ON REMAND TO THE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

Fond du Lac Band of Lake Superior Chippewa, Plaintiff, v. Cathy Stepp, et al., Defendants, and Poly Met Mining, Inc., Proposed Intervenor-Defendant.	Civil No. 19-CV-2489 (PJS/LIB) **DECLARATION OF CLIFF TWAROSKI**

I, Cliff Twaroski, pursuant to 28 U.S.C. § 1746, do hereby state and declare as follows:

1. I am a Vice President and Senior Environmental Scientist at Barr Engineering, where I have worked for 23 years. I have a Master of Science degree from the University of Minnesota in Forest Management with a minor in Soil Science (1982) and a Bachelor of Science degree from the University of Wisconsin – Steven Point in Forest Management with a minor in Soil Science (1979). My Master of Science thesis work was part of a series of studies assessing reclamation of mined peatlands (Field Testing of Grasses and Site Treatments on a Mined Peatland in Northeast Minnesota, April 1982).

2. Before I worked for Barr, I spent more than 15 years at the Minnesota Pollution Control Agency, where I worked in the Acid Rain Program assessing atmospheric deposition of sulfate and nitrate on aquatic and terrestrial ecosystems in northern Minnesota; the Superfund Program assessing chemical contamination of soil,

surface water, and groundwater aquifers, determining potential risks to human health from drinking water, and developing site-specific remedies; and the Air Toxics Program assessing hazardous air pollutants and other toxic air pollutants for potential multipathway effects on human health and ecological receptors, including deposition of metals, mercury, polycyclic aromatic hydrocarbons, and dioxins/furans to vegetation, soils, and surface waters.

3. I have more than 38 years of experience assessing potential environmental effects and human health and ecological risks from chemicals released to the environment, including from power plants, mines, and manufacturing facilities.

4. Among my many different assignments with Barr, I have been working on Poly Met Mining, Inc.'s NorthMet Project for more than 17 years.

5. Many scientists contributed to the Cross-Media Analysis that was prepared in connection with PolyMet's Section 401 certification, but I was its lead scientist and author. As further described below, the Cross-Media analysis evaluates the potential downstream impacts of not only PolyMet's water discharges, but also air emissions, watershed changes, and water capture and withdrawals.

6. In preparing this declaration, I reviewed Dr. Brian Branfireun's 2019 comments on MPCA's Clean Water Act Section 401 certification. The following declaration addresses those comments.

7. After reviewing Dr. Branfireun's 2019 comments, I am confident that the results of the Cross-Media Analysis remain valid and that Dr. Branfireun's concerns have been addressed either within the Cross-Media Analysis or with the additional supporting data provided herein.

8. As stated on page 14 of MPCA's Section 401 Certification Fact Sheet the Cross-Media Analysis shows that, even when accounting for air-related emissions and cumulative effects (air emissions and water discharges) from the Project and all other Project changes:

a. There is no measurable change in mercury concentrations in water or fish from project-related depositions of sulfur;

b. There will be no exceedances of copper, cobalt, or arsenic class 2D water quality standards or to any other numeric water quality criteria from project-related air emissions or the cumulative impact of the project; and

c. The project will not result in any measurable changes to water quality downstream of the project in the St. Louis River, including downstream locations at Forbes.

A. Development of the Cross-Media Analysis and the potential cumulative effects of the Project impacts.

9. Dr. Branfireun states that the Cross-Media Analysis limited sulfur loading to dust deposition in a single wetland (the Wetland of Interest), and that this fails to account for environmental risks from other Project changes (e.g., hydrologic changes, aqueous sulfate releases, and mercury air deposition to wetlands) (Section 2.1.1; Branfireun 2019). The following provides an overview of the Cross-Media Analysis as well as the evidence that these specific claims by Dr. Branfireun are incorrect.

10. Staff from the Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Natural Resources (MDNR) were active participants in designing the analysis and reviewing/approving the approach and methods to provide information to support MPCA's water permitting.

11. The scope of the Cross-Media analysis was not to provide an analysis of all of the Project's potential environmental impacts as if it were a substitute for an environmental impact statement or other environmental review document. Rather, the scope was to evaluate comprehensively potential water quality effects A) from air emissions associated with the Project and B) from the potential cumulative consequences of these air-related effects when added to the effects of traditional water quality-related discharges (such as from the Project's Waste Water Treatment System (WWTS)) and

other Project changes (such as use of tailings basin seepage capture systems, mine water collection, and use of high mercury water from Colby Lake for plant make-up water), to nearby streams and wetlands. Contrary to Dr. Branfireun's comments, this was not a narrowly focused study. It assesses potential Project impacts from multiple (and all potentially significant) sources associated with Project operations over a large geographic area (50-kilometer radius from the Project) encompassing multiple major watersheds in northeast Minnesota, including the Partridge River watershed, Embarrass River watershed, and St. Louis River.

a. The Cross-Media Analysis also included levels of protectiveness and overestimation similar to human health and ecological risk assessments (Cross-Media Report, Section 3.7, Pages 72 to 76).
b. The degree of overestimation in the Cross-Media Analysis when compared to the representative assessment (Barr 2018) averages more than a factor of 10 (ranges from a factor of 3 for sulfate loading to more than 700 for copper) based on the changes to selected input values regarding particle fate, environmental conditions, and geochemical reactions (Barr 2018). For the representative assessment the selected input values were adjusted to be more in line with the environmental setting of the Project (e.g., mineral weathering occurs for 30 days instead of a full year as fairly rapid particle movement downward in soils to less oxygenated levels and snow and cold temperatures limit dissolution) (Barr 2018). The representative assessment (Barr 2018) was provided to the MPCA in support of the 401 Certification.
c. Overall, the high-level of protectiveness incorporated into the Cross-Media Analysis provides confidence similar to typical risk assessments that potential effects have not been underestimated.

