Date : 9/7/2016 8:58:04 AM
From : "Carter, Paul A."
To : "'Wayne Thistle'"
Cc : "Jane Kirk"
Subject : ECCC Comments pdf converted: Draft Workshop Report - Methylmercury Mitigation & Muskrat Falls (Aug 4, 2016 in Goose Bay)
Attachment : Jane Kirk (ECCC) Workshop Comments.pdf;

Hi Wayne
Attached is a pdf version.

Paul
Tel. 709-729-0188

From: Wayne Thistle [mailto:wayne.thistle@[redacted]
Sent: Wednesday, September 07, 2016 8:41 AM
To: Carter, Paul A.
Subject: Re: ECCC Comments : Draft Workshop Report - Methylmercury Mitigation & Muskrat Falls (Aug 4, 2016 in Goose Bay)

Hi Paul

Still didn't get Jane's document

Wayne

On Wed, Sep 7, 2016 at 8:34 AM, Carter, Paul A. <pcarter@gov.nl.ca> wrote:
Hi Wayne,
See attached word document from Jane Kirk, ECCC.

Paul
Tel. 709-729-0188

From: Kirk, Jane (EC) [mailto:jane.kirk@canada.ca]
Sent: Tuesday, September 06, 2016 5:10 PM
To: wayne.thistle@[redacted]
Cc: Carter, Paul A.
Subject: RE: Draft Workshop Report - Methylmercury Mitigation & Muskrat Falls (Aug 4, 2016 in Goose Bay)

Hi there,
I have reviewed the notes and made several major comments. I was a bit surprised about the organizational structure that was chosen and the topics in the table of contents. These don't reflect the agenda or the flow of the meeting in my mind and one presentation is recorded slide by slide in the notes while the others are not. For example, it is not clear where Dr. Sunderland's presentation begins and ends. Also, there is no differentiation in the notes among information that was presented as synthesized, published science and when the group was brainstorming/discussing a new idea, such as the engineering of full clearing. I also think a list of definitions and abbreviations at the beginning would be helpful.
See my detailed comments attached.
Thanks, Jane

From: Carter, Paul A. [mailto:pcarter@gov.nl.ca]
Sent: August 31, 2016 10:52 AM
To: Carter, Paul A.
Cc: Wayne Thistle
Subject: Draft Workshop Report - Methylmercury Mitigation & Muskrat Falls (Aug 4, 2016 in Goose Bay)

Date Wednesday August 31, 2016

To All Workshop Participants,

Re: Review of Draft (August 30, 2016) Workshop Report by Wayne Thistle
Methylmercury Mitigation and Muskrat Falls: A Discussion of Practical Solutions

Attached is a draft report of the workshop (Methylmercury Mitigation and Muskrat Falls: A Discussion of Practical Solutions) held on August 4, 2016 in Happy Valley-Goose Bay, Labrador. The facilitator, Mr. Wayne Thistle (Centre for Innovative Dispute Resolution, email address wayne.thistle@[redacted] is asking you to review the draft and send any comments to him by Friday September 16, 2016. Please cc me on any comments you have.

If you have any questions, please contact the undersigned at (709)729-0188 or Mr. Martin Goebel, ADM-Environment Branch at (709)729-

2862.

Regards,

Paul Carter

Environmental Scientist

Environmental Assessment Division

Department of Environment and Climate Change

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--

Wayne Thistle Q.C., C.Arb., C.Med.
Principal
Innovative Dispute Resolution Inc.

DRAFT – AUGUST 30, 2016

Methylmercury Mitigation and Muskrat Falls: A Discussion of Practical Solutions

Scientific Workshop

Happy Valley-Goose Bay

August 4, 2016

Facilitated by:

Wayne Thistle, Q.C., C. Arb., C. Med.

Centre for Innovative Dispute Resolution

Prepared for:

Department of Environment and Climate Change

Hon. Perry Trimper, Minister

Report Dated: September xx, 2016

EXECUTIVE SUMMARY

A Scientific Workshop "Methylmercury Mitigation and Muskrat Falls: A Discussion of Practical Solutions" was organized by the Department of Environment and Conservation (ENVC) and held on August 4, 2016 at Hotel North Two in Happy Valley-Goose Bay beginning at 8:30 am.

The Workshop brought together as participants, technical experts, Aboriginal groups, government and Nalcor representatives, academic researchers and there were a number of observers. The purpose was to convey perspectives and provide for open dialogue and an opportunity for questions and discussion on the topic of methylmercury measures regarding the Muskrat Falls project. There was a total of 26 participants attending in person and 5 by teleconference. A total of 20 observers were present.

Comment [JK1]: grammar

The attached Report is not intended as a verbatim record of all the discussion but rather encapsulates the main messages and themes and has been categorized under various headings. It was also not intended, in all cases, to identify the individuals (or who they represented) who offered the various commentary.

There was a detailed analysis of the science involving methylmercury, how it is created and propagated. There were three slide presentations providing significant information relevant to the main theme of the Workshop, viz. how to mitigate the adverse consequences when methylmercury is produced as a result of flooding a reservoir? Mitigation measures, both pre-flooding and post-flooding were explored with a variety of opinions and positions being presented. There was also considerable dialogue about the need for monitoring and how consumption advisories should be developed and promulgated. The Aboriginal groups expressed, in very strong terms the need to take all reasonable measures to remove the timber, vegetation and soil from the

Comment [JK2]: ?

reservoir before flooding since the science has established that this is the most effective measure to reduce the amount of methylmercury when flooding of the reservoir occurs.

The issue of soil removal was explored in a very detailed fashion and it was acknowledged that this is an area deserving of a further feasibility study. There are many factors to consider if such an undertaking is to be implemented and it is recognized that there are constraints such as terrain and safety involved in such a project.

Dietary studies were explored since, with the increase in methylmercury in Lake Melville it was acknowledged that the diet of aboriginal groups and other residents of the area would be significantly impacted when consumptions advisories warn of dangers to human health associated with the consumption of certain country food.

The Workshop concluded with a thorough discussion of possible follow-up action using both science and indigenous knowledge to develop reasonable and feasible approaches to reduce, to the extent possible the negative impact of the growth of methylmercury. The idea of convening an Expert Science Table met with wide-spread consensus.

Comment [JK3]: Suggest list of abbreviations and definitions including HC, NG, methylmercury, partial clearing, full clearing, etc. at the beginning

TABLE OF CONTENTS

Comment [JK4]: How were these decided as different items to be placed in the table of contents? Are they different discussions that were had? I don't recall a particular discussion on "what is methylmercury, how is it formed and related issues?" although this background was provided in some of the presentations also, where is Dr. Sunderland's talk? Why is it not a topic in the table of contents? Experts were given a chance to remark after the presentations were done – why is there no record of comments made by the various experts?

1. **Background to the Scientific Workshop Held on August 4, 2016**

On June 30, 2016, Premier Ball wrote the Innu Nation, the Nunatsiavut Government and the NunatuKavut Community Council referring to the rally he attended in Happy Valley-Goose Bay on June 27, 2016 and acknowledging that the concern of those in attendance was evident. He further stated:

> People's health is of utmost importance and concerns with respect to the potential effects of methylmercury on people's health must be taken seriously while also considering the ecology of the reservoir.
>
> I understand there are varying positions on how to address those concerns. Minister Trimper offered to reconvene the scientific experts from the March 2016 workshop and asked the Nunatsiavut Government to come to the table. I fully support this approach to reassess the issues related to methylmercury, specifically from a mitigation perspective.
>
> Not only will we reconvene the experts from the March workshop, but we will expand the table, inviting the participation of additional provincial and federal government agencies, such as Environment and Climate Change Canada.

2. **Goal of the August 4, 2016 Workshop**

In a letter dated July 29, 2016, Martin Goebel, Assistant Deputy Minister (Environment) stated the goal of the Workshop as follows:

> As a meeting of technical experts, Aboriginal groups and their observers, the goal of this workshop is to

convey perspectives, encourage open dialogue and provide an opportunity for questions and discussion on the topic of methylmercury mitigation measures regarding the Muskrat Falls project. The Department of Environment and Conservation looks forward to this opportunity to hear positions and intends to use the information gained from the workshop to prepare a report on the outcomes and findings by the independent facilitator, Mr. Wayne Thistle (Centre for Innovative Dispute Resolution).

