Baseline Human Health Risk Assessment

South Minneapolis Soil Contamination Site, Minneapolis, MN
WA No. 016-RICO-B5BY, Contract No. EP-S5-06-01

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Executive Summary

This Technical Memorandum (TM) presents the approach, assumptions, and results of the baseline human health risk assessment (HHRA) for soils at the South Minneapolis Site ("the Site"). The proposed approach and assumptions for the HHRA were presented in the *Interim Deliverable for the Human Health Risk Assessment – RAGS Part D Tables – South Minneapolis Site* (CH2M HILL, 2006) and were posted on EPA's website in October 2006 for a 30-day public comment period. No public comments were received on the Interim Deliverable, and therefore the assumptions and approach presented in that document were used in the baseline HHRA. Additional realistic exposure assumptions were also incorporated into the HHRA. Public comments made during the September 2006 public meeting were taken into consideration and resulted in changes to the residential and construction worker reasonable maximum exposure (RME) and central tendency exposure (CTE) variables.

This HHRA includes quantitative risk estimates for potential soil, outdoor air, and garden vegetable exposures. Although indoor dust samples were planned as identified in the Interim Deliverable, no samples were collected after the evaluation of the surface soil sample results. Indoor dust concentrations are represented in the HHRA by outdoor soil concentrations since residents may ingest indoor dust potentially impacted through fugitive dust emissions from impacted soil or from tracking indoors. Health-protective preliminary remediation goals (PRGs) were calculated for residents with and without vegetable gardens and construction workers; site-specific background concentrations are also discussed. The tables prepared for the HHRA are provided in EPA RAGS Part D (EPA, 2001) format in **Appendix A**. The overall conceptual site model (CSM) is presented in **Table 1** of **Appendix A** and is described in the following sections.

Exposure parameters used in this HHRA are identified in Tables 4.1 through 4.5 of **Appendix A**. A few of the key parameters used in the HHRA are listed below:

- Adult and infant/child residents and construction workers were evaluated as potential receptors in the area;

- Residents were assumed to be exposed to arsenic in soil or dust via incidental ingestion for 350 days/year; construction workers were assumed to be exposed to soil for 90 days/year.
- Residents were assumed to be exposed to arsenic adhered to soil particulates in ambient air and to dermally contact soil for 185 days/year (the number of days where the soil is not snow-covered and it is not raining in Minneapolis).
- Residents were assumed to grow vegetables in their home gardens. The homegrown garden vegetables were categorized into two groups: above-ground vegetables (e.g., eggplants, tomatoes, and leafy vegetables) and below-ground vegetables (e.g., carrots and potatoes). Over an assumed 4-month growing period during the year, residents are assumed to consume above-ground vegetables for 90 days and below-ground vegetables for 60 days.
- Residents were assumed to be exposed to arsenic in soil/dust for 50 years (to evaluate a high-end exposure) and 15 years (to evaluate an average exposure); construction workers were assumed to be exposed to arsenic in soil for 10 years (to evaluate a high-end exposure) and 1 year (to evaluate an average exposure).

Potential exposures to four arsenic concentrations were evaluated in the HHRA:

- 16 mg/kg (representing background concentrations);
- 95 mg/kg (the interim removal action level);
- 500 mg/kg (a value close to the mean concentration in residential yards currently above the removal action level); and
- 1,500 mg/kg (the approximate maximum detected concentration at homes that have not yet been remediated)

The Excess Lifetime Cancer Risk (ELCR) and hazard calculations indicate potential risks above the upper end of EPA's typical target risk range from arsenic exposures at concentrations of 95 mg/kg, 500 mg/kg, and 1,500 mg/kg for residents and at concentrations of 500 mg/kg and 1,500 mg/kg for construction workers. Most of the estimated risk is from incidental ingestion of soil and dust (approximately 70%) and eating garden vegetables (approximately 25%). A small proportion of estimated risk (approximately 4%) is from dermal contact with soil, and a very small relative proportion of estimated risk (<0.05%) is from inhalation of dusts. Risk-based PRGs were calculated for residents with and without vegetable gardens and construction workers; calculations indicate that arsenic concentrations of 25 mg/kg (or less) are protective of persons residing in the area for up to 50 years with vegetable gardens; arsenic concentrations of 261 mg/kg (or less) are protective of constructions workers. The final cleanup levels for the site will be determined after taking into consideration the uncertainties in the risk assessment.

1. Data Used in the HHRA

The source of arsenic in South Minneapolis Neighborhood soil may be partially attributable to airborne deposition of arsenic herbicides and pesticides that were blended, stored, and distributed at the CMC Heartland Lite Yard Site from 1938 to 1963. The arsenic cycle in soils

is a complex process involving many biotic and abiotic processes that control its overall fate and environmental impact. Arsenic can be present in soil in various oxidation states and chemical species depending on the soil pH and oxidation-reduction potential (**ATDSR, 2005**). The specific form of arsenic currently present at the Site has not been determined.

Soil samples were collected during the Phase 1 and Phase 2 RI, and during post-excavation sampling at remediated properties. For each property sampled, a five-point composite soil sample was collected from the yard from depth intervals within 0-18 inches. If more than one sizable yard was present on a property (e.g., front yard, side yard, and/or backyard), one five-point composite sample was collected from each yard. The available dataset consists of 7,521 soil samples that were collected through the end of 2006 (including original samples and post-remediation samples) for arsenic analysis. All data were validated in accordance with EPA's Quality Assurance/Quality Control (QA/QC) process. The soil samples were collected by various companies or organizations from the general areas identified below:

- **Residential yards not remediated as of 2007** - 0 to 3 inch interval; collected by the EPA; EPA's Fully Integrated Environmental Location Decision Support (FIELDS) group; a contractor under the EPA Response Engineering and Analytical Contract ("REAC"); Minnesota Department of Agriculture (MDA); and Minnesota Department of Health (MDH) from June 2001 through November 2005.
- **Remediated residential properties –** 12 to 18 inch interval; post-excavation samples collected by REAC and EPA from October 2004 through Fall 2006.
- **School properties sampled in Summer 2006 –** 0 to 3 inch interval; collected by the EPA in 2006.
- **Right-of-Way areas along streets** - 0 to 3 inch interval; collected by the MDH, FIELDS, and EPA from June 2001 through October 2005.
- **Vacant land** - 0 to 3 inch interval; collected by FIELDS in August 2005.

2. Potential Receptors

The Site is situated in a densely populated residential area with scattered industrial/commercial properties. Due to the higher exposure frequency and duration for residents compared to workers and schoolchildren, the HHRA focuses on residential exposure scenarios. Industrial and commercial workers are exposed to the same soil depth interval, but at a lower exposure frequency and shorter exposure duration than adult residents. Likewise, schoolchildren are exposed to the same soil depth interval, but at a lower exposure frequency and shorter exposure duration, than residential children. In addition, industrial/commercial workers would likely not eat vegetables grown at the workplace. Therefore, the risks estimated for adult residents and child residents conservatively represent the potential risks to industrial/commercial workers and schoolchildren, respectively, from soil exposures.

The following receptors were identified at the Site and were evaluated in the HHRA:

- **Residents –** child and adult residents at residential properties; and

- **Construction Workers** – workers engaged in short-term remodeling or construction activities at residential properties to soil depths of 5 feet.

The human health CSM presents potential exposure media, exposure points, receptors (current and future), and exposure routes, and is provided in **Table 1** of **Appendix A**.

3. Data Evaluation

The background range of arsenic in surface soil (up to 16 mg/kg) was estimated for the site based on samples collected in the South Minneapolis neighborhood (**CH2M HILL, 2007**). Concentrations up to 10 mg/kg were identified as clearly background at the site. Concentrations between 10 mg/kg and 16 mg/kg were identified as potentially impacted and indistinguishable from either background or impacted soils, while concentrations above 16 mg/kg were concluded to be clearly impacted. A concentration of 16 mg/kg was used to calculate potential risks to receptors exposed to background concentrations of arsenic. Since the risk estimate is proportional to the soil exposure point concentration (EPC), three additional (higher) arsenic EPCs were evaluated in the Risk Characterization Section of the HHRA (see Section 7).

4. Exposure Pathways Quantified in the HHRA

Various potential exposure pathways were quantified in the HHRA. For both adult and child residents, potential accidental ingestion (via hand-to-mouth activities), dermal contact (through the skin), and inhalation (outdoor air) exposures of arsenic in soil and outdoor air were quantified. In addition, potential intakes were quantified for ingestion of homegrown garden vegetables based on modeled concentrations in vegetables grown in impacted soil.

5. Exposure Factors

To assess potential exposures to arsenic in soil, potential intakes were quantified. A soil EPC based on background (16 mg/kg) was first evaluated. Potential risks associated with three additional soil EPCs were quantified:

- 95 mg/kg (the interim removal action level);
- 500 mg/kg (a value close to the mean concentration of residential yards currently above the removal action level); and
- 1,500 mg/kg (the approximate maximum detected concentration at homes that have not yet been remediated).

Multiple soil EPCs are not presented in the risk calculation tables since risk estimates are directly proportional to EPCs, and when risk estimates are calculated for one soil EPC, the estimated risks associated with other EPCs can be calculated by applying the ratio of the original EPC to the associated risk estimate.

RME and CTE scenarios were estimated for residents and construction workers. The term "RME" refers to a type of high-end exposure estimated by using default values, and is typically used as the basis for action at a Superfund site. The term "CTE" refers to an average exposure that is more likely to occur at a site. The exposure factors used in the RME intake calculations are presented in **Tables 4.1 RME** through **4.5 RME** of **Appendix A,** while

the exposure factors used in the CTE intake calculations are presented in **Tables 4.1 CTE** through **4.5 CTE** of **Appendix A.** The majority of the RME and CTE exposure factors are standard default exposure factors presented in EPA guidance **(EPA, 1991; EPA, 1997; EPA, 2004b)**, while others are site- or region- specific parameters determined based on best professional and scientific judgment, as appropriate. A brief summary of absorption factors and non-standard, site-specific exposure factors is presented below. Additional (standard) exposure factors are provided in **Tables 4.1** through **4.5** of **Appendix A**.

Soil Exposure Frequencies for Residents

A regional-specific soil exposure frequency was used in the intake calculations for dermal and inhalation exposures to soil. The soil exposure frequency was identified based on consideration of local climate conditions – specifically, the number of days when the soil is not snow-covered (and the ground is not frozen) and it is not raining.

Based on climate data from October 1959 to May 1979, the average number of days with snow cover of one inch or more in Minneapolis is 100. The average date of the first 1-inch snow cover is November 22 and the average date of the last 1-inch snowfall is April 2 (**University of Minnesota, 1982**). These data indicate that the snow cover is not continuous for the entire period from November 22 through April 2. Therefore, continuous snow cover was assumed for the months of December, January, and February (i.e., no snowfall for 275 days per year).

Based on data available on the Internet at www.weatherbase.com, the average number of days with rainfall in Minneapolis during the months of March through November is 90. Subtracting 90 days (i.e., days with rainfall) from 275 days (i.e., days without snow) yields 185 days where there is no snow cover and no precipitation. Therefore, a soil exposure frequency of 185 days/year was used in the HHRA for dermal and inhalation exposures. However, an exposure frequency of 350 days/year was used for the soil ingestion exposure pathway to account for indoor dust exposure.

Age-Adjusted Intake Rate for Residents

The EPA nationwide default adult and child resident intake rates for soil ingestion, soil dermal contact, and soil inhalation were age-adjusted to account for multiple intake rates, soil-to-skin adherence factors, skin surface areas, inhalation rates, and body weights over an extended time-period (for use in ELCR estimates). Calculations are presented in **Table 4.1 Supplement of Appendix A**. In addition, the EPA nationwide default child resident intake rates for soil ingestion, soil dermal contact, and particulate inhalation were age-adjusted to account for multiple intake rates, soil-to-skin adherence factors, skin surface areas, and body weights over a 7-year period (ages 1 to 8 for use in infant/child hazard estimates). Calculations are presented in **Table 4.3 Supplement of Appendix A.**

Vegetable Intake Rates

A homegrown vegetable ingestion rate of 0.464 kg/day was identified for a RME scenario for an adult in the Midwest (including Minnesota) in EPA's Exposure Factors Handbook (**EPA, 1997**): this ingestion rate roughly equates to vegetable consumption of 1 pound/day for an adult and 0.4 pounds/day for a child. It was assumed that 70% and 30% of their ingestion rates are of above-ground vegetables and below-ground vegetables, respectively,

and 50% of the vegetables are grown in impacted soil in a resident's yard and the remaining vegetables are obtained from another source (or grown in unimpacted soil). Over an assumed 4-month growing period during the year, residents are assumed to consume above-ground vegetables for 90 days and below-ground vegetables for 60 days.