12. All of the Project's potential sulfur emissions were included in the air dispersion/deposition modeling, including sulfide particles from fugitive dust and stack/tailpipe emissions of gas-phase and aerosol sulfur species (i.e., sulfur dioxide, sulfuric acid mist, hydrogen sulfide, and sulfur bound to fine particles) (Cross-Media Report, Figure 2-1, Page 9; Appendix A, Air Emissions Modeling Protocol).

13. The air modeling receptor grid included numerous wetlands within the property controlled by PolyMet and on other properties (included private and publicly owned lands) to identify where the highest potential sulfate loading from the Project would occur. This allowed the potential sulfate loading to those wetlands to be estimated and accounted for in the more detailed evaluation of downstream impacts (Cross-Media Report, Large Figure 7 (Mine Site), Large Figure 8 (Plant Site)).

14. The Project's highest atmospheric loading of sulfate (primarily from sulfide particles with a small contribution from stack emissions) was clearly identified to occur in a small wetland and associated watershed at the Mine Site. Deposition to other wetlands and receptor areas was notably less (Cross-Media Report, Large Figure 7 (Mine Site), Large Figure 8 (Plant Site)).

15. PolyMet, MPCA, and MDNR mutually agreed to evaluate the potential impacts to the wetland and associated watershed receiving the highest sulfur deposition, which was identified as the Wetland of Interest for the analysis. If no measurable changes were associated with the wetland receiving the highest loading of sulfur from the Project, then other wetlands receiving notably less sulfur loading from the Project would also have no measurable change.

16. While the Wetland of Interest became a focal point for metal loading and an evaluation point for sulfate, mercury, and methylmercury, the Cross-Media Analysis also evaluated A) air deposition of sulfur (sulfide particles from fugitive dust and gas-phase/aerosol sulfur species from stacks/tailpipes) across the entire 50-kilometer radius air modeling receptor grid, and B) air deposition of sulfur (sulfide particles from fugitive

dust and gas-phase/aerosol sulfur species from stacks/tailpipes) and water discharges to the immediate Project area, for potential export of mercury and methylmercury to evaluation points just downstream of Project operations on the Embarrass River (at monitoring location PM-13) and Partridge River (at monitoring location SW004a), and further downstream in the St. Louis River at Forbes and Cloquet (Cross-Media Report, Figure 2-1 (Schematic for Information Flow and Decisions, Page 9); Table 4-3 (Atmospheric Loading of Sulfate by Project Source Type, Page 85); Figure 6-1 (Geographic Scope of this Analysis, Page 130); Table 5-1 (Evaluation Point Summary, Page 117); Table 5-2 (Estimated Project Effect on Flow (at each evaluation point), Page 119); Large Figure 12 (Evaluation Point Locations)).

Figure 6-1 from the Cross-Media Report is provided immediately below to provide perspective on the geographic scope of the analysis, including the extent of the mercury air emissions modeling grid (10 kilometers), the Cross-Media 50-kilometer air modeling receptor grid, and the evaluation point locations just downstream of the Project in the Embarrass River and Partridge River watersheds and further downstream in the St. Louis River at Forbes (downstream of the Project but upstream of tribal lands) and near Cloquet (downstream of both the Project and tribal lands).

