Final

Williston Reservoir Watershed – Fish Mercury Consultation and Next Steps

Prepared for

Fish and Wildlife Compensation Program – Peace
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EXECUTIVE SUMMARY

The BC *Freshwater Fishing Regulations Synopsis* contains an advisory stating that '*normal consumption of bull trout and lake trout from Williston Reservoir does not pose a health risk, but high consumption might*'. While the advisory is specific to Williston, there is a perception that elevated mercury levels in fish are widespread, extending into tributaries and downstream into the Peace River. This has led to a widespread belief that fish are mercury 'contaminated' and that no more than one to three meals of fish should be consumed per month, to stay within health guidelines.

The Board of the Fish and Wildlife Compensation Program – Peace (FWCP-Peace) determined that they wished to resolve the issue of the mercury advisory in Williston Reservoir watershed, which has been a lingering issue for many years. Azimuth Consulting Group Partnership (Azimuth) was engaged to conduct an 'Engagement and Consultation' study and develop a scope of work for next steps, with the following objectives: consult with and identify concerns of First Nations and other stakeholders; identify key issues and data gaps and; based on these findings, propose a scope of work to direct the way forward/next steps to update the fish mercury database for Williston Reservoir watershed and resolve the advisory.

This report summarizes the deliverables from ten discrete tasks including; 1) outcome of the engagement and consultation process held with members of each First Nations community, Ministry of Environment, BC Hydro and other stakeholders; 2) distribution of a 'mercury fact sheet' that provides an overview of the science of mercury and methylmercury dynamics in lakes and reservoirs; 3) presentation to the FWCP-Peace Board and First Nations Working Group on October 21, 2104 regarding preliminary findings of the communication and consultation process; 4) findings of supplementary discussions held with members from several First Nations, BC Hydro and Peace Valley Environmental Association on December 10, 2014; 5) presentation and minutes of a meeting with Northern Heath on January 20, 2015; 6) summary of existing, historic fish mercury information from Williston watershed; 7) data gap summary; 8) overview of strategy to address a fish mercury consumption advisory in BC; 9) study design overview and data requirements (e.g., spatial scope, species, statistical design considerations) from a fish mercury field program; and lastly, 10) outline the responsibilities and role of First Nations and recreational fishing groups to provide information essential to the success of the field investigation and ultimately, address the fish consumption advisory for Willison Reservoir.

The final section is a summary of action-orientated and sequential next steps for the Board to follow in order to develop a Scope of Work and Terms of Reference that a consultant will enact and to ultimately allow for clear and unambiguous decision making. The specific sequence of tasks to be followed are: hire a consultant; form a Mercury Technical Working Group; identify a champion(s) within key communities to work with the consultant and Mercury Technical Working Group and coordinate community

activities; conduct a creel survey to gather critical information used to guide and focus the field investigation (e.g., identify target areas and fish species, reference waterbodies); initiate a reconnaissance program in 2015 with five goals / outcomes; and finally, plan and execute a field collection program in 2016 from Williston Reservoir and possibly, key tributary streams, Dinosaur Reservoir and reference waterbodies. This program should form the basis of a long-term monitoring program in the Williston Reservoir watershed.

1. INTRODUCTION

1.1. Background

For many years now, several northern First Nations communities living on or near Williston Reservoir watershed, Dinosaur Reservoir or the Peace River (**Figure 1**) have expressed concerns that consumption of fish from this system may pose a health risk due to mercury. The BC Sport Fishing Guide contains an advisory stating that '*normal consumption of bull trout and lake trout from Williston Reservoir does not pose a health risk, but high consumption might*'. This advisory was placed on the reservoir back in the early 1990s when there was legitimate concern that mercury concentrations in some fish were elevated, following creation of Williston Reservoir in 1968. While the advisory is specific to Williston Reservoir, there is a perception that elevated mercury levels in fish is more widespread, extending both upstream into tributaries (i.e., through migrating fish) and downstream into the lower Peace River.

Consequently, members of some First Nations communities and others have expressed concern that fish and possibly other country foods or water, are contaminated with mercury. This perhaps is due, in part, to the vague wording of the existing fish consumption advisory for Williston Reservoir that appears to have had the unintended consequence of causing people to believe that fish are still not 'safe' to eat or that they can only be consumed on a very infrequent basis. Unfortunately, no recent data have been brought to bear on this issue. The most recent study of mercury concentrations in environmental media in Williston Reservoir was in 2000/2001 (Baker et al. 2002). During the time of that survey mercury concentrations in bull trout (*Salvelinus confluentus*) were elevated, but were not necessarily at concentrations warranting a consumption advisory.

Recently, as part of the proposed Site C Hydroelectric Development, a fish mercury study was conducted on the Peace River downstream of Dinosaur Reservoir targeting bull trout, mountain whitefish (*Prosopium williamsoni*) and rainbow trout (*Oncorhynchus mykiss*) (Azimuth 2012). These data indicated that Peace River fish mercury concentrations were low, averaging less than 0.1 ppm (parts per million) wet weight (ww) in muscle tissue. Finally, bull trout (63 adult fish) were collected from the Crooked River (a tributary to Williston Reservoir, near the Parsnip River) in 2012 by the West Moberly First Nations (2013). Although mean mercury concentrations were only moderately elevated (0.45 ppm), this further raised concerns among other First Nations communities and other local residents. Results of the above studies are discussed in more detail in **Section 2.6.1**.

1.2. Objectives

The Board of the Fish and Wildlife Compensation Program – Peace (FWCP-Peace) determined through workshop dialogue that further information was required on mercury

levels in fish in Williston and Dinosaur Reservoir basins and wish to develop and carry out a plan to fill existing data gaps. The Board recognizes that the mercury advisory that is currently advertised in the BC Sport Fishing guide is a provincial health agency responsibility and is willing to assist in the preparation of an updated advisory by providing scientific information on mercury concentrations in fish. As a first step, Azimuth Consulting Group Partnership (Azimuth) was engaged to conduct a Phase 1 study entitled 'Engagement and Consultation' with the following objectives:

1. Consult with and identify concerns of First Nations and other stakeholders (e.g., BC Hydro, provincial agencies, local outfitters, public stakeholders) regarding mercury concentrations in environmental media (this could include water, plankton, fish, wildlife etc.) of Williston Reservoir and key tributary streams; this may also include Dinosaur Reservoir.

2. Develop a list of key issues to be addressed regarding concerns about mercury in environmental media and fish in particular, based on feedback from all participants.

3. Identify partners that may be willing to participate in the process to address priority issues that arise from the consultation process.

4. Develop a Scope of Work (SOW) and next steps beyond the engagement process. The SOW will propose a strategy to address residual issues regarding mercury in environmental media of the Peace Williston watershed.

The long-term goal of this project is to improve available scientific information on mercury levels in fish in the Williston and Dinosaur Reservoir areas, communicate this information accurately, and support provincial agencies responsible for updating the mercury advisory. More recent data from Williston Reservoir and possibly, key tributary streams will be required – most likely through a targeted field program. The proposed framework for this study is outlined below. The ultimate study design and approach can only be achieved with further input from local First Nations, Province of BC (e.g., Ministry of Environment, Ministry of Forest Lands and Natural Resources), BC Hydro and representatives of the FWCP-Peace. Northern Health will also play a key role, with the requirement to establish a decision-making framework prior to field data collection to ensure that whatever data are collected will be sufficient to make decisions.

1.3. Deliverables

Ten discrete elements of work evolved from this process and were accomplished as deliverables for this project. Details of each are as follows:

1. *Preliminary Engagement* – Each member of the FWCP-Peace Board was contacted via email and/or telephone. The objective of this consultation and engagement step was to initiate dialogue with First Nations and other interested parties to develop a better appreciation of concerns about mercury in fish in order

to ensure these concerns are addressed. The deliverable consists of a summary of key concerns identified, distilled from conversations held with all persons contacted (**Section 2.1**).

2. *Prepare Mercury 'Fact Sheet'* – Subsequent to formal communication, all members of the Board were provided with a 2-page document called 'Overview of *Mercury in the Environment*', that summarized the mercury issue in Williston Reservoir and put it into context with what is known about fish mercury in other Canadian reservoirs (**Section 2.2**).

3. *Present at the joint FWCP-Peace Board and First Nations Working Group Meeting in Prince George* – A meeting of the FWCP-Peace was held on October 21, 2014 in Prince George (**Section 2.3**).

4. *Direct Community Consultation* – At the board meeting in Prince George and on the telephone, several people expressed interest in further discussions within their communities. Although this initially was an optional task, the community of Saulteau was visited opportunistically on December 10, 2014. Representatives of each band were invited to attend, but because of geographic proximity, several members from the McLeod and West Moberly First Nations, as well as interested stakeholders, attended the meeting at Saulteau (**Section 2.4**).

5. *Consultation with Northern Health* – A meeting was held in Prince George BC on January 20 with several representatives from Northern Health. The objective of this meeting was to introduce the objectives by the FWCP-Board regarding the Williston Reservoir fish mercury advisory and determine the means by which Northern Health can be involved in decision making (**Section 2.5**).

6. *Data Summary* – This section summarizes all available, historic data on fish mercury concentrations for a variety of fish species from Williston Reservoir watershed, between 1980 and the current day (**Section 2.6**).

7. *Data Gaps* – A number of data gaps were identified as a result of execution of the above steps. Data gaps were assembled as a result of consultation with First Nations, Province of BC, BC hydro and the data summary. These gaps will help guide data requirements for a dedicated field program within the reservoir (**Section 2.7**).

8. *Mercury Advisory Strategy* – The province of BC is unfamiliar with fish consumption advisories for mercury. In order to address the advisory, a strategy will need to be developed that is transparent and provides an unambiguous way forward. This strategy may employ new data, new science and advice / guidance from other provinces or agencies (**Section 2.8**).

9. *Next Steps / Phase 2 Scope of Work* – The deliverable of the Scope of Work for next steps has been partly based on discussions held with all parties contacted including First Nations, FWCP-Peace Board members, select public stakeholders,

Province of BC, BC Hydro and Northern Health and distilled from outcomes of the above tasks. This section presents a sequence of concise and clear next steps for the Board to follow to initiate and execute a phased approach to the Terms of Reference that will ultimately guide a field investigation in Williston Reservoir that will gather the necessary information required to address the advisory. This will include timing, fishing locations, fish species, sample size, sampling design considerations, reference areas and identification of partners in the process during implementation (**Section 2.9**).

10. *Community Engagement* – Participation by key First Nations communities during each step of the process is essential and they are seen as key participants in the process. For example, input from recreational fishers and First Nations will be important in designing and executing any field investigation. Roles and requirements are outlined here.

