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Subject: **Human Health Assessment of the Consumption of Animals Harvested from the Sauk Prairie Recreational Area.**

Summary

At the request of the Wisconsin Department of Natural Resources (DNR), the Wisconsin Department of Health Services (DHS) has conducted a human health assessment of the risks associated with the consumption of hunter-harvested and agricultural animals that may graze at the site of the former Badger Army Ammunition Plant (BAAAP). To date, no tissue samples have been collected at the former BAAAP site from terrestrial animals that are typically consumed by humans. The present human health assessment is based on calculations of theoretical risk, using "worst-case" exposure assumptions where appropriate data are not available. It is not intended to provide definitive estimates of actual risk, but rather to serve as a conservative screening-level risk assessment to refine the list of soil contaminants of concern (COCs) and grazing species in need of further investigation via this exposure pathway.

For each COC, estimated daily exposure doses from regular consumption of animals grazing at the former BAAAP site were calculated for children and adults. Excess cancer risks were also calculated for carcinogenic COCs. Deer and beef cattle were chosen as representative hunter-harvested and agricultural species. The estimated daily exposure doses and excess cancer risks from deer and cattle consumption were extrapolated to other wild and domestic grazing animals. Conservative risk estimates indicate that regular consumption of deer or other wild animals from the former BAAAP site is not expected to pose a human health hazard for any of the residual soil COCs at low, moderate or even high rates of ingestion. However, risk calculations based on regular consumption of agricultural grazing animals raised at the former BAAAP site indicate that species with high percent fat contents (e.g., cattle and sheep) may pose some elevated risks to human health, particularly for dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs).

Background

Site description and history. The area under assessment is the site of the former BAAAP, which has recently been renamed the Sauk Prairie Recreational Area (SPRA). The BAAAP was originally constructed in 1942 to produce small arms and ordnance for World War II. The BAAAP encompassed over 10,000 acres of farmland in Sauk County, between Prairie du Sac and Baraboo, WI. It continued to operate on and off throughout the Korean War and Vietnam Conflict, manufacturing various propellants. After the Vietnam Conflict ended in 1975, the BAAAP was on standby status for many years until it was decommissioned in 1999.

Remediation and future use. Although the BAAAP wasn't fully decommissioned until 1999, environmental investigations and remediation activities have been ongoing since 1977, in an effort to address residual contamination at the site. Over this time, the Department of the Army has developed and revised site-specific soil remediation goals for COCs in accordance with the methodology outlined in Chapter NR 720, Wis. Adm. Code. **Table 1** lists the current site-specific soil remediation goals for the COCs at the BAAAP.

Table 1
Soil Remediation Goals for Residual Contaminants of Concern
Sauk Prairie Recreation Area

Contaminant of Concern	Soil Remediation Goal (mg/kg)
Arsenic	10
Chromium	35.5
2,4-Dinitrotoluene (DNT)	24.7
2,6-Dinitrotoluene (DNT)	620
2,4- and 2,6-Dinitrotoluene (DNT)	11.4
Di-n-butyl phthalate	6,100
Diphenylamine	1,500
Dieldrin	0.03
4,4'-DDT (Dichlorodiphenyltrichloroethane)	1.7
Lead	50/250/500*
Mercury	23
Nitrocellulose	180,000,000
Nitroglycerin	62
Polychlorinated Biphenyls (PCBs)	0.22
Polycyclic Aromatic Hydrocarbons (PAHs)	N/A

*500 mg/kg was used for human health risk calculations.

As remediation efforts at the BAAAP come to a close and land parcels are transferred to the DNR and other State and Federal entities, questions have arisen concerning the safety of the land for recreational or other uses. One of the health concerns in need of evaluation relates to the consumption of wild game and/or agricultural animals that graze at the former BAAAP and future SPRA. The DHS has evaluated the potential for residual COCs at the SPRA to bioaccumulate through the terrestrial food chain to determine whether the consumption of animals that graze at this site poses a human health hazard.

Human Health Risk Assessment

As the former BAAAP site transitions to the SPRA, an assessment of the human health risks associated with the recreational use of this land is necessary. Some of the proposed activities that are under consideration at the SPRA include its use as a hunting ground and/or a site for agricultural grazing as a method of land management. If these activities are permitted at the SPRA, the potential exists for the transfer of residual contaminants from soil to plants, plants to animals, and animals to humans through consumption. The purpose of this risk assessment is to evaluate the safety of consuming animals that may graze at the SPRA and to develop recommendations that adequately protect human health.

