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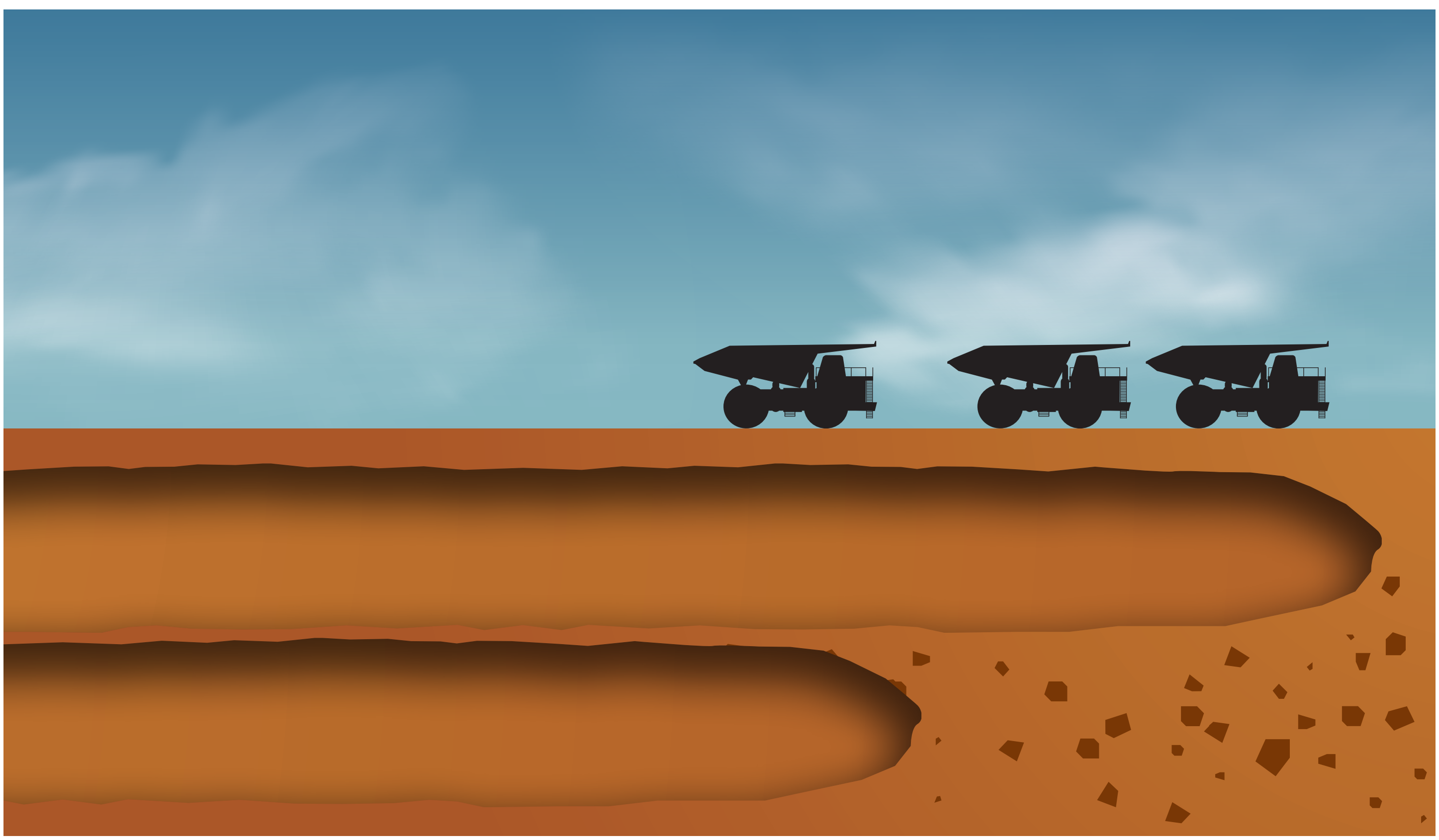
Minnesota's Think Tank

Unearthing Prosperity

How Environmentally Responsible Mining Will Boost Minnesota's Economy



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Executive Summary

Minnesota's unique geology makes the state a treasure trove of mineral resources. In 2017, Minnesota mined $3.18 billion in metals and minerals primarily iron ore, sand and gravel, and dimension stone, making the state the sixth-largest producer of non-fuel minerals in the United States.[1, 2] However, Minnesota's mining industry could be much larger.

In fact, it could be a powerful force for the economy of the entire state.

This report evaluates the mining potential of Minnesota and reaches twelve main findings that buttress one conclusion: Minnesota can reap the tremendous economic benefits of mining its mineral resources and enjoy a safe and clean environment at the same time.

Daily life requires mining: The Minerals Education Coalition (MEC) reports that every American born in 2017 will require an average of 3.188 million pounds of minerals, metals, and fuels in his or her lifetime. For example, the average house built in the United States contains 400 pounds of copper, and the average car contains approximately 50 pounds of copper.[3]

Minnesota is well positioned to help meet America's demand for metals.

Minnesota's mineral deposits are massive: Northern Minnesota is home to one of the largest undeveloped deposits of copper, nickel, and platinum group elements in the world.[4] Minnesota also has the largest deposits of ilmenite, the most important ore for titanium, in North America.

The economic benefits of mining these resources would be tremendous: Developing these resources would add approximately $3.7 billion to Minnesota's annual economic output, support more than 1,900 direct jobs and 6,566 indirect and induced jobs, with total wages of $635 million, and generate nearly $198 million in tax dollars for state and local governments.

These estimates are very conservative: Our calculations are based only on publicly-available data from mining projects in the permitting or preliminary planning stages, but several of Minnesota's copper-nickel deposits—including the Mesaba, which is the largest copper-nickel deposit in the state—do not have public resource calculation estimates available at this time.

As a result, our numbers are a floor, not a ceiling.

Minnesota would have been the number-three state: In terms of non-fuel mineral production, Minnesota would have ranked third if it had mined these resources in 2017. Minnesota has not ranked third since 2012, and it has been falling in the rankings ever since.

In total: Minnesota's metals and minerals are worth more than $187 billion at current prices, if they are developed.[5]

Minnesota schools will especially benefit from more mining: Because much of the non-ferrous mining will be done on land held by the Minnesota Permanent School Trust Fund, schools all over Minnesota will receive additional revenue in addition to the $198 million in tax revenue generated for state and local governments.[6]

Modern mining is safe for the environment: Mining critics argue that developing Minnesota's mineral wealth will endanger the environment, but strict environmental protections and advances in mining and environmental protection technologies have vastly reduced the environmental impact of modern mines. Mining and a healthy environment can, and do, coexist.

No mines permitted since 1990 by either the Bureau of Land Management (BLM) or the U.S. Forest Service have been added to the National Priorities List (NPL), a prerequisite to becoming a Superfund site: BLM has approved 659 mining plans since 1990, and the Forest Service has approved 2,685 plans since 1990 with no sites being placed on the NPL.

The Flambeau Mine and the Eagle Mine show mining can be done safely in the Midwest: Two modern mines in neighboring states, the Flambeau copper-gold-silver mine in Wisconsin and the Eagle nickel-copper mine in Michigan, show how today's mines are safe for the environment and good for local communities. Modern environmental protection measures, including liners, covers, and water treatment systems, were used at the Flambeau Mine and are being used at the Eagle Mine to effectively manage acid mine drainage and protect the environment.

If these minerals are not mined in Minnesota, they will be mined somewhere else: Despite the fact that the United States is one of the largest consumers of metals and minerals in the world, Americans are heavily dependent upon imported resources to meet their mineral needs.

Oftentimes, this means mining occurs in countries with poor protections for mine workers and the environment: For example, 55 percent of the world's cobalt is produced in the Democratic Republic of the Congo (DRC), where the United Nations International Children's Emergency Fund (UNICEF) estimates as many as 40,000 young boys and girls are working in cobalt mines.

Our state can benefit economically from developing these resources and protect the environment at the same time.

Contents

Introduction

Minnesota contains some of the largest undeveloped deposits of copper, nickel, platinum group elements, and ilmenite (the most important ore for titanium) in the world. Developing these resources will create more than 1,900 mining jobs, 6,566 indirect and induced jobs, and generate $3.7 billion in annual output—the economic equivalent of hosting nearly 10 Super Bowls every year for the next 20 years.

Section I discusses the vital role that metals and minerals play in our daily lives and puts these uses into context for general audiences. Section II describes Minnesota's vast mineral wealth in greater detail. Section III details how mining these minerals would boost Minnesota's economy. Section IV explains that if these minerals are not mined in Minnesota, they will be mined elsewhere. This often means mining is conducted in countries with few protections for workers or the environment.

Section V discusses the environmental track record of modern mining and explains how environmental-protection technologies, such as liners, covers, water treatment facilities, air emission control equipment, dust abatement measures, environmental monitoring systems, and other environmental controls, have successfully protected the environment at Minnesota manufacturing facilities, water treatment plants, industrial sites, construction projects, and businesses. They are used worldwide for similar purposes.

Section VI provides two compelling examples of how these environmental protection technologies have been successfully implemented at mines in Wisconsin and Michigan.

Section VII provides detailed information about Minnesota's comprehensive and stringent environmental regulatory requirements for proposed mining projects and the authorities granted to state regulators to ensure these regulations are enforced.

The choice between economic development and environmental stewardship is a false narrative. Minnesota can, and should, have both.

Section I: What's in Your Phone?

Before discussing Minnesota's mineral deposits and the economic benefits associated with developing them, it helps to remind ourselves of the important roles raw materials such as copper and nickel play in our daily lives.

To get a sense of how our modern lifestyles require ever-increasing quantities of raw materials, look at your smartphone. Most people would probably struggle to identify just a few—if any—of the metals and minerals used to manufacture their phone, let alone the entire suite of raw materials that allows them to check their Instagram feed whenever, and wherever, they want (See Figure1).

The failure to understand which raw materials make up the items we rely upon, and where these raw materials come from, is not limited to smartphones and other electronic devices. Ask people what the pipes in their houses are made of, which elements comprise their refrigerators, and what materials were used to build their vehicles and the roads they drive to work on, and you are likely to draw similar blank stares.

The Minerals Education Coalition (MEC) reports that every American born in 2017 will require an average of 3.188 million pounds of minerals, metals, and fuels in his or her lifetime.[8] This equates to every person needing approximately 40,500 pounds of new raw materials every single year.[9]

Minnesota is well positioned to help meet that demand.

Section II: Minnesota's Mineral Wealth

Northern Minnesota is home to a massive rock formation called the Duluth Complex which stretches from Duluth to Pigeon Point, Minnesota. This rock formation contains some of the largest undeveloped deposits of copper, nickel, platinum group elements, and ilmenite (the most important ore for titanium) in the world (See Figure 2). It also contains other valuable metals such as cobalt, gold, and silver.[10, 11]

<u>Copper:</u> Copper is an essential component of the electrical equipment used in construction, appliances

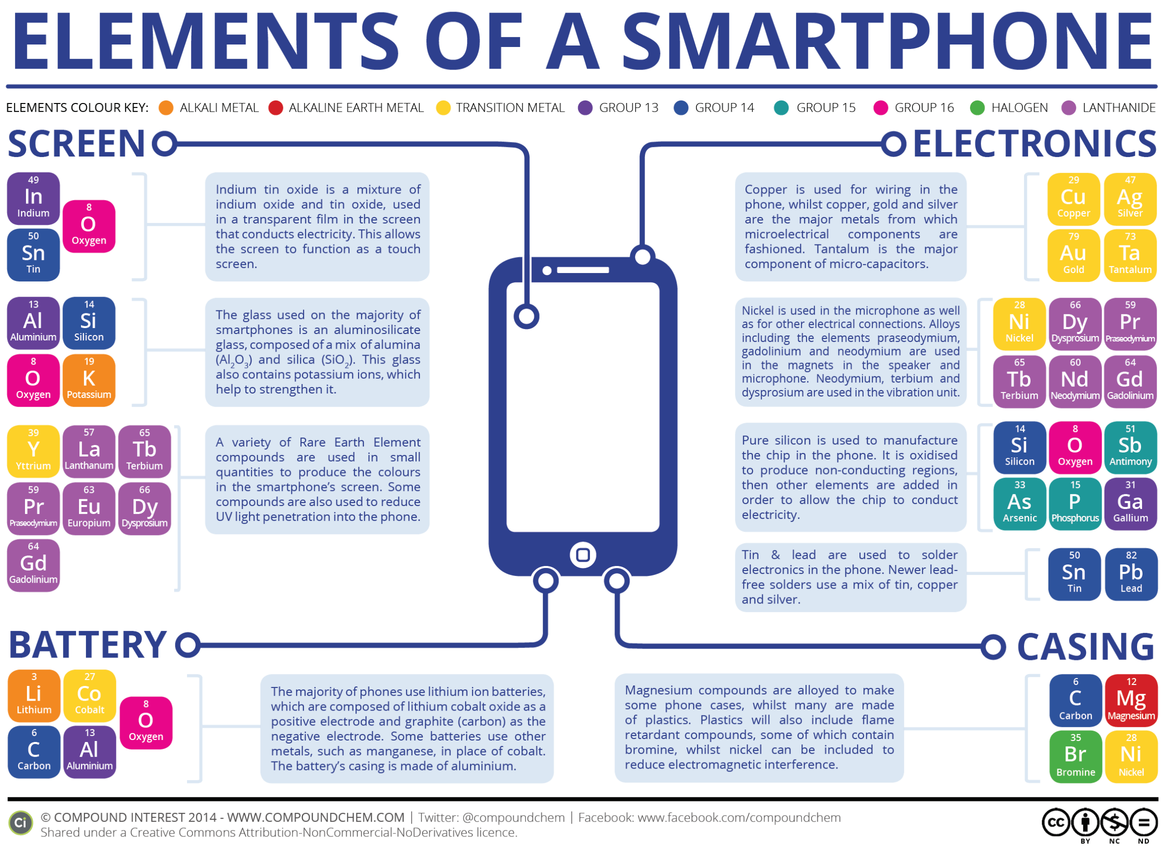
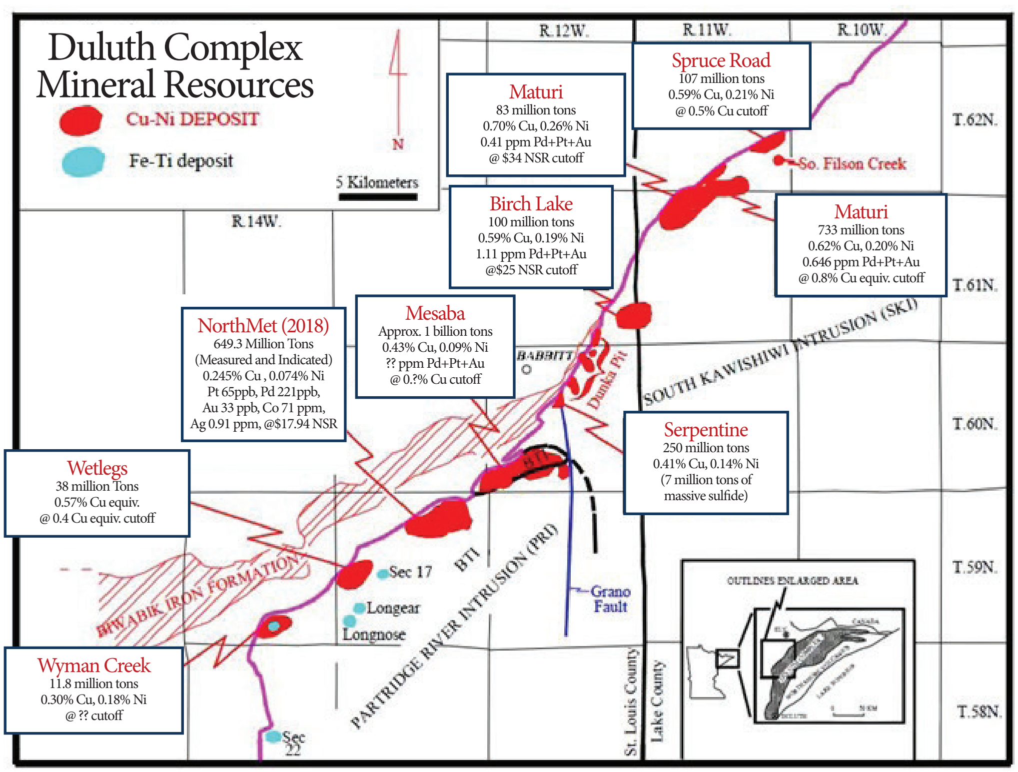
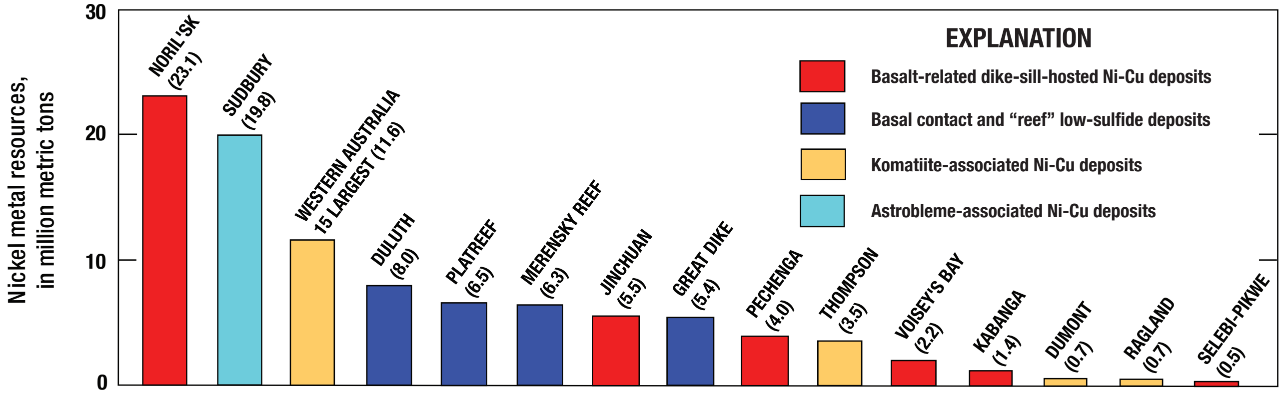