2. FINDINGS

2.1. Consultation and Engagement Summary

The first step of the engagement process was to discuss the issue of mercury in Williston Reservoir watershed fish with the First Nations Working Group and Board members (**Table 1**) to acquire an understanding of what people thought or believed to be most important from their community's perspective. The information gathered would be used to develop a list of key questions for which a common understanding and approach would be sought. To this end, all members of the First Nations Working Group and the Board (**Table 1**) were contacted directly by telephone and by email to arrange telephone interviews. The majority of people contacted provided input and feedback to questions posed, or offered opinions and statements regarding their understanding of the issue and what they have 'heard' or understood. Although the format of the interview was informal, the conversation was directed by querying individuals about their knowledge of the issue of mercury in fish and in Williston Reservoir in particular. This included their awareness regarding risk of mercury exposure via water, fish or other country food sources (e.g., wildlife), the amount of fish that can 'safely' be consumed, or whatever other issues regarding mercury they wished to express.

A summary of the key messages received, distilled from the information provided by the respondents is provided below. None of the comments or concerns expressed here are ascribed to any individual, as all responses were considered confidential. An overview of key points was also presented to the board in Prince George on October 21, 2014 (see **Section 2.3**). Key findings of the consultation and engagement phase of this study are as follows:

- *Concern about Dietary Restrictions of Fish due to Mercury* – Most people interviewed indicated that they believed that mercury levels in fish from Williston Reservoir were "high" and that they have held this concern for a long time. Most people believed that consumption of only one to three fish meals per month of bull trout was permissible to stay within a 'safe' level of mercury exposure. However, most people did not know specifically where or how they heard about this, or how it came to be common knowledge. At a supplemental meeting in Saulteau First Nation in December, we learned that the source of this knowledge might have come from a variety of sources, including health agencies, BC Hydro information and 'signage' (historically situated along the river) that advised people about mercury (see **Section 2.4** below).

  Related to this issue, some said there is concern that this issue infringes on treaty rights. People are not sure what to believe, having heard much conflicting information, such as the 'fish are mercury contaminated' and that 'you should not eat more than 1 fish per month', while some others say that you can eat several, or many meals per month.

- *Avoidance of Fish* – Because of the advisory and the uncertainty regarding the potential spatial extent of the issue (i.e., due to migration of fish with elevated tissue mercury concentrations), many people have said they have chosen to avoid eating fish, eat fewer fish, or have residual concerns when consuming fish from a wider area than just Williston Reservoir.

- *Crooked River Study* – Several people mentioned the recent data collected for bull trout from Crooked River in 2012 (West Moberly First Nation 2013), which has exacerbated concerns for some. Some people indicated they heard that only a few of the 60+ fish captured were 'safe' to eat. Fish were captured in spring and were relatively large fish, greater than 18 inches and 10 – 15 pounds. The belief is that these fish came from Williston Reservoir via the McLeod, Pack and Parsnip rivers to access the Crooked River. They also captured rainbow trout (8 – 10" 1 – 1.5 lbs) from the Pack river. The fish were quite fatty and there was a belief that there is more mercury in the fat than the flesh.

- *Residual Mercury in Williston Reservoir Vegetation* – Some people believed that the submerged standing trees or forest in Williston Reservoir is a continuing, residual source of mercury. We were told that this is a common belief as there was no clear cutting prior to flooding, reflecting an understanding that there is a relationship between flooded forest and residual or stored mercury. Thus, "people simply don't want to eat the fish" from the reservoir.

- *Downstream Effects* – A few people mentioned that they have been concerned for some time about the downstream effects that Williston Reservoir has had on fish in Dinosaur Reservoir and further down the Peace River. The suspicion that

Williston Reservoir is still a source of mercury to downstream areas (i.e., via water or biota [plankton, fish]) has led to a reluctance by some to eat fish.

- *Contamination of Other Media* – A minority of respondents indicated that they believed that all animals and water in the region are 'contaminated' with mercury. This is because some people reasonably surmised that if animals drink the water from Williston Reservoir they may also absorb mercury, or that upstream fish migrations spread mercury. A few people indicated they were concerned for wildlife species, such as moose. However, most people indicated that they did not perceive there was a health risk to other animal species – they did not regard mercury as an issue for other wildlife species. However, at least one person expressed a concern that plants along the shorelines of Williston Reservoir may contain methylmercury and there was concern for the moose that may feed on these plants. With the belief that everything is connected in the environment, if mercury is in fish, it must also be in other things.
- *Effects on Human Health* – No person specifically suggested or identified any existing perceived adverse effects on human health related to mercury exposure from fish consumption. However, people indicated that they avoid eating fish because of perceived risk related to the advisory (e.g., avoidance of bull trout in Tsay Keh Village). One individual commented that 'if it is bad for pregnant women, it is certainly bad for me'. This perception has caused people to avoid eating fish, or be wary of potential adverse effects.
- *Ecological Shifts* – Several people mentioned that there have been significant ecological changes in the reservoir over time. For example, since kokanee were introduced to the reservoir this species has rapidly expanded in numbers and in distribution, extending farther up several main tributary streams. Wolves and bears have been seen feeding on or targeting kokanee as a food source. Furthermore, lake trout (*Salvelinus namaycush*) appear to be taking over from bull trout as a top predator in the system. Kokanee are now present in all accessible rivers from Williston; First Nations members are not interested in eating them, but they do have concerns about other animals that are eating them. Some people identified kokanee as a vehicle for export of mercury from the reservoir.

Summary – Mercury remains a health concern for members from several First Nations communities. In the absence of well-communicated, updated scientific information documenting current mercury levels, many perceptions regarding the safety of country foods have arisen that appear to have affected resource use in the region. These range from moderate interpretations of the consumption advisory for the reservoir (e.g., the widespread belief that only one to three meals per month of fish from the reservoir is permissible) to very conservative assumptions regarding the extent of mercury transfer through the food chain and spatially over the landscape. Overall, there was a general consensus that more information was needed to help make informed decisions.

2.2. Summary of Mercury Science

A two-page document entitled '*Overview of Mercury in the Environment*' was prepared for this project to provide basic information on the chemical nature and use of mercury, different chemical forms of mercury (e.g., methylmercury), dynamics of methylmercury generation and bioaccumulation in reservoirs and aquatic food webs, summary of fish mercury concentrations in Williston Reservoir and explanation of the concept of mercury exposure and dose. This document was presented to all members of the Board and First Nations Working Group (**Table 1**) and Northern Health and is presented in **Appendix A**.

2.3. Board Meeting Presentation

On October 21, 2014 R. Baker presented his preliminary findings of the Phase 1 consultation and engagement findings to the FWCP-Peace Board and First Nations Working Group in Prince George. This presentation was prefaced by an overview of his role, experience and objectives of this Phase 1 scope of work. A copy of the PowerPoint presentation given at this meeting is provided in **Appendix B**.

2.4. Direct Community Consultation

On December 10, 2014 a meeting was held in Saulteau First Nation to further discuss information presented at the Board meeting. While all First Nations were invited, due to geographic proximity and ease of travel, members from Saulteau, West Moberly and the McLeod Lake First Nations attended, as well as two members from the Peace River Environmental Association. The agenda and attendees at this meeting are provided in **Appendix C**, in addition to the PowerPoint presentation delivered at the meeting. A brief summary of the issues discussed and input from the participants is as follows:

- There was a wide-ranging discussion on the general topic of mercury, its chemical forms (i.e., inorganic mercury and methylmercury), how it is sequestered from the atmosphere by plants and accumulated in soils, transformed by bacteria to methylmercury when soils are inundated during reservoir creation, the methylmercury bioaccumulation phenomenon through the aquatic food web to reach highest concentrations in fish, the time frame and pattern of elevation in fish mercury concentrations in reservoirs, a background on health effects from exposure to too much methylmercury, how protective guidelines have been developed and applied by different health agencies, inherent conservatism and rationale for this and relevance of this to First Nations communities.
- Many questions and answers were provided at the meeting, such as why mercury in fish in the Peace River are as low as they are, and why they are low relative to other Canadian fish. Some participants asked specific questions related to the proposed Site C Clean Energy Project. Other topics included direct effects to fish

from exposure to methylmercury, downstream effects, the concept of reference lakes and pre-development mercury concentrations.

- Some discussion ensued regarding how it came to be understood that a very limited number of fish meals was permissible from Williston Reservoir and other areas. There was no definitive answer, but there was some belief that this guidance came from direct interpretation of the vague advisory in the Sports Fishing Regulations, and/or from BC Hydro and health agencies. It was also stated that at some time in the past, there were signs on the reservoir advising people not to consume or limit fish consumption due to concerns with mercury.
- This information delivered during the presentation was then used to help to frame and scope the main objectives of Phase 2 of the work. That is, what species are of greatest interest to First Nations and recreational fishers? What is the geographic scope of the study? How can partnerships be formed in the communities? How will the communities 'champion' the project and carry it forward to their membership? How will this information be used to make decisions about fish consumption from different lakes? The feedback from these questions has been incorporated into **Section 2.6.2** under the study design component.

2.5. Presentation to Northern Health

R. Baker met with Dr. Sandra Allison, Dr. William Osei, Barb Oke and Doug Quibell of Northern Health on January 16, 2015 to discuss the FWCB-Peace objectives for this project. A copy of the PowerPoint presentation is located in **Appendix D**; minutes of the meeting are provided below.

> Minutes of the January 16, 2015 meeting between Northern Health and Randy Baker, Azimuth:
>
> Northern Health is a key participant in the process to address the fish consumption advisory for Williston Reservoir. Determining the process by which a decision can be made to revise or discard the advisory and what information is required by that agency or others (e.g., Health Canada) to make this decision is seen as a critical data gap. We recognize that Northern Health has no experience with the issue of mercury advisories, given that there are only three advisories in the province of BC, all of which were applied at least 20 years ago. Thus our presentation necessarily contained elements of the mercury 'fact sheet' (**Appendix A**) and an overview of the objectives of this project and preliminary results of the consultation and engagement process.
>
> A summary of the meeting minutes, as assembled by Northern Health is as follows. Randy is working for the FWCP-Peace and has been retained to consult with BC Hydro, Province of BC, Northern Health, and First Nations FN

participating with FWCP-Peace. A document prepared by the Province of Quebec and Quebec Hydro entitled "The Northern Fish Nutrition Guide" for the James Bay Region was presented as an example that provides fish consumption advice specifically for First Nations fish consumers that is not conservatively based on Health Canada guidance. The guide can be found at http://www.hydroquebec.com/sustainable-development/pdf/guide-baie-james-en.pdf. Randy indicated that a field program will be initiated in 2015. The FWCP-Peace is seeking a clear path forward before beginning studies, identifying roles and responsibilities of interested parties and a determination of what information is needed to address the advisory?