Bioaccumulation models for aquatic food chains have been widely used for many years to assess the human health hazard potential of environmental contaminants; however, similar models for terrestrial food chains are still under development. Efforts to estimate the potential for contaminant bioaccumulation through the terrestrial food chain are complicated by the numerous physicochemical and physiological variables that impact contaminant bioavailability in soils, plant uptake and distribution, and animal absorption, distribution, metabolism and excretion. Despite these difficulties, the development of plant uptake factors and animal accumulation factors has allowed one to estimate the concentration of a contaminant in an animal from the concentration in the soil that it grazes upon.

Risk Assessment Rationale. For this human health risk assessment, the DHS focused on estimating the bioaccumulation of residual soil COCs at the SPRA in deer and beef cattle. Both deer and cattle are large ruminant mammals that were chosen as representative hunter-harvested and agricultural species due to the availability of data on their diets and physical characteristics. Similarities to other ruminants (e.g., goats, sheep and bison) make extrapolation of estimated tissue contaminant concentrations fairly straightforward.

The ability of a contaminant to bioconcentrate in animals and humans is positively correlated with its fat solubility, as indicated by its octanol-water partition coefficient (K_{ow}) (*Travis and Arms 1988; Travis 1988*). When comparing the bioaccumulation potential of a particular soil contaminant among different terrestrial animals, the percent fat content of a species is the most critical factor that drives the human health risks associated with their consumption for two main reasons: 1) the fat tissues are one of the main sites for the long-term storage of environmental contaminants in animals, and 2) animal muscle and its associated fat are the tissues most commonly consumed by humans. Cattle are especially useful for evaluating the human health risks associated with terrestrial bioaccumulation, as they typically have the highest percent fat content of animals that are commonly consumed (**Table 2**). Deer are also an appropriate representative species for this assessment, as they are the largest of the hunter-harvested animals in Sauk County and have fat contents similar to other wild game.

Table 2
Average Percent Fat Content of Selected Terrestrial Animals (Cooked)

Species	Average Percent Fat Content*
Cattle	19.0
Sheep	18.0
Bison	8.2
Turkey^	5.4
Squirrel^	4.8
Rabbit^	3.3
Deer^	3.2
Goat	3.1

^Hunter-harvested species
***Source:** http://nutritiondata.self.com/

Estimating contaminant bioaccumulation in non-ruminants (e.g., wild turkeys, squirrels and rabbits) is more difficult, as they have more varied diets (e.g., nuts, seeds and insects). Although there is some variation in the uptake and distribution of soil contaminants in plants, nuts, seeds and soil invertebrates, the percent fat content of the animal is generally a more critical determinant of terrestrial bioaccumulation and human health risk. For this reason, the DHS views cattle as having the highest overall potential to bioaccumulate residual soil contaminants and deer as a good representative species for hunter-harvested game.

Risk Assessment Methodology. The University of Tennessee, in collaboration with Oak Ridge National Laboratory, has compiled plant uptake factors and beef accumulation factors for 1700 chemicals (*SADA 2011*). For each COC, estimates of the daily exposure dose to humans (children and adults) from the consumption of cattle or deer that graze at the SPRA were calculated using the equations and parameters outlined in **Appendix A**. As a conservative measure, worst-case assumptions for various parameters were used in the absence of available data. For example, it is assumed that:

- soil concentrations of COCs across the SPRA are uniformly present at the level of their soil remediation goal.
- the animals spend 100% of their time at the SPRA and only consume vegetation from SPRA.
- human receptors consume venison or beef from the SPRA at the same intake rate over their entire childhood and/or lifetime.

For non-carcinogenic toxicities, a simple hazard index (HI) was calculated by dividing the daily exposure dose of each COC by its US Environmental Protection Agency (US EPA) Oral Reference Dose (RfD). An HI over 1.0 indicates that the calculated daily exposure dose for a COC exceeds its oral RfD and that the potential for COC-dependent toxicities cannot be ruled out. For carcinogens, the calculated daily exposure dose for a COC is multiplied by its US EPA Oral Cancer Slope Factor to calculate an excess lifetime cancer risk. In general, the US EPA considers excess cancer risks that are below 1 chance in 1,000,000 (1×10^{-6} or 1E-06) to be so small as to be negligible, and risks above 1×10^{-4} to be sufficiently large that some sort of (additional) remediation is desirable. Excess cancer risks that range between 1×10^{-6} and 1×10^{-4} are generally considered by the US EPA to be acceptable (*US EPA 2013*). The DHS generally considers excess cancer risks of 1×10^{-5} as acceptable at sites where remediation has occurred.