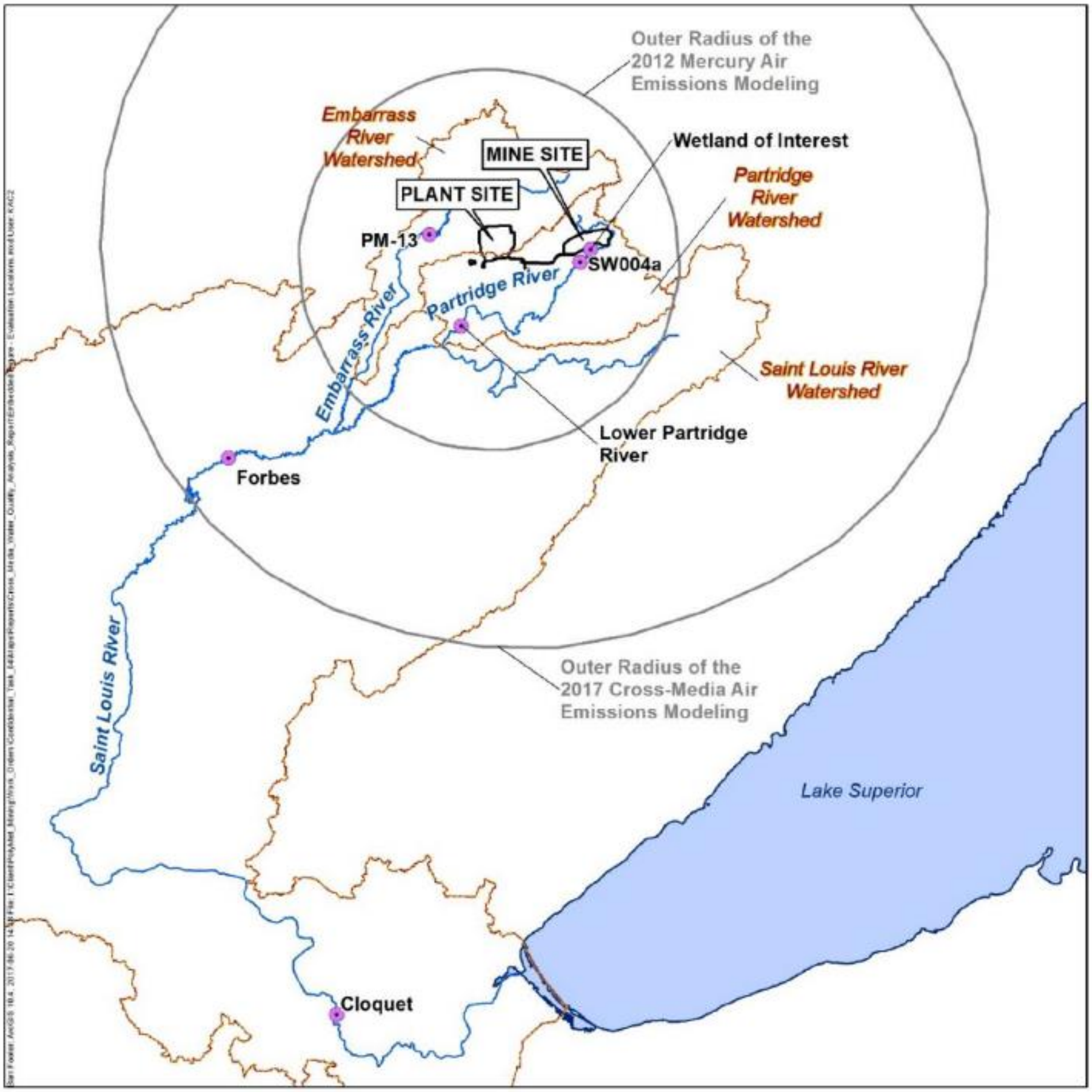

Figure 6-1 Geographic Scope of this Analysis

(Source: Cross-Media Analysis Report, 2017; Page 130)

17. The Project's atmospheric loading of sulfide particles and sulfur released from those particles, and total sulfate loading (sulfate from sulfide particles and gas-phase/aerosol sulfur species), was clearly identified in the air modeling results to decrease rapidly with distance from the Project (Cross-Media Report, Large Figure 7 and Large Figure 10 (Mine Site), Large Figure 8 and Large Figure 11 (Plant Site)).

18. Overall Project loading of sulfide particles and total sulfate (sulfate from sulfide particles and gas-phase/aerosol sulfur species) to the Embarrass River watershed, upper Partridge River watershed, and small individual streams/watersheds near the tailings basin (e.g., Trimble Creek (TC-1a and at PM-19), Unnamed Creek (PM-11), and Second Creek (including SD026)) was small (Table 4-1, Page 79; Table 4-2, Page 81).

19. Sulfate loading from the Project was small compared to measured background deposition and indistinguishable from existing conditions.

a. Estimated Project sulfate loading (wet and dry; from dust and stack emissions of sulfur species) was estimated to be ~0.006 $g/m^2/yr$ to the Embarrass River watershed (1.2% of background), ~0.007 $g/m^2/yr$ for the upper Partridge River watershed (1.5% of background), and ~0.02 $g/m^2/yr$ for small streams/watershed around the tailings basin (4.2% of background) (Cross-Media Report, Table 4-2, Page 81).

b. Background deposition was variable from year to year, with wet deposition having an estimated variability of approximately of 0.04 $g/m^2/yr$ (~14%) in any given year (Cross-Media Report, Page 59). Given this variability, the estimated Project loading of sulfate to the Embarrass River, upper Partridge River, and the small streams/watersheds around the tailings basin is so minimal that it is not distinguishable from existing (background) conditions.

20. The Project's setting in a boreal landscape with numerous wetlands is not a unique methylating environment compared to other boreal forest areas. Methylation potential is defined as the "percent of total mercury that is methylmercury", which in the

Project area (2 to 20%) is similar to other boreal forest areas to the east in northern Wisconsin (5 to 15%) and to the north in northwest Ontario, Canada (1 to 26%) (Cross-Media Report, Table 3-1, Page 61; Barr 2010, Table 3).

21. The potential change in fish tissue mercury concentration due to the Project was estimated for two evaluation points close to the Project; one in the Partridge River at monitoring location SW004a and one in the Embarrass River at monitoring location PM-13. These calculations demonstrate that no measurable change in methylmercury surface water concentrations or fish tissue mercury concentrations are expected due to the Project.

22. The Project's cumulative sulfate and mercury loading from atmospheric deposition (wet and dry) and from water discharges and other Project changes was evaluated in Section 5 of the Cross-Media Analysis Report (Pages 115-128).

a. PolyMet's water management (i.e., mine water collection, tailings basin seepage capture, use of Colby Lake water as makeup water which has high mercury concentrations) at the Mine Site and Plant Site were accounted for in the cumulative loading calculations (Cross-Media Report, Table 5-2, Page 119).

b. Potential mercury deposition from the Project's air emissions (stack and fugitive dust) were also included (Cross-Media Report, Section 5.1.4.2, Pages 120-123).

c. The Project water management results in a net reduction in sulfate and mercury loading to the Embarrass River watershed, the Partridge River watershed, and the downstream portion of the St. Louis River watershed evaluated at Forbes and further downstream at Cloquet (Cross-Media Report, Table 5-5, Page 126; Table 5-6, Page 127). These results are consistent with the Project's antidegradation assessment conducted in support of the Section 401 certification and the antidegradation evaluation conducted in support of NPDES permitting.

23. The Project's predicted contribution of sulfate and mercury to downstream waters, accounting for both the Project's atmospheric loading and water releases, was not measurable in the Embarrass River, the Partridge River, and in the St. Louis River at Forbes and further downstream at Cloquet (Cross-Media Report, Table 5-5, Page 126; Table 5-6, Page 127). This determination is consistent with the Project's antidegradation and nondegradation analyses conducted in support of the Section 401 certification and NPDES permitting, which also accounted for reductions in loading related to PolyMet's water capture at both the Plant Site and Mine Site.

24. A panel of independent peer reviewers retained by the MPCA evaluated the Cross-Media approach and methods and results and concluded the analysis provided a protective scenario of potential cumulative effects on downstream water quality. The panel did not recommend any changes to the Analysis's conclusions with respect to the absence of any measurable impacts for the parameters studied (MPCA 2018).