Figure 1. This diagram shows the metals and minerals needed to make a smartphone. Copper, nickel, cobalt, gold, silver, and silicon are all needed to make the components in smartphones, and all of these materials can be mined in Minnesota. If they are not mined here, they will be mined somewhere else.[7]

Figure 2. Red areas on the map indicate copper, nickel, and PGE deposits, light blue areas indicate ilmenite (titanium) deposits.[12] *PolyMet Mining Corp. is seeking to develop the NorthMet Deposit, and Twin Metals Minnesota is seeking to develop the Maturi Deposit.*





Histogram comparing the total nickel metal resources for the fifteen largest deposits worldwide. Numbers are in millions of metric tons. Figure modified from Hoatson and others (2006).

Figure 3. This chart shows the largest nickel deposits in the world. The Duluth Complex ranks fourth in the world in terms of total nickel content.

and automobiles.[13] The average house built in the United States contains 400 pounds of copper, and the average car contains approximately 50 pounds of copper.[14]

Figure 2 indicates the ore bodies in the Duluth Complex may hold as many as 12.6 million tons of copper—enough to build 63 million homes.[15] Other smaller copper deposits, such as the Tamarack Deposit located near Tamarack, Minnesota, are also being explored.[16]

Nickel: Minnesota's Duluth Complex contains eight million tons of nickel, which makes these deposits the largest undeveloped nickel deposits in the world and the fourth-largest in terms of total nickel content (See Figure 3).[17]

Nickel is used primarily as an alloy to strengthen and prevent corrosion of steel products, such as stainless steel. This accounted for 48 percent of U.S. nickel consumption in 2017. About 40 percent is used to make non-iron alloys and superalloys for, e.g., microphones in smartphones. Eight percent is used for electroplating, and four percent is used for other purposes, such as electric guitar strings and rechargeable batteries.[18]

Platinum Group Elements: The Platinum Group Elements (PGEs) consist of six elements: iridium, osmium, palladium, platinum, rhodium, and ruthenium. Minnesota's PGE deposits are the largest undeveloped PGE deposits in the world and rank as the fifth largest in terms of total metal content.[19]

Platinum and palladium are the most important PGEs because they are used primarily in catalytic converters, which reduce pollution generated by cars. Demand for these metals is expected to increase as more countries adopt stricter air-pollution standards.[20] Platinum is also used in jewelry and in medical implants, such as pacemakers, because it resists corrosion and, like cobalt, is not rejected by the body.

Cobalt: Minnesota contains the vast majority of the cobalt deposits of the United States, with just three of the several ore bodies in the Duluth Complex holding 47 percent of U.S. cobalt resources.[21]

Cobalt is used in rechargeable batteries and jet engines, and it is a key element in prosthetic hips, knees, and dental products. Approximately 42 percent of the global cobalt supply is used to make the batteries in cell phones, laptops, electric vehicles, and the batteries designed to store electricity generated from renewable energy sources.[22]

Cobalt is used in jet engines because it makes them more resistant to heat and corrosion. It serves a similar function in cutting tools. Cobalt is also used in prosthetics because it is strong and does not react negatively with bodily fluids.[23]

Titanium: Minnesota has the potential to become one of the largest titanium-producing areas in North America. According to the Minnesota Department of

Natural Resources, Minnesota is home to 13 known deposits of the mineral ilmenite—the most important ore for titanium. One of these deposits, the Longnose Deposit, is the largest and richest ilmenite deposit in North America, with more than 100 million tons of ore confirmed under a 160-acre site (See Figure 2).[24, 25]

Titanium consumption occurs in two principal forms: titanium dioxide, a white powdered form of titanium used in pigments, and refined titanium used as a metal. Titanium dioxide is used as a white pigment for paints, sunscreen, cosmetics, food additives, and pharmaceutical products, because it has a bright white color and reflects light.[26, 27]

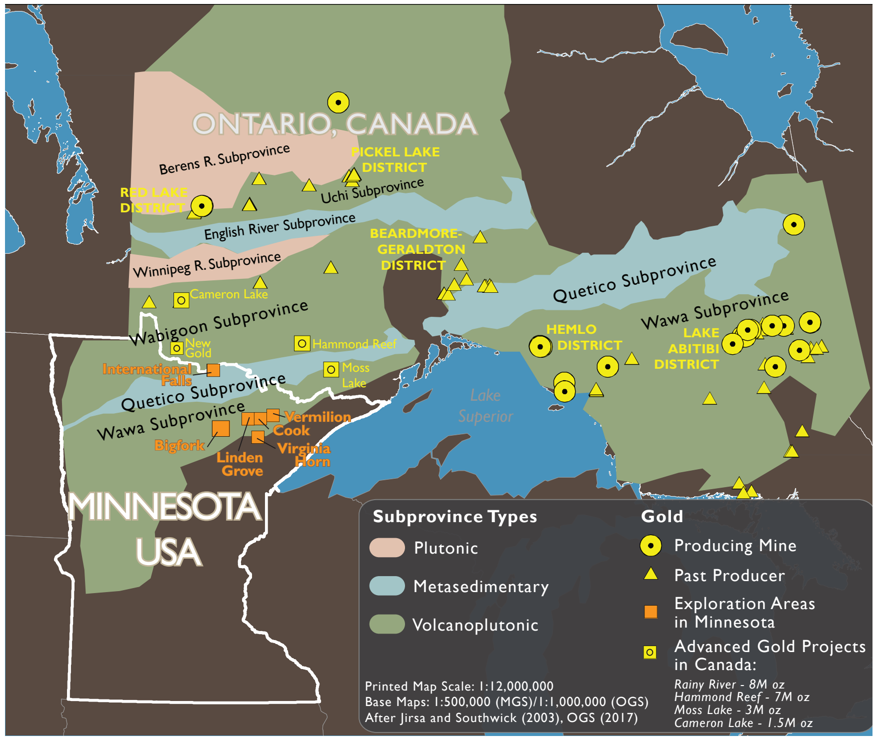


Figure 4. Minnesota has promising potential for gold mining because it shares many of the same rock formations as gold-rich areas of Canada. Areas currently being explored in Minnesota are located at Bigfork, Cook, International Falls, Linden Grove, Vermillion, and Virginia Horn.[30]

Titanium metal is used mostly in airplane manufacturing, space shuttles, and missile applications, but it is also found in jewelry, prosthetics, surgical tools, and high-end sports equipment because it is lightweight and does not corrode easily.[28]

<u>Gold and Silver:</u> Gold and silver have been found in the copper-nickel deposits of the Duluth Complex, but northern Minnesota may also have significant gold and silver resources independent of these metal deposits. Six areas of Minnesota are currently being explored for gold deposits because northern Minnesota shares many of the same geologic characteristics as gold-rich areas of Canada (See Figure 4).[29]

Gold is primarily used in jewelry, which accounted for 38 percent of the gold consumed in 2017. Gold is also used in electronics and official coins, with these uses accounting for 34 percent and 22 percent of gold consumption, respectively.[31] Gold is also used in the medical industry. Silver is an important component in electronics because it is an excellent conductor of heat and electricity. It is also used for coins, medals, jewelry, photography, pharmaceuticals, and silverware.[32]

Although Minnesota's gold and silver potential is speculative at this time, a Canadian gold mine named the New Gold Mine operates approximately 40 miles north of the Minnesota border in the same watershed as the Boundary Waters Canoe Area Wilderness. This gold mine is massive, holding an estimated 3.8 million ounces of gold reserves and 9.4 million ounces of silver reserves, about $4.7 billion worth of gold and $155 million worth of silver.[33]

<u>Manganese:</u> Emily, Minnesota contains what is believed to be the richest known deposit of manganese in the United States. In total, this deposit could contain between 1.4 billion and 7.3 billion pounds of manganese.[34, 35] Additionally, Crow Wing Power, which owns 180 acres of this 500-acre deposit, is seeking to conduct further exploratory drilling to improve the resource estimate associated with the manganese deposit.

Manganese is a very valuable metal that historically has been used in steelmaking. Today, it is an important part of environmentally friendly technologies including power plant emissions reduction, air and water pollution abatement, water purification, and rechargeable and storage batteries.

Iron Ore and Steel: Minnesota contains the largest iron deposits in the United States. In 2017, Minnesota accounted for 75 percent of the iron ore mined in the U.S. The Mesabi Range—the last active iron range in Minnesota—contains more than 170 billion tons of crude ore and 36 billion tons of iron-ore concentrate that will be recoverable for more than 200 years using current surface mining methods.[36, 37]

Iron ore is the primary feedstock for steel and other iron products. Steel is used for support beams, rebar, automobiles, trains, ships, cans, and containers.[38]

Industrial Sand and Gravel: Half of the sand and gravel mined in Minnesota is used as aggregate in public roads, bridges, sidewalks, and sewer systems.[39] Southeastern Minnesota also has deposits of the specialized sand that is used for glassmaking, household and industrial cleaners, molding metal castings at foundries, bedding for livestock, and as a proppant in hydraulic fracturing to increase oil and natural gas production.[40, 41] Minnesota produced the eighth-most industrial sand of any state in 2017.

Section III: Mining Minnesota's Minerals Will Generate Billions for the Economy and Create 8,500 Jobs

Minnesota was the sixth-largest producer of non-fuel minerals (in terms of dollar amount) in the United States in 2017, producing $3.18 billion in metals and minerals, primarily iron ore, sand and gravel for

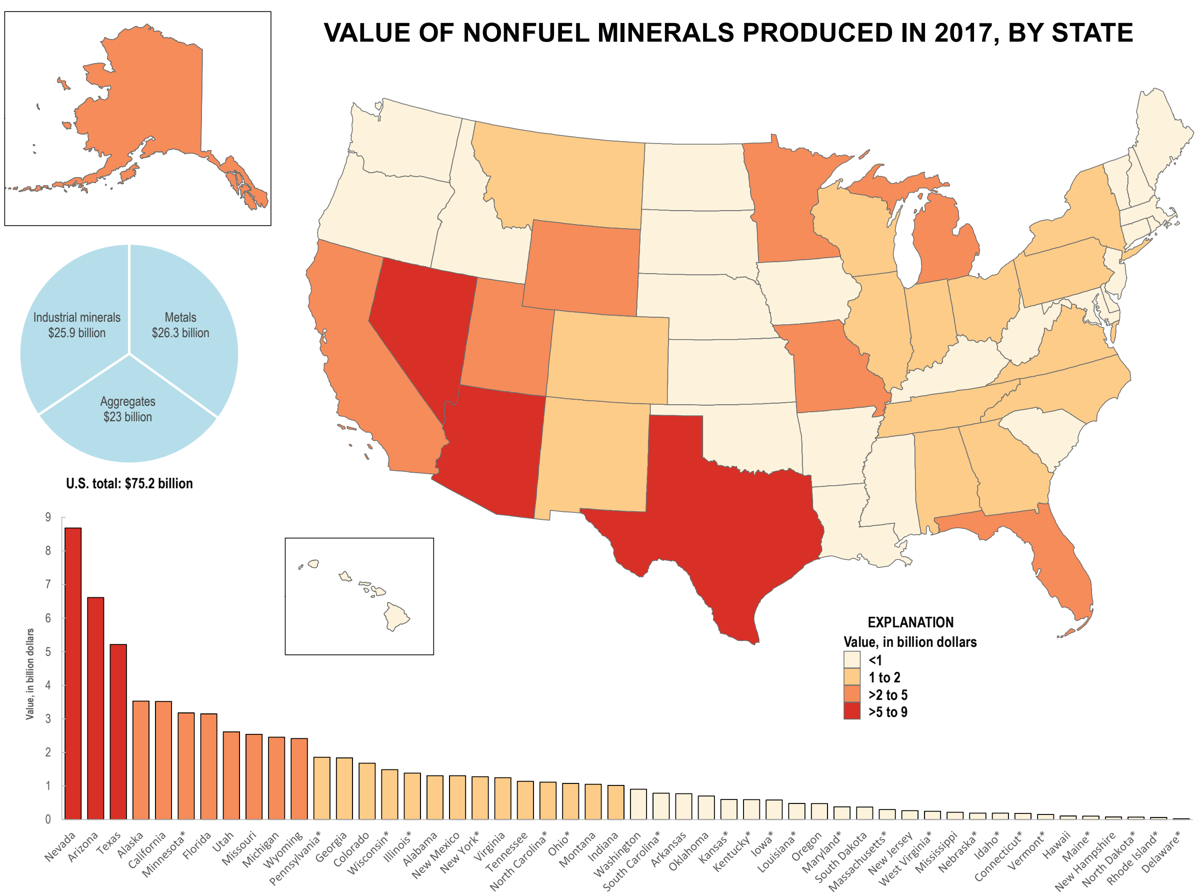


Figure 5. Minnesota was the sixth-largest producer of non-fuel minerals in the United States, producing $3.18 billion in minerals in 2017.[42]

construction and industrial purposes, and dimension stone (See Figure 5).

Mining already plays an important role in Minnesota's economy, but our calculations indicate it should be much larger. If Minnesota had taken advantage of its copper, nickel, platinum group elements, and ilmenite resources, it would have increased the direct sales of minerals and metals by approximately $2.1 billion in 2017, bringing the total sales of metals and minerals from the state to approximately $5.28 billion.[43]

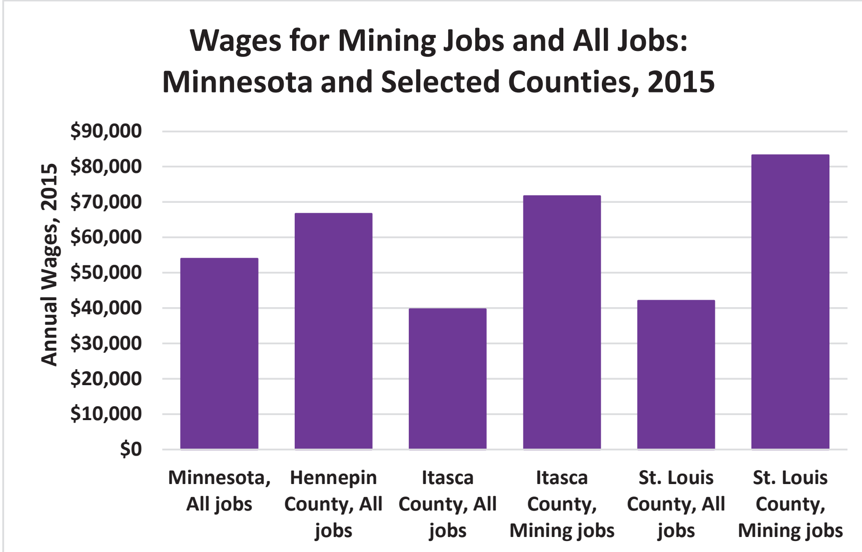


Figure 6. This graph compares the average income for jobs in Hennepin County, Itasca County, St. Louis County, and an average of all Minnesota counties. Average incomes in Hennepin County are approximately $66,600—far greater than the average income for non-mining jobs in northern Minnesota, where wages are nearly $12,000 lower than the state average.