The RME garden vegetable intake rates for a child resident ages 1-8 were calculated using age-specific intake rates presented in the Exposure Factors Handbook (**EPA, 1997**). Calculations are provided in **Table 4.3 Supplement of Appendix A**.

Ingestion of homegrown garden vegetables was not evaluated under the CTE scenario. Most people do not grow vegetables in their own gardens but rather use one of various community gardens available in the area or purchase their vegetables from the grocery store.

Exposure Durations

A duration of exposure (expressed as years) to arsenic is used when estimating intakes for all exposure scenarios. Based on feedback received at the September 26, 2006 public meeting, 50 years was used for the RME scenario and 15 years was used for the CTE scenario for residents. In addition, since construction workers may work in the site vicinity over multiple years, exposure durations of 10 years (RME) and one year (CTE) were used based on feedback received at the September 26, 2006 public meeting. For the aggregate 50-year exposure duration (RME scenario), it was assumed that 6 years of the exposure were spent as a child and 44 years were spent as an adult. For the aggregate 15-year exposure duration (CTE scenario), it was assumed that 6 years of the exposure were spent as a child and 9 years were spent as an adult.

Relative Bioavailability of Arsenic in Soil

The fraction of an ingested dose that is available for distribution to internal tissues and organs (termed "bioavailability") was conservatively assumed to be 90% due to the lack of site-specific bioavailability information. The actual bioavailability is dependent on the physical and chemical form of arsenic present in the soil, and the physical and chemical characteristics of the association between the metal and soil particles. In a study conducted by Sarkar and Dalta (as presented in ATSDR, 2005), arsenic bioavailability was measured in two soils after spiking with sodium arsenate for 4 months: 1) Immokalee (a sandy soil) from Florida, which is likely to have minimal arsenic retention capacity, and 2) Orelia (a sandy clay soil) from Texas, that likely has high arsenic retention capacity. Initially after pesticide application, 100% of the arsenic was bioavailable; after 4 months, the bioavailable fraction decreased to 88 and 69% in the Immokalee and Orelia soils, respectively (ATSDR, 2005). Because the suspected source area was used to manufacture arsenic-based pesticides over 60 years ago, an assumed bioavailability of 90% is expected to be conservative.

Dermal Absorption

A dermal absorption factor is used when evaluating potential dermal exposures to arsenic in soil. The arsenic dermal absorption factor of 0.03 was obtained from EPA dermal guidance (**Wester, et al., 1993 as cited in EPA, 2004**). Although absorption of arsenic by the dermal route has not been well-characterized for humans, reviews of animal studies indicate

that absorption through skin is expected be low compared to other exposure routes (**ATSDR, 2005**).

6. Toxicity Assessment

The specific form of arsenic present at the Site is unknown, and the form of arsenic present in soil or plants is related to its toxicity. Therefore, toxicity information for inorganic arsenic (the most toxic form) was used in the HHRA. The following hierarchy of sources was used to obtain toxicity data for arsenic:

- Integrated Risk Information System (IRIS) **(EPA, 2007)**;
- Provisional Peer-Reviewed Toxicity Values (PPRTVs); and
- Health Effects Assessment Summary Tables (HEAST; **EPA, 1997**).

IRIS provides a database of human health effects that may result from exposure to arsenic. Arsenic is a human carcinogen that can be inhaled, ingested, or absorbed. Studies have shown that arsenic intake can be associated with certain types of cancer such as lung, liver, kidney, bladder, and skin. The RfD is an estimate of a daily exposure to people that will not cause appreciable risks during a lifetime. The RfD for arsenic is based on human chronic oral exposure studies and a safety factor of 3. The RfD is based on the Lowest Observed Adverse Effect Level (LOAEL) and the critical health effects are hyperpigmentation, keratosis and possible vascular complications.

Non-cancer toxicity values used in the HHRA are presented in **Tables 5.1** and **5.2** of **Appendix A**; non-cancer inhalation toxicity values could not be located for arsenic. Cancer toxicity values for arsenic are provided in **Tables 6.1** and **6.2** of **Appendix A.**

Toxicity values provided by EPA typically reflect doses to study subjects via ingestion or inhalation exposures. However, dermal exposures are expressed as absorbed doses. Therefore, the absorbed-dose intakes for dermal exposure must be used with absorbed-dose toxicity values. The absorbed-dose toxicity values were calculated by applying oral absorption factors to administered-dose toxicity values. The EPA's recommended arsenic oral absorption factor is 95%(**Bettley, 1975 as cited in EPA, 2004b**). This value is consistent with findings in several studies in humans that indicate that arsenates and arsenites are well-absorbed across the gastrointestinal tract (**ATSDR, 2005**). In accordance with EPA dermal guidance (**EPA, 2004b**), oral toxicity values were used as dermal toxicity values without adjustment in the HHRA because the recommended oral absorption factor is greater than 50%.

7. Risk Characterization

Risk characterization involves estimating the magnitude of potential adverse health effects from exposure to arsenic. This step of the HHRA combines the estimated intakes (exposure levels) and toxicity values to provide numerical estimates of potential carcinogenic health risks and semi-quantitative estimates of non-carcinogenic health risks. Risk characterization also considers the nature and weight of evidence supporting these estimates, and the magnitude of uncertainty surrounding the estimates.

The risk estimates are intended to provide the basis for management decisions and do not predict actual health outcomes. The estimates are based on conservative (health-protective) assumptions, and therefore actual site-related risks are likely to be less than these estimates.

7.1 Approach for Assessing Potential Cancer Risks

To characterize potential carcinogenic effects, statistical probabilities are estimated from calculated intakes and toxicity values that a hypothetical receptor group will develop cancer over a lifetime as a result of the assumed exposures.

Using the cancer slope factors (CSFs), estimated daily intakes averaged over a lifetime of exposure were converted to incremental risks of a hypothetical receptor group developing cancer. The following formula was used to estimate potential ELCR from site exposure:

$$ELCR = Intake \times CSF$$

EPA's target range for carcinogenic risk associated with Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) sites is 1 in 10,000 (1×10^{-4}) to 1 in 1 million (1×10^{-6}). The potential risk associated with the site should not exceed this target range.

7.2 Approach for Assessing Potential Non-carcinogenic Health Effects

Potential non-carcinogenic health risks were estimated by calculating a hazard quotient (HQ) for arsenic for each exposure route. The HQ was calculated as the ratio of the estimated intake to the reference dose (RfD) as follows:

$$HQ = \frac{Intake}{RfD}$$

If the estimated daily intake for arsenic exceeds its RfD, the HQ will exceed 1. An HQ above 1 indicates a potential for adverse health effects associated with arsenic exposure, but does not indicate the actual probability of the adverse health effects.

A hazard index (HI) approach was used to evaluate potential non-carcinogenic health risks for a receptor group posed by more than one exposure route. The HI approach assumes that simultaneous subthreshold exposures by several exposure routes are additive. The HI is equal to the sum of the HQs and was calculated as follows:

$$HI = \frac{I_1}{RfD_1} + \frac{I_2}{RfD_2} \cdots \frac{I_i}{RfD_i}$$

Where:

I = intake level (mg/kg-day)
RfD = chronic reference dose (mg/kg-day)
I_i = intake level (intake) for the ith pathway
RfD_i = reference dose for the ith pathway

A cumulative HI above 1.0 indicates the potential for adverse health effects. The cumulative HI is defined as the sum of the HQs for all media and all pathways of exposure for a particular receptor.

It is EPA's policy to use the chronic RfD when the exposure duration exceeds 10% of a lifetime or 7 years (EPA, 1989). The most at-risk persons are infants and children. The calculation for the infant/child receptor scenario yields the most conservative hazard estimate (i.e., the HI value is highest). Therefore, an exposure from age 1 to age 8 was used to calculate hazard estimates for the residential scenario.

7.3 Results

Potential ELCRs and HIs were calculated for residents with and without vegetable gardens and construction workers for the exposure pathways identified in **Section 4**. Potential intakes and risks for the RME scenarios are presented in **Tables 7.1.RME** through **7.3.RME** of **Appendix A**, while the potential intakes and risks for the CTE scenarios are presented in **Tables 7.1.CTE** through **7.3.CTE** of **Appendix A**. Intake and risk estimates are summarized in **Tables 9.1.RME** through **9.3.RME** and **Tables 9.1.CTE** through **9.3.CTE** of **Appendix A**. Risk estimates greater than 10^{-6} and HIs greater than 1.0 are presented in **Tables 10.1.RME** through **10.3.RME** and **Tables 10.1.CTE** through **10.3.CTE** of **Appendix A**.

Most of the estimated risk is from incidental ingestion of soil and dust (approximately 70%) and eating garden vegetables (approximately 25%). A small proportion of estimated risk (approximately 4%) is from dermal contact with soil, and a very small relative proportion of potential risk (<0.05%) is from inhalation of dusts.

7.3.1 Aggregate Infant/Child Resident (Non-carcinogenic Hazard)

Ingestion and dermal contact exposures to surface soil and inhalation of ambient air were estimated for an aggregate infant/child resident. **Table 9.1.RME** of **Appendix A** summarizes the HI for the infant/child resident based on the background concentration of arsenic in soil (16 mg/kg). The RME HIs (0.6 for both with and without consumption of homegrown garden vegetables) and CTE HI (0.3; **Table 9.1.CTE** of **Appendix A**) are below EPA's target HI of 1.0.

7.3.2 Aggregate Child/Adult Resident (Carcinogenic Risk)

Ingestion and dermal contact exposures to surface soil and inhalation of ambient air were estimated for an aggregate child/adult resident exposed to the background concentration of arsenic in soil (16 mg/kg). The RME ELCR (6×10^{-5} and 5×10^{-5} with and without consumption of homegrown garden vegetables, respectively; **Table 9.2.RME** of **Appendix A)** is within EPA's acceptable target risk range of 10^{-6} to 10^{-4}. The CTE ELCR (1×10^{-5}; **Table 9.2.CTE of Appendix A**) is also within EPA's target risk range of 10^{-6} to 10^{-4}.

7.3.3 Construction Worker

Ingestion and dermal contact exposures to soil (0–5 ft) and inhalation of ambient air were estimated for a construction worker based on the background concentration of arsenic (16 mg/kg). The RME ELCR (4×10^{-6}; **Table 9.3.RME** of **Appendix A)** and CTE ELCR (2×10^{-7}; **Table 9.3.CTE** of **Appendix A**) are within EPA's target risk range. The RME HI (0.06) and CTE HI (0.1) are below EPA's target HI of 1.0.

7.4 Risk Estimates for Other Arsenic Concentrations

The estimated HIs for infant/child residents and construction workers associated with other EPCs (95 mg/kg, 500 mg/kg, and 1,500 mg/kg) were calculated by applying the ratio of the original EPC to its associated HI. The HIs for these additional EPCs are provided in **Table**

11.1a.RME and **Table 11.1b.CTE** of **Appendix A**. The HI estimates for these additional EPCs under the RME scenario are summarized in **Table 7-1**. The estimated HIs exceeding EPA's target HI (1.0) are indicated with highlighting.