B. Sulfate loading effects in small headwater wetlands.

25. Dr. Branfireun states that sulfate and mercury loading from direct discharge and seepage to wetlands north of the tailings basin (collectively referred to by Dr. Branfireun as the "Embarrass River wetlands") was not evaluated within the Cross-Media Analysis (Section 2.1.2; Branfireun 2019). The following evidence shows that Dr. Branfireun's claims are incorrect.

a. Results from assessing sulfate and mercury loading from direct discharge and seepage to the Embarrass River wetlands are included in Section 5 of the Cross-Media Report (Table 5-5, Mercury Loads, Page 126; Table 5-6, Sulfate Loads, Page 127).

b. The Embarrass River wetlands (e.g., Trimble Creek, Unnamed Creek) were assessed for potential change in mercury loading. Mercury loading and associated concentrations in these wetlands are estimated to decrease as a function of water capture by the Project and lower mercury concentration (1.3 ng/L) in the wastewater discharge compared to existing conditions (average of 1.9 ng/L) (Cross-Media Report, Table 5-5, Page 126).

c. The Embarrass River wetlands were also assessed for potential changes in sulfate loading. For example, for the Trimble Creek headwater wetlands, sulfate loading is estimated to be decreased by 126,000 kilograms per year (kg/yr) as compared to existing conditions, with a decrease in the average sulfate concentration from 51.4 mg/L to 10 mg/L (Cross-Media Report, Table 5-6, Page 127). Sulfate loading to Unnamed Creak headwater wetlands is estimated to be reduced by 139,000 kg/yr from existing conditions, with a decrease in the average sulfate concentration from 114 mg/L to 10 mg/L (Cross-Media Report, Table 5-6, Page 127.

d. Section 5 of the Cross-Media Analysis clearly discusses (with citations to support documents) and identifies reduced loading of sulfate and mercury to the Embarrass River wetlands, directly contradicting Dr. Branfireun's comments on the topic.

26. Additional support for the Cross-Media Analysis results and conclusions is provided by a previous study of the Embarrass River wetlands. Wetlands are a predominant feature around the tailings basin at the Plant Site. The MPCA and MDNR previously considered these wetlands a "high risk situation" for mercury methylation per MPCA (2006) definitions (i.e., a "high risk situation" due to pre-Project tailings basin seepage with elevated concentrations of sulfate contributed to adjacent wetlands). PolyMet conducted a study in 2009 to assess the effects of the current tailings basin seepage on sulfate, mercury, and methylmercury in wetland streams to the north and west of the tailings basin. The study included: two streams presently receiving tailings basin seepage (Trimble Creek, monitoring location PM-19; and Unnamed Creek,

monitoring location PM-11) with sulfate concentrations averaging 152 milligrams per liter (mg/L) and 17.6 mg/L, respectively; two background streams in non-mining portions of the Embarrass River watershed (upper Embarrass River, monitoring location PM-12; Bear Creek, monitoring location PM-20), with sulfate concentrations averaging 13 and 1.1 mg/L, respectively; and two downstream lakes (Sabin Lake and Wynne Lake) with sulfate concentrations averaging 25.0 and 22.8 mg/L, respectively (Barr 2010). Results included the following:

a. Methylmercury concentrations in the streams receiving tailing basin seepage ranged from ~0.05 to 0.67 nanograms per liter (ng/L) compared to 0.12 to 2.7 ng/L in the background streams; statistical analyses indicated methylmercury concentrations in the streams receiving tailings basin seepage were not elevated (average = 0.35 ng/L for Trimble Creek; 0.2 ng/L for Unnamed Creek) compared to the background streams (0.72 ng/L for the upper Embarrass River and 0.29 ng/L for Bear Creek).

b. Methylation efficiency, as identified by "% of total mercury that is methylmercury" averaged 20% for Trimble Creek and 14% for Unnamed Creek compared to an average of 20% for the upper Embarrass River and 13% for Bear Creek. Statistical analyses indicated methylation efficiency in the streams receiving tailings basin seepage was similar to the background streams.

c. Storm-event analysis indicated more methylmercury may flush from background streams than from streams receiving tailings basin seepage.

d. For the two downstream lakes, methylmercury concentrations were similar in both lakes (e.g., surface water (0-1 meter depth) average concentration was 0.23 ng/L for Sabin lake and 0.21 ng/L for Wynne Lake). However, methylmercury was inversely related to sulfate; as sulfate concentration increased, methylmercury concentrations decreased. In Sabin Lake and Wynne Lake (as well as the streams receiving tailings basin seepage), elevated sulfate concentration has not resulted in elevated methylmercury concentration.

e. A finding of increased sulfate not resulting in elevated methylmercury in streams is similar to the findings of the MDNR studies (e.g., MDNR 2009; Johnson et al. 2014; MDNR 2014).

f. The Barr (2010) assessment was provided to the MPCA and MDNR in April 2010 as support information for the SDEIS, was a reference in the Cross-Media Analysis, and was also provided to the MPCA and MDNR in preparing the FEIS and the 401 Certification.

27. The information in the Barr (2010) technical memorandum and Section 5 of the Cross-Media Analysis (Cross-Media Report, Table 5-5, Page 126) indicates that PolyMet's water discharges to wetlands around the tailings basin, referred to by Dr. Branfireun as the "Embarrass River wetlands," are not expected to result in measurable increases in mercury or methylmercury concentrations, or export from, these wetlands. This conclusion contradicts the dire predictions by Dr. Branfireun (Section 2.1.2, Pages 4-6, of Dr. Branfireun's comments).

