Appendix B: ORD Mercury Memo

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OFFICE OF
RESEARCH AND DEVELOPMENT

January 25, 2022

MEMORANDUM

SUBJECT: Request for Scientific Support Regarding Potential Downstream Impacts of the NorthMet Mine

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Introduction

Under the auspices of the Clean Water Act Section 401(a)(2), the United States Environmental Protection Agency (EPA) Region 5 is involved in evaluating the potential impacts to downstream waters related to the construction, operation, and maintenance of Polymet's proposed NorthMet mine. The proposed NorthMet mine is situated in the St. Louis River watershed in northeast Minnesota, upstream of the Fond du Lac Band of the Lake Superior Chippewa reservation, which is situated on the St. Louis River. The NorthMet project will have two facilities that are in adjacent subwatersheds of the St. Louis River. The proposed mine processing plant and associated tailings basin are in the Embarrass River and Partridge watersheds, whereas the proposed open pit mine is in the Partridge River watershed. The confluence of the Embarrass River and St. Louis River is located 79 river miles from the northern boundary of the Fond du Lac Band reservation.

As part of this evaluation, EPA Office of Research and Development (ORD) was requested by EPA Region 5 to review a letter submitted to EPA from the Fond du Lac Band of Lake Superior Chippewa that includes their determination that the proposed NorthMet mine will affect the quality of Fond du Lac's waters. The letter embodies key assertions regarding the potential for downstream impact of the NorthMet mine as it relates to the CWA Section 401(a)(2) process. In particular, the letter identifies potential downstream effects in the St. Louis River caused by the NorthMet project either due to increased mercury or sulfate additions or due to changes in the wetland and peatland hydrology and geochemistry, which have the potential to increase mercury and sulfate loadings, or both. The authors contend that these downstream effects would result in increased concentrations of mercury in fish. Fond du Lac Band members rely on the St. Louis River to provide a sufficient diet of fish to sustain a healthy, current, on-reservation population (subsistence fishing designated use), and thus there is concern about increased methylmercury concentrations in fish.

Atmospheric deposition is a primary source of mercury (Hg) to terrestrial and aquatic ecosystems. Increased Hg emissions have resulted in increased deposition and accumulation in these environments, and ecological disturbance or stress can mobilize accumulated Hg. Under certain conditions, Hg may be converted to methylmercury (MeHg) (Benoit et al., 2002; Eckley and Hintelmann, 2006; Gilmour and Henry, 1991; Hintelmann et al., 2000), which bioaccumulates and biomagnifies in food webs with increasing trophic position (Bloom, 1992). Exposure to MeHg may cause severe human health effects, including immune system suppression, delayed neurodevelopment in children, and compromised cardiovascular health in adults (Mergler et al., 2007).

Mercury bioaccumulation in fish is a public health concern in northeast Minnesota. Atmospheric mercury emissions to the St. Louis River watershed are relatively high for the region (10-100 $g/km^2/yr$; Cohen et al., 2004) and total mercury (THg) in surface waters of the St. Louis River is among the highest in Minnesota (Monson, 2013). The State of Minnesota has posted a fish consumption advisory for fish in the St. Louis River related to the high mercury concentrations found in fish tissues; for example, St. Louis River walleye have mercury concentrations higher than the regional background (Monson, 2012). Newborns tested from the Minnesota portion of the Lake Superior basin have a relatively high blood mercury concentration, and the data pattern suggests that exposure through fish consumption is a likely factor (McCann, 2011).

In broad terms, the request from EPA Region 5 to ORD was to address whether the available science supports the conclusion that the wetlands that will be affected by the dredge and fill activities authorized by the 404 permit contain mercury, whether the mine activities will result in increased production of methylmercury in the wetlands and/or waters impacted by the project, and whether this will result in pollutants being transported downstream, thereby impacting Fond du Lac Band's reservation waters and fish, especially due to increased concentrations of methylmercury in fish. We summarized available scientific information for the different components of this query. Initially, we summarize what is generally known from peer-reviewed scientific studies regarding potential downstream or downhill transport of mercury, especially due to water drawdown of wetlands and peatlands. In this context, we specifically consider what is known about the impact of drawdowns on mercury methylation, the areal extent of wetlands impacted at the facility, and the subsequent potential for transport. We also consider scientific information regarding the potential role for treated, discharged waters; the effect on mercury methylation from sulfate addition; and the potential for long-distance, downstream export of mercury from the mine site. Finally, we address common scientific practice for prediction effects on methylmercury fish tissue concentrations based on methylmercury concentrations in surface waters.

