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Subject: Health Canada's Comments Human Health Risk Assessment of Consumption of Country Foods for the Meadowbank Gold Project

Dear Ms Briscoe and Mr Lim,

Please find below Health Canada's comments on the Human Health Risk Assessment of Consumption of Country Foods for the Meadowbank Gold Project, received by Health Canada on March 6, 2006.

Overall Comments

With respect to the potential contamination of country foods, Health Canada recommends that the proposed monitoring program include monitoring the levels of contaminants of potential concern in country foods. Specifically, we would recommend that baseline concentrations of the COPCs in the country foods be determined, and then concentrations be monitored throughout development, operation, and post-development of the project. In particular, such a monitoring program should include mercury levels in the muscle of fish species caught for consumption in the project area, since watershed changes are proposed. Without collecting baseline chemical data for country foods before the mine development is initiated, there would be no means against which to compare any future data that are collected and to validate the predictions from the above-mentioned document.

Section-specific Comments

The SLRA evaluated the risks under baseline conditions posed to young children (1-4 years; 14.4kg) and adults (53.8kg) from the potential intake of 18 metals (the identified Chemicals of Potential Concern, COPCs) by consumption of country foods from the proposed project area.

The foods for which risks were assessed are caribou muscle, caribou organs (kidney and liver), Canada goose muscle and lake trout muscle. Concentrations of the COPCs in caribou and goose tissues were estimated using modeling. It appears that mercury concentration was estimated in lake trout muscle by using a size-adjusted value derived from analytical data from the project lakes, and all other COPC concentrations were mean concentrations recently reported for lake trout in Third Portage Lake and Wally Lake. Consumption rates were estimated using Richardson (1997)[1], Oral Testimony, and professional judgement, with three consumption scenarios (heavy, moderate and low) evaluated.

The SLRA concluded that, under baseline conditions, the risks associated with most country foods are likely acceptable, and that marginally unacceptable risk is posed by heavy consumption of lake trout by young children (p48)[2]. The SLRA also stated the following: "The mine is not expected to result in appreciable increases in concentrations of metals in the receiving environment. Consequently, the risks that persons may receive from consumption of country foods should also not appreciably increase post-development."

The expertise and competencies of Health Canada lie in the conduct of human health risk assessments of contaminants in food when empirical data are provided by the proponent or stakeholder. Accordingly, the comments included herein do not address data collection or derivation methodologies, including the suitability of models that are used to predict chemical concentrations in food or environmental media. We have assumed that the baseline information employed is accurate and pertinent to the subject site. The comments below are based on the assumption that the following information provided in the SLRA is valid:

- COPCs were identified accurately, such that the 18 metals listed on page 12 are the only COPCs that need to be included in a quantitative health risk assessment, and other chemicals that may be associated with project activities (e.g. polycyclic aromatic hydrocarbons, cyanide and its species) do not need to be considered.
- The baseline concentrations of COPCs used in the SLRA are accurate and pertinent to the subject site, and where surrogate data and/or modeling are employed to estimate concentrations the data are reasonable substitutes and the models are appropriate (Section 2.2.1 and Appendix A)
- The methods (i.e. modeling) used to predict the concentrations of COPCs in food yielded representative and accurate results for the baseline, operation, and post-development conditions related to the project.
- The country foods that were identified (caribou muscle, caribou liver and kidney, Canada goose muscle, and lake trout muscle) are the only food items that potentially may be contaminated by COPCs associated with mine-related activities and consumed by humans.
- Consumption rates represent the best estimates that can be made given current information.
- Unreferenced claims are accurate (e.g. lake trout is the fish species with the greatest potential for mercury accumulation, p7).
- Residents of other communities do not need to be considered as human receptors.

In general, the SLRA followed the guidelines presented in Chapter 8 of Volume 3 of Health Canada's *Canadian Handbook on Health Impact Assessment* (2005) for exposure estimation (section 2.2.2), non-cancer risk characterization (section 2.4), and estimation of the Recommended Maximum Weekly Intake (RMWI) (section 2.5). While Chapter 8 of the Handbook

[1] Richardson GM. 1997. Compendium of Canadian Human Exposure Factors for Risk Assessment.

[2] Unless otherwise indicated page/section references refer to the SLRA.

does not address estimation of cancer risk due to exposure to COPCs through consumption of country foods, the SLRA did so for inorganic arsenic using an Incremental Lifetime Cancer Risk (ILCR) calculation[3], and assumed that an ILCR less than 1×10^{-5} is an acceptable risk. Health Canada is currently reviewing the estimation of cancer risk due to inorganic arsenic and feels that, at this time, it was probably appropriate to include this calculation in the SLRA.