Some of the issues presented and discussed included devising an advisory similar to what was produced for James Bay, a discussion of new science suggesting that mercury/selenium ratios should be considered, given the protective effect from mercury that selenium has demonstrated. In addition, better information on consumption rates of both First Nations and other sports fisherman is needed to make better decisions. Randy also indicated that the study will examine mercury concentrations in nearby reference lakes as a baseline to compare with Williston. It was suggested that a working group dedicated to this issue be formed, to identify a path forward. However, Northern Health indicated that its resources were slim and that is was premature to form such a group without more recent fish mercury data to discuss. Ideally, it would be beneficial to have a clear indication of outcomes/thresholds before collecting field data, however, given the constraints of Northern Health, this is not likely possible. At a minimum we discussed having a single point of contact from Northern Health, who would be willing to participate with a working group in the future.

Northern Health indicated that further data (tissue and consumption information) are required in order to address or lift the advisory. Northern Health has limited capacity; however, a single point of contact can be resource.development@northernhealth.ca. In addition, Linda Pillsworth of the First Nation Health Authority should be consulted during planning. In the short-term, no one is available or has the capacity to actively sit on a working group. Northern Health envisages their role in more of a review capacity – for example reviewing the study design, with help from other health agencies and then reviewing the results with technical support from Ministry of Health, BC Center for Disease Control and potentially Health Canada. Input from other agencies will be required to help make decision on whether advisory could/should be lifted. Northern Health reiterated that they would not have a direct role in carrying out any studies. They requested at least a one month notification prior to review of any documents or study designs and/or data.

2.6. Overview of Existing, Relevant Information

This section summarizes what is known about mercury concentrations in fish and other media from Williston Reservoir. A brief chronological summary of results is presented below. Since reservoir creation in 1968, there have only been three dedicated surveys of mercury concentrations in fish within Williston Reservoir; these occurred in 1980, 1988 and 2000. No further collections of bull trout or any other species have been made for the purposes of understanding fish mercury patterns since 2000. The only other related study was the 2012 collection of bull trout from the Crooked River by the West Moberly First Nation (2013) – where some or all of these fish are presumed to originate from the Parsnip Reach of the reservoir.

Details of the findings of mercury studies within Williston Reservoir are described below. Note that all fish mercury data are discussed in terms of parts per million (ppm) wet weight (ww), which is equivalent to mg/kg or µg/g (i.e. micro-gram of mercury per gram of wet fish muscle tissue), depending on the laboratory or author that presents the data. When referring to mercury in fish, it is assumed that the vast majority of this mercury (>90%) occurs as methylmercury. Fish are the only aquatic animal species where chemically, methylmercury comprises the vast majority of the total concentration of mercury measured in the animal (Bloom 1992).

1980 – Health and Welfare Canada (1980, unpublished). Health and Welfare Canada collected 35 bull trout from near the mouths of the Akie (13 fish) and Ingenika rivers (22 fish). Raw data are found in Baker (2001). Thirty lake whitefish (*Coregonus clupeaformis*) were also collected. This was the first collection of fish for mercury analysis since reservoir creation in 1968; there are no pre-flood data. Based on the Health and Welfare Canada data, the arithmetic mean (range) mercury concentrations in bull trout were 0.58 ppm (0.16 – 1.69 ppm ww) and 0.71 ppm (0.20 – 1.62 ppm ww) respectively from Akie and Ingenika locations.

The arithmetic mean mercury concentration in 30 lake whitefish from the Akie and Ingenika areas in 1980 was 0.19 ppm (0.10 – 0.38 ppm) at an average fish length of 405 mm.

1988 – BC Hydro (1988, unpublished data). BC Hydro collected 41 bull trout and 22 lake whitefish in 1988 from the Finlay Reach and analysed muscle tissue for mercury concentration. Two lake trout and 16 kokanee were also sampled. The mean bull trout mercury concentration was 1.16 ppm (0.14 – 4.87 ppm) and appeared to have increased since 1980. The maximum mercury concentration of 4.87 ppm was one of the highest fish mercury concentrations recorded in British Columbia (Baker 2001). However, the fish sampled in 1980 were smaller (450 mm) than the mean size sampled in 1988 (553 mm) and some degree of variation is to be expected. It is well known that larger, carnivorous

fish typically have higher mercury concentrations than small, young fish. Nevertheless, there was no diminishing trend in concentration apparent between 1980 and 1988.

Because the average fish mercury concentration in the 1988 samples exceeded the recommended 'historic' federal guideline for commercial sale and consumption of fish (0.5 ppm), an advisory was placed on bull trout from Williston Reservoir in 1992 (see **Section 1.1**). This advisory has been published within the BC *Freshwater Fishing Regulations Synopsis* on an annual basis and states that normal consumption of bull trout from Williston Reservoir does not pose a health risk, but high consumption might. In 2008 an additional mercury advisory was added to the *Synopsis* that provided a link to a BC Ministry of Health "Health Guide" providing more information on healthy eating and fish consumption guidelines. Note that mercury concentrations in fish are not routinely monitored in BC lakes and reservoirs, given typically low levels. Nevertheless, in 2013, lake trout were also added, 'unofficially', to the Williston mercury advisory. This presumably was done in response to the increased abundance of lake trout in the reservoir and the expectation that mercury levels would be similar to those found in bull trout. However, there are no mercury data for lake trout in Williston Reservoir.

Other data gathered from Williston Reservoir and downstream, by BC Hydro in 1988, included the following:

- Lake whitefish mean mercury concentration (n = 22 fish, 301 mm) from Finlay Reach was 0.23 ppm, ranging from 0.07 – 0.40 ppm.

- Lake whitefish mean mercury concentration from Dinosaur Reservoir in 1988 (n = 25 fish, 343 mm) was 0.10 ppm, ranging from 0.03 – 0.14 ppm.

- Four bull trout from Dinosaur Reservoir in 1988 had a mean mercury concentration of 0.10 ppm, mean length 377 mm).

- Lake whitefish mean mercury concentration from Peace River downstream of Dinosaur in 1988 (n = 20 fish, 338 mm) was 0.09 ppm, ranging from 0.05 – 0.17 ppm.

- Lake trout mercury concentrations from two fish captured in Parsnip Reach in 1988 were 0.17 ppm and 0.46 ppm. Two lake trout captured in the Peace Reach had mercury concentrations of 0.21 ppm and 0.26 ppm.

- Kokanee (*Oncorhynchus nerka* – landlocked sockeye) mean mercury concentration from Peace Reach in 1988 (n = 16) was 0.04 ppm, ranging from 0.02 – 0.05 ppm.

2000 – EVS Environment Consultants (Baker et al. 2002). In 2000, EVS collected 45 bull trout and 23 lake whitefish from a number of tributary stream mouths within Finlay

Reach. In addition to fish, the EVS (Baker et al. 2002) study included measurements of total and methylmercury concentrations in surface waters, sediment, sediment pore water, benthic invertebrates and zooplankton in Finlay Reach and the Junction area to understand mercury dynamics in the aquatic food web of the reservoir. Key results are as follows:

- Total (THg) mercury (i.e. the sum of inorganic and methylmercury concentrations) and methylmercury (MeHg) concentrations in water throughout Finlay Reach were low (THg = 0.4 – 1.5 ng/L, MeHg = <0.04 – 0.09 ng/L; note that 1 ng/L = 1 part per trillion or 1,000 µg/L). These water data are consistent with concentrations found in pristine lakes (Hurley et al. 1995, Kannan et al. 1998, Krabbenhoft et al. 2007).
- Total mercury concentrations in sediments from all stations in Finlay Reach in 2000 and 2001 were also low (0.024 to 0.092 µg/g dry weight [dw]) with MeHg accounting for about 1% of this total. The sediment data are consistent with concentrations found in pristine lakes (Kannan et al. 1998, Kamman et al. 2005, Krabbenhoft et al. 2007).
- Total mercury concentrations in zooplankton ranged from 0.03 to 0.18 µg/g dw in August 2000 with methylmercury comprising from 19 to 70% of the total. Total mercury concentration in benthos ranged from 0.15 – 0.57 µg/g dw in 2000, with methylmercury accounting for 40% of total concentrations. These concentrations are also typical of zooplankton and benthos from pristine lakes.
- The arithmetic mean mercury concentration of 47 bull trout in Williston Reservoir from the 2000 study was 0.46 ppm, ranging from 0.08 – 2.22 ppm. The mean concentration is lower than the ‘guideline’ used in 1992 to place an advisory. However, fish size in 2000 was smaller than in 1988, especially in terms of mean weight. To make comparisons in mercury concentrations over time or between waterbodies, a standardized or common size must be used. For the purposes of this study and based on mean historic size of bull trout, a standardized size of 550 mm was chosen.
- Based on standardized size of 550 mm, bull trout mercury concentrations in 2000 was 0.56 ppm. This concentration was significantly lower than in 1980 (0.85 ppm) and 1988 (0.87 ppm).
- Mean mercury concentration of 22 lake whitefish (mean length = 238 mm) from Finlay Reach was 0.14 ppm, ranging from 0.03 to 0.24 ppm. Based on a standardized length of 300 mm, the mean was 0.19 ppm in 2000, higher than in 1980 (0.09 ppm), but equivalent to the 1988 concentration (0.21 ppm). Given the small sample size and different size fish, it is difficult to say how real these changes are over time. We have noted that mean fish size has been steadily decreasing over time, with smaller fish captured in 2000 than historically.

Note that the Baker et al. (2002) study did not locate mercury concentrations for bull trout from nearby lakes or other systems for comparison. No surveys for mercury in bull trout have been conducted in northern British Columbia outside of this watershed.

2012 Crooked River Bull Trout. In September 2012, the West Moberly First Nation (2013), with assistance from Rescan Environmental Services (Vancouver BC) collected more than 60 'large' bull trout from the Crooked River for analysis of mercury and metals. The Crooked River capture location is about 60 km south of the southern arm of Parsnip Reach of the reservoir. The fish are presumed to have originated from Williston Reservoir. Length (mm), weight (g) and age (y) data of the bull trout were also collected. These data are currently unavailable to us, but it is our understanding the data will be made available in April 2015. The largest fish captured by the West Moberly First Nations (2013) study weighted more than 10 kg, but was not analysed for mercury. The mean mercury concentration of ~60 fish analysed was 0.44 ppm, ranging from 0.04 ppm – 1.0 ppm. A size-adjusted concentration cannot be calculated until we acquire fish length and any other ancillary data.

