APPENDIX E

Development of Toxicity Reference Values

DEVELOPMENT OF TOXICITY REFERENCE VALUES AND SOIL SCREENING LEVELS FOR ARSENIC AND MERCURY IN DOMESTIC ANIMALS, WITH PARTICULAR REFERENCE TO THE HORSE

I. Metals Bioavailability in Soil

Soils represent the most concentrated pool of metals in the terrestrial environment. The potential health risks posed by trace metals in soils are not determined solely by their quantity. A number of chemical, environmental and biological conditions and processes influence the bioavailability of metals to organisms, and hence their toxicological significance. First, speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of metals. Second, the distribution coefficient between soil and water (K_d) depends upon both the properties of the metal and the composition of the soil. This coefficient also governs the bioavailability of a metal to organisms contacting the soil, with weakly bound metals highly bioavailable and more strongly bound metals less bioavailable. Other influential factors include (1) the characteristics of the interface (e.g., lung, skin, intestine), (2) the reactivity of the metal with the interface, and (3) the concurrent presence of other metals or other substances that may stimulate or inhibit metal uptake.

The bioavailability of metals associated with soils (defined as the percentage of total metal in soil that is absorbed following exposure via inhalation, ingestion or dermal contact) is dependent on the physical and chemical characteristics of both the metal and the soil. Available data suggest that arsenic and other metals associated with mine tailings or smelter-impacted soils are much less bioavailable than those from other sources (Davis *et al.*, 1996; Gasser *et al.*, 1996). To estimate the bioavailability of metals in the Mount. Egerton tailings, information regarding the mineralogical characteristics of these tailings should be obtained. Clay type (e.g., kaolinite, smectite, chlorite) and content should be determined because these parameters have been shown to affect trace metal sorption. The clay fraction may be the most important soil component in controlling metal sorption by soils. The cation exchange capacity (CEC) represents the ability of a soil to attract and accumulate cations (Brady, 1974). The higher the CEC value, the greater the capacity of the soil to sorb metals in cationic form. Typical values range from 2 meq/100 g for sandy soils to 57 meq/100 g for clay loams (Brady, 1974). Particle size distribution and pH should also be considered important as CEC increases with increasing soil pH and percent fines (clay + silt) (Brady, 1974). The point of zero charge (PZC) is a measure of the surface charge on the solid at the pH of interest and can provide an indication of the potential for sorption of metal ions in solution by solids. For example, a PZC of 5.9 indicates that the soil will be negatively charged above this value, and in the GI tract of a human (pH 6-7) the soil would retain cationic species of arsenic. On the other hand, As cations may not remain sorbed on soils with pH values of >7.0 and hence may become bioavailable in the pH 6-7 human GI tract. High levels of organic matter, primarily in the B horizon of soils, leads to increased microbial activity and hence volatility of arsenic (NR, 1992). Characterization of soils with regard to these characteristics will provide a general indication of the availability of arsenic in stock animals.

Arsenic

Once released into a soil system, arsenic may precipitate in the form of insoluble arsenic minerals, adsorb onto soil exchange sites, or be taken up by plants (Woolson, 1977; Sadiq, 1986). Arsenic undergoes a variety of physical, chemical, and biological transformations in the environment as well as in organisms. It can exist in four valence states: As^{3-}, metallic (As^0), trivalent arsenite (As^{+3}), and pentavalent arsenate (As^{+5}). Trivalent arsenic forms organic derivatives of arsine (AsH_3) containing one, two, or three alkyl or aryl groups. Remaining valence positions can be filled by hydrogen, halogens, some metals, oxygen, or sulfur. Pentavalent arsenic can form similar but fewer types of organic compounds (Penrose, 1974). In soil, arsenic occurs predominantly in an insoluble adsorbed form. Anion exchange interactions as well as complexation and chelation by organic material, iron, and calcium are the major mechanisms of arsenic retention in soils. Arsenate is the dominant arsenic species in aerobic soils (ATSDR, 1991).

Available data indicate that soil adsorption can significantly reduce the bioavailability of arsenic to both plants and animals. Arsenic bioavailability in smelter-impacted soils are limited by encapsulation in insoluble matrices, formation of insoluble alteration or precipitation rinds, and formation of iron-arsenic oxide and arsenic phosphate cements that reduce the arsenic-bearing surface area available for dissolution (Davis *et al.*, 1996). These limitations combined with kinetic limitations associated with dissolution of these phases during the short transit time through the GI tract help explain the reduced bioavailability (Davis *et al.*, 1996).