If Minnesota had mined these resources in 2017, it would have regained its position as the third-largest producer of minerals, by dollar amount, in the United States—a position it has not held since 2012.

If gold and silver are discovered in mineable quantities in the areas currently being explored in northern Minnesota, it could significantly add to these totals.

Section III. A: Thousands of Jobs for Decades to Come

Minnesota's mining history has resulted in a highly-skilled workforce that is supportive of the mining industry. Many Minnesotans living on the Iron Range view mining as a way of life and support increased mining activity in their region of the state.[44]

Iron Range residents support mining in large part because the wages paid for mining jobs are far greater than wages earned at other jobs in the area (See Figure 6).[45] Hoyt Lakes Mayor Mark Skelton compared the $515 million annual economic benefits generated from the proposed PolyMet mine to hosting the Super Bowl, every year for 20 years.[46] According to Skelton, mining has a chance to be northern Minnesota's "big game."

Residents of the Twin Cities metropolitan area often take their relatively high wages for granted, but jobs paying more than $66,000 per year are difficult to come by in northern counties. In St. Louis County, the average income per job is approximately $42,000. In contrast, jobs in the mining sector pay an average of $83,235—nearly twice the income from other jobs in the county.

These high wages are a key reason why many people living in northern Minnesota are eager to see more mining opportunities.

American Experiment used the economic modeling software IMPLAN to estimate the impact of additional mining on economic output, jobs, wages, and taxes from developing the copper, nickel, and PGE deposits associated with PolyMet's proposed NorthMet mining project, Twin Metals Minnesota's proposed TMM mining project, and developing the Tamarack Deposit.

All together, these three copper-nickel-PGE projects would directly employ 1,243 workers and support a further 3,436 jobs. They would generate $2.5 billion in additional output and $161 million annually in state and local tax revenues.[47, 48, 49]

Impact Type	Employment	Labor Income ($)	Value Added ($)	Output ($)
Direct Effect	1,902	$260,579,680	$922,044,209	$2,499,574,473
Indirect Effect	3,181	$210,427,565	$366,721,156	$716,469,323
Induced Effect	3,385	$163,508,298	$273,563,569	$478,211,856
Total Effect	**8,468**	**$634,515,542**	**$1,562,328,935**	**$3,694,255,652**

Table 1. According to the economic modeling software IMPLAN, mining Minnesota's copper, nickel, PGE and titanium deposits could be a significant boom to the state's economy. Developing these resources would generate nearly $3.7 billion in economic output, create 1,902 mining jobs, and support 6,566 jobs throughout the economy with a total labor income of $634.5 million. Source: IMPLAN

In addition to copper-nickel-PGE mining, a new technology pioneered at the Natural Resources Research Institute at the University of Minnesota, Duluth promises to turn Minnesota into a large producer of ilmenite—the primary ore for titanium—and titanium products, such as the high-quality titanium dioxide used in pigments.[50]

Mining ilmenite will increase economic activity and reduce our need to import titanium concentrates, but the true economic potential of ilmenite lies in processing the ore into value-added products such as titanium dioxide. For example, titanium dioxide sells for approximately $3,200 per ton, whereas processed taconite iron ore sells for approximately $102 per ton.[51, 52]

IMPLAN estimates titanium mining and support activities could generate an estimated 659 jobs in these sectors directly and support another 3,130 jobs throughout the state. It would generate an estimated $1.1 billion of output for the state and produce an extra $37 million annually in state and local tax revenue.[53]

If all of these projects went ahead, the boost to the state's economy would be considerable. They would create new jobs that directly employ approximately 1,900 people and support 6,600 indirect and induced jobs across Minnesota. They would generate new output amounting to an extra $3.7 billion of economic output annually. Mining would also contribute an additional $198 million a year in state and local tax revenues (See Table 1).

These estimates are conservative because our calculations are based only on publicly-available data from mining projects that are currently in the permitting or preliminary planning stages. However, several of the copper-nickel deposits—including the largest copper-nickel deposit in Minnesota—do not have public resource calculation estimates available. Furthermore, our estimates do not attempt to quantify the economic impact of manganese mining.

Therefore, our calculations represent the floor, and not the ceiling, of the potential economic impact of mining in the state.

At this time, none of the companies exploring for gold have official resource estimates for the mineral deposits they are exploring, making it impossible to model the economic impacts of gold mining in the state. However, the New Gold Mine in Ontario, Canada will employ approximately 400 people when production from the surface mine begins and 600 people when underground mining commences a few years later.[54]

Mining has been integral to Minnesota's economy since 1884, and it should be for decades to come.

Section IV: Minnesota Minerals will Reduce Imports from Countries with Child Labor and Poor Environmental and Worker Safety Rules

It is highly unlikely that anyone—including mining opponents—will be willing to surrender their smartphones, laptops, cars, indoor plumbing, or air conditioners anytime soon. This means the true choice is not whether these minerals and metals will be mined, but rather, *where?*

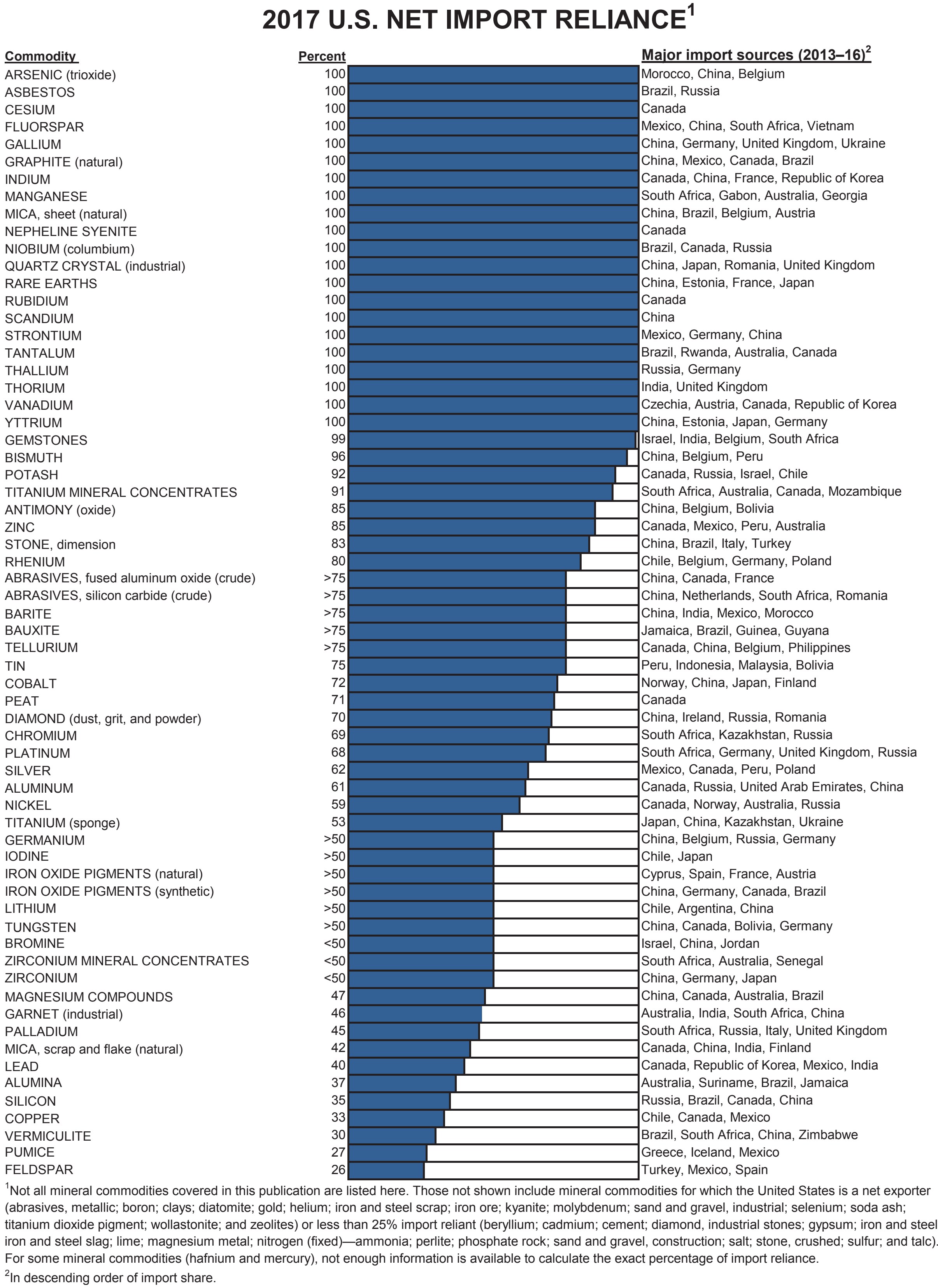


Figure 7. Americans depend heavily on countries like Brazil, Canada, Chile, China, Congo, Russia, and South Africa for cobalt, copper, nickel, palladium, platinum, silver, and titanium, even though Minnesota has vast deposits of these metals and minerals.

Despite the fact that the United States is one of the largest consumers of metals and minerals in the world, Americans are heavily dependent upon imported resources to meet our mineral needs. This often means we are importing minerals from countries that have lax—or virtually non-existent—protections for miners or the environment.

Figure 8. Approximately 20 percent of the cobalt mined in the DRC is mined by hand. UNICEF estimates 40,000 children are working in cobalt mines.

Figure 7 shows the degree to which the United States is dependent upon imports of selected metals and minerals, and which countries are the primary suppliers.[55]

The United States relies on imports for 100 percent of its manganese consumption, nearly all of its cobalt consumption, 91 percent of its consumption of titanium concentrates, 90 percent of its PGE consumption, 59 percent of its nickel consumption, 33 percent of its copper consumption, and 18 percent of its steel consumption.[56] The U.S. is a net exporter of gold, silver, iron ore, and industrial sand.[57, 58]

Discussion of why mining is essential to all of us and where minerals are mined is important, but it is also important to consider how mining is conducted.

Are we protecting workers and the environment by not mining in the United States, as mining opponents argue? Or are we simply exporting the impacts of mining to poorer nations with lower standards for protecting workers and the environment? A strong case can be made for the latter.

For example, approximately 55 percent of the world's cobalt is produced in the Democratic Republic of the Congo (DRC), where the United Nations International Children's Emergency Fund (UNICEF) estimates as many as 40,000 young boys and girls are working in cobalt mines (See Figure 8).[59]

While children under 18 cannot legally work in the mines in the DRC, these laws are widely disregarded for economic and societal reasons. Many children start working in mines at a very young age.[60] Unenforced regulations could never persist to this degree in the United States where labor rules are strictly enforced by the Mine Safety and Health Administration (MSHA). MSHA is required to inspect each underground mine four times a year and each surface mine twice a year for health and safety compliance.[61]

The DRC also lacks effective environmental protections. For example, Figure 8 shows people washing cobalt ore in a river. This crude processing technique would be unthinkable and illegal in the United States.

Those who oppose mining in Minnesota should be forced to acknowledge that their position means our state will not be doing its part to reduce cobalt imports from countries that use child labor and have poor environmental protections. Even when these countries have regulations on the books that supposedly prohibit these actions, they are rarely enforced. Unlike the DRC, Minnesota has rigorous permitting standards and strict enforcement of statutes and regulations.

Developing Minnesota's copper, nickel, PGE, titanium, and cobalt resources would make the state an important domestic source of strategic minerals that are essential to the U.S. economy, defense, infrastructure, and technology and manufacturing sectors.

Our country's current reliance on imported minerals creates a paradox. Minnesotans must choose whether we wish to continue purchasing various minerals from nations like Brazil, China, Congo, Russia, and South Africa, which may be hostile to our national interests and where environmental protections and protections for mine workers are inferior to those in the United States, or whether we will follow Canada's lead by reaping the economic benefits of responsibly developing these resources while also being good stewards of the environment.

The following sections explain why Minnesotans should choose the latter.

Section V: Why Are Modern Mines Safe for the Environment?

Mining opponents have charged that copper-nickel mining will necessarily pollute the air and water in northern Minnesota, particularly the Boundary Waters Canoe Area Wilderness and the Lake Superior watershed. However, when discussing the potential impacts of copper-nickel mining in Minnesota, anti-mining groups use examples from old mines that were developed elsewhere before the advent of modern mining practices and state and federal regulations that protect the environment.

Modern mines, like the proposed copper-nickel mines in Minnesota's Mesabi Iron Range Mining District, are safe for the environment for two reasons. First, these mines will be designed, built, operated, and closed using effective and proven environmental safeguards that provide comprehensive protection for all elements of the environment. Second, federal and state environmental regulations establish and enforce stringent environmental protection criteria and monitoring requirements for all industries. Mining in Minnesota is no exception.

Section V. A: Environmental Protection at Modern Mines: A Track Record of Success

The U.S. Environmental Protection Agency (EPA) recently concluded a lengthy rulemaking, evaluating whether U.S. hardrock mines should provide EPA with additional financial assurance pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—also known as the Superfund legislation—Section 108(b) that is separate from the financial assurance that mines are already required to provide to state regulators, the U.S. Bureau of Land Management (BLM), and the U.S. Forest Service.[62, 63, 64] In the course of this rulemaking process, EPA made a detailed assessment of the scope and effectiveness of existing federal and state environmental protection rules for hardrock mines.

Based on this assessment, EPA found that current state and federal environmental protection rules and financial assurance requirements are adequate, and that additional financial assurance is not needed to protect the environment and U.S. taxpayers:

> EPA has decided not to issue final regulations because the Agency has determined that final regulations are not appropriate… EPA has analyzed the need for financial responsibility based on risk of taxpayer funded cleanups at hardrock mining facilities operating under modern management practices and modern environmental regulations…That risk is identified by examining the management of hazardous substances at such facilities, as well as by examining federal and state regulatory controls on that management and federal and state financial responsibility requirements…[T]he record demonstrates that…the degree and duration of risk associated with the modern production, transportation, treatment, storage or disposal of hazardous substances by the hardrock mining industry does not present a level of risk of taxpayer funded response actions that warrant imposition of financial responsibility requirements for this sector.[65]

In explaining its decision, EPA further noted that:

> The conclusion that modern regulation has greatly reduced the risk of taxpayer financed response actions also is supported by the experience of other federal agencies. For example, in letters sent to Senator Murkowski, BLM and the Forest Service stated that no modern mines permitted since 1990 by either BLM or the Forest Service have been added to the National Priorities List (NPL), BLM responded that it had approved 659 plans since 1990 and none had been added to the NPL and the Forest Service reported approval of 2,685 plans since 1990 with no sites being placed on the NPL.[66, 67]

The fact that none of the sites permitted since 1990, which is roughly the time when modern environmental regulations went into effect, has been placed on the National Priorities List, a list of hazardous waste sites in the United States that are eligible for long-term remedial cleanup financed under the Environmental Protection Agency's Superfund program, is compelling proof that these regulations are protecting the environment at mine sites throughout the country. Pursuant to CERCLA, EPA can only conduct long-term remedial response actions at Superfund sites that are on EPA's NPL.[68]

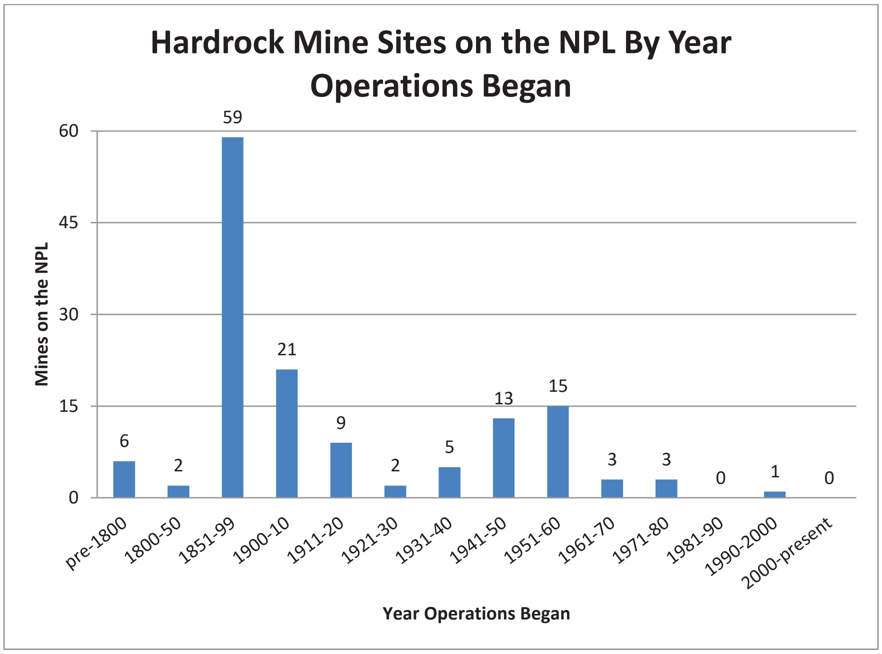


Figure 9. Modern mining has an impressive history of environmental stewardship. The vast majority of mine sites that have had negative environmental impacts began production before the year 1900. The Barite Hill Mine in South Carolina is the only site that has been added to the NPL since 1990. Based on EPA's research about this site, EPA states that it does not consider the mine to be representative of modern mining practices and instead would be more properly characterized as a legacy mine site. EPA has confirmed that South Carolina updated its mining law in 1990, after the mine began operating, to impose reclamation requirements for mines.