Executive Summary

At this time, the scientific information to predict the timing and magnitude of mercury concentration change in waters or fish downstream of the NorthMet mine is incomplete because the impact on regional wetlands and peatlands has not been sufficiently studied. Mercury methylation geochemistry and subsequent bioaccumulation depends on a set of important factors. To evaluate the effect of wetland impacts on methylmercury, as well as the additions of mercury and sulfate from treated, discharged waters, it is necessary to develop a process-based mass balance model of the system. Such an approach must incorporate wetlands and peatlands; surface, pore, and ground waters; and include future hydrologic changes owing to mine operations. While there are examples of such hydrologic models in the scientific literature (e.g., a Hydrologic Simulation Program FORTRAN, Berndt et al., 2016), no such model was applied to evaluate the NorthMet mine and processing facility impacts on area wetlands and peatlands with respect to changes in hydrology (whether direct or indirect). To apply such a model, it would first be necessary to characterize the current conditions at the proposed mine site and processing site, including mercury inventories and relevant water quality parameters such as sulfur and dissolved organic carbon concentrations in wetlands, surface waters, and ground waters, as well as measurements of surface and ground water flows. To address the timing and magnitude of mercury concentration change downstream and in fish, the model would be used to assess potential change in loading of mercury and methylmercury to the St. Louis River under varying mine operations and environmental conditions. Specifically, to address the CWA Section 401(a)(2) process, the model should also address fate and transport downstream of the mine site and processing facility to the Fond du Lac Reservation boundaries.

NorthMet Mine Site

The proposed NorthMet mine is situated in the St. Louis River watershed in northeast Minnesota (FigureFigure **1**), upstream of the Fond du Lac Band of the Lake Superior Chippewa reservation (“Fond du Lac”). As noted previously, the proposed mine processing plant (formerly the LTV Steel Mining Company processing plant) and associated tailings basin is situated within both the Partridge and Embarrass River watersheds. The proposed open pit mine is located in the Partridge River watershed. The confluence of the Embarrass River and St. Louis River is located 79 river miles from the northern boundary of the Fond du Lac Band reservation. The NorthMet processing facility will be near the northern boundary of the Embarrass River watershed, another 52 river miles from the confluence of two rivers, 131 river miles upstream of the Fond du Lac Band reservation. The confluence of the Partridge River is located 99 river miles from the northern boundary of the Fond du Lac Band reservation. The mine pit will be located 31 river miles from the confluence, 130 river miles upstream of the Fond du Lac Band reservation.

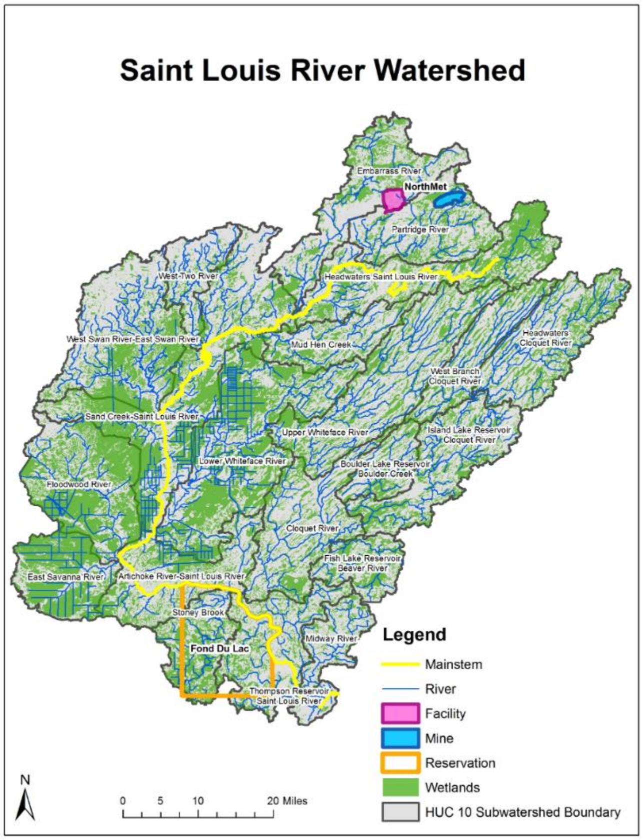

***Figure 1**. St. Louis River watershed and subwatersheds, wetlands, and the locations of the NorthMet processing facility ("Facility") and open pit mine ("Mine") as well as the Fond du Lac Band of Lake Superior Chippewa Reservation.*

