FOCUSED HUMAN HEALTH RISK EVALUATION

At the request of MBOH, two focused risk evaluations were conducted to evaluate the potential risk to human health from inhalation exposure to fugitive dust. Although no compounds were detected in soil at concentrations above their respective USEPA Region 9 Inhalation Preliminary Remediation Goal (PRG), these quantitative risk assessments were performed consistent with USEPA guidance which states that inhalation of fugitive dusts should be evaluated for sites with proposed future commercial/industrial land use. The focused risk evaluations were based on analytical results from soil samples collected throughout Bailey Point during Fall 2001 and Spring 2002 and current USEPA and MDEP risk assessment guidance (MDEP, 1994 and 2004; USEPA, 1991a, USEPA, 1994, USEPA, 2001b and USEPA, 2002b).

Exposure Assessment

Inhalation exposure to fugitive dust can be a significant route of exposure during site remediation or construction as dust may be generated by wind erosion of exposed soils. Consistent with USEPA guidance, this exposure assessment evaluates exposure to construction workers present throughout a construction project as well as exposures to nearby off-site residents (USEPA, 2001b). These receptors are potentially subject to higher contaminant exposures due to increased emissions during construction activities. However, to be consistent with the Baseline HHRA, an on-site worker exposure was also evaluated.

Exposure Scenarios: The following exposure assumptions were used and are consistent with standard USEPA and MDEP guidance (MDEP, 1994, USEPA 1991a, 1997b and 2001b):

Resident: A person resides at or near the site for 30 years (6-years as a child and 24 years as an adult) and is exposed to soils through inhalation of fugitive dust generated by wind erosion. An exposure frequency of 150 days per year for a 30-year exposure duration was assumed (USEPA, 1994). An inhalation rate of 13 m^3/day for an adult and 8.1 m^3/day for a child was assumed over a 24 hour exposure duration (USEPA, 1997b). The USEPA default particulate emission factor (PEF) of 1.36×10^9 m^3/kg was used to relate the soil contaminant concentration to a dust particulate contaminant concentration (USEPA, 2001b).

On-Site Worker: An On-site worker is exposed to soils through the inhalation of fugitive dust. An inhalation rate of 1.3 m^3/hour over an 8 hour/day exposure time was assumed for an exposure frequency of 150 days per year over a 25 year exposure duration (USEPA, 1994 and 1997b). The USEPA default PEF of 1.36×10^9 m^3/kg was used to relate the soil contaminant concentration to a dust particulate contaminant concentration (USEPA, 2001b).

Construction Worker: A construction worker is exposed to soils through the inhalation of fugitive dust generated as a result of construction related activities (i.e.,

excavation and vehicle traffic on unpaved roads). The construction worker is assumed to have a more intense exposure to soil contaminants resulting from the increased "dust" level in the breathing zone. The construction worker, however, is assumed to have a shorter exposure duration than the on-site worker as most construction projects are expected to last one-year. An inhalation rate of 1.3 m^3/hour over an 8 hour/day exposure time was assumed to occur 173 days over a 1-year exposure duration (USEPA, 1994, 1997b and 2001b).

The USEPA default PEF could not be used for the construction worker scenario as it is likely to underestimate dust concentrations in air resulting from construction activities. Although emission factors are available for specific construction activities, their application requires more information on the types, locations and schedule of construction activities proposed for this site than is currently available. Therefore, dust emission for the construction worker was estimated using the construction emission factor for Total Suspended Particulate (TSP) emissions recommended by USEPA of 1.2 tons/acre/month or 1.04 x 10^{-4} g/m^2-sec (USEPA, 1993d). Using this factor, the contaminant emissions from soil can calculated as:

$$\mathbf{Q = E \times C \times 10^{-6}}$$

Where:

Q = contaminant emissions flux (g/m^2-s)
E = heavy construction dust emissions factor (g/m^2-s)
C = contaminant concentration in soil (mg/kg)
10^{-6} = conversion factor