EPA's finding is important to the debate about copper-nickel-PGE mining in northern Minnesota because mining critics point to problems at old, historic mines operated with pre-regulations practices, and assert the problems at the old sites foretell what the future will hold at new, highly regulated mines. Many of these same mining opponents filed comments during the EPA rulemaking that relied on the same distorted conflation of outdated, pre-regulation practices at old mines to predict future risks at new mines that are strictly regulated and use modern environmental protection measures. In response to these assertions EPA found:

> …the primary determinant of risk is how current operations at the mine are conducted, including the current regulatory regime under which they operate… EPA has determined that modern regulation of hardrock mining facilities, among other factors, reduces the risk of federally financed response actions to a low level such that no additional financial responsibility requirements for this industry are appropriate.[69]

In its comments on the EPA rulemaking, the National Mining Association provided the chart shown in Figure 9, documenting that most of the mines on EPA's NPL started mining in the mid-to-late 1800s—a century or more before the enactment of today's environmental protection regulations or the use of modern environmental protection technologies.[70] Figure 9 vividly demonstrates the dramatic success that modern regulations have had in preventing environmental problems at today's mines.

Figure 9 also conclusively debunks mining opponents' use of problems at old, pre-regulations sites as a proxy for what will happen at modern mines. Although their forecasts may be effective at fomenting concern and generating alarming headlines, they are based on a distortion that omits two key facts: 1) new mines are highly regulated; and 2) these regulations mandate the use of proven environmental protection measures. The following section describes how the environmental protection technologies commonly used at modern mines protect the environment. Section VI describes how these environmental technologies have been successfully used to protect the environment at two modern copper mines in Wisconsin and Michigan.

Section V. B: Overview of Environmental Protection Measures at Modern Mines

Section V. B.1: Liners

Impermeable synthetic liners have been used for decades to protect water resources at many different types of facilities.[71] Liners isolate municipal and industrial solid wastes—including mine wastes—from the environment by preventing migration of leachate from these materials into area soils, underground water supplies (i.e., aquifers), and nearby streams and rivers. Liners are also used to construct impermeable ponds, lagoons, reservoirs, and containment ponds at municipal and industrial sites.

Synthetic liners, which are also called geomembranes, are made of chemically resistant plastics such as High-Density Polyethylene (HDPE) or similarly durable and impervious materials that are stable when exposed to caustic, acidic, or corrosive liquids and to ultraviolet light. According to one liner manufacturer, geomembranes are made from some of the most chemically resistant materials available, which is why one of the main uses of HDPE is for base liners at landfills because this material does not react or degrade when exposed to a broad range of chemical conditions.[72]

When a liner is constructed below a waste pile, leachate from the landfill or mine waste storage facility is contained within the facility and prevented from seeping through the ground to the water table and contaminating an aquifer. When a waste facility is closed, liners or other types of impervious caps and covers are built on top of the waste pile to keep rain and snowmelt from infiltrating into these waste piles to minimize leachate development.

Regardless of whether synthetic liners are used at a municipal solid waste landfill, an authorized hazardous waste disposal site, or used at a mine for a heap leach pad, a tailings basin, or a waste rock storage facility, the construction methods are the same. The liner is placed on top of the ground, which has been carefully prepared to remove stones, sticks or other protuberances. The waste is then placed on top of the liner.

Many facilities use a liner system consisting of more than one layer of impermeable materials, such as clays, underneath the synthetic liner to provide an extra measure of protection. The underlying low-permeability clay liner or a secondary synthetic liner beneath the first liner provides additional protection in the event of a defect or tear in the upper synthetic liner. A network of perforated pipes or other type of drainage materials is typically placed on top of the liner to collect leachate.[73] As discussed below, at a heap leach facility the gold- and silver-bearing leachate is collected and processed to recover these valuable metals.

Liners are also used to construct water storage ponds and reservoirs and to contain liquid wastewaters produced at manufacturing, industrial, or mining facilities. Mines must also use lined ponds to manage stormwater that has come into contact with mine wastes and treat this mine-impacted water before it can be discharged into surface water or groundwater. Ponds that store fresh water are typically single-lined ponds. Ponds used to contain chemically-impacted water, like mine process water, water that contacts mine wastes, or industrial wastewaters, are typically double lined. Double liner systems for ponds are built like a sandwich with two synthetic liners that are separated by a leak detection system layer.

At industrial sites, pond operators monitor the pond leak detection system on a regular basis—often daily—to verify that the pond liners are functioning as designed. If liquid is observed in the leak detection monitoring ports at a pond, the operator will immediately know that the upper pond liner may be leaking. The state permits for the pond stipulate that the operator must take all appropriate actions to find and repair the leak. In the event of a leak in the upper pond liner, the lower liner contains the leak and protects the environment. Thus, double-lined ponds provide an extra safeguard—two liners to isolate liquid wastes and prevent contamination of groundwater supplies. Additionally, most industrial facilities have more than one pond to allow the liner in a pond with an identified or suspected leak to be drained and repaired.

Whether used for a reservoir, a pond, a landfill, or a mine waste disposal facility, all liners are constructed in the field using site-specific engineering specifications for how the liner must be built to fit the exact site conditions. Site-specific liner installation and testing procedures must comply with detailed specifications in the project plans, engineering documents, and industry-standardized liner installation protocols.[74] Regulators must approve the liner construction specifications before the liner can be installed. Liners are installed by trained and specially qualified contractors who must follow specific quality assurance and quality control (QA/QC) measures to ensure the liner has been properly constructed. These measures include tests of the liner seams to ensure there are no gaps or defects and that the welded seams are water tight.

Before the operator is authorized to place waste materials on the liner or fill the ponds with liquids, a registered engineer must submit a QA/QC report to state regulators that documents the liner has been properly constructed and tested to meet the liner design specifications in the project permits. Regulators may also inspect the liner and perform field checks prior to authorizing the operator to start using the lined facility.

Section V. B.1.a: Heap Leach Gold Projects Prove the Effectiveness of Liners

There is no better way to demonstrate that liners effectively protect the environment at mine sites than to examine how liners are used at gold and silver mines that use heap leach processing technology to recover precious metals. Heap leach gold and silver mineral processing operations are common in Nevada and throughout the world where they produce gold and silver in an environmentally responsible manner.[75] Heap leaching involves placing crushed or run-of-mine gold and silver ores on a lined, impermeable heap leach pad, irrigating the stacked ore with a dilute sodium cyanide solution which dissolves the precious metals. The gold- and silver-bearing solution is collected in double-lined solution containment ponds, and these metals are recovered from the solution to produce bars containing a mixture of gold and silver (doré).[76]

These solutions are the mine's payday because they contain dissolved gold and silver. The mine's profitability depends on being able to collect and send the gold and silver heap leach solutions to the processing plant. Consequently, heap leach operators are completely reliant on the ability of liner systems to contain these precious metals solutions and prevent them from being lost due to seepage into the underlying soils.

State and federal environmental protection regulations mandate that heap leach solutions be contained. These regulations require heap leach facilities and other types of mineral processing facilities to be operated as zero-discharge facilities. Further, as noted above, the economics of a heap leach project demand containment of the heap leach solutions.

The regulations for heap leach facilities establish detailed monitoring requirements to verify the pad and pond solution containment systems are complying with the zero-discharge performance standard.[77] Both the pads and ponds are typically designed with leak detection monitoring ports that must be checked frequently on a schedule specified in the project's permits. For example, operators of most Nevada heap leach facilities must check the pad and pond leak detection monitoring ports weekly. As discussed in Section V.B.5, if the monitoring data suggest that a liner may not be functioning properly, the operator must investigate whether there is a potential leak and take appropriate steps to repair any identified leaks.

Section V. B.2: Covers and Caps

When a mine waste storage facility or a landfill needs to be closed, Minnesota regulations require such facilities to be closed in a manner that provides long-term environmental protection. It is common for industrial, mine, municipal, and hazardous waste storage facilities throughout the country to be capped or covered with an engineered system of impermeable materials that reduce or eliminate meteoric waters (i.e., rainfall and snowmelt) from infiltrating into the stored wastes and generating a contaminated leachate.[78] These caps and covers, which encapsulate the waste materials, are constructed with slopes to promote drainage off of, and away from, the landfill or waste pile.

Like the base liner, an impermeable cover or cap must be designed to fit the conditions at each waste storage facility based on the types of wastes stored at the facility, the site precipitation levels, and other factors. A cover or cap is typically a multi-layered system built with geomembranes, compacted impermeable soils or clay, and drainage layers that are covered with a top layer of soil or fill that is either revegetated or armored with rock. If vegetation is established, evapotranspiration from the plants adds another measure of protection by reducing infiltration of meteoric waters. If a soil cover is revegetated, the thickness of the soil layer and the types of plants used are carefully selected to ensure that the plant roots do not penetrate the underlying engineered cover system. Soil covers that are not revegetated are typically armored with rock to minimize erosion and promote drainage. The financial assurance for Minnesota mines includes the cost to monitor and maintain caps and covers following mine closure.[79]

Section V. B.3: Water Treatment

We all rely on water treatment technologies to provide us with clean and safe drinking water. Municipal water treatment facilities use a variety of water treatment systems to produce water that meets stringent state and federal drinking water standards. Publicly owned treatment works (POTWs) also use water treatment systems.

Many industrial sites, including mines, use water treatment technologies to treat wastewater to comply with water quality protection standards so that it can be discharged into area streams or into the groundwater. The Minnesota Pollution Control Agency (MPCA) regulates discharges of treated water through the National Pollutant Discharge Elimination System (NPDES), a federal permit program delegated to the state, for surface water discharges and the Minnesota State Disposal System (SDS) permit program for discharges to groundwater. (Minnesota Statutes Chapter 115)

During operation, most mines use some type of active water treatment system that uses energy and chemicals to treat contaminated water to reach the water quality limits specified in the project's NPDES and/or SDS permits. Examples of active water treatment systems include chemical precipitation, ion exchange, membrane filtration, and reverse osmosis. The specific type of active water treatment system selected will depend on the concentration of the chemical constituents that need to be removed from the water, how much water must be treated, and the water quality and beneficial uses of the receiving water into which the treated water will be discharged. At some sites, it may be necessary to use more than one type of water treatment system to treat solutions with different chemical compositions.

The NPDES permit will dictate specific effluent discharge limits that regulate the type, quantity, and concentration of pollutants that can be discharged safely. This permit also stipulates the kind and frequency of monitoring that is required to ensure the facility is not exceeding these limits, which are designed to protect beneficial uses of the receiving water.[80] At many sites, the treated effluent must meet stringent water quality discharge limits to protect fish and other aquatic life. Minnesota mines must treat mine wastewaters to comply with the sulfate standard in Minnesota's wild rice protection regulations.

Many industrial sites, including mines where acid generation occurs, produce low-pH (acidic) waters that must be treated. Water treatment systems at these sites typically use lime, limestone, or caustic soda to neutralize the acid and raise the solution pH. Elevating the pH causes the dissolved metals to precipitate out of solution and accumulate as a sludge on the bottom of lined water treatment ponds. The metals-bearing water treatment sludge is periodically removed from the pond. The chemistry of this sludge will determine whether it can be disposed of in a licensed solid waste disposal facility or if it must be managed as a regulated, hazardous waste and disposed in a hazardous waste disposal facility. Following pH adjustment, additional active water treatment steps must be used at some sites to reach the water quality discharge standards specified in the project's NPDES and/or SDS permits.

Passive water treatment systems use natural, physical, and biological processes that are frequently used to treat municipal wastewater and urban runoff. Examples of passive water treatment include bacteria-controlled metal precipitation, uptake by plants in wetlands or other settings, and filtration through soil and sediments.[81] Passive treatment may be suitable at some mines, especially following mine closure.

In order to issue NPDES and SDS permits to a Minnesota facility, MPCA must determine that the project will not violate any applicable water quality standards.

These standards include numeric and narrative water quality criteria, anti-degradation standards for surface water, non-degradation standards for groundwater, and beneficial use designations. The NPDES and SDS permits include extensive monitoring and reporting requirements to ensure that the operator is complying with all applicable water quality standards. It is important to note that these permit requirements are not unique to mining projects; they apply to all Minnesota facilities that must treat and discharge water.

Mine operators must provide financial assurance that covers the cost to operate and maintain the mine site's water treatment systems for as long as they are necessary. The cost calculations used to determine the required amount of financial assurance reflect the cost that state or federal regulators would incur to operate and maintain the water treatment facilities.

At mine sites that require water treatment in perpetuity, the financial assurance instrument must include a long-term funding mechanism to provide regulators with bankruptcy-proof financial assurance that guarantees they will have sufficient financial resources to operate and maintain the water treatment facility in the event the operator has abandoned the site or is no longer operating the site due to bankruptcy.

Section V. B.4: Air Emissions Controls

Like all industrial facilities, mines must control and limit emissions to the air from specific pieces of equipment that are ultimately vented to the air via stacks. They must also control fugitive emissions (i.e., dust) that blow off of unpaved road and stockpile projects.

Air emission control equipment for stack emissions includes fabric filters, scrubbers, water sprays, and baghouses. Facility operators must prepare a dust control plan that outlines dust control measures. Operators typically use water and chemical dust suppressants and vehicle speed limits to minimize dust generated from project roads. Other sources of fugitive dust must be covered, kept in a moist condition, armored with rock, or revegetated to control dust.

The MPCA regulates both stack and fugitive emissions and issues air quality permits that include specific emission limits for each piece of equipment that has a potential to emit air pollutants. In order to secure an air quality permit, a facility must demonstrate that all emission sources will comply with state and federal ambient air quality standards for two sizes of particulate matter (10 microns and 2.5 microns), sulfur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, volatile organic compounds, and hazardous air pollutants.

Facilities must demonstrate compliance with the emission limits established in their project permits. Onsite air monitoring equipment and stack tests are used to measure compliance with the permit. This monitoring equipment collects real-time information that tracks throughput, hours of operation, and other operating parameters specified in the air quality permit. Operators must submit monitoring reports to MPCA to verify the facility is operating in compliance with the operating parameters and emission limits specified in the permit. Additionally, MPCA officials conduct regular site inspections to ensure that a facility is operating in compliance with its permit.

Section V. B.5: Environmental Monitoring Systems

As discussed in Section VII, Minnesota's regulations include detailed environmental monitoring requirements. The environmental monitoring systems mandated in the regulations play an important role in safeguarding the environment at mines and other industrial facilities for two reasons. First, they provide real-time verification that the facility is complying with its permits. Secondly, these systems act as early-warning systems to alert the operator and regulators that there may be an environmental problem that needs to be investigated and addressed. If there is a problem, the environmental monitoring system will detect it early.

