A Review of Polymet DEIS and Selected Supporting Documents Related to Site Hydrologic and Wetland Issues

Paul H. Glaser, PhD

February 1, 2010

Exhibit 3
to MCEA Comments

1. Introduction

1.1 My name is Dr. Paul Glaser. I am a Senior Research Associate and Research Professor at the University of Minnesota in the Department of Geology and Geophysics. During the past 30 years I have worked extensively on groundwater-wetland interactions in Minnesota and across the entire boreal belt of Canada and Alaska. A summary of my publications and experience can be found in my attached C.V.

1.2 I have made 2 trips to the Polymet site in 2006 and 2009 to see the existing facilities, vegetation, and general environmental setting of the project areas. I have also reviewed sections 4.1 Water Resources and 4.2 Wetlands of the Draft EIS. My principal concerns regarding the Draft EIS are listed below.

2. Principal Concerns

2.1 Acid Mine Drainage

The Draft EIS (4.1-53) recognizes that waste rock from the Polymet mine could be a source for acid mine drainage (AMD). The plan to eliminate this source for AMD involves: 1) depositing the waste rock in the mine pits, 2) submerging the rock to create anoxic pore waters, and 3) applying limestone as a neutralizing agent. Although these treatments are commonly used to limit acid mine drainage elsewhere they are not always effective since exceptions have been reported in the scientific literature. First, it is now recognized that *Acidithiobacillus ferrooxidans* (formerly known as *Thiobacillus ferrooxidans*), the common bacterium responsible for pyrite oxidation and acid mine drainage, is a facultative anaerobe since it is capable of surviving and solubilizing metals under anaerobic conditions (Pronk et al. 1992). *A. ferrooxidans*, for example was the dominant bacterium in anaerobic and highly acidic (pH of 2.4) mine waters that were pumped from 2 flooded copper mines in Wales (Coupland and Johnson 2004). Second, *A. ferrooxidans* has been shown to grow and etch pyrite crystals under circumneutral conditions in laboratory cultures apparently by forming biofilms that maintain an internal environment favorable for its growth (Mielke et al. 2003). In view of these findings a degree of caution should be exercised in the Draft EIS with regard to predicting the generation of acid mine drainage by the waste rock. Specifically statements such as those listed below should be either altered or qualified to recognize that the prescribed treatments have not always been effective in preventing AMD at other locations.

Specific Examples from the DEIS that need modification include at EIS, 4.1-56, 3rd paragraph:

> After inundation, wall-rock oxidation essentially stops due to the low solubility (~10 mg/L) and the slow diffusion rate (i.e., ~1/10,000th as fast as in air) of oxygen in water, so submerged wallrock may be considered essentially **inert**.
> (emphasis added);

and DEIS, 4.1-56, last paragraph:

> Waste rock backfilled to the pit lake has a chemical effect similar to wall rock, with waste rock above the lake surface oxidizing and leaching solutes to the pit lake. When inundated by the pit lake, however, leaching stops and the submerged rock is essentially **inert** fill.
> (emphasis added).

Recommendation:

Although the measures taken with regard to waste rock disposal may limit acid mine drainage an element of uncertainty still exists with regard to the effectiveness of these measures because of the heterogeneities of the waste rock itself and the ability of the bacteria responsible for pyrite oxidation to cope with apparently unfavorable environmental conditions (e.g. anoxia and circumneutral waters). As a result a continuing monitoring plan should be designed to check for the generation of acid mine drainage within the mine pits and its seepage into surrounding areas.

References:

Coupland K, Johnson DB. 2004. Geochemistry and microbiology of an impounded subterranean acidic water body at Mynydd Parys, Anglesey, Wales Geobiology 2: 77-86.

Mielke, R.E. Pace DL, Porter T, Southam, G. 2003. A critical stage in the formation of acid mine drainage: Colonization of pyrite by Acidithiobacillus ferrooxidans under pH-neutral conditions. Geobiology 1: 81-90.

Pronk, J. T., J. C. De Bruyn, P. Bos, and J. G. Kuenen. 1992. Anaerobic growth of Thiobacillus ferrooxidans. Applied and Environmental Microbiology. 58: 2227-2230.

2.2 Treatment of AMD by wetlands

The Draft EIS (e.g. 4.1-89) proposes that wetlands could be used to treat acid mine drainage that leaks from the tailings basin and/or other sources. Although wetlands are often used to consume the acidity and immobilize metals arising from AMD they have not always been effective in other locations. Acid mine waters, for example were pumped from 2 Welsh mines and discharged into a wetland, which had little or no effect on either the acidity or metal content of these waters (Coupland and Johnson 2004). Unfortunately the term wetland covers a very wide range of ecosystems that are characterized by very different sets of physical, chemical, and biotic properties. It should therefore not be surprising that their capacity to neutralize the acidity and remove contaminants from different types of pollution sources varies depending on the type of wetland considered and its hydrogeologic setting. The natural neutralizing capacity of wetlands, within the project site, moreover, may be limited by the low carbonate content of the glacial deposits in this area that are derived from the Rainy Lobe of the Wisconsin Ice Sheet.

