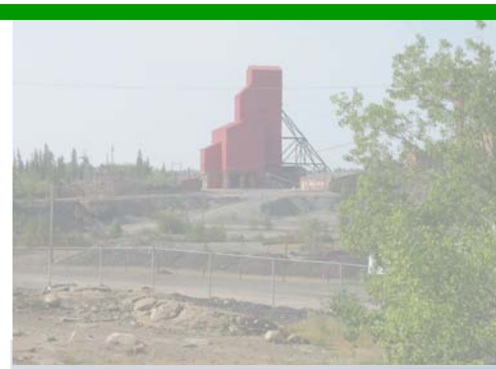
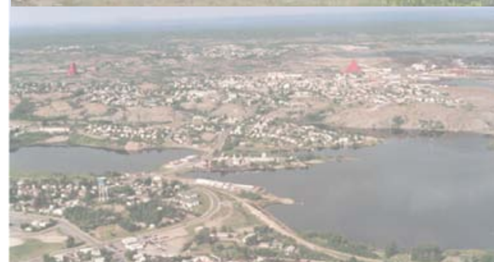
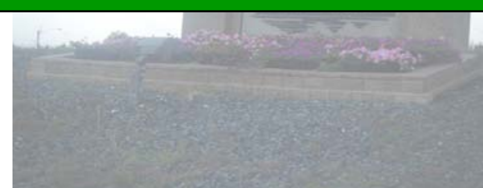
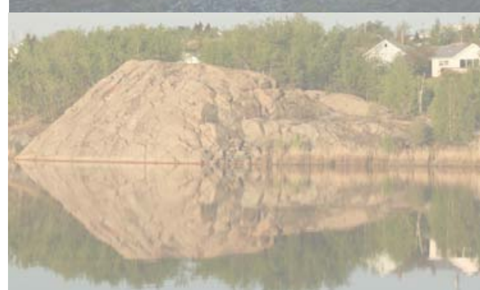
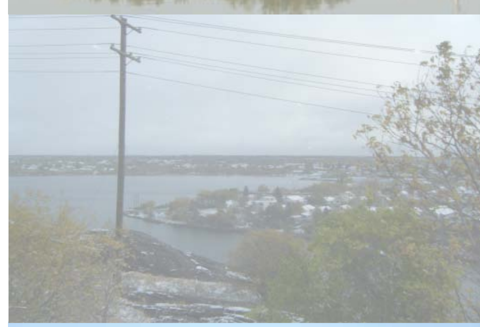
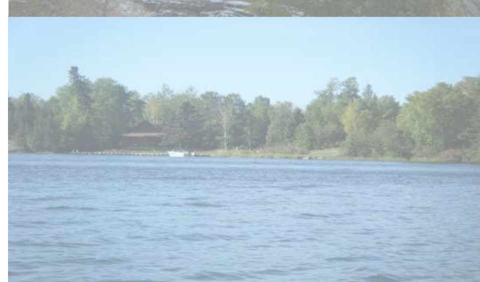



APPENDIX O

METHODS USED TO ESTIMATE WILD GAME TISSUE CONCENTRATIONS FOR THE HUMAN HEALTH RISK ASSESSMENT

APPENDIX O: METHODS USED TO ESTIMATE WILD GAME TISSUE CONCENTRATIONS FOR THE HUMAN HEALTH RISK ASSESSMENT

The Human Health Risk Assessment (HHRA) identified that it is reasonable to expect individuals within communities of the Flin Flon area to consume game tissue obtained from the wild land areas through activities such as hunting and trapping. Game meat concentrations have not been measured to-date in the study area; therefore, predicted concentrations were required for input to the human health exposure model to quantify potential exposures from this pathway. Two large mammals (*i.e.*, moose and deer) and two upland birds (*i.e.*, grouse and mallard) were selected as appropriate wildlife receptors for consumption by humans because residents have indicated that the consumption of these animals is popular or frequent. This appendix provides a description of the rationale, methods and results that were used to estimate game meat concentrations in the study area. A detailed summary of the exposure model assumptions, variables and calculations is provided at the end of this Appendix as Attachment A.

O-1.0 EXPOSURE POINT CONCENTRATIONS USED TO ESTIMATE GAME MEAT CONCENTRATIONS

<u>Soil Concentrations</u>

During the summers of 1998, 1999, and 2003, Manitoba Conservation conducted a soils study for forest sites in the Flin Flon area. A total of 16 samples were taken at each of the seven locations in Flin Flon and one reference location, at depths ranging from 0 to 15 cm bgs. The first round of sampling at these locations occurred during the summers of 1998 and 1999. These locations were re-sampled during the summer of 2003. Measured soil concentrations in 2003 were used to estimate wildlife game meat concentrations for the HHRA. Soil concentrations were use to estimate the following:

- Wildlife exposures to direct or incidental soil ingestion; and,
- Predict dietary concentrations in terrestrial invertebrates.

Mineral and organic soil samples were collected at various depth intervals. Metal concentrations in soil are observed to be dramatically higher in the organic soil layer or top 5 cm of mineral soil. Therefore, top surface soil samples (*i.e.*, organic + mineral soil) were used to estimate wildlife exposures to direct or incidental soil ingestion. Earthworms and terrestrial insects will be exposed to metals through foraging in the organic and mineral soil layer. Therefore, the top mineral and organic soil samples were also used to estimate concentrations in terrestrial invertebrates.

Spatial averaging must be considered when estimating exposure point concentrations for wildlife receptors. The area and density where samples are collected and the area receptors require to live (*i.e.*, home range) should be considered. In addition, metal concentrations in soil are observed to decrease with increasing distance from the smelter and that the highest concentrations of chemicals of concern (COC) are observed within 15 km of the smelter. Finally, a food survey conducted with residents in the Flin Flon and Creighton area indicated that almost 20% of residents harvest game meat within 15 km of the smelter. In order to accommodate the spatial averaging aspects and provide a conservative assessment, the wildlife model used exposure point concentrations within 15 km of the smelter to estimate game meat concentrations.

Table O-1 provides a statistical summary of the organic soil and surface soil concentrations (*i.e.*, top 5 cm) within 15 km of the smelter. In addition, for comparative purposes, Table O-2 provides a statistical summary of the soil concentrations observed at depths greater than 5 cm depth and within 15 km of the smelter. The 95% upper confidence limit for the mean (95% UCLM) is based on calculations and recommendations provided by Pro UCL software (U.S. EPA, 2007). Summary statistics used a proxy value equivalent to the detection limit if data were reported non-detect. Game tissue concentrations were predicted based on the mean, 95% UCLM and 95th percentile.

Table O-1 Statistical Summary of Soil Concentrations for COC Observed in Surface Soil and Organic Soil Layer Within 15 km of Smelter [mg/kg]

Chemical	***Mean ± Std Dev***	***Min - Max***	***95th Percentile***	***Sample Size (ND)[a]***	***95% UCLM[b]***
Arsenic	49.4 ± 29.9	8.5 – 101	95.3	38 (0)	59.7
Cadmium	12.8 ± 14.4	0.2 – 44.2	37.7	38 (0)	36.1
Copper	647.2± 820.2	17 – 2820	2,405	38 (0)	1,971
Lead	467 ± 557	6.3 – 1730	1,597	38 (0)	1,365
Mercury	4.8± 7.7	0.02 – 30.6	20.8	38 (0)	17.2
Selenium	7.16 ± 8.31	0.3 – 25.2	22.32	38 (0)	20.6

[a] ND indicates number of samples reported non-detect.
[b] Used recommended 95% UCLM provided by ProUCL software (U.S. EPA, 2007).

Table O-2 Statistical Summary of Soil Concentrations for COC Observed in Soil Greater Than 5 cm Depth and Within 15 km of Smelter [mg/kg]

Chemical	***Mean ± Std Dev***	***Min - Max***	***95th Percentile***	***Sample Size (ND)[a]***	***95% UCLM[b]***
Arsenic	19.9 ± 22.1	1.7 – 99.8	65.9	58 (0)	28.7
Cadmium	0.7 ± 0.85	0.2 – 4.5	1.79	58 (16)	1.19
Copper	30.5 ± 30.0	5 – 162	83.9	58 (0)	36.6
Lead	16.7 ± 23.6	1.6 –150	49.3	58 (0)	20.1
Mercury	0.048 ± 0.050	0.007 – 0.24	0.17	58 (3)	0.077
Selenium	0.53 ± 0.46	0.2 – 2.6	1.21	58 (10)	0.79

[a] ND indicates number of samples reported non-detect.
[b] Used recommended 95% UCLM provided by ProUCL software (U.S. EPA, 2007).

Sediment Concentrations

Table O-3 provides a statistical summary of the sediment concentrations collected as part of the fish study conducted by Stantec (2008) that were used to estimate wildlife game meat concentrations for the HHRA. Sediment concentrations were used to estimate the following:

- Wildlife exposures to direct or incidental sediment ingestion; and
- Predict dietary concentrations in benthic invertebrates.

The summary statistics are based on sediment samples collected from lakes surrounding the smelter. The following lakes were sampled for sediment in the fall of 2008:

- Amisk Lake;
- Athapapuskow Lake;
- Bakers Narrows;
- Big Island Lake;
- Denare Beach;
- Embury Lake;
- Hamell Lake;
- Jan Lake;
- Kisseyenw Lake;
- Phantom Lake; and,
- Schist Lake.