3. The Four Requests of the Nunatsiavut Government

In a letter dated November 9, 2015 from Minister Shiwak to Collen Janes, Deputy Minister of ENVC the Minister had requested that the Government of Newfoundland and Labrador direct Nalcor Energy to:

1. Fully clear the future Muskrat Falls reservoir area of wood, brush and vegetation before flooding to reduce Methylmercury inputs downstream into Inuit territory, consistent with recommendation 4.5 of the Joint Review Panel.
2. Negotiate an Impact Management Agreement with the Nunatsiavut Government before Muskrat Falls flooding and subsequent damaging downstream impacts occur, consistent with recommendation 13.9 of the Joint Review Panel.
3. Establish an independent Expert Advisory Committee of recognized academic experts to advise on the design of and audit, a rigourous, credible and predictive monitoring program for downstream impacts of Muskrat Falls on the environment and health, using the best available scientific and Inuit knowledge.

4. Grant Inuit joint decision making authority over downstream environmental monitoring and management of the Lower Churchill project.

4. Presentation by Department of Environment and Conservation ("ENVC") – Overview of the Environmental Assessment ("EA") Process for the Muskrat Falls Project ("the Project") and the evidence that informed the Government of Newfoundland and Labrador's ("GNL") June Decision

Comment [JK5]: Why did the note taker go slide by slide for only this presentation and not the other powerpoint presentations?

- Slide:
  - The Project was registered on 01 December 2006;
  - Numerous agencies were appointed to the assessment committee;
  - The Joint Review Panel ("JRP")was formed on 08 January 2009;
  - Public hearings were held in 2011;
  - The JRP Report was issued in August 2011 with 83 recommendations
  - #4.5: full clearing of the reservoir;
  - #6.7: assessment of downstream effects;
  - #13.9: possible requirement of consumption advisories;

- Slide:
  - The Federal Government and GNL responded on 15 March 2012;
  - On #4.5, GNL agreed with the principle, but with limited opportunity for use of the timber, supported partial clearing;
  - #6.7 was directed at DFO;
  - On #13.9, GNL accepted the intent, and required Nalcor, if consumption advisories were required, to consult on mitigation and compensation measures;

- Slide:
o The Project was released on 15 March 2012, subject to a variety of conditions, such as an Environmental Protection Plan ("EPP"), Environmental Effects Monitoring Plan ("EEMP"), and Human Health Risk Assessment Plan ("HHRAP").

- Slide: Human Health Risk Assessment Plan
o The HHRAP was submitted by Nalcor, to satisfy a condition of the Release Order;
o It includes monitoring plans for MeHg, country foods, and human health;
o Key components include a dietary survey.

- Slide:
o In June 2016, the HHRAP was approved, subject to the requirement that Nalcor consult local groups should monitoring indicate consumption advisories would be required.

- Slide: Analysis and Key Considerations
o A Scientific Workshop was held in March 2016.
o Findings noted that Harvard and Nalcor predicted similar results, but differed on how far downstream effects would be seen
o Removing all the topsoil creates its own problems
o The Harvard Study was highly credited
o The recent NG Report confirms that regardless of mitigation, monitoring is required to protect human health

- Slide:
o Health Canada determined the HHRAP was acceptable, and would monitor results;
o NL Department of Health and Community Services also determined the HHRAP was acceptable
o Key Considerations:

o CCME standard: 4ng/l, although it is notable that this is for aquatic life and is not necessarily reflective of the impacts of biomagnification or protective of higher trophic forms of life
o NG research predicts up to 0.06ng/l, less than 66 times the CCME standard

5. The Human Health Risk Assessment Plan (HHRAP)

- It was noted that Nalcor is doing more work on the HHRA and that regulators would consider that further information;
- Extra work on HHRA will also inform Nalcor's monitoring post-impoundment;
- GNL approved the HHRA Plan, not the HHRA itself;
- Regarding the HHRA Plan, its objective was to ensure there were no human health impacts. The question was asked until Nalcor's further work is completed, how can you Nalcor be allowed to flood;
- During the EA, the MeHg pathway to humans was considered; it is not dependant on the HHRA;
- It was pointed out that the project was approved as proposed, so the best thing to do is focus on post-flooding mitigations;
- The point was made that the HHRA will look at all information on balance and this can inform mitigation and the monitoring program. As new information becomes available, it will be incorporated;
- It was further noted that the downstream environment was not considered during the EA and as new information has come to light then GNL needs to reconsider the decisions that have been made;
- The extent to which MeHg would flow downstream was acknowledged in the EA and to the JRP as being uncertain; the DFP permit and the HHRA Plan acknowledges that uncertainty;

Comment [JK6]: Not clear what is meant

- The Shartup *et al* Study showed MeHg may go further than thought so Nalcor is making improvements to monitoring, including adding a third monitoring station.

6. What is Methylmercury (MeHg), how is it formed and related issues?

- It is inorganic Mercury (Hg) which is converted to Methylmercury (MeHg)
- It is a compound created by microorganisms which convert Hg into MeHg;
- MeHg is not a specified toxic substance under S. 36(3) of the *Fisheries Act* which discusses deleterious substances;
- The difference between inorganic Hg and MeHg is a significant factor on human health;
- Inorganic: low absorption (0.01 – 7% average);
- MeHg: high absorption (greater than 90%) primarily in the blood stream; half-life of 50-70 days; chelation not effective as a treatment;
- Elemental Hg is what is called quicksilver;
- Inorganic Hg has very different properties ;
- The river upstream of the dam will become a reservoir and land will be flooded. The newly flooded soil will release mercury into the water, some of which will be converted to MeHg for a number of years after the flooding. For a while, therefore fish will have more MeHg in their bodies;
- Methylation takes place in flooded soil and MeHg is then diffused through the water;
- Bacteria provide the means for the conversion of Hg to MeHg;
- MeHg bio–accumulates up the food chain in the flesh of organisms with the final consumers being humans;
- The question was asked as to whether production of MeHg in the estuary would increase and how much water column methylation will there be. There is uncertainty since the

Comment [JK7]: I don't recall this information being presented at the meeting

Dissolved Organic Carbon (DOC) may increase because of loading and because it is hard to quantify water-column methylation, it was not included in the Shartup *et al* Study;
- The estuary was treated as if methylation happens post-flooding exactly as it is happening now;
- What will be transported down the Churchill River is the Hg-rich surface waters;
- In terms of methylation in the reservoir, it was noted the Shartup *et al* Study projected the inflow of DOC could have impacts, but did not seem to consider that if there is already methylation occurring in the estuary, what is coming down the river may not have a great additive impact;
- The modelling in the Shartup *et al* Study also included demethylation but actual findings do not suggest much demethylation;
- The production in the estuary could be greater than imagined, thereby lessening the impact or importance of riverine input although there was not much demethylation seen;
- Riverine inputs are small – water-column methylation is definitely the biggest source of MeHg right now. After impoundment, it is not clear that will still be the case;
- There is enough Hg to fuel production; in the water column, methylation is consuming just a fraction of the Hg in the environment

Comment [JK8]: I don't believe this is a fair representation of what was presented or discussed.