The estimated ELCRs for aggregate child/adult residents and construction workers associated with other EPCs (95 mg/kg, 500 mg/kg, and 1,500 mg/kg) were calculated by applying the ratio of the original EPC to its associated ELCR. The ELCRs for these additional EPCs are provided in **Table 11.1a.RME** and **Table 11.1b.CTE** of **Appendix A.** The ELCR estimates for these additional EPCs under the RME scenario are summarized in **Table 7-1** below, and those exceeding EPA's target risk range are indicated with highlighting:

Table 7-1. RME Scenario Risk Estimates for Various Arsenic Concentrations

Excess Lifetime Cancer Risk Estimates	**Arsenic Concentration (mg/kg)**			
	16	**95**	**500**	**1,500**
Aggregate Child/Adult Resident (with garden vegetable consumption)	$6x10^{-5}$	**$4x10^{-4}$**	**$2x10^{-3}$**	**$6x10^{-3}$**
Aggregate Child/Adult Resident (without garden vegetable consumption)	$5x10^{-5}$	**$3x10^{-4}$**	**$1x10^{-3}$**	**$4x10^{-3}$**
Construction Worker	$4x10^{-6}$	$2x10^{-5}$	$1x10^{-4}$	**$4x10^{-4}$**

Hazard Index Estimates	**Arsenic Concentration (mg/kg)**			
	16	**95**	**500**	**1,500**
Infant/Child Resident (with garden vegetable consumption)	0.6	**4**	**20**	**60**
Infant/Child Resident (without garden vegetable consumption)	0.6	**3**	**17**	**52**
Construction Worker	0.06	0.4	**2**	**6**

Notes:

ELCRs were calculated for aggregate adult/child residents since ELCRs are averaged over a lifetime.

HIs were calculated for aggregate infant/child residents only since HIs calculated for this receptor are more conservative than the HI for an adult resident.

7.5 Uncertainty Analysis

All HHRAs involve assumptions, professional judgments, and imperfect data to varying degrees; these, in turn, result in uncertainty in the final estimates of risk. Risk assessment in general is a highly conservative process and often is based on extremely conservative assumptions and scenarios. The major sources of uncertainty associated with each of the four major steps of the HHRA process are discussed below.

7.5.1 Uncertainty Associated with the Data Evaluation

Soil samples were collected from each yard (front, side, and back) present at a residential property. Subsamples were collected on a five-point grid from each yard (e.g., backyard)

and merged into one sample for analysis. Therefore, the average EPC in each yard is expected to be characterized.

Arsenic soil concentrations were measured in terms of "total arsenic" instead of identifying the specific form of arsenic as organic or inorganic. Inorganic arsenic is considered more toxic than organic arsenic (see additional discussion of arsenic toxicity in Section 7.5.3). Organic arsenic converts to inorganic arsenic over time, so the Arsenic Committee of the Technical Review Workgroup for Metals and Asbestos (TRW) does not recommend speciating arsenic in soil. In surface soil, inorganic arsenic almost always predominates. Therefore, as a conservative approach, the Arsenic Committee of the TRW recommends that all arsenic be treated as inorganic. Consequently, not speciating the form of arsenic currently present in soil is not expected to add significant uncertainty to estimated ELCRs for the incidental ingestion of soil pathway.

Similarly, for the evaluation of ELCR associated with consumption of homegrown garden vegetables, 100 % of arsenic modeled in the vegetables was assumed to be in the carcinogenic form. Studies indicate that the proportion of the inorganic form of arsenic present in produce varies widely among vegetables: there is a high proportion of inorganic arsenic in leafy vegetables (approximately 100%) and a relatively low proportion of inorganic arsenic in tomatoes, green beans, carrots, onions, and cucumbers (less than 60%) (Yost, et. al., 2004). Therefore, the assuming that 100 % of arsenic modeled in the vegetables is present in carcinogenic form may over-estimate the ELCR associated with consumption of homegrown garden vegetables.

Two point-estimate plant uptake factors for above-ground and below-ground plants, obtained from EPA's Human Health Risk Assessment Protocol (EPA, 2005), were used to predict arsenic concentrations in homegrown garden vegetables. The application of these point estimate plant uptake factors assumes that the arsenic concentration in plants linearly increases with an increase of arsenic concentration in soil. Conversely, a literature-based regression model suggests that accumulation of metals in plants decreases as the concentration of arsenic in soil increases (ORNL, 1998). Additionally, exposures to high levels of arsenic limits the growth of vegetable plants, preventing arsenic concentration in plants from reaching levels that would cause adverse health effects to humans (Lepp, 1981). Therefore, estimated ELCRs and HIs associated with consumption of garden vegetables based on the assumed high arsenic EPCs were likely overestimated.

Unsieved soil samples were analyzed for total arsenic although arsenic concentrations may vary by particle size. If higher arsenic concentrations are associated with smaller grain size (e.g., the particle size [<250 microns] that adheres to people's hands and is ingested), then actual EPCs for receptors will be higher than the concentrations measured for unsieved soil samples. Consequently, the use of unsieved soil samples may result in an underestimate of exposure.

Although decreasing concentration trends are observed in several directions relative to the original source area, statistical analyses of arsenic concentrations in soil do not indicate a predominant pattern of decreasing concentrations away from the former source area consistent with air dispersion. Therefore, the soil EPCs addressed in this HHRA may not be wholly related to the former pesticide facility.

7.5.2 Uncertainty Associated with the Exposure Assessment

The exposure pathways analyzed are assumed to occur and most of the exposure factors used to estimate intakes are conservative and reflect worst-case or upper-bound assumptions about exposure. Some of the EPA default exposure factor values (e.g., exposure duration) were increased based on input received during the September 26, 2006 public meeting.

The relative bioavailability of arsenic in soil was conservatively assumed to be 90% due to the lack of site-specific bioavailability information. However, it is likely that the actual bioavailability of arsenic in soil is much lower than this estimated value. In fact, various studies using animal models (including rodents, swine, and monkeys) indicate that bioavailability of arsenic in soils is generally much lower, ranging from 0 to 50% (Roberts et al., 2002; Ruby et al., 1999). Other relevant studies can also be found in ATSDR's Toxicological Profile for Arsenic (ATSDR, 2005). In a recent study that Robert and his colleagues conducted, bioavailability of arsenic in soils from a variety of contaminated sites and soil types was measured in cynomolgus monkeys. They reported measured bioavailability of arsenic ranged from 5% to 31%, with most values in the 10 to 20% range (Robert et. al., 2007). Therefore, using an assumption of 90% bioavailability likely overestimates potential exposure and risk.

7.5.3 Uncertainty Associated with the Toxicity Assessment

Carcinogenic slope factors developed by EPA represent upper-bound estimates. The ELCRs generated in this HHRA should be regarded as upper-bound estimates on the potential ELCRs rather than an accurate representation of potential ELCRs. The true ELCRs are likely to be less than the predicted values.

The toxicity of arsenic varies based on the specific form of arsenic (As III or As V) present. The toxicity values used in the HHRA were for the inorganic form of arsenic, although some of the arsenic present at the properties may be in an organic (non-carcinogenic) form. Inorganic arsenic is more toxic than organic arsenic; therefore, the use of toxicity values for inorganic arsenic is expected to result in an overestimate of exposure.

7.5.4 Uncertainty in the Risk Characterization

The uncertainties identified within each major step of the HHRA ultimately contribute to uncertainty in the overall risk characterization. The addition of risks and HIs across pathways contributes to uncertainty since it is assumed that the same receptor group is exposed to arsenic via multiple exposure pathways.

8. Preliminary Remediation Goals

The ELCR and HI estimates presented in **Section 7** indicate risks above the upper end of EPA's typical target risk range ($1x10^{-4}$) and target HI (1.0) from arsenic at concentrations of 95 mg/kg, 500 mg/kg, and 1,500 mg/kg for residents. In addition, risk estimates at concentrations of 500 mg/kg and 1,500 mg/kg for construction workers exceed the upper end of EPA's typical target risk range or HI. Target concentrations (PRGs) that are protective for persons residing in South Minneapolis Neighborhood based on various possible exposure scenarios were estimated. PRGs were estimated based on target cancer risk levels of $1x10^{-4}$, $1x10^{-5}$, and $1x10^{-6}$ and an HI of 1. The detailed PRG calculations based on a target ELCR of $1x10^{-6}$ and a target HI of 1 are provided in **Tables 12.1** through **12.3** of **Appendix A**.

8.1 PRGs Based on Reasonable Maximum Exposures

The PRGs that were calculated based on RME scenarios are summarized in **Table 8-1** below. The PRGs in Table 8-1 were calculated assuming 90% relative bioavailability of arsenic in soil, which is a very conservative assumption.

Table 8-1. Risk-Based Cleanup Levels (Reasonable Maximum Exposure)

Receptor	ELCR = $1x10^{-4}$	ELCR = $1x10^{-5}$	ELCR = $1x10^{-6}$	HI = 1
PRG (mg/kg) for Direct Contact with Soil Only				
Infant/Child Resident	--	--	--	29
Child/Adult Resident	34	3	0.3	--
Construction Worker	405	41	4	261
PRG (mg/kg) for Ingestion of Garden Vegetables and Direct Contact with Soil				
Infant/Child Resident	--	--	--	25
Child/Adult Resident	25	2.5	0.3	--

Notes:

ELCRs were calculated for aggregate adult/child residents since ELCRs are averaged over a lifetime.

An HI was calculated for an aggregate infant/child resident since the HI for this receptor is more conservative than the HI for an adult resident.

Calculations are based on reasonable maximum exposures and an exposure duration of 50 years (i.e., 44 years as an adult and 6 years as a child).

As shown in **Table 8-1** above, based on a target ELCR of $1x10^{-4}$ and target HI of 1, arsenic concentrations of 29 mg/kg or less in soil are protective of residents without vegetable gardens, concentrations of 25 mg/kg or less in soil are protective of residents with vegetable gardens, and concentrations of 261 mg/kg or less are protective of construction workers based on RME values.

8.2 PRGs Based on Central Tendency Exposures

The PRGs that were calculated based on CTE scenarios are summarized in **Table 8-2** below.

Table 8-2. Risk-Based Cleanup Levels (Central Tendency Exposure)

Receptor	ELCR = $1x10^{-4}$	ELCR = $1x10^{-5}$	ELCR = $1x10^{-6}$	HI = 1
PRG (mg/kg) for Direct Contact				
Infant/Child Resident	--	--	--	59
Child/Adult Resident	119	12	1	--
Construction Worker	7245	725	72	115

Notes:

ELCRs were calculated for aggregate adult/child residents since ELCRs are averaged over a lifetime.

An HI was calculated for an aggregate infant/child resident since the HI for this receptor is more conservative than the HI for an adult resident.

Calculations are based on central tendency exposures and an exposure duration of 15 years (i.e., 9 years as an adult and 6 years as a child).

As shown in **Table 8-2** above, based on a target ELCR of $1x10^{-4}$ and target HI of 1, arsenic concentrations of 59 mg/kg or less in soil are protective of residents and concentrations of 115 mg/kg or less are protective of construction workers based on CTE values.

9. Human Health Risk Summary

The HHRA was conducted to evaluate potential human health risks associated with arsenic concentrations in soil at the South Minneapolis Site. Results of the risk estimates for the four arsenic concentrations in soil that were evaluated in the HHRA are summarized below for residential exposures and are presented on **Figure 1 (RME-**ELCR**), Figure 2 (RME- HI), Figure 3 (CTE-**ELCR**),** and **Figure 4 (CTE-HI)**:

- 16 mg/kg (Background) - Estimated ELCRs and HIs associated with the RME and CTE scenarios are within EPA's target risk range and HI.
- 95 mg/kg (Interim Action Level) – The estimated ELCR associated with a RME scenario exceeds EPA's target risk range. For the CTE scenario, the estimated ELCR is within EPA's target range. For the RME and CTE scenarios, the estimated HI for an aggregate infant/child exceeds EPA's target level.
- 500 mg/kg (Approximate Average Concentration at Residences Above the Remedial Action Level) - Estimated ELCRs and HIs associated with RME and CTE scenarios exceed EPA's target risk range and HI.
- 1,500 mg/kg (Approximate Maximum Concentration At Residences) - Estimated ELCRs and HIs associated with RME and CTE scenarios exceed EPA's target risk range and HI.

