

The Minnesota Prove It First Bill and the Myth of Sulfide Ore Mining without Environmental Contamination

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LIGHTNING SUMMARY

The Minnesota Prove It First Bill would prohibit sulfide ore mining unless it could be demonstrated that a sulfide ore mine in the USA and in a similar environment to the proposed mine site had operated for 10 years and had been closed for 10 years without environmental contamination. The nine candidates for model sulfide ore mines (Bagdad, Cactus, Cullaton Lake, Eagle, Flambeau, McLaughlin, Raglan, Rainy River, Stillwater) all have extensive records of environmental contamination. Although the Flambeau mine is often cited as a model sulfide ore mine, the Certificate of Completion of Reclamation merely certifies that the reclamation plan was carried out, but not that it was successful.

EXECUTIVE SUMMARY

Sulfide ore mining refers to the extraction of commodities from ore bodies that contain sufficient sulfide minerals for the generation of acid mine drainage. Despite the abundance of tools for the mitigation of acid mine drainage, some degree of environmental contamination has, thus far, been inevitable simply because there are so many ways for failure to occur. The concept that all mining, including sulfide ore mining, involves inevitable environmental contamination is widely assumed in the mining literature. In response, in 1997 the Wisconsin legislature enacted the “Moratorium on Issuance of Permits for Mining of Sulfide Ore Bodies,” which prohibited sulfide ore mining in Wisconsin unless it could be demonstrated that, in the USA or Canada, at least one sulfide ore mine had operated for 10 years without environmental contamination and at least one sulfide ore mine had been closed for 10 years without environmental contamination. At various times, eight mines were formally or informally put forward as candidates for model sulfide ore mines, including:

- 1) Bagdad copper mine (Arizona)
- 2) Sacaton (now called Cactus) copper-silver-gold mine (Arizona)
- 3) Cullaton Lake gold mine (Nunavut)
- 4) Eagle nickel-copper mine (Michigan)
- 5) Flambeau copper-gold-silver mine (Wisconsin)
- 6) McLaughlin gold mine (California)
- 7) Raglan nickel mine (Quebec)
- 8) Stillwater palladium-platinum mine (Montana)

All eight candidates were discredited because they actually did have records of environmental contamination or, in some cases, insufficient monitoring data. The impasse was broken in favor of the mining industry only when the moratorium was repealed in 2017.

The current Minnesota Prove It First Bill would prohibit sulfide ore mining in Minnesota unless it could be demonstrated that, in the USA and in an environment similar to the proposed mine site, at least one sulfide ore mine had operated for 10 years and had been closed for 10 years without environmental contamination. Nine candidates have been informally put forward as model sulfide ore mines that would meet the requirements of the Minnesota bill, including the exact same candidates that were put forward and rebuffed during the tenure of the Wisconsin statute, and with the addition of the Rainy River gold mine in Ontario. The objective of this report is to compile and update the record of environmental contamination of the first eight candidates for model mines, which has not previously been available in a single document, and to evaluate the record of environmental contamination for the ninth candidate.

It is important to note that, regardless of their history of environmental contamination, none of the candidate mines would meet the criteria established in the Minnesota Prove it First Bill. The Cullaton Lake, Raglan and Rainy River mines would not count because they are not in the USA. The Bagdad, Eagle, Raglan, Rainy River, and Stillwater mines would not count because they have not yet been closed. The Cullaton Lake, Flambeau and Rainy River mines would not count because they were not operated for at least 10 years. Only the Eagle, Flambeau, McLaughlin, and Rainy River mines have mean annual precipitation in the range for Minnesota defined by the wettest location in Minnesota (Caledonia) and the driest location in Minnesota (Karlstad), with all other candidate mines being drier than the driest location in Minnesota. The mean monthly precipitations at the Flambeau and Rainy River mines approximately fit in the range defined by the wettest and driest locations in Minnesota. The mean monthly precipitation at the Eagle mine is a much worse fit, being wetter in the winter than the wettest location in Minnesota and drier in the summer than the driest location in Minnesota. The mean monthly precipitation at the McLaughlin mine is very wet in the winter and very dry in the summer, which is opposite to the pattern in Minnesota. Only the Eagle, Flambeau and Rainy River mines have mean monthly temperatures within the range defined by the warmest location in Minnesota (Winona) and the coldest location in Minnesota (International Falls), although the Stillwater mine is somewhat close, the principal difference being that it is warmer in the winter.

The record of environmental contamination by each of the candidate mines is reviewed in detail in this report. For each of the candidate mines, a single salient observation is listed as follows:

- 1) The U.S. Department of Justice brought a civil action against the operating Bagdad mine for discharging contaminated water in violation of the Clean Water Act, including discharges from tailings ponds, pipelines, leach dumps, other facilities and a sewage treatment plant, resulting in an agreement by the mining company to pay a civil penalty of \$760,000.
- 2) After closure, the pit lake water at the former Sacaton (now called Cactus) mine has been acidic in the range pH 3.8 – 4.1.
- 3) After closure, the pit lake water at the Cullaton Lake mine has been acidic at pH 3.2, while drainage from the pit toward natural water bodies has exceeded Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life.
- 4) The operating Eagle mine has caused numerous exceedances of EPA drinking water guidelines in groundwater downstream from the mine as recently as 2019 (the most recent year for which records are available).
- 5) After closure of the Flambeau mine, the copper concentration in Stream C, which crosses the mine site before it joins with the Flambeau River, has been so high that the stream is nearly devoid of life and has been placed on the EPA list of Impaired Waters.

- 6) Successive closure plans at the McLaughlin mine have proven unworkable as the water quality in the pit lake and tailings pond remains very poor, there is potential for spillage into the environment, and perpetual maintenance may be required.
- 7) Runoff from the Raglan mine has been very high in total dissolved solids, especially in comparison to the receiving waters.
- 8) Even before opening in 2017, the Rainy River mine was fined \$187,500 for discharge of excessive ammonia from the mine pit and another \$100,000 for non-compliance with permits that led to failure of a dam.
- 9) The mine effluent discharge from the Stillwater Mine has exceeded standards for iron, selenium and total suspended solids, with violations of the Clean Water Act identified every quarter since the fourth quarter of 2019 until the present.

Although the closure of the Flambeau mine has been widely touted as a success story by the mining industry, the Certificate of Completion of Reclamation that was issued by the Wisconsin Department of Natural Resources indicates only that the mining company has completed its reclamation plan and in no way states that there has been no environmental contamination. In fact, even more of Stream C has been added to the EPA list of Impaired Waters and the Revised Mining Permit for the Flambeau Mining Company requires additional assessment and a remediation plan for Stream C. The earliest viable candidate for a model sulfide ore mine would have to be a mine that opens in 2023 or an existing mine that ceases environmental contamination in 2023, operates until 2033 without environmental contamination, closes in 2033, and then still has no record of environmental contamination by 2043. Thus, the Minnesota Prove It First Bill is essentially a 20-year moratorium on nonferrous sulfide ore mining in Minnesota pending the demonstration of sulfide ore mining without environmental contamination in some other jurisdiction. The author supports the Minnesota Prove It First Bill since no jurisdiction, not Minnesota, and not anywhere, should have to be the sacrifice zone so that the rest of the world can have metals.

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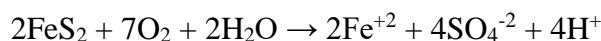
OVERVIEW

Acid Mine Drainage

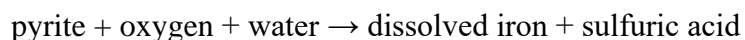
Sulfide ore mining refers to the extraction of commodities from ore bodies that contain sufficient sulfide minerals for the generation of acid mine drainage (Minnesota Legislature, 2021). The mining process typically involves crushing the ore body, extracting the commodity of value using various chemical reagents, followed by permanent aboveground disposal of the remaining material, called the mine tailings. Acid generation occurs when sulfide minerals from beneath the surface are excavated and exposed to oxygen and water on the surface, so that the reaction with oxygen and water (called oxidation) converts the sulfides into sulfuric acid. The conversion of sulfide minerals to sulfuric acid is promoted both by crushing the sulfide minerals, which increases the surface area that is exposed to oxygen and water, and by the permanent aboveground disposal, which allows for an extended time over which the acid-generating

reactions can occur. Acid generation can also result from the aboveground disposal of waste rock, the rock that must be removed to reach the ore body, especially when the waste rock also contains sulfide minerals. It should be noted that the distinction between ore and waste rock can vary with time, depending upon what concentration of the commodity of value is necessary to justify extraction and processing from an economic perspective.

The general acid-generating reaction can be written as a balanced chemical reaction as



or in words as



Pyrite (iron sulfide) is the most common sulfide mineral, but many other metallic elements form sulfides, such as chalcopyrite (copper sulfide or CuFeS_2), galena (lead sulfide or PbS), and sphalerite (zinc sulfide or ZnS). Based on the above reaction, a by-product of acid generation is the mobilization of heavy metals into the dissolved form. The oxidation of pyrite results in the mobilization of dissolved iron. However, most sulfide minerals include a variety of other heavy metals that can substitute for the primary metal (such as substitutes for iron in the mineral pyrite), so that the oxidation of pyrite can result in the mobilization of a wide range of other heavy metals.

Acid mine drainage results when the dissolved metals and sulfuric acid are introduced into surface water or groundwater, which can have detrimental impacts on public water supply and aquatic life. Acid mine drainage can induce a positive feedback in that the downstream load of dissolved metals can greatly exceed the dissolved metals that result from the oxidation of the exposed sulfide minerals. Stream sediments typically include clay minerals, whose surfaces have negatively-charged sites that bind cations (positively-charged ions). Most dissolved metals are cations, although there are some exceptions, such as arsenic (actually a metalloid), molybdenum and uranium, which occur in dissolved form as oxyanions (polyatomic negatively-charged ions that include oxygen). When acidic water interacts with these stream sediments, the hydrogen cations in the water displace other cations (such as metallic cations) from the negatively-charged sites on stream sediments, so that metals are no longer fixed onto sediment, but are mobilized in the stream column as dissolved metals. Stream beds can also include tailings from previous episodes of mining that have heavy metals attached to surface sites. As above, these heavy metals can be mobilized by the introduction of new acid mine drainage into streams or by other anthropogenic increases in stream acidity. For this reason, mine tailings in stream beds are often referred to as a “chemical time bomb.” The literature on acid mine drainage and its impacts on human health and the environment is vast and a good starting point is Maest et al. (2005).

Acid mine drainage is not the only source of environmental contamination resulting from sulfide ore mining. For example, under some circumstances, metal leaching (introduction of dissolved metals from mining by-products into surface water or groundwater) from sulfide minerals can also occur in the absence of acidity or even under alkaline conditions. However, acid mine drainage is so damaging to the environment that sulfide ore mining should be regarded as a separate category from every other form of mining. It should be noted that Minnesota Legislature (2021) refers to “nonferrous sulfide ore,” meaning “any ore, other than iron ore, consisting of sufficient sulfide minerals to generate acid mine drainage.” However, it is almost

unheard of to exploit sulfide ores for iron because of the possibility of acid mine drainage, a variety of processing challenges, and the remaining abundance of iron oxide ore bodies in the world.

A wide range of tools have been developed for the mitigation of acid mine drainage from sulfide ore mining. For example, soil or clay covers on tailings disposal facilities can minimize the contact of tailings with oxygen and rainfall, while stormwater diversion channels around the facilities can minimize the contact with surface water. Crushed limestone can be mixed with the tailings to neutralize any acidity that is generated. Impermeable liners can be placed beneath tailings disposal facilities to prevent seepage into groundwater. Wells can be placed around tailings disposal facilities for the capture and treatment of any acid mine drainage that escaped into groundwater. Water from tailings disposal facilities can be treated for removal of acidity and dissolved metals prior to release into surface water. In fact, most of the above tools should be used at any mine site that carries out sulfide ore mining and there should be no reliance on a single tool, such as a liner.

Inevitability of Environmental Contamination

Despite the abundance of tools for the mitigation of acid mine drainage, some degree of environmental contamination has, thus far, been inevitable simply because there are so many ways for failure to occur. For example, liners could leak or some oxidation of tailings could occur before discharge into a tailings disposal facility or before the emplacement of a soil cover. As part of a review of the Flambeau sulfide ore mine, Moran (2019) summarized, “I know of no metal-sulfide mines anywhere in the world that have operated without degrading the original water quality, long-term – even those employing modern technologies.” In fact, this inevitability of environmental contamination has been applied to all mining, not just to sulfide ore mining. According to Safety First: Guidelines for Responsible Mine Tailings Management, “It is important to recognize that mining is a fundamentally destructive industry, meaning that a goal of zero harm to the environment is impossible to achieve. Nevertheless, operating companies must do all that they can to minimize environmental harm everywhere. In particular, they must limit any environmental harm that inevitably occurs to within the mine site ... A mine site is the area of surface disturbance necessary to conduct a mining operation. This includes extraction, processing, and waste disposal facilities, and roads. A mine site does not necessarily include the entire area as defined by the mine permit or claim” (Morrill et al., 2022).

The concept that mining involves inevitable environmental contamination is widely assumed in the mining literature. In fact, the assumption runs so deep that it is usually not even mentioned except in the context of making some other point. For example, in the context of critiquing one of the Fundamental Values of Geoethics (Di Capua et al., 2017), Abbott (2020) wrote, “The costs for environmental and social impact mitigation increase the cut-off grade, the minimum grade that allows for profitable extraction. Dialog between the mining industry and the various environmental and social impact stakeholders is the key to finding the unique appropriate balance for each mineral deposit. The dialog among the various stakeholders about a particular deposit should recognize society’s need for mineral products as an important, socially desirable goal ... Figure 2 [see Fig. 1 in this report] presents the need to balance maximum resource recovery with minimizing the adverse social and environmental impacts of mining.” Abbott (2021a) continued, “The facts that future generations will need newly mined mineral products and that extraction of individual mineral deposits is not a sustainable activity are things about

which the mining industry must educate the general public. Public education about the need to balance the costs of the environmental and social impacts of mining with the need for future generations' need for minerals is required for the sustainability of the mining industry.”

