Western Science

June 27, 2024

To: Joseph B. Fobister, Grassy Narrows First Nation

Re: WSP Memo No. OMEMA2303 from Dr. Amy Elliott concerning Review of Riverbank Mercury Methylation Study Dated May 28, 2024

Dear Mr. Fobister,

I have reviewed the Memo identified above which was sent to ANA by WSP as a response to the technical report that I produced for ANA concerning the stimulation of mercury methylation in the Wabigoon River by sulphate and other materials in paper mill wastewater from Dryden. Our experiment found that additional sulphate significantly stimulated the formation of methylmercury in Wabigoon River sediments, and that the current discharges of sulphate and organic matter from the currently operating paper mill in Dryden Ontario had a combined effect on methylation that was greater than sulphate alone. The intent of the WSP memo is to comment on the relevance and applicability of the results of our laboratory experiment to the Great Bear Project. The broad conclusion of the Memo is that "The Riverbank Mercury Methylation Study does not provide new or relevant insights into the potential for mercury methylation downstream of the Great Bear Project.".

Based on the information presented in the Memo, the actual conclusion by the authors of the Memo is that the science concerning mercury methylation in freshwater environments is irrelevant to the Great Bear Project because **the authors of the Memo contend that mercury methylation is not a process that occurs to any meaningful degree in the receiving waters downstream of the project.** The justifications provided in the Memo for this conclusion are flawed, discount existing data to the contrary, and reveal either a weak understanding of mercury cycling in natural ecosystems, or a deliberate obfuscation of the potential impacts of the proposed project on mercury methylation and methylmercury in biota due to the release of sulphate from Project operations.

The Memo focusses on three main considerations, all of which are an attempt to frame the results of the technical report as irrelevant to the Great Bear Project. The memo highlights that the experimental study:

1) was undertaken in the laboratory

2) had a continuous absence of oxygen in the experiment/strongly reducing conditions (i.e., no nitrate or ferric iron).

3) had very high concentrations of total mercury in sediment (49 mg/kg) available to be converted into methyl-mercury.

None of these observations in any way render the results of the report of the experimental study irrelevant to the Great Bear Project.

Western University, Department of Biology
1151 Richmond St., London, ON, Canada N6A 3K7 t. 226-977-0226
e: bbranfir@uwo.ca w: ecohydrology.ca, www.westernu.ca

1) Laboratory Setting

Although not an explicit criticism, the repeated mention of the laboratory nature of the work would appear to be intended to infer limited transferability of the results to the 'real world'. This is a common strategy used to draw non-scientists attention away from valid outcomes of laboratory work and numerical modelling studies because they are not 'complex enough' or don't reflect all of the processes that occur in the environment. In fact, this is not a weakness at all and is precisely the objective of a well designed experiment or model – to distill the understanding of a process or system to its primary drivers and in the case of an experiment, unequivocally reveal cause and effect. The definitive publication that identified the role of sulphate reducing bacteria in the mercury methylating process was a laboratory experiment[1]. To suggest that a laboratory experiment cannot be definitive would require us to also not accept the results of bench experiments to determine acid-generating potential, trial experiments to evaluate water treatment technology efficacy, geotechnical models of ore deposits (which are extrapolations of core results and geophysics), or groundwater flow models for pit de-watering and regional hydrology which are parameterized with virtually no empirical data relative to the size of the systems that are being modelled. For a laboratory experiment to be valid, there needs to be a clear **hypothesis** to be tested, careful **control** over experimental parameters, and high **replication** to understand variability and uncertainty. I ensured that these criteria were in place and satisfied in order to generate meaningful and clear outcomes of the experiment. I would be interested to know if the contact water quality predictions included in Table 2 in the Memo can be substantiated with the same level of rigour.

Controlled laboratory experiments provide valuable insights into the fundamental mechanisms of important processes that occur in the natural environment. In my opinion the laboratory results are relevant to the Great Bear Project in that there is a clear increase in mercury methylation in natural river and river-adjacent sediments with the addition of sulphate. As the Great Bear Project will be mining and stockpiling potentially acid (i.e. sulphate) generating waste rock, the findings are relevant to the Project.