The 95% UCLM is based on calculations and recommendations provided by Pro UCL software (U.S. EPA, 2007). Summary statistics used a proxy value equivalent to the detection limit if data were reported non-detect. Game tissue concentrations were predicted based on the mean, 95% UCLM and 95th percentile.

Table O-3 Statistical Summary of Sediment Concentrations in the Study Area [mg/kg]

Chemical	*Mean ± Std Dev*	*Min - Max*	*95th Percentile*	*Sample Size (ND)*[a]	*95% UCLM*[b]
Arsenic	42 ± 67	1 – 260	185	36 (1)	153
Cadmium	27.3 ± 72.9	0.5 – 300	235	39(6)	76.2
Copper	536 ± 1199	6 – 4800	3,530	39 (0)	1,340
Lead	168 ± 430	5 – 2500	700	39(2)	457
Mercury	0.82 ± 1.7	0.05 – 7	4.8	38(7)	1.89
Selenium	18 ± 51	0.5 – 220	150	36 (11)	102

[a] ND indicates number of samples reported non-detect.
[b] Used recommended 95% UCLM provided by ProUCL software (U.S. EPA, 2007).

<u>Surface Water Concentrations</u>

Table O-4 provides a summary of the surface water concentrations collected as part of the fish study conducted by Stantec (2008) and Manitoba Conservation that were used to estimate wildlife game meat concentrations for the HHRA. Surface water concentrations were used to estimate the following:

- Wildlife exposures through ingestion of surface water; and,
- Predict dietary concentrations in aquatic plants or algae.

The summary statistics are based on surface water samples collected from lakes surrounding the smelter. Surface water samples were collected from the same lakes where sediment samples were collected. Manitoba Conservation indicated that the results of the mercury analysis in surface water from lakes near Flin Flon in the August 2008 sampling period were significantly higher than concentrations measured historically (Manitoba Conservation, 2009). Therefore, a re-analysis of surface water data was performed to confirm the accuracy of these results. Samples were submitted to three analytical laboratories (*i.e.*, Cantest, Maxxam and ALS Laboratories). The Cantest and Maxxam results were reported to be non-detect at 0.02 µg/L and the ALS laboratory reported detect values at lower detection limit of 0.001 µg/L.

Mercury concentrations in surface water used for the prediction of game meat concentrations were based on the recent results obtained from ALS laboratories as these are consistent with historic monitoring data collected by Manitoba Conservation. The 95% UCLM is based on calculations and recommendations provided by Pro UCL software (U.S. EPA, 2007). Summary statistics used a proxy value equivalent to the detection limit if data were reported non-detect. Game tissue concentrations were predicted based on the mean, 95% UCLM and 95th percentile.

Table O-4 Summary of Surface Water Concentrations in the Study Area [µg/L]

Chemical	Mean ± Std Dev	Min - Max	95th Percentile	Sample Size (ND)[a]	95% UCLM[b]
Arsenic	2.75 ± 2.09	1 – 8	6.35	12(3)	4.07
Cadmium	0.47 ± 0.62	0.1 – 2.2	1.54	12(5)	2.26
Copper	7.58 ± 6.95	1 – 19	18.5	12(1)	13.4
Lead	0.56 ± 0.15	0.5 – 1	0.84	12(10)	0.64
Mercury[c]	0.0035 ± 0.0072	0.001 – 0.024	0.014	10(2)	0.013
Selenium	2.4 ± 1.0	2 – 5	4.5	12(10)	2.9

a ND indicates number of samples reported non-detect.
b Used recommended 95% UCLM provided by ProUCL software (U.S. EPA, 2007).
c Based on re-analysis of mercury concentrations by ALS laboratories in water from lakes near Flin Flon, related to apparent elevated mercury in water found in August 2008 samples.

Browse Concentrations

Vegetation samples collected by Manitoba Conservation in 2003 and 2004 were used to estimate wildlife exposures. Samples consisted of alder, wild sarsaparilla, Labrador tea and black spruce needles collected from 5 to 40 km of the smelter. Only alder and black spruce needles collected within a 15 km radius were considered for use in the wildlife exposure model. Concentrations of alder were consistently observed to be 1.3 to 2.5 times higher than spruce concentrations. To be conservative, alder concentrations were used in the wildlife exposure model to provide an estimate of game meat concentrations from "browse" (*i.e.*, alder) consumption. Table O-5 provides a summary of the browse concentrations collected by Manitoba Conservation that were used to estimate wildlife game meat concentrations for the HHRA.

Table O-5 Summary of Alder Concentrations in the Study Area [mg/kg dry weight]

Chemical	Mean ± Std Dev	Min - Max	95th Percentile	Sample Size (ND)[a]	95% UCLM[b]
Arsenic	0.50 ± 0.37	0.2 – 1.4	1.21	20(0)	0.85
Cadmium	0.70 ± 0.55	0.24 – 2.2	2.0	20(0)	0.93
Copper	14 ± 4.3	7.3 - 21	21	20(0)	16
Lead	4.1 ± 3.0	1.2 - 12	10	20(0)	5.4
Mercury	0.020 ± 0.0061	0.01 – 0.034	0.027	20(0)	0.022
Selenium	All 20 samples non-detect (<0.2)				

a ND indicates number of samples reported non-detect.
b Used recommended 95% UCLM provided by ProUCL software (U.S. EPA, 2007).

O-2.0 TROPHIC TRANSFER MODELS USED TO ESTIMATE DIETARY CONCENTRATIONS

Terrestrial Invertebrate Concentrations

Wildlife species forage and consume various types of terrestrial insects (worms, beetles, ants and grasshoppers) depending on preference, nutrition requirements and availability of food. In this assessment, site-specific data is not available; therefore, literature models were used to predict terrestrial invertebrate concentrations.

Invertebrate concentrations are based on empirical regression models developed and recommended by research conducted at the Oak Ridge Reservation (Sample *et al*., 1998). The database used to derive the empirical models was based on numerous data points (*i.e*., 14 to 245) and studies primarily focused on depurated earthworms. These models are preferred because earthworms consume and are exposed to large quantities of soil and depurated models are preferred because direct soil ingestion is calculated separately in the exposure model. The following regression model equation was used to estimate terrestrial invertebrate concentrations:

$$\ln[Terr.Invert.] = Constant + Slope \times \ln[Soil] \quad \text{Equation 1}$$

or

$$[Terr.Invert.] = e^{(Constant + Slope \times \ln[Soil])}$$

where:

Terr. Invert.	=	concentration in terrestrial invertebrates (mg/kg dry weight (dw))
Constant	=	Y-intercept variable in the regression model (mg/kg dw)
Slope	=	slope or $\Delta Y/\Delta X$ of regression model (kg-soil/kg-plant)
Soil	=	concentration in soil (mg/kg)

The regression model parameters used to estimate invertebrate concentrations are provided in Table O-6.

Table O-6 Terrestrial Invertebrate Regression Model Parameters

Chemical	***Constant***[a]	***Slope***[a]
Arsenic	-1.42	0.706
Cadmium	2.11	0.795
Copper	1.68	0.264
Lead	-0.218	0.807
Mercury	-0.684	0.118
Selenium	-0.0750	0.733

[a] Value was taken from Sample *et al*. (1998).

<u>Benthic Invertebrate Concentrations</u>

Measured sediment concentrations were used to predict concentrations in benthic invertebrates. Wildlife species such as the mallard will forage and wallow in sediments in search of sediment-associated biota such as oligochaetes and amphipoda, depending on preference, nutrition requirements and availability of food. In this assessment, site-specific data is not available; therefore, literature models were used to predict benthic invertebrate concentrations.

Benthic invertebrate concentrations are based on empirical regression models developed and recommended by research conducted at the Oak Ridge Reservation (BJC, 1998). The database used to derive the empirical models was based on numerous data points (*i.e*., 15 to 120) and included studies with depurated and non-depurated biota. Although sediment ingestion is calculated separately in the exposure model, predicted benthic invertebrate concentrations were based on the two types of studies combined (*i.e*., depurated and non-depurated) due to the following:

- Use of regression models based on depurated and non-depurated biota would produce a conservative estimate;

- Some of the depurated models were observed to be statistically non-significant, where as non-depurated models were found to be significant – the combined datasets were used for consistency; and,
- The sample size for depurated studies is often quite small in comparison to the non-depurated studies; therefore, the combined dataset was used to improve the power of the prediction models.

The following models were used to estimate benthic invertebrate concentrations:

$$\ln[BenthicInvertebrate] = Cons\tan t + Slope \times \ln[Se\dim ent] \quad \text{Equation 2}$$

or

$$[BenthicInvertebrate] = [Se\dim ent] \times BAF \quad \text{Equation 3}$$

where:

Benthic Invertebrate	=	concentration in biota (mg/kg dw)
Constant	=	Y-intercept variable in the regression model (mg/kg dw)
Slope	=	slope or ΔY/ΔX of regression model (kg-sediment/kg-benthic)
Sediment	=	concentration in sediment (mg/kg)
BAF	=	Sediment to benthic invertebrate bio-accumulation factor (kg-sediment/kg-invertebrate)

Table O-7 provides a summary of the regression model or BAF parameters used to estimate benthic invertebrate concentrations.