28. Downstream waters in the St. Louis River have been sampled by the MDNR in numerous studies since 2007 to assess the effects from mining on sulfate, mercury, and methylmercury concentrations. Results from these investigations indicate mining-dominated watersheds contribute sulfate to the St. Louis River, but very little mercury and methylmercury (MDNR 2008; MDNR 2014). The MDNR studies also show that non-mining watersheds such as the Whiteface River, Floodwood River, and Cloquet River contribute most of the methylmercury load to the St. Louis River. All three streams enter the St. Louis River downstream of the mining region, with the Whiteface River and Floodwood River entering the St. Louis River several miles upstream of the Fond du Lac Reservation while the Cloquet River enters the St. Louis River within the boundaries of the Fond du Lac Reservation (MDNR 2009). These MDNR studies indicate that the main

source of methylmercury is wetland areas within the respective non-mining watersheds and the delivery of that methylmercury to the lower St. Louis River watershed, where the Fond du Lac Reservation is located (MDNR 2009; MDNR 2014). Additional findings from the MDNR studies of the St. Louis River watershed relevant to the Project include:

a. Sulfate in mining discharge water typically remains oxygenated in a channel flow, is not subject to flow through riparian wetlands or sediments and their associated reducing conditions (MDNR 2014), and is not associated with methylmercury concentrations in tributary streams or the St. Louis River (MDNR 2009; MDNR 2014; Berndt et al. 2016).

b. Methylmercury in the St. Louis River is produced primarily in extensive wetland areas in non-mining watersheds located mostly downstream from the mining region (MDNR 2009). In addition, methylmercury associated with shallow flow through riparian sediments to the river was the primary contributor of methylmercury in downstream waters (MDNR 2014), while headwater wetlands were not identified as an important source of methylmercury (Berndt et al. 2016). In other words, the methylmercury in tributary streams and the St. Louis River was predominantly from the riparian zone wetlands and sediments, as this was the last medium through which the water flowed (MDNR 2014; Berndt et al. 2016). This is similar to the findings from Branfireun and Roulet (2002) where methylmercury in outflow water from their study catchment was controlled by the last 300 meters of peatland over which the outflow stream flowed, and methylmercury dynamics in the headwaters wetland area essentially played no role in the methylmercury exported from the catchment. As noted by the MDNR (2009), methylmercury will not contaminate fish unless it is transported from the wetland into a river, and it is possible for methylmercury to be produced in a wetland and never affect fish.

c. PolyMet's wastewater discharge with sulfate concentration of 10 mg/L will be dispersed to wetlands near the tailings basin, eventually becoming channel flow. Based on the findings from Barr (2010), wastewater discharge is expected to have minimal effect on mercury methylation in receiving and downstream waters in the Embarrass River and no measurable effect in the St. Louis River. The MDNR's studies (e.g., Berndt et al. 2016) also indicate Dr. Branfireun's concern with headwater wetlands around the tailings basin receiving wastewater with 10 mg/L of sulfate being a huge source of methylmercury to downstream waters is unwarranted. Dr. Branfireun has not accounted for natural limits on methylation, de-methylation, and other loss mechanisms important in controlling methylmercury export from watersheds (Branfireun and Roulet 2002), in particular methylation limits and loss mechanisms in the Embarrass River watershed (Barr 2010).

d. Mine dewatering and tailings basin discharges are a constant source of water to the tributary stream in a mining-dominated watershed (MDNR 2009). Seasonal chemistry sampling at the mouth of the individual tributary streams where they enter the St. Louis River indicates elevated concentrations of sulfate but not elevated methylmercury concentrations (MDNR 2009; MDNR 2012; MDNR 2014). The DNR's findings are very similar to the study results reported by Barr (2010) for the wetlands and associated streams receiving tailings basin seepage.

e. In the MDNR studies, mining discharge water with elevated sulfate concentrations contributed to net methylmercury production in a nearby lake, but in some instances during the MDNR's study the net production was lower than expected (Bailey et al. 2014a). In addition, even with sulfate addition from mining waters, there was little next export of methylmercury from either lake (Bailey et al. 2014b). These findings indicate that increasing sulfate loading does not necessarily increase methylmercury production or export of methylmercury to downstream waters. The cumulative findings from the studies in the St. Louis River watershed contradict Dr. Branfireun's assumption any increase in sulfate loading to a wetland will automatically increase methylmercury export.

f. Even when a flooding event occurred and mine discharge water inundated a wetland, the MDNR studies showed no increased export of methylmercury as the waters receded and continued to contribute to downstream waters (Johnson et al. 2014). This is another demonstration, similar to the findings in PolyMet's studies (Barr 2010), that sulfate from mining does not necessarily result in increased methylmercury concentrations or export to downstream waters.

29. PolyMet will capture tailings basin seepage with a current average concentration of 112 mg/L sulfate, treat the water to remove sulfate, and discharge water that meets a sulfate limit of 10 mg/L. The treated water flow is required to be equal to (+/- 20% of) the captured seepage. As a result, mass balance calculations for the Project, including the antidegradation analysis for the NPDES permit and Section 5 of the Cross-Media Report (Table 5-6, Page 127), identify a net *reduction* in sulfate loading to the Embarrass River (at monitoring location PM-13), Partridge River (at monitoring location SW004a), and the St. Louis River at Forbes and Cloquet. Note that Forbes is approximately 66 river miles upstream of Fond du Lac Reservation, and Cloquet is approximately 5 river miles downstream of the Reservation. The Project's sulfate loading reductions with a sulfate discharge limit of 10 mg/L means no increase in sulfate to downstream waters.

30. Based on the MDNR's studies of the St. Louis River watershed indicating non-mining watersheds contribute most of the methylmercury and PolyMet's evaluations (including the Cross-Media Analysis) demonstrating a reduction in sulfate load and mercury load, as well as no measurable change in concentrations of mercury or methylmercury in the Embarrass River or Partridge River, the only reasonable conclusion

is that the Project will not measurably increase sulfate, mercury, or methylmercury concentrations in downstream waters in the St. Louis River.