Davis *et al.* (1992) showed that only 11% of soil-associated arsenic was solubilized in rabbit small intestine. A subsequent study by the same group yielded an oral bioavailability of 48% for a single dose of arsenic relative to sodium arsenate solution (Freeman *et al.*, 1993). Groen *et al.* (1994) used dogs to compare urinary excretion of injected arsenate and arsenic in soil mixed with food, a more biologically realistic exposure method than the single-dose gavage protocol used in other studies. The bioavailability measured in this study was 9%. In view of the fact that the bioavailability of arsenic in tailings is generally lower than that in native soils, the value of 11% was selected for use as a conservative estimate of bioavailability in this analysis.

Mercury

The chemistry of mercury in the environment is complex, not only because of its various oxidation states but also because of biotic and abiotic methylation and demethylation processes, complexation with organic and inorganic ligands, and the differential solubility and volatility of various forms. As speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of mercury compounds lack of knowledge of the state of the mercury in the Mount. Egerton tailings is a large source of uncertainty in both exposure and effects assessments. Much less information is available regarding the oral bioavailability of mercury associated with soil or mine tailings. A recent study performed to evaluate the bioavailability of mercury in floodplain soils

demonstrated an average RAF_o of 5.3% (0.053) (Barnett and Turner, 1996). Accordingly, a conservative bioavailability factor of 10% can be selected.

II. Toxicity Reference Values

A toxicity reference value (TRV) is defined as a dose for a receptor taxon (including sensitive subgroups such as taxa under regulatory protection) that is likely to be without appreciable risk of deleterious effects from chronic exposure.

Arsenic

Arsenic - Dogs

A TRV of 2.35mg/kg-day was based on a 2 year NOAEL of 2.35mg/kg-bw/day for dogs (Byron *et al.*, 1967). The NOAEL was based on survival and growth of beagle dogs. The dietary dose of 50mg/kg was multiplied by the estimated ingestion rate of 0.39kg/d (Nagy, 1987) and then divided by the estimated weight of a beagle dog (8.3kg; Gralla *et al.*, 1977) to obtain 2.35mg/kg-bw/day.

Arsenic - Horses

A TRV of 0.46mg/kg-day was established based on a reported no-effect dose range of 0.24 - 0.72g As_2O_3/day for two years (Puls, ?). Assuming an equine body weight of 400kg, this dose range corresponds to a weight-normalised range of 0.6 - 1.8mg As_2O_3/kg-day. As arsenic comprises approximately 76% of this compound, these values are adjusted to 0.46 - 1.37mg As/kg-day. To ensure protectiveness, the lower bound of this range was selected. This is highly conservative as trivalent arsenicals are known to be more toxic than the pentavalent forms more common in the environment (Osweiler *et al.*, 1985).

Mercury

Mercury (Organic) - Dogs

No data were found for dogs. A TRV of 0.076mg/kg-day was based on a 93 d NOAEL of 0.076mg/kg-bw/day for adult female mink exposed to methyl mercury chloride (Wobeser *et al.*, 1975). No obvious clinical signs of toxicity were observed (eg., anorexia, weight loss, ataxia, head tremors) at the NOAEL dose after 93 days. The NOAEL dose of 1.1mg/kg feed was multiplied by the average daily feeding rate for mink (0.069kg/d; Aulerich *et al.*, 1985) and then divided by the average weight of adult female mink (1.0kg-bw; U.S. EPA, 1993) to obtain a TRV of 0.076mg/kg-bw/day. The mink value was used to generate the TRV because it is more taxonomically similar to ROCs than domestic animals such as cats.

Mercury (Organic) - Horses, Cattle, Sheep

No data were found for horses, cattle, or sheep. A TRV of 0.18mg/kg-day was based on a single oral dose LD_{50} of 17.88mg/kg-bw for mule deer (Hudson *et al.*, 1984). Deer were exposed to the pesticide MEMA RM (7.15% mercury), resulting in a LD50 of 250mg MEMA RM/kg-bw. This value was multiplied by 7.15% mercury to yield 17.88mg Hg/kg-bw. This value was divided by 100 to estimate a chronic NOAEL based on judgement of the reliability of the data referenced.