In the event the monitoring system detects a potential problem, state regulators will require the operator to investigate the problem and develop and implement an appropriate corrective action plan to fix it. This early detection-response mechanism minimizes potential risks to the environment and human health and safety by limiting the amount of time that a problem goes undetected and by requiring timely remediation.

Mining project permits include numerous monitoring requirements designed to verify that the mine is complying with all of the water quality, air quality, and other environmental standards and discharge limits in the project's permits. The permits stipulate the locations where samples must be collected, the sample collection protocols, the sample collection frequency, and the types of analytical tests that must be performed by an independent, third-party laboratory on the collected samples.

The project monitoring requirements cover all phases of mining, starting with construction of the mine and continuing for many years after the mine has been closed. Examples of the types of monitoring data that mine operators must collect include the following:

Surface Water Quality:

- Water flow measurements and sample collection from surface water monitoring stations at downgradient and upgradient (downstream and upstream) locations stipulated in the project permits to verify compliance with permitted water quality limits.

- Water quality samples from the wastewater treatment facilities to determine the systems are working properly in compliance with permitted effluent limits.

Groundwater Quality:

- Water quality samples from groundwater monitoring wells located near the project boundary to determine compliance with the permit standards.

- Water quality samples from indicator wells located between the project facilities and the project boundary to provide an early warning system for changes in groundwater quality and possible problems.

- Water table elevation measurements from groundwater monitoring wells.

Water Appropriations:

- Well pumping, water table elevation and drawdown data, and water use quantities to verify compliance with the project's water appropriation permits.

Wild Rice Harvesting Areas:

- Water quality sampling and vegetation monitoring.

Wetlands:

- Water quantity measurements, water quality sampling, and vegetation monitoring to evaluate impacts to wetlands and the effectiveness of wetlands protection and mitigation measures.

Aquatic Biology and Fisheries:

- Water quality data.

- Fish tissue analyses to document any adverse impacts to aquatic life.

- Species population information.

Avian and Terrestrial Wildlife:

- Monitoring of plant and wildlife habitat conditions including habitats for protected or sensitive wildlife species.

Air Quality:

- Stationary source and fugitive dust emissions monitoring.

- Greenhouse gas emissions monitoring.

Tailings Dam:

- Geotechnical data during construction and operation to verify stability and compliance with the dam design and operating specifications in the Dam Safety Permit.

Noise:

- Background (ambient) and operational noise levels.

The financial assurance for mining projects includes the costs for regulators to operate the environmental monitoring system in the event the operator goes bankrupt.

Section VI: Environmentally Safe Mining of Sulfide Mineral Deposits: The Flambeau Mine and the Eagle Mine

Two modern mines in nearby states, the Flambeau Copper-Gold-Silver Mine in Wisconsin and the Eagle Nickel-Copper Mine in Michigan, show how today's mines are safe for the environment and good for local communities. The deposits at both mines contain sulfide minerals that are acid generating. The modern environmental protection measures including liners, covers, and water treatment systems discussed in Section V were used at the Flambeau Mine and are being used at the Eagle Mine to effectively manage acid mine drainage and protect the environment.

The development and reclamation of the Flambeau Mine provides a compelling example of an acid-generating mine developed adjacent to a river that safeguarded the environment and maintained water quality in the river and the groundwater. Today, the closed and restored mine site is an interpretive nature center, a recreation area, and a business park.

The Eagle Mine, which started operations in 2014, is another excellent example of how modern environmental protection technology, state-of-the-art water treatment facilities, and a strong corporate commitment to environmental stewardship are successfully controlling acid mine drainage and protecting the environment at the nation's only primary nickel mine. The Eagle Mine also has an exemplary community engagement program to keep area residents well informed about the mine and a unique Community Environmental Monitoring Program that pays for independent site environmental monitoring of its operations.

This section presents information about the effective environmental control measures used to safeguard the environment at the Flambeau and Eagle Mines and the significant economic and community benefits associated with these mines.

Section VI. A: The Flambeau Mine

The Flambeau Mine is located just south of the town of Ladysmith in Rusk County, Wisconsin, in the northwestern part of the state. On its website for the Flambeau Mine, Rio Tinto describes this surface mine as "Promises Made, Promises Kept."[82]

In developing this mine, Rio Tinto and its subsidiaries, Kennecott Minerals Company and Flambeau Mining Company, made good on their promises to develop and reclaim the Flambeau Mine in an environmentally responsible way; to create jobs and improve the local economy; and to generate tax revenues that the community could use to stimulate future economic growth. The companies also fulfilled their commitment to provide post-mining sustainable development by working with the community to re-purpose a portion of the mine site into an industrial park that continues to employ people and benefit the area's economy.

The Flambeau Mine was developed in an unusually high-grade mineral deposit, which made it feasible to mine the deposit in just four years and ship the mined ore to Canada for processing.[83] From 1993 to 1997, the mine produced 181,000 tons of copper, 334,000 ounces of gold, and 3.3 million ounces of silver. At its peak, the mine provided nearly 100 family-supporting jobs and paid millions of dollars to area businesses that provided goods and services to the mine. During its mine life, the Flambeau Mine paid more than $27.7 million in taxes into a state fund that was returned to the community to promote long-term business development that will benefit the area for years. Today, some of the mine facilities have been transformed into an industrial site called Copper Park.

Reclamation took about two years to complete and cost $20 million. As shown in the video on the Flambeau Mine website, restoration of the mine site has produced a 150-acre site where over 250 native species of wildflowers, prairie grasses, and trees flourish. Today, the community enjoys four miles of nature trails and five miles of equestrian paths that wind their way through a beautifully restored open space. Fishing enthusiasts use the shoreline of the scenic Flambeau River, which the Flambeau Mining Company pledged to maintain in its natural condition forever.

According to the Wisconsin Department of Natural Resources' (WDNR) Flambeau Mine website, the Flambeau mining operation covered 181 acres of land located near the Flambeau River.[84] Prior to mining, the site was an agricultural and forested area that included several intermittent streams flowing to the Flambeau River and about eight acres of wetlands. At the end of mining, the surface mine covered 35 acres and was 220 feet deep.

The reclamation plan for the mine called for restoring the land so it could be used for light recreation and provide wildlife habitat. This restoration effort involved planting more than 7,000 wild strawberry plugs, wild geranium, columbine and woodland sunflowers in various upland areas. Woodland areas were planted with more than 2,500 tree and shrub seedlings and about 300 larger trees were transplanted from an on-site nursery where trees removed from the site during project construction were nurtured so they could be replanted during reclamation. Flambeau Mining Company mitigated the loss of the wetlands during mining by constructing an 8.5-acre wetland area using wetland soils that were salvaged and stockpiled during site construction. The restored wetlands were planted with more than 10,000 plants and bare rootstock of typical wetland species. Drainageways and biofilters were also planted with more than 17,000 live stakes of alder, willow and dogwood species.[85]

Flambeau Mining Company's promise to protect the environment started at the design stage and its commitment to use state-of-the-art technology to meet or exceed Wisconsin's stringent regulatory requirements to protect the Flambeau River, the area's groundwater system, wetlands, wildlife, and air quality. Because the mine was developed in a sulfide orebody that was acid generating, management of acidic mine drainage and wastewater was a key focus of the environmental review for the project. Some of the project waste rocks contained more than one percent sulfur. These high-sulfur materials were acid generating and had to be carefully managed to control acid rock drainage during and after mining. During operations, this high-sulfur material was temporarily stored on a 27-acre stockpile area that was lined with a plastic membrane and built with a leachate collection system to prevent migration of acidic and contaminated wastewater from entering the groundwater system.[86]

All water that came into contact with high sulfur materials, including runoff from stockpiles and from other mine facilities and groundwater that flowed into the pit, was collected and treated in a wastewater treatment plant. The water treatment plant used lime neutralization, sulfide precipitation, and filtration technologies to meet the water quality discharge limits specified in the WDNR permits that authorized release of the treated wastewaters into the Flambeau River. During operations, the water treatment facilities discharged about 300 gallons per minute of clean water. Treating all water that was touched by mining ensured that only clean water was returned to the river.

According to WDNR, the reclamation plan called for completely backfilling the pit with the waste rocks that had been mined from the pit and temporarily stored on the surface, and then allowing groundwater to refill the pit. After mining was completed, the acid-generating waste rock stockpile was sampled and tested to determine how much crushed limestone needed to be added to neutralize the known and predicted acid generation. Based on the testing results, the acid generating high-sulfur waste rock was blended with the specified quantity of crushed limestone.

Once the crushed limestone was added, the material was hauled to the pit, placed on the bottom of the pit, and compacted. This mixture of high-sulfur waste rock and limestone was then covered with layers of materials that were not acid generating including low-sulfur waste rock, weathered bedrock, sandstone, and glacial sediments. After the pit was completely backfilled, it was allowed to refill with groundwater to submerge the high-sulfur waste rock-limestone mixture. Oxidation of this material in the reflooded pit is very limited, which effectively minimizes the potential for future acid generation. The backfilled pit was then graded to promote drainage away from the pit. The final reclamation steps for the mine site included placing salvaged topsoil on the reclaimed areas, revegetating these areas, and completing the wetland restoration efforts.[87]

As described on WDNR's website:

> Resaturation of the waste rock by groundwater infiltration is the primary mechanism by which oxidation of the remaining sulfides will be controlled and the long-term environmental stability of the backfilled materials will be achieved. This is important to reduce or eliminate potential for generation of acid drainage, which is a significant concern at many mining sites worldwide… The DNR will continue monitoring conditions at the reclaimed Flambeau Mine for many years. Monitoring results will be compared to predictive analyses and modeling, and if substantial differences are observed to the extent that they may not comply with the permit conditions and applicable regulations, the company would be required to take action to prevent adverse impacts… Under current law, FMC is responsible for the maintenance of the site in perpetuity.[88]

The Flambeau Mine is a stellar example of how a mining project can be leveraged to provide economic benefits long after mining has been completed. In 1998, after the completion of mining, the Ladysmith Community Industrial Development Corporation asked Flambeau Mining Company to keep the mine's administration building, the wastewater treatment plant, the ore loading area, and the rail spur in place. Rather than removing these facilities during reclamation, the community wanted to repurpose them for future use by other businesses. In response to this request, Flambeau Mining Company asked WDNR to modify the approved Reclamation Plan to authorize leaving these facilities for redevelopment by others. Today, there is a 32-acre industrial park called Copper Park that houses WDNR's Ladysmith Service Center and Xcel Energy's powerline maintenance shop.[89]

During operations, over 100,000 people visited the Flambeau Mining Company's information center and mine viewing area.[90] The Flambeau Mine Community Advisory Group prepared The Copper Park Vision Statement, which discusses the community's long-range plans to ensure the restored mine site will remain available for outdoor education, recreation, nature tourism, and other suitable public use as opposed to being sold off for, perhaps, less desirable uses; and to provide the Ladysmith and Rusk County area with a tourist attraction that has the potential to increase the tourism base in the area.[91] Participants in this advisory group included the City of Ladysmith, Flambeau Mining Company, Flambeau Riders, Ladysmith Area Trails Association, Ladysmith Community Industrial Development Corporation, Rusk County, Town of Grant, WDNR, and others.

In 2007, WDNR issued a Certificate of Completion after determining the 149-acre portion of the Flambeau Mine site that contains the backfilled pit was in compliance with the standards specified in the reclamation plan and mining permit. Based on this decision, the mine pit is now in a 40-year long-term care period. Following the 40-year long-term care period, the Flambeau Mining Company will remain responsible for maintaining the site in perpetuity.[92]

The Certificate of Completion does not include the 32-acre Industrial Outlot where the mine facilities that are now within the industrial park are located. The WDNR's website describes ongoing monitoring and inspections of the reclaimed Flambeau Mine and the industrial park where elevated copper levels were detected in an area where ore had been accidentally spilled during loading onto rail cars. Flambeau Mining Company obtained a permit to modify and enhance the stormwater management measures in this area. The Company paved this area with asphalt for use as a parking lot and implemented the remedial actions specified in the contingency plan in the mining permit to correct the problem. Because pre-mining water quality data was not collected for this small, intermittent stream, it is unclear whether the detected copper levels reflect natural conditions due to the proximity of the stream to the Flambeau mineral deposit or whether it is due to the mining operation. The Flambeau Mining Company and WDNR are continuing to monitor the site to determine the effectiveness of the remedial actions and the stormwater management controls.[93]

Section VI. B: The Eagle Mine

Lundin Mining Corporation's Eagle Mine in Michigan's Upper Peninsula in western Marquette County produces high-grade nickel and copper from an underground mine. Lundin Mining acquired the mine in 2013 from Rio Tinto and started producing nickel and copper in 2014. According to the Eagle Mine's website, the mine will produce nickel and copper for eight years, from 2014 to 2022, during which time the mine is expected to produce 365 million pounds of nickel, 265 million pounds of copper, and small amounts of cobalt, platinum, palladium, silver, and gold.[94] The Eagle deposit is comprised of two ore types: massive sulfide ore and semi-massive sulfide ore. The Eagle Mine is the nation's only primary nickel mine.[95]

As described on the Lundin Mining website, and in an online booklet, the Eagle Mine is Michigan's newest mine and the first mine to be permitted and developed under Michigan's Part 632 Nonferrous Mineral Mining Law.[96] Because this is an underground mine, the surface impact is limited and covers about 150 acres, which Lundin Mining compares to "a small 18-hole golf course." The underground mine is accessed via a mile-long decline tunnel and uses long-hole stoping and backfilling underground mining techniques. Stopes are horizontal, open spaces in an underground mine created as the ore is removed. Every other stope is mined and backfilled with a mix of rock, aggregate, and cement to maintain the stability of the underground workings before mining the surrounding stopes. The mill processes approximately 2,000 metric tonnes of ore per day.

The mined ore is transported from the underground workings to the surface using 45-ton loaders and placed in the enclosed Coarse Ore Storage Area. Front-end loaders then fill highway-sized haul trucks which are covered and pass through a truck wash before traveling about 66 miles to the Humboldt Mill where the ore is processed. Ore hauling follows the project's Transport Plan which adheres to all Michigan Department of Transportation guidelines, dictating the length and weight of the haul trucks. The Eagle Mine has a $44 million agreement with the Marquette County Road Commission to upgrade the roads used for hauling the ore. Each day, approximately 44 round trips are made between the mine and the Humboldt Mill. Lundin Mining constantly monitors ore truck speeds, locations, and braking efforts to ensure the ore is transported to the mill safely, courteously, and in compliance with the Transport Plan requirements.

The Humboldt Mill is a historic brownfield site built by Cleveland Cliffs Iron Company in the 1950s for milling of iron ore from their adjacent open pit mine. Cleveland Cliffs ceased operations in the early 1980s and the pit began to naturally fill with water. In 2008, Rio Tinto, the former owner of the Eagle Mine, purchased the Humboldt Mill. Over $275 million was invested to refurbish the historic mill so it could be used to process the nickel and copper ores.

The Humboldt Mill uses conventional crushing, grinding, flotation, and pressing to produce separate nickel and copper concentrates. Front-end loaders are used to place the concentrates into rail cars that are covered before traveling off-site to the mine's customers for further refinement.

The finely-ground rock material left over once the nickel and copper have been extracted is referred to as tailings. The tailings are sent to the Humboldt Tailings Disposal Facility (HTDF) where they are stored under water. Water from the HTDF is decanted off the top and pumped back to the mill as process water. Excess water is treated at the on-site water treatment plant before being recycled to the environment.

Because the Eagle Mine is developed in a sulfide ore body, reaction of water and oxygen with the sulfide minerals in the ore, the development (waste) rocks, and the tailings has the potential to generate acid and release metal contaminants to the area groundwater and surface water if these materials are not properly managed. In order to control acid generation and prevent adverse impacts to the environment, the Eagle Mine uses special handling for each of these materials.

The ore is stored above ground in the enclosed Coarse Ore Storage Area where it is not exposed to wind or precipitation that could react with the sulfide minerals in the ore and form acidic and metals-bearing drainage. The development rock, which is unmineralized waste rock that must be mined to reach the ore body, is stored temporarily on a multi-lined storage area that is designed to prevent any water that comes into contact with the development rock from entering groundwater or nearby streams or wetlands.