Recommendation:

A long-term monitoring plan is needed to test the effectiveness of the wetlands for remediation of acid mine drainage from the tailings basins and/or waste rock stockpiles. A contingency plan should also be in place in case these wetlands prove to be ineffective in treating drainage from the tailings basins since many types of wetlands have a low acid neutralizing capacity.

2.3. Perched water tables

According to the DEIS, 4.1-4:

> The Mine Site has extensive wetlands overlying the relatively thin surficial till aquifer with bedrock fairly close to the surface. Based on well logs, soil borings, and available soil mapping, the hydrology of these wetlands is characterized by a waterlogged organic soil body perched over dense clayey till or a more localized sandy surficial aquifer and represent bog wetlands (RS44, Barr 2006). Most of the wetlands are mapped as Rifle mucky peat and Greenwood peat mapping units in the Natural Resources Conservation Service soil survey system. These soils are typically characterized by fibric peat in the upper horizons underlain by mucky peat to a depth of up to five feet or more. These bogs are isolated from the underlying groundwater, receiving virtually all of their water and nutrient input from precipitation. They receive essentially no groundwater inflow and have extremely low seepage rates to the underlying surficial aquifer.

The DEIS assumes that many of the wetlands within the project area have perched water tables and are therefore isolated from groundwater flow systems. The basis for this assumption is not clear since the local hydrogeologic setting seems unfavorable for perched water tables to develop. Perched water tables develop over a relatively impermeable stratum that lies within more-permeable strata such as sand and gravel. Perching therefore is more common within deep heterogeneous glacial deposits such as terminal moraines and till plains. However, the DEIS reports that the project area has only a shallow layer of relatively impermeable glacial deposits and only localized occurrences of sand and gravel. Since the hydrologic connectivity of wetlands to groundwater flow systems has important implications for the production and transport of methyl mercury the assumption of perching should have been based on actual field data and supported fully. It should be kept in mind that hydrogeologic investigations in the extensive peatlands of the Glacial Lake Agassiz region of Minnesota and the Hudson Bay Lowland of northern Ontario provide strong evidence for the upward transport of solutes from the mineral substratum to the peat surface in fens by upwelling groundwater or transverse dispersion even where the peat is underlain by relatively impermeable silts and clays (see references in Glaser CV). References to perched water tables in the Draft EIS should therefore be either supported by actual data or eliminated from the text. Erroneous explanations for perching contained in the DEIS (e.g. DEIS, 4.2-2: "slow water movement through soils causing the perched wetland water tables") should be deleted.

Recommendation:

The hydrology of representative wetlands should be determined by monitoring nests of piezometers to determine hydraulic head gradients and profiles for pore-water chemistry and their response to precipitation and snowmelt. A longer-term monitoring plan would also be desirable to detect unexpected changes in the pore-water chemistry that can be related to acid mine drainage and the transport of contaminants from the mine pits, waste rock stockpiles, and tailings basin. It should not be assumed that the wetlands within the entire project area are isolated from solutes, such as sulfides transported by surface waters or groundwater because they are perched unless perching can be documented by actual hydrogeologic analyses.

2.4. Wetland Classification

The wetland classification was based on a generalized, largely physiognomic scheme that was not effective for characterizing wetlands within either the project area or potential mitigation sites. With respect to peatlands, this scheme failed to distinguish between bogs and fens, which have contrasting sets of physical, chemical, and biotic properties. It was therefore difficult to adequately evaluate Polymet mining impacts on peatlands within the project area or the quality of the mitigation plan.

According to the Draft EIS (4.2-3):

> The coniferous bog and open bog communities make up the majority of the wetlands at the Mine Site. Black spruce, tamarack, and balsam fir are the dominant canopy tree conifers. White cedar and deciduous swamp birch are also occasionally found in this community............Shrubs are usually ericaceous (belonging to the heath family) and/or speckled alder and raspberry. Sphagnum

moss comprises an almost continuous mat with interspersed, non-dominant forbs such as bunchberry and blue bead lily along with sedges and grasses.

However, balsam fir, white cedar, swamp birch, speckled alder, raspberry, blue bead lily, and all the grasses in Minnesota are reliable fen indicator species that are never found on true raised bogs (see papers in the Glaser C.V. and also Field Guide to the Native Plant Communities of Minnesota. The Laurentian Mixed Forest Province). The scientific literature defines raised bogs on the basis of a discrete set of physical, chemical, biotic, and hydraulic factors such as: 1) the interior of these peat landforms is higher than its margins (so the peatlands are called "raised bogs), 2) the surface waters have a pH less than 4.2 and Ca concentrations less than 2 mg/l, 3) the peatland has no fen indicator species, and 4) the peatland receives *all* its waters and salts solely from atmospheric deposition (so raised bogs are considered to be "ombrotrophic") (see Glaser CV for citations). Since the species composition provided for the bog vegetation types within the Draft EIS includes species that are clearly fen indicators, it is impossible to say that these wetlands are disconnected from groundwater or surface water flow systems as stated in this report. It is also illogical to conclude that these wetlands are "perched" since many of the wetlands in the Polymet site are probably forested or non-forested fens (or poor fens) that are supplied at least partly by surface or ground waters that have percolated through mineral soil. If these surface or groundwaters have elevated concentrations of sulfate, the wetlands could be significant sources of methyl mercury. The Draft EIS also fails to note that fens can be either forested or non-forested or that marshes are distinguished from non-forested peatlands by the absence of peat accumulation so that the vascular plants root directly into the mineral soil.