FWCP-Peace Funded Programs – Several recent studies (e.g., Sebastian et al. 2009, Plate et al. 2012) have confirmed that the fish community within Williston Reservoir has evolved and may be continuing to change. Depending on the new food web structure, this may further influence mercury dynamics and bioaccumulation by fish. Since 2000, the abundance of lake whitefish has continued to decline, so that this species now appears to constitute only a very small portion of the fish community. Alternatively, kokanee has increased considerably in abundance, particularly in the Peace Reach. This species appears to have now assumed a dominant role with respect to abundance in the reservoir. In response to this, lake trout may also be displacing bull trout as the top level predator in this system.

The possible absence of lake whitefish, absence of data for kokanee and paucity of data for bull trout and lake trout, notwithstanding the shift in population structure, adds further uncertainty to mercury concentrations in key species and changes over time.

2.7. Data Gap Summary

It has been 15 years since a dedicated survey of fish mercury concentrations has been conducted within Williston Reservoir and/or important tributary streams. The most recent collection of fish from Finlay Reach in 2000 (Baker et al. 2002) suggested that fish mercury concentrations have diminished since the 1980 and 1988 studies. A brief summary of key data gaps identified from this work are as follows:

- No information on mercury concentrations in Williston Reservoir fish have been collected since 2000, 15 years ago. This is too long ago upon which to make decisions today.

- The spatial resolution of our understanding of fish mercury concentrations is very small. Good data exist only for Finlay Reach, but these are 15 years old. Data for the Parsnip and Peace reaches of the reservoir are more than 25 years old.

- There are few recent fish mercury data or fish population data for Dinosaur Reservoir.

- There has been a change or evolution of fish population structure within the reservoir, particularly over the last 10 – 15 years. This has resulted in a shift of key species. Recent fish population data collected suggests that lake trout may have taken over as the top predator within the reservoir and that kokanee may have taken over from whitefish as a key food web species. Bull trout will still persist, but they would be limited in distribution to tributary streams and at the mouths of these streams in the reservoir. However, as shown by the Crooked River study, bull trout are still harvested and consumed from some rivers and reservoir areas where they continue to exist in significant numbers.

- There is very little information on harvest patterns by local First Nations communities or local fishing groups and individual harvesters. Knowing what species are being harvested for consumption and from where, will help target or narrow down areas within Williston Reservoir from which to collect fish. This information is needed prior to implementing a field program.

- There is a lack of regional and/or reference information on mercury concentrations of key species (e.g., bull trout, lake trout, whitefish) in nearby watersheds unconnected to Williston. It is not known how Williston Reservoir fish mercury concentrations compare to the same species in regional waterbodies.

In addition to the above specific points, other data gaps may be revealed or may be more subtle, such as the absence of experience within BC regarding fish mercury consumption advisories, or how to best apply recent science into the decision making framework.

2.8. Mercury Advisory Considerations / Strategy

British Columbia regulatory agencies currently have no experience with fish consumption advisories due to mercury. There are only three historic fishing advisories on BC waterbodies – for Pinchi and Jack of Clubs lakes due to mining and Williston Reservoir in 1992, the only advisory on a reservoir. By contrast, many other provinces such as Saskatchewan, Ontario and Quebec, have advisories on many hundreds of lakes due to mercury and have well developed strategies and communication protocols to deal with this issue. Given that it has been more than 30 years since an advisory was placed, BC regulatory and health agencies have no experience with this issue and no established provincial process or existing decision-making framework to guide them. Furthermore,

the placement of fish consumption advisories is a provincial matter and each province across the country takes a different approach. There is no harmonization for this process within Canada.

Further consultation will be required with all interested parties to develop a plan to update the mercury advisory currently in place for the Williston Reservoir. Ultimately what is required is a transparent decision-making framework or decision matrix to identify the steps required to update the advisory based on new and existing scientific information. This framework should establish the data requirements to make decisions and an approach to update or eliminate the advisory. These guidelines may follow Health Canada guidance or may be adopted to be specific to British Columbia, as has been done in Quebec (e.g., Institute National de Santé Publique du Quebec 2013) for example.

2.9. Next steps and Development of Scope of Work

The most recent survey of fish mercury data for key species from Finlay Reach, Williston Reservoir took place 15 years ago. There are no data from other parts of the reservoir since 1988, more than 25 years ago. Given the lack of recent data and limited spatial extent of data collected from the reservoir, it is clear that an updated fish mercury database is required from Williston Reservoir in order to make informed decisions. In light of the on-going ecological changes to the fish community occurring within the reservoir that may affect mercury bioaccumulation patterns, consideration should be given to establishing a long-term monitoring program in Williston Reservoir, with regular (e.g., every five years) fish collections from pre-determined locations to track changes over time. This is common practice for reservoirs in other Canadian provinces, such as in Manitoba (Bodaly et al. 2007, Jansen and Strange 2007) and Quebec (Schetagne et al. 2003).

Assuming that an updated fish mercury database from Williston Reservoir is required, several key data gaps must be filled to address differences associated with the large geographic scale of the area, fish species, study design and other aspects. Recommendations to identify next steps and SOW development are provided below.

2.9.1. Creel Survey

In order to definitively identify those fish species that are routinely captured and consumed to determine the main pathway of exposure to mercury by recreational and First Nations fishers, a creel survey is recommended. Within First Nations communities this information is best gathered through the Band Offices via harvest surveys, fishing derby’s (e.g., annual fishing derby at Mackenzie, Hudson’s Hope) and/or dedicated consumption surveys of select households by in-person interviews or surveys. Following are the most important data requirements:

- Fish species targeted
- Location of capture
- Frequency of capture from each location and timing (e.g., once annually, twice per month during open water, weekly during summer, etc.)
- Average serving size (gm) per meal to determine exposure.
- Frequency of consumption by different members of the household including adults, women of child bearing age, teenagers, children, toddlers.

This information will assist in informing and focusing the study design parameters above and if necessary, provide information on magnitude of exposure to mercury by different receptor groups (i.e., adults, children).

2.9.2. Spatial Resolution in Williston Reservoir

Williston Reservoir measures 250 km along the north-south axis and 150 km from east to west and is the seventh largest reservoir in the world, by volume. Given the very large spatial extent of the reservoir, there is inherent uncertainty regarding whether fish captured in one reach are representative of another reach. In addition, some species, such as bull trout, ascend key tributary streams for spawning and rearing, further expanding the geographic scale. Furthermore, given the widespread geographic distribution of communities that might access the reservoir (e.g., Tsay Keh, Mackenzie, McLeod Lake, Ft. St. John), consideration should be given to acquiring data from several discrete areas of the reservoir, including the following:

- Finlay Reach – To match up with and compare to historic data from this area in 1988 and 2000. This area may also be fished by members of Tsay Keh Dene and Kwadacha First Nations.
- Parsnip Reach – This area is easily accessible by residents of Mackenzie and the McLeod, Saulteau and West Moberly First Nations.
- Peace Reach – This area feeds Dinosaur Reservoir and Peace River downstream. Also, there are boat launch facilities on the Peace Reach (e.g., Dunlevy, Elizabeth Creek, Portage Mountain) that recreational and First Nations fishers can use to access the reservoir.
- Tributary Streams – Based on findings of the West Moberly First Nations (2013) study of bull trout from the Crooked River and the belief that these fish originated from Williston Reservoir, there may be a requirement or need to determine mercury concentrations from select, migratory species such as bull trout or

kokanee, if they are targeted by upstream communities. Monitoring of fish from key tributary streams to Williston Reservoir should be considered and might include Parsnip River, Crooked River, Finlay River and possibly others, pending direct discussions with First Nations, recreational fishers and the FWCP-Peace Fish Technical Committee members.

2.9.3. Fish Species Selection

There is good historic continuity for only one species, bull trout, which has been targeted in all surveys, including the most recent Crooked River study. Lake whitefish has also been a target species, however, considering the evolution of fish species within the reservoir and the apparent decline in abundance of lake whitefish, capturing a sufficient number of fish, from different areas, might be difficult. Following is our recommendation and rationale for species selection. Note that this list might change pending the outcome of community consultation, a creel survey (**Section 2.6.3.3** below) or during a field investigation:

- *Bull trout* – This has been the target species in all historic surveys and is specifically named by the consumption advisory. Bull trout are migratory and have been targeted by First Nations in tributary streams outside of the reservoir and are a preferred sport fish by recreational fishers. Note that according to the regulations, bull trout may only be retained by recreational fishers from the reservoir during the non-spawning window (August 15 – October 15) and may not be retained from streams.

- *Lake whitefish* – Although abundance of this species has declined, there is a reasonably good historic database for this key food chain species of bull trout and possibly lake trout. Because lake whitefish are presumed to be an important dietary item of bull trout, knowledge of the mercury concentration of this species is important.

- *Kokanee* – Kokanee appears to have replaced lake whitefish as the key food chain species of upper level predators in the reservoir. Given the near absence of data, this species should be targeted to understand mercury concentrations of this species as a dietary item of bull trout and lake trout, as well as to address the magnitude of exposure to mercury by wildlife species such as eagle, bear and wolf.

- *Lake trout* – As the fish community of Williston Reservoir continues to evolve, it may be that lake trout becomes the dominant top-level predator and thus targeted by First Nations and recreational fishers. Furthermore, although lake trout have been added to the advisory, there are virtually no mercury data for lake trout.

Should other species be identified by First Nations or recreational fishing groups (e.g., Arctic grayling), these can be considered. Graying would not normally be considered a target species because they feed on terrestrial or aquatic invertebrates in areas outside of the direct influence of the reservoir. Thus, the above four species are considered the most important from an historic continuity and exposure perspective by humans and wildlife.

2.9.4. Statistical Design Considerations

It is well known that as a fish gets larger in terms of length and weight, or older, mercury concentration in the muscle tissue increases (Bodaly et al. 1984; Somers and Jackson, 1993). In addition, highly carnivorous or piscivorous (i.e., fish-eating) species such as lake trout, bull trout and burbot (*Lota lota*) tend to have higher mercury concentrations than omnivorous fish such as rainbow trout, whitefish and suckers, that consume food with lower mercury concentrations. Thus, fish with the highest mercury concentrations tend to be the largest and/or oldest fish of these piscivorous species.

To monitor mercury concentrations in fish populations over time or between geographic areas, one must be very careful about the size of fish being compared, to avoid the bias of differences in size or age. To control for this, mercury concentrations should be measured in fish across a wide size range, from small, young fish to large, old fish. Appropriate statistical procedures, such as analysis of covariance (ANCOVA), are then used to characterize the size-mercury relationship and to test for statistical differences between areas or over time. Once the relationships are known, they can be used to determine the average mercury concentration of the fish population being measured at a specific size, usually the size most commonly captured by fishers or eaten. This is called the size-adjusted or “standardized” mean mercury concentration. Typical standard lengths used in BC and other provinces are 550 mm for bull trout (and lake trout) and 350 mm for lake whitefish. When this is done for multiple lakes or years, comparisons of mean mercury concentration can be made that are unbiased by differences in fish size.