Lead is a special case, as the US EPA has not developed an RfD for lead. Instead, risk is interpreted in terms of blood lead concentration rather than an HI. At present, the maximum level of lead in the blood that is considered to be acceptable is 5 µg/dL. To assist in risk assessments involving lead, the US EPA has developed a specialized computer model, referred to as the Integrated Exposure Uptake Biokinetic (IEUBK) model, for evaluating lead risks to children (*US EPA 2010*). The model contains over 100 input parameters to account for various environmental sources of lead exposure. Default inputs and assumptions were used for all parameters except for meat ingestion, in which case the estimated lead concentrations of cattle and deer grazing at the SPRA were used instead to calculate estimated child blood levels.

Results and Discussion

Deer and other wild game. Since there is a wide variation in the human consumption rates of venison and other wild game throughout Wisconsin, it was considered most appropriate to calculate average daily doses of COCs from these animals using a range of ingestion rates. To this end, estimated daily doses were calculated for four groups, those whose annual consumption of total meat would be 25, 50, 75 or 100% comprised of venison harvested from the SPRA. For those that would get 25, 50 or 75% of their annual meat intake from SPRA-harvested deer, estimated daily doses of all COCs would be below an HI of 1.0 for adults and children and all estimated excess cancer risks would be below the 1×10^{-5} level (**Appendix B**). Only for those that would get 100% of their annual meat intake from SPRA-harvested deer would there be a slightly elevated risk of non-cancer toxicity from mercury (HI = 1.05) in children and an excess adult cancer risk from exposure to hexavalent chromium (1.03×10^{-5}) that is barely above the acceptable risk level of 1×10^{-5}. As other wild game have similar percent fat contents (3.2 - 5.4%), it is safe to assume that the calculated risks would be comparable for other hunter-harvested species.

The results above indicate that the consumption of wild game from the SPRA is safe for adults and children over a lifetime. The only slightly elevated risks were associated with mercury and hexavalent chromium in individuals whose entire consumption of meat over their entire lives would consist of SPRA-harvested deer. Furthermore, mercury was not known to have been used in any of the processes that took place at the BAAAP, and is thought to have come only from thermometers, barometers, thermostats or other mercury-containing switches or devices used in the buildings. The assumption for these calculations is that mercury is present across the entire SPRA at the level of the soil remediation goal. Based on the known activities at the site, this is almost certainly a large overestimation of the total soil burden of mercury. There were also no documented historical uses of hexavalent chromium at the BAAAP (e.g., in metal etching or plating). The source of chromium (total) detected in soils at the BAAAP is thought to be a result of acid-induced dissolution of chrome plated machinery. If this is the case, chromium metal dissolved with commonly-used mineral acids releases trivalent chromium (*Cardarelli 2008*), which is relatively non-toxic. Thus, trivalent chromium is most likely the predominant form of chromium in soils at the SPRA and the slightly elevated excess cancer risk calculated for hexavalent chromium in individuals whose only source of meat over their lifetime would be SPRA-harvested venison can likely be dismissed.

Cattle and other agricultural animals. Since there is good data on the ingestion rates of beef in children and adults, estimated daily doses were calculated for those whose annual consumption of beef (not total meat as with venison) would be 25, 50, 75 or 100% comprised of cattle harvested from the SPRA. For cattle, even at the 25% SPRA-raised beef consumption rate, the estimated daily dose of mercury constitutes an elevated risk for non-cancer toxicities and results in elevated excess cancer risk levels for hexavalent chromium and DDT (**Appendix B**). At the 100% SPRA-raised beef consumption rate, there are additional elevated excess cancer risk levels for arsenic and PCBs. Based on the percent fat contents of other agricultural grazers, the estimated risk levels associated with the consumption of sheep (lamb and mutton) would likely be similar to those calculated for cattle, while those for bison and goats would likely be lower.

A strong case can be made that the elevated risks calculated for hexavalent chromium and mercury in cattle from the SPRA are improbable for the reasons stated above for deer. Additionally, the elevated excess cancer risk calculated for arsenic is likely to be unrealistic due to its distribution in mammalian tissues. The mammalian transfer factor for arsenic is based on whole body uptake concentrations, but long-term storage of arsenic predominantly occurs in the hair, nails and bones (*ATSDR 2007*), which are not typically consumed by humans. However, the elevated estimated risks for DDT and PCBs are more concerning because they are both highly persistent in the environment and have a high potential for bioaccumulation in animal fats as a result of their high lipid solubilities.

Based on the estimated risk calculations and practical considerations discussed above, DHS recommends that DNR collect tissues samples from agricultural animals grazing at the SPRA to definitively quantitate the risks associated with their consumption, should agricultural activities be allowed at the site. At a minimum, cattle and sheep tissues should be analyzed for DDT and PCBs if they are intended for human consumption. Finally, the DHS also recommends that SPRA-raised agricultural animals intended for human consumption have their tissues analyzed for lead content, as a precautionary measure. Although estimated child blood lead levels based on the regular consumption of SPRA-raised beef are below the Center's for Disease Control (CDC) recommendation of 5 µg/dL, there is no known safe level of lead exposure and regular consumption may significantly raise a child's blood lead level from baseline.