Figure 1

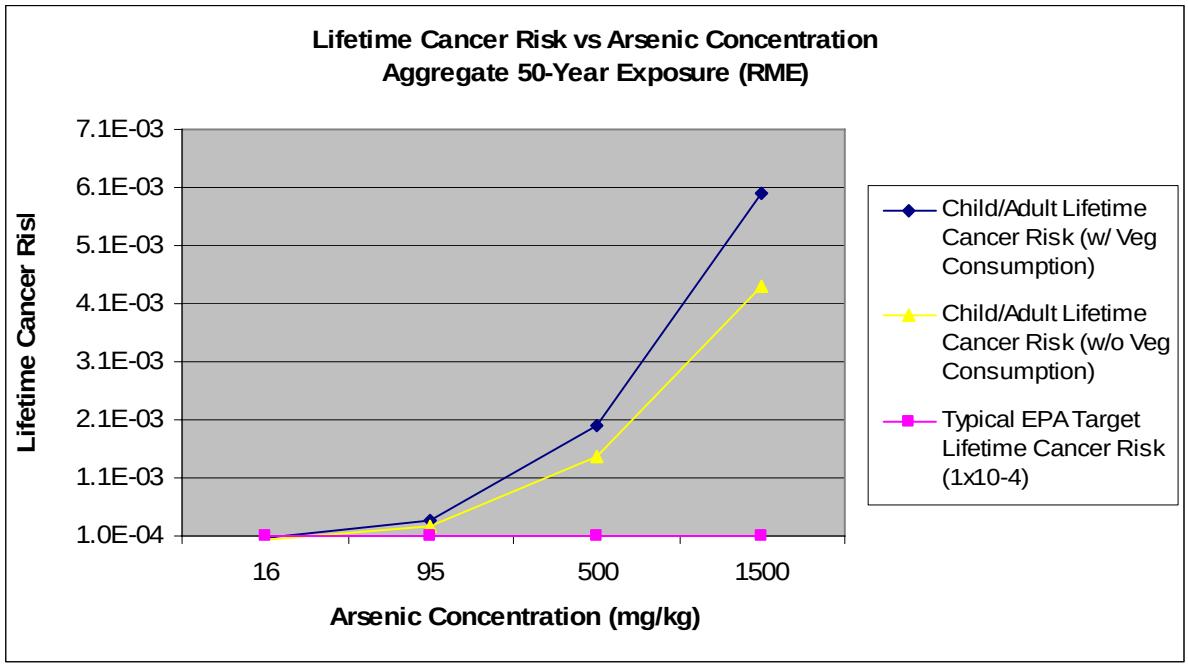


Figure 2

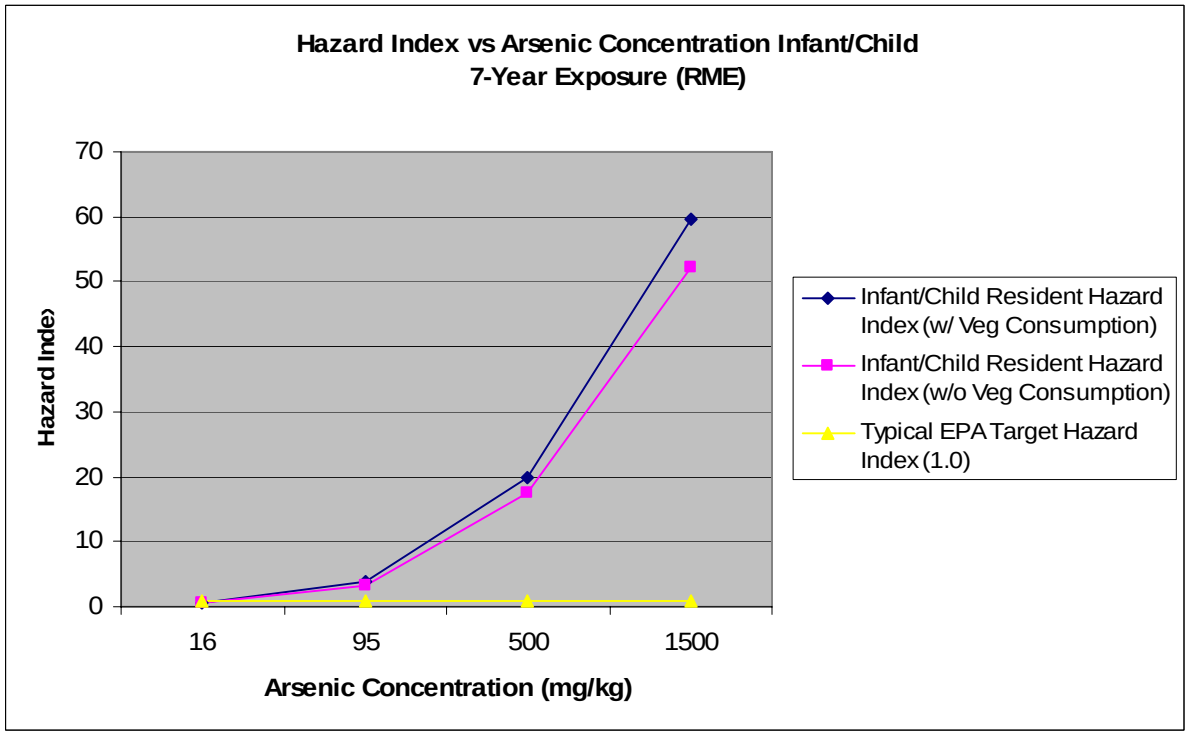


Figure 3

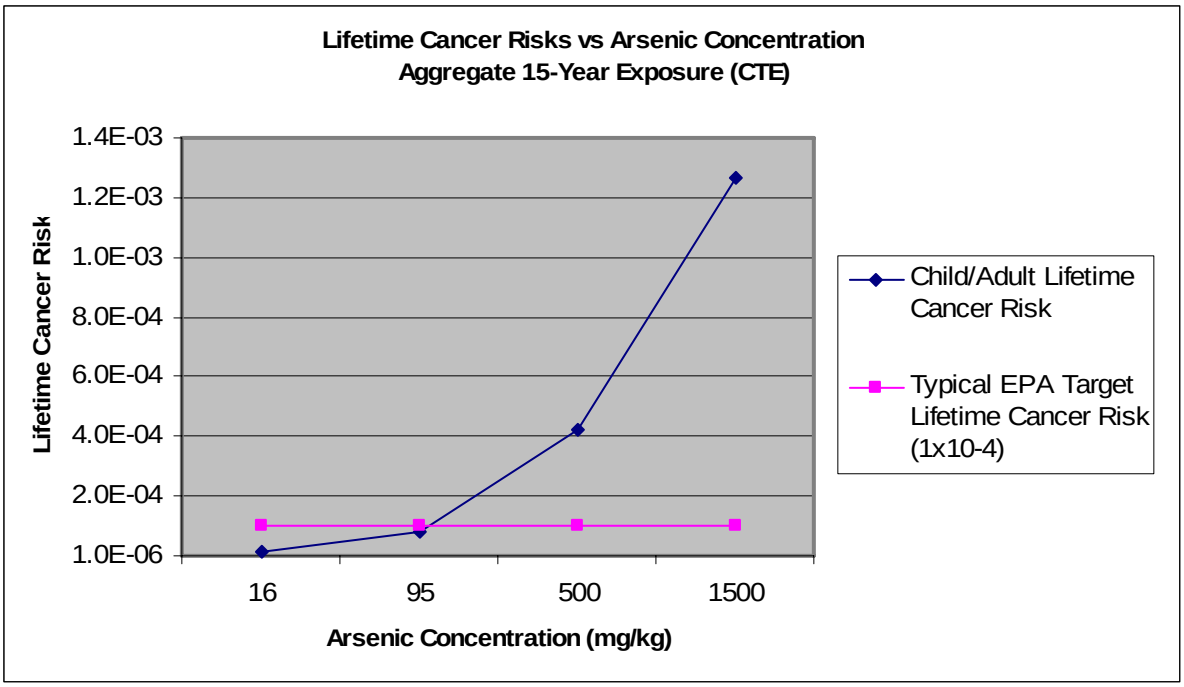
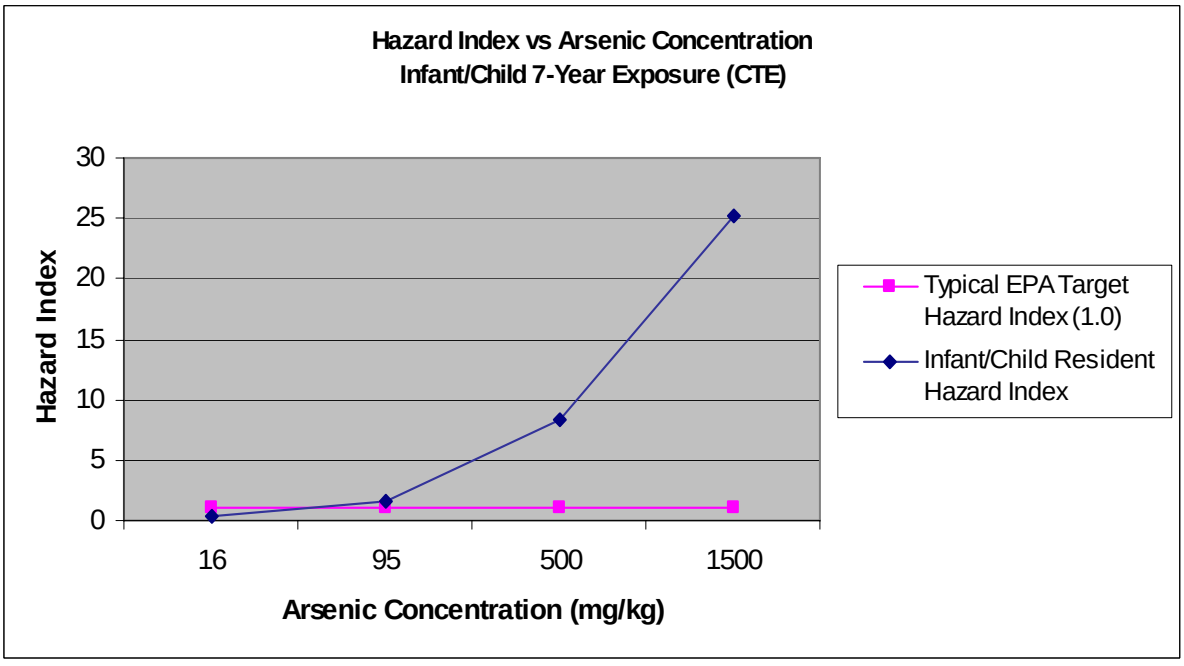


Figure 4



Results of the construction worker risk estimates for the four arsenic concentrations in soil are summarized below:

- 16 mg/kg (Background) - Estimated ELCRs and HIs associated with the RME and CTE scenarios are within EPA's target risk range and HI.
- 95 mg/kg (Interim Action Level) - Estimated ELCRs and HIs associated with RME and CTE scenarios are within EPA's target risk range and HI.
- 500 mg/kg (Approximate Average Concentration at Residences Above the Remedial Action Level) – For the RME and CTE scenarios, the estimated ELCRs are within EPA's target risk range. For the RME and CTE scenarios, the estimated HIs exceed EPA's target HI.
- 1,500 mg/kg (Approximate Maximum Concentration At Residences) – The estimated ELCR and HI associated with an RME scenario exceeds EPA's target risk range and HI. For the CTE scenario, the estimated ELCR is within EPA's target risk range, while the estimated HI exceeds EPA's target HI.

The ELCR and HI estimates indicate that potential risks from arsenic exceed the upper end of EPA's typical target risk range ($1x10^{-4}$) and target HI at concentrations of 95 mg/kg, 500 mg/kg, and 1,500 mg/kg for residents assuming RME scenarios. Estimated risks exceed the upper end of EPA's typical target risk range or target HI at concentrations of 500 mg/kg and 1,500 mg/kg for construction workers assuming RME scenarios. Based on a target ELCR of $1x10^{-4}$ and target HI of 1, an arsenic concentration of 25 mg/kg (or less) for a 50-year exposure duration is protective of residents (including those with vegetable gardens), while concentrations of 261 mg/kg or less are protective of constructions workers. It should be noted that these PRGs are based on the assumption of 90% bioavailability of arsenic from soils and 100% inorganic arsenic in soil and homegrown vegetables, which is a very conservative assumption. Factors affecting uncertainties in the risk assessment will play a role when final cleanup levels for the site are selected.