Potential for Increased Loading of Mercury

Increased methylation of mercury due to wetland dewatering. Dewatering of wetlands would result in drawdown of ground water with potential fluctuations of the water table. At this time, the acreage of wetlands that would be dewatered during mine operation and construction is not definitively known and should be addressed using hydrologic data on groundwater connectivity along with hydrologic models. With respect to the impact of the proposed mine pit, a question is raised as to what the implications for release of total mercury (THg) and methylmercury (MeHg) during the construction process are, as well as during the long-term operation of the proposed mine, which would result in long-term drawdown of ground water and drying of wetlands in the vicinity. Subsequently, seasonal precipitation patterns would cause periodic wetting and drying of wetlands as well as potential fluctuations of the water table. Research has demonstrated that wetlands have high potential for converting divalent mercury (Hg(II)) into MeHg, as shown in higher fractions of THg being present as MeHg (%MeHg) (e.g., Krabbenhoft et al., 1999; Kelly et al., 1995). Research has also shown that the cycle of drying and flooding of wetlands results in increased production of MeHg (St. Louis et al., 2004). A study in northern Minnesota showed that water fluctuations in a boreal peatland increased methylation potential, thereby increasing MeHg loads to downstream sources through mobilization in pore waters (Coleman Wasik et al., 2012). Further, long-term drying of peatlands causes MeHg release to pore waters and can result in a net increase relative to pre-drying conditions of MeHg production (Coleman Wasik et al., 2015), which can then serve as a MeHg source to downstream waters. Changing the hydrology of peatlands has been shown to enhance peat decomposition, regenerate electron acceptors, and release elevated [DOC], all of which enhance Hg release and transport downstream (Haynes et al., 2017; Hribljan et al., 2014; Strack et al., 2008; Whittington, et al., 2006). Based on the scientific literature, therefore, it is feasible that the hydrologic impacts of dewatering (drying wetlands) at this site and then subjecting the dried wetlands to annual precipitation cycles would result in enhanced production of MeHg and export to downstream waters.

The total mass of Hg in the wetlands that would be impacted by the proposed mine is unknown. However, it is generally understood that wetlands are sinks for organic matter, sulfates, and mercury, and that they have elevated percent MeHg compared to nearby receiving waters. Coleman Wasik et al. (2015) showed that in a boreal peatland, hydrologic fluctuations released increased concentrations of sulfate and THg over time as well as a higher percent MeHg. Thus, disturbing the wetlands via draining could result in the release of increased THg, MeHg, and sulfates into downstream receiving waters, all feasibly resulting in increased MeHg concentrations in fish tissue. Notably, it is unclear how long the increased release would last, and it is also unclear what the magnitude of increased concentrations of fish tissue could be and how long such an increase would persist.

<u>Extent of wetland impacted</u>. The full extent of the area of wetlands that would be impacted by this project is unclear. It is difficult to assess whether the 6,000-acre estimate provided in the Environmental Impact Statement is accurate or another estimate would be more appropriate given the limited information available. It is further unclear at this time how the potentially impacted wetlands are connected hydrologically to ground or surface waters. A confounding factor is that the mine construction would change the hydrology and associated connectivity of the system. This, in turn, can potentially increase or decrease downstream loads of mercury and sulfate (e.g., Devito and Hill, 1998). To fully estimate the area of impact and to ascertain the level of uncertainty associated with that estimate would require both field sampling and hydrologic modeling. The best way to address how the changes would affect the hydrology would be through hydrologic modeling of the current condition and then the proposed condition.