Conclusions

- Conservative risk estimates indicate that regular consumption of wild game from the SPRA would not pose a human health risk to either children or adults.

- Conservative risk estimates indicate that regular consumption of agricultural grazing animals with a high percent fat content (e.g., cattle and sheep) from the SPRA may pose a human health risk to both children and adults.

- Conservative risk estimates indicate that regular consumption of agricultural grazers with a lower percent fat content (e.g., bison and goat) from the SPRA are unlikely to pose a human health risk to either children or adults.

Recommendations

- The DHS recommends that the DNR provide educational information on the soil COCs present at the SPRA and their potential for terrestrial bioaccumulation in animals that graze on the land to future hunters and consumers.

- If the DNR decides to permit agricultural grazing activities at the SPRA, the DHS recommends that tissue samples be collected and analyzed prior to allowing human consumption of these animals, particularly for DDT and PCBs in cattle and sheep. Lead levels should also be analyzed for precautionary reasons.

Public Health Action Plan

The DHS endorses efforts to characterize the human health risks associated with the consumption of hunter-harvested and agricultural grazing animals from the SPRA. The DHS will continue to assist DNR staff with this effort by providing technical consultation and assistance with public health questions. Finally, the DHS will continue to work through the DNR to answer environmental health questions from interested citizens about potential environmental health concerns associated with future recreational activities at the SPRA.

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Appendix A.

Soil to Beef/Deer Ingestion Pathway Equations and Parameters

$$\text{Dose}_{\text{beef ingestion}} = \frac{F_b\, C_{sn}\, f_p\, (Q_p\, f_s\, (BV_{dry} + MLF) + Qs)\, IR_b\, FI\, EF\, ED}{CF_2\, BW\, AT}$$

Parameter	Units	Value (note, source)
Beef transfer coefficient = F_b	day/kg	Chemical-specific
Non-radionuclide chemical concentration in soil = C_{sn}	mg/kg	BAAAP soil remediation goal
Fraction of year animal is on site = f_p	unitless	1 (Site-specific)
Quantity of pasture ingested = Q_p	kg/day	7.2 (IAEA 1994) 1.7 (NY DEC/DOH 2006)
Fraction of animal feed from site = f_s	unitless	1 (Site-specific)
Soil to plant uptake factor (dry) = BV_{dry}	kg/kg	Chemical-specific
Mass loading factor = MLF	unitless	0.26 (Pinder and McLeod 1989)
Quantity of soil ingested = Q_s	kg/day	1 (Darwin 1990)
Beef ingestion rate= IR_b	kg/day	0.026 (child, EPA 2011) 0.057 (adult, EPA 2011)
Diet fraction = FI	unitless	1 (Site-specific)
Exposure frequency = EF	day/yr	Variable
Exposure duration = ED	years	30 (adult, ATSDR 2005) 6 (child, ATSDR 2005)
Conversion Factor = CF_2	days/yr	365
Body weight = BW	kg	70 (adult, ATSDR 2005) 16 (child, ATSDR 2005)
Lifetime = LT	years	70 (ATSDR 2005)
Averaging time = AT	years	LT (carcinogen) ED (noncarcinogen)

Adapted from: http://www.tiem.utk.edu/~sada/hh_appendix_a.pdf

Additional Equations:

Deer Transfer Coefficient (F_d) = F_b x (% Fat Content of Deer / % Fat Content of Beef)

$$\text{Hazard Index} = \frac{\text{Estimated Daily Dose of COC from Animal}}{\text{EPA Reference Dose for COC}}$$

Excess Cancer $\text{Risk}_{\text{lifetime}}$ = (Estimated Daily Dose of COC from Animal) x (Oral Slope Factor for COC)

Appendix B.