10. References

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Appendix A

EPA RAGS Part D Tables

The following RAGS PART D Tables are not included in the document because they are not applicable to the HHRA prepared for this site:

Table 2 – Occurrence, Distribution and Selection of Chemicals of Potential Concern
Table 3 – Medium-Specific Exposure Point Concentration Summary
Table 8 – Calculation of Radiation Cancer Risks

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

South Minneapolis Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Soil	Surface Soil	Surface Soil	Resident	Infant/Child, Adult/Child	Ingestion, Dermal Contact	Quant	Residents may contact arsenic in impacted soil.
		Ambient Air	Emissions from Surface Soil			Inhalation	Quant	Residents may inhale ambient air potentially impacted through fugitive dust emissions from impacted soil.
		Indoor Dust	Indoor Dust			Ingestion	Quant	Residents may ingest indoor dust potentially impacted through fugitive dust emissions from impacted soil or from tracking indoors. Indoor dust concentrations are represented by outdoor soil.
		Garden Vegetables[1]	Garden Vegetables[1]			Ingestion	Quant[1]	Residents may consume garden vegetables grown on impacted soil.
		Soil	Soil (0-5 ft)	Construction Worker	Adult	Ingestion, Dermal Contact	Quant	Construction workers may contact arsenic in impacted soil.
		Ambient Air	Emissions from Soil			Inhalation	Quant	Construction workers may inhale ambient air potentially impacted through fugitive dust emissions from impacted soil.
	Groundwater	--	--	--	--	--	--	No private potable wells are located within the area. The neighborhood over the plume is served by City of Minneapolis water. Municipal wells are not impacted.
	Surface Water, Sediment	--	--	--	--	--	--	No ponds or streams are located within the investigation area. A lake is present to the southwest outside the investigation area.

Type of Analysis:

Quant - Quantitative Analysis

[1] Quantitative analysis is performed for the RME scenario only, since most people would not grow vegetables in their own gardens but would use one of various community gardens available in the area or purchase vegetables from the grocery store.

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	80	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(6)	IR-S-Adj (mg-year/kd-day) =
				EF	Exposure Frequency	350	days/year	(1)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-C/E	Exposure Duration, Infant/Child	7	years	(5)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	149	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(6)	IR-S-Adj (mg-year/kd-day) =
				ED-A	Exposure Duration, Adult	44	years	(4)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				EF	Exposure Frequency	350	days/year	(1)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Dermal	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	236	mg-year/kg-day	Calculated	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-C/E	Exposure Duration, Infant/Child	7	years	(5)	(ED-A x SA-A x SSAF-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	515	mg-year/kg-day	Calculated (2,3)	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				ED-A	Exposure Duration, Adult	44	years	(4)	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	(ED-A x SA-A x SSAF-A / BW-A)
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(2) Adult SA includes head, hands, forearms, and lower legs.

(3) Child SA includes head, hands, forearms, lower legs, and feet.

(4) Based on community input provided during the September 26, 2006 public meeting.

(5) Infant/child (1 to 8 yrs).

(6) Professional Judgment

TABLE 4.2.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Resident	Infant/Child	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	3.4	m^3/day	calculated	
				ED-C/E	Exposure Duration, Infant/Child	7	years	(3)	IN-Adj (m^3-year/kg-day) =
				EF	Exposure Frequency	185	days/year	(1)	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	12.7	m^3/day	calculated	
				ED-A	Exposure Duration, Adult	44	years	(2)	IN-Adj (m^3-year/kg-day) =
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(2) Based on community input provided during the September 26, 2006 public meeting.

(3) Infant/child (1 to 8 yrs).

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Garden Vegetables

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Infant/Child	Garden Vegetables	CS	Chemical Concentration in Soil	16	mg/kg	background	
				FI	Fraction of Vegetables Consumed	50%	unitless	(10)	
				ABSgi	Bioavailability Factor (GI Absorption)	100%	unitless	(10)	
				ED-C/E	Exposure Duration, Infant/Child	7	years	(10)	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
			(Above-ground Vegetable)	Cveg_ag	Chemical Concentration in Above-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_ag	Plant-Soil Bioconcentration Factor (above-ground)	0.00633	unitless	EPA, 2005 (2)	Cveg_ag x FI x ABSgi x IR-Veg x EF x ED x CF1 x 1/AT
				IR-Veg-ag	Ingestion Rate of Vegetables (above-ground)	0.007	kg/kg-day	Calculated	Cveg_ag = CS x Br_ag
				CF1	Moisture Content (above-ground)	17.4%	kg (dry)/ kg (wet)	ATSDR, 2003	
				EF	Exposure Frequency (above-ground)	90	days/year	(9)	
			(Below-ground Vegetable)	Cveg_bg	Chemical Concentration in Below-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_bg	Plant-Soil Bioconcentration Factor (below-ground)	0.008	unitless	EPA, 2005 (3)	Cveg_bg x FI x ABSgi x IR-Veg x EF x ED x CF2 x 1/AT
				IR-Veg-bg	Ingestion Rate of Vegetables (below-ground)	0.003	kg/kg-day	Calculated	Cveg_bg = CS x Br_bg
				CF2	Moisture Content (below-ground)	22.2%	kg (dry)/ kg (wet)	ATSDR, 2003	
				EF	Exposure Frequency (below-ground)	60	days/year	(9)	
		Child/Adult	Garden Vegetables	CS	Chemical Concentration in Soil	16	mg/kg	background	
				FI	Fraction of Vegetables Consumed	50%	unitless	(10)	
				ABSgi	Bioavailability Factor (GI Absorption)	100%	unitless	(10)	
				ED-A	Exposure Duration, Adult	44	years	(1)	
				BW-A	Body Weight , Adult	70	kg	EPA, 1991	
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				BW-C	Body Weight , Child	15	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
			(Above-ground Vegetable)	Cveg_ag	Chemical Concentration in Above-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_ag	Plant-Soil Bioconcentration Factor (above-ground)	0.00633	unitless	EPA, 2005 (2)	Cveg_ag x FI x ABSgi x IR-Veg-Adj x EF x CF1 x 1/AT
				CF1	Moisture Content (above-ground)	17.4%	kg (dry)/ kg (wet)	ATSDR, 2003	Cveg_ag = CS x Br_ag
				IR-Veg-A_ag	Ingestion Rate of Garden Vegetables, Adult (above-ground)	0.325	kg/day	EPA, 1997 (4,6,7,8)	
				IR-Veg-C_ag	Ingestion Rate of Garden Vegetables, Child (above-ground)	0.121	kg/day	EPA, 1997 (5,6,7,8)	IR-Veg-Adj (kg-year/kd-day) =
				IR-Veg-Adj	Ingestion Rate of Vegetables, Age-adjusted	0.253	kg-year/kg-day	Calculated	(ED-C x IR-Veg-C / BW-C) + (ED-A x IR-Veg-A / BW-A)
				EF	Exposure Frequency	90	days/year	(9)	
			(Below-ground Vegetable)	Cveg_bg	Chemical Concentration in Below-ground Vegetables	calculated	mg/kg	calculated	CDI (mg/kg-day) =
				Br_bg	Plant-Soil Bioconcentration Factor (below-ground)	0.008	unitless	EPA, 2005 (3)	Cveg_bg x FI x ABSgi x IR-Veg-Adj x EF x CF2 x 1/AT
				CF2	Moisture Content (below-ground)	22.2%	kg (dry)/ kg (wet)	ATSDR, 2003	Cveg_bg = CS x Br_bg
				IR-Veg-A_bg	Ingestion Rate of Garden Vegetables, Adult (below-ground)	0.139	kg/day	EPA, 1997 (4,6,7,8)	
				IR-Veg-C_bg	Ingestion Rate of Garden Vegetables, Child (below-ground)	0.052	kg/day	EPA, 1997 (5,6,7,8)	IR-Veg-Adj (kg-year/kd-day) =
				IR-Veg-Adj	Ingestion Rate of Vegetables, Age-adjusted	0.108	kg-year/kg-day	Calculated	(ED-C x IR-Veg-C / BW-C) + (ED-A x IR-Veg-A / BW-A)
				EF	Exposure Frequency	60	days/year	(9)	

Sources:

ATSDR, 2003: Health Consultation Arsenic Soil Clean-up Levels El Paso County Metal Survey.

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

EPA, 2005: Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA530-R-05-006.

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Garden Vegetables

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name

Notes:

(1) Based on community input provided during the September 26, 2006 public meeting.

(2) Plant-soil bioconcentration factor for arsenic for above-ground produce.

(3) Plant-soil bioconcentration factor for arsenic for below-ground produce. $VG_{rootveg}$ value of 1.0 is used.

(4) Intake rate of homegrown vegetables (for Midwest region) was obtained from Table 13-15. Units were converted to kg/day using an assumed body weight of 60 kg.

(5) Intake rate of homegrown vegetables (1-5 year old children) was obtained from Table 13-13. Units were converted to kg/day using an average body weight of boys and girls (see Table 4.3 Supplement).

(6) Assumed that 30% of their consumption rate is of below-ground vegs and 70% is above-ground vegetables.

(7) Approximately equivalent to 1.02 lbs/day (adult) and 0.39 lbs/day (child).

(8) 95th percentile was used for the RME scenario.

(9) Assumed that vegetables are grown for a 4-month period and above-ground vegetables are eaten for only 3 months and below-ground vegs are eaten for only 2 months.

(10) Best professional judgment.

TABLE 4.3.Supplement
VALUES USED FOR INTAKE OF HOMEGROWN VEGETABLES
South Minneapolis Site

Body Weight (kg)[1]				Body Weight (kg)[2]		Intake of Homegrown Vegetables (g/kg-day)[3]	Intake of Homegrown Vegetables (g/day)[4]
Age	Boys Mean	Girls Mean	Boys and Girls Mean	Age	Boys and Girls Mean	95th percentile	95th percentile
1 year	11.8	10.8	11.3	1 - 2 years	12.3	19.6	241
2 years	13.6	13	13.3				
3 years	15.7	14.9	15.3	3 -5 years	17.5	7.74	135
4 years	17.8	17	17.4				
5 years	19.8	19.6	19.7				
6 years	23	22.1	22.6	6 - 7 years	23.75	6.16	146
7 years	25.1	24.7	24.9				
					Average[5] =	10.68	169

Sources:

EPA, 1997: Exposure Factors Handbook (EFH). EPA/600/P-95/002F.

Notes:

(1) Body weights were obtained from Table 7-3 of the EFH (EPA, 1997).

(2) Mean Body weights calculated for three infant/child age groups (1-2 yrs, 3-5 yrs, and 6-7 yrs).

(3) Intakes for homegrown vegetables were obtained from Table 13-13 of the EFH (EPA, 1997).

(4) Intakes for homegrown vegetables were calculated by multiplying body weight by intake.

(5) Average intake for homegrown vegetables.

TABLE 4.4.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	330	mg/day	EPA, 2002	CS x IR-S x RBAF x EF x ED x CF1 x 1/BW x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(4)	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	10	years	(3)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3650	days	(3)	
Dermal	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004 (1)	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2002	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	10	years	(3)	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	(3)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

Notes:

(1) SA includes head, hands, and forearms.

(2) Best Professional Judgment

(3) Based on community input provided during the September 26, 2006 public meeting.

(4) Professional Judgment

TABLE 4.5.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future

Medium: Soil

Exposure Medium: Ambient Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Worker	Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	NA	m^3/kg	--	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	20	m^3/day	EPA, 2002	
				EF	Exposure Frequency	90	days/year	(1)	
				ED	Exposure Duration	10	years	(2)	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	3,650	days	(2)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1996: Soil Screening Guidance: User's Guide. EPA/540/F-95/041.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Best Professional Judgment

(2) Based on community input provided during the September 26, 2006 public meeting.

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	40	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(5)	IR-S-Adj (mg-year/kd-day) =
				EF	Exposure Frequency	350	days/year	(1)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-C/E	Exposure Duration, Infant/Child	7	years	(4)	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				IR-S-Adj	Ingestion Rate of Soil, Age-adjusted	45	mg-year/kg-day	Calculated	CS x IR-S-Adj x RBAF x EF x CF1 x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--		IR-S-Adj (mg-year/kd-day) =
				EF	Exposure Frequency	350	days/year	(1)	(ED-C x IR-S-C / BW-C) + (ED-A x IR-S-A / BW-A)
				ED-A	Exposure Duration, Adult	9	years	EPA, 1997	
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
Dermal	Resident	Infant/Child	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	46	mg-year/kg-day	Calculated	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-C/E	Exposure Duration, Infant/Child	7	years	(4)	(ED-A x SA-A x SSAF-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	EPA, 1989	
		Child/Adult	Surface Soil	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	52	mg-year/kg-day	Calculated (2,3)	CS x DA-Adj x DABS x CF1 x EF x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	DA-Adj (mg-year/kg-day) =
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	(ED-C x SA-C x SSAF-C / BW-C) +
				ED-A	Exposure Duration, Adult	9	years	EPA, 1997	(ED-A x SA-A x SSAF-A / BW-A)
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(2) Adult SA includes head, hands, forearms, and lower legs.