The following table lays out a size-stratified study design for 30-35 fish per species, which is the target sample size to generate a reliable and precise size- mercury relationship for each species. Length is most frequently used because it is easy to measure, changes slowly over time and is less affected by short-term life history influence such as stomach weight and spawning condition. Note that these sample size recommendations would need to be implemented in each area of interest. Adding a reference water body (or two) would proportionately increase the number of fish sampled.

Following are the recommended numbers of fish to be targeted, by length interval, to generate a length – mercury distribution, for the four species mentioned above. Actual sample size will vary depending on fishing success and ecological changes in the reservoir since the last survey.

Suggested sample size, by length interval for target species.

LENGTH INTERVAL (MM)	LAKE WHITEFISH	LAKE TROUT	BULL TROUT	KOKANEE
100-199	12			12
200-299	12			12
300-399	12	7	7	?
400-499	?	7	7	
500-599		7	7	
600-699		7	7	
>700		7	7	
Total	**36**	**35**	**35**	**24**

2.9.5. Reference Waterbodies

All fish contain mercury. Given Williston Reservoir was created nearly 50 years ago, well beyond the time where fish mercury concentrations are elevated due to reservoir creation (i.e., 25 – 30 years post-impoundment; Bodaly et al. 2007, Shetagne et al. 2003) concentrations should have 'stabilized' at a new equilibrium. How these values currently compare with mercury concentrations in key species such as bull trout, lake trout, whitefish and kokanee from other regional waterbodies is unknown. As part of any well designed, long-term monitoring program, data from at least one and preferably more, reference waterbodies are essential to: a) compare with impact or exposure waterbodies; b) establish spatial patterns within a discrete geographic area; and c) compare trends over time within Williston Reservoir relative to other lakes/streams.

Given that Williston Reservoir is much more 'lake-like' than river-like, it may be difficult to find a sufficiently large lake with healthy populations of bull trout and lake trout, as well as other species such as lake whitefish (or mountain whitefish, *Prosopium williamsoni*) and kokanee. It may be that several waterbodies may have to be sought to characterize 'background' mercury concentrations to target key species (i.e., a lake population of lake trout and a riverine population of bull trout that is un-connected to the Williston Reservoir watershed).

Identification of reference waterbodies will necessarily involve input and guidance from local First Nations, recreational fishing organizations and provincial government staff (MOE, MFLNRO) staff. In this way we can take advantage of local knowledge and opportunistically harvest tissue samples from fish during routine or scheduled monitoring programs rather than launching a targeted study, which is much more cost-efficient.

Reference lakes ideally should be physically unconnected to Williston Reservoir, have a similar latitude, similar limnological conditions and fish species community. Candidate reference waterbodies might include the following:

- Babine Lake – Contains lake trout, kokanee, rainbow trout (*Oncorhynchus mykiss*).

- Takla Lake – Contains lake trout and lake whitefish, not known if it contains bull trout

- McLeod Lake – Contains bull trout and whitefish and is actively harvested. However, there is uncertainty about this lake as a reference for bull trout should Williston bull trout move through here and up the Crooked River.

- Thutade Lake / Upper Finlay River – There is an impassable falls that prevents movement by bull trout from Williston Reservoir into this section of the Finlay.

2.10. Community Engagement and Participation

One of the major outcomes of the engagement and participation process with First Nations represented on the FWCP and direct discussion with the Saulteau, McLeod and West Moberly Bands, was the desire that community members be involved at each step along the way. In particular they expressed how important it was for them to participate in and understand the overall strategy and procedure to collect and process fish for analysis of mercury or other parameters. Outcomes of the data analysis affect them directly and it is important that follow-up communication be incorporated into the overall strategy for dissemination of information.

During the design phase of the program, input from each of the bands should be sought to determine the key fish species of interest, fish size most frequently consumed, the area's most frequently fished within the Williston Reservoir watershed, insight into potential reference waterbodies and other information as needed. This may also include field related materials such as boats, gill nets and other fish capture gear.

Identifying a 'champion' or coordinator within each First Nations community (working with the First Nations Working Group), recreational fishing group and any other regional community interests is essential. This person or persons would be responsible for the following activities:

- liaise with the study coordinator to determine what resources can be brought to bear to support the overall project;

- organize and coordinate for routine or opportunistic collection of fish tissue samples during regular or routine fishing events;

- engage recreational and First Nations fishers to acquire and store fish tissue samples during routine fishing trips, from fish derbies members (e.g., Portage Mountain Yacht Club, Mackenzie, for example), creel surveys or other means. Instructions and materials for the collection, preservation and storage of fish tissue can be distributed and coordinated by the champion;

- act as point person for the dissemination of findings of results of fish mercury data to individuals and the community in general.

At the community meeting in Saulteau on December 11, 2014 this was identified as an important part of the continuing engagement process.

3. SUMMARY OF NEXT STEPS FOR SCOPE WORK

Ultimately, one of the main outcomes of this document is to provide the FWCP-Peace Board with a summary of next steps. Action-oriented, sequential directives for implementing a Scope of Work to gather the necessary information required to address the fish consumption advisory in Willison Reservoir. Using what has been learned from the community consultation and engagement process, our understanding of historic mercury data from the reservoir and current ecological conditions, we recommend the following sequential steps, with the ultimate goal of building a fish mercury database that will allow for clear and unambiguous decision making.

1. **Develop and issue a Terms of Reference (TOR)** – A professional should be engaged to assist with implementation of the Scope of Work steps outlined below.

2. **Form a Mercury Technical Working Group** – A decision regarding the advisory cannot be made in isolation by the PWCP-Peace Board or any other single agency. Thus it is our recommendation that a 'Mercury Technical Working Group' be formed consisting of representatives from key First Nations communities, health agencies (e.g., Northern Health, Ministry of Health), Government of BC (e.g., MOE, MFLNRO) and BC Hydro. The group will be organized and led by the consultant. At the outset, little will be required from members of the group. The consultant will apprise the working group on a monthly basis regarding progress made as the steps of work are undertaken.

3. **Identify 'Champions'** – Identify 'champions' whose responsibility would be to act as the key point of contact between the technical working group and consultant. Champions are required from key recreational fishing groups and from

all First Nations communities. Ideally, a subset of community champions would also sit on the Mercury Technical Working Group and/or the FWCP Peace First Nations Working Group (**Table 1**). These people would act as coordinators for data gathering within communities, communication and information dissemination and work as the point-person in each community. The role and involvement may vary by community, depending on the level of interest and relevance of fish consumption from Williston.

4. **Conduct a Creel Survey** – We are not aware of sufficiently detailed information that describes the fish species, area of fishing and consumption information (meal size in gm and frequency of consumption) by individual communities. Although some of this information was collected during the proposed Site C project, there is insufficient detail to allow decision making for communities that may access Williston Reservoir/tributary fish. Given the very large size of Williston Reservoir and number of fish species potentially harvested, to keep costs down, the fish mercury study can be focused on more narrow spatial bounds and fish species of greatest interest. The community champions should be responsible for coordinating results from interested communities.

5. **Identify Target Areas for Fish Collections** – Given the very large size of the reservoir, one cannot assume that mercury concentrations in bull trout or lake trout from the upper end of Finlay Reach are the same as the lower end of Parsnip or Peace Reach. However, if there is minimal fishing in one reach or another, a decision may be made not to implement a program there, thereby reducing costs. This information can only reasonably be collected via the creel survey. This information is essential prior to study design and implementation.

6. **Identify Target Fish Species** – The fish community of Williston Reservoir has changed since the 2000 survey. At that time, target species were bull trout and their prey species, whitefish. Key domestic consumption and food web species (e.g., kokanee) must be identified as part of the study design and prior to implementation. Again, this information can only reasonable acquired through the creel survey or information provided directly by communities and recreational fishing groups.

7. **Identify Reference Waterbodies** – It is important that at least one, preferably two waterbodies are identified as reference areas to Williston. At a minimum, these areas must by physically and/or hydrologically independent from Williston Reservoir (e.g., separate lake or river; upstream of an impassable falls), with the same target species and within the same general latitude and similar ecological conditions. Identification of reference waterbodies can be gathered with the assistance of First Nations communities in the area, local fishing organizations and FWCP-Peace Fisheries Technical Committee.

8. **Initiate a Reconnaissance Program in 2015** – Given the scale of the study, its complexity and the data gaps described above, it is premature to undertake a full scale sampling program of Williston Reservoir in 2015. This preliminary effort should include the following tasks:

    a. Establish lines of communications, roles and responsibilities with 'champions' and the mercury technical working group

    b. Plan to collect fish mercury data opportunistically during routine fishing by local communities; establish a fish tissue collection protocol with each First Nations Band that fishes within the Williston Reservoir watershed.

    c. Organize or build from existing summer fishing derbies to collect fish tissues and freeze for submission to a laboratory.

    d. Canvas MOE, MFLNRO, and local communities to identify candidate reference waterbodies that contain target species (e.g., bull trout, lake trout).

    e. Submit fish tissues to a laboratory to acquire preliminary mercury data for study planning purposes for 2016.

9. **Plan 2016 Field Collection Program** – Following and building on the 2015 reconnaissance information and results, plan a dedicated and strategic fish collection program in target areas of Williston Reservoir watershed and reference areas for candidate species. Elements of this stage of work will include securing boats, field equipment, skilled assistants and other resources necessary to optimize success of the fish collection program.

As described above, the Mercury Technical Working Group will become more involved following the reconnaissance phase, to review the study design and once again, after results of the field investigation have been completed. The process to resolve the fish consumption advisory should be developed collaboratively with input from Northern Health, Ministry of Health, Province of BC and/or other interested agencies.

The information gathered from the 2015 reconnaissance and strategic 2016 fish mercury surveys from Williston Reservoir, reference waterbodies and if necessary, key tributary streams and Dinosaur Reservoir, should form the basis of a long-term monitoring program to be carried out at 5- and/or 10-year intervals.

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TABLES

Table 1. List of Board and First Nations Working Group members contacted.