Estimated Risks for Deer Consumption at the SPRA, 25% Meat Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	3.24E-07	1.08E-03	4.86E-07	1.46E-07	4.88E-04	2.19E-07
Chromium (III), Insoluble Salts	1.50E+00		1.21E-05	8.05E-06		2.73E-05	1.82E-05	
Chromium (VI)	3.00E-03	5.00E-01	5.17E-06	1.72E-03	2.59E-06	2.34E-06	7.79E-04	1.17E-06
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	9.08E-09	4.54E-06	2.82E-09	4.10E-09	2.05E-06	1.27E-09
Dinitrotoluene, 2,6-	1.00E-03		6.06E-07	6.06E-04		1.37E-06	1.37E-03	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	5.20E-09		3.54E-09	2.35E-09		1.60E-09
Dibutyl Phthalate	1.00E-01		2.14E-04	2.14E-03		4.82E-04	4.82E-03	
Diphenylamine	2.50E-02		8.99E-06	3.59E-04		2.03E-05	8.12E-04	
Dieldrin	5.00E-05	1.60E+01	2.94E-09	5.88E-05	4.70E-08	1.33E-09	2.65E-05	2.12E-08
DDT	5.00E-04	3.40E-01	4.95E-06	9.90E-03	1.68E-06	2.24E-06	4.47E-03	7.60E-07
Lead			3.75E-06			1.69E-06		
Mercury (elemental)	3.00E-04		3.50E-05	1.17E-01		7.89E-05	2.63E-01	
Mercury, Inorganic Salts	3.00E-04		3.50E-05	1.17E-01		7.89E-05	2.63E-01	
Nitrocellulose	3.00E+03		2.51E-04	8.36E-08		5.66E-04	1.89E-07	
Nitroglycerin	1.00E-04	1.70E-02	1.54E-08	1.54E-04	2.63E-10	6.97E-09	6.97E-05	1.19E-10
Polychlorinated Biphenyls		2.00E+00	1.56E-07		3.13E-07	7.06E-08		1.41E-07

RfDs and Estimated Doses in mg/kg/day
Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Deer from SPRA, 25% Meat Consumption Rate

Age	Estimated Blood Lead Level (μg/dL)
Year 1-2	3.5
Year 2-3	3.2
Year 3-4	3.1
Year 4-5	2.5
Year 5-6	2.2

Estimated Risks for Deer Consumption at the SPRA, 50% Meat Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	6.48E-07	2.16E-03	9.72E-07	2.93E-07	9.75E-04	4.39E-07
Chromium (III), Insoluble Salts	1.50E+00		2.41E-05	1.61E-05		5.45E-05	3.63E-05	
Chromium (VI)	3.00E-03	5.00E-01	1.03E-05	3.45E-03	5.17E-06	4.67E-06	1.56E-03	2.34E-06
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	1.82E-08	9.08E-06	5.63E-09	8.20E-09	4.10E-06	2.54E-09
Dinitrotoluene, 2,6-	1.00E-03		1.21E-06	1.21E-03		2.74E-06	2.74E-03	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	1.04E-08		7.07E-09	4.70E-09		3.19E-09
Dibutyl Phthalate	1.00E-01		4.27E-04	4.27E-03		9.65E-04	9.65E-03	
Diphenylamine	2.50E-02		1.80E-05	7.19E-04		4.06E-05	1.62E-03	
Dieldrin	5.00E-05	1.60E+01	5.88E-09	1.18E-04	9.41E-08	2.65E-09	5.31E-05	4.25E-08
DDT	5.00E-04	3.40E-01	9.90E-06	1.98E-02	3.37E-06	4.47E-06	8.94E-03	1.52E-06
Lead			7.50E-06			3.39E-06		
Mercury (elemental)	3.00E-04		6.99E-05	2.33E-01		1.58E-04	5.26E-01	
Mercury, Inorganic Salts	3.00E-04		6.99E-05	2.33E-01		1.58E-04	5.26E-01	
Nitrocellulose	3.00E+03		5.02E-04	1.67E-07		1.13E-03	3.78E-07	
Nitroglycerin	1.00E-04	1.70E-02	3.09E-08	3.09E-04	5.25E-10	1.39E-08	1.39E-04	2.37E-10
Polychlorinated Biphenyls		2.00E+00	3.13E-07		6.25E-07	1.41E-07		2.82E-07

RfDs and Estimated Doses in mg/kg/day
Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Deer from SPRA, 50% Meat Consumption Rate

Age	Estimated Blood Lead Level (µg/dL)
Year 1-2	3.5
Year 2-3	3.3
Year 3-4	3.1
Year 4-5	2.6
Year 5-6	2.2