A box model was used to calculate the contaminant concentrations in the air over the source area. The box model assumed the air concentrations within a box is proportional to the emission rate and wind speed across the source area:

$$\mathbf{C_c = \frac{Q \times A \times 1{,}000 mg/g}{L \times V \times H}}$$

Where:

C_c = concentration in air
Q = surface emission flux (g/m^2-s)
A = source area m^2
L = width of source area perpendicular to wind direction (m)
V = average wind speed (m/s)
H = box height (m)

A source area (A) of 2.5 acres square (10,120 m^2) corresponding to a width (L) of 100 m was assumed as a reasonable estimate of an area of the site undergoing remediation. This was based on the discrete areas of contamination that have been characterized and may

require remediation. The USEPA default wind speed and box height values were used as model inputs.

The exposure parameters for these scenarios are presented in **Table H3-1.**

Compounds of Potential Concern (COPCs) and Exposure Point Concentrations (EPCs): All compounds detected in soil throughout Bailey Point were retained as COPCs. This was done to provide an overly conservative estimate of risk. A total of 73 compounds were detected in at least one soil sample (all depths) and were retained for the focused risk evaluation. The Exposure Point Concentration (EPCs) for each COPC was set at the maximum detected concentration. As such, the exposure scenarios assume long-term concurrent exposure to the maximum detected contaminant concentration. This is an extremely conservative assumption as the location of the maximum detected concentrations varied across the site. Actual exposure and subsequent risk will be much less than estimated in this evaluation. The COPCs and EPCs are presented in **Table H3-2**.

Toxicity Assessment

Quantitative estimates of inhalation toxicity (e.g., Chronic and Subchronic Reference Concentrations (RfCs) and Unit Risk Factors (URFs)) were obtained from the USEPA Integrated Risk and Information System (IRIS) or National Center for Environmental Assessment (NCEA) for the COPCs. RfCs for carcinogenic compounds were identified and used to evaluate the noncarcinogenic risks from exposure to carcinogenic compounds. RfCs and URFs can be converted to inhalation Reference Dose (RfDs) and inhalation cancer slope factors (CSF) using the following equations:

Inhalation RfD (mg/kg-day) = RfC (mg/m^3) x 20 m^3/day x 1/70 kg

Inhalation CSF $(mg/kg\text{-}day)^{-1}$ = URF $(ug/m^3)^{-1}$ x day/20 m^3 x 70 kg x 10^3 ug/mg

Chronic URF and/or RfC were available for 19 of the 73 soil COPCs as many of these compounds are not considered to be toxic through inhalation exposure (USEPA, 2001b). Subchronic RfC were available for 16 of the 73 soil COPCs. A summary of the toxicity information for the soil COPCs is presented in **Table H3-2**.

Risk Assessment

Two quantitative risk evaluations were conducted and are presented in this section. The first evaluation is based on less than lifetime exposure and provides estimates of noncancer hazards and carcinogenic risk using the standard USPEPA risk assessment methodology and converted RfC and URFs (USEPA, 1989). The second evaluation is based on a continuous exposure to a predicted air concentration and was conducted at the request of MDEP to address the limitations in applying converted RfC and URFs to less than lifetime (i.e., acute and sub chronic) exposures (USEPA, 2002b). This evaluation

includes a comparison of predicted air concentrations to RfC for noncarcinogenic COPCs and multiplying the predicted air concentrations by the URF for carcinogenic COPCs.

Less Than Lifetime Exposure Risks: Based on standard USEPA methodology, the non-carcinogenic risks from exposure to fugitive dust are expressed in terms of a Hazard Index (HI), which is calculated by dividing the estimated exposure dose by the inhalation RfD (USEPA, 2001b):

Hazard Index (HI) = Exposure Dose (mg/kg-day) / Inhalation RfD (mg/kg-day)

If the HI is less than 1.0, no adverse health effects are anticipated from the predicted exposure dose level. If the HI is greater than 1, the predicted exposure dose level could potentially cause adverse effects (USEPA, 1989c).