<u>Effect of drawdown on mercury export from wetlands</u>. A concern from the drawdown of the wetlands is the extent of mercury export during the process and over the long-term. Given the scientific community's understanding of the processes that would occur through drawdown of the wetlands, there is a potential with a strong likelihood that stored sulfate, organic matter, and THg with a high percent MeHg will be released over time. Wetlands are generally net sinks for sulfate, organic matter, and Hg. Disturbing the wetlands releases them, and (as described previously) it is feasible that the drawn down and hydrologic fluctuation would release more of these constituents than a wetland under baseline conditions. Therefore, the release of these constituents would likely increase with the construction of the project. It is unclear, however, the magnitude and timing as well as the extent of impact of their release on downstream waters. To fully evaluate the impact on the release of THg, sulfates, organic matter, and MeHg, a mass balance approach would be useful.

The only way to fully evaluate the effect of mine construction and operation on water quality would be to do a site study combined with process-based mass balance modeling with appropriate estimates of uncertainty. To obtain a conservative approximation, simplifying assumptions could be made to bound the extent of impact on the system. This type of effort would need to include characterizing wetlands and instream processes. The changes to the water chemistry of downstream systems would need to incorporate the increased load of THg, MeHg, sulfate, and organic matter. Process-based (also called "mechanistic") mass balance models of mercury that include fate and transport are complicated by the dynamics of transformation due to different governing processes, including methylation of inorganic mercury to MeHg, as well as oxidation, reduction, and demethylation as well as transport.

To start, one would need to know the amount and forms of mercury present in the wetlands as the source of mercury and also the rate and amount at which they are being released. Generally, this is done by considering the load from the wetlands (mass per time, e.g., kg/d), which is the volumetric flow rate (volume per time, e.g., m^3/d) multiplied by the concentration (mass per volume, ng/L). A commonly applied simplifying assumption is that the amount of mercury released from the wetlands is negligible compared to the source. That is, one assumes the current release rate of mercury (load of mercury to receiving waters) remains constant over the time of interest and the total mass of mercury in the wetlands doesn't change. This assumption can be validated later by calculating how much total mass would be lost compared to the initial mass during the length of the simulation.

Porewater concentration in the sediment can be calculated using partition coefficients and the soil mercury concentrations. The best method for doing so would be to use soil Hg concentration at the site and calculating partition coefficients based on site observations. In lieu of on-site partition coefficients, estimates could be used understanding the extent of uncertainty, as partition coefficients can range over orders of magnitude. Once the pore water concentration is calculated, the flow rate associated with the pore water is needed. Multiplying the flow rate by the pore water concentration would yield the total load of THg and MeHg leaving the wetlands and entering the ground water and/or surface water. An important consideration is the wetland types (e.g., fens, riparian wetlands) situated close to the area where the water table would be drawn down because ground water connectivity is related to wetland type.

Role of discharged waters. Although we cannot comment on the future quality of treated water discharged to Trimble Creek from the mine processing facility because this relates to the conditions of a permitted discharge and not scientific uncertainty, we do note that any mercury or sulfur loads in permitted discharge will be subject to potential long-distance, downstream transport as described below.

Effect on methymercury production from sulfate addition. Methylmercury is produced by methylating inorganic Hg to MeHg. Methylation occurs in anoxic, organic, saturated environments. These environments include saturated soils, wetlands, surface water sediments, and low oxygen waters above sediments. Sulfur reducing bacteria along with iron reducing bacteria are often the primary microorganisms responsible for methylation. Because of the role of sulfur reducing bacteria, the concentration of sulfate plays an important role. It has been widely demonstrated that mercury methylation occurs in sediments and soils where the redox potential is in the sulfur reducing zone. Studies that have manipulated sulfur concentrations have shown that increasing sulfate concentrations result in increased sulfur reduction and thus increased potential methylation and elevated MeHg concentration. Net production of MeHg is favored under conditions where sulfate supports microbial sulfate reduction, without accumulation of sulfide. High dissolved organic carbon (DOC) concentration enhances methylation because DOC increases the bioavailable inorganic Hg for methylation and because organic carbon is critical for microbial metabolism (see e.g., Matthews et al., 2013; Gilmour, 2011; Benoit et al., 2002). Thus, identifying potential uncontrolled sources of sulfate, such as from impacted wetlands or a tailings waste pile, and estimating the associated potential loads are critical to assess the downstream impact of the proposed mine because the sulfate could stimulate increased methylation in downstream wetlands and tributaries. It should be noted that it is scientifically challenging to quantitatively predict changes in methylation with respect to sulfate addition. It is not always the case that sulfate additions to wetlands cause an increase in mercury methylation, and in this instance, the history of past impacts in the basin may be a relevant factor (Johnson et al., 2016).