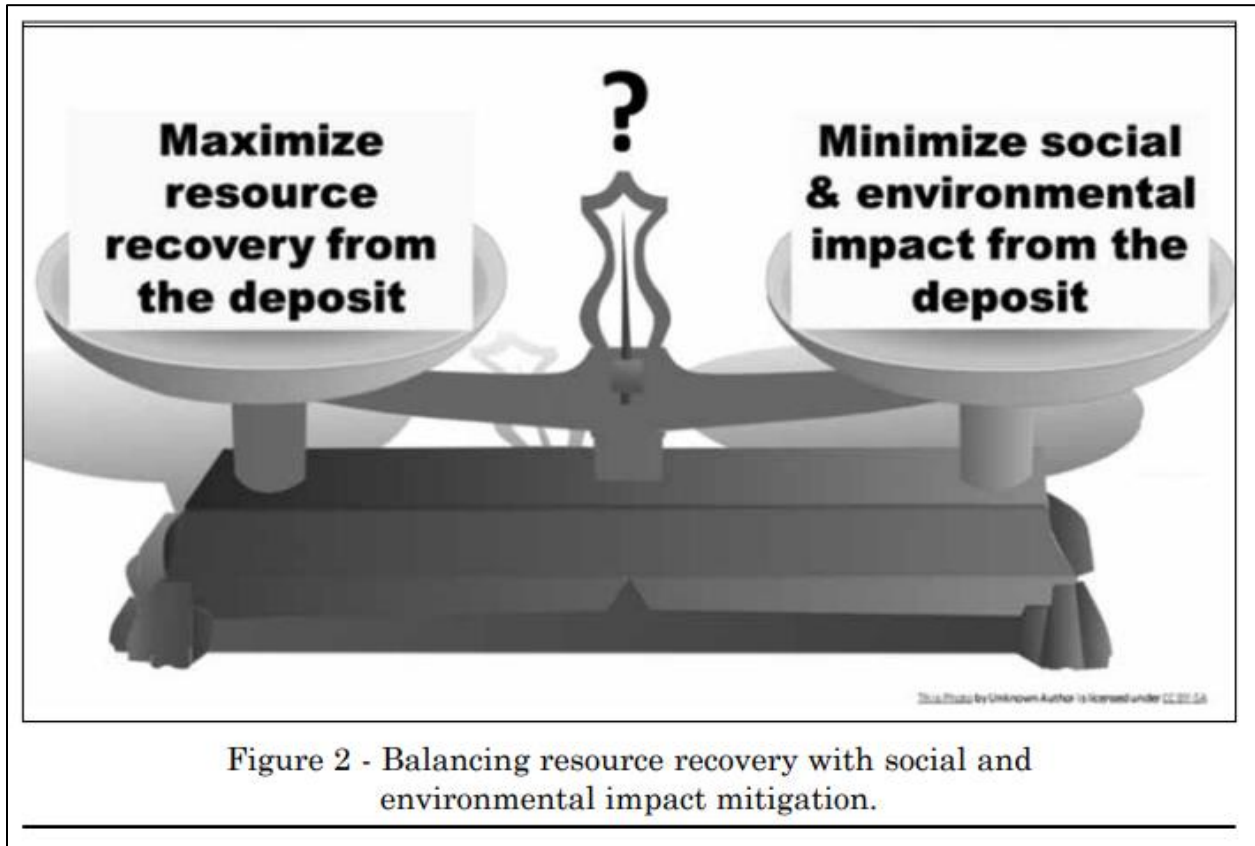


Figure 1. Abbott (2020) used the above figure to emphasize the inevitability of some degree of environmental degradation from any form of mining. According to Abbott (2020), “Figure 2 presents the need to balance maximum resource recovery with minimizing the adverse social and environmental impacts of mining ... Dialog among the mining industry and these stakeholders is the key to finding the appropriate balance for each mineral deposit shown in Figure 2. However, the discussion among the various stakeholders about a particular deposit should also recognize society’s need for mineral products including acceptance of some level of adverse impacts.” Figure from Abbott (2020).

In the context of arguing for the inevitability of the creation of post-mining ghost towns, Abbott (2021b) explicitly assumed the inevitability of environmental contamination as a “fact.” According to Abbott (2021b), “This article is based on four facts: ... 4. Exploitation of individual mineral deposits or occurrences involves environmental degradation ... Ensuring future generations’ supply of mineral products requires balancing mineral product recovery with an acceptable amount of environmental degradation at the deposit ... Exploitation of mineral deposits results in widely varying social impacts and environmental degradation. Various mitigation measures can reduce, but not fully eliminate, the negative impacts of this exploitation. The costs of complete remediation of a mine site will eliminate the possibility of profitable extraction, yet society’s need for mineral products requires that exploitation of mineral deposits will continue into the future.”

The inevitability of environmental degradation is so deeply assumed in the mining literature that environmental protection is often discussed not as a real issue, but only as a show

that must be carried out in order to appease certain voting blocs. For example, following the election of President Biden, in a passage that is difficult to follow through the twists of sarcasm, the President of the Society for Mining, Metallurgy and Exploration wrote, “It will be very challenging for the government to promote sustainable electrical energy sources (wind, solar, hydro, nuclear, geothermal) and their transmission and energy storage (all of which require our products [from mining]) without rejecting some of the demands of environmental preservationists. And despite the movement toward green energy, there will still be a need for coal ... That will be the political rub. How will the Biden administration promote the megadevelopments of a clean-energy economy while simultaneously encouraging governmental regulatory agencies to tighten environmental oversight and deny development permits in areas preservationists consider off-limits to keep Biden’s constituency happy? All the while the new administration collectively knows it needs to satisfy the demands for goods and services and advance the values and comforts of First World societies to maintain its leadership position in future elections” (Schafer, 2021). As an alternative, Schafer (2021) called for a “BIG compromise” (capitalization in original) in which the “environmental preservationists” would be pushed aside for the purpose of promoting an energy transition.

In summary, nearly all sides see some degree of environmental contamination as a necessary sacrifice that society makes in order to obtain metals and other commodities from the Earth. One caution is that the concept of society making sacrifices is profoundly apolitical. There is no “society” that is collectively making decisions as to whether to accept the risks of mining in exchange for the benefits. These decisions result from the interaction of political actors with more or less access to power and resources. In their book about the development of the Global Industry Standard for Tailings Management and using the high fatality rate of rail workers as an example, Hopkins and Kemp (2021) wrote, “Risk analysts do not normally consider whether the risk is acceptable to those on whom the risk is imposed. Rather the question is whether the risk is acceptable to ‘society.’ This does not make much sense. Society is not in a position to accept risk; governments might, on behalf of society, but society is not an entity that can make these normative judgements ... However, we believe that rather than seeing the existing distribution of risk as a result of some kind of value consensus, it is better to see it as the outcome of a political process, the result of a contest between unequal political forces. Rail track workers would clearly like to have a workplace that was 10 times safer, but they are not a politically influential group, and given existing resources and rail track priorities, this is quite beyond their reach.” In a sense, the discussion by Hopkins and Kemp (2021) is not much different than the call for “dialog” by Abbott (2020, 2021a-b) and for “compromise” by Schafer (2021), except that the mining literature rarely recognizes the power differentials among the various political actors. This point will be further addressed in the Discussion section.

Prove it First Legislation in Wisconsin and Minnesota

In response to the preceding widely-accepted concerns, in 1997 the Wisconsin legislature enacted Statute 239.50 entitled “Moratorium on Issuance of Permits for Mining of Sulfide Ore Bodies” (National Wildlife Federation, 2012). According to the statute, “Beginning on May 7, 1998, the department [Department of Natural Resources] may not issue a permit under s. 293.49 for the purpose of the mining of a sulfide ore body until all of the following conditions are satisfied: (a) The department determines, based on information provided by an applicant for a permit under s. 293.49 and verified by the department, that a mining operation has operated in a

sulfide ore body which, together with the host nonferrous rock, has a net acid generating potential in the United States or Canada for at least 10 years without the pollution of groundwater or surface water from acid drainage at the tailings site or at the mine site or from the release of heavy metals. (b) The department determines, based on information provided by an applicant for a permit under s. 293.49 and verified by the department, that a mining operation that operated in a sulfide ore body which, together with the host nonferrous rock, has a net acid generating potential in the United States or Canada has been closed for at least 10 years without the pollution of groundwater or surface water from acid drainage at the tailings site or at the mine site or from the release of heavy metals” (Wisconsin Statutes Archive, 2023). In other words, the Wisconsin statute implicitly recognized the theoretical possibility of sulfide ore mines that had either operated or been closed without environmental contamination, but also implicitly insisted that Wisconsin should not be the testing ground. Another implicit implication was that any successful proposal for a sulfide ore mine in Wisconsin should demonstrate how it would incorporate the lessons from any previous sulfide ore mines that had been free from environmental pollution, as well as the myriad of sulfide ore mines that had resulted in environmental pollution.

Over the next two decades, despite the generally-recognized inevitability of environmental contamination by sulfide ore mining, eight candidates were formally or informally put forward as model sulfide ore mines that met the requirements of the Wisconsin statute. Each of the eight candidates were rebuffed because, in fact, they each had extensive records of environmental contamination. As a consequence, no sulfide ore mines were approved in Wisconsin during the tenure of the statute (National Wildlife Federation, 2012). The impasse was broken in favor of the mining industry when the statute was repealed in 2017 with effect in 2018 (Frye, 2018).

Each year since 2021 a bill for a similar statute has been introduced into the Minnesota legislature entitled 93.2501 “Moratorium on Issuing Permits for Nonferrous Sulfide Ore” and popularly known as the “Prove It First Bill.” According to the bill, “The commissioner [of Natural Resources] may not issue a permit required to mine nonferrous sulfide ore unless the commissioner and the commissioner of the Minnesota Pollution Control Agency both determine, based on published, peer-reviewed scientific information and public records, that a mine for nonferrous sulfide ore has operated commercially for at least ten years and has been closed for at least ten years without resulting in a release of a hazardous substance, hazardous waste, or pollutant or contaminant as defined under section 115B.02. The mine must have operated in the United States in a similar environment to the mine for which the permit is sought and must have used reclamation techniques substantially similar to those proposed in the permit application. The applicant for a permit required to mine nonferrous sulfide ore bears the burden of demonstrating each of the conditions necessary for a determination under this paragraph that a permit may be issued” (Minnesota Legislature, 2021). “Similar environment” is defined as “a location with similar abiotic ecological features, such as average annual precipitation and average monthly temperature, and in which the proximity of surface water and groundwater to mining operations is similar to the proximity of surface water or groundwater to the Minnesota site or sites for which the permit is sought” (Minnesota Legislature, 2021).

In some ways, the Minnesota bill is more conservative than the repealed Wisconsin statute, meaning that it is more protective of people and the environment. The Wisconsin statute allowed for the consideration of sulfide ore mines anywhere in the USA or Canada, whereas the Minnesota bill would allow for consideration of mines only in the USA and only in an

environment similar to the proposed mine site. The Wisconsin statute allowed for consideration of one mine that had operated for 10 years and a possibly totally different mine that had been closed for 10 years. The Minnesota bill would allow for consideration of only a single mine that had been operated for at least 10 years and then closed for at least 10 years. In other words, the only mines that could be considered for comparison would have opened no later than 2003 and closed no later than 2013 (assuming that the bill would take effect in 2023). Thus, the Minnesota bill is even more insistent that Minnesota is not the testing ground for the possibility of sulfide ore mining without environmental contamination.

Since the opening of the public discussion over the Minnesota Prove it First Bill, again despite the generally-recognized inevitability of environmental contamination by sulfide ore mining, nine candidates have been informally put forward as model sulfide ore mines that would meet the requirements of the Minnesota bill. The proposals for model mines have been informal, such as in communications from elected officials or blogs or letters to the editor, since there is not yet any formal process. For example, Orr (2020) wrote, “The Eagle Mine, which is located in Upper Michigan in the Lake Superior watershed, has been safely producing nickel and copper since the fall of 2014. Additionally, the Flambeau mine in Wisconsin also responsibly developed natural resources in a water rich environment. If the DFL [Democratic Farmer Labor] party platform were being honest about needing to see an example of a responsible mine in the Midwest before allowing projects to proceed in Minnesota, these projects would satisfy their demands.” Motley and Frederick (2021) referred to the same two mines in writing, “New and unnecessary legislation emerged at the Minnesota Capitol in January, led by Duluth’s new Sen. Jennifer McEwen, demanding ‘proof’ that nonferrous mining — copper-nickel and precious-metals mining, in this case — has been done safely before allowing new mining to be developed in Minnesota. I have news for the ill-informed legislators who signed on to the legislation: It can be and it is being done safely already. Our Wisconsin neighbors produced copper, gold, and silver in the 1990s at the Flambeau open-pit mine, located just yards from the Flambeau River. The mine was closed and reclaimed without ever receiving an environmental violation ... For more proof, consider the Eagle nickel-copper mine in Michigan’s Upper Peninsula. It’s been operating safely for 10 years.” Orr (2022) returned to the same theme in writing, “Proponents of the Prove it First legislation will argue that Flambeau does not satisfy the criteria in ‘Prove it First’ because the mine did not operate for ten years. This is true ... Mining proponents argue that whether a mine was in operation for ten years is less important than determining whether the reclamation was successful at protecting the environment. Flambeau has been a reclaimed mine site for more than 20 years.” The distinction between the term “reclaimed” as defined in Wisconsin regulations and the phrase “closed for at least ten years without resulting in a release of a hazardous substance, hazardous waste, or pollutant or contaminant” as used in the Minnesota Prove it First Bill will be addressed in the Discussion section. It should be noted that, despite the claim by Motley and Frederick (2021), the Eagle mine had been open for only seven years at the time the editorial was written (Eagle Mine, 2023a).