Estimated Risks for Deer Consumption at the SPRA, 75% Meat Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	9.72E-07	3.24E-03	1.46E-06	4.39E-07	1.46E-03	6.58E-07
Chromium (III), Insoluble Salts	1.50E+00		3.62E-05	2.41E-05		8.18E-05	5.45E-05	
Chromium (VI)	3.00E-03	5.00E-01	1.55E-05	5.17E-03	7.76E-06	7.01E-06	2.34E-03	3.50E-06
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	2.72E-08	1.36E-05	8.45E-09	1.23E-08	6.15E-06	3.81E-09
Dinitrotoluene, 2,6-	1.00E-03		1.82E-06	1.82E-03		4.10E-06	4.10E-03	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	1.56E-08		1.06E-08	7.05E-09		4.79E-09
Dibutyl Phthalate	1.00E-01		6.41E-04	6.41E-03		1.45E-03	1.45E-02	
Diphenylamine	2.50E-02		2.70E-05	1.08E-03		6.09E-05	2.43E-03	
Dieldrin	5.00E-05	1.60E+01	8.82E-09	1.76E-04	1.41E-07	3.98E-09	7.96E-05	6.37E-08
DDT	5.00E-04	3.40E-01	1.49E-05	2.97E-02	5.05E-06	6.71E-06	1.34E-02	2.28E-06
Lead			1.12E-05			5.08E-06		
Mercury (elemental)	3.00E-04		1.05E-04	3.50E-01		2.37E-04	7.89E-01	
Mercury, Inorganic Salts	3.00E-04		1.05E-04	3.50E-01		2.37E-04	7.89E-01	
Nitrocellulose	3.00E+03		7.52E-04	2.51E-07		1.70E-03	5.66E-07	
Nitroglycerin	1.00E-04	1.70E-02	4.63E-08	4.63E-04	7.88E-10	2.09E-08	2.09E-04	3.56E-10
Polychlorinated Biphenyls		2.00E+00	4.69E-07		9.38E-07	2.12E-07		4.24E-07

RfDs and Estimated Doses in mg/kg/day
Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Deer from SPRA, 75% Meat Consumption Rate

Age	Estimated Blood Lead Level (µg/dL)
Year 1-2	3.5
Year 2-3	3.3
Year 3-4	3.1
Year 4-5	2.6
Year 5-6	2.2

Estimated Risks for Deer Consumption at the SPRA, 100% Meat Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	1.30E-06	4.32E-03	1.94E-06	5.85E-07	1.95E-03	8.78E-07
Chromium (III), Insoluble Salts	1.50E+00		4.83E-05	3.22E-05		1.09E-04	7.27E-05	
Chromium (VI)	3.00E-03	5.00E-01	2.07E-05	6.90E-03	1.03E-05	9.35E-06	3.12E-03	4.67E-06
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	3.63E-08	1.82E-05	1.13E-08	1.64E-08	8.20E-06	5.09E-09
Dinitrotoluene, 2,6-	1.00E-03		2.42E-06	2.42E-03		5.47E-06	5.47E-03	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	2.08E-08		1.41E-08	9.40E-09		6.39E-09
Dibutyl Phthalate	1.00E-01		8.54E-04	8.54E-03		1.93E-03	1.93E-02	
Diphenylamine	2.50E-02		3.59E-05	1.44E-03		8.12E-05	3.25E-03	
Dieldrin	5.00E-05	1.60E+01	1.18E-08	2.35E-04	1.88E-07	5.31E-09	1.06E-04	8.50E-08
DDT	5.00E-04	3.40E-01	1.98E-05	3.96E-02	6.73E-06	8.94E-06	1.79E-02	3.04E-06
Lead			1.50E-05			6.77E-06		
Mercury (elemental)	3.00E-04		1.40E-04	4.66E-01		3.16E-04	1.05E+00	
Mercury, Inorganic Salts	3.00E-04		1.40E-04	4.66E-01		3.16E-04	1.05E+00	
Nitrocellulose	3.00E+03		1.00E-03	3.34E-07		2.27E-03	7.55E-07	
Nitroglycerin	1.00E-04	1.70E-02	6.18E-08	6.18E-04	1.05E-09	2.79E-08	2.79E-04	4.74E-10
Polychlorinated Biphenyls		2.00E+00	6.25E-07		1.25E-06	2.82E-07		5.65E-07

RfDs and Estimated Doses in mg/kg/day
Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Deer from SPRA, 100% Meat Consumption Rate

Age	Estimated Blood Lead Level (µg/dL)
Year 1-2	3.5
Year 2-3	3.3
Year 3-4	3.1
Year 4-5	2.6
Year 5-6	2.2

Appendix C.