Table O-7 Benthic Invertebrate Regression Model or BAF Parameters

Chemical	*Constant*[a]	*Slope*[a]	*BAF*
Arsenic	-0.292	0.754	NA
Cadmium	0.0395	0.692	NA
Copper	1.09	0.278	NA
Lead	-0.779	0.801	NA
Mercury	-0.670	0.327	NA
Selenium	NA	NA	3.80[b]

[a] Value was taken from BJC (1998).
[b] Value was taken from Hamilton and Buhl (2003).
NA Not available

Aquatic Plant Concentrations

Measured surface water concentrations were used to predict concentrations in aquatic plants such as emergent plants and algae. Wildlife species such as the moose will consume aquatic plants depending on preference, nutrition requirements and availability of food. In this assessment, site-specific data is not available; therefore, literature models were used to predict aquatic plant concentrations.

Aquatic plant concentrations are based on bio-concentration (BCF) models developed and recommended by the U.S. EPA (1999). The database used to derive the empirical models was primarily based on laboratory studies with phytoplankton and algae. Only BCF models were available.

The following model was used to estimate aquatic plant concentrations:

$$[AquaticPlant] = [Water] \times BCF \qquad \text{Equation 4}$$

where:

Aquatic Plant = concentration in biota (mg/kg dw)
Water = concentration in surface water (mg/L)
BCF = Water to aquatic plant bio-concentration factor (kg-water/kg-plant)

Table O-8 provides a summary of the BCF model parameters used to estimate aquatic plant concentrations.

Table O-8 Benthic Invertebrate Regression Model or BCF Parameters

Chemical	***BCF[a]***
Arsenic	856
Cadmium	2,280
Copper	1,580
Lead	4,980
Mercury	72,300
Selenium	5,390

[a] Value was taken from U.S. EPA (1999).

O-3.0 WILDLIFE EXPOSURES TO FOOD

Food ingestion rates were based on free-living (or field) metabolic rate (FMR) studies. This accounts for the metabolizable energy in an animal's food and the energy requirements for wildlife to forage for food, escape predators, generate heat or survive in the wild. Other generic allometric equations are available but often based on captive animals (*e.g.*, mass of food consumed per day) which consume less food and require less energy to survive. More accurate estimates of food ingestion rates by type of diet are obtained with FMR.

The empirically derived equation describing the FMR relationship for wildlife receptors is as follows as described by Nagy *et al*. (1999):

$$FMR = a \times BW^{b} \qquad \text{Equation 5}$$

where:

FMR = free metabolic rate (kcal/day)
a & b = empirical power function constants
BW = body weight (grams)

The equation used to estimate wildlife exposures is based on the following equation:

$$Exposure = \sum_{j}^{i} \frac{Diet\%_i \times FMR_j \times C_i}{ME_{avg}} \qquad \text{Equation 6}$$

where:

Exposure = total dose or exposure for receptor "j" (mg-chemical/day)
$Diet\%_i$ = dietary apportionment of food item "i" (%)
FMR_j = free-metabolic rate for receptor "j" (kcal/day)

C_i = concentration of chemical in food item "i" (mg/kg)
ME_{avg} = weighted average metabolizable energy (kcal/kg-food)

Table O-9 provides a summary of the dietary apportionment assumed for each receptor in this assessment and Attachment A provides a summary of the gross energy (GE), assimilation energy (AE), metabolisable energy (ME = GE x AE) and ME_{avg}.

The following equation was used to estimate the weighted average metabolizable energy:

$$ME_{avg} = \sum_{j}^{i} Diet\%_i \times ME_i \quad \text{Equation 7}$$

where:

ME_{avg} = weighted average metabolizable energy for receptor "j" (kcal/kg-food)
$Diet\%_i$ = dietary apportionment of food item "i" (%)
ME_i = metabolizable energy for food item "i" (kcal/kg-food)

Table O-9 Dietary Apportionment Assumed for Wildlife Receptors

Dietary Item	*Deer*	*Grouse*	*Mallard*	*Moose*
Aquatic Plant	0%	0%	10%	20%
Benthic Invertebrate	0%	0%	40%	0%
Browse	100%	80%	40%	80%
Invertebrate	0%	20%	10%	0%

O-4.0 WILDLIFE EXPOSURES TO SOIL, SEDIMENT AND WATER INGESTION

The following equation was used to estimate wildlife exposures to soil through ingestion:

$$Exposure = SIR \times C_s \quad \text{Equation 8}$$

where:

Exposure = chemical exposure through soil or sediment ingestion (mg/day)
SIR = soil or sediment ingestion rate (kg/day)
C_s = concentration of chemical in soil or sediment (mg/kg)

The following equation was used to estimate wildlife exposures to surface water through ingestion:

$$Exposure = WIR \times C_w \quad \text{Equation 9}$$

where:

Exposure = chemical exposure through water ingestion (mg/day)
SIR = water ingestion rate (kg/day)
C_s = concentration of chemical in water (mg/L)

O-5.0 PREDICTED GAME TISSUE CONCENTRATIONS

Predicted exposures received by wildlife from consumption of terrestrial and aquatic dietary items and from consumption of surface water and soil or sediment are used to estimate game meat concentrations through the use of biotransfer factors (BTFs) that have been recommended by the U.S. EPA OSW (2005). The BTFs (Table O-10) are primarily based on empirical studies with beef cattle, but a few chemicals have BTFs based on studies with chickens. The BTFs are used to translate the estimated daily dose of a chemical to a tissue concentration.

Table O-10 Biotransfer Factors (BTFs) (day/kg ww)[a]

Chemical	***Deer***	***Grouse***	***Mallard***	***Moose***
Arsenic	0.002	0.002	0.002	0.002
Cadmium	0.00012	0.106[b]	0.106[b]	0.00012
Copper	0.01	0.01	0.01	0.01
Lead	0.0003	0.0003	0.0003	0.0003
Mercury	0.00522	0.0239[b]	0.0239[b]	0.00522
Selenium	0.00227	1.13[b]	1.13[b]	0.00227

[a] BTFs based on beef unless noted otherwise.
[b] BTFs based on chicken.

The following equation was used to estimate game meat concentrations:

$$C_M = BTF \times \sum Food + Soil + Water + Se\dim ent \qquad \text{Equation 10}$$

where:

C_m = concentration of chemical in game meat (mg/kg wet weight (ww))
BTF = bio transfer factor (days/kg ww)
Food = estimated daily intake food items (mg-chemical / day)
Soil = estimated daily intake from soil (mg-chemical / day)
Water = estimated daily intake from water (mg-chemical / day)
Sediment = estimated daily intake from sediment (mg-chemical / day)

Attachment A provides a summary of the predicted game meat tissue concentrations for input to the HHRA.

O-6.0 REFERENCES

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Attachment A
Ecological Risk Assessment (ERA) Model Used to Predict Game Meat Concentrations

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Summary of Game Concentrations for the HHRA (mg/kg ww)					
			Scenario		
Site	Receptor	Chemical	95th Percentile	95UCLM	Average
<15km	Max large game	Arsenic(As)	6.5E-02	4.2E-02	2.6E-02
<15km	Max large game	Cadmium(Cd)	3.0E-03	2.5E-03	8.4E-04
<15km	Max large game	Copper(Cu)	5.5E+00	4.8E+00	1.7E+00
<15km	Max large game	Lead(Pb)	8.2E-02	5.7E-02	2.4E-02
<15km	Max large game	Mercury(Hg)	1.8E-02	1.5E-02	4.4E-03
<15km	Max large game	Selenium(Se)	7.2E-02	5.3E-02	3.4E-02
<15km	Max upland bird	Arsenic(As)	4.2E-03	2.9E-03	1.7E-03
<15km	Max upland bird	Cadmium(Cd)	3.5E-01	3.2E-01	1.3E-01
<15km	Max upland bird	Copper(Cu)	1.3E-01	1.2E-01	4.4E-02
<15km	Max upland bird	Lead(Pb)	4.1E-03	3.4E-03	1.3E-03
<15km	Max upland bird	Mercury(Hg)	2.5E-03	2.1E-03	1.0E-03
<15km	Max upland bird	Selenium(Se)	2.7E+00	2.5E+00	1.2E+00
<15km	Deer	Arsenic(As)	6.1E-03	4.0E-03	2.9E-03
<15km	Deer	Cadmium(Cd)	3.2E-04	1.9E-04	1.1E-04
<15km	Deer	Copper(Cu)	6.7E-01	5.4E-01	2.7E-01
<15km	Deer	Lead(Pb)	1.2E-02	9.6E-03	3.9E-03
<15km	Deer	Mercury(Hg)	2.3E-03	1.9E-03	5.9E-04
<15km	Deer	Selenium(Se)	1.5E-03	1.4E-03	7.8E-04
<15km	Grouse	Arsenic(As)	1.2E-03	8.0E-04	6.4E-04
<15km	Grouse	Cadmium(Cd)	3.2E-01	3.0E-01	1.3E-01
<15km	Grouse	Copper(Cu)	1.3E-01	1.0E-01	4.4E-02
<15km	Grouse	Lead(Pb)	4.0E-03	3.4E-03	1.3E-03
<15km	Grouse	Mercury(Hg)	2.5E-03	2.1E-03	8.0E-04
<15km	Grouse	Selenium(Se)	3.1E-01	2.9E-01	1.3E-01
<15km	Mallard	Arsenic(As)	4.2E-03	2.9E-03	1.7E-03
<15km	Mallard	Cadmium(Cd)	3.5E-01	3.2E-01	1.3E-01
<15km	Mallard	Copper(Cu)	1.3E-01	1.2E-01	4.3E-02
<15km	Mallard	Lead(Pb)	4.1E-03	2.9E-03	1.3E-03
<15km	Mallard	Mercury(Hg)	2.5E-03	2.1E-03	1.0E-03
<15km	Mallard	Selenium(Se)	2.7E+00	2.5E+00	1.2E+00
<15km	Moose	Arsenic(As)	6.5E-02	4.2E-02	2.6E-02
<15km	Moose	Cadmium(Cd)	3.0E-03	2.5E-03	8.4E-04
<15km	Moose	Copper(Cu)	5.5E+00	4.8E+00	1.7E+00
<15km	Moose	Lead(Pb)	8.2E-02	5.7E-02	2.4E-02
<15km	Moose	Mercury(Hg)	1.8E-02	1.5E-02	4.4E-03
<15km	Moose	Selenium(Se)	7.2E-02	5.3E-02	3.4E-02