C. Mine dewatering and wetland water level fluctuations

31. Dr. Branfireun states that mine site water table drawdown and wetland impacts at the mine site were not considered within the Cross-Media Analysis or in the Project impact analyses (Section 2.1.3; Branfireun 2019). The following evidence shows that Dr. Branfireun's claims are incorrect.

32. The Cross-Media Analysis did not specifically evaluate water level fluctuations due to mine pit dewatering because pit dewatering was evaluated separately.

a. MDNR and the U.S. Army Corps of Engineers (USACE) assessed potential effects from pit dewatering on Mine Site wetlands using a field-based method known as the analog method. Contrary to Dr. Branfireun's claims, using the analog method is not a flaw. Using computer models to assess potential impacts is not always the best approach for complex environmental conditions. Other assessment techniques often provide for a more representative assessment. For example, the MPCA determined in 2013 that quantitative modeling for Minnesota's mercury TMDL for the St. Louis River was not appropriate (Monson 2021). The professional opinions of agency staff responsible for developing this TMDL and a separate peer review panel determined the readily available computer model would lead to inaccurate conclusions for the TMDL study. Instead, a field-based assessment relying on past and planned future sample collections was initiated (Monson 2021). Similarly in connection with the NorthMet Project, the MDNR and USACE determined that a field-based method (i.e., the analog method based on actual monitoring data) was the best way to assess potential water level drawdown because it provides a more representative assessment of potential wetland impacts.

b. Wetland water flow and potential effects from dewatering of mine pits were previously evaluated for the Draft, Supplemental Draft, and Final Environmental Impact Statement (DEIS, SDEIS, FEIS). With regard to wetlands, potential effects on the surficial aquifer (shallow groundwater less than 50 feet below the ground surface) are considered most important. Conclusions from previous evaluations were as follows (FEIS, Page 4-173 to Page 4-174):

i. There is a general lack of interaction between the surficial and bedrock aquifers. The hydrology of many wetlands at the Mine Site is primarily supported by direct precipitation with some variable surficial groundwater components from the uplands.

ii. Organic and mineral soils at the Mine Site are typically perched over the dense till or a local sandy textured surficial aquifer, resulting in perched wetlands. The primary method for water to move across the landscape towards the Partridge River is by lateral flow either at/near the soil surface or within the subsurface soil. Surface flow laterally across the wetland complexes (i.e., flow from one wetland to the next) is negligible.

iii. Lateral flow within the wetland soils is typically very slow. Fibric peat at the surface allows infiltration of surficial water; however, the more highly decomposed sapric peat has greatly reduced lateral and vertical hydraulic conductivity compared to the fibric peat. Therefore, water tends to stay perched and stored within the wetland, which typically exhibit only subtle variations in the water tables over time in those deeper peat soils. The silty sand or clay typically underlying the organic soil also has low hydraulic conductivity and, therefore, is a contributing factor maintaining the hydrology of the wetlands. These findings are consistent with other peatlands in northern Minnesota (Boelter and Verry 1977). As further discussed by Boelter and Verry (1977), wetland waters in ombrotrophic peatlands essentially have no mixing with groundwater (either surficial or regional groundwater).

c. Based on the Project information, additional reviewed literature, and evaluation in the FEIS, the potential for water level drawdown in Mine Site wetlands is low, and the aerial extent of drawdown (i.e., distance away from a mine pit) is estimated to be minimal.

d. The potential for indirect wetland impacts was assessed as part of the FEIS and detailed in the Antidegradation Assessment for the Section 401 Certification (Section 4). The agencies required monitoring to evaluate whether indirect impacts occur. If needed, an adaptive management strategy to address potential impacts would be implemented. Specifically, the 401 Certification requires PolyMet to monitor for indirect impacts at 61 wetland hydrology monitoring locations across the Project site by measuring water levels and vegetation. (Vegetation will be assessed using the relevé method, which is used extensively by the MDNR (2013)).

33. Dr. Branfireun's comments (Section 2.1.3, Pages 6-9) discussing water level drawdown scenarios do not match with known wetland/peatland hydrology at the Mine Site or take into account actual data from managing water for peat mining operations.

a. The landscape setting of the Mine Site area has been described in Project permitting documents and in the FEIS. The majority of wetlands within the area to be occupied by mine pits and stockpiles tend to be conifer bog located on an elevational high, with a watershed divide running through the northern part of the Mine Site just north of the proposed pit locations. Depth of soils within the area to be occupied by mine pits and stockpiles averages about 10 feet and is described as "thin and discontinuous", which means that most of the wetlands are sitting within depressional areas in the bedrock. The bedrock does not have a smooth surface, rather it has mini hills and depressions which either shed water or collect water (i.e., water collected in the depressional areas). This means the wetlands in this specific area of the Mine Site have short flow paths due to the characteristics of the bedrock and are separated from the shallow aquifer. Several surveys of the wetlands at the Mine Site, with oversight and results reviewed by the MDNR and USACE, indicate the wetlands within the area to be occupied by mine pits and stockpiles are ombrotrophic, i.e., they receive their water from direct precipitation either on the wetland or on upland slopes immediately adjacent to the wetland area. Additionally, the bedrock is sloping away from the mine pits which means surficial water in soils and at the soil-bedrock interface moves away from the mine pits. This site-specific information, in addition to the application of the analog method (FEIS, Section 5.2.3.1.2, Page 5-279 to 5-309) and general peatland characteristics that sequester water (Boelter and Verry 1977), indicates that pit construction and dewatering is expected to have no effect on about 99% of the Mine Site wetland acreage.