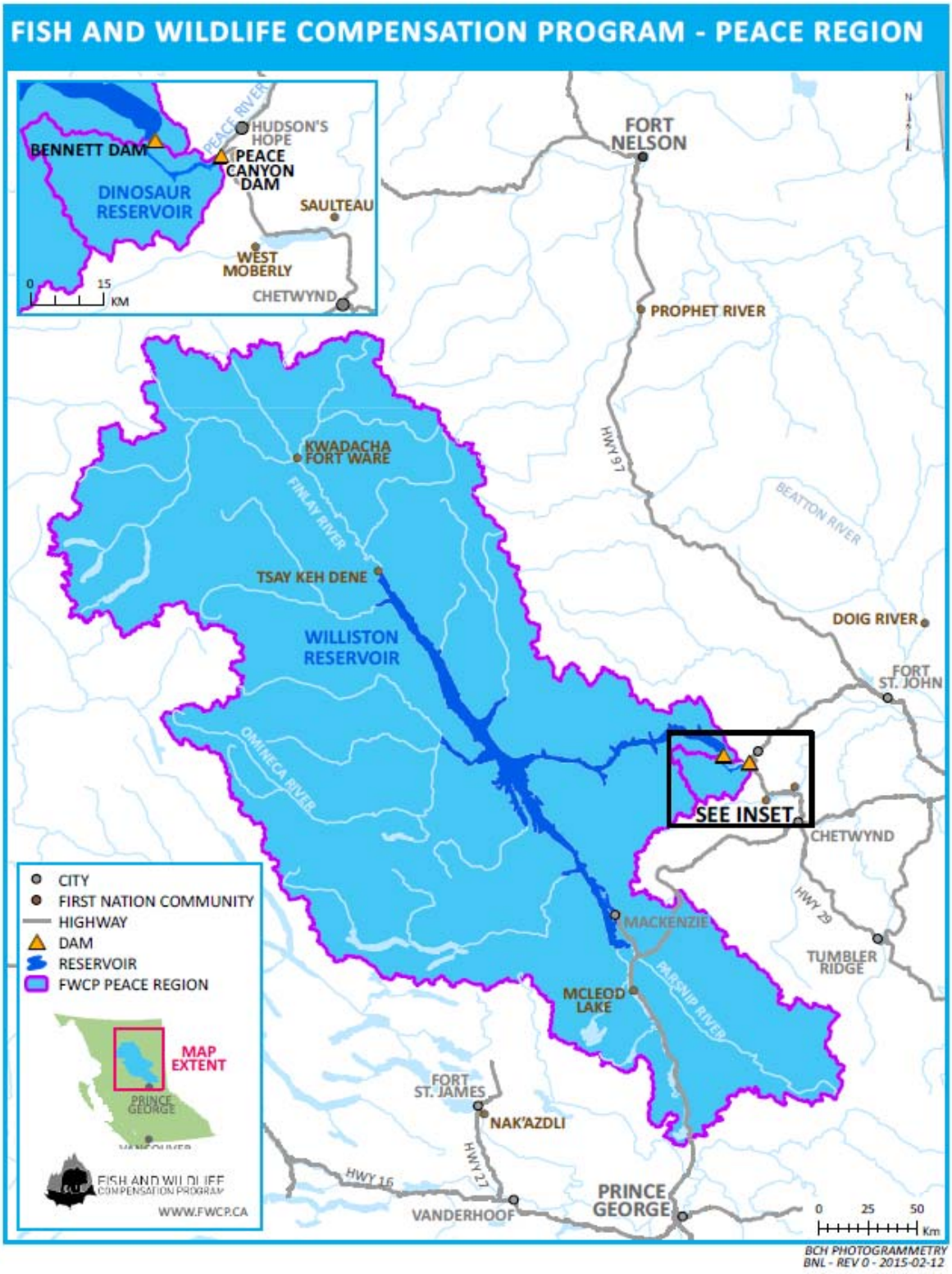
Member	Affiliation
Debbie Beattie	Public
Mike Nash	Public
Ross Peck	Public
Ted Down (Eric Lofroth transition)	BC Gov't (MOE)
Norm Bilodeau	BC Gov't (FLNRO)
Trevor Oussoren	BCH
Rian Hill	BCH
Luke Gleeson	Tsay Keh Dene
Jason Lee	Treaty 8 Tribal Association
Teena Demeulemeester	Saulteau
T. Rosemarie Sam	Nak'azdli
Alec Chingee	McLeod Lake
Luke Vince	Kwadacha
Cec Heron	West Moberly
Robin Tsakoza	Prophet River
Gord Haines	Doig River

First Nations Working Group

Member	Affiliation
Luke Gleeson	Tsay Keh Dene
Jason Lee	Treaty 8 Tribal Association
Fernie Garbitt	Saulteau
George Desjarlais	West Moberly
Robin Tsakoza	Prophet River
Gord Haines	Doig River
Charlotte Boya (Luke Vince alternate)	Kwadacha
Alec Chingee	McLeod Lake
T. Rosemarie Sam (Wayne Sam alternate)	Nak'azdli

FIGURES

Figure 1. Map of Williston Reservoir Watershed and boundaries of the FWCP.



APPENDIX A – OVERVIEW OF MERCURY IN THE ENVIRONMENT DOCUMENT

APPENDIX B – POWERPOINT PRESENTATION GIVEN TO FWCP-PEACE, OCTOBER 21, 2014

APPENDIX C – POWERPOINT PRESENTATION TO FIRST NATIONS COMMUNITIES AND INTERESTED PARTIES, SAULTEAU COMMUNITY CENTER, DECEMBER 10, 2014

APPENDIX D – POWERPOINT PRESENTATION TO NORTHERN HEALTH REPRESENTATIVES, JANUARY 16, 2015

APPENDIX A – OVERVIEW OF MERCURY IN THE ENVIRONMENT DOCUMENT

Overview of Mercury in the Environment

Background

Mercury is a unique metal. In the pure, elemental form, it is the only metal that exists as a liquid at room temperature. Because it is a liquid, it evaporates at a low temperature and (like water), so it also exists as a gas in the air. Mercury has had many historic uses (e.g., thermometers, switches, caustic soda manufacture), but it has been gradually been phased out of most industries because there are better, less toxic alternatives. It is still widely used however, in dental amalgams and in low energy fluorescent light bulbs.

Mercury occurs naturally and is present in small quantities everywhere in the environment, including in water, sediment, soil and in the tissue of all plants and animals, like lead, iron, zinc or other metals. Mercury gas is released from volcanoes, natural degassing from the earth and from forest fires. Man contributes mercury to the atmosphere from burning of coal and other fossil fuels, mining and losses from other products (e.g., light bulbs) and industrial sources. Gaseous mercury that is emitted to the air is transported around the world, some of which is absorbed by plants, accumulated in soils and consumed by animals.

There are two main forms of mercury in the environment – the elemental form (Hg) existing as a liquid and a gas and the organic or methylmercury (MeHg) form, which is a more toxic form of mercury that is present in all animals. Methylmercury is the main form of mercury found in fish, which is why there are sometimes advisories for fish, but not for other animals. When referring to 'total mercury', this is the sum of all forms of mercury, whether in the inorganic or organic forms. While both forms are widespread in the environment, their concentrations vary widely according to which media (e.g., soil, mammals, fish) is being referred to. For example, the concentration of methylmercury in fish is about 100 times higher than in nearly all other animals that we eat (e.g., chickens, cattle, pigs) and many million times higher than in water. When referring to the mercury in fish, although the term 'total mercury' is used, it is assumed that the vast majority of the mercury measured is methylmercury. This is why commercial laboratories measure for 'total mercury' in fish, not MeHg, which is more complex and costly.

As an example, the concentration of mercury in British Columbia fish typically ranges from 0.1 to 0.5 parts per million (ppm). The typical mercury concentration in tinned tuna is around 0.15 ppm; in albacore tuna is 0.31 ppm and 0.36 ppm in halibut (Health Canada 2007). However, on their own, concentration data are not that important. It is the 'dose' that is important, which is a combination of fish concentration and how often and how much fish are consumed over time.

How is methylmercury created?

Tiny amounts of inorganic mercury circulating in the atmosphere fall to the ground and water in rain and snowfall. The leaves and needles of plants also capture mercury from the air. Over time, some of this mercury is becomes accumulated within the organic material on the forest floor. Some of this inorganic mercury is transformed into methylmercury by a very specific group of bacteria that live in the soil and sediment of lakes and rivers, but also in the water column of the ocean. This transformation process occurs within the cells of bacteria, at the base of the food web. Under these conditions, the natural rate of Hg methylation is low. However, when soils are flooded, such as when a reservoir is created, degradation of the organic material is accelerated and creates more favourable conditions for bacteria to "methylate" some of the inorganic Hg, transforming it to methylmercury.

Once methylmercury has been created within bacterial tissue, it is now part of the food chain. In new reservoirs, methylmercury is accumulated at a greater rate than it can be eliminated from the body and thus accumulates over time within an organism. The concentration of methylmercury also increases at progressively higher steps through the food web, from small invertebrates, to large invertebrates, small fish, big fish and carnivorous fish. Thus, the concentration of methylmercury is highest in large, older fish, especially predatory fish at the top of the food chain such as lake trout, bull trout and walleye.

The rate and magnitude of methylmercury production is governed by many factors. In new reservoirs, mercury concentration in large, predatory species increases rapidly, with peak concentrations three to eight years after flooding. After this, mercury concentrations slowly decline, eventually returning to a new baseline concentration between 15 and 25 years later.

Mercury in Williston Reservoir

Williston Reservoir was created between 1968 and 1972 when the W.A.C. Bennett Dam, flooded part of the Peace, Parsnip and Finlay rivers to create BCs largest reservoir. In 1980 and 1988, mercury concentrations measured in bull trout (*Salvelinus confluentus*) were deemed high enough that a 'consumption advisory' was placed on the reservoir. The advisory states that "Mercury levels in bull trout (Dolly Varden) from Williston Lake and tributaries may be high. Normal consumption is not a significant hazard to human health, but high consumption may be".

The most recent survey of mercury in environmental media of the Finlay Reach of the reservoir (water, sediment, invertebrates and fish) occurred in 2000, nearly 30 years after reservoir creation. Results of this study showed that mean mercury concentration in 550 mm bull trout was 0.56 ppm, down from 0.87 ppm in 1988. Mercury in a 350 mm lake whitefish was 0.19 ppm, down from 0.30 ppm. While it appears that mercury concentrations in some fish species have declined, there has been no fish mercury data collected for nearly 15 years.

How are people exposed to mercury?

Mercury as an environmental contaminant is well known to the public and regularly receives media attention. People are exposed to mercury almost exclusively from the consumption of fish and shellfish. Many people have dental amalgams that have mercury as an ingredient. This is a minor pathway of exposure to mercury. While there are only three fish consumption advisories in BC, there are thousands of advisories across North America due to mercury.