Summary of Browse Concentrations Used for Predicting Game Meat Concentrations (mg/kg dw)					
Site	Receptor	Chemical	Scenario		
			95th Percentile	95UCLM	Average
<15km	Deer	Arsenic(As)	1.2E+00	8.5E-01	5.0E-01
<15km	Deer	Cadmium(Cd)	2.0E+00	9.3E-01	7.0E-01
<15km	Deer	Copper(Cu)	2.1E+01	1.6E+01	1.4E+01
<15km	Deer	Lead(Pb)	1.0E+01	5.4E+00	4.1E+00
<15km	Deer	Mercury(Hg)	2.7E-02	2.2E-02	2.0E-02
<15km	Deer	Selenium(Se)	2.0E-01	2.0E-01	2.0E-01

Detailed calculation of predicted exposures and tissue concentrations

Scenario	Site	Receptor	Chemical	Soil mg/kg	Surface Soil mg/kg	Surface Water mg/L	Sediment mg/kg	Concentrations: Browse Soil mg/kg dw	Concentrations: Aquatic Plant Aquatic mg/kg dw	Concentrations: BenthicInvert Sediment mg/kg dw	Concentrations: Invert Soil mg/kg dw	EDI: Soil EDI mg/day	EDI: Sediment EDI mg/day	EDI: Browse EDI mg/day	EDI: Aquatic Plant EDI mg/day	EDI: BenthicInvert EDI mg/day	EDI: Invert EDI mg/day	EDI: Water EDI mg/day	EDI: Total EDI mg/day	Tissue Concentration mg/kg ww
95UCLM	<15km	Deer	Arsenic(As)	2.87E+01	5.97E+01	4.07E-03	9.13E+01	8.53E-01	3.48E+00	2.25E+01	4.33E+00	1.16E+00	0.00E+00	8.31E-01	0.00E+00	0.00E+00	0.00E+00	1.24E-02	2.01E+00	4.01E-03
95UCLM	<15km	Deer	Cadmium(Cd)	1.19E+00	3.61E+01	2.26E-03	9.08E+01	9.28E-01	5.16E+00	2.36E+01	1.43E+02	7.03E-01	0.00E+00	9.04E-01	0.00E+00	0.00E+00	0.00E+00	6.88E-03	1.61E+00	1.94E-04
95UCLM	<15km	Deer	Copper(Cu)	3.66E+01	1.97E+03	1.34E-02	2.22E+03	1.59E+01	2.12E+01	2.53E+01	3.98E+01	3.84E+01	0.00E+00	1.55E+01	0.00E+00	0.00E+00	0.00E+00	4.08E-02	5.40E+01	5.40E-01
95UCLM	<15km	Deer	Lead(Pb)	2.01E+01	1.36E+03	6.36E-04	3.84E+02	5.41E+00	3.17E+00	5.39E+01	2.72E+02	2.66E+01	0.00E+00	5.27E+00	0.00E+00	0.00E+00	0.00E+00	1.94E-03	3.19E+01	9.56E-03
95UCLM	<15km	Deer	Mercury(Hg)	7.73E-02	1.72E+01	1.30E-05	1.73E+00	2.22E-02	9.40E-01	6.12E-01	7.06E-01	3.35E-01	0.00E+00	2.16E-02	0.00E+00	0.00E+00	0.00E+00	3.96E-05	3.56E-01	1.86E-03
95UCLM	<15km	Deer	Selenium(Se)	7.95E-01	2.06E+01	2.93E-03	5.58E+01	2.00E-01	1.58E+01	3.89E+01	8.51E+00	4.01E-01	0.00E+00	1.95E-01	0.00E+00	0.00E+00	0.00E+00	8.92E-03	6.05E-01	1.37E-03
95UCLM	<15km	Grouse	Arsenic(As)	2.87E+01	5.97E+01	4.07E-03	9.13E+01	8.53E-01	3.48E+00	2.25E+01	4.33E+00	2.57E-01	0.00E+00	6.30E-02	0.00E+00	0.00E+00	8.00E-02	1.89E-04	4.00E-01	8.01E-04
95UCLM	<15km	Grouse	Cadmium(Cd)	1.19E+00	3.61E+01	2.26E-03	9.08E+01	9.28E-01	5.16E+00	2.36E+01	1.43E+02	1.55E-01	0.00E+00	6.86E-02	0.00E+00	0.00E+00	2.65E+00	1.05E-04	2.87E+00	3.04E-01
95UCLM	<15km	Grouse	Copper(Cu)	3.66E+01	1.97E+03	1.34E-02	2.22E+03	1.59E+01	2.12E+01	2.53E+01	3.98E+01	8.49E+00	0.00E+00	1.17E+00	0.00E+00	0.00E+00	7.35E-01	6.24E-04	1.04E+01	1.04E-01
95UCLM	<15km	Grouse	Lead(Pb)	2.01E+01	1.36E+03	6.36E-04	3.84E+02	5.41E+00	3.17E+00	5.39E+01	2.72E+02	5.88E+00	0.00E+00	4.00E-01	0.00E+00	0.00E+00	5.03E+00	2.96E-05	1.13E+01	3.39E-03
95UCLM	<15km	Grouse	Mercury(Hg)	7.73E-02	1.72E+01	1.30E-05	1.73E+00	2.22E-02	9.40E-01	6.12E-01	7.06E-01	7.39E-02	0.00E+00	1.64E-03	0.00E+00	0.00E+00	1.30E-02	6.05E-07	8.86E-02	2.12E-03
95UCLM	<15km	Grouse	Selenium(Se)	7.95E-01	2.06E+01	2.93E-03	5.58E+01	2.00E-01	1.58E+01	3.89E+01	8.51E+00	8.86E-02	0.00E+00	1.48E-02	0.00E+00	0.00E+00	1.57E-01	1.36E-04	2.61E-01	2.95E-01
95UCLM	<15km	Mallard	Arsenic(As)	2.87E+01	5.97E+01	4.07E-03	9.13E+01	8.53E-01	3.48E+00	2.25E+01	4.33E+00	1.33E-01	2.03E-01	3.80E-02	3.88E-02	1.00E+00	4.82E-02	2.71E-04	1.46E+00	2.92E-03
95UCLM	<15km	Mallard	Cadmium(Cd)	1.19E+00	3.61E+01	2.26E-03	9.08E+01	9.28E-01	5.16E+00	2.36E+01	1.43E+02	8.04E-02	2.02E-01	4.13E-02	5.75E-02	1.05E+00	1.60E+00	1.51E-04	3.03E+00	3.21E-01
95UCLM	<15km	Mallard	Copper(Cu)	3.66E+01	1.97E+03	1.34E-02	2.22E+03	1.59E+01	2.12E+01	2.53E+01	3.98E+01	4.39E+00	4.94E+00	7.08E-01	2.36E-01	1.13E+00	4.43E-01	8.93E-04	1.18E+01	1.18E-01
95UCLM	<15km	Mallard	Lead(Pb)	2.01E+01	1.36E+03	6.36E-04	3.84E+02	5.41E+00	3.17E+00	5.39E+01	2.72E+02	3.04E+00	8.55E-01	2.41E-01	3.53E-02	2.40E+00	3.03E+00	4.24E-05	9.61E+00	2.88E-03
95UCLM	<15km	Mallard	Mercury(Hg)	7.73E-02	1.72E+01	1.30E-05	1.73E+00	2.22E-02	9.40E-01	6.12E-01	7.06E-01	3.82E-02	3.85E-03	9.89E-04	1.05E-02	2.73E-02	7.86E-03	8.67E-07	8.87E-02	2.12E-03
95UCLM	<15km	Mallard	Selenium(Se)	7.95E-01	2.06E+01	2.93E-03	5.58E+01	2.00E-01	1.58E+01	3.89E+01	8.51E+00	4.58E-02	1.24E-01	8.91E-03	1.76E-01	1.73E+00	9.48E-02	1.95E-04	2.18E+00	2.47E+00
95UCLM	<15km	Moose	Arsenic(As)	2.87E+01	5.97E+01	4.07E-03	9.13E+01	8.53E-01	3.48E+00	2.25E+01	4.33E+00	5.72E+00	8.74E+00	3.27E+00	3.34E+00	0.00E+00	0.00E+00	9.84E-02	2.12E+01	4.23E-02
95UCLM	<15km	Moose	Cadmium(Cd)	1.19E+00	3.61E+01	2.26E-03	9.08E+01	9.28E-01	5.16E+00	2.36E+01	1.43E+02	3.46E+00	8.69E+00	3.56E+00	4.95E+00	0.00E+00	0.00E+00	5.47E-02	2.07E+01	2.48E-03
95UCLM	<15km	Moose	Copper(Cu)	3.66E+01	1.97E+03	1.34E-02	2.22E+03	1.59E+01	2.12E+01	2.53E+01	3.98E+01	1.89E+02	2.12E+02	6.09E+01	2.03E+01	0.00E+00	0.00E+00	3.24E-01	4.83E+02	4.83E+00
95UCLM	<15km	Moose	Lead(Pb)	2.01E+01	1.36E+03	6.36E-04	3.84E+02	5.41E+00	3.17E+00	5.39E+01	2.72E+02	1.31E+02	3.68E+01	2.07E+01	3.04E+00	0.00E+00	0.00E+00	1.54E-02	1.91E+02	5.74E-02
95UCLM	<15km	Moose	Mercury(Hg)	7.73E-02	1.72E+01	1.30E-05	1.73E+00	2.22E-02	9.40E-01	6.12E-01	7.06E-01	1.64E+00	1.66E-01	8.51E-02	9.01E-01	0.00E+00	0.00E+00	3.14E-04	2.80E+00	1.46E-02
95UCLM	<15km	Moose	Selenium(Se)	7.95E-01	2.06E+01	2.93E-03	5.58E+01	2.00E-01	1.58E+01	3.89E+01	8.51E+00	1.97E+00	5.34E+00	7.67E-01	1.51E+01	0.00E+00	0.00E+00	7.09E-02	2.33E+01	5.28E-02
95th Percentile	<15km	Deer	Arsenic(As)	6.59E+01	9.53E+01	6.35E-03	1.42E+02	1.21E+00	5.43E+00	3.13E+01	6.03E+00	1.86E+00	0.00E+00	1.18E+00	0.00E+00	0.00E+00	0.00E+00	1.93E-02	3.06E+00	6.11E-03
95th Percentile	<15km	Deer	Cadmium(Cd)	1.79E+00	3.77E+01	1.54E-03	1.09E+02	2.00E+00	3.52E+00	2.67E+01	1.48E+02	7.34E-01	0.00E+00	1.95E+00	0.00E+00	0.00E+00	0.00E+00	4.69E-03	2.69E+00	3.22E-04
95th Percentile	<15km	Deer	Copper(Cu)	8.38E+01	2.41E+03	1.85E-02	2.24E+03	2.07E+01	2.91E+01	2.54E+01	4.19E+01	4.69E+01	0.00E+00	2.02E+01	0.00E+00	0.00E+00	0.00E+00	5.62E-02	6.71E+01	6.71E-01
95th Percentile	<15km	Deer	Lead(Pb)	4.93E+01	1.60E+03	8.35E-04	7.94E+02	1.02E+01	4.16E+00	9.65E+01	3.09E+02	3.11E+01	0.00E+00	9.95E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-03	4.11E+01	1.23E-02
95th Percentile	<15km	Deer	Mercury(Hg)	1.70E-01	2.08E+01	1.40E-05	3.04E+00	2.74E-02	1.01E+00	7.36E-01	7.22E-01	4.05E-01	0.00E+00	2.67E-02	0.00E+00	0.00E+00	0.00E+00	4.26E-05	4.32E-01	2.25E-03
95th Percentile	<15km	Deer	Selenium(Se)	1.21E+00	2.23E+01	4.45E-03	6.19E+01	2.00E-01	2.40E+01	4.11E+01	9.04E+00	4.35E-01	0.00E+00	1.95E-01	0.00E+00	0.00E+00	0.00E+00	1.35E-02	6.44E-01	1.46E-03
95th Percentile	<15km	Grouse	Arsenic(As)	6.59E+01	9.53E+01	6.35E-03	1.42E+02	1.21E+00	5.43E+00	3.13E+01	6.03E+00	4.10E-01	0.00E+00	8.94E-02	0.00E+00	0.00E+00	1.11E-01	2.96E-04	6.11E-01	1.22E-03
95th Percentile	<15km	Grouse	Cadmium(Cd)	1.79E+00	3.77E+01	1.54E-03	1.09E+02	2.00E+00	3.52E+00	2.67E+01	1.48E+02	1.62E-01	0.00E+00	1.48E-01	0.00E+00	0.00E+00	2.74E+00	7.17E-05	3.05E+00	3.23E-01
95th Percentile	<15km	Grouse	Copper(Cu)	8.38E+01	2.41E+03	1.85E-02	2.24E+03	2.07E+01	2.91E+01	2.54E+01	4.19E+01	1.04E+01	0.00E+00	1.53E+00	0.00E+00	0.00E+00	7.74E-01	8.59E-04	1.27E+01	1.27E-01
95th Percentile	<15km	Grouse	Lead(Pb)	4.93E+01	1.60E+03	8.35E-04	7.94E+02	1.02E+01	4.16E+00	9.65E+01	3.09E+02	6.88E+00	0.00E+00	7.55E-01	0.00E+00	0.00E+00	5.71E+00	3.89E-05	1.33E+01	4.00E-03