III. Interactions of Mercury and Selenium in Animals

Studies have shown that fish tissue high in selenium protects fish from mercury toxicity (El-Begearmi *et al.*, 1977). Concurrent administration of both Se and Hg in rats resulted in decreased Hg toxicity, decreased Hg excretion, increased Hg retention, and markedly increased levels of Hg in the blood of rats (El-Begearmi *et al.*, 1977; Ammerman *et al.*, 1977). Similar results were observed in quail and chickens fed Hg and Se (El-Begearmi *et al.*, 1977). It has been suggested that a portion of the toxic effects of Hg in swine results from complexing essential biologically active forms of Se, resulting in a conditioned Se deficiency induced by mercury ingestion (El-Begearmi *et al.*, 1977).

IV. Interactions of Arsenic and Selenium in Animals

Arsenic toxicity in most mammals is manifested by acute exposure and not chronic because detoxication and excretion of arsenic are rapid (Eisler, 1988; Ammerman *et al.*, 1977). Chronic toxicity of inorganic arsenicals is associated with weakness, paralysis, conjunctivitis, dermatitis, decreased growth, and liver damage (Eisler, 1988). Most reports of arsenic poisoning in domestic animals are due to dips, herbicides, and defoliants where organisms are exposed acutely to soluble trivalent forms of arsenic (Eisler, 1988). Arsenic salts have been shown to be effective in counteracting selenium toxicity in poultry and rats (Ammerman *et al.*, 1977). Dietary sodium arsenate (1 ppm) in selenium-deficient diets reduced the incidence of myopathy in lambs (Ammerman *et al.*, 1977). Ruminants have been reported to selectively graze on arsenic-contaminated forage and may actually develop a taste for arsenic (Ammerman *et al.*, 1977). No information was found regarding the possible effect of arsenic ingestion on selenium deficiency in stock animals.

V. Calculation of Soil Screening Levels for Arsenic and Mercury for Horses

To calculate soil screening levels (SSLs) for arsenic and mercury present in Mount. Egerton mine tailings, soil concentrations of these metals corresponding to the acceptable doses defined above (*ie.*, TRVs) for horses were calculated assuming exposure via direct ingestion of tailings as well as ingestion of plants containing metals from the tailings.

General Parameters for Horses

Parameter	Value	Reference
Body weight (BW)	400 kg	
Food ingestion rate (IR)	9.1 kg/day	
Fraction of soil in diet (P_s)	0.068 kg soil/kg diet	Value reported by Beyer *et al.* (1994) for American bison
Fraction of plants in diet	0.932 kg plant/kg diet	Calculated as 1 - P_s

Chemical-Specific Parameters

Parameter	Units	Arsenic	Reference	Mercury	Reference
Toxicity reference value (TRV)	mg/kg-day	0.46	Puls (?)	0.18	Hudson *et al.* (1984)
Plant uptake factor (PUF)	mg/kg plant/mg/kg soil	0.04	Baes *et al.* (1984)	0.9	Baes *et al.* (1984)
Oral bioavailability factor (BF)	mg absorbed/mg ingested	0.11	Davis *et al.* (1992)	0.1	Barnett & Turner (1996)

The concentration of metals in soil corresponding to the TRV for horses can be estimated according to the equation:

(1)

$$Soil\ Screening\ Level\left[\frac{mg}{kg\text{-}soil}\right] = \frac{TRV \times BW}{[(P_v \times PUF) + (P_s \times BF)] \times IR}$$

where

TRV	=	Toxicity reference value (mg/kg-day)
BW	=	Horse body weight (400kg)
P_v	=	Percent of diet comprised of plants (6.8%)
P_s	=	Percent of diet comprised of soil (9.32%)
IR	=	Dietary intake rate (9.1kg dry weight/day)
PUF	=	Plant uptake factor
BF	=	Oral Bioavailability Factor. It should be noted that the soil screening level calculated by the method does not include the dose attributable to contamination of drinking water.