Comment [JK9]: Again not a fair representation of what was presented or discussed. The note taker has misunderstood

Comment [JK10]: Same comment as above

7. Effect of MeHg on Human Health

- Shartup *et al* concluded the elevated methylmercury levels in the lake Melville food web will adversely impact human health. MeHg is a potent neurotoxin that can cause negative health effects through chronic exposure at very low levels and that Inuit who rely on Lake Melville for their source of essential county food will experience increased risk of methylmercury exposure following flooding of the reservoir;
- Consumed by humans, MeHg can cross the blood-brain barrier, leading to cardiovascular effects in adults (e.g. higher

Comment [JK11]: Again, why is Elsie Sunderland's presentation split up into these strange different topics and does not go slide by slide like the first presentation? The organization of the notes is very odd and does not capture the flow of the meeting.

risk of heart attack), and neurological and cognitive impairment among infants and children.
- MeHg crosses the brain/blood/placental interfaces;
- MeHg stays in the system for a couple of months;
- There is no known treatment for MeHg, other than limiting its further intake and waiting it out;
- When people talk mitigation, they talk risks to the project – they should be talking risks to human health;
- The Workshop must concern itself with human health impacts – how do we mitigate the risks to our health? The project is secondary,

8. The Canadian Council of Ministers of the Environment(CCME) Standard for MeHg

- The CCME standard is 4 ng/~~l~~ L but it was noted this is for aquatic life and is not necessarily reflective of the impacts of biomagnification or protective of higher tropic forms of life;
- The CCME standard is not protective of human health;
- NG research predicts up to 0.06 ng/l, less than 66 times the CCME standard;
- The US standard for maximum exposure to MeHg is 1 ug/~~l~~ L (= 1ppm). Health Canada level is 2ppm; These numbers are for daily intake whereas the data shows baseline levels, not daily intake;
- Health Canada's 2ppm is for children and women of child bearing age. For the general population, it is 4.7ppm;
- Currently, there are 43 individuals above the Health Canada 2ppm standard, almost all in Rigolet;
- It was questioned why the US EPA is half of the Health Canada standard;
- Using the EPA guidelines, 150 individuals are already in excess of the 1ppm standard;

Comment [JK12]: This is an incorrect unit I believe we discussed in terms of ug/kg/day intake levels.

- US EPA guidelines are predicated at the level necessary for neurotoxicity; lesser levels can still have health impairments, such as cardiovascular impairments;
- The guidelines also do not consider lower level neurological impairments, such as ADD;
- EPA itself notes 1ppm is out of date and should be lower and yet Health Canada is double that.

Comment [JK13]: This is not related to CCME guidelines and thus should not be under that subheading

9. **Country Foods and MeHg**

- The Shartup *et al* Study conducted dietary surveys by sampling people from the Lake Melville area to establish baseline levels;
- Approximately 70–% of current MeHg exposure is from locally caught foods;
- Several methods were used to determine MeHg source for fish, such as examination of stable mercury isotopes~~ic testing~~;
- The Study established baseline biomagnification data to determine MeHg change in country foods due to flooding;
- It used measured factors to project biomagnification from baseline data;
- There is a lot of variability in terms of when peak in fish happens and how long before levels return to base line levels;
- There is likely to be a lot of variability in the Lake Melville context but peaks are estimated 15 years post-flooding;
- The Study assumes freshwater species move throughout the lake system;
- Salmon can bioaccumulate as they move out to sea as part of normal seasonal migration;
- Levels in fish are about what researchers were expecting when seeking to establish baseline data;
- The Study only sampled portions of fish/animals that people reported eating from locations where they were reported to be harvested;

Comment [JK14]: Doesn't make sense

- DFO data shows high levels in trout, low in landlocked salmon – almost the inverse of the Study;
- With respect to uncertainty in the results, it was noted the Shartup *et al* Study is as certain as possible; It assessed people's diet in comparison with an assessment of the physical environment and it was felt this is as close as can be achieved via measurements and the Study has produced a lot of baseline data;
- The communities which are impacted are HVGB, Northwest River and Rigolet. Levels in Rigolet are higher than in HVGB or NWR because Rigolet residents eat more country food;
- Dietary survey sampled 1,566 people; Rigolet: 87% response rate, HVGB: 32%, North West River: 44%. These response rates are much higher than Nalcor's (0%, 2%, 10%).
- Levels are higher in older versus younger age groups; also, higher for men than women;
- Comparisons have not been made with other Inuit populations but it is likely the further north you go, the greater the baseline levels;
- Numerous NG employees worked in communities to talk about diet and collect hair samples;
- Right now exposures are not that high but the base line data was collected to propagate future levels based on the projected MeHg increase;
- The current median is below any regulatory standard;

- Slides from the presentation by Dr. Elsie Sunderland:

. Slide:
o Country foods = 67% of MeHg intake (33% store-bought)
o Considered 90 different food items
o Propagate forward to show changes after flooding

• Slide: MeHg change due to flooding
o Distinguished between landlocked and Atlantic salmon

Comment [JK15]: Not the Shartup… the new information on human health is presented in the "Lake Melville: Avativut Kanuittailinnivut (Our Environment, Our Health) Scientific Report".

- Slide: Highly exposed individuals disproportionately impacted
  - Based on the literature, cardiovascular and IQ impacts heightened for those most at risk.

- Slide: Projected % above 2ppm standard
  - HVGB: 10% (high scenario), 5% (medium), 1% (low)
  - NWR: 25%, 7%, 2%
  - Rigolet: higher than HVGB or NWR.
- Slide: Using 1ppm standard
  - HVGB: 25% (high scenario)
  - NWR: 50% (high)
  - Rigolet: 64% (high)

- Slide: Total # of people above the guidelines:
  - Health Canada Standard: 26 (low scenario); 104 (medium); 618 (high)
  - EPA Standard: 40; 252; 1,027

- Slide: Acute Toxicity Possible
  - Intake/day / Low Scenario / Medium / High

1-3ppm	14	19	249
3-5	0	0	17
5+	0	0	16

- Slide: Given what they eat now, a lot of people are at risk

- Slide: Comparison of HHRAs
  - Harvard: > 1,000 participants, all Inuit or family member
  - Nalcor: 293 participants, 196 of whom were Aboriginal
  - Harvard: conducted over 3 seasons
  - Nalcor: Winter only
  - Harvard: concludes reservoir clearing will reduce Inuit exposure by 2/3rds

o Nalcor: no conclusions can be made about Inuit-specific future exposure or those most vulnerable

- Nalcor's study did not capture the diversity of the diet of respondent's that was captured by the Harvard study so unless Nalcor projects forward, it will not see potentially dangerous exposures;
- It was noted that Nalcor is doing more work on the HHRA and that regulators would consider that further information;
- Extra work on HHRA will also inform Nalcor's monitoring post-impoundment;
- GNL approved the HHRA Plan, not the HHRA itself;

Comment [JK16]: Typos/grammar errors – not sure what is meant

10.Further information from the Shartup *et al* Study:

- There was general consensus that the Study is based on sound research and sound methodologies;
- There is general acceptance that there will be increases in MeHg as a result of reservoir flooding;
- There are data and predictions in reaching that conclusion;
- The Projected increases in reservoir MeHg:
  - Baseline
  - Low: 3x to ~~O~~o.~~O67~~ o67 ng/~~l~~ L (13%)
  - Medium: 10x to 0.2 ng/~~l~~ L (80%)
  - High: 15x to 0.3 ng/~~l~~ L (380%)

(It was noted the increases in MeHg production predicted by the Study were not unlike the levels predicted by Nalcor)

- Lake Melville is highly stratified, with high salinity on the bottom and a freshwater layer on top with very little mixing;
- The model shows high input of Hg and Dissolved Organic Carbon (DOC) to the Lake Melville estuary, a high level of methylation at the salt/freshwaters interface ("marine snow")
- There are higher Hg levels in the freshwater layer;
- The signal will be stronger in the reservoir and carry down into the Lake;

- The entire freshwater layer will be impacted, maybe higher near Goose Bay, lower near Rigolet;
- The projections are for the surface layer annual average especially because there is so little mixing in the estuary;
- Fish are not likely to stay just near Goose Bay so it is probably fair to say there may be differences in their exposure throughout the Lake system;
- The time frame in which the increases are likely to be seen would probably be within a few weeks of flooding with the peak being in the first 1-3 years. The pulse in fish will last 10-30 years;

(It was noted these estimates are consistent with DFO evidence)

- Creating extra tropic levels leads to more biomagnification;
- Plankton are opportunistic feeders.