Limestone is added in a sufficient quantity to the development rock storage area to neutralize any acid. Ultimately, the mixture of development rock and limestone is used to make cement rock fill to backfill the mined-out stopes. Stormwater that contacts the development rock storage area is collected and treated in a sophisticated water treatment plant to better than drinking water quality before being discharged to the environment.[97]

The tailings are stored underwater in the flooded open pit mine that was previously mined for iron ore. The subaqueous (i.e., underwater) disposal of acid-generating tailings is the mining industry's best practice for long-term management of acid generating tailings. The anoxic (oxygen poor) underwater environment minimizes oxidation of the sulfide minerals and acid generation.

A cut-off wall was installed on the north end of the pit where there used to be soils that allowed water to flow naturally from the iron ore pit into a nearby wetland. The engineered cut-off wall prevents the release of water from the HTDF through the alluvial soils and eliminates any discharge of untreated water from the pit to the wetlands or to the groundwater system.

Any water that comes into contact with mined material is captured and treated in the water treatment plant prior to being released into the environment. The water treatment facility at the Eagle Mine is a state-of-the-art, multi-phase water treatment plant that produces clean water that meets the stringent water quality parameters specified in the project permits.[98] The Eagle Mine discharges treated process water, treated process wastewater, treated laboratory wastewater, and treated water treatment backwash via a pipeline to the wetland contiguous to the Middle Branch Escanaba River.[99] This river is protected for agricultural uses, navigation, industrial water supply, public water supply in areas with designated public water supply intakes, warm-water fish, other indigenous aquatic life and wildlife, partial body contact recreation, total body contact recreation (May through October), and fish consumption.[100]

The Michigan Department of Environmental Quality (MDEQ) permits for the Eagle Mine establish detailed monitoring requirements for groundwater levels and quality, surface water quality, air quality, the purity of the water produced by the water treatment plant, wetlands, aquatic life, and other environmental resources. In response to the MDEQ monitoring requirements, Lundin Mining submits two separate annual reports for the mine area and the Humboldt Mill. Both of these reports are available on the Eagle Mine website.[101] The reports include monitoring data for surface water and groundwater quality, regional hydrologic monitoring, biological monitoring, and geochemical monitoring to evaluate water quality in the underground mine and the acid generation characteristics of the development rock in the temporary storage area.

In addition to Lundin Mining's in-house monitoring program, the Eagle Mine established a Community Environmental Monitoring Program that is conducted by two independent, third-party groups: the Superior Water Partnership (SWP) and the Community Foundation of Marquette County. The mine provides $300,000 annually to fund this unique community monitoring program. SWP collects monitoring data for air quality, groundwater and surface water quality, plant life, and more at the mine, the mill, and along the transportation corridor. SWP's monitoring results are summarized in a quarterly report card that is available online.[102]

As part of its commitment to keep the community well informed, the Eagle Mine offers summer tours of the mine and mill and conducts frequent community forums to provide regular updates about the status of the mining operation.

The Eagle Mine has developed a Responsible Mining Framework that defines the way Lundin Mining manages economic, social, and environmental challenges.[105] The Guiding Principles listed below are the foundation for the Responsible Mining Framework:

- "We are committed to achieving a safe, productive and healthy work environment wherever we operate. The health and safety of our employees and contractors is first and foremost in everything that we do.

- We engage in open and inclusive dialogue with local communities and our stakeholders in a spirit of transparency, cooperation and good faith. We recognize every community as unique and respect the cultural and historical perspectives and rights of those affected by our operations. We work to improve the long term well-being of those affected by our activities.

- We foster the provision of lasting benefits to local communities, aligned with their priorities.

- We are vigilant and collaborative in our protection of the environment and in seeking ways to minimize our environmental impacts.

- We conduct our activities in accordance with recognized standards for respect of Indigenous & human rights.

- We maintain high standards of ethics, corporate governance and honesty in all aspects of our business."

The Framework includes five key elements, one of which is Environmental Stewardship, which establishes a policy "to avoid, minimize, or mitigate environmental impacts of operations and ensure appropriate management and monitoring systems are in place at all times."[106]

The Eagle Mine has provided the MDEQ with financial assurance to guarantee there are sufficient funds to pay for the clean-up, closure, and post-closure of mining operations in the event state regulators need to perform this work. Lundin Mining Corporation has furnished MDEQ with a surety bond that names the State as the beneficiary. The current required financial assurance amount is roughly $25 million for the mine and $25 million for the mill.[107]

Section VII: Minnesota's Mining Regulations: A World-Class Regulatory Program for World-Class Mineral Deposits

As discussed in Section II, Minnesota's copper-nickel ore bodies are the largest undeveloped deposits in the world. Because Minnesota has some of the most stringent environmental protection regulations for mining in the country, development of these important mineral resources will produce mines that set an exemplary standard for environmentally responsible mining.

Minnesota's regulations include many provisions that are similar to counterpart regulations in Wisconsin and Michigan that have successfully protected the environment at the Flambeau and Eagle Mines, as described in Section VI. Additionally, Minnesota's regulators are recognized as world-class experts in Acid Mine Drainage (AMD), a problem that can develop at some mines with sulfide minerals if the proper designs, environmental and operating controls, and reclamation measures are not in place.

As described earlier, there are currently two proposed copper-nickel-precious metals mines in northeastern Minnesota: PolyMet Mining Corporation's NorthMet Mining Project, and Twin Metals Minnesota LLC's Twin Metals Minnesota Project (TMM Project). The NorthMet Project is in the final stage of the State's permitting process. Minnesota regulators have issued draft permits for the project and are considering the thousands of public comments filed in response to the draft permits. Regulators are also evaluating whether an administrative law judge should review one or more of the permit applications in a contested case hearing proceeding. TMM's website states the company anticipates initiating the permitting process for the TMM Project by submitting a project proposal to regulators in about 18 months.[108]

Despite the fact that both projects are located in the Mesabi Iron Range, which is famous for its giant, world-class taconite iron ore mines, there is nonetheless a heated and highly publicized debate about whether these copper-nickel-precious deposits should be developed due to environmental concerns. Unfortunately, this debate is premised on the falsehood that mining and a clean environment are mutually incompatible, with mining opponents demanding that Minnesotans choose between mine development and protecting the environment. Thanks to Minnesota's regulations and regulators, Minnesotans do not have to make this artificial choice between the much-needed jobs and economic benefits that mining will generate and the equally important need to protect the environment at Minnesota copper-nickel mines. Minnesota can have both.

In order to secure permits to build and operate a Minnesota mine, companies bear a significant burden of proof—they must demonstrate that the proposed project will comply with all aspects of Minnesota's environmental protection requirements throughout the life of the mine and afterwards. Minnesota mining companies must submit detailed engineering designs and technical studies with their permit applications to show how their use of environmental protection measures will successfully meet all of Minnesota's strict regulatory requirements to protect surface water and groundwater resources, air quality, wetlands, wildlife, cultural resources, public health and safety, and socioeconomic values at their proposed operations. Minnesota regulators must deny the project's permit applications if their technical review of the permit applications concludes the operation may not meet all applicable regulatory requirements and environmental protection standards. As described below, Minnesota's comprehensive environmental protection regulations for mining and Minnesota regulators' state-of-the art acid rock drainage expertise work together to ensure that development of Minnesota's copper-nickel deposits will be safe for the environment.

Section VII. A: Overview of Minnesota's Stringent Environmental Regulatory and Permitting Programs for Mining

Recognizing the exceptional promise that responsible nonferrous mining brings to the state, Minnesota legislators have established the following policy for mineral development:

> It is the policy of the state to provide for the diversification of the state's mineral economy through long-term support of mineral exploration, evaluation, environmental research, development, production, and commercialization.[109] (Minnesota Statutes Section 93.001)

In the Minnesota Mineland Reclamation Act, (MMRA), Minnesota Statutes Sections 93.44 to 93.5, state lawmakers established the requirement for reclamation and environmental protection at Minnesota mines:

> In recognition of the effects of mining upon the environment, it is hereby declared to be the policy of this state to provide for the reclamation of certain lands hereafter subjected to the mining of metallic minerals or peat where such reclamation is necessary, both in the interest of the general welfare and as an exercise of the police power of the state, to control possible adverse environmental effects of mining, to preserve the natural resources, and to encourage the planning of future land utilization, while at the same time promoting the orderly development of mining, the encouragement of good mining practices, and the recognition and identification of the beneficial aspects of mining. (Minnesota Statutes Section 93.44, Declaration of Policy)

The MMRA is the statutory authority for the Minnesota Chapter 6132 Nonferrous Metallic Mineral Mining regulations ("Chapter 6132 Regulations"), the strict and comprehensive regulations that govern mineral exploration, development, operation, and reclamation. Compliance with the Chapter 6132 regulations ensures that Minnesota mines are safe for the environment during all phases of mining and following mine closure and reclamation.

Two state agencies, the Minnesota Department of Natural Resources (MDNR)–Division of Lands and Minerals and the Minnesota Pollution Control Agency (MPCA) have principal environmental regulatory jurisdiction over Minnesota mining projects including copper-nickel mining projects. The MDNR's regulatory program is specific to mining whereas MPCA's program applies broadly to many types of industrial projects. Minnesota's mining regulations require proposed mining operations to be planned, operated, reclaimed and closed to protect the environment, prevent impacts from acid mine generation, and provide financial assurance.

As outlined in Part 6132.1100, mining companies seeking to develop a mine in Minnesota must first meet with MDNR to discuss the proposed project and then submit a Permit to Mine, which requires detailed information including, but not limited to, the following:

- The proposed mine plan and designs for the mineral processing and mine waste storage facilities;

- Mine closure and reclamation plans and a reclamation cost estimate;
- An environmental review supported with detailed and numerous environmental baseline studies documenting the environmental conditions of the proposed mine site and surrounding areas;
- Results of the mine waste characterization studies to document the long-term geochemical behavior of project mine wastes and whether they are likely to be acid generating;
- Descriptions of all project ancillary facilities such as roads, powerlines, pipelines, fencing, and water supply and storage;
- An insurance certificate documenting that the company has a public liability insurance policy in place for the proposed mine that provides personal injury and property damage protection; and
- The $50,000 permit application fee.

Mining companies spend years and many millions of dollars gathering all of the necessary environmental baseline data, performing the waste characterization tests, and developing the engineering and technical studies that are needed for the Permit to Mine.

Section VII. A.1: The Permit to Mine and Environmental Impact Statement Processes

The Chapter 6132 Regulations establish the requirement for a mine proponent to obtain a Permit to Mine from MDNR before mining can occur. In order to review a Permit to Mine, MDNR must prepare an Environmental Impact Statement (EIS) to comply with the Minnesota Environmental Policy Act (MEPA).[110] Chapter 6132 and the Permit to Mine cover the entire mining lifecycle starting with exploration and each subsequent step of mine planning, development, construction, operation, reclamation, closure, and post-closure. The overarching purpose of Chapter 6132 is to:

> …control possible adverse environmental effects of nonferrous metallic mineral mining, to preserve natural resources, and to encourage planning of future land utilization, while at the same time promoting orderly development of nonferrous metallic mineral mining, encouragement of good mining practices, and recognition and identification of the beneficial aspects of nonferrous metallic mineral mining. (Part 6132.0200)

The Chapter 6132 Regulations mandate minimizing the environmental impacts associated with mining in order to achieve a balance between mine development and environmental protection and resource conservation:

> …it is the policy of the Department of Natural Resources that mining be conducted in a manner that will reduce impacts to the extent practicable, mitigate unavoidable impacts, and ensure that the mining area is left in a condition that protects natural resources and minimizes to the extent practicable the need for maintenance. This shall be accomplished…through the use of mining, mine waste management, and passive reclamation methods that maximize physical, chemical, and biological stabilization of areas disturbed by mining, as opposed to the use of ongoing active treatment technologies. The department recognizes that in some cases passive treatment alone will not entirely meet all reclamation goals. In these cases, active treatment technologies may be necessary and provisions for continued maintenance of the treatments will be required.

Because most Minnesota mining projects are likely to affect wetlands, they typically require a federal Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers (USACE).[111] The Section 404 permit process requires USACE to prepare a federal EIS pursuant to the National Environmental Policy Act (NEPA).[112] If both MDNR and a federal agency like USACE have to prepare EIS documents, the agencies will usually enter into a formal agreement to prepare one joint state/federal EIS that satisfies both MEPA and NEPA requirements. For example, MDNR, USACE, and the U.S. Forest Service jointly prepared the 2015 Final EIS for PolyMet's proposed NorthMet Project. (The U.S. Forest Service's involvement with the EIS started in 2010 in order to evaluate a then newly proposed exchange of federal and private lands in the project area.)

As dictated in MEPA and NEPA, the purpose of an EIS is to inform the public and decisionmakers about the environmental conditions at a proposed project in order to quantify the potential environmental consequences that would occur if the proposed project is built, and to develop mitigation measures that would avoid or minimize project impacts. MEPA and NEPA also require the agencies to consult with other federal and state agencies that have regulatory jurisdiction over specific project elements. For example, the U.S. Fish and Wildlife Service must be involved to determine if there are any plant or animal species on the federal list of Threatened or Endangered Species that might be impacted by a proposed project. MEPA and NEPA also require formal consultation with Native American tribes to solicit their input.

The EIS and Permit to Mine review processes work hand-in-hand to refine a project to avoid or minimize project impacts, mitigate unavoidable impacts, and enhance project benefits. As part of these environmental reviews, MDNR evaluates feasible project alternatives such as different locations or designs for specific project facilities to determine if an alternative project layout or plan could avoid or minimize impacts. As a result of this alternatives analysis and any agency requirements for mitigation measures, there may be substantial changes to the proposed project design and operating parameters that the project applicant must incorporate into a revised Permit to Mine application.

In a recent op-ed published in the *Star Tribune*, MDNR Commissioner Tom Landwehr describes the Permit to Mine review process as "iterative," stating MDNR's review "…often leads to additional analysis, design changes or permit conditions."[113] Commissioner Landwehr emphasized MDNR's review of a Permit to Mine application carefully considers public comments on the draft permit and does not have a pre-determined outcome. "Our current step involves considering the large volume of public comments received on our draft permits."

Landwehr characterizes MDNR's Permit to Mine permit review as a "neutral and rigorous" process during which the agency "determine[s] whether draft permit changes are needed or whether an administrative law judge should review some questions before we complete our decisionmaking." According to Landwehr, 40 people are currently reviewing approximately 22,000 public comments that MDNR received on the agency's Permit to Mine for the proposed NorthMet Project.[114]

The MEPA and NEPA processes are time consuming. It took 10 years for state and federal regulators to complete the EIS for PolyMet's proposed NorthMet Project. The NorthMet Project EIS process started in October 2005 when MDNR and USACE announced they would prepare a joint state-federal EIS to satisfy MEPA and NEPA environmental analysis requirements. The agencies published the Final EIS in November 2015. Two years later, MDNR published the draft Permit to Mine in December 2017. According to PolyMet, the EIS process for the NorthMet Project "is the largest and lengthiest environmental review ever conducted in Minnesota."[115]

Although a thorough and detailed review of mine permit applications is certainly warranted, it is important for all Minnesota stakeholders to acknowledge that protracted permit reviews diminish the overall value of a project. The 2015 SNL Metals & Mining study entitled, "Permitting, Economic Value and Mining in the United States" found that on average, a typical mining project loses over one-third of its economic value as a result of lengthy permitting timelines that delay mineral production.[116] A prolonged permitting process can cut the expected value of a mine in half before production begins. The diminished value of a project should be of concern to more than the company and its shareholders because it reduces and delays mining-related revenue to local and state governments and direct and indirect job creation.