b. Wetland hydrology data and information from peer-reviewed and government agency literature indicates widespread water level drawdown due to pit dewatering is unlikely to occur. Wetlands/peatlands are not easy to drain due to the low hydraulic conductivity of the more decomposed peat (Boelter 1968). While water moves through the surface layer of the wetland/peatland relatively freely (approximately the upper 12 to 15 inches), lateral and vertical water flow is severely restricted in the deeper and compacted peat layers (Boelter 1968; Boelter and Verry 1977). Vertical flow is also restricted due to very slowly permeable underlying soils/sediments (Boelter and Verry 1977). Given these wetland characteristics and the landscape setting of the Mine Site, it is Barr staff's professional opinion that water level drawdown in wetlands should not occur more than about 100 feet from a pit rim.

c. Some wetlands near the pit rim may be affected by pit development and dewatering. These wetland areas were accounted for in the FEIS; only about 46 acres of wetlands were identified to be close enough to the pit rims to have a "High Likelihood" of being affected by water level drawdown (<1% of the wetland acreage at the Mine Site; Table 5.2.3-4, FEIS, Page 5-295). This small percentage of affected wetlands contradicts Dr. Branfireun's claim that Mine Site wetlands will be adversely impacted by pit dewatering. Data from peat mining operations can be used to indicate the potential distance mine pit development may affect a nearby wetland.

i. A study of water levels was conducted on a peatland where mining occurred in a portion of a raised peat bog while the adjacent portion was left in its original condition (Mioduszewski et al. 2013). Water level data indicated the dense drainage network (15 to 25 meter spacing of ditches) constructed for mining had a maximum water level drawdown of 10 cm, had a maximum impact extent of from 30 to 60 meters from the mine border (main canals and ditches), but had no effect on the water levels in the immediately adjacent non-mining portion of the raised bog (Mioduszewski et al. 2013). At a distance of 30 to 40 meters from the drainage ditches, the water level was at the ground surface.

ii. Data compiled by Landry and Rochefort (2012) indicate the typical distance of water table effects when wetlands are drained ranges from about 10 to 50 meters from the drainage structure. However, the maximum distance was estimated to be 150 to 200 meters (Landry and Rochefort 2012).

iii. Boelter and Verry (1977) identify for peatlands developed in basins separated from the regional groundwater system by very slowly permeable peat or lacustrine deposits, even when a bog is nestled in the regional aquifer, there is essentially no mixing of the bog water with the regional aquifer.

34. Based on the characteristics of the Mine Site wetlands in the mining/stockpile area being ombrotrophic and isolated from groundwater inputs, the limited vertical water movement in wetlands as described by Boelter (1968) and Boelter and Verry (1977), and the limited distance water level drawdown occurs even in drained wetlands (Landry and Rochefort 2012), dewatering of the mine pits is not expected to have the widespread effect portrayed by Dr. Branfireun. The wetland characteristics within the mine/stockpile area and limited movement of water through compacted deeper layers of the peat soil and the underlying silty sands and clays strongly indicate pit construction and dewatering is unlikely to affect the wetlands at distance from the mine pits. This conclusion is consistent with the drawdown effects estimated in the FEIS, Section 401 Certification, and wetland permits that were based on the MDNR's analog method.

35. Methylmercury export from the Mine Site due to water level fluctuations in wetlands related to pit dewatering is not expected to be as significant as predicted by Dr. Branfireun.

a. As previously discussed, water level drawdown for Mine Site wetlands is expected to be minimal due to the characteristics of the wetlands within the mine/stockpile area and their associated hydrology (Boelter and Verry 1977).

b. Data from the MDNR's study of the St. Louis River watershed indicate mine dewatering is unlikely to increase methylmercury export to downstream waters. For example, mine dewatering is constant and results in almost continuous flow at discharge locations and to downstream waters. Methylmercury concentrations in the streams draining mining watersheds is low (MDNR 2009). During large storm events, methylmercury from wetlands within a mining watershed can be flushed downstream, but this methylmercury is not associated with sulfate from mining activities (Johnson et al. 2014).

c. If current mine dewatering were adversely affecting water levels in wetlands and causing increased methylmercury export to downstream waters (to tributaries and to the St. Louis River), those effects would be expected to be observed in the MDNR's published studies for the St. Louis River watershed (e.g., MDNR 2009; Berndt et al. 2016). But the MDNR's studies did not observe such effects. Instead, those studies indicate elevated methylmercury concentrations and export is not associated with mining operations. Because current mining activities and mine dewatering are not increasing methylmercury export to downstream waters, then it is highly unlikely PolyMet's mine dewatering would increase methylmercury export.

D. Monitoring requirements

36. Dr. Branfireun states that the monitoring required by the 401 Certification and NPDES/SDS permit is insufficient to detect irreparable harm resulting from mercury release and methylation (Section 2.2; Branfireun 2019). The following evidence shows that Dr. Branfireun's claims are incorrect.

37. PolyMet's NPDES Permit and Section 401 Certification monitoring requirements for the Project include numerous wetland pore water sampling locations at both the Mine Site and Plant Site, along with water quality monitoring of the wastewater discharge, surface water sampling locations in the headwater wetland streams, and surface water sampling locations in the Embarrass River and Partridge River just downstream of the Project operations. This monitoring to establish baseline conditions is more extensive than required for other mining or industrial operations in Minnesota.

38. The Section 401 Certification requires wetland pore water monitoring locations directly related to the Cross-Media Analysis results (e.g., wetland Well #36 in the northern part of the Wetland of Interest), and many of the wetland monitoring locations provide additional information on wetland pore water in different wetland types (conifer bog versus the Wetland of Interest (an alder thicket wetland type)). Monitoring requirements for the Plant Site and along the Transportation and Utility Corridor also include wetland pore water monitoring locations to assess potential wetland impacts across the Project area, well outside of the areas of any impacts associated with the Cross-Media Analysis.