11. Water Monitoring Presentation by Renee Patterson:

- Testing is done for MeHg but biota is not sampled;
- Testing is done for Hg, and water quality;
- There are 3 methods of monitoring on the Churchill River and in Lake Melville: Real Time Water Quality Monitoring; Real Time Water Quantity Monitoring; and, Ambient (grab sampling);
- There are 5 monitoring stations between Muskrat Falls and Lake Melville;
- Hourly data is taken during ice-free months, on water temperature, pH, specific conductivity, dissolved O2, and turbidity, providing a fingerprint of water quality;
- Data is available on ENVC's website within 2 hours;
- There are some limitations, including that only certain parameters are monitored; hence, monitoring is supplemented with grab samples;
- 4-5 grab samples are collected at each station during the annual ice-free months and assessed for total Hg;
- Grab samples have been done annually since 2009-10, when stations were installed;

- Under NL-federal agreement, selected grab samples are also done at sites on various tributaries to the Churchill River;
- This data also allows ENVC to establish baseline info so as to monitor post-impoundment changes and impacts.

12. Pre-flooding Mitigation Measures:

(a) Full clearing versus partial clearing of timber:

-Concerns were expressed around the ability to fully clear timber, reiterating that "full clearing" would amount to clearing 85% of the timber, given that 15% is inaccessible due to the steep slope of the reservoir banks, equipment and engineering issues and safety issues

- There is equipment available that could do the full clearing of timber but it was argued that while not all organics could be removed, Nalcor must do better than 75%;
- Full vs. partial clearing would result in only a 10% difference in the amount of timber cleared;
- Full versus partial clearing of timber is not effective because ultimately only timber and not the carbon-rich soil is being removed;
- A geotechnical assessment would be required before it could be determined whether the equipment could operate safely given the slope instability is some areas;
- There is no literature on "full" clearing;
- There is a tremendous amount of uncertainty and risks-;
- Including a mitigation measure such as full clearing is unprecedented and would require a massive undertaking and research;
- This would be one of the largest civil engineering jobs in the country if it included soil clearing;

Comment [JK17]: I believe "full" clearing was defined early in the discussions as removal of all timber and organic rich surface soil. Suggest a list of definitions at the beginning, including defining full and partial clearing. Other words that could be defined: methylmercury, bioaccumulation, biomagnificaiton

Comment [JK18]: Massive? wording

- Effectively, there is the same reduction in MeHg for either full clearing and partial clearing, when compared to no clearing;
- Even if you fully clear the reservoir, there will remain an influx of organics from upriver, from the sides of the reservoir. So after a year or two, there will be the same buildup of organic material as there was before;
- When a new reservoir is created, there is a big pulse from leaves, organic litter at the outset. The pulse is greater than you would normally get from just water running through organic materials;
- After a couple of years, the production of MeHg from organics in the reservoir would likely be the same as if you had never cleared but the pulse would be lessened;
- There seems to be uncertainty around the feasibility of full clearing and perhaps a feasibility study is required;
- There was a suggestion that maybe 3 - 5 people could look at full, including soil removal vs. partial clearing.

Comment [JK19]: This was not the consensus on these comments and I don't recall this comment being made. Perhaps an error in how the comment was recorded?

Comment [JK20]: there was not consensus on these points and there seem to be errors in how these comments were recorded. Also, this was a discussion where experts were thinking as they were talking during the meeting and thus it should be presented this way. I think that facts that were presented should be differentiated from brainstorming discussions.

(a) Soil clearing:

- There are environmental concerns such as sedimentation and erosion impacts with respect to the proposed removal of soil from the reservoir;
- The loss of fish habitat was also noted, given the reservoir would be effectively sterilized;
- The question was asked is there any peer-reviewed science which studied the impact of such sterility and it was suggested it seems speculative to say a reservoir denuded of soil would destroy habitat and create sterility;
- Further it was suggested that "sterility" may be the wrong word since there is an understanding that the

habitat would be re-established, though it would take some time for the river to re-establish soil and sediment;

- It ~~would~~ may take between 3 – 5 years to rehabilitate the habitat after full clearing;
- The reservoir is oligotrophic; plankton production is from the Smallwood Reservoir;
- Full clearing will affect fish that otherwise would feed on the plankton, so there would be dead and distressed fish;
- Humus soils are the largest reservoir for Hg;
- The amount of soil required to be removed would be 5M cubic metres which creates environmental problems on land such as where to dispose of that soil and how to prevent it from running back into the reservoir;
- On this issue, it was further noted, that much more than 5M cubic metres of soil would have to be removed to increase bowl stability;
- 5M cubic metres of soil would have to be deposited somewhere and there would be an unknown factor as to its potential to contribute to the production of MeHg;
- Blading off 20 cm of soil would be very difficult;
- The amount of soil that would be removed and deposited elsewhere was estimated to be one kilometre in diameter and 20 metres high;
- No reservoir has ever been scraped of soil, so there must remain a significant level of speculation;
- Carbon is concentrated in the upper few centimetres of soil;
- If you can reduce 10% of easily degraded carbon, the reduction in MeHg in fish is estimated at 10%,
- Using data respecting the volume of carbon content, based on a global date set, there is a clear indication

that there is a strong linear relationship between the amount of carbon available and the amount of MeHg produced;
- Soil can only be transported 3 km before it becomes a real challenge;
- Scientists would need to tell the engineers how far the soil had to be transported;
- Piles of soil could create fire risk;
- Is there potential for methylation within the piles?
- Would the use of heavy equipment to remove soil contribute to increased MeHg production?
- It was suggested that if you stripped vegetation and organics in soils you could prevent much of the MeHg. If the soil is removed, it would remove the potential for MeHg. However, it is probably not feasible to remove even half the soil so it is likely there would be some soil left in the reservoir to contribute to MeHg production;
- The NG estimated full clearing of timber as 1 % of total project cost. Stripping 15 cm of soil would cost $178 million. Stripping 20 cm would cost $230 million;
- An undertaking of soil clearing would almost certainly require a new EA.

(b) A Mesocosm Study
- The Shartup *et al* Study removed the top 1-2 cm of organics of the core samples in its experiments;
- Further experiments could be done comparing core samples with and without topsoil;
- The problem is that core samples are not always realistic – it may be a good idea to use a mesocosm;
- New core samples could be tested in a couple of weeks. A mesocosm would take a couple of months;
- A mesocosm study would use enclosures with different types of contents right in the reservoir itself;

- A mesocosm can be suboptimal because of organic growth on the walls of the enclosures;
- The set-up of the experiment may not be effective. As a result – the "enclosure effect;"

Comment [JK21]: Typo/comments not captured here. More appropriate to say "there may be an enclosure effect in mescosm studies." Also, this was a brain storming exercise where people were thinking through things as they talked – this type of discussion should be differentiated from when the actual scientific presentations were made and facts were presented

13. Why did GNL conclude that monitoring was necessary and what would be involved in monitoring?

- The answer given was that monitoring is the only way to prove or disprove predictions;
- To protect human health, monitoring is the only way to inform mitigation;
- The objective of monitoring is to determine the potential human health effects of downstream exposure to MeHg in fish and other country foods;
- The NG's scientific report and study concluded there is no safe threshold for MeHg and that monitoring was always required;
- The HHRAP submitted by Nalcor proposes to address conditions of the environmental release order, namely, environmental effects monitoring plans for:
  - MeHg
  - Fish and other country foods (e.g. seal, waterfowl)
  - Human health
- Key components in monitoring include a dietary survey and a human biomonitoring program (hair sampling).