Table 2 Jurisdiction of Minnesota Permits and Environmental Impact Statements Covers All Environmental Resources at Minnesota Mining Projects		
Environmental Resource	MDNR Permits and EIS	MPCA Permits
Surface Water Quality and Hydrogeology	Permit to Mine, Dam Safety Permit, EIS	NPDES*/State Disposal System Permit/ Stormwater Permit
Groundwater Hydrogeology and Modeling	Permit to Mine, EIS	NPDES/State Disposal System Permit
Water Quantity	Water Appropriation Permits, Permit to Mine, EIS	
Tailings Basin Design, Safety, and Operation	Permit to Mine, Dam Safety Permit, EIS	Air Emissions Permit
Wetlands* and Wetlands Replacement Plan	Permit to Mine, Dam Safety Permit, EIS	Section 401 Water Quality Certification
Air Quality	Permit to Mine, EIS	Air Emissions Permit
Aquatic Wildlife	Permit to Mine, EIS	NPDES Permit
Avian and Terrestrial Wildlife	Permit to Mine, EIS	
Threatened and Endangered Species (plants and animals)	Permit to Mine, EIS	
Soils and Vegetation	Permit to Mine, EIS	
Geology, Minerals, and Waste Characterization	Permit to Mine, EIS	Air Emissions Permit
Fibrous Amphibole Minerals	Permit to Mine, EIS	Air Emissions Permit
Cultural Resources	Permit to Mine, EIS	
Native American Issues and Values	Permit to Mine, EIS	
Wild Rice Beds	Permit to Mine, EIS	401 Certification
Mercury	Permit to Mine, EIS	Air Emissions Permit
Public Safety and Human Health	Permit to Mine, Dam Safety Permit, EIS	Air Emissions Permit
Solid Waste Management	Permit to Mine, EIS	Solid Waste, Waste Tire and Storage Tank Permits
Hazardous Materials and Hazardous Waste	Permit to Mine, EIS	MPCA Hazardous Waste Generator License
Land Status and Ownership	Permit to Mine, EIS	
Transportation and Utility Corridors	Permit to Mine, EIS	
Noise	Permit to Mine, EIS	
Visual Resources	Permit to Mine, EIS	
Socioeconomics	Permit to Mine, EIS	
Reclamation, Closure, Post Closure and Financial Assurance	Permit to Mine, EIS	
Cumulative Effects	EIS	

*Table 2. This lists the requirements needed to obtain a Permit to Mine—MDNR's umbrella permit that regulates all aspects of a mining project. *The National Pollutant Discharge Elimination System (NPDES) permit required under the federal Clean Water Act governs discharges to surface water. MPCA has primacy for administering this federal permit program in Minnesota. ** The USACE also has jurisdiction over permitting impacts to wetlands pursuant to Section 404 of the federal Clean Water Act.*

Section VII. A.2: MDNR's and MPCA's Permitting Processes Have Unparalleled Public Involvement and Transparency

Public involvement is a critically important component of the MEPA and NEPA processes, starting with public scoping at the beginning of the processes. During this process, the public can inform regulators about their concerns regarding how a project might impact them and the environment and discuss the issues they believe need to be evaluated in an EIS. Throughout the MEPA and NEPA processes, state and federal regulators consider public comments to identify alternatives and potential mitigation measures that would avoid or minimize environmental impacts. The public is given numerous additional opportunities to provide comments on the draft and final EIS documents. The agencies hold public meetings to receive comments on the document and also have public comment periods during which the public can submit written comments.

MDNR and MPCA have taken extraordinary measures to provide the public with online access to all of the NorthMet permit applications, environmental studies, the Draft and Final EIS, and other permit and technical documents. Both agencies have developed websites specifically devoted to the NorthMet Project that give the public easy and comprehensive access to information about the proposed project.[117]

Although permit documents and environmental studies for proposed mining projects in other jurisdictions are public documents, the ease with which Minnesotans can obtain electronic copies of the many hundreds of documents pertaining to the NorthMet Project is truly impressive, making Minnesota's permitting process one of the most publicly accessible and transparent permitting processes in the United States. Commissioner Landwehr recently noted: "We have gone to unprecedented lengths to do our work as thoroughly and transparently as possible, including posting applications and technical reports online in real time and providing for public comment—even when not required by law."[118]

Section VII. A.3: Minnesota's Mining Regulations Provide Comprehensive Environmental Protection During and After Mining

As is evident from Table 2, the Permit to Mine is MDNR's umbrella permit that regulates all aspects of a mining project. MPCA's permits establish stringent and enforceable standards for discharging pollutants into surface water, groundwater, and the air. They also regulate the storage and disposal of solid and hazardous wastes and the use of hazardous materials. MPCA's regulatory permitting requirements are reflected in the environmental analysis presented in the EIS and are coordinated with MDNR's Permit to Mine.

The length of the permit documents for PolyMet's proposed NorthMet Project provides a useful quantification of the amount of information and the level of detail presented in the Permit to Mine application and in the EIS. According to PolyMet, the Company's August 2016 Permit to Mine application is over 15,000 pages long.[119] PolyMet submitted a Revised Permit to Mine application in December 2017 that incorporates the technical data and analyses in the 2015 EIS, which is a 4,194 page document as downloaded from MDNR's website.[120] The November 2015 Final EIS that MDNR, the U.S. Army Corps of Engineers, and the U.S. Forest Service prepared to evaluate the proposed NorthMet Project is 3,576 pages long.[121] These agencies also prepared an October 2009 Draft EIS that was over 1,600 pages long and a December 2013 Supplemental Draft EIS that was 2,169 pages.[122]

Section VII. A.4: There is No Blueprint—Permitting a Mine is Not a One-Size-Fits-All Exercise

Part 6132.0200 explicitly recognizes "the unique character and the extreme diversity of the types and sizes of operations" and the importance of site-specific information in evaluating a mine permit application. The requirement to focus on site-specific information is a key element of Minnesota's mining regulations. In response to this requirement, mining companies must submit detailed environmental, technical, geological, and engineering data in their Permit to Mine and other applications for a proposed mining project.

MDNR conducts a detailed and expert review of the information in a Permit to Mine application, incorporating the findings of the EIS process, and obtaining advice from third-party experts. If this analysis concludes that the proposed mining project will comply with all regulatory requirements, the resulting MDNR permit will stipulate custom-tailored requirements dictating how the mine must be designed, built, operated, closed, and reclaimed to ensure the mine will protect the environment.

Mine opponents typically overlook the site-specific nature of MDNR's environmental analysis and permitting process and instead take a one-size-fits-all approach based on the false premise that problems

Table 3 Part 6132.2000 Subpart 3 Siting Criteria Prohibiting and Restricting Mining	
Areas Where Mining is Prohibited or Restricted	Minimum Buffer Zone
Boundary Waters Canoe Area Wilderness (BWCAW)	Complete prohibition – no allowable buffer zone in the BWCAW Mineral Management Corridor, shown on the MDNR map of the BWCAW Mineral Management Corridor
Voyagers National Park	Within one-fourth mile
State wilderness areas	Within one-fourth mile
Agassiz and Tamarac National Wilderness Areas	Within one-fourth mile
Pipestone and Grand Portage National Monuments	Within one-fourth mile
State scientific and natural areas	Within one-fourth mile
State peatland scientific and natural areas	Within one-fourth mile
A calcareous fen	Within one-fourth mile
A state park	Within one-fourth mile
Sites on the National Register of Historic Places	No allowable buffer zone
Sites on the Registry of State Historic Sites	No allowable buffer zone
National Wild, Scenic or Recreational Rivers and State Wild, Scenic or Recreational Rivers	No allowable buffer zone; underground mining may be allowed if it complies with management plans
Lake Superior North Shore Management Plan Area	No allowable buffer zone
Occupied dwellings, public schools, churches, public institutions, and county or municipal parks	500 feet unless owner waives this restriction
Cemeteries, and the outside right-of-way line of a public roadway	100 feet

Table 3. Despite the fixed location of mineral deposits, Table 3 lists the areas where mining is prohibited or restricted and the minimum buffer zones applicable to these areas.

at mines elsewhere with completely different geology and site conditions will happen in Minnesota. Their opposition largely ignores MDNR's meticulous analysis of site-specific factors in its deliberations about a Permit to Mine application. In an attempt to influence public opinion, mine opponents are using irrelevant examples of problems at other sites, many of which are historic problems that occurred decades before the enactment of modern environmental protection regulations.

Section VII. B: MDNR's Regulations Put Environmentally Sensitive Areas Off-Limits to Mining

A fundamental principle about mineral deposits is that they only occur at fixed locations where favorable geologic processes resulted in the formation of a valuable mineral deposit. Consequently, mineral deposits are rare, hard to discover, and expensive to develop. Because mineral deposits cannot be moved, the mine must be developed at the specific place where the valuable minerals have been discovered.

Despite the fixed location of mineral deposits, Part 6132.2000 Subpart 2 designates many environmentally sensitive areas as unsuitable for mine development and puts these special areas off-limits to mineral exploration and mine development. Table 3 describes Part 6132.2000 Subpart 3 which lists the areas where mining is prohibited or restricted and the minimum buffer zones applicable to these areas.

Part 6132.2000 Subpart 4 creates *de facto* no-impact restrictions on mining within national wildlife refuges, national waterfowl production areas, on national trails, within state designated trails, in peatlands identified as peatland watershed protection areas, and within certain public waters and adjoining shorelines that have not been created or substantially altered by human activities. Mining is only allowed in these areas if there are no other feasible locations for project facilities and the project proponent can demonstrate compliance with the no-impact standard, or the impacts can be substantially mitigated:

> Mining shall be conducted…only if there is no prudent and feasible siting alternative. If mining is proposed, the commissioner shall base siting approval decisions on the specific characteristics and qualities of the natural resources for which the area has been designated, and the potential impacts that are likely to result. Mining shall be allowed only if there will be either no adverse impacts on the natural resources, or provisions acceptable to the commissioner are proposed to either mitigate adverse effects, or replace, reroute,

or in some other manner reclaim the affected natural resources.

Section VII. C: Stringent Siting Criteria Protect the Environment and Public Safety

Depending upon site-specific factors such as topography, land ownership, and engineering constraints, there may be some flexibility on where it is economically and technically feasible to locate the mineral processing, waste storage, and other mine support facilities. Minnesota's mine siting criteria are based on the following goal:

> Mining shall be conducted on sites that minimize adverse impacts on natural resources and the public. Separations shall be maintained between mining areas and adjacent conflicting land uses. All sites shall incorporate setbacks or separations that are needed to comply with air, water, and noise pollution standards; local land use regulations; and requirements of other appropriate authorities. (Part 6132.2000 Subpart 1)

A detailed evaluation of alternative locations for site facilities is a key element of Minnesota's environmental review process for proposed mining projects. Part 6132.2100 regulations establish specific siting, design, construction, and maintenance criteria that require "a mining operation [to be] compatible with surrounding non-mining uses." (Part 6132.2100 Subpart 1) Mining facilities must use existing terrain, vegetation, or revegetated berms to diminish impacts and comply with the buffer zones shown in Table 2 around existing dwellings, schools, churches, public institutions, county or municipal parks, cemeteries, and public roadways. (Part 6123.2100 Subpart 2)

Depending on site-specific factors, at some projects more than one location may be feasible for mine facilities such as storage piles, tailings basins, water reservoirs, processing plants, offices, roads, and auxiliary facilities. Part 6132.2000 Subpart 5 establishes general siting criteria for these facilities. To the extent practicable, facilities must:

- Minimize impacts on the public and to natural resources due to wind erosion, noise, and air emissions;
- Minimize potential injury to life and property damage due to flooding, caving, or slope failures;
- Minimize major modifications of watersheds including surface water diversions and changes to groundwater levels;
- Manage runoff and seepage to minimize impacts to surface water and groundwater;
- Minimize conflicts with historical heritage sites; and
- Preferentially use previously mined areas instead of creating new surface disturbance.

Section VII. D: MDNR's Regulations Establish Rigorous Mine Waste Characterization Requirements

Section VII. D.1: State-of-the Art Waste Characterization Tests Required for Mined Materials

The ore deposits in the Duluth Complex contain sulfide minerals that have the potential to generate acidic runoff if mined materials are not properly managed. Much of the current debate about the NorthMet and TMM Projects focuses on acid generation and concerns that acid mine drainage will contaminate area streams and groundwater aquifers if these mines are developed. As explained below, Minnesota's regulations place special emphasis on determining a project's acid generating potential and preventing impacts from acid generation.

The Chapter 6132 Regulations include specific parts dealing with Mine Waste Characterization and Reactive Mine Waste (Parts 6132.1000 and 6132.2000, respectively). The Chapter 6132 Regulations define "Reactive Mine Waste" to mean "waste that is shown through characterization studies to release substances that adversely impact natural resources." (Part 6132.0100 Subpart 28) In other words, Minnesota regulations classify acid generating mine wastes as Reactive Mine Waste.

The mine waste characterization requirements establish a detailed protocol that mining companies must follow in planning and conducting specific mineralogical and petrological studies, chemical analyses, and laboratory tests to determine if the mined materials have the potential to generate acid. Prior to conducting these tests, the project applicant must secure MDNR's approval of the planned tests and the experts and laboratories that will perform the tests. Mining companies must include the results of the mine waste characterization testing program in the Permit to Mine application for the proposed mine.

In addition to providing mine waste characterization test data with a Permit to Mine application, once a mine is in operation the mine operator must perform mine waste characterization tests throughout the life of the mine and submit the test results to MDNR with the annual report required under Part 6132.1300 Subpart 2E. Mine operators must also provide these results to other regulatory agencies including MPCA to verify compliance with applicable water quality and compliance monitoring standards.

Section VII. D.2: Reactive Mine Waste Requirements Provide Extra Environmental Safeguards

The provisions in Chapter 6132.2200 pertaining to Reactive Mine Waste distinguish Minnesota's regulations from counterpart regulations in other mining states. Although all states require the proper management of mine wastes, the specific section on Reactive Mine Waste in Minnesota's regulations categorically requires mine operators to *prevent* the release of contaminants from acid generating mine wastes: "Reactive mine wastes shall be mined, disposed of, and reclaimed to prevent the release of substances that result in the adverse impacts on natural resources." (Part 6132.2000 Subpart 1) Minnesota's explicit requirement to prevent impacts from acid generation is one of the most rigorous standards in the country. The Reactive Mine Waste provision in Part 6132.2200 augments the requirements dictating the design, operation, and closure of mine waste facilities like tailings basins and storage piles in other sections of the Chapter 6132 Regulations.

Part 6132.2200 requires mining companies to engage a Minnesota-registered Professional Engineer who has expertise in designing, constructing, operating, and reclaiming facilities that will store reactive mine wastes. Reactive Mine Waste facilities must be designed to meet one of the following Part 6132.2200 Subpart 2 criteria:

- To modify the physical or chemical characteristics of the mine waste such that the waste is no longer reactive; or
- To store the mine waste such that it is no longer reactive; or
- To permanently prevent substantially all water from moving through or over the mine waste and provide for the collection and disposal of any remaining residual waters that drain from the mine waste in compliance with federal and state standards.

Mining companies are required to adhere to strict operating guidelines during the life of Reactive Mine Waste storage facilities that include frequent inspection and monitoring during operation of the mine and for many years after the mine is closed. As discussed in Section VII. G, regulatory inspection and project monitoring verify the mine facilities are operating as designed and in compliance with all of the stipulations in the project permits.

Section VII. D.3: Minnesota Regulators are World-Class Authorities on Reactive Mine Wastes

Another aspect of MDNR's mining regulatory program that differentiates it from other states' programs is MDNR's unparalleled acid mine drainage expertise. MDNR regulators have studied the Duluth Complex for over 40 years, making them world-recognized experts in evaluating the acid generating potential of these mineral deposits. The longevity of this research sets MDNR's work apart from the tests performed in other states for most mines which typically last for months—not years. The multi-year—and even multi-decade—MDNR tests provide considerably more data and a much higher level of confidence in MDNR's acid generation test results compared to test results for mines in other jurisdictions. In fact, a test of Duluth Complex materials is one of the longest tests ever performed anywhere in the world to determine acid generation potential, lasting for a record-setting 24 years.

In evaluating the caliber of Minnesota's mining regulatory program, Minnesotans should recognize MDNR's unmatched expertise in evaluating the acid generating potential of rocks to be mined from proposed Duluth Complex projects. Based on this expertise, Minnesotans can place considerable confidence in MDNR's requirements for managing acid generating (i.e., reactive mine wastes) at proposed mining projects.

Section VII. E: Strict Design, Operating, and Reclamation Requirements Govern Mine Facilities

In addition to the Part 6132.2200 design and operating requirements for Reactive Mine Waste, the Chapter 6132 Regulations include specific design, operating, and reclamation requirements for open pit mines (Part 6132.2300), storage piles (Part 6132.2400), tailings basins (Part 6132.2500), and heap and dump leaching facilities (Part 6132.2600). The requirements for open pit mines and storage piles focus primarily on design criteria to facilitate and enhance reclamation of these features.