For arsenic, a soil screening level can thus be calculated as:

(2)

$$SSL_{As}\left[\frac{mg}{kg-soil}\right] = \frac{0.46mg/kg-day \times 400kg}{\left[\left(0.932\frac{kg\ plant}{kg\ diet} \times 0.04\frac{mg/kg\ plant}{mg/kg\ soil}\right) + \left(0.068\frac{kg\ soil}{kg\ diet} \times 0.11\frac{mg\ absorbed}{mg\ ingested}\right)\right] \times 9.1kg\ diet/day}$$

$$= 451.7mg/kg\ As\ in\ soil$$

Similarly, a mercury soil screening level for horses may be calculated as:

(3)

$$SSL_{As}\left[\frac{mg}{kg-soil}\right] = \frac{0.18 mg/kg-day \times 400 kg}{\left[\left(0.932 \frac{kg\ plant}{kg\ diet} \times 0.9 \frac{mg/kg\ plant}{mg/kg\ soil}\right) + \left(0.068 \frac{kg\ soil}{kg\ diet} \times 0.1 \frac{mg\ absorbed}{mg\ ingested}\right)\right] \times 9.1 kg\ diet/day}$$

$$= 79.9 mg/kg\ Hg\ in\ soil$$

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APPENDIX F

Human Health Risk Assessment Calculations

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 1

CONTAMINANT: Arsenic
RECEPTOR: Adult
SCENARIO: Maximum intake, including contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	495
Bioavailability (soil)		0.2
Concentration in Water	mg/L	0.002
Concentration in Fish	mg/kg	0.3
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.04
Daily Intake of Soil	mg/day	25
Daily Intake of Fish	kg	0.03
Daily Intake of Water	L	2
Daily Inhaled Volume	m3	20
Body Weight	kg	70

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	0.002

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	3.54E−05	4.45%	1.77%
Inhaled Dust	2.83E−06	0.36%	0.14%
Drinking Water	5.71E−05	7.18%	2.86%
Food	5.71E−04	71.85%	28.57%
Fish	1.29E−04	16.17%	6.43%
Total	7.95E−04	100.00%	39.77%

Ratio of Total Intake to TDI 0.40

File 22148\007\ CASE1

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 2

CONTAMINANT: Mercury
RECEPTOR: Adult
SCENARIO: Maximum intake, including contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	4.3
Bioavailability (soil)		0.1
Concentration Water	mg/L	0.0005
Concentration in Fish	mg/kg	0.5
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.004
Daily Intake of Soil	mg/day	25
Daily Intake of Fish	kg	0.03
Daily Intake of Water	L	2
Daily Inhaled Volume	m3	20
Body Weight	kg	70

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	3.30E–04

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	1.54E–07	0.05%	0.05%
Inhaled Dust	2.46E–08	0.01%	0.01%
Drinking Water	1.43E–05	5.00%	4.33%
Food	5.71E–05	19.99%	17.32%
Fish	2.14E–04	74.95%	64.94%
Total	2.86E–04	100.00%	86.63%
Ratio of Total Intake to TDI	0.87		

File 22148\007\ case2

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 3

CONTAMINANT: Arsenic
RECEPTOR: Child
SCENARIO: Maximum intake, including contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	495
Bioavailablity (soil)		0.2
Concentration in Water	mg/L	0.002
Concentration in Fish	mg/kg	0.3
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.012
Daily Intake of Soil	mg/day	100
Daily Intake of Fish	kg	0.005
Daily Intake of Water	L	0.66
Daily Inhaled Volume	m3	5
Body Weight	kg	13.2

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	2.00E–03

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	7.50E–04	39.97%	37.50%
Inhaled Dust	3.75E–06	0.20%	0.19%
Drinking Water	1.00E–04	5.33%	5.00%
Food	9.09E–04	48.45%	45.45%
Fish	1.14E–04	6.06%	5.68%
Total	1.88E–03	100.00%	93.82%

Ratio of Total Intake to TDI 0.94

File 22148\007\ case3

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 4

CONTAMINANT: Mercury
RECEPTOR: Child
SCENARIO: Maximum intake, including contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	4.3
Bioavailability (soil)		0.1
Concentration Water	mg/L	0.0005
Concentration in Fish	mg/kg	0.5
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.0005
Daily Intake of Soil	mg/day	100
Daily Intake of Fish	kg	0.005
Daily Intake of Water	L	0.66
Daily Inhaled Volume	m3	5
Body Weight	kg	13.2

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	3.30E–04

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	3.26E–06	1.27%	0.99%
Inhaled Dust	3.26E–08	0.01%	0.01%
Drinking Water	2.50E–05	9.78%	7.58%
Food	3.79E–05	14.82%	11.48%
Fish	1.89E–04	74.11%	57.39%
Total	2.56E–04	100.00%	77.44%