14. Main Messages from Aboriginal Groups

- Inuit health and our way of life and food security for our children and grandchildren are all very important;
- Protecting that is the responsibility of the NG;
- How can you put a cost on culture, health?
- Full clearing is a priority for the Aboriginal groups;
- The NG's proposed mitigations are all pre-flood mitigation;
- Safety is important; the rest is secondary;

- Human health trumps all;
- The Innu position is that they want to discuss these issues further and consider the science to ensure impacts are minimized and there is effective mitigation and motoring;
- There seems to be a conclusion that mitigation measures will help human health. An advisory may lessen impacts on health but it does not lessen impacts on indigenous rights;
- Aboriginal groups want more than consultation; they want to negotiate an Impact Management Agreement;
- The JRP recommended that federal and provincial governments require a comprehensive assessment of downstream effects, including identifying all possible pathways for MeHg in the food web. This has not occurred;
- It is clear that Nalcor and the federal and provincial governments cannot do this alone. There must be a full and thorough review conducted with the participation of independent scientists, indigenous experts and representatives from the Innu, Inuit and local residents. Every option must be examined while there are still options;
- The NG is urging the GNL to adopt the precautionary principle in the assessment of the health risks to Inuit from the Project and that would require the full clearing of the reservoir;
- There was an expression of appreciation for the scientific and research community for working on this issue of such importance to the aboriginal communities.

15. Consumption Advisories

- How will consumption advisories be created?;
- In the past, consumption advisories were just posted. This was not effective and the NG worked with the GNL and agreed that information would be provided to the communities before posting the signs. This has been a more effective approach;
- The view was expressed that consumption advisories are a last resort and not to be desired;
- The consumption advisory process is something for which the province does not have the resources; it is the responsibility of HC.

15. Pausing the Project

- The NG suggested the project should be paused until satisfactory answers can be found to outstanding issues. No water should flow into the reservoir until this is done;
- Certain decisions must be made before flooding the reservoir;
- The NG's proposed mitigations are all pre-flood mitigations.

16. Post Flooding Mitigation Measures

(a) General Comments

- The whole approach to post-mitigation measures needs to be designed in consultation with the communities and needs to include a strong education component;
- The concept of post–mitigation measures at this time is somewhat precedent-setting, as in most places, the action is to just issue a consumption advisory;
- The view was expressed that any post-flooding mitigation measure is suboptimal; The primary mitigation is full clearing. Everything else is secondary;

(b)Nitrates and Oxygenation

- Consideration should be given to nitrate additions or oxygenation to suppress MeHg;
- When you add nitrate to water, the nitrate shifts the activity of bacteria so methylating bacteria is less active whereas the nitrating bacteria is very active;
- Nitrates work best in solution and in anaerobic contexts;
- This is not a one-time addition and may require addition once a year for several years;
- This approach only works if you add nitrates on a regular basis and a pilot would have to be conducted;
- Since methylation is very season dependent, you may not need to add nitrates year round;
- It is necessary to determine how feasible it would be to do this on a recurring basis;
- Adding nitrates worked in a contaminated lake in New York (Onondaga Lake). They used iron and manganese hydroxides which acted as a cap and such an approach may be effective;
- Freshwater systems are phosphorous-limited so adding nitrates should not affect algae production;
- Care should be taken when considering the impacts of adding nitrates since the risks of algal production could be counterproductive;
- If the system is nitrogen-limited, adding nitrates could lead to algal blooms;
- Since the reservoir water turns over every 10 days, it should be easy to determine the concentrations required;
- This approach is not guaranteed to work but may work best where water loses oxygen;
- This approach would have to be tested pre-flooding if it planned to rely on it post-flooding;

- If nitrates are added to the reservoir it would result in less MeHg going from the reservoir to Lake Melville but it one cannot be sure what would be the impact on methylation in Lake Melville;
- Oxygenation may also work given methylating bacteria thrive in anaerobic conditions;
- Oxygenation could help but only if the water column is deoxygenated;
- There is no anoxia in the water column since the reservoir is part of the river so there is constant mixing;
- Iron and manganese oxidants can also act as a cap for MeHg;
- Nalcor has concluded that the reservoir is not predicted to be stratified or deoxygenated but both methods would be worth considering.

(c) Dietary Studies

- Health Canada has two programs – the First Nations Food Nutrition and Environment Study and the First Nations Environmental Contaminants Program. These programs can provide funding and technical support to study diet, impacts on MeHg, changes in country foods to help fully understand the impacts of the changes;
- Land Claim organizations should be able to build a case for why they want to access the programs;
- These are annual programs and there is no reason the NG could not access them;
- If there are any concerns about Nalcor led work, this could be an option to secure independent research;
- You can shift diets but that is harder to do where food insecurity already exists;
- Nalcor is envisioning education and engagement campaigns which would also include discussion of cooking practices which could help reduce MeHg

intake, as could changing dietary practices, such as pairing specific drinks with specific foods;
- There are 12-15 papers on the potential of changing cooking practices, focusing on the changing of proteins in the cooking processes; given MeHg attaches to protein in the tissue, altering the protein provided an opportunity to reduce MeHg ingestion;
- There may be a need or opportunity to involve nutrition experts in these discussions;
- Selenium could also be considered as an option to reduce MeHg ingestion.

18. Possible follow-up action

(a) Expert Science Table

- The NG has proposed an Independent Expert Advisory Committee since politicians have said they do not understand the science well enough;
- From the Workshop discussion, there seemed to be a consensus perhaps this idea should be proposed to Environmental Assessment (EA) Modernization. EAs are highly complex; it is always a challenge for decision-makers to understand the science and explain it to the public;
- As part of Environment and Climate Change Canada's (ECCC) role, it can convene and chair an expert science table which brings together representatives from across government to discuss issues. Such a table guided ECCC action in respect of the Manolis L.

(b) A Mesocosm Study

- It was suggested that a possible action from the Workshop could be a Mesocosm study carried out as

soon as possible. This could be part of an amendment to the environmental plan.

(c) Nitrates and Oxygenation

- It was suggested there should be consideration given to the use of nitrates and oxygenation.

(c) Dietary Studies, as previously described should be undertaken.

(d) Full Clearing versus Partial Clearing

There appeared to be some consensus it may be necessary to get a further assessment of benefits from full clearing versus partial clearing. There has to be a recognition that the terrain and safety issues may be a limiting factor in so far as removal of all vegetation and organic material is concerned. It was suggested a feasibility study could be undertaken to determine how much organic material can be removed. The experimental aspect of such a study could be completed using core samples which are flooded with most of the organics on the top of the soil core being removed. Full clearing would amount to the top 20% of the soil being removed.

REFERENCES

Comment [JK22]: What about "Lake Melville: Avativut Kanuittailinnivut (Our Environment, Our Health) Scientific Report"? This is a key reference

1. Schartup, A.T., P.H. Soerensen, A.L. Gosnell, etc., K.J. Calder, R.S.D. Mason, R.P. and E.M Sunderland. Freshwater discharges drive high level of methylmercury in Artic marine biota. Proceedings of the National Academy of Sciences of the USA (PNAS). 2015, 112:11, 789-11, 794 ("Schartup et al, 2015")
2. DFO. 2016 Review of Mercury Bioaccumulation in the Biota of Lake Melville, DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/015. ("DFO Review")
3. Nalcor (Nalcor Energy). 2015 Human Health Risk Assessment Plan (Revision B4). February 25, 2015. Doc. No. LCP-PT-MD-0000-EV-PL-0026-01. ("Nalcor HHRAP, 2015")
4. Government of NL and Government of Canada response to the Report of the Join Review Panel for Nalcor Energy's Lower Churchill Hydroelectric Generation Project – March 2012
5. Scientific Workshop: Methylmercury and Muskrat Falls: Sharing and Understanding Our Varied Perspectives – March 22, 2016

Appendix "A" - Scope of Work

The Facilitator (Consultant) was engaged effective July 19, 2016 to complete the following services:

1. The Consultant shall be responsible for facilitating a one day scientific workshop to be held in Happy Valley-Goose Bay, Labrador on Thursday, August 4, 2016 starting at 8:30am and ending at 5:30pm. The workshop, entitled, Methylmercury Mitigations and Muskrat Falls: A Discussion of Practical Solutions, will be a forum to provide an opportunity for attending provincial and federal government representatives and representatives of the Nunatsiavut Government, Innu Nation and the NunatuKavut Community Council to discuss and dialogue issues related to methylmercury production pertaining to the Muskrat Falls project in an effort to identify practical solutions.

2. Following the workshop, the Consultant shall provide to the Client a "Contract Document" which provides a summary of the discussion which took place at the workshop. The document shall be in sufficient detail so as to outline the key topics raised, a summary of the discussion of the various topics as per the workshop agenda and any recommendation or advice provided by the participants.

