:	1.94E+00
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06		
DAYS PER YEAR	365	365		
AVERAGING TIME (YR)	70	6		
BODY WEIGHT (KG)	14.5	14.5		

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
BEHP	1.90E+01	1.01E-06	1.40E-02	1.42E-08	1.18E-05	2.00E-02	5.90E-04
1,2-dichloroethene	2.28E-01	1.21E-08		0.00E+00	1.42E-07	9.00E-03	1.57E-05
Endosulfan II	1.70E-02	9.04E-10		0.00E+00	1.06E-08	6.00E-03	1.76E-06
Endrin Aldehyde	2.90E-03	1.54E-10		0.00E+00	1.80E-09	3.00E-04	6.00E-06
Endrin Ketone	3.90E-01	2.07E-08		0.00E+00	2.42E-07	3.00E-04	8.07E-04
Tetrachloroethene	3.50E-01	1.86E-08	5.20E-02	9.68E-10	2.17E-07	1.00E-02	2.17E-05
Trichloroethene	3.32E-01	1.77E-08	1.10E-02	1.94E-10	2.06E-07	6.00E-03	3.43E-05
Antimony	1.50E+01	7.98E-07		0.00E+00	9.31E-06	4.00E-04	2.33E-02
Arsenic	1.71E+01	9.10E-07	1.75E+00	1.59E-06	1.06E-05	3.00E-04	3.54E-02
Barium	2.33E+02	1.24E-05		0.00E+00	1.45E-04	7.00E-02	2.07E-03
Beryllium	3.92E-01	2.09E-08	4.30E+00	8.97E-08	2.43E-07	5.00E-03	4.87E-05
Cadmium	9.25E+02	4.92E-05		0.00E+00	5.74E-04	1.00E-03	5.74E-01
Chromium	4.33E+04	2.30E-03		0.00E+00	2.69E-02	3.00E-02	8.96E-01
Cyanide	1.22E+03	6.49E-05		0.00E+00	7.57E-04	2.00E-02	3.79E-02
Manganese	5.33E+02	2.84E-05		0.00E+00	3.31E-04	5.00E-03	6.62E-02
Nickel	7.93E+02	4.22E-05		0.00E+00	4.92E-04	2.00E-02	2.46E-02
Zinc	1.36E+05	7.24E-03		0.00E+00	8.44E-02	3.00E-01	2.81E-01

RECREATIONAL USE CENTRAL TENDENCY DERMAL EXPOSURE SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:

	CANCER RISK	HAZARD INDEX
EXPOSURE DURATION (YEARS)	6	6
EXPOSURE FREQUENCY (DAYS/Y)	73	73
ADHERENCE FACTOR (MG/CM2)	1	1
SKIN SURFACE AREA (CM2)	1735	1735
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06
DAYS PER YEAR	365	365
AVERAGING TIME (YR)	70	6
BODY WEIGHT (KG)	14.5	14.5
ABSORPTION FACTOR PCBS	0.06	0.06
ABSORPTION FACTOR CADMIUM	0.01	0.01

TOTAL CANCER RISK: 0.00E+00

TOTAL HI: 4.43E+00

COMPOUND	CONCENTRATION (MG/KG)	CANCER DOSE (MG/KG/D)	CANCER CPF	CANCER RISK	NONCANCER DOSE (MG/KG/D)	NONCANCER RfD	NONCANCER HQ
CADMIUM	9.25E+02	1.90E-05	0.00E+00	0.00E+00	2.21E-04	5.00E-05	4.43E+00

RECREATIONAL CENTRAL TENDENCY DUST INHALATION SCENARIO (0-2′ SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:

	CANCER RISK	HAZARD INDEX
EXPOSURE DURATION (YEARS)	6	6
EXPOSURE FREQUENCY (DAYS/Y)	73	73
INHALATION RATE (M3/D)	12	12
CONVERSION FACTOR (KG/UG)	1.00E-09	1.00E-09
DAYS PER YEAR	365	365
AVERAGING TIME (YR)	70	6
BODY WEIGHT (KG)	14.5	14.5
FRACTION INHALED ONSITE	8.33E-02	8.33E-02
RESPIRABLE DUST CONC	6.5	6.5