Health Canada is of the opinion that it is better to overestimate the health risks due to contaminants in food than to underestimate them, particularly when there is considerable uncertainty surrounding the parameters (e.g. concentrations of COPCs, consumption rates) used in the assessment, as is the case in the current SLRA. Consistent with this, the SLRA appeared to use a generally conservative approach with these parameters, as illustrated by the following examples:

- Caribou and Canada goose were chosen as the terrestrial and waterfowl food species of interest, since a review of the Oral Testimony and discussions with Project Team members led to the conclusion that these represent the mammalian and avian species most likely to be found near the mine site and most frequently consumed by area Inuit (p6).
- Lake trout were chosen as the fish food species of interest because (it is claimed) it accounts for 75% of the fish in all project lakes and has the most potential for mercury accumulation.
- It was assumed that fish will be eaten, even though it is expected that consumption of all fish species from the mine site will be low due to a no-fishing policy for workers at the future mine site.
- Children 1-4 years old, which comprise a sensitive population subgroup, were considered as potential human receptors. The SLRA employed the same body weight (14.4 kg) that Health Canada uses for this age group in its health risk assessments (there is a discrepancy, however, on page 8 of the SLRA with the age range associated with this body weight: 1 - 4 years is correct, not 7 months - 4 years).
  •Health risks were estimated for consumption of multiple country foods under baseline conditions, and not only for the individual foods. The heavy consumption scenario for meal frequency is higher than the highest consumption frequencies recorded for caribou muscle and caribou liver, based on 7-day food records for Kivalliq region communities (Kuhnlein et al., 2000).
- Concentrations of COPCs in caribou muscle and Canada goose muscle were estimated assuming that dose rates received by these species were due to 100% of their time spent at the site, which is unlikely for these migratory animals (pp13, 15).
- Toxicological reference values (TRVs) that were used (Section 2.3) were either equivalent to those that Health Canada would use or were more conservative (i.e. lower values), except in the cases of inorganic arsenic, copper, lead, and possibly chromium, which are discussed below. In particular, for both children and adults the SLRA used the TRV for mercury that is considered at this time by Health Canada to be protective of children and women of child-bearing age.
- In most cases, the RMWI of a food was calculated using the metal estimated to pose the greatest amount of risk (Section 2.5). This would give the lowest, and thus most protective, RMWI value.

[3] ILCR = estimated exposure (µg/kg bw/day) x potency factor $(\mu g/kg\ bw/day)^{-1}$, where the potency factor was 1.7 x 10-3 $(\mu g/kg\ bw/day)^{-1}$ (pp21,31)

While Health Canada agrees that the approach outlined above is reasonable for a screening level health risk assessment, we would nevertheless raise the following questions and provide these comments:

I. General comment

The Centre for Indigenous Peoples'Nutrition and Environment (CINE) published a document[4] that contains, in our opinion, valuable background information on country food consumption in northern Canadian communities, including communites from the Kivalliq region. We are wondering if Wilson Scientific Consulting is aware of this document.

II. Identification of Country Foods

We would question the exclusion of arctic char from the assessment. Kuhnlein et al. (2000) provided typical concentrations of arsenic, cadmium, lead and mercury that may be found in various animal tissues in northern Canada. While much higher levels of mercury are presented for lake trout flesh compared to flesh from arctic char, the opposite is true for arsenic (i.e. 753 ng/g fresh weight of arsenic in raw flesh of arctic char versus 100 ng/g in raw flesh of lake trout).

Furthermore, for Kivalliq communities 39% of the population was reported to consume trout meat at an average weekly frequency of consumption of 0.5 days per week. Char meat was reported to be consumed by 72% of the population, 0.7 days per week.

The SLRA identified caribou liver and kidney (caribou organs) and muscle, Canada goose muscle and lake trout muscle as the foods of interest. However, residents of Kivalliq communities do consume other tissues of these animals (Kuhnlein et al., 2000). Why was caribou heart identified as a potential food (Appendix A, p4) but was excluded from evaluation?

Health Canada considers that reasonable justification was provided for excluding waterfowl eggs and plants (specifically mentioned were huckleberries and blueberries) from the assessment. The SLRA (p7) cites the Traditional Knowledge Report as indicating that egg collection near the mine site does not apparently occur and states that collection of plants from the mine area is unlikely since suitable harvesting areas are available closer to Baker Lake.