3. The Consultant shall act in a position of neutrality both in his role as facilitator and author of the Contract Document.

Appendix "B" – Workshop Agenda

8:30 am Opening Welcome
Facilitator
- Workshops origins, objectives and themes

8:45 am Review of Workshop Process and Agenda
Facilitator
- Review workshop process and agenda and facilitator/recorded role

9:00 am Participant Introductions
All participants
- Each person will introduce themselves and note the organization they are representing.

9:15 am Opening Comments
Martin Goebel
- The Department of Environment and Conservation will present an overview of the EA process for the Muskrat Falls project and the evidence that informed Government's June announcement.

9:45 am Pre-inundation Mitigations: Evidence and Options
All participants
- Beginning with the Nunatsiavut Government's expert representative(s), who will present their research, each organization's expert(s) will have approximately 10 minutes to introduce their perspective and evidence on mitigation options for methylmercury reduction; this will be followed by a discussion amongst participants.

11:00 am Coffee Break

11:15 am (continued) Pre-inundation Mitigations: Evidence and Options
All participants

1:30 pm Lunch Break (Provided)

2:00 pm Post-inundation Mitigation/Monitoring and other tools
All participants

- Beginning with the Nunatsiavut Government's expert representative(s), who will present their perspectives and proposed solutions regarding the implications for Inuit Health, each organization's expert(s) will have approximately 5 -10 minutes to outline their perspective regarding this issue, inclusive of the monitoring program in place; this will be followed by a discussion amongst participants

5:00 pm Closing Comments
Facilitator

- The Facilitator will explain how the outcome summary document will be completed and distributed to participants. Thank all participants for attending the workshop.

5:15 pm Close of workshop

Appendix "C" – Workshop Attendees

Table:
Wayne Thistle – Facilitator
Brian Harvey – Note Keeper
Paul Carter – NL Department of Environment and Conservation (ENVC)
Martin Goebel – ENVC
Geoff Mercer – Environment and Climate Change Canada (ECCC)
Dr. Wolfgang Jansen – Innu Nation
George Russell, NunatuKavut Community Council, Inc.
Jim McCarthy – Nalcor
Jackie Wells – Nalcor
Rob Willis – Nalcor
Peter Madden – Nalcor
Jane Kirk – ECCC
Greg Kaminski – Health Canada
Colin Carroll – NL Forestry & Agrifoods Agency
Bruce Pauli – ECCC
Dr. Margo Wilson – Labrador-Grenfell Regional Health Authority (LGH)
Diane Oliver-Scales – LGH
Dr. David Allison – NL Department of Health and Community Services
Rodd Laing – Nunatsiavut Government (NG)
Carl McLean – NG
Dr. Trevor Bell – Memorial University of Newfoundland

Telephone:
Dr. Elsie Sunderland – Harvard University
Robin Anderson – Fisheries and Oceans Canada (DFO)
Renee Patterson – ENVC
David Haley – Nalcor
Reed Harris – Nalcor

Seated:
Johannes Lampe – President, NG
Darryl Shiwak – Minister, NG
Greg Flower – Minister, NG
Isabella Pain – NG
Michelle Kinney – NG
Loretta Michelin – NG
Bert Pomeroy – NG
Anastasia Qupee – Grand Chief, Innu Nation
Richard Nuna – Innu Nation
Donna Paddon – Innu Nation
Paula Reid – Innu Nation
Cathy Guirguis – Innu Nation
Todd Russell – President, NCC
Roberta Benefiel – Grand Riverkeepers
Lisa Dempster – MHA, Deputy Speaker
Randy Edmunds – MHA
Minister Perry Trimper – ENVC
Emily Timmins – ENVC
Bonnie Learning – ENVC
Michelle Watkins – NL Labrador and Aboriginal Affairs Office

Appendix "D" – Workshop Participants

Facilitator	
Centre for Innovation Dispute Resolution	Wayne Thistle
Labrador & Aboriginal Affairs (note keeper)	Brian Harvey
Federal Departments	
Fisheries and Oceans Canada	Robin Anderson (By teleconference)
Environment and Climate Change Canada	Bruce Pauli Jane Kirk Geoff Mercer
Health Canada	Gregory Kaminski
Provincial Departments	
Health and Community Services	Dr. David Allison Dr. Margo Wilson Diane Oliver-Scales
Forestry and Agrifoods Agency	Colin Carroll
Environment and Conservation	Martin Goebel, Renee Paterson (By teleconference) Paul Carter
Nalcor Energy	Peter Madden Jackie Wells

	Dave Haley (by teleconference) Reed Harris (by teleconference) Jim McCarthy Rob Willis
Aboriginal Groups	
Nunatsiavut Government	Carl McLean Rodd Laing
Innu Nation	Dr. Wolfgang Jansen
NunatuKavut Community Council	George Russell Jr.
Academic Researchers	Dr. Elsie Sunderland (by teleconference) Dr. Trevor Bell

Appendix "E" – Workshop Participants' Bios

NL Department of Environment and Conservation
Martin Goebel
Assistant Deputy Minister (Environment)

Martin Goebel, P.Eng, started his career with the Department of Environment and Conservation in October 1983. As ADM since 2009, Martin has worked on many projects including the environmental assessment of the Lower Churchill Power Development, environmental clean-up projects at Buchans and Hopedale and continues to lead water resources projects such as drinking water safety, waste water management and real-time water quality monitoring. Work in this area includes developing policy, budgeting, preparing cabinet papers, formulating legislation and representing the Department in public forums.

Martin represents the province on Federal/Provincial/Territorial committees including the Canadian Council of Ministers of Environment Environmental Planning and Protection Committee and the National Administrators Table of the F/P/T Hydrometric Surveys Program.

Renee Paterson
Senior Environmental Scientist

Renee has been working in the Water Resources Management Division for 15 years and is the coordinator for the Real-time Water Quality Monitoring Program. Renee has been involved with the Lower Churchill Project throughout the environmental assessment process and continues to work towards addressing water quality/quantity issues relating to

the project. Renee holds a B.SC. (Biology) and M.Sc. (Environmental Science) from Memorial University.

Paul Carter
Environmental Scientist

Paul Carter joined the Department of Environment and Conservation in 1990 and worked eight years working in the Water Resources Management Division in various positions with the Surface Water, Water Quality and Water Investigations before moving to his current position of Environmental Scientist with the Environmental Assessment Division. In 2008, Paul was appointed to Chair the Assessment Committee for the Lower Churchill Hydroelectric Generation Project. For this role he has worked on the Terms of Reference for the Joint Review Panel, Guidelines for the Environmental Impact Statement, and Provincial Government response to the Report of the Joint Review Panel.

Paul holds a B.Sc. in Physical Geography, B.Sc. (Honours) specializing in Hydrology, and M.A.Sc. Environmental Engineering and Applied Science from Memorial University of Newfoundland.

NL Department of Health and Community Services
David Allison
Chief Medical Officer of Health

Dr. David Allison MD, FRCPC, is Chief Medical Officer of Health for the province. David has served in public health roles New Brunswick, Alberta and Saskatchewan since 1982. He is also a member of the Emergency Response Unit (ERU)

roster of the Canadian Red Cross and has completed short deployments in Haiti (2010), Sierra Leone (2012) and Nepal (2015).

David is a past co-chair of Immunize Canada and has been involved in environmental health research as an investigator assessing concerns about environmental lead in St. John's, NL. As a clinical associate professor in the Division of Community Health and Humanities of the Faculty of Medicine at Memorial University, he has been involved with teaching of medical students and supervision of MPH students undertaking practicums.

Margo Wilson
Labrador-Grenfell Health

Dr. Margo Wilson is a family physician in Happy Valley-Goose Bay. She completed her residency with additional training in emergency medicine in St. John's, then became a staff physician at the Labrador Health Centre, where she has been working since 2011. In addition to her role with Labrador-Grenfell Health, Dr. Wilson is a clinical associate professor with the Discipline of Family Medicine in the Faculty of Medicine at Memorial University.