2) Absence of oxygen/presence of strongly reducing conditions

This point converges two items listed separately in the WSP memo but are effectively addressing the same issue concerning the biogeochemical environment being conducive to sulphate reduction. The memo rightly states that reducing conditions are required for methylating bacteria and that these were established in the experiment discussed. The memo states that these conditions do not exist in the Chukuni River system, the receiving waters of the Great Bear Project. This is a fundamentally unsupportable statement that reveals a lack of understanding of relatively straightforward environmental biogeochemistry. It is true that the reducing conditions required for methylation do not generally occur in the oxygenated flowing water of main river and stream channels, but to exclusively focus on this with respect to mercury methylation is deliberately narrow in scope. Environments where these conditions DO occur abound in all freshwater systems, including stream and river channel bottom sediments, zones of floodplain hyporheic exchange, biofilms and periphyton layers, and hydrologically connected river-adjacent wetlands, all of which are well documented in the scientific literature. Indeed, a survey of satellite imagery of the

1 Compeau, G. C., and R. Bartha. 1985. Sulfate-reducing bacteria: principal methylators of mercury in anoxic estuarine sediment. Appl. Environ. Microbiol. 50:498-502

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Chukuni River upstream of Pakwash Lake on Google Earth reveals a river with all of the requisite conditions to support mercury methylation; a meandering planform, extensive vegetated point bars and flood plain wetlands, and river-adjacent wetland complexes.

If we were to accept the Memo's statement that river systems do not support mercury methylation because they are oxygenated, then we would not expect methylation to occur in the nearby Wabigoon River system. The continuous increase in methylmercury concentrations in water in the Wabigoon River clearly indicates that this is not the case, since these increases can only be the result of active methylation in that system. Finally, the Chukuni River flows into other water bodies that themselves also have sites of methylation (e.g. Pakwash Lake). To focus only on the immediate receiving waters discounts both downstream and cumulative effects.

The Memo's statement that mercury methylating conditions do not exist in the aquatic ecosystem that will be receiving wastewaters from the Great Bear Project cannot be substantiated, and in fact is contradicted by existing data. We need to look no further than the province of Ontario's own publicly-available data on methylmercury in fish to find human consumption advisories for fish in waters immediately downstream of the proposed project to see that this is a mercury methylating aquatic environment (see section 3 below).

Nearly all river systems have environments in them that are suitable for the formation of methylmercury, and there is no scientific reason to conclude that the Chukuni River system is an exception. The Memo's conclusion that the oxygenated river water of the Chukuni River means that no methylmercury can be formed in that system cannot be scientifically supported, and reveals that the proponent is not taking a full ecosystem approach to the potential ecosystem impacts of the proposed Project.

3) High concentrations of inorganic mercury are required to form meaningful amounts of methylmercury

The Memo incorrectly states that the lower levels of mercury in Chukuni River system means that the laboratory experiment results are not applicable, and that with such low levels of mercury, the risk of "releasing methyl-mercury is very low to non-existent". If this uninformed statement were even remotely factually true, then we would not have fish consumption advisories for methylmercury in nearly every freshwater body in Ontario, including in the far north where the total amount of mercury in sediments and waters is even lower than in the region of the proposed Project. Indeed, we only have to look at the provinces guide to eating Ontario MECP sport fish to see that fish in the Chukuni River system are contaminated with methylmercury that was derived from these 'very low to non-existent" sources. There are consumption advisories in place for Northern Pike, Small Mouth Bass and Walleye in Wegg Lake (https://www.ontario.ca/page/fish-consumption-report?id=50349334) and Pakwash Lake where the list includes Lake Whitefish and White Sucker in addition to the above species (https://www.ontario.ca/page/fish-consumption-report?id=50459330). The fact that the Memo leans on the fact that sediments in Pakwash Lake are below Provincial Sediment Quality Guidelines, yet five fish species have mercury consumption advisories for that very lake fully undermines the credibility of that argument, and also reveals the complete lack of utility of the provincial guidelines for protecting aquatic life with respect to risks to

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e: bbranfir@uwo.ca w: ecohydrology.ca, www.westernu.ca

Grassy Narrows people, as these guidelines do nothing to protect fish consumers because they are not designed to do that.