95th Percentile	<15km	Grouse	Mercury(Hg)	1.70E-01	2.08E+01	1.40E-05	3.04E+00	2.74E-02	1.01E+00	7.36E-01	7.22E-01	8.95E-02	0.00E+00	2.02E-03	0.00E+00	0.00E+00	1.33E-02	6.52E-07	1.05E-01	2.51E-03
95th Percentile	<15km	Grouse	Selenium(Se)	1.21E+00	2.23E+01	4.45E-03	6.19E+01	2.00E-01	2.40E+01	4.11E+01	9.04E+00	9.61E-02	0.00E+00	1.48E-02	0.00E+00	0.00E+00	1.67E-01	2.07E-04	2.78E-01	3.14E-01
95th Percentile	<15km	Mallard	Arsenic(As)	6.59E+01	9.53E+01	6.35E-03	1.42E+02	1.21E+00	5.43E+00	3.13E+01	6.03E+00	2.12E-01	3.16E-01	5.39E-02	6.05E-02	1.40E+00	6.71E-02	4.23E-04	2.11E+00	4.21E-03
95th Percentile	<15km	Mallard	Cadmium(Cd)	1.79E+00	3.77E+01	1.54E-03	1.09E+02	2.00E+00	3.52E+00	2.67E+01	1.48E+02	8.38E-02	2.43E-01	8.90E-02	3.92E-02	1.19E+00	1.65E+00	1.03E-04	3.30E+00	3.49E-01
95th Percentile	<15km	Mallard	Copper(Cu)	8.38E+01	2.41E+03	1.85E-02	2.24E+03	2.07E+01	2.91E+01	2.54E+01	4.19E+01	5.36E+00	5.00E+00	9.23E-01	3.25E-01	1.13E+00	4.67E-01	1.23E-03	1.32E+01	1.32E-01
95th Percentile	<15km	Mallard	Lead(Pb)	4.93E+01	1.60E+03	8.35E-04	7.94E+02	1.02E+01	4.16E+00	9.65E+01	3.09E+02	3.56E+00	1.77E+00	4.55E-01	4.63E-02	4.30E+00	3.44E+00	5.57E-05	1.36E+01	4.07E-03
95th Percentile	<15km	Mallard	Mercury(Hg)	1.70E-01	2.08E+01	1.40E-05	3.04E+00	2.74E-02	1.01E+00	7.36E-01	7.22E-01	4.63E-02	6.77E-03	1.22E-03	1.13E-02	3.28E-02	8.04E-03	9.33E-07	1.06E-01	2.54E-03
95th Percentile	<15km	Mallard	Selenium(Se)	1.21E+00	2.23E+01	4.45E-03	6.19E+01	2.00E-01	2.40E+01	4.11E+01	9.04E+00	4.97E-02	1.38E-01	8.91E-03	2.67E-01	1.83E+00	1.01E-01	2.97E-04	2.39E+00	2.71E+00
95th Percentile	<15km	Moose	Arsenic(As)	6.59E+01	9.53E+01	6.35E-03	1.42E+02	1.21E+00	5.43E+00	3.13E+01	6.03E+00	9.13E+00	1.36E+01	4.64E+00	5.21E+00	0.00E+00	0.00E+00	1.54E-01	3.27E+01	6.54E-02
95th Percentile	<15km	Moose	Cadmium(Cd)	1.79E+00	3.77E+01	1.54E-03	1.09E+02	2.00E+00	3.52E+00	2.67E+01	1.48E+02	3.61E+00	1.04E+01	7.66E+00	3.37E+00	0.00E+00	0.00E+00	3.72E-02	2.51E+01	3.01E-03
95th Percentile	<15km	Moose	Copper(Cu)	8.38E+01	2.41E+03	1.85E-02	2.24E+03	2.07E+01	2.91E+01	2.54E+01	4.19E+01	2.30E+02	2.15E+02	7.94E+01	2.79E+01	0.00E+00	0.00E+00	4.46E-01	5.53E+02	5.53E+00
95th Percentile	<15km	Moose	Lead(Pb)	4.93E+01	1.60E+03	8.35E-04	7.94E+02	1.02E+01	4.16E+00	9.65E+01	3.09E+02	1.53E+02	7.60E+01	3.91E+01	3.99E+00	0.00E+00	0.00E+00	2.02E-02	2.72E+02	8.16E-02
95th Percentile	<15km	Moose	Mercury(Hg)	1.70E-01	2.08E+01	1.40E-05	3.04E+00	2.74E-02	1.01E+00	7.36E-01	7.22E-01	1.99E+00	2.91E-01	1.05E-01	9.70E-01	0.00E+00	0.00E+00	3.39E-04	3.36E+00	1.75E-02
95th Percentile	<15km	Moose	Selenium(Se)	1.21E+00	2.23E+01	4.45E-03	6.19E+01	2.00E-01	2.40E+01	4.11E+01	9.04E+00	2.14E+00	5.93E+00	7.67E-01	2.30E+01	0.00E+00	0.00E+00	1.08E-01	3.19E+01	7.24E-02
Average	<15km	Deer	Arsenic(As)	1.99E+01	4.94E+01	2.75E-03	4.01E+01	4.95E-01	2.35E+00	1.21E+01	3.79E+00	9.63E-01	0.00E+00	4.82E-01	0.00E+00	0.00E+00	0.00E+00	8.37E-03	1.45E+00	2.91E-03
Average	<15km	Deer	Cadmium(Cd)	7.00E-01	1.28E+01	4.67E-04	2.19E+01	6.95E-01	1.07E+00	8.81E+00	6.27E+01	2.49E-01	0.00E+00	6.77E-01	0.00E+00	0.00E+00	0.00E+00	1.42E-03	9.28E-01	1.11E-04
Average	<15km	Deer	Copper(Cu)	3.05E+01	6.47E+02	7.58E-03	4.79E+02	1.42E+01	1.20E+01	1.65E+01	2.96E+01	1.26E+01	0.00E+00	1.39E+01	0.00E+00	0.00E+00	0.00E+00	2.31E-02	2.65E+01	2.65E-01
Average	<15km	Deer	Lead(Pb)	1.67E+01	4.66E+02	5.58E-04	1.84E+02	4.14E+00	2.78E+00	2.99E+01	1.15E+02	9.09E+00	0.00E+00	4.03E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-03	1.31E+01	3.94E-03
Average	<15km	Deer	Mercury(Hg)	4.86E-02	4.79E+00	3.50E-06	7.30E-01	1.99E-02	2.53E-01	4.62E-01	6.07E-01	9.33E-02	0.00E+00	1.94E-02	0.00E+00	0.00E+00	0.00E+00	1.07E-05	1.13E-01	5.88E-04
Average	<15km	Deer	Selenium(Se)	5.33E-01	7.16E+00	2.42E-03	1.20E+01	2.00E-01	1.30E+01	1.75E+01	3.93E+00	1.40E-01	0.00E+00	1.95E-01	0.00E+00	0.00E+00	0.00E+00	7.36E-03	3.42E-01	7.76E-04
Average	<15km	Grouse	Arsenic(As)	1.99E+01	4.94E+01	2.75E-03	4.01E+01	4.95E-01	2.35E+00	1.21E+01	3.79E+00	2.13E-01	0.00E+00	3.66E-02	0.00E+00	0.00E+00	7.00E-02	1.28E-04	3.19E-01	6.39E-04
Average	<15km	Grouse	Cadmium(Cd)	7.00E-01	1.28E+01	4.67E-04	2.19E+01	6.95E-01	1.07E+00	8.81E+00	6.27E+01	5.50E-02	0.00E+00	5.14E-02	0.00E+00	0.00E+00	1.16E+00	2.17E-05	1.27E+00	1.34E-01
Average	<15km	Grouse	Copper(Cu)	3.05E+01	6.47E+02	7.58E-03	4.79E+02	1.42E+01	1.20E+01	1.65E+01	2.96E+01	2.79E+00	0.00E+00	1.05E+00	0.00E+00	0.00E+00	5.48E-01	3.53E-04	4.39E+00	4.39E-02
Average	<15km	Grouse	Lead(Pb)	1.67E+01	4.66E+02	5.58E-04	1.84E+02	4.14E+00	2.78E+00	2.99E+01	1.15E+02	2.01E+00	0.00E+00	3.06E-01	0.00E+00	0.00E+00	2.12E+00	2.60E-05	4.43E+00	1.33E-03
Average	<15km	Grouse	Mercury(Hg)	4.86E-02	4.79E+00	3.50E-06	7.30E-01	1.99E-02	2.53E-01	4.62E-01	6.07E-01	2.06E-02	0.00E+00	1.47E-03	0.00E+00	0.00E+00	1.12E-02	1.63E-07	3.33E-02	7.96E-04
Average	<15km	Grouse	Selenium(Se)	5.33E-01	7.16E+00	2.42E-03	1.20E+01	2.00E-01	1.30E+01	1.75E+01	3.93E+00	3.08E-02	0.00E+00	1.48E-02	0.00E+00	0.00E+00	7.26E-02	1.12E-04	1.18E-01	1.34E-01
Average	<15km	Mallard	Arsenic(As)	1.99E+01	4.94E+01	2.75E-03	4.01E+01	4.95E-01	2.35E+00	1.21E+01	3.79E+00	1.10E-01	8.93E-02	2.20E-02	2.62E-02	5.38E-01	4.22E-02	1.83E-04	8.28E-01	1.66E-03
Average	<15km	Mallard	Cadmium(Cd)	7.00E-01	1.28E+01	4.67E-04	2.19E+01	6.95E-01	1.07E+00	8.81E+00	6.27E+01	2.84E-02	4.88E-02	3.10E-02	1.19E-02	3.92E-01	6.98E-01	3.11E-05	1.21E+00	1.28E-01
Average	<15km	Mallard	Copper(Cu)	3.05E+01	6.47E+02	7.58E-03	4.79E+02	1.42E+01	1.20E+01	1.65E+01	2.96E+01	1.44E+00	1.07E+00	6.34E-01	1.33E-01	7.36E-01	3.30E-01	5.06E-04	4.34E+00	4.34E-02
Average	<15km	Mallard	Lead(Pb)	1.67E+01	4.66E+02	5.58E-04	1.84E+02	4.14E+00	2.78E+00	2.99E+01	1.15E+02	1.04E+00	4.10E-01	1.84E-01	3.10E-02	1.33E+00	1.28E+00	3.72E-05	4.27E+00	1.28E-03
Average	<15km	Mallard	Mercury(Hg)	4.86E-02	4.79E+00	3.50E-06	7.30E-01	1.99E-02	2.53E-01	4.62E-01	6.07E-01	1.07E-02	1.63E-03	8.86E-04	2.82E-03	2.06E-02	6.76E-03	2.33E-07	4.33E-02	1.04E-03
Average	<15km	Mallard	Selenium(Se)	5.33E-01	7.16E+00	2.42E-03	1.20E+01	2.00E-01	1.30E+01	1.75E+01	3.93E+00	1.60E-02	2.67E-02	8.91E-03	1.45E-01	7.81E-01	4.37E-02	1.61E-04	1.02E+00	1.15E+00
Average	<15km	Moose	Arsenic(As)	1.99E+01	4.94E+01	2.75E-03	4.01E+01	4.95E-01	2.35E+00	1.21E+01	3.79E+00	4.73E+00	3.84E+00	1.90E+00	2.25E+00	0.00E+00	0.00E+00	6.65E-02	1.28E+01	2.56E-02
Average	<15km	Moose	Cadmium(Cd)	7.00E-01	1.28E+01	4.67E-04	2.19E+01	6.95E-01	1.07E+00	8.81E+00	6.27E+01	1.22E+00	2.10E+00	2.66E+00	1.02E+00	0.00E+00	0.00E+00	1.13E-02	7.02E+00	8.42E-04
Average	<15km	Moose	Copper(Cu)	3.05E+01	6.47E+02	7.58E-03	4.79E+02	1.42E+01	1.20E+01	1.65E+01	2.96E+01	6.20E+01	4.59E+01	5.45E+01	1.15E+01	0.00E+00	0.00E+00	1.83E-01	1.74E+02	1.74E+00
Average	<15km	Moose	Lead(Pb)	1.67E+01	4.66E+02	5.58E-04	1.84E+02	4.14E+00	2.78E+00	2.99E+01	1.15E+02	4.47E+01	1.76E+01	1.59E+01	2.67E+00	0.00E+00	0.00E+00	1.35E-02	8.08E+01	2.42E-02
Average	<15km	Moose	Mercury(Hg)	4.86E-02	4.79E+00	3.50E-06	7.30E-01	1.99E-02	2.53E-01	4.62E-01	6.07E-01	4.58E-01	6.99E-02	7.63E-02	2.43E-01	0.00E+00	0.00E+00	8.46E-05	8.47E-01	4.42E-03
Average	<15km	Moose	Selenium(Se)	5.33E-01	7.16E+00	2.42E-03	1.20E+01	2.00E-01	1.30E+01	1.75E+01	3.93E+00	6.86E-01	1.15E+00	7.67E-01	1.25E+01	0.00E+00	0.00E+00	5.84E-02	1.51E+01	3.44E-02