Potential for long-distance, downstream transport of mercury**.** Roughly one-third of the area within the Partridge River and Embarrass River watersheds is wetland (Figure 1), and roughly 15% is peatlands (U.S. Fish and Wildlife Service National Wetlands Inventory, www.fws.gov/wetlands/data/mapper.html; Minnesota Department of Natural Resources, gisdata.mn.gov/dataset/geos-geomorphology-of-minnesota). The extensive wetlands and peatlands enhance the mercury bioaccumulation potential of the river because wetlands and peatlands are a source of mercury (i.e., a net sink of deposited mercury) to surface waters, as noted previously. As water moves through peatland systems, fluxes of THg and DOC through both surface and subsurface soils are both important and interlinked components owing to binding of organic carbon (whether dissolved or particulate form) and mercury. Based on research in northern Minnesota peatland systems, most THg and DOC in streams adjacent to peatlands are derived from those peatlands compared to upland sources (Kolka et al., 2011). However, the pathway is not conservative; there is the potential for THg losses (e.g., soil accumulation, volatilization) en route to the stream. Further, movement of upland waters carrying sulfate, nutrients, and labile DOC into wetlands in peat landscapes can provide ideal conditions for methylation (Kolka et al., 2011), which can then potentially transport to adjacent streams.

Available data reveal that inorganic mercury loaded into the Partridge River or Embarrass River has high potential to be converted to MeHg and transported downstream through the St. Louis River. First, available mercury data from the Partridge River and Embarrass Rivers indicate high potential to convert Hg to MeHg in the immediate receiving waters and associated wetlands. In the Final Environmental Impact Statement (MN Department of Natural Resources, US Army Corps of Engineers, US Forest Service 2015), the surface waters of the Partridge River had an average MeHg concentration of 0.4 ng/L, and surface waters of the Embarrass River had an average MeHg concentration of 0.5 ng/L. These concentrations are higher than the St. Louis River average concentration of 0.33 ng/L. The percent MeHg in the Partridge River increases from 2.2% (SW-001, upstream) moving downstream to 14.6% (SW-004a) and then remains around 10% at 2 stations further downstream. In the Embarrass River, the percent MeHg is 10.4% and 8.8%. Methylation potential of an aquatic ecosystem can be related to the fraction of total mercury present as MeHg (i.e., %MeHg), calculated as [FMeHg]/[FTHg]*100% (the use of %MeHg as an indicator for methylation potential has been well-documented (e.g., Tierngren et al., 2012; Gilmour et al., 1988; Drott et al., 2008). Different aquatic ecosystems have demonstrated different percentages of FTHg as FMeHg. On average, rivers have %MeHg of 4%, lakes are 8%, whereas wetlands, which have high methylation potential, are 15% (Krabbenhoft et al., 1999; Kelly et al., 1995), similar to what is observed in the Partridge River (the watershed in which the mine pit will be located).

Second, the data from the St. Louis River indicate it has high methylation potential and is not a net demethylating system, thereby facilitating downstream transport. Specifically, data reveal that filtered total mercury (FTHg) concentration increases going upstream from the Fond du Lac Reservation (Figure 2; linear regression, $p<0.05$). This suggests that there are processes reducing the concentration of FTHg as one goes downstream. These losses could include volatilization or settling (burial) into the sediments. Incoming tributaries with lower FTHg concentrations than the mainstem could reduce (dilute) instream FTHg concentrations. Also, since this figure is focused on filtered concentrations, additional particles (increased total suspended solids) or decreases in DOC, could also shift the filtered species to particulate species (Brigham et al. (2009) provides details on the role of DOC and suspended particles on the transport of THg and MeHg). A regression of the filtered methylmercury (FMeHg) concentration versus distance, however, shows FMeHg concentrations remain relatively constant over distance (slope = 0.0011, $p=0.11$; Figure 2). Correspondingly, there is not a decrease in percent FMeHg from upriver to downriver, suggesting that the methylation potential throughout the watershed is relatively constant and that the overall system is not a net demethylating system, which is why MeHg concentrations remain at elevated levels throughout the St. Louis River. The corresponding values, generally 4-11% MeHg, are higher than typical rivers (Krabbenhoft et al. 1999), also indicating high methylation potential.