The irony is that, out of the nine candidates that have been put forward as model sulfide ore mines that would meet the requirements of the Minnesota Prove It First Bill, eight are the exact same candidates that were put forward and rebuffed during the tenure of the Wisconsin statute, including the Eagle and Flambeau mines. The fact that only one new potential candidate for model mines has emerged over the past 25 years is the best evidence of all that there has never been a sulfide ore mine that did not result in environmental contamination. The ninth potential candidate was described by Congressman Pete Stauber (2022) in the context of

debating H.R.2794 – Boundary Waters Wilderness Protection and Pollution Prevention Act (Congress.gov, 2022) in the U.S. House of Representatives. According to Congressman Pete Stauber (2022), “Despite what the bill's sponsor, the Democrat cosponsors, and the Democrat witnesses today will lead you to believe, you don't have to bushwhack and portage your way to the Twin Metals site. And yes, it's in the same watershed as the BWCA [Boundary Waters Canoe Area Wilderness]. But guess what else is: an *open pit gold mine*, just 40 miles north of my district in Ontario, Canada” (emphasis in original). The open pit gold mine must be the Rainy River mine, which is actually downstream from the Boundary Waters Canoe Area Wilderness. It is not clear what point was being made by Congressman Pete Stauber (2022), but, for the purpose of this report, it will be assumed that he was proposing the Rainy River mine as a model sulfide ore mine. The objective of this report is to compile and update the record of environmental contamination of the first eight candidates for model mines, which has not previously been available in a single document, and to evaluate the record of environmental contamination for the ninth candidate. The nine candidates will be reviewed before proceeding to the methodology for this report.

CANDIDATES FOR MODEL MINES

The nine candidates for model sulfide ore mines are listed in Table 1 and mapped in Fig. 2. The only mines that are close to Minnesota are the previously-mentioned Eagle mine in Michigan, Flambeau mine in Wisconsin, and Rainy River mine in Ontario. The Eagle mine is located in western Marquette County of the Upper Peninsula of Michigan (see Fig. 2) and is an underground mine that extracts a sulfide ore for production of nickel and copper. The company Eagle Mine LLC is a subsidiary of the Canadian company Lundin Mining. The mine opened in 2014 and is scheduled to close in 2026 (Eagle Mine, 2023a). The Eagle mine is an atypical example of a sulfide ore mine because no ore processing occurs on the mine site. The raw ore is shipped to the Humboldt mill, 32 miles to the south, and also owned by Eagle Mine LLC, for processing into copper and nickel concentrates (Eagle Mine, 2023b). Therefore, for the purpose of assessing the non-polluting status of a sulfide ore mine, the Eagle mine and Humboldt mill should be regarded as a single entity. The Flambeau mine is an open-pit mine owned by Flambeau Mining Company, a wholly owned subsidiary of the British-Australian company Rio Tinto, that extracted a sulfide ore for production of copper, gold and silver. The mine operated only from 1993 to 1997 (Rio Tinto, 2023; The Menominee Indian Tribe of Wisconsin, 2023). According to Rio Tinto (2023), the mine had been reclaimed by 1999. The Flambeau mine is atypical in the same way in that all ore was shipped to Canada for processing and no tailings were stored on-site (Deer Tail Scientific, 2021). However, any environmental contamination at the Canadian facility will not be considered in this report. The Rainy River mine is owned by the Canadian company New Gold and combines open pit and underground mining for the extraction of gold and silver from a sulfide ore (Mining Data Online, 2023c). The Rainy River mine was opened in 2017 and is scheduled for closure in 2032 (Northern Ontario Business Staff, 2020; Mining Data Online, 2023c).

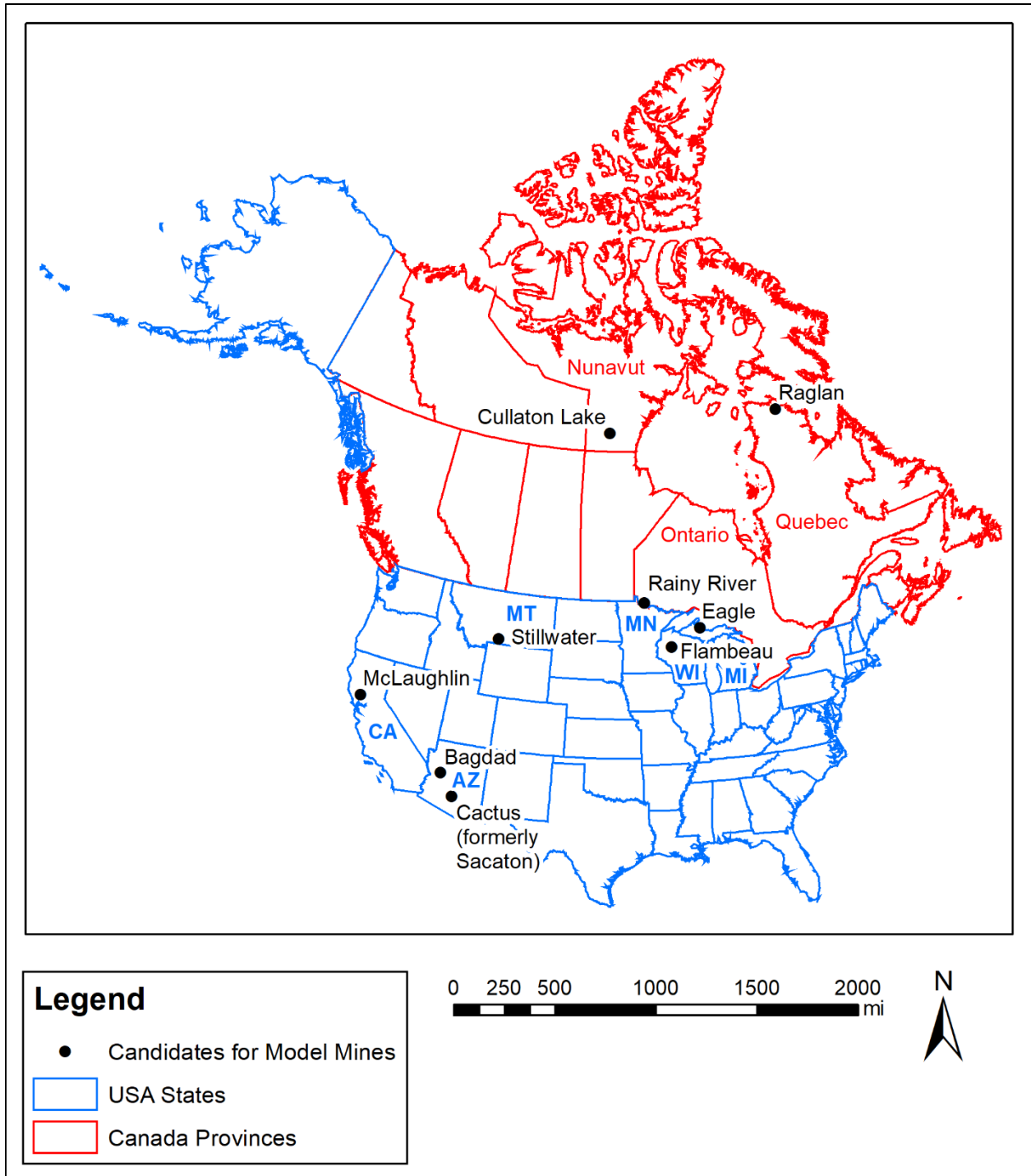


Figure 2. Nine mines have been put forward as candidates for model sulfide ore mines with no history of environmental contamination. Of the nine mines, only the Flambeau mine in Wisconsin, the Eagle mine in Michigan, and the Rainy River mine in Ontario occur in a climate similar to that of Minnesota.

Table 1. Candidates for model sulfide ore mines with comparison to precipitation range in Minnesota

Mine	Location	Principal Commodities	Opening – Closure	Mean Annual Precipitation (in)
Bagdad ¹	Arizona (USA)	Copper	1928-2101	16.71
Cactus ²	Arizona (USA)	Copper, silver, gold	1972-1984	9.27
Cullaton Lake ³	Nunavut (Canada)	Gold	1976-1985	9.61
Eagle ⁴	Michigan (USA)	Nickel, copper	2014-2026	29.13
Flambeau ⁵	Wisconsin (USA)	Copper, gold, silver	1993-1997	33.87
McLaughlin ⁶	California (USA)	Gold	1985-2002	31.42
Raglan ⁷	Quebec (Canada)	Nickel	1997-2027	15.79
Rainy River ⁸	Ontario (Canada)	Gold, silver	2017-2032	27.93
Stillwater ⁹	Montana (USA)	Palladium, platinum	1986-2055	18.05
Karlstad, Minnesota				18.59
Caledonia, Minnesota				36.93

¹Data from Freeport-McMoRan (2023), Mining Data Online (2023a), U.S. Climate Data (2023a)

²Formerly Sacaton mine. Data from Cactus Mine (2023), U.S. Climate Data (2023b).

³Data from Nicolet Minerals Company (1998b), Weather2Travel.com (2023a).

⁴Data from Eagle Mine (2023a), U.S. Climate Data (2023c).

⁵Data from Rio Tinto (2023), The Menominee Indian Tribe of Wisconsin (2023), U.S. Climate Data (2023e).

⁶Data from Benchmark Resources (2023), U.S. Climate Data (2023f).

⁷Data from Mining Data Online (2023b), Natural Resources Canada (2023), Weather2Travel.com (2023b).

⁸Data from Northern Ontario Business Staff (2020), Mining Data Online (2023c), El Dorado Weather (2023).

⁹Data from Sibanye-Stillwater (2023), U.S. Climate Data (2023d).

The two candidates for model sulfide ore mines in Arizona are the Bagdad mine and the Cactus mine (see Table 1 and Fig. 2). The mill at the Bagdad mine opened in 1928 to process sulfide ore from the underground mine. The mine was gradually converted into an open-pit mine beginning in 1945. The Bagdad mine currently produces copper and molybdenum. Although the ownership has changed hands many times, the Bagdad mine is now owned by Freeport-McMoRan and the community of Bagdad is an unincorporated Freeport-McMoRan company town (Freeport-McMoRan, 2023). The Bagdad mine is scheduled for closure in 2101 (Mining Data Online, 2023a). The Cactus mine was formerly called the Sacaton mine and was operated by American Smelting and Refining Company (ASARCO) from 1972 to 1984 for extraction of copper, silver and gold from a sulfide ore body. The mine was open-pit and attempts to transition to underground mining were unsuccessful. The mine property was acquired by Arizona Sonoran Copper in 2020. At present, there is no plan for re-opening the mine (Cactus Mine, 2023).

The two remaining candidates for model sulfide ore mines in the USA are the Stillwater mine in Montana and the McLaughlin mine in California (see Table 1 and Fig. 2). The Stillwater mine is an underground PGE (Platinum Group Element) mine in which the principal commodities are palladium and platinum. The mine is owned by the South African company Sibanye-Stillwater. The Stillwater mine opened in 1986 and is scheduled for closure in 2055 (Sibanye-Stillwater, 2023). The McLaughlin open-pit mine extracted gold from a sulfide ore from 1985 to 2002. The mine was operated by Homestake Mining of California, which was purchased by the Canadian company Barrick Gold in 2001 (Barrick Gold, 2001; Benchmark Resources, 2023; Mindat.org, 2023).

The two remaining candidates for model sulfide ore mines in Canada are the Cullaton Lake mine in Nunavut and the Raglan mine in Quebec (see Table 1 and Fig. 2). The underground

Cullaton Lake mine was operated by Cullaton Lake Gold Mines Ltd. from 1976 to 1985 and produced gold from a sulfide ore. The mine property was acquired by Homestake Canada in 1993 (Nicolet Minerals Company, 1998a). The underground Raglan mine produces nickel from a sulfide ore and is owned by the Swiss company Glencore. The mine opened in 1997 and is scheduled for closure in 2027 (Mining Data Online, 2023b; Natural Resources Canada, 2023).