Wildlife receptor exposure variables					
Receptor	**Variable**	**Abbreviation**	**Value**	**Units**	**Reference**
Deer	AIR	AIR_Deer	1.1E+01	m3/day	US EPA 1993
Grouse	AIR	AIR_Grouse	3.1E-01	m3/day	Allometric equation for birds 3-19 (US EPA 1993)
Mallard	AIR	AIR_Mallard	4.7E-01	m3/day	Allometric equation for birds 3-19; US EPA 1993
Moose	AIR	AIR_Moose	7.2E+01	m3/day	Allometric equation for mammals 3-20; US EPA 1993
Deer	BW	BW_Deer	4.50E+01	kg-WW	Lesage et al. 2001
Grouse	BW	BW_Grouse	7.02E-01	kg-WW	USEPA 1993
Mallard	BW	BW_Mallard	1.20E+00	kg-WW	BC MOE 2001
Moose	BW	BW_Moose	4.50E+02	kg-WW	ASRD 2002
Deer	Per_SedIR	Per_SedIR_Deer	0.0%	% of Diet	Assumed
Grouse	Per_SedIR	Per_SedIR_Grouse	0.0%	% of Diet	Assumed
Mallard	Per_SedIR	Per_SedIR_Mallard	2.0%	% of Diet	Actually <2%; Beyer et al. 1997
Moose	Per_SedIR	Per_SedIR_Moose	2.0%	% of Diet	Actually <2%; Suter et al. 2000
Deer	Per_SIR	Per_SIR_Deer	2.0%	% of Diet	Actually <2%; Suter et al. 2000
Grouse	Per_SIR	Per_SIR_Grouse	9.3%	% of Diet	Assumed similar to wild turkey; Suter et al. 2000
Mallard	Per_SIR	Per_SIR_Mallard	2.0%	% of Diet	Actually <2%; Beyer et al. 1994
Moose	Per_SIR	Per_SIR_Moose	2.0%	% of Diet	Actually <2%; Suter et al. 2000
Deer	SedIR	SedIR_Deer	0.00E+00	kg-sed/day	Assumed
Grouse	SedIR	SedIR_Grouse	0.00E+00	kg-sed/day	Calculated; See Soil & Sediment Ingestion Rate
Mallard	SedIR	SedIR_Mallard	2.23E-03	kg-sed/day	Calculated; See Soil & Sediment Ingestion Rate
Moose	SedIR	SedIR_Moose	9.58E-02	kg-sed/day	Calculated; See Soil & Sediment Ingestion Rate
Deer	SIR	SIR_Deer	1.95E-02	kg-soil/day	Calculated; See Soil & Sediment Ingestion Rate
Grouse	SIR	SIR_Grouse	4.31E-03	kg-soil/day	Calculated; See Soil & Sediment Ingestion Rate
Mallard	SIR	SIR_Mallard	2.23E-03	kg-soil/day	Calculated; See Soil & Sediment Ingestion Rate
Moose	SIR	SIR_Moose	9.58E-02	kg-soil/day	Calculated; See Soil & Sediment Ingestion Rate
Deer	WIR	WIR_Deer	3.0E+00	L/day	Allometric equation 3-17; US EPA 1993
Grouse	WIR	WIR_Grouse	4.65E-02	L/day	Allometric equation 3-15 (US EPA 1993)
Mallard	WIR	WIR_Mallard	6.67E-02	L/day	Allometric equation 3-15; US EPA 1993
Moose	WIR	WIR_Moose	2.42E+01	L/day	Allometric equation 3-17; US EPA 1993