(3) Child SA includes head, hands, forearms, lower legs, and feet.

(4) Infant/child (1 to 8 yrs)

(5) Professional Judgment

TABLE 4.2.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Resident	Infant/Child	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	3.4	m^3/day	calculated	IN-Adj (m^3-year/kg-day) =
				ED-C/E	Exposure Duration, Infant/Child	7	years	(2)	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
		Child/Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN-Adj x EF x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	CA (mg/m^3) = CS / PEF
				IN-Adj	Inhalation Rate, Age-adjusted	4.7	m^3/day	calculated	
				ED-A	Exposure Duration, Adult	9	years	EPA, 1997	IN-Adj (m^3-year/kg-day) =
				ED-C	Exposure Duration, Child	6	years	EPA, 1991	(ED-C x IN-C / BW-C) + (ED-A x IN-A / BW-A)
				EF	Exposure Frequency	185	days/year	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Days where there is no snow on the ground, the ground is not frozen, and it is not raining

(4) Infant/child (1 to 8 yrs).

TABLE 4.4.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	170	mg/day	(1)	CS x IR-S x RBAF x EF x ED x CF1 x 1/BW x 1/AT
				RBAF	Relative Bioavailability Factor	0.90	--	(4)	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	1	years	EPA, 2002	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	90	days	(2)	
Dermal	Construction Worker	Adult	Soil (0-5 ft)	CS	Chemical Concentration in Soil	16	mg/kg	background	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300	cm^2	EPA, 2004 (3)	CS x SA x SSAF x DABS x CF1 x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2002	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	0.03	--	EPA, 2004	
				CF1	Conversion Factor 1	1.0E-06	kg/mg	- -	
				EF	Exposure Frequency	90	days/year	(2)	
				ED	Exposure Duration	1	years	EPA, 2002	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	90	days	(2)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

TABLE 4.5.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future

Medium: Soil

Exposure Medium: Ambient Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Construction Worker	Adult	Ambient Air	CS	Chemical Concentration in Soil	16	mg/kg	background	Chronic Daily Intake (CDI) (mg/kg-day) =
				CA	Chemical Concentration in Air	calculated	mg/m^3	calculated	CA x IN x EF x ED x 1/BW x 1/AT
				PEF	Particulate Emission Factor	1.36E+09	m^3/kg	EPA, 2002	
				VF	Volatilization Factor for volatile constituents	NA	m^3/kg	--	CA (mg/m^3) = CS (1/PEF + 1/VF)
				IN	Inhalation Rate	20	m^3/day	EPA, 2002	
				EF	Exposure Frequency	90	days/year	(1)	
				ED	Exposure Duration	1	years	EPA, 2002	
				BW	Body Weight	70	kg	EPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	EPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	90	days	(1)	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1996: Soil Screening Guidance: User's Guide. EPA/540/F-95/041.

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.

Notes:

(1) Best Professional Judgment

TABLE 4.1. Supplement
CALCULATION OF AGE-ADJUSTED INTAKE RATES
REASONABLE MAXIMUM EXPOSURE / CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Age	Mean BW[2] (kg)	Ingestion						Dermal							Inhalation				
		IR-S		ED		IR-S-Adj (IR * ED) / BW		SSAF[3]		SA[3,4,5]	ED		DA-Adj (SSAF*SA*ED)/BW		IN[2]	ED		IN-Adj (IN*ED)/BW	
		RME[1]	CTE[2]	RME	CTE	RME	CTE	RME	CTE		RME	CTE	RME	CTE	RME/CTE	RME	CTE	RME	CTE
1 year	11.3	200	100	1	1	17.7	8.8	0.2	0.04	2571	1	1	45.50	9.10	6.8	1	1	0.60	0.60
2 years	13.3	200	100	1	1	15.0	7.5	0.2	0.04	2434	1	1	36.60	7.32	6.8	1	1	0.51	0.51
3 years	15.3	200	100	1	1	13.1	6.5	0.2	0.04	2893	1	1	37.81	7.56	8.3	1	1	0.54	0.54
4 years	17.4	200	100	1	1	11.5	5.7	0.2	0.04	3175	1	1	36.49	7.30	8.3	1	1	0.48	0.48
5 years	19.7	200	100	1	1	10.2	5.1	0.2	0.04	3255	1	1	33.04	6.61	8.3	1	1	0.42	0.42
6 years	22.6	200	100	1	1	8.9	4.4	0.2	0.04	3538	1	1	31.38	6.28	10.0	1	1	0.44	0.44
7 years	24.9	100	50	1	1	4.0	2.0	0.1	0.01	3884	1	1	15.60	1.56	10.0	1	1	0.40	0.40
		Total =		7	7	80	40			**Total =**	7	7	236	46	**Total =**	7	7	3.40	3.40

Footnotes:

[1] EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

[2] EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

[3] EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

[4] SA for adult includes head, hands, forearms, and lower legs; SA for child includes head, hands, forearms, lower legs, and feet.

[5] SA was calculated for child using Exhibit C-1 of RAGS Part E.

[6] Age-adjusted intake factors using EPA's default values.

BW - body weight (kg)
DA - Adj - adjusted dermal absorption (mg-year/kg-day)
ED - exposure duration (years)
IN - inhalation rate (m^3/day)
IN-Adj - adjusted inhalation rate (m^3/day)
IR-S - soil ingestion rate (mg/day)
IR-S-Adj - adjusted soil ingestion rate (mg-year/kg-day)
SA - skin surface area (cm^2)
SSAF - soil-to-skin adherence factor (mg/cm^2-day)

TABLE 4.2. Supplement
CALCULATION OF AGE-ADJUSTED INTAKE RATES
REASONABLE MAXIMUM EXPOSURE / CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Age	Mean BW[2] (kg)	Ingestion						Dermal							Inhalation				
		IR-S		ED		IR-S-Adj (IR * ED) / BW		SSAF[3]		SA[3,4,5]	ED		DA-Adj (SSAF*SA*ED)/BW		IN[2]	ED		IN-Adj (IN*ED)/BW	
		RME[1]	CTE[2]	RME	CTE	RME	CTE	RME	CTE		RME	CTE	RME	CTE	RME/CTE	RME	CTE	RME	CTE
1 year	11.3	200	100	1	1	17.7	8.8	0.2	0.04	2571	1	1	45.50	9.10	6.8	1	1	0.60	0.60
2 years	13.3	200	100	1	1	15.0	7.5	0.2	0.04	2434	1	1	36.60	7.32	6.8	1	1	0.51	0.51
3 years	15.3	200	100	1	1	13.1	6.5	0.2	0.04	2893	1	1	37.81	7.56	8.3	1	1	0.54	0.54
4 years	17.4	200	100	1	1	11.5	5.7	0.2	0.04	3175	1	1	36.49	7.30	8.3	1	1	0.48	0.48
5 years	19.7	200	100	1	1	10.2	5.1	0.2	0.04	3255	1	1	33.04	6.61	8.3	1	1	0.42	0.42
6 years	22.6	200	100	1	1	8.9	4.4	0.2	0.04	3538	1	1	31.38	6.28	10.0	1	1	0.44	0.44
7 years	24.9	100	50	1	NA	4.0	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1	NA	0.40	NA
8 years	28.1	100	50	1	NA	3.6	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1	NA	0.36	NA
9 years	31.5	100	50	1	NA	3.2	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.43	NA
10 years	36.3	100	50	1	NA	2.8	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.37	NA
11 years	41.1	100	50	1	NA	2.4	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.33	NA
12 years	45.3	100	50	1	NA	2.2	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.30	NA
13 years	50.4	100	50	1	NA	2.0	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.27	NA
14 years	56.0	100	50	1	NA	1.8	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.24	NA
15 years	58.1	100	50	1	NA	1.7	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.25	NA
16 years	67.1	100	50	1	NA	1.5	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.22	NA
17 years	63.2	100	50	1	NA	1.6	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.23	NA
18 < 25 years	67.2	100	50	7	5	10.4	3.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 < 35 years	71.5	100	50	10	4	14.0	2.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35 < 45 years	74.0	100	50	10	NA	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
45 < 55 years	74.5	100	50	6	NA	8.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<7 to <18	45.6	NA	NA	NA	NA	NA	NA	0.1	0.01	5800	12	NA	106.82	NA	NA	NA	NA	NA	NA
Adult (>18)	69.3	NA	NA	NA	NA	NA	NA	0.1	0.01	5800	32	9	187.41	7.53	13.25	33	9	6.31	1.72
			Total =	50	15	149	45			**Total =**	50	15	515	52	**Total =**	50	15	12.7	4.72

Footnotes:

[1] EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

[2] EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

[3] EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

[4] SA for adult includes head, hands, forearms, and lower legs; SA for child includes head, hands, forearms, lower legs, and feet.

[5] SA was calculated for child using Exhibit C-1 of RAGS Part E.

[6] Age-adjusted intake factors using EPA's default values.

BW - body weight (kg)
DA - Adj - adjusted dermal absorption (mg-year/kg-day)
ED - exposure duration (years)
IN - inhalation rate (m^3/day)
IN-Adj - adjusted inhalation rate (m^3/day)
IR-S - soil ingestion rate (mg/day)
IR-S-Adj - adjusted soil ingestion rate (mg-year/kg-day)
SA - skin surface area (cm^2)
SSAF - soil-to-skin adherence factor (mg/cm^2-day)

TABLE 5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

South Minneapolis Site

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Uncertainty Factor	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	3.0E-04	mg/kg-day	0.95	3.0E-04	mg/kg-day	skin	3	IRIS	04/07/2006

Note:

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1.

(2) EPA recommends that the oral RfD not be adjusted to estimate the absorbed dose when the absorption efficiency is greater than 50%; therefore, the Oral RfD was used as Absorbed RfD for demal exposure for arsenic.

Definitions: IRIS = Integrated Risk Information System

TABLE 5.2

NON-CANCER TOXICITY DATA -- INHALATION

South Minneapolis Site

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD		Primary Target Organ(s)	Uncertainty Factor	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	NA	NA	NA	NA	NA	NA	NA	NA

Definitions: NA = Not Available

TABLE 6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

South Minneapolis Site

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral Cancer Slope Factor	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	1.5E+00	$(mg/kg\text{-}day)^{-1}$	95%	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/07/2006

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1.

(2) EPA recommends that the oral cancer slope factor not be adjusted to estimate the absorbed dose when the absorption efficiency is greater than 50%; therefore, Oral Cancer Slope Factor is used as Absorbed Cancer Slope Factor for demal exposure for arsenic.

Definitions: IRIS = Integrated Risk Information System

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

South Minneapolis Site

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/07/2006

Definitions: IRIS = Integrated Risk Information System

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Infant/Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Soil	Surface Soil	South Minneapolis Surface Soil	Ingestion	Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.3E-01
			Exp. Route Total								NA					5.3E-01
			Dermal	Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	8.2E-06	mg/kg/day	3.0E-04	mg/kg/day	2.7E-02
			Exp. Route Total								NA					2.7E-02
		Exposure Point Total									NA					5.6E-01
	Exposure Medium Total										NA					5.6E-01
	Ambient Air	South Minneapolis Emissions from Surface Soil	Inhalation	Arsenic	1.2E-08	mg/m^3	NA	NA	NA	NA	NA	2.9E-09	mg/kg/day	NA	NA	NA
			Exp. Route Total								NA					0.0E+00
		Exposure Point Total									NA					0.0E+00
	Exposure Medium Total										NA					0.0E+00
	Garden Vegetables	South Minneapolis Garden Vegetables (aboveground)	Ingestion	Arsenic	1.0E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	3.0E-04	mg/kg/day	5.4E-02
		(belowground)	Ingestion	Arsenic	1.3E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-06	mg/kg/day	3.0E-04	mg/kg/day	2.5E-02
			Exp. Route Total								NA					7.9E-02
		Exposure Point Total									NA					7.9E-02
	Exposure Medium Total										NA					7.9E-02
Surface Soil Total											NA					6.3E-01
Receptor Total (with vegetable consumption)											NA					6.3E-01
Receptor Total (without vegetable consumption)											NA					5.6E-01

EPC = Exposure point concentration based on background level in soil (16 mg/kg).