Recommendations:

The Draft EIS should be improved by using more generally accepted definitions for bogs, fens, marshes, peatlands, and other types of wetlands so that they conform to international scientific literature and also the scheme adopted by the Minnesota DNR's County Biological Survey's treatise on the native plant communities of Minnesota. It would be highly advantageous to collect samples of the surface water in the wetlands of the project areas for analysis of pH, *alkalinity, and dissolved solutes particularly Ca for help in separating bogs from fens but also for assessing the acid neutralizing capacity of these wetlands.*

2.5. Wetland Mitigation Plan

The mitigation plan was outlined in the DEIS:

DEIS 4.2-21:

> The primary goal of the wetland mitigation plan was to restore high quality wetland communities of the same type, quality, function, and value as those to be impacted by the Project to the extent practicable. To achieve that goal, state and federal guidelines were followed during the wetland mitigation planning process, with a preference placed on restoring drained wetlands over creating wetlands. The four main categories of mitigation methods considered appropriate in northern Minnesota by state and federal agencies were 1) restoration of impacted wetlands; 2) enhancement of existing wetlands and buffers; 3) wetland preservation, and 4) wetland creation.

DEIS 4.2-24:

> **Off-Site Mitigation** The initial wetland mitigation study scope focused on the areas containing greater than 80 percent of their historic wetland resources as defined in the WCA. This area was selected as the initial study area to comprehensively cover the priority mitigation areas, with the understanding that suitable opportunities may not be available within each priority area (Figure 4.2-9). Available wetland mitigation banking credits which were available for purchase by PolyMet were evaluated in portions of Bank Service Areas 1 through 6 and found to be insufficient to satisfy the compensatory mitigation requirements for this Project. Subsequently, a GIS analysis was performed to identify potential wetland mitigation sites within the defined study area (Figure 4.2-10)."

The Draft EIS needs more documentation with regard to all the sites evaluated for the mitigation plan. I realize that the report is very long and broad in scope but it was not possible to evaluate the reasons why so many nearby sites for wetland mitigation were rejected within the Saint Louis River watershed and adjacent areas. This decision weakened the mitigation plan because the closer sites have the highest probability of containing wetlands that are similar to those that will be directly impacted by the Polymet mine. At the minimum a table should be included that contains the geographic coordinates and some rationale for rejecting each of these sites. As it stands the case for selecting 2 distant sites near Aitken or Hinckley for the mitigation plans seems weak and unsupported given their distance from the Polymet site and their differences with respect to vegetation and environmental setting.

My reservations with regard to the mitigation plan are fourfold: First, the 2 sites identified for mitigation efforts have different environmental settings with respect to climate, depth to bedrock, and glacial deposits than those at the Polymet project site. Second, the wetlands selected within these sites are also probably significantly different from those of the Polymet project areas because the Aitken and Hinckley sites are located at the extreme southern fringe of the boreal and mixed-conifer hardwood peatlands of the northern portions of Minnesota. Third, geographic coordinates were not provided for all the sites evaluated for mitigation efforts so they could not be independently located with certainty and examined on Google Earth or topographic maps. Fourth, it is impossible to replace a peatland ecosystem within the lifetime of human beings since it takes centennial to millennial time scales for peatlands to form and develop into raised bogs. Fifth, I still feel that Polymet and the state of Minnesota are missing an important opportunity for restoring and protecting an exceptional complex of wetlands north of the town of Alborn in the Saint Louis River watershed that contains peatlands and wetlands very similar to those found in the Polymet site. This site was described in depth in my past report to Janette Brimmer of the MCEA and I am here enclosing digital files of its satellite image and a map of the site.

Recommendation:

In my opinion the DEIS misses an outstanding opportunity to restore and preserve an exceptional wetland complex in the Saint Louis River watershed that contains a complex of bogs, fens, and other types of wetlands similar to those at the project site and adjacent areas. In *addition, this complex just north of the town of Alborn also has the most outstanding patterned fen in northeastern MN, robust populations of several rare and endangered plant species (Carex exilis, Rhychospora fusca, Xyris montana, and Jungius stygius). The site has been previously impacted by drainage ditches and a now abandoned road, but occupies largely tax forfeit land and is relatively wild. It has a wolf pack in the vicinity and is apparently a prime wildlife habitat based on its lack of development. The land could be purchased, restored (by filling in drainage ditches) and provided to the state or county to be managed as a scientific and natural area.*