Notes:

BW = Body Weight

SIR = Soil ingestion rate

Sed_IR = Sediment ingestion rate

WIR = Water ingestion rate

Estimation of Soil / Sediment Ingestion Rate

Receptor moose	**Percent Soil in Diet** 2.0%
NFMR 1.89E+01 kcal/kg/day 8.52E+03 kcal/day 8.52E+06 cal/day	**Percent Sediment in Diet** 2.0%
BW 4.50E+02 kg	

Estimation of Average Metabolizable Energy

Diet	Portion	GE [kcal/kg-DW]	AE [%]	ME x Diet% [kcal/kg-DW]	NIR [kg/kg-BW/day]	FIR kg/day
Invert	0%	5400	72%	0.00E+00	0.00E+00	0.00E+00
Browse	80%	4200	47%	1.58E+03	8.52E-03	3.83E+00
BenthicInvert	0%	5000	77%	0.00E+00	0.00E+00	0.00E+00
Aquatic Plant	20%	4300	23%	1.98E+02	2.13E-03	9.58E-01
			Sum	**1.78E+03**	**1.06E-02**	**4.79E+00**

Notes:
Calculation based on U.S. EPA 1993

Estimation of Total Ingestion Rate [kg-food / day]	4.79E+00
Soil Ingestion Rate [kg-soil / day]	9.58E-02
Sediment Ingestion Rate [kg-sediment / day]	9.58E-02

Normalized to Body Weight Free-living (Field) Metabolic Rate (NFMR)

Receptor	NFMR [kcal/kg bw/day] A	FMR [kcal/day] B	Body Weight [grams]	a	b	Reference/Comments
Deer	4.28E+01	1.92E+03	4.50E+04	7.94E+00	6.46E-01	Used "Herbivores" (Nagy et al. 1999)
Grouse	3.10E+02	2.18E+02	7.02E+02	1.05E+01	6.81E-01	Used "All birds" (Nagy et al. 1999)
Mallard	2.61E+02	3.14E+02	1.20E+03	1.05E+01	6.81E-01	Used "All birds" (Nagy et al. 1999)
Moose	1.89E+01	8.52E+03	4.50E+05	7.94E+00	6.46E-01	Used "Herbivores" (Nagy et al. 1999)

A) NFMR = Normalized Free Metabolic Rate = FMR / BW; Where BW is in kg
B) FMR = Free Metabolic Rate [kcal/day] = (a x BW^b) / 4.184 Kj/calorie; Where BW is in grams

Receptor dietary composition [media % of diet]			
Receptor	**Media**	**Abbreviation**	**Value**
Deer	Aquatic Plant	Deer_Aquatic Plant	0.0%
Deer	BenthicInvert	Deer_BenthicInvert	0.0%
Deer	Browse	Deer_Browse	100.0%
Deer	Invert	Deer_Invert	0.0%
Grouse	Aquatic Plant	Grouse_Aquatic Plant	0.0%
Grouse	BenthicInvert	Grouse_BenthicInvert	0.0%
Grouse	Browse	Grouse_Browse	80.0%
Grouse	Invert	Grouse_Invert	20.0%
Mallard	Aquatic Plant	Mallard_Aquatic Plant	10.0%
Mallard	BenthicInvert	Mallard_BenthicInvert	40.0%
Mallard	Browse	Mallard_Browse	40.0%
Mallard	Invert	Mallard_Invert	10.0%
Moose	Aquatic Plant	Moose_Aquatic Plant	20.0%
Moose	BenthicInvert	Moose_BenthicInvert	0.0%
Moose	Browse	Moose_Browse	80.0%
Moose	Invert	Moose_Invert	0.0%

Weighted Average Metabolizable Energy - MEavg (kcal/kg)		
Receptor	**Value**	**Comment**
Deer	1.97E+03	Calculated
Grouse	2.36E+03	Calculated
Mallard	2.82E+03	Calculated
Moose	1.78E+03	Calculated

Metabolizable Energy (ME) of Dietary Items [kcal/kg] [A]			
Receptor	**Dietary Item**	**Abbreviation**	**Value**
Deer	Aquatic Plant	Deer_Aquatic Plant	989
Deer	BenthicInvert	Deer_BenthicInvert	3850
Deer	Browse	Deer_Browse	1974
Deer	Invert	Deer_Invert	3888
Grouse	Aquatic Plant	Grouse_Aquatic Plant	989
Grouse	BenthicInvert	Grouse_BenthicInvert	3850
Grouse	Browse	Grouse_Browse	1974
Grouse	Invert	Grouse_Invert	3888
Mallard	Aquatic Plant	Mallard_Aquatic Plant	989
Mallard	BenthicInvert	Mallard_BenthicInvert	3850
Mallard	Browse	Mallard_Browse	1974
Mallard	Invert	Mallard_Invert	3888
Moose	Aquatic Plant	Moose_Aquatic Plant	989
Moose	BenthicInvert	Moose_BenthicInvert	3850
Moose	Browse	Moose_Browse	1974
Moose	Invert	Moose_Invert	3888

A) US EPA 1993; Equation 4-17

Gross Energy (GE) of Dietary Items [kcal/kg dw] [A]

Receptor	Dietary Item	Abbreviation	Value	Reference/Comments
Deer	Aquatic Plant	Deer_Aquatic Plant	4300	aquatic emergent vegetation; US EPA 1993
Deer	BenthicInvert	Deer_BenthicInvert	5000	isopods, amphipods, cladocerans; US EPA 1993
Deer	Browse	Deer_Browse	4200	monocot young grasses; US EPA 1993
Deer	Invert	Deer_Invert	5400	grasshopper, crickets; US EPA 1993
Grouse	Aquatic Plant	Grouse_Aquatic Plant	4300	aquatic emergent vegetation; US EPA 1993
Grouse	BenthicInvert	Grouse_BenthicInvert	5000	isopods, amphipods, cladocerans; US EPA 1993
Grouse	Browse	Grouse_Browse	4200	monocot young grasses; US EPA 1993
Grouse	Invert	Grouse_Invert	5400	grasshopper, crickets; US EPA 1993
Mallard	Aquatic Plant	Mallard_Aquatic Plant	4300	aquatic emergent vegetation; US EPA 1993
Mallard	BenthicInvert	Mallard_BenthicInvert	5000	isopods, amphipods, cladocerans; US EPA 1993
Mallard	Browse	Mallard_Browse	4200	monocot young grasses; US EPA 1993
Mallard	Invert	Mallard_Invert	5400	grasshopper, crickets; US EPA 1993
Moose	Aquatic Plant	Moose_Aquatic Plant	4300	aquatic emergent vegetation; US EPA 1993
Moose	BenthicInvert	Moose_BenthicInvert	5000	isopods, amphipods, cladocerans; US EPA 1993
Moose	Browse	Moose_Browse	4200	monocot young grasses; US EPA 1993
Moose	Invert	Moose_Invert	5400	grasshopper, crickets; US EPA 1993