The non-carcinogenic risks associated with exposure to fugitive dust from Bailey Point are presented in **Table H3-3 through H3-6** for the resident, on-site worker, 6-year childhood exposure and construction worker scenarios. All non cancer risks were below an HI of 1.0 and include HI = 0.007 (resident), HI = 0.006 (on-site worker), HI = 0.02 (child) and HI = 0.05 (construction worker).

The carcinogenic risk from exposure to soils is evaluated by multiplying the estimated exposure dose of each carcinogenic COPC by its respective inhalation CSF to obtain an estimate of incremental risk, as follows:

Carcinogenic Risk = Exposure Dose (mg/kg-day) x Inhalation CSF $(mg/kg\text{-}day)^{-1}$

The CSF converts the estimated daily intake of a chemical averaged over a lifetime of exposure to an incremental risk of an individual developing cancer. The CSF used in these calculations is often the upper 95-percentile confidence limit of the probability of a response based on experimental data. As such, the carcinogenic risk estimates presented in this assessment are considered to be an upper-bound estimate of risk. The "true risk" to an individual is likely to be much less than predicted in this assessment (USEPA, 1989c).

USEPA guidelines state that the total incremental carcinogenic risk for an individual resulting from exposure at a RCRA Corrective Action site should not exceed a target risk range of $1x10^{-6}$ to $1x10^{-4}$ (USEPA, 1990). The MDEP has set $1x10^{-5}$ as the upper bound for an acceptable incremental lifetime cancer risk (MDEP, 1994).

The incremental carcinogenic risk associated with exposure to fugitive dust at Bailey Point are presented in **Table H3-7, H3-8 and H3-9** for resident, on-site worker and construction worker scenarios, respectively. Cancer risks were estimated by multiplying the exposure dose of each COPC by its inhalation CSF. These risks were then summed to provide a total site incremental cancer risk. All cancer risks were below the MDEP target risk of 10^{-5} and the USEPA target risk range of 10^{-4} to 10^{-6} and include 2.0×10^{-8} (resident), 1.4×10^{-8} (on site worker) and 2.0×10^{-6} (construction worker). Inhalation of

naturally occurring arsenic in soils contributed significantly to the cancer risks for the construction worker. Arsenic is present throughout Bailey Point at concentrations associated with background conditions (see Section 4.7.1 of the Bailey Point RFI). Eliminating arsenic from the risk calculation results in a cancer risk of 1.2×10^{-6}.

Continuous Lifetime Exposure: To address the limitations of applying converted RfCs and URFs to less than lifetime exposure, the predicted long-term air concentrations were compared directly to RfCs for noncarcinogenic compounds and multiplied by URFs for carcinogenic compounds (USEPA, 2002b). This evaluation assumes that exposure occurs continuously over a lifetime. The predicted airborne dust air concentrations (mg/m^3) for each soil COPC was calculated by dividing the maximum detected soil concentration (mg/kg) by the USEPA PEF of 1.36×10^9 (m^3/kg). The noncancer and cancer risks associated with exposure to airborne dust are presented in **Table H3-10 and H3-11**, respectively. Both risk evaluations are below their respective target risk level. The noncarcinogenic risks associated with exposure to airborne dust is 0.03, below the target HI of 1.0 and the carcinogenic risks associated with exposure to airborne dust is 1.8×10^{-7}, below the target risk level of 10^{-5}.

Summary and Conclusions

The purpose of these two focused risk evaluations was to evaluate potential human health risks from exposure to fugitive dust. These risk assessments were conducted in accordance with USEPA and MDEP guidance and is consistent with standard USEPA and MDEP methodology. The exposure scenarios and assumptions used in these evaluations were overly conservative including long-term repetitive exposure to the maximum detected chemical concentration. However, even with these assumptions, the noncarcinogenic risk estimates are well below the target HI of 1.0 and the carcinogenic risk estimates are below the MDEP target risk level and the USEPA target risk range. These risk estimates support the conclusion that inhalation of fugitive dust is not a significant route of exposure at this site.