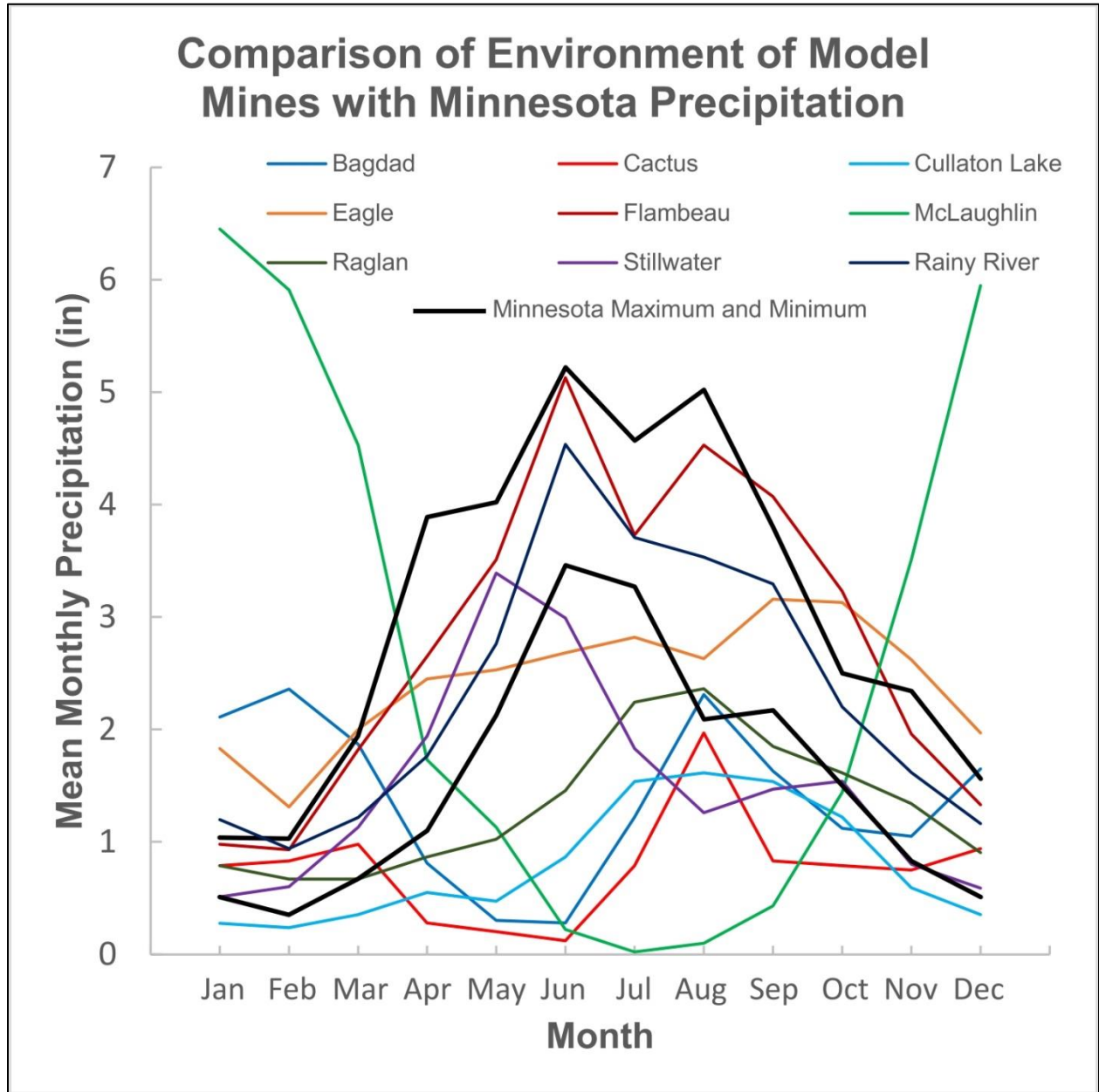


Figure 3a. Nine mines have been put forward as candidates for model sulfide ore mines with no history of environmental contamination. Based on the mean monthly precipitation, of the nine mines, only the Flambeau mine in Wisconsin, the Rainy River mine in Ontario, and possibly the Eagle mine in Michigan, have precipitation ranges within the range of what is found in Minnesota. The precipitation range in Minnesota is defined by the range between Caledonia (wettest location in Minnesota) and Karlstad (driest location in Minnesota). Data from U.S. Climate Data (2023a-h), Weather2Travel.com (2023a-b), and El Dorado Weather (2023).

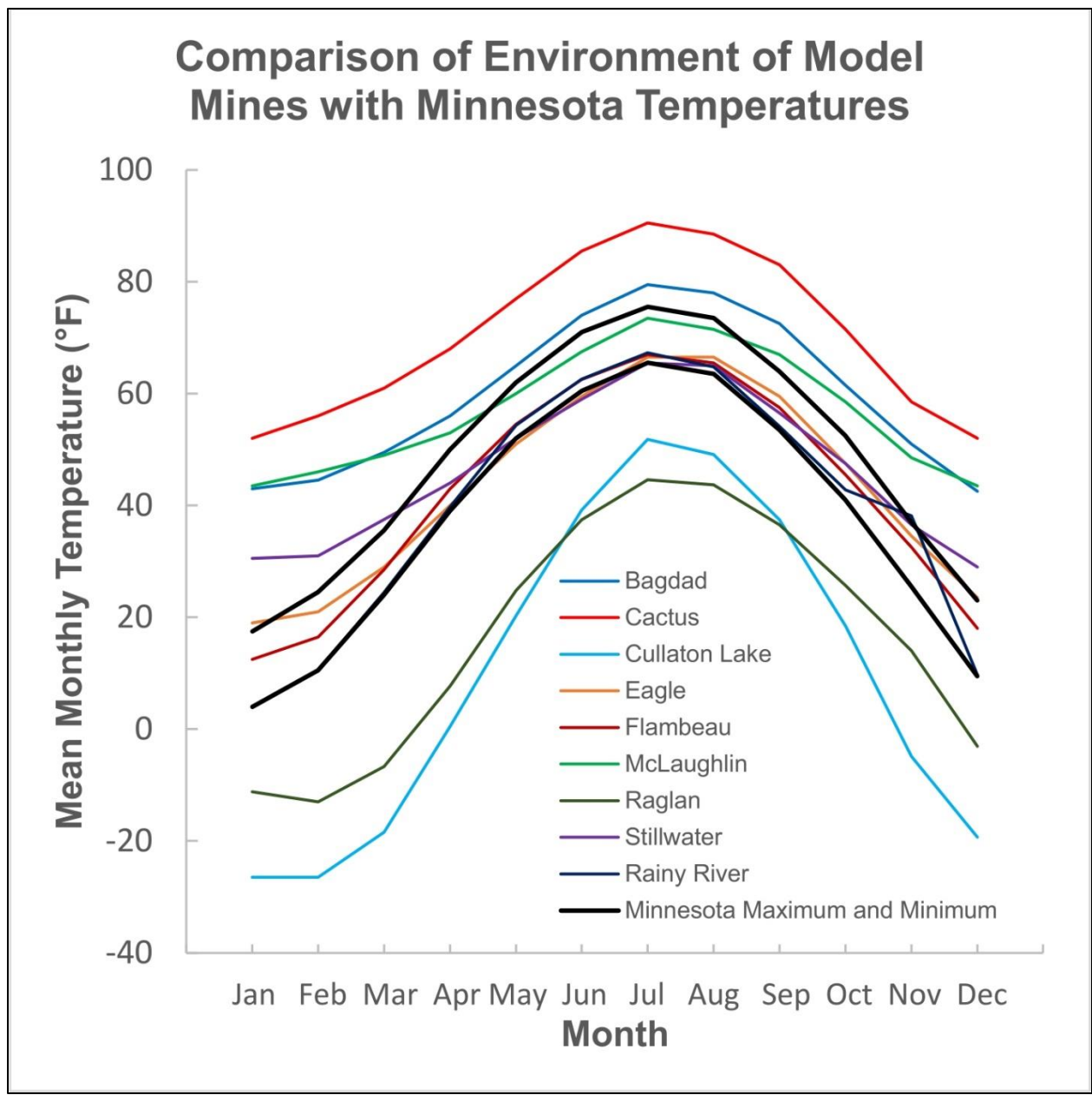


Figure 3b. Nine mines have been put forward as candidates for model sulfide ore mines with no history of environmental contamination. Of the nine mines, only the Flambeau mine in Wisconsin, the Eagle mine in Michigan, the Rainy River mine in Ontario, and possibly the Stillwater mine in Montana have temperature ranges within the range of what is found in Minnesota. The temperature range in Minnesota is defined by the range between International Falls (coldest location in Minnesota) and Winona (warmest location in Minnesota). Data from U.S. Climate Data (2023a-f, i-j), Weather2Travel.com (2023a-b), and El Dorado Weather (2023).

It is important to note that, regardless of their history of environmental contamination, none of the candidate mines would meet the criteria established in the Minnesota Prove it First Bill (Minnesota Legislature, 2021). The Cullaton Lake, Raglan and Rainy River mines would not count because they are not in the USA. The Bagdad, Eagle, Raglan, Rainy River, and Stillwater mines would not count because they have not yet closed, so that they could not show a lack of environmental contamination through 10 years of closure. The Cullaton Lake, Flambeau and

Rainy River mines would not count because they were not operated for at least 10 years. Only the Eagle, Flambeau, McLaughlin, and Rainy River mines have mean annual precipitation in the range for Minnesota, as defined by the wettest location in Minnesota (Caledonia) and the driest location in Minnesota (Karlstad) (see Table 1). All other candidate mines have mean annual precipitation that is drier than the driest location in Minnesota (see Table 1). The mean monthly precipitations at the Flambeau and Rainy River mines approximately fit in the range defined by the wettest and driest locations in Minnesota (see Fig. 3a). The mean monthly precipitation at the Eagle mine is a much worse fit, being wetter in the winter than the wettest location in Minnesota and drier in the summer than the driest location in Minnesota (see Fig. 3a). The mean monthly precipitation at the McLaughlin mine is very wet in the winter and very dry in the summer, which is opposite to the pattern in Minnesota (see Fig. 3a). Only the Eagle, Flambeau and Rainy River mines have mean monthly temperatures within the range defined by the warmest location in Minnesota (Winona) and the coldest location in Minnesota (International Falls), although the Stillwater mine is somewhat close, the principal difference being that it is warmer in the winter (see Fig. 3b). The above discussion does not even consider similarity in reclamation techniques, distances to surface water or groundwater, or other elements of what would constitute “similar location” (Minnesota Legislature, 2021). In summary, even if the criteria for a comparison mine in the Minnesota Prove it First Bill were less conservative (less protective of people and the environment), there would still be no comparison sulfide ore mine that had not resulted in environmental contamination.

METHODOLOGY

Most of the information in this report was developed by the various community and environmental organizations that were involved in refuting the candidates for sulfide ore mines that were proposed during the tenure of the Wisconsin moratorium (1998 – 2018). Previous reports of environmental contamination were supplemented by reports of contamination that occurred after the repeal of the Wisconsin moratorium. The author did not file any requests through the Freedom of Information Act (FOIA) because of the abundance of information that was already publicly available. The records of environmental contamination in the following section are largely complete in terms of what has been available to the author. The exception is the Flambeau mine, for which the documentation of environmental contamination is so voluminous that an entire website is devoted toward compiling all of the documents (Deer Tail Scientific, 2023). In the case of the Flambeau mine, the available documentation is only summarized in this report. All documents that are cited in this report that are not listed as available online in the References section can be requested from the author.

The climatic data were obtained from the long-term weather station that is closest to each mine site (see Table 2). All weather stations were reasonably close with the exception of the station closest to the Cullaton Lake mine in Nunavut, where there are very few long-term weather stations. Climatic data, including data for the extreme climatic sites in Minnesota, were obtained from U.S. Climate Data (2023a-j) for the USA, and Weather2Travel.com (2023a-b) and El Dorado Weather (2023) for Canada. Since the sole purpose of reporting climatic data was comparison with the climatic ranges in Minnesota (see Table 1 and Figs. 3a-b), no attempt was made to adjust the climatic data to the particular mine site.

Table 2. Candidates for model sulfide ore mines with closest long-term weather station

Mine	Location	Weather Station	Distance (mi)	Direction from Mine
Bagdad	Arizona (USA)	Bagdad	0	—
Cactus	Arizona (USA)	Casa Grande	4	SE
Cullaton Lake	Nunavut (Canada)	Baker Lake	220	NNE
Eagle	Michigan (USA)	Marquette	27	SE
Flambeau	Wisconsin (USA)	Ladysmith	1	NNE
McLaughlin	California (USA)	Clearlake	16	NW
Raglan	Quebec (Canada)	Kangiqsujuaq	57	ESE
Rainy River	Ontario (Canada)	Fort Francis	32	SE
Stillwater	Montana (USA)	Nye	5	NW

For the candidates for model mines in the USA, frequent comparisons will be made to exceedances of EPA drinking water guidelines. The EPA National Primary Drinking Water Regulations (EPA, 2023a) refer to contaminants that have been shown to have human health effects, while the EPA Secondary Drinking Water Standards (2023b) refer to contaminants that do not have human health effects, but can affect the willingness to drink water due to its taste, color or odor. Many jurisdictions in the USA recognize all aquifers as potential sources of drinking water, so that water quality standards for groundwater are the same as EPA drinking water standards. Even if a water sampling site is not a potential source of drinking water, the EPA drinking water guidelines could be regarded as a conservative reference point for water quality. However, they are not the most conservative reference point, since for some parameters (e.g. acute and chronic exposure to cadmium, cyanide, and mercury, as well as chronic exposure to lead), the EPA National Recommended Aquatic Life Criteria (2023c) are even more conservative than the National Primary Drinking Water Regulations (EPA, 2023a). In addition, there are many chemical parameters that are regulated for aquatic life, but not for drinking water, such as nickel.

RECORD OF ENVIRONMENTAL CONTAMINATION BY MODEL MINES

Bagdad Mine

Kuipers et al. (2006) reviewed environmental contamination from the Bagdad mine from 1991 to 2004 in the context of comparing actual water quality impacts with water quality impacts predicted from Environmental Impact Statements for a wide variety of hardrock mines, including sulfide ore mines. In May-June of 1991, a tailings impoundment failed, resulting in fish kills in Copper Creek and Boulder Creek with elevated concentrations of mercury, phenols, ammonia, copper and acidity. In 1991 and 1992 periodic exceedances of water quality standards for arsenic, beryllium copper, lead, mercury, pH and turbidity were found in Copper Creek, Boulder Creek, and Wilder-Burro Creek. From 1998 to 2002 periodic exceedances of water quality standards for arsenic, copper, lead, mercury, selenium and turbidity were found in Boulder Creek, Burro Creek, and Butte Creek. In May 1991 seepage of pregnant leach solution (sulfuric acid solution containing copper extracted from the crushed ore) from the Copper Creek Leaching System was discovered in a receiving pool in Boulder Creek. The total copper concentration in Boulder Creek was as high as 76.4 mg/L, which was nearly 59 times the EPA National Primary Drinking Water Regulation for copper (1.3 mg/L; EPA, 2023a) and over 76 times the EPA

Secondary Drinking Water Standard (1.0 mg/L; EPA, 2023b) for copper. Moreover, out of 18 samples collected from the receiving pool during the month that the seepage was discovered, every sample exceeded background copper levels by more than 0.5 mg/L, which is the Arizona Agricultural Livestock Watering Standard for total recoverable copper.