Diane Oliver-Scales
Labrador Grenfell Health

Diane is a clinical nurse manager of public health at Labrador-Grenfell Health in Happy Valley-Goose Bay.

Fisheries and Oceans Canada
Robin Anderson
Research Scientist

Dr. Robin Anderson is a Research Scientist in the Ecological Sciences Section and has developed and carried out research projects in quantitative aquatic ecology for over 35 years. Robin came to Newfoundland in 1991 after holding faculty positions at the University of Quebec at Montreal and at the University of Maryland.
Robin's research program examines and models the effects of human activity on aquatic habitats, including substantial research in mercury impacts on fish following reservoir creation, evaluating risks to ecosystems, and integrating spatial patterns and processes in food web and environmental studies. She has provided expert testimony and scientific advice on the potential and observed environmental impacts of human activity on fish and fish habitat including major environmental assessments of mines, hydroelectric projects and offshore oil development, environmental effects monitoring (EEM) programs and site decommissioning proposals.

Robin holds a B.Sc. in Biology from Université Laval, an M.Sc. in Biology from Université Laval, and a Ph.D. in Biology from McGill University.

Health Canada
Gregory Kaminski
Senior Environmental Health Assessment Specialist

Gregory Kaminski works as a Senior Environmental Health Assessment Specialist in the Healthy Environments and Consumer Safety Branch. He has over 25 years of experience

in the areas of environmental and human health risk assessment. He worked for Inuit-owned Makivik corporation as a wildlife biologist, assessed effects of pulp and paper mill effluents on fish and biota when working as a consultant on cycle 1 Environmental Effects Monitoring required by the federal regulation, and developed computer models for Hydro Quebec in the areas of utility pole treatment, storage sites and accidental spills into terrestrial and aquatic environments.

Gregory joined the federal government in 2001. At the Pest Management Regulatory Agency he helped to assess human and ecological risks linked to the application and registration of pesticides. As the head of the office of Environmental Effects Monitoring for Pulp and Paper with Environment Canada, he helped to re-design the regulation for that sector and developed regulations for the mining sector. In 2010 Greg moved to Health Canada where he works on assessing effects of proposed development projects on human health. Gregory holds a B.Sc. and an M.Sc. from McGill University.

Environment and Climate Change Canada
Geoff Mercer
Regional Director General, Atlantic and Quebec Regions

Geoff Mercer was appointed Regional Director General on June 23, 2016 and represents the interests of the Atlantic and Quebec Regions within Environment and Climate Change Canada. As well, he contributes to the delivery of national programs and manages major horizontal issues. He is tasked with ensuring ongoing relations with private and public partners and key stakeholders in the regions.

Geoff came to Environment and Climate Change Canada in January 2009 as the Atlantic Regional Director, Environmental Protection Operations Directorate. In July 2013, he was appointed as the Associate Regional Director General, Atlantic and Quebec Regions. From 1988 until 2008, Geoff was a member of National Defence where he held various positions in the Canadian Forces, and also in the department's environmental management program.

He is originally from Montreal, Quebec, and obtained a Bachelor's degree and a Master's degree in Science (Biology) from Memorial University of Newfoundland.

Jane Kirk
Research Scientist, Water Science & Technology, Science & Technology Branch

Dr. Jane Kirk's research focuses on the impacts of human alterations to aquatic ecosystems, including the transport, fate, and bioaccumulation of contaminants such as mercury, metals, and polycyclic aromatic hydrocarbons, the role of anthropogenic stressors, such as eutrophication, in altering contaminant cycling, and the impacts of climate change on carbon cycling and biological communities in freshwater lakes. Dr. Kirk completed her PhD at the University of Alberta in the Department of Biological Sciences on sources of toxic methylmercury to Arctic marine ecosystems, including the atmosphere, production of methylmercury within the marine water column, and inputs from rivers that have been altered for hydroelectric power production. Dr. Kirk is currently a Research Scientist in the Aquatic Contaminants Research Division of Environment and Climate Change Canada and an Adjunct Assistant Professor in the Department of Geography at University of Toronto

Mississauga. She is based out of the Canada Centre for Inland Waters in Burlington, Ontario.

Bruce Pauli
Chief, Ecosystem Health Research, Wildlife & Landscape Science, Science & Technology Branch

Bruce Pauli's research and monitoring activities on the levels and biological effects of environmental pollution are aimed at establishing techniques that can be used to evaluate and assess environmental change. His research focuses on techniques to use wildlife species as sentinel organisms to assess levels of contaminants and adverse effects of multiple stressors on wildlife in human-changed ecosystems. This research has included efforts to standardize toxicity tests with native amphibian species, to examine determinants of disease in amphibians, and to develop an understanding of cumulative effects and the response of wildlife to multiple stressors. The goal is to establish relevant and robust measures useful for assessments of ecosystem health and change. Bruce Pauli is currently a Research Manager and Chief, Ecosystem Health Research Section in the Ecotoxicology and Wildlife Health Division, Science and Technology Branch, Environment and Climate Change Canada. He is based at the National Wildlife Research Centre at Carleton University in Ottawa, Ontario.

Forestry and Agrifoods Agency
Colin Carroll
Regional Ecosystem Director, Labrador

Colin Carroll is the Regional Ecosystem Director with the Forest Service's Branch for the Labrador Region in Happy Valley – Goose Bay and Western Region in Corner Brook. He is currently one of two Provincial Government Appointed members of the Torngat Wildlife and Plants co-Management Board and is Chair of the Model Forest NL and the Canadian Institute of Forestry NL Section.

Colin graduated from the University of British Columbia's Forestry Program in 1996 and is a Registered Professional Forester. He has worked in both the Forest Industry in Northern BC and forestry related wildlife research. Worked as an instructor in the Natural Resources Programs (forestry and fish and wildlife technician) at the College of the North Atlantic in Corner Brook and Bonavista campuses. District Ecosystem Manager with the Provinces Forestry Services Branch in Cartwright and Northwest River in Labrador. He was part of the Environmental Assessment group for the Lower Churchill Project who's role was to focus on the reservoir and transmission line clearing activities and provide comments as part of the forestry team that also presented at the panel hearings.

Innu Nation
Wolfgang Jansen
Aquatic Scientist

Dr. Wolfgang Jansen is an aquatic scientist with North/South Consultants Inc. He has worked in consulting and a casual research scientist with DFO (Winnipeg) from 1999 to 2009.

He also has project experience with Manitoba Hydro in environmental impact assessment and monitoring, fish passage and movement, as well as mercury in fish.

His areas of expertise include aquatic ecology: fish and invertebrates, bioaccumulation of mercury, monitoring and bioindication, aquatic environment study design/data analysis and interpretation, fish bioenergetics and migration, aquatic invasive species, environmental impact assessment, ecology of bogs, and life-history of mayflies.

Wolfgang holds a B.Sc. in Agricultural Engineering from University of Bonn in Germany, an M.Sc. Department of Zoology, University of Manitoba, and a Ph.D. from Department of Zoology, University of Hohenheim in Germany.

NunatuKavut Community Council
George Russell Jr.
Environment and Resource Manager

Nunatsiavut Government
Carl McLean
Deputy Minister of Lands and Natural Resources

Rodd Laing
Director of Environment

Academic Researchers
Elsie Sunderland
Associate Professor, Harvard University

Dr. Elsie Sunderland is the Thomas D. Cabot Associate Professor of Environmental Science and Engineering in the Harvard John A. Paulson School of Engineering and Applied Science. She holds a secondary appointment in the Department of Environmental Health in the Harvard T.H. Chan School of Public Health. She is a faculty associate in the Harvard University Center for the Environment and the Harvard Center for Risk Analysis. Prior to joining the faculty at Harvard, she held several positions at the headquarters for the U.S. Environmental Protection Agency, where she worked on regulatory impact assessments and the development and application of models to inform regulatory decisions. Dr. Sunderland's research group (http://bgc.seas.harvard.edu) studies how global contaminants are distributed in the environment, magnify in food webs and pose risks to human health. Much of Dr. Sunderland's present research is focused on understanding how global contaminants are affecting the health of northern communities and how climate change and industrial development will affect future health risks.

