Information Note
Department of Municipal Affairs and Environment

Title: Potential Health Effects of Methylmercury from Muskrat Falls

Issue: Newly constructed reservoirs can increase methylmercury (MeHg) in the food chain and expose the human population to increased levels in their diet. Extensive scientific study has been done on many aspects of this topic, yet there is considerable disagreement among scientists as to the severity of the effect of Muskrat Falls on human exposure. This note has been requested to explain what we now know about MeHg exposure and to weigh this knowledge in light of possible mitigation options.

Background and Current Status:

- MeHg is formed in water by methylating bacteria. Newly formed reservoirs provide bacteria with the necessary raw materials, including food in the form of organic matter. MeHg is built up through the food chain by bio-accumulation and bio-magnification. Human exposure to MeHg depends upon how much MeHg there is in the various foods and how much such food constitutes the person's diet.
- Human exposure to MeHg can be determined from hair samples or blood samples. If exposure is reduced, MeHg will slowly be expelled from the body.
- At relatively low levels, the main MeHg health effect is to interfere with neurological development of infants and children. Accordingly, Health Canada has developed MeHg guidance values for the general population and stricter values for children and women of childbearing age. See Annex A. Based on this, Health Canada's provisional total daily intake (pTDI) of MeHg is 0.2 µg/kg of body weight for children and females of child bearing age and 0.47 µg/kg BW for adults assuming lifetime consumption.
- Two human bio-monitoring studies were carried out in the region, one by Calder et al. (for Harvard) the other by Golder & Associates (for Nalcor). Both performed extensive hair sampling for MeHg. Although the subject base differed, they came to similar conclusions. In Golder all 293 participants were below the respective Health Canada guidance values. In Calder, out of 474 participants, one female was slightly above the normal acceptable range and one male was also slightly above the normal acceptable range for adult males, ie increasing risk. No one was even near the "at risk" level.
- In Calder et al, communities were assessed as sub-groups. It was found the participants in Rigolet had higher MeHg levels than other people in the region.
- Overall, the average or median values were very close to Canadian average or median values. This is very good news because typically, other Canadian northern populations such as aboriginal people in Nunavut, Northern Quebec (Nunavik Inuit) and first nations communities in general have significantly higher MeHg levels than Canadians as a whole. See Annex B for more detailed comparisons.
- In order to minimize exposure to MeHg, Health Canada set a maximum MeHg content in retail fish (other than tuna) at 0.5 µg/g. Seal meat at Rigolet had average MeHg content of about 0.13 µg/g. In Nunavik, beluga muscle and liver as well as seal meat were >1 µg/g or in the order of ten times greater than at the Muskrat Falls project area. However, seal liver from seals caught in Lake Melville was very high at 13.42 µg/g.

- The objective of MeHg modelling by Calder et al has been to relate estimated increased MeHg production at the Muskrat Fall reservoir to increased MeHg in country foods and based on a typical food basket, to increased exposures in the area population. Furthermore, the same model was used in the IEAC process to test the effectiveness of mitigation scenarios such as soil removal and wetland capping.

Analysis

- Calder et al concluded that MeHg levels in the surface waters of Lake Melville would increase by an average factor of about 2.5 times. This would push up the MeHg concentration in country foods such that MeHg would increase from about 70% to about 89%.in a typical diet. This would not have much impact for most area residents but for some individuals, especially in Rigolet (95% percentile), MeHg exposure could exceed the Health Canada guidance values for the pTDI.
- Mitigation scenarios were quantified using the same Calder model. Soil removal would only reduce the MeHg exposure to the above small sub-group by 25%. If alternative input parameters were considered, the effectiveness could be as little as 6% reduction. For the wetland capping mitigation the effect is much smaller still, less than 2%.
- Subsequent to the IEAC work, independent consultants for Nalcor have concluded that Calder's estimates for MeHg production are too high, that the impact of country foods was overestimated based on the actual presence and consumption patterns of potentially affected species and that other factors that made Calder's model appear to overstate the issue. 4 of the 6 western scientists did not recommend soil removal.
- Surface water monitoring results in the Churchill River and in Lake Melville shows very little impact from the initial 25% flooding that has already taken place.
- A comprehensive soil flux experiment did not demonstrate any benefit for removing soil (in fact it showed the opposite). Concerns related to the unknown effect on MeHg of digging up massive amounts of soil were not even considered by the Calder model. The Innu Nation is opposed to the idea of soil removal, citing possible greater environmental impacts from carrying out such work on their lands
- A comprehensive community based monitoring program combined with care health management through dietary advice will be completely effective in protecting the health of the local population. Should there be significant adverse impacts on country food, government has already committed to providing compensation but further guarantees could be provided in the form of an impact security fund.

Action Being Taken:

- Before taking a final decision, further consultation with leaders of the three Indigenous groups is required.