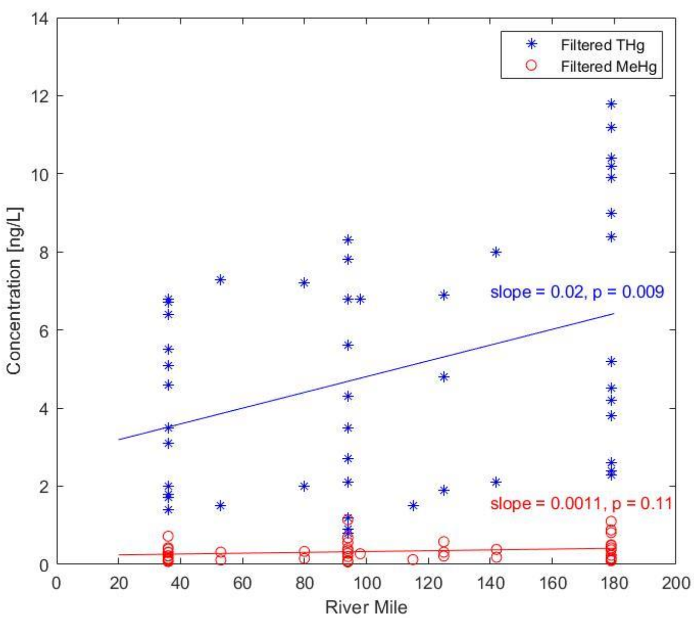

***Figure 2**. St. Louis River concentrations of filtered total mercury (FTHg, blue) and filtered methylmercury (FMeHg, orange) plotted versus downstream distance. Fond du Lac is at River Mile = 0. As FMeHg is a fraction of total mercury, it is always lower than the FTHg. Multiple data points at a given location are due to sampling at different times. Data are filtered surface water THg and MeHg (FTHg, FMeHg) concentrations reported in Berndt and Bavin (2009), Berndt and Bavin (2012), and Berndt et al. (2014) from the mainstem of the St. Louis River.*

Third, recent research has demonstrated that mercury can be distributed along the St. Louis River kilometers from the known point source and enter the food web (Janssen et al. 2021). Mercury stable isotope data from sediments and sampled organisms revealed that a watershed source of mercury was prevalent in the upstream portion of the area sampled, just below Fond du Lac dam and downstream of the Fond du Lac Band reservation. This is indicative of downstream mercury transport and suggestive of connectivity in mercury over long distances in the river. However, the study did not differentiate specific locations within the watershed, so these exact distances cannot be inferred from the study.

Bioaccumulation Potential

The question arises whether downstream transport of THg, MeHg, and sulfate will lead to an increase in tissue mercury concentration of fish located downstream. Most mercury in fish tissue is present as MeHg, generally 95% or greater, and is largely acquired through the diet (Bloom, 1992). Fish tissue MeHg concentration is strongly correlated with MeHg concentration in water (e.g., Brumbaugh et al., 2001); that is, as water MeHg concentration increases, so does the concentration in primary producers (i.e., algae) and secondary producers (e.g., invertebrates), which ultimately results in an increase in methylmercury concentration in high trophic level consumers such as fish. If only THg concentration increases, however, it is not necessarily the case that surface water MeHg concentration will increase. As described above, direct (i.e., from treated discharges or air emissions) or indirect (i.e., from wetland impacts) additions of mercury to the watershed from the mine and mining operations will likely undergo methylation owing to the high methylation potential of the local tributaries and associated wetlands. Thus, additions of THg could increase MeHg concentration. If the percent MeHg in the surface water remains constant, then as THg concentration in the water increases, MeHg concentration in the water will correspondingly increase, thereby increasing MeHg concentration in fish. Additionally, if conditions in the system result in increased methylation potential (e.g., by increasing sulfate), then percent MeHg in the water will increase. In this case, if THg concentration remains constant, then MeHg concentration in the water would increase and fish MeHg would subsequently increase. Given the location surrounding the proposed NorthMet mine, the conditions are such that there is the potential for increased loading of THg, MeHg, and sulfate, which would have the potential to result in increased MeHg tissue concentration of fish located downstream.