Ratio of Total Intake to TDI 0.77

File 22148\007\ case4

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 5

CONTAMINANT: Arsenic
RECEPTOR: Adult
SCENARIO: Maximum intake, excluding contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	495
Bioavailability		0.2
Concentration in Water	mg/L	0.002
Concentration in Fish	mg/kg	0.3
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.04
Daily Intake of Soil	mg/day	25
Daily Intake of Fish	kg	0
Daily Intake of Water	L	2
Daily Inhaled Volume	m3	20
Body Weight	kg	70

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	0.002

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	3.54E−05	5.30%	1.77%
Inhaled Dust	2.83E−06	0.42%	0.14%
Drinking Water	5.71E−05	8.57%	2.86%
Food	5.71E−04	85.70%	28.57%
Fish	0.00E+00	0.00%	0.00%
Total	6.67E−04	100.00%	33.34%

Ratio of Total Intake to TDI 0.33

File 22148\007\ case5

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 6

CONTAMINANT: Mercury
RECEPTOR: Adult
SCENARIO: Maximum intake, excluding contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	4.3
Bioavailability		0.1
Concentration Water	mg/L	0.0005
Concentration in Fish	mg/kg	0.5
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.004
Daily Intake of Soil	mg/day	25
Daily Intake of Fish	kg	0
Daily Intake of Water	L	2
Daily Inhaled Volume	m3	20
Body Weight	kg	70

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	3.30E--04

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	1.54E–07	0.21%	0.05%
Inhaled Dust	2.46E–08	0.03%	0.01%
Drinking Water	1.43E–05	19.95%	4.33%
Food	5.71E–05	79.80%	17.32%
Fish	0.00E+00	0.00%	0.00%
Total	7.16E–05	100.00%	21.70%
Ratio of Total Intake to TDI	0.22		

File 22148\007\ case6

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 7

CONTAMINANT: Arsenic
RECEPTOR: Child
SCENARIO: Maximum intake, excluding contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	495
Bioavailability		0.2
Concentration in Water	mg/L	0.002
Concentration in Fish	mg/kg	0.3
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.012
Daily Intake of Soil	mg/day	100
Daily Intake of Fish	kg	0
Daily Intake of Water	L	0.66
Daily Inhaled Volume	m3	5
Body Weight	kg	13.2

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	2.00E–03

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	7.50E–04	42.54%	37.50%
Inhaled Dust	3.75E–06	0.21%	0.19%
Drinking Water	1.00E–04	5.67%	5.00%
Food	9.09E–04	51.57%	45.45%
Fish	0.00E+00	0.00%	0.00%
Total	1.76E–03	100.00%	88.14%
Ratio of Total Intake to TDI	0.88		

File 22148\007\ case7

MOUNT EGERTON - HUMAN HEALTH RISK ASSESSMENT
CASE : 8

CONTAMINANT: Mercury
RECEPTOR: Child
SCENARIO: Maximum intake, excluding contaminated local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	**mg/kg**	6.1
Bioavailability		0.1
Concentration Water	**mg/L**	0.0005
Concentration in Fish	**mg/kg**	0.5
Dust Concentration in Air	**mg/m3**	0.02
Daily Intake in Food	**mg/day**	0.0005
Daily Intake of Soil	**mg/day**	100
Daily Intake of Fish	**kg**	0
Daily Intake of Water	**L**	0.66
Daily Inhaled Volume	**m3**	5
Body Weight	**kg**	13.2

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	3.30E-04

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	4.62E-06	6.84%	1.40%
Inhaled Dust	4.62E-08	0.07%	0.01%
Drinking Water	2.50E-05	37.01%	7.58%
Food	3.79E-05	56.08%	11.48%
Fish	0.00E+00	0.00%	0.00%
Total	6.75E-05	100.00%	20.47%
Ratio of Total Intake to TDI	0.20		

File 22148\007\ case8

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 9

CONTAMINANT: Arsenic
RECEPTOR: Child
SCENARIO: Adjusted soil concentration to match TDI excluding local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	650
Bioavailability		0.2
Concentration in Water	mg/L	0.002
Concentration in Fish	mg/kg	0.3
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.012
Daily Intake of Soil	mg/day	100
Daily Intake of Fish	kg	0
Daily Intake of Water	L	0.66
Daily Inhaled Volume	m3	5
Body Weight	kg	13.2

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	2.00E−03

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	9.85E−04	49.27%	49.24%
Inhaled Dust	4.92E−06	0.25%	0.25%
Drinking Water	1.00E−04	5.00%	5.00%
Food	9.09E−04	45.48%	45.45%
Fish	0.00E+00	0.00%	0.00%
Total	2.00E−03	100.00%	99.94%