Prepared/Approved by: M. Goebel / J. Chippett, DM (pending)

Ministerial Approval: Received from Hon. Andrew Parsons (pending)

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Annex A
Canadian Methylmercury Guidance Values and Recommended Actions

Group and age	Blood value µg/L	Corresponding hair value, µg/g		Recommended action
Pregnant Women Females, birth - 49 Males ≤ 18	**< 8**	**< 2**	a	**No follow-up required**
Pregnant Women Females, birth - 49 Males ≤ 18	**8 - 40**	**2 - 10**	a	**Repeat hair/blood test in 6 months provide dietary advice**
Pregnant Women Females, birth - 49 Males ≤ 18	**> 40**	**> 10**	a	**Repeat hair/blood test immediately Schedule appointment with public health official**
Females > 50 Males > 18	**< 20**	**< 6**	b	**No follow-up required**
Females > 50 Males > 18	**20 - 100**	**6 - 30**	b	**Repeat hair/blood test in 6 months provide dietary advice**
Females and males at any age	**> 100**	**> 30**	b	**Repeat hair/blood test immediately Schedule appointment with health official Refer to physician or medical toxicologist**

a) harmonized provisional interim MeHg blood guidance value proposed by Legrand et al (2010); hair:blood ratio of 250:1
b) Proposed by Health Canada (1999); based on hair:blood ratio of 300:1

normal acceptable range
increasing risk
at risk

note: Health Canada's pTDI of 0.2 µg/kg BW is based on 10 µg/g (hair) for children and females of child bearing age and 0.47 µg/kg BW for other adults. (lifetime consumption is assumed).

Annex B – Selected Methylmercury Biomonitoring Results

Canadian Health Measures Survey (2007-09)

Overall population ages 6 to 79 ..... 0.69 µg/L mean blood concentration (0.17 µg/g hair)
Highest group - men ages 40-59 ..... 1.04 µg/L mean blood concentration (0.26 µg/g hair)
95th percentile, overall male population ..... 5.13 µg/L mean blood concentration (1.28 µg/g hair)
95th percentile, overall female population ..... 4.45 µg/L mean blood concentration (1.11 µg/g hair)

Inuit, Dene/Métis, Non-Aboriginal NWT 1994-99

Inuit mothers ..... 3.51 µg/L mean blood concentration (0.88 µg/g hair)
Dene / Métis mothers ..... 1.35 µg/L mean blood concentration (0.35 µg/g hair)
Non-Aboriginal ..... 0.87 µg/L mean blood concentration (0.22 µg/g hair)

Nunavut 1997

Pregnant Inuit women ..... 6.72 µg/L mean blood concentration (1.68 µg/g hair)
2005-07 follow-up, pregnant Inuit Women ..... 4.0 µg/L mean blood concentration (1.00 µg/g hair)

Northern Quebec Nunavik Region Health Survey 2004

Inuit men on 14 coastal regions ..... 9.18 µg/L mean blood concentration (2.30 µg/g hair)
Inuit women on 14 coastal regions ..... 11.5 µg/L mean blood concentration (2.88 µg/g hair)
(the overall mean was a 32% decrease from values reported in 1992 after women were advised to limit consumption of beluga whale meat, which was the main source of MeHg))

British Columbia First Nations 2008-09

Overall male population ..... 1.52 µg/L mean blood concentration (0.38 µg/g hair)
Overall female population ..... 1.39 µg/L mean blood concentration (0.35 µg/g hair)

Anglers and Sport Fish Consumers, Ontario 1992-93
Sport fish non-eaters ..... 1.5 µg/L mean blood concentration (0.38 µg/g hair)
Sport fish eaters ..... 2.2 µg/L mean blood concentration (0.55 µg/g hair)

Bermuda, King Edward VII Memorial Hospital 2003

Female chord blood at birth ..... 8.28 µg/L (arith) mean blood concentration (2.07 µg/g hair)
Follow up study after diet advice program ..... 0.84 µg/L mean blood concentration (0.22 µg/g hair)

Faroe Islands, 5 studies 1980-2009

Maternal umbilical chord samples (1986-7) ..... 22.9 µg/L, 4.5 µg/g hair
Follow up 2007-09 studies after broad communications indicating that pilot whale meat was no longer safe to eat ..... 3.01 µg/L, 0.70 µg/g hair

Golder Muskrat Falls area 2015

All Participants (n=293) ..... No blood sample data, 0.0931 µg/g hair

Calder et al. Muskrat Falls area 2016

All Participants (n=474) ..... No summary statistics available due to lack of the raw data. Approx. 0.5 µg/g hair based on plot of data provided by Calder. In that plot, data for individuals from Rigolet shows the highest average concentration in hair samples while children appear to have a lower average than the Canadian median

Notes: Data interpreted from various sources. In general blood MeHg concentrations that were reported were converted to hair concentration equivalent by using the Legrand hair:blood ratio of 250:1 and are shown in brackets.

In general, means were calculated as geometric means unless otherwise indicated.

References:

Environment and Climate Change Canada, Canadian Mercury Science Assessment Report, 2016

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