Trevor Bell
Professor, Memorial University

Dr. Trevor Bell is a Professor of Geography at Memorial University. For over three decades he has studied landscape history from a variety of perspectives, including climate change impacts and human-environment interactions. He has played an important role in the ArcticNet NCE, both as project leader and coordinator of the eastern Arctic integrated regional impact assessment. One of these ArcticNet projects, Nunatsiavut Nuluak, co-led with Tom Sheldon, Director of Environment for the Nunatsiavut Government, focused on Labrador fiords including Lake Melville. Dr. Bell shared the

2013 Arctic Inspiration Prize with the Nunatsiavut Government for their knowledge-to-action program on healthy homes in sustainable subarctic communities. He has led the recent development of the SmartICE initiative, which supports safer travel for sea-ice users and shipping in northern coastal regions.

Nalcor Energy
Jackie Wells
EA Commitments / Environmental Effects Monitoring Programs Lead

Jackie Wells is an Environmental Effects Monitoring Lead for the Lower Churchill Project, responsible for environmental effects monitoring programs for the Labrador – Island Transmission Link and the Lower Churchill Hydroelectric Generation Facility. These programs ensure our environmental commitments are being met and environmental protection measures are mitigating the effects of the project on various environmental components. Some of the key programs include: Labrador caribou, Newfoundland caribou, furbearers, methylmercury, human health risk assessment, Newfoundland marten, avifauna, and listed plants. She has 15 years experience in the environmental sector including environmental research, education and environmental assessment.

Jackie holds a B.Sc. (Biology), a B.Ed. and an M.Sc. (Biology) degrees from Memorial University of Newfoundland.

Peter Madden
Regulatory Compliance Lead

Peter Madden is the Regulatory Compliance Lead for the Lower Churchill Project. His primary responsibilities with include implementation of the LCP EMS, regulatory stakeholder management, project environmental effects monitoring and mitigation programs. He has 10 years experience in environmental research, environmental assessment, and environmental and regulatory compliance.

Peter holds a B.Sc. (Hons) in Behavioural Neuroscience, an M.A.Sc. in Environmental Engineering, an M.B.A, and Masters Certificate in Project Management.

David Haley
Environmental Regulatory Compliance Manager

David Haley has more than thirty one (31) years of applied Environmental Engineering and Project Management experience. David has worked and managed numerous projects in Atlantic and Arctic Canada, including the 5 Wing Goose Remediation Project. David has worked on the Lower Churchill Project since 2012 in the role of Environmental Engineering Manager.

David is recognized as a Site Professional under the Newfoundland and Labrador Contaminated Site Management Programs, was named a Fellow of Engineers Canada (FEC), and in 2010 was granted the certification of Environmental Professional (EP) by ECO-Canada. David is a registered Professional Engineer in the Province of Newfoundland and Labrador.

Education: 1981 – 1983 Diploma Engineering, Dalhousie University, Halifax, Nova Scotia; and, 1983 – 1985 B.Eng. Civil, Technical University of Nova Scotia, Halifax, Nova Scotia.

Rob Willis
Senior Toxicologist & Risk Assessor Dillon Consulting

Rob Willis is the Senior Toxicologist and Risk Assessor for Dillon Consulting Limited and extensive experience and expertise in human health and ecological (terrestrial and aquatic) risk assessment (HHERA), toxicity-based benchmarks development, the development of HHERA guidance and approaches, chemicals management and priority setting, and various aspects of applied toxicology and environmental chemistry. Rob has evaluated mercury and methylmercury exposure and risk in a number of previous human health risk assessment (HHRA) studies in various regions of Canada. He is currently retained by Nalcor Energy as their HHRA subject matter expert for the Lower Churchill Hydroelectric Generation Project.

Rob frequently serves as an expert reviewer of risk assessment and toxicological documents prepared by others, is routinely invited to participate in federal risk assessment program guidance development, and serves (or has served) as an invited member on a number of provincial and regional technical committees that pertain to HHERA.

Rob holds an M.E.S. from Dalhousie University and a B.Sc. with an emphasis in environmental toxicology, from the University of Guelph. He is a Canadian Certified Environmental Practitioner (EP) in the areas of air quality protection, and human and environmental health and safety

(since 2004), and a qualified person for risk assessment under Ontario Reg. 153/04.

James McCarthy
Senior Aquatic Lead, Lower Churchill Project

James McCarthy is an associate biologist and Certified Fisheries Professional with over twenty years of experience. Jim has been involved in a wide range of projects in Newfoundland and Labrador, Alaska, British Columbia and Nova Scotia for private organizations and government agencies. Projects have generally entailed the design and implementation of environmental assessments, aquatic offset plans, baseline studies, and environmental effects monitoring programs related to various human activities such as oil and gas, hydroelectric developments, mining/construction, and forest harvesting. His efforts in aquatic research and offset planning have focused on the identification of habitats sensitive to human disturbance for aquatic species.

Jim is a Ph.D. candidate at University of New Brunswick's Canadian Rivers Institute where a portion of his research will focus on potential ecosystem niche changes within and downstream of the Muskrat Falls reservoir and how they may affect mercury bioaccumulation and transport.

Reed Harris
President, Reed Harris Environmental Ltd

Reed Harris, BSc. (Civ Eng), M. Eng., P. Eng., has over 30 years of experience in the environmental engineering field. Since 1988, Reed has specialized in the behaviour of mercury in aquatic and terrestrial ecosystems. He has developed and applied models of mercury cycling and bioaccumulation in

freshwater, marine and terrestrial systems, and made predictions of fish mercury concentrations in connection with the Lower Churchill River Hydroelectric project.

Facilitator
Wayne Thistle
Centre for Innovative Dispute Resolution

Wayne Thistle has been an active Arbitrator, Mediator, Facilitator and Dispute Resolution expert and for the past forty years assisting parties throughout Canada in resolving disputes primarily in labour, insurance, industrial and commercial areas. He has worked with all levels of governments and Crown agencies, and with many employers and unions in diverse sectors including natural resources, particularly oil and gas, mining, forestry and fishery sectors, the airline industry, the health sector, the education sector, transportation and communications sector, the insurance industry, the construction industry and the banking and financial sector.

Mr. Thistle was admitted to the Chartered Arbitrator designation by the Arbitration and Mediation Institute of Canada in 1988 and to the Chartered Mediator designation in 2011. He has completed the Advanced Program in Alternative Dispute Resolution presented by the University of Windsor, Faculty of Law, and Stitt Feld Handy Houston law firm of Toronto. He also has undergone training offered in the Harvard Law School Program on Negotiation specializing in Conflict Resolution and Human Resource Effectiveness. He has been recognized by his peers in the *Best Lawyers in Canada* publication in the field of Dispute Resolution in each edition from 2008 – 2017.

Mr. Thistle has served in various administrative capacities over a thirty-five year career at Memorial University of Newfoundland and prior to his retirement in 2003 held, for twenty-one years, the position of Vice-President (Administration and Finance) and Legal Counsel. He has taught Commercial Law in the Faculty of Business Administration and Education Law in the Faculty of Education. He holds a Bachelor of Science (Honours Math and Physics) degree, a Bachelor of Education Degree and a Master of Arts Degree from Memorial University and a Bachelor of Laws degree from Dalhousie University.

Brian Harvey
Director, Aboriginal Affairs
Assistant recorder / note keeper

Brian holds a B.Sc. (Biology) From Memorial University and an LL.B. from Dalhousie. Following a short time in private practice, Brian joined Government in 2005, with the Department of Natural Resources. Since then, Brian has worked throughout Government, including as a Cabinet Officer with Cabinet Secretariat, and including two secondments to Nalcor Energy to work on the Hebron Project negotiations and on the acquisition of the former Abitibi Bowater properties in Grand Falls-Windsor.

Brian has been Director of Aboriginal Affairs since 2010, and in 2015, received a Public Service Award of Excellence.