III. Consumption rates

The SLRA states that revised values based on more specific consumption pattern information should be evaluated if the information becomes available (p9), and emphasizes (p10) "that the values provided . . . are based primarily on professional judgement and review of Oral Testimony rather than specfic dietary surveys of persons in the vicinity of the site."

Consumption information for persons 15 years and older from Kuhnlein et al. (2000) could be used in concert with review of the Oral Testimony to provide estimated consumption rates for which there is less uncertainty than those in the SLRA.

With respect to young children, Kuhnlein et al. (2000) does not provide data for persons younger than 15 years. Nevertheless, the "heavy" consumption scenario rates used in the SLRA for caribou organs (12 g/day), Canada goose muscle (37 g/day) and lake trout

[4] Kuhnlein HV, Receveur O, Chan HM, and Loring E. 2000 (August). Assessment of Dietary Benefit/Risk in Inuit Communities. Centre for Indigenous Peoples' Nutrition and Environment (CINE), Macdonald Campus of McGill University. ISBN# 0-7717-0558-1

muscle (12 g/day) appear to be too low by comparison to consumption rates of similar foods by the rest of the Canadian population. Specifically, for 1-4 year olds, the mean eaters-only consumption rate from the Nutrition Canada survey for hamburger beef is 58.9 g/day and for liver is 17.6 g/day. Lee (2004)[5] recommended that the mean eaters-only intake of commercial finfish be considered to be 10g/day for this age group, but for high-level consumers the eaters only mean intake should be considered to be 19.5 g/day.

IV. Estimation of metal concentrations in country foods under baseline conditions

As indicated above, Kuhnlein et al. (2000) provided typical concentrations of arsenic, cadmium, lead and mercury that may be found in various animal tissues in northern Canada. "Typical" values for lead and cadmium may be up to two orders of magnitude greater compared to the estimated tissue concentrations calculated in the SLRA. For example, the SLRA estimated the concentration of cadmium in caribou organs to be 0.017 mg/kg fresh weight (17 parts per billion, ppb; p15) whereas Kuhnlein et al. (2000) presented a typical level to be 1610 ng/g fresh weight (1610 ppb) for raw caribou liver and 1260 ng/g for cooked caribou kidney.

Because arsenic tends to be associated with gold-mining operations, in the absence of analytical data or conclusive evidence from the literature that supports the assumption used in the SLRA that 1% of total arsenic is present as inorganic arsenic in animal tissues, Health Canada likely would conservatively assume that all arsenic is present in the inorganic form. The SLRA cited Schoof et al. (1999)[6] to support the 1% assumption, but this paper also states: "Concentrations for inorganic arsenic reported in the present study were generally lower than those previously reported for seafood, meat and poultry, even though total arsenic concentrations were similar among studies (Schoof et al., 1999, p843)".

Using data from the Ontario Ministry of the Environment, Yost et al (1998) calculated that in pickerel 15% of arsenic is present in the inorganic form, and even greater percentages of inorganic arsenic exist in cured pork (144%), pastrami (99%) and chicken (41%). We are not suggesting that these calculated values are suitable surrogates to be used in the SLRA; rather, they underscore the need for baseline speciated analytical data on the actual concentrations of the 18 COPCs in caribou muscle, organs, Canada goose muscle and lake trout muscle. In our opinion, the validity of the 1% assumption for inorganic arsenic used in the SLRA needs to be further researched.

As indicated in Point 2, arsenic levels potentially could be much higher in arctic char compared to levels in lake trout, and therefore arctic char should be included in any investigation of concentrations of COPCs in animal tissues.

V. Human receptors

The body weight employed for adults in the SLRA was 53.8 kg, which is lower then the mean measured body weights reported in Kuhlein et al (2000) for males and females ages 15 and older in the Northern communities studied. The lower body weight used by

[5] Lee, E J. 2004, July 21. Fish consumption: review of current intake figures for Canadian consumers and further recommendations. Bureau of Chemical Safety, Food Directorate, Health Products and Food Branch, Health Canada (executive summary cited).

[6] Schoof RA, Yost LJ, Eickhoff J, Crecelius EA, Cragin DW, Meacher DM, Menzel DB. A market basket survey of inorganic arsenic in food. *Food and Chemical Toxicology* 37:839-846

the SLRA should result in a more conservative estimate of exposure for adult males and females past child-bearing age (i.e. the calculation for contaminant intake should yield a higher value). However, one of the chemicals of potential concern (COPC) identified in the SLRA is mercury. Mercury intake by children, pregnant women and women of childbearing age is of particular concern to Health Canada at this time. The Canadian Total Diet Study (CTDS)[7] body weights for females 12-19 and 20-39 years old, respectively, are 49.9 kg and 57.2 kg, and therefore the most conservative body weight to use for estimating health risks to pregnant women and women of childbearing age would be 49.9 kg.