Estimated Risks for Cattle Consumption at the SPRA, 25% Beef Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	5.51E-06	1.84E-02	8.27E-06	2.20E-06	7.34E-03	3.30E-06
Chromium (III), Insoluble Salts	1.50E+00		2.06E-04	1.37E-04		4.10E-04	2.73E-04	
Chromium (VI)	3.00E-03	5.00E-01	8.81E-05	2.94E-02	4.40E-05	3.52E-05	1.17E-02	1.76E-05
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	1.16E-07	5.82E-05	3.61E-08	4.65E-08	2.32E-05	1.44E-08
Dinitrotoluene, 2,6-	1.00E-03		7.81E-06	7.81E-03		1.56E-05	1.56E-02	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	6.74E-08		4.58E-08	2.69E-08		1.83E-08
Dibutyl Phthalate	1.00E-01		3.49E-03	3.49E-02		6.96E-03	6.96E-02	
Diphenylamine	2.50E-02		1.32E-04	5.27E-03		2.63E-04	1.05E-02	
Dieldrin	5.00E-05	1.60E+01	5.06E-08	1.01E-03	8.09E-07	2.02E-08	4.04E-04	3.23E-07
DDT	5.00E-04	3.40E-01	8.73E-05	1.75E-01	2.97E-05	3.48E-05	6.97E-02	1.18E-05
Lead			6.14E-05			2.45E-05		
Mercury (elemental)	3.00E-04		4.72E-04	1.57E+00		9.41E-04	3.14E+00	
Mercury, Inorganic Salts	3.00E-04		4.72E-04	1.57E+00		9.41E-04	3.14E+00	
Nitrocellulose	3.00E+03		3.09E-03	1.03E-06		6.17E-03	2.06E-06	
Nitroglycerin	1.00E-04	1.70E-02	1.95E-07	1.95E-03	3.32E-09	7.79E-08	7.79E-04	1.32E-09
Polychlorinated Biphenyls		2.00E+00	2.74E-06		5.49E-06	1.09E-06		2.19E-06

RfDs and Estimated Doses in mg/kg/day

Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Cattle from SPRA, 25% Beef Consumption Rate

Age	Estimated Blood Lead Level (µg/dL)
Year 1-2	3.8
Year 2-3	3.6
Year 3-4	3.4
Year 4-5	2.9
Year 5-6	2.5

Estimated Risks for Cattle Consumption at the SPRA, 50% Beef Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	1.10E-05	3.68E-02	1.65E-05	4.40E-06	1.47E-02	6.60E-06
Chromium (III), Insoluble Salts	1.50E+00		4.11E-04	2.74E-04		8.20E-04	5.47E-04	
Chromium (VI)	3.00E-03	5.00E-01	1.76E-04	5.87E-02	8.81E-05	7.03E-05	2.34E-02	3.52E-05
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	2.33E-07	1.16E-04	7.22E-08	9.29E-08	4.65E-05	2.88E-08
Dinitrotoluene, 2,6-	1.00E-03		1.56E-05	1.56E-02		3.12E-05	3.12E-02	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	1.35E-07		9.16E-08	5.38E-08		3.66E-08
Dibutyl Phthalate	1.00E-01		6.98E-03	6.98E-02		1.39E-02	1.39E-01	
Diphenylamine	2.50E-02		2.64E-04	1.05E-02		5.26E-04	2.10E-02	
Dieldrin	5.00E-05	1.60E+01	1.01E-07	2.02E-03	1.62E-06	4.04E-08	8.07E-04	6.46E-07
DDT	5.00E-04	3.40E-01	1.75E-04	3.49E-01	5.94E-05	6.97E-05	1.39E-01	2.37E-05
Lead			1.23E-04			4.90E-05		
Mercury (elemental)	3.00E-04		9.43E-04	3.14E+00		1.88E-03	6.27E+00	
Mercury, Inorganic Salts	3.00E-04		9.43E-04	3.14E+00		1.88E-03	6.27E+00	
Nitrocellulose	3.00E+03		6.18E-03	2.06E-06		1.23E-02	4.11E-06	
Nitroglycerin	1.00E-04	1.70E-02	3.90E-07	3.90E-03	6.64E-09	1.56E-07	1.56E-03	2.65E-09
Polychlorinated Biphenyls		2.00E+00	5.49E-06		1.10E-05	2.19E-06		4.38E-06

RfDs and Estimated Doses in mg/kg/day
Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Cattle from SPRA, 50% Beef Consumption Rate

Age	Estimated Blood Lead Level (μg/dL)
Year 1-2	4.0
Year 2-3	3.9
Year 3-4	3.8
Year 4-5	3.3
Year 5-6	2.9