Ratio of Total Intake to TDI 1.00

File 22148\007\ case9

MOUNT EGERTON – HUMAN HEALTH RISK ASSESSMENT
CASE : 10

CONTAMINANT: Mercury
RECEPTOR: Child
SCENARIO: Adjusted soil concentration to match TDI excluding local fish

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	350
Bioavailability		0.1
Concentration Water	mg/L	0.0005
Concentration in Fish	mg/kg	0.5
Dust Concentration in Air	mg/m3	0.02
Daily Intake in Food	mg/day	0.0005
Daily Intake of Soil	mg/day	100
Daily Intake of Fish	kg	0
Daily Intake of Water	L	0.66
Daily Inhaled Volume	m3	5
Body Weight	kg	13.2

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	3.30E−04

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil Ingestion	2.65E−04	80.18%	80.35%
Inhaled Dust	2.65E−06	0.80%	0.80%
Drinking Water	2.50E−05	7.56%	7.58%
Food	3.79E−05	11.45%	11.48%
Fish	0.00E+00	0.00%	0.00%
Total	3.31E−04	100.00%	100.21%
Ratio of Total Intake to TDI	1.00		

File 22148\007\ case10

APPENDIX G

Animal Health Risk Assessment Calculations

MOUNT EGERTON – ANIMAL HEALTH RISK ASSESSMENT
CASE : 1

CONTAMINANT: Arsenic
RECEPTOR: Horse
SCENARIO: Typical intakes in food, soil and water

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	495
Concentration in Water	mg/L	0.58
Daily Intake of Food	kg/day	9
Daily Intake of Soil	kg/day	1
Daily Intake of Water	L/day	60
Plant Uptake Factor	decimal	0.04
Bioavailability (soil)	decimal	0.11
Bioavailability (food and water)	decimal	1
Body Weight	kg	400

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	0.46

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	1.36E−01	20.36%	29.59%
Water	8.70E−02	13.01%	18.91%
Food	4.46E−01	66.63%	96.85%
Total	6.69E−01	100.00%	145.35%

Ratio of Total Intake to TDI 1.45

File 22148\007\ CASE1

MOUNT EGERTON – ANIMAL HEALTH RISK ASSESSMENT
CASE : 2

CONTAMINANT: Arsenic
RECEPTOR: Cattle
SCENARIO: Typical intakes in food, soil and water

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	495
Concentration in Water	mg/L	0.58
Daily Intake of Food	kg/day	8
Daily Intake of Soil	kg/day	0.7
Daily Intake of Water	L/day	70
Plant Uptake Factor	decimal	0.04
Bioavailability (soil)	decimal	0.11
Bioavailability (food and water)	decimal	1
Body Weight	kg	350

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	0.46

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	1.09E–01	16.07%	23.67%
Water	1.16E–01	17.12%	25.22%
Food	4.53E–01	66.80%	98.39%
Total	6.77E–01	100.00%	147.28%
Ratio of Total Intake to TDI	1.47		

File 22148\007\ case2

MOUNT EGERTON - ANIMAL HEALTH RISK ASSESSMENT
CASE : 3

CONTAMINANT: Arsenic
RECEPTOR: Sheep
SCENARIO: Typical intakes in food, soil and water

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	495
Concentration in Water	mg/L	0.58
Daily Intake of Food	kg/day	1
Daily Intake of Soil	kg/day	0.1
Daily Intake of Water	L/day	5
Plant Uptake Factor	decimal	0.04
Bioavailability (soil)	decimal	0.11
Bioavailability (food and water)	decimal	1
Body Weight	kg	40

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	0.46

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	1.36E-01	19.35%	29.59%
Water	7.25E-02	10.30%	15.76%
Food	4.95E-01	70.35%	107.61%
Total	7.04E-01	100.00%	152.96%
Ratio of Total Intake to TDI	1.53		

File 22148\007\ case3

MOUNT EGERTON - ANIMAL HEALTH RISK ASSESSMENT
CASE : 4

CONTAMINANT: Mercury
RECEPTOR: Horse
SCENARIO: Typical intakes in food, soil and water