Communicating information about mercury in fish is tricky. While long-term, frequent consumption of fish with 'high' mercury concentrations may pose a risk, adverse health effects are difficult to diagnose and have rarely been observed. Health Canada (2007) states that it is essential that any public risk communication on methylmercury in fish "include information on the health benefits of fish consumption alongside information on the risks of methylmercury exposure so that citizens can consider both the benefits and risks in reaching their own decisions about appropriate fish consumption." Research has shown that poor communication can result in decreased fish consumption. Because fish are an excellent source of high quality protein and omega-3 fatty acids, Health Canada's Food Guide for Healthy Eating recommends eating at least two 75 g servings of fish per week. Thus care must be taken to ensure that the health benefits from consuming fish are maximized, while recognizing potential adverse health effects associated with frequent consumption of fish with high mercury concentrations.

APPENDIX B – POWERPOINT PRESENTATION GIVEN TO FWCP-PEACE, OCTOBER 21, 2014

FWCP – Peace Williston Reservoir Watershed Mercury Presentation

Prince George October 21

AZIMUTH

Background

- First Nation communities are concerned about mercury in fish and implications for health; lots of talk but no action… it's time
- There is widespread support for a 'study' of mercury in Williston Reservoir, Peace River, tributaries with focus on fish
- Perception that fish and other country foods in Williston, Dinosaur, Peace R. are contaminated with mercury; may cause some to avoid fishing and hunting

2

Background

- There is currently a 'fish consumption advisory' for bull trout on Williston Reservoir that states "normal consumption of bull trout and lake trout from Williston Reservoir does not pose a health risk, but high consumption might".
- Uncertainty with respect to the spatial scope or extent – does it include tributary streams? How far upstream? How far downstream?

3

Objectives and Scope of Work

- Azimuth retained to conduct a Phase 1 study to consult with representatives from FWCP board and FN Working Group
- Consultation and engagement process
  - Scope of the issue and concern,
  - Identify gaps in data and understanding,
  - Synthesis of current understanding/concerns
  - Plot a way forward and develop scope of work
  - Other: 'Mercury 101' document, community meetings, engage Northern Health

4

Objectives and Scope of Work

- Phase 2 will occur in 2015 – 2016 and will consist of:
  - Identifying participating partners, communities
  - Identifying 'key questions', data gaps, uncertainties
  - Planning a field investigation, if warranted
  - Re-visit need for consumption advisory and determine appropriate guidelines, if warranted

5

Recurrent Themes / Key Messages

- The 'consumption advisory' on Williston is vague, outdated, non-specific, unclear
- Widespread perception that only 1 meal per month of bull trout is permissible to stay within HC guidelines
- Many people are concerned about Hg in fish – has been an issue for a long time
- Crooked River bull trout – Only 5 fish at a concentration below which is 'safe' to eat
- What are 'safe limits'?

6

Recurrent Themes / Key Messages

- Some people expressed concern that there is residual Hg in submerged trees in WR
- Some have expressed concern about Hg in water, plants, exposure to wildlife (e.g., moose)
- Many used the word ‘contamination’ to refer to mercury – it is time to think in terms of the concept of ‘dose’ and not ‘concentration’
- There were no issues raised with respect to health effects from exposure to mercury

7

Recurrent Themes / Key Messages

- There have been large changes in the fish community of WR – a good deal of concern about kokanee; bears, wolves, birds feeding on kokanee – a source of uncertainty
- Lake trout are emerging as a top predatory in WR and Dinosaur – no data on lake trout
- Very little concern expressed about consuming non-fish eating wildlife such as moose, deer, geese (not from a mercury perspective anyway)

8

Challenges

- Williston is a large reservoir – the spatial scale (Parsnip, Peace, Finlay) needs to be considered, especially if we extend to tributary streams
- Lack of regional or ‘reference’ data
- Use of stable C and N isotopes in fish tissue as an investigative tool
- Use of ‘elemental signature’ of water can be used to identify source of bull trout – e.g., Crooked River

9

Challenges

- Role of Northern Health and input from Health Canada
- Should a creel census be incorporated into next steps?
- Identify a 'reference lake' or two, that contain bull trout, lake trout, whitefish to compare to Williston
- Communication about health issues and exposure to 'contaminants' is always challenging (think cholesterol, trans-fats)

10

Challenges

- Cumulative effects from other, diverse developments (mining, forestry, oil and gas, roads) impact the environment and wildlife – some confusion that these activities contribute to mercury issue
- Keeping a manageable scope of work
- Notwithstanding new results, some people will remain skeptical and concerned

11

Next Steps

- Identify participants and partners
- Narrow the scope to Key Questions
- Design a field investigation to address these questions
- Science-based program
- Engage Northern Health and develop a strategy to address the advisory
- Communicate findings and increase the level of education

12

Background of Mercury in Williston Reservoir Fish

- Fish consumption advisory placed on Williston Reservoir in early-1980s
- Mercury concentrations in WR bull trout have changed over time
  - 0.85 ppm in 1980
  - 0.87 ppm in 1988
  - 0.56 ppm in 2000 (47 trout)
- Based on standardized size of 550 mm / 2 kg trout

13

Next Steps…

APPENDIX C – POWERPOINT PRESENTATION TO FIRST NATIONS COMMUNITIES AND INTERESTED PARTIES, SAULTEAU COMMUNITY CENTER, DECEMBER 10, 2014

FWCP – Peace
Williston Reservoir Watershed
Follow-up on Mercury Issue

Saulteau, W. Moberly, McLeod Bands
December 10

AZIMUTH

Agenda

- Welcome and opening prayer
- Overview on background/objective of study
- Review basics of mercury science
- Summary of findings to date, from interviews
- Lunch (12 – 1230)
- Role of regulatory agencies/ decision making
- Next steps – Study design (spatial extent, species, timing)
- Questions/answers and concerns
- Closing prayer, wrap up

2

Attendees

- Randy Baker, Azimuth Consulting Group
- Fernie Garbitt, Saulteau F.N.
- Carmen Marshall, Saulteau F.N.
- George Desjarlais, West Moberly F.N.
- Cec Heron, West Moberly F.N.
- Eran Spence, McLeod Lake Indian Band
- Ken and Arlene Boon, Peace Valley Environmental Association
- Dan Bouillon, BC Hydro

3

Objectives and Scope of Work

- Azimuth retained to conduct a Phase 1 study to consult with representatives from PWFC board and FN Working Group
- Consultation and engagement process
  - Scope of the issue and concern,
  - Identify gaps in data and understanding,
  - Synthesis of current understanding/concerns
  - Plot a way forward and develop scope of work
  - Other: 'Mercury Fact Sheet' document, community meetings, engage Northern Health

4

Objectives and Scope of Work

- Phase 2 will occur in 2015 – 2016 and will consist of:
  - Identifying participating partners, communities
  - Identifying 'key questions', data gaps, uncertainties
  - Conducting a field investigation
  - Re-visit / abolish consumption advisory and determine appropriate guidelines, if warranted
- One objective of this meeting is to begin scoping these potential next steps…

5

Background

- First Nation communities are concerned about mercury in fish and health implications
- In August, Azimuth began a study of mercury in Williston Reservoir, Peace River, tributaries with focus on fish
- 'Fish consumption advisory' for bull trout and lake trout on Williston Reservoir that states "normal consumption does not pose a health risk, but high consumption might". What does this mean?
- Uncertainty with respect to the spatial scope or extent – does it include tributary streams? How far upstream? How far downstream?

6

Background

- No recent data on mercury concentrations in fish from Williston – not since 2000
- More recent investigations on Dinosaur Res. and Peace River during 2010 Site C studies
- Crooked River bull trout, possibly some from Williston collected in 2012
- The 2000 study indicated that mercury in fish is lower than when the advisory was placed and may not be warranted

7

Mercury '101' Fact Sheet

- Mercury (Hg) is unique, exists as gas, liquid, solid
- Historically, many uses, but few today
- Hg occurs in small quantities in *everything, everywhere*
- Mercury occurs in water but in very low concentrations … more Hg in 1 fish meal than in all the water you will drink in your life…
- More Hg in 1 dental filling than in 1,000 fish
- This elemental form is not as toxic as other forms of Hg…

9

Mercury Fact Sheet

- The two main forms of Hg are elemental, or inorganic Hg and methylmercury (Hg-CH_3). MeHg is the main kind of Hg found in fish
- MeHg is naturally created from inorganic Hg in sediments of lakes by bacteria, some in water and in deep ocean
- Exposure to MeHg is almost exclusively from eating fish – MeHg is accumulated and magnified by fish over many steps in food web
- Concentration of Hg in fish is 100x higher than in other animals

10

Mercury Fact Sheet

- 'Typical' fish Hg concentration to which most people are exposed is 0.1 – 0. 3 parts per million or ppm (mg/kg)
  - Salmon, 'dark' tuna, shellfish are low (0.1 – 0.2 ppm)
  - Light albacore tuna, halibut, cod are moderate (0.2 – 0.4 ppm)
- BC fish Hg concentrations are lowest in country
  - Lake and mountain whitefish, rainbow trout <0.2 ppm
  - lake trout, burbot, bull trout, halibut in BC are 0.2 – 0.5 ppm
  - Elsewhere in Canada, lake trout, walleye, burbot are 0.4 – 1.5 ppm
- Only 1 Hg advisory in BC for fish in a reservoir – in Ontario and Quebec there are thousands of advisories

11

Mercury Fact Sheet

- A measure of 'Exposure' is based a dose that is a combination of:

$$\frac{\textit{Fish [Hg] x meal size (g) x frequency (meals/wk)}}{\textit{body size (kg)}}$$

- Thus, 'safe' dose is adjusted for the weight of a person, which differs between men, women, kids
- Health Canada determines a safe dose based on whether you are a child, pregnant woman, adult
  - Measured as µg/MeHg/kg body weight / day
  - More conservative for pregnant women, young kids

12

Mercury Fact Sheet

- Health Canada defines this safe dose as the threshold below which no health effect has ever been observed for a life-time of exposure
  - Noteworthy that there is a 5x conservation factor built in – that is even if you were to consume 5x more fish than is 'safe' you would only be at the threshold of the most sensitive 5% of population
  - More recent science is showing that health benefits of consuming fish outweighs potential risks
  - Selenium science also showing promise

13

Recurrent Themes / Key Messages

- The 'consumption advisory' on Williston is vague, outdated, non-specific, unclear
- Widespread perception that only 1 meal per month of bull trout is permissible to stay within HC guidelines
- Many people are concerned about Hg in fish – has been an issue for a long time
- Crooked River bull trout – Only 5 fish at a concentration below which is 'safe' to eat
- What are 'safe limits'?