A) US EPA 1993; Tables 4-1 & 4-2

Assimilation Efficiency (AE) of Dietary Items [Percent% Efficiency] [A]				
Receptor	**Dietary Item**	**Abbreviation**	**Value**	**Reference/Comments**
Deer	Aquatic Plant	Deer_Aquatic Plant	23%	aquatic vegetation; US EPA 1993
Grouse	Aquatic Plant	Grouse_Aquatic Plant	23%	aquatic vegetation; US EPA 1993
Mallard	Aquatic Plant	Mallard_Aquatic Plant	23%	aquatic vegetation; US EPA 1993
Moose	Aquatic Plant	Moose_Aquatic Plant	23%	aquatic vegetation; US EPA 1993
Deer	Browse	Deer_Browse	47%	grasses, leaves; US EPA 1993
Grouse	Browse	Grouse_Browse	47%	grasses, leaves; US EPA 1993
Mallard	Browse	Mallard_Browse	47%	grasses, leaves; US EPA 1993
Moose	Browse	Moose_Browse	47%	grasses, leaves; US EPA 1993
Deer	BenthicInvert	Deer_BenthicInvert	77%	aquatic invertebrates; US EPA 1993
Grouse	BenthicInvert	Grouse_BenthicInvert	77%	aquatic invertebrates; US EPA 1993
Mallard	BenthicInvert	Mallard_BenthicInvert	77%	aquatic invertebrates; US EPA 1993
Moose	BenthicInvert	Moose_BenthicInvert	77%	aquatic invertebrates; US EPA 1993
Deer	Invert	Deer_Invert	72%	terrestrial insects; US EPA 1993
Grouse	Invert	Grouse_Invert	72%	terrestrial insects; US EPA 1993
Mallard	Invert	Mallard_Invert	72%	terrestrial insects; US EPA 1993
Moose	Invert	Moose_Invert	72%	terrestrial insects; US EPA 1993

A) US EPA 1993; Table 4-3

Percent of exposure derived from impacted area		
Receptor	Value	Comment
Moose	100%	Assumed
Deer	100%	Assumed
Grouse	100%	Assumed
Mallard	100%	Assumed

Water content in wildlife food [%]		
Receptor	Value	Reference
Browse	70%	young grasses; Suter et al. 2000
BenthicInvert	80%	isopods, amphipods,cladocerans; Suter et al. 2000
Invert	69%	grasshoppers & crickets; Suter et al. 2000
Aquatic Plant	65%	emergent vegetation; Suter et al. 2000

Literature derived regression models and bio-concentration factors for the ERA [DW Basis]						
Media	**Chemical**	**Abbreviation**	**Constant**	**Slope**	**UF**	**Reference/Comment**
Aquatic Plant	Arsenic(As)	Aquatic Plant_Arsenic(As)			8.56E+02	US EPA 1999
Aquatic Plant	Cadmium(Cd)	Aquatic Plant_Cadmium(Cd)			2.28E+03	US EPA 1999
Aquatic Plant	Copper(Cu)	Aquatic Plant_Copper(Cu)			1.58E+03	US EPA 1999
Aquatic Plant	Lead(Pb)	Aquatic Plant_Lead(Pb)			4.98E+03	US EPA 1999
Aquatic Plant	Mercury(Hg)	Aquatic Plant_Mercury(Hg)			7.23E+04	US EPA 1999
Aquatic Plant	Selenium(Se)	Aquatic Plant_Selenium(Se)			5.39E+03	US EPA 1999
BenthicInvert	Arsenic(As)	BenthicInvert_Arsenic(As)	-2.92E-01	7.54E-01		BJC 1998b
BenthicInvert	Cadmium(Cd)	BenthicInvert_Cadmium(Cd)	3.95E-02	6.92E-01		BJC 1998b
BenthicInvert	Copper(Cu)	BenthicInvert_Copper(Cu)	1.09E+00	2.78E-01		BJC 1998b
BenthicInvert	Lead(Pb)	BenthicInvert_Lead(Pb)	-7.79E-01	8.01E-01		BJC 1998b
BenthicInvert	Mercury(Hg)	BenthicInvert_Mercury(Hg)	-6.70E-01	3.27E-01		BJC 1998b
BenthicInvert	Selenium(Se)	BenthicInvert_Selenium(Se)	1.57E+00	5.19E-01		Hamilton & Buhl 2003; Ham
Invert	Arsenic(As)	Invert_Arsenic(As)	-1.42E+00	7.06E-01		Sample et al. 1998
Invert	Cadmium(Cd)	Invert_Cadmium(Cd)	2.11E+00	7.95E-01		Sample et al. 1998
Invert	Copper(Cu)	Invert_Copper(Cu)	1.68E+00	2.64E-01		Sample et al. 1998
Invert	Lead(Pb)	Invert_Lead(Pb)	-2.18E-01	8.07E-01		Sample et al. 1998
Invert	Mercury(Hg)	Invert_Mercury(Hg)	-6.84E-01	1.18E-01		Sample et al. 1998
Invert	Selenium(Se)	Invert_Selenium(Se)	-7.50E-02	7.33E-01		Sample et al. 1998

Notes:

UF: [Media] x BCF

Regression model: ln[Media] = Constant + Slope x ln[Soil]

Bio transfer factors [day/kg FW]				
Media	Chemical	Abbreviation	Value	Comment
Deer	Arsenic(As)	Deer_Arsenic(As)	2.00E-03	U.S.EPA 2005 BTF for beef
Deer	Cadmium(Cd)	Deer_Cadmium(Cd)	1.20E-04	U.S.EPA 2005 BTF for beef
Deer	Copper(Cu)	Deer_Copper(Cu)	1.00E-02	U.S.EPA 2005 BTF for beef
Deer	Lead(Pb)	Deer_Lead(Pb)	3.00E-04	U.S.EPA 2005 BTF for beef
Deer	Mercury(Hg)	Deer_Mercury(Hg)	5.22E-03	U.S.EPA 2005 BTF for beef
Deer	Selenium(Se)	Deer_Selenium(Se)	2.27E-03	U.S.EPA 2005 BTF for beef
Grouse	Arsenic(As)	Grouse_Arsenic(As)	2.00E-03	U.S.EPA 2005 BTF for beef
Grouse	Cadmium(Cd)	Grouse_Cadmium(Cd)	1.06E-01	U.S.EPA 2005 BTF for chicken
Grouse	Copper(Cu)	Grouse_Copper(Cu)	1.00E-02	U.S.EPA 2005 BTF for beef
Grouse	Lead(Pb)	Grouse_Lead(Pb)	3.00E-04	U.S.EPA 2005 BTF for beef
Grouse	Mercury(Hg)	Grouse_Mercury(Hg)	2.39E-02	U.S.EPA 2005 BTF for chicken
Grouse	Selenium(Se)	Grouse_Selenium(Se)	1.13E+00	U.S.EPA 2005 BTF for chicken
Mallard	Arsenic(As)	Mallard_Arsenic(As)	2.00E-03	U.S.EPA 2005 BTF for beef
Mallard	Cadmium(Cd)	Mallard_Cadmium(Cd)	1.06E-01	U.S.EPA 2005 BTF for chicken
Mallard	Copper(Cu)	Mallard_Copper(Cu)	1.00E-02	U.S.EPA 2005 BTF for beef
Mallard	Lead(Pb)	Mallard_Lead(Pb)	3.00E-04	U.S.EPA 2005 BTF for beef
Mallard	Mercury(Hg)	Mallard_Mercury(Hg)	2.39E-02	U.S.EPA 2005 BTF for chicken
Mallard	Selenium(Se)	Mallard_Selenium(Se)	1.13E+00	U.S.EPA 2005 BTF for chicken
Moose	Arsenic(As)	Moose_Arsenic(As)	2.00E-03	U.S.EPA 2005 BTF for beef
Moose	Cadmium(Cd)	Moose_Cadmium(Cd)	1.20E-04	U.S.EPA 2005 BTF for beef
Moose	Copper(Cu)	Moose_Copper(Cu)	1.00E-02	U.S.EPA 2005 BTF for beef
Moose	Lead(Pb)	Moose_Lead(Pb)	3.00E-04	U.S.EPA 2005 BTF for beef
Moose	Mercury(Hg)	Moose_Mercury(Hg)	5.22E-03	U.S.EPA 2005 BTF for beef
Moose	Selenium(Se)	Moose_Selenium(Se)	2.27E-03	U.S.EPA 2005 BTF for beef

Notes:
Tissue concentration (mg/kg-WW) = Total Intake (mg/day) x BTF (day/kg-WW)

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