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	4.3
Concentration in Water	mg/L	0.0012
Daily Intake of Food	kg/day	9
Daily Intake of Soil	kg/day	1
Daily Intake of Water	L/day	60
Plant Uptake Factor	decimal	0.9
Bioavailability (soil)	decimal	0.1
Bioavailability (food and water)	decimal	1
Body Weight	kg	400

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	0.18

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	1.08E-03	1.22%	0.60%
Water	1.80E-04	0.20%	0.10%
Food	8.71E-02	98.58%	48.38%
Total	8.83E-02	100.00%	49.07%
Ratio of Total Intake to TDI	0.49		

File 22148\007\ case4

MOUNT EGERTON - ANIMAL HEALTH RISK ASSESSMENT
CASE : 5

CONTAMINANT: Mercury
RECEPTOR: Cattle
SCENARIO: Typical intakes in food, soil and water

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	4.3
Concentration in Water	mg/L	0.0012
Daily Intake of Food	kg/day	8
Daily Intake of Soil	kg/day	0.7
Daily Intake of Water	L/day	70
Plant Uptake Factor	decimal	0.9
Bioavailability (soil)	decimal	0.1
Bioavailability (food and water)	decimal	1
Body Weight	kg	350

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	0.18

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	8.60E-04	0.96%	0.48%
Water	2.40E-04	0.27%	0.13%
Food	8.85E-02	98.77%	49.14%
Total	8.96E-02	100.00%	49.75%
Ratio of Total Intake to TDI	0.50		

File 22148\007\ case5

MOUNT EGERTON - ANIMAL HEALTH RISK ASSESSMENT
CASE : 6

CONTAMINANT: Mercury
RECEPTOR: Sheep
SCENARIO: Typical intakes in food, soil and water

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	4.3
Concentration in Water	mg/L	0.0012
Daily Intake of Food	kg/day	1
Daily Intake of Soil	kg/day	0.1
Daily Intake of Water	L/day	5
Plant Uptake Factor	decimal	0.9
Bioavailability (soil)	decimal	0.1
Bioavailability (food and water)	decimal	1
Body Weight	kg	40

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	0.18

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	1.08E-03	1.10%	0.60%
Water	1.50E-04	0.15%	0.08%
Food	9.68E-02	98.75%	53.75%
Total	9.80E-02	100.00%	54.43%
Ratio of Total Intake to TDI	0.54		

File 22148\007\ case6

MOUNT EGERTON - ANIMAL HEALTH RISK ASSESSMENT
CASE : 7

CONTAMINANT: Arsenic
RECEPTOR: Horse
SCENARIO: Adjusted soil concentration to match TDI

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	**mg/kg**	317
Concentration in Water	**mg/L**	0.58
Daily Intake of Food	**kg/day**	9
Daily Intake of Soil	**kg/day**	1
Daily Intake of Water	**L/day**	60
Plant Uptake Factor	**decimal**	0.04
Bioavailability (soil)	**decimal**	0.11
Bioavailability (food and water)	**decimal**	1
Body Weight	**kg**	400

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Arsenic	0.46

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	8.72E-02	18.97%	18.95%
Water	8.70E-02	18.93%	18.91%
Food	2.85E-01	62.09%	62.02%
Total	4.59E-01	100.00%	99.89%
Ratio of Total Intake to TDI	1.00		

File 22148\007\ case7

MOUNT EGERTON - ANIMAL HEALTH RISK ASSESSMENT
CASE : 8

CONTAMINANT: Mercury
RECEPTOR: Horse
SCENARIO: Adjusted soil concentration to match TDI

EXPOSURE PARAMETERS

Parameter	Unit	Value
Concentration in Soil	mg/kg	8.4
Concentration in Water	mg/L	0.0012
Daily Intake of Food	kg/day	9
Daily Intake of Soil	kg/day	1
Daily Intake of Water	L/day	60
Plant Uptake Factor	decimal	0.9
Bioavailability (soil)	decimal	0.5
Bioavailability (food and water)	decimal	1
Body Weight	kg	400

TOLERABLE DAILY INTAKE (TDI)

Contaminant	mg/kg/day
Mercury	0.18

CONTAMINANT INTAKE

Source/Pathway	Intake mg/kg/day	Percent Intake	Percent TDI
Soil	1.05E-02	5.81%	5.83%
Water	1.80E-04	0.10%	0.10%
Food	1.70E-01	94.09%	94.50%
Total	1.81E-01	100.00%	100.43%
Ratio of Total Intake to TDI	1.00		

File 22148\007\ case8