It is common practice to estimate a linear relationship between water MeHg concentration and fish tissue MeHg concentration. This is estimated as a bioaccumulation factor, or BAF (e.g., Brumbaugh et al., 2001, USEPA, 1997). This empirical, linear relationship (BAF) is commonly used to measure or model changes in fish tissue residue. Unlike organic contaminants, where the concentration in the fish is independent of the age, length, or weight of the fish, mercury not only bioaccumulates but also biomagnifies with increasing trophic position in the food web. The BAF used to estimate Hg concentration in fish must account for the fish length, weight, and age, as the concentration in fish increases with these factors. Additionally, the BAF is related to several other factors, including lake trophic status, fish trophic level, food web complexity, and seasonality. As these factors may vary over the length of the river, it is feasible that different BAFs would be appropriate in different locations.

Conclusion

There are a series of data gaps that limit the ability to discern the extent of impact of the development of the NorthMet mine, specifically the impact owing to the disturbance of wetlands and potential impact on regional wetland hydrology. To fully understand the effects of the wetlands impact would require a study comparing current conditions to future conditions (NorthMet mine construction and/or operations) that uses site-specific data (as feasible) to support a process-based mass balance model. The model should have associated estimates of uncertainty. Site characterization would need to include current conditions of surface and ground water at the proposed NorthMet mine site, including measurements of water quality, particularly total mercury, methylmercury, sulfate, and dissolved organic carbon concentration and pH. Further, site characterization would need to include current types and conditions of regional wetlands, including total and methylmercury concentrations in the soils and pore waters, with estimated partition coefficients, along with soil characterization, including sulfate and soil organic carbon content. The site characterization could include measures of mercury losses (e.g., volatilization, burial), though these potentially could be estimated depending on model form. Seasonal site characterization data under different hydrological conditions would greatly aid model development and help to reduce uncertainty. Further, to support the model, the hydrology of the system would need to be characterized, including measurements of surface and ground water flows and characterizing the extent of hydrologic connection between different types of wetlands and the surface and ground waters. Once the future loads from wetlands within the impacted sub-watersheds are estimated, this information could be summed with other inputs (e.g., from treated waters or air emissions) to evaluate total load and ultimately downstream transport.

In absence of such a modeling effort that could quantify the potential downstream effect of the NorthMet mine, the letter presented by the Fond du Lac Band of Lake Superior Chippewa regarding the potential for downstream impact of the NorthMet mine presents a set of concerns that we find to be well-grounded in contemporary scientific research. Wetlands accumulate and store sulfate, organic matter, and mercury. Wetlands also have a high methylation potential, indicated by a high percent methylmercury of the mercury present in wetlands, and thus wetlands generally have a high methylmercury concentration. Available mercury data from the Embarrass and Partridge Rivers reveal relatively high methylmercury percent values and high methylmercury concentrations, consistent with this general finding. Should NorthMet mine construction and operation disturb wetlands and drawdown the local water table as a part of the dewatering process, the impacted wetlands have the potential to release high concentrations of sulfate, organic matter, total mercury, and methylmercury. Based on relevant scientific studies, these concentrations would likely be higher than the concentrations released under undisturbed (current) conditions. The loads of these environmental constituents would potentially impact downstream receiving waters subject to long-distance transport. Specifically, the potential for downstream transport of mercury is supported by recent data indicating that the St. Louis River has a high methylation potential in the watershed and by recent research that demonstrated long-distance transport of mercury within the system. In addition to the release of mercury, released sulfate and organic matter may result in increased downstream methylation potential, which would increase the percent methylmercury downstream. The combination of increased loads and higher methylation potential could therefore result in increased mercury in fish tissue downstream. Typically, this is because increasing methylmercury in surface waters increases the methylmercury concentration in primary producers (through uptake) and secondary consumers (through the diet), which subsequently increases methylmercury concentration in high trophic-level consumers such as fish through the food web.

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