39. Stream sampling during Project operations will be conducted in the Wetland of Interest at the outlet stream and in the Embarrass River and Partridge River watersheds, including at headwater streams. Periodic sample collection over a number of years has typically been used to assess potential changes in water chemistry. Data collected during Project operations will be compared to baseline data. MPCA requiring PolyMet to conduct this type of monitoring is consistent with the NPDES permit and Section 401 Certification programs.

40. Wetland hydrology and vegetation monitoring will also continue during Project operations. Wetland water levels will be monitored throughout the growing season at 61 locations across the Mine Site, Plant Site, and Transportation and Utility Corridor.

41. Stream monitoring at 16 surface water locations in the Embarrass River and Partridge River watersheds during Project operations is to provide the chemistry data to determine if export of methylmercury is increasing/decreasing during operations, as well as increases/decreases in sulfate, arsenic, cobalt, and other parameters. The MDNR studies of the St. Louis River watershed, where periodic sampling was conducted over several years on tributary streams and the St. Louis River (i.e., larger channels), provide a template for assessing changes in chemistry over time, evaluating trends, and identifying

source contributions. The MDNR studies were also interested in methylmercury flushing from wetlands within watersheds, and the periodic sampling conducted over several years provided data to assess the hydrologic conditions associated with those flushing events. The MDNR was able to assess potential mining effects on mercury and methylmercury concentrations under variable hydrologic conditions. PolyMet's sampling is also expected to provide data to assess potential Project effects on mercury and methylmercury concentrations under variable hydrologic conditions, despite Dr. Branfireun's opinions. With periodic sampling over a number of years at monitoring locations in the Embarrass River headwaters, and main channels of the Embarrass River and Partridge River watersheds just downstream of Project operations, there is no need to monitor numerous individual wetland locations. Similar to the sampling conducted by the MDNR, flushing sulfate, mercury, methylmercury, and/or metals from wetlands to the downstream monitoring locations are expected to be detectable, if present, in PolyMet's sampling network during both baseline conditions and throughout operations for comparison.

42. Potential changes in downstream methylmercury concentrations due to Project operations are estimated to be minimal and not measurable using the Cross-Media Analysis's conservative overestimate of potential change. Dr. Branfireun's comments on increased methylmercury uptake by birds and bats and other organisms is not relevant to this Section 401 evaluation. For comparison, the MDNR's assessment of mercury in dragonfly larvae found no statistical relationship between mining areas with elevated surface water sulfate and non-mining areas with low surface water sulfate (Jeremiason et al. 2014). So even if it were relevant to the Section 401 evaluation, there is no indication from either the Cross-Media Analysis or MDNR's research that Project operations have the potential to increase mercury concentrations in biota.

43. Mercury and methylmercury in filtered samples (i.e., dissolved concentrations) are representative of the mercury that biota may be exposed to and is the form of mercury most correlated with mercury concentrations in biota; mercury

associated with organic or inorganic particulate is not bioavailable. For example, Jeremiason et al. (2014) found methylmercury concentrations in dragonfly larvae were positively correlated with peak dissolved methylmercury surface water concentrations. The USGS (Wentz et al. 2014) found mercury concentrations in fish correlated strongly with methylmercury concentrations in stream water (dissolved methylmercury). Filtering samples also allows hydrology to be taken into consideration as spring snowmelt or large precipitation events may carry a higher load of particle-bound mercury (soil particles; Balogh et al. 2006) not related to Project operations and not biologically relevant (MDNR 2009). As identified by the USGS (Wentz et al. 2014), only during low flow conditions in streams is the difference between mercury and methylmercury from filtered (dissolved) and unfiltered samples unimportant; under high flow regimes the difference in concentrations between filtered and unfiltered samples is very important. Therefore, the focus of PolyMet's monitoring to filter samples to assess biologically relevant mercury and methylmercury concentrations for all potential streamflow conditions is appropriate.

44. Changes typically occur in surface water chemistry more quickly than they do in biota. Sampling of surface water is also more efficient and cost-effective than biological sampling. Chemistry changes as a surrogate for biological changes has previously been used by the MPCA and the MDNR to assess potential changes from acid deposition. Relying on chemistry changes as an early indicator of potential changes in biota is consistent with prior state agency methods. Regardless, PolyMet is required to conduct macroinvertebrate and fish surveys in the tailings basin headwater streams as part of our Water Appropriation Permit monitoring, so there will be an assessment of potential changes to the aquatic biota as part of Project monitoring.

E. Conclusion

45. Dr. Branfireun has raised four issues that he has characterized as "fatal flaws" in the Cross-Media Analysis. As discussed above, those four issues were either based on a misunderstanding of the study (e.g., Dr. Branfireun's claims that the analysis did not

account for hydrologic changes, aqueous sulfate release or air deposition and that the analysis didn't account for loading from direct discharges of sulfate or mercury), an unwillingness to accept field-based methods as a valid assessment approach (e.g., his rejection of the analog method to assess mine site water table drawdown from pit dewatering), not being familiar with monitoring required for the NPDES permit which is in addition to the 401 Certification monitoring, or his academic desire for detailed mechanistic studies (which MPCA has found unnecessary because the pertinent data collections are otherwise accounted for in the extensive monitoring requirements for NPDES and 401 Certification). Dr. Branfireun's rationales, for the reasons addressed above, do not provide persuasive justifications for rejecting the methodology and findings of the Cross-Media Analysis. As stated at the beginning of this declaration, I am confident that the results of the Cross-Media Analysis remain valid, showing Project-related reduction in sulfate and mercury loads and no measurable change in concentrations of mercury and methylmercury in the Embarrass River, Partridge River, and St. Louis River, including both upstream and downstream of the Fond du Lac Reservation.

46. I am appending a list of the references cited in this declaration.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: April 23, 2021

Cliff Twaroski
Ramsey County, MN

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