On March 29, 1993, the EPA issued a Finding of Violation and Order against the mining company. On September 13, 1996, the U.S. Department of Justice brought a civil action against the mining company for discharging contaminated water in violation of the Clean Water Act and Arizona law, including discharges from tailings ponds, pipelines, leach dumps, other facilities and a sewage treatment plant, with the largest discharge coming from the mine's Copper Creek Leaching Basin. In a Consent Decree, the mining company agreed to pay a civil penalty of \$760,000. Further details regarding violations of water quality standards during 1991 to 2004 are available in Kuipers et al. (2006b).

Cactus Mine

The Sacaton mine (now known as the Cactus mine) was one of three mines that were formally proposed by the Nicolet Minerals Company as model mines that satisfied the requirements of the Wisconsin moratorium on sulfide ore mining. The proposal for the Sacaton mine as a model mine was rejected by the State of Wisconsin not because there was a record of environmental contamination, but because there were no records of environmental monitoring. According to Wisconsin Department of Natural Resources (2002), “The Sacaton Mine, near Casa Grande, Arizona, was submitted as an example of a mine that satisfies both the ten-year operation requirement and ten-year closure requirement specified in the law. We have reviewed the information provided by Nicolet Minerals Company to support the submittal and other information obtained independently by the Department. Based on that review, we have concluded that the Sacaton Mine is not acceptable as an example of a mine that has been operated or closed for ten years without resulting in significant environmental pollution. This is the case not because we have reason to believe that there has been environmental pollution at the site, but rather there is simply not enough information from which to draw any conclusion regarding the mining site’s performance in the period following closure. In accordance with the statutes, the department is required to make a finding that the site did not result in significant environmental pollution and this finding is to be based on the results of relevant monitoring data. Since closure of the mining operation in 1984, the only significant monitoring activity that has taken place is related to the Hexcel chromium waste disposal facility located on the mine site. The material we have reviewed includes the results of groundwater sampling conducted at the mining site in 1985, but that is the extent of the monitoring data for the site.”

In addition to addressing the lack of environmental monitoring, Robinson (1999) also emphasized the acidity of the pit lake as an example of environmental contamination by the Sacaton mine. According to Robinson (1999), “Pit lake water of pH 3.8 – 4.1 is a demonstration of significant pollution ... such a low pH is certainly a clear indication of ‘significant environmental pollution’ at the mine site. The relevant statute addresses pollution at ‘at the mine site’ explicitly, and does not contemplate that ‘off site contamination’ is the only pollution of concern ... the drop of pH from approximately pH 7 to approximately pH 4 is a major deterioration in water quality.” Robinson (2004) reviewed a rebuttal by Nicolet Minerals Company and again concluded that “Sacaton Mine pit lake water of pH 3.8 – 4.1 is demonstration of significant pollution.”

In fact, extensive environmental cleanup of the mine property was carried out beginning in 2009. According to Cactus Mine (2023), “In 2009, the site was placed into the care of an environmental trust that was tasked with the care, stabilization, and reclamation of the site. During that time extensive environmental characterization and cleanup work was completed under the supervision of the Arizona Department of Environmental Quality (ADEQ) and the US Environmental Protection Agency ... In all, \$20 million was invested to reclaim the property.” There is no available document that specifies the environmental cleanup that was required, but the price tag suggests that the environmental contamination was considerable.

Cullaton Lake Mine

The Cullaton Lake mine is the second of the three mines that were formally proposed by the Nicolet Minerals Company as a model mine that satisfied the requirements of the Wisconsin moratorium on sulfide ore mining. However, environmental contamination by the Cullaton Lake mine was documented even during the operation of the mine. For example, according to Ripley et al. (1995), “Wetlands may protect water bodies from mine drainage. At Cullaton Lake Gold Mines, Northwest Territories, a wetland blocked a leak of metals and cyanide out of tailings, preventing it from reaching the Kognak River, which flows into Hudson Bay (Diamond and Meech 1984). It is not known how long such immobilization would be effective.”

Environmental contamination, including acid mine drainage, continued after closure of the mine in 1985 due to a combination of the ineffectiveness of the closure plan and the lack of completion of the plan. According to the mining company, “By 1999, it was obvious that the contractor was not able to complete the project and remove the balance of equipment. In 2000, HCI [Homestake Canada Inc.] engaged a consultant to review the equipment left on site and to determine if it was feasible to remove the equipment for sale. After the review, it was determined that the salvage value of the equipment was negligible and the best alternative was to dispose of the equipment on site ... During the 2000 site visit and planning process HCI staff noticed dead vegetation around the toe of the Shear Lake Waste Rock area. Samples of the rock were collected and analysed in the fall of 2000. It was determined that the rock was generating acid from sulphides contained in the rock ... HCI then determined that the best solution for disposal of this material was to place it underwater in Shear Lake ... As the end of the construction season was nearing HCI determined that it would not be possible to wait for final approvals without running a risk of being caught by winter conditions and being unable to demobilize the site ... In 2001, a significant proportion of the solid waste was buried in the quarry, and the analytical results from the quarry pit (station 940-23) met the licence limits but exceeded the Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life for arsenic (5.6 µg/L vs 5 µg/L), copper (6 µg/L vs 4 µg/L), iron (2.48 mg/L vs 0.3 mg/L), and zinc (70 µg/L vs 30 µg/L) ... During the 2001 inspection, dead vegetation was noted in this area and the analytical results from a sample of pooled water revealed that the field pH (3.2 vs. 6.0-9.5) breached the effluent quality requirements set under the Water Licence. Furthermore, concentrations of cadmium (4.5 µg/L vs 0.017 µg/L), copper (210 µg/L), iron (3.14 mg/L), nickel (268 µg/L vs 150 µg/L), and zinc (420 µg/L) exceeded the Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life. Since the drainage from this area flows towards Shear Creek and/or Lake, reclamation of the area cannot be deemed complete until further monitoring assesses that runoff from the site no longer implies potential for the deposit of waste into waters” (Homestake Canada Inc., 2002).

Godfrey & Kahn Attorneys at Law (2003) emphasized the major concerns of the mining company itself and also drew attention to the general lack of monitoring data that would be required to demonstrate a lack of environmental contamination. According to Godfrey & Kahn Attorneys at Law (2003), “Since the Cullaton Mine's acid generation not only made land deleterious to plant life, but actually killed vegetation, the [Wisconsin] Department [of Natural Resources] clearly can find that the Cullaton Mine caused significant environmental pollution ... Indeed, it is difficult to imagine that the Department would not consider such water contamination and pH of 3.2 to constitute significant environmental pollution.” Godfrey & Kahn Attorneys at Law (2003) continued, “As is noted by Indian and Northern Affairs Canada, there apparently is a lack of necessary monitoring data to determine the full extent of the environmental impacts of the acid drainage from the Cullaton Mine Shear Lake waste rock area ... This apparent lack of data is especially concerning, given the significant environmental pollution that has already been identified with respect to the site, which only operated for four years. Accordingly, for this reason as well, the Cullaton Mine cannot serve as an example mine under the [Wisconsin] Mining Moratorium Law.”

Eagle Mine

Pollution by the Eagle mine and Humboldt mill has been documented by the Michigan Department of Environmental Quality (MDEQ), the Michigan Department of Environment, Great Lakes and Energy (MDEGLE), the Superior Watershed Partnership, and in a study by Michigan Technological University for the Superior Watershed Partnership. Most of the documentation by the state regulatory agencies has related to the inability of the water treatment plant to meet Whole Effluent Toxicity (WET) tests. These violations were documented in April 2017, December 2017, September 2017, October 2018, November 2018, February 2019, and September 2019 (Eagle Mine, 2018, 2019a-b). In June 2019 the MDEGLE (2019) reported on a spill of influent water to the water treatment plant at the Humboldt mill that released 2360 gallons of untreated mine wastewater into nearby wetlands and mentioned a spill of sulfuric acid that had occurred earlier in 2019. The relevant regulatory documents are not yet available for 2020, 2021 and 2022.

The study by Michigan Technological University (Lafreniere et al., 2018) reported on the chemical analysis of samples from groundwater monitoring wells near the Eagle mine and the Humboldt mill between May 2008 and August 2016, from surface water near the Humboldt mill between February 2015 and May 2016, and from the water treatment plant at the Humboldt mill between May 2014 and February 2017. This study looked for long-term trends, significant deviations from mean values, and exceedances of EPA drinking water guidelines. It was mentioned previously that there are many chemical parameters that are regulated for aquatic life, but not for drinking water. In the case of the Eagle mine, nickel would be the most significant parameter that is regulated for aquatic life, but not for drinking water. In fact, for most of the violations of the WET tests, excessive nickel in the effluent was suspected or identified as the cause (Eagle Mine, 2019a-b).

Lafreniere et al. (2018) documented exceedances of EPA National Primary Drinking Water Regulations and EPA Secondary Drinking Water Standards (EPA, 2023a-b) for arsenic, chloride, and nitrate in groundwater in the vicinity of the Eagle mine, and for sulfate in groundwater in the vicinity of the Humboldt mill. Values of pH were both below and above the permitted range (6.5 – 8.5) in the EPA Secondary Drinking Water Standards for groundwater in

the vicinity of both the Eagle mine and the Humboldt mill, while values of pH were below the permitted range in surface water in the vicinity of the Humboldt mill. EPA Secondary Drinking Water Standards (EPA, 2023b) were exceeded for iron and manganese in the groundwater in the vicinity of the Humboldt mill and for manganese in the effluent from the water treatment plant at the mill. In fact, for groundwater near the mill, every detectable measurement of manganese exceeded the EPA Secondary Drinking Water Standard.

The Superior Watershed Partnership (2016) reported 36 violations of the allowable pH and 39 violations of the allowable vanadium according to the groundwater discharge permits for the Eagle mine that were in place until April 1, 2015. For all violations of allowable pH, the groundwater was too alkaline (the pH was too high). However, as of April 1, 2015, the groundwater discharge permits were modified, so that all of the preceding violations became non-violations. For example, at some monitoring wells, the allowable vanadium was increased from 2.2 to 3.1 µg/L, while at other wells, the maximum daily limit (MDL) for vanadium was waived, so that there was only a requirement to report the vanadium concentration. For all monitoring wells, the allowable pH range was expanded from 6.5 – 9.0 to 6.5 – 9.7, in order to accommodate more alkaline measurements.

Flambeau Mine

The open pit of the Flambeau mine is only 140 feet from the Flambeau River, a popular fishing river that provides habitat for a variety of aquatic species, including threatened mussel and dragonfly species (Deer Tail Scientific, 2021). Thus, any mining-related contaminants in groundwater between the open pit and the Flambeau River, in tributaries that cross the mine site to reach the river, or in the Flambeau River itself are of great concern. The contamination of groundwater has been ongoing since the closure of the mine. For example, in December 2015, the mining company reported 45 exceedances of groundwater quality standards in 17 different wells on the mine site, including wells located directly between the open pit and the Flambeau River (Flambeau Mining Company, 2015). Two monitoring wells located between the mine pit and the river have shown marked increases in manganese and sulfate concentrations over baseline, with manganese levels so high that both wells have been in violation of permit standards ever since the mine ceased operation (Moran, 2019). It is noteworthy that, according to mining laws in Wisconsin, groundwater pollution cannot be prosecuted within the project boundary of a mine (Wisconsin Department of Natural Resources, 2018).

The water quality standards for the compliance and intervention boundaries in the mine permit were based upon a model by the consultants for the mining company that predicted the groundwater quality in the open pit after backfilling with sulfide-rich waste rock and mixing with crushed limestone to neutralize the acidity. The compliance boundary is set at 1200 feet from the outer edge of the waste rock disposal site, or at the boundary of the mine property, whichever distance is less (Wisconsin Department of Natural Resources, 2018), while the intervention boundary can be set somewhere between the waste rock disposal site and the compliance boundary (Wisconsin Department of Natural Resources, 2018; Deer Tail Scientific, 2021). However, the actual concentrations of contaminants measured in the monitoring wells in the backfilled pit vastly exceeded the predictions in that median dissolved concentrations were as high as 503 µg/L for copper (35 times greater than predicted), 14 mg/L for iron (43 times greater than predicted), 33.5 mg/L for manganese (60 times greater than predicted), and 1600 mg/L for sulfate (1.5 times higher than predicted). Even the predicted concentrations were markedly

higher than either baseline concentrations or typical drinking water or aquatic standards. For example, the surface water quality standard for sulfate approved by the EPA for the protection of wild rice is 10 mg/L (Moran, 2019).

The quality of the groundwater in the vicinity of the backfilled pit is not likely to improve as the limestone becomes exhausted through its chemical reaction with the sulfide-rich waste rock. According to Moran (2019), “After the limestone has reacted with the waste rock, its neutralizing action will diminish and the pit waters will become increasingly acidic and the concentrations of potentially-toxic contaminants are likely to increase, assuming representative data are obtained. As the limestone becomes coated with other chemical reaction products, the buffering action ceases. Roughly 20 years, post-closure, the deeper pit well waters at Flambeau show evidence of water quality degradation relative to baseline data and relevant standards and criteria, in spite of FMC’s [Flambeau Mining Company’s] limestone amendment program. It is reasonable to conclude that the Flambeau ground and surface water quality will further degrade in the coming decades if current site maintenance practices continue.” A somewhat similar situation is described for the closed McLaughlin mine in a subsequent subsection.