Indeed, given that the proposed project will release sulphate from mined and stockpiled materials to surface waters, the potential for the Project to have both near-field and distal impact on methylation is significant depending on the additional loading of sulphate. Sulphate loading from the current operating mill in Dryden has measurable effects on sulphate concentrations in Ball Lake, which is over 150 km downstream, even with substantial dilution from tributaries. Addition of sulphate from the proposed Project will similarly propagate downstream, with potential impacts on mercury methylation.

By the very nature of the proposed Project (sulphate-generating mined and stockpiled materials), cumulative increases in sulphate concentrations in surface waters from the proposed Project (even if within regulatory limits for the protection of aquatic life) are inevitable and would increase methylmercury production in receiving waters. Even where absolute mercury levels are relatively lower, the availability of inorganic mercury is not limiting since the fraction that is methylated is a few percent at most. Sulphate addition will increase methylation, and will increase mercury in fish. Consumption advisories already exist for fish in downstream waters (e.g. Pakwash Lake). Additional sulphate will amplify this effect.

General Discussion

The Memo hints at some understanding of the primary message of our technical report and the role of sulphate as the primary control on mercury methylation, but leans on the assertion that the sulphate is discharged to a non-methylating "well-oxygenated" environment to dispel concerns. Indeed, the Dryden Mill wastewater is also released into an immediate environment that is likely non-methylating, however its interaction with methylating microbial communities downstream is contributing to enhanced methylation based on our experimental results, and first principles from the scientific literature.

The Memo focusses on the Chukuni River as the receiving water body for the Project. The Chukuni River flows into receiving lakes such as Pakwash Lake, the English River, and then to the lower English-Wabigoon River system. The focus on strictly achieving levels of discharge that meet provincial water quality guidelines fails to account for the cumulative effects of additional loads on downstream ecosystems, which is particularly relevant for mercury in biota. The disconnect between provincial water and sediment quality guidelines and the provinces own data on methylmercury in fish clearly reveals that these are not guidelines that should be leaned on for the protection of fish consumers.

Finally, the opening paragraph of the Memo uses carefully crafted language that I can only surmise is intended to undermine the credibility of the study. The author unnecessarily states that the work was a "lab experiment by a Master of Science student", a statement that (incorrectly) implies a lower degree of rigour or competence to a less-informed reader. The fact that it is not published in a Journal yet is certainly true, however to suggest that the work was not peer-reviewed is untrue – the results were discussed deeply and widely with other experts in the field before its release. I would suggest that if journal publication were a requirement for the validity of all work such as this, then the vast majority of work done for environmental impact assessment, regulatory compliance, and indeed the formulation of regulations themselves would not be considered valid. I proposed and designed the experiment, oversaw the experimental work, under-

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took the quality assurance of the data, and wrote the technical report – more than an 'interpretation' as indicated in the Memo.

Overall Conclusion and Recommendation

I not only stand by the contents and conclusions of the technical report, I will state plainly here that the positive relationship between even fractional increases in sulphate load and the enhanced production of methylmercury in downstream waters and sediments with even relatively low levels of mercury is highly relevant to the Great Bear Project, and should be carefully considered. The Memo's attempt to dismiss the potential for the Project's impact on mercury methylation in downstream aquatic ecosystems through a selective consideration of both our experimental findings and the conditions of the receiving waters raises concerns for me about the Project proponents lack of willingness to transparently address issues of downstream impairment of water quality due to methylmercury, particularly in light of the history the impairment of aquatic resources by methylmercury in this watershed.

Yours sincerely,

Dr. Brian Branfireun
Professor, Department of Biology
Western University