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Aggregate Adult/Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern[1]	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Soil	Surface Soil	South Minneapolis Surface Soil	Ingestion	Arsenic	1.6E+01	mg/kg	2.9E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.4E-05	NA	NA	NA	NA	NA
			Exp. Route Total								4.4E-05					NA
			Dermal	Arsenic	1.6E+01	mg/kg	1.8E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.7E-06	NA	NA	NA	NA	NA
			Exp. Route Total								2.7E-06					NA
		Exposure Point Total									4.7E-05					NA
	Exposure Medium Total										4.7E-05					NA
	Ambient Air	South Minneapolis Emissions from Surface Soil	Inhalation	Arsenic	1.2E-08	mg/m^3	1.1E-09	mg/kg/day	1.5E+01	1/(mg/kg/day)	1.6E-08	NA	NA	NA	NA	NA
			Exp. Route Total								1.6E-08					NA
		Exposure Point Total									1.6E-08					NA
	Exposure Medium Total										1.6E-08					NA
	Garden Vegetables	South Minneapolis Garden Vegetables (aboveground)	Ingestion	Arsenic	1.0E-01	mg/kg	7.8E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.2E-05	NA	NA	NA	NA	NA
		(belowground)	Ingestion	Arsenic	1.3E-01	mg/kg	3.6E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.4E-06	NA	NA	NA	NA	NA
			Exp. Route Total								1.7E-05					NA
		Exposure Point Total									1.7E-05					NA
	Exposure Medium Total										1.7E-05					NA
Surface Soil Total											6.4E-05					NA
Receptor Total (with vegetable consumption)											6.4E-05					NA
Receptor Total (without vegetable consumption)											4.7E-05					NA

EPC = Exposure point concentration based on background level in soil (16 mg/kg).

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	South Minneapolis Soil (0 - 5 ft)	Ingestion	Arsenic	1.60E+01	mg/kg	2.4E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.6E-06	1.7E-05	mg/kg/day	3.0E-04	mg/kg/day	5.6E-02
			Exp. Route Total								3.6E-06					5.6E-02
			Dermal	Arsenic	1.6E+01	mg/kg	2.4E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.6E-07	1.7E-06	mg/kg/day	3.0E-04	mg/kg/day	5.6E-03
			Exp. Route Total								3.6E-07					5.6E-03
		Exposure Point Total									3.9E-06					6.1E-02
	Exposure Medium Total										3.9E-06					6.1E-02
	Ambient Air	South Minneapolis Soil (0 - 5 ft)	Inhalation	Arsenic	1.2E-08	mg/m^3	1.2E-10	mg/kg/day	1.5E+01	1/(mg/kg/day)	1.8E-09	8.3E-10	mg/kg/day	NA	NA	NA
			Exp. Route Total								1.8E-09					0.0E+00
		Exposure Point Total									1.8E-09					0.0E+00
	Exposure Medium Total										1.8E-09					0.0E+00
Soil Total											3.9E-06					6.1E-02
Receptor Total											3.9E-06					6.1E-02

EPC = Exposure point concentration based on background level in soil (16 mg/kg).

TABLE 7.1.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Infant/Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Soil	Surface Soil	South Minneapolis Surface Soil	Ingestion	Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.6E-01
			Exp. Route Total								NA					2.6E-01
			Dermal	Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	3.0E-04	mg/kg/day	5.3E-03
			Exp. Route Total								NA					5.3E-03
		Exposure Point Total									NA					2.7E-01
	Exposure Medium Total										NA					2.7E-01
	Ambient Air	South Minneapolis Emissions from Surface Soil	Inhalation	Arsenic	1.2E-08	mg/m^3	NA	NA	NA	NA	NA	2.9E-09	mg/kg/day	NA	NA	NA
			Exp. Route Total								NA					0.0E+00
		Exposure Point Total									NA					0.0E+00
	Exposure Medium Total										NA					0.0E+00
Soil Total											NA					2.7E-01
Receptor Total											NA					2.7E-01

EPC = Exposure point concentration based on background level in soil (16 mg/kg).

TABLE 7.2.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Aggregate Adult/Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern[1]	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Soil	Surface Soil	South Minneapolis Surface Soil	Ingestion	Arsenic	1.6E+01	mg/kg	8.8E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.3E-05	NA	NA	NA	NA	NA
			Exp. Route Total								1.3E-05					NA
			Dermal	Arsenic	1.6E+01	mg/kg	1.8E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.7E-07	NA	NA	NA	NA	NA
			Exp. Route Total								2.7E-07					NA
		Exposure Point Total									1.3E-05					NA
	Exposure Medium Total										1.3E-05					NA
	Ambient Air	South Minneapolis Emissions from Surface Soil	Inhalation	Arsenic	1.2E-08	mg/m^3	4.0E-10	mg/kg/day	1.5E+01	1/(mg/kg/day)	6.0E-09	NA	NA	NA	NA	NA
			Exp. Route Total								6.0E-09					NA
		Exposure Point Total									6.0E-09					NA
	Exposure Medium Total										6.0E-09					NA
Soil Total											1.3E-05					NA
Receptor Total											1.3E-05					NA

TABLE 7.3.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil (0 - 5 ft)	Soil (0 - 5 ft)	South Minneapolis Soil (0 - 5 ft)	Ingestion	Arsenic	1.60E+01	mg/kg	1.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.8E-07	3.5E-05	mg/kg/day	3.0E-04	mg/kg/day	1.2E-01
			Exp. Route Total								1.8E-07					1.2E-01
			Dermal	Arsenic	1.6E+01	mg/kg	2.4E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.6E-08	6.8E-06	mg/kg/day	3.0E-04	mg/kg/day	2.3E-02
			Exp. Route Total								3.6E-08					2.3E-02
		Exposure Point Total									2.2E-07					1.4E-01
	Exposure Medium Total										2.2E-07					1.4E-01
	Ambient Air	South Minneapolis Emissions from Soil	Inhalation	Arsenic	1.2E-08	mg/m^3	1.2E-11	mg/kg/day	1.5E+01	1/(mg/kg/day)	1.8E-10	3.4E-09	mg/kg/day	NA	NA	NA
			Exp. Route Total								1.8E-10					0.0E+00
		Exposure Point Total									1.8E-10					0.0E+00
	Exposure Medium Total										1.8E-10					0.0E+00
Soil Total											2.2E-07					1.4E-01
Receptor Total											2.2E-07					1.4E-01

EPC = Exposure point concentration based on background level in soil (16 mg/kg).

NA = Not applicable.

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Infant/Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis	Arsenic	NA	NA	NA	NA	skin, vascular	5.E-01	NA	3.E-02	6.E-01
			Chemical Total	NA	NA	NA	NA		5.E-01	NA	3.E-02	6.E-01
		Exposure Point Total					NA					6.E-01
	Exposure Medium Total						NA					6.E-01
	Ambient Air	South Minneapolis Emissions from Soil	Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		NA	NA	NA	NA
		Exposure Point Total					NA					NA
	Exposure Medium Total						NA					NA
	Garden Vegetables (aboveground)	South Minneapolis	Arsenic	NA	NA	NA	NA	skin, vascular	5.E-02	NA	NA	5.E-02
	(belowground)		Arsenic	NA	NA	NA	NA	skin, vascular	2.E-02	NA	NA	2.E-02
			Chemical Total	NA	NA	NA	NA		8.E-02	NA	NA	8.E-02
		Exposure Point Total					NA					8.E-02
	Exposure Medium Total						NA					8.E-02
Surface Soil Total							NA					6.E-01
Receptor Total (with vegetable consumption)							NA				Receptor HI Total	6.E-01
Receptor Total (without vegetable consumption)							NA				Receptor HI Total	6.E-01

Notes:
EPC = Exposure point concentration based on background level in soil (16 mg/kg).
NA = Not applicable.

With Vegetable Consumption	Total Skin HI Across All Media =	6.E-01
	Total Vascular HI Across All Media =	6.E-01
Without Vegetable Consumption	Total Skin HI Across All Media =	6.E-01
	Total Vascular HI Across All Media =	6.E-01

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Aggregate Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis	Arsenic	4.E-05	NA	3.E-06	5.E-05	skin, vascular	NA	NA	NA	NA
			Chemical Total	4.E-05	NA	3.E-06	5.E-05		NA	NA	NA	NA
		Exposure Point Total					5.E-05					NA
	Exposure Medium Total						5.E-05					NA
	Ambient Air	South Minneapolis Emissions from Soil	Arsenic	NA	2.E-08	NA	2.E-08	NA	NA	NA	NA	NA
			Chemical Total	NA	2.E-08	NA	2.E-08		NA	NA	NA	NA
		Exposure Point Total					2.E-08					NA
	Exposure Medium Total						2.E-08					NA
	Garden Vegetables (aboveground)	South Minneapolis	Arsenic	1.E-05	NA	NA	1.E-05	skin, vascular	NA	NA	NA	NA
	(belowground)		Arsenic	5.E-06	NA	NA	5.E-06	skin, vascular	NA	NA	NA	NA
			Chemical Total	2.E-05	NA	NA	2.E-05		NA	NA	NA	NA
		Exposure Point Total					2.E-05					NA
	Exposure Medium Total						2.E-05					NA
Surface Soil Total							6.E-05					NA
Receptor Total (with vegetable consumption)							6.E-05				Receptor HI Total	NA
Receptor Total (without vegetable consumption)							5.E-05				Receptor HI Total	NA

Notes:
EPC = Exposure point concentration based on background level in soil (16 mg/kg).
NA = Not applicable.

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 - 5 ft)	Soil (0 - 5 ft)	South Minneapolis	Arsenic	4.E-06	NA	4.E-07	4.E-06	skin, vascular	6.E-02	NA	6.E-03	6.E-02
			Chemical Total	4.E-06	NA	4.E-07	4.E-06		6.E-02	NA	6.E-03	6.E-02
		Exposure Point Total					4.E-06					6.E-02
	Exposure Medium Total						4.E-06					6.E-02
	Ambient Air	South Minneapolis Emissions from Soil	Arsenic	NA	2.E-09	NA	2.E-09	NA	NA	NA	NA	NA
			Chemical Total	NA	2.E-09	NA	2.E-09		NA	NA	NA	NA
		Exposure Point Total					2.E-09					NA
	Exposure Medium Total						2.E-09					NA
Surface Soil Total							4.E-06					6.E-02
Receptor Total							4.E-06				Receptor HI Total	6.E-02

Notes:
EPC = Exposure point concentration based on background level in soil (16 mg/kg).
NA = Not applicable.

Total Skin HI Across All Media = 6.E-02
Total Vascular HI Across All Media = 6.E-02

TABLE 9.1.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Infant/Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis	Arsenic	NA	NA	NA	NA	skin, vascular	3.E-01	NA	5.E-03	3.E-01
			Chemical Total	NA	NA	NA	NA		3.E-01	NA	5.E-03	3.E-01
		Exposure Point Total					NA					3.E-01
	Exposure Medium Total						NA					3.E-01
	Ambient Air	South Minneapolis Emissions from Soil	Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Chemical Total	NA	NA	NA	NA		NA	NA	NA	NA
		Exposure Point Total					NA					NA
	Exposure Medium Total						NA					NA
Surface Soil Total							NA					3.E-01
Receptor Total							NA				Receptor HI Total	3.E-01

Notes:
EPC = Exposure point concentration based on background level in soil (16 mg/kg).
NA = Not applicable.

Total Skin HI Across All Media =	3.E-01
Total Vascular HI Across All Media =	3.E-01

TABLE 9.2.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis	Arsenic	1.E-05	NA	3.E-07	1.E-05	skin, vascular	NA	NA	NA	NA
			Chemical Total	1.E-05	NA	3.E-07	1.E-05		NA	NA	NA	NA
		Exposure Point Total					1.E-05					NA
	Exposure Medium Total						1.E-05					NA
	Ambient Air	South Minneapolis Emissions from Soil	Arsenic	NA	6.E-09	NA	6.E-09	NA	NA	NA	NA	NA
			Chemical Total	NA	6.E-09	NA	6.E-09		NA	NA	NA	NA
		Exposure Point Total					6.E-09					NA
	Exposure Medium Total						6.E-09					NA
Surface Soil Total							1.E-05					NA
Receptor Total							1.E-05				Receptor HI Total	NA

Notes:

EPC = Exposure point concentration based on background level in soil (16 mg/kg).