A tributary of the Flambeau River, named Stream C, crosses the mine site before joining the river. Since 2002 when the mining company first started reporting water quality data for Stream C, water samples collected downstream from stormwater entry points have consistently and significantly exceeded copper standards for aquatic life. For example, in 2008 copper concentrations were approximately ten times the aquatic standard, while zinc concentrations were approximately twice the aquatic standard for zinc (Chambers and Zamow, 2009). Even a 2005 study contracted by the mining company concluded that Stream C was nearly devoid of all life, including vegetation, insects and fish (Foth & Van Dyke, 2005). According to Chambers and Zamow (2009), “With copper levels [in Stream C] significantly exceeding both chronic and acute water quality criteria, it is likely that these high metal levels are contributing to the lack of aquatic life in Stream C. These levels also suggest that better monitoring of Stream C and the Flambeau River below Stream C should be done.” In 2010-11 Wisconsin Department of Natural Resources carried out their own water quality study of Stream C and, based on the copper concentration, placed the stream on the EPA list of Impaired Waters (Wisconsin Department of Natural Resources, 2012; EPA, 2014). Stream C is still on the list of Impaired Waters and copper concentrations still exceed Wisconsin aquatic standards by factors of two to four (Deer Tail Scientific, 2021). In 2022, an additional reach of Stream C within the project site was added to the EPA’s Impaired Waters list (Deer Tail Scientific, Wisconsin Resources Protection Council, and Sierra Club Wisconsin Chapter, 2023). The State of Wisconsin has issued no citations to the mining company and in 2019 ceased requiring the mining company to report water quality data for Stream C (Deer Tail Scientific, 2021).

There are numerous pathways for contaminated water to enter the Flambeau River, including the heavily contaminated Stream C that crosses the mine site, intentional discharge from the wastewater treatment plant into the river, and subsurface seepage from the backfilled pit. Subsurface seepage of contaminants was, in fact, predicted by consultants for the mining company. According to Foth & Van Dyke and Associates, Inc. (1989), “All of the groundwater flowing through the Type-II [high sulfur] waste rock in the reclaimed pit will exit the pit through the Precambrian rock in the river pillar and flow directly into the bed of the Flambeau River. Since this flow path is very short and occurs entirely within fractured crystalline rock, there will be little if any dispersion or retardation of the dissolved constituents in the groundwater ... Since there will be no dispersion, dilution, or retardation in the river pillar, the concentrations of these

constituents in the groundwater leaving the pit will be the same as the concentrations entering the river bed.” As mentioned earlier, monitoring reports from the mining company report the presence of mining-related contaminants between the backfilled pit and the Flambeau River.

Thus, the obvious question is whether there have been water quality impacts on the Flambeau River. As with many of the mines in this section, the question cannot be answered due to a lack of monitoring data. The mining company has never reported surface water quality from the reach of the Flambeau River immediately adjacent to the backfilled pit. By contrast, the only location used by the mining company for routine monitoring is 500 feet downstream of the mine pit and actually upstream from the confluence with Stream C (Deer Tail Scientific, 2021). Although the mining company claims that sediment, macroinvertebrate, crayfish and walleye studies conducted by the company between 1991 and 2011 showed no adverse impacts on the Flambeau River, external reviews of their studies were highly critical (Parejko, 2009a-d). The mining company has presented no new sediment or biological data since 2011 (Deer Tail Scientific, 2021).

A problem running through all of the reports from the Flambeau Mining Company is that all of their water quality data have been obtained by forcing the water samples through an ultrafine filter prior to chemical analysis (Moran, 2019; Deer Tail Scientific, 2021). The effect of filtering is to remove all solid particles, which may include attached contaminants. Thus, the analysis of filtered samples yields dissolved concentrations, while the analysis of unfiltered samples yields total concentrations. Clearly, dissolved concentrations will always be less than total concentrations, so that filtering always improves the measured water quality. Whether filtered or unfiltered samples are appropriate depends upon the context of the study and the question that is being asked. For example, if a monitoring well is placed into a clay bed with a very low permeability, obtaining a sample might involve pumping the well so hard that particles would be dislodged that would not normally be flowing with the groundwater. In that case, filtering would be appropriate to obtain a more accurate picture of the true in-situ groundwater quality. However, if the concern is health impacts on livestock or wildlife or other organisms that consume raw (unfiltered water), such as might be flowing in a stream, then filtering samples prior to analysis would falsely minimize the actual contaminant load on organisms. The standard industry practice for at least the past four decades has been to analyze both filtered and unfiltered samples for every sampling event of either surface water or groundwater. More information about filtered and unfiltered samples in the context of another Rio Tinto mine is available in Emerman (2021).

McLaughlin Mine

The McLaughlin mine is the last of the three mines that were formally proposed by the Nicolet Minerals Company as a model mine that satisfied the requirements of the Wisconsin moratorium on sulfide ore mining. At various times, the McLaughlin mine was also put forward as a model mine outside of the formal proposal process in Wisconsin. According to Kuipers et al. (2006), “The McLaughlin Mine in California has been touted by the mining industry as an example of a mine with laudable environmental behavior.” However, Kuipers et al. (2006) reported that the McLaughlin mine had a regulatory exclusion for meeting typical groundwater standards with alternative groundwater standards set at no increase over background. Moreover, the regulatory exclusion prohibited groundwater enforcement actions by the California Regional Water Quality Control Board (RWQCB). In fact, during the period 1984 to 1992, monitoring

wells downgradient of the tailings impoundment facility showed exceedances of total dissolved solids (up to 12,000 mg/L), chloride, nitrate (up to ~37 mg/L), and sulfate, and increases in copper (up to 280 µg/L) and other metals. Wells downgradient of waste rock dumps showed increasing concentrations of sulfate (up to 5000 mg/L), boron, total dissolved solids, calcium, iron, manganese and other chemical parameters from 1985 to 1998 and for zinc (up to 1.7 mg/L) after 1998 (Kuipers et al., 2006). The maximum concentrations of total dissolved solids and sulfate in downgradient wells were 24 times and 20 times the respective EPA Secondary Drinking Water Standards (EPA, 2023b), while the maximum concentration of nitrate was 3.7 times the EPA National Primary Drinking Water Regulation (EPA, 2023a).

Kuipers et al. (2006a) also documented that surface monitoring locations downstream of the mine showed exceedances of drinking water standards for arsenic, chromium, copper, lead, manganese, mercury, lead, iron, and zinc. Concentrations of nickel in surface water were as high as 8 mg/L (Kuipers et al., 2006b) or 154 times the EPA National Recommended Aquatic Life Criterion of 0.052 mg/L for chronic exposure to nickel in freshwater (EPA, 2023c). According to Kuipers et al. (2006a), “No violations were noted. According to the RWQCB, if concentrations chronically exceed standards, enforcement actions are issued. However, apparently due to the regulatory exclusion for groundwater at the site no enforcement actions were taken by the RWQCB despite evidence that groundwater has been chronically degraded below the tailings impoundment and waste rock storage areas. Similarly, no enforcement actions were taken by the RWQCB, despite apparent evidence of chronic degradation of surface water.” Further details regarding exceedances of water quality standards during 1982 to 2003 are available in Kuipers et al. (2006b).

Even the application by Nicolet Minerals Company (1998b) for the consideration of the McLaughlin mine as a model sulfide ore mine acknowledged numerous accidental spills during the period of operation of the McLaughlin mine, while still emphasizing that these releases did not result in any corrective actions by regulatory authorities. According to Nicolet Minerals Company (1998b), “While several releases of sediment and accompanying metals have occurred during severe storm events, more than ten years of environmental monitoring has shown that downstream aquatic ecology remains unchanged from pre-mine conditions ... Review of the Central Valley Regional Water Quality Control Board files indicates that the mine has reported all upsets and potential releases, regardless of their consequence. These have included minor ore slurry releases and occasional, but infrequent, transient exceedances of permit limits resulting from temporary upset conditions that overwhelmed capacity at waste dump leachate containment or pumpback facilities during extreme rainfall events ... Slurry which sprayed beyond secondary containment was collected and removed to the tailings pond and did not enter any waterway. Escaped waste dump leachate was of such low volume that receiving waters were not impacted by acid or metals. Transient concentrations of TSS [Total Suspended Solids] exceeding permit effluent limits had no impact on receiving waters. The mine's M-1 sediment pond overtopped as the result of an accumulation of 16.3 inches of rainfall during a nine-day period in February of 1986 ... Both the Regional Water Quality Control Board and Napa County, as the lead environmental review agency, concluded that the incident did not constitute a permit violation and caused no environmental harm ... Neither the Regional Board nor any other local, state or federal agency with jurisdiction over the mine has ever found it necessary to issue any corrective action orders, or to initiate other enforcement or compliance actions with regard to the McLaughlin mine or any of its facilities.”

Subsequent to the closure of the McLaughlin mine in 2002, reports from California regulatory agencies and the mining company itself have reported on ongoing environmental contamination as successive closure plans have proved unworkable. According to State Mining and Geology Board (2007), “Problems have been encountered in closing the tailings facility in accordance with the approved closure plan. Water quality concerns have arisen regarding the two open pits that are filling with low pH water that may pose an ecological hazard to wildlife.” According to California Regional Water Quality Control Board (2012), “The waste rock and tailings contain nonhazardous concentrations of soluble pollutants including: TDS [Total Dissolved Solids], sulfate, sodium, arsenic, nickel, boron, copper and zinc. The concentrations of these soluble pollutants exceed water quality objectives and could cause degradation of waters of the state ... Leachate is collected at the base of the WRFs [Waste Rock Facilities] and pumped to the MPs [Mine Pits] for disposal. WRF leachate contains concentrations greater than background of TDS, sulfate, arsenic, copper, iron, nickel and zinc. The concentrations of these soluble pollutants exceed water quality objectives and could cause pollution of waters of the state ... Water quality in the mine pits is generally poor. The September 2010 sampling event detected the following concentrations: TDS – 10,000 mg/L, Sulfate – 9200 mg/L, Zinc – 2200 µg/L and Nickel – 17,000 µg/L ... The mine pit lakes are very large and there is a potential for a large scale discharge event that may be impossible to contain without providing substantial available capacity ... The Discharger has demonstrated that the initial Reclamation and Closure Plan for the TIF [Tailings Impoundment Facility] is infeasible because the physical conditions of the tailings do not provide a stable surface to construct a final cover and the preliminary plan creates a drainage structure that could allow a tailings release in case of a seismic event. Because natural springs discharge into the base of the tailings impoundment the tailings will never de-water sufficiently to support a conventional cover ... Water quality in the internal pond is poor, the September 2009 sampling event detected the following concentrations: TDS - 7600 mg/L, Sulfate - 7500 mg/L, Arsenic - 320 µg/L and Copper - 130 µg/L. Over time water quality is expected to degrade through the process of evapoconcentration, one investigation projected TDS concentrations to increase to the saturation level (approximately 130,000 ppm). This closure plan is viable only if the TIF embankment dam and run-on interception and removal system are maintained indefinitely.”

The continued very low quality of the water contained in the mine pits and in the pond of the tailings impoundment facility at the McLaughlin mine cannot be overemphasized. Based on the September 2010 sampling of the mine pits, the concentrations of total dissolved solids and sulfate were, respectively, 20 times and nearly 37 times the EPA Secondary Drinking Water Standards (EPA, 2023b), while the zinc and nickel concentrations were, respectively, over 18 times and nearly 327 times the EPA National Recommended Aquatic Life Criterion for chronic exposure in freshwater (EPA, 2023c). Based on the September 2009 sampling of the internal pond of the tailings impoundment facility, the arsenic concentration was 64 times the EPA National Primary Drinking Water Regulation (EPA, 2023a). The issue is not only whether the water remaining on the mine site is suitable as a potable water source or aquatic habitat, but as stated by California Regional Water Quality Control Board (2012), the potential for this water to escape into the environment.

The observation by California Regional Water Quality Control Board (2012) that the proposed revised closure plan would be workable only if it included perpetual maintenance should be a matter of great concern. It should be assumed that the proposed revised closure plan was certainly not accompanied by a plan for the perpetual existence of the mining company. A

progress report by the mining company (now called the McLaughlin Reclamation Project) continued to document the nonviability of the closure plan. According to McLaughlin Reclamation Project (2016), “The 2015 evaluation determined there was not sufficient area of exposed tailings to feasibly place cover material. The 2016 evaluation completed at the end of the wet season demonstrated increased precipitation and a subsequently a larger water pool compared to 2015. Monitoring of the pond size has confirmed that cover activities in the TIF are infeasible in 2016 due to saturated conditions.”

Raglan Mine

At the Raglan mine site in far northern Quebec (see Fig. 2), permafrost is used as a cover for the potentially acid generating tailings (Klohn Crippen Berger, 2017). Thus, widespread environmental contamination is a potential future scenario as global warming causes thawing of the permafrost. Based on existing knowledge, this scenario is difficult to predict. According to Klohn Crippen Berger (2017), “The effect of climate change was modeled over a period of 100 years; prediction beyond this length of time was deemed too uncertain (Erazola 2013). Prediction modelling for the Nunavik area shows that the ground temperature may increase by 3°C to 4°C by 2050 (Sushama et al. 2006; Garneau 2012). Within this context of possible thawing of the tailings material, studies were conducted to evaluate the capacity of the cover to prevent oxidation and prevent acid mine drainage in the long- term (Garneau 2012). Analyses of available temperature data from various adjacent stations resulted in a mean annual air temperature (MAAT) being estimated at -8.8°C (Nixon 2000; Holubec 2004; Table 1), a thawing index of 707 degree-days (Holubec 2004) and the probability of an extreme warm year occurrence being one in 100 years with a thawing index of 976 degree-days (Holubec 2004). However, there were difficulties in selecting design air temperatures and thawing indices due to significant fluctuations of values over the available 20 years of records from the various sources (Holubec 2004).”