TOTAL CANCER RISK: 2.38E-06

TOTAL HI: 3.30E-03

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
BEHP	1.90E+01	1.46E-10			1.70E-09		
1,2-dichloroethene	2.28E-01	1.75E-12			2.04E-11		
Endosulfan II	1.70E-02	1.31E-13			1.52E-12		
Endrin Aldehyde	2.90E-03	2.23E-14			2.60E-13		
Endrin Ketone	3.90E-01	3.00E-12			3.50E-11		
Tetrachloroethene	3.50E-01	2.69E-12	2.00E-03	5.38E-15	3.14E-11		
Trichloroethene	3.32E-01	2.55E-12	6.00E-03	1.53E-14	2.98E-11		
Antimony	1.50E+01	1.15E-10			1.34E-09		
Arsenic	1.71E+01	1.31E-10	1.51E+01	1.98E-09	1.53E-09		
Barium	2.33E+02	1.79E-09			2.09E-08		
Beryllium	3.92E-01	3.01E-12	8.40E+00	2.53E-11	3.51E-11		
Cadmium	9.25E+02	7.11E-09	6.30E+00	4.48E-08	8.29E-08		
Chromium	4.33E+04	3.33E-07	7.00E+00	2.33E-06	3.88E-06		
Cyanide	1.22E+03	9.38E-09			1.09E-07		
Manganese	5.33E+02	4.10E-09			4.78E-08	1.45E-05	3.30E-03
Nickel	7.93E+02	6.09E-09			7.11E-08		
Zinc	1.36E+05	1.05E-06			1.22E-05		

WORKER CENTRAL TENDENCY SOIL INGESTION SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:	CANCER RISK	HAZARD INDEX		
EXPOSURE DURATION (YEARS)	9	9	TOTAL CANCER RISK:	1.40E-06
EXPOSURE FREQUENCY (DAYS/Y)	250	250		
INGESTION RATE (MG/D)	35	35	TOTAL HI:	3.86E-01
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06		
DAYS PER YEAR	365	365		
AVERAGING TIME (YR)	70	25		
BODY WEIGHT (KG)	70	70		

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG-D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
BEHP	1.90E+01	8.37E-07	1.40E-02	1.17E-08	2.34E-06	2.00E-02	1.17E-04
1,2-dichloroethene	2.28E-01	1.00E-08		0.00E+00	2.81E-08	9.00E-03	3.12E-06
Endosulfan II	1.70E-02	7.49E-10		0.00E+00	2.10E-09	6.00E-03	3.49E-07
Endrin Aldehyde	2.90E-03	1.28E-10		0.00E+00	3.58E-10	3.00E-04	1.19E-06
Endrin Ketone	3.90E-01	1.72E-08		0.00E+00	4.81E-08	3.00E-04	1.60E-04
Tetrachloroethene	3.50E-01	1.54E-08	5.20E-02	8.01E-10	4.32E-08	1.00E-02	4.32E-06
Trichloroethene	3.32E-01	1.46E-08	1.10E-02	1.61E-10	4.09E-08	6.00E-03	6.82E-06
Antimony	1.50E+01	6.60E-07		0.00E+00	1.85E-06	4.00E-04	4.62E-03
Arsenic	1.71E+01	7.53E-07	1.75E+00	1.32E-06	2.11E-06	3.00E-04	7.03E-03
Barium	2.33E+02	1.03E-05		0.00E+00	2.87E-05	7.00E-02	4.10E-04
Beryllium	3.92E-01	1.73E-08	4.30E+00	7.42E-08	4.83E-08	5.00E-03	9.67E-06
Cadmium	9.25E+02	4.07E-05		0.00E+00	1.14E-04	1.00E-03	1.14E-01
Chromium	4.33E+04	1.91E-03		0.00E+00	5.34E-03	3.00E-02	1.78E-01
Cyanide	1.22E+03	5.37E-05		0.00E+00	1.50E-04	2.00E-02	7.52E-03
Manganese	5.33E+02	2.35E-05		0.00E+00	6.57E-05	5.00E-03	1.31E-02
Nickel	7.93E+02	3.49E-05		0.00E+00	9.78E-05	2.00E-02	4.89E-03
Zinc	1.36E+05	5.99E-03		0.00E+00	1.68E-02	3.00E-01	5.59E-02

WORKER CENTRAL TENDENCY DERMAL EXPOSURE SCENARIO (0-2' SOILS, EXCLUDING PCBs):

EXPOSURE PARAMETERS:	CANCER RISK	HAZARD INDEX
EXPOSURE DURATION (YEARS)	9	9
EXPOSURE FREQUENCY (DAYS/Y)	50	50
ADHERENCE FACTOR (MG/CM2)	1	1
SKIN SURFACE AREA (CM2)	840	840
CONVERSION FACTOR (KG/MG)	1.00E-06	1.00E-06
DAYS PER YEAR	365	365
AVERAGING TIME (YR)	70	25
BODY WEIGHT (KG)	70	70
ABSORPTION FACTOR PCBS	0.06	0.06
ABSORPTION FACTOR CADMIUM	0.01	0.01

TOTAL CANCER RISK: 0.00E+00

TOTAL HI: 1.09E-01

		CANCER			NONCANCER		
COMPOUND	CONCENTRATION (MG/KG)	DOSE (MG/KG/D)	CPF	CANCER RISK	DOSE (MG/KG/D)	RfD	HQ
CADMIUM	9.25E+02	1.95E-06	0.00E+00	0.00E+00	5.47E-06	5.00E-05	1.09E-01