NA = Not applicable.

TABLE 9.3.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 - 5 ft)	Soil (0 - 5 ft)	South Minneapolis	Arsenic	2.E-07	NA	4.E-08	2.E-07	skin, vascular	1.E-01	NA	2.E-02	1.E-01
			Chemical Total	2.E-07	NA	4.E-08	2.E-07		1.E-01	NA	2.E-02	1.E-01
		Exposure Point Total					2.E-07					1.E-01
	Exposure Medium Total						2.E-07					1.E-01
	Ambient Air	South Minneapolis Emissions from Soil	Arsenic	NA	2.E-10	NA	2.E-10	NA	NA	NA	NA	NA
			Chemical Total	NA	2.E-10	NA	2.E-10		NA	NA	NA	NA
		Exposure Point Total					2.E-10					NA
	Exposure Medium Total						2.E-10					NA
Surface Soil Total							2.E-07					1.E-01
Receptor Total							2.E-07				Receptor HI Total	1.E-01

Notes:
EPC = Exposure point concentration based on background level in soil (16 mg/kg).
NA = Not applicable.

Total Skin HI Across All Media = 1.E-01
Total Vascular HI Across All Media = 1.E-01

TABLE 10.1.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Infant/Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis										
			Chemical Total									<1
		Exposure Point Total										<1
	Exposure Medium Total											<1
	Ambient Air	South Minneapolis Emissions from Soil										
			Chemical Total									<1
		Exposure Point Total										<1
	Exposure Medium Total											<1
	Garden Vegetables (aboveground) (belowground)	South Minneapolis										
												<1
		Exposure Point Total										<1
	Exposure Medium Total											<1
Surface Soil Total												<1
Receptor Total (with vegetable consumption)								Receptor HI Total				<1
Receptor Total (without vegetable consumption)								Receptor HI Total				<1

Notes:
NA = Not applicable

TABLE 10.2.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis	Arsenic	4.E-05	NA	3.E-06	5.E-05					
			Chemical Total	4.E-05	NA	3.E-06	5.E-05					
		Exposure Point Total					5.E-05					
	Exposure Medium Total						5.E-05					
	Ambient Air	South Minneapolis Emissions from Soil										
			Chemical Total				<1E-06					
		Exposure Point Total					<1E-06					
	Exposure Medium Total						<1E-06					
	Garden Vegetables (aboveground)	South Minneapolis	Arsenic	1.E-05	NA	NA	1.E-05					
	(belowground)		Arsenic	5.E-06	NA	NA	5.E-06					
			Chemical Total	2.E-05	NA	NA	2.E-05					
		Exposure Point Total					2.E-05					
	Exposure Medium Total						2.E-05					
Surface Soil Total							6.E-05					
Receptor Total (with vegetable consumption)							6.E-05	Receptor HI Total				
Receptor Total (without vegetable consumption)							5.E-05	Receptor HI Total				

Notes:
NA = Not applicable

TABLE 10.3.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil (0 - 5 ft)	Soil (0 - 5 ft)	South Minneapolis	Arsenic	4.E-06	NA	4.E-07	4.E-06					
			Chemical Total	4.E-06	NA	4.E-07	4.E-06					<1
		Exposure Point Total					4.E-06					<1
	Exposure Medium Total						4.E-06					<1
	Ambient Air	South Minneapolis Emissions from Soil										
			Chemical Total				<1E-06					<1
		Exposure Point Total					<1E-06					<1
	Exposure Medium Total						<1E-06					<1
Surface Soil Total							4.E-06					<1
Receptor Total							4.E-06					<1

Notes:
NA = Not applicable

TABLE 10.1.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis										
			Chemical Total									<1
		Exposure Point Total										<1
	Exposure Medium Total											<1
	Ambient Air	South Minneapolis Emissions from Soil										
			Chemical Total									<1
		Exposure Point Total										<1
	Exposure Medium Total											<1
Surface Soil Total												<1
Receptor Total								Receptor HI Total				<1

Notes:
NA = Not applicable

TABLE 10.2.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis	Arsenic	1.E-05	NA	3.E-07	1.E-05					
			Chemical Total	1.E-05	NA	3.E-07	1.E-05					
		Exposure Point Total					1.E-05					
	Exposure Medium Total						1.E-05					
	Ambient Air	South Minneapolis Emissions from Soil										
			Chemical Total				<1E-06					
		Exposure Point Total					<1E-06					
	Exposure Medium Total						<1E-06					
Surface Soil Total							1.E-05					
Receptor Total							1.E-05				Receptor HI Total	

Notes:
NA = Not applicable

TABLE 10.3.CTE
RISK SUMMARY
CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	South Minneapolis										
			Chemical Total				<1E-06					<1
		Exposure Point Total					<1E-06					<1
	Exposure Medium Total						<1E-06					<1
	Ambient Air	South Minneapolis Emissions from Soil										
			Chemical Total				<1E-06					<1
		Exposure Point Total					<1E-06					<1
	Exposure Medium Total						<1E-06					<1
Surface Soil Total							<1E-06					<1
Receptor Total							<1E-06					<1

Notes:
NA = Not applicable

TABLE 11.1.RME

CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

South Minneapolis Site

Excess Lifetime Cancer Risk Estimates for Various Arsenic Concentrations:

Receptor	Arsenic Concentration (mg/kg)			
	16	**95**	**500**	**1500**
Aggregate Child/Adult Resident (w/ Veg)	6E-05	4E-04	2E-03	6E-03
Aggregate Child/Adult Resident (w/o Veg)	5E-05	3E-04	1E-03	4E-03
Construction Worker	4E-06	2E-05	1E-04	4E-04

Hazard Index Estimates for Various Arsenic Concentrations:

Receptor	Arsenic Concentration (mg/kg)			
	16	**95**	**500**	**1500**
Aggregate Child/Adult Resident (w/ Veg)	0.6	4	20	60
Aggregate Child/Adult Resident (w/o Veg)	0.6	3	17	52
Construction Worker	0.06	0.4	2	6

Notes:

Excess lifetime cancer risks are calculated for an aggregate adult/child resident since lifetime cancer risks are averaged over a lifetime.

Hazard Index is calculated for an aggregate infant/child resident since HIs are calculated for the duration of exposure (not a lifetime average).

TABLE 11.1b.CTE

CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURE

South Minneapolis Site

Excess Lifetime Cancer Risk Estimates for Various Arsenic Concentrations:

Receptor	Arsenic Concentration (mg/kg)			
	16	**95**	**500**	**1500**
Aggregate Child/Adult Resident	1E-05	8E-05	4E-04	1E-03
Construction Worker	2E-07	1E-06	7E-06	2E-05

Hazard Index Estimates for Various Arsenic Concentrations:

Receptor	Arsenic Concentration (mg/kg)			
	16	**95**	**500**	**1500**
Aggregate Infant/Child Resident	0.3	2	8	25
Construction Worker	0.1	0.8	4	13

TABLE 12.1.RME

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Infant/Child

Chemical	Target Risk	Target Hazard Quotient	Soil Preliminary Remediation Goals											
			Protection of Direct Contact with Soil								Protection of Garden Vegetables		Protection of Direct Contact with Soil and Consumption of Garden Vegetables	
			Calculated PRG for Each Exposure Pathway - Carcinogenic Effects				Calculated PRG For Each Exposure Pathway - Non-Carcinogenic Effects				Carcinogenic Effects	Non-carcinogenic Effects		
			Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Ingestion Only	Carcinogenic Effects	Non-carcinogenic Effects
Arsenic	--	1	--	--	--	--	30	NA	584	**29**	--	**202**	--	**25**

Notes:
NA - Toxicity value not available to calculate a PRG based on this pathway.
The final PRG for infant/children based on non-carcinogenic effects is the calculated soil PRG for 1) ingestion, inhalation, and dermal exposures combined or 2) including all 3 soil pathways and ingestion of vegetables.

TABLE 12.2.RME

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Aggregate Child/Adult

			Soil Preliminary Remediation Goals											
			Protection of Direct Contact with Soil								Protection of Garden Vegetables		Protection of Direct Contact with Soil and Consumption of Garden Vegetables	
			Calculated PRG for Each Exposure Pathway - Carcinogenic Effects				Calculated PRG For Each Exposure Pathway - Non-Carcinogenic Effects				Carcinogenic Effects	Non-carcinogenic Effects		
Chemical	Target Risk	Target Hazard Quotient	Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Ingestion Only	Carcinogenic Effects	Non-carcinogenic Effects
Arsenic	1.0E-06	--	0.4	983	6.0	**0.34**	--	--	--	--	**0.93**	--	**0.25**	--

Notes:
The final PRG for an aggregate (adult/child) resident based on carcinogenic effects is the calculated soil PRG for 1) ingestion, inhalation, and dermal exposures combined or 2) including all 3 soil pathways and ingestion of vegetables.

TABLE 12.3.RME

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

South Minneapolis Site

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Chemical	Target Risk	Target Hazard Quotient	Soil Preliminary Remediation Goals								
			Calculated PRG for Each Exposure Pathway - Carcinogenic Effects				Calculated PRG For Each Exposure Pathway - Non-Carcinogenic Effects				Final PRG (mg/kg)
			Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	
Arsenic	1.0E-06	1	4.5	8,979	44.6	**4**	287	NA	2,868	**261**	**4**

Notes:
NA - Toxicity value not available to calculate a PRG based on this pathway.
The final PRG for construction workers is the lower of the calculated soil PRG for ingestion, inhalation, and dermal exposures combined for 1) carcinogenic effects and 2) non-carcinogenic effects.

TABLE 12.1.CTE

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Infant/Child

Chemical	Target Risk	Target Hazard Quotient	Soil Preliminary Remediation Goals								
			Protection of Direct Contact with Soil								
			Calculated PRG for Each Exposure Pathway - Carcinogenic Effects				Calculated PRG For Each Exposure Pathway - Non-Carcinogenic Effects				
			Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Final PRG (mg/kg)
Arsenic	--	1	--	--	--	--	61	NA	3,020	**59**	**59**

Notes:
NA - Toxicity value not available to calculate a PRG based on this pathway.
The final PRG for infant/children is based on non-carcinogenic effects for all 3 soil pathways combined (ingestion, inhalation, and dermal exposures).

TABLE 12.2.CTE

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

South Minneapolis Site

Scenario Timeframe: Current
Receptor Population: Resident
Receptor Age: Aggregate Child/Adult

Chemical	Target Risk	Target Hazard Quotient	Soil Preliminary Remediation Goals								
			Protection of Direct Contact with Soil								
			Calculated PRG for Each Exposure Pathway - Carcinogenic Effects				Calculated PRG For Each Exposure Pathway - Non-Carcinogenic Effects				
			Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Final PRG (mg/kg)
Arsenic	1.0E-06	--	1.2	2,646	59	**1.2**	--	--	--	--	**1.2**

Notes:
The final PRG for an aggregate (adult/child) resident is based on carcinogenic effects for all 3 soil pathways combined (ingestion, inhalation, and dermal exposures).

TABLE 12.3.CTE

CALCULATION OF SOIL PRELIMINARY REMEDIATION GOALS

South Minneapolis Site

Scenario Timeframe: Current/Future
Receptor Population: Construction Worker
Receptor Age: Adult

Chemical	Target Risk	Target Hazard Quotient	Soil Preliminary Remediation Goals								
			Calculated PRG for Each Exposure Pathway - Carcinogenic Effects				Calculated PRG For Each Exposure Pathway - Non-Carcinogenic Effects				Final PRG (mg/kg)
			Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	Ingestion Only	Inhalation Only	Dermal Only	Including all 3 Pathways	
Arsenic	1.0E-06	1	87	89,788	446	**72**	137	NA	707	**115**	**72**

Notes:
NA - Toxicity value not available to calculate a PRG based on this pathway.
The final PRG for construction workers is the lower of the calculated soil PRG for ingestion, inhalation, and dermal exposures combined for 1) carcinogenic effects and 2) non-carcinogenic effects