Section VII. E.1: Detailed Design, Operating, and Closure Requirements for Tailings Basins

The tailings basin provisions require these facilities to "be designed, constructed, and operated to be structurally sound, control air emissions, minimize hydrologic impacts, promote progressive reclamation, and enhance the survival and propagation of vegetation."[123] (Part 6132.250 Subpart 1) Project proponents seeking to build a tailings basin must engage a Minnesota-registered Professional Engineer with expertise in designing, constructing, operating, and reclaiming tailings basins. The tailings basin portion of the Permit to Mine application must include the following detailed information:

- A site alternatives study that evaluates the feasibility of various locations for the tailings basin and documentation that the selected site is a safe and suitable location for a dam to be constructed;
- Detailed operating parameters and limits to ensure protection of natural resources in the vicinity of the tailings basin;
- A reclamation plan for the tailings basin that details how the facility will be reclaimed and managed following mine closure;
- A monitoring plan that shows the location of monitoring stations such as downgradient groundwater monitoring wells and piezometers to measure the water levels in the dam to verify the tailings basin embankment is operating as designed; and
- An inspection program that provides for operator and regulator inspections throughout the entire mining lifecycle from construction to closure and post-closure.

Section VII. E.2: Special Regulations Govern Tailings Dams and Require Maintenance in Perpetuity

In addition to the Chapter 6132 Regulations for tailings basins, a second MDNR regulatory program (Parts 6115.0300–0520) governs dam safety and establishes minimum standards and criteria for dam classification and regulation to protect public health, safety, and welfare. Minnesota's dam safety program includes requirements for the construction, operation, maintenance, and closure of the tailings embankment (i.e., the dam) and any future repairs or modifications to this structure. MDNR's Dam Safety Unit of the Division of Ecological and Water Resources (EWR) administers the dam safety regulations. The dam safety regulations cover the initial permitting of the dam structure and require regulatory oversight throughout the life of the dam to ensure its structural integrity and to verify that the dam is being properly maintained and functioning as designed.

Part 6115.0390 requires dam owners to maintain the integrity of the dam in perpetuity. Accordingly, the dam owner must guarantee it has the financial resources to perform perpetual maintenance of the dam structure. Part 6115.0390 Subpart 3 requires dam owners to submit plans for the planned termination of operation of the dam and for perpetual maintenance. These plans must also cover an unanticipated or premature termination of operations. The termination and perpetual maintenance plans must address the following issues:

- Perpetual maintenance and safety of the dam including adequate monitoring programs;
- Disposal and treatment of ponded and channeled waters;
- Monitoring and mitigation of surface water and groundwater pollution;
- Silt, sedimentation, and erosion control; and
- Vegetation and landscaping.

Section VII. F: Financial Assurance Protects Minnesota Taxpayers During and After Mining

Section VII. F.1: Financial Assurance Functions as an Insurance Policy for Minnesota Taxpayers

Minnesota's financial assurance regulations require mine operators to provide funds to guarantee that the mine and all related features, including tailings basins, will be properly reclaimed and closed if mining operations are unexpectedly or prematurely terminated or if mine closure is required for any reason at any time during the life of the project. Mine operators can use several kinds of financial instruments including surety bonds, letters of credit from qualified entities, and cash to satisfy Minnesota's financial assurance requirements.

As described in Part 6123.1200 Subpart 1, the fundamental premise of Minnesota's financial assurance regulations is to guarantee that Minnesota regulators have ready access to funds if an operator fails to close and reclaim the mine and MDNR needs to hire third-party contractors to close and reclaim the mine site: "The purpose of financial assurance is to ensure that there is a source of funds to be used by the commissioner if the permittee fails to perform." In other words, financial assurance acts like an insurance policy that eliminates risks to the state, Minnesota taxpayers, and the environment that a mine will not be properly closed and reclaimed.

Section VII. F.2: Minnesota's Financial Assurance Program is Bankruptcy Proof

Under normal circumstances, mining companies use corporate resources, including project personnel and equipment, to close and reclaim a mine once mining is complete. Once the mine has been closed and reclaimed to meet all regulatory requirements, regulators will release the financial assurance. Thus, mining companies have a compelling business incentive to complete the reclamation and closure work in order to secure release of the financial assurance instruments and eliminate the reclamation and closure obligations that financial reporting regulations require to be shown as a liability on the company's balance sheet.

However, in the event the mine owner goes bankrupt or fails to comply with the reclamation obligations in the project permits, Minnesota's financial assurance program provides MDNR with company-paid funds so MDNR can hire third-party contractors to perform the reclamation and closure work instead of the mine owner. Part 6123.1200 Subpart 5 explicitly states that the financial assurance instruments must be fully valid, binding, and enforceable under state laws. Additionally, these instruments cannot be dischargeable through bankruptcy. As such, MDNR has bankruptcy-proof financial assurance that guarantees that Minnesota mines will be properly closed and reclaimed with no expenditure of public resources.

Section VII. F.3: Annual Financial Assurance Reviews Keep Pace with Inflation and Project Development

During project permitting, before issuance of mine permits, Minnesota mining companies must provide a Contingency Reclamation Cost Estimate of the reclamation and closure costs if the mine closes (i.e., fails) within the first year of operation. (Part 6123.1200

Subpart 2) In December 2017, PolyMet provided an updated Permit to Mine application to MDNR that included a $75 million financial assurance estimate for the first two years of construction comprised of $65 million in financial assurance instruments (letters of credit, surety bonds, etc.) and $10 million in cash to be held in trust by the state.[124]

Once a mine is in operation, the operator must provide MDNR with annual Contingency Reclamation Cost Estimates to provide funds for reclaiming and closing the mine facilities that are planned to be operating in each upcoming year. (Part 1632.1300 Subpart 4) Because the Contingency Reclamation Cost Estimate must be calculated using the current value of the dollar, the resulting cost estimate is annually adjusted for inflation and accurately reflects the third-party contractor costs that MDNR would incur if it had to hire third-party contractors to reclaim and close the mine. The annual Contingency Reclamation Cost Estimate also includes the costs to reclaim any new surface disturbance that is projected to be created or facilities that are planned to be built during the coming year as project development proceeds.

MDNR's annual review of the amount and type of financial instruments is an important and beneficial element of Minnesota's financial assurance program. Based on this review, the financial assurance amounts are adjusted to reflect actual and recent operating data, rather than long-term models or predictions. Consequently, a project's financial assurance requirements are based in real-time using a site-specific assessment of the financial resources the State would need if it had to step in suddenly and reclaim the facilities during the upcoming year.

The financial assurance calculations in PolyMet's Permit to Mine application illustrate the substantial level of financial assurance that a mine operator must provide. MDNR is currently evaluating PolyMet's $544 million Contingency Reclamation Cost Estimate for the first year of mining. According to PolyMet, this amount represents the costs for the state to perform the closure and reclamation activities, including long-term water treatment, to meet current federal and state environmental standards if PolyMet is unable to perform the work.[125]

Section VII. F.4: Requirement to Provide Financial Assurance to Clean Up Identified Problems Distinguishes Minnesota's Program from Other States

Although other mining states have robust mining financial assurance programs that govern the mining lifecycle from operations through closure and post-closure, Minnesota's financial assurance regulations include unique requirements that provide additional safeguards at Minnesota mines. In addition to providing financial assurance during and after mining, Minnesota mine operators must also provide financial assurance to cover the cost of any corrective action that MDNR determines is necessary to remediate an identified problem.

The explicit requirement for Minnesota mine operators to provide financial assurance to cover the costs of corrective actions to respond to an environmental problem is another component of Minnesota's financial assurance program that guarantees Minnesota taxpayers will not have to pay for an environmental cleanup if a problem occurs. In the event MDNR determines there may be an environmental problem that requires corrective action (i.e., remediation or cleanup), Part 6132.1200 Subpart 3 stipulates the mine operator must furnish a corrective action plan, calculate the costs for MDNR to implement the plan, provide additional financial assurance to cover these costs, and submit annual updates documenting the status of the corrective action and the remaining costs to complete the corrective action plan.

By connecting the corrective action plan costs to the financial assurance program, Minnesota's mine regulatory program gives MDNR clear and comprehensive authority to require mine operators to provide MDNR with additional financial assurance. This additional financial assurance ensures MDNR will have sufficient resources to hire contractors to reclaim and close a mine and to perform any necessary corrective actions. Thus, in the event a mining company fails to implement a necessary corrective action plan or reclaim the mine site, Minnesota taxpayers are not on the hook for the costs to do this work. State regulators can use the financial assurance instruments to reclaim the site and clean up any environmental problems.

Section VII. G: Monitoring, Inspections, and Enforcement

Section VII. G.1: Project Monitoring Provides Regulators with Real-Time Information

Reviewing mine permit applications and issuing permits for projects that can meet all regulatory requirements is just the beginning of Minnesota regulators' involvement with mining operations. MDNR and MPCA have ongoing responsibilities for verifying that a mine is complying with all of the environmental protection measures and standards established in the project permits throughout the life of the mine and for many years after the mine has closed. These regulatory agencies use the extensive monitoring data that mine operators are required to collect to determine whether the mine is satisfying all requirements. (See Section V. B.5 for a discussion of environmental monitoring systems at modern mines.) Minnesota regulators also conduct frequent inspections of operating mines as required by Part 6132.5200 to provide direct observations of the operating, environmental, and health and safety conditions at the mine.

The MDNR and MPCA permits for a mining project will stipulate numerous monitoring requirements that compel the mine operator to collect samples at specific locations on an established schedule using scientifically-vetted sample collection protocols. For example, samples collected from downgradient groundwater quality monitoring wells and surface water quality monitoring stations will be subject to strict chain-of-custody procedures to document that the samples have been collected and handled properly and that no one has tampered with them during transportation to third-party, certified laboratory testing facilities.

At the laboratory, the samples will be analyzed for numerous water quality parameters including, but not limited to: sulfate, chloride, fluoride, copper, nickel, iron, lead, zinc, arsenic, mercury, cobalt, chromium, selenium, and total dissolved solids. MDNR and MPCA will compare the sample results with the environmental protection standards specified in the project's permits. As an additional safeguard, the environmental monitoring program will include indicator monitoring sites located between the project facilities and the downgradient project boundary to provide early detection of a possible problem, so the mine operator and state regulators can investigate immediately and take appropriate actions.

The sampling requirements apply to all environmental media (e.g., water resources, air quality, wetlands, etc.) in and near the site. The project monitoring plan will stipulate that some project facilities will have to be monitored and sampled on a daily basis; others will require weekly, monthly, or quarterly sampling. Specific facilities and equipment may need to be monitored on a continuous (24/7) basis. Examples of the project permits that require monitoring and sampling include the MDNR Permit to Mine, the MDNR Dam Safety Permit, the MPCA NPDES Permit, and the MPCA Air Emissions Permit.

The project monitoring requirements cover all aspects of the environment and last throughout the project life and for many years following mine closure. Companies must provide the monitoring data results to MDNR and MPCA on a regular basis in reports that become publicly available documents. The financial assurance for the project includes the costs for state regulators to implement the monitoring plan if the operator goes bankrupt. Examples of the types of monitoring data that mine operators must collect are described in Section V. B.5.

Section VII. G.2: Monitoring Produces Timely Corrective Actions in Contrast to Prolonged and Uncorrected Environmental Problems at Historic Sites

The environmental monitoring systems and reporting requirements in the operating permits for a Minnesota mine act as real-time, early-warning systems that provide MDNR, MPCA, and the mine operator with indicators that an environmental problem may be developing. If project monitoring data indicate there may be a problem, Part 6132.1300 regulations compel the operator to investigate the potential problem and remediate any confirmed problem. Failure to comply with a corrective action order can result in permit suspension (Part 6132.4500), civil penalties (Part 6132.5100), and permit revocation (Part 6132.4600).

MDNR can also require a mine operator to modify its Permit to Mine in response to a problem pursuant to Part 6132.4300.

The timely corrective response actions triggered by project monitoring data and site inspections minimize both the degree and the duration of risk to the environment and human health and safety associated with an environmental problem. The limited amount of time that an environmental problem can go undetected and uncorrected stands in marked contrast to pre-regulation sites where environmental problems may have gone undetected for years—because monitoring was not required—and in many cases were never corrected.

The monitoring systems required in Minnesota's regulations for mining operations provide timely information about the performance of the site's environmental controls and reveal if there may be a problem that needs to be investigated and corrected straightaway. Thus, if there is a problem, the magnitude of the problem and the length of time the problem exists are limited, which significantly minimizes potential harm to the environment.

Mining critics' use of problems at historic mines ignores the monitoring requirements in Minnesota's regulations, which are specifically designed to limit the duration of an undetected or uncorrected problem at a Minnesota mine. The early detection and corrective action requirements in Minnesota's regulations provide environmental safeguards that simply never existed at historic mines where there are environmental problems that, in some cases, have never been cleaned up. Consequently, mining opponents' conflation of historic problems elsewhere with predictions of what will happen in the future in Minnesota is an exercise in distortion that is not relevant to a modern, highly regulated Minnesota mine.

Conclusions

Securing permits for a Minnesota mining project requires patience, tenacity, and an enormous commitment of corporate resources. Minnesota's rigorous mine permitting process takes years and costs hundreds of millions of dollars. For example, the permitting process for PolyMet's NorthMet Project started in 2005 and is still ongoing. TMM recently announced that the company has invested over $400 million in exploring the Maturi mineral deposit and developing technical and environmental studies.[126] Twin Metals Minnesota has made this substantial investment in advance of submitting a Permit to Mine application for the TMM Project.

Once a mining company has submitted permit applications for a proposed Minnesota mining project, state and federal regulators meticulously evaluate the application and all of the supporting engineering, technical, and environmental studies to determine whether the project can be built, operated, and closed in compliance with all state and federal environmental protection standards. This evaluation sets a very high bar. Regulators cannot approve a project if their analysis shows the project may not satisfy all requirements—or if changes to the project would avoid or minimize some environmental impacts. In such cases, regulators send the project applicant back to the drawing board to redesign or reconfigure the project so that it will achieve compliance, avoid or minimize impacts, and optimize environmental protection.

In the midst of the fierce debate about copper-nickel mining, Minnesotans would be wise to consider the detailed environmental review that Minnesota's mining regulations demand MDNR and MPCA to perform, and the regulators' technical expertise and professionalism in performing these reviews. Because the agencies' review process is transparent, with hundreds of documents readily available on MDNR's and MPCA's websites, Minnesotans who want all of the details can roll up their sleeves and dig into the facts about a proposed mining project if they want to evaluate the technical work for themselves.

In trying to sort out fact from fiction in mining opponents' shrill and alarmist statements, Minnesotans should remember that Duluth Complex mineral deposits like the NorthMet and TMM Projects have very different geologies than the copper mines elsewhere that anti-mining activists use as poster children. Because the geology of a mineral deposit directly influences the types of environmental impacts that may occur without proper engineering and environmental protection measures (as was the case at many historic, pre-regulation copper mines), comparing copper mines elsewhere to Minnesota's Duluth Complex deposits is a misleading apples-to-oranges exercise. Consequently, old, unregulated mines located in distant places, with different kinds of copper deposits, do not determine Minnesota's future. The problems at historic copper mines in other states are not relevant to MDNR's and MPCA's evaluation of the site-specific technical and environmental facts provided in a Permit to Mine or other permit applications for a proposed Duluth Complex mine.

Finally, Minnesotans should have confidence in the State's regulatory requirements, in the rigorous environmental review process, and most of all in the expertise and integrity of state regulators. Let this process work. Let regulators do their jobs diligently and fairly. The process will produce fact-based permit decisions that will either: disapprove a project that does not meet all regulatory requirements to protect the environment and public health and safety; or approve a project—*if and only if*—MDNR and MPCA conclude that the proposed project will protect the environment.

Minnesotans *can* have it all—a healthy environment and the economic benefits that developing the world-class copper-nickel mineral deposits in the Duluth Complex will bring to the state. The Mesabi Iron Range Mining District, which is already famous for its rich taconite mining history, can enjoy a prosperous future as the Duluth Complex Mining District. As Minnesota defines a new era of environmentally responsible copper-nickel mining, Minnesotans can take great pride in becoming an important domestic producer of copper, nickel, cobalt, and other Duluth Complex minerals, and reducing the nation's reliance on foreign sources of these strategic minerals. ■

Endnotes

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