14

Break …

15

Findings to Date

- Based on literature review
- Experience with studies on Williston and elsewhere
- Telephone conversations with First Nations, BC Hydro, BC MOE

16

Recurrent Themes / Key Messages

- Most people believe that it is not 'safe' to eat more than 1-3 fish meals/month from Williston Reservoir
- Some have expressed concern about Hg in water, plants, exposure to wildlife (e.g., moose)
- Many used the word 'contamination' to refer to mercury – it is time to think in terms of the concept of 'dose' and not 'concentration'

17

Recurrent Themes / Key Messages

- Large changes in the fish community of WR – concern about kokanee; bears, wolves, birds feeding on kokanee – a source of uncertainty
- Lake trout are emerging as a top predatory in WR and Dinosaur – no data on lake trout
- Minor concern expressed about consuming non-fish eating wildlife such as moose, deer, geese
- No issues raised with respect to health effects from exposure to mercury from fish consumption

18

Lunch Break…

19

Role of Health Agencies

- Northern Health is likely the responsible agency for decision making
- Will need to consult with Health Canada for guidance – no BC experience on this issue
- Every province is different in its approach and there are no 'rules'
- This will be an iterative process and will require time and negotiation, assuming that fish Hg concentrations warrant the removal of the advisory (they were in 2000).

20

Draft Consumption Guidelines

Number of servings of fish/ per week that can be consumed without exceeding Health Canada's provisional tolerable daily intake for methylmercury

		Average peak methylmercury concentration in fish	age	Toddler	Child	Female Teen	Women of Child Bearing Age	Male Teen	Other Adult
				7 mo. - 4 y	5 - 11 y	12 - 19 y	> 20 y	12 - 19 y	> 20 y
Species	Location	mg MeHg/kg ww	fish serving size (g/serving)	75	125	150	163	150	163
Bull trout - 1988	Williston Reservoir	0.87		0	0	1	1	2	2
Bull trout - 2000	Williston - Finlay Reach	0.54		1	1	1	1	2	3
Bull trout - 2012	Crooked River	0.44		1	1	1	1	4	4
Commercial canned albacore tuna	Health Canada (2007)	0.36		1	1	2	2	4	4
Commercial canned light tuna (skipjack)	Health Canada (2007)	0.06		5	6	9	10	22	24
Commercial halibut	Health Canada (2007)	0.31		1	1	2	2	4	5
Commercial trout	Health Canada (2007)	0.14		2	3	4	4	9	10

21

Issues / Challenges / Next Steps!

- Williston is a large reservoir – the spatial scale (Parsnip, Peace, Finlay) needs to be considered, especially if we extend to tributary streams – which ones?
- Lack of regional or 'reference' data – need to identify 1 or 2 reference waterbodies
- Multiple species are involved – which ones?
  - Bull trout, lake trout, lake whitefish, kokanee
  - Others? (rainbow trout?)

22

Issues / Challenges / Next Steps!

- Identify resources available such as boats, experienced people
- Important to determine 'exposure' – who eats fish, what species, how often?
- Consider a creel census and/or dietary survey in each community

23

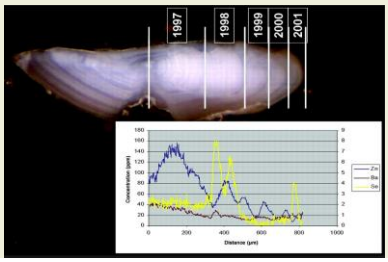
Science Based Tools

- Use of Carbon and Nitrogen stable isotopes in fish tissue – used to confirm where different fish fall within the food web (who eats who?)
- Use of 'elemental signature' of water can be used to identify source or residency of fish e.g., Crooked River bull trout
  - Used in Williston Reservoir to identify 23 discrete populations of Arctic grayling

24

Science Based Tools

- Use of laser ablation to help determine origin of fish – combined with elemental signature



25

Challenges

- Role of Northern Health and input from Health Canada
- Mercury – Selenium health benefit ratio
- Communication about health issues and exposure to 'contaminants' and what is 'safe' is always challenging. For example,
  - Alcohol in wine
  - Saturated, trans-fat in beef
  - Cholesterol in eggs

26

Challenges

- Cumulative effects from other, diverse developments (mining, forestry, oil and gas, roads) impact the environment and wildlife – some confusion that these activities contribute to mercury issue
- Keeping a manageable scope of work
- Notwithstanding new results, some people will remain skeptical and concerned

27

Background of Mercury in Williston Reservoir Fish

- Fish consumption advisory placed on Williston Reservoir in early-1980s
- Mercury concentrations in WR bull trout have changed over time
  - 0.85 ppm in 1980
  - 0.87 ppm in 1988
  - 0.56 ppm in 2000 (47 trout)
  - 0.44 ppm in 2012 (Crooked River)
- Based on standardized size of 550 mm / 2 kg trout

28

Next Steps…

APPENDIX D – POWERPOINT PRESENTATION TO NORTHERN HEALTH REPRESENTATIVES, JANUARY 16, 2015

FWCP – Peace
Williston Reservoir Watershed
Mercury Issue

Northern Health December 11

AZIMUTH

Background

- Mercury scientist having worked on mercury (Hg) issues in fish and other environmental media since 1979.
- Studied many Manitoba and BC reservoirs, as well as in SE Asia, South America
- Azimuth specializes in ecological and human health risk assessment of metals and Hg
- Clean up of Hg mines (Pinchi, Bralorne Takla)
- Worked for UN for 3 y in SE Asia with artisanal gold miners, using Hg

2

Background

- There is currently a 'fish consumption advisory' for bull trout and lake trout on Williston Reservoir that states "normal consumption of bull trout and lake trout from Williston Reservoir does not pose a health risk, but high consumption might"
- This advisory was placed ~1980 in response to reservoir creation, elevated fish [Hg]
- Most recent study in 2000 confirms that fish [Hg] has diminished

3

Background

- First Nation communities are concerned about mercury in fish and implications for health
- Perception that fish and other country foods in Williston, Dinosaur, Peace R. are Hg contaminated – affects fishing, hunting, health
- Widespread belief that only 1 meal per month of bull trout is permissible to stay within Health Canada guidelines
- Unintended consequence of avoiding fish consumption, pursuit of culturally important activities, connection to the land

5

Objectives and Scope of Work

- Azimuth retained to consult with BCH, MOE, Northern Health (NH) and representatives from FWCP board and FN Working Group
  - Saulteau, Treaty 8, McLeod, Kwadacha, Nak'azdli, West Moberly, Tsay Key, Doig, Prophet
- Consultation and engagement process
  - Scope of the issue and concern,
  - Identify gaps in data and understanding,
  - Synthesis of current understanding/concerns
  - Plot a way forward and develop scope of work

6

Objectives and Scope of Work

- Very few recent data (my work on Williston in 2000/2001), Peace River in 2010 (Site C), Crooked River bull trout Hg (McLeod FN 2012)
- Clear need for updated information, but challenges exist – spatial extent, species, migrations, communication, lack of experience, communication
- Work with NH to bring up to speed, identify responsible parties, determine what information NH requires to make decisions, facilitate interaction with HC or other agencies
- Re-visit and revise/abolish/communicate Hg advisory

7

Mercury '101' Fact Sheet

- Mercury (Hg) is unique, exists as gas, liquid, solid
- Historically, many uses, but few today
- Hg occurs in small quantities in *everything, everywhere*
- Mercury occurs in water but in very low concentrations … more in 1 meal of fish than in all the water you will drink in your life…
- More Hg in 1 amalgam filling than in 1,000 fish
- This elemental form is not as toxic as other forms of Hg…

8

Mercury Fact Sheet

- Two main forms of Hg – elemental, or inorganic Hg and methylmercury ($Hg\text{-}CH_3$ or MeHg). This is the main kind of Hg found in fish
- MeHg is naturally created from inorganic Hg by bacteria in sediments of lakes, some in water and ocean
- Exposure to MeHg is almost exclusively from eating fish – accumulated and magnified to fish in many steps up the food web
- Concentration of Hg in fish is 100x higher than in other animals

9

Mercury Fact Sheet

- 'Typical' MeHg concentration in fish to which most people are exposed is 0.1 – 0. 3 parts per million or ppm (mg/kg)
  - Salmon, 'dark' tuna, shellfish are low (<0.1 – 0.2 ppm)
  - Light tuna, halibut, cod are moderate (0.2 – 0.4 ppm)
- BC fish Hg concentrations are lowest in country
  - Lake and mountain whitefish, rainbow trout <0.2 ppm
  - Lake trout, burbot, bull trout in BC are <0.2 – 0.5 ppm
  - Elsewhere in Canada, lake trout, walleye, burbot are 0.4 – 1.5 ppm
- Only 1 Hg advisory in BC for fish in a reservoir – in Ontario and Quebec there are thousands of advisories

10

Mercury Fact Sheet

- A measure of 'Exposure' is based a dose that is a combination of:

$$\frac{\text{Fish [Hg] x meal size (g) x frequency (meals/wk)}}{\text{body size (kg)}}$$

- Thus, dose is adjusted for the weight of a person, which differs between men, women, kids
- Health Canada determines a 'safe' dose based on whether you are a child, pregnant woman, adult
  - Measured as µg/MeHg/ kg body weight / day
  - More conservative for pregnant women, kids <12 y (0.2 µg/MeHg/kg bw/d vs adults (0.47 µg/kg bw/d)

11

Issues / Challenges / Next Steps!

- Williston is very large – spatial scale must be considered (Parsnip, Peace, Finlay)
- Lack of regional or 'reference' data – need to identify at least 2 reference waterbodies
- Multiple species are involved – which ones?
  - Bull trout, lake trout, lake whitefish, kokanee
- Role of Northern Health and input from Health Canada
- New science – Mercury : Selenium health benefit ratio

12

Challenges

- Communication about health issues and exposure to 'contaminants' and what is 'safe' is always challenging.
- Cumulative effects from other, diverse developments (mining, forestry, oil and gas, roads) impact the environment and wildlife – some confusion that these activities contribute to mercury issue
- Notwithstanding new results, some people will remain skeptical and concerned

13

Role and Input from NH

- Identify responsible party/parties
- What information will NH require to re-visit the Hg advisory for Williston?
- How can FWCP assist / facilitate?
- Role of MOE, Health Canada, others?
- Next steps…
  - Field study design for 2015/2016
  - Science based

14

Background of Mercury in Williston Reservoir Fish

- Fish consumption advisory placed on Williston Reservoir in early-1980s
- Size-adjusted mercury concentrations in WR bull trout have changed over time
  - 0.85 ppm in 1980
  - 0.87 ppm in 1988
  - 0.56 ppm in 2000 (47 trout)
  - 0.44 ppm in 2012 (63 Crooked River trout)
- Based on standardized size 550 mm / 2 kg trout

15