Estimated Risks for Cattle Consumption at the SPRA, 75% Beef Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	1.65E-05	5.51E-02	2.48E-05	6.60E-06	2.20E-02	9.90E-06
Chromium (III), Insoluble Salts	1.50E+00		6.17E-04	4.11E-04		1.23E-03	8.20E-04	
Chromium (VI)	3.00E-03	5.00E-01	2.64E-04	8.81E-02	1.32E-04	1.05E-04	3.52E-02	5.27E-05
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	3.49E-07	1.75E-04	1.08E-07	1.39E-07	6.97E-05	4.32E-08
Dinitrotoluene, 2,6-	1.00E-03		2.34E-05	2.34E-02		4.68E-05	4.68E-02	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	2.02E-07		1.37E-07	8.07E-08		5.49E-08
Dibutyl Phthalate	1.00E-01		1.05E-02	1.05E-01		2.09E-02	2.09E-01	
Diphenylamine	2.50E-02		3.95E-04	1.58E-02		7.89E-04	3.16E-02	
Dieldrin	5.00E-05	1.60E+01	1.52E-07	3.03E-03	2.43E-06	6.05E-08	1.21E-03	9.69E-07
DDT	5.00E-04	3.40E-01	2.62E-04	5.24E-01	8.90E-05	1.05E-04	2.09E-01	3.55E-05
Lead			1.84E-04			7.35E-05		
Mercury (elemental)	3.00E-04		1.41E-03	4.72E+00		2.82E-03	9.41E+00	
Mercury, Inorganic Salts	3.00E-04		1.41E-03	4.72E+00		2.82E-03	9.41E+00	
Nitrocellulose	3.00E+03		9.27E-03	3.09E-06		1.85E-02	6.17E-06	
Nitroglycerin	1.00E-04	1.70E-02	5.86E-07	5.86E-03	9.95E-09	2.34E-07	2.34E-03	3.97E-09
Polychlorinated Biphenyls		2.00E+00	8.23E-06		1.65E-05	3.28E-06		6.57E-06

RfDs and Estimated Doses in mg/kg/day
Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Cattle from SPRA, 75% Beef Consumption Rate

Age	Estimated Blood Lead Level (μg/dL)
Year 1-2	4.3
Year 2-3	4.2
Year 3-4	4.1
Year 4-5	3.7
Year 5-6	3.3

Estimated Risks for Cattle Consumption at the SPRA, 100% Beef Consumption Rate

Names	Oral RfD	Oral SF	Adult Estimated Dose	Adult Hazard Index	Adult Cancer Risk	Child Estimated Dose	Child Hazard Index	Child Cancer Risk
Arsenic, Inorganic	3.00E-04	1.50E+00	2.21E-05	7.35E-02	3.31E-05	8.80E-06	2.93E-02	1.32E-05
Chromium (III), Insoluble Salts	1.50E+00		8.22E-04	5.48E-04		1.64E-03	1.09E-03	
Chromium (VI)	3.00E-03	5.00E-01	3.52E-04	1.17E-01	1.76E-04	1.41E-04	4.69E-02	7.03E-05
Dinitrotoluene, 2,4-	2.00E-03	3.10E-01	4.66E-07	2.33E-04	1.44E-07	1.86E-07	9.29E-05	5.76E-08
Dinitrotoluene, 2,6-	1.00E-03		3.12E-05	3.12E-02		6.24E-05	6.24E-02	
Dinitrotoluene Mixture, 2,4/2,6-		6.80E-01	2.69E-07		1.83E-07	1.08E-07		7.31E-08
Dibutyl Phthalate	1.00E-01		1.40E-02	1.40E-01		2.79E-02	2.79E-01	
Diphenylamine	2.50E-02		5.27E-04	2.11E-02		1.05E-03	4.21E-02	
Dieldrin	5.00E-05	1.60E+01	2.02E-07	4.05E-03	3.24E-06	8.07E-08	1.61E-03	1.29E-06
DDT	5.00E-04	3.40E-01	3.49E-04	6.98E-01	1.19E-04	1.39E-04	2.79E-01	4.74E-05
Lead			2.46E-04			9.81E-05		
Mercury (elemental)	3.00E-04		1.89E-03	6.29E+00		3.76E-03	1.25E+01	
Mercury, Inorganic Salts	3.00E-04		1.89E-03	6.29E+00		3.76E-03	1.25E+01	
Nitrocellulose	3.00E+03		1.24E-02	4.12E-06		2.47E-02	8.22E-06	
Nitroglycerin	1.00E-04	1.70E-02	7.81E-07	7.81E-03	1.33E-08	3.12E-07	3.12E-03	5.30E-09
Polychlorinated Biphenyls		2.00E+00	1.10E-05		2.19E-05	4.38E-06		8.76E-06

RfDs and Estimated Doses in mg/kg/day
Oral SFs in $(mg/kg/day)^{-1}$

US EPA IEUBK Modeling of Child Blood Levels Based on Consumption of Cattle from SPRA, 100% Beef Consumption Rate

Age	Estimated Blood Lead Level (μg/dL)
Year 1-2	4.6
Year 2-3	4.6
Year 3-4	4.5
Year 4-5	4.0
Year 5-6	3.7