Aside from the effects of future thawing of the permafrost cover, the Raglan mine has resulted in detrimental impacts on surface water even without the development of acid mine drainage. According to Stantec Consulting Ltd. (2004), “Neutral drainage may be characterized by low total dissolved solids (TDS) values but can contain metal concentrations that exceed discharge limits. An example of this water quality issue has been observed at the Raglan mine where runoff from mine rock stockpiles and an open pit area requires treatment. The runoff is characterized by low milligram per litre levels of nickel, with low TDS consisting mainly of sulphate that is typically less than 50 mg/L ... Treatment efficiency was not always as good as desired and the resulting treated effluent had very high TDS values compared to the soft receiving waters.” The mining company (which was then Falconbridge) acknowledged, “At the Raglan mine site runoff and tailings water discharge that is collected in a holding pond, treated and then released to the environment has exceeded limits for toxicity” (Falconbridge Limited, 2005).

Rainy River Mine

The mining company started receiving fines for environmental violations even before the Rainy River mine opened in 2017. In 2016 the provincial agency Environmental Compliance Approval sampled the discharge from two in-pit sumps and found levels of un-ionized ammonia

that exceeded the daily maximum discharge limit. Despite the notification on July 26, 2016, the mining company continued to discharge water from the sump until July 29, releasing an additional 19 million liters of contaminated water. The mining company also arranged for its own analysis of the discharge from its in-pit sumps. Although an independent lab confirmed exceedances of maximum discharge levels, the mining company failed to notify the Ministry of the Environment until eight days later. In response, the mining company was fined \$150,000 plus an additional \$37,500 victim surcharge fee under the Environmental Protection Act (TBnewswatch.com Staff, 2017).

Again in 2016, officials from the Ministry of Natural Resources and Forestry observed water flowing over the embankment of the incomplete Teeple Dam at the Rainy River mine. The overtopping caused a portion of the dam to erode and allowed sediment from the dam to enter the downstream Pinewood River. The subsequent investigation by the Ministry of Natural Resources and Forestry determined that the mining company was aware of the incomplete status of the dam and that the company had failed to comply with the conditions for approval by allowing water to flow through the network and to impound behind the incomplete dam before the design specifications had been met. In response, the mining company was fined another \$100,000 (Forbes, 2018).

Issues of environmental non-compliance, including unauthorized effluent discharge and exceedances of surface water quality permits, continued after opening of the mine. Between 2018 and 2021, the mining company recorded 33 incidents of environmental non-compliance (AMC Mining Consultants (Canada) Ltd., 2020; InnovExplo Inc., 2022). On July 31, 2020, the Impact Assessment Agency of Canada issued a Notice of Non-Compliance for failure to compensate for the loss of fish habitat by failing to achieve the success criterion of creating functional fish habitat in the Stockpile Pond. Investigation into fish habitat was ongoing through 2021 (InnovExplo Inc., 2022).

Stillwater Mine

It should be noted that, despite the fact that the Stillwater mine is a sulfide ore mine, its acid drainage potential has been classified as low by Kuipers et al. (2006), due to the presence of neutralizing minerals. According to Kuipers et al. (2006), “In some cases, the geology of the deposit provided neutralizing ability, even if the rock type was other than carbonate. For example, the layered mafic intrusions of the Stillwater and East Boulder mines in Montana have inherent neutralizing ability even though they do not have carbonates.” Nevertheless, environmental contamination by the Stillwater mine was documented in the succession of Environmental Impact Statements (EIS) that were released throughout the 1990s to support the expansion of the mine. According to Kuipers et al. (2006), “The 1992 EIS stated that chromium, zinc and to a lesser extent, cadmium, were elevated in well downgradient of the LAD [Land Application Discharge] relative to upgradient wells. Increased TDS, sulfate, nitrate and to a lesser extent, chromium and zinc, were thought to reflect the disposal of excess adit water through land application and percolation. According to the 1998 EIS, water discharged from the West Side Adit and East Side Adit between March 1990 and June 1997 exceeded standards (either Montana human life or aquatic standards) for dissolved cadmium, copper, manganese, zinc and total recoverable cadmium, copper and lead. Nitrogen in adit discharge water was much higher than baseline levels. Dissolved chromium regularly exceeded human health standards at

all groundwater monitoring sites in the LAD area, and there were slight elevations of sulfate, chloride, phosphorus, cadmium, iron, and zinc observed downgradient of the LAD area.”

Incidents of environmental contamination by the Stillwater mine continued into the next decade. In 2003 it was discovered that a tailings underdrain discharge pipe was allowing a leak of about 10 gallons per minute to groundwater near the dam toe. It was also discovered that a LAD solution storage pond liner was allowing seepage of 150 gallons per minute into groundwater (Kuipers et al., 2006). According to EPA (2023d), violations and benchmark limit exceedances in mine effluent discharge have continued to the present day in terms of iron, selenium and total suspended solids, with violations of the Clean Water Act identified every quarter since the fourth quarter of 2019. For example, in the first quarter of 2021, total iron in the effluent discharge exceeded the benchmark limit by 58,100%, while total suspended solids exceeded the benchmark limit by 128,900% (EPA, 2023d).

DISCUSSION

The Flambeau Mine as a Fake Success Story

Despite the extensive record of environmental contamination that is recorded in the many documents available on Deer Tail Scientific (2023), the unearned status of the Flambeau mine as an environmental success study has been remarkably persistent. Some of this persistence is simply due to the propagation of misinformation. According to Moran (2019), “Flambeau ground and surface water quality is being and has been degraded—despite years of industry public relations statements touting the success of the FMC [Flambeau Mining Company] operation. Rio Tinto said in a 2013 public relations (PR) release regarding the Flambeau Mine: ‘Testing shows conclusively that ground water quality surrounding the site is as good as it was before mining.’ In efforts to encourage development of the other metal-sulfide deposits in northern Wisconsin and the Great Lakes region, the industry approach has been to simply repeat this false statement over and over, assuming that repetition will make it believed. Unfortunately, the FMC data show otherwise.”

On the other hand, another factor has been the intentional or unintentional misconception that the State of Wisconsin has endorsed the success of the Flambeau mine. For example, Motley and Frederick (2021) wrote, “In 2014, the state released the [Flambeau] mine’s reclamation bonds because the company had met all closure and reclamation obligations.” In fact, Wisconsin Department of Natural Resources (2022) did issue a Certificate of Completion of Reclamation for the Flambeau mine on December 20, 2022. However, the Certificate of Completion of Reclamation indicates only that the mining company has completed its reclamation plan. It in no way states that there has been no environmental contamination.

Deer Tail Scientific, Wisconsin Resources Protection Council, and Sierra Club Wisconsin Chapter (2023) explains, “The so-called ‘Certificate of Completion’ (COC), originally sought by the company in 2007, was denied earlier due to surface water contamination problems in a Flambeau River tributary that crosses a portion of the project site. The tributary at issue in 2007 (‘Stream C’) remains polluted to the present day, but the DNR nonetheless decided to grant Flambeau Mining Company the certificate, citing provisions in Wisconsin’s mining code that allowed them to do so despite the pollution ... In handing down its decision to certify that FMC had successfully reclaimed the Flambeau Mine project site, the DNR cited provisions of Wisconsin’s mining code that allowed them to do so. Primarily, they focused attention on their

determination that FMC had ‘completed reclamation in accordance with the approved reclamation plan.’ That approach was consistent with what FMC had maintained in a legal brief filed in 2007, the first time the company sought COC certification. When making their legal arguments before the judge, the company characterized the COC process as ‘simple and limited to essentially checking off whether FMC has or has not completed certain specified reclamation tasks ...’. Absent was any consideration of whether or not the reclamation plan had actually succeeded in protecting public waters ... In other words, Wisconsin’s mining laws simply require a mining company to prove they did whatever their reclamation plan said they were going to do ... The recent Flambeau Mine decision confirms that the issue of whether or not a mining company’s reclamation plan succeeded in protecting the state’s waters does not factor into a COC decision. When the DNR awarded the COC to Flambeau Mining Company, there was no mention of how the groundwater within the backfilled mine pit is highly contaminated and undrinkable. Nor was there any mention of how FMC’s stormwater detention basin had failed to adequately sequester contaminants and that, as a result, a tributary of the Flambeau River is now impaired.”

Wisconsin Department of Natural Resources (2022) did not disagree with the preceding interpretation, but even affirmed that it is still necessary to determine the extent of environmental contamination. According to Wisconsin Department of Natural Resources (2022), “DNR and Flambeau Mining Company have agreed that additional assessment of the biologic condition of Stream C is appropriate to determine whether Stream C is attaining its designated uses. Flambeau Mining Company will develop a work plan for the study consistent with all applicable DNR rules and guidance and submit it to DNR, for review and approval in early 2023. The Department anticipates the company will initiate assessment activities in 2023 and that all critical aspects of the work, including sample collection and analysis, will be verified by DNR. The DNR will determine what, if any, additional monitoring or other actions are needed once the study is completed.” It should be noted that Wisconsin Department of Natural Resources (2022) also stated, “The Revised Mining Permit will remain in force until the remaining reclamation bond is released, which will not occur for a minimum of 20 years,” which contradicts the claim by Motley and Frederick (2021) that all reclamation bonds had been released.

The Minnesota Prove It First Bill as a 20-Year Moratorium

It should be abundantly clear by this point that there are no viable candidates for sulfide ore mines in the USA that have been operated for 10 years and closed for 10 years without environmental contamination, as would be required under the Minnesota Prove It First Bill. There would be no viable candidates under the weaker provisions of the Wisconsin law that allowed for consideration of mines in both the USA and Canada, as well as separate mines that had been operated for 10 years and closed for 10 years. The obvious question is: When is the earliest that a viable candidate for a model mine that would satisfy the provisions of the Minnesota Prove It First Bill could appear? Sulfide ore mines in a climate similar to that of Minnesota are of particular interest and that is another requirement of the Minnesota Prove It First Bill. It should be noted that the Eagle mine will never be a candidate since it had documented environmental contamination as late as 2019 (relevant regulatory documents are not yet available for 2020, 2021 and 2022) and is scheduled for closure in 2026, so that no more than six years of operation without environmental contamination could ever be possible. The Flambeau mine will never be a candidate because it was only operated from 1993 to 1997. The

Stillwater mine in Montana could possibly be a candidate, although it is drier at the Stillwater mine site than anywhere in Minnesota (see Table 1). Even if the Stillwater mine never experienced another incident of environmental contamination during operation, it is not scheduled for closure until 2055, so that it could not be a viable candidate until 2065, or 42 years into the future.

The earliest viable candidate for a model sulfide ore mine would have to be a mine that opens in 2023 or an existing mine that ceases environmental contamination in 2023, operates until 2033 without environmental contamination, closes in 2033, and then still has no record of environmental contamination as of 2043. In other words, the Minnesota Prove It First Bill is essentially a 20-year moratorium on nonferrous sulfide ore mining in Minnesota pending the demonstration of sulfide ore mining without environmental contamination in some other jurisdiction. Perhaps it is not a complete coincidence that on January 26, 2023, the U.S. Department of the Interior (2023) issued Public Land Order 7917, which withdrew from mining, for a 20-year period, 225,504 acres in the Superior National Forest in northeastern Minnesota, thus protecting the Rainy River watershed, including the Boundary Waters Canoe Area Wilderness and the 1854 Ceded Territory of the Chippewa Bands. Thus, two decades seems to be an appropriate time period for the sulfide ore mining industry to demonstrate its ability to use modern technology to extract metals from sulfide ores without environmental contamination.

Support for the Minnesota Prove It First Bill

Although it will not come as a surprise, it is now appropriate for the author to disclose his support for the Minnesota Prove It First Bill and that his company, Malach Consulting, is a member of the Prove It First Coalition. Sulfide ore mining comes with both benefits and risks. The risk is environmental contamination, which could include the loss of irreplaceable ecosystems, such as the Boundary Waters Canoe Area Wilderness. The benefits are metals, as well as revenue from employment and taxes. It should go without saying that, in terms of the availability of metals, the people of Minnesota can equally benefit from metals that are mined and processed outside of Minnesota. Thus, the balance of risks and benefits is a balance between money and a clean environment.

It is the most basic principle of justice that one party cannot receive the benefits, while another party suffers the risks or the damages. This is the point that was made in the Overview section in stating that, while discussions regarding mining often involve calls for “compromise” and “dialogue,” the decisions that are made typically result from the interactions among political actors with profound differentials in power. Justice requires that discussions regarding risks and benefits take place within the group of people who will both reap the potential benefits and suffer the potential consequences. Thus, it is entirely inappropriate for a foreign mining company to debate risks and benefits with the people of Minnesota, in that a foreign company cannot possibly bear the same risks of environmental contamination as the local residents.

Any sulfide ore mine that operated in Minnesota without contamination would be the first such sulfide ore mine anywhere in the world. There is no principle of justice that would require the people of Minnesota to be the testing ground for new technologies for sulfide ore mining. Being the testing ground means accepting not only risks, but unknown risks. There is no principle that should require any jurisdiction to be the testing ground, although the people of some jurisdiction might choose to do so for whatever reasons they choose. Even when choices are made to accept sulfide ore mining or new technologies for sulfide ore mining, due attention

should be paid to possible power differentials among the stakeholders and the possible separation of risks and benefits. In summary, no jurisdiction, not Minnesota, and not anywhere, should have to be the sacrifice zone so that the rest of the world can have metals.