VI. Toxicological Reference Values (TRVs).

The following TRVs should have been used: inorganic arsenic (1 rather than 2 µg/kg bw/day); copper (125 rather than 250 µg/kg bw/day); and lead (3.57 rather than 3.6 µg/kg bw/day, although this difference is negligible and is considered to be of no concern).

With respect to chromium, it is not clear that a TRV for drinking water is applicable to foods. We would require further information on the proportion of hexavalent to trivalent chromium in the country foods of interest to provide meaningful comments on an appropriate TRV for this metal.

VII. Estimation of Risk

We are somewhat concerned with the intepretation of risk estimates where the Hazard Quotient (HQ) was calculated to be 1.0 or greater, since an HQ = 1.0 effectively means the intake is estimated to be equal to the TRV. For example, the HQs were 1.2, 1.5 and 1.4 for young children exposed to manganese, nickel and thallium, respectively, through heavy consumption of caribou organs.[8] However, it was argued that the dose rates received by caribou may not be accurate, and therefore the risk estimates due to consumption of caribou tissues could be overestimates.

While recognizing the value of the data from Gamberg (2006)[9] that indicate lower concentrations in moose organ tissue than estimated for caribou organs in the SLRA, we would point out that this situation highlights the need for baseline analytical data on the concentrations of COPCs in the country foods of interest, particularly where calculations based on the modeling exercise indicated potential risk to young children and we have already indicated that the heavy consumption rates assumed for young children consuming caribou organs, Canada goose muscle and lake trout muscle are too low (Point 3).

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[7] Dabeka RW, McKenzie AD. 1995. Survey of lead, cadmium, fluoride, nickel, and cobalt in food composites and estimation of dietary intakes of these elements by Canadians in 1986-1988. *Journal of AOAC International* 78(4):897-909. Body weights are from Dr. Bob Dabeka of the Food Research Division.

[8] As indicated on p35 of the SLRA. However, the applicable table from Appendix B (Table B-4) indicates an HQ 1.0 or greater only for manganese and nickel. The HQ for thallium is here given as 3.66E-01 (~0.4).

[9] Gamberg. 2006 (2005 indicated in SLRA references). Contaminants in Yukon Moose and Caribou – 2004. Yukon Contaminants Committee and Department of Indian and Northern Affairs Northern Contaminants Program. Whitehorse, Yukon.

A "marginally unacceptable" risk (HQ = 1.2) was estimated for young children exposed to methyl mercury through heavy consumption of lake trout under baseline conditions. In our opinion, this is of concern for at least three reasons: First, the methyl mercury concentration in lake trout muscle was derived from analytical data (pp 17,18) and is likely to be more accurate than a value based on modeling; second, the heavy consumption rate of lake trout muscle assumed for young children is, in our opinion, too low, and therefore actual intake of mercury might be greater; and third, watershed changes are proposed for the project area which potentially could increase methyl mercury concentrations in fish. [10]

The above issues are seen again in the estimation of risk due to consumption of multiple country foods (Section 3.5).

In summary, we agree with the general sentiment of the SLRA that monitoring of the COPCs is required. Specifically, we would recommend that baseline concentrations of the COPCs in the country foods be determined, and then concentrations be monitored throughout development, operation, and post-development of the project. In particular, such a monitoring program should include mercury levels in the muscle of fish species caught for consumption in the project area, since watershed changes are proposed. Without collecting baseline chemical data for country foods before the mine development is initiated, there would be no means against which to compare any future data that are collected and to validate the following predictions from page 48 of the SLRA: "The mine is not expected to result in appreciable increases in concentrations of metals in the receiving environment. Consequently, the risks that persons may receive from consumption of country foods should also not appreciably increase post-development"

Thank you for the opportunity to participate in the environmental assessment process for this project. Should you have any further questions or comments, please feel free to contact Margaux Brisco at (613) 946-3543 or by email at Margaux_Brisco@hc-sc.gc.ca

Yours sincerely,

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[10] On page 135 of the Environmental Impact Statement, Item #7, Section 4.21.2.1, "Project Components", rewatering and flooding is discussed with regard to affected portions of Third Portage Lake and Vault and Phaser Lakes.