CONCLUSIONS

The chief findings of this report can be summarized as follows:

- 1) The U.S. Department of Justice brought a civil action against the operating Bagdad mine for discharging contaminated water in violation of the Clean Water Act, including discharges from tailings ponds, pipelines, leach dumps, other facilities and a sewage treatment plant, resulting in an agreement by the mining company to pay a civil penalty of \$760,000.
- 2) After closure, the pit lake water at the former Sacaton (now called Cactus) mine has been acidic in the range pH 3.8 – 4.1.
- 3) After closure, the pit lake water at the Cullaton Lake mine has been acidic at pH 3.2, while drainage from the pit toward natural water bodies has exceeded Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life.
- 4) The operating Eagle mine has caused numerous exceedances of EPA drinking water guidelines in groundwater downstream from the mine as recently as 2019 (the most recent year for which records are available).
- 5) After closure of the Flambeau mine, the copper concentration in Stream C, which crosses the mine site before it joins with the Flambeau River, has been so high that the stream is nearly devoid of life and has been placed on the EPA list of Impaired Waters.
- 6) Successive closure plans at the McLaughlin mine have proven unworkable as the water quality in the pit lake and tailings pond remains very poor, there is potential for spillage into the environment, and perpetual maintenance may be required.
- 7) Runoff from the Raglan mine has been very high in total dissolved solids, especially in comparison to the receiving waters.
- 8) Even before opening in 2017, the Rainy River mine was fined \$187,500 for discharge of excessive ammonia from the mine pit and another \$100,000 for non-compliance with permits that led to failure of a dam.
- 9) The mine effluent discharge from the Stillwater Mine has exceeded standards for iron, selenium and total suspended solids, with violations of the Clean Water Act identified every quarter since the fourth quarter of 2019 until the present.
- 10) Although the closure of the Flambeau mine has been widely touted as a success story by the mining industry, the Certificate of Completion of Reclamation that was issued by the Wisconsin Department of Natural Resources indicates only that the mining company has completed its reclamation plan and in no way states that there has been no environmental contamination. In fact, even more of Stream C has been added to the EPA list of Impaired Waters and the Revised Mining Permit for the Flambeau Mining Company requires additional assessment and a remediation plan for Stream C.

RECOMMENDATIONS

The recommendation of this report is that the Minnesota Prove It First Bill be passed during the current legislative session.

ABOUT THE AUTHOR

Dr. Steven H. Emerman has a B.S. in Mathematics from The Ohio State University, M.A. in Geophysics from Princeton University, and Ph.D. in Geophysics from Cornell University. Dr. Emerman has 31 years of experience teaching hydrology and geophysics, including teaching as a Fulbright Professor in Ecuador and Nepal, and has 70 peer-reviewed publications in these areas. Dr. Emerman is the owner of Malach Consulting, which specializes in evaluating the environmental impacts of mining for mining companies, as well as governmental and non-governmental organizations. Dr. Emerman has evaluated proposed and existing mining projects in North America, South America, Europe, Africa, Asia and Oceania, and has testified on mining issues before the U.S. House of Representatives Subcommittee on Indigenous Peoples of the United States, the European Parliament, the United Nations Permanent Forum on Indigenous Issues, and the United Nations Environment Assembly. Dr. Emerman is the Chair of the Body of Knowledge Subcommittee of the U.S. Society on Dams and one of the authors of Safety First: Guidelines for Responsible Mine Tailings Management.



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APPENDIX

Musselwhite Mine

In a March 2023 Letter to the Editor of The Ely Echo, Colombo (2023) proposed the Musselwhite gold mine in west-central Ontario as an example of a sulfide-ore mine that would satisfy the requirements of the Minnesota Prove it First Bill. According to Colombo (2023), “You want a ‘prove it first’ example of mining in a water rich environment? Here’s a good one ... Musselwhite Mine is a gold mine in Sulfide ore and is located approximately 500 kilometers north of Thunder Bay, Canada ... I could not find any citations against this property for environmental reasons. However, in 2015 an employee was killed and there may have been a Mine Safety Administration citation issued upon closure of the accident.”

The Musselwhite mine is an underground mine beneath Lake Opapamiskan (Newmont, 2023). The mine was opened in 1997 by Goldcorp, which was acquired by Newmont in 2019 (Newmont, 2023). The Musselwhite mine is scheduled for closure in 2029 (Mining Data Online, 2023d). The closest long-term weather station is at Pickle Lake, 78 miles to the south (El Dorado Weather, 2023b).

The Musselwhite mine would not satisfy the requirements of the Minnesota Prove It First Bill on multiple grounds. The mine is in Canada, not the US. Although the precipitation is within the range found in Minnesota (see Fig. A1), the mine site is considerably colder than even the coldest location in Minnesota (see Fig. A2). Finally, since the Musselwhite mine is still open, it does not meet the requirement of at least 10 years of closure without environmental contamination.

The most important requirement that is not met is the requirement of operation without environmental contamination. The most recent review of the environmental impact of the Musselwhite mine by an independent party was released in 2008 (Rights Action, 2008). According to Rights Action (2008), “At Goldcorp’s Musselwhite Mine, the communities say that there has been inadequate disclosure of environmental problems (local residents were not told about a cyanide spike in 2005 until six weeks after it happened) ... Wildlife including geese and ducks have been spotted near or on the tailings area at Musselwhite, worrying people that live in local communities who eat those same birds and animals.” According to an informant quoted in Assembly of First Nations and MiningWatch Canada (2001), “We saw a lot of ducks swimming around in the tailings pond at the Musselwhite Mine, and one of the contractors described some geese here last week. Those ducks probably go to our area, and end up being eaten. There have also been bear and moose sighted in the ponds.”

In fact, destruction of the environment was an integral component of the plan for mine waste management. According to Rights Action (2008), “One fish-bearing lake was drained to create a tailings dam, and a new wetland was created; however, another wetland area was destroyed by the implementation of the tailings dam ... The community feels that not all habitat was considered during the planning of the mine.” Goldcorp declined an opportunity by Business and Human Rights Resource Center (2008) to respond to the report by Rights Action (2008). It should be noted that environmental contamination of the mine site would not be excluded from the requirements of the Minnesota Prove It First Bill.

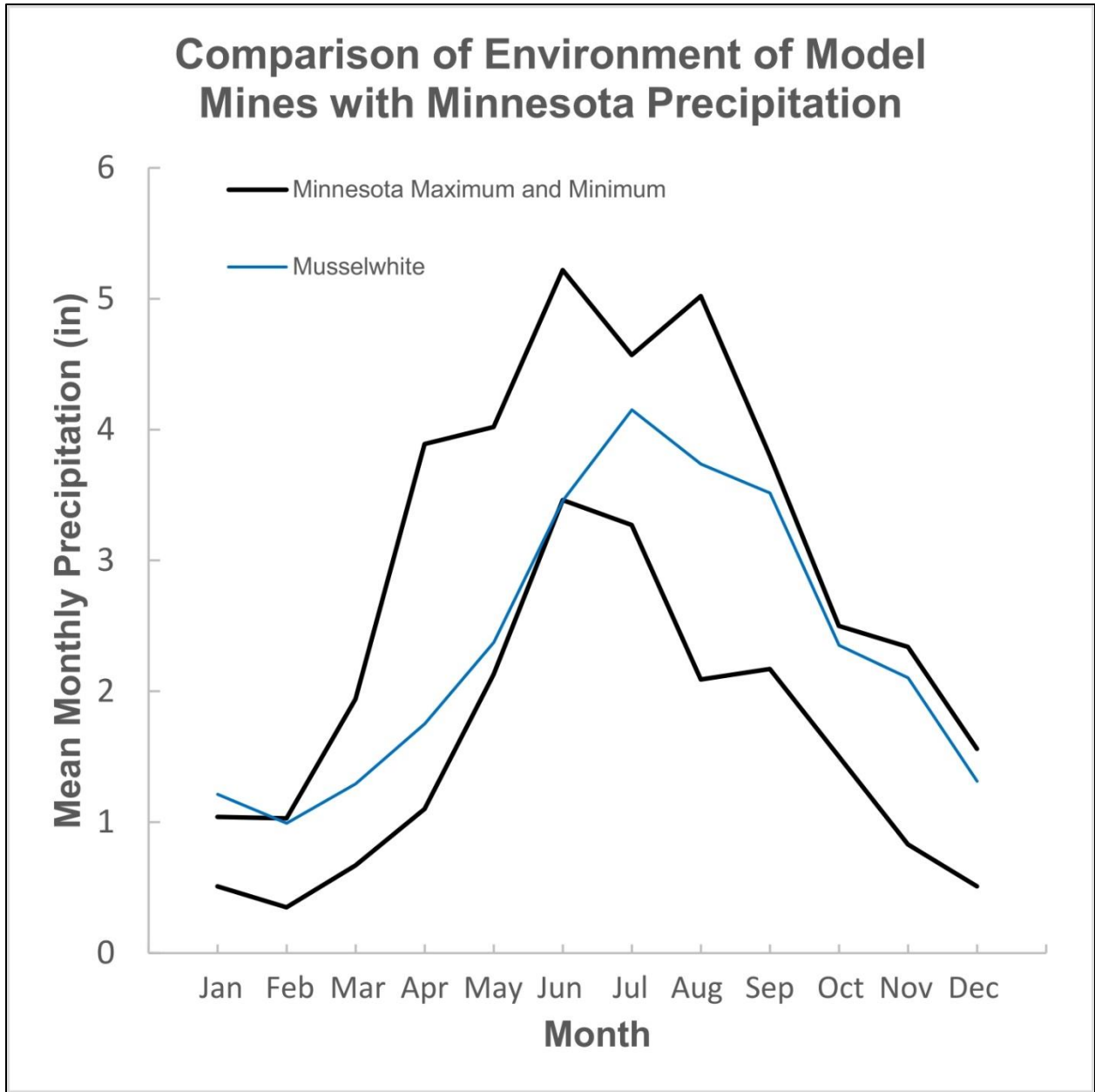


Figure A1. The Musselwhite mine has been put forward as a candidate for a model sulfide ore mine with no history of environmental contamination. The mean monthly precipitation at the site of the Musselwhite mine is within the range of what is found in Minnesota. The precipitation range in Minnesota is defined by the range between Caledonia (wettest location in Minnesota) and Karlstad (driest location in Minnesota). Data from U.S. Climate Data (2023g-h) and El Dorado Weather (2023b).

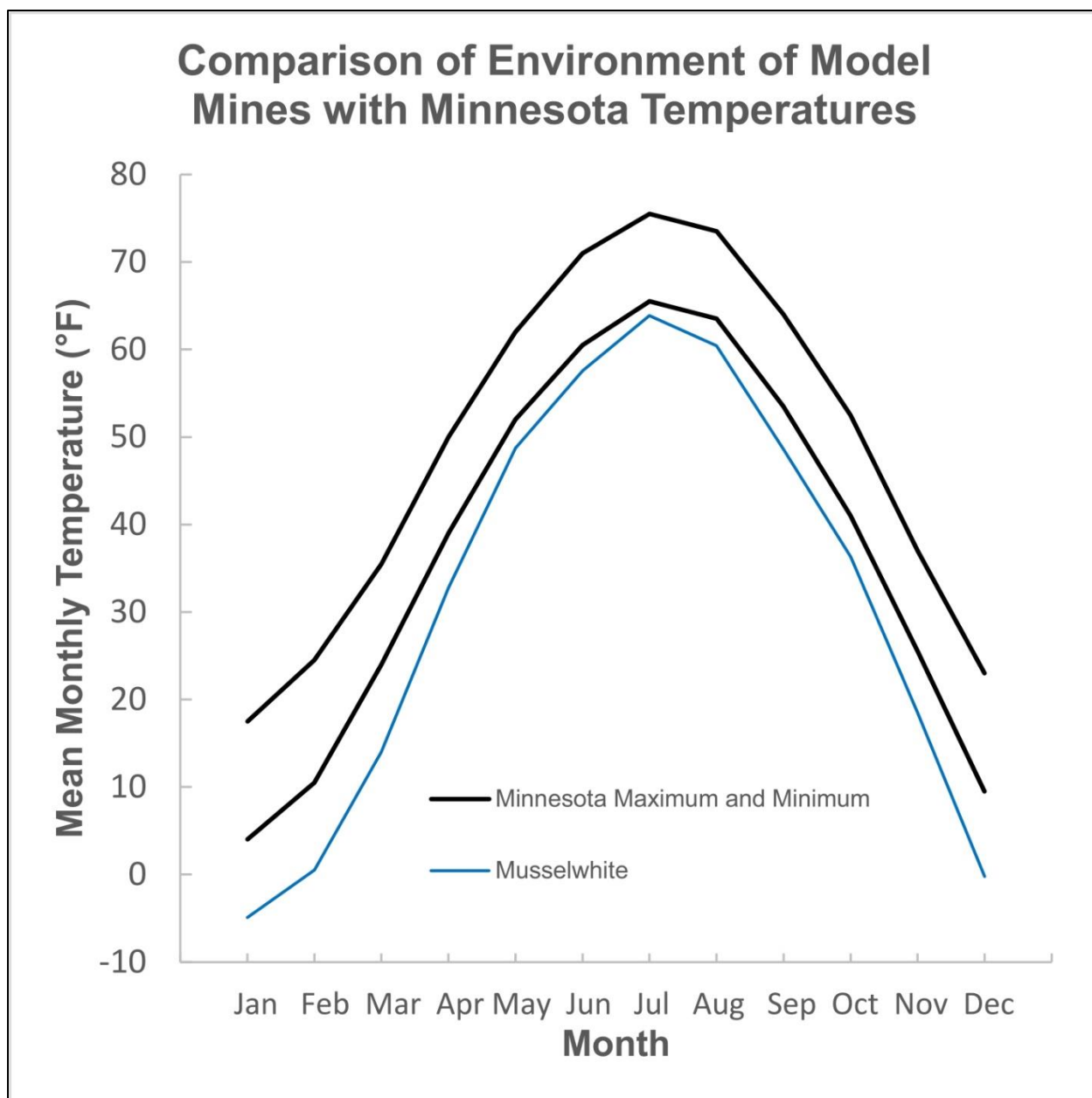


Figure A2. The Musselwhite mine has been put forward as a candidate for a model sulfide ore mine with no history of environmental contamination. Based on the mean monthly temperature, the site of the Musselwhite mine is considerably colder than even the coldest location in Minnesota. The temperature range in Minnesota is defined by the range between International Falls (coldest location in Minnesota) and Winona (warmest location in Minnesota). Data from U.S. Climate Data (2023 i-j) and